Nerve 2.5.0 Documentation

Getting started

Getting started

Nerve is an industrial edge computing platform that delivers flexibility and openness. It provides a software infrastructure for the plant floor and the cloud that enables users to access data, manage devices and deploy applications remotely. As a modular system, modules can be licensed individually or combined to deliver more functionality. Nerve is used by machine builders and plant operators at every stage of their digitalization and Industrial IoT projects.

Follow the instructions below to set up Nerve for the first time. They serve as a guideline from receiving the Nerve Device and software until Nerve is running and ready to be used.

1. Check the contents of the delivery:
   - E-mail from sales representative
   - Customer profile
   - Link to Nerve Software Center
   - *Optional: MFN 100*

> **NOTE**
>
> - The MFN 100 is only part of the delivery if acquired with Nerve software, and it comes with Nerve pre-installed, whereas third party devices need to be ordered from the manufacturers directly and Nerve needs to be installed manually.
> - If an item has not been part of the delivery, contact a sales representative or TTTech Industrial customer support at support@tttech-industrial.com.

2. Select a Nerve Device from the table below. Each device page covers device setup, Nerve software installation and setting up the node in the Management System in step-by-step instructions.

	Nerve Devices	
MFN 100	Kontron Kbox A-150-APL	Kontron Kbox A-250
Maxtang AXWL10-8665U	Siemens SIMATIC IPC427E	Siemens SIMATIC IPC127E
Supermicro SuperServer E100-9AP-IA	Supermicro SuperServer 1019D-16C-FHN13TP	Supermicro SuperServer 5029C-T
Toshiba FA2100T-700	Vecow SPC-5600-i5-8500	Winmate EACIL20

3. The system is up and running. Check out these recommended topics in the Management System next:

    - Management System overview
    Take a look here to get a grasp of the menus and features of the Management System.
    - Adding a user
    As an admin, look at how to add new users to the Management System.
    - Adding a new role
    Similar to above, if new users are created, they might need separate roles.

4. Workloads are one of the core features of Nerve. Create one with the instructions for each workload type below:

    - Provisioning a CODESYS workload
    - Provisioning a Docker workload
    - Provisioning a Virtual Machine workload

5. Created workloads are best when deployed to nodes. Deploy workloads to nodes by following the instructions below:

    - Deploying a workload

This concludes the initial setup and the introduction to the base features of the Nerve system. Take a look at the suggested topics below for a deeper dive into Nerve:

- Nerve Data Services introduction
- Remote connections
- Node internal networking
- First steps with CODESYS programming

Latest documentation updates

2022-08-01

Updated documentation to reflect version 2.5.0. Updated chapters are:

- Provisioning a CODESYS workload
- Provisioning a Docker workload
- Provisioning a Virtual Machine workload
- Managing nodes in the node tree
- Workload control
- Remote connections
- Local UI
- OPC UA Client
- OPC UA Client Output

Other updates:

- Added a features overview in the Nerve Data Services introduction.
- Improved the getting started guide.
- Updated the device guide pages of each device for clearer installation and setup instructions.
- Updated the "What's new?" section with a 2.5.0 summary.
- Improved the landing page of the documentation.
- Updated the color scheme.

2022-03-01

Updated documentation to reflect version 2.4.1. New and updated chapters are:

- Release notes for 2.4.1
- Virtual machine snapshots
- Virtual machine backups
- Node capabilities
- Virtual machine network info

Nerve Data Services updates:

- Added instructions for Grafana home dashboard and kiosk mode settings.
- Added descriptions for Kafka Consumer input.

Other updates:

- Added a real-time performance monitoring tutorial.
- Added a device guide page for the Toshiba FA2100T-700.
- Moved all tutorials to their own Tutorials section.
- Moved latest documentation updates to their own page.
- Moved everything related to workload control and workload specific features to a new workload control section.
- Added a "What's new?" section to highlight the most recent product features in a blog style post.
- Minor updates, typo corrections and improvements.

2021-09-30

Updated documentation to reflect version 2.3.1:

- Added Release Notes for 2.3.1
- Nerve Data Services: Adapted documentation for new features (Kafka Producer output, incremental data mode and custom JSON format messages for JSON outputs)
- Minor changes and improvements

Added the Security Recommendations section.
Moved the Downloads and Previous Versions sections to the footer.

2021-08-03

Completed documentation for version 2.3.0. The latest updates include:

Nerve Data Services
Data Services documentation reworked to reflect the implementation of the new GUI and the local Gateway as the single point of configuration.

- Applying a configuration through the GUI
  Added instructions on how to configure the Gateway with the graphical configuration tool.
- NerveDB with data buffering
  Added a new example demonstrating the data buffering feature and the new NerveDB.
- Nerve Data Services Database
  Added a new page for more information on the database menu item.

2021-06-16

Partial release of version 2.3.0 documentation. New and updated chapters are:

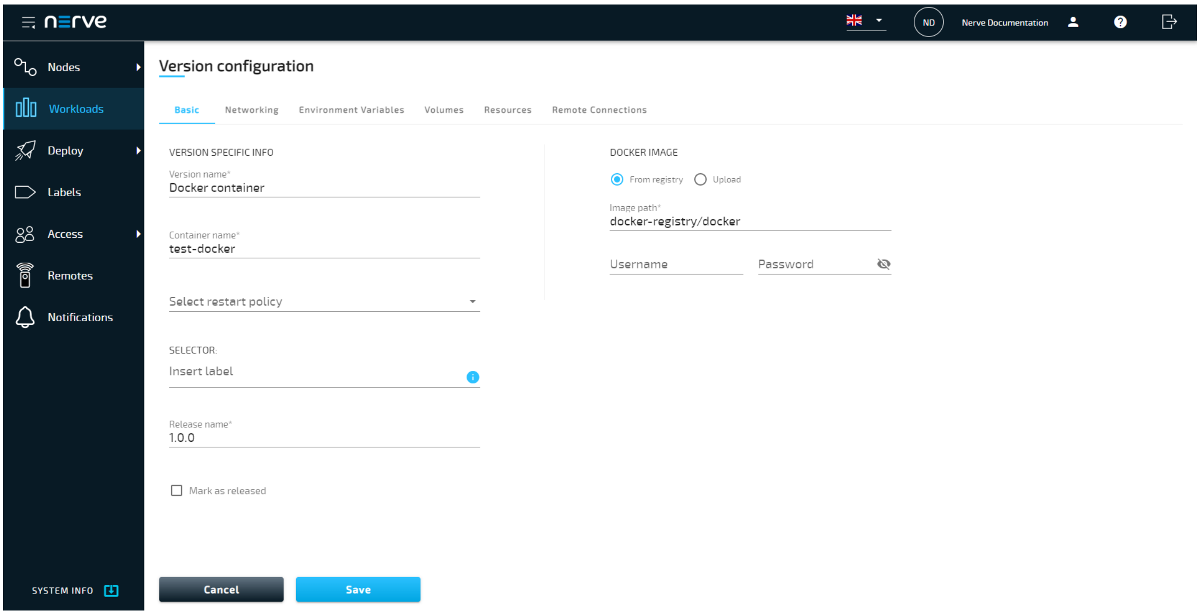
- Release Notes for 2.3.0
- Menu structure of the Management System
  Updated table with descriptions of new elements in the Management System.
- Setting system notifications
- Usage reports
- Logging and monitoring
- Managing nodes in the node tree
  Updated table with descriptions of new elements in the node details view.
- Workload control
  Updated table with descriptions of new elements in the workload control window.
- Applying configuration files to a workload
- Changing resource allocation of a deployed Virtual Machine workload
- Virtual machine video options
- Updating a deployed workload
- Local UI dashboard
  Updated table with descriptions of new elements in the Local UI.
- Workload management
  Updated table with descriptions of new elements in the workload management window.
- Updating a deployed workload in the Local UI

What is new in version 2.5.0?

This is an overview of the features and changes added in the latest version of Nerve. For an extensive list of all changes, refer to the release notes. For more details on each feature, follow the links after the feature descriptions.

Workload version configuration overhaul

The workload version configuration screens have been improved for all three workload types. Settings are now split into tabs, offering improved readability and usability. The content of the tabs depends on the workload type.



Version configuration

VERSION SPECIFIC INFO

Version name* Docker container

Container name* test-docker

Select restart policy

SELECTOR:
Insert label

Release name* 1.0.0

□ Mark as released

DOCKER IMAGE

● From registry ○ Upload

Image path* docker-registry/docker

Username

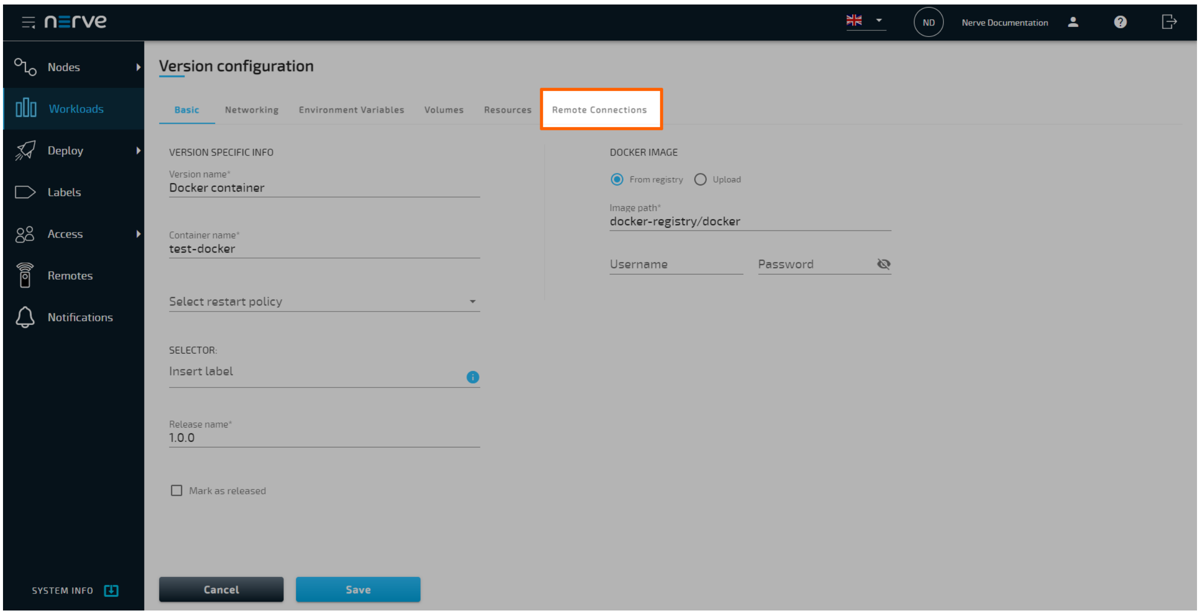
Password

Refer to the workload settings of each workload type for more information:

- Settings for CODESYS workloads
- Settings for Docker workloads
- Settings for VM workloads

Remote connections added to initial workload configuration

Remote connections can now be configured during the initial configuration of a workload. Up until this version remote connections could only be configured after the provisioning of the workload.



Version configuration

VERSION SPECIFIC INFO

Version name* Docker container

Container name* test-docker

Select restart policy

SELECTOR:
Insert label

Release name* 1.0.0

□ Mark as released

DOCKER IMAGE

● From registry ○ Upload

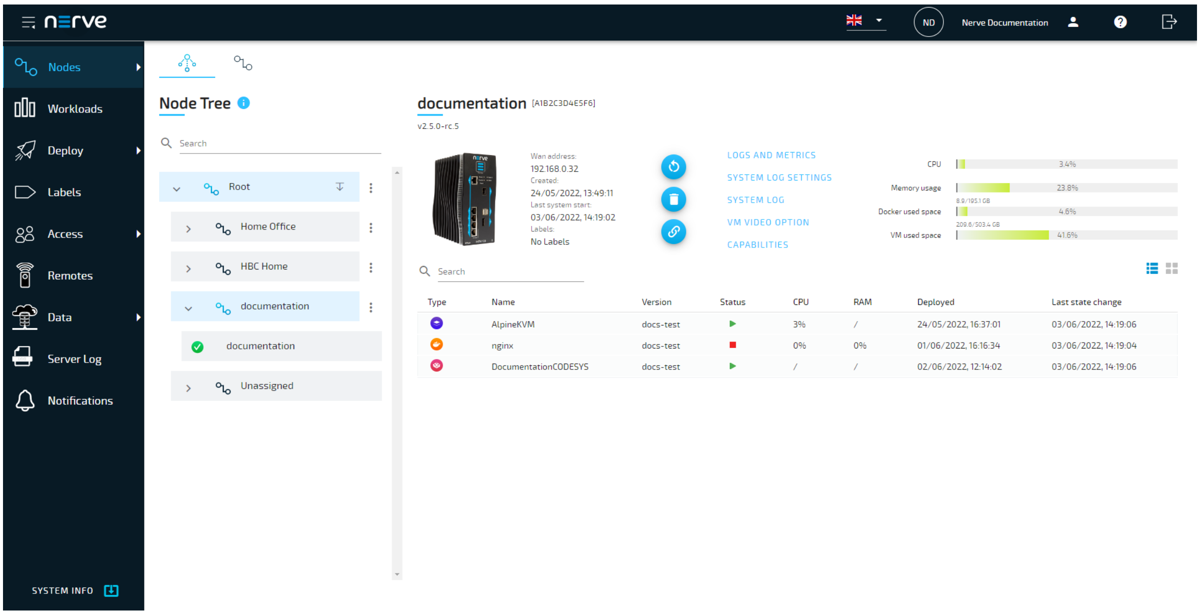
Image path* docker-registry/docker

Username

Password

Node details and table view for workloads

Buttons, graphs and information have been rearranged in the node details screen with the aim to increase readability and usability. In addition, a new view for deployed workloads on the node has been added. All deployed workloads can now be viewed in table view, offering basic information about the workload in addition. Note that the new table view is set as the default view for workloads. If desired, the tile view can be toggled with by selecting the corresponding symbol on the right side.



documentation [A1B2C3D4E5F6]

v2.5.0-rc.5

Wan address: 192.168.0.32

Created: 24/05/2022, 13:49:11

Last system start: 03/06/2022, 14:19:02

Labels: No Labels

CPU 3.4%

Memory usage 23.8%

8.9/195.1 GB

Docker used space 4.6%

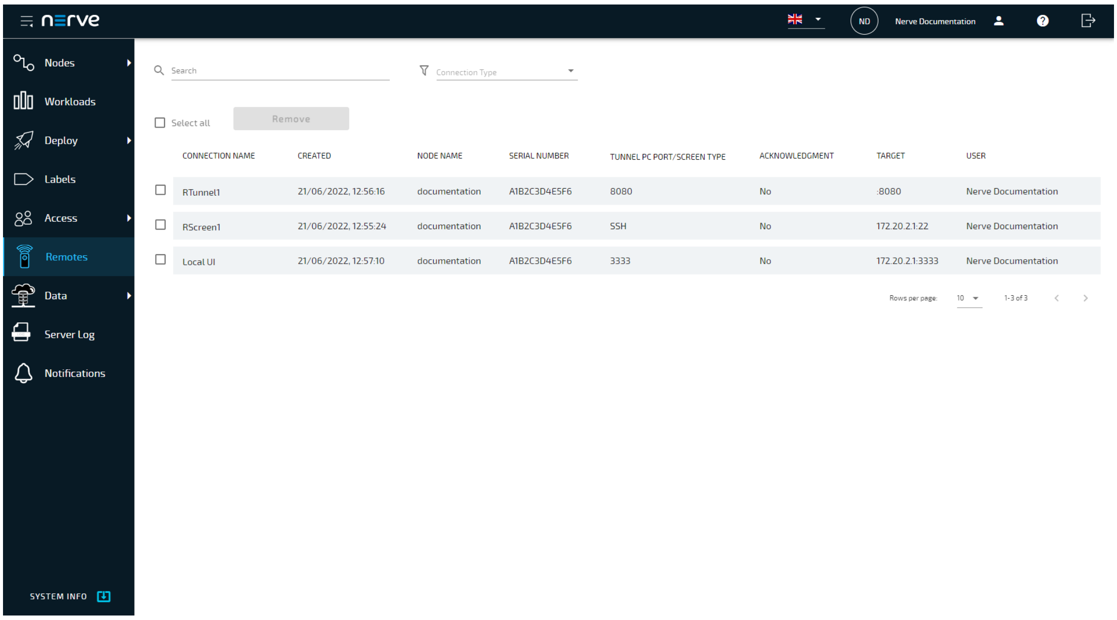
209.6/503.4 GB

VM used space 41.6%

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
●	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	03/06/2022, 14:19:06
●	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	03/06/2022, 14:19:04
●	DocumentationCODESYS	docs-test	▶	/	/	02/06/2022, 12:14:02	03/06/2022, 14:19:06

Remote connections list

The remote connection lists in the Management System and the Local UI have been improved. Extra columns with more information for each connection have been added, as well as new ways to remove remote connections from the list. Checkboxes and a remove button now make it easier to remove multiple connections at once.



□ Select all

	CONNECTION NAME	CREATED	NODE NAME	SERIAL NUMBER	TUNNEL PC PORT/SCREEN TYPE	ACKNOWLEDGMENT	TARGET	USER
□	RTunnel1	21/06/2022, 12:56:16	documentation	A1B2C3D4E5F6	8080	No	:8080	Nerve Documentation
□	RScreen1	21/06/2022, 12:55:24	documentation	A1B2C3D4E5F6	SSH	No	172.20.2.1:22	Nerve Documentation
□	Local UI	21/06/2022, 12:57:10	documentation	A1B2C3D4E5F6	3333	No	172.20.2.1:3333	Nerve Documentation

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Brute force protection

The Management System and the Local UI now have brute force login protection in place. Five failed login attempts in a row will block the user from logging in again for 1 minute in the Local UI. In the Management System, five failed login attempts in a row will block the current user from logging in again from the same IP address for 30 minutes. After a hundred failed log in attempts from one IP address, the IP address will be blocked for 24 hours.

OpenSearch

In version 2.5.0, the logging and monitoring backend has been migrated from the Elastic Stack to OpenSearch. However, there have been no changes when it comes to functionality or UI, so the features can be used as before.

Rebrowsing of the address space for OPC UA Client

Periodical rebrowsing to detect changes in the address space of an OPC UA server has been added to the OPC UA Client input of the Gateway. The time interval can be defined in the input settings.

OPC UA Client as an output

OPC UA Client has been added as a new output format to the Gateway in the Nerve Data Services.

Filtering of node IDs with regex expressions for OPC UA Client inputs.

In the Nerve Data Services Gateway, Regex expressions can be used in the node IDs field to filter node IDs when configuring a OPC UA Client input. The format is `r=<regexstring>`. This is a Nerve Data Services feature and not part of the OPC UA standard.

User Guide

User Guide

The user guide for Nerve covers the features and configurations a user has with Nerve using the two user interfaces of Nerve: the Local UI and the Management System. It is supported by the device guide that contains device specific information required for working with Nerve and the instructions in the user guide.

If there are any questions about the software installed and the features provided, contact a sales representative or TTTech Industrial customer support at support@tttech-industrial.com.

Hardware specifics

The user guide focuses on how to operate the Nerve software. As such it will not contain any device specific information. Whenever device specific information is required, the user guide will link to the device guide.

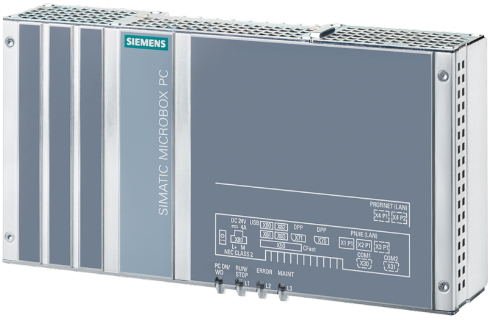
Refer to the chapter of the Nerve Device in the device guide in order to setup and install the hardware, and find out device specific information:

MFN 100

Kontron Kbox A-150-APL

Kontron Kbox A-250

Maxtang AXWL10-8665U



Siemens SIMATIC IPC427E

Siemens SIMATIC IPC127E

Supermicro SuperServer E100-9AP-IA	Supermicro SuperServer 1019D-16C-FHN13TP
Supermicro SuperServer 5029C-T	Toshiba FA2100T-700
Vecow SPC-5600-i5-8500	Winmate EACIL20

License activation

NOTE

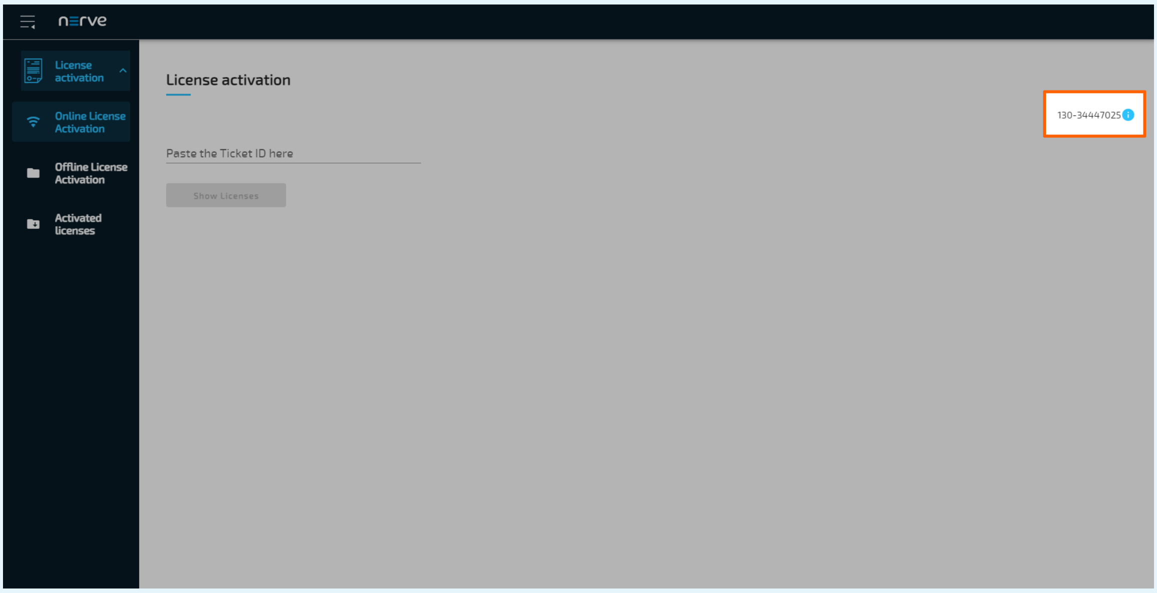
The instructions below are also valid for the activation of trial licenses, as the process is the same. However, note that the CODESYS runtime in the RTVM is running in demo mode in the trial version, meaning that the CODESYS runtime shuts off after 30 minutes and needs to be restarted again. The trial license is valid for 30 days.

The license for using Nerve has to be activated on the node before the product can be used. A ticket ID that is required for the activation of the license has been sent as part of the delivery, along with a link to a web depot. With this ticket ID and the web depot link, the product can be activated in two ways:

- **Online activation**
  The node must have access to the internet.
- **Offline activation**
  The node does not have access to the internet. Note that offline activation requires a workstation with a connection to the internet.

NOTE

Note down the license serial number on the right side. It is required to reactivate a license that has been used before.



Refer to Reusing activated licenses below for more information on how to activate the product by reusing previously activated licenses.

Make sure to connect a workstation to the physical port of the Nerve Device associated with host access and configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the host access interface with a `255.255.255.0` subnet mask. Connect a workstation to the Nerve Device and follow the link to reach the UI for activating the license. This is Nerve Device specific and is listed per Nerve Device in the table below:

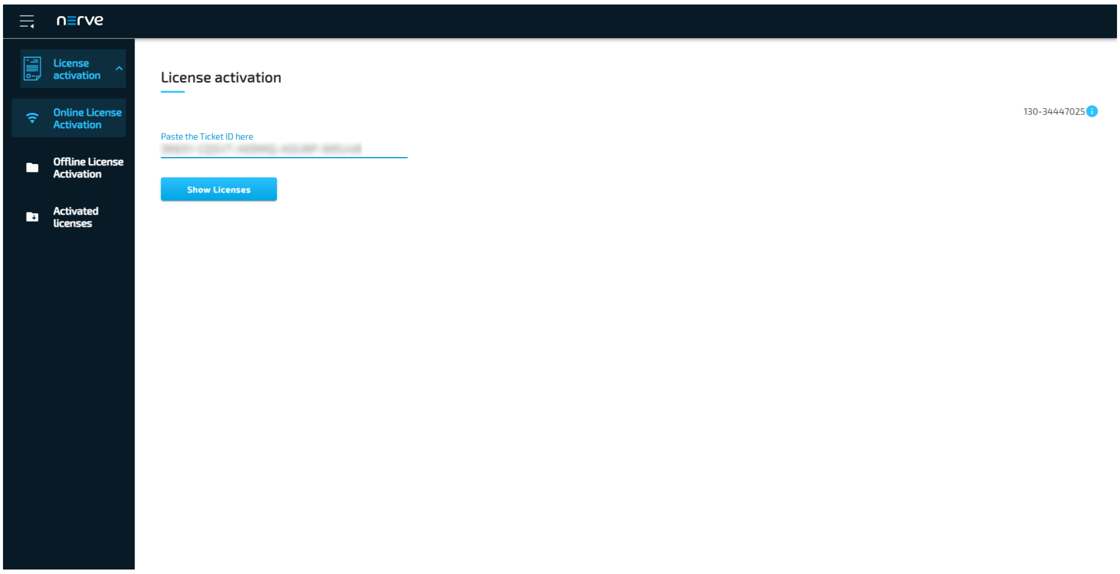
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

Online license activation

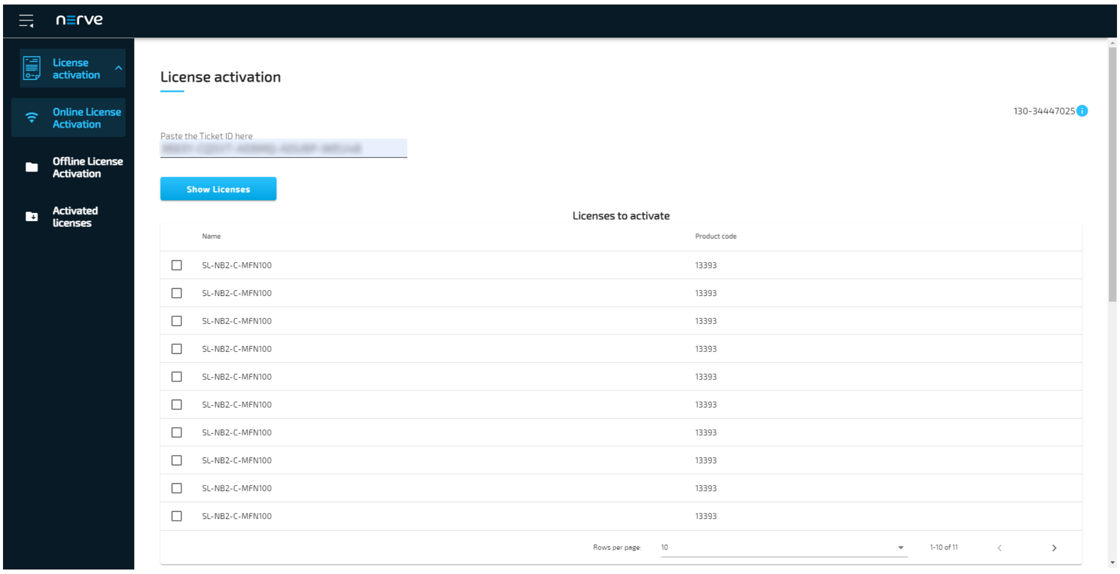
If the node has internet access, the node will automatically connect to the licensing server. Online license activation is selected in the navigation on the left by default.

1. Enter the ticket ID under **Paste the Ticket ID here**.



[redacted]

2. Select **Show Licenses**. Available licenses will appear below.



[redacted]

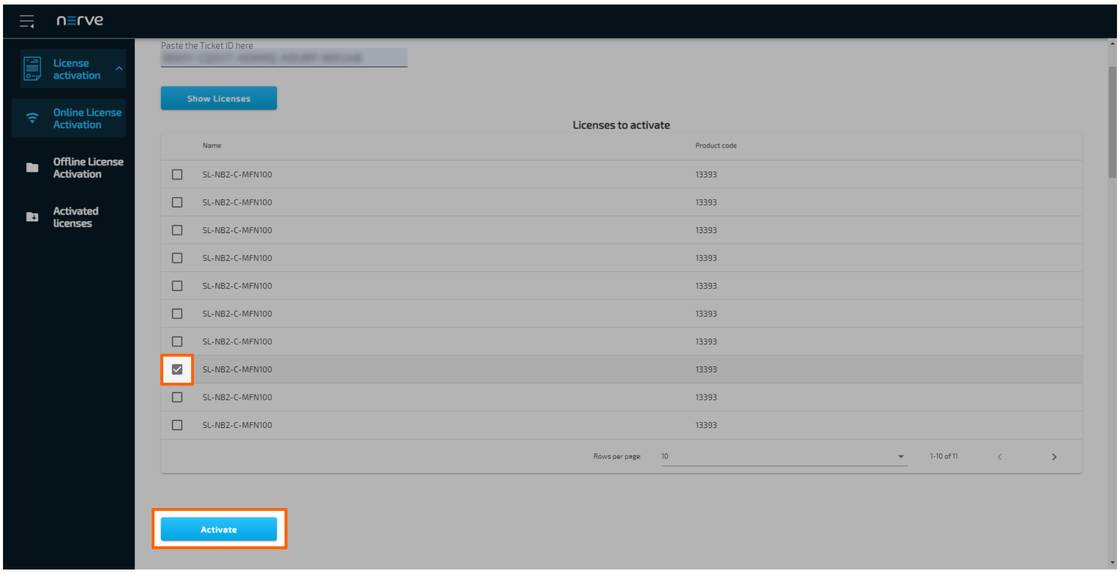
Licenses to activate

	Name	Product code
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393

Rows per page: 10 1-10 of 11

3. Tick the checkbox next to a license. The list is automatically filtered to only show licenses for the Nerve Device currently used.

4. Select **Activate** below the list of licenses.



Paste the Ticket ID here
[redacted]

Show Licenses

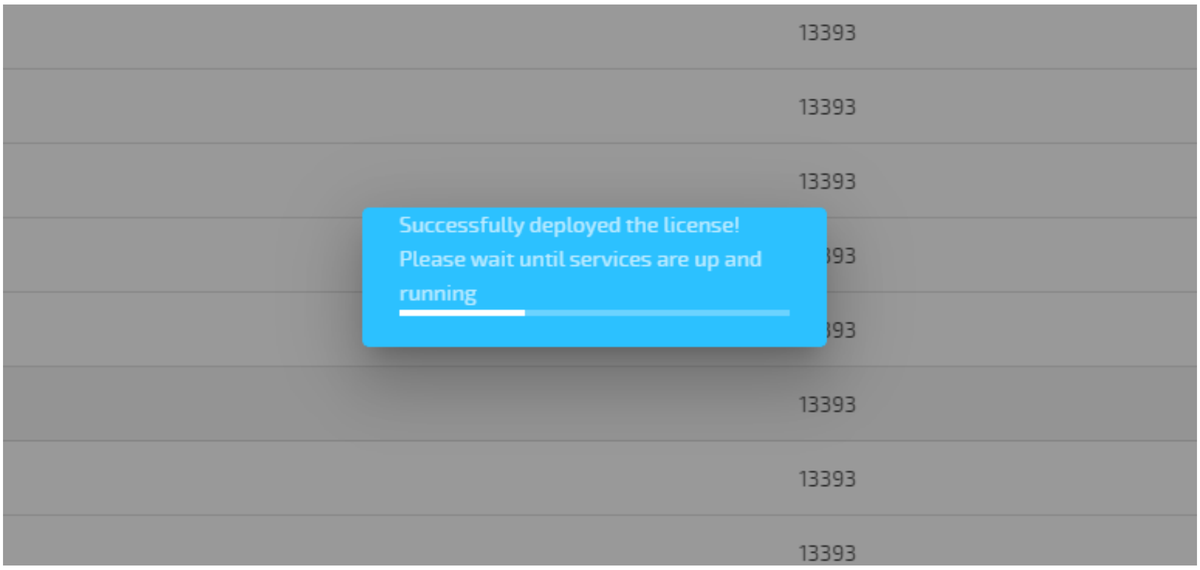
Licenses to activate

	Name	Product code
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
☑	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393

Rows per page: 10 1-10 of 11

Activate

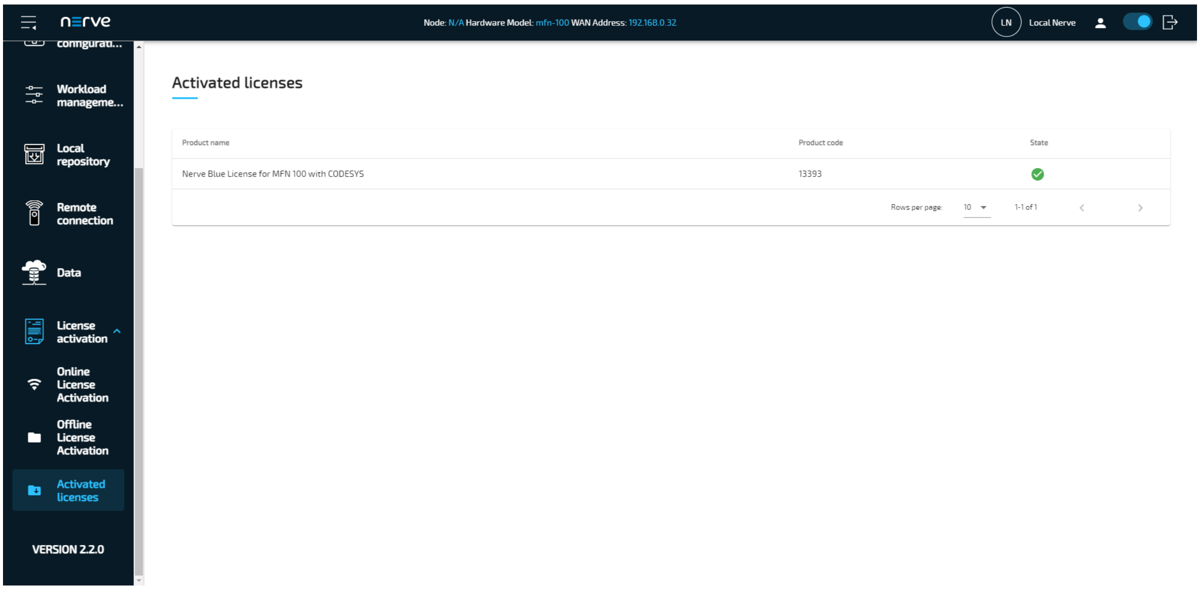
The system will proceed to activate the license and automatically redirect to the Local UI after a successful activation.


13393
13393
13393
93
93
13393
13393
13393

Successfully deployed the license! Please wait until services are up and running

> ### NOTE
>
> When using an MFN 100, the device will light up blue once the license has been activated and the necessary services are up and running.

To double-check if the license has been activated properly, expand **License activation > Activated licenses** in the navigation on the left of the Local UI. An activated license is displayed in the table with a green check mark on the right side, signifying a successful activation on the correct Nerve Device.



Activated licenses

Product name	Product code	State
Nerve Blue License for MFN 100 with CODESYS	13393	✓

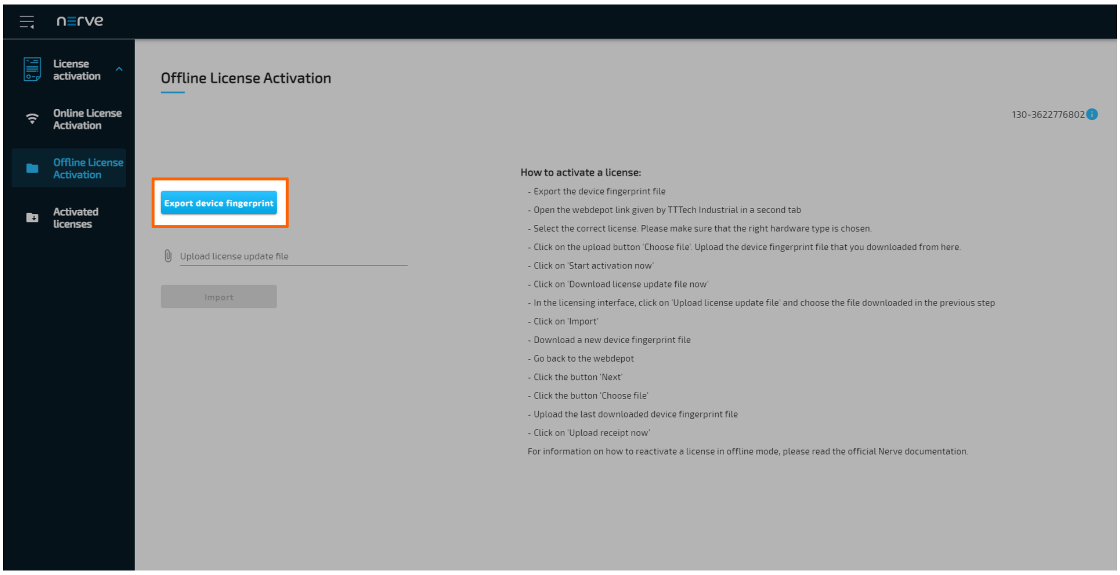
Rows per page: 10 1-1 of 1

Offline license activation

In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files.

1. Select **License activation > Offline License Activation** in the navigation on the left.

2. Select **Export device fingerprint** to download the license update file.


nerve
License activation
Online License Activation
Offline License Activation
Activated licenses
Export device fingerprint
Upload license update file
Import

Offline License Activation

130-3622776802

How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

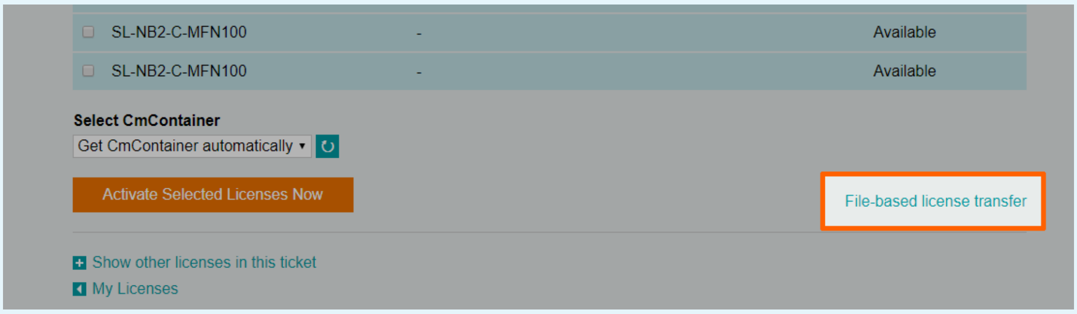
For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

3. Open a new browser tab.

4. Enter the link to the web depot. The link has been sent as part of the delivery.

NOTE

If other applications using licenses from Wibu Systems (e.g. CODESYS) are present on the workstation, the web depot will suggest activating licenses in a different way. In order to properly activate Nerve following the instructions here, select **File-based license transfer** at the bottom of the page.



□	SL-NB2-C-MFN100	-	Available
□	SL-NB2-C-MFN100	-	Available

Select CmContainer: Get CmContainer automatically ▾

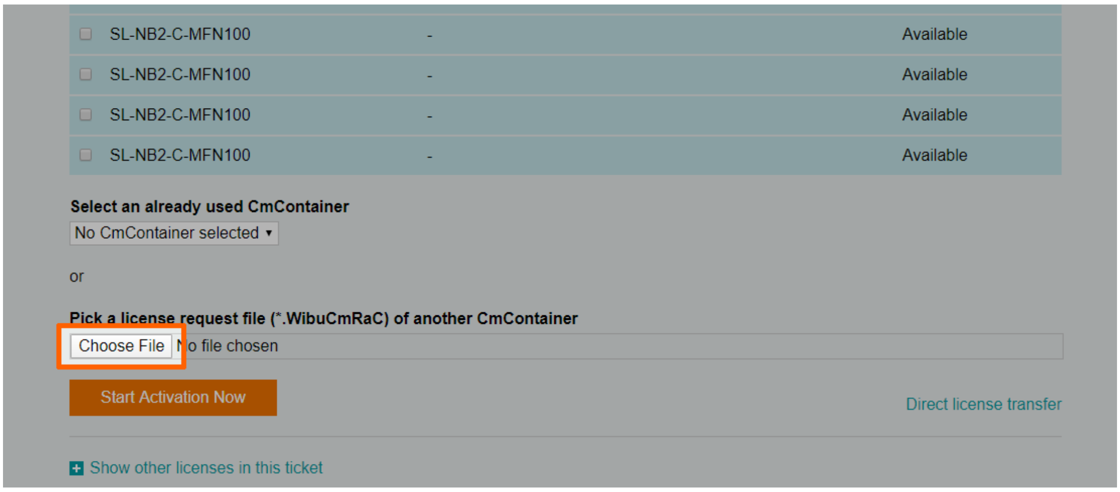
Activate Selected Licenses Now
File-based license transfer
Show other licenses in this ticket
My Licenses

5. Select a license for the appropriate Nerve Device. The license will have the device name in its name.

NOTE

Make sure to always select a single license per device. Selecting multiple licenses when activating one device will waste purchased licenses.

6. Select **Choose File** below the list of licenses under **Pick a license request file (*.WibuCmRaC) of another CmContainer** to open the file browser.



□	SL-NB2-C-MFN100	-	Available
□	SL-NB2-C-MFN100	-	Available
□	SL-NB2-C-MFN100	-	Available
□	SL-NB2-C-MFN100	-	Available

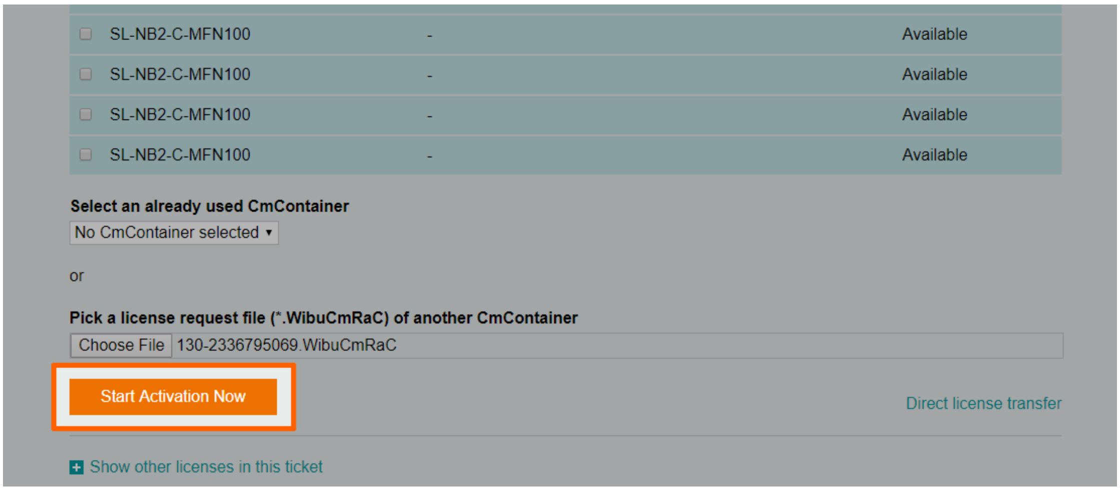
Select an already used CmContainer: No CmContainer selected ▾

or

Pick a license request file (*.WibuCmRaC) of another CmContainer: Choose File No file chosen

7. Upload the device fingerprint file that was download before.

8. Select **Start Activation Now**.



□ SL-NB2-C-MFN100	-	Available
□ SL-NB2-C-MFN100	-	Available
□ SL-NB2-C-MFN100	-	Available
□ SL-NB2-C-MFN100	-	Available

Select an already used CmContainer

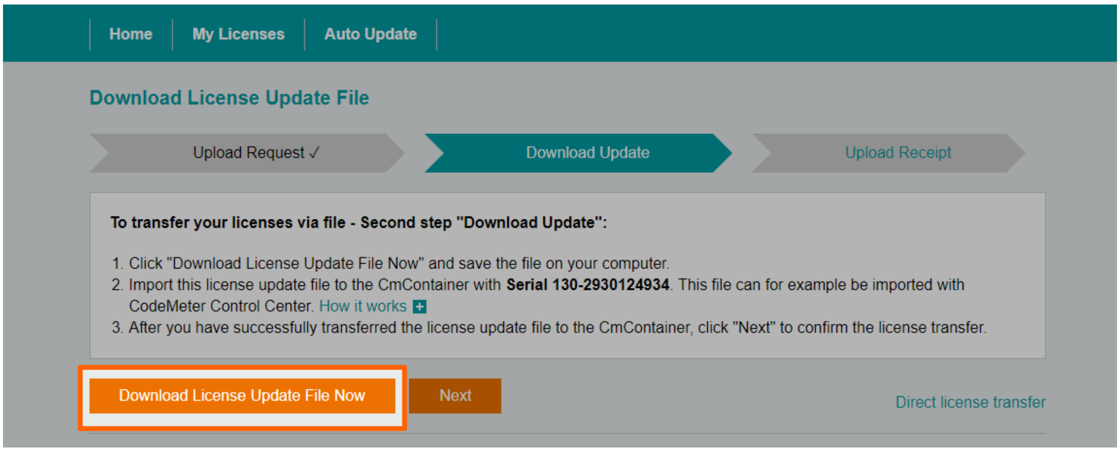
No CmContainer selected ▾

or

Pick a license request file (*.WibuCmRaC) of another CmContainer

Choose File 130-2336795069.WibuCmRaC

9. Select **Download License Update File now** in the next window to download the license update file named `<licensenumber>.WibuCmRaU`.

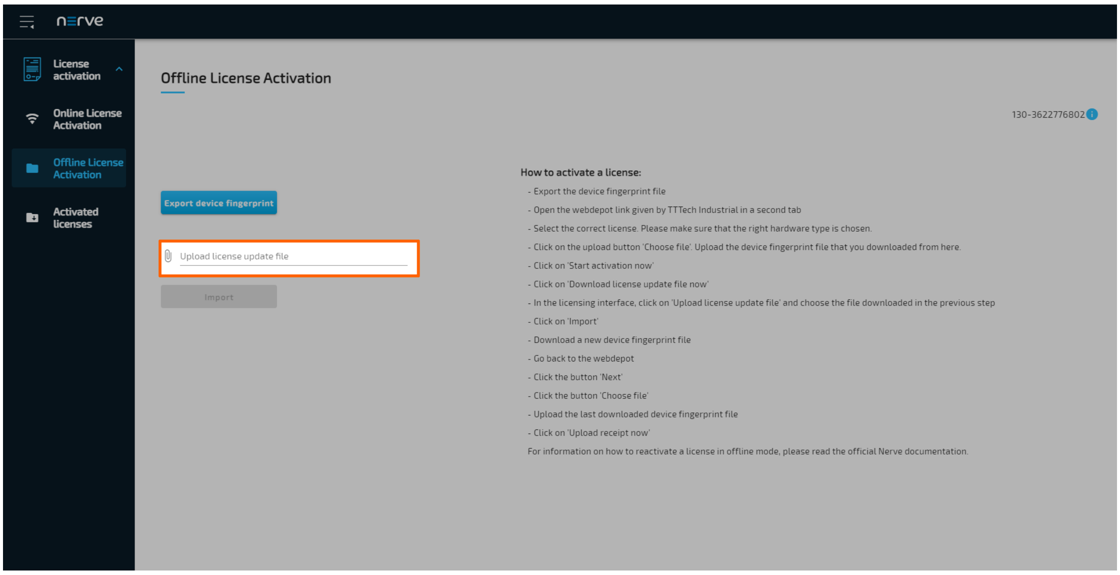


To transfer your licenses via file - Second step "Download Update":

1. Click "Download License Update File Now" and save the file on your computer.
2. Import this license update file to the CmContainer with **Serial 130-2930124934**. This file can for example be imported with CodeMeter Control Center. How it works
3. After you have successfully transferred the license update file to the CmContainer, click "Next" to confirm the license transfer.

10. Switch back to the Local UI.

11. Select the **Upload license update file** field to open the file browser.


nerve
License activation
Online License Activation
Offline License Activation
Activated licenses
Offline License Activation
130-3622776802
Export device fingerprint
Upload license update file
Import

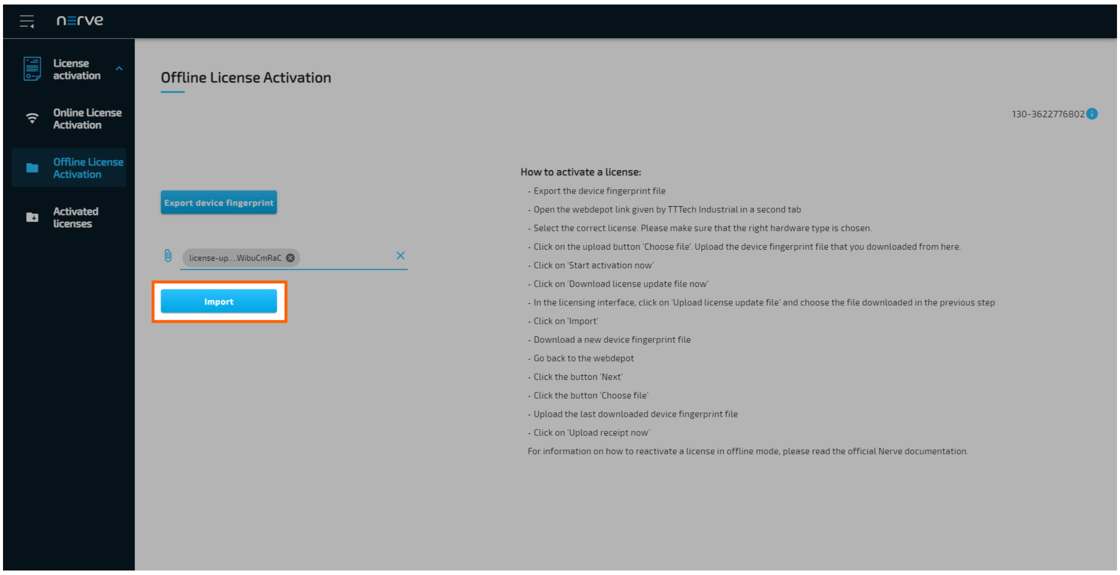
How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

12. Navigate to where the `<licensenumber>.WibuCmRaU` file is saved and select it.

13. Select **Import** to import the license.



Offline License Activation

130-3622776802

Export device fingerprint

license-up....WibuCmRaC

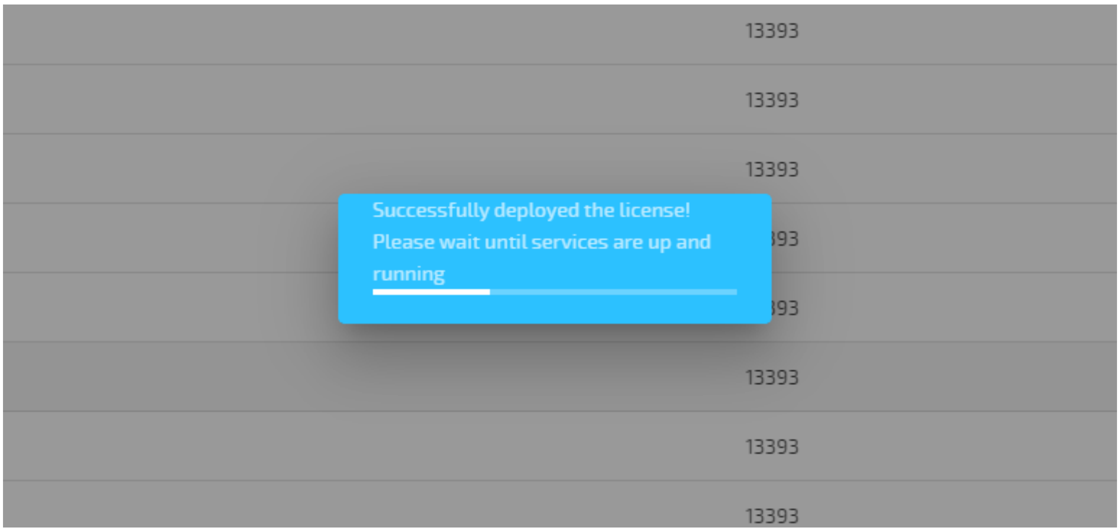
Import

How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

The system will proceed to activate the license and automatically redirect to the Local UI after a successful activation.

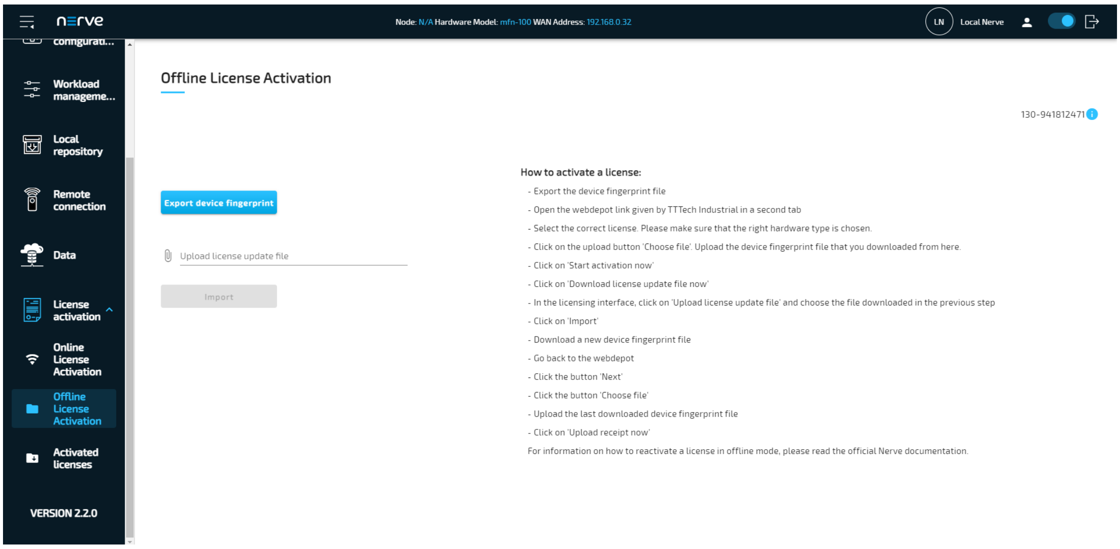


Successfully deployed the license! Please wait until services are up and running

NOTE

When using an MFN 100, the device will light up blue once the license has been activated and the necessary services are up and running.

14. Log in to the Local UI with the credentials from the customer profile.
15. Select **License activation > Offline License Activation** in the navigation on the left.
16. Select **Export device fingerprint** to download the updated device fingerprint.


nerve
Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.32
LN
Local Nerve
configurati...
Workload manageme...
Local repository
Remote connection
Data
License activation
Online License Activation
Offline License Activation
Activated licenses
VERSION 2.2.0
Export device fingerprint
Upload license update file
Import

Offline License Activation

130-941812471

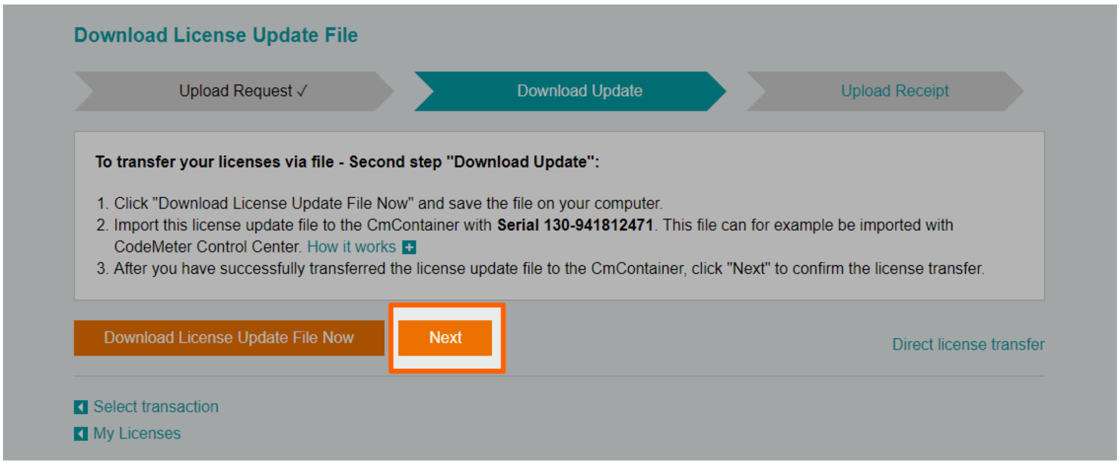
How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

17. Switch back to the web depot.

18. Select **Next**.

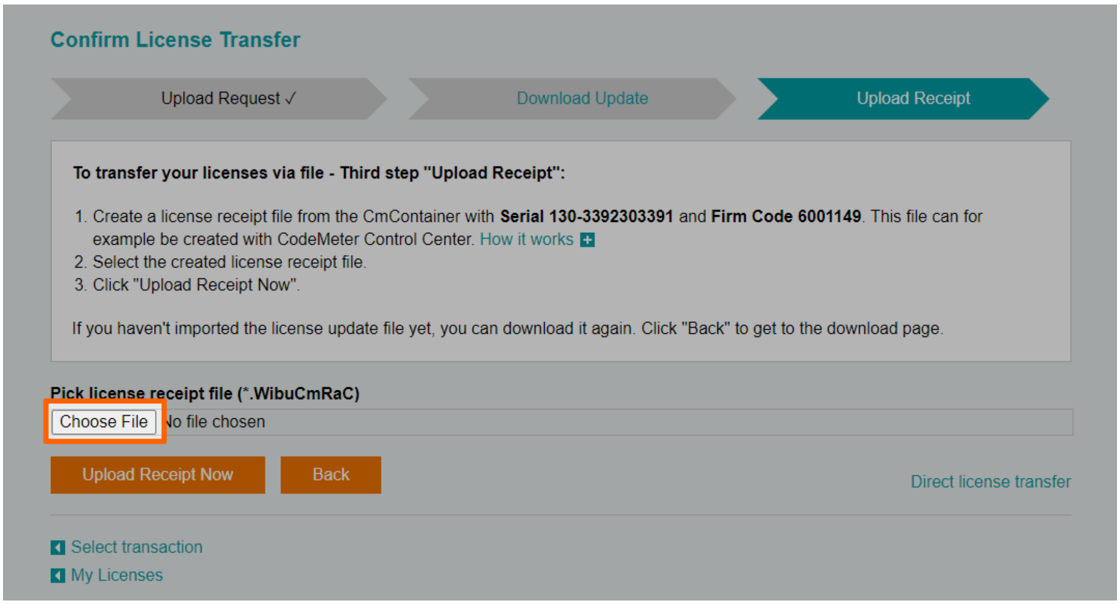


Download License Update File

To transfer your licenses via file - Second step "Download Update":

1. Click "Download License Update File Now" and save the file on your computer.
2. Import this license update file to the CmContainer with **Serial 130-941812471**. This file can for example be imported with CodeMeter Control Center. How it works
3. After you have successfully transferred the license update file to the CmContainer, click "Next" to confirm the license transfer.

19. Select **Choose file**.



Confirm License Transfer

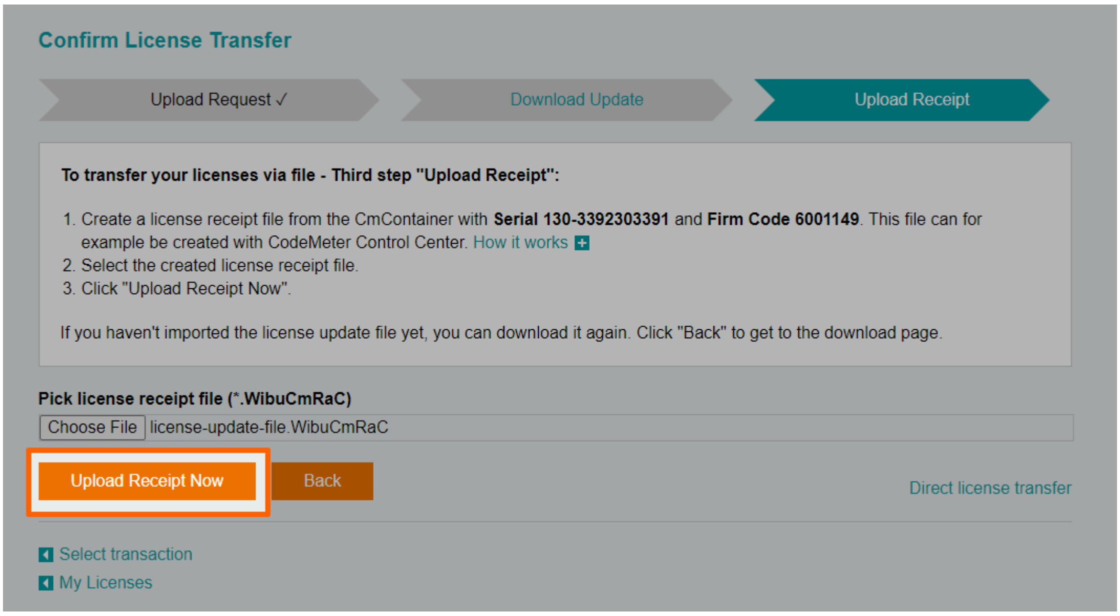
To transfer your licenses via file - Third step "Upload Receipt":

1. Create a license receipt file from the CmContainer with **Serial 130-3392303391** and **Firm Code 6001149**. This file can for example be created with CodeMeter Control Center. How it works
2. Select the created license receipt file.
3. Click "Upload Receipt Now".

If you haven't imported the license update file yet, you can download it again. Click "Back" to get to the download page.

Pick license receipt file (*.WibuCmRaC)

20. Add the device fingerprint that was downloaded a few steps before.
21. Select **Upload receipt now**.



Confirm License Transfer

To transfer your licenses via file - Third step "Upload Receipt":

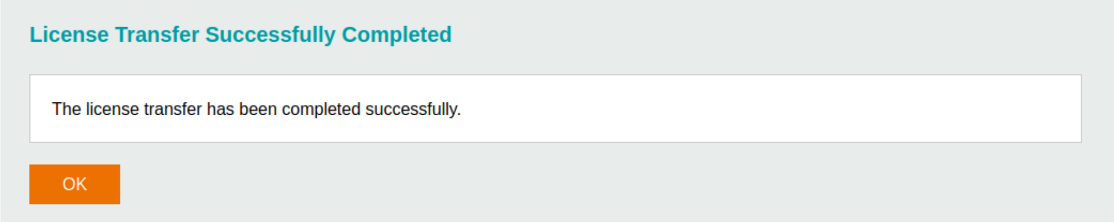
1. Create a license receipt file from the CmContainer with **Serial 130-3392303391** and **Firm Code 6001149**. This file can for example be created with CodeMeter Control Center. How it works
2. Select the created license receipt file.
3. Click "Upload Receipt Now".

If you haven't imported the license update file yet, you can download it again. Click "Back" to get to the download page.

Pick license receipt file (*.WibuCmRaC)

Choose File license-update-file.WibuCmRaC

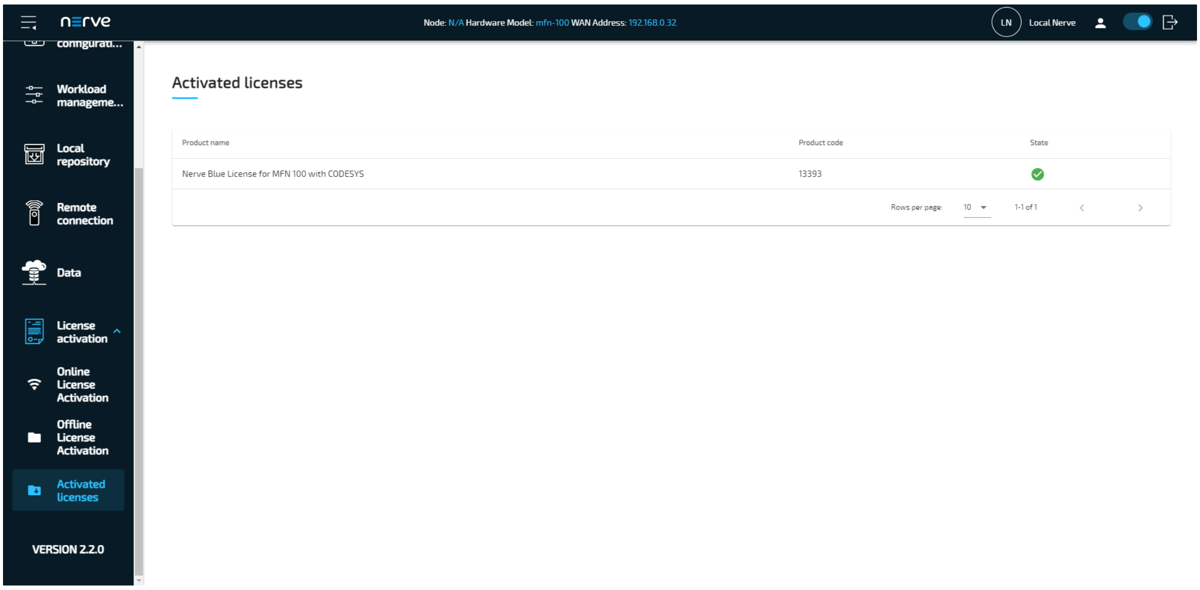
The web depot confirms a successful activation.



License Transfer Successfully Completed

The license transfer has been completed successfully.

To double-check if the license has been activated properly, expand **License activation > Activated licenses** in the navigation on the left of the Local UI. An activated license is displayed in the table with a green check mark on the right side, signifying a successful activation on the correct Nerve Device.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.32

Activated licenses

Product name	Product code	State
Nerve Blue License for MFN 100 with CODESYS	13393	✓

Rows per page: 10 1-1 of 1

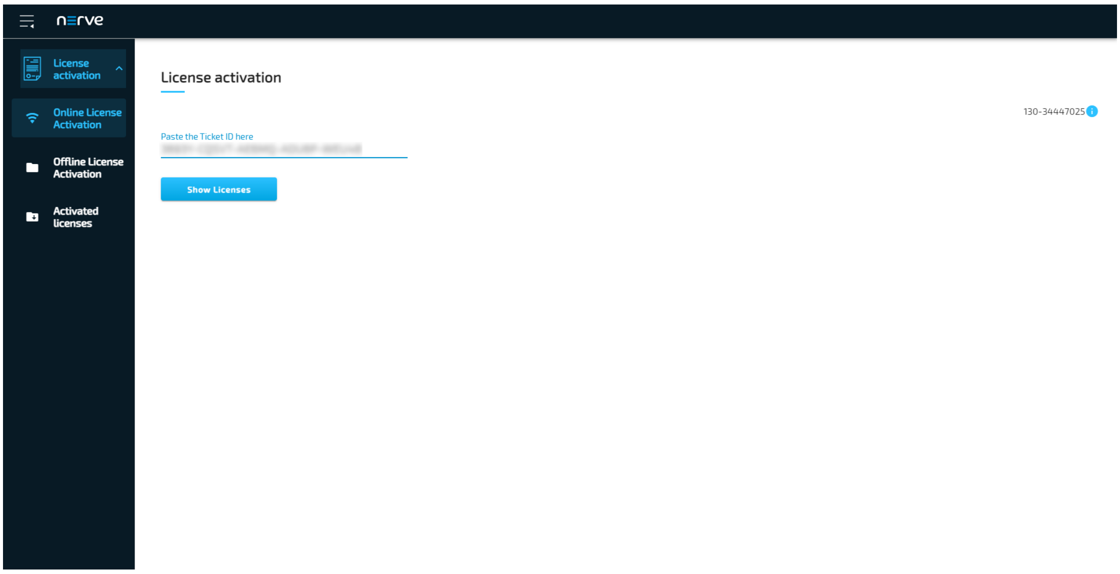
Reusing activated licenses

Previously activated licenses can be reactivated. This is useful in cases when Nerve is reinstalled in order to wipe the disk or disk failure. However, licenses can only be reused for the same Nerve Device. In addition, the license serial number is required from the time the license was activated first. Without the license serial number from the previous installation, a new license has to be used.

Online reactivation

If the node has internet access, the node will automatically connect to the licensing server. The process is virtually identical to regular online license activation. Online license activation is selected in the navigation on the left by default.

1. Enter the ticket ID under **Paste the Ticket ID here**.

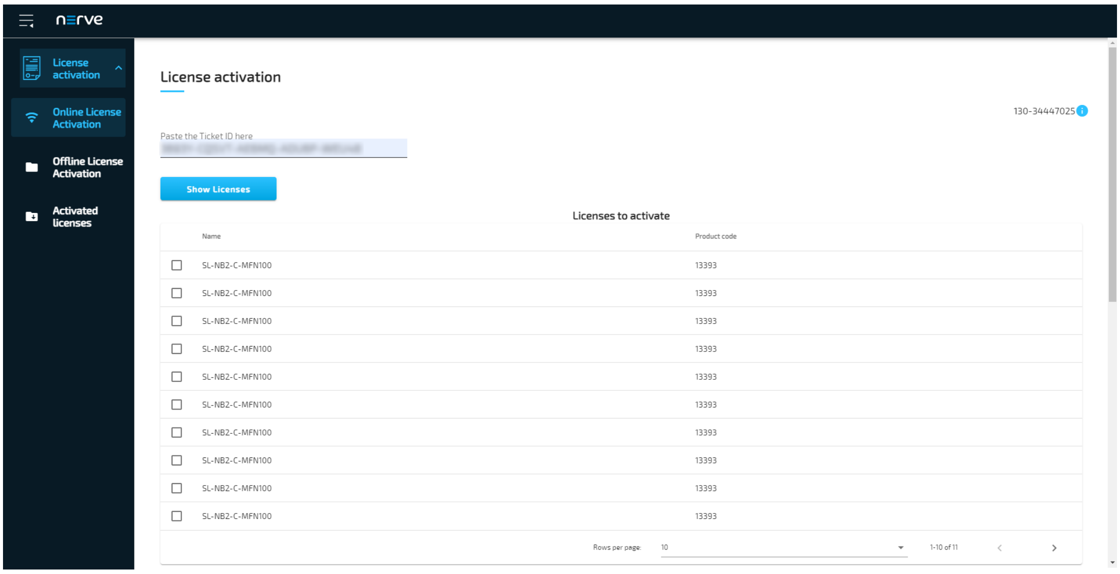


License activation

130-34447025

Paste the Ticket ID here
[redacted]

2. Select **Show Licenses**. Available licenses will appear below.



License activation

130-34447025

Paste the Ticket ID here
[redacted]

Licenses to activate

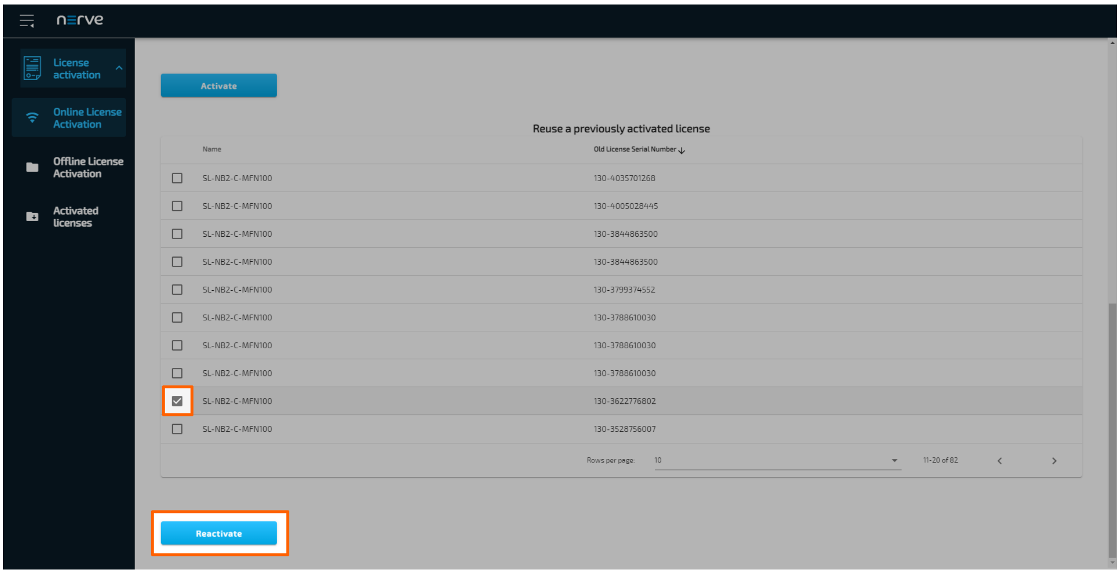
	Name	Product code
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393
□	SL-NB2-C-MFN100	13393

Rows per page: 10 1-10 of 11

3. Scroll down to reach **Reuse a previously activated license**.

4. Tick the checkbox next to the appropriate license. Look for the license that matches the license serial number of the previous installation in the **Old License Serial Number** column.

5. Select **Reactivate** below the list of licenses.

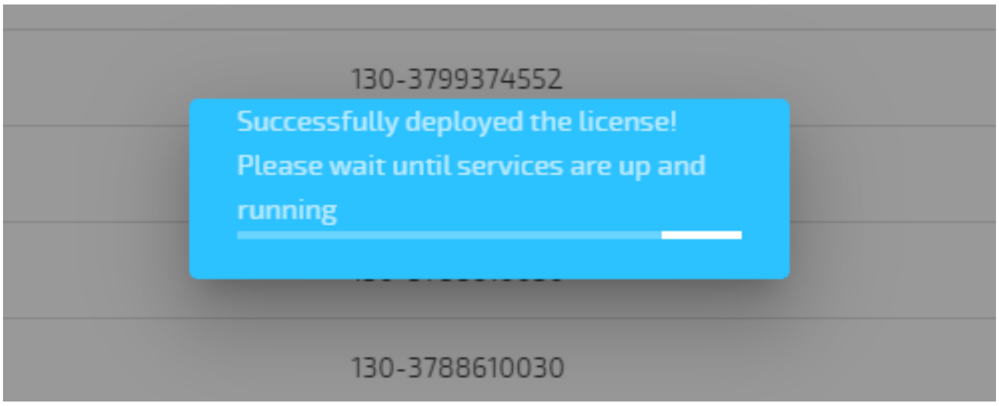


Reuse a previously activated license

	Name	Old License Serial Number ↓
☐	SL-NB2-C-MFN100	130-4035701268
☐	SL-NB2-C-MFN100	130-4005028445
☐	SL-NB2-C-MFN100	130-3844863500
☐	SL-NB2-C-MFN100	130-3844863500
☐	SL-NB2-C-MFN100	130-3799374552
☐	SL-NB2-C-MFN100	130-3788610030
☐	SL-NB2-C-MFN100	130-3788610030
☐	SL-NB2-C-MFN100	130-3788610030
☑	SL-NB2-C-MFN100	130-3622776802
☐	SL-NB2-C-MFN100	130-3528756007

Rows per page: 10 11-20 of 82

The system will proceed to activate the license and automatically redirect to the Local UI after a successful activation.

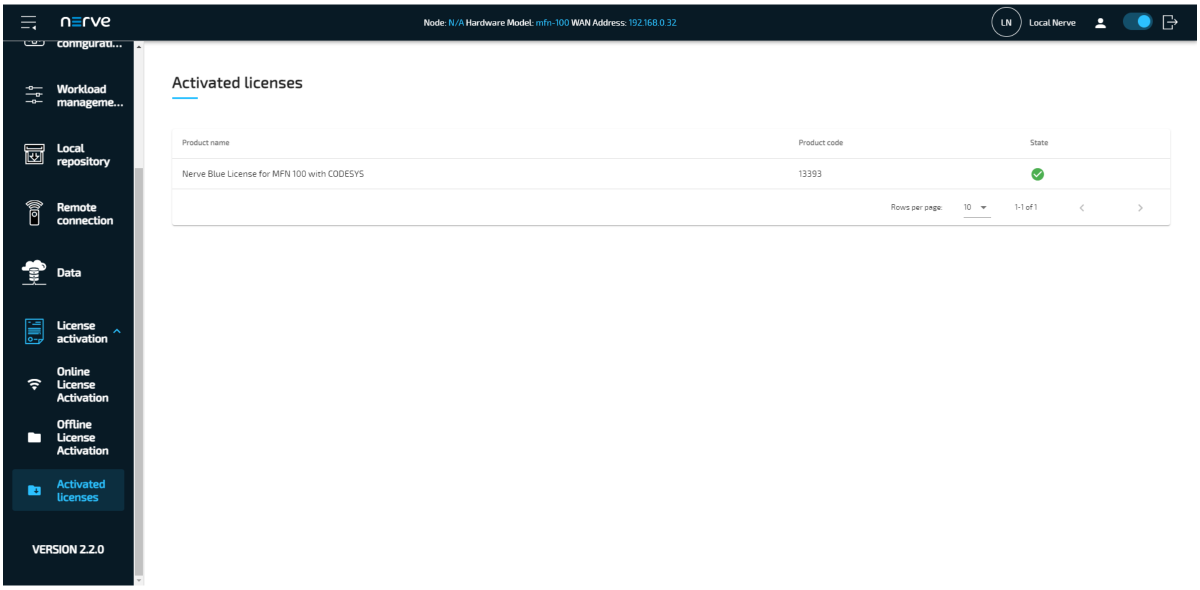


Successfully deployed the license! Please wait until services are up and running

NOTE

When using an MFN 100, the device will light up blue once the license has been activated and the necessary services are up and running.

To double-check if the license has been activated properly, expand **License activation > Activated licenses** in the navigation on the left of the Local UI. An activated license is displayed in the table with a green check mark on the right side, signifying a successful activation on the correct Nerve Device.



Activated licenses

Product name	Product code	State
Nerve Blue License for MFN 100 with CODESYS	13393	✓

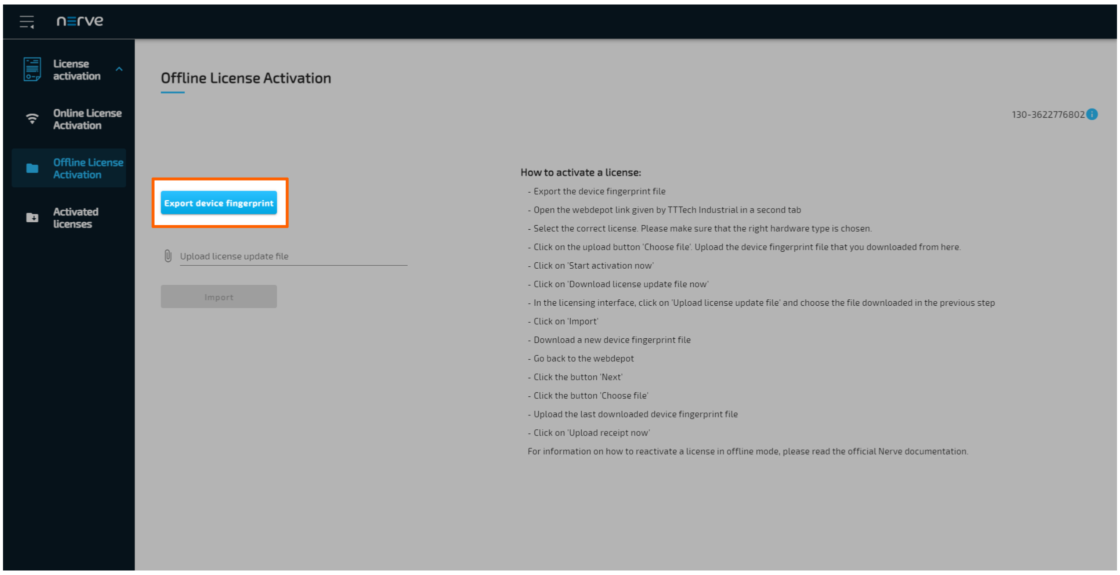
Rows per page: 10 1-1 of 1

Offline reactivation

In case of the node not having internet access, the license can be reactivated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files.

1. Select **License activation > Offline License Activation** in the navigation on the left.

2. Select **Export device fingerprint** to download the license update file.



nerve
License activation
Online License Activation
Offline License Activation
Activated licenses
Export device fingerprint
Upload license update file
Import

Offline License Activation

130-3622776802

How to activate a license:

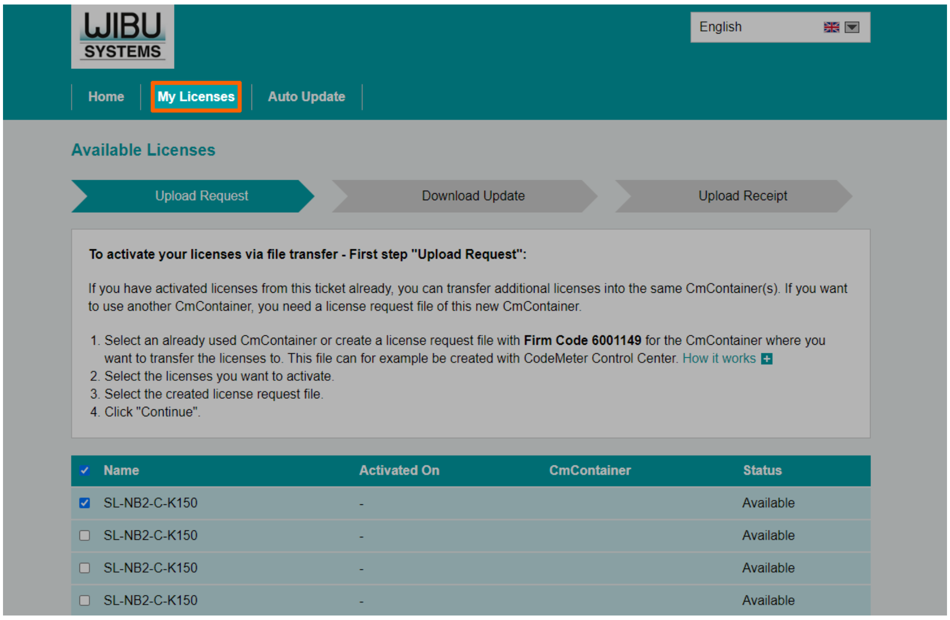
- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

3. Open a new browser tab.

4. Enter the link to the web depot. The link has been sent as part of the delivery.

5. Select **My Licenses**.



Available Licenses

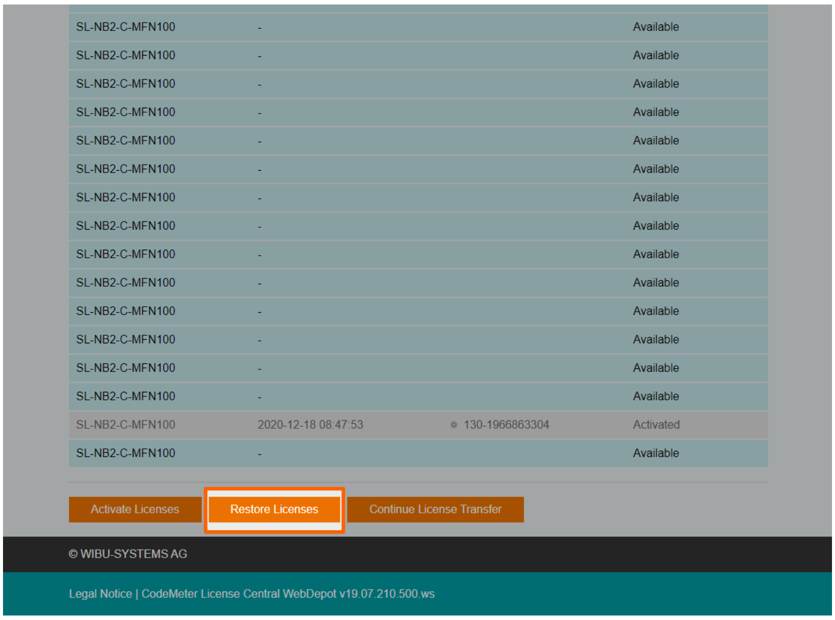
To activate your licenses via file transfer - First step "Upload Request":

If you have activated licenses from this ticket already, you can transfer additional licenses into the same CmContainer(s). If you want to use another CmContainer, you need a license request file of this new CmContainer.

1. Select an already used CmContainer or create a license request file with **Firm Code 6001149** for the CmContainer where you want to transfer the licenses to. This file can for example be created with CodeMeter Control Center. How it works
2. Select the licenses you want to activate.
3. Select the created license request file.
4. Click "Continue".

☑	Name	Activated On	CmContainer	Status
☑	SL-NB2-C-K150	-		Available
□	SL-NB2-C-K150	-		Available
□	SL-NB2-C-K150	-		Available
□	SL-NB2-C-K150	-		Available

6. Select **Restore licenses** at the bottom of the page.



SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	-		Available
SL-NB2-C-MFN100	2020-12-18 08:47:53	130-1966863304	Activated
SL-NB2-C-MFN100	-		Available

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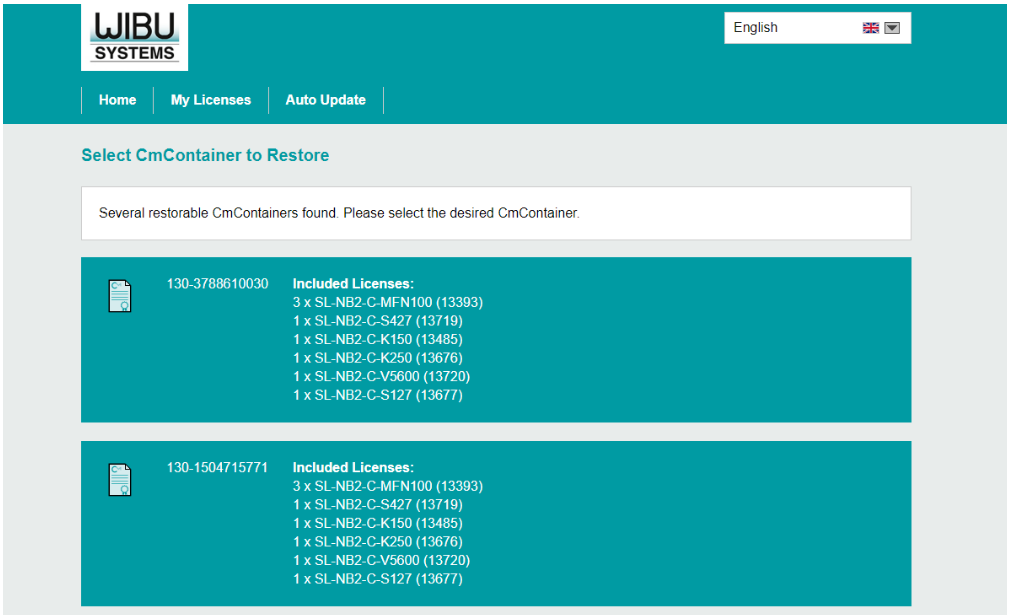
7. Select the appropriate license. Look for the license that matches the license serial number of the previous installation.



Select CmContainer to Restore

Several restorable CmContainers found. Please select the desired CmContainer.

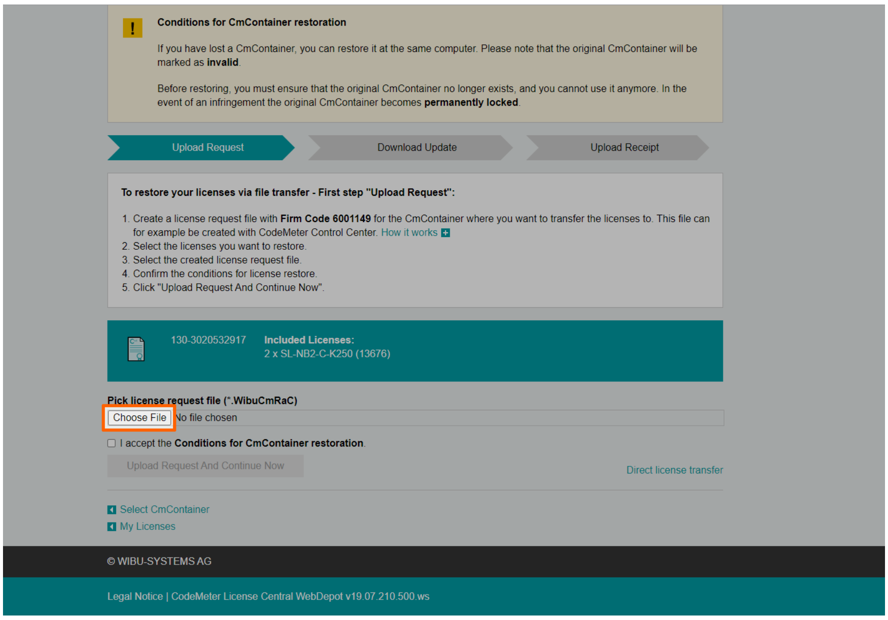
130-3788610030

Included Licenses:
3 x SL-NB2-C-MFN100 (13393)
1 x SL-NB2-C-S427 (13719)
1 x SL-NB2-C-K150 (13485)
1 x SL-NB2-C-K250 (13676)
1 x SL-NB2-C-V5600 (13720)
1 x SL-NB2-C-S127 (13677)

130-1504715771

Included Licenses:
3 x SL-NB2-C-MFN100 (13393)
1 x SL-NB2-C-S427 (13719)
1 x SL-NB2-C-K150 (13485)
1 x SL-NB2-C-K250 (13676)
1 x SL-NB2-C-V5600 (13720)
1 x SL-NB2-C-S127 (13677)

8. Select **Choose file** under **Pick license request file (*.WibuCmRaC)**.



Conditions for CmContainer restoration

If you have lost a CmContainer, you can restore it at the same computer. Please note that the original CmContainer will be marked as **invalid**.

Before restoring, you must ensure that the original CmContainer no longer exists, and you cannot use it anymore. In the event of an infringement the original CmContainer becomes **permanently locked**.

To restore your licenses via file transfer - First step "Upload Request":

1. Create a license request file with **Firm Code 6001149** for the CmContainer where you want to transfer the licenses to. This file can for example be created with CodeMeter Control Center. How it works
2. Select the licenses you want to restore.
3. Select the created license request file.
4. Confirm the conditions for license restore.
5. Click "Upload Request And Continue Now".

130-3020532917

Included Licenses:
2 x SL-NB2-C-K250 (13676)

Pick license request file (*.WibuCmRaC)
Choose File No file chosen

□ I accept the **Conditions for CmContainer restoration**.

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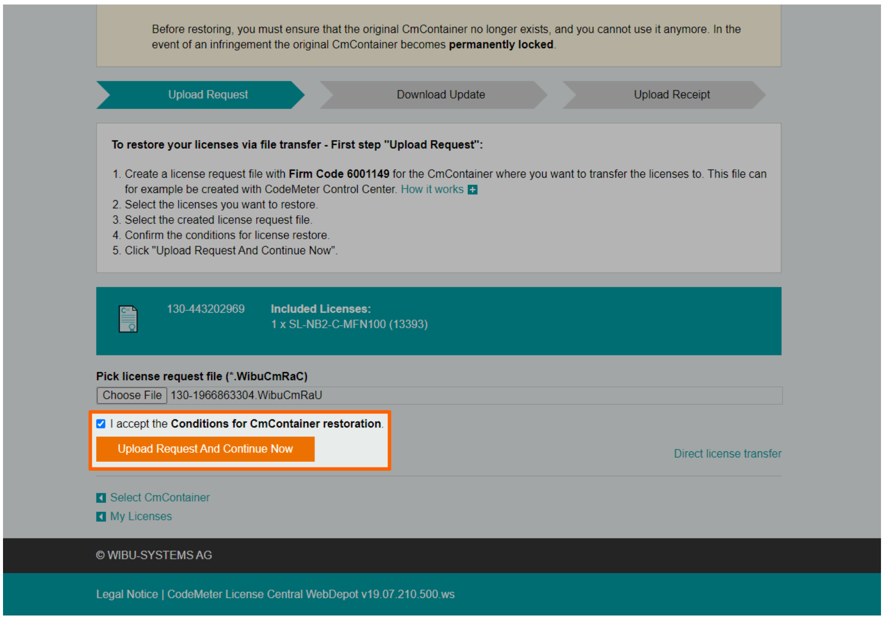
9. Navigate to where the device fingerprint file is saved and select it.

10. Tick the checkbox next to **I accept the Conditions for CmContainer restoration**.

11. Select **Upload Request And Continue Now**.



Before restoring, you must ensure that the original CmContainer no longer exists, and you cannot use it anymore. In the event of an infringement the original CmContainer becomes **permanently locked**.

To restore your licenses via file transfer - First step "Upload Request":

1. Create a license request file with **Firm Code 6001149** for the CmContainer where you want to transfer the licenses to. This file can for example be created with CodeMeter Control Center. How it works
2. Select the licenses you want to restore.
3. Select the created license request file.
4. Confirm the conditions for license restore.
5. Click "Upload Request And Continue Now".

130-443202969 **Included Licenses:**
1 x SL-NB2-C-MFN100 (13393)

Pick license request file (*.WibuCmRaC)

Choose File 130-1966863304.WibuCmRaU

☑ I accept the **Conditions for CmContainer restoration**.

Upload Request And Continue Now
Direct license transfer
Select CmContainer
My Licenses
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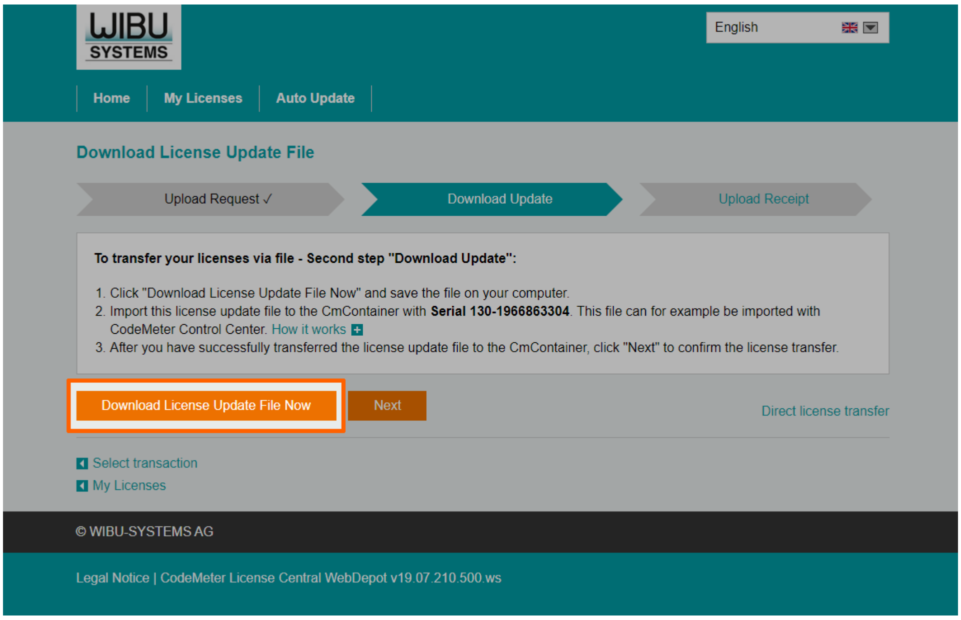
12. Select **Download License Update File now** in the next window to download the license update file named `<licensenumber>.WibuCmRaU`.



Download License Update File

To transfer your licenses via file - Second step "Download Update":

1. Click "Download License Update File Now" and save the file on your computer.
2. Import this license update file to the CmContainer with **Serial 130-1966863304**. This file can for example be imported with CodeMeter Control Center. How it works
3. After you have successfully transferred the license update file to the CmContainer, click "Next" to confirm the license transfer.

Download License Update File Now
Next
Direct license transfer
Select transaction
My Licenses
© WIBU-SYSTEMS AG
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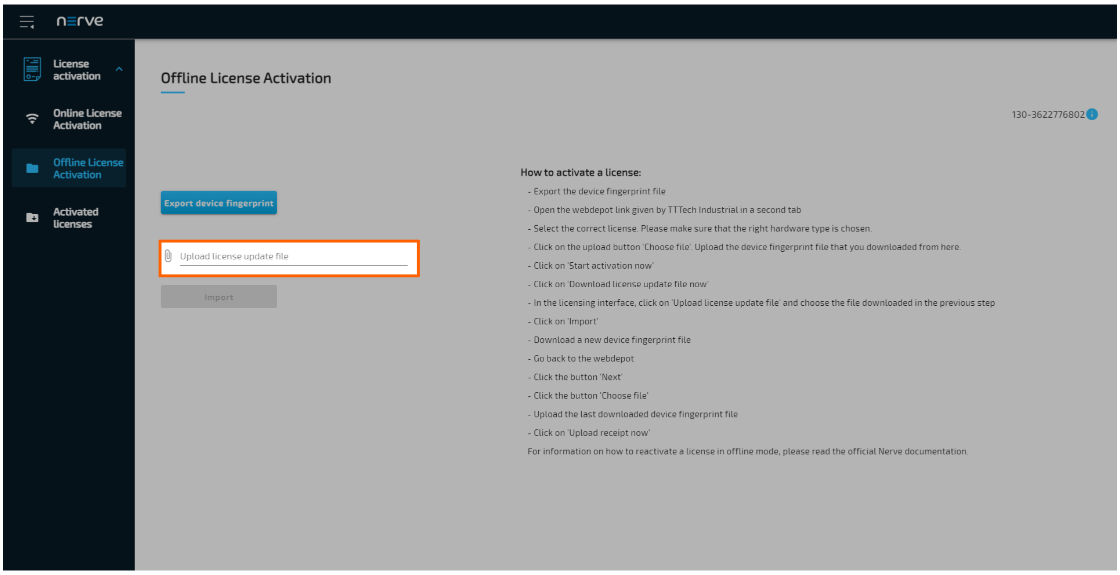
13. Switch back to the Local UI.

14. Select the **Upload license update file** field to open the file browser.


nerve
License activation
Online License Activation
Offline License Activation
Activated licenses
Export device fingerprint
Upload license update file
Import

Offline License Activation

130-3622776802

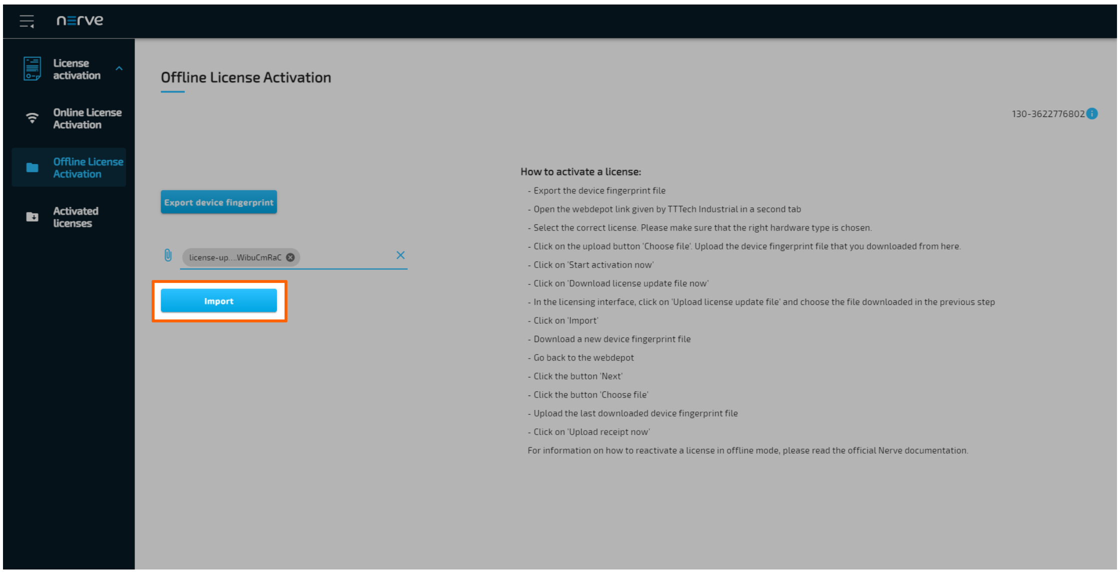
How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

15. Navigate to where the `<licensenumber>.WibuCmRaU` file is saved and select it.

16. Select **Import** to import the license.


nerve
License activation
Online License Activation
Offline License Activation
Activated licenses
Export device fingerprint
license-up....WibuCmRaC
Import

Offline License Activation

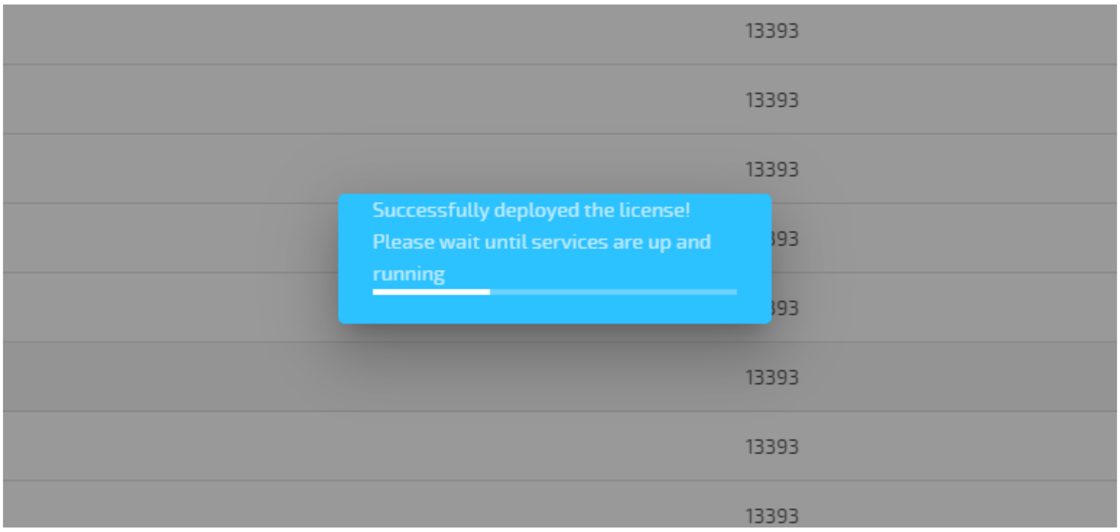
130-3622776802

How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

The system will proceed to activate the license and automatically redirect to the Local UI after a successful activation.



Successfully deployed the license! Please wait until services are up and running

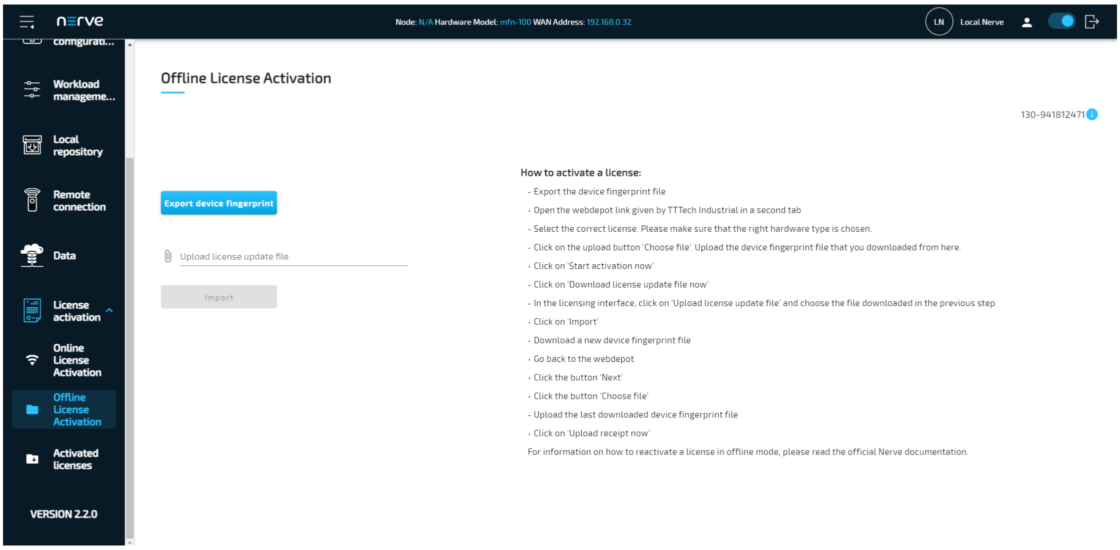
NOTE

When using an MFN 100, the device will light up blue once the license has been activated and the necessary services are up and running.

17. Log in to the Local UI with the credentials from the customer profile.

18. Select **License activation > Offline License Activation** in the navigation on the left.

19. Select **Export device fingerprint** to download the updated device fingerprint.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.32

Offline License Activation

130-941812471

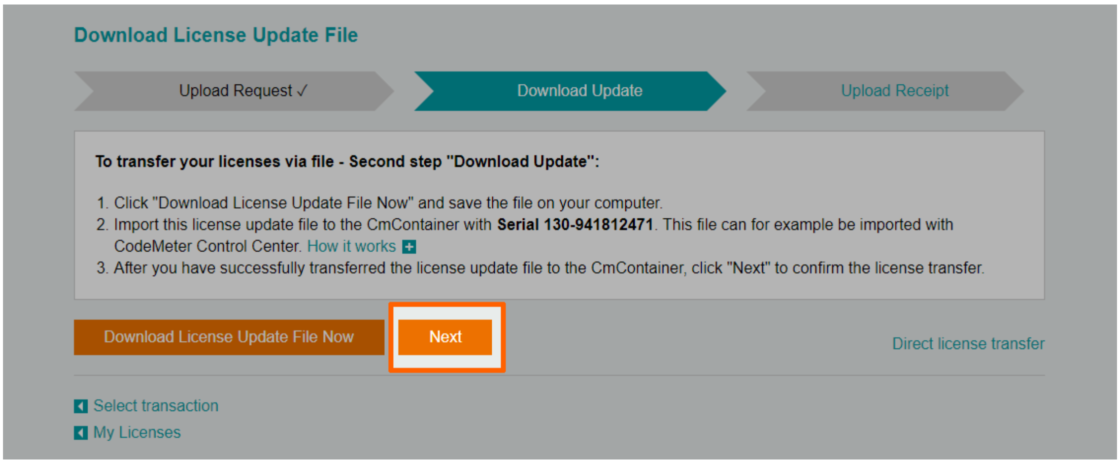
How to activate a license:

- Export the device fingerprint file
- Open the webdepot link given by TTTech Industrial in a second tab
- Select the correct license. Please make sure that the right hardware type is chosen.
- Click on the upload button 'Choose file'. Upload the device fingerprint file that you downloaded from here.
- Click on 'Start activation now'
- Click on 'Download license update file now'
- In the licensing interface, click on 'Upload license update file' and choose the file downloaded in the previous step
- Click on 'Import'
- Download a new device fingerprint file
- Go back to the webdepot
- Click the button 'Next'
- Click the button 'Choose file'
- Upload the last downloaded device fingerprint file
- Click on 'Upload receipt now'

For information on how to reactivate a license in offline mode, please read the official Nerve documentation.

20. Switch back to the web depot.

21. Select **Next**.

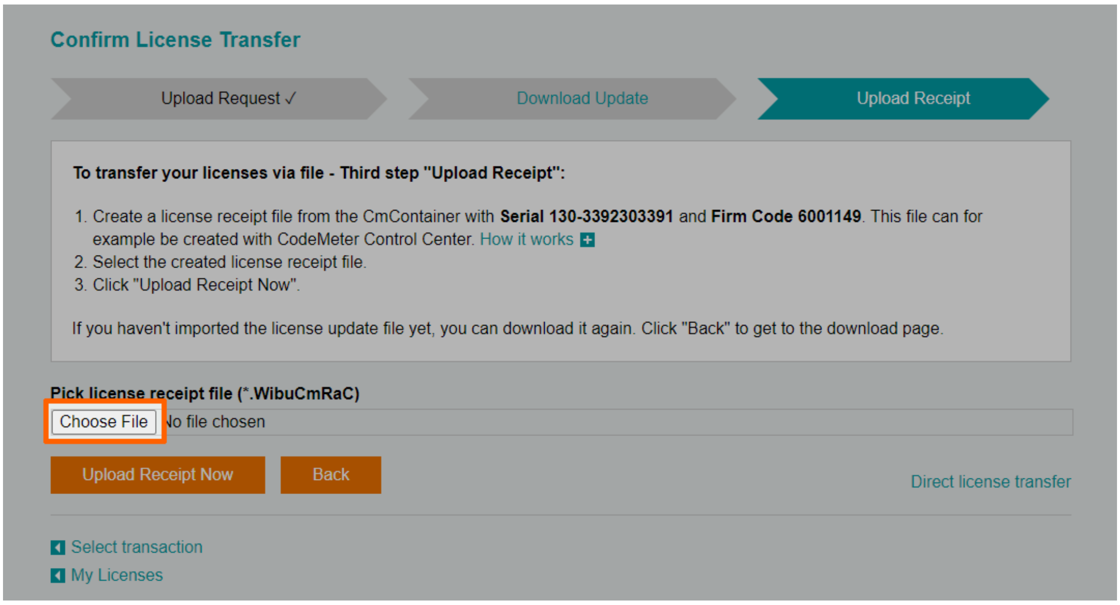


Download License Update File

To transfer your licenses via file - Second step "Download Update":

1. Click "Download License Update File Now" and save the file on your computer.
2. Import this license update file to the CmContainer with **Serial 130-941812471**. This file can for example be imported with CodeMeter Control Center. How it works
3. After you have successfully transferred the license update file to the CmContainer, click "Next" to confirm the license transfer.

22. Select **Choose file**.



Confirm License Transfer

To transfer your licenses via file - Third step "Upload Receipt":

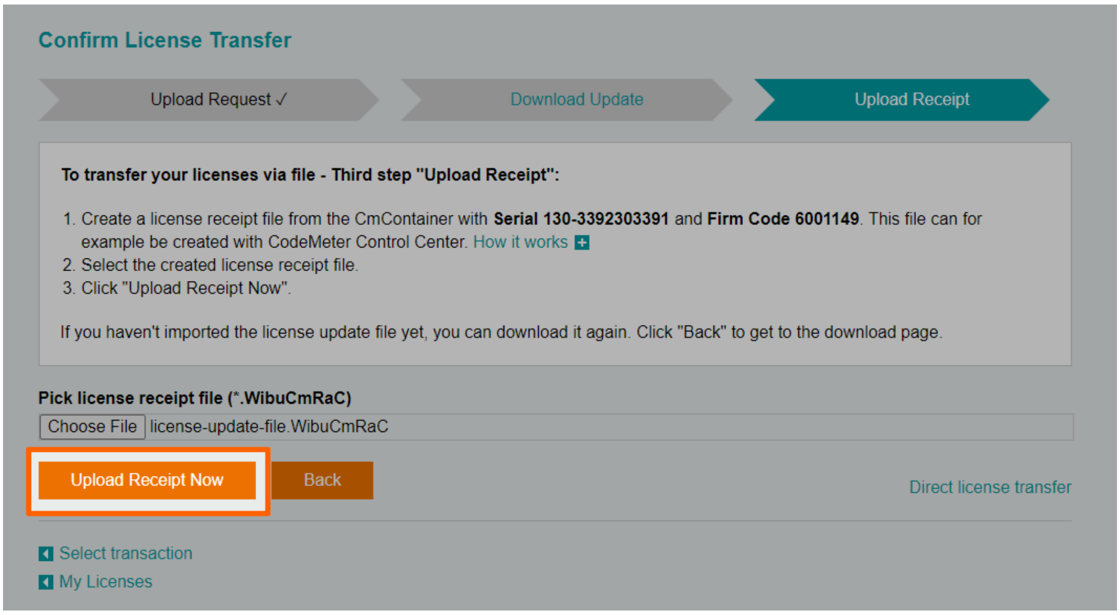
1. Create a license receipt file from the CmContainer with **Serial 130-3392303391** and **Firm Code 6001149**. This file can for example be created with CodeMeter Control Center. How it works
2. Select the created license receipt file.
3. Click "Upload Receipt Now".

If you haven't imported the license update file yet, you can download it again. Click "Back" to get to the download page.

Pick license receipt file (*.WibuCmRaC)

23. Add the device fingerprint that was downloaded a few steps before.

24. Select **Upload receipt now**.



To transfer your licenses via file - Third step "Upload Receipt":

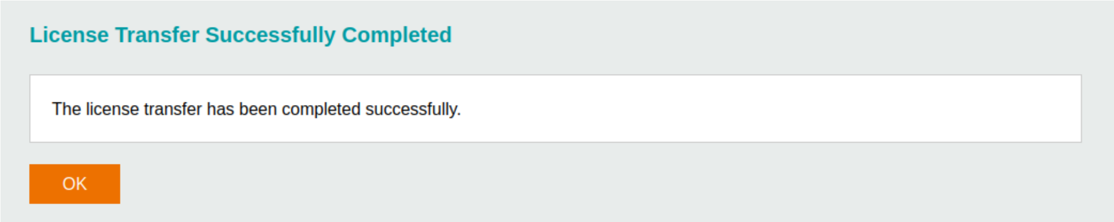
1. Create a license receipt file from the CmContainer with **Serial 130-3392303391** and **Firm Code 6001149**. This file can for example be created with CodeMeter Control Center. How it works ⊞
2. Select the created license receipt file.
3. Click "Upload Receipt Now".

If you haven't imported the license update file yet, you can download it again. Click "Back" to get to the download page.

Pick license receipt file (*.WibuCmRaC)

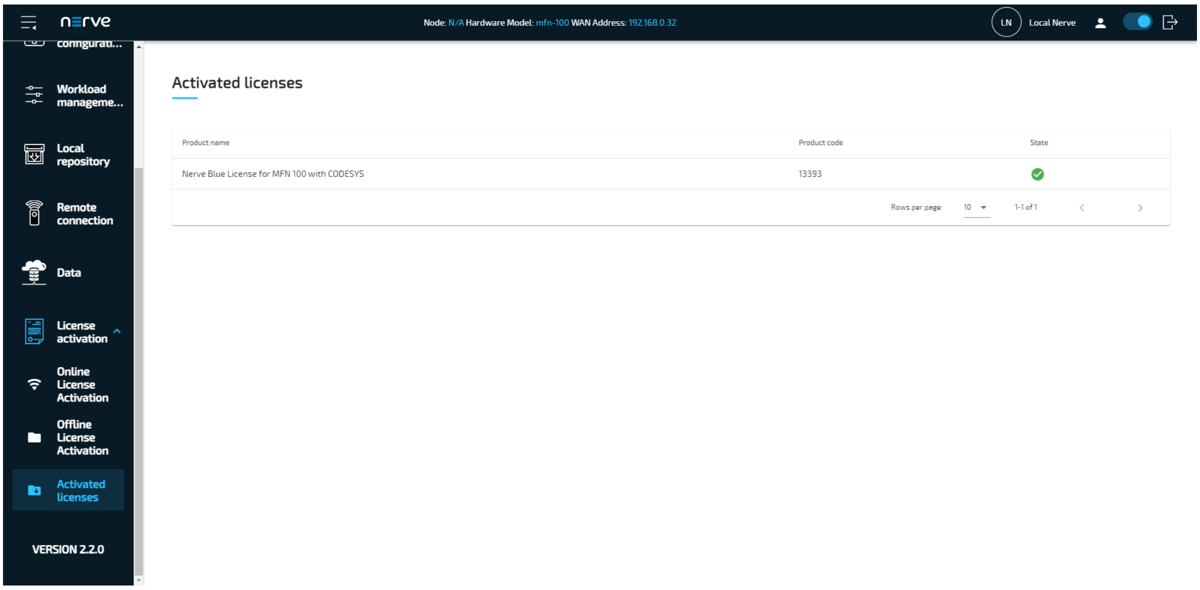
Choose File license-update-file.WibuCmRaC

The web depot confirms a successful activation.



The license transfer has been completed successfully.

To double-check if the license has been activated properly, expand **License activation > Activated licenses** in the navigation on the left of the Local UI. An activated license is displayed in the table with a green check mark on the right side, signifying a successful activation on the correct Nerve Device.



Activated licenses

Product name	Product code	State
Nerve Blue License for MFN 100 with CODESYS	13393	✓

Rows per page: 10 1-1 of 1

Local UI

The Local UI is provided by a web server that is running locally on the Nerve Device. Compared to the Management System, the Local UI covers features that only concern the node itself.
The Local UI gives access to the following features:

- Network configuration
- Node registration and password management
- Workload management
- Local workload deployment
- Local workload repository
- Management of remote connections

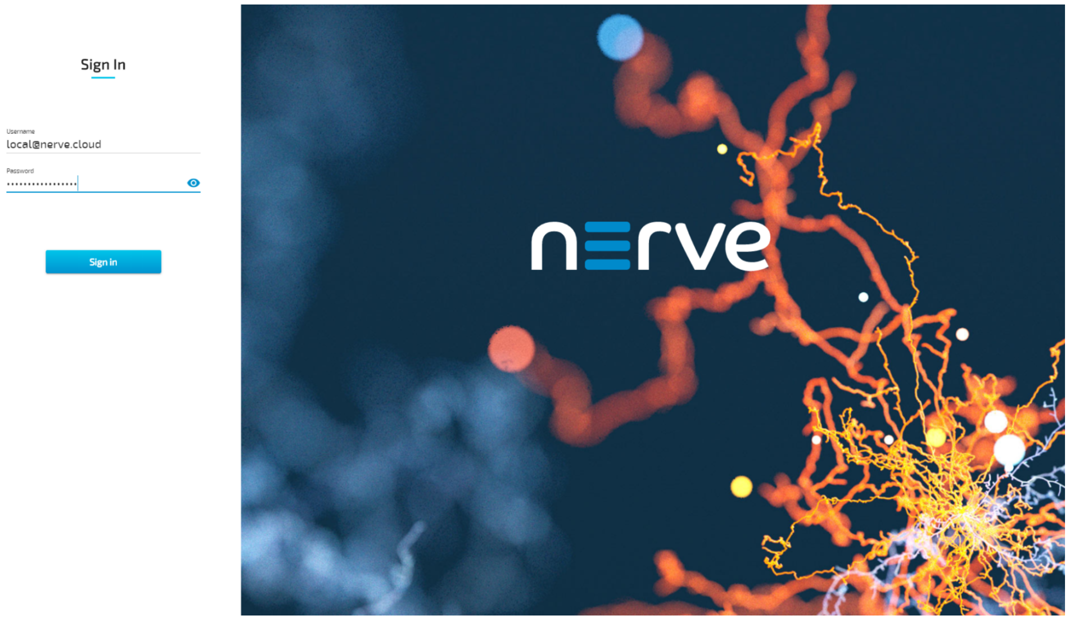
Connecting to the Local UI

Connecting to the Local UI depends on the Nerve Device. Refer to the table below on how to reach the Local UI for each Nerve Device. Make sure to connect a workstation to the physical port of the Nerve Device associated with host access and configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the host access interface with a `255.255.255.0` subnet mask.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.

Nerve Device	Physical port	Local UI
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

Once a connection is established, log in with the credentials for the Local UI to reach the Local UI dashboard.



Sign In

Username: local@nerve.cloud

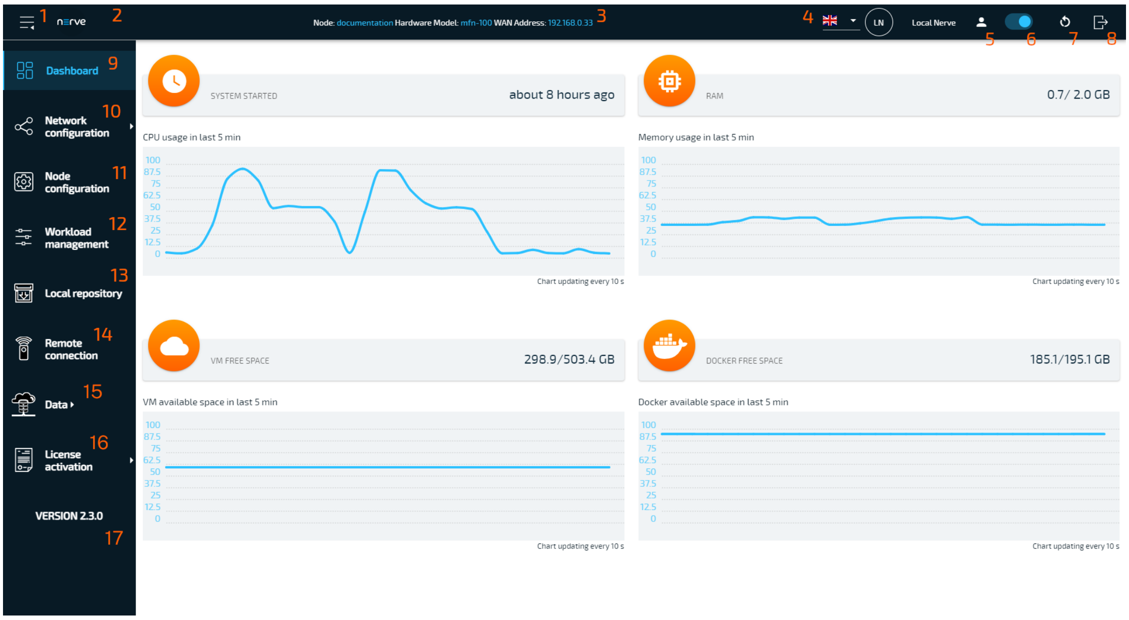
Password: ••••••••••••••••••

NOTE

The Local UI has brute force login protection in place. Five failed login attempts in a row will block the user from logging in again for 1 minute.

Local UI dashboard

The dashboard of the Local UI is the default screen after the log in. Usage statistics of the Nerve Device are displayed in the window with more options in the menu on the left side.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

SYSTEM STARTED about 8 hours ago

RAM 0.7/ 2.0 GB

CPU usage in last 5 min

Chart updating every 10 s

Memory usage in last 5 min

Chart updating every 10 s

VM FREE SPACE 298.9/503.4 GB

DOCKER FREE SPACE 185.1/195.1 GB

VM available space in last 5 min

Chart updating every 10 s

Docker available space in last 5 min

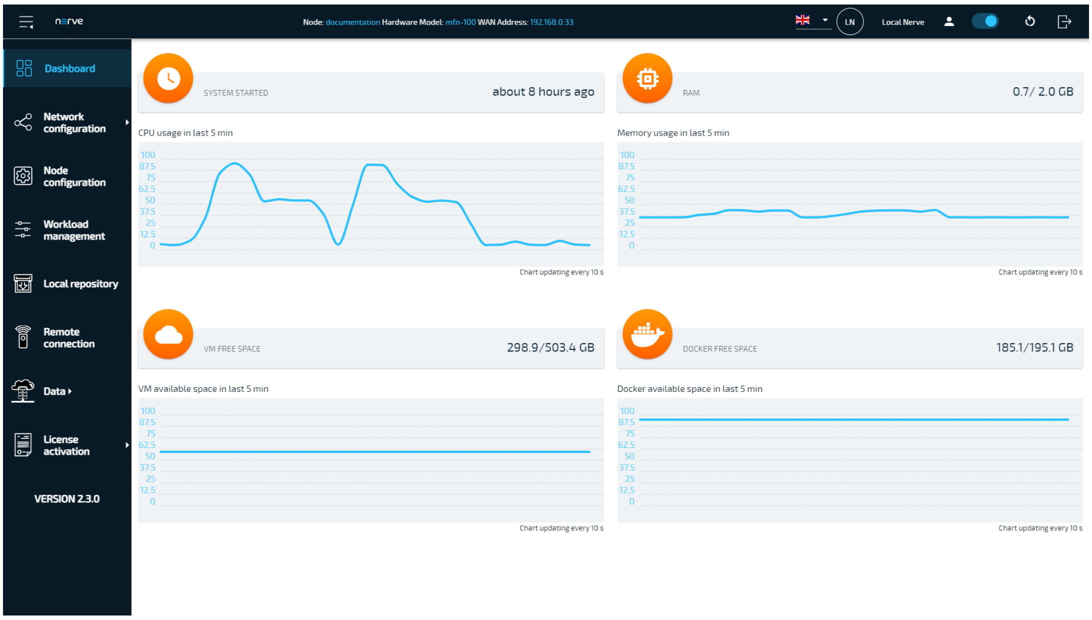
Chart updating every 10 s

Term	Description
Burger menu (1)	Expand and collapse the left-hand menu by selecting this.
Nerve logo (2)	Select this to return to the dashboard and reload the page.
Node details (3)	Details of the node are displayed here, showing the name of the node in the Management System, the hardware model and the WAN address of the node.
Language selection (4)	Select this to change the interface language. Available languages are English and Korean.
Change password (5)	Selecting this leads to an area where the password to the Local UI can be changed.
Connect button (6)	Toggle the slider here to disconnect the node from the network. Blue indicates an active connection to the network. If the button is white, the node is offline.
Reboot Node (7)	Selecting this will reboot the node after a confirmation dialog. Select **YES** to initiate the reboot. All running workloads will be stopped. After the reboot, the workloads will return to their previous state. Running workloads will be started. Stopped workloads will stay stopped.
Log out (8)	Select this to log out of the Local UI.
Dashboard (9)	Select this to display the dashboard containing the system metrics — graphs showing available resources of the Nerve Device and their usage over time.
Network configuration (10)	This menu allows to configure the Ethernet ports of the Nerve Device, as well as proxy settings for the node.

Term	Description
Node configuration (11)	Configure data such as the Management System URL that the node will connect to or the serial number of the node here. The information required to register a node in the Management System is configured in this menu. Also, passwords can be changed here.
Workload management (12)	Select this menu for control options for deployed workloads and manual deployment of workloads.
Local Repository (13)	Find settings for the configuration of a local workload repository here.
Remote connection (14)	Manage incoming and active remote connections here.
Data (15)	Access the instance of the Nerve Data Services in the Local UI here. Refer to Nerve Data Services for more information.
License activation (16)	This is the UI that is used for activating licenses. Use this menu to check currently activated licenses.
Node version (17)	This is the currently installed version of the node.

System metrics

The graphs in the Local UI dashboard show available resources of the Nerve Device and their usage over time. The y-axis displays percentages and the x-axis is updated every 10 seconds, showing a time span of 5 minutes. The percentages displayed are always in relation to the maximum of the available resource:



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

SYSTEM STARTED about 8 hours ago

RAM 0.7/ 2.0 GB

VM FREE SPACE 298.9/503.4 GB

DOCKER FREE SPACE 185.1/195.1 GB

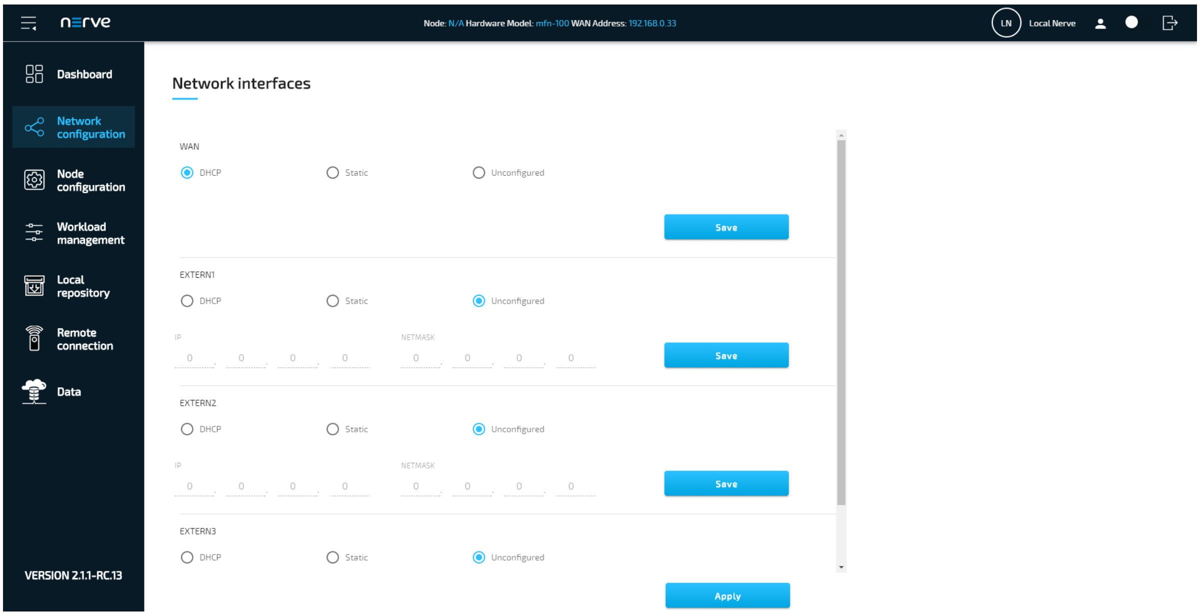
VERSION 2.3.0

Item	Description
SYSTEM STARTED	This shows how long the Nerve Device has been running. If the device is restarted, this value is reset.

Item	Description
CPU usage in last 5 min	The graph here shows the percentage of processing power that is being used. This includes CPUs that have been assigned to VMs and Docker containers.
RAM	This shows how much memory is used (left value) and how much memory is available in total (right value). Example: 0.3/1.9 GB Note that the total amount of memory the Nerve Device offers is not shown here. This is the memory that is available for the host.
Memory usage in last 5 min	Similar to CPU usage, the graph shows the percentage of memory used. This includes memory that has been assigned to VMs or Docker containers.
VM FREE SPACE	Virtual machines have their dedicated virtual partition (Logical Volume Manager). The values show how much of this partition is used (left value) and how much is available in total (right value). Example: 86.5/238.5 GB
VM free space in last 5 min	This graph shows the percentage of space that is being used by the Logical Volume Manager.
DOCKER FREE SPACE	Similar to VM free space, Docker containers have their dedicated virtual partition. The values show how much of this partition is used (left value) and how much is available in total (right value). Example: 2.9/40.3 GB
Docker free space in last 5 min	This graph shows the percentage of space for Docker containers that is being used.

Local network configuration

From the Local UI, the Ethernet ports of the Nerve Device can be configured. Select **Network configuration** in the navigation on the left to reach this menu. The example below is of the MFN 100. The page is specific to the Nerve Device. The number and names of interfaces may differ.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.33

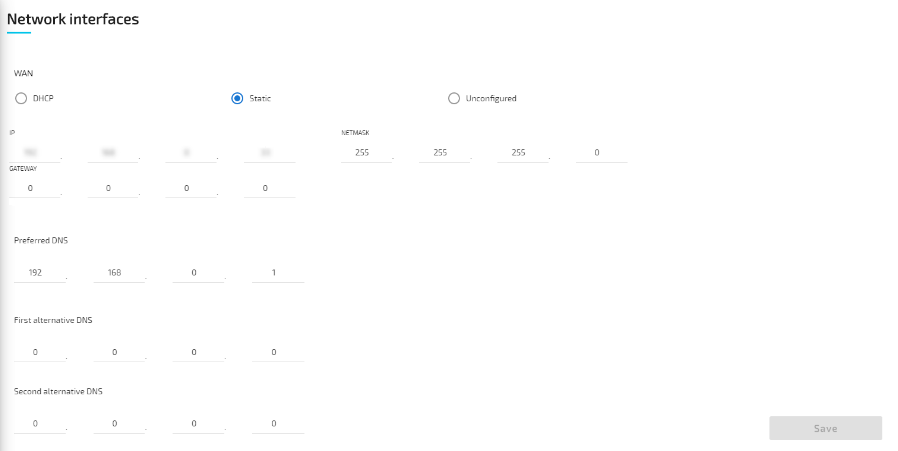
Network interfaces

WAN
● DHCP ○ Static ○ Unconfigured

EXTERN1
○ DHCP ○ Static ● Unconfigured
IP 0 . 0 . 0 . 0 NETMASK 0 . 0 . 0 . 0

EXTERN2
○ DHCP ○ Static ● Unconfigured
IP 0 . 0 . 0 . 0 NETMASK 0 . 0 . 0 . 0

EXTERN3
○ DHCP ○ Static ● Unconfigured

Item	Description
DHCP	The IP address of the port will be assigned by the DHCP server. If an IP address has been assigned, it will be displayed here.
Static	By selecting **Static**, the IP address of the port needs to be manually defined. Enter the IP address and subnet mask under **IP** and **NETMASK** to set a static IP address. For the WAN interface, the **GATEWAY**, the preferred **DNS** as well as two alternative DNS can also be set.  Network interfaces WAN ○ DHCP ● Static ○ Unconfigured IP [redacted] NETMASK 255 . 255 . 255 . 0 GATEWAY 0 . 0 . 0 . 0 Preferred DNS 192 . 168 . 0 . 1 First alternative DNS 0 . 0 . 0 . 0 Second alternative DNS 0 . 0 . 0 . 0 Save
Unconfigured	If **Unconfigured** is checked, the port is disabled for the host but can still be used for virtual machines with bridged interfaces.

NOTE

For more information on networking and interfaces refer to the networking chapter.

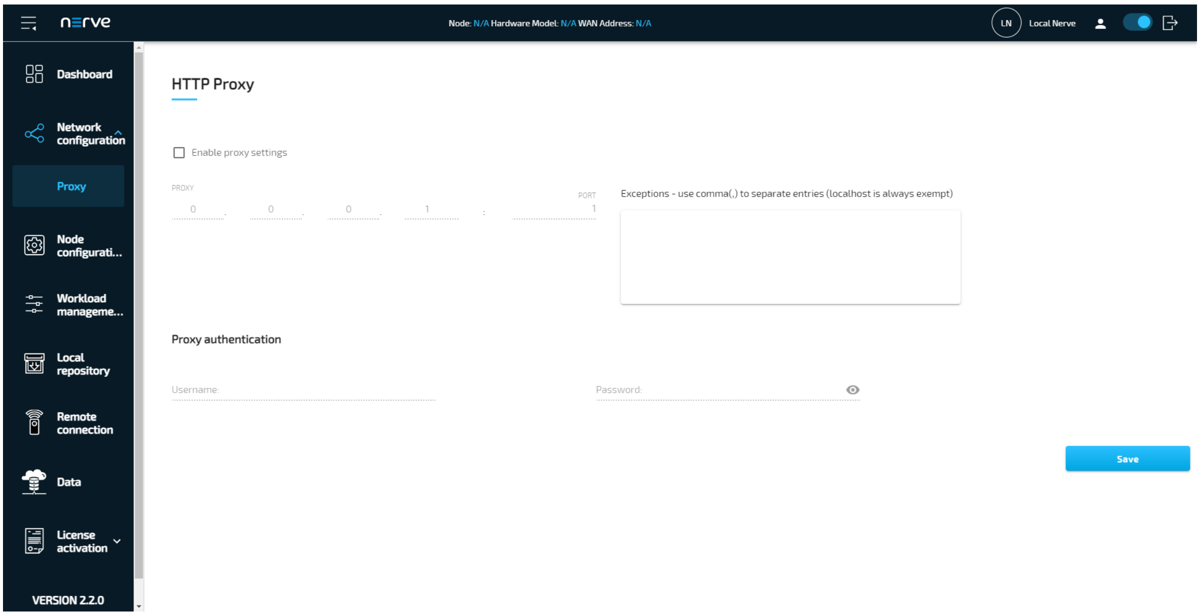
Proxy settings

Network configuration settings can be extended with the possibility to specify proxy settings. In case a proxy server is present in the company network, these settings can be used to enable communication between the node and the Management System. The proxy settings define an HTTP/S proxy for the node with the possibility to specify credentials if they are requested, as well as exceptions. Note that the proxy settings affect the internal communication of the node towards the Management System, and the connections covered by the proxy settings are only those related to:

- the management of workloads on the node
- logs sent from the node to the Management System
- data transmitted from the Data Services Gateway
- the Debian Advanced Package Tool (APT)

Potential connections generated by workloads on the node do not use the node proxy settings.

Expand **Network configuration > Proxy** to reach the proxy settings.



HTTP Proxy

☐ Enable proxy settings

PROXY 0 . 0 . 0 . 1 : PORT 1

Exceptions - use comma(,) to separate entries (localhost is always exempt)

Proxy authentication

Username:

Password:

Item	Description
Enable proxy settings	Tick the checkbox here to enable proxy settings.
PROXY	Enter the IP address of the proxy server here.
PORT	Enter the number of the port that is open for communication at the proxy server.
Exceptions - use comma(,) to separate entries (localhost is always exempt)	List IP addresses or hostnames of exceptions separated by a comma here. The node will directly communicate with the exceptions without using the proxy server. An example is a local workload repository that can be defined in the Local UI. Refer to Setting a local repository for more information.
Proxy authentication	Enter the **Username** and **Password** required to access the proxy server. This is optional. If the proxy server does not require login credentials, the fields can be left empty.

Select **Save** to apply the configuration. To undo the proxy settings, uncheck **Enable proxy settings** and select **Save**.

Node configuration

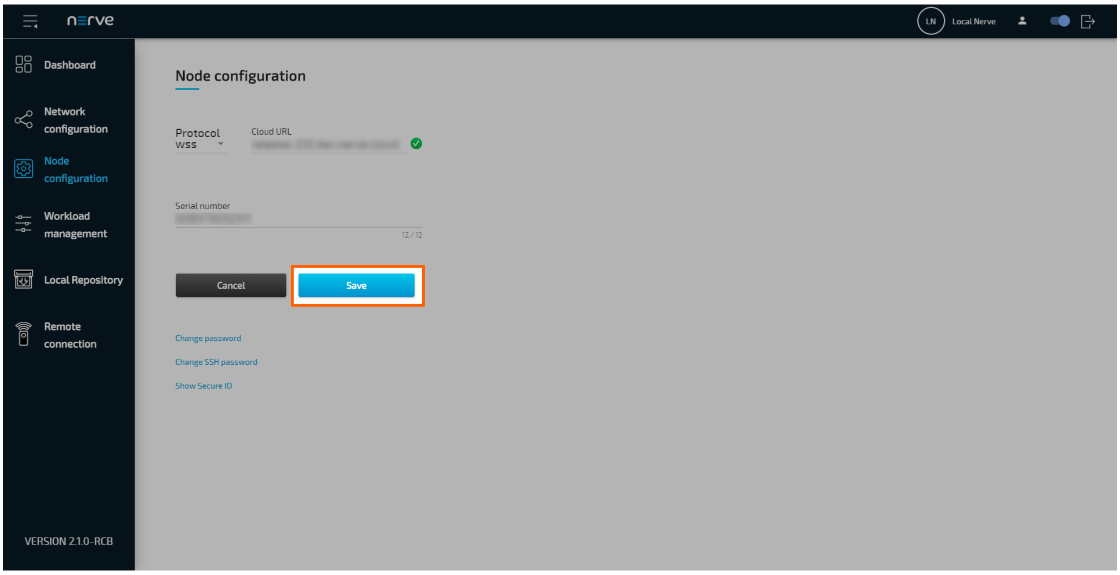
The first part of registering a node in the Management System is performed in the Local UI. Node details and information required for registering a node in the Management System are configured under **Node configuration**.

1. Select **Node configuration** in the navigation on the left.
2. Enter the following information:

Protocol	WebSocket Secure protocol (**wss**) is used for the registration of the node, meaning that port 443 will be used for communication between the node and the Management System.

Cloud URL	Enter the URL of the Management System without the protocol, e.g `example.nerve.cloud`. A green check mark will appear next to the URL if the URL is correct and the node can reach the Management System. If a red icon appears, check the URL for errors and whether network access is established.
Serial number	Enter a serial number with a minimum of 12 characters. Note that this serial number can be freely defined. It is required for node registration in the Management System and serves as a means of identification. Entering the serial number that is printed on the Nerve Device is not required but recommended.

3. Select **Save**.



With the serial number saved in the node configuration, the secure ID has been generated and can be displayed by selecting **Show Secure ID**. This secure ID is required when adding the node in the Management System. Refer to Adding a node on how to add nodes to the Management System.

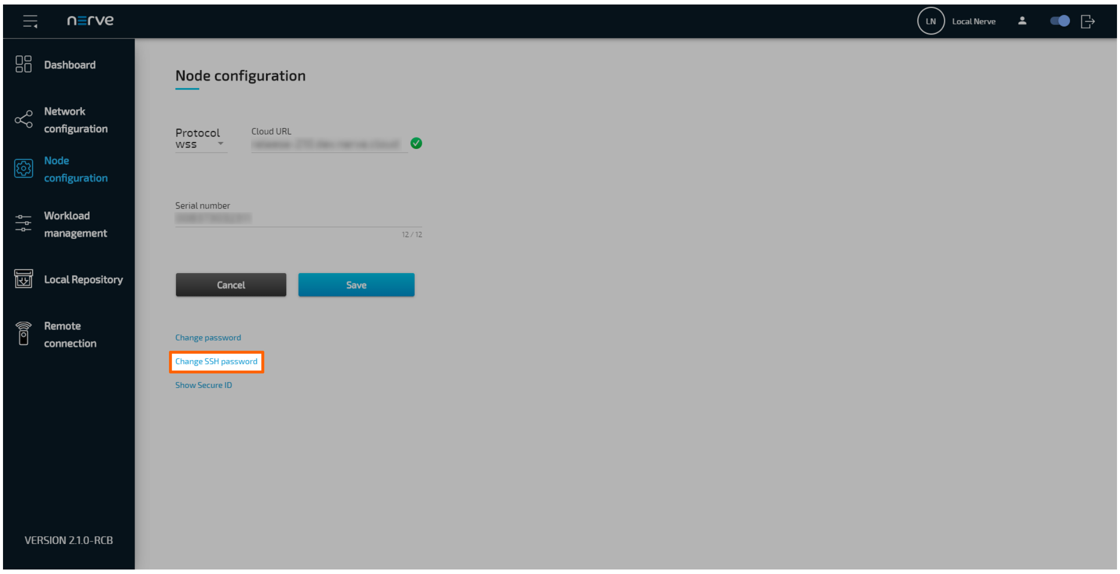
Changing the password for host access

The password for host access via SSH can be changed. The default password for host access is found in the customer profile. Changing the host access password makes it persist through version updates. If the default password is not changed, updating the node to a newer version will change the host access password to a new default.

> **NOTE**
>
> Access to the Linux host system of Nerve is provided in order to enable advanced use cases. Using host access requires expert Linux knowledge as system internal changes can be performed. Note that changes may impact the Nerve system.

1. Select **Node configuration** in the navigation on the left.

2. Select **Change SSH password**



Node configuration

Protocol: WSS

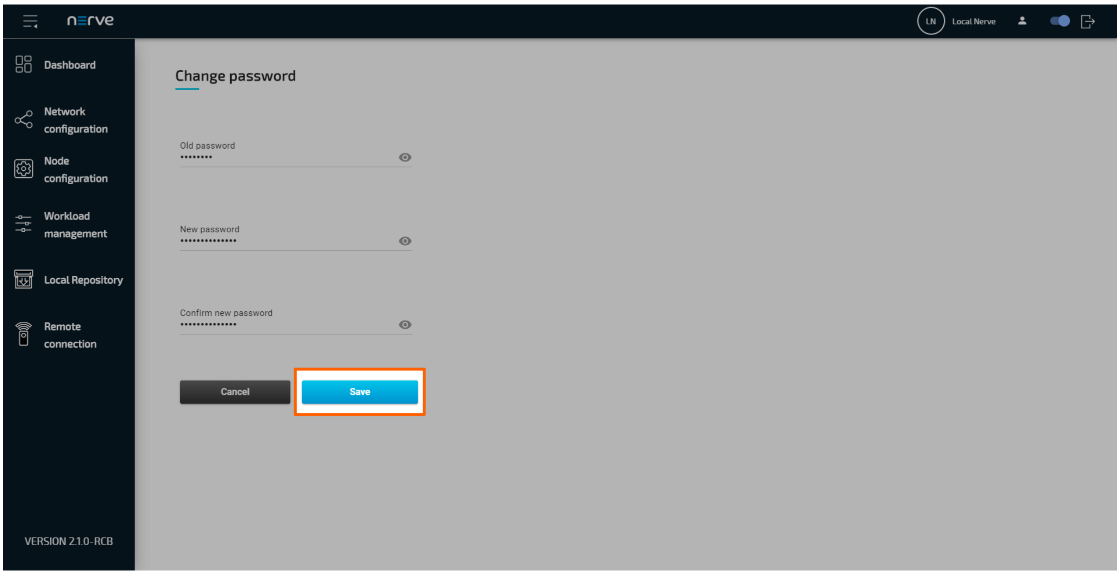
Cloud URL: [redacted]

Serial number: [redacted] 12 / 12

3. Enter the following information:

Item	Description
Old password	Enter the old password for host access.
New password	Enter the new password here. The new password must be 8 characters or longer and it can only consist of alphanumeric characters.
Confirm new password	Enter the new password again. Both passwords must match in order to proceed.

4. Select **Save** to set the new password.



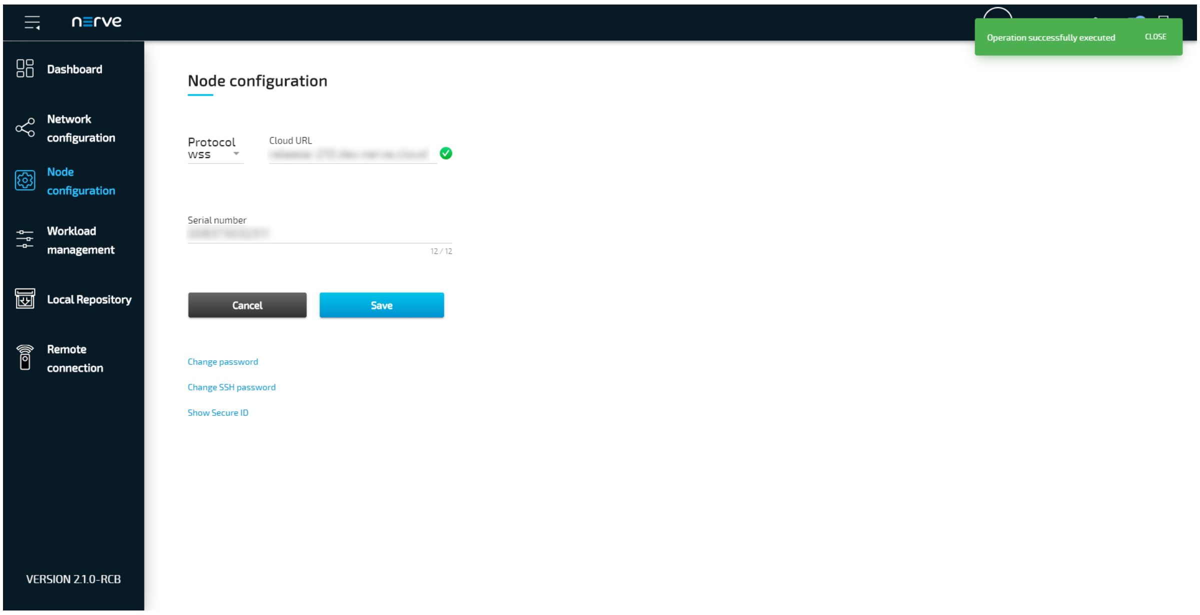
Change password

Old password: ••••••••

New password: ••••••••••••••

Confirm new password: ••••••••••••••

If the process was successful, the Local UI will display the dashboard with a green notice confirming the change in the upper-right corner.



Node configuration

Protocol wss

Cloud URL [redacted] ✓

Serial number [redacted] 12 / 12

Change password

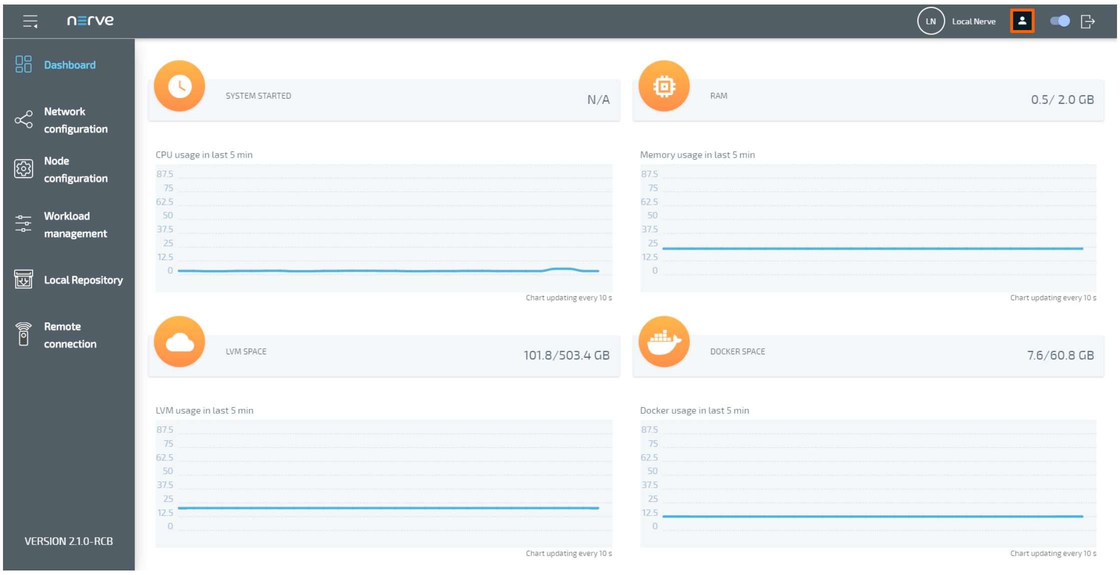
Change SSH password

Show Secure ID

Changing the password for the Local UI

The password to the Local UI can be changed. The default password for Local UI access can be found in the customer profile. Changing the password to the Local UI makes it persist through version updates. If the default password is not changed, updating the node to a newer version will change the Local UI password to a new default.

1. Select the user icon (**Change password**) in the upper-right.



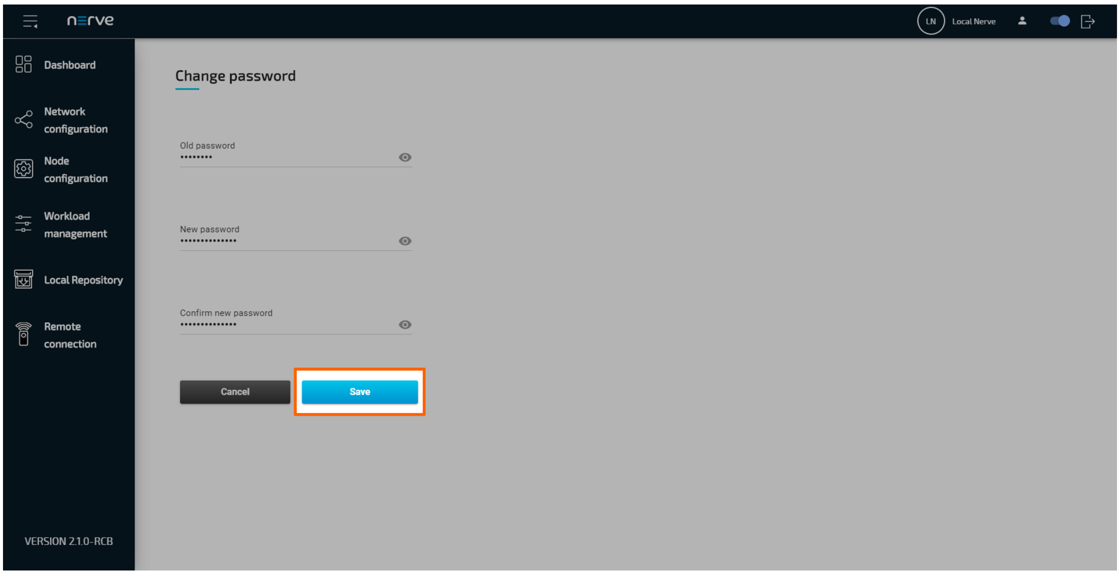
NOTE

Alternatively, it is also possible to change the password in the Node configuration menu. Select **Node configuration** in the navigation on the left and select **Change password** to reach the password form.

2. Enter the following information:

Item	Description
Old password	Enter the old password to the Local UI.
New password	Enter the new password here. The new password must be 8 characters or longer and it can only consist of alphanumeric characters.
Confirm new password	Enter the new password again. Both passwords must match in order to proceed.

3. Select **Save** to set the new password.



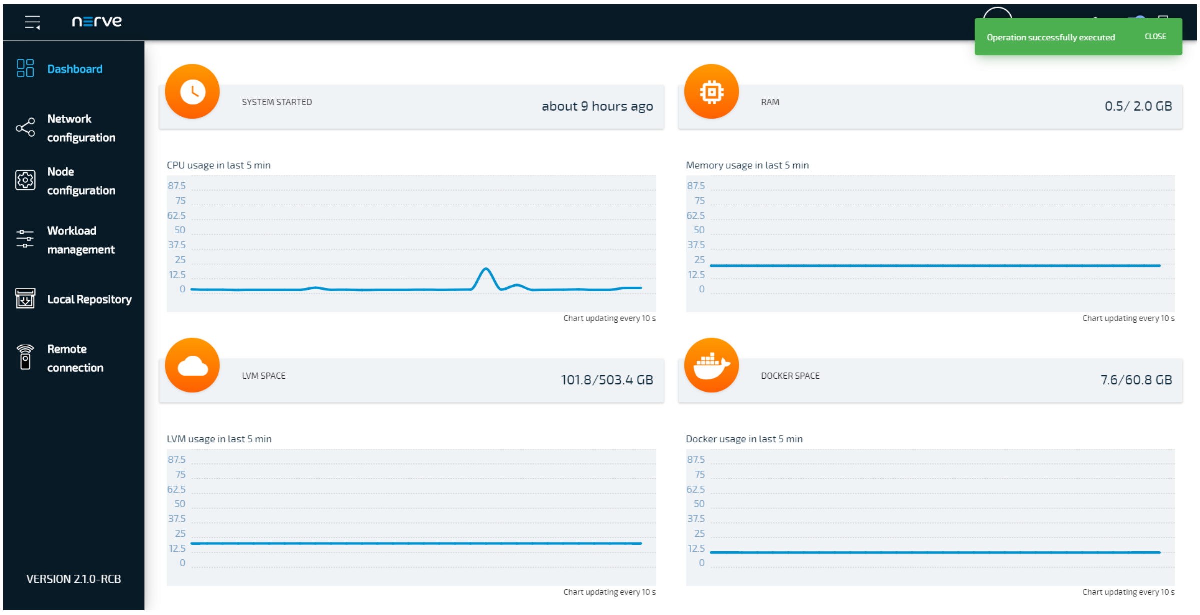
Change password

Old password
••••••••

New password
••••••••••••••

Confirm new password
••••••••••••••

If the process was successful, the Local UI will display the dashboard with a green notice confirming the change in the upper-right corner.



Operation successfully executed

SYSTEM STARTED about 9 hours ago

RAM 0.5/ 2.0 GB

CPU usage in last 5 min

Memory usage in last 5 min

LVM SPACE 101.8/503.4 GB

DOCKER SPACE 7.6/60.8 GB

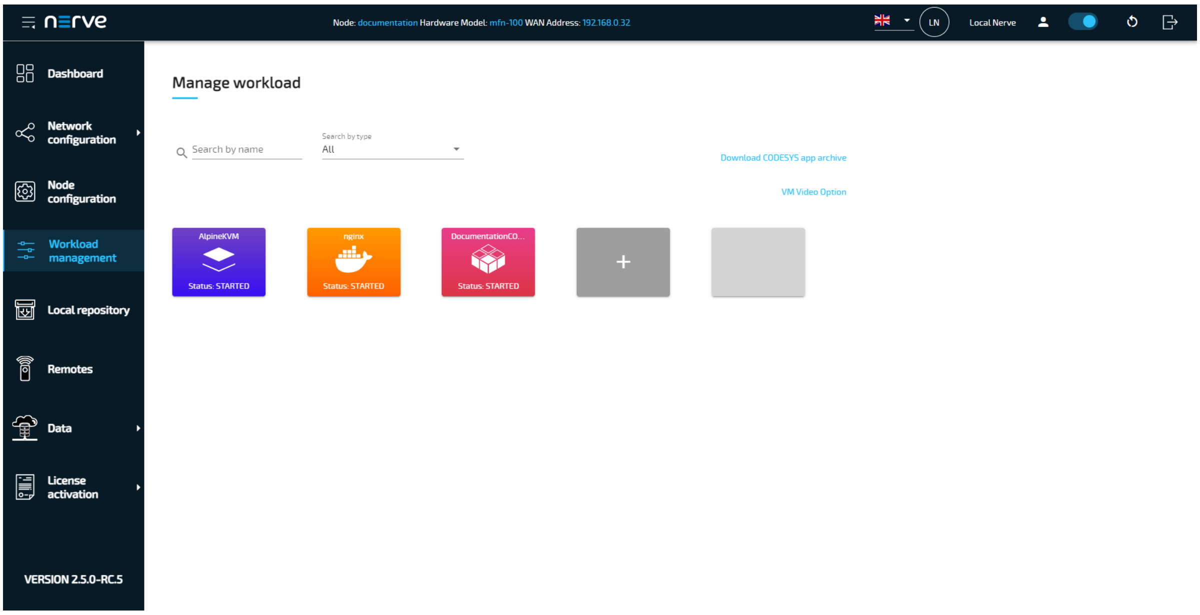
LVM usage in last 5 min

Docker usage in last 5 min

Workload management

Deployed workloads can be controlled in the Local UI. Select **Workload management** in the navigation menu on the left-hand side for an overview of all deployed workloads.

Then, select a workload to reach the interface for controlling workloads running on the Nerve Device. If there is a large number of workloads deployed, filter the list by name or by type. Enter a search query under **Search by name** to filter the list by name. Select **All**, **VM**, **Codesys** and **Docker** from the drop-down menu to filter workloads by type.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.32

Manage workload

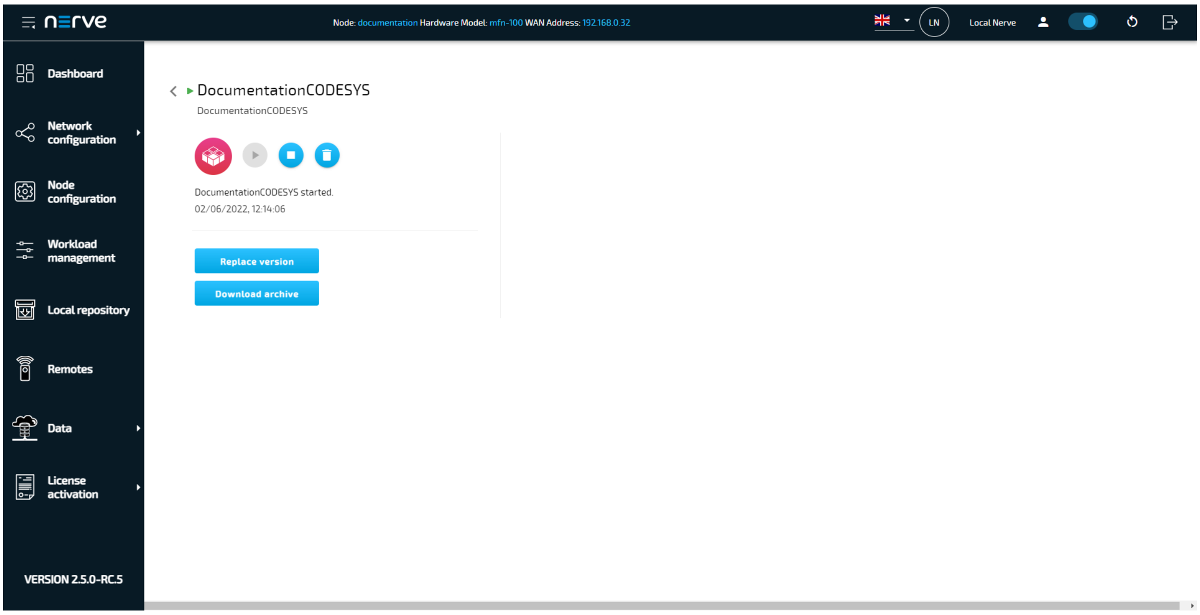
Search by type: All

AlpineKVM Status: STARTED

nginx Status: STARTED

DocumentationCO... Status: STARTED

Note that CODESYS workloads can only be controlled in the Local UI, as operation of a CODESYS workload may have an impact on machine operation and therefore should not be controlled remotely. Virtual Machine workloads and Docker workloads can also be controlled in the Management System. Therefore, the screenshot and description below focuses on CODESYS workload specifics only. Refer to Workload control for general information on workload control.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.32

DocumentationCODESYS

DocumentationCODESYS

DocumentationCODESYS started.
02/06/2022, 12:14:06

Item	Description
Replace version	Select this to replace the current workload version with a different one as a TAR file. Note that the new workload version must be exported from the Management System first. Refer to Updating a deployed workload in the Local UI below for more information.

Item	Description
Control panel	The control panel for CODESYS workloads only offers **Play** and **Stop** control options: • **Play** If the workload is in a stopped state, selecting **Play** will start the workload. • **Stop** If the workload is running, selecting **Stop** will stop the workload. Also, stopping a CODESYS workload will reset it to its initial values unless the CODESYS application has been written using the retain variables library. Refer to Enabling retain variables for more information.
Message window	The message window displays the latest message the workload has sent out including how much time has passed since it was sent out. The type of message that is displayed here depends on the workload. CODESYS workloads have the following set of messages: • "Preparing files for installation" • "Starting CODESYS application" • "CODESYS application started" • "Stopping CODESYS application" • "CODESYS application stoppped" • "Removing CODESYS application file" • "An unexpected error has occurred. <errormessage>" Here, <errormessage> is a message that is sent between the node and CODESYS.

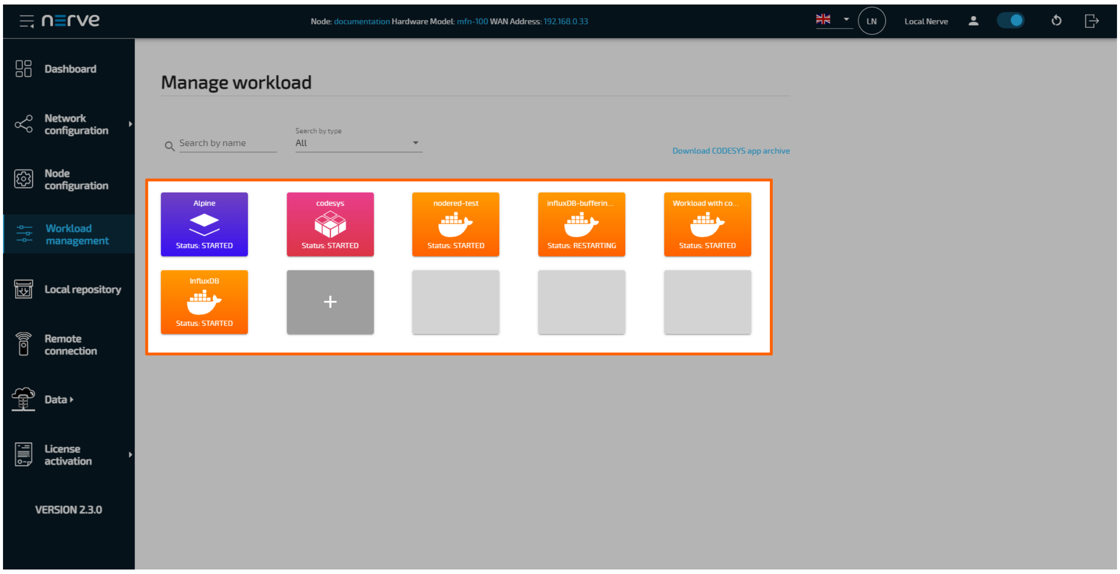
All changes performed in the Local UI are reflected in the Management System.

Replacing the version of a deployed workload in the Local UI

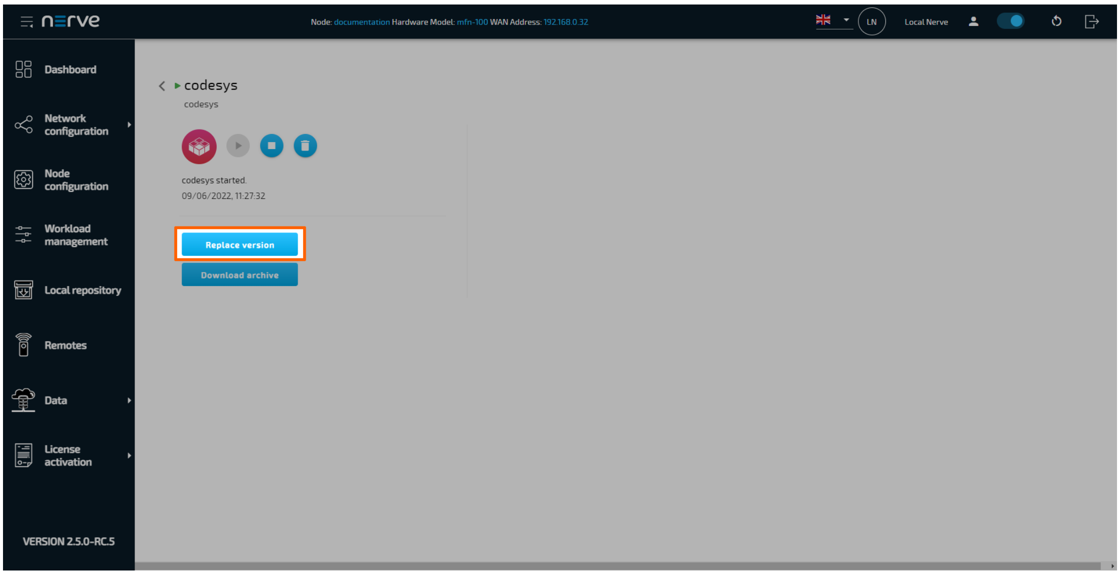
Versions of deployed CODESYS and Docker workloads can be replaced by other versions through the workload control screen. Replacing the workload version is a quick way to deploy a new version of the same workload. However, note that the new workload version needs to be exported first when replacing a workload version through the Local UI. Refer to Exporting a workload for more information on how to export a workload version in the Management System.

1. Select **Workload management** in the navigation on the left.

2. Select the tile of a workload with multiple versions.



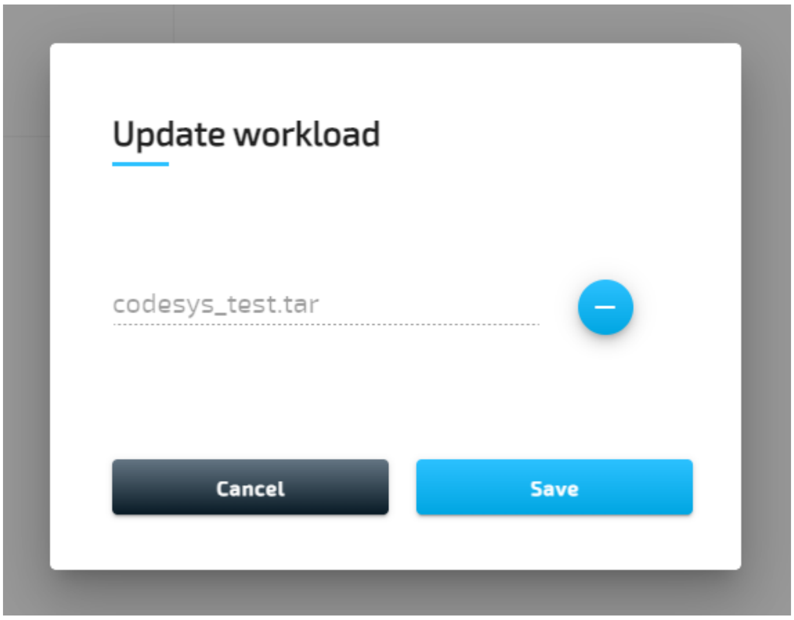
3. Select **Replace version**.



4. Select the plus icon to open the file browser.

5. Select the exported workload version update in TAR format.

6. Select **Open** to add the exported workload update.

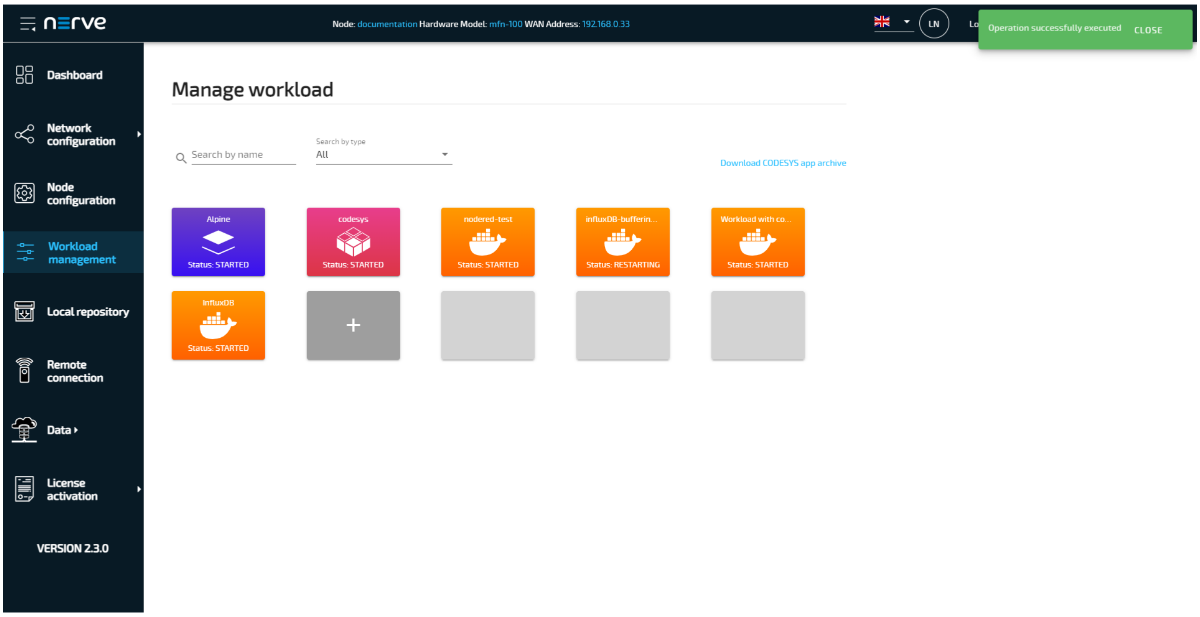


Update workload

codesys_test.tar

7. Select **Save**.

This starts the replacement of the workload version. Once the deployment of the new version is completed, the Local UI will return to the workload management screen and display a green success message in the upper-right corner.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

Operation successfully executed

Manage workload

Search by type: All

Alpine Status: STARTED

codesys Status: STARTED

nodered-test Status: STARTED

influxDB-bufferin... Status: RESTARTING

Workload with co... Status: STARTED

InfluxDB Status: STARTED

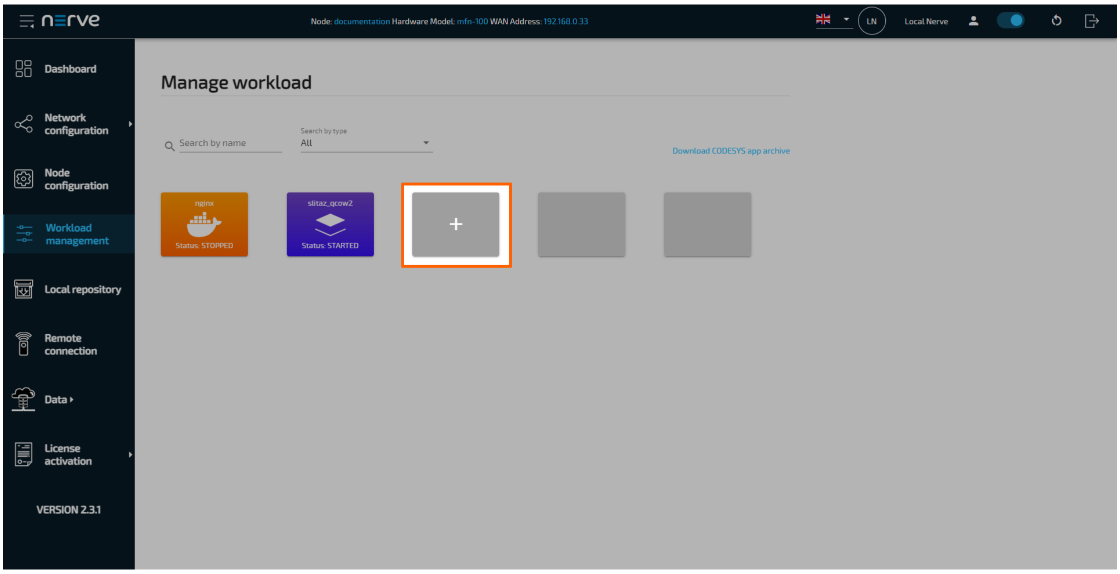
VERSION 2.3.0

Local workload deployment

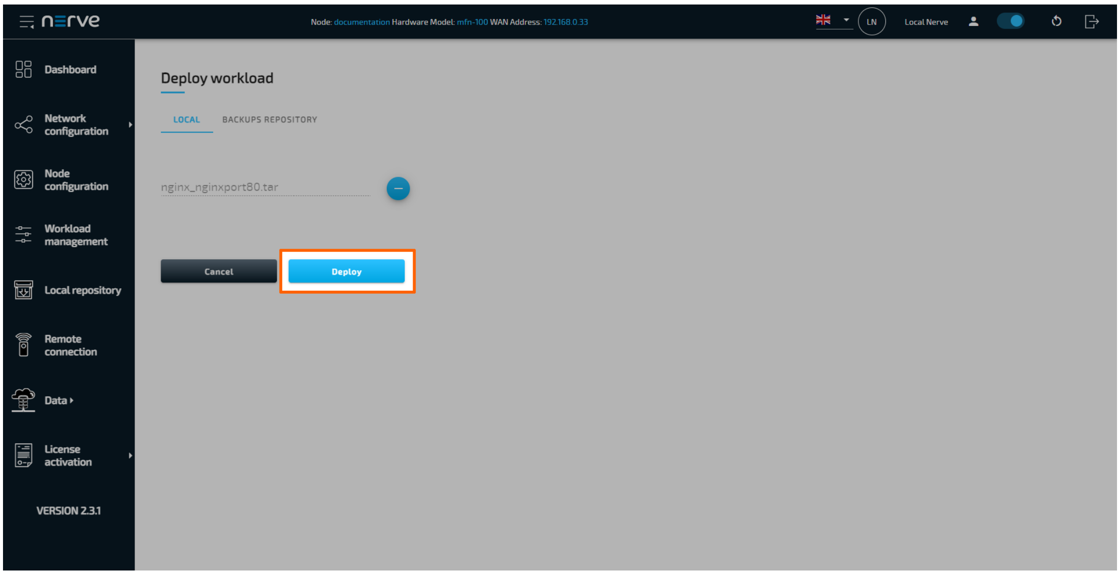
Workloads that have been provisioned in the Management System can be exported and then deployed directly through the Local UI. Refer to the workloads chapter on how to export a workload before following the instructions below.

1. Export a workload in the Management System.
2. Switch to the Local UI.
3. Select **Workload management** in the navigation on the left side.

4. Select the plus tile in the middle.



5. Select the plus symbol to open the file browser.
6. Add the TAR file containing the exported workload.
7. Select **Save** to deploy the workload.



Setting a local repository

If desired, the required files for deploying workloads can be stored in a local repository that does not require internet connection. In doing so, the workload image files for deployment are taken from a user defined repository instead of the workload repository in the Management System.
Refer to Exporting a Workload for information on how to obtain the workload images. Also note that every workload needs to be provisioned in the Management System once before the image files can be transferred to a local repository.

A web server that services static files is required. Popular web servers like Nginx or Apache HTTP Server can be used, as well as a Network-attached storage (NAS) device. Recommended are:

- the NodeJS http-server for Linux

- the built-in Internet Information Services (IIS) for Windows

The IIS for Windows needs to be activated first in newer versions of Windows like Windows 8 and Windows 10.

1. Open the **Control Panel**
2. Navigate to **Control Panel > Programs > Programs and Features**.
3. Select **Turn Windows features on or off**
4. Tick the checkbox next to **Internet Information Services**.
   Note that ticking the checkbox will only enable the components required to publish a web site. Expand the folder to select other needed features.
5. Select **OK**.

With this the IIS can be used on a Windows machine. Take the following steps to enable the hosting of the workload images. The steps below are not carried out in detail as they are only serving as a guideline.

1. Remove all files from the document root. The default location of the document root is `C:\inetpub\wwwroot`.
2. Copy the TAR files of the workloads that have been exported from the Management System to the document root.
3. Enable directory listing.
4. Test the web server by opening http://localhost in a web browser.
5. Test if a computer can be reached from another computer in the network.

NOTE

Note that all served files can be accessed from all computers connected to the same network.

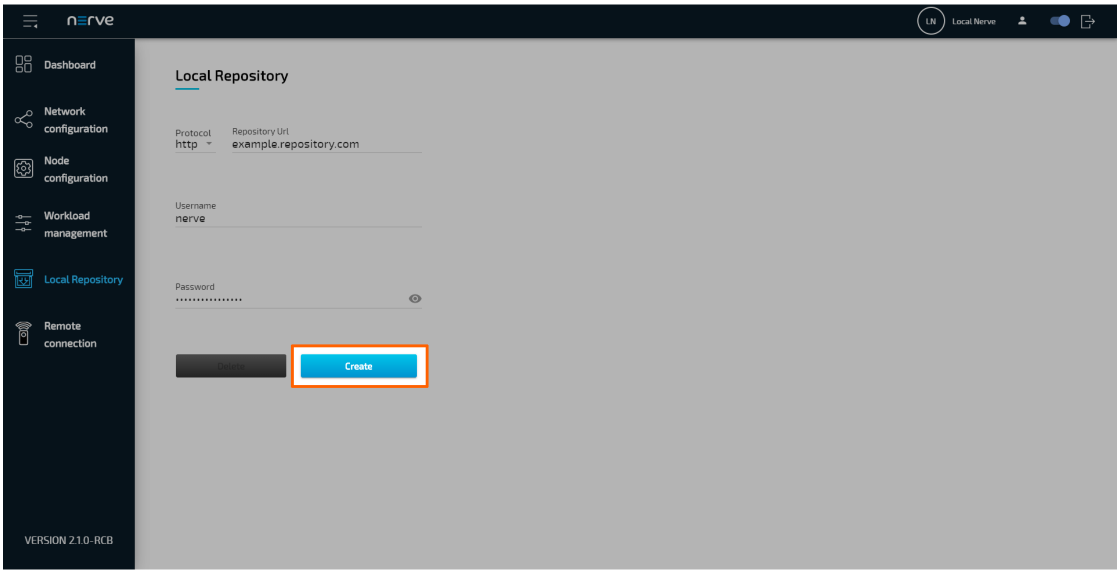
For more information, refer to the IIS documentation. Follow the instructions below to enable a local repository for a node:

1. Select **Local Repository** in the navigation on the left.

2. Enter the following information:

Protocol	Select the protocol for communication with the local repository: **http** or **https**.
Repository URL	Enter the URL through which the web server hosting the workload images can be accessed.
Username	If login credentials have been defined for the web server, enter the username for accessing the web server hosting the workload images.
Password	If login credentials have been defined for the web server, enter the password for accessing the web server hosting the workload images.

3. Select **Create** to finish the setup.



Local Repository

Protocol: http

Repository Url: example.repository.com

Username: nerve

Password: ••••••••••••••••

Delete

Create

If a local repository is defined in the Local UI, the Management System will look for the workload images in the local repository first when a workload is deployed to this node. If the workload image is not present in the local repository, the workload repository in the Management System will be used instead. To revert back to using the repository of the Management System, select **Local Repository** in the navigation on the left and select **Delete**.

Managing remote connections

The behavior of nodes for remote connections is defined when a remote connection is configured in the Management System. Refer to Remote connections for more information.

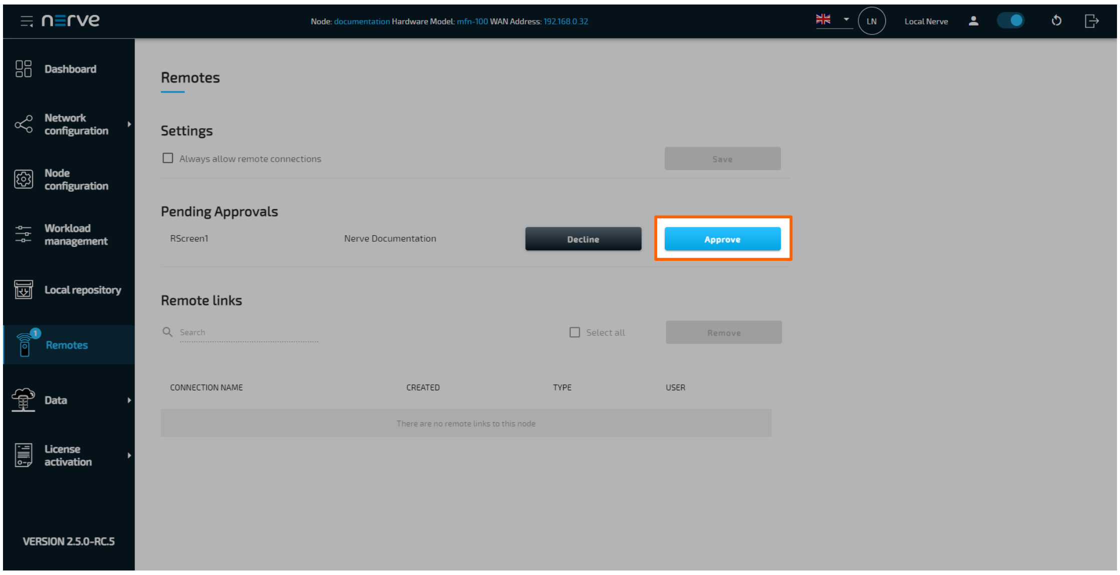
Settings	Tick the checkbox next to **Always allow remote connections** to automatically approve all remote connection requests. This setting is only valid when **Local acknowledgment** is set to **Yes** in the remote connection configuration in the Management System.
Pending Approvals	Incoming connection requests are displayed here. Select **Approve** to accept the remote connection. Selecting **Cancel** denies the incoming request. This setting is only valid when **Local acknowledgment** is set to **Yes** in the remote connection configuration in the Management System.
Remote links	Connection requests that have been approved and are currently open are listed here.

Approving a remote connection

Local approval for remote connections can be configured in the Management System. Set **Local acknowledgment** to **Yes** when configuring a remote connection. When set to **Yes**, every remote connection has to be approved in the Local UI before it can be established. If approval for an incoming remote connection is pending, a notification bubble appears next to **Remote connections** in the navigation on the left.

1. Select **Remote connections** in the navigation on the left.
2. Search for incoming remote connections under **Pending Approval**.

3. Select **Approve** on the right for the remote connection that shall be established.



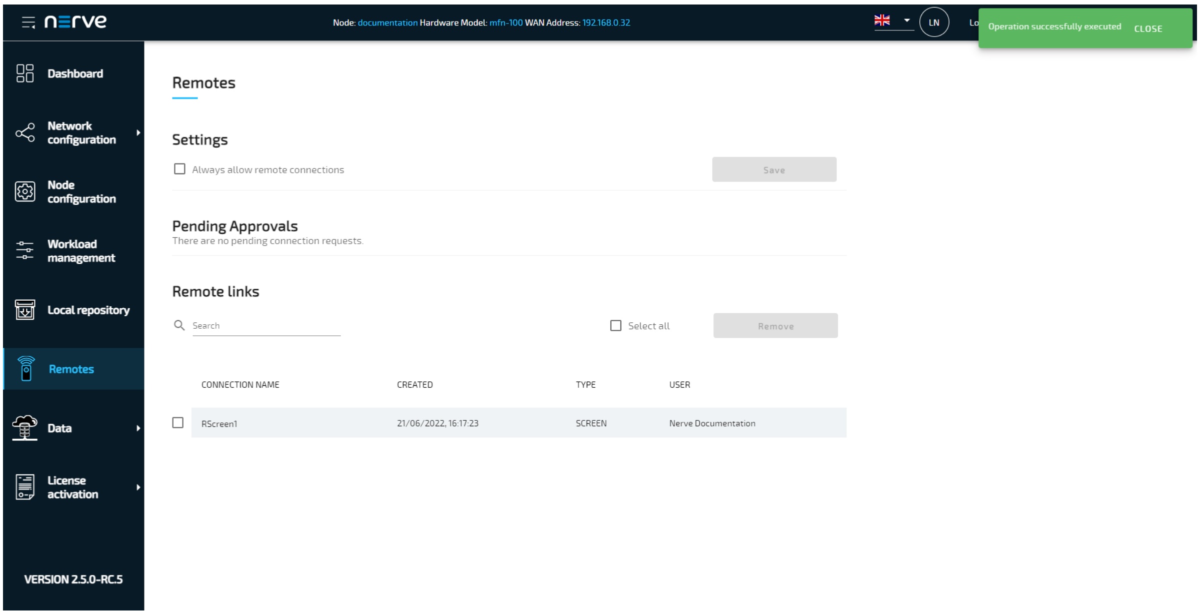
□ Always allow remote connections

RScreen1	Nerve Documentation	Decline	Approve

CONNECTION NAME	CREATED	TYPE	USER

There are no remote links to this node

Once approved, the open connection will be displayed under **Remote links** below. Shown are the name of the remote connection and the user that is currently using the remote connection. If the same remote connection is used by multiple users, multiple entries of the same remote connection are shown with different users.



Operation successfully executed

□ Always allow remote connections

There are no pending connection requests.

	CONNECTION NAME	CREATED	TYPE	USER
□	RScreen1	21/06/2022, 16:17:23	SCREEN	Nerve Documentation

Nerve Management System

Nerve Management System

The Nerve Management System is a web-based service that permits management of Nerve nodes that are registered. The Management System communicates through pop-up notifications in the upper-right corner. Success messages are displayed in green boxes. Red boxes are used for error messages, while light blue boxes are used for general notifications.

> **NOTE**
>
> Google Chrome or Firefox Version 63 or later are recommended for the usage of the Management System.

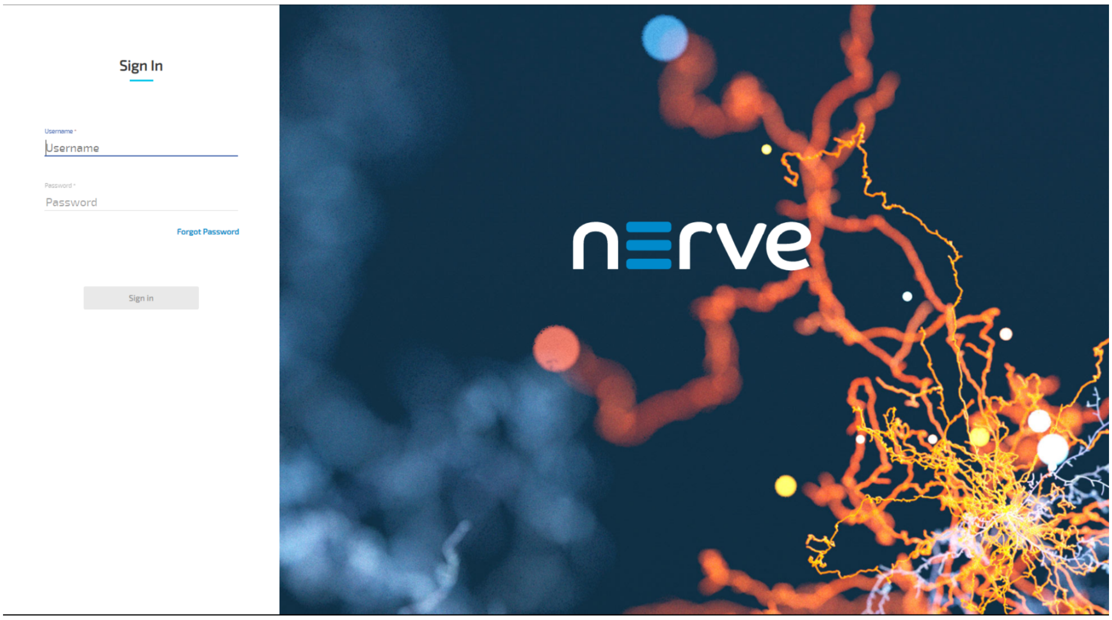
Logging in to the Management System

The Management System is either hosted by TTTech Industrial or installed on premise. The URL of the Management System changes accordingly. Find the URL of the Management System in the customer profile if it is hosted by TTTech Industrial.

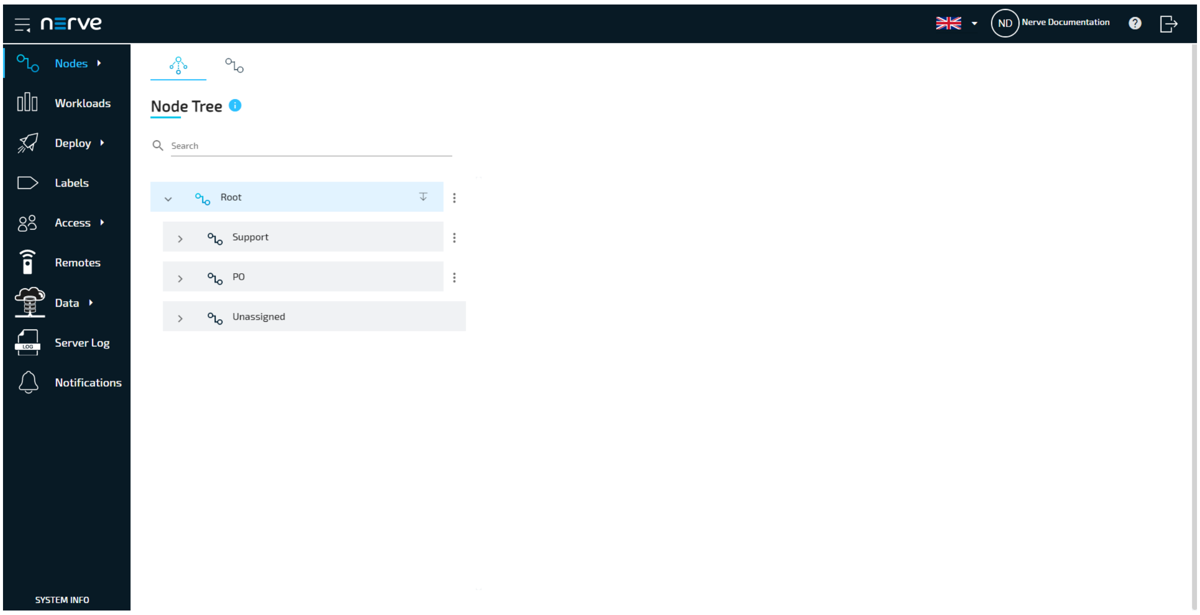
> **NOTE**
>
> The Management System has brute force login protection in place. Five failed login attempts in a row will block the current user from logging in again from the same IP address for 30 minutes. After a hundred failed log in attempts from one IP address, the IP address will be blocked for 24 hours.

1. Go to the URL of the Management System.
2. Log in with the credentials for the Management System.

   > **NOTE**
   >
   > The initial login credentials of the Management System can be found in the customer profile. If a customer profile has not been part of the delivery, contact a sales representative or TTTech Industrial customer support at support@tttech-industrial.com.

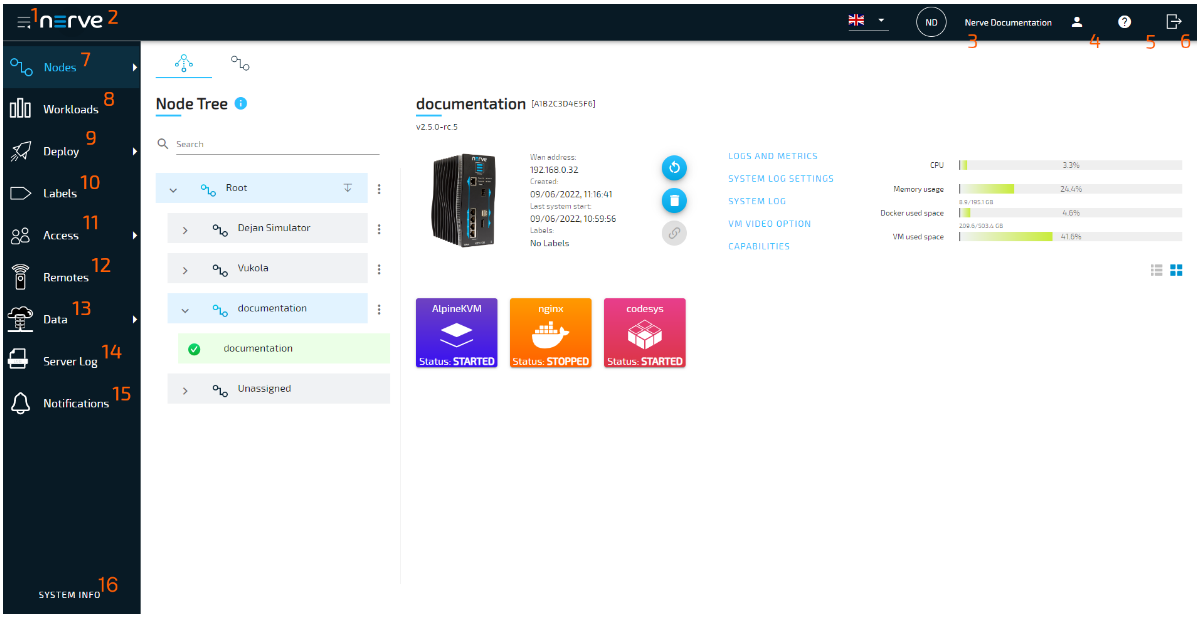


The node tree is the landing page of the Management System. Note that after 30 minutes of inactivity, users are logged out automatically.



Menu structure of the Management System

As a landing page the Management System shows the node tree. Navigate the site by using the menu bar on the left side.



Item	Description
Burger Menu (1)	Clicking here will expand and collapse the menu bar on the left side. The expanded version of the menu adds names to the menu icons.
Nerve logo (2)	Return to the node tree by clicking the Nerve logo.
Language selection (3)	Click here to select the interface language. Available languages are English and Korean.
User display (4)	Access the user details of the active user from here.
Documentation link (5)	Click the question mark to open the Nerve documentation in a new browser tab.
Log out button (6)	Clicking this icon will log out the active user from the Management System.

Item	Description
Nodes (7)	The nodes menu has two sub-menus in the navigation on the left and two tabs in the default view. **Tabs** • **Node Tree Tab** This is the default view of the Management System. It displays all registered nodes in a node tree. Add, delete and move tree elements freely here. It mainly serves an organizational purpose and does not impact the functionality of the nodes. Nodes and workloads can be managed in the node details view, which is reached through the node tree. • **Node List Tab** Selecting the nodes tab displays a list of all available nodes that have been registered in the Management System. Add and remove nodes, as well as edit their details here. **Sub menus** ◦ **Updates** Available updates for nodes can be found here. ◦ **Update Log** Past node updates can be viewed here. When an update is performed, this view also shows the current progress of the update.
Workloads (8)	All workloads that have been provisioned in the Management System are listed here. Workloads can be added, deleted, disabled and edited through this menu. New versions of workloads can also be added here.
Deploy (9)	Workloads that have been provisioned previously can be deployed using this menu. However, there are two sub menus available here: • **Log** Find a list of all workloads that have been deployed or are currently being deployed. Also, view details of all deployments and delete log entries from the list. • **Dry Run** A dry run is a simulation of a workload deployment. It allows to test out if the deployment of a workload could be successful. However, note that a successful dry run is not a guarantee for successful deployment.
Labels (10)	This is a list of all labels that have been defined in the Management System. Add, delete, edit and merge labels here.

Item	Description
Access (11)	Find settings for user, permission and access management in this menu. • **Users** This is the user management menu. It lists all registered users and allows to edit profiles and add new users. • **Roles** Manage user roles and and permissions here. • **LDAP** Synchronize the Nerve access management with an existing LDAP server here.
Remotes (12)	Currently active remote connections are displayed here. Refer to Remote Connections for more information.
Data (13)	Access the instance of the Nerve Data Services in the Management System here. This feature is disabled by default and must first be activated by an admin user. Refer to Nerve Data Services for more information.
Server Logs (14)	Look at internal server logs here. These internal server logs are aimed at Nerve service technicians in case of error and failure. Data is stored with OpenSearch and visualized with OpenSearch Dashboard.
Notifications (15)	Set user-defined system notifications here. A notification can be set to display either before or after logging in using this menu.
SYSTEM INFO (16)	Clicking here leads to two menus: **Available Updates** and **Usage Reports**. • **Available Updates** This is the first visible menu after selecting **SYSTEM INFO**. It displays information about the current version of the Management System and available updates of the Management System. • **Usage Reports** Find usage information in regards to the Management System that is required for proper billing here. Refer to Usage reports below for more information.

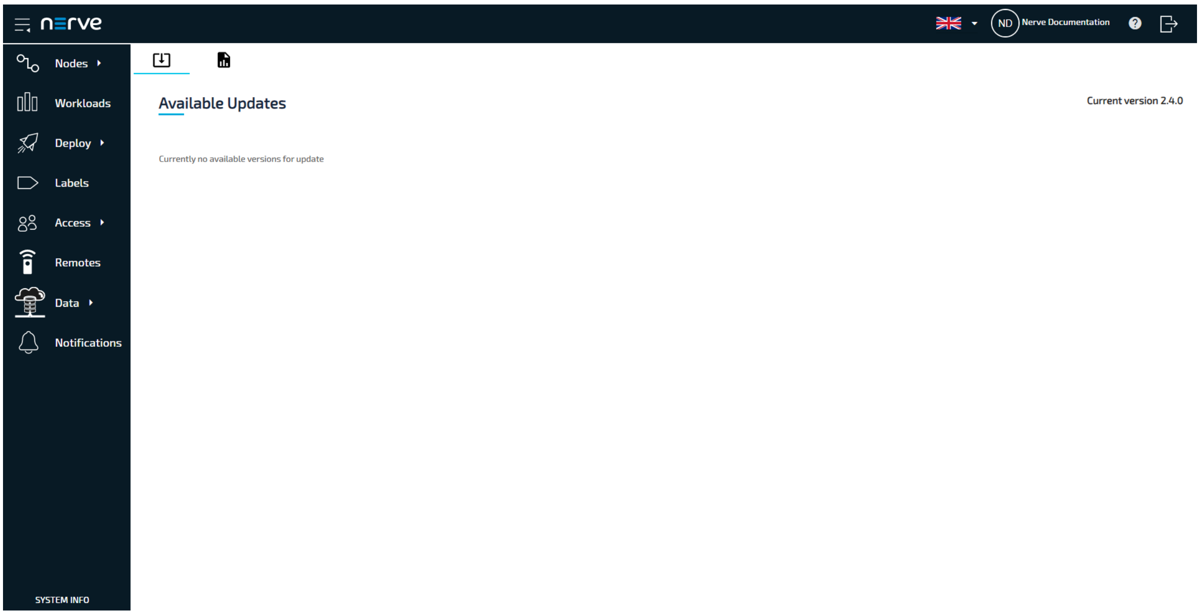
NOTE

The available features of the Management System depend on the user role. Refer to Roles and Permissions for more information.

Updating the Management System

A download icon next to **SYSTEM INFO** appears in the lower-left corner of the Management System if an update to the Management System is available. However, updates of the Management System need to be performed by Nerve service technicians from version 2.3.0 on. Contact a sales representative or TTTech Industrial customer support at support@tttech-industrial.com. A backup of the current Management System is made when an update is performed. Reverting to the previous version is possible.

Select **SYSTEM INFO** in the lower-left corner to see currently available updates in the **Available Updates** tab.



Current version 2.4.0

Currently no available versions for update

The current version of the Management System is displayed in the upper-right corner in the **Available Updates** tab. Hovering over **SYSTEM INFO** also displays the current version of the Management System.

Reverting the Management System to the previous version

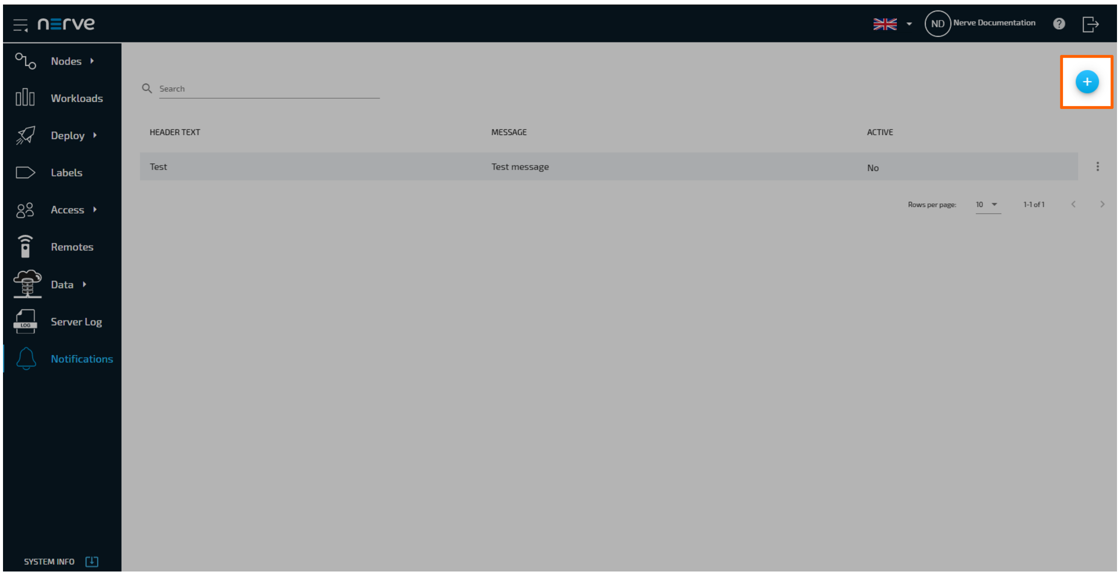
As it is the case with Management System updates, reverting the Management System to the previous version needs to be performed by Nerve service technicians. Downgrading the Management System to an older version is not possible.

Setting system notifications

User-defined system notifications can be set for the Management System. Notifications are displayed as a pop-up, consisting of header and body text. Multiple notifications can be defined. However, only one message at a time can be active. Notifications are displayed for every user either before or after logging in to the Management System. No notifications are set by default.

1. Select **Notifications** in the navigation on the left.

2. Select the plus symbol in the upper-right.

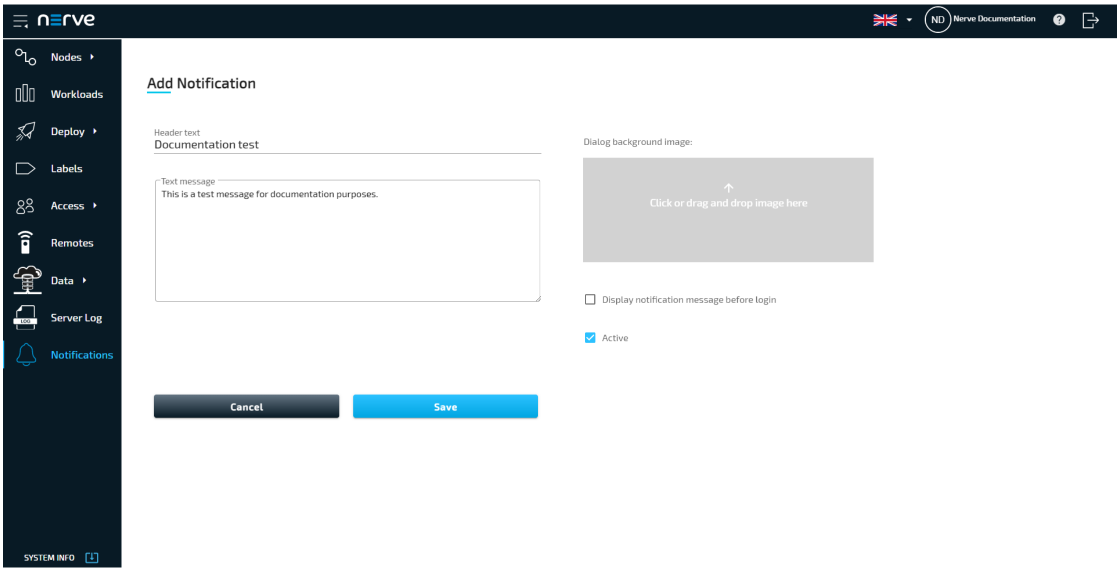


HEADER TEXT	MESSAGE	ACTIVE
Test	Test message	No

3. Enter the following information:

Setting	Description
Header text	Enter the header text of the notification pop-up. This text has a limit of 60 characters.
Text message	Enter the body text of the notification pop-up.
Digital background image	Add a background image to the notification pop-up. Supported formats are JPEG, PNG, JPG, JFIF, PJPEG and PJP. Note that the image will be stretched to fit the entire pop-up, including header and body.
Display notification message before login	Tick the checkbox here to have the notification displayed before logging in. If this checkbox is not ticked, the notification is displayed after logging in.
Active	Tick the checkbox here to set the current notification as active. Doing so deactivates all other notifications. Untick the checkbox to deactivate the notification. Note that this also deactivates notifications in general until another notification is set to active.

4. Select **Save** to save the notification settings.



Add Notification

Header text: Documentation test

Text message: This is a test message for documentation purposes.

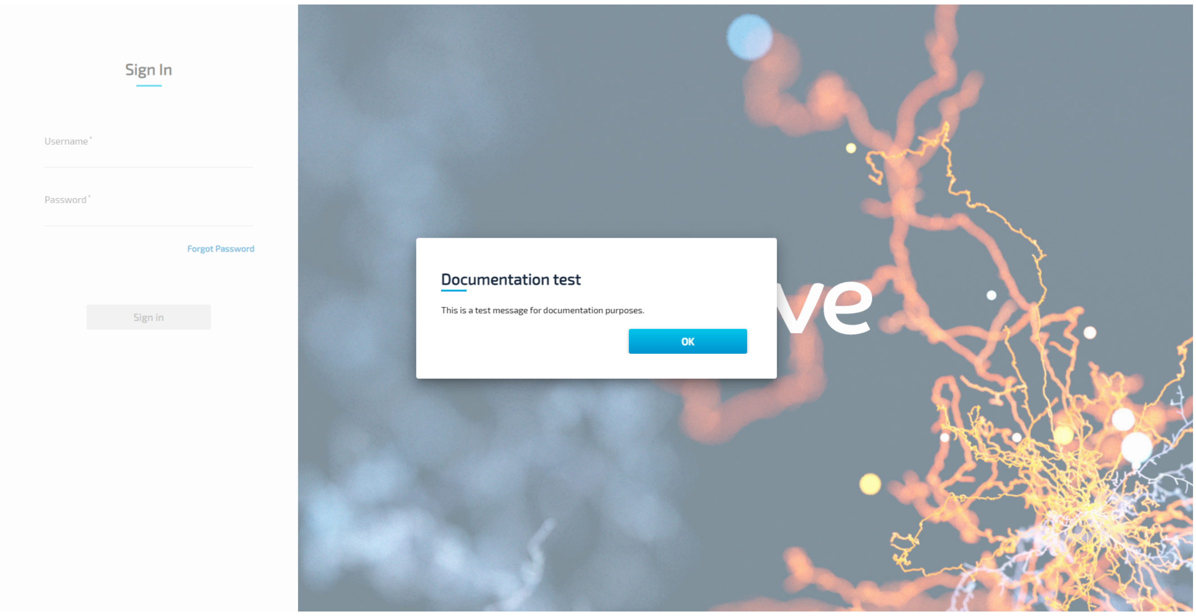
Dialog background image:

□ Display notification message before login

☑ Active

The notification now appears in the list of notifications. The list is split into three columns: **HEADER TEXT**, **MESSAGE** and **ACTIVE**. Select **DELETE** from the ellipsis menu to the right of a notification to delete a notification. Refer to the screenshots below for examples of notifications in use:

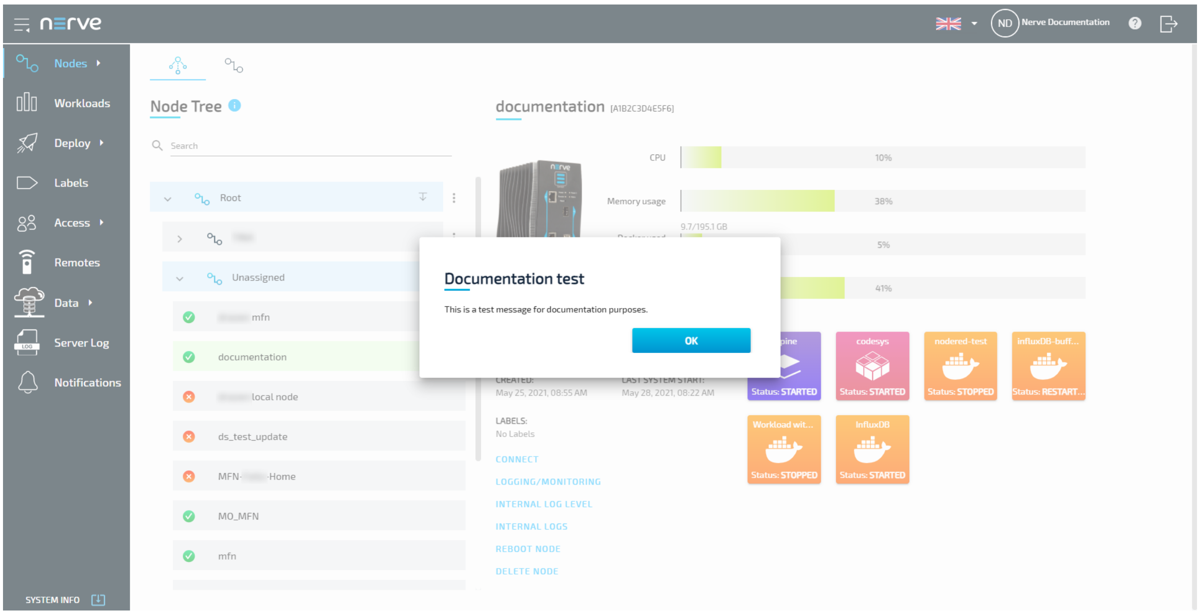
Before logging in



Documentation test

This is a test message for documentation purposes.

After logging in



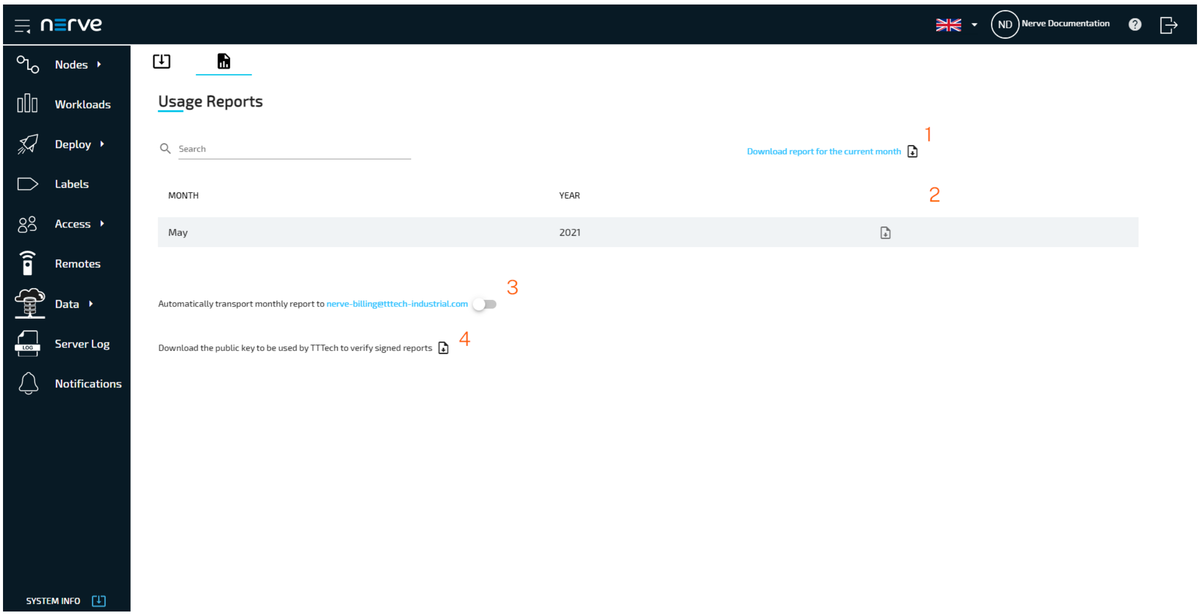
Documentation test

This is a test message for documentation purposes.

Usage reports

Usage reports contain information about the usage of the Management System that is required for proper billing by TTTech Industrial. They need to be delivered monthly according to the contractual agreement. This can be done manually or automatically. Usage reports are compiled for each month and digitally signed for authenticity.

Select **SYSTEM INFO** in the lower-left corner and then select the usage reports tab to reach the usage reports menu.



MONTH	YEAR
May	2021

Automatically transport monthly report to nerve-billing@tttech-industrial.com

Download the public key to be used by TTTech to verify signed reports

Item	Description
Current report download (1)	Download a temporary report of the current month. It shows the following information: • **Date** This is the year and month at the time of the usage report export. • **Created** This is the date the usage report was created. • **Management System instance** This is the URL of the Management System. • **Number of connected nodes** This is the number of registered nodes which have had a connection to the Management System instance within the reference month. • **Number of updated nodes** This is the number of registered nodes in this Management System instance that have been updated to a newer version within the reference month. • **Updated nodes** This shows details of the node updates that have been performed. The information collected is the serial number, the previous version of the node, the version the node has been updated to and the time of the update. Note that this report serves as information for the user.
List of past months (2)	This is a list of the months the Management System has been in use. A new entry is created after every month including a finished usage report that can be downloaded. Select the download symbol on the right side of every entry to download the report of the listed month. The content of the reports are the following: • **Date** This is the year and month the usage report refers to. • **Created** This is the date the usage report was created. • **Management System instance** This is the URL of the Management System. • **Number of connected nodes** This is the total number of registered nodes which have had a connection to the Management System instance within the reference month. • **Number of updated nodes** This is the total number of registered nodes in this Management System instance that have been updated to a newer version within the reference month. • **Updated nodes** This shows details of the node updates that have been performed. The information collected is the serial number, the previous version of the node, the version the node has been updated to and the time of the update. The reports are digitally signed to ensure authenticity. They are also stored indefinitely without any data retention policy.
Automatic report transfer (3)	Toggle this slider to automatically transfer the usage report each month. If the automatic transfer is not activated, the usage reports need to be sent manually.

Item	Description
Public key download (4)	Ignore this if the Management System is hosted by TTTech Industrial. Download the public key that is required to verify the signature of the usage reports. Note that this key needs to be sent to TTTech Industrial once if the Management System is not hosted by TTTech Industrial or if usage reports are sent manually.

Nodes

The nodes menu has two sub-menus in the navigation on the left and two tabs in the default view.

The node tree tab is the default view of the Management System. It displays all registered nodes in a node tree. It mainly serves an organizational purpose and does not impact the functionality of the nodes. Nodes and workloads can be managed in the node details view, which is reached through the node tree.

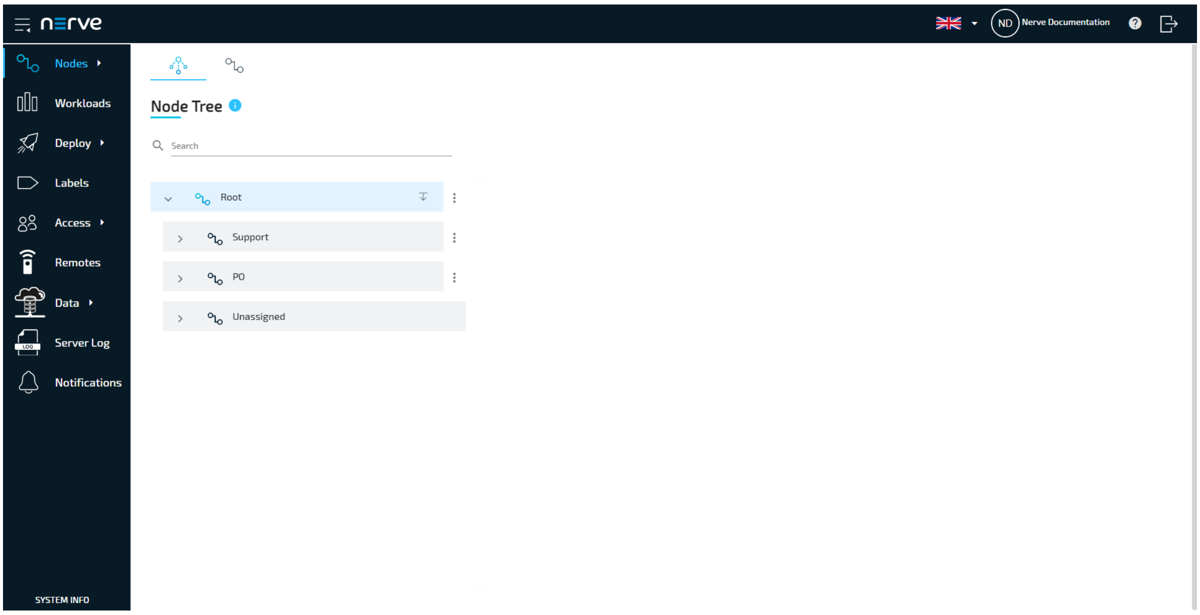
Selecting the node list tab displays a list of all available nodes that have been registered in the Management System. Add, remove, and edit nodes here.

Available updates for nodes can be found in the **Updates** sub-menu. Performed node updates can be viewed in the **Update Log**. When an update is performed, the update log also shows the current progress of the update.

Node tree

The node tree is the landing page of the Management System. It presents an overview of all nodes that are connected to the Management System, embedded into tree view elements. Being mainly a means of organization, it has no impact on the functionality of the nodes and their workloads. Select **Nodes** in the navigation on the left. Then select the node tree tab

on the right.

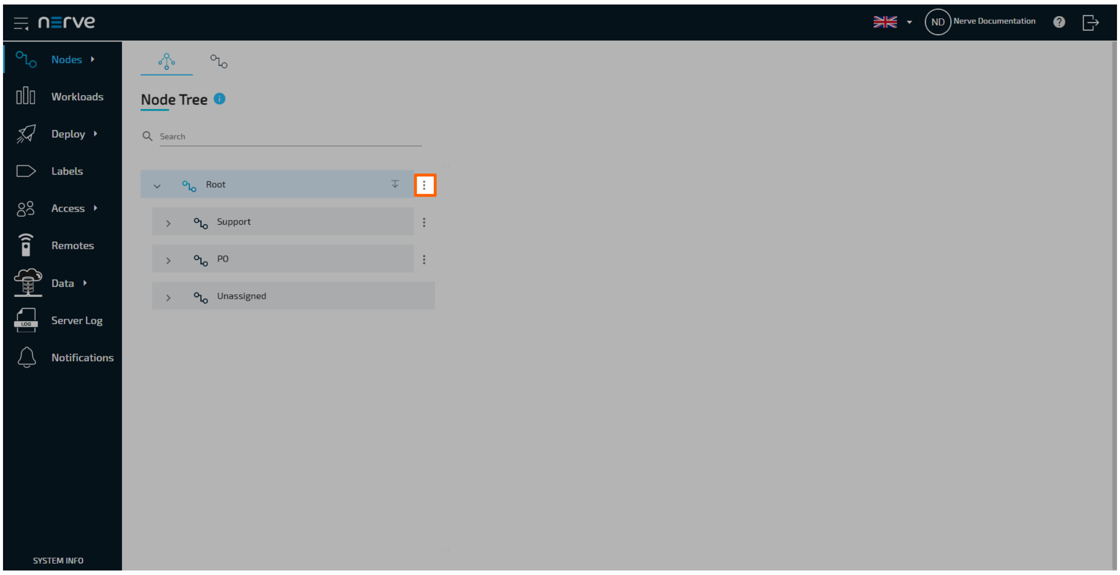


There is only one element under the root after the initial setup: **Root > Unassigned**. All nodes that are registered in the Management System are placed in the **Unassigned** element by default. From there they can be moved to new elements that have to be created first.

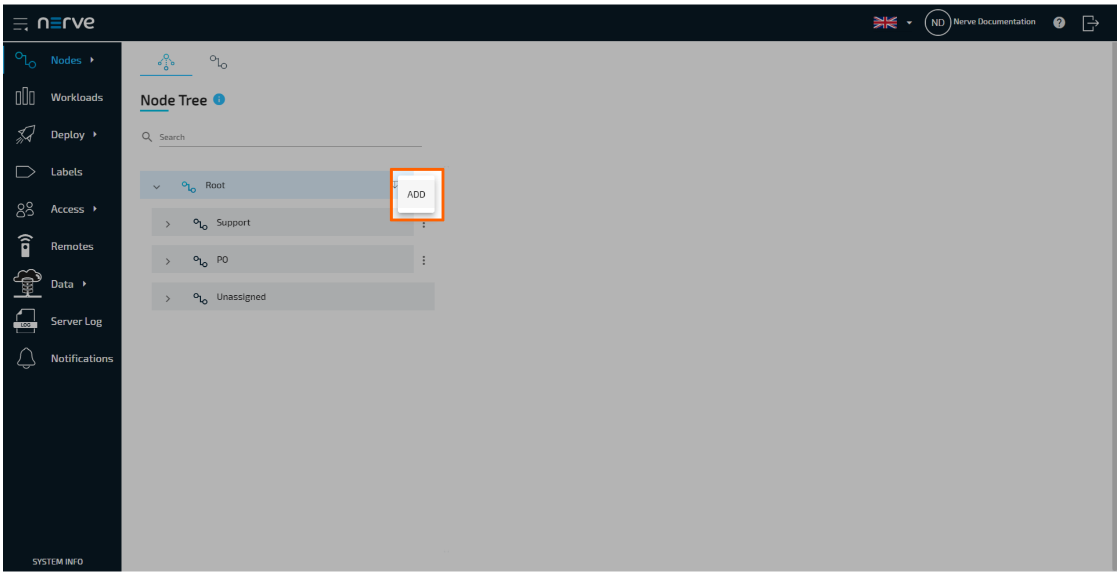
Creating a new element in the node tree

Before moving a node out of the **Unassigned** element, create a new element in the node tree. Elements in the node tree exclusively serve an organizational purpose.

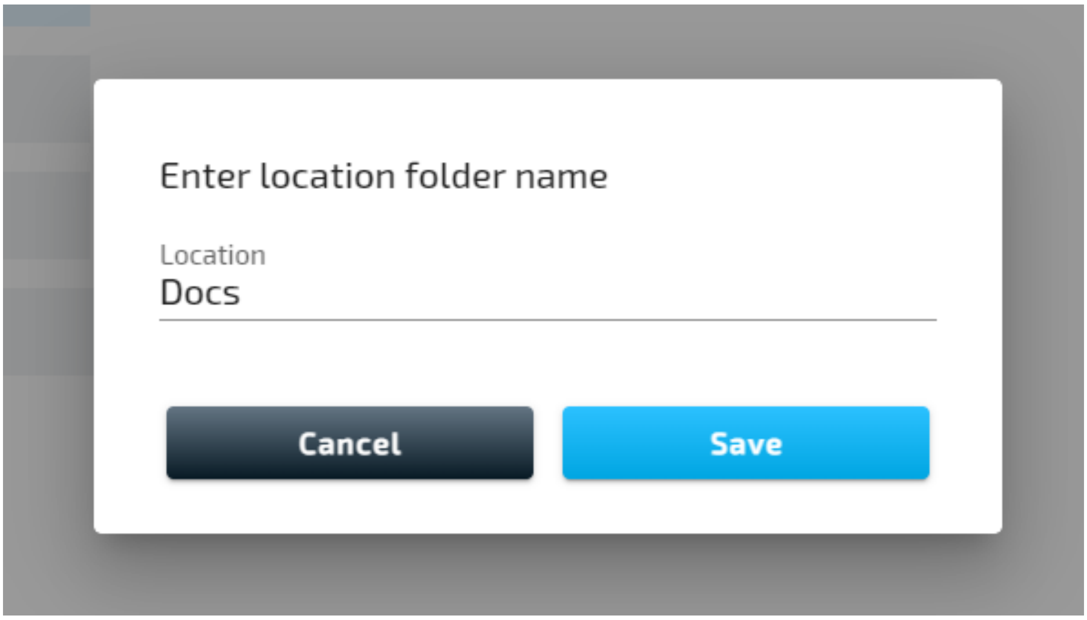
1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab on the right.
3. Select the ellipsis menu to the right of **Root** in the node tree.



4. Select **ADD** in the overlay that popped up.



5. Enter the name of the new element in the field under **Location**.



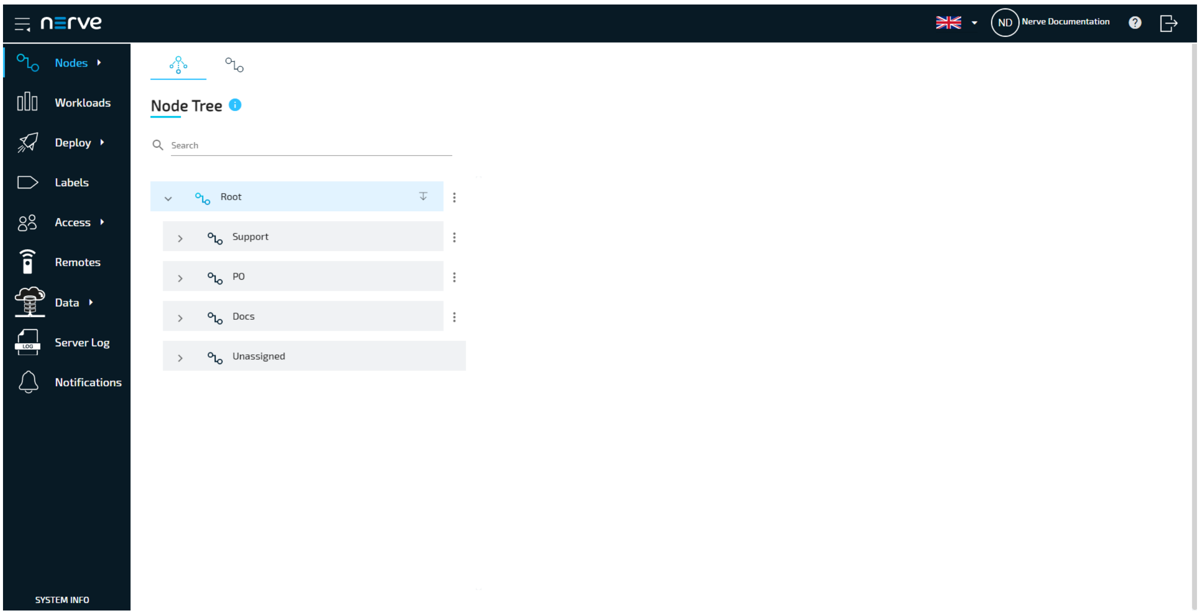
Enter location folder name

Location

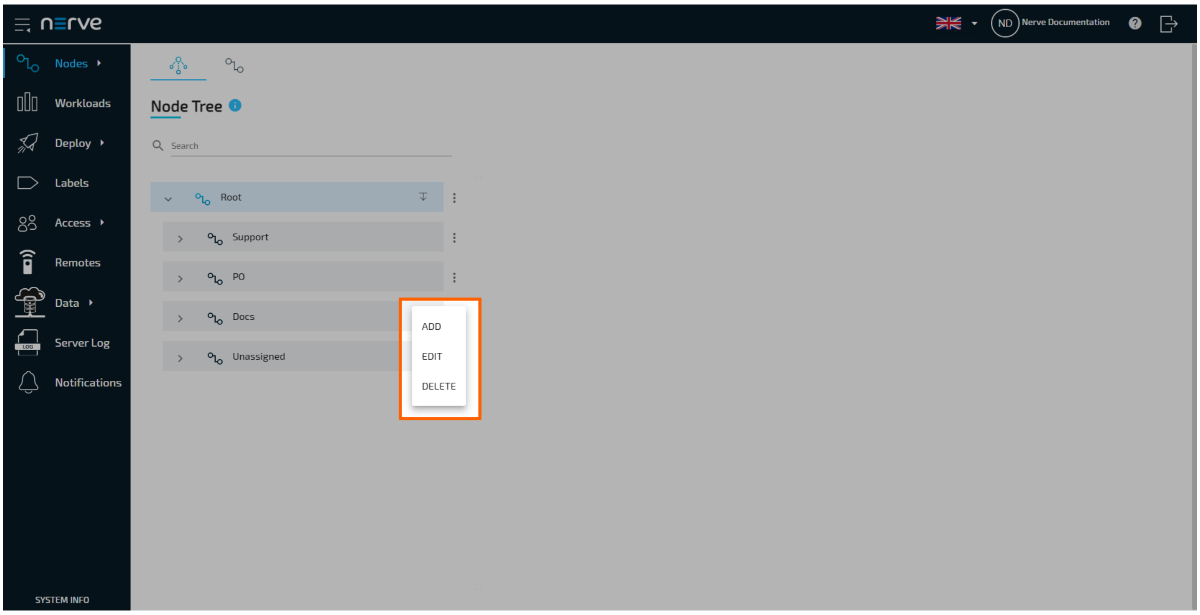
Docs

6. Select **Save**.

The new element now appears under the **Root** element.



Create more elements and freely modify the node tree. To the right of every created element, there is an ellipsis menu that opens up an overlay. Add additional elements, edit the names of elements or delete the elements here.



NOTE

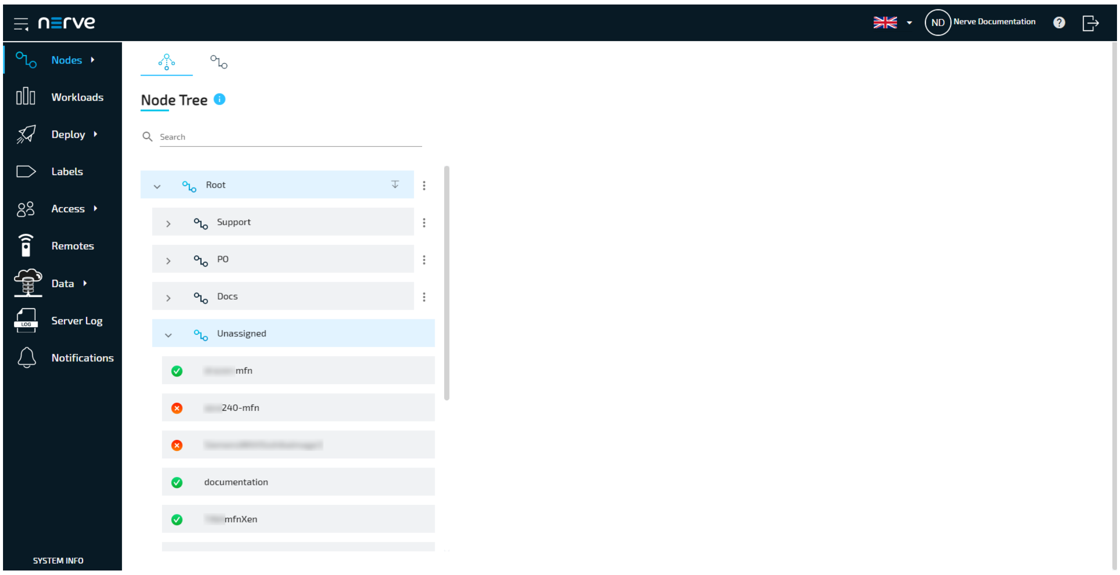
- The order of the tree elements can be modified easily. Drag and drop an element to its new position.
- When a tree element is deleted, all of the nodes inside the element will be moved to **Unassigned**.

Moving a node from one tree element to another

Moving nodes in the node tree is very straightforward and intuitive and possible by drag and drop. Make sure that a new tree element is created before attempting to move a node.

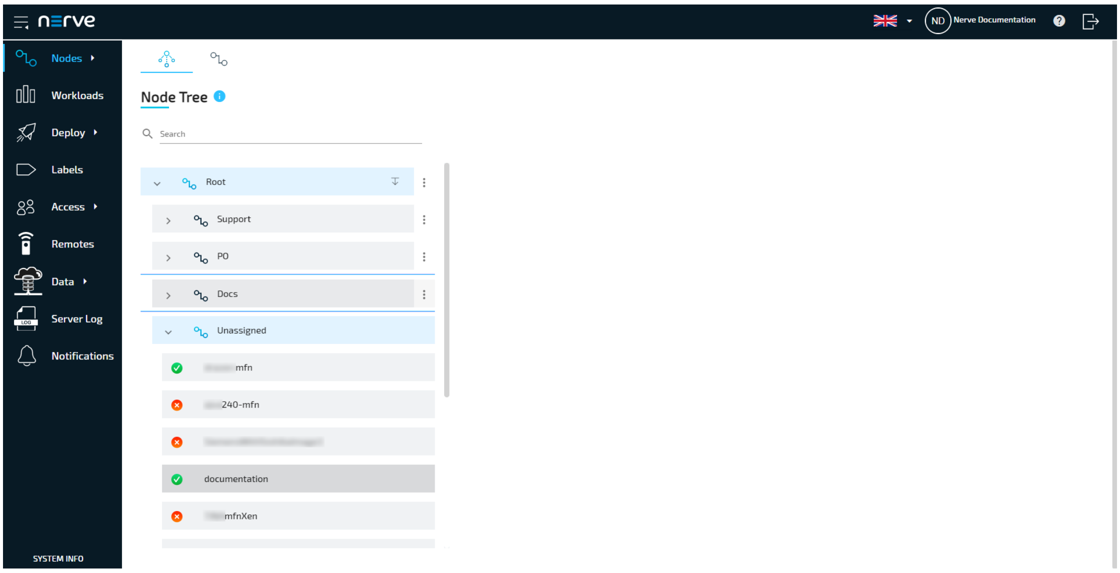
1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab

   on the right.
3. Expand the tree element of the node that will be moved. The default element is **Root > Unassigned**.

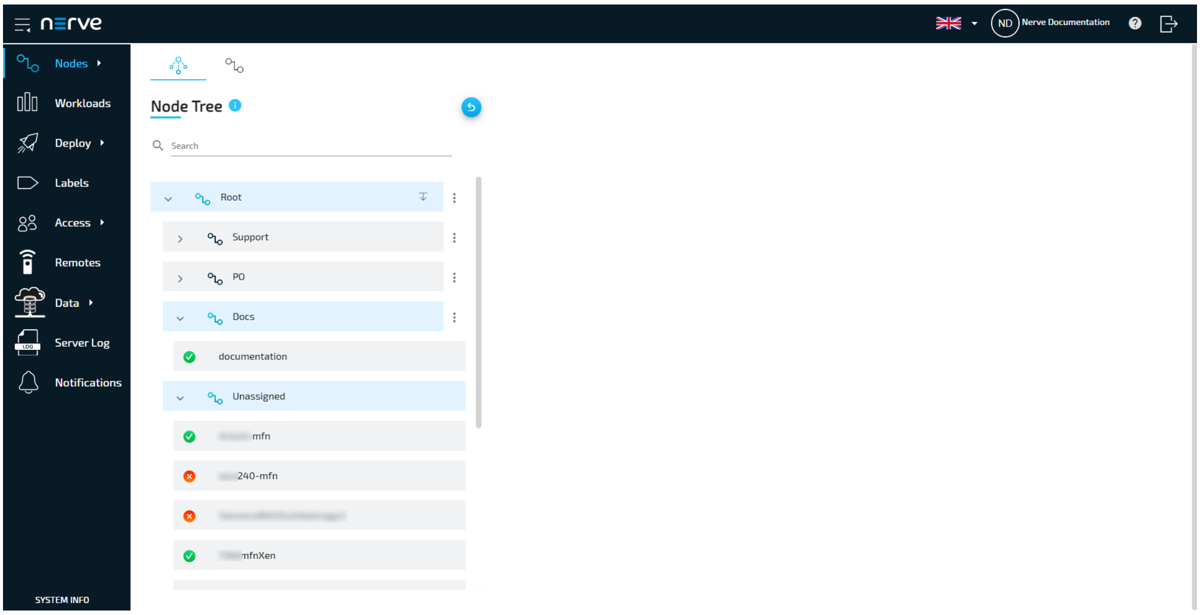


4. Choose the node to move.

5. Drag and drop the node to the newly created element. Elements expand automatically once as they are hovered over.



The node has now been moved to the new element.

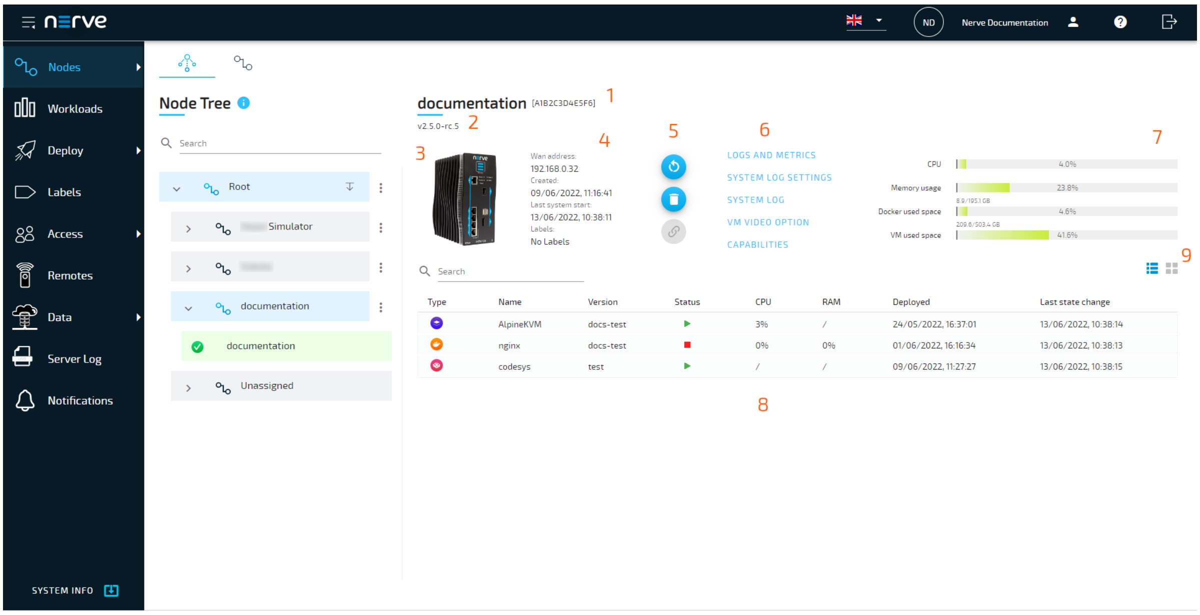


NOTE

A node cannot be moved back manually to **Unassigned** once it has been moved to another element.

Managing nodes in the node tree

Once nodes are registered in the Management System, view their details next to the node tree. To view the details of a node, select the node tree element.



documentation [A1B2C3D4E5F6]

v2.5.0-rc.5

Wan address: 192.168.0.32
Created: 09/06/2022, 11:16:41
Last system start: 13/06/2022, 10:38:11
Labels: No Labels

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

Item	Description
Node name and serial (1)	Here the name and serial number of the node are shown. The serial number is next to the name in brackets.

Item	Description
Node version (2)	The version of the node depending on the product version of Nerve.
Device image (3)	An image of the hardware model is displayed here according to the device type that was selected when the node was added.
Node information (4)	**Wan address** This is the network address of the node that has been assigned by the DHCP server. **Created** This is the date when the node was added to the Management System. **Last system start** This is the timestamp of the last node restart in the format `DD/MM/YYYY, hh:mm:ss`. **Labels** Labels that are assigned to this node are listed here. Labels can be set in the Management System. Refer to Labels for more information.
Rebooting, deleting and remote connections (5)	**Reboot node** Selecting the reboot icon will reboot the node after a confirmation dialog. Select **Yes** to initiate the reboot. All running workloads will be stopped. After the reboot, the workloads will return to their previous state. Running workloads will be started. Stopped workloads will stay stopped. **Delete node** Selecting the garbage can icon removes the node from the Management System. The node needs to be registered again after removal. **Connect** Selecting the chain link icon opens an overlay, through which a remote connection to the node can be established. Refer to Remote Connections for more information.

Item	Description
Logs, metrics and more (6)	**LOGS AND METRICS** Select this to open an overlay that allows enabling of logging and monitoring, as well as viewing dashboards. Enable the following settings by toggling the button for each setting: • **SYSTEM MONITORING** Toggle this slider to enable monitoring of the node's resource utilization as a whole. • **DOCKER WORKLOAD MONITORING** Toggle this slider to enable gathering of metadata about installed Docker containers, as well as monitoring of their resource utilization. • **DOCKER WORKLOAD LOGGING** Toggle this slider to enable the sending of application logs from Docker workloads on the node to the Management System. To open the dashboards, select the clickable links next to the sliders. For more detailed information, refer to Logging and monitoring. **SYSTEM LOGS & SYSTEM LOG SETTINGS** Selecting **SYSTEM LOG** will open a new window and show the system logs of the node. The internal node logs are aimed at Nerve service technicians in case of error and failure. Data is stored and visualized with OpenSearch. The amount of logs can be modified through the **SYSTEM LOG SETTINGS** by Nerve service technicians. Contact customer support for more information. **VM VIDEO OPTION** Note that this feature is only available on request. Configure the video output of Nerve Devices to directly output the interface of deployed virtual machines. Doing so allows operating virtual machines directly at the Nerve Device. Refer to Virtual machine video options for more information. **CAPABILITIES** The capabilities of each node are available as a list in both the Local UI and the Management System. A capability represents a specific feature or a set of features allowing the node to run workloads, to provide logs etc.

Item	Description
System metrics (7)	The system metrics that are available in the Local UI dashboard are also visible here: • **CPU** The percentage here shows how much processing power is being used in total at the moment. This includes CPUs that have been assigned to VMs and Docker containers as well. • **Memory** Similar to CPU usage, the percentage of memory used in total at the moment is shown here. This includes memory that has been assigned to VMs or Docker containers. • **Docker used space** Two things are shown in this graph: The percentage shows how much of the available space for Docker containers is already used. The value shows the amount of space that is free. Docker containers have their dedicated virtual partition. • **VM used space** Similar to Docker used space, two things are shown in this graph as well: The percentage shows how much of the available space for virtual machines is already used. The value shows the amount of free space. Note that deployed Virtual Machine workloads share a logical volume group with the Nerve Base System. Therefore the percentages and values displayed in this graph are in relation to the total amount of space available of the logical volume group.

Item	Description
Workloads overview (8)	Find workloads that have been deployed to the Nerve Device displayed here. The workloads can be displayed as tiles or as a list in a table. Table view gives the following information on workloads: • **Type** The symbol of the workload type (CODESYS, Docker or VM workload) is displayed here. • **Name** This is the name of the workload. • **Version** This is the name of the workload version. • **Status** The symbol here indicates the status of the workload. Here, different symbols can be shown: a green play symbol, a yellow pause symbol and a red stop symbol, showing whether a workload is running, suspended or stopped respectively. In addition, a triangular warning sign is displayed in an error state, and a gray dot is shown when the workload is idle. • **CPU** This column shows values for VM and Docker workloads. The percentage here shows the usage of CPU resources in relation to the assigned CPUs. • **RAM** Similar to the CPU usage statistic, the percentage here shows the usage of system memory resources in relation to the assigned memory. This column only shows values for Docker workloads. • **Deployed** This is the date and time the workload was deployed in the format `DD/MM/YYYY, hh:mm::ss`. • **Last state change** This is the date and time the workload changed from its previous state to its current state, for example when a running workload was stopped. The format is `DD/MM/YYYY, hh:mm::ss`. Selecting a workload leads to a control area in which the workload can be controlled. Workload control features depend on the workload type. If there are no tiles or rows of workloads, no workloads have been deployed to the Nerve Device. Refer to Workload control for more information.
Workload view selection (9)	Toggle between table view and tile view here.

Node capabilities

The capabilities of each node are available as a list in both the Local UI and the Management System. A capability represents a specific feature or a set of features allowing the node to run workloads, to provide logs etc. As of now most nodes share the same list of capabilities. In the future, with increasing modularity in the Nerve solution, the list will differ based on the specific Nerve solution running on the node.

Reach the list of node capabilities in the following locations:

Location	Path
Local UI	Log in to the Local UI. > Select **Node configuration** in the navigation on the left. > Select **Capabilities**.
Management System	Log in to the Management System > Select a node from the node tree. > Select **CAPABILITIES**.

Here is a list of all currently available capabilities:

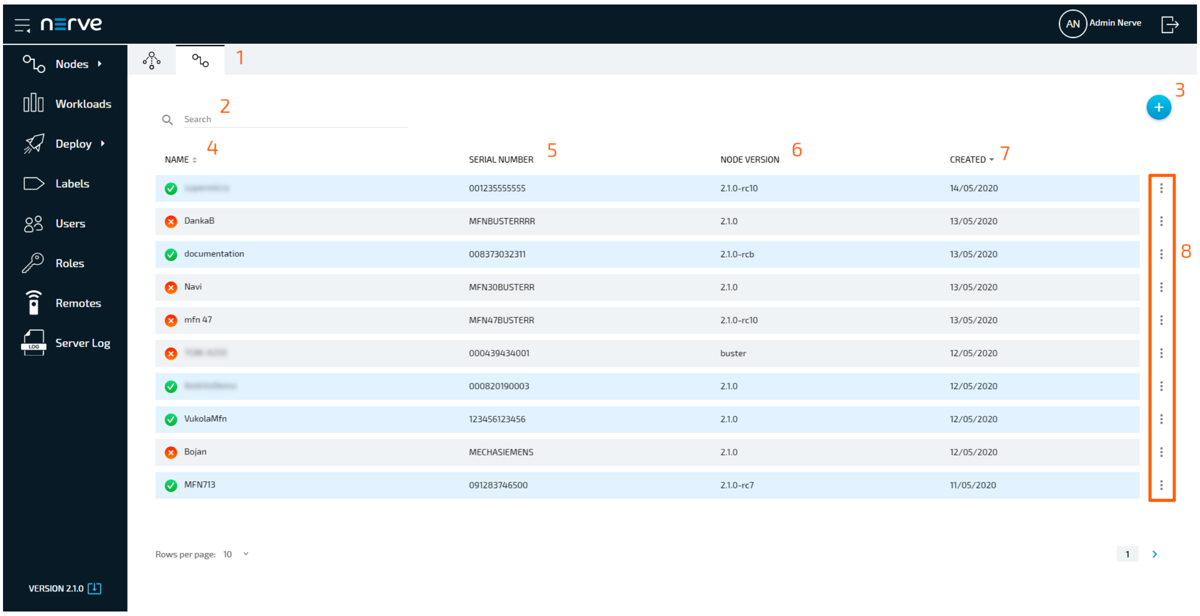
Capability	Description
CODESYS PLC	The CODESYS application is installed in the RTVM and the execution of CODESYS workloads is possible.
Docker Container	Docker container technology is included and the node can run Docker workloads.
Logging via Filebeat	A daemon is running on the node that sends logs to the Management System.
Monitoring via Metricbeat	A daemon is running on the node that sends metric logs to the Management System.
Nerve Data Services	Nerve Data Services are available for nodes with this capability.
Virtualization via ACRN	The node is running on the ACRN hypervisor.
Virtualization via KVM	The node is running on the KVM hypervisor.
Virtualization via XEN	The node is running on the XEN hypervisor.

Node list

The topics covered in this chapter are mainly means of organization and have no impact on the functionality of the nodes and their workloads. Select **Nodes** in the navigation on the left. Then select the nodes tab

on the right to display the list of registered nodes.

> **NOTE**
>
> Operational functions of the nodes are located in the node details view in the node tree.



NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓ [redacted]	001235555555	2.1.0-rc10	14/05/2020
✗ DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓ documentation	008373032311	2.1.0-rcb	13/05/2020
✗ Navi	MFN30BUSTERR	2.1.0	13/05/2020
✗ mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✗ [redacted]	000439434001	buster	12/05/2020
✓ [redacted]	000820190003	2.1.0	12/05/2020
✓ VukolaMfn	123456123456	2.1.0	12/05/2020
✗ Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓ MFN713	091283746500	2.1.0-rc7	11/05/2020

Item	Description
Tab selection (1)	Switch between the node tree and the node list by selecting the appropriate tab.
Search bar (2)	Use the search bar to filter nodes by name.
Add new node (3)	Click here to manually add a new node.
NAME (4)	This is the name of the node. If a node is online or offline can be seen to the left of the name. A green check mark indicates an online node while a red cross shows an offline node. The sorting of the list can also be switched from alphabetical to reverse alphabetical by clicking **NAME**, as well as being sorted by creation date by clicking **CREATED**.
SERIAL NUMBER (5)	This is the serial number of the node that was defined during node configuration.
NODE VERSION (6)	This is the version of the node reflecting the version of the Nerve product.
CREATED (7)	This is the date the node was registered in the Management System in the format DD/MM/YYYY. The list can be sorted by creation date when clicking **CREATED**.
Ellipsis menu (8)	Clicking here opens an overlay that allows deleting nodes.

Adding a node

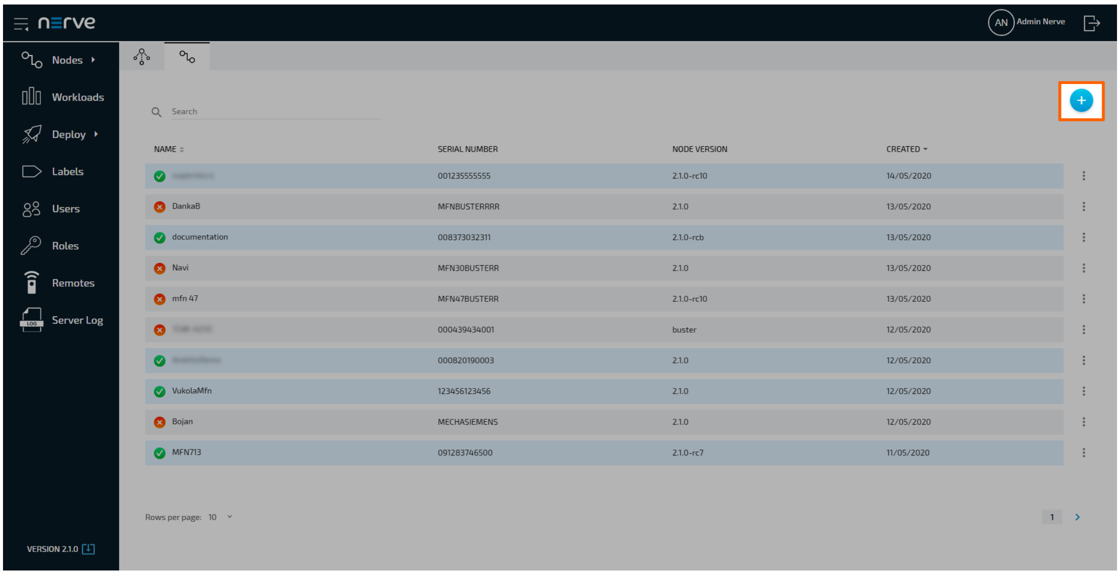
Nodes can only be added to the Management System if they have been configured in the Local UI, as the serial number and secure ID of the node are required. Refer to Node configuration before continuing.

1. Select **Nodes** in the menu on the left side.

2. Select the nodes tab

   on the right to display the list of registered nodes.

3. Select the plus symbol (**Add new node**) in the upper-right corner.

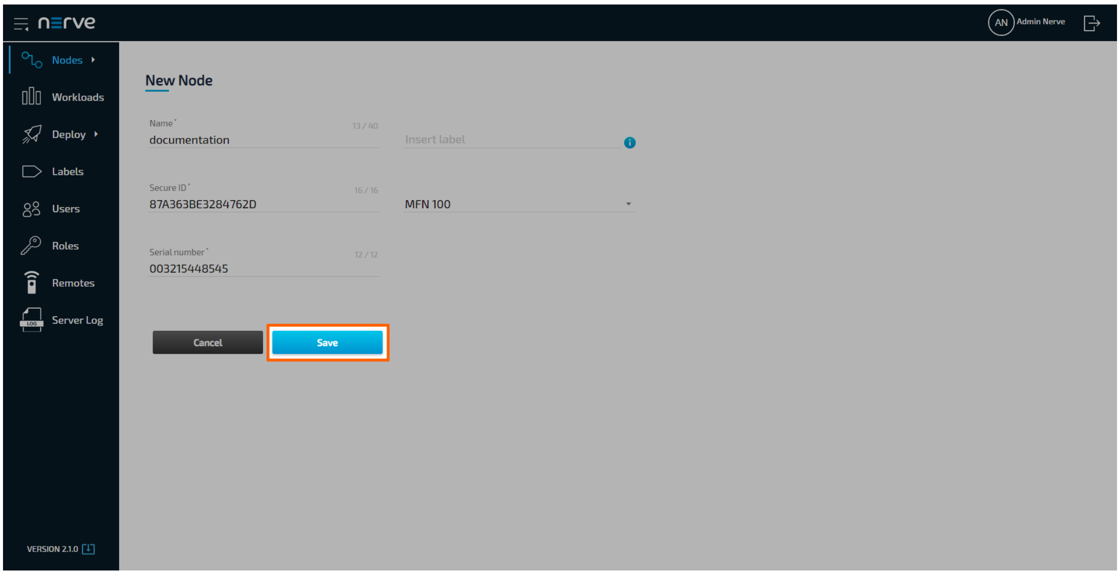


	NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓	[redacted]	001235555555	2.1.0-rc10	14/05/2020
✗	DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓	documentation	008373032311	2.1.0-rcb	13/05/2020
✗	Navi	MFN30BUSTERR	2.1.0	13/05/2020
✗	mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✗	[redacted]	000439434001	buster	12/05/2020
✓	[redacted]	000820190003	2.1.0	12/05/2020
✓	VukolaMfn	123456123456	2.1.0	12/05/2020
✗	Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓	MFN713	091283746500	2.1.0-rc7	11/05/2020

4. Enter the following information:

Item	Description
Name	Enter the name for the node that will make it easy to identify.
Secure ID	Enter the secure ID that is generated when the node is configured in the Local UI. Refer to Node configuration for more information.
Serial no.	Enter the serial number of the Nerve Device that was defined during node configuration.
Insert Label	This field is optional. Add labels to the node for easier identification and workload deployment. Note that labels have to be created first before they can be assigned to nodes. Refer to Labels for more information.
Nerve Device name	Select the Nerve Device, on which the node is hosted from the drop-down menu. The name is set to **MFN 100** by default. A picture of the selected Nerve Device will be displayed in the node details. Refer to the device guide for more information on qualified Nerve Devices.

5. Click **Save** to save the changes.



New Node

Name* documentation 13 / 40

Insert label

Secure ID* 87A363BE3284762D 16 / 16

MFN 100

Serial number* 003215448545 12 / 12

Cancel | Save

The node now appears in the node list and in **Root > Unassigned** in the node tree and can be worked with. At first, the node is marked as offline. It can take up to a minute until the node is shown as online in the Management System. The Management System refreshes automatically.

Editing the details of nodes

After registering a node, edit its details in the **Nodes** menu. Use the search bar at the top to search for nodes if a large number of nodes is registered.

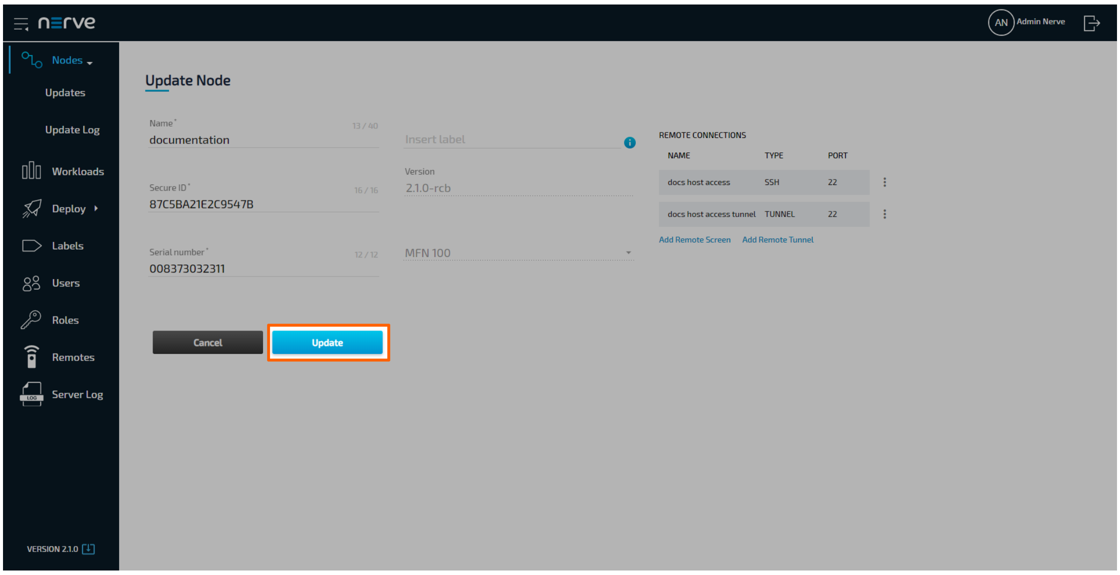
1. Select **Nodes** in the left-hand menu.
2. Select the nodes tab on the right to display the list of registered nodes.
3. Click a node from the list.
4. Edit the details of the node:

Item	Description
Name	Enter the name of the node.
Secure ID	This is the ID generated during the node registration process. Do not edit this ID without a valid reason.
Serial number	This is the serial number of the node. Do not edit the serial number without a valid reason.
Insert label	This field is optional. Add labels to the node for easier identification and workload deployment. Refer to Labels for more information.
Version	This is the node version. This field cannot be edited.
Device type	This is the device the node is hosted on. This field cannot be edited.
REMOTE CONNECTIONS	This is a list of remote connections to the node stating the **NAME**, **TYPE**, and **PORT** of available remote connections. Add or delete remote connections here. Refer to Remote Connections for more information.

NOTE

Changing the **Secure ID** or **Serial no.** of a node will break the connection between the node and the Management System.

5. Click **Update** to save the changes.



Update Node

Name* 13 / 40
documentation

Insert label

Secure ID* 16 / 16
87C5BA21E2C9547B

Version
2.1.0-rcb

Serial number* 12 / 12
008373032311

MFN 100

REMOTE CONNECTIONS

NAME	TYPE	PORT
docs host access	SSH	22
docs host access tunnel	TUNNEL	22

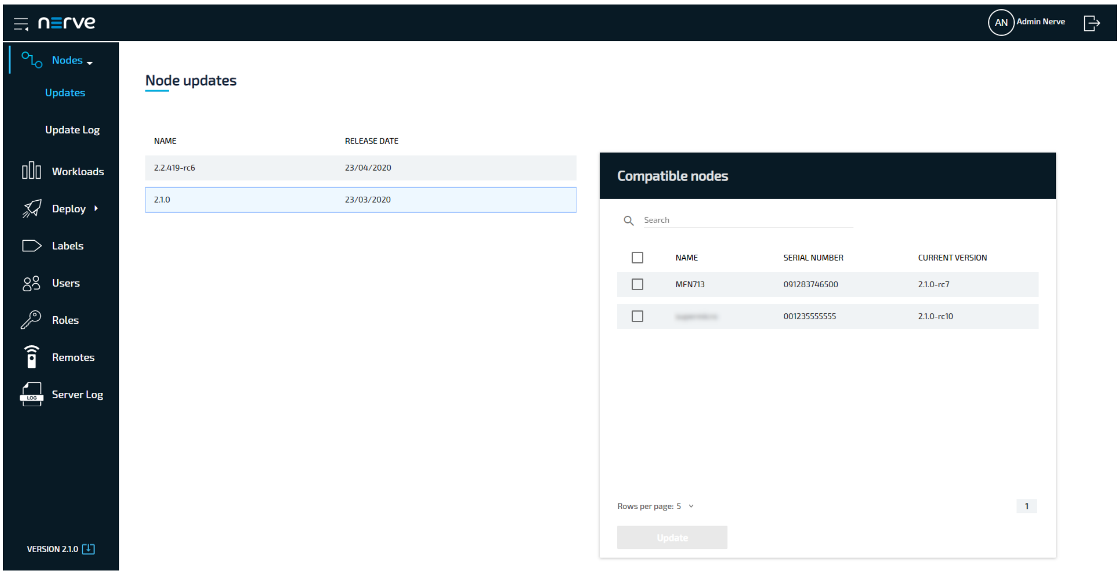
Updating a node to a new version

Nodes are updated through the Management System where currently available updates are listed. Note that nodes can only be updated in order, meaning that node versions cannot be skipped. When an update is started, a snapshot of the user data is made and running workloads are stopped. Reverting to the previous version is possible. Workloads remain stopped after an update or revert.

NOTE

- By updating a node, the passwords to the Local UI and host access are reset if they have not been changed by the user. Local UI and host access passwords set by the user persist through updates.
- Note that the update process described here is valid for nodes from version 2.1.0 and later. Nodes below version 2.1.0 need to be updated manually by installing an image at the Nerve Device. Refer to Manual image installation for more information.

1. Expand **Nodes > Updates** in the navigation on the left.
2. Select a node version from the list. Available nodes for the update to the selected version will appear on the right.

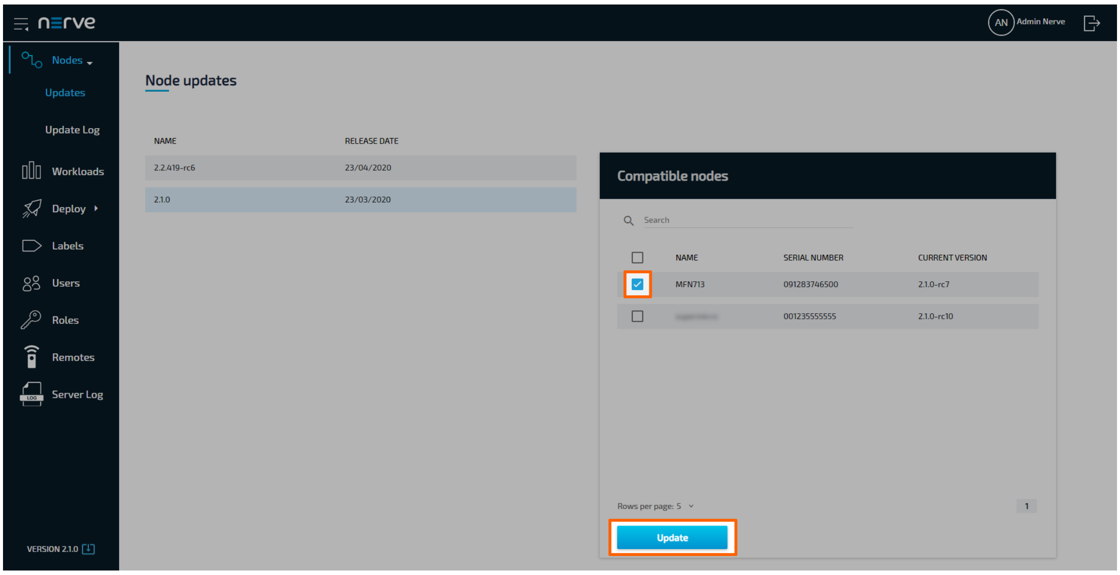


NAME	RELEASE DATE
2.2.419-rc6	23/04/2020
2.1.0	23/03/2020

	NAME	SERIAL NUMBER	CURRENT VERSION
□	MFN713	091283746500	2.1.0-rc7
□	[redacted]	001235555555	2.1.0-rc10

3. Tick the checkboxes next to the nodes that will be updated.

4. Select **Update**.



NAME	RELEASE DATE
2.2.419-rc6	23/04/2020
2.1.0	23/03/2020

	NAME	SERIAL NUMBER	CURRENT VERSION
☑	MFN713	091283746500	2.1.0-rc7
□	[redacted]	001235555555	2.1.0-rc10

5. Select **Yes** in the pop-up window.

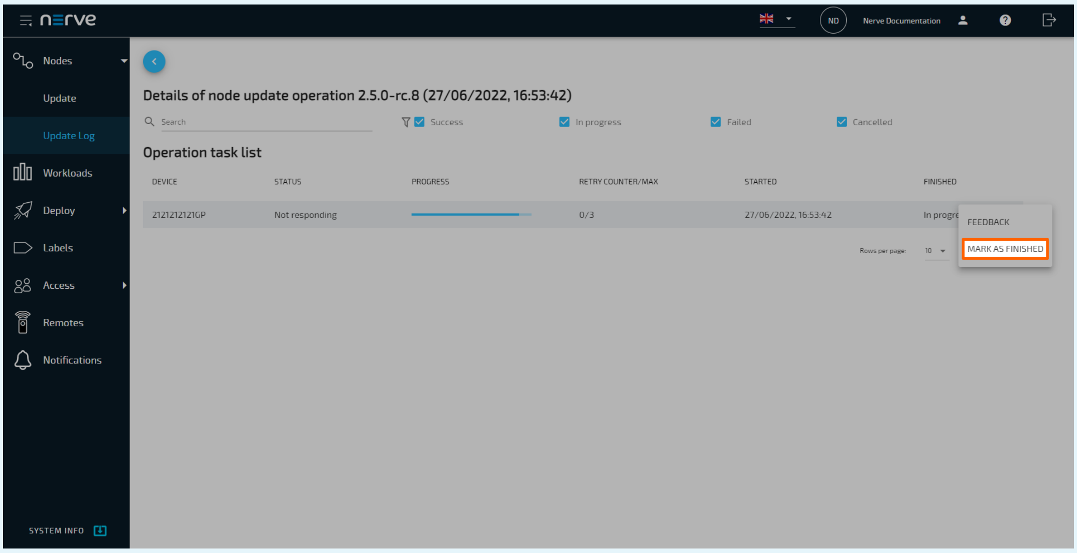
The Management System will display the log screen where the update is shown as in progress. The progress bar here shows the progress of the entire update campaign if more than one node has been selected before. Click the progress bar to see the progress of the update to each node.

NOTE

There are two possible error states in case the node update fails:

- **Fail**
  Support needs to take action. Please contact TTTech Industrial customer support at support@tttech-industrial.com.
- **Not Responding**
  In this case, attempt a physical reboot by unplugging the node from power and

plugging it back in again. The node should come online with the new version installed. However, the update log will still show the update as **In progress**. Select the ellipsis menu in the update log and select **MARK AS FINISHED** to manually mark the node update as finished.



Details of node update operation 2.5.0-rc.8 (27/06/2022, 16:53:42)

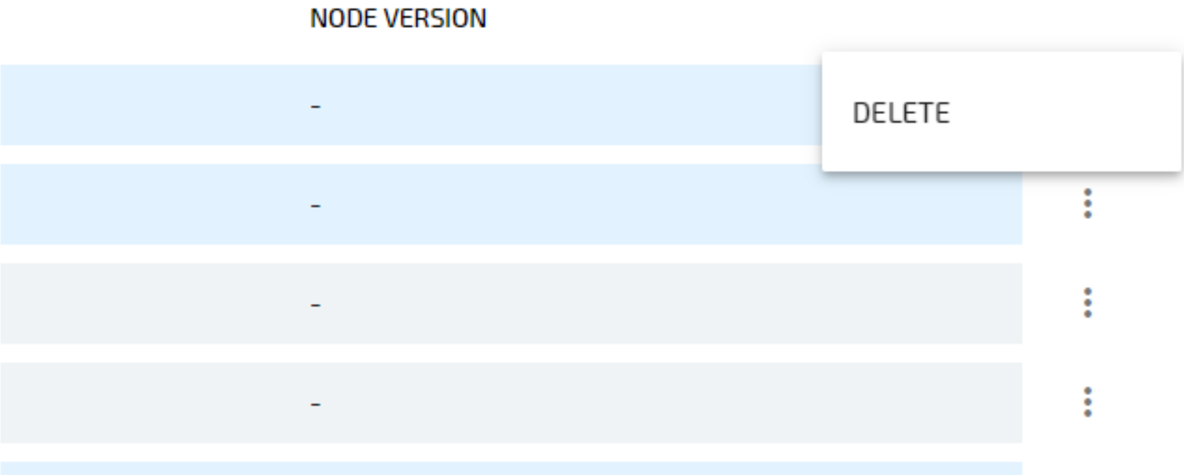
Search ☑ Success ☑ In progress ☑ Failed ☑ Cancelled

Operation task list

DEVICE	STATUS	PROGRESS	RETRY COUNTER/MAX	STARTED	FINISHED
2121212121GP	Not responding		0/3	27/06/2022, 16:53:42	In progre

Removing a node

Note that generally there is no need in removing a node. Only remove a node in case of technical difficulties or by request of customer support. To remove a node, select **DELETE** in the ellipsis menu on the right side of a node in the node list.



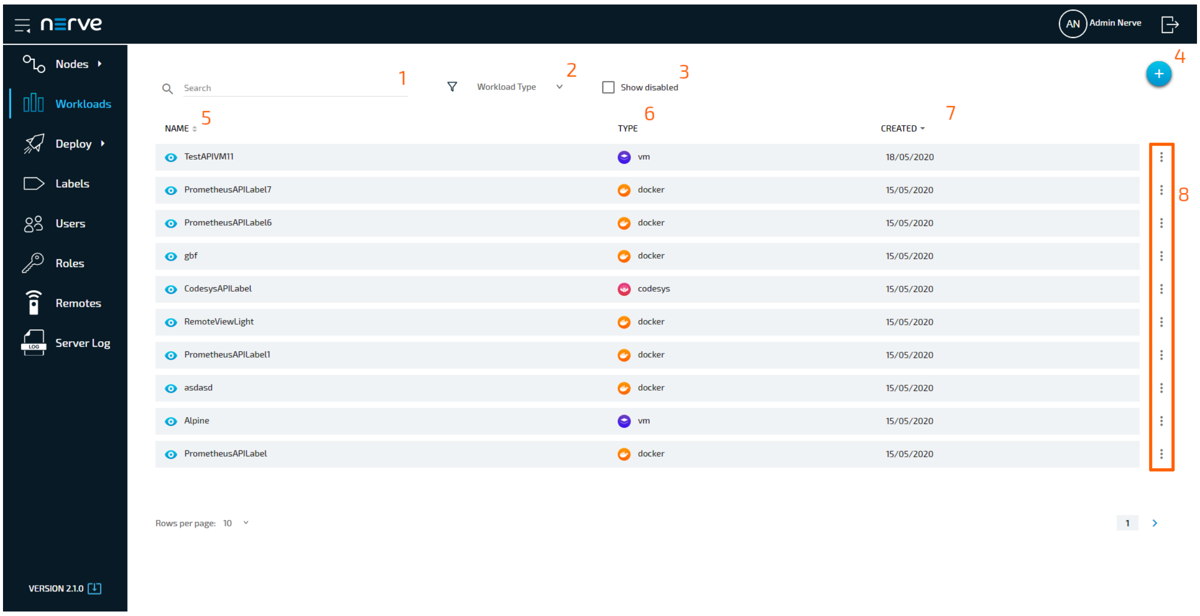
NODE VERSION
-
-
-
-

Workloads

In order to work with CODESYS applications, virtual machines or Docker containers on nodes, workloads need to be provisioned in the Management System. Here, provisioning is the creation of a workload and its storage in the workload repository of the Management System so that it can be deployed to nodes. This requires configuration of the workload and files that need to be uploaded to the Management System. After that, the workload can be deployed to nodes.

There are three types of workloads that can be provisioned: CODESYS workloads, Virtual Machine workloads and Docker workloads. The process of provisioning each workload is described in their respective chapters.

Select **Workloads** in the left-hand menu to find a list of all workloads that have been provisioned.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

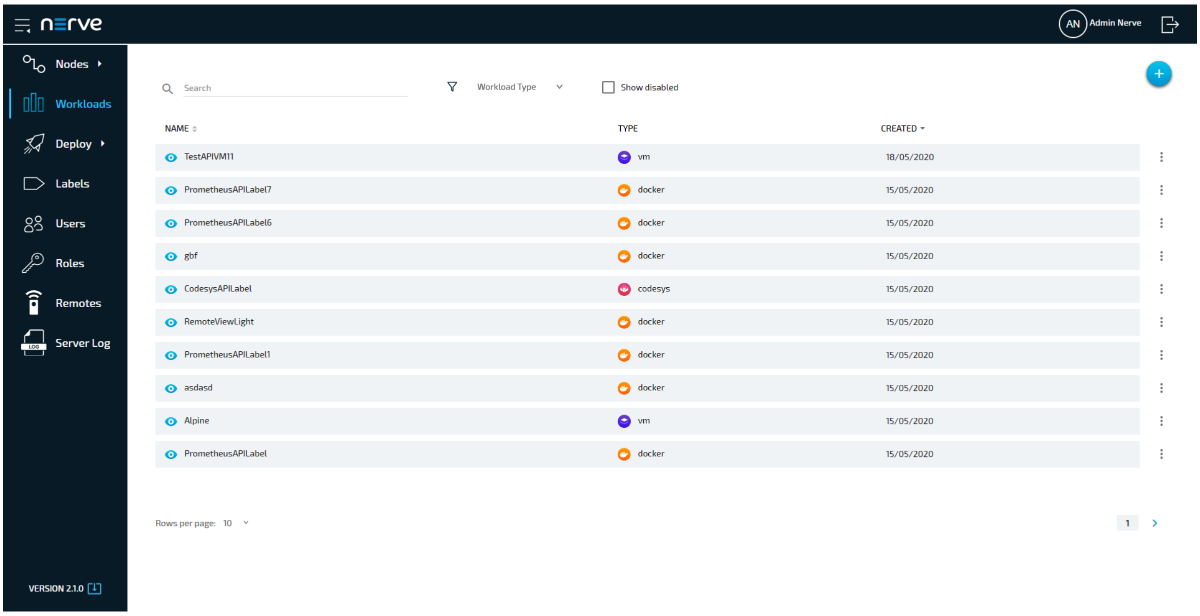
Item	Description
Search bar (1)	Use the search bar to filter workloads in the list by name. Select the cross symbol next to the search bar to reset the search field.
Workload Type (2)	This is a drop-down menu that allows filtering the list below by workload type. The available options are **VM**, **Docker**, **CODESYS** and **All**.
Show disabled (3)	Disabled workloads are not shown in the list of workloads. Ticking this checkbox shows them again. However, note that this does not enable the workloads again.
Add new workload (4)	Select the plus symbol to provision a new workload.
NAME (5)	This is the name of the workload that has been defined in the provisioning process. The list can be sorted in alphabetical and reverse alphabetical order by clicking **NAME**.
TYPE (6)	The type of workload is displayed here: **codesys**, **vm** or **docker**. The list can be sorted by workload type when clicking **TYPE**.
CREATED (7)	This is the date when the workload was provisioned in the format DD/MM/YYYY. The list can be sorted by creation date when clicking **CREATED**.
Ellipsis menu (8)	Clicking here opens an overlay that gives two options: **DELETE** and **DISABLE**.

Provisioning a workload

Provisioning a workload is the creation of a workload in the workload repository of the Management System. Workloads that have been provisioned are ready to be deployed to nodes.
Select the plus symbol in the upper-right corner of the workloads list to start provisioning a workload. The provisioning process of each workload type is covered separately in the following chapters.

- Provisioning a CODESYS workload
- Provisioning a Virtual Machine workload
- Provisioning a Docker workload

After provisioning a workload, it will appear in the list of workloads.



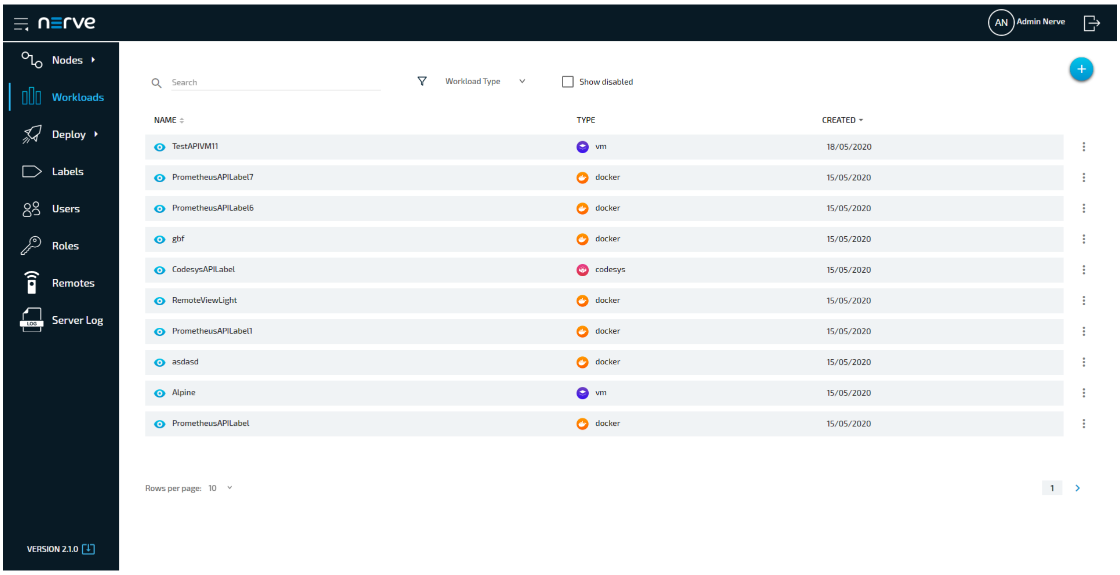
NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

Adding a new workload version

Add new versions to a provisioned workload to accommodate different use cases.

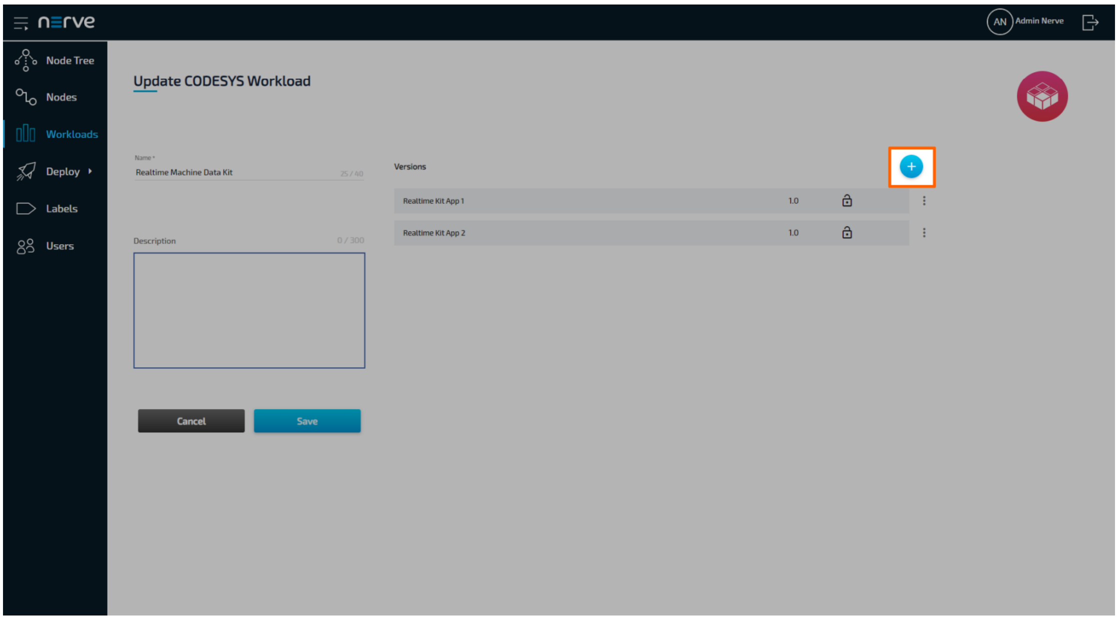
1. Select **Workloads** from the menu on the left side.

2. Select the workload to which a new version will be added.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

3. Click the plus symbol in the upper-right.



Update CODESYS Workload

Name * Realtime Machine Data Kit 25 / 40

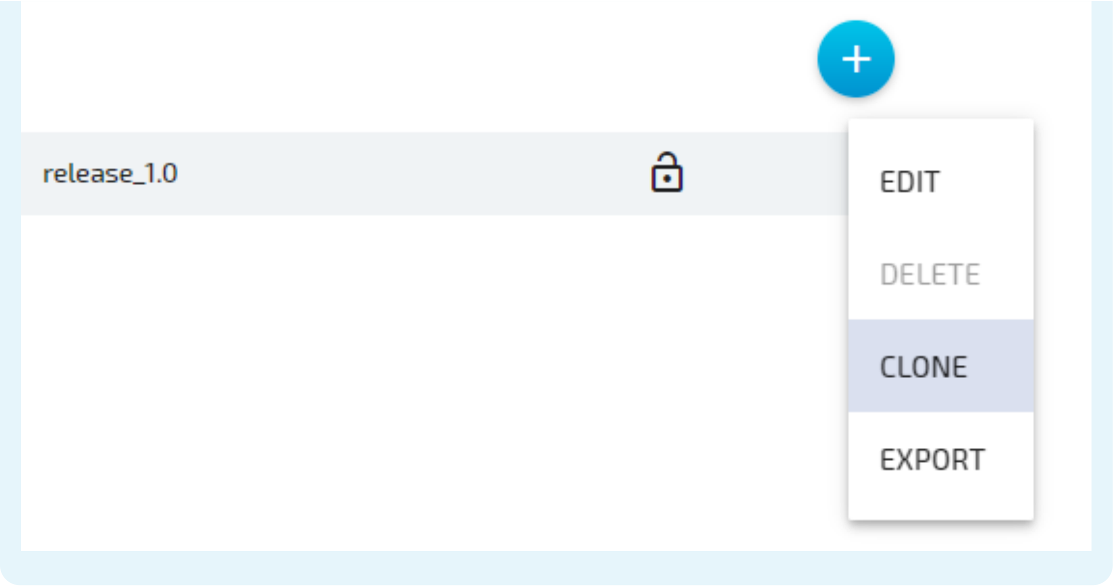
Description 0 / 300

Versions

Realtime Kit App 1	1.0	🔒
Realtime Kit App 2	1.0	🔒

NOTE

To add a new version that is a slight modification of an existing one, click the ellipsis menu next to a workload and select **CLONE** from the overlay.



4. Configure the new workload version. Refer to the provisioning chapters of each workload type linked above for more information on configuration settings.

> **NOTE**
>
> The fields of the new version will already have information filled in. The system enters the settings of the latest version automatically. If **CLONE** next to a workload version was used, the information filled in will be from that version instead.

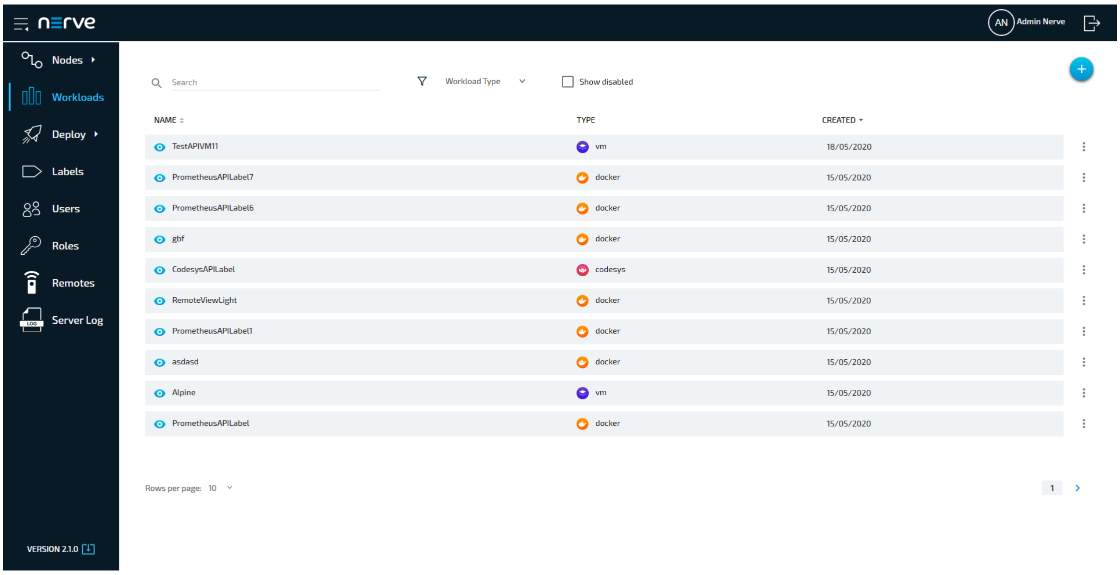
5. Click **Update** to save the new version of the workload.

Editing a workload

General information of a workload and configuration settings of each version can be edited starting from the workload list. General information of a workload is valid for all workload versions.

1. Select **Workloads** from the menu on the left side.

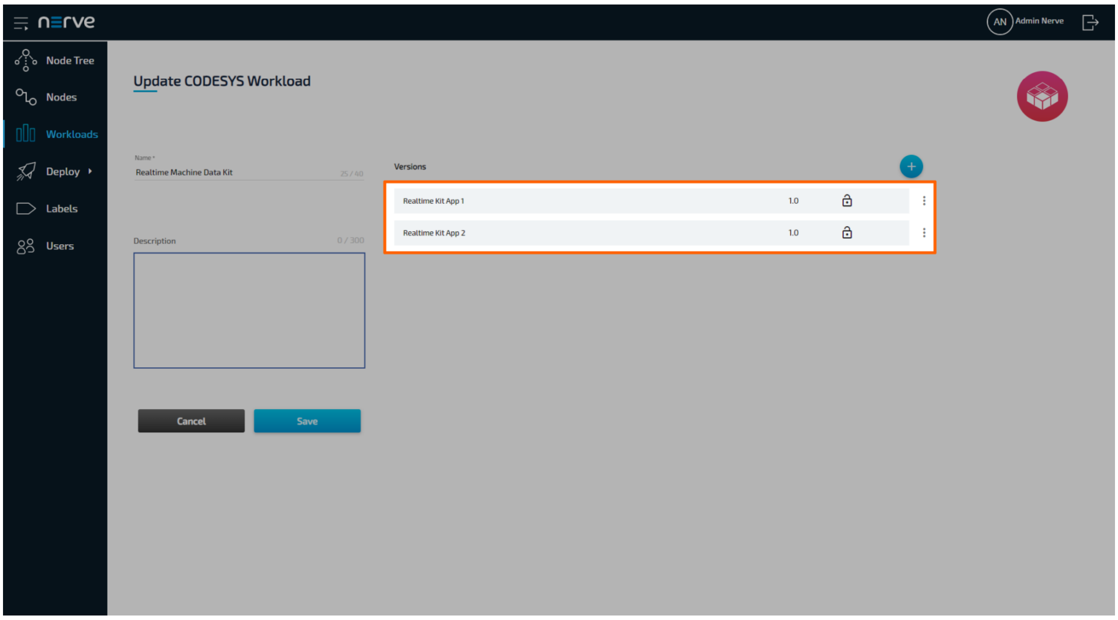
2. Select the workload to edit.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

Rows per page: 10

3. Select the workload version to edit from the list on the right.



Update CODESYS Workload

Name *
Realtime Machine Data Kit 25 / 40

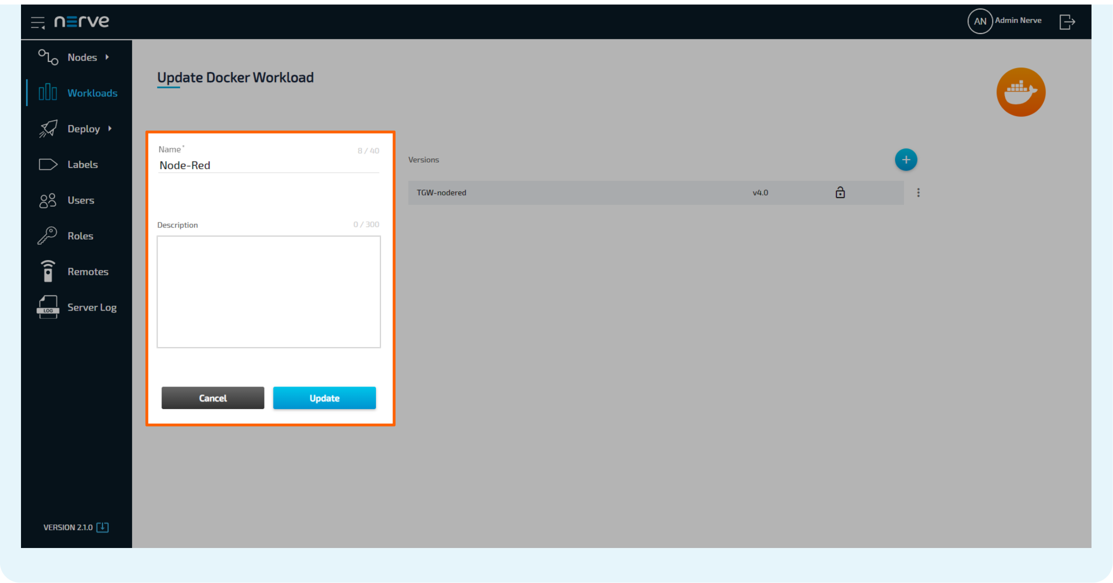
Description 0 / 300

Versions

Realtime Kit App 1	1.0	🔓
Realtime Kit App 2	1.0	🔓

NOTE

Editing the **Name** and **Description** of the workload can be done on the left side before selecting a version. Perform the desired changes and click **Update**.



Name* 8 / 40
Node-Red

Description 0 / 300

TGW-nodered v4.0

4. Perform changes to the workload version. The settings of a workload depend on the workload type. See the version settings for each workload in the provisioning chapters:

   - CODESYS workloads
   - Virtual Machine workloads
   - Docker workloads.

5. Click **Update** to save the changes.

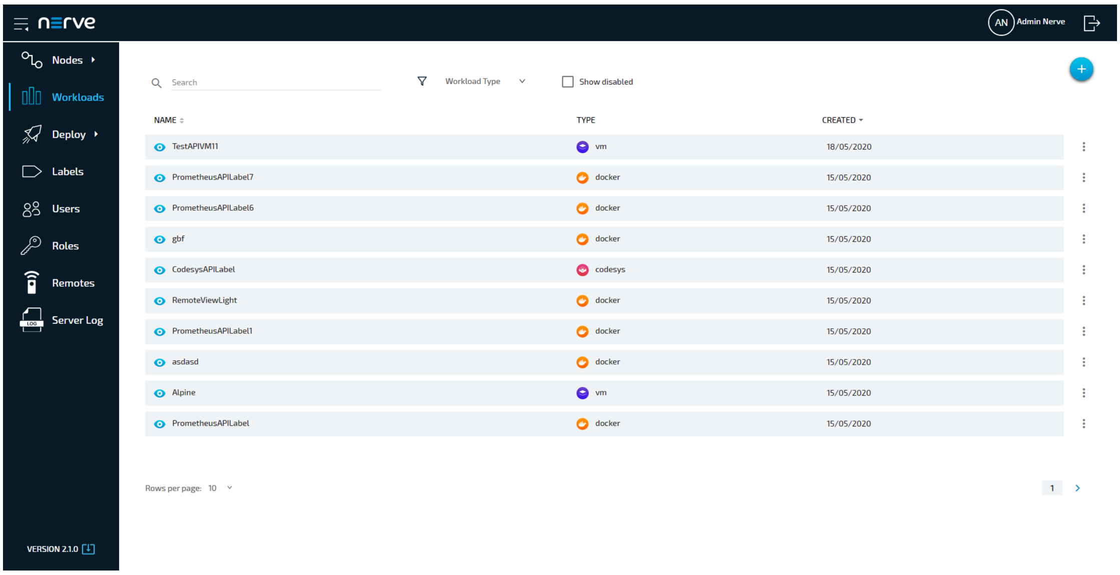
Note that a workload needs to be undeployed first before an updated version can be deployed. However, this does not apply to remote connections. Once a remote connection is configured, it is available immediately for the workload on all nodes that it was deployed to.

Disabling a workload

A workload can be disabled to make it hidden and not selectable. This will hide the workload in the workload list and deployment process but it will not be deleted from the Management System. This also means that the workload cannot be deployed. Workloads that have been deployed to nodes before are not affected.

1. Select **Workloads** from the menu on the left side.

2. Choose the workload to disable.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
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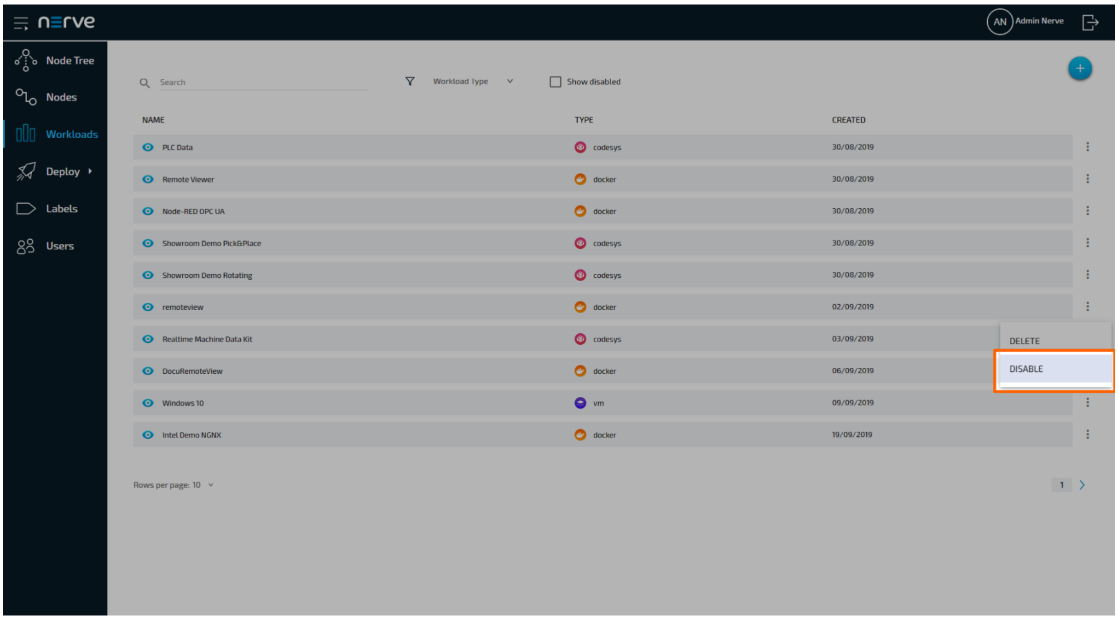
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

3. Click the ellipsis menu to the right of the workload.

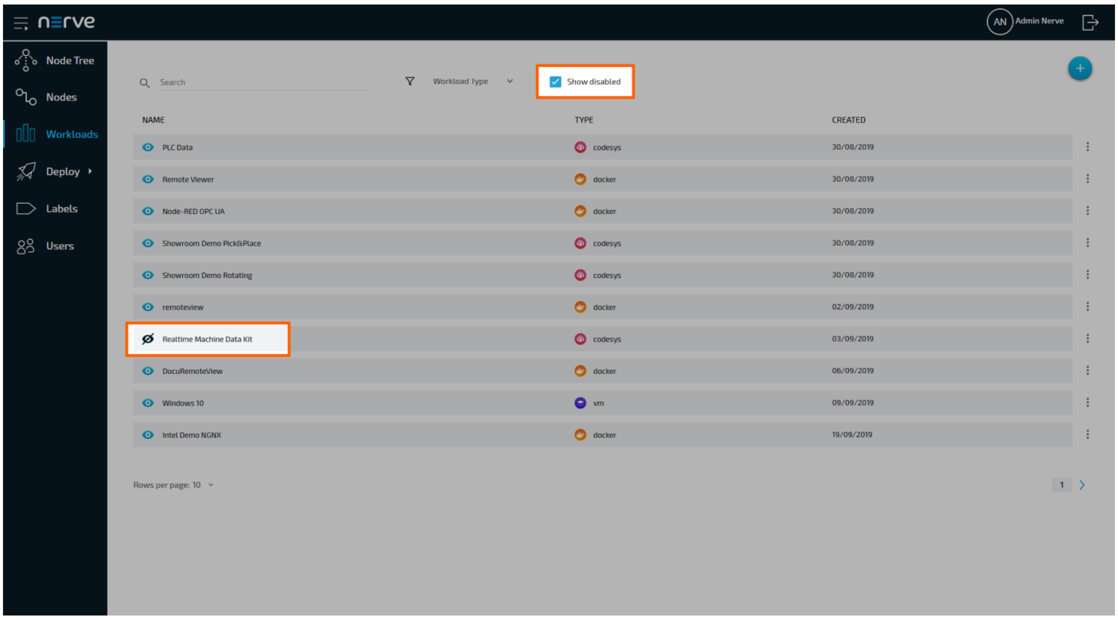
4. Select **DISABLE** from the overlay that appeared.



NAME	TYPE	CREATED
PLC Data	codesys	30/08/2019
Remote Viewer	docker	30/08/2019
Node-RED OPC UA	docker	30/08/2019
Showroom Demo Pick&Place	codesys	30/08/2019
Showroom Demo Rotating	codesys	30/08/2019
remoteview	docker	02/09/2019
Realtime Machine Data Kit	codesys	03/09/2019
DocuRemoteView	docker	06/09/2019
Windows 10	vm	09/09/2019
Intel Demo NGNX	docker	19/09/2019

5. Click **OK** in the new window.

The workload is now disabled and hidden in the list. To show disabled workloads again, tick the checkbox next to **Show Disabled** in the list of workloads. All disabled workloads are marked by an icon resembling a crossed out eye.



☑ Show disabled

NAME	TYPE	CREATED
PLC Data	codesys	30/08/2019
Remote Viewer	docker	30/08/2019
Node-RED OPC UA	docker	30/08/2019
Showroom Demo Pick&Place	codesys	30/08/2019
Showroom Demo Rotating	codesys	30/08/2019
remoteview	docker	02/09/2019
Realtime Machine Data Kit	codesys	03/09/2019
DocuRemoteView	docker	06/09/2019
Windows 10	vm	09/09/2019
Intel Demo NGNX	docker	19/09/2019

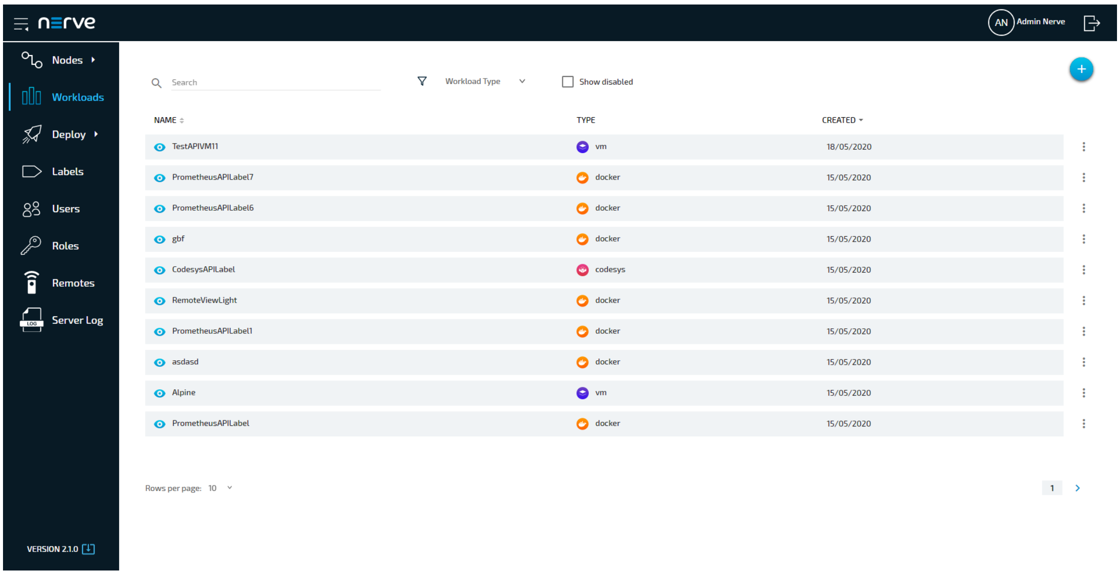
Rows per page: 10

Follow the steps above to enable the workload again. However, select **ENABLE** in the overlay.

Deleting a workload

The instructions below cover the deletion of a workload from the repository in the Management System. Note that deleting a workload from the Management System will not automatically remove the workload from nodes. To remove a workload from a node, undeploy the workload in the node tree.

1. Select **Workloads** from the menu on the left side.
2. Choose the workload to delete.

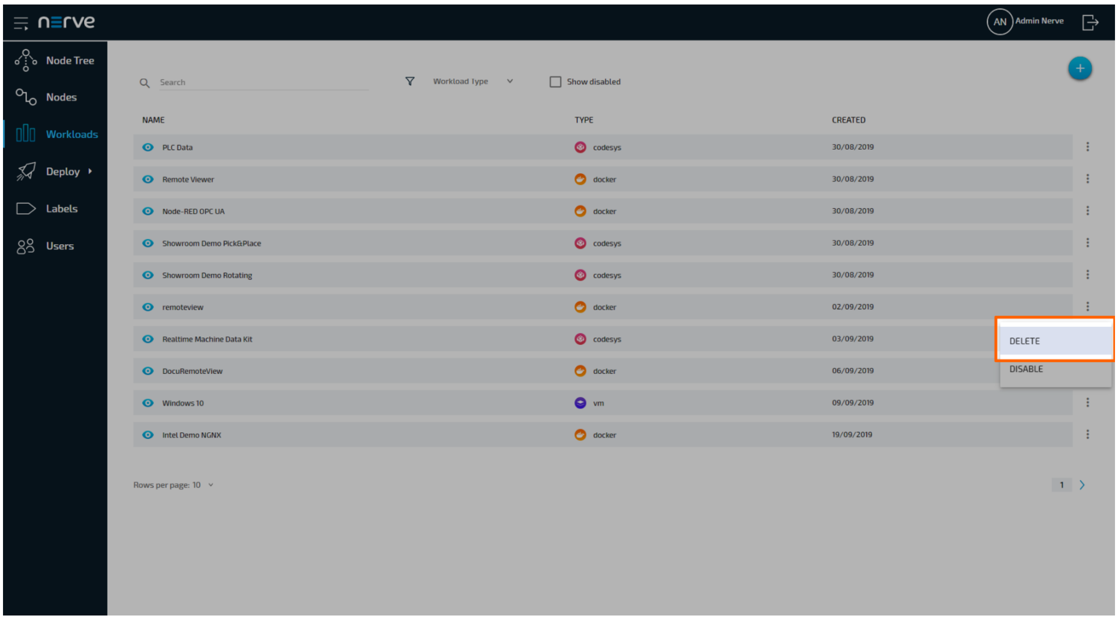


□ Show disabled

NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

Rows per page: 10

3. Click the ellipsis menu to the right of the workload.
4. Select **DELETE** in the overlay that appeared.



NAME	TYPE	CREATED
PLC Data	codesys	30/08/2019
Remote Viewer	docker	30/08/2019
Node-RED OPC UA	docker	30/08/2019
Showroom Demo Pick&Place	codesys	30/08/2019
Showroom Demo Rotating	codesys	30/08/2019
remoteview	docker	02/09/2019
Realtime Machine Data Kit	codesys	03/09/2019
DocuRemoteView	docker	06/09/2019
Windows 10	vm	09/09/2019
Intel Demo NGNX	docker	19/09/2019

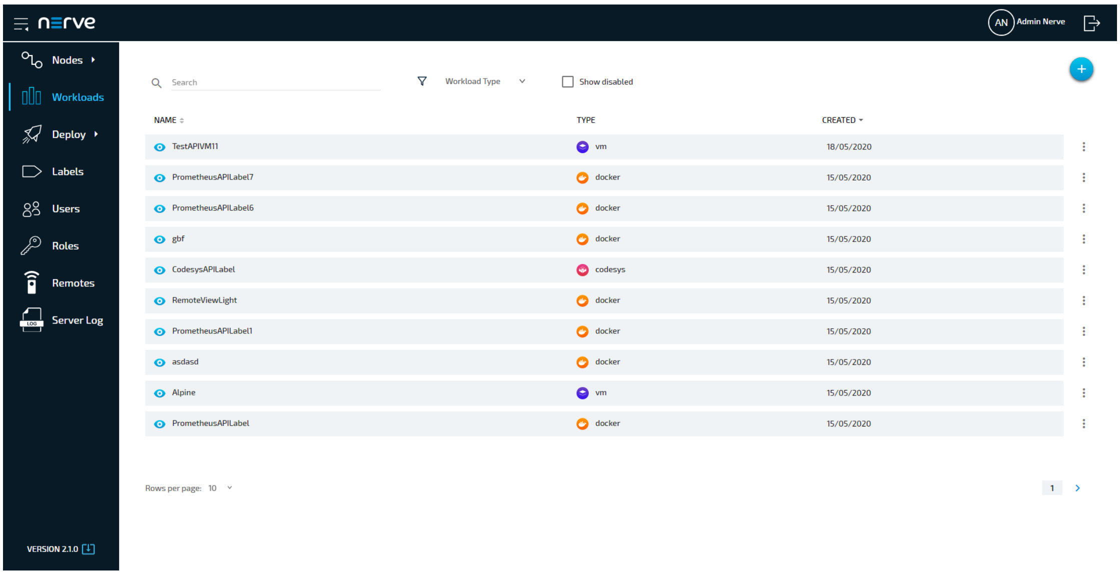
5. Click **OK** in the new window to confirm the deletion.

> **NOTE**
>
> Deleting a workload will automatically delete all versions of the workload as well.

Deleting a workload version

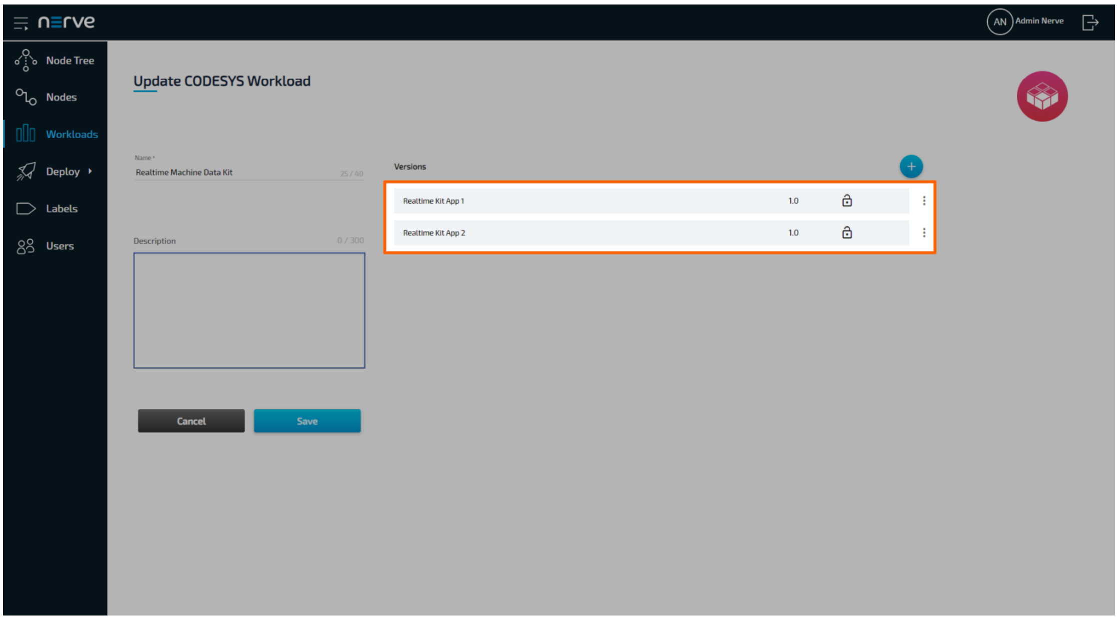
Workload versions can be deleted separately in the workload details. Note that deleting a workload version is not possible if only one version of the workload exists. Delete the entire workload instead.

1. Select **Workloads** from the menu on the left side.
2. Select the workload of which a version will be deleted.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

3. Choose the workload version to delete.



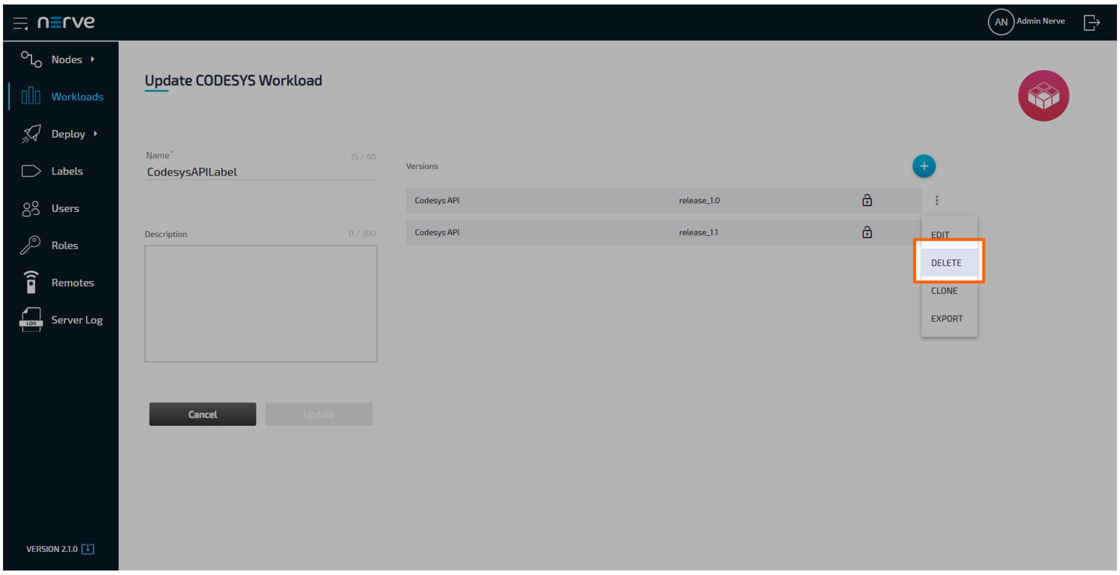
Name *
Realtime Machine Data Kit 25 / 40

Description 0 / 300

Realtime Kit App 1	1.0	🔒
Realtime Kit App 2	1.0	🔒

4. Click the ellipsis menu to the right of the workload version.

5. Select **DELETE** in the overlay that appeared.



Name *
CodesysAPILabel 15 / 40

Description 0 / 300

Codesys API	release_1.0	🔒
Codesys API	release_1.1	🔒

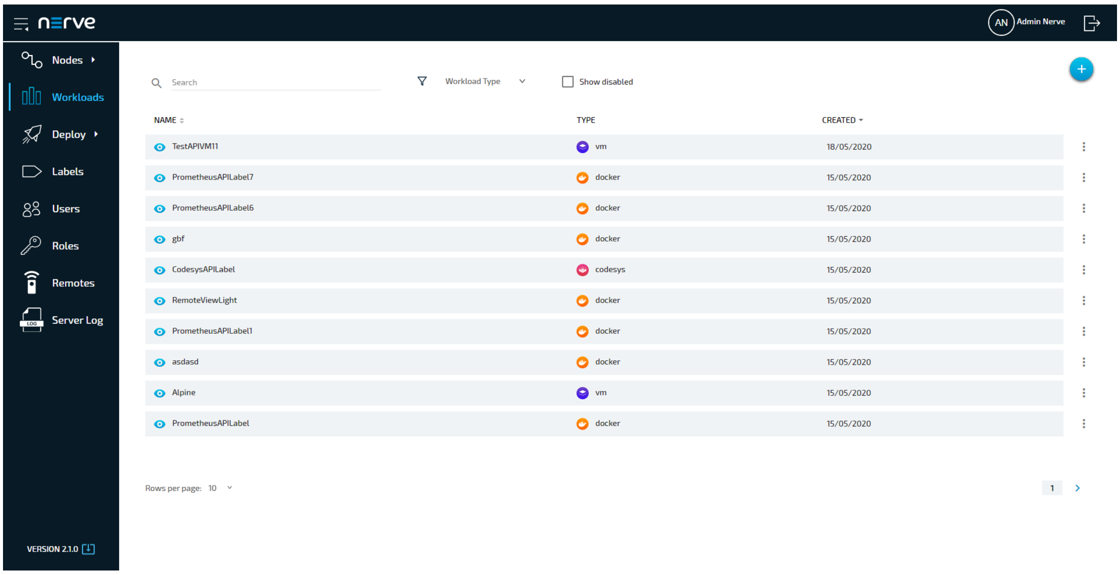
6. Click **OK** in the new window to confirm the deletion.

Exporting a workload

Workloads can be manually deployed to nodes. To do that, a workload version must be exported. For more information on Refer to Local Workload Deployment for more information on local workload deployment.

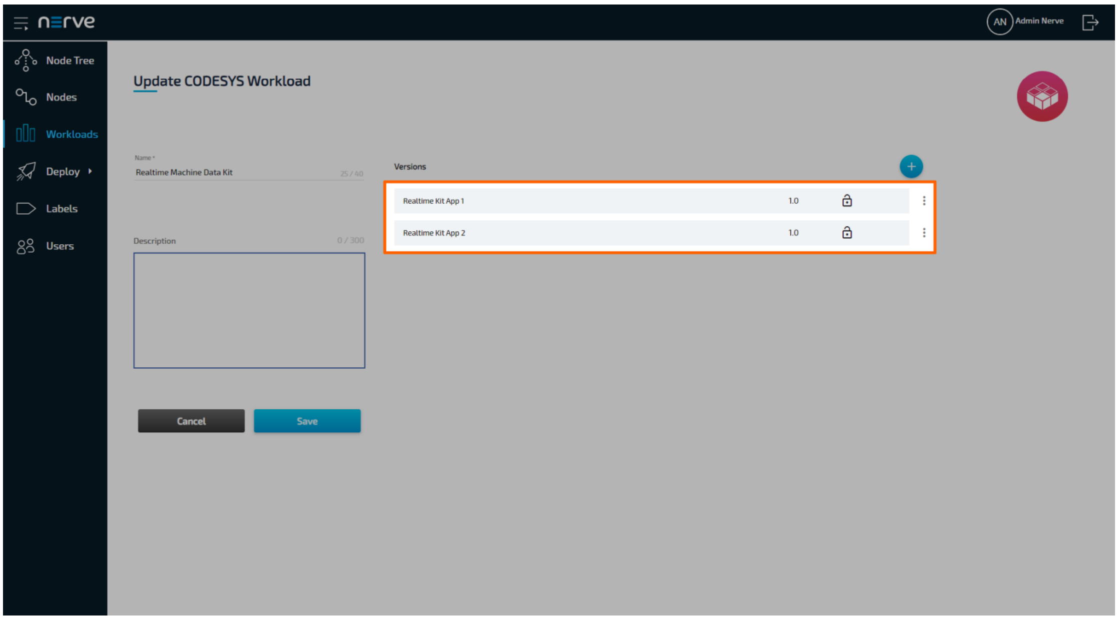
1. Select **Workloads** from the menu on the left side.

2. Select the workload of which a version will be exported.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

3. Choose the workload version to export.



Update CODESYS Workload

Name * Realtime Machine Data Kit 25 / 40

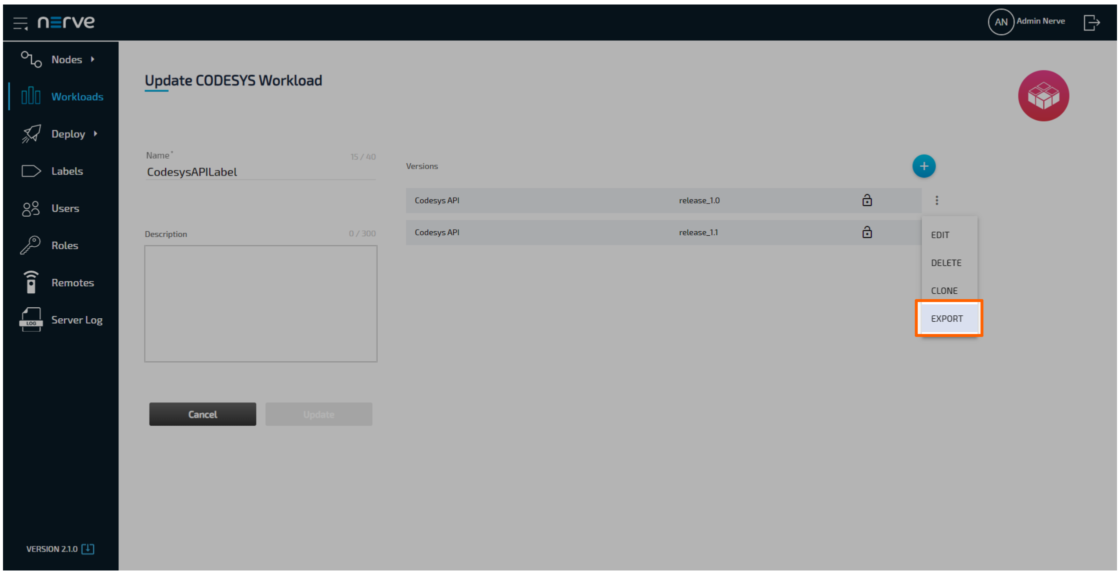
Description 0 / 300

Versions

Realtime Kit App 1	1.0
Realtime Kit App 2	1.0

4. Click the ellipsis menu to the right of the workload version.

5. Select **EXPORT** in the overlay that appeared.



Update CODESYS Workload

Name* CodesysAPILabel 15 / 40

Description 0 / 300

Versions

Codesys API	release_1.0	
Codesys API	release_1.1	

The download of the exported workload version is started automatically. The workload version is compressed into a TAR file.

NOTE

- Be careful if a workload export produces a TAR.GZ file. Using a TAR.GZ file for local workload deployment will break the deployment process. Transform the TAR.GZ file into a TAR file before locally importing a workload.
- If the workload export fails with a 403 error code, delete the cookies from the web browser and try again.

Controlling a workload

Workloads can be controlled from the node details view in the node tree. Refer to the node tree chapter for more information.

Replacing the version of a deployed workload

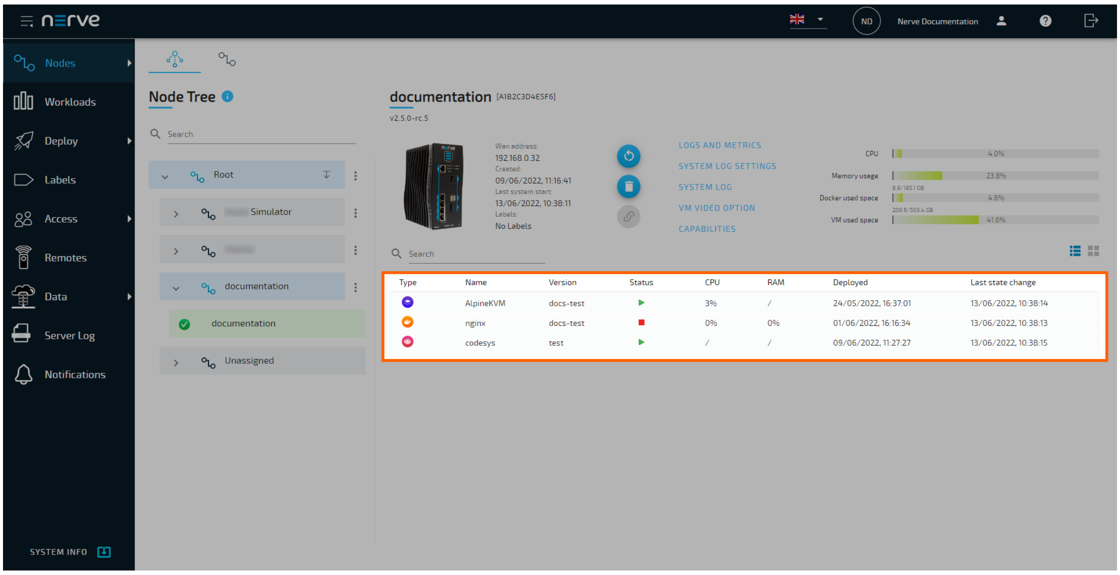
Versions of deployed CODESYS and Docker workloads can be replaced by other versions through the workload control screen. Replacing the workload version is a quick way to deploy a new version of the same workload. Also, note that a Docker volume used for configuration storage will be removed if the new workload version does not have a volume defined and the version is replaced.

NOTE

Note that this functionality is also available in the Local UI. However, note that the workload version needs to be exported first. Refer to Replacing the version of a deployed workload in the Local UI for more information.

1. Select **Nodes** in the navigation on the left.
2. Select a node in the node tree that has multiple versions.

3. Select the workload in the node details view.



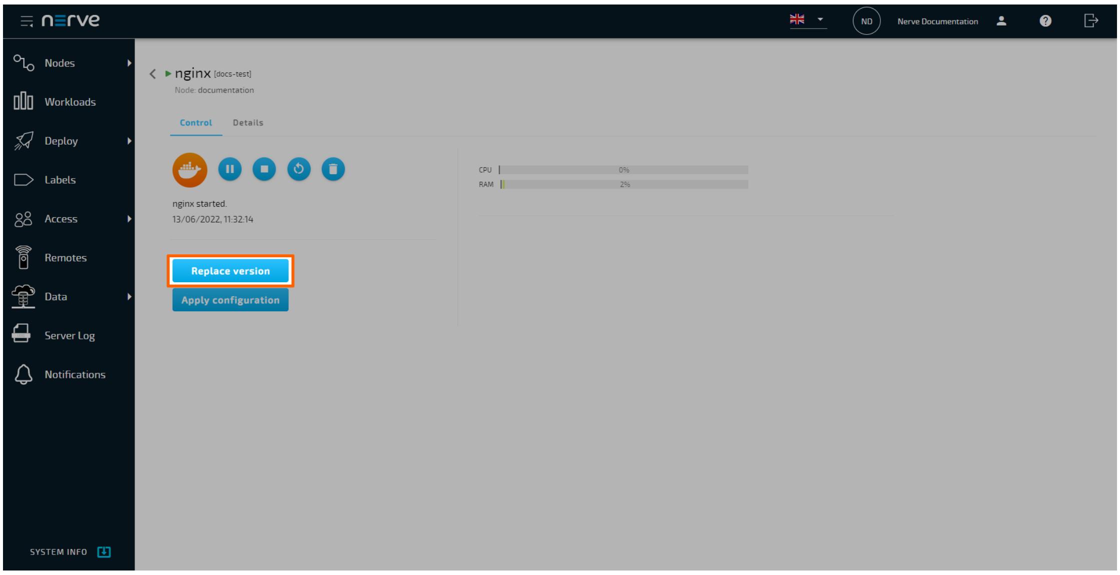
documentation [A1B2C3D4E5F6]
v2.5.0-rc.5

Wan address:
192.168.0.32
Created:
09/06/2022, 11:16:41
Last system start:
13/06/2022, 10:38:11
Labels:
No Labels

CPU 4.0%
Memory usage 23.8%
8.9/195.1 GB
Docker used space 4.6%
209.6/503.4 GB
VM used space 41.6%

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

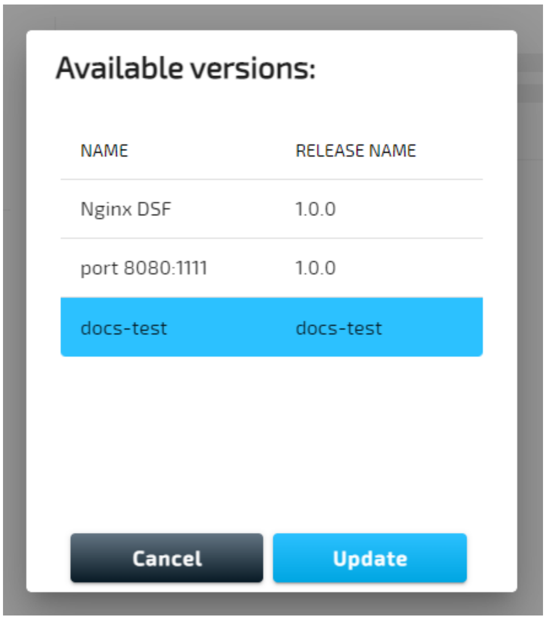
4. Select **Replace version**.



nginx [docs-test]
Node: documentation

nginx started.
13/06/2022, 11:32:14

5. Select a version from the list of available versions.

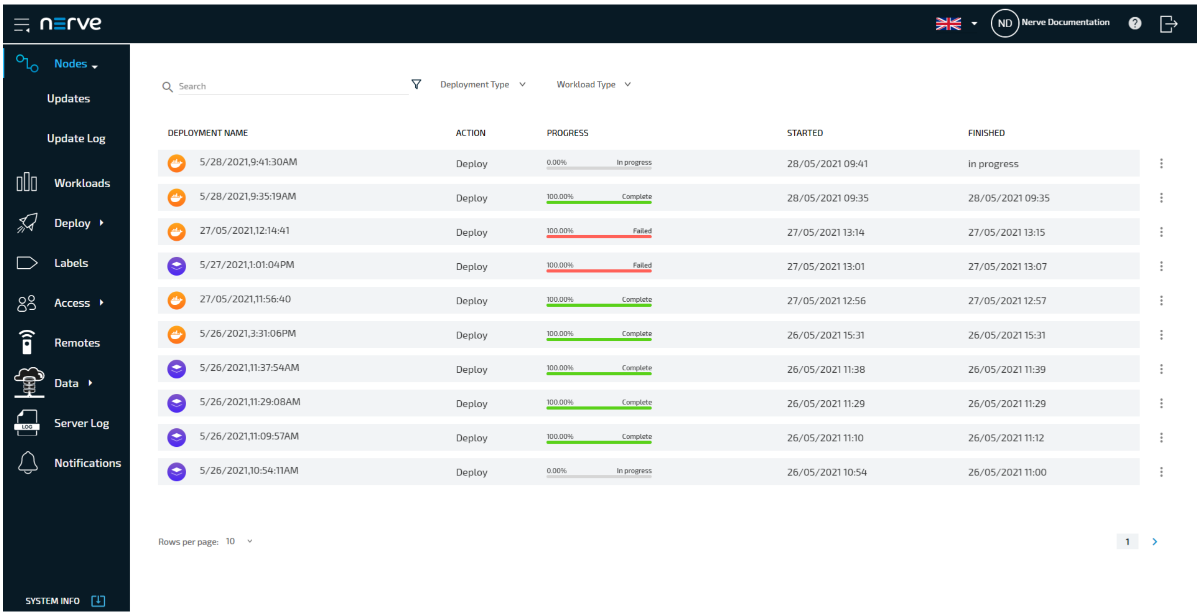


Available versions:

NAME	RELEASE NAME
Nginx DSF	1.0.0
port 8080:1111	1.0.0
docs-test	docs-test

6. Select **Update**.

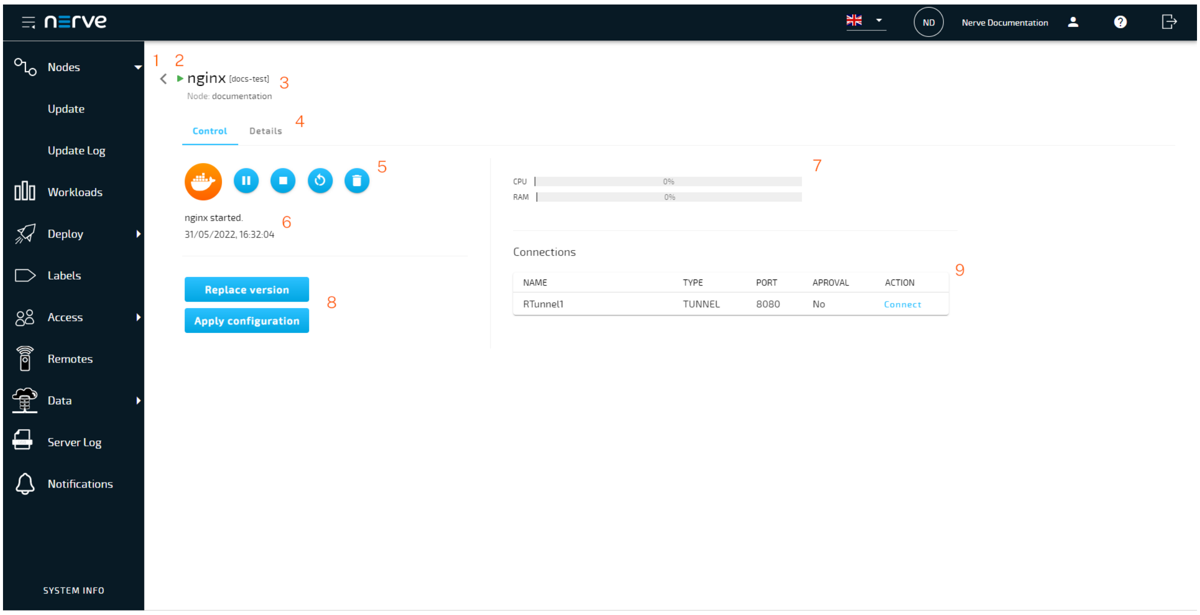
This starts the replacement of the workload version. The Management System will continue to the log next. The deployment of new version is at the top of the list. A timestamp is the name that identifies the deployment in the log.



DEPLOYMENT NAME	ACTION	PROGRESS	STARTED	FINISHED
5/28/2021,9:41:30AM	Deploy	0.00% In progress	28/05/2021 09:41	in progress
5/28/2021,9:35:19AM	Deploy	100.00% Complete	28/05/2021 09:35	28/05/2021 09:35
27/05/2021,12:14:41	Deploy	100.00% Failed	27/05/2021 13:14	27/05/2021 13:15
5/27/2021,1:01:04PM	Deploy	100.00% Failed	27/05/2021 13:01	27/05/2021 13:07
27/05/2021,11:56:40	Deploy	100.00% Complete	27/05/2021 12:56	27/05/2021 12:57
5/26/2021,3:31:06PM	Deploy	100.00% Complete	26/05/2021 15:31	26/05/2021 15:31
5/26/2021,11:37:54AM	Deploy	100.00% Complete	26/05/2021 11:38	26/05/2021 11:39
5/26/2021,11:29:08AM	Deploy	100.00% Complete	26/05/2021 11:29	26/05/2021 11:29
5/26/2021,11:09:57AM	Deploy	100.00% Complete	26/05/2021 11:10	26/05/2021 11:12
5/26/2021,10:54:11AM	Deploy	0.00% In progress	26/05/2021 10:54	26/05/2021 11:00

Workload control

In the Management System, workloads are located below the node details in the node tree. In the Local UI, they can be found in the **Workload management** menu. Selecting a workload allows control of the respective workload. There are unique additional control options for each workload type. Note that CODESYS workloads can only be controlled from the Local UI.



nginx started.
31/05/2022, 16:32:04

NAME	TYPE	PORT	APROVAL	ACTION
RTunnel1	TUNNEL	8080	No	Connect

Item	Description
Back button (1)	Select this to return to the node tree.
Status indicator (2)	The symbol here indicates the status of the workload: • **Green play symbol** This symbol is displayed when the workload is running. • **Yellow pause symbol** This symbol is displayed when the workload is suspended. • **Red stop symbol** This symbol is displayed when the workload is stopped. • **Animated loading symbol** This symbol is displayed when the workload is transitioning between statuses. • **Triangular warning sign** This symbol is displayed when an error has been encountered. • **Gray dot** This symbol is displayed when the workload is idle.
Workload and device name (3)	The names of the workload, the device and the release name are displayed here as: **<workloadname> [<versionname>]** **Node: <devicename>** Note that due to compatibility reasons, the release name is displayed instead of the version name for nodes older than 2.5.0.
Tabs (4)	Information and control options for the deployed workload are structured into tabs. The **Control** tab is the default view, containing the control panel, workload specific features, resource graphs and more. The **Details** tab shows workload type related information, e.g. defined environmental variables and mapped ports for Docker workloads. In this version, tabs are only available for Docker workloads.

Item	Description
Control panel (5)	The following control options are available: • **Play/Suspend** If the workload is in a stopped or suspended state, selecting **Play** will start the workload. If the workload is running, the play button will be a pause button instead. Selecting **Suspend** will pause the workload. • **Stop** If the workload is running, selecting **Stop** will stop the workload. • **Restart** This will restart the workload. • **Undeploy** Selecting this removes the workload from the node. The workload can be deployed again from the deployment menu.

Item	Description
Message window (6)	The message window displays the latest message the workload has sent out including a time stamp. The type of message that is displayed here depends on the workload. **Messages for VMs and Docker containers:** • "Domain creating." • "ERROR during creating! <errormessage>" • "Domain starting." • "ERROR during starting! <errormessage>" • "Domain <domainname> started." • "Domain stopping." • "ERROR during stopping! <errormessage>" • "Domain <domainname> stopped." • "Domain suspending." • "ERROR during suspending! <errormessage>" • "Domain <domainname> suspended." • "Domain resuming." • "ERROR during resuming! <errormessage>" • "Domain restarting." • "ERROR during restarting." • "Domain removing!!!" • "ERROR during removing." • "ERROR!!! Domain stopping." In the messages above, <domainname> is a placeholder for the name of the VM or Docker. In case of Docker containers, <errormessage> signifies a message that is generated by the Docker container if an error occurs. **Additional set of messages for VMs only:** • "Failed to connect to hypervisor." • "Failed to create domain." • "Domain <domainname> created." • "Cannot start <domainname> domain because it may already be running!" • "Failed to resume <domainname> domain!" <errormessage> • "Failed to start domain <domainname>. " <errormessage> In this case, <errormessage> is a message that is fetched from the libvirt library. **Messages from CODESYS workloads:** • "Preparing files for installation" • "Starting CODESYS application" • "CODESYS application started" • "Stopping CODESYS application" • "CODESYS application stoppped" • "Removing CODESYS application file" • "An unexpected error has occurred. <errormessage>" Here, <errormessage> is a message that is sent between the node and CODESYS.

Item	Description
Usage statistics (7)	Virtual Machine workloads and Docker workloads have their assigned resources they can use. The use of these resources is displayed with bar graphs: • **CPU (VM and Docker)** The percentage here shows the usage of CPU resources in relation to the assigned CPUs. Example: A VM is assigned one CPU core out of four and the core is at 75 % usage capacity. The graph will be at 75 %. • **RAM (Docker only)** Similar to the CPU usage statistic, the percentage here shows the usage of system memory resources in relation to the assigned memory. If the assigned memory is at a 100 % usage capacity, the graph will be at 100 %. If no memory has been assigned, the graph will show the percentage of used memory in relation to the total available memory of the host.
Workload commands (8)	This area has a list of selectable items with different actions and features for workloads. Which commands appear in this list depends on the workload type, permissions and whether the requirements for the command are met. Refer to Workload type specifics below for more information on workload specific commands and features.
Remote Connections (9)	All configured remote connections to the workload are displayed here in a list. Remote connections to the workload can be established by selecting **Connect** in the list. Note that this area is empty if no remote connection has been defined. Refer to Remote Connections for more information.

NOTE

Since CODESYS workloads can only be controlled through the Local UI, the workload control screen does not offer any control options. It offers a message window. the option to undeploy the workload and the remote connections list for establishing remote connections.

Workload type specifics

The table above covers the general workload control screen. Find below exclusive control options per workload type. Note that the options below will not appear in the workload control screen unless the requirements are met.

CODESYS workloads

Item	Description
Replace version	Select this to open an overlay displaying all available versions of this workload. Select a version from the list to deploy it to the node in a quick way. Refer to Updating a deployed workload for more information.

Docker workloads

Item	Description
Apply configuration	This element only appears for Docker workloads with configuration storage defined. Selecting this allows the upload of configuration files. The configuration files have to be archived and uploaded in a ZIP file. For more information, refer to Applying configuration files to a workload below.
Replace version	Select this to open an overlay displaying all available versions of this workload. Select a version from the list to deploy it to the node in a quick way. Refer to Updating a deployed workload for more information.

Virtual Machine workloads

Item	Description
Resources allocation	The allocation of resources for Virtual Machine workloads can be modified while the workload is deployed and running on a node. This allows for balancing of resources when several Virtual Machine workloads are running on one node. For more information, refer to Changing resource allocation of a deployed Virtual Machine workload below.
Network info	Select this to view information about networks attached to virtual machines in form of a read-only window. The information collected pertains the interface name, the source interface name on the Nerve host, the MAC address, the IP address, as well as the amount of received and transferred network data. Refer to Virtual machine network info below for more information.
Snapshot	The current configuration of a virtual machine running in the Nerve system can be temporarily saved by taking a snapshot. One snapshot can be created at a time, either manually or through scheduling an automatic snapshot. They are designed to be temporary save states or fallbacks before a virtual machine is configured or updated. The process takes seconds or minutes and the result is a dynamically growing file stored on the Nerve Device. Note that snapshots are not persistent. If the workload is undeployed, the snapshot is lost. Refer to Virtual machine snapshots below for more information.
Backup	Saving a certain or optimal configuration of a virtual machine can be done with backups. Backups can only be created manually and they take much longer to create compared to snapshots. They are not designed to be done frequently. Backups are stored in a separate repository that needs to be defined by the user in the Local UI. The repository needs to be an NFS server that is accessible for the Nerve system. The repository for virtual machine backups can be shared between nodes, making the deployment of a VM backup to another node possible. Note that an NFS server needs to be set up first and made accessible for the Nerve Device. Once the NFS server is set up, connect to the Local UI and define the NFS server as the VM backup repository. NFS v3 and v4 are supported. Refer to Virtual machine backups below for more information.

Item	Description
VM VIDEO OPTION	The video output of Nerve Devices can be configured to directly output the interface of deployed virtual machines. This means that by connecting one or more monitors, a keyboard and a mouse, virtual machines can be operated directly at the Nerve Device. Note that the feature is not enabled by default and needs to be activated by Nerve service technicians. Refer to Virtual Machine video options below for more information.

Applying configuration files to a workload

Configuration files can be applied to deployed Docker workloads through the workload control screen. In this case, configuration files are files that the application in the Docker workload needs to perform a specific task. The nature of these files is completely dependent on the application. Therefore, these configuration files need to be prepared by the workload creator beforehand. They also need to be archived as a ZIP file so that they can be applied to a Docker workload using the Management System. Configuration files can be applied to the Docker workload while it is running, stopped or suspended.

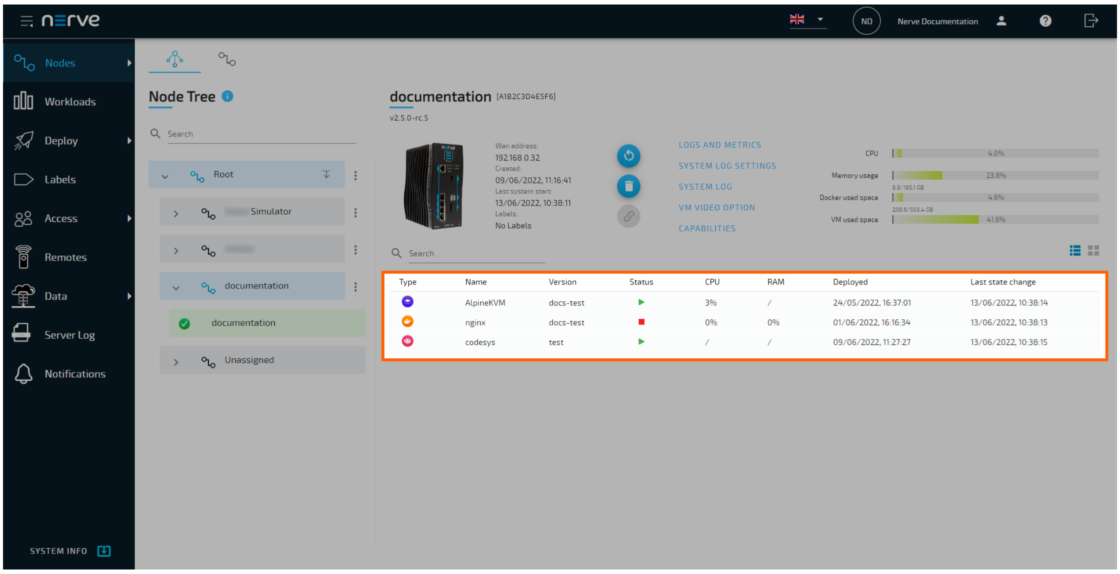
Also, note that the workload needs to be properly configured before it is deployed in order to apply a configuration. At least one Docker volume needs to be defined and designated as configuration storage. For more information, refer to Settings for Docker workloads.

NOTE

Note that this functionality is also available in the Local UI.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree symbol.
3. Select a node with a deployed Docker workload from the node tree.

4. Select the Docker workload in the node details view on the right.

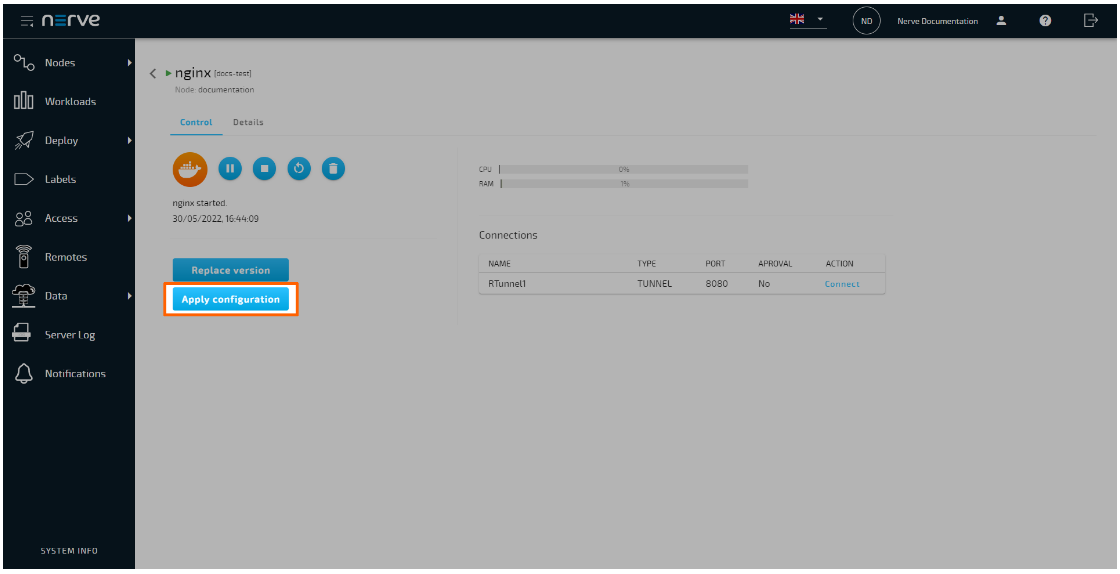


documentation [A1B2C3D4E5F6]
v2.5.0-rc.5

Wan address: 192.168.0.32
Created: 09/06/2022, 11:16:41
Last system start: 13/06/2022, 10:38:11
Labels: No Labels

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

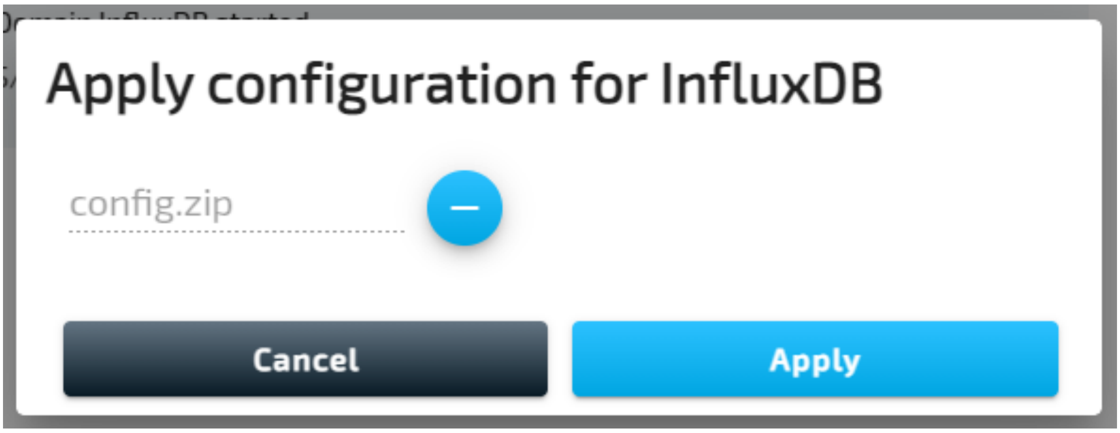
5. Select **Apply configuration**.



nginx started.
30/05/2022, 16:44:09

NAME	TYPE	PORT	APROVAL	ACTION
RTunnel1	TUNNEL	8080	No	Connect

6. Select the plus icon to open the file browser.
7. Select the ZIP file containing the configuration files.
8. Select **Open** to add the ZIP file.

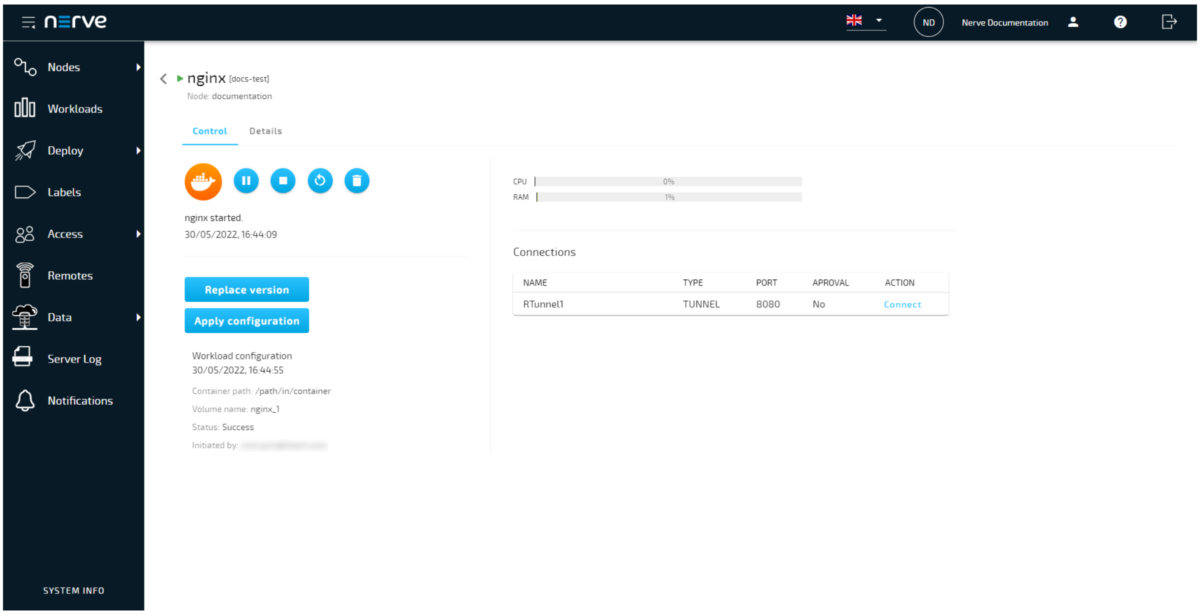


9. Select **Apply**.

A success message will pop up in the upper-right corner once the ZIP file has been applied. Also, a new message window labelled **Workload configuration** is added. It includes the following information:

Item	Description
Timestamp	A timestamp in the format `M/DD/YYYY, h:mm:ss am/pm` is added next to **WORKLOAD CONFIGURATION** in the header of the workload configuration message window. This indicates the most recent time configuration files have been applied.
Container path	This is the path of the Docker volume that has been defined in the workload version settings before the deployment of the workload.
Volume name	This is the name of the Docker volume that has been defined in the workload version settings before the deployment of the workload.
Status	This indicates whether the files containing in the ZIP file have been successfully transferred to the Docker container.

Item	Description
Initiated by	Here the user is listed that applied the configuration files.



nginx [docs-test]
Node: documentation

nginx started.
30/05/2022, 16:44:09

CPU 0%
RAM 1%

Connections

NAME	TYPE	PORT	APROVAL	ACTION
RTunnel1	TUNNEL	8080	No	Connect

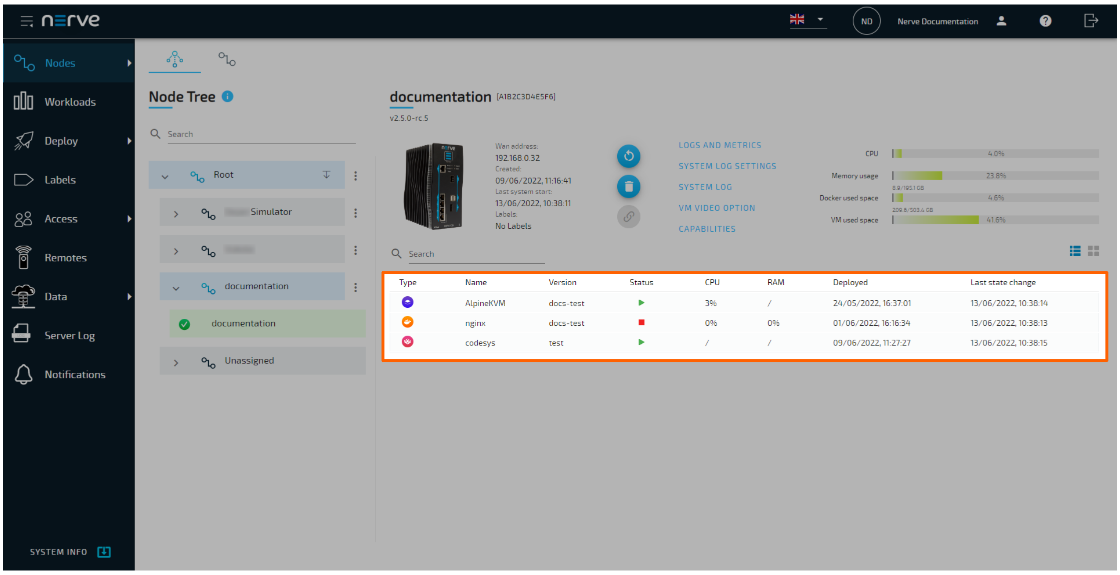
Workload configuration
30/05/2022, 16:44:55
Container path: /path/in/container
Volume name: nginx_1
Status: Success
Initiated by: [redacted]

Changing resource allocation of a deployed Virtual Machine workload

The allocation of resources for Virtual Machine workloads can be modified while the workload is deployed and running on a node. This allows for balancing of resources when several Virtual Machine workloads are running on one node. Note that the workload automatically restarts in order to apply the changes.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree symbol.
3. Select a node with a deployed Virtual Machine workload from the node tree.

4. Select the Virtual Machine workload in the node details view on the right.



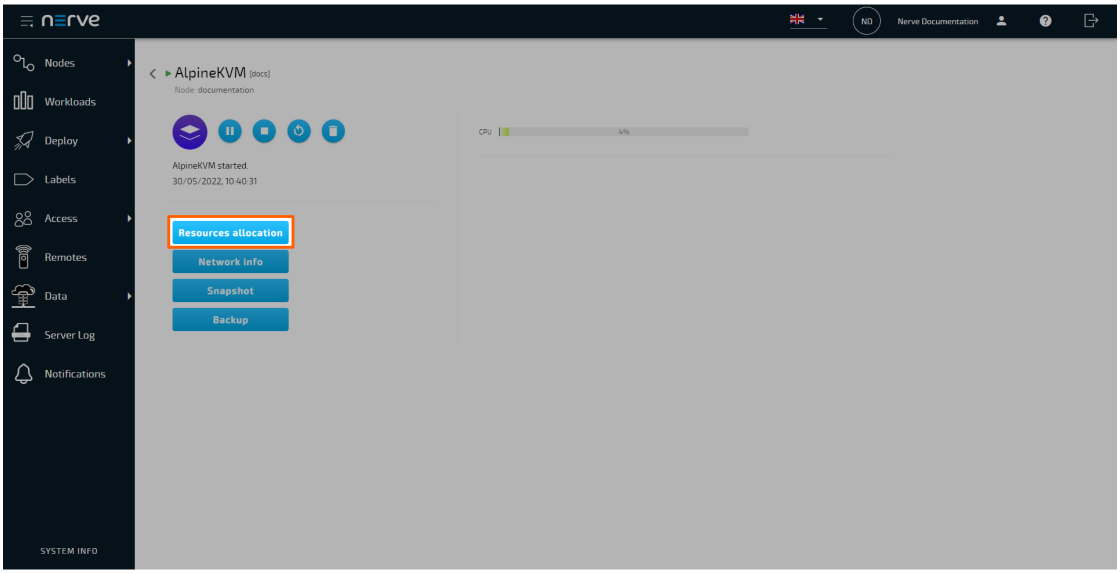
documentation [A1B2C3D4E5F6]
v2.5.0-rc.5

Wan address:
192.168.0.32
Created:
09/06/2022, 11:16:41
Last system start:
13/06/2022, 10:38:11
Labels:
No Labels

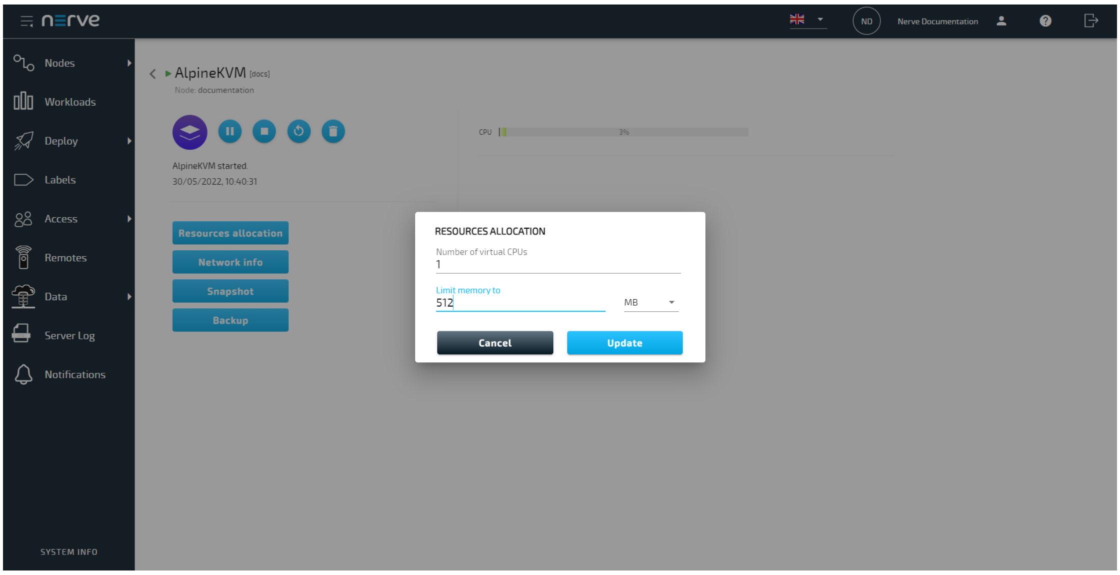
CPU 4.0%
Memory usage 23.8%
8.9/195.1 GB
Docker used space 4.6%
209.6/503.4 GB
VM used space 41.6%

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

5. Select **Resources allocation** in the list.



6. Edit the values of **Number of virtual CPUs** and **Limit memory to** to the desired values.



RESOURCES ALLOCATION

Number of virtual CPUs: 1

Limit memory to: 512 MB

7. Select **Update**.

8. Select **Yes** in the pop-up that appeared.

A green notification pops up in the upper-right and the Virtual Machine workload is automatically restarted to apply the changes.

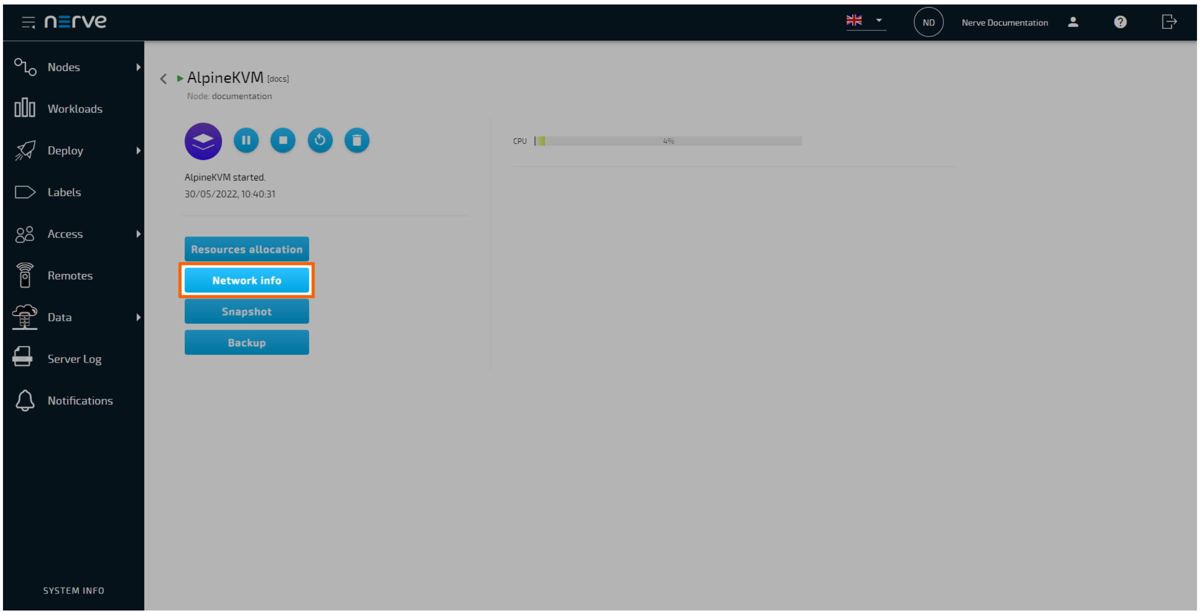
NOTE

This functionality is also available in the Local UI. Log in to the Local UI and select **Workload management** in the navigation on the left. Select a Virtual Machine workload and follow the steps above.

Virtual machine network info

Information about networks attached to virtual machines can be looked into in form of a read-only window. Select **Network info** in the workload control screen of a Virtual Machine workload to access the information. Here is how to reach the workload control screen in the Local UI and the Management System:

Location	Path
Local UI	**Workload management** > Select the VM workload.
Management System	**Nodes** > Select a node from the node tree that has a compatible virtual machine deployed. > Select the VM workload.



AlpineKVM started.
30/05/2022, 10:40:31

Here is an overview of the information shown.

Item	Description
INTERFACE NAME	Name of the virtual network device attached to the host interface.
SOURCE	This is the name of the Nerve network interface that was assigned when provisioning the workload. However, the name displayed here is the name of the interface on the host. This means bridged interfaces (`rtvm` and `isolated1-5`) will be displayed differently, i.e. `isolated1` will be displayed as `br-isolated1` etc.
MAC ADDRESS	MAC address assigned to the virtual network device.
IP ADDRESS	This is the IP address of the interface, either given by a DHCP server or set manually.
RECEIVED KB	Network data received since last VM workload start.
TRANSMITTED KB	Network data transferred since last VM workload start.

If there are no networks attached to the workload, the dialog will be empty.

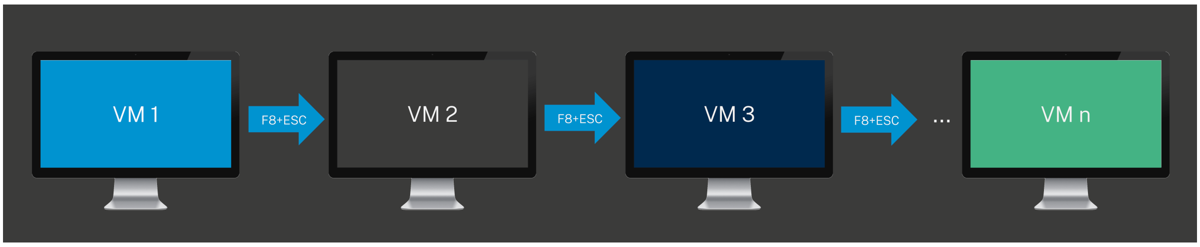
Virtual machine video options

NOTE

The following feature is not enabled by default. The Nerve Device needs to be configured by service technicians first. Contact a sales representative or TTTech Industrial customer support to request this feature to be enabled. Note that there are two options: regular and grid display. Make sure to state the display mode when requesting the feature to be enabled.

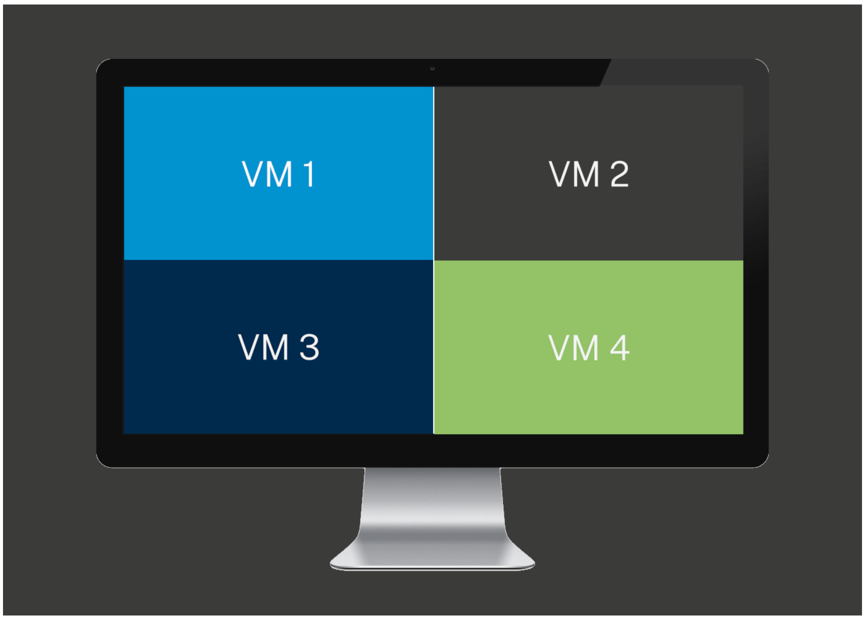
The video output of Nerve Devices can be configured to directly output the interface of deployed virtual machines. This means that by connecting one or more monitors, a keyboard and a mouse, virtual machines can be operated directly at the Nerve Device. There are two display modes that can be chosen: regular and grid display. Note that only one of the two modes can be active. Refer to the images below for more information on possible VM display scenarios:

One monitor, multiple virtual machines, one at a time



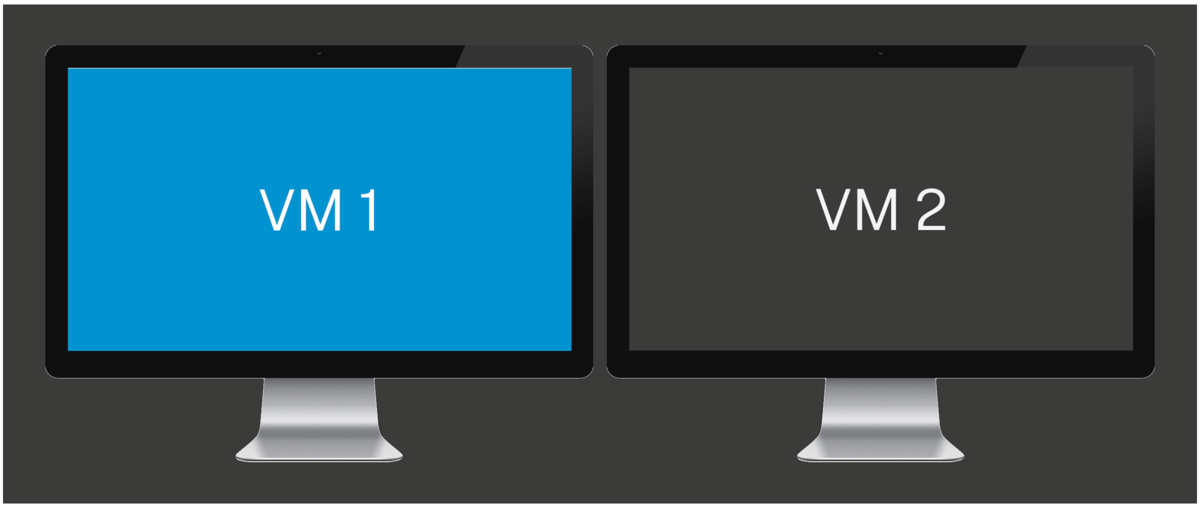
Request regular display mode to use the feature this way. Press F8+Esc to switch between VMs. Determine the order of the VMs by changing the display order settings in the VM video options menu in the Management System.

One monitor, multiple virtual machines at once



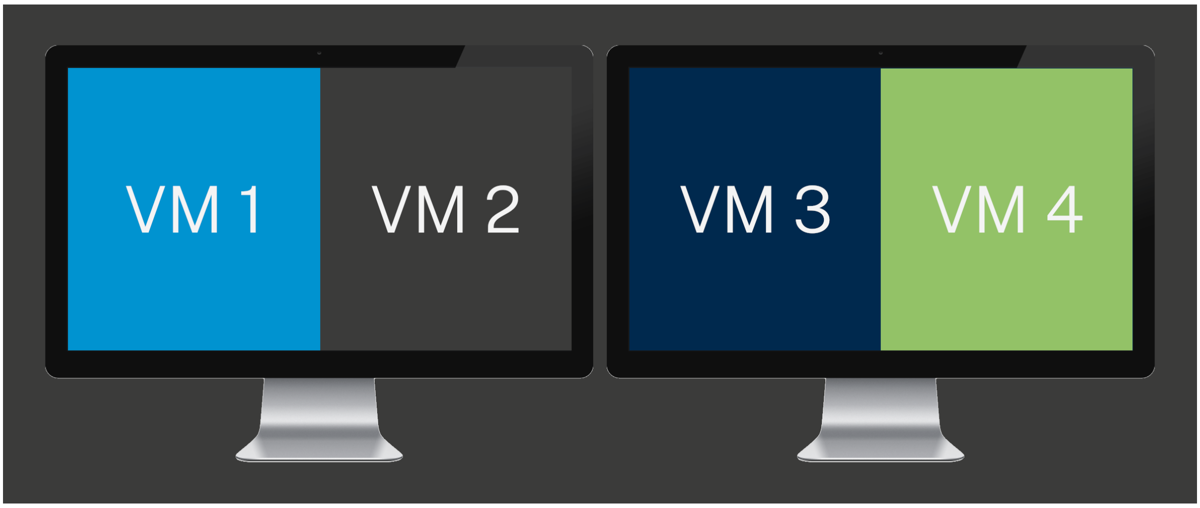
Request grid display mode to use the feature this way. The maximum number of virtual machines that can be displayed is four. Determine the screen position of each VM by changing the display order settings in the VM video options menu in the Management System. All virtual machines can be operated by seamlessly moving the mouse pointer.

Two monitors, two virtual machines



Request regular display mode to use the feature this way. This scenario is only possible with Nerve Devices that have more than one video output. Determine the position of each VM by changing the display order settings in the VM video options menu in the Management System. Both virtual machines can be operated by seamlessly moving the mouse pointer.

Two monitors, multiple virtual machines

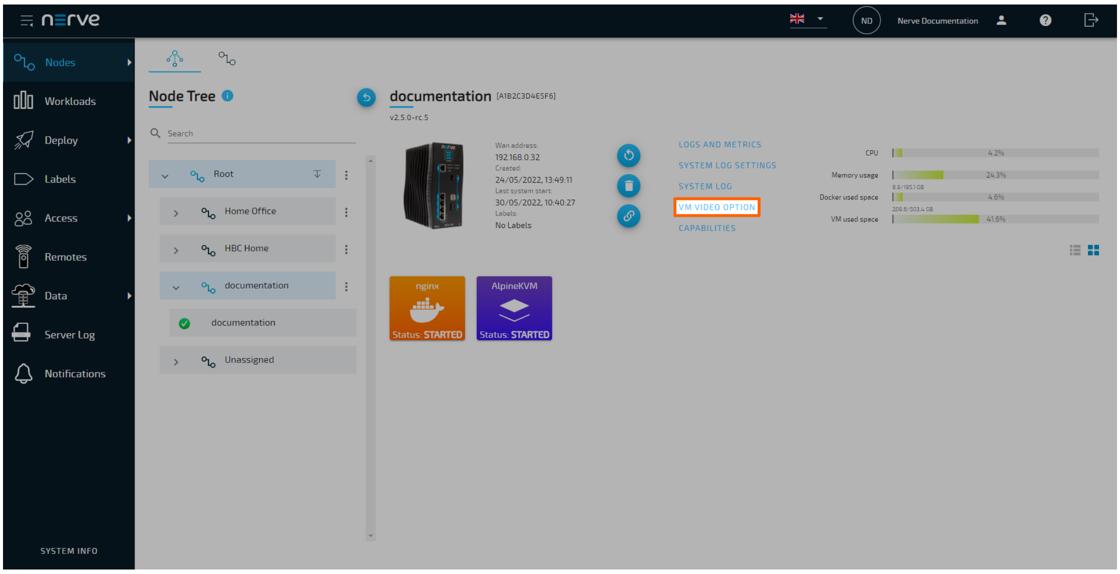


Request grid display mode to use the feature this way. This scenario is only possible with Nerve Devices that have more than one video output. Determine the screen position of each VM by changing the display order settings in the VM video options menu in the Management System. All virtual machines can be operated by seamlessly moving the mouse pointer.

NOTE

Connect a monitor to the Nerve Device before the Nerve Device is powered on. This is to avoid having to reboot the node once the VM video options are activated.

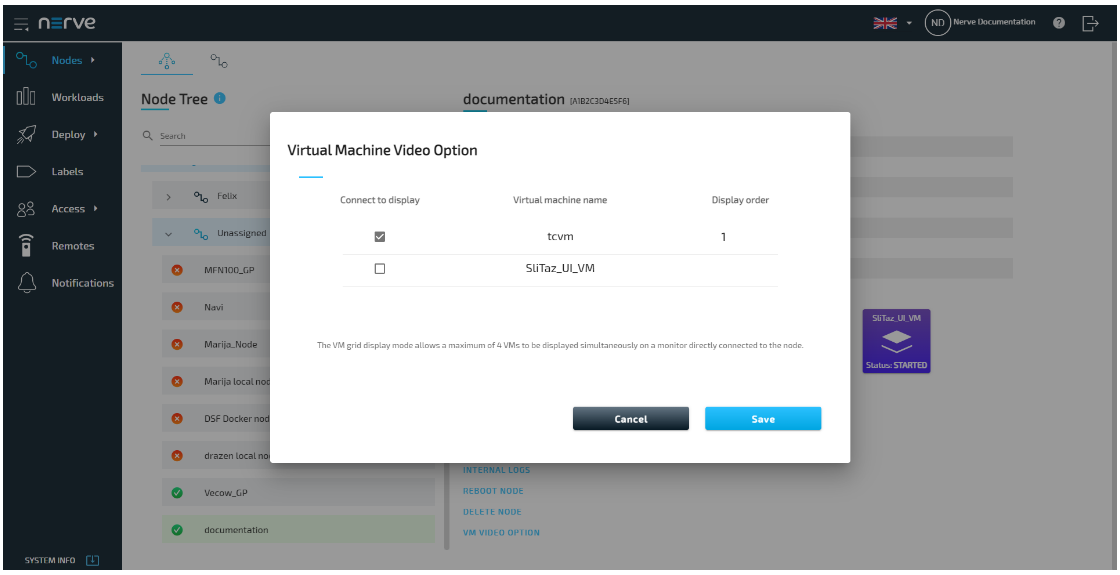
1. Make sure the user has the required permission to view the VM video options. The permission is **VM video output configuration**. Refer to Editing a role for more information on changing the permissions of a role.
2. Select **Nodes** in the navigation on the left.
3. Select the node that has VM video options enabled from the node tree.
4. Select **VM VIDEO OPTION** in the node details view.



documentation [A1B2C3D4E5F6]
v2.5.0-rc.5

Wan address: 192.168.0.32
Created: 24/05/2022, 13:49:11
Last system start: 30/05/2022, 10:40:27
Labels: No Labels

5. Tick the checkbox next to the VMs that shall have video output at the Nerve Device.

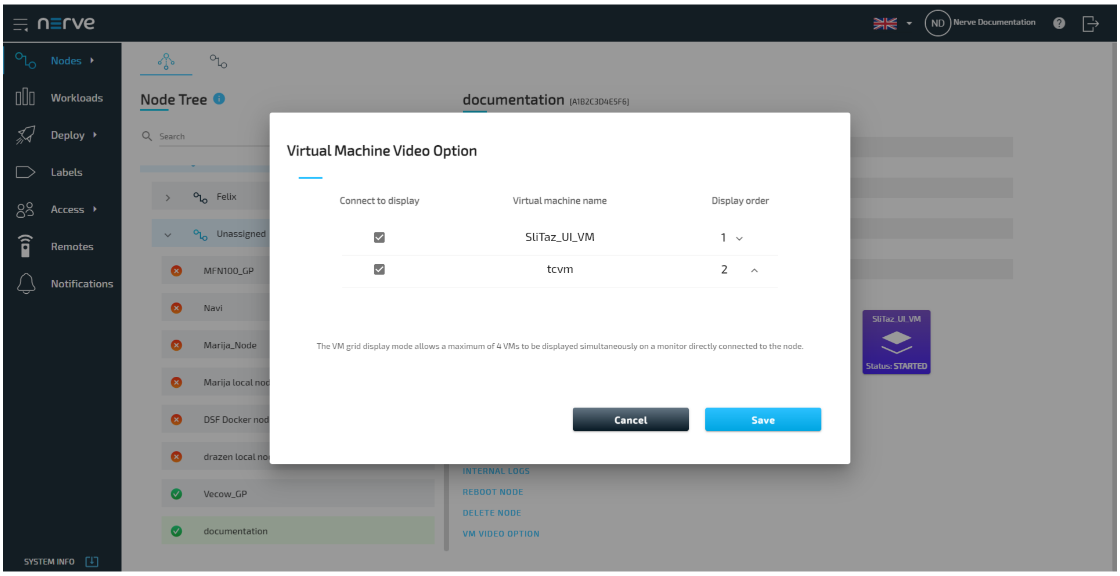


Virtual Machine Video Option

Connect to display	Virtual machine name	Display order
☑	tcvm	1
☐	SliTaz_UI_VM	

The VM grid display mode allows a maximum of 4 VMs to be displayed simultaneously on a monitor directly connected to the node.

6. Use the arrows under **Display order** to define in which order the VMs shall be displayed.



Virtual Machine Video Option

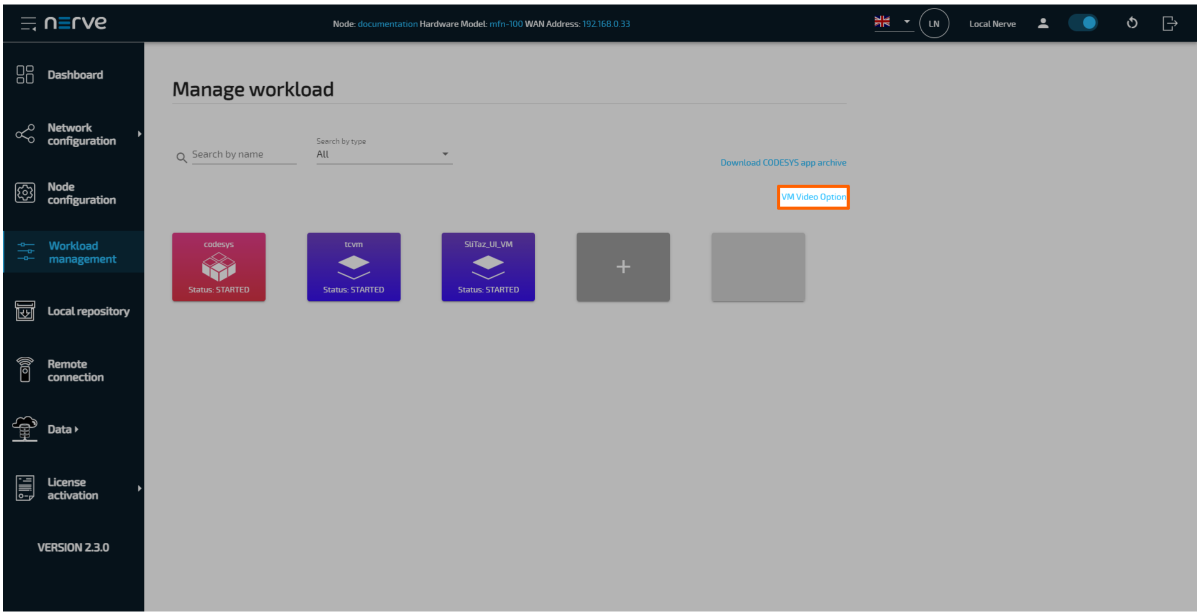
Connect to display	Virtual machine name	Display order
☑	SliTaz_UI_VM	1
☑	tcvm	2

The VM grid display mode allows a maximum of 4 VMs to be displayed simultaneously on a monitor directly connected to the node.

7. Select **Save**.

The selected virtual machine will now be displayed at the video output of the Nerve Device. However, the VM display resolution might need to be adjusted inside of the VM to make the VM fit its portion of the screen. Note that the node needs to be restarted for the video output to be displayed if the node was already running when the monitor was connected. Also note that having video options enabled for a given virtual machine, makes VNC remote connections to that virtual machine not possible.

This feature is also available in the Local UI. Select **Workload management** in the navigation on the left and then select **VM Video Option**.



Virtual machine snapshots

The current state of a virtual machine running in the Nerve system can be temporarily saved by taking a snapshot. One snapshot can be created at a time, either manually or through scheduling an automatic snapshot. They are designed to be fallbacks before a virtual machine is updated or before its configuration is changed. The process takes seconds or minutes and the result is a dynamically growing file stored on the Nerve

Device. Note that snapshots are not persistent. If the workload is undeployed, the snapshot is lost.

NOTE

- Snapshots are supported only for VMs using the QCOW2 image format. Snapshots are not supported for virtual machines using IMG or RAW image files.
- Keep in mind that by reverting a snapshot all changes occurred in the VM after the creation of the snapshot will be lost.

Enabling virtual machine snapshots

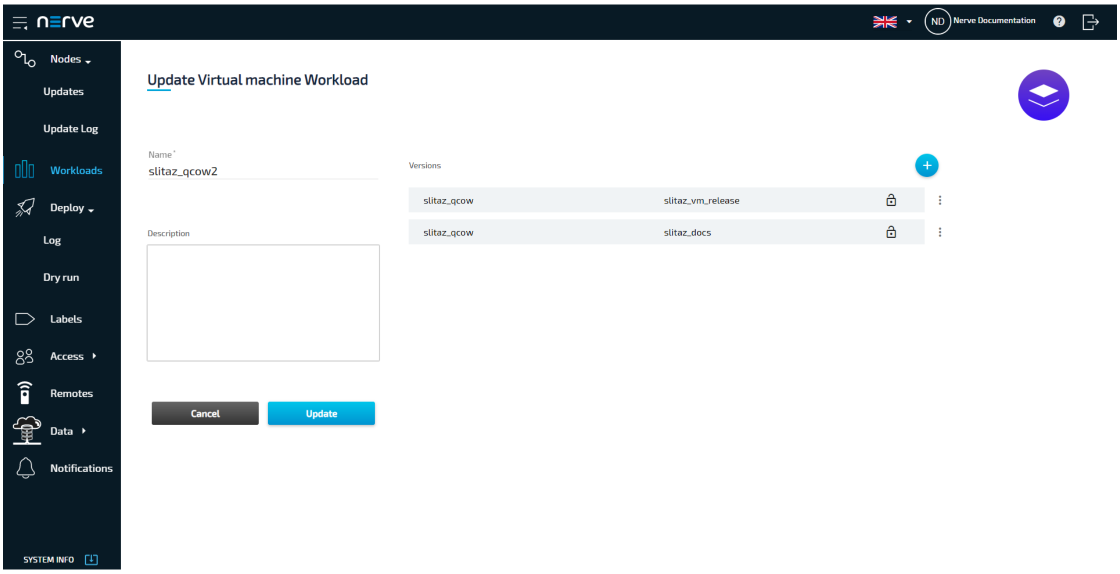
Snapshots are only available to virtual machine workloads using a QCOW2 image. So when following Provisioning a Virtual Machine workload, make sure to convert the resulting IMG file to QCOW2 and use the QCOW2 file when creating the workload in the Management System. For existing virtual machine workloads, convert the uploaded IMG or RAW file to QCOW2, replace it with the new QCOW2 and redeploy the VM workload. To enable snapshots in the Management System, follow the steps below:

NOTE

Snapshots cannot be taken for VM workloads that have an additional disk defined through the Management System.

1. Select **Workloads** in the navigation on the left.
2. Select a Virtual Machine workload with a workload version that uses a QCOW2 image.

3. Select the appropriate workload version.



Update Virtual machine Workload

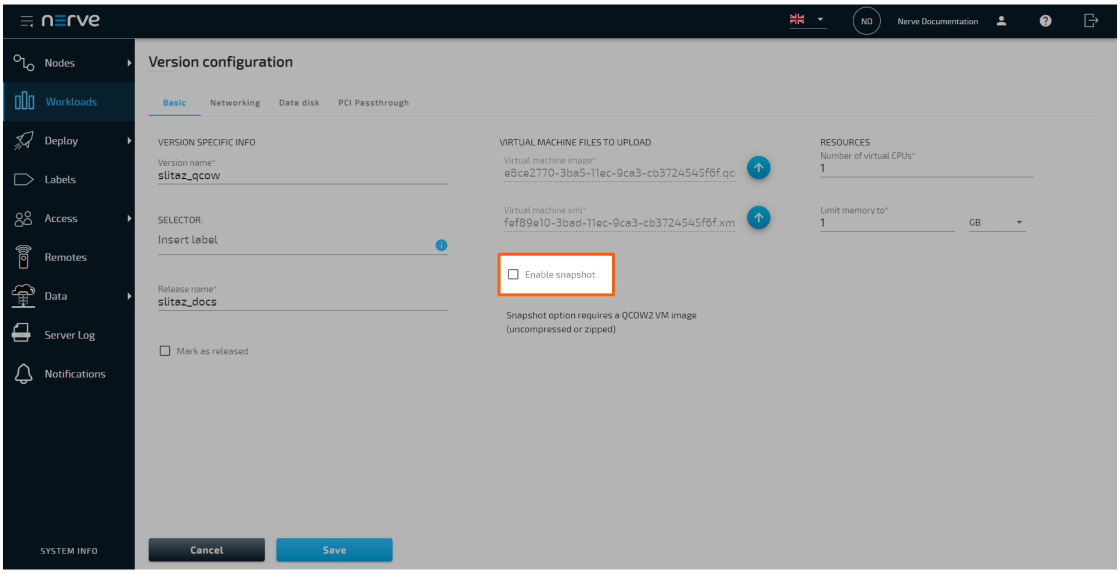
Name*
slitaz_qcow2

Description

Versions

slitaz_qcow	slitaz_vm_release
slitaz_qcow	slitaz_docs

4. Tick the checkbox next to **Enable Snapshot**.



Version configuration

VERSION SPECIFIC INFO

Version name* slitaz_qcow

SELECTOR: Insert label

Release name* slitaz_docs

□ Mark as released

VIRTUAL MACHINE FILES TO UPLOAD

Virtual machine image* e8ce2770-3ba5-11ec-9ca3-cb3724545f6f.qc

Virtual machine xml* fef89e10-3bad-11ec-9ca3-cb3724545f6f.xm

□ Enable snapshot

Snapshot option requires a QCOW2 VM image (uncompressed or zipped)

RESOURCES

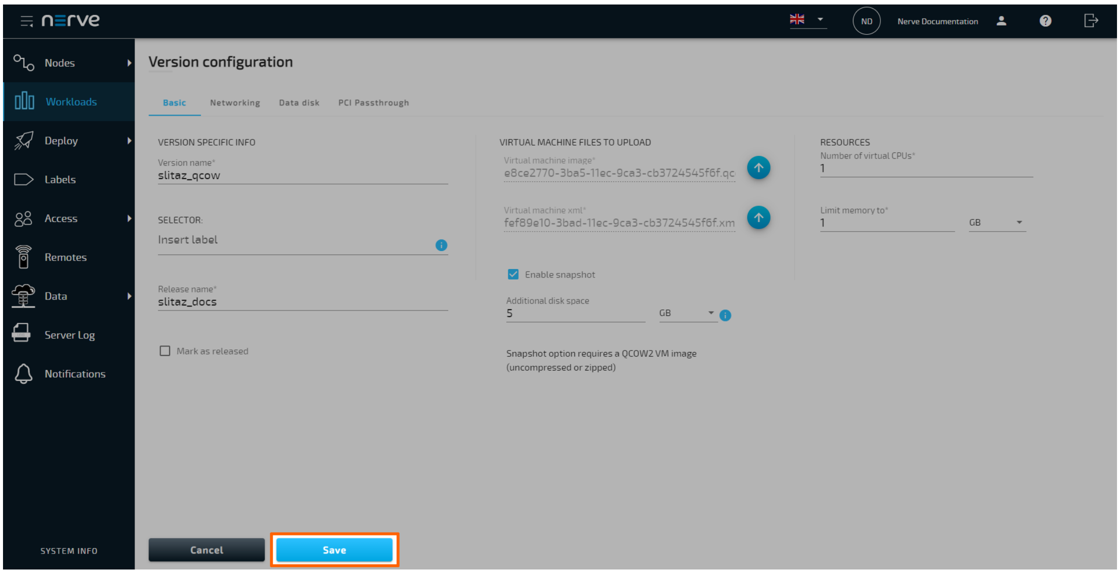
Number of virtual CPUs* 1

Limit memory to* 1 GB

5. Enter a value under **Additional disk space** to define additional disk space for the snapshot. The additional disk space depends on the defined memory for the VM, the VM disk size and should also include about 3% of overhead.

> **NOTE**
>
> Keep in mind the duration of how long the snapshot will be kept. The longer a snapshot is kept, the larger it will grow, requiring a larger amount of additional disk space. As an example, keeping a snapshot for a month could possibly double its size.

6. Select **Save** to save the changes.



Version configuration

VERSION SPECIFIC INFO

Version name* slitaz_qcow

SELECTOR: Insert label

Release name* slitaz_docs

□ Mark as released

VIRTUAL MACHINE FILES TO UPLOAD

Virtual machine image* e8ce2770-3ba5-11ec-9ca3-cb3724545f6f.qc

Virtual machine xml* fef89e10-3bad-11ec-9ca3-cb3724545f6f.xm

☑ Enable snapshot

Additional disk space 5 GB

Snapshot option requires a QCOW2 VM image (uncompressed or zipped)

RESOURCES

Number of virtual CPUs* 1

Limit memory to* 1 GB

7. Follow Deploying a workload to deploy the workload.

With snapshots enabled, they can be taken manually or automatically through scheduling an automatic snapshot.

Taking a virtual machine snapshot manually

Taking a snapshot is done from the workload control screen in the Local UI and the Management System. To reach the workload control screen, follow the paths below:

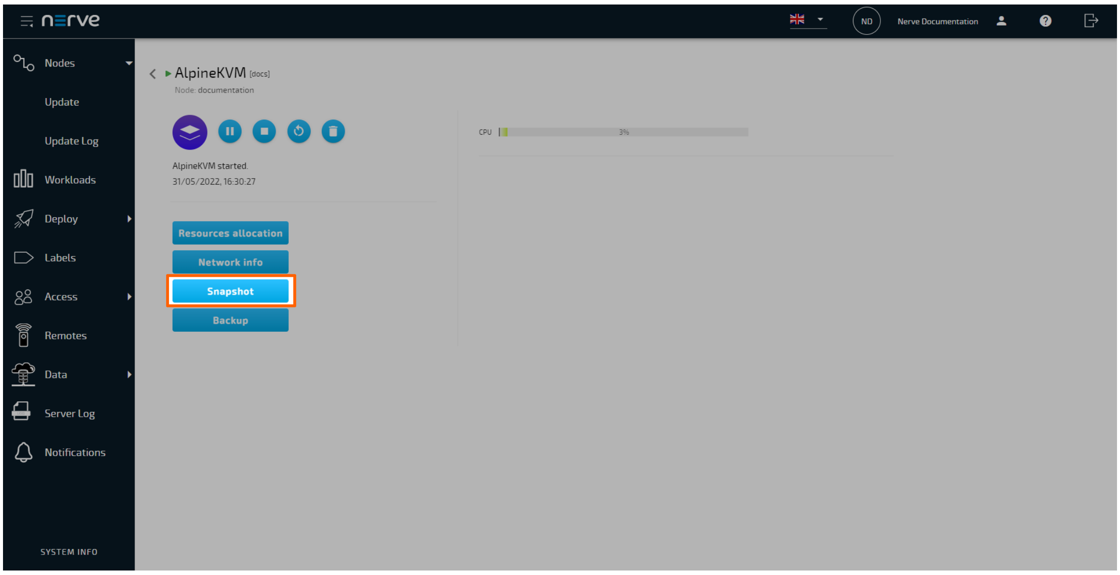
Location	Path
Local UI	**Workload management** > Select the VM workload.
Management System	**Nodes** > Select a node from the node tree that has a compatible virtual machine deployed. > Select the VM workload.

The **Snapshot** option is located on the left side underneath the workload icon. Snapshots can be taken in any state — running, stopped or suspended.

NOTE

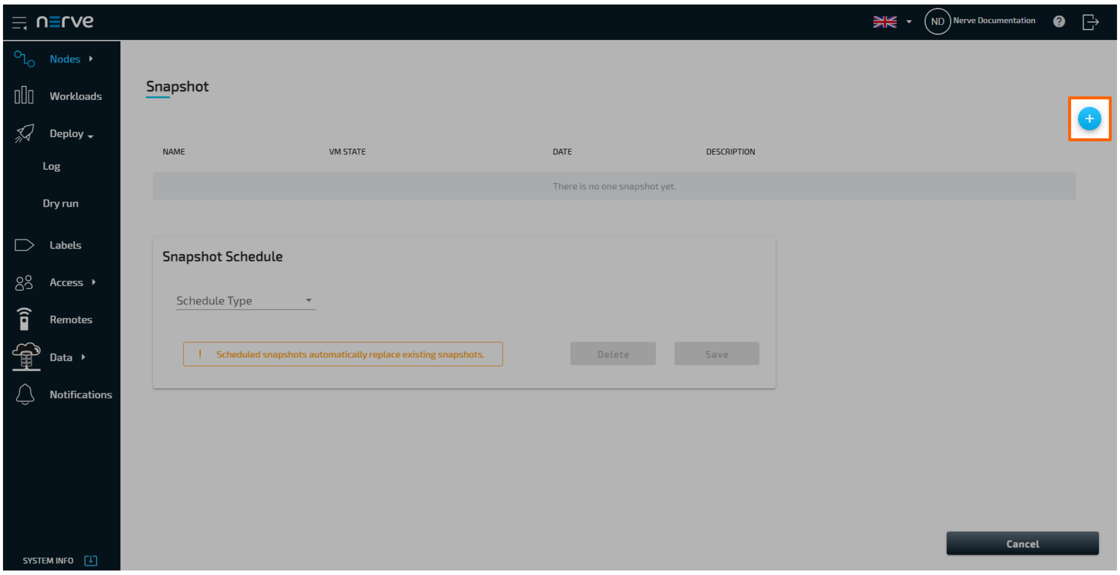
If a VM is running a heavy process before taking a snapshot, it is recommended to stop the VM before taking the snapshot. Data could be lost. For scheduled snapshots, set **VM State** to **Stopped**.

1. Select **Snapshot** on the left to access the snapshot menu.



AlpineKVM started.
31/05/2022, 16:30:27

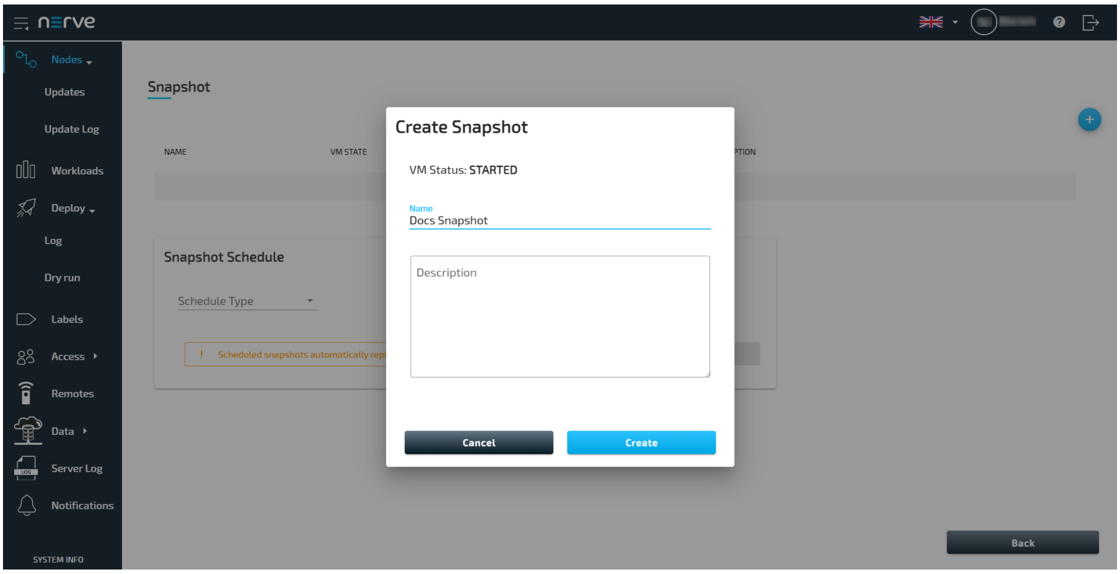
2. Select the **plus icon** in the upper-right.



There is no one snapshot yet.

Scheduled snapshots automatically replace existing snapshots.

3. Select **Create** to create the snapshot.
   Optional: Enter a custom name or description to make the snapshot easier to identify.



Create Snapshot

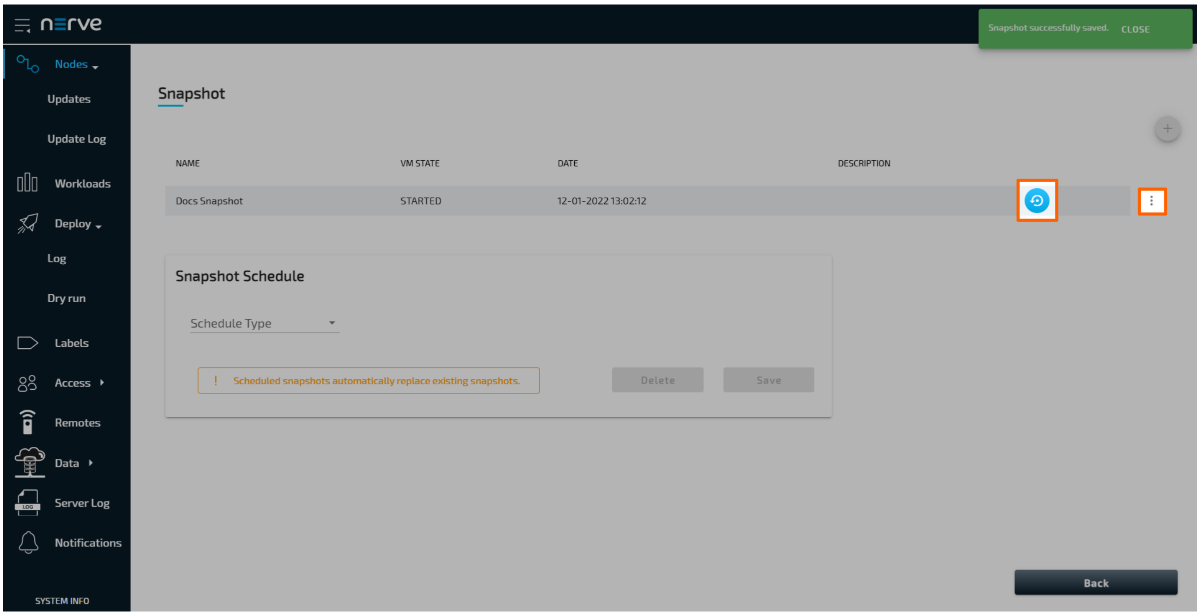
VM Status: STARTED

Name: Docs Snapshot

Description

Scheduled snapshots automatically repl

The snapshot now appears in the list. Revert to a snapshot by selecting the **Restore Snapshot** symbol next to the snapshot. Delete a snapshot from the ellipsis by selecting **DELETE** from the ellipsis menu next to the snapshot details. Keep in mind that only one snapshot can be taken at a time.



Snapshot successfully saved.

NAME	VM STATE	DATE	DESCRIPTION
Docs Snapshot	STARTED	12-01-2022 13:02:12	

Scheduled snapshots automatically replace existing snapshots.

Scheduling automatic snapshots

If taking snapshots is a recurring event or snapshots need to be taken in regular intervals, snapshots can be scheduled in the Local UI and the Management System. To reach the workload control screen, follow the paths below:

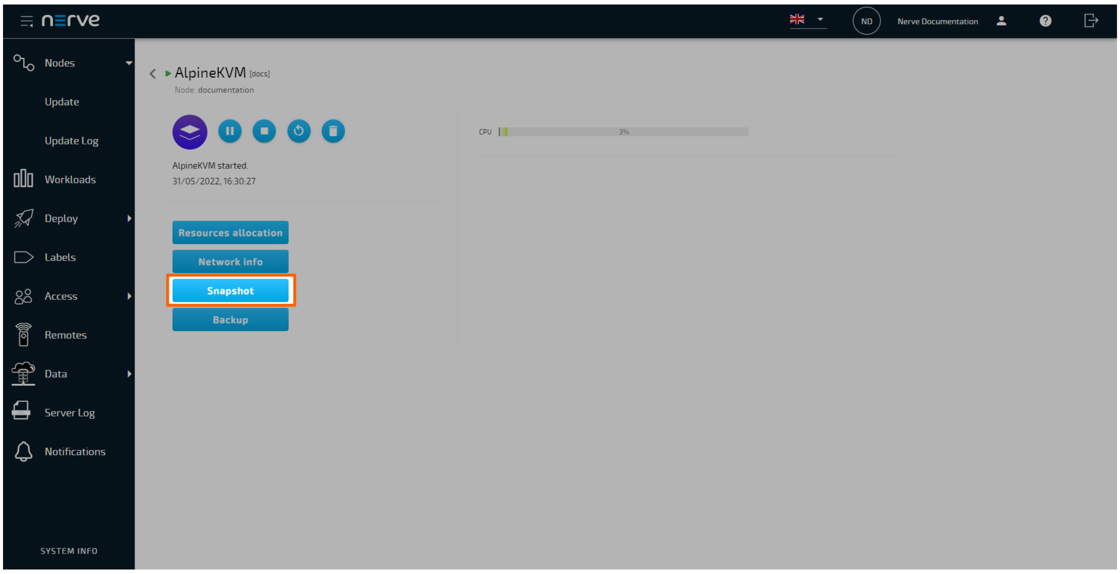
Location	Path
Local UI	**Workload management** > Select the VM workload.
Management System	**Nodes** > Select a node from the node tree that has a compatible virtual machine deployed. > Select the VM workload.

The **Snapshot** option is located on the left side underneath the workload icon. Note that scheduled snapshots always delete existing snapshots before creating a new one.

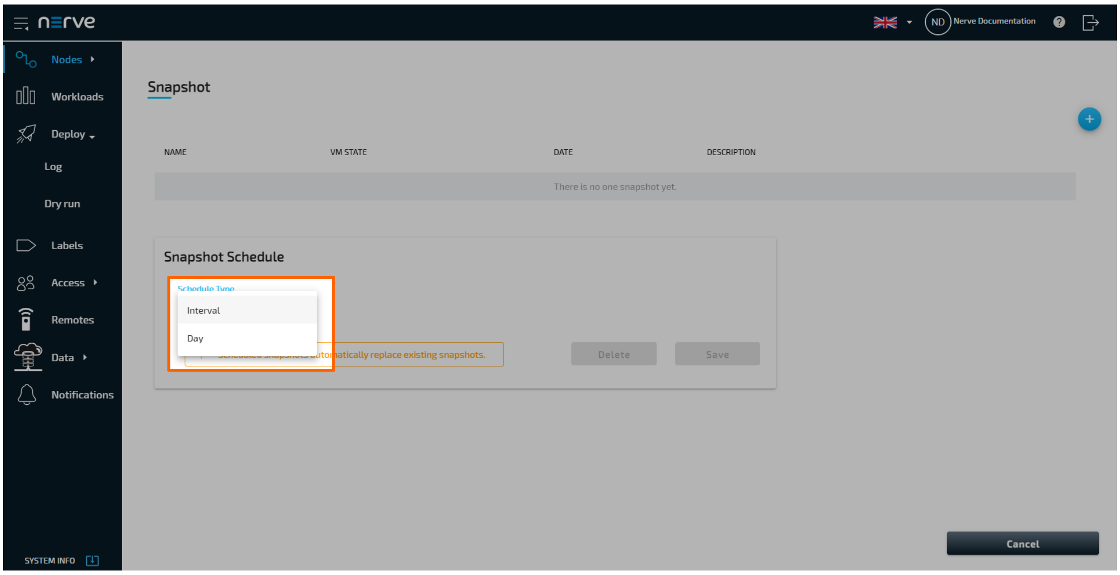
NOTE

If a VM is running a heavy process, it is recommended to set the VM state to **Stopped**. Data could be lost when the snapshot is taken. For scheduled snapshots, set **VM State** to **Stopped**.

1. Select **Snapshot** on the left to access the snapshot menu.



2. Select **Interval** or **Day** in the **Schedule Type** drop-down menu under **Snapshot Schedule**.



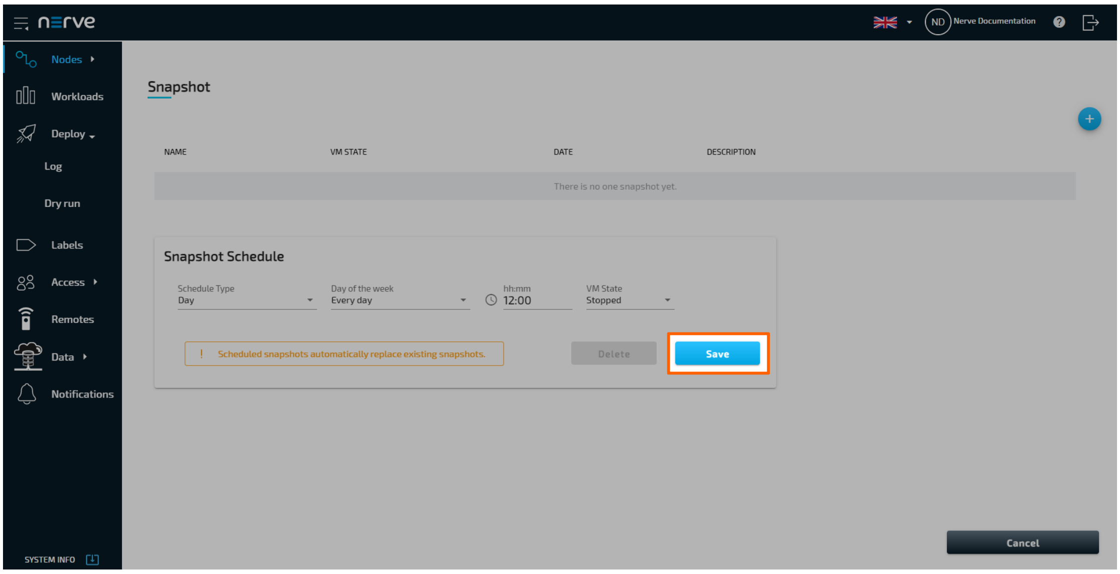
NOTE

In case of using an interval, note that the system does not keep memory of the already elapsed time. This means that after a node reboot, the interval timer is reset and the interval starts over according to the configured interval.

3. Fill in the values according to the selection:

Schedule Type	Description
Interval	**hh** Enter a numbered value. This is the interval in hours in between scheduled snapshots. **VM State** ◦ **Current** The status of the VM will not be changed while the snapshot is being taken. ◦ **Stopped** The running VM is stopped, the snapshot is taken, and the VM is started again.
Day	**Day of the week** Select a day of the week or **Every day**. **hh:mm** Select this to enter a time of day. **VM State** ◦ **Current** The status of the VM will not be changed while the snapshot is being taken. ◦ **Stopped** The running VM is stopped, the snapshot is taken, and the VM is started again.

4. Select **Save**.



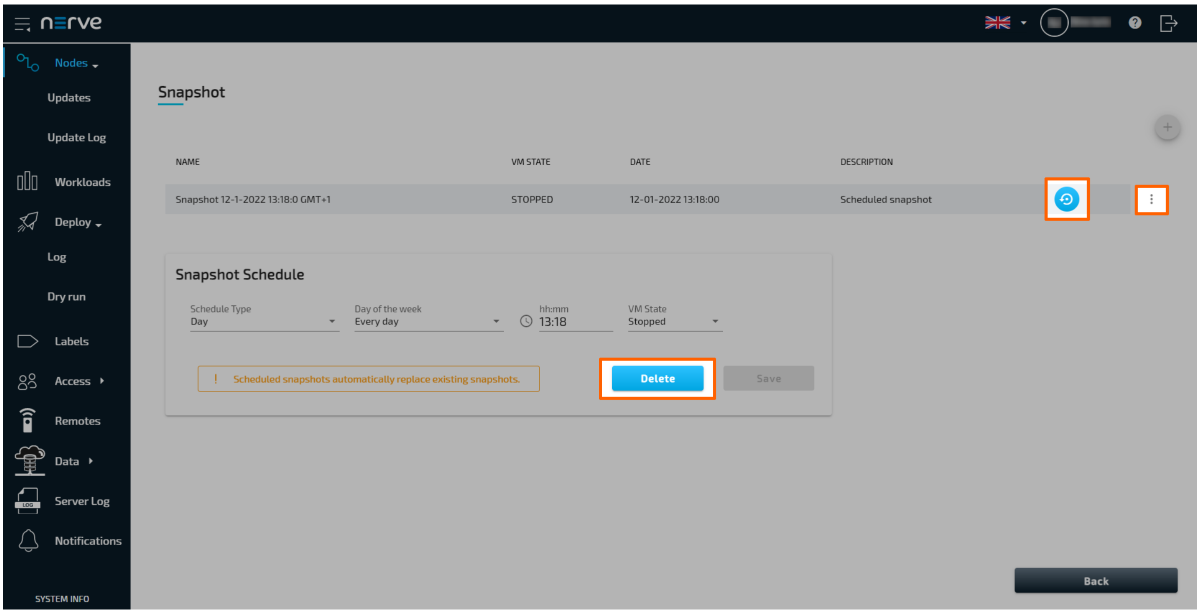
There is no one snapshot yet.

Snapshot Schedule

Schedule Type: Day
Day of the week: Every day
hh:mm: 12:00
VM State: Stopped

! Scheduled snapshots automatically replace existing snapshots.

Once the snapshot is taken at the scheduled time, it will appear in the list. Revert to a snapshot by selecting the **Restore Snapshot** symbol next to the snapshot. Delete a snapshot by selecting **DELETE** from the ellipsis menu next to the snapshot details. Disable the snapshot schedule by selecting **Delete** in the **Snapshot schedule** window. Keep in mind that the next scheduled snapshot is going to delete the existing snapshot since only one snapshot can be taken at a time.



Snapshot

NAME	VM STATE	DATE	DESCRIPTION
Snapshot 12-1-2022 13:18:0 GMT+1	STOPPED	12-01-2022 13:18:00	Scheduled snapshot

Snapshot Schedule

Schedule Type: Day
Day of the week: Every day
hh:mm: 13:18
VM State: Stopped

! Scheduled snapshots automatically replace existing snapshots.

Virtual machine backups

Saving a certain or optimal configuration of a virtual machine can be done with backups. Backups can only be created manually and they take much longer to create compared to snapshots. They are not designed to be done frequently. Backups are stored in a separate repository that needs to be defined by the user in the Local UI. The repository needs to be an NFS server that is accessible for the Nerve system. The repository for virtual machine backups can be shared between nodes, making the deployment of a VM backup to another node possible.

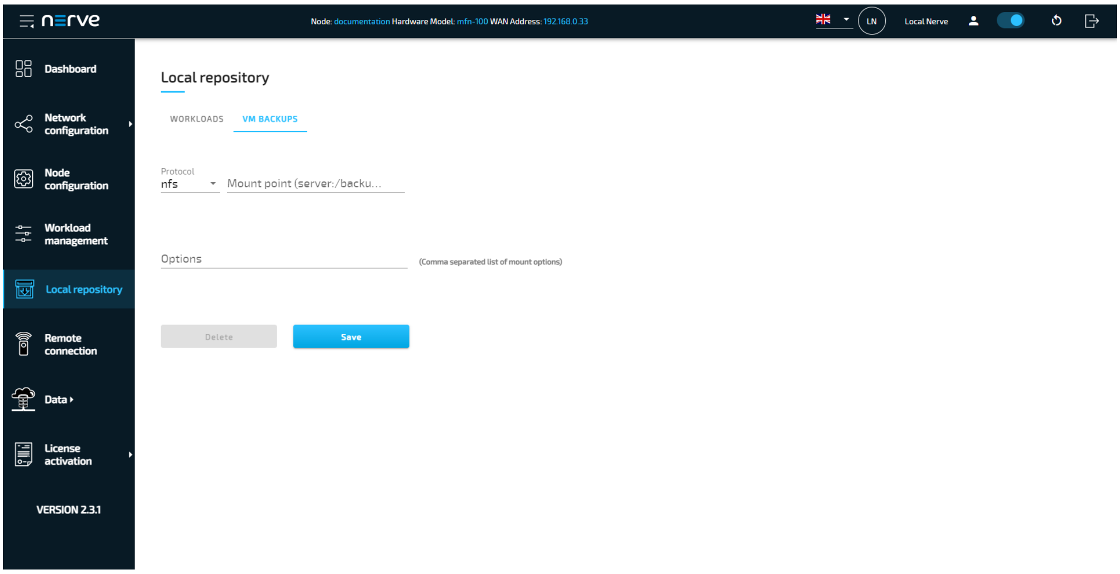
Note that an NFS server needs to be set up first and made accessible for the Nerve Device. Once the NFS server is set up, connect to the Local UI and define the NFS server as the VM backup repository. NFS v3 and v4 are supported.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.

Nerve Device	Physical port	Local UI
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select **Local repository** in the navigation on the left.
3. Select the **VM BACKUPS** tab.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

Local repository

Protocol: nfs

Mount point (server:/backu...

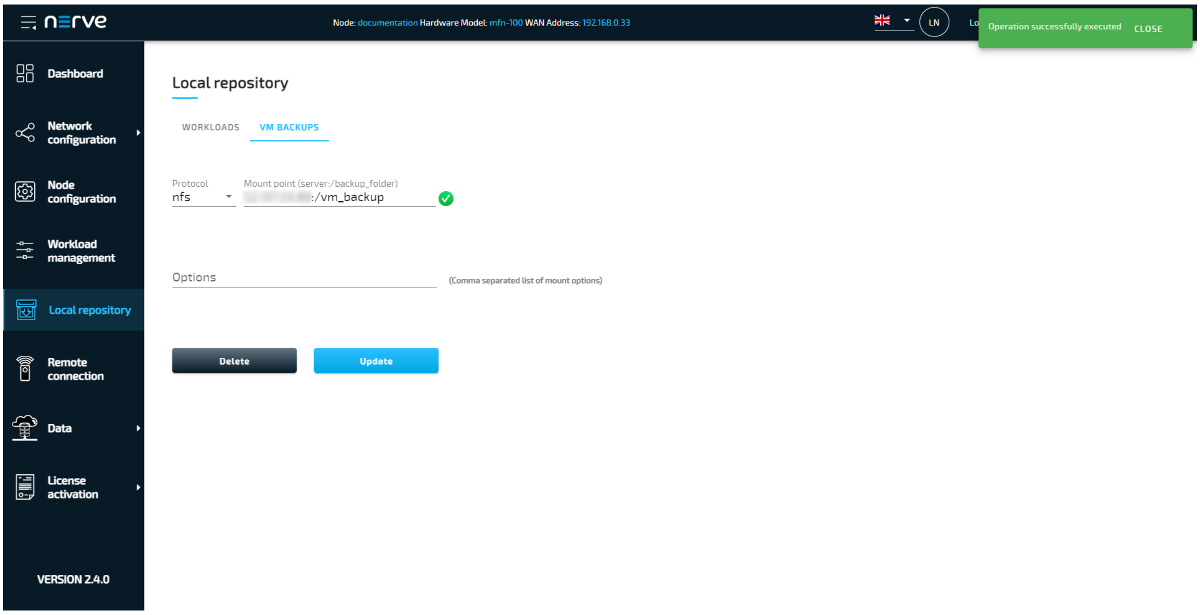
Options (Comma separated list of mount options)

4. Enter the following information:

Field	Value
Protocol	The only available protocol is **nfs**.
Mount point (server:/ backup_folder)	Enter the URL of the NFS server in the format `server:/backup_folder` that was set up before. The NFS server needs to be accessible for the Nerve system.
Options	Enter the list of mount options here. Mount options need to be separated by a comma. Refer to this link for NFS mounting options. Note that the following options are not considered by the system: ◦ rw (read/write) ◦ ro (read only) ◦ fg (foreground) ◦ bg (background) ◦ O (Overlay mount) ◦ remount

5. Select **Save**.

A green check mark appears next to the server address when the connection is successful.



Protocol: nfs

Mount point (server:/backup_folder): [redacted]:/vm_backup

Options

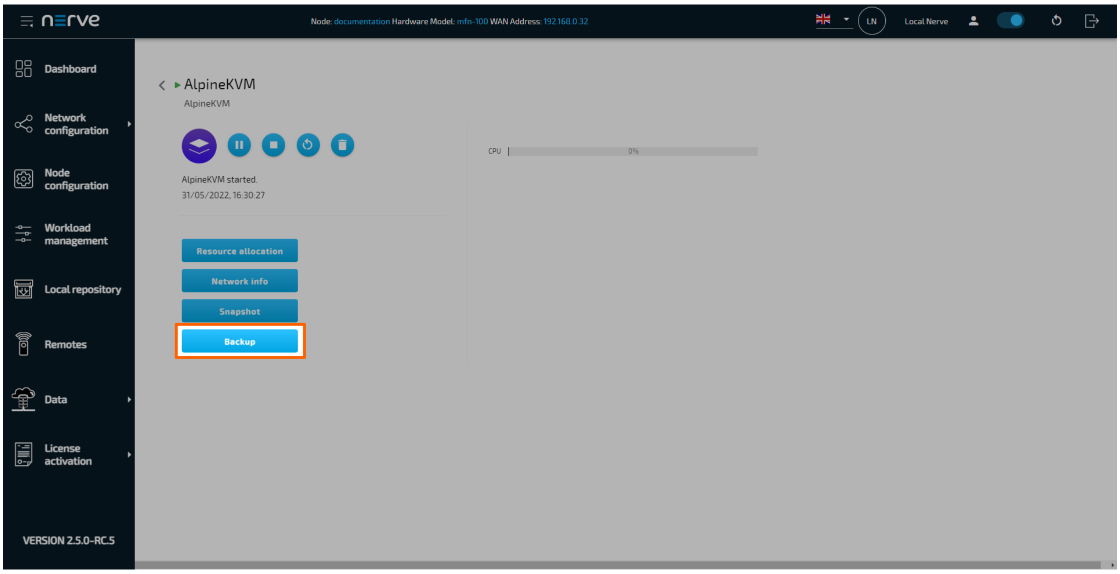
(Comma separated list of mount options)

Creating a virtual machine backup

VM backups are taken in a stopped state. The Nerve system will stop the VM automatically if it is not stopped manually before. Note that an NFS server needs to be set up and defined as a VM backup repository before creating a backup. To reach the workload control screen, follow the paths below:

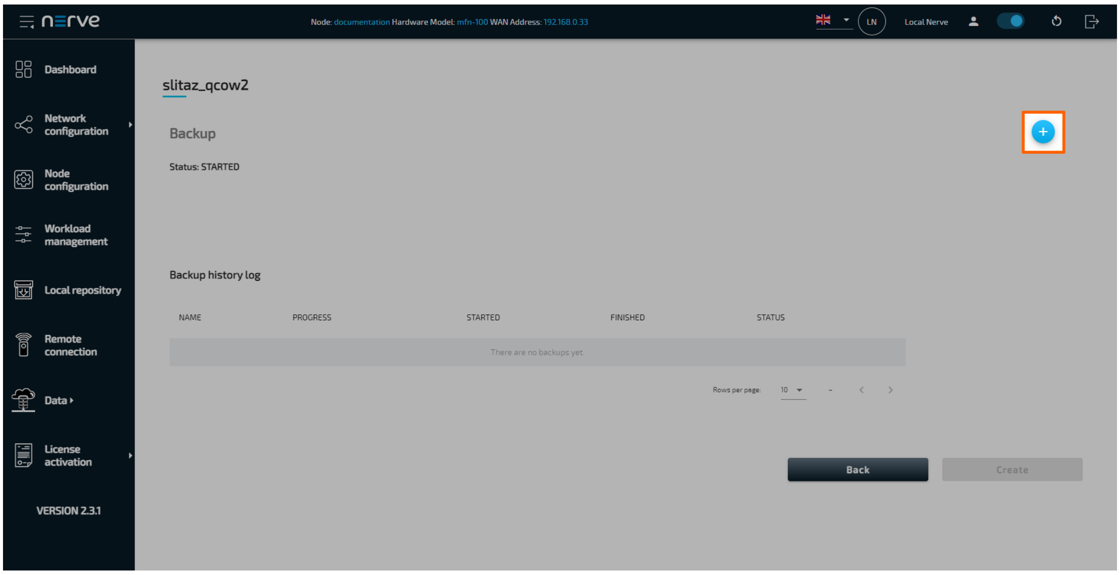
Location	Path
Local UI	**Workload management** > Select the VM workload.
Management System	**Nodes** > Select a node from the node tree that has a virtual machine deployed. > Select the VM workload.

1. Select **Backup** in the list.



AlpineKVM started.
31/05/2022, 16:30:27

2. Select the **plus icon** in the upper-right.



slitaz_qcow2

Backup

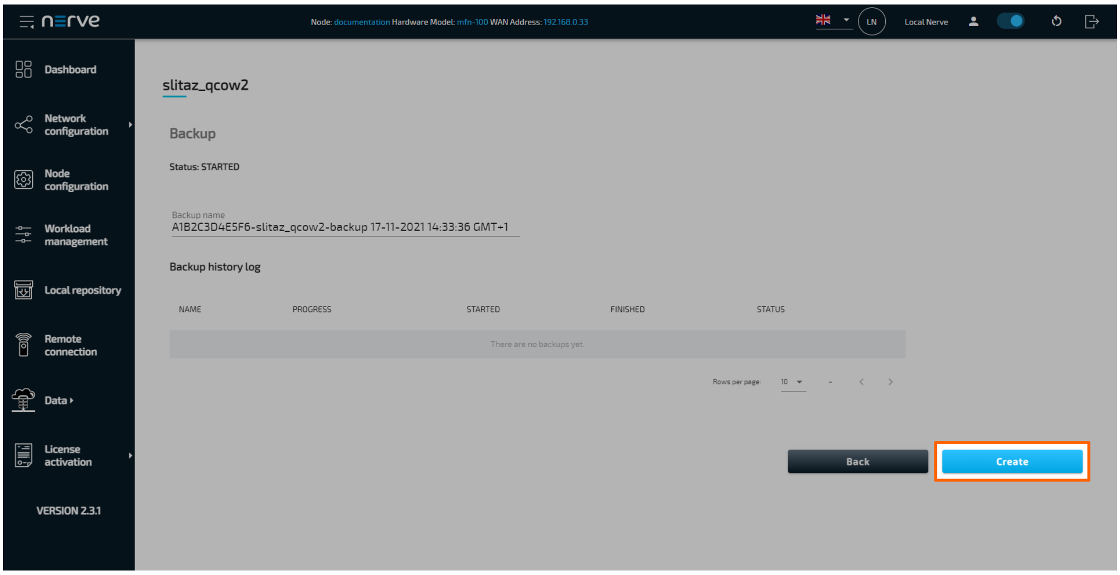
Status: STARTED

Backup history log

NAME	PROGRESS	STARTED	FINISHED	STATUS
There are no backups yet				

Rows per page: 10

3. Select **Create**.
   *Optional: Enter a name under **Backup name** to make the backup easier to identify.*



slitaz_qcow2

Backup

Status: STARTED

Backup name
A1B2C3D4E5F6-slitaz_qcow2-backup 17-11-2021 14:33:36 GMT+1

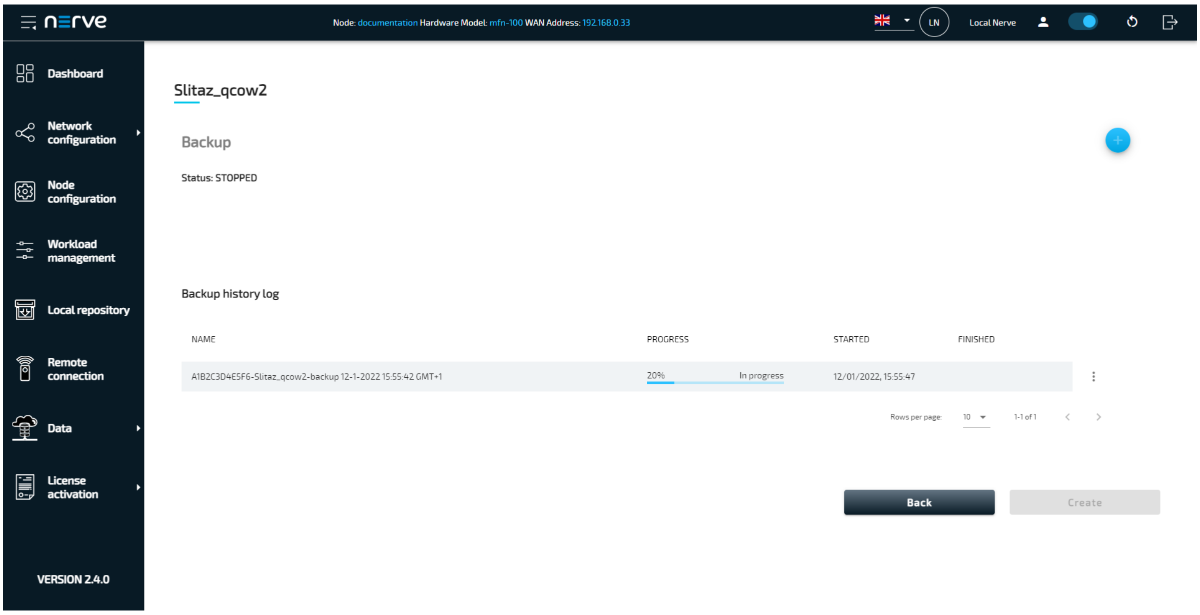
Backup history log

NAME	PROGRESS	STARTED	FINISHED	STATUS
There are no backups yet				

Rows per page: 10

4. Select **Yes**.

The backup creation process is now started. The duration of the backup creation depends on the size of the VM. It takes a considerable amount of time, as an identical copy of the VM is being created and transferred to the VM backups repository. A backup creation history is created and can be viewed in the UI.



Status: STOPPED

Backup history log

NAME	PROGRESS	STARTED	FINISHED
A1B2C3D4E5F6-Slitaz_qcow2-backup 12-1-2022 15:55:42 GMT+1	20% In progress	12/01/2022, 15:55:47	

Rows per page: 10 1-1 of 1

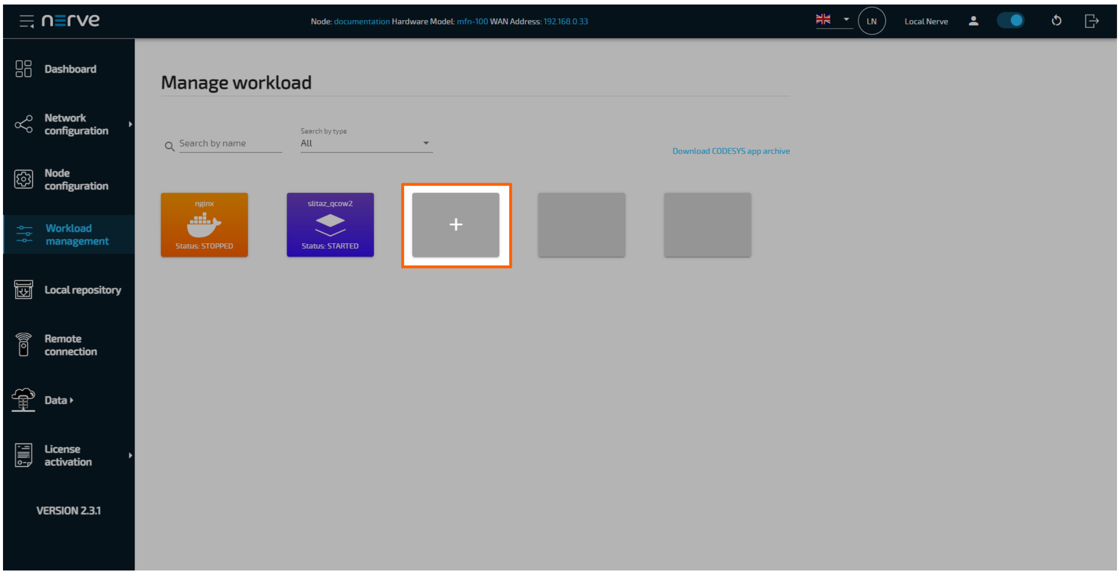
Deleting a backup is done through connecting to the NFS server locally or remotely. Each VM backup consists of multiple files: image files, an XML and a JSON file. All files contained in the backup are listed in the JSON file containing the VM metadata.

Deploying a virtual machine backup

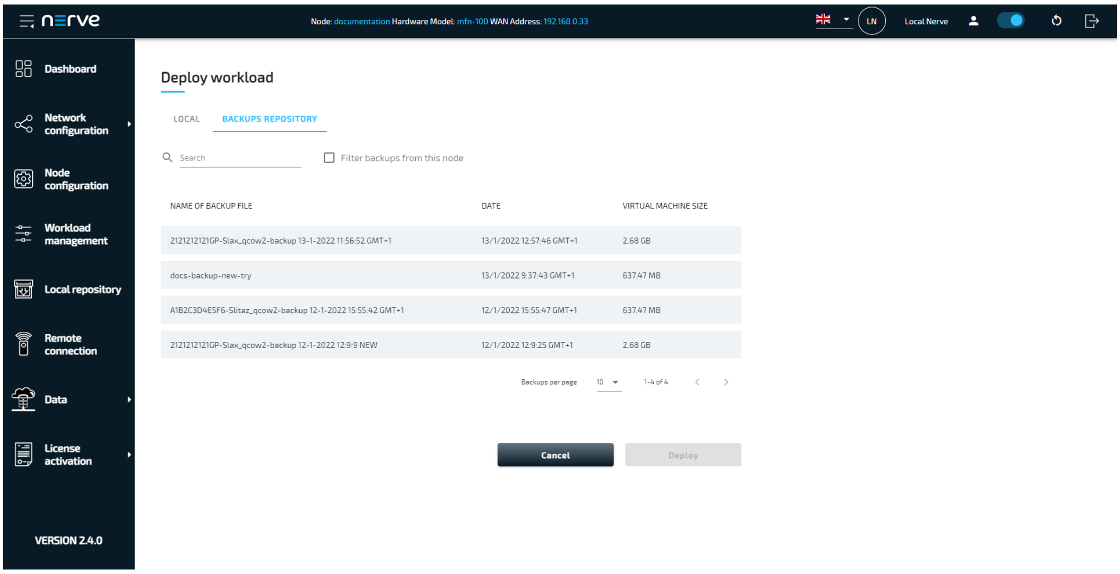
Backups can only be deployed in the Local UI. VM backups can be deployed at other nodes if they have the same VM backup repository set in the Local UI. Note that if an exact replica of a VM is desired, by keeping the original VM UUID and MAC address, the original VM needs to be undeployed first before deploying the backup.

1. Select **Workload management** in the navigation on the left.

2. Select the **+** tile to deploy a new workload.



3. Select the **BACKUPS REPOSITORY** tab.



Deploy workload

LOCAL | BACKUPS REPOSITORY

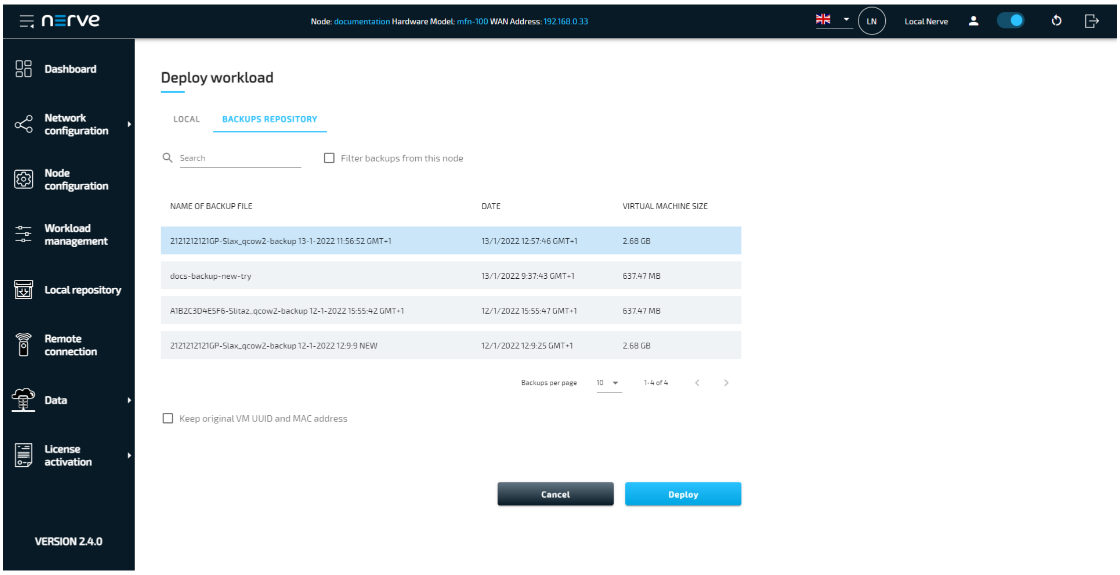
Search □ Filter backups from this node

NAME OF BACKUP FILE	DATE	VIRTUAL MACHINE SIZE
2121212121GP-Slax_qcow2-backup 13-1-2022 11:56:52 GMT+1	13/1/2022 12:57:46 GMT+1	2.68 GB
docs-backup-new-try	13/1/2022 9:37:43 GMT+1	637.47 MB
A1B2C3D4E5F6-Slitaz_qcow2-backup 12-1-2022 15:55:42 GMT+1	12/1/2022 15:55:47 GMT+1	637.47 MB
2121212121GP-Slax_qcow2-backup 12-1-2022 12:9:9 NEW	12/1/2022 12:9:25 GMT+1	2.68 GB

Backups per page 10 1-4 of 4

Cancel Deploy

4. Select a backup from the list.
   Optional: Tick the checkbox next to ***Filter backups from this node*** *to show backups that were created on the current node.*



Deploy workload

LOCAL | BACKUPS REPOSITORY

Search □ Filter backups from this node

NAME OF BACKUP FILE	DATE	VIRTUAL MACHINE SIZE
2121212121GP-Slax_qcow2-backup 13-1-2022 11:56:52 GMT+1	13/1/2022 12:57:46 GMT+1	2.68 GB
docs-backup-new-try	13/1/2022 9:37:43 GMT+1	637.47 MB
A1B2C3D4E5F6-Slitaz_qcow2-backup 12-1-2022 15:55:42 GMT+1	12/1/2022 15:55:47 GMT+1	637.47 MB
2121212121GP-Slax_qcow2-backup 12-1-2022 12:9:9 NEW	12/1/2022 12:9:25 GMT+1	2.68 GB

Backups per page 10 1-4 of 4

□ Keep original VM UUID and MAC address

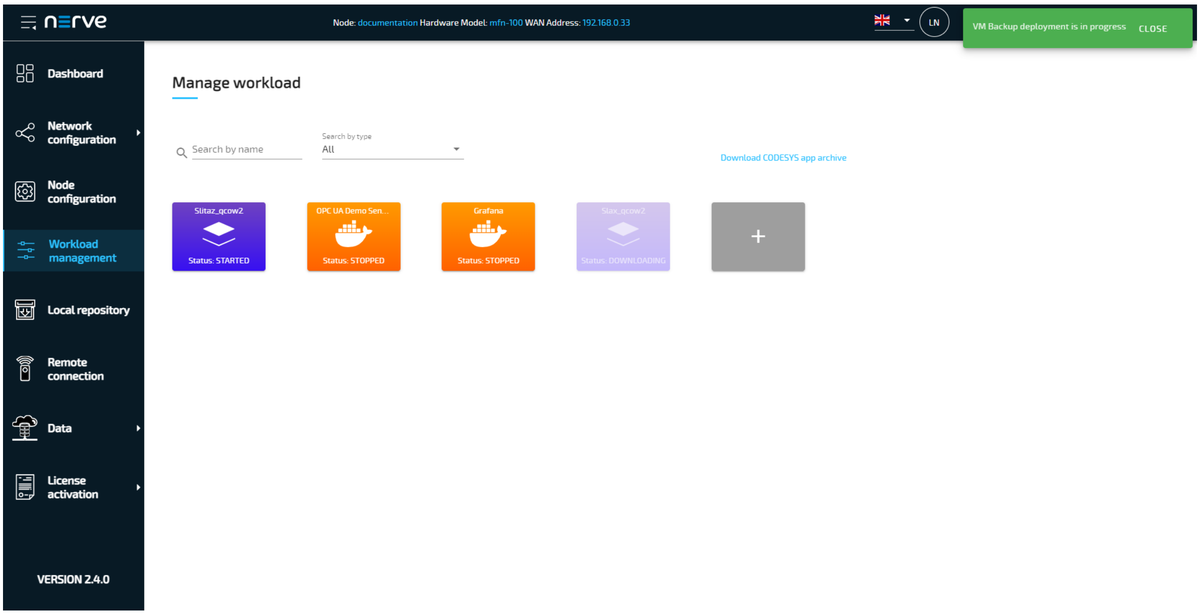
Cancel Deploy

NOTE

When deploying a backup, the original VM UUID and MAC address can be preserved. Tick the checkbox next to **Keep original VM UUID and MAC address** to do so. In this case the original VM needs to be undeployed first, if it is still present on the node.

5. Select **Deploy**.

The VM backup will show up as a Virtual Machine workload in the workload management view once the deployment has finished.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

VM Backup deployment is in progress

Search by type: All

Slitaz_qcow2 Status: STARTED

OPC UA Demo Sen... Status: STOPPED

Grafana Status: STOPPED

Slax_qcow2 Status: DOWNLOADING

Provisioning a CODESYS workload

Before a CODESYS workload can be provisioned, a CODESYS application has to be loaded into the CODESYS runtime first. Refer to First steps with CODESYS first before continuing.

Once a CODESYS application has been loaded into the CODESYS runtime, the following steps have to be taken before the workload can be provisioned:

1. Creating the ZIP file of the CODESYS application
2. Transferring the ZIP file to a local workstation

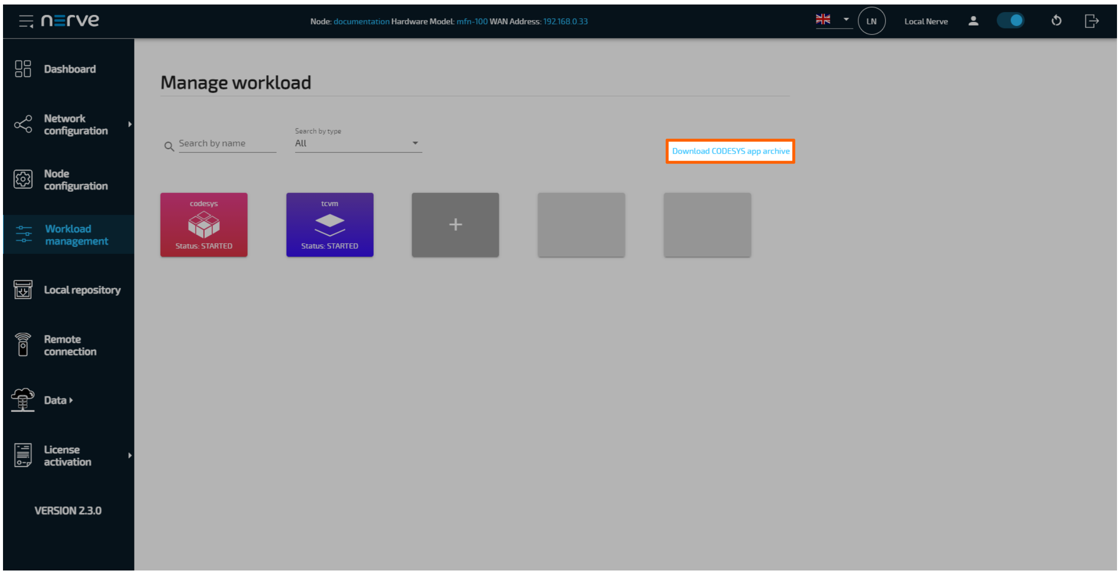
Also the workstation needs to be connected to the physical port of the Nerve Device associated with host access, and the network adapter IP address of the workstation needs to be configured in the correct range. This information is device specific. Refer to the device guide for information on the Nerve Device.

Creating the ZIP file on the Nerve Device

First, the CODESYS project needs to be zipped on the Nerve Device before it can be copied from the CODESYS runtime. This is done through the Local UI.

1. Follow the link to the Local UI of the used Nerve Device. Refer to the device guide for more information.
2. Select **Workload management** in the navigation on the left.

3. Click **Download CODESYS app archive**.



4. Select **YES** in the pop-up. Note that the CODESYS application will be stopped.

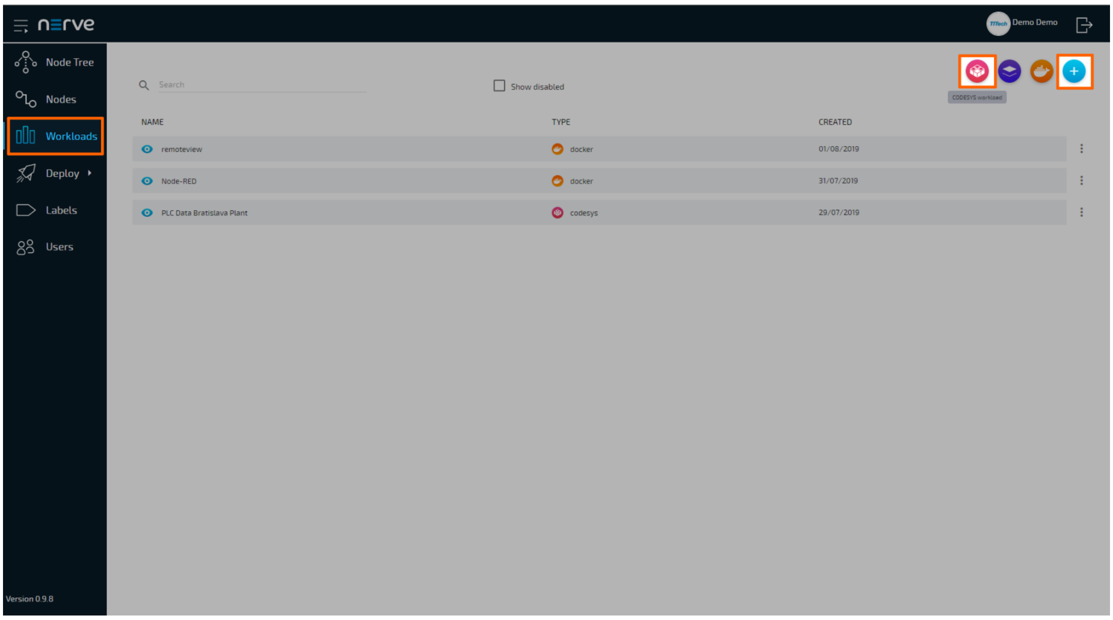
The ZIP file is automatically downloaded to the workstation and a CODESYS workload can now be provisioned in the Management System.

Provisioning a CODESYS workload

The following instructions cover the basic requirements for provisioning a CODESYS workload. Optional settings will be left out. Extended options are addressed in the last section of this chapter.
There are two further types of workloads that can be provisioned: Virtual Machine workloads and Docker workloads. The process for each workload is highlighted in its respective chapter.

1. Log in to the Management System.
2. Select **Workloads** in the left-hand menu.
3. Select the plus symbol in the upper-right corner.

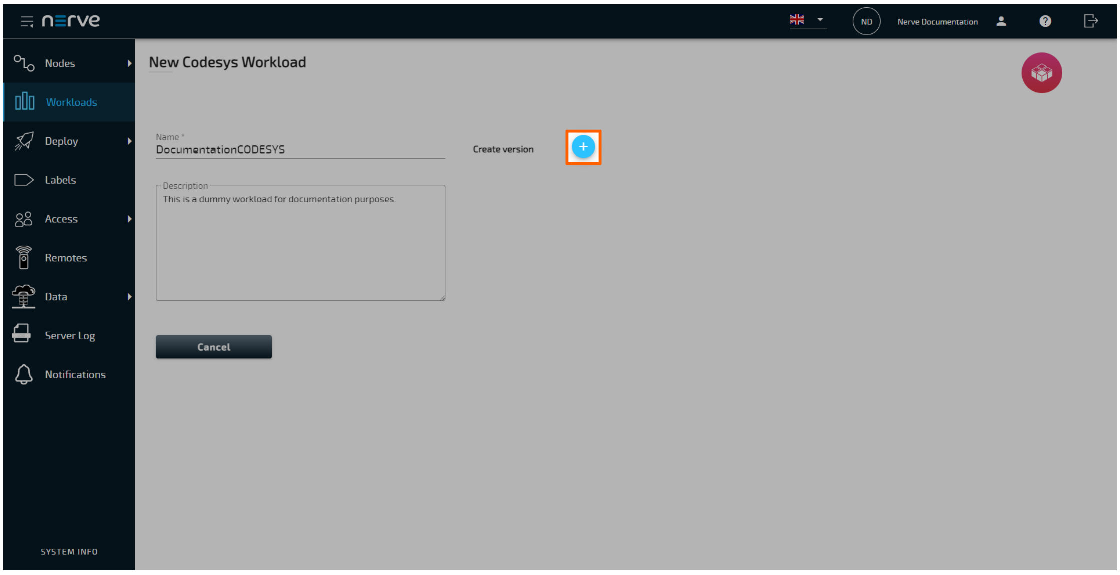
4. Select the CODESYS symbol (**CODESYS workload**) on the left of the three symbols that expanded.



NAME	TYPE	CREATED
remoteview	docker	01/08/2019
Node-RED	docker	31/07/2019
PLC Data Bratislava Plant	codesys	29/07/2019

5. In the new window, enter a name for the workload.

6. Select the plus symbol next to **Create versions** to add a new version of the workload.



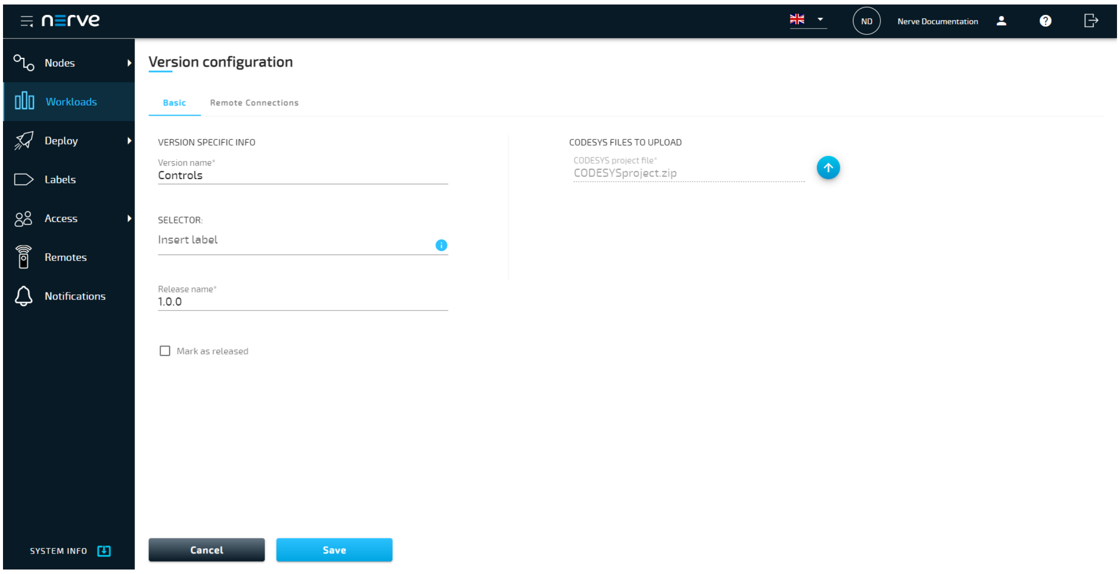
New Codesys Workload

Name * DocumentationCODESYS

Description This is a dummy workload for documentation purposes.

7. In the new window, enter the following information:

Setting	Description
Version name	Enter a name for the version of this workload.
Release name	Enter a **Release name** for the version of this workload.
CODESYS project file	Click the **upward arrow** symbol to add the CODESYS application ZIP file. This is the ZIP file that was created above.



Version configuration

Basic | Remote Connections

VERSION SPECIFIC INFO

Version name* Controls

SELECTOR: Insert label

Release name* 1.0.0

□ Mark as released

CODESYS FILES TO UPLOAD

CODESYS project file* CODESYSproject.zip

Cancel | Save

8. Click **Save**.

The workload has now been provisioned and is ready to be deployed in the **Deploy** menu.

Settings for CODESYS workloads

In the instructions above, optional settings have been left out. Below is an overview of all options with an explanation to each option.

Basic tab

Category	Settings and descriptions
VERSION SPECIFIC INFO	**Version name** A name for the workload version. Choose a precise name to make the workload version unambiguous. **SELECTOR** If labels have been defined and assigned to nodes, add them as selectors to the workload. When deploying a workload, the list of nodes will be filtered automatically to the specified label. Select the **Insert label** field to see a list of available labels. **Release name** A release name for the workload version. This could be a version number or any string. Example: 1.0.1 **Mark as released** Tick this checkbox to mark this workload as released. Once marked as released, the workload cannot be edited anymore.
CODESYS FILES TO UPLOAD	Upload the **CODESYS project file** here. This is a ZIP file that has to be generated from a CODESYS project running in the CODESYS runtime. Upload it here by selecting the **upward arrow** symbol to open the file browser.

Remote connections tab

Category	Settings and descriptions
REMOTE CONNECTIONS	Select the **Remote connections** tab to configure a remote connection to the workload. Note that CODESYS workloads can only be reached with remote tunnels. Refer to Remote connections for more information and instructions for all remote connection types.

Provisioning a Virtual Machine workload

Before a Virtual Machine workload can be provisioned, it is required to set up the virtual machine. Virtual Machine workloads can be created on any PC but an environment to effectively create a Virtual Machine workload is not always readily available. Therefore, it is described how the Nerve Device can be utilized to create a Virtual Machine workload. What needs to be done is:

1. Creating a virtual machine on the node
2. Installing an operating system on the virtual machine
3. Obtaining the virtual machine IMG and XML files
4. Provisioning the Virtual Machine workload in the Management System

In this version, Nerve does not provide a GUI based method for installing an OS on a virtual machine and obtaining the virtual machine IMG and XML configuration files. Therefore, this chapter focuses on the manual process. Three tools are required for the instructions below, assuming Windows is used on the workstation:

- an X Server application like Xming
- an SSH client like PuTTY
- a file transfer client like WinSCP

Also the workstation needs to be connected to the physical port of the Nerve Device associated with host access, and the network adapter IP address of the workstation needs to be configured in the correct range. This information is device specific. Refer to the device guide for information on the Nerve Device.

The instructions below are split up into multiple parts to make them easier to follow. The subsections of the instructions are connected and every subheading is a requirement for the next paragraph.

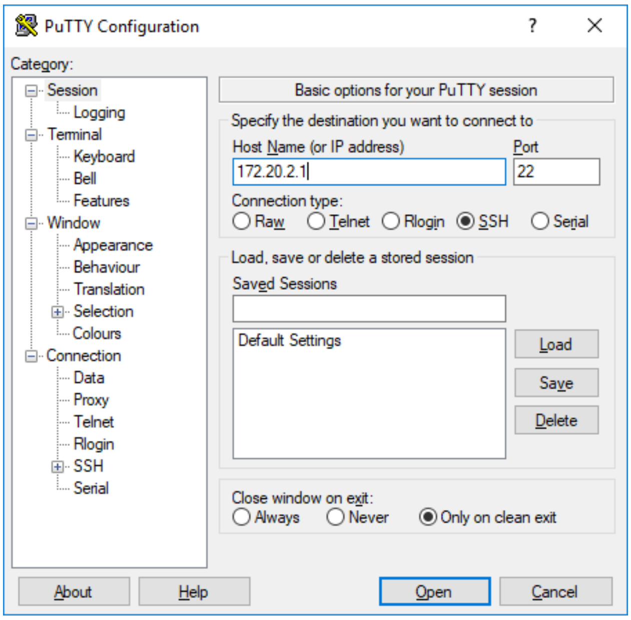
> **NOTE**
>
> The virtual machine generated in this chapter is a fresh installation and will be generated on the Nerve Device directly.

Creating a logical volume

Logical volumes are created using the `lvcreate` command, which takes a number of command-line arguments. Firstly, the `-L` flag is used to specify the size of the volume. Secondly, the `-n` flag is used to specify a name for the logical volume. `<image_size>`

and <volume_name> are used as placeholders in the instructions below. The volume group is already predefined with nerve as its name.

1. Open an SSH client like PuTTY.
2. Enter the IP address for host access to the Nerve Device under **Host Name (or IP address)** to log in to the host of the Nerve Device.



PuTTY Configuration

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address): 172.20.2.1

Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

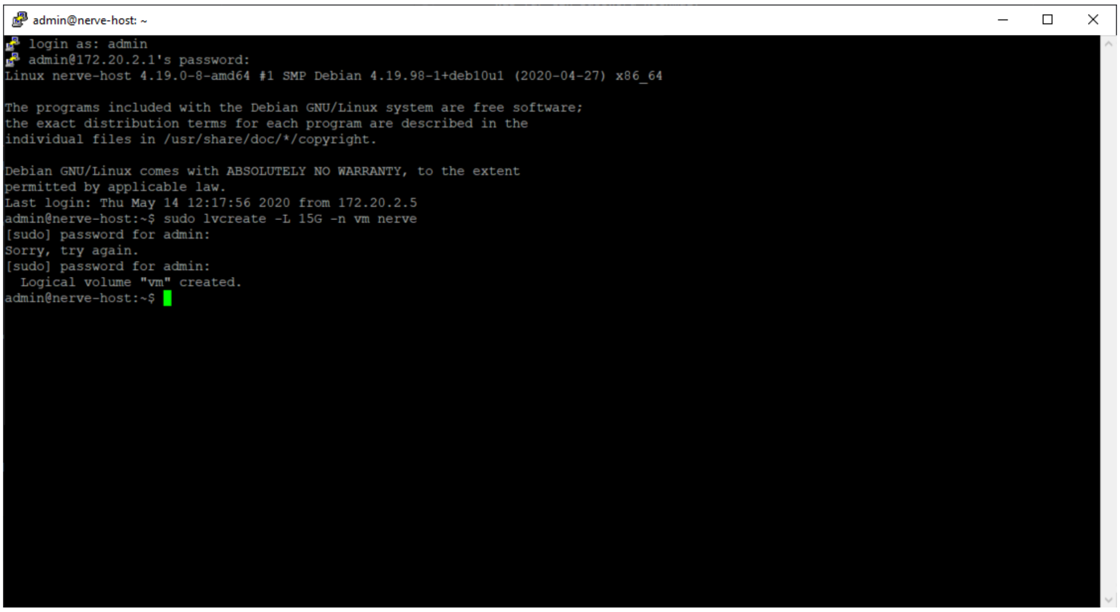
Load, save or delete a stored session

Saved Sessions: Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

3. Log in with the credentials for host access to the Nerve Device.
4. Enter the following command:

```
sudo lvcreate -L <image_size> -n <volume_name> nerve
```



admin@nerve-host: ~

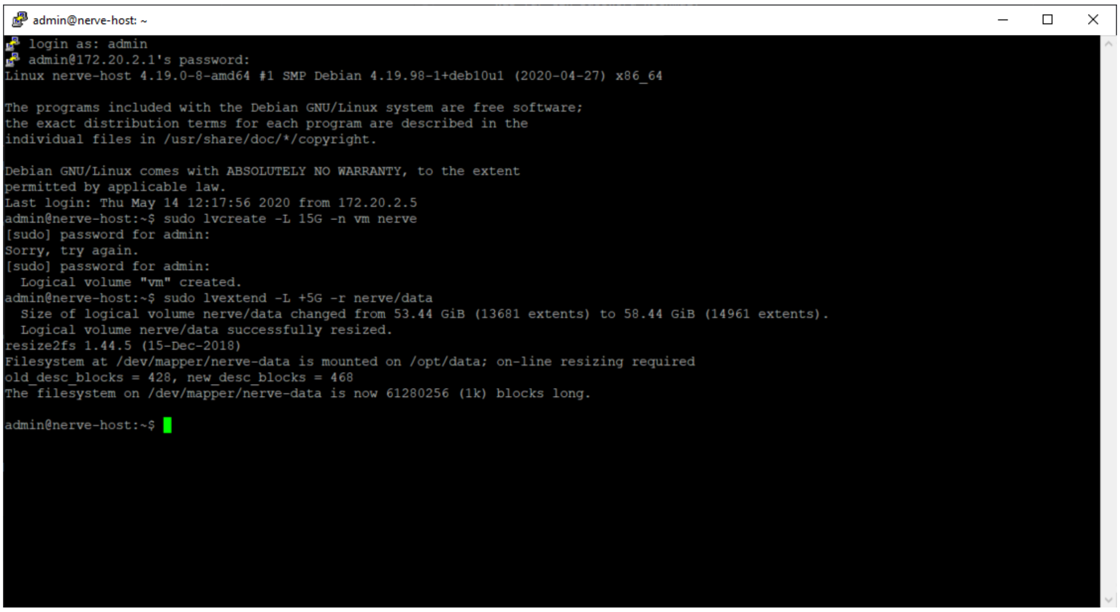
```
login as: admin
admin@172.20.2.1's password:
Linux nerve-host 4.19.0-8-amd64 #1 SMP Debian 4.19.98-1+deb10u1 (2020-04-27) x86_64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu May 14 12:17:56 2020 from 172.20.2.5
admin@nerve-host:~$ sudo lvcreate -L 15G -n vm nerve
[sudo] password for admin:
Sorry, try again.
[sudo] password for admin:
  Logical volume "vm" created.
admin@nerve-host:~$
```

Increasing storage in /opt/data and creating a filesystem

The ISO image of the OS needs to be copied to the device from which the virtual machine will be installed. In order to do that, the size of `/opt/data` needs to be increased. A path to store the ISO file will also be created. `<size>` is a placeholder for the amount of storage that is added, while `nerve/data` is the name of the volume group and the logical volume.

1. Enter the following command to increase storage:

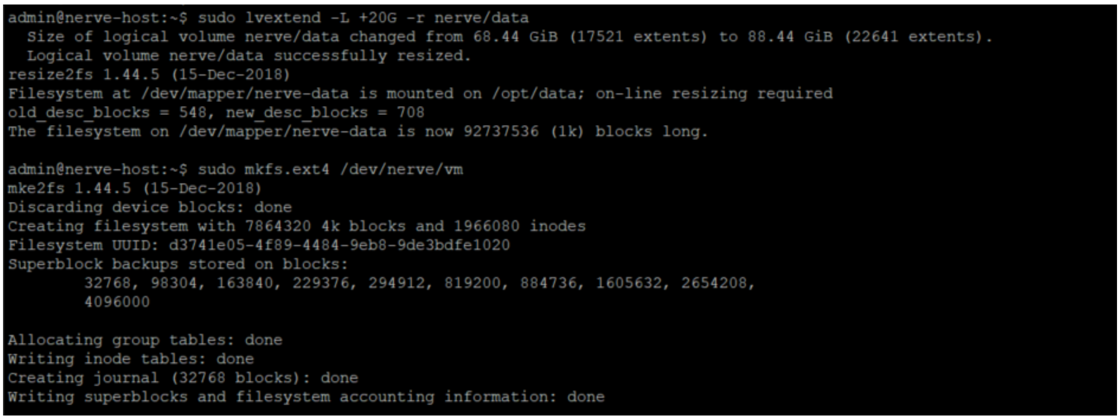
   ```
   sudo lvextend -L +<size> -r nerve/data
   ```

   ```
   login as: admin
   admin@172.20.2.1's password:
   Linux nerve-host 4.19.0-8-amd64 #1 SMP Debian 4.19.98-1+deb10u1 (2020-04-27) x86_64

   The programs included with the Debian GNU/Linux system are free software;
   the exact distribution terms for each program are described in the
   individual files in /usr/share/doc/*/copyright.

   Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
   permitted by applicable law.
   Last login: Thu May 14 12:17:56 2020 from 172.20.2.5
   admin@nerve-host:~$ sudo lvcreate -L 15G -n vm nerve
   [sudo] password for admin:
   Sorry, try again.
   [sudo] password for admin:
     Logical volume "vm" created.
   admin@nerve-host:~$ sudo lvextend -L +5G -r nerve/data
     Size of logical volume nerve/data changed from 53.44 GiB (13681 extents) to 58.44 GiB (14961 extents).
     Logical volume nerve/data successfully resized.
   resize2fs 1.44.5 (15-Dec-2018)
   Filesystem at /dev/mapper/nerve-data is mounted on /opt/data; on-line resizing required
   old_desc_blocks = 428, new_desc_blocks = 468
   The filesystem on /dev/mapper/nerve-data is now 61280256 (1k) blocks long.

   admin@nerve-host:~$
   ```

2. Enter the following command to create a filesystem:

   ```
   sudo mkfs.ext4 /dev/nerve/<volume_name>
   ```

   ```
   admin@nerve-host:~$ sudo lvextend -L +20G -r nerve/data
     Size of logical volume nerve/data changed from 68.44 GiB (17521 extents) to 88.44 GiB (22641 extents).
     Logical volume nerve/data successfully resized.
   resize2fs 1.44.5 (15-Dec-2018)
   Filesystem at /dev/mapper/nerve-data is mounted on /opt/data; on-line resizing required
   old_desc_blocks = 548, new_desc_blocks = 708
   The filesystem on /dev/mapper/nerve-data is now 92737536 (1k) blocks long.

   admin@nerve-host:~$ sudo mkfs.ext4 /dev/nerve/vm
   mke2fs 1.44.5 (15-Dec-2018)
   Discarding device blocks: done
   Creating filesystem with 7864320 4k blocks and 1966080 inodes
   Filesystem UUID: d3741e05-4f89-4484-9eb8-9de3bdfe1020
   Superblock backups stored on blocks:
           32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208,
           4096000

   Allocating group tables: done
   Writing inode tables: done
   Creating journal (32768 blocks): done
   Writing superblocks and filesystem accounting information: done
   ```

Creating a directory for the ISO file and mounting the filesystem

Create a directory in `/opt/data` in order to be able to generate the IMG file and XML file that are required for the provisioning of the Virtual machine in the Management System

1. Enter the following command to create a directory for the ISO file:

   ```
   sudo mkdir /opt/data/<directory>
   ```

2. Enter the following command to mount the filesystem:

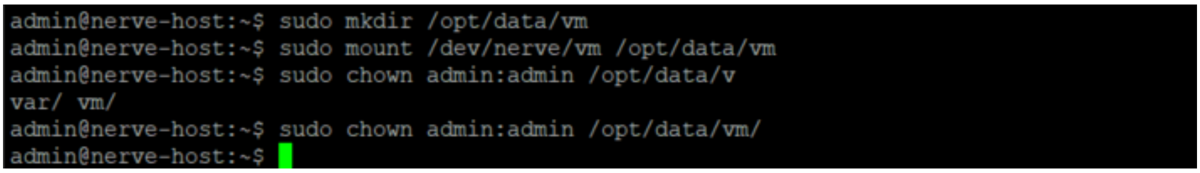
   ```
   sudo mount /dev/nerve/<volume_name> /opt/data/<directory>
   ```

Granting permission for the newly created directory

Take ownership of the new directory in order to be able to work with it, e.g. copying the ISO file into the directory.

Enter the following command to take ownership of the created directory:

```
sudo chown admin:admin /opt/data/<directory>
```



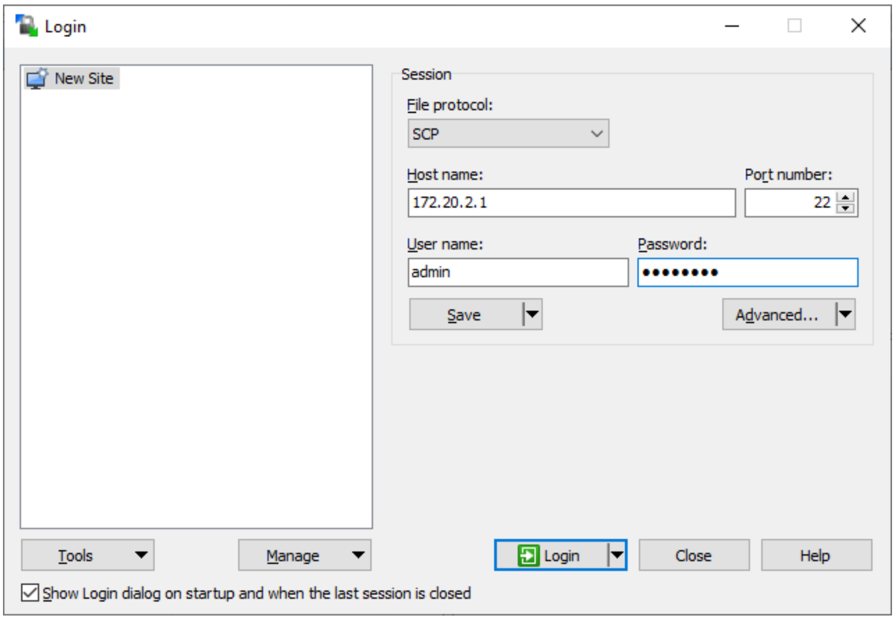
```
admin@nerve-host:~$ sudo mkdir /opt/data/vm
admin@nerve-host:~$ sudo mount /dev/nerve/vm /opt/data/vm
admin@nerve-host:~$ sudo chown admin:admin /opt/data/v
var/ vm/
admin@nerve-host:~$ sudo chown admin:admin /opt/data/vm/
admin@nerve-host:~$
```

Copying the ISO file to the Nerve Device

With the directory created and ownership established, copy the ISO file of the OS to the Nerve Device for the installation on the virtual machine.

> **NOTE**
>
> The instructions below are hardware specific. The MFN 100 is used as an example in the screenshots. Refer to the device guide for specific information on the Nerve Device.

1. Open a file transfer client like WinSCP.
2. Enter the IP address for host access to the Nerve Device under **Host Name**.
3. Enter the credentials for host access to the Nerve Device below under **User name** and **Password**.



File protocol: SCP

Host name: 172.20.2.1

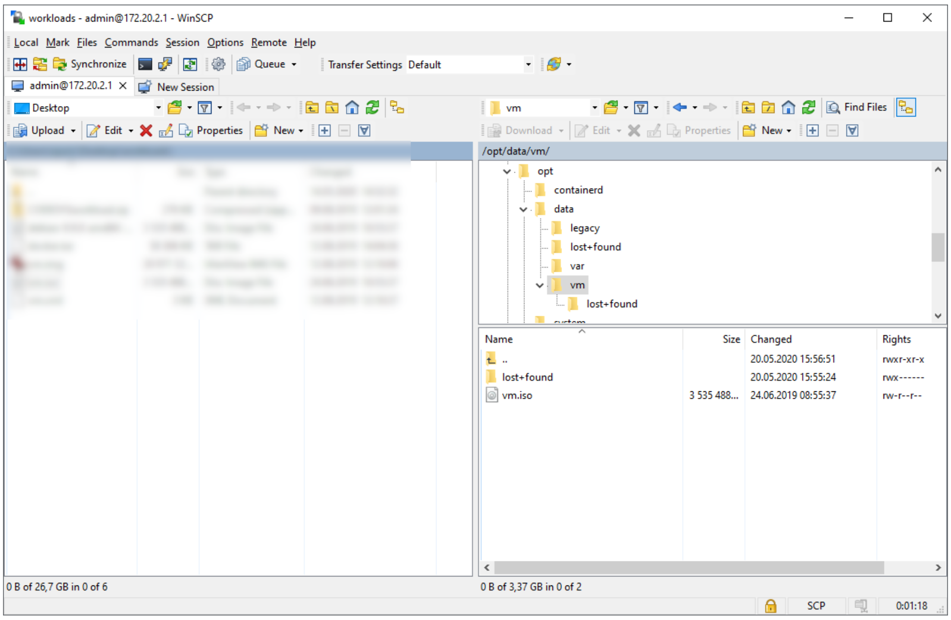
Port number: 22

User name: admin

Password: ••••••••

☑ Show Login dialog on startup and when the last session is closed

4. Navigate to the **/opt/data/<directory>** directory on the right side of the WinSCP window. It is located in the **root** directory.



Name	Size	Changed	Rights
..		20.05.2020 15:56:51	rwxr-xr-x
lost+found		20.05.2020 15:55:24	rwx------
vm.iso	3 535 488...	24.06.2019 08:55:37	rw-r--r--

0 B of 26,7 GB in 0 of 6

0 B of 3,37 GB in 0 of 2

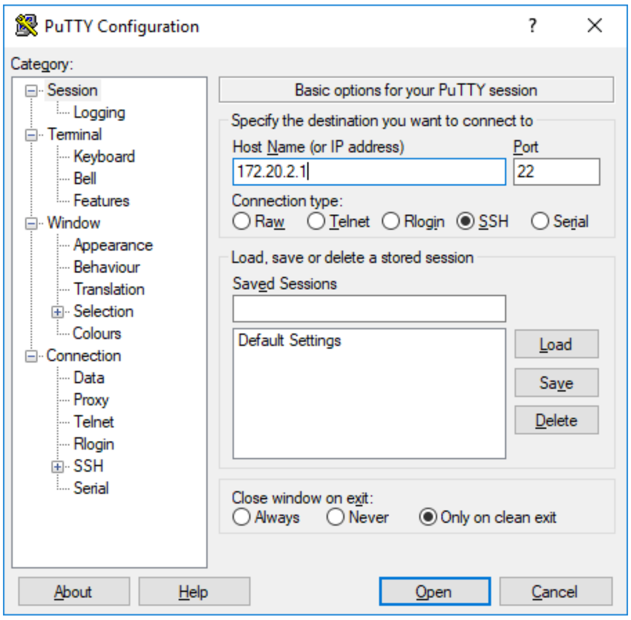
5. Copy the ISO file of the OS that is to be installed on the virtual machine to the directory on the Nerve Device.

Creating a virtual machine on a node

Using the Virtual Machine Manager is recommended to create a virtual machine and install the OS from the ISO file. Note that the virtual machine in this chapter is a fresh installation and will be generated on the Nerve Device directly.

1. Run Xming or an alternative.
2. Open an SSH client like PuTTY.

3. Enter the IP address for host access to the Nerve Device under **Host Name (or IP address)** to log in to the host of the Nerve Device.



PuTTY Configuration

Basic options for your PuTTY session

Specify the destination you want to connect to

Host Name (or IP address): 172.20.2.1

Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

Load, save or delete a stored session

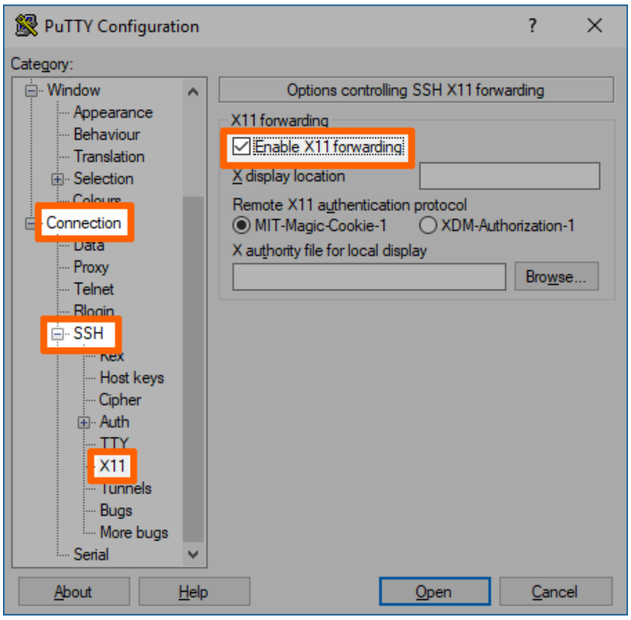
Saved Sessions

Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

4. Expand **Connection > SSH > X11** on the left side.

5. Tick the checkbox next to **Enable X11 forwarding**.



PuTTY Configuration

Options controlling SSH X11 forwarding

X11 forwarding

☑ Enable X11 forwarding

X display location

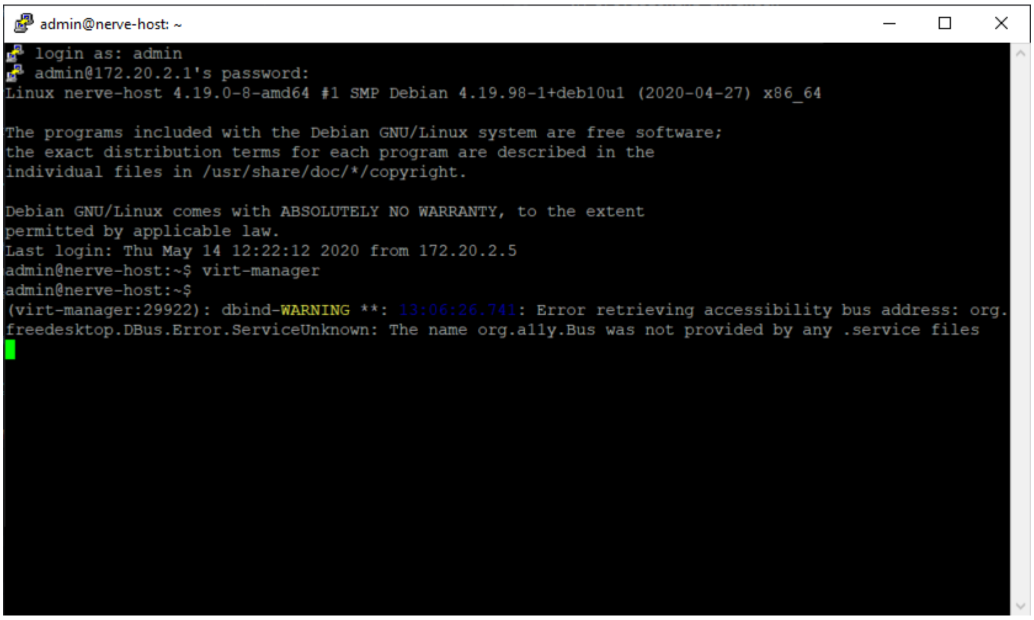
Remote X11 authentication protocol: ● MIT-Magic-Cookie-1 ○ XDM-Authorization-1

X authority file for local display

6. Select **Open**.

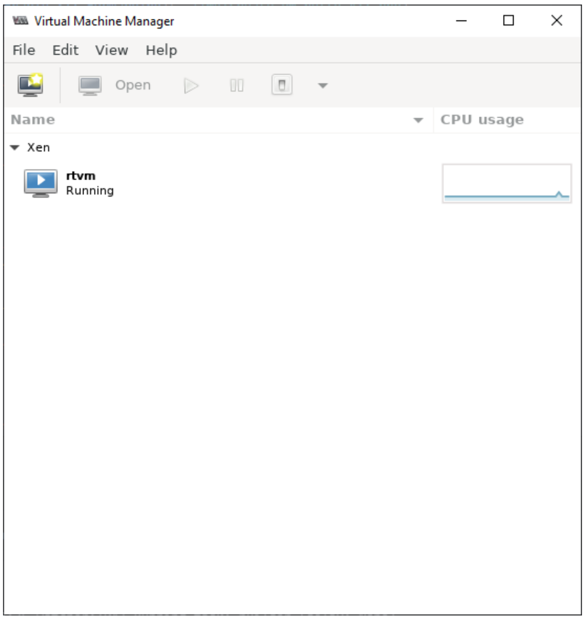
7. Log in with the credentials for host access to the Nerve Device.

8. Enter `virt-manager`.



```
login as: admin
admin@172.20.2.1's password:
Linux nerve-host 4.19.0-8-amd64 #1 SMP Debian 4.19.98-1+deb10u1 (2020-04-27) x86_64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Thu May 14 12:22:12 2020 from 172.20.2.5
admin@nerve-host:~$ virt-manager
admin@nerve-host:~$
(virt-manager:29922): dbind-WARNING **: 13:06:26.741: Error retrieving accessibility bus address: org.
freedesktop.DBus.Error.ServiceUnknown: The name org.a11y.Bus was not provided by any .service files
```

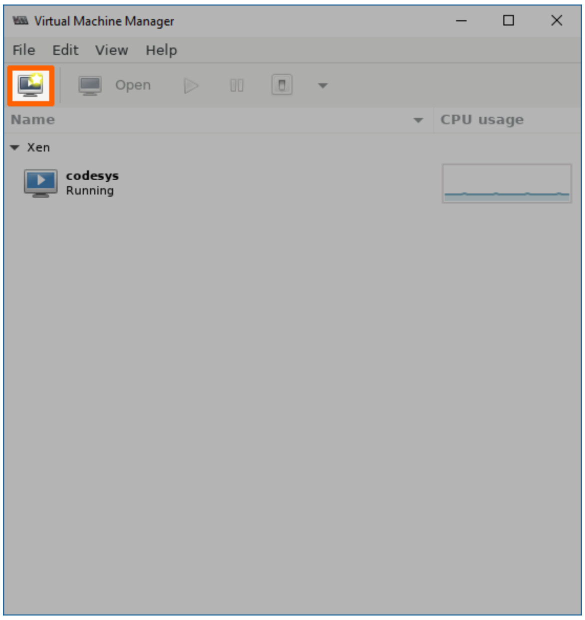
The interface of the Virtual Machine Manager will open.



Inserting the installation file (ISO)

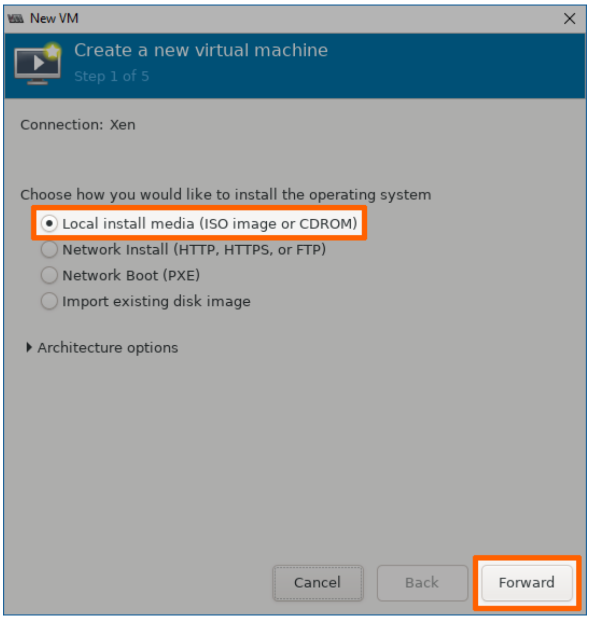
The creation of the virtual machine can now be initiated with the installation of the OS following right after. Note that the Virtual Machine Manager requires the virtual insertion of the ISO file in the beginning while resources for the virtual machine are defined later.

1. Select **File > New Virtual Machine** or select the symbol.



2. Select **Local install media (ISO image or CDROM)**.

3. Select **Forward**.


New VM

Create a new virtual machine

Step 1 of 5

Connection: Xen

Choose how you would like to install the operating system

● Local install media (ISO image or CDROM)

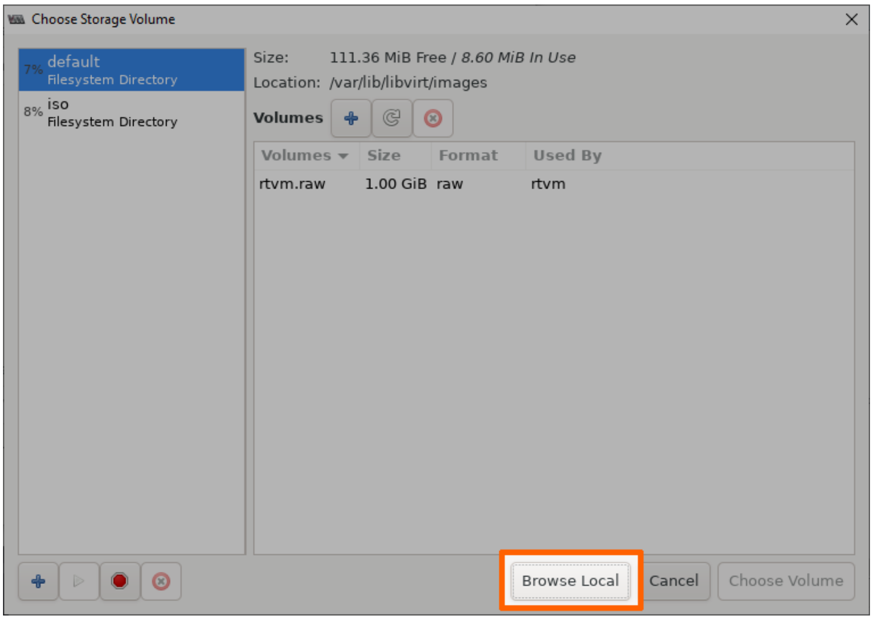
○ Network Install (HTTP, HTTPS, or FTP)

○ Network Boot (PXE)

○ Import existing disk image

4. Select **Browse...** in the next window.

5. In the new window select **Browse Local**.



Size: 111.36 MiB Free / *8.60 MiB In Use*

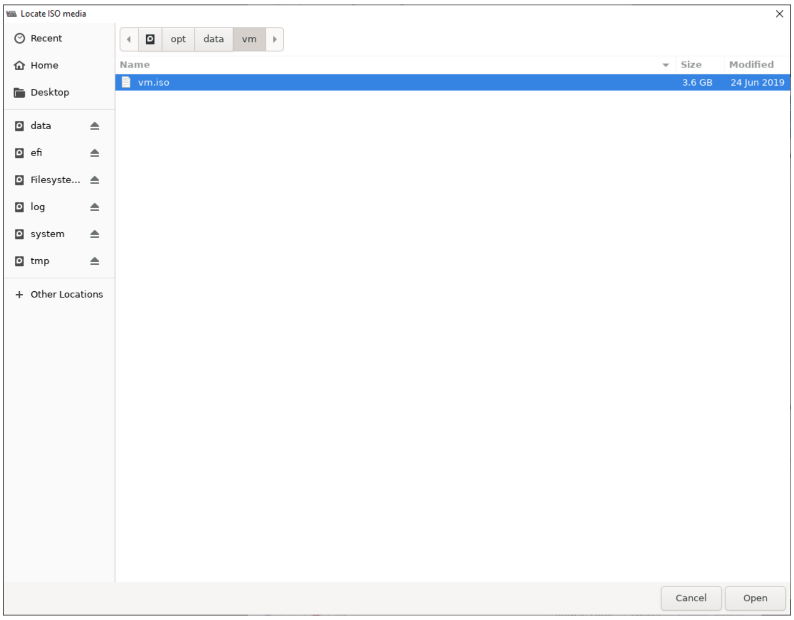
Location: /var/lib/libvirt/images

Volumes	Size	Format	Used By
rtvm.raw	1.00 GiB	raw	rtvm

6. Navigate to **/opt/data/** by selecting the left arrow next to **admin**. The **opt** directory is located in the root directory.

7. Double-click the directory containing the ISO file.

8. Select the ISO file of the OS that was copied before.



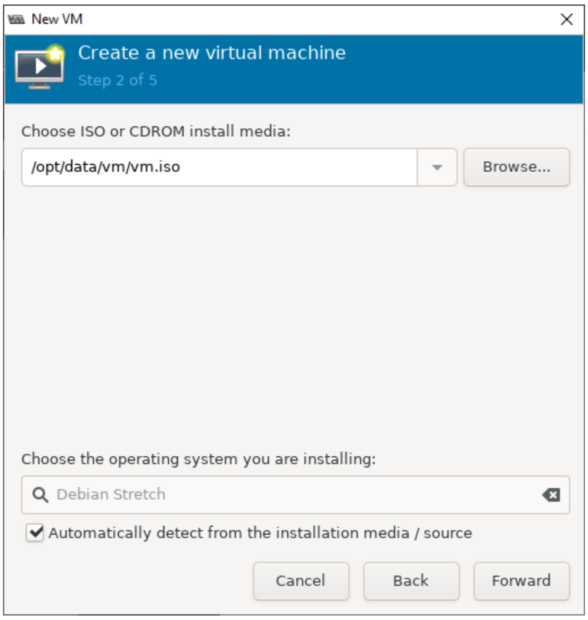
Name	Size	Modified
vm.iso	3.6 GB	24 Jun 2019

9. Select **Open**.

Defining resources for the virtual machine

Next, the amount of memory and the number of CPUs need to be defined, and the logical volume assigned to the virtual machine needs to be selected.

1. Select **Forward**.



Choose ISO or CDROM install media:

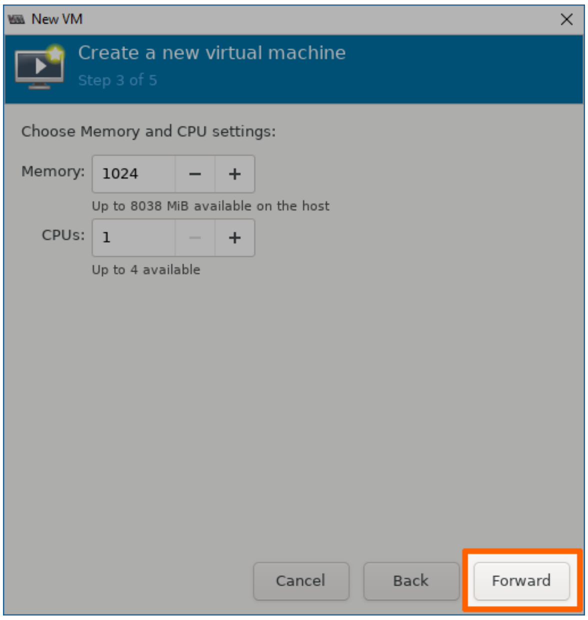
/opt/data/vm/vm.iso

Choose the operating system you are installing:

Debian Stretch

☑ Automatically detect from the installation media / source

2. Define how much memory and how many CPUs to assign to this virtual machine.
3. Select **Forward**.



Choose Memory and CPU settings:

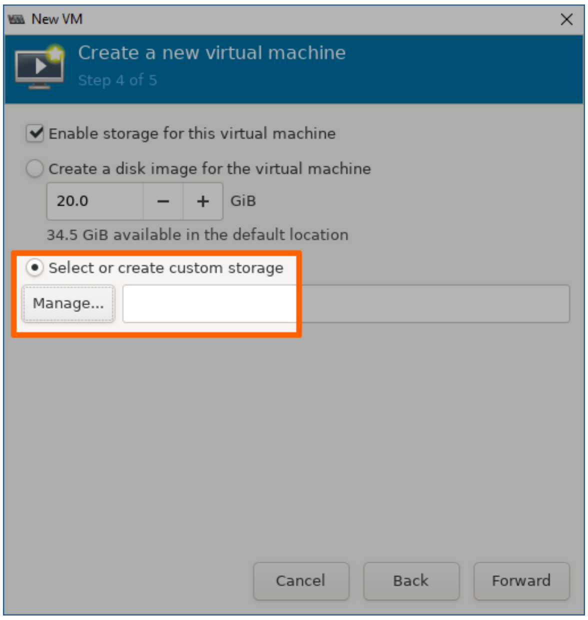
Memory: 1024

Up to 8038 MiB available on the host

CPUs: 1

Up to 4 available

4. Select **Select or create custom storage**.
5. Select **Manage...**.



☑ Enable storage for this virtual machine

○ Create a disk image for the virtual machine

20.0 GiB

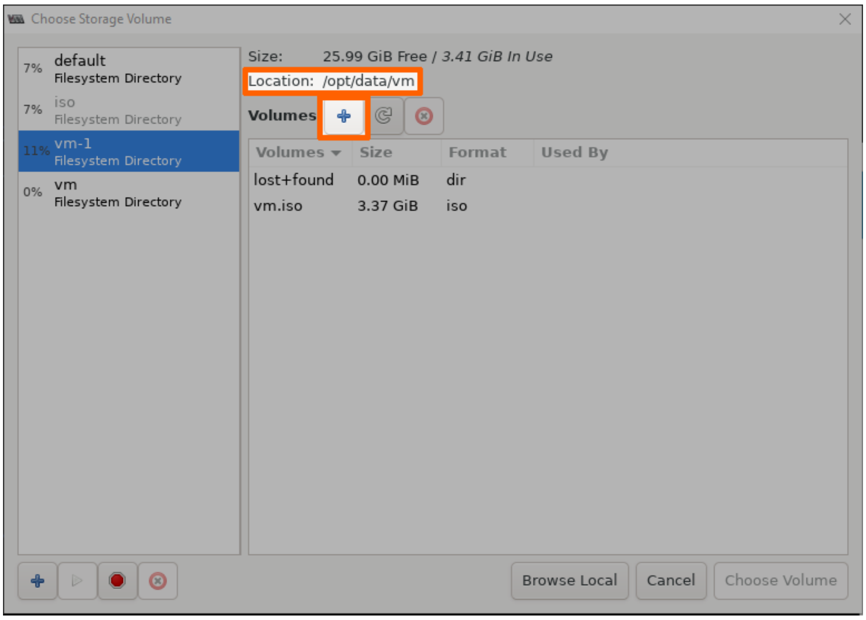
34.5 GiB available in the default location

● Select or create custom storage

Installing the operating system

Now the virtual machine will be initiated and the installation of the OS will be started.

1. Select the pool that was created in the command line on the left side in the **Choose Storage Volume** window. Make sure it is the volume with the location **opt/data/**.
2. Select the plus symbol in the middle of the screen.



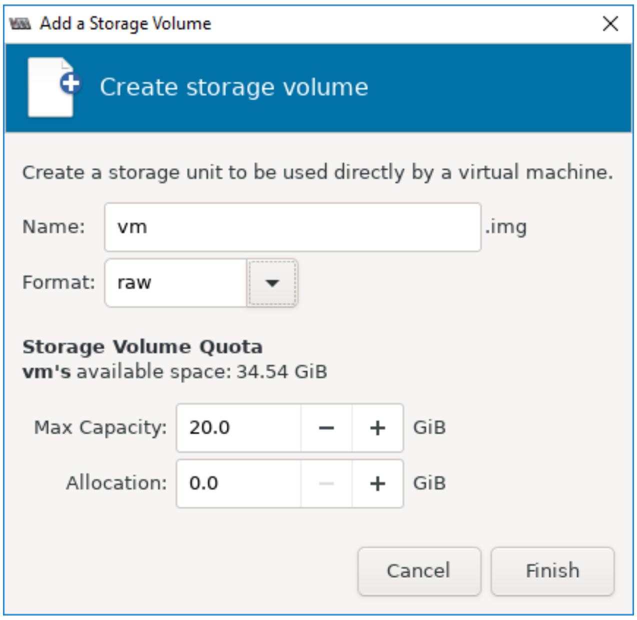
7%	default	Filesystem Directory
7%	iso	Filesystem Directory
11%	vm-1	Filesystem Directory
0%	vm	Filesystem Directory

Size: 25.99 GiB Free / *3.41 GiB In Use*

Location: /opt/data/vm

Volumes	Size	Format	Used By
lost+found	0.00 MiB	dir	
vm.iso	3.37 GiB	iso	

3. Enter a name for the IMG file.



Create a storage unit to be used directly by a virtual machine.

Name: vm .img

Format: raw

Storage Volume Quota

vm's available space: 34.54 GiB

Max Capacity: 20.0 GiB

Allocation: 0.0 GiB

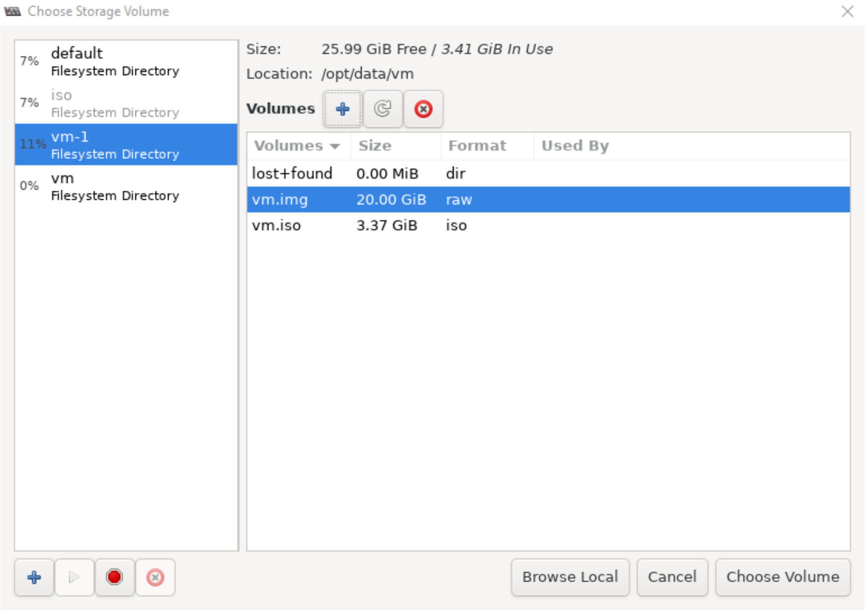
NOTE

Make sure that the value entered for **Max Capacity** is a factor of 512 Bytes. Any value that is not a factor of 512 B will cause an error when the virtual machine workload is deployed. In other words, do not enter any decimal value except `.0` or `.5`.

4. Select **Finish**.

5. Select the IMG file from the list in the middle.

6. Select **Choose Volume**.



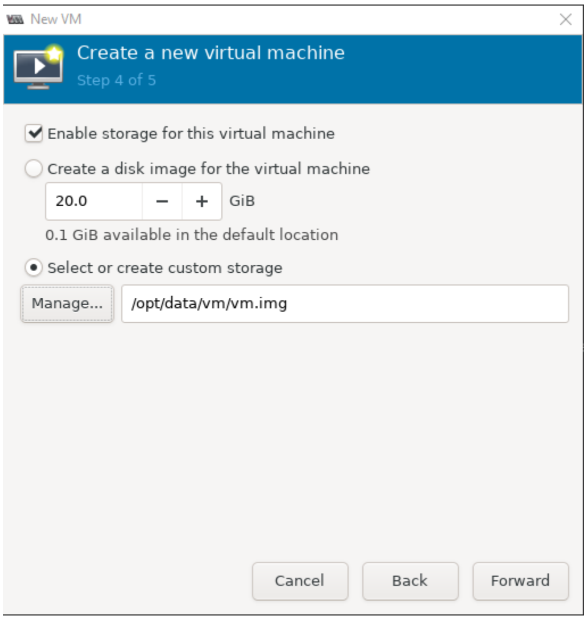
7%	default	Filesystem Directory
7%	iso	Filesystem Directory
11%	vm-1	Filesystem Directory
0%	vm	Filesystem Directory

Size: 25.99 GiB Free / *3.41 GiB In Use*

Location: /opt/data/vm

Volumes	Size	Format	Used By
lost+found	0.00 MiB	dir	
vm.img	20.00 GiB	raw	
vm.iso	3.37 GiB	iso	

7. Select **Forward** to initialize the installation of the OS on the virtual machine.



New VM

Create a new virtual machine

Step 4 of 5

☑ Enable storage for this virtual machine

○ Create a disk image for the virtual machine

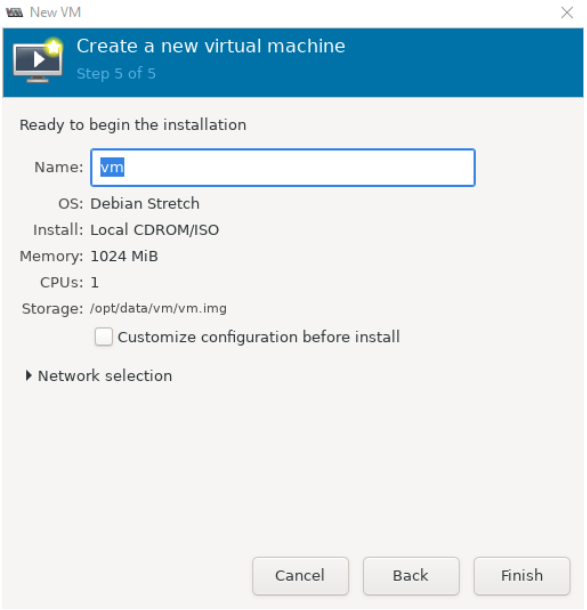
20.0 − + GiB

0.1 GiB available in the default location

● Select or create custom storage

Manage... /opt/data/vm/vm.img

8. Enter a name for the virtual machine.
9. Select **Finish**. The virtual machine will be initiated and the installation of the OS will be started.



New VM

Create a new virtual machine

Step 5 of 5

Ready to begin the installation

Name: vm

OS: Debian Stretch

Install: Local CDROM/ISO

Memory: 1024 MiB

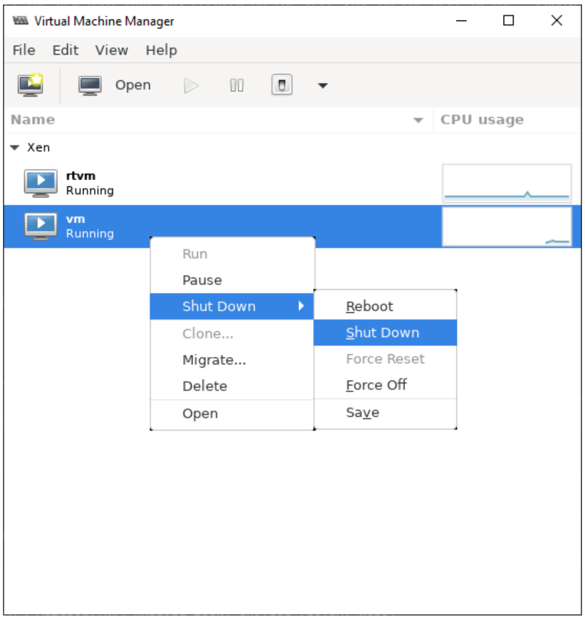
CPUs: 1

Storage: /opt/data/vm/vm.img

□ Customize configuration before install

▸ Network selection

10. Complete the installation of the OS. Follow the instructions provided by the vendor.
11. After the installation is completed, right-click the virtual machine in the main Virtual Machine Manager window.
12. Select **Shut Down > Shut Down** to shut down the VM.

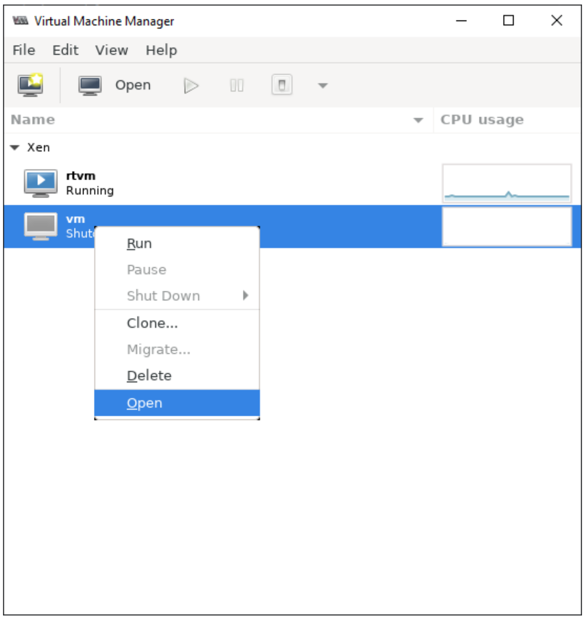


Defining network interfaces

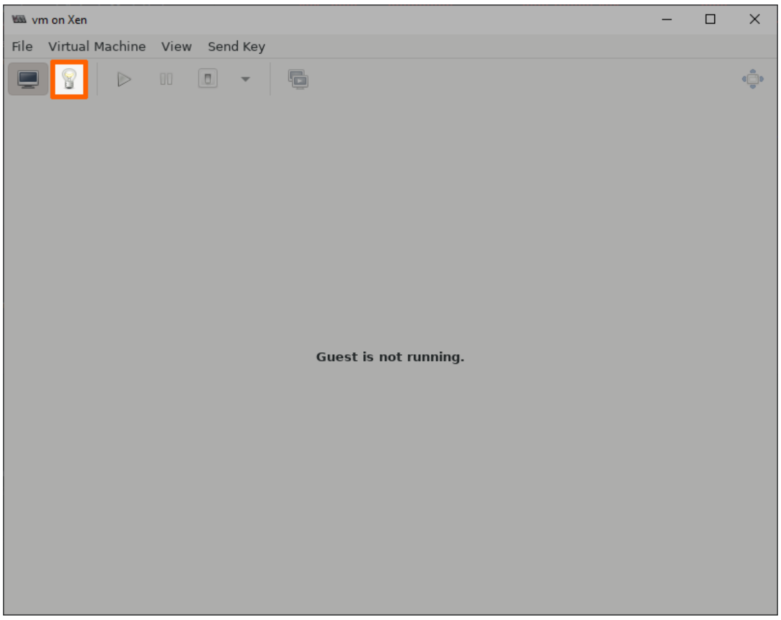
In order for the VM to communicate with the Nerve network, it needs network interfaces. While these are defined when provisioning the VM workload in the Management System, the VM itself needs to have "network cards" installed that represent these interfaces. This means that the purpose of the VM and its interfaces, the number of interfaces and the Nerve networks that will be connected to them need to be known before attempting the following instructions. Note that this step also requires a user with knowledge about the VM, as it requires configuration inside of the VM.

1. Right-click the virtual machine in the main Virtual Machine Manager window.

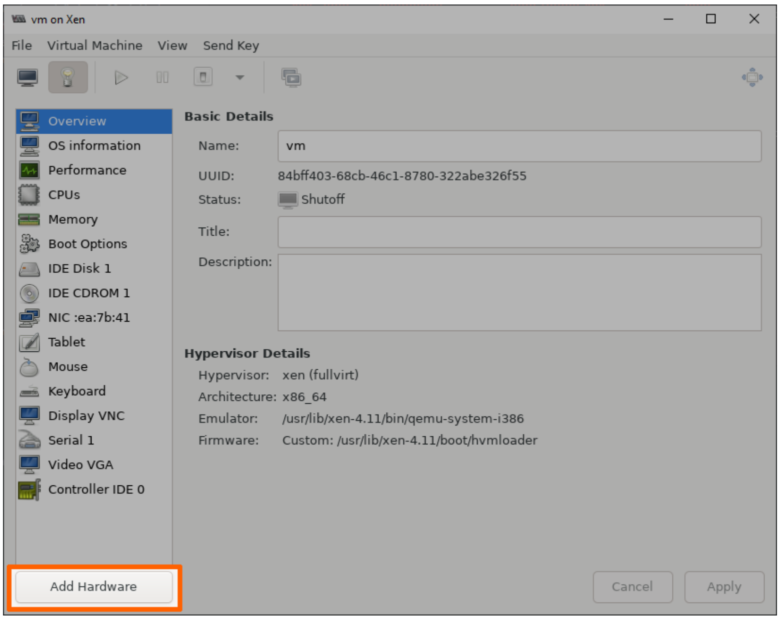
2. Select **Open** to open the control window.



3. Select the light bulb symbol in the toolbar to display hardware details.



4. Select **Add Hardware** in the lower-left.



Basic Details

Name: vm

UUID: 84bff403-68cb-46c1-8780-322abe326f55

Status: Shutoff

Title:

Description:

Hypervisor Details

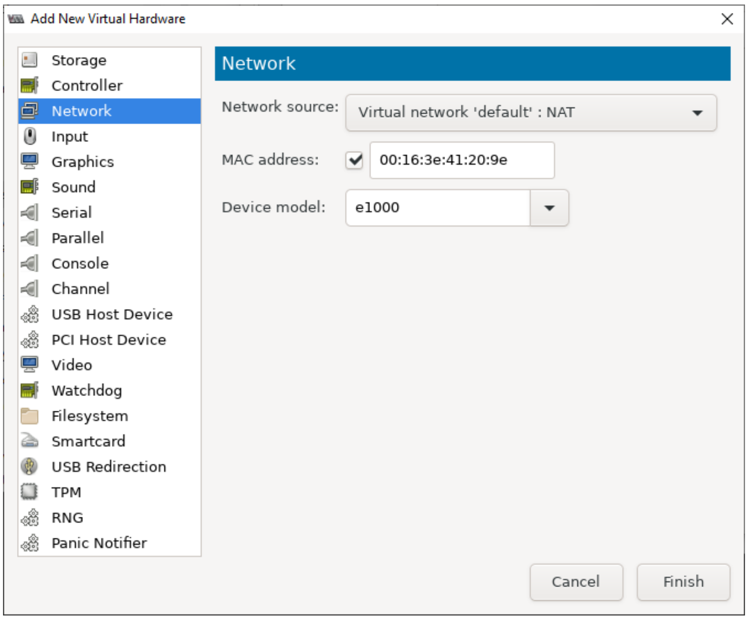
Hypervisor: xen (fullvirt)

Architecture: x86_64

Emulator: /usr/lib/xen-4.11/bin/qemu-system-i386

Firmware: Custom: /usr/lib/xen-4.11/boot/hvmloader

5. Select **Network** in the list.



Network source: Virtual network 'default' : NAT

MAC address: ☑ 00:16:3e:41:20:9e

Device model: e1000

6. Configure the **Network source** the following way depending on the desired interface. Refer to Networks for Virtual Machine workloads for more information on the interfaces.

Interface	Action
mgmt	1. Select **Specify shared device name** from the drop-down menu 2. Enter `mgmt` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
wan	1. Select **Specify shared device name** from the drop-down menu . 2. Enter wan in the **Bridge name:** field. 3. Select **Finish** to add the network card.
extern1	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `extern1` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
extern2	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `extern2` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
extern3	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `extern3` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
default	1. Select **Virtual network 'default' : NAT** from the drop-down menu. 2. Select **Finish** to add the network card.
extern1-nat	1. Select **Virtual network 'extern1-nat' : NAT to extern1** from the drop-down menu. 2. Select **Finish** to add the network card.
extern2-nat	1. Select **Virtual network 'extern2-nat' : NAT to extern2** from the drop-down menu. 2. Select **Finish** to add the network card.

Interface	Action
extern3-nat	1. Select **Virtual network 'extern3-nat' : NAT to extern3** from the drop-down menu. 2. Select **Finish** to add the network card.
rtvm	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `br-rtvm` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
isolated1	1. Select **Specify shared device name** from the drop-down menu 2. Enter `br-isolated1` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
isolated2	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `br-isolated2` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
isolated3	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `br-isolated3` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
isolated4	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `br-isolated4` in the **Bridge name:** field. 3. Select **Finish** to add the network card.
isolated5	1. Select **Specify shared device name** from the drop-down menu . 2. Enter `br-isolated5` in the **Bridge name:** field. 3. Select **Finish** to add the network card.

NOTE

The device model can be ignored, as the Management System will set the required parameters once the VM is provisioned as a workload.

7. Repeat steps 4 to 6 until all desired interfaces have been defined.

NOTE

Note that one virtual network card is defined by default when creating the virtual machine. The **Network source** is set to **Virtual network 'default' : NAT** so that the VM can have internet access through the **default** network. Remove or modify this network card if internet access for the VM is not desired.

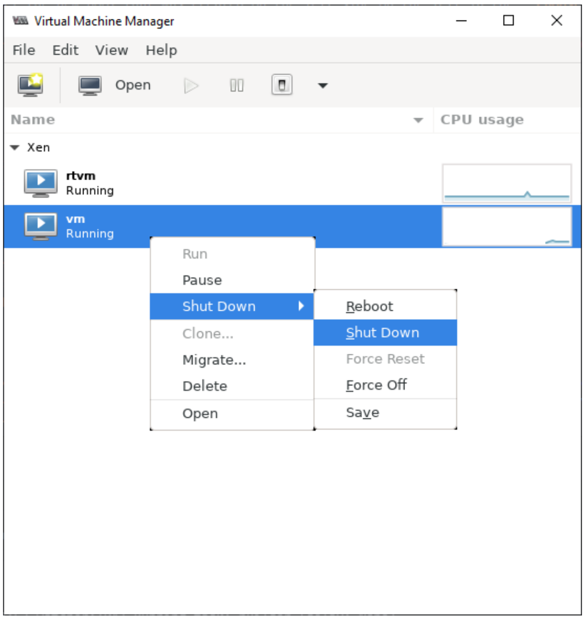
8. Select the play symbol to launch the virtual machine.

The virtual machine is being launched because further configuration steps need to be taken inside of the VM. The IP addresses of the network cards that were defined above need to be configured (static or dynamic). This step requires a user with knowledge about the VM, as it requires configuration inside of the VM. Refer to Networks for Virtual Machine workloads for more information on the interfaces and their IP ranges.

Copying the IMG file to a local workstation

With the generation of the VM, the IMG file of the VM has also been generated on the Nerve Device. Copy the IMG file to the local workstation.

1. Right-click the virtual machine in the main Virtual Machine Manager window.
2. Select **Shut Down > Shut Down** to shut down the VM.

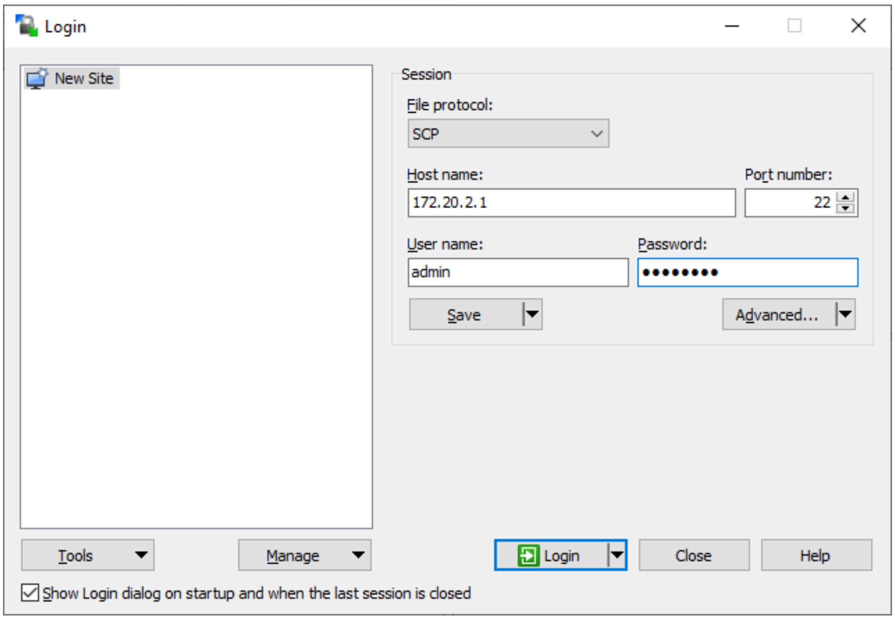


3. Switch to the SSH client window.
4. Enter the following command:

```
sudo chmod o+r /opt/data/<directory>/<vmname>.img
```

> **NOTE**
>
> The IMG file is called <vmname>.img in the command example above. Replace the placeholder name of the image in the command with the actual name of the IMG file.

5. Open a file transfer client like WinSCP.
6. Enter the IP address for host access to the Nerve Device under **Host Name**.
7. Enter the credentials for host access to the Nerve Device below under **User name** and **Password**.



Session

File protocol: SCP

Host name: 172.20.2.1

Port number: 22

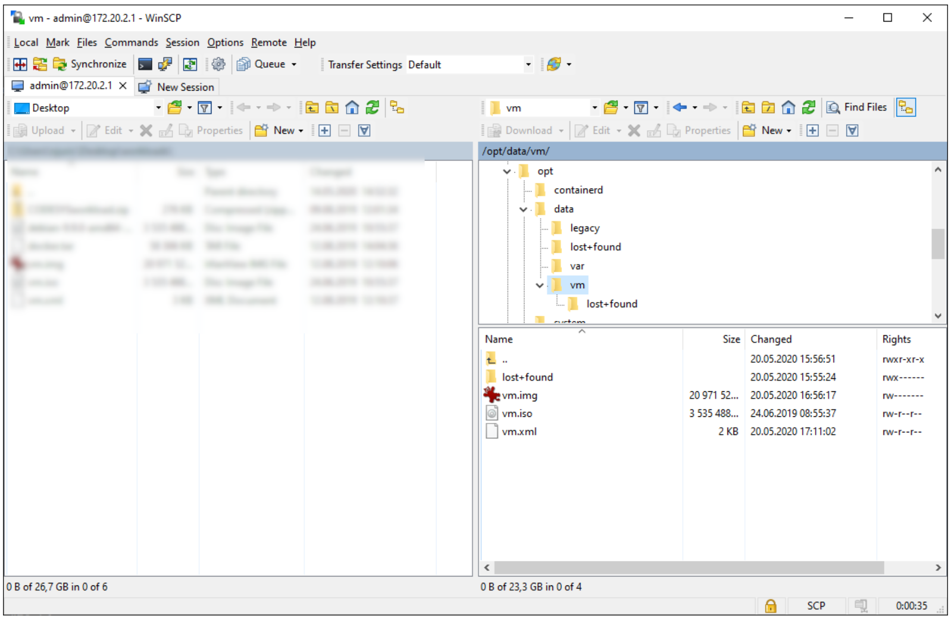
User name: admin

Password: ••••••••

☑ Show Login dialog on startup and when the last session is closed

8. Navigate to `/opt/data/<directory>` on the right side of the window. The **opt** directory is located in the **root** directory.

9. Copy the `<vmname>.img` file to the local workstation.



/opt/data/vm/

Name	Size	Changed	Rights
..		20.05.2020 15:56:51	rwxr-xr-x
lost+found		20.05.2020 15:55:24	rwx------
vm.img	20 971 52...	20.05.2020 16:56:17	rw-------
vm.iso	3 535 488...	24.06.2019 08:55:37	rw-r--r--
vm.xml	2 KB	20.05.2020 17:11:02	rw-r--r--

The virtual machine has now been generated on the Nerve Device and the IMG file of the virtual machine is now on the local workstation.

NOTE

- To use the Virtual machine snapshots feature, the IMG or RAW file of the VM needs to be converted to the QCOW2 format. Use the converted QCOW2 file as the image file when provisioning the workload in the Management System. A tool that can be used is qemu-img on Linux for example.
- Do not deploy the virtual machine from the process above to the same Nerve Device through the Management System. The virtual machine will be present

twice. The deployment of the virtual machine from the process above should be done to different nodes.

Obtaining the XML file

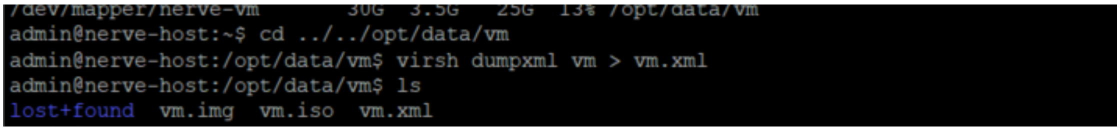
When the IMG file was generated on the Nerve Device, an XML file for the IMG file was generated as well. It also has to be obtained manually. However, before it can be copied to the workstation. It has to be transferred out of the **etc** directory.

1. Switch to the SSH client window.
2. Navigate to `/opt/data/<directory>` by entering the following command:

   ```
   cd ../../opt/data/<directory>
   ```

3. Enter the following command to dump the XML file into the directory:

   ```
   virsh dumpxml <volume_name> > <filename>.xml
   ```

   ```
   /dev/mapper/nerve-vm        30G  3.5G   25G  13% /opt/data/vm
   admin@nerve-host:~$ cd ../../opt/data/vm
   admin@nerve-host:/opt/data/vm$ virsh dumpxml vm > vm.xml
   admin@nerve-host:/opt/data/vm$ ls
   lost+found  vm.img  vm.iso  vm.xml
   ```

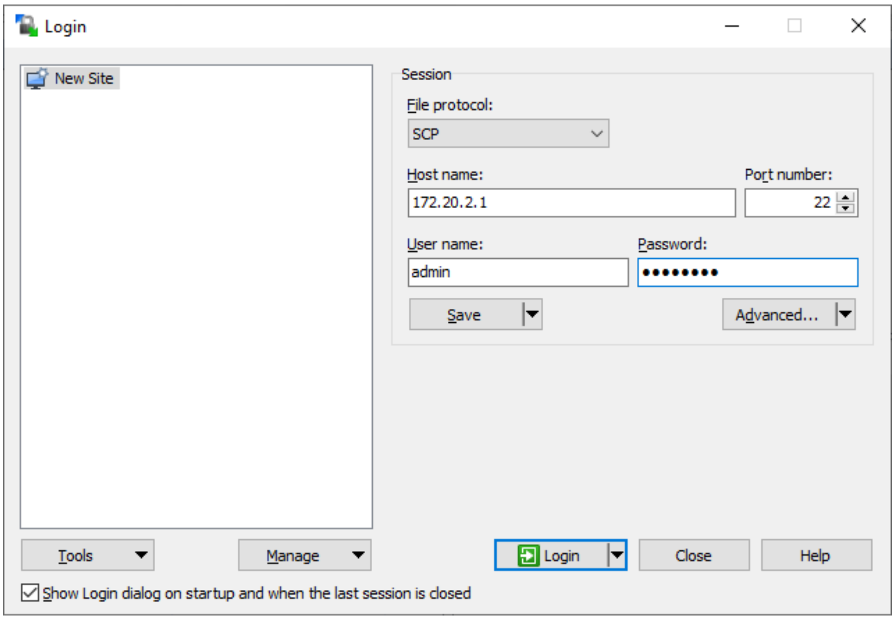
4. Enter the following command:

   ```
   sudo chmod o+r /opt/data/<directory>/<filename>.xml
   ```

   NOTE

   Replace the placeholder name of the XML file in the command with the actual name of the XML file. The XML file is called `vm.xml` in the following screenshots below.

5. Open a file transfer client like WinSCP.
6. Enter the IP address for host access to the Nerve Device under **Host Name**.
7. Enter the credentials for host access to the Nerve Device below under **User name** and **Password**.



File protocol: SCP

Host name: 172.20.2.1

Port number: 22

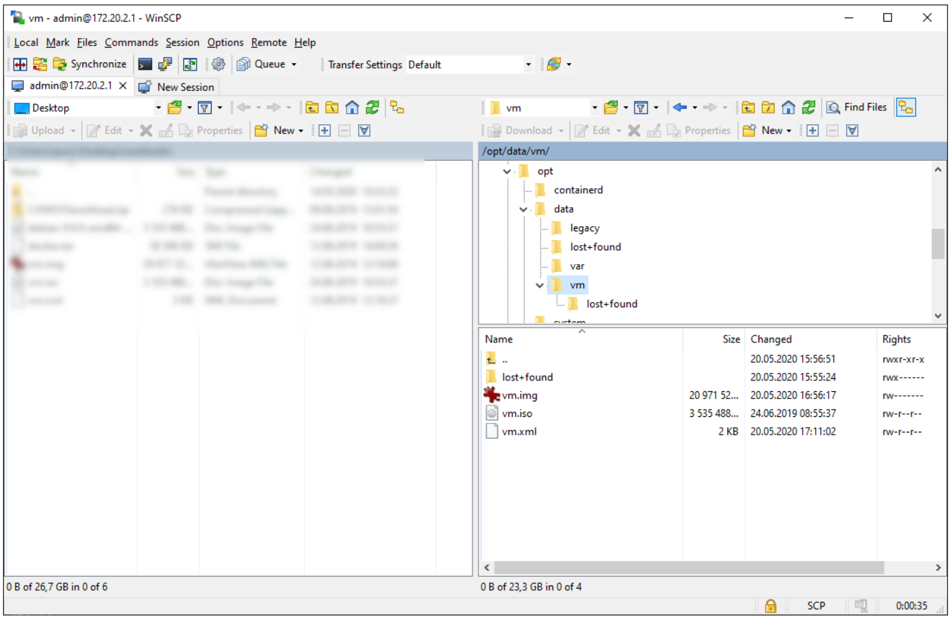
User name: admin

Password: ••••••••

☑ Show Login dialog on startup and when the last session is closed

8. Navigate to `/opt/data/<directory>` on the right side of the window. The **opt** directory is located in the **root** directory.

9. Copy the `<filename>.xml` file to the local workstation.



/opt/data/vm/

Name	Size	Changed	Rights
..		20.05.2020 15:56:51	rwxr-xr-x
lost+found		20.05.2020 15:55:24	rwx------
vm.img	20 971 52...	20.05.2020 16:56:17	rw-------
vm.iso	3 535 488...	24.06.2019 08:55:37	rw-r--r--
vm.xml	2 KB	20.05.2020 17:11:02	rw-r--r--

0 B of 26,7 GB in 0 of 6

0 B of 23,3 GB in 0 of 4

With this all the necessary files to provision a Virtual Machine workload for this virtual machine are ready.

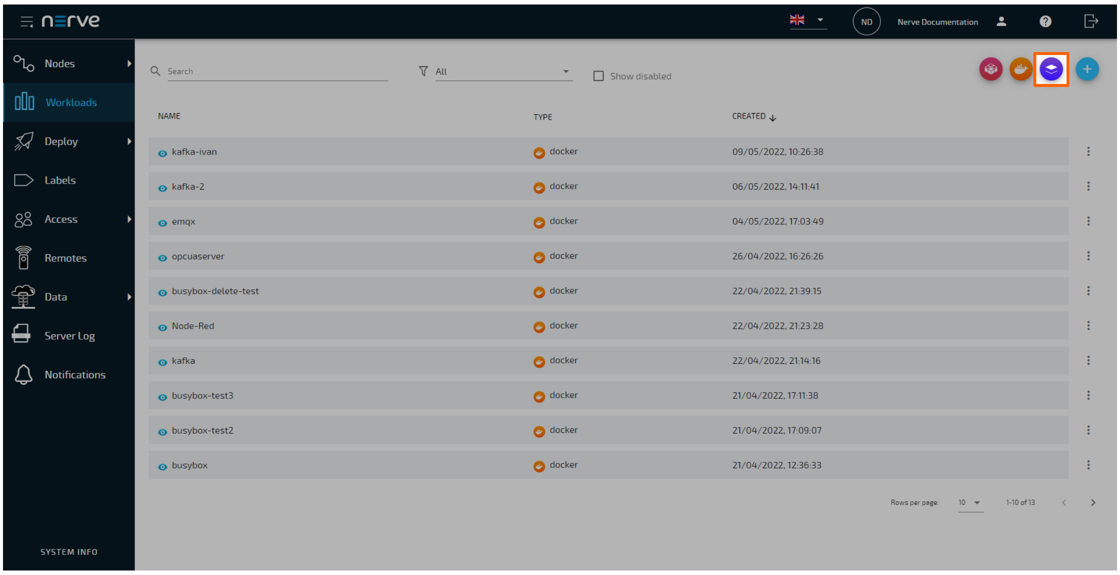
Provisioning a Virtual Machine workload

The following instructions cover the basic requirements for provisioning a Virtual Machine workload. Optional settings will be left out. Extended options are addressed in the last section of this chapter.
There are two further types of workloads that can be provisioned: CODESYS workloads and Docker workloads. The process for each workload is highlighted in its respective chapter.

1. Log in to the Management System.

2. Select **Workloads** in the left-hand menu.
3. Select the plus symbol in the upper-right corner.

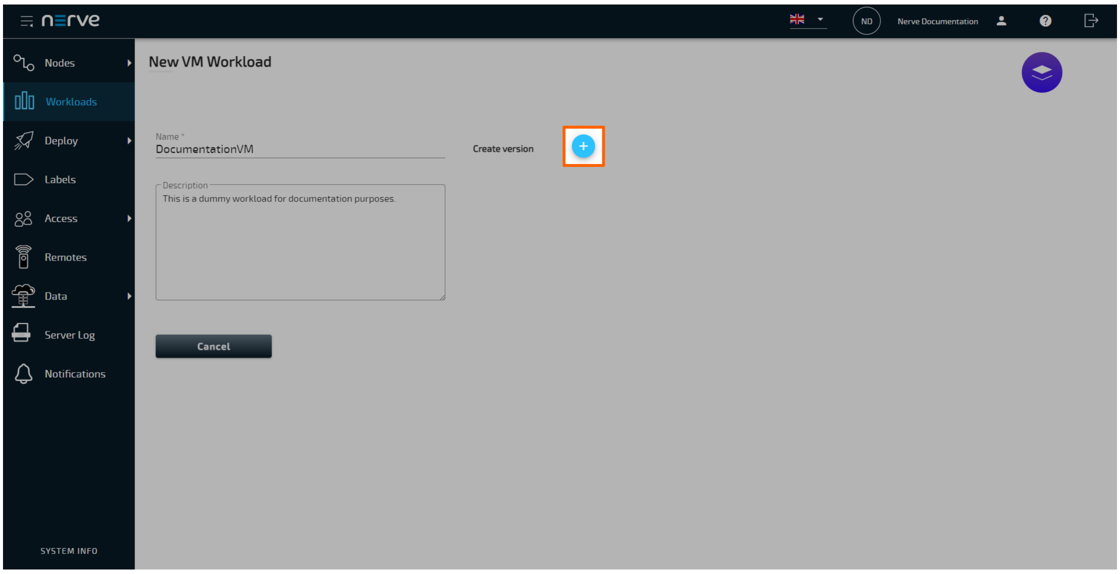
4. Select the virtual machine symbol (**Virtual Machine workload**) on the right of the three symbols that expanded.



NAME	TYPE	CREATED ↓
kafka-ivan	docker	09/05/2022, 10:26:38
kafka-2	docker	06/05/2022, 14:11:41
emqx	docker	04/05/2022, 17:03:49
opcuaserver	docker	26/04/2022, 16:26:26
busybox-delete-test	docker	22/04/2022, 21:39:15
Node-Red	docker	22/04/2022, 21:23:28
kafka	docker	22/04/2022, 21:14:16
busybox-test3	docker	21/04/2022, 17:11:38
busybox-test2	docker	21/04/2022, 17:09:07
busybox	docker	21/04/2022, 12:36:33

5. In the new window, enter a name for the workload.

6. Select the plus symbol next to **Create versions** to add a new version of the workload.



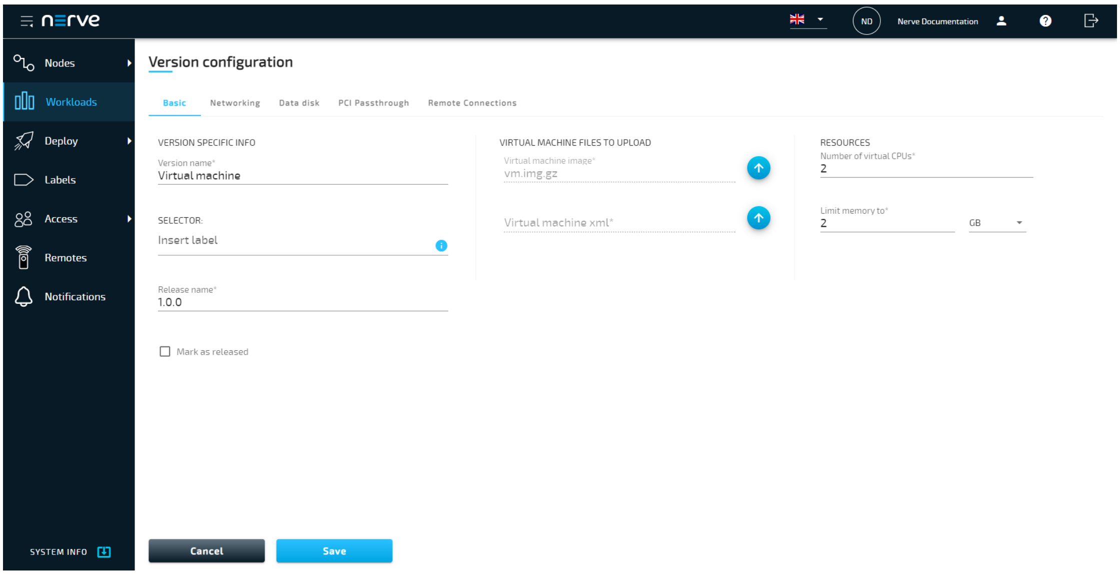
Name *
DocumentationVM

Description
This is a dummy workload for documentation purposes.

7. In the next window, enter the following information in the **Basic** tab:

Category	Settings and descriptions
VERSION SPECIFIC INFO	**Version name** Enter a name for the version of this workload. **Release name** Enter a **Release name** for the version of this workload.

Category	Settings and descriptions
VIRTUAL MACHINE FILES TO UPLOAD	**Virtual machine image** Select the **upward arrow** symbol here to add the virtual machine image. The image has to be a QCOW2, IMG or RAW file. In case of a large file, the virtual machine image can also be compressed and uploaded as a GZIP or ZIP file. Note that the Virtual machine snapshots feature is only available when using a QCOW2 image. Convert IMG or RAW files to the QCOW2 format first before uploading. **Virtual machine xml** Select the **upward arrow** symbol here to add the virtual machine XML file.
RESOURCES	**Number of virtual CPUs** Enter the number of virtual CPUs to use for this virtual machine. This setting can be changed again after the deployment of the workload. **Limit memory to** Assign how much system memory the workload is allowed to use. This setting can be changed again after the deployment of the workload.



Version configuration

VERSION SPECIFIC INFO

Version name*: Virtual machine

SELECTOR: Insert label

Release name*: 1.0.0

☐ Mark as released

VIRTUAL MACHINE FILES TO UPLOAD

Virtual machine image*: vm.img.gz

Virtual machine xml*

RESOURCES

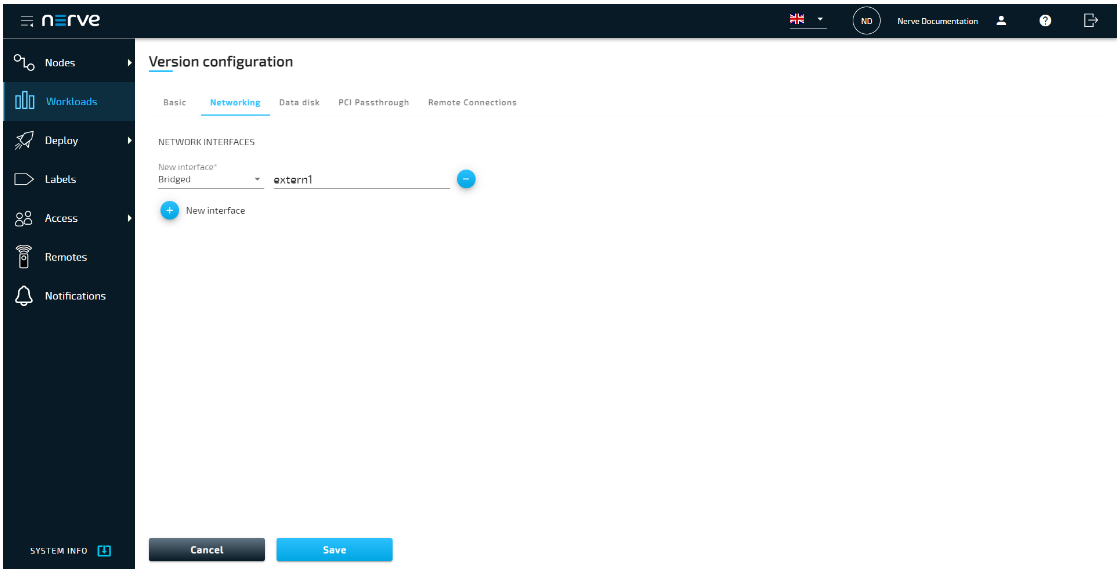
Number of virtual CPUs*: 2

Limit memory to*: 2 GB

8. Select the **Networking** tab.

9. Select the plus symbol to add a new interface.
10. Select **Bridged** or **NAT** from the drop-down menu.

11. Enter the interface name in the **Interface** field.



NETWORK INTERFACES

New interface* Bridged

extern1

> **NOTE**
>
> Repeat this process to add the same number and type of interfaces in the same order as they were added as network cards in Defining network interfaces above.

12. Select **Save** in the lower-left corner to save the workload version.

The workload has now been provisioned and is ready to be deployed in the **Deploy** menu.

> **NOTE**
>
> While some settings are not required to provision a Virtual Machine workload in the Management System, additional settings will have to be filled in for the workload to perform as desired. Depending on the virtual machine that will be deployed, new interfaces might have to be defined. Keep this in mind and make sure to learn the details about the virtual machine.

Settings for Virtual Machine workloads

In the instructions above, all optional settings have been left out. Below is an overview of all the options with an explanation to each option.

Basic tab

Category	Settings and descriptions
VERSION SPECIFIC INFO	**Name** A name for the workload version. This could be a reminder for a certain configuration. Example: "Unlimited" as a name for a virtual machine that has unlimited access to CPU resources. **SELECTOR** If labels have been defined and assigned to nodes, add them as selectors to the workload. When deploying a workload, the list of nodes will be filtered automatically to the specified label. Select the **Insert label** field to see a list of available labels. **Release name** A release name for the workload version. This could be a version number. Example: 1.0.1 **Mark as released** Tick this checkbox to mark this workload as released. Once marked as released, the workload cannot be edited anymore.
VIRTUAL MACHINE FILES TO UPLOAD	**Virtual machine image** Upload the virtual machine image with the file extension QCOW2, RAW or IMG here. Do this by selecting the **upward arrow** symbol and selecting the file in the file browser. This is the first file generated in the process before. In case of a large file, the virtual machine image can also be compressed and uploaded as a GZIP or ZIP file. Note that the Virtual machine snapshots feature is only available when using a QCOW2 image. Convert IMG or RAW files to the QCOW2 format first before uploading. **Virtual machine xml** Upload the virtual machine XML file here. Do this by selecting the **upward arrow** symbol and selecting the file in the file browser. This is the second file generated in the process before. Note that the settings defined under **Virtual machine specific info** are going to overwrite parts of this XML file. **Enable snapshot** Tick the checkbox to enable the Virtual machine snapshots feature. Note that this is only available if a QCOW2 image is uploaded (uncompressed or zipped). In addition, the active user needs to have the appropriate permissions assigned for the snapshot command to appear in the workload control screen. Once the criteria are met and the checkbox is ticked, a field labeled **Additional disk space** appears. Define the disk space here that will be reserved for the VM snapshot. The additional disk space depends on the defined memory for the VM, the VM disk size and should also include about 3% of overhead. Also, keep in mind the duration of how long the snapshot will be kept. The longer a snapshot is kept, the larger it will grow, requiring a larger amount of additional disk space. It is not recommended to keep a snapshot for a long time. In that case, consider creating a backup instead.

Category	Settings and descriptions
RESOURCES	**Number of virtual CPUs** Define the number of virtual CPUs to assign to this virtual machine. The CPUs are then reserved exclusively for the Virtual Machine workload and cannot be used by other processes. This setting is mandatory and the workload cannot be provisioned if it is left blank. Note that this setting can be changed again after the deployment of the workload without having to undeploy and redeploy the workload. Refer to Changing resource allocation of a deployed Virtual Machine workload for more information. **Limit memory to** Assign how much system memory the workload is allowed to use. The memory assigned here will be reserved exclusively for this Virtual Machine workload and will not be available for any other processes. This setting is mandatory and the workload cannot be provisioned if it is left blank. Note that this setting can be changed again after the deployment of the workload without having to undeploy and redeploy the workload. Refer to Changing resource allocation of a deployed Virtual Machine workload for more information.

Networking tab

Category	Settings and descriptions
NETWORK INTERFACES	Select the plus symbol to add a new interface. Choose between a bridged interface and a NAT-interface. For NAT-interfaces port mappings for TCP and UDP can be defined. Also, remember to add the same number and type of interfaces in the same order as they were added as network cards in Defining network interfaces above. The names of the interfaces here have to match the names of the pre-defined network interfaces. Also, make sure to not use reserved ports for the workload. Refer to the networking chapter for more detailed information.

Data disk tab

Category	Settings and descriptions
DATA DISK	Select the plus symbol to add a new data disk for the virtual machine. This data disk functions like an extra hard drive for data outside of the virtual machine. Enter a **Data disk name** and define the **Disk size**.

PCI Passthrough tab

Category	Settings and descriptions
PCI PASSTHROUGH	Select the plus symbol to add a PCI passthrough to the virtual machine. Enter the PCI address of the interface to pass through to be directly used by the virtual machine. Note that the PCIe address is specific to a certain hardware. When using this option, the nodes running on this specific hardware should be limited by using selectors. Refer to the labels chapter for more information on selectors.

Remote connections tab

Category	Settings and descriptions
REMOTE CONNECTIONS	Select the **Remote connections** tab to configure a remote connection to the workload. Make sure to configure the workload first so that a remote connection can be established. Refer to Remote connections for more information and instructions for all remote connection types.

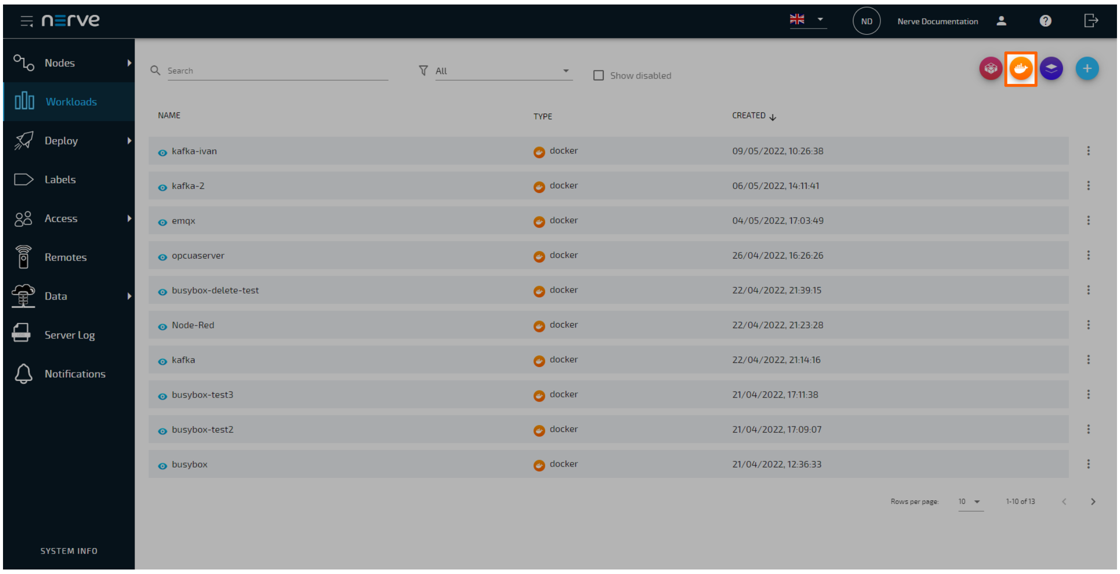
Provisioning a Docker workload

The following instructions cover the basic requirements for provisioning a Docker workload. Optional settings will be left out. Extended options are addressed in the last section of this chapter.
There are two further types of workloads that can be provisioned: CODESYS workloads and Virtual Machine workloads. The process for each workload is highlighted in its respective chapter.

NOTE

A Docker image is required for the following instructions. Refer to the Docker documentation for help on creating a Docker image. Note that Docker images in TAR.GZ format are not supported.

1. Log in to the Management System.
2. Select **Workloads** in the left-hand menu.
3. Select the plus symbol in the upper-right corner.
4. Select the Docker symbol (**Docker workload**) in the middle of the three symbols that expanded.



NAME	TYPE	CREATED ↓
kafka-ivan	docker	09/05/2022, 10:26:38
kafka-2	docker	06/05/2022, 14:11:41
emqx	docker	04/05/2022, 17:03:49
opcuaserver	docker	26/04/2022, 16:26:26
busybox-delete-test	docker	22/04/2022, 21:39:15
Node-Red	docker	22/04/2022, 21:23:28
kafka	docker	22/04/2022, 21:14:16
busybox-test3	docker	21/04/2022, 17:11:38
busybox-test2	docker	21/04/2022, 17:09:07
busybox	docker	21/04/2022, 12:36:33

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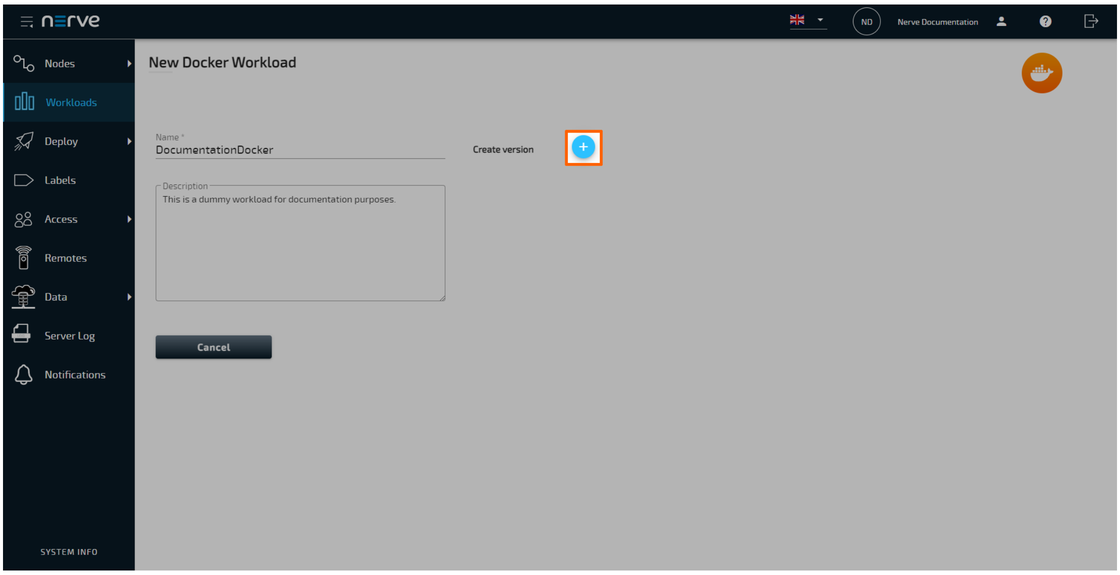
5. In the new window, enter a name for the workload.

6. Select the plus symbol next to **Create version** to add a new version of the workload.



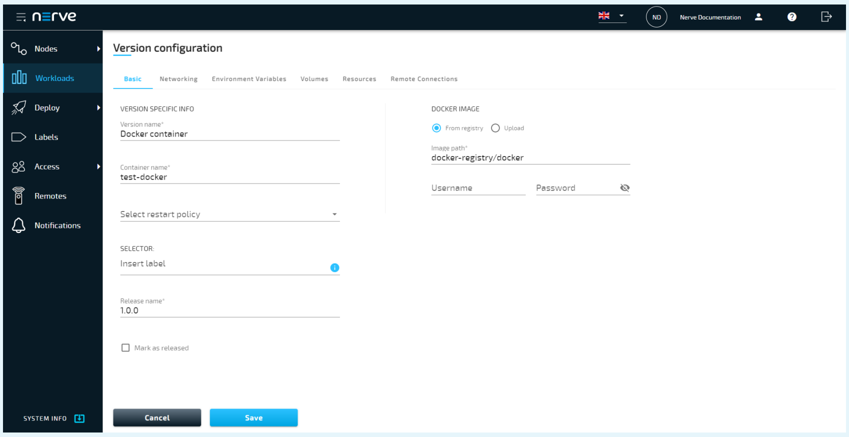
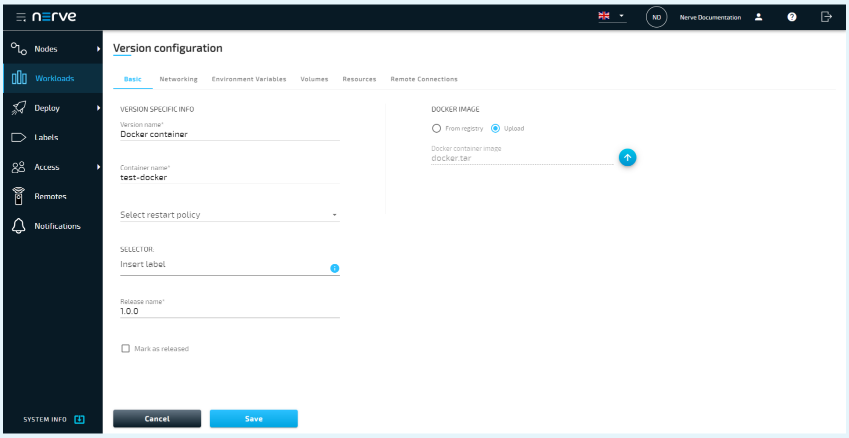
New Docker Workload

Name *
DocumentationDocker

Description
This is a dummy workload for documentation purposes.

7. In the next window, enter the following information:

Category	Settings and descriptions
VERSION SPECIFIC INFO	**Version name** Enter a name for the version of this workload. **Container name** Enter a name for the Docker container. This will be the name of the Docker container on the node. **Release name** Enter a **Release name** for the version of this workload.

Category	Settings and descriptions
DOCKER IMAGE	Select **From registry** or **Upload**. Note that Docker images in TAR.GZ format are not supported. **From registry**: Enter the Docker registry to the Docker container image under **Image path**. Note that the image path in the screenshot is a placeholder path. Enter registries according to their name and URL found on Docker Hub or in private registries. Refer to the Docker image settings in the Basic tab below for more information.  Version configuration Basic | Networking | Environment Variables | Volumes | Resources | Remote Connections VERSION SPECIFIC INFO Version name*: Docker container Container name*: test-docker Select restart policy SELECTOR: Insert label Release name*: 1.0.0 □ Mark as released DOCKER IMAGE ● From registry ○ Upload Image path*: docker-registry/docker Username Password Cancel Save **Upload:** Select the **upward arrow** symbol to open the file browser and upload the Docker container image. Do not upload a Docker image in TAR.GZ format. This will produce a Docker workload file in the wrong format when the workload is exported.  Version configuration Basic | Networking | Environment Variables | Volumes | Resources | Remote Connections VERSION SPECIFIC INFO Version name*: Docker container Container name*: test-docker Select restart policy SELECTOR: Insert label Release name*: 1.0.0 □ Mark as released DOCKER IMAGE ○ From registry ● Upload Docker container image: docker.tar Cancel Save

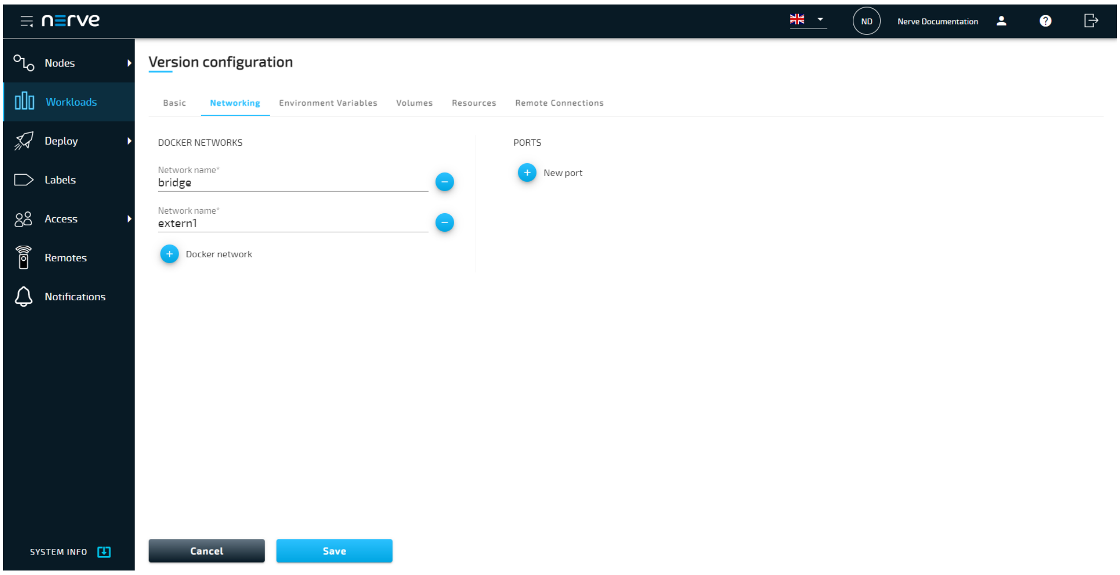
8. Select the **Networking** tab.

9. Select the plus symbol to add a new Docker network.

NOTE

Note that the **bridge** network is automatically assigned.

10. Enter the interface name in the **Network name** field.



Network name*
bridge

Network name*
extern1

11. Select **Save** in the lower-left corner to save the workload version.

The workload has now been provisioned and is ready to be deployed in the **Deploy** menu.

NOTE

While certain settings are not required to provision a Docker workload in the Management System, additional settings have to be filled in for the workload to perform as desired. Depending on the Docker container that will be deployed, ports need to be defined and environment variables need to be configured. Keep this in mind and make sure to learn the details about the Docker container. Refer to the description of Docker workload settings below for more information.

Settings for Docker workloads

In the instructions above, all optional settings have been left out. Below is an overview of all the options with an explanation to each option.

Basic tab

Category	Settings and descriptions
VERSION SPECIFIC INFO	**Version name** A name for the workload version. This could be a reminder for a certain configuration. Example: "Unlimited" as a name for a Node-RED version that has unlimited access to CPU resources. **Container name** Enter a name for the Docker container. This will be the name of the Docker container on the node. **Select restart policy** Choose the container restart policy from the drop-down menu to determine when the Docker container can be restarted. • **no** The container does not restart automatically. • **on-failure** The container restarts when it exits due to an error. • **always** The container restarts every time it stops. However, manually stopping the container is the exception. If a container is manually stopped, it is only restarted when the Docker daemon restarts or the container is restarted manually. • **unless-stopped** The container only restarts if it is manually stopped. **SELECTOR** If labels have been defined and assigned to nodes, add them as selectors to the workload. When deploying a workload, the list of nodes will be filtered automatically to the specified label. Select the **Insert label** field to see a list of available labels. **Release name** A release name for the workload version. This could be a version number. Example: 1.0.1 **Mark as released** Tick this checkbox to mark this workload as released. Once marked as released, the workload cannot be edited anymore.

Category	Settings and descriptions

DOCKER IMAGE	Select between two options here and either use a Docker registry URL to link to an online repository or upload the Docker container image from the workstation. Note that Docker images in TAR.GZ format are not supported.
	
	From registry
	Specify a URL pointing to the Docker container image under **Image path**.
	Note the differences between public Docker Hub registries and private registries. Private registries require the full URL to be specified, as well as a username and password if they require authentication. Public Docker Hub registries can be specified in their short form. Visit Docker Hub to find Docker images and their paths.
	
	Examples:
	
	• Public Docker Hub registry
	`nodered/node-red`
	`nginx`
	• Private registry with authentication and a tag at the end
	`auth.docker.test.host.cloud/workload:v1.3`
	
	Upload
	Upload the Docker container image from the workstation. Obtain a Docker image for the upload by executing a command on the workstation where the Docker image for provisioning is located. Enter `docker save <image_name> -o <filename>`. Then in the Management System select the **upward arrow** symbol to open the file browser and upload the resulting `<filename>` Docker image. Also, do not upload Docker images in TAR.GZ format. This will produce a Docker workload file in the wrong format when the workload is exported.

Networking tab

Category	Settings and descriptions
DOCKER NETWORKS	Select the **plus symbol** and enter the network interface name through which the Docker container can be reached. Note that the **bridge** network is automatically assigned. Note that IP addresses for network interfaces connected to physical interfaces are configured in the Local UI. If no network is defined, then the Docker workload can be reached through `http://172.20.2.1:<hostport>` for Nerve Devices having a physical interface associated with host access. For more information on node internal networking, refer to Node Internal Networking.

Category	Settings and descriptions
PORTS	Select the plus symbol to define **Host port**, **Container port**, and **Protocol**. • **Protocol** Choose **TCP** or **UDP** here. • **Host port** This is the port through which the Docker workload will be reachable on the host. Make sure to not use reserved ports in the Nerve system for the workload. Refer to the networking chapter for more information. • **Container port** This is the internal port of the Docker container. Note that every Docker container has a default port. Entering a value that is different than the default port will use the entered port instead of the standard port of the Docker container.

Environment Variables tab

Category	Settings and descriptions
ENVIRONMENT VARIABLE	Select the plus symbol to add an environment variable (**Env. variable**) and its **Variable value**. Make sure to define the appropriate variables and values as they depend on the Docker container that will be deployed.

Volumes tab

Category	Settings and descriptions
DOCKER VOLUMES	Select the **plus symbol** to add a new Docker volume. This volume is persistent storage for a Docker workload, defined using named volumes. • **Volume name** Define a name through which the persistent Docker volume can be accessed on the host. This name can be any string. Note that the Management System fills in a volume name suggestion by default using the workload name. • **/path/in/container** Define a path inside the Docker container for the storage. Note that defining a folder in the container path is required and root is not a valid folder. Defining root, i.e. leaving the container path empty by entering `/`, might cause the deployment process to fail when deploying the workload. The volume is not erased when the Docker workload is restarted or undeployed. The data also persists through a node version update. However, note that a volume will be removed if the next version of the workload does not have a volume defined and a workload update is performed. Docker volumes can be used for any workload by using the same volume name again. Docker workload storage can be found in `/opt/data/var/lib/docker/volumes` by default. **Configuration storage** After defining one or more Docker volumes, a volume can be used as storage for configuration files. Select a Docker volume from the drop-down menu to designate a volume as configuration storage and enable the application of configuration files. Refer to Applying configuration files to a workload for more information. **Restart on configuration update** Tick this checkbox to trigger an automatic restart of the Docker workload when configuration files are applied.

Resources tab

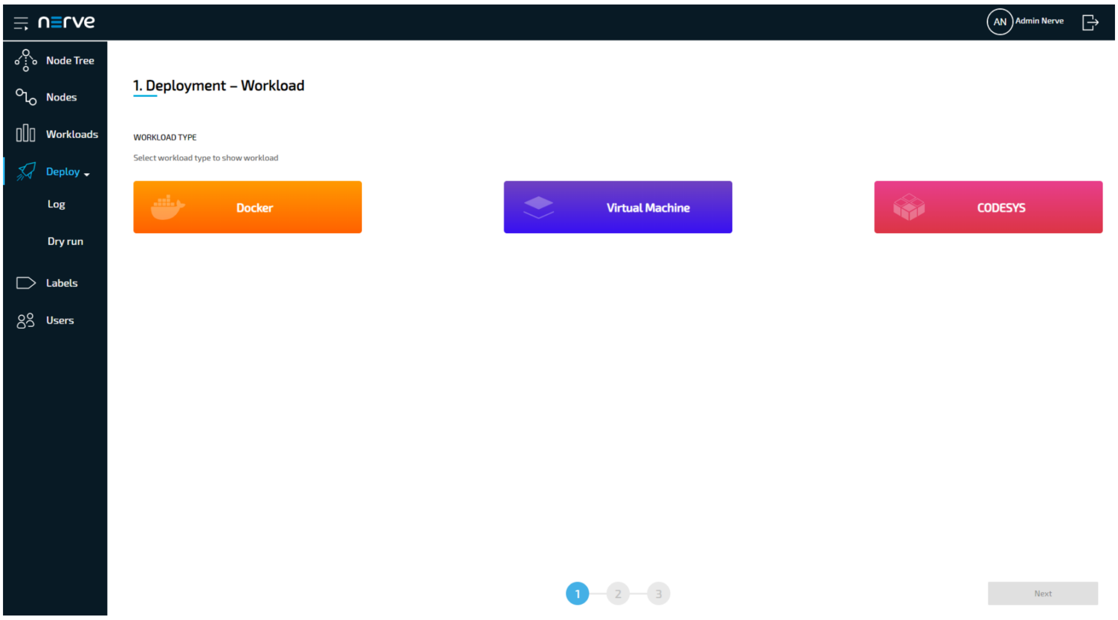
Category	Settings and descriptions
RESOURCES	**Limit memory to** Assign how much system memory this workload is allowed to use. The memory assigned here is an upper limit that the Docker workload can use and is not exclusively reserved for the Docker workload. Other processes can use these resources as well. **CPU resource in percentage** Specify here the percentage of CPU resources the workload is allowed to use. If this field is left blank, the workload is allowed to use all available resources. Note that percentages are used in a specific way with 100% representing one CPU core. So in order to use two and a half CPU cores, enter `250`.

Remote connections tab

Category	Settings and descriptions
REMOTE CONNECTIONS	Select the **Remote connections** tab to configure a remote connection to the workload. Make sure to configure the workload first so that a remote connection can be established. Refer to Remote connections for more information and instructions for all remote connection types.

Deploy menu

Workloads that have been provisioned in the Management System are ready to be deployed to nodes through the **Deploy** menu. It expands into three menus:



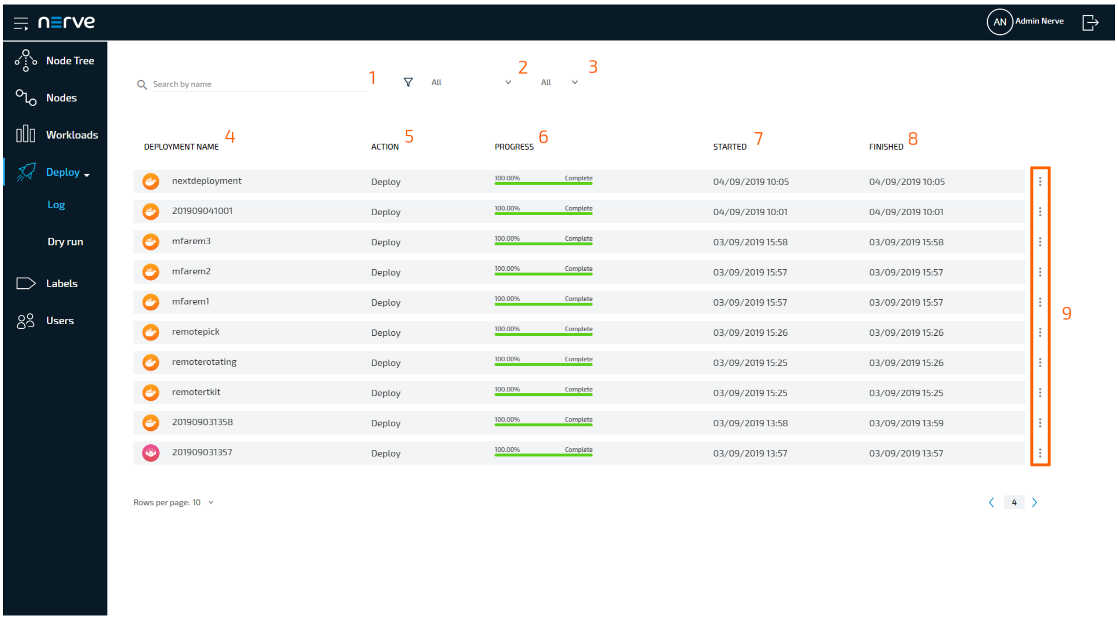
Item	Description
Deploy	This is the landing page of the deployment menu. Deploy workloads to nodes from here.
Log	This is the history of deployments and dry runs.
Dry run	Structurally the same as the deployment process for workloads, simulate the deployment of a workload from this menu.

Log

The log is the history of deployments and dry runs. This includes:

- deployments in progress
- dry runs in progress
- failed deployments
- failed dry runs
- successful deployments
- successful dry runs

It is displayed in reverse chronological order and can be filtered according to search criteria. It also offers some control functionality for active and failed deployments.



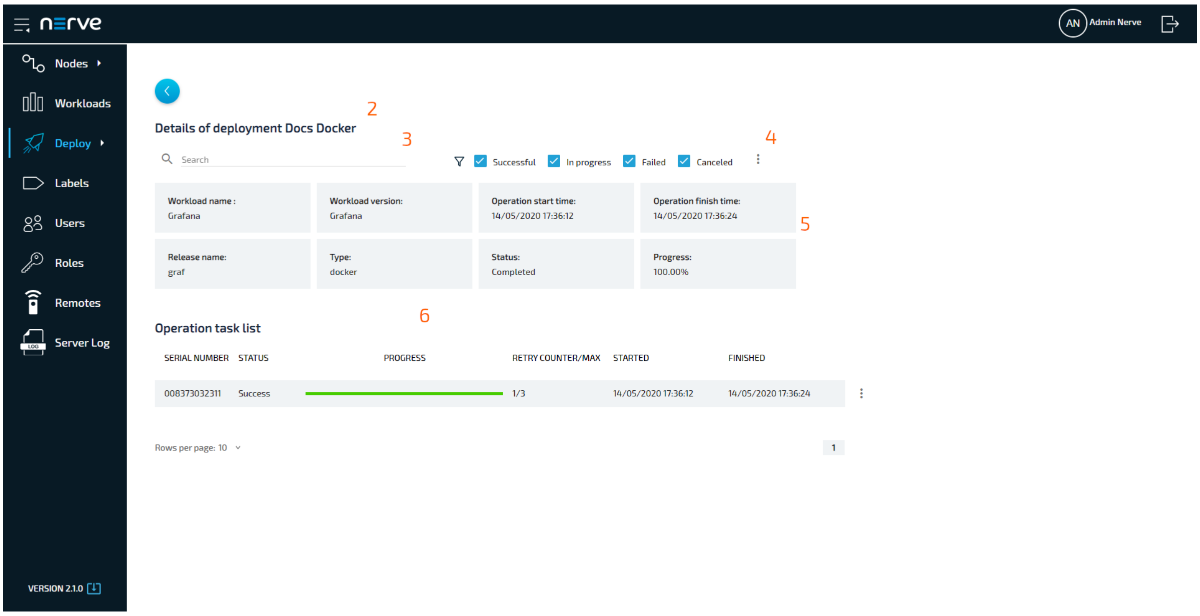
DEPLOYMENT NAME	ACTION	PROGRESS	STARTED	FINISHED
nextdeployment	Deploy	100.00% Complete	04/09/2019 10:05	04/09/2019 10:05
201909041001	Deploy	100.00% Complete	04/09/2019 10:01	04/09/2019 10:01
mfarem3	Deploy	100.00% Complete	03/09/2019 15:58	03/09/2019 15:58
mfarem2	Deploy	100.00% Complete	03/09/2019 15:57	03/09/2019 15:57
mfarem1	Deploy	100.00% Complete	03/09/2019 15:57	03/09/2019 15:57
remotepick	Deploy	100.00% Complete	03/09/2019 15:26	03/09/2019 15:26
remoterotating	Deploy	100.00% Complete	03/09/2019 15:25	03/09/2019 15:26
remotertkit	Deploy	100.00% Complete	03/09/2019 15:25	03/09/2019 15:25
201909031358	Deploy	100.00% Complete	03/09/2019 13:58	03/09/2019 13:59
201909031357	Deploy	100.00% Complete	03/09/2019 13:57	03/09/2019 13:57

Item	Description
Search by name (1)	Enter text here to filter the list by deployment name.
Deployment Type (2)	Select an option from the drop-down menu to filter the list for **Deploys** or **Dry runs**.
Workload Type (3)	Select an option from the drop-down menu to filter the list for a specific workload type: **VM**, **Docker** or **CODESYS**.
DEPLOYMENT NAME (4)	This is the name of the deployment with the workload type displayed as a symbol. The default is the time of deployment unless a deployment name has been entered during the deployment process. Note that this is not the name of the workload.
ACTION (5)	Here the deployment type is displayed: **Deploy** or **Dry run**.
PROGRESS (6)	The progress bar is an indicator for both progress and status. Depending on the status of the deployment it changes its color: • **Green** If a workload was deployed successfully, the bar will be green at a 100%. • **Blue** If a workload is currently being deployed, the bar will be blue, fill up gradually and display the progress of the deployment in percent. • **Red** If the deployment of a workload has failed, the bar will be red at a 100%.
STARTED (7)	This is the date and time the workload deployment was started. The date format is DD/MM/YYYY.

Item	Description
FINISHED (8)	This is the date and time the workload deployment was completed. The date format is DD/MM/YYYY. This field will display **In progress** if a workload is in progress of being deployed.
Ellipsis menu (9)	Select the ellipsis menu to trigger an overlay with the **DELETE** option. Selecting **DELETE** will remove the entry from the log. When a workload is in progress, this entry is grayed out.

Deployment details

Clicking an entry in the log will show the details of the deployment.



Details of deployment Docs Docker

Workload name : Grafana

Workload version: Grafana

Operation start time: 14/05/2020 17:36:12

Operation finish time: 14/05/2020 17:36:24

Release name: graf

Type: docker

Status: Completed

Progress: 100.00%

Operation task list

SERIAL NUMBER	STATUS	PROGRESS	RETRY COUNTER/MAX	STARTED	FINISHED
008373032311	Success		1/3	14/05/2020 17:36:12	14/05/2020 17:36:24

Item	Description
Back button (1)	Click here to return to the log.
Header (2)	The header states the name of the deployment in the format **Details of deployment <deploymentname>**.
Search (3)	Enter text here to filter the **Operation task list** by device name. The search function can be combined with the status checkboxes to the right of the search bar.

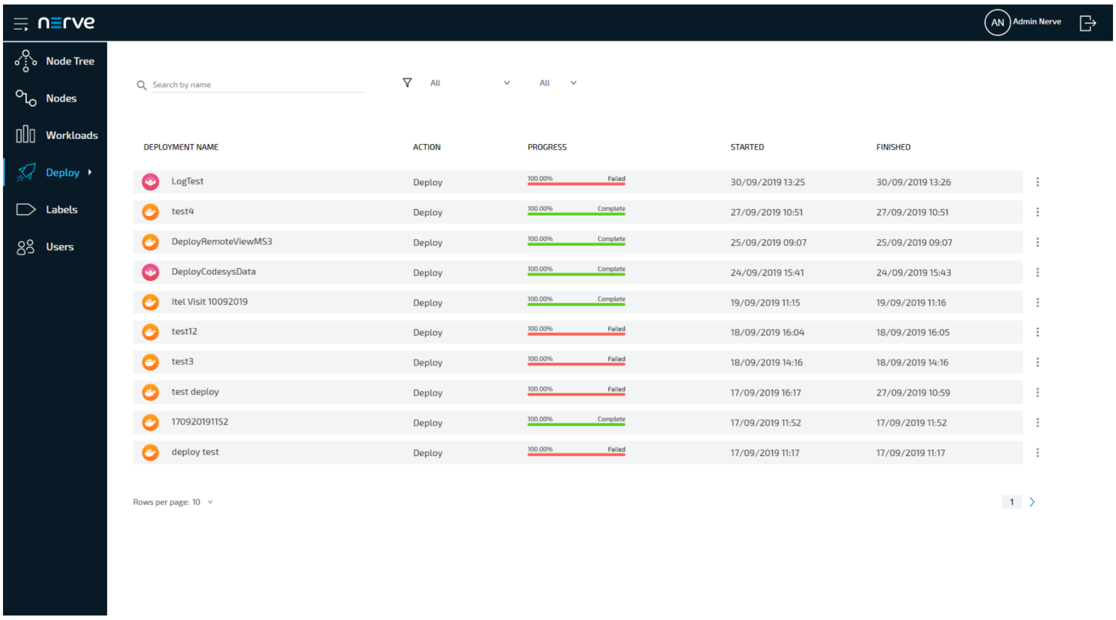
Item	Description
Status checkboxes (4)	The checkboxes to the right of the search bar filter the **Operation task list** by status: • **Success** Deployments that were completed successfully are shown in the list if this checkbox is ticked. • **In progress** Deployments that are currently in progress are shown in the list if this checkbox is ticked. • **Failed** Deployments that could not be completed are shown if this checkbox is ticked. • **Canceled** Deployments that have been aborted by the user are shown in the list if this checkbox is ticked. However, it is not possible to cancel deployments in this version. If a checkbox is ticked, tasks with the corresponding status will be displayed in the operation task list. All checkboxes are ticked by default.
Deployment information (5)	This is information about the deployment. • **Workload name** The name of the workload that has been defined in the provisioning process. • **Workload version** The name of the workload version. • **Operation start time** This is the date and time the workload deployment was started. The date format is DD/MM/YYYY. • **Operation finish time** This is the date and time the workload deployment finished. The date format is DD/MM/YYYY. • **Release name** This is the release name of the workload version. • **Type** This is the type of the workload that has been deployed: **codesys**, **vm** or **docker**. • **Status** This is the status of the deployment. Possible statuses are **Created**, **In progress**, **Completed**, **Error**, **Canceled**. • **Progress** The progress of the deployment in percent.

Item	Description
Operation task list (6)	The operation task list displays details for single deployments that are part of the deployment campaign. The list displays information in six columns: • **SERIAL NUMBER** This is the serial number of the node that is the target of the deployment. • **STATUS** This is the status of the deployment. The information in this column here corresponds with the checkboxes to the right of the search bar: **Success**, **In progress**, **Failed** and **Canceled** • **PROGRESS** This is the progress bar. It displays a different color and gradually fills up according to the progress and status of the deployment. ◦ **Success** If a workload was deployed successfully, the bar will be green at a 100%. ◦ **In progress** If a workload is currently being deployed, the bar will be blue and display the progress of the deployment in percent. ◦ **Failed** If the deployment of a workload has failed, the bar will be red at a 100%. • **RETRY COUNTER/MAX** In case of failure, the Management System will attempt the deployment of a workload up to three times automatically. The left number of the counter shows the number of the current attempt. The right number is the maximum number of attempts. • **STARTED** This is the date and time the workload deployment was started. The date format is DD/MM/YYYY. • **FINISHED** This is the date and time the workload deployment was finished. The date format is DD/MM/YYYY.

Restarting a failed deployment

In case a deployment fails, the Management System will attempt the deployment of a workload up to three times automatically. After that, the deployment can be restarted manually through the ellipsis menu in the operation task list.

1. Select **Deploy > Log** from the menu on the left.
2. Select the failed deployment from the log.

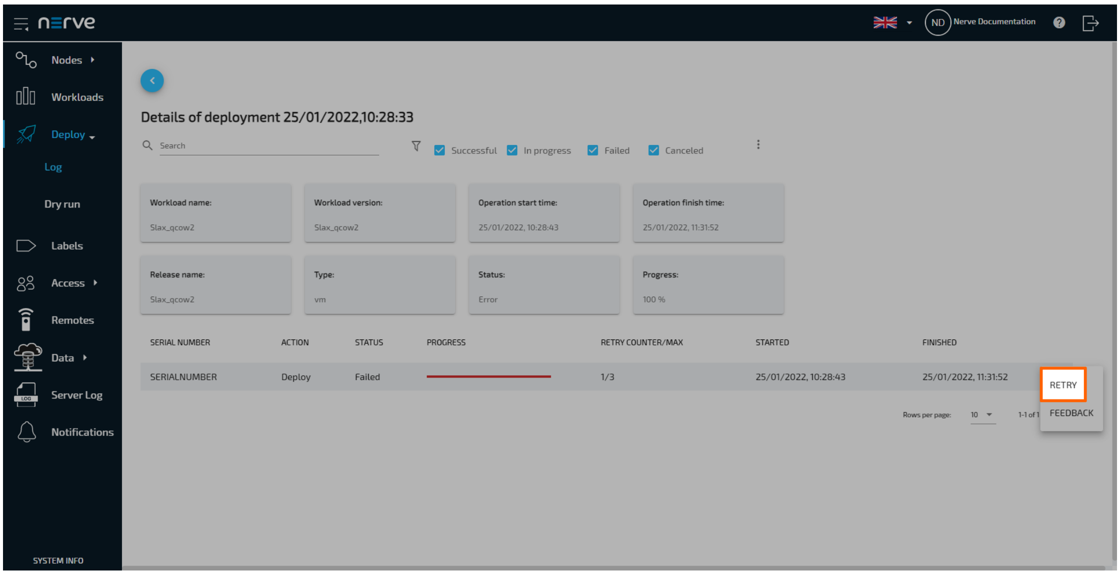


DEPLOYMENT NAME	ACTION	PROGRESS	STARTED	FINISHED
LogTest	Deploy	100.00% Failed	30/09/2019 13:25	30/09/2019 13:26
test4	Deploy	100.00% Complete	27/09/2019 10:51	27/09/2019 10:51
DeployRemoteViewMS3	Deploy	100.00% Complete	25/09/2019 09:07	25/09/2019 09:07
DeployCodesysData	Deploy	100.00% Complete	24/09/2019 15:41	24/09/2019 15:43
Itel Visit 10092019	Deploy	100.00% Complete	19/09/2019 11:15	19/09/2019 11:16
test12	Deploy	100.00% Failed	18/09/2019 16:04	18/09/2019 16:05
test3	Deploy	100.00% Failed	18/09/2019 14:16	18/09/2019 14:16
test deploy	Deploy	100.00% Failed	17/09/2019 16:17	27/09/2019 10:59
170920191152	Deploy	100.00% Complete	17/09/2019 11:52	17/09/2019 11:52
deploy test	Deploy	100.00% Failed	17/09/2019 11:17	17/09/2019 11:17

3. Choose the failed deployment from the operation task list.

4. Select the ellipsis menu to the right of the deployment entry.

5. Select **RETRY** in the overlay that appeared.



Details of deployment 25/01/2022,10:28:33

☑ Successful ☑ In progress ☑ Failed ☑ Canceled

Workload name: Slax_qcow2

Workload version: Slax_qcow2

Operation start time: 25/01/2022, 10:28:43

Operation finish time: 25/01/2022, 11:31:52

Release name: Slax_qcow2

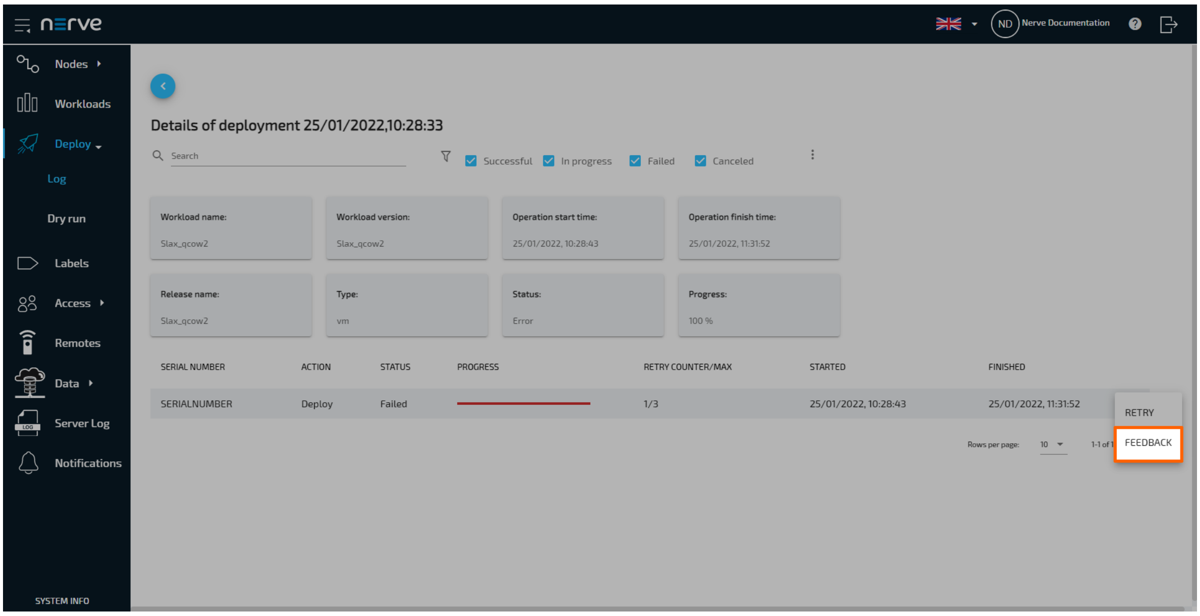
Type: vm

Status: Error

Progress: 100 %

SERIAL NUMBER	ACTION	STATUS	PROGRESS	RETRY COUNTER/MAX	STARTED	FINISHED
SERIALNUMBER	Deploy	Failed		1/3	25/01/2022, 10:28:43	25/01/2022, 11:31:52

The deployment is restarted immediately. To see the error information of the deployment, select **FEEDBACK** in the overlay of the ellipsis menu instead.



Details of deployment 25/01/2022,10:28:33

☑ Successful ☑ In progress ☑ Failed ☑ Canceled

Workload name: Slax_qcow2

Workload version: Slax_qcow2

Operation start time: 25/01/2022, 10:28:43

Operation finish time: 25/01/2022, 11:31:52

Release name: Slax_qcow2

Type: vm

Status: Error

Progress: 100 %

SERIAL NUMBER	ACTION	STATUS	PROGRESS	RETRY COUNTER/MAX	STARTED	FINISHED
SERIALNUMBER	Deploy	Failed		1/3	25/01/2022, 10:28:43	25/01/2022, 11:31:52

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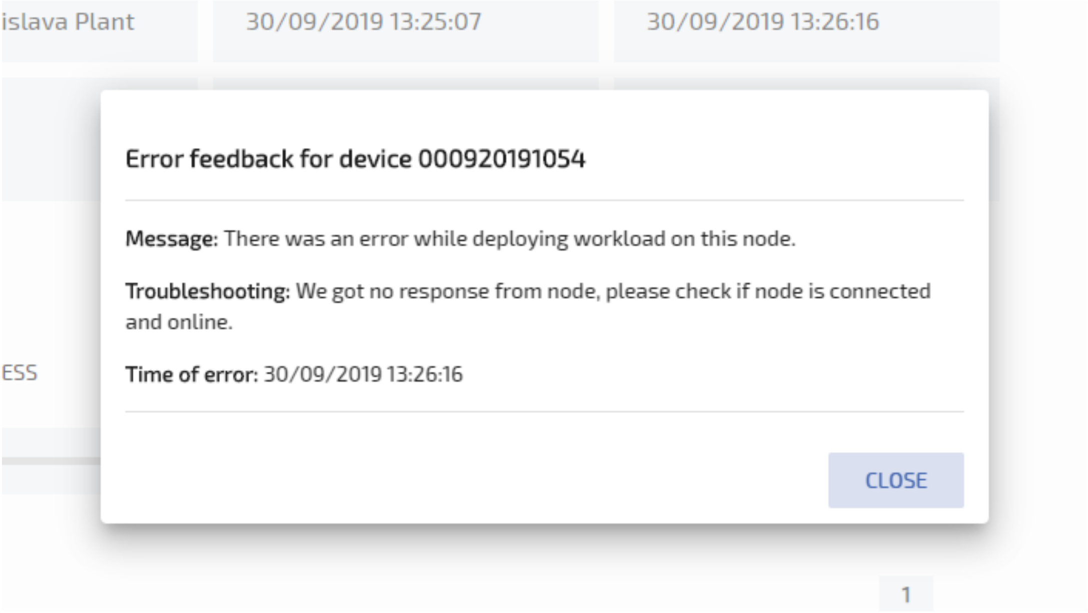
This opens a window giving information on the type of error in a message, a short troubleshooting hint and the time the error occurred. Note that troubleshooting hints are not available for every error case.



Error feedback for device 000920191054

Message: There was an error while deploying workload on this node.

Troubleshooting: We got no response from node, please check if node is connected and online.

Time of error: 30/09/2019 13:26:16

Deploying workloads and dry runs

Deployment of workloads and dry runs are covered in a separate chapter: Deploying a Workload.

Deploying a workload

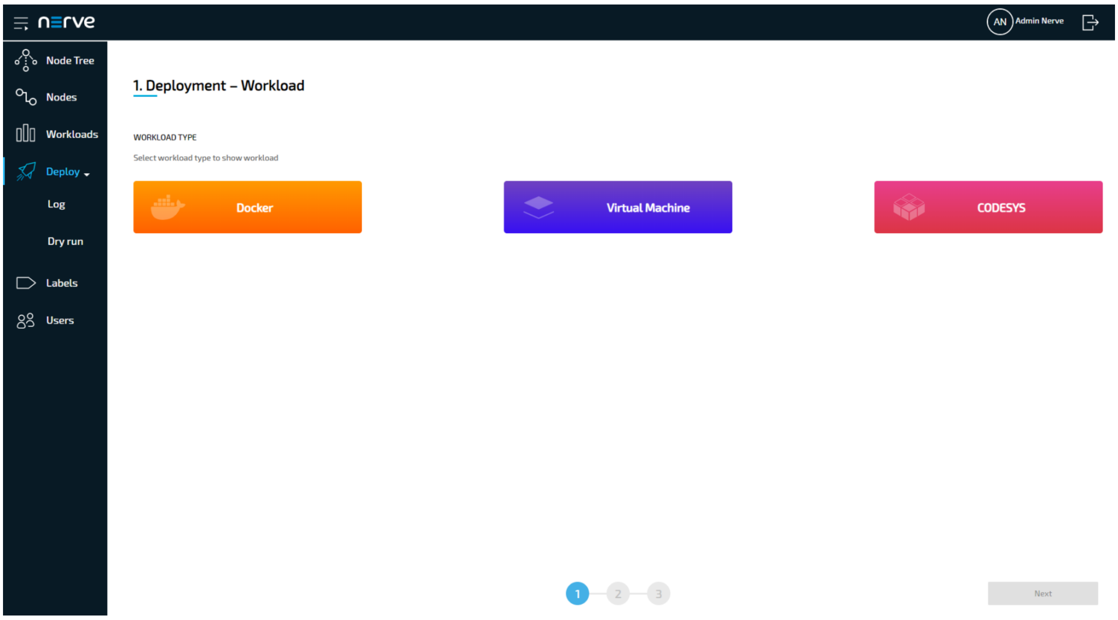
This chapter covers the deployment process of the available workloads: CODESYS workloads, Virtual Machine workloads and Docker workloads. The process of deploying workloads is identical for all three types of workloads. Therefore, the instructions below contain no specific information.

NOTE

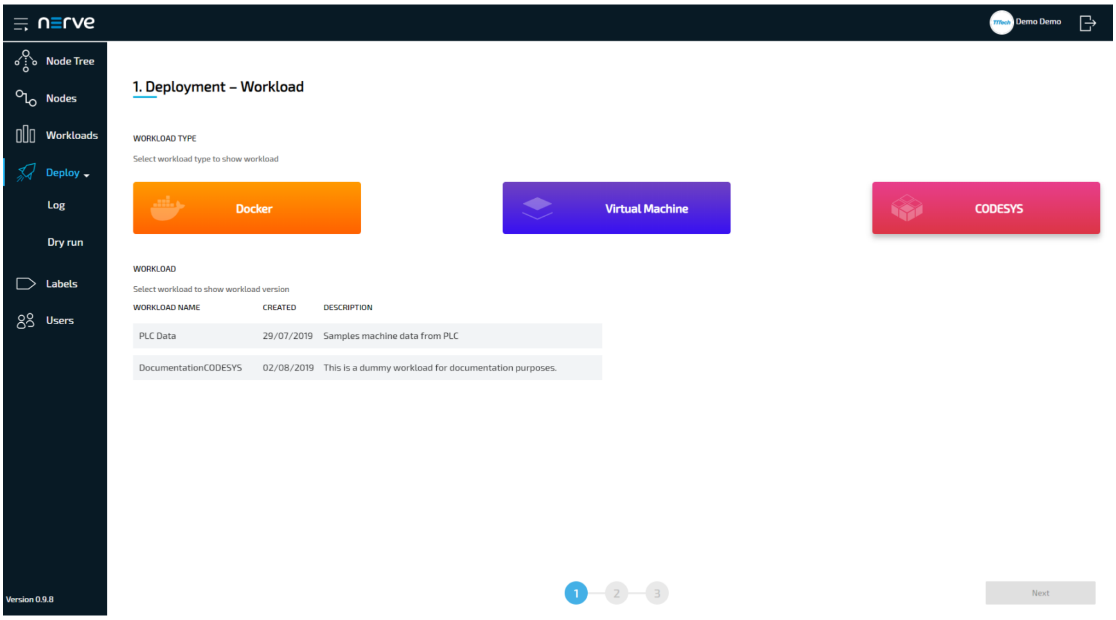
To test a deployment first, select **Deploy > Dry run** in the left-hand menu and follow the steps below starting from step 3.

However, note that a successful dry run does not guarantee a successful deployment as it is only a simulation.

1. Select **Deploy** in the left-hand menu.



2. Select one of the three icons for workload types. A list of corresponding workloads will appear below.

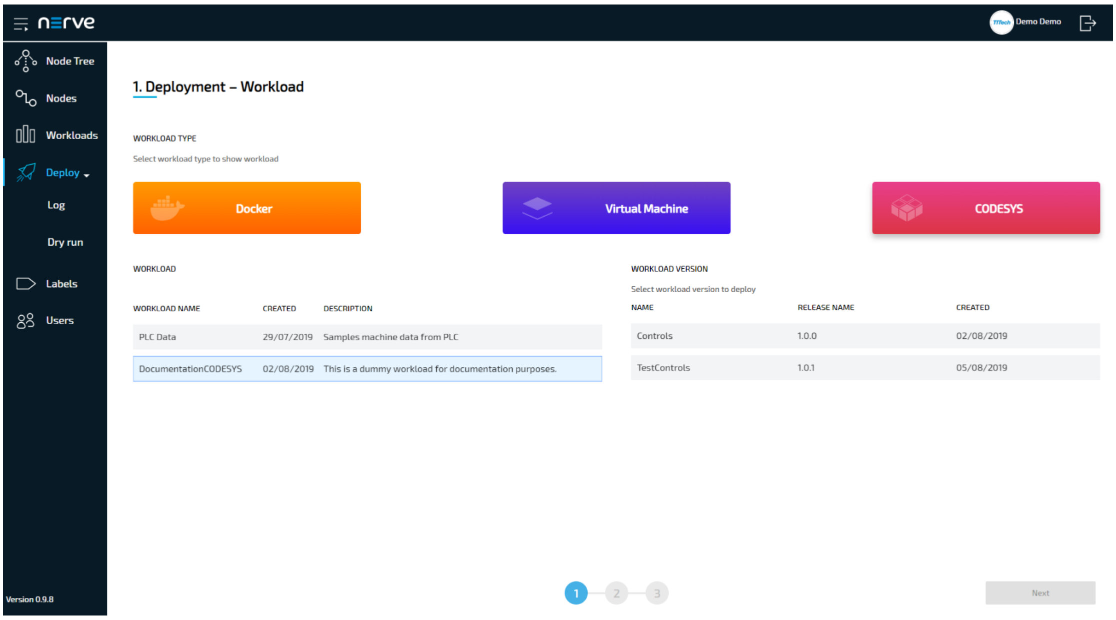


WORKLOAD

Select workload to show workload version

WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

3. Select a workload from the list. A list of versions of this workload will appear to the right.



1. Deployment – Workload

WORKLOAD TYPE

Select workload type to show workload

WORKLOAD

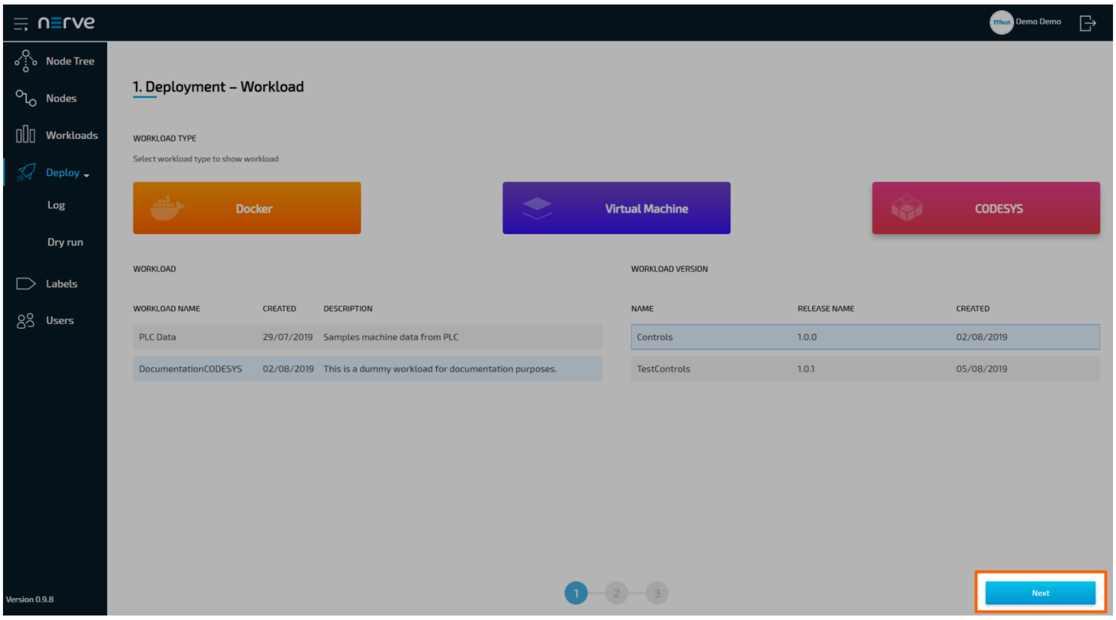
WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

WORKLOAD VERSION

Select workload version to deploy

NAME	RELEASE NAME	CREATED
Controls	1.0.0	02/08/2019
TestControls	1.0.1	05/08/2019

4. Select the version of the workload to deploy.
5. Click **Next** in the bottom-right corner.



1. Deployment – Workload

WORKLOAD TYPE

Select workload type to show workload

WORKLOAD

WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

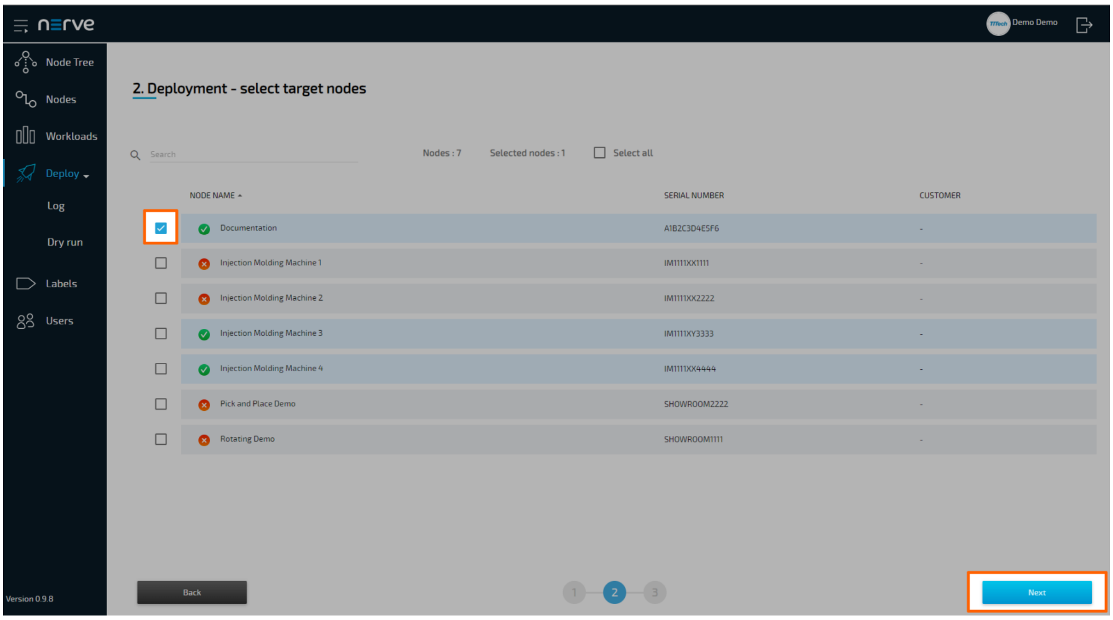
WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Controls	1.0.0	02/08/2019
TestControls	1.0.1	05/08/2019

6. In the next window, select one or more nodes from the list for deployment by ticking the checkboxes on the left.

> **NOTE**
>
> This list of nodes might not include all nodes that are registered in the Management System. It is automatically filtered depending on the labels the workload has assigned.

7. Select **Next** in the lower-right corner.



2. Deployment - select target nodes

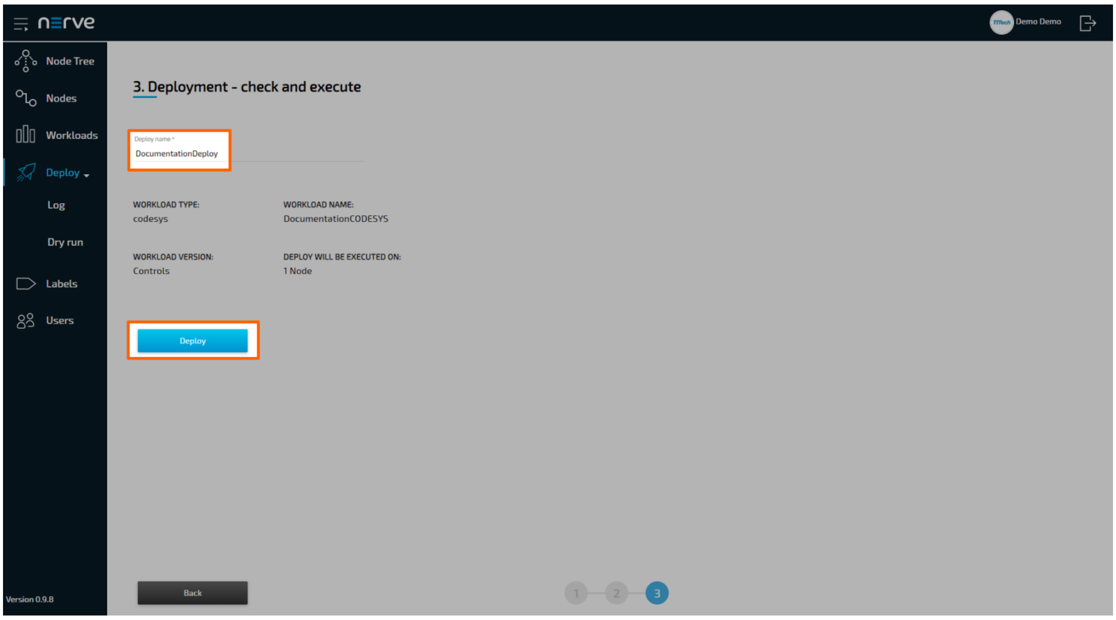
Search   Nodes : 7   Selected nodes : 1   □ Select all

	NODE NAME	SERIAL NUMBER	CUSTOMER
☑	✓ Documentation	A1B2C3D4E5F6	-
□	✗ Injection Molding Machine 1	IM1111XX1111	-
□	✗ Injection Molding Machine 2	IM1111XX2222	-
□	✓ Injection Molding Machine 3	IM1111XY3333	-
□	✓ Injection Molding Machine 4	IM1111XX4444	-
□	✗ Pick and Place Demo	SHOWROOM2222	-
□	✗ Rotating Demo	SHOWROOM1111	-

NOTE

Note that automatic filtering of nodes is applied according to labels, online status and capabilities. The list of available nodes only displays nodes compatible for the workload.

8. Select **Deploy** to execute the deployment.
   Optional: Enter a **Deploy name** *above the* **Summary** *of the workload to make this deployment easy to identify. A timestamp is filled in automatically.*



3. Deployment - check and execute

Deploy name *
DocumentationDeploy

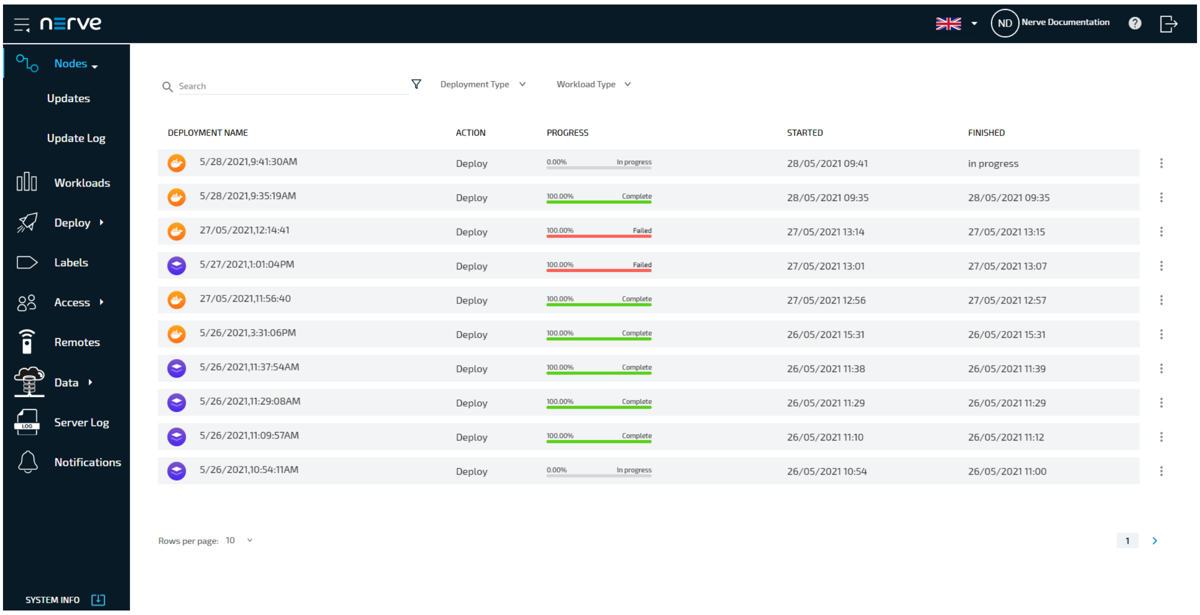
WORKLOAD TYPE:
codesys

WORKLOAD NAME:
DocumentationCODESYS

WORKLOAD VERSION:
Controls

DEPLOY WILL BE EXECUTED ON:
1 Node

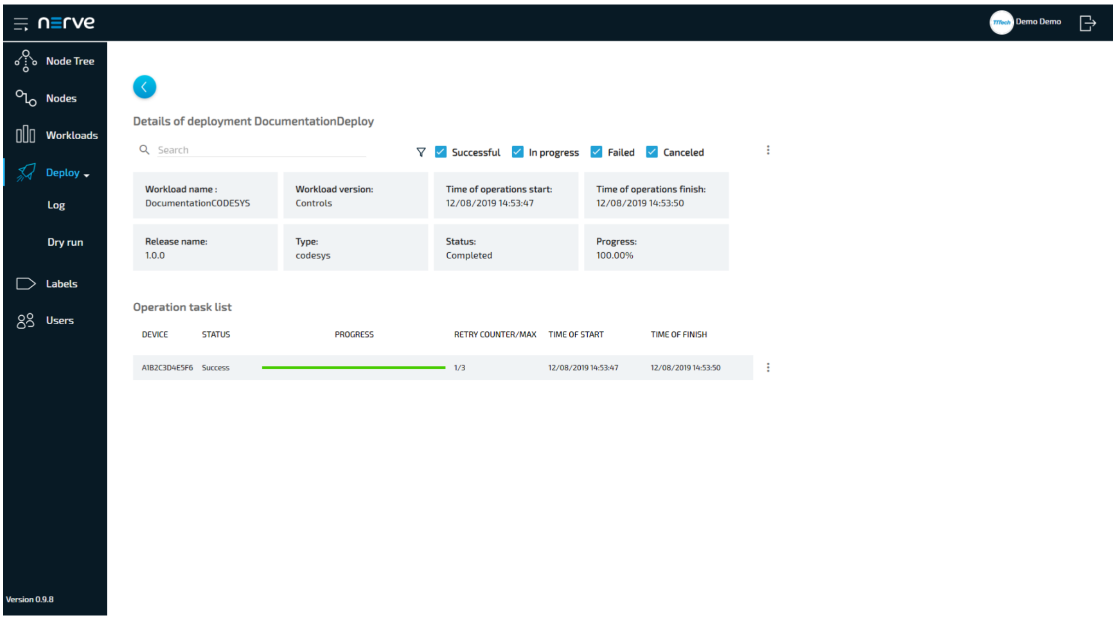
The Management System will continue to the log next. The current deployment is at the top of the list. The **Deploy name** chosen before is the name that identifies the deployment in the log.



DEPLOYMENT NAME	ACTION	PROGRESS	STARTED	FINISHED
5/28/2021,9:41:30AM	Deploy	0.00% In progress	28/05/2021 09:41	in progress
5/28/2021,9:35:19AM	Deploy	100.00% Complete	28/05/2021 09:35	28/05/2021 09:35
27/05/2021,12:14:41	Deploy	100.00% Failed	27/05/2021 13:14	27/05/2021 13:15
5/27/2021,1:01:04PM	Deploy	100.00% Failed	27/05/2021 13:01	27/05/2021 13:07
27/05/2021,11:56:40	Deploy	100.00% Complete	27/05/2021 12:56	27/05/2021 12:57
5/26/2021,3:31:06PM	Deploy	100.00% Complete	26/05/2021 15:31	26/05/2021 15:31
5/26/2021,11:37:54AM	Deploy	100.00% Complete	26/05/2021 11:38	26/05/2021 11:39
5/26/2021,11:29:08AM	Deploy	100.00% Complete	26/05/2021 11:29	26/05/2021 11:29
5/26/2021,11:09:57AM	Deploy	100.00% Complete	26/05/2021 11:10	26/05/2021 11:12
5/26/2021,10:54:11AM	Deploy	0.00% In progress	26/05/2021 10:54	26/05/2021 11:00

Rows per page: 10

The progress of the current deployment is displayed here. Select the log entry of the deployment to see a more detailed view.



Details of deployment DocumentationDeploy

☑ Successful ☑ In progress ☑ Failed ☑ Canceled

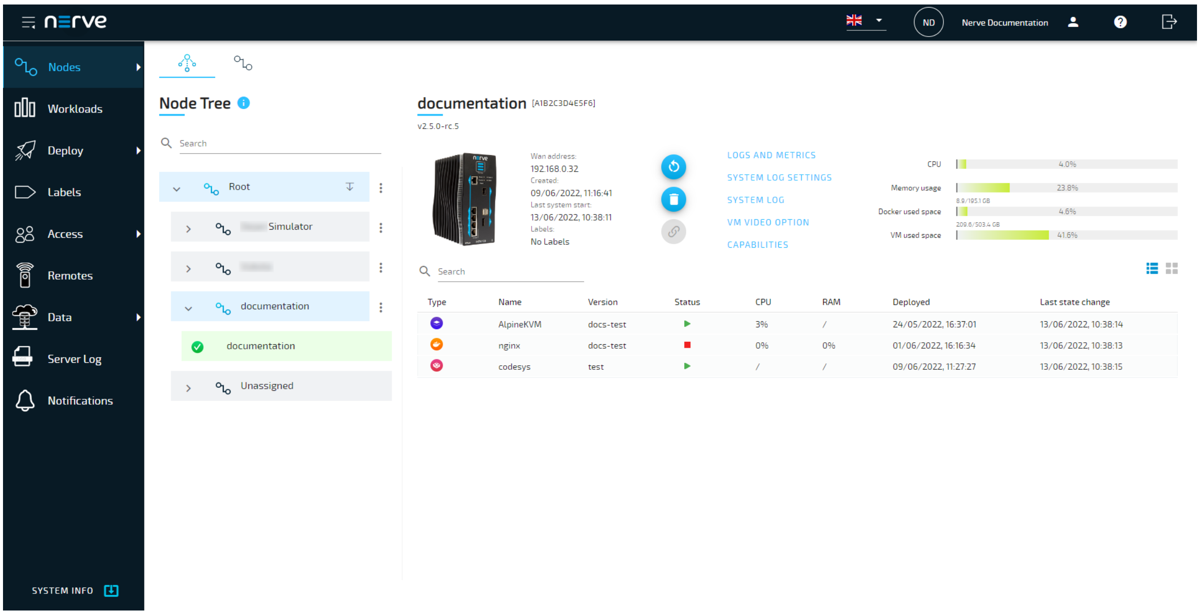
Workload name : DocumentationCODESYS	Workload version: Controls	Time of operations start: 12/08/2019 14:53:47	Time of operations finish: 12/08/2019 14:53:50
Release name: 1.0.0	Type: codesys	Status: Completed	Progress: 100.00%

Operation task list

DEVICE	STATUS	PROGRESS	RETRY COUNTER/MAX	TIME OF START	TIME OF FINISH
A1B2C3D4E5F6	Success		1/3	12/08/2019 14:53:47	12/08/2019 14:53:50

The workload has been deployed and can be controlled in the node tree. Select **Nodes** in the navigation on the left and select the node tree tab

on the right. Select the node with the deployed workload to find the deployed workload in the workload list.



documentation [A1B2C3D4E5F6]

v2.5.0-rc.5

Wan address: 192.168.0.32
Created: 09/06/2022, 11:16:41
Last system start: 13/06/2022, 10:38:11
Labels: No Labels

Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

Reach the workload control area by selecting a workload. All workloads are started as soon as they are deployed.

> **NOTE**
>
> CODESYS applications can only be controlled through the Local UI.

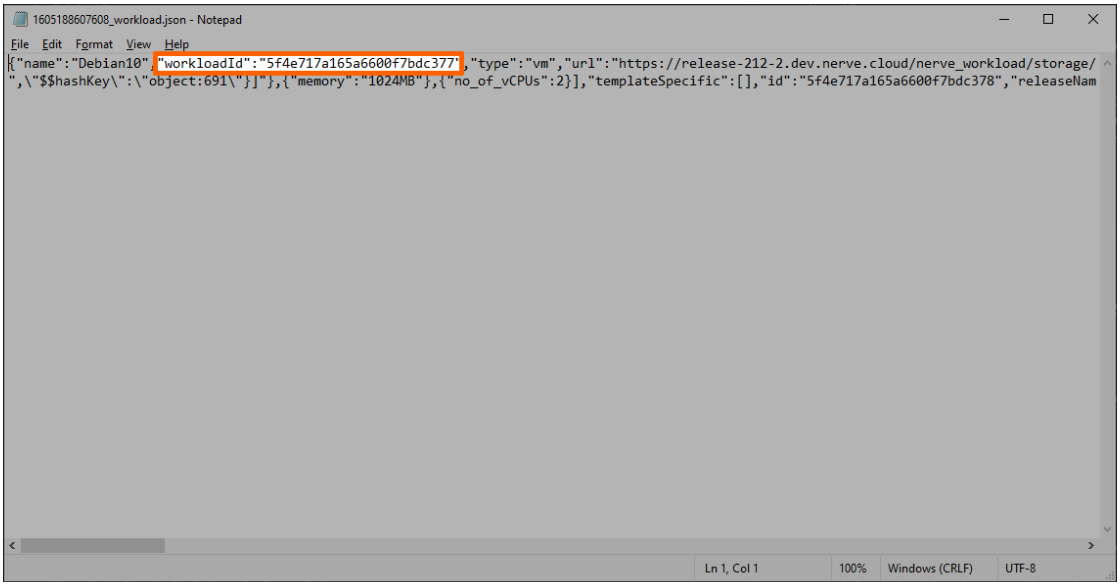
Removing logical volumes after unsuccessful VM deployment

If a virtual machine workload fails in the download phase of the deployment process, it is possible that the logical volumes created for the workload stay behind. This does not negatively impact the system. However, the disk space reserved for the virtual machine workload will stay reserved unless it is removed. Follow the instructions below to find out the workload ID of the failed deployment and how to remove the logical volume.

Finding out the workload ID

Every workload has a unique ID that is used for naming the logical volume when it is created during the deployment process. This workload ID can be found in a JSON file when a workload is exported from the Management System.

1. Access the Management System.
2. Export the virtual machine workload the deployment of which has failed by following Exporting a workload. The workload is downloaded as a TAR file.
3. Navigate to the folder where the TAR file is located.
4. Extract the TAR file.
5. Open the JSON file with a text editor. The TAR file only contains one JSON file.
6. Look for "`workloadId`" in the file. It is the second entry in the file.



```
{"name":"Debian10","workloadId":"5f4e717a165a6600f7bdc377","type":"vm","url":"https://release-212-2.dev.nerve.cloud/nerve_workload/storage/
",\"$$hashKey\":\"object:691\"}]"},{"memory":"1024MB"},{"no_of_vCPUs":2}],"templateSpecific":[],"id":"5f4e717a165a6600f7bdc378","releaseNam
```

7. Note down the ID. It is required to identify the logical volume that needs to be removed.

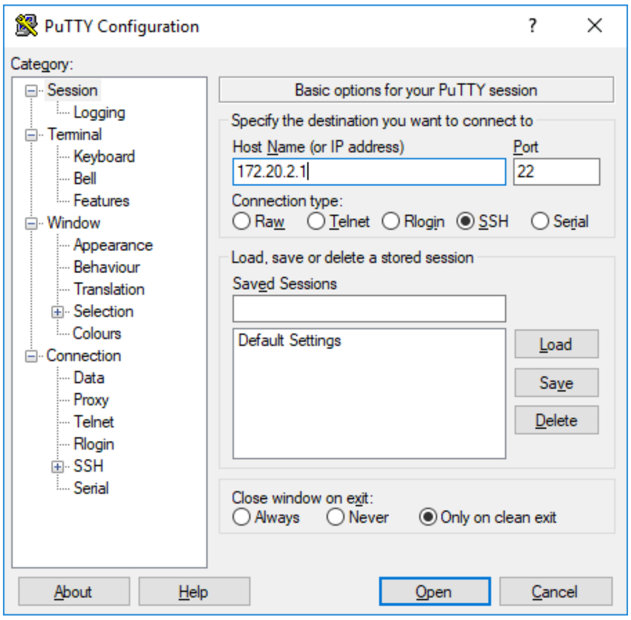
Removing the logical volumes

With the workload ID of the unsuccessfully deployed workload, the logical volumes can be correctly identified and removed. For this, the workstation needs to be connected to the physical port of the Nerve Device associated with host access, and the network adapter IP address of the workstation needs to be configured in the correct range. This information is device specific. Refer to the device guide for information on the Nerve Device.

NOTE

The following instructions require access to the Linux host system of Nerve. Using host access requires expert Linux knowledge as system internal changes can be performed. Note that changes may impact the Nerve system.

1. Open an SSH client like PuTTY.
2. Enter the IP address for host access to the Nerve Device under **Host Name (or IP address)** to log in to the host of the Nerve Device.



Specify the destination you want to connect to

Host Name (or IP address): 172.20.2.1

Port: 22

Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial

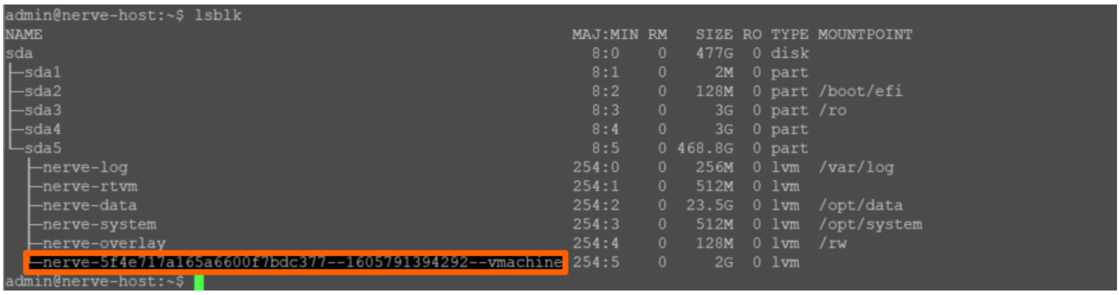
Saved Sessions: Default Settings

Close window on exit: ○ Always ○ Never ● Only on clean exit

3. Log in with the credentials for host access to the Nerve Device.

4. Enter `lsblk` to display a list of volumes.

5. Find the logical volume containing the `workloadId` from the JSON file.



```
admin@nerve-host:~$ lsblk
NAME                                                      MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
sda                                                         8:0    0   477G  0 disk
├─sda1                                                      8:1    0     2M  0 part
├─sda2                                                      8:2    0   128M  0 part /boot/efi
├─sda3                                                      8:3    0     3G  0 part /ro
├─sda4                                                      8:4    0     3G  0 part
└─sda5                                                      8:5    0 468.8G  0 part
  ├─nerve-log                                             254:0    0   256M  0 lvm  /var/log
  ├─nerve-rtvm                                            254:1    0   512M  0 lvm
  ├─nerve-data                                            254:2    0  23.5G  0 lvm  /opt/data
  ├─nerve-system                                          254:3    0   512M  0 lvm  /opt/system
  ├─nerve-overlay                                         254:4    0   128M  0 lvm  /rw
  └─nerve-5f4e717a165a6600f7bdc377--1605791394292--vmachine 254:5    0     2G  0 lvm
admin@nerve-host:~$
```

6. Enter the following command to remove the logical volumes:

```
sudo lvremove /dev/nerve/<volume-name> -y
```

> **NOTE**
>
> Note that the steps above can also be performed through a remote connection. Refer to Configuring a remote tunnel to a node for more information.

Remote connections

Remote connections are a fully integrated feature of Nerve. They are available in two flavors: remote screens and remote tunnels.

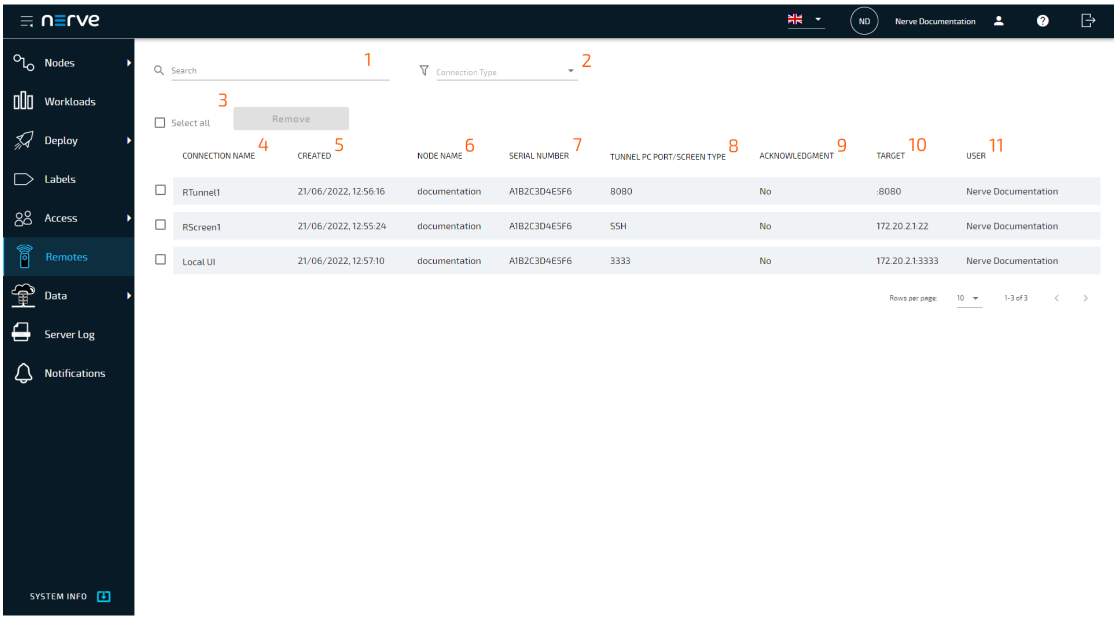
- Remote screens are connections that are established between the Management System and a target. They are visualized by the Management System in a new browser tab and support SSH, RDP and VNC protocols.

- Remote tunnels are connections that are established from the local workstation to a target, similar to a VPN connection. They allow access to services and servers on the target from the user's local workstation. Remote tunnels are managed and established in the Nerve Connection Manager application and the Management System. The locally opened connection endpoint can then be used in a web browser, with SSH clients, or with remote desktop applications, depending on the target.

The targets of these remote connections can be nodes, workloads or external devices, which can be accessed from the node through the network.

Remote connections to workloads can be defined in existing workloads. Note that a workload does not have to be deployed again if a remote connection has been added. Defining a remote connection to a workload adds the remote connection to the workload across the Management System, meaning that it will also be available if the workload has already been deployed to nodes.

Select **Remotes** in the navigation on the left to view a list of currently established remote connections.



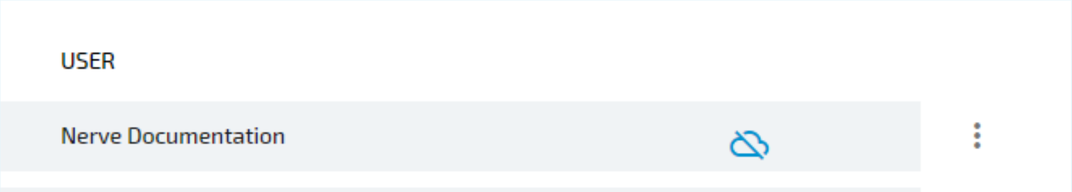
	CONNECTION NAME	CREATED	NODE NAME	SERIAL NUMBER	TUNNEL PC PORT/SCREEN TYPE	ACKNOWLEDGMENT	TARGET	USER
□	RTunnel1	21/06/2022, 12:56:16	documentation	A1B2C3D4E5F6	8080	No	:8080	Nerve Documentation
□	RScreen1	21/06/2022, 12:55:24	documentation	A1B2C3D4E5F6	SSH	No	172.20.2.1:22	Nerve Documentation
□	Local UI	21/06/2022, 12:57:10	documentation	A1B2C3D4E5F6	3333	No	172.20.2.1:3333	Nerve Documentation

Item	Description
Search bar (1)	Use the search bar to filter remote connections by name.
Connection Type (2)	Filter the list of connections by connection type. Select the type of connection to display from the drop-down menu. Selections are **All**, **Tunnel** and **Screen**.
Remove button and checkboxes (3)	Tick the checkbox next to a connection and select the **Remove** button to terminate the connection and remove it from the list. Tick the checkbox next to **Select all** to select all connections.
CONNECTION NAME (4)	This is the name of the remote connection that is defined when the remote connection is configured.
CREATED (5)	This is the point in time when the connection was established and a user started using it. The format is `DD/MM/YYYY, hh:mm:ss`.

Item	Description
NODE NAME (6)	This is the name of the node the connection is established to.
SERIAL NUMBER (7)	This is the serial number of the node the remote connection is established to. In case of remote connections to workloads, the serial number of the node will be displayed to which the workload was deployed. For remote connections to external devices, the serial number of the node that the external device is connected to will be displayed.
TUNNEL PC PORT/ SCREEN TYPE (8)	The information here is different depending on the connection type. **Remote screens** In case of a remote screen, the type of screen is displayed here — **SSH**, **VNC** or **RDP** **Remote tunnels** For remote tunnels, the port on the PC used for the connection is displayed here.
ACKNOWLEDGMENT (9)	This column states if local acknowledgment is required to establish the connection.
TARGET (10)	This is the target of the remote connection. The hostname that was defined in the remote connection configuration is displayed here. For remote tunnels to Docker workloads, the port used on the node is displayed here.
USER (11)	This shows which user is using the established remote connection. If the same remote connection is used by two users, the remote connection will be listed again with a different user in the **User** column.

NOTE

- Note that the list of active remote connections is not updated in real-time. Refresh the page to see changes.
- If a node goes offline while a remote connection is established, a cloud symbol will be displayed next to the remote connection to indicate that the connection to the node is interrupted.



Remote screens

A remote screen is established from the Management System to the target. It is opened in a new tab in the web browser as soon as the remote connection is established.

Below are instructions on how to create SSH, VNC and RDP connections to nodes and workloads in the Management System.

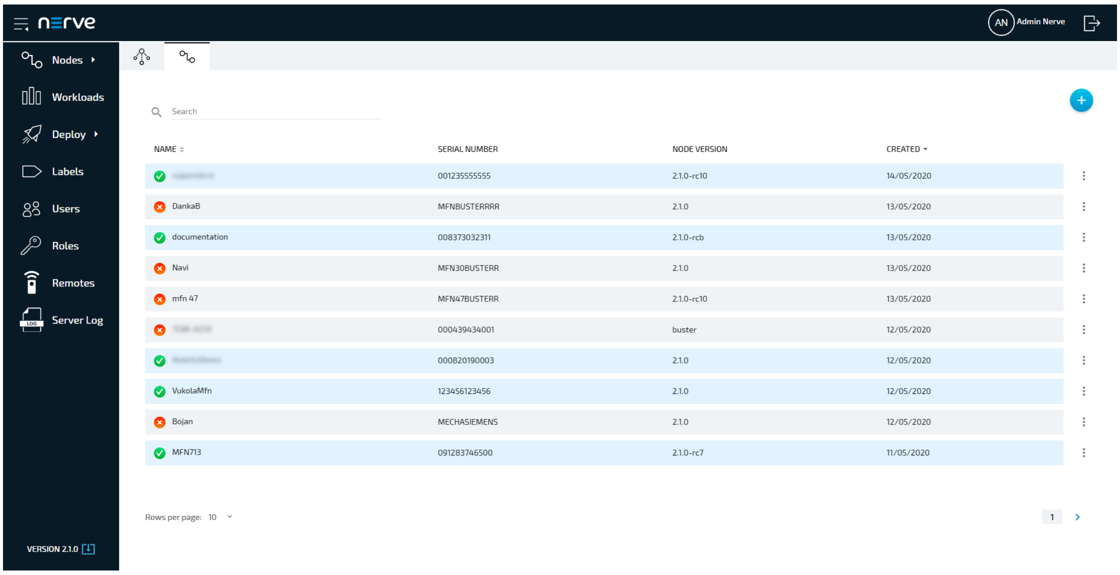
> **NOTE**
>
> If the target of the remote connection is the host of the Nerve system, use the IP address of the host: `172.20.2.1`. Using `localhost` is not supported.

Configuring an SSH connection to a node

An SSH connection to a node can be used for accessing the host operating system of the node or an external device connected to the node that is reachable through an SSH connection.

1. Select **Nodes** from the navigation on the left.
2. Select the nodes tab

   on the right to display the list of registered nodes.
3. Select a node from the list to which a remote connection will be established.

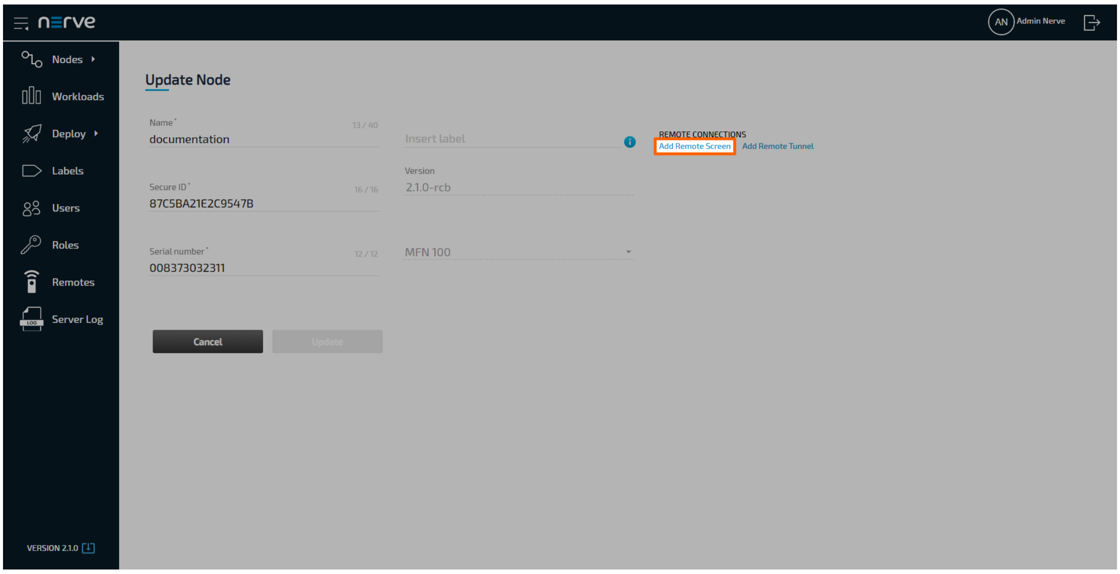


	NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓	[redacted]	001235555555	2.1.0-rc10	14/05/2020
✗	DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓	documentation	008373032311	2.1.0-rcb	13/05/2020
✗	Navi	MFN30BUSTERR	2.1.0	13/05/2020
✗	mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✗	[redacted]	000439434001	buster	12/05/2020
✓	[redacted]	000820190003	2.1.0	12/05/2020
✓	VukolaMfn	123456123456	2.1.0	12/05/2020
✗	Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓	MFN713	091283746500	2.1.0-rc7	11/05/2020

Rows per page: 10

1

4. Select **Add Remote Screen** under **REMOTE CONNECTIONS** on the right side.



Update Node

Name* documentation 13 / 40

Insert label

Secure ID* 87C5BA21E2C9547B 16 / 16

Version 2.1.0-rcb

Serial number* 008373032311 12 / 12

MFN 100

REMOTE CONNECTIONS
Add Remote Screen Add Remote Tunnel

Cancel Update

5. Enter a name for the remote connection in the new window.

> **NOTE**
>
> Make sure to use a unique name for every connection on a node to avoid confusion.

6. Select **SSH** from the drop-down menu under **Connection type**.

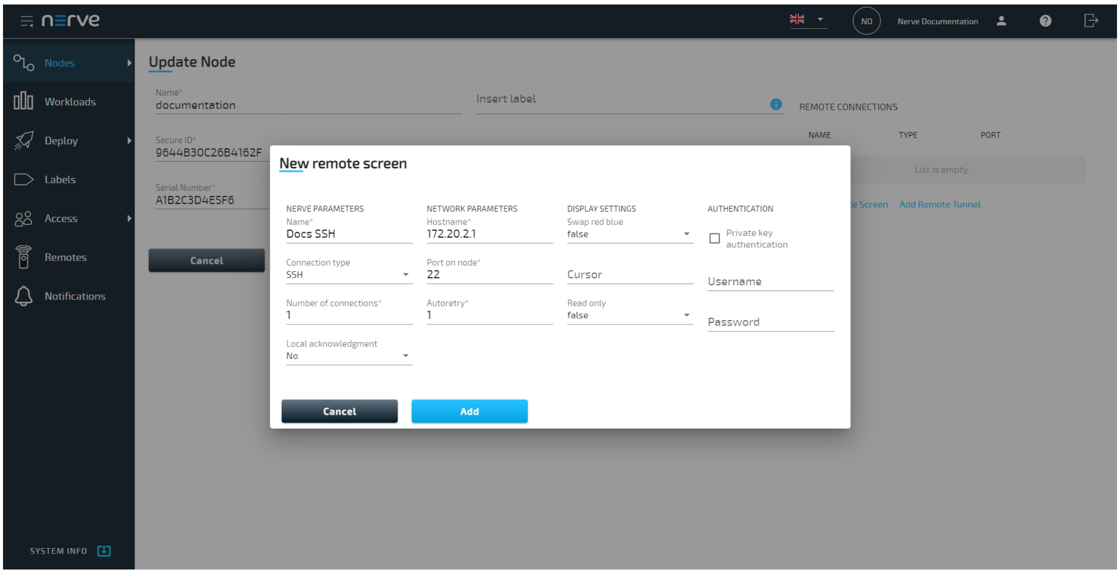
7. Enter the port used for SSH connection. The default port 22 is automatically filled in.

8. Enter the remaining information if applicable:

NERVE PARAMETERS	**Number of connections** Enter the maximum number of simultaneous connections. The default value is 1. **Local acknowledgment** Select **Yes** or **No** from the drop-down menu. Selecting **Yes** will require approval of the remote connection in the Local UI before the connection can be established. If **No** is selected, the settings in the Local UI do not apply. Refer to Approving a remote connection for information on how to approve remote connections in the Local UI.
NETWORK PARAMETERS	**Hostname** Enter the IP address or the hostname of the target here. **Autoretry** Set the number of retries if the remote connection fails. The default value is 1.

DISPLAY SETTINGS	The display settings offer configuration options that affect visualization. **Swap red blue** If colors appear to not be displayed correctly, select **true** from the drop-down menu. This can occur when using VNC servers. Select **false** otherwise. **Cursor** This setting determines if the cursor is rendered locally or remotely. Enter `local` for a local cursor or enter `remote` for a remote cursor. If set to `remote`, the mouse pointer will be rendered remotely, and the local position of the mouse pointer will be indicated by a small dot. A remote mouse cursor will have added input lag compared to a local cursor. However, a remote cursor might be necessary if the server does not support sending the cursor image to the client. **Read only** Select **true** or **false** from the drop-down menu. If set to **true**, no input will be accepted on the connection. Select **false** to allow input.
AUTHENTICATION	Enter **Username** and **Password** or tick the checkbox next to **Private key authentication** to use a private SSH key. Note that ticking the checkbox changes the interface. Enter the username and choose one of the methods to add the private SSH key: ◦ Select **Choose File** to open the local file browser and select the private SSH key file. ◦ Drag and drop the private SSH key file into the dotted line box saying **Drop Private Key Here**. ◦ Copy the private SSH key and paste it into the empty input field. Note that entering wrong login credentials will cause an error when the remote screen is established. If an error occurs, close the browser tab. Check the login credentials and re-establish the remote screen.

9. Select **Add** to add the remote connection.



Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F

Serial Number* A1B2C3D4E5F6

REMOTE CONNECTIONS

NAME	TYPE	PORT
List is empty		

Add Remote Screen Add Remote Tunnel

Cancel

New remote screen

NERVE PARAMETERS
Name* Docs SSH
Connection type SSH
Number of connections* 1
Local acknowledgment No

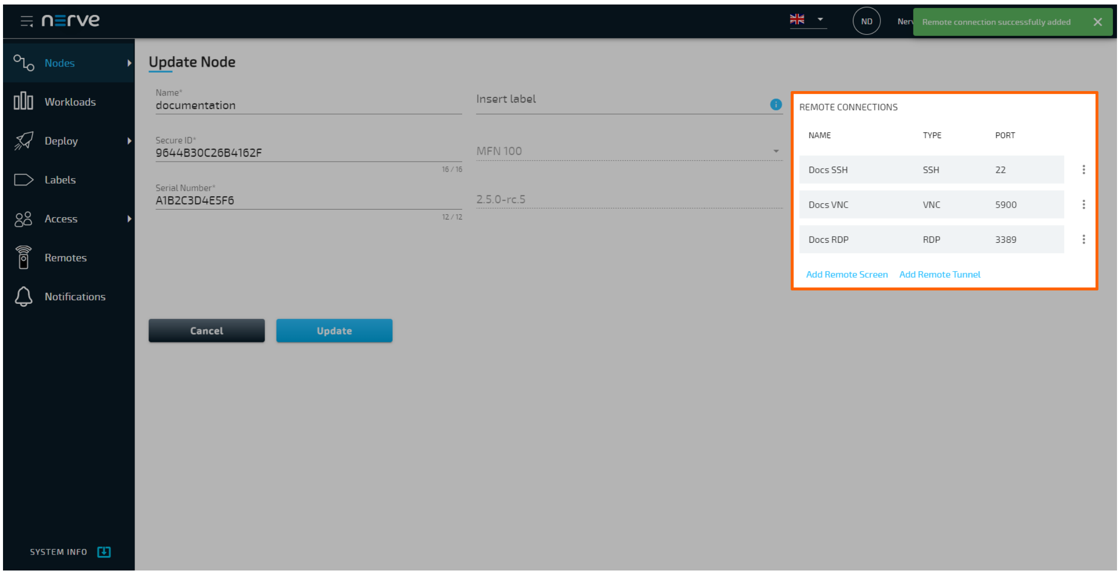
NETWORK PARAMETERS
Hostname* 172.20.2.1
Port on node* 22
Autoretry* 1

DISPLAY SETTINGS
Swap red blue false
Cursor
Read only false

AUTHENTICATION
☐ Private key authentication
Username
Password

Cancel Add

The connection is now displayed under **REMOTE CONNECTIONS** on the right side, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Remote connection successfully added

Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F 16 / 16

MFN 100

Serial Number* A1B2C3D4E5F6 12 / 12

2.5.0-rc.5

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs SSH	SSH	22
Docs VNC	VNC	5900
Docs RDP	RDP	3389

Add Remote Screen Add Remote Tunnel

Cancel Update

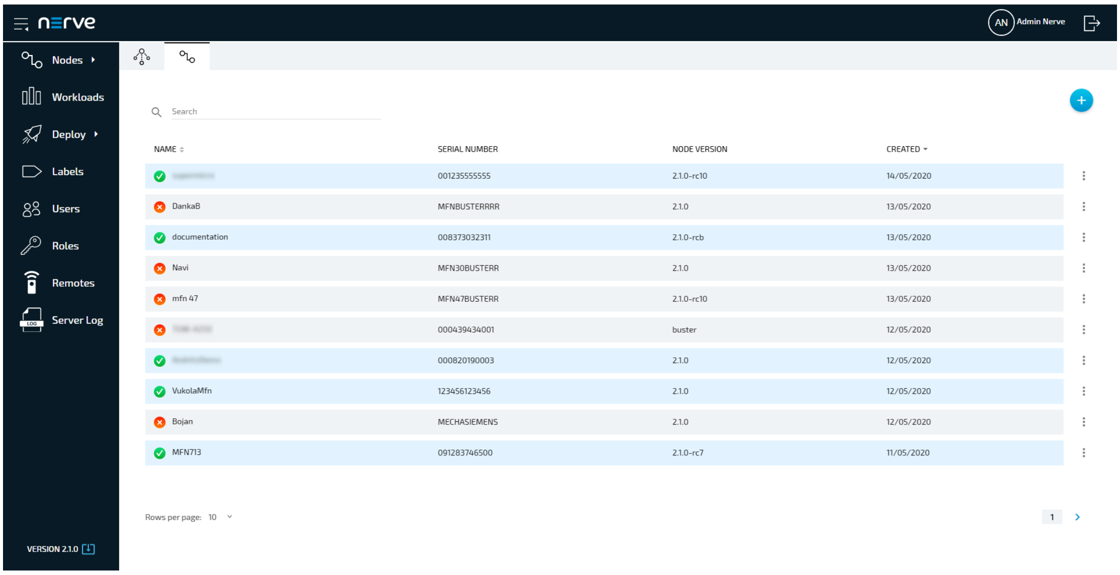
10. Select **Update** to save the changes.

Configuring a VNC connection to a node

A VNC connection to a node can be used to connect to a Linux environment on an external device, which is connected to the node or to the same network that the node is connected to.

1. Select **Nodes** from the navigation on the left.
2. Select the nodes tab

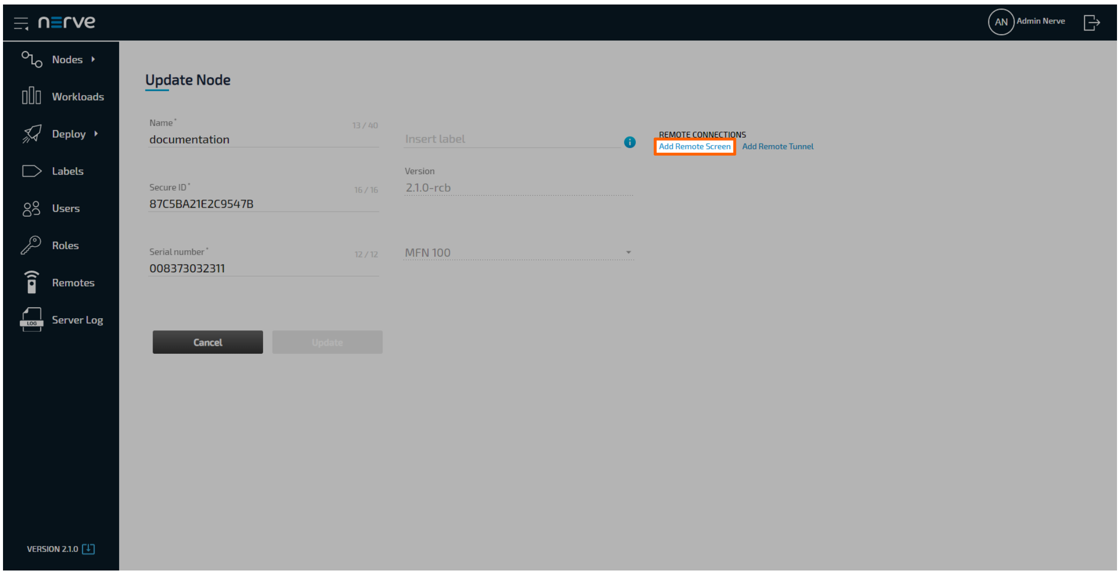
   on the right to display the list of registered nodes.
3. Select a node from the list to which a remote connection will be established.



NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓ [redacted]	001235555555	2.1.0-rc10	14/05/2020
☒ DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓ documentation	008373032311	2.1.0-rcb	13/05/2020
☒ Navi	MFN30BUSTERR	2.1.0	13/05/2020
☒ mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
☒ [redacted]	000439434001	buster	12/05/2020
✓ [redacted]	000820190003	2.1.0	12/05/2020
✓ VukolaMfn	123456123456	2.1.0	12/05/2020
☒ Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓ MFN713	091283746500	2.1.0-rc7	11/05/2020

Rows per page: 10

4. Select **Add Remote Screen** under **REMOTE CONNECTIONS** on the right side.



Update Node

Name* documentation 13 / 40

Insert label

Secure ID* 87C5BA21E2C9547B 16 / 16

Version 2.1.0-rcb

Serial number* 008373032311 12 / 12

MFN 100

REMOTE CONNECTIONS

5. Enter a name for the remote connection in the new window.

> **NOTE**
>
> Make sure to use a unique name for every connection on a node to avoid confusion.

6. Select **VNC** from the drop-down menu under **Connection type**.

7. Enter the port used for VNC connection. The default port `5900` is automatically filled in.

8. Enter the password that was set for VNC connections at the target.

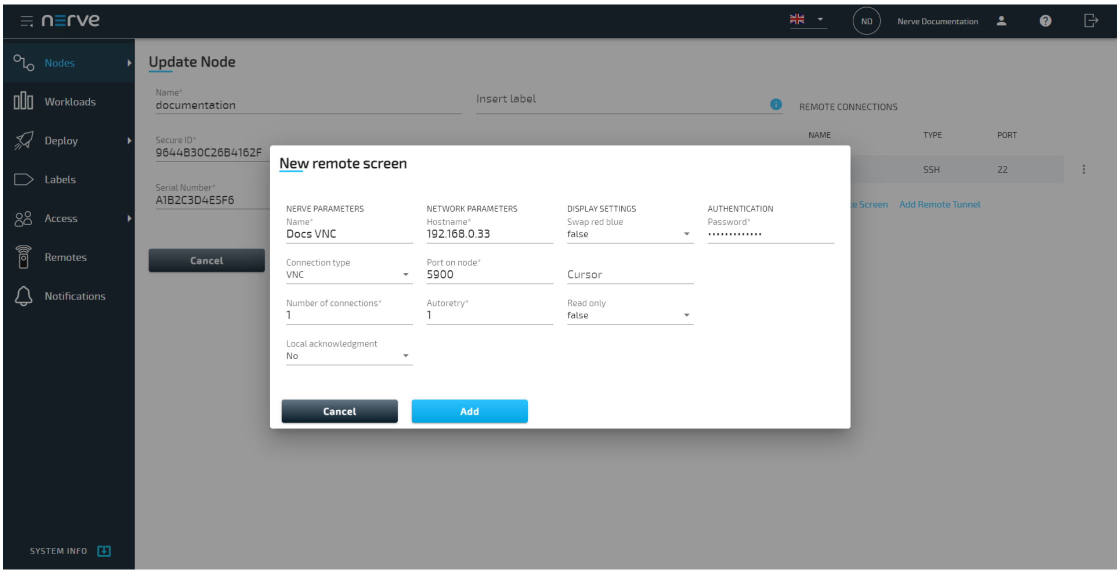
> **NOTE**

Entering wrong login credentials will cause an error when the remote screen is established. If an error occurs, close the browser tab. Check the login credentials and re-establish the remote screen.

9. Enter the remaining information if applicable:

NERVE PARAMETERS	**Number of connections** Enter the maximum number of simultaneous connections. The default value is 1. **Local acknowledgment** Select **Yes** or **No** from the drop-down menu. Selecting **Yes** will require approval of the remote connection in the Local UI before the connection can be established. If **No** is selected, the settings in the Local UI do not apply. Refer to Approving a remote connection for information on how to approve remote connections in the Local UI.
NETWORK PARAMETERS	**Hostname** Enter the IP address or the hostname of the target here. **Autoretry** Set the number of retries if the remote connection fails. The default value is 1.
DISPLAY SETTINGS	The display settings offer configuration options that affect visualization. **Swap red blue** If colors appear to not be displayed correctly, select **true** from the drop-down menu. This can occur when using VNC servers. Select **false** otherwise. **Cursor** This setting determines if the cursor is rendered locally or remotely. Enter `local` for a local cursor or enter `remote` for a remote cursor. If set to `remote`, the mouse pointer will be rendered remotely, and the local position of the mouse pointer will be indicated by a small dot. A remote mouse cursor will have added input lag compared to a local cursor. However, a remote cursor might be necessary if the server does not support sending the cursor image to the client. **Read only** Select **true** or **false** from the drop-down menu. If set to **true**, no input will be accepted on the connection. Select **false** to allow input.

10. Select **Add** to add the remote connection.



Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F

Serial Number* A1B2C3D4E5F6

REMOTE CONNECTIONS

NAME	TYPE	PORT
	SSH	22

New remote screen

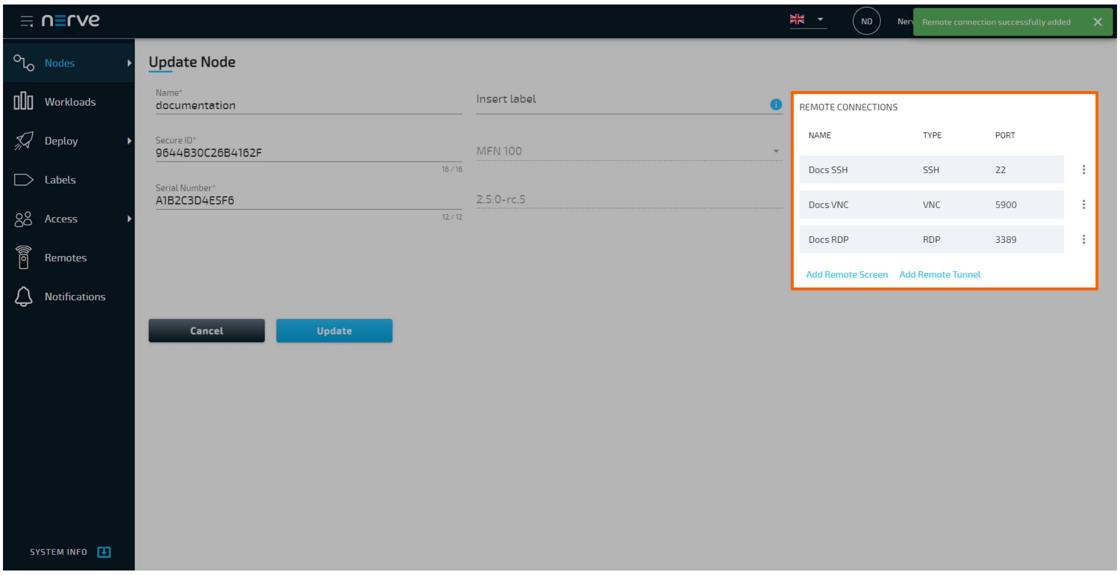
NERVE PARAMETERS
Name* Docs VNC
Connection type VNC
Number of connections* 1
Local acknowledgment No

NETWORK PARAMETERS
Hostname* 192.168.0.33
Port on node* 5900
Autoretry* 1

DISPLAY SETTINGS
Swap red blue false
Cursor
Read only false

AUTHENTICATION
Password* ••••••••••••••

The connection is now displayed under **REMOTE CONNECTIONS** on the right side, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F 16 / 16

MFN 100

Serial Number* A1B2C3D4E5F6 12 / 12

2.5.0-rc.5

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs SSH	SSH	22
Docs VNC	VNC	5900
Docs RDP	RDP	3389

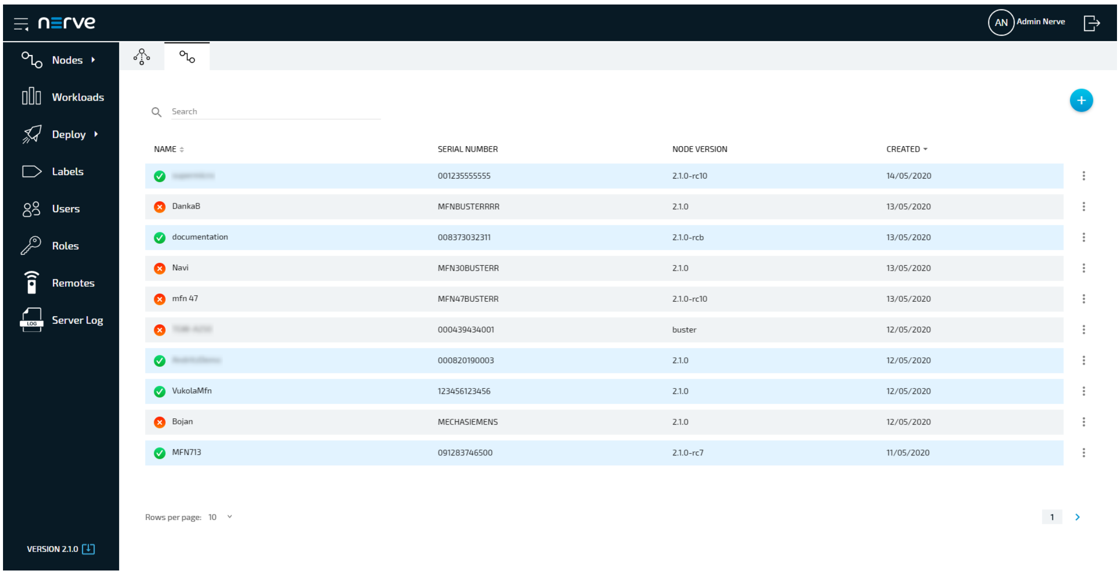
11. Select **Update** to save the changes.

Configuring an RDP connection to a node

An RDP connection to a node can be used to connect to a Windows environment on an external device, which is connected to the node or to the same network that the node is connected to.

1. Select **Nodes** from the navigation on the left.
2. Select the nodes tab

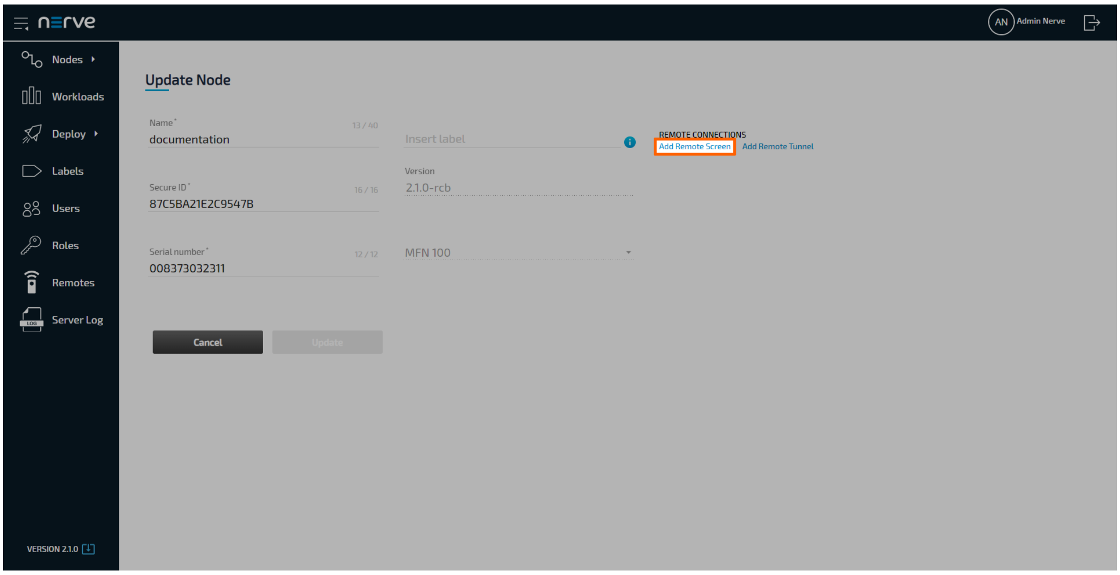
   on the right to display the list of registered nodes.
3. Select a node from the list to which a remote connection will be established.



NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓ [redacted]	001235555555	2.1.0-rc10	14/05/2020
✗ DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓ documentation	008373032311	2.1.0-rcb	13/05/2020
✗ Navi	MFN30BUSTERR	2.1.0	13/05/2020
✗ mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✗ [redacted]	000439434001	buster	12/05/2020
✓ [redacted]	000820190003	2.1.0	12/05/2020
✓ VukolaMfn	123456123456	2.1.0	12/05/2020
✗ Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓ MFN713	091283746500	2.1.0-rc7	11/05/2020

Rows per page: 10

4. Select **Add Remote Screen** under **REMOTE CONNECTIONS** on the right side.



Update Node

Name* 13 / 40
documentation

Insert label

Secure ID* 16 / 16
87C5BA21E2C9547B

Version
2.1.0-rcb

Serial number* 12 / 12
008373032311

MFN 100

5. Enter a name for the remote connection in the new window.

> **NOTE**
>
> Make sure to use a unique name for every connection on a node to avoid confusion.

6. Select **RDP** from the drop-down menu under **Connection type**.

7. Enter the port used for RDP connection. The default port 3389 is automatically filled in.

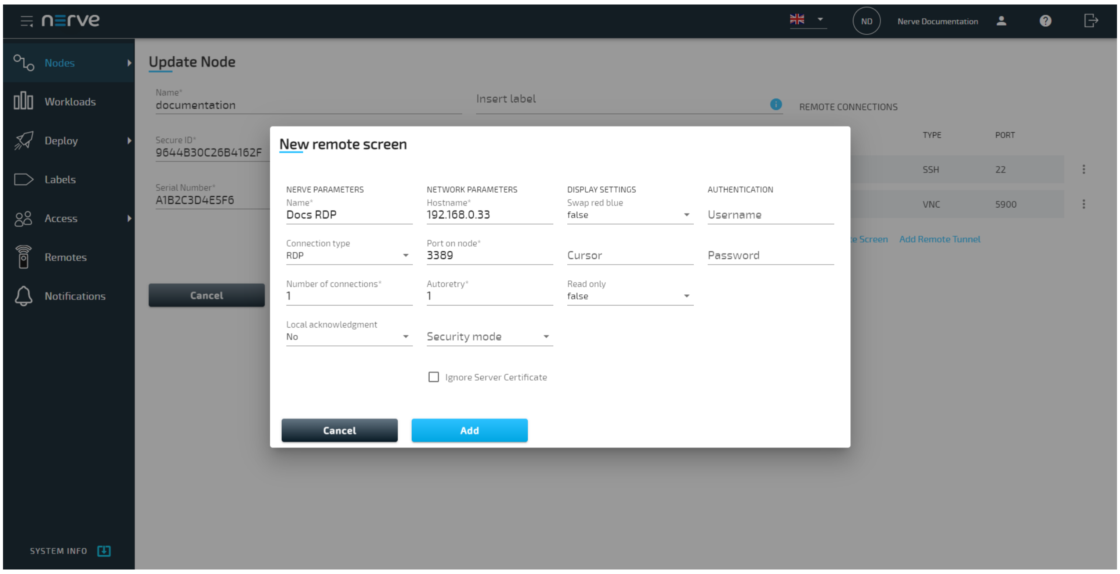
8. Enter the remaining information if applicable:

NERVE PARAMETERS	**Number of connections** Enter the maximum number of simultaneous connections. The default value is 1. **Local acknowledgment** Select **Yes** or **No** from the drop-down menu. Selecting **Yes** will require approval of the remote connection in the Local UI before the connection can be established. If **No** is selected, the settings in the Local UI do not apply. Refer to Approving a remote connection for information on how to approve remote connections in the Local UI.

NETWORK PARAMETERS	**Hostname** Enter the IP address or the hostname of the target here. **Autoretry** Set the number of retries if the remote connection fails. The default value is 1. **Security mode** This mode dictates how data will be encrypted and what type of authentication will be performed, if any. Select an option from the drop-down menu. Possible values are: ◦ **ANY** This is the default if the field is left blank. Automatically select the security mode based on the security protocols supported by both the client and the server. ◦ **NLA (Network Level Authentication)** This mode uses TLS encryption and requires the username and password to be given in advance. Unlike RDP mode, the authentication step is performed before the remote desktop session actually starts, avoiding the need for the Windows server to allocate significant resources for users that may not be authorized. ◦ **RDP encryption** This is the standard RDP encryption. It is generally only used for older Windows servers or in cases where a standard Windows login screen is desired. Newer versions of Windows have this mode disabled by default and will only accept NLA unless explicitly configured otherwise. ◦ **TLS encryption** Select this for RDP authentication and encryption implemented via TLS (Transport Layer Security). The TLS security mode is primarily used in load balanced configurations where the initial RDP server may redirect the connection to a different RDP server. **Ignore Server Certificate** If checked, the certificate returned by the server will be ignored, even if that certificate cannot be validated. This is useful if the server and the connection to the server is universally trusted, and if the server's certificate cannot be validated (for example, if it is self-signed).

DISPLAY SETTINGS	The display settings offer configuration options that affect visualization. **Swap red blue** If colors appear to not be displayed correctly, select **true** from the drop-down menu. This can occur when using VNC servers. Select **false** otherwise. **Cursor** This setting determines if the cursor is rendered locally or remotely. Enter `local` for a local cursor or enter `remote` for a remote cursor. If set to `remote`, the mouse pointer will be rendered remotely, and the local position of the mouse pointer will be indicated by a small dot. A remote mouse cursor will have added input lag compared to a local cursor. However, a remote cursor might be necessary if the server does not support sending the cursor image to the client. **Read only** Select **true** or **false** from the drop-down menu. If set to **true**, no input will be accepted on the connection. Select **false** to allow input.
AUTHENTICATION	Enter **Username** and **Password** for Windows login. Note that entering wrong login credentials will cause an error when the remote screen is established. If an error occurs, close the browser tab. Check the login credentials and re-establish the remote screen.

9. Select **Add** to add the remote connection.



Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F

Serial Number* A1B2C3D4E5F6

REMOTE CONNECTIONS

TYPE	PORT
SSH	22
VNC	5900

New remote screen

NERVE PARAMETERS

Name* Docs RDP

Connection type RDP

Number of connections* 1

Local acknowledgment No

NETWORK PARAMETERS

Hostname* 192.168.0.33

Port on node* 3389

Autoretry* 1

Security mode

☐ Ignore Server Certificate

DISPLAY SETTINGS

Swap red blue false

Cursor

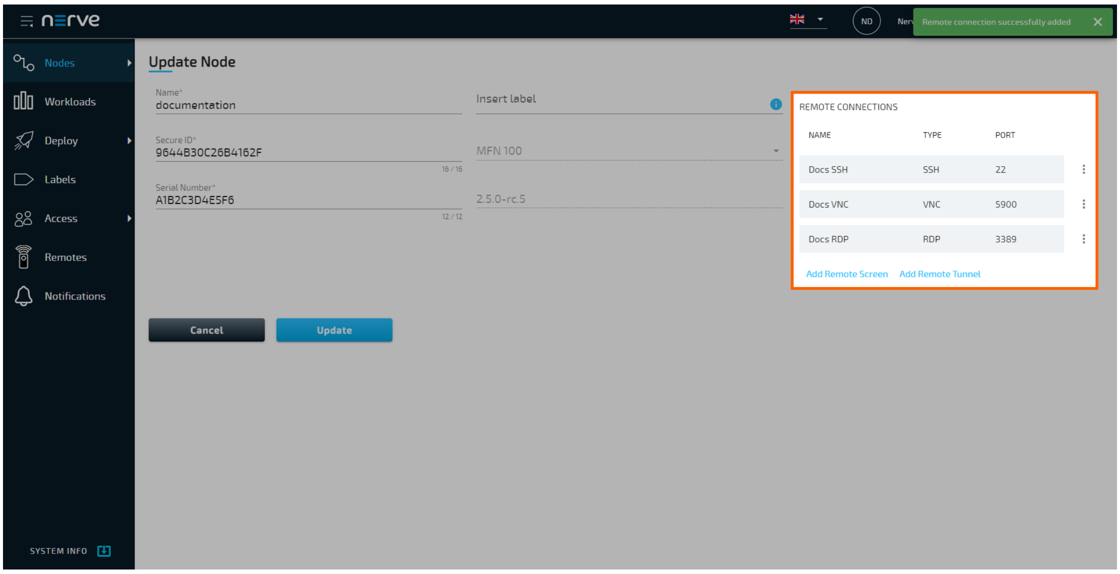
Read only false

AUTHENTICATION

Username

Password

The connection is now displayed under **REMOTE CONNECTIONS** on the right side, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Remote connection successfully added

Update Node

Name*: documentation

Insert label

Secure ID*: 9644B30C26B4162F (16 / 16)

MFN 100

Serial Number*: A1B2C3D4E5F6 (12 / 12)

2.5.0-rc.5

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs SSH	SSH	22
Docs VNC	VNC	5900
Docs RDP	RDP	3389

Add Remote Screen   Add Remote Tunnel

Cancel   Update

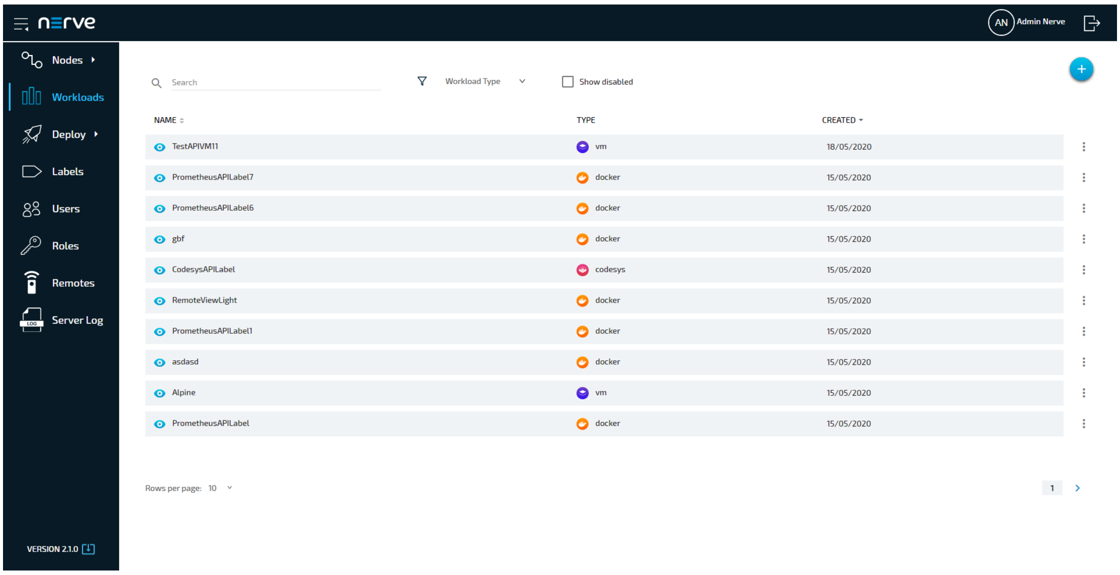
10. Select **Update** to save the changes.

Configuring a remote screen to a workload

A remote screen to a workload can be configured, regardless of a workload being deployed or not. Configuring a remote screen for a workload will immediately add the remote screen to the workload on all nodes that it has been deployed to. Note that remote screens to CODESYS workloads cannot be established.

1. Select **Workloads** in the navigation on the left.

2. Select a workload from the list.



Search   Workload Type   □ Show disabled

NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

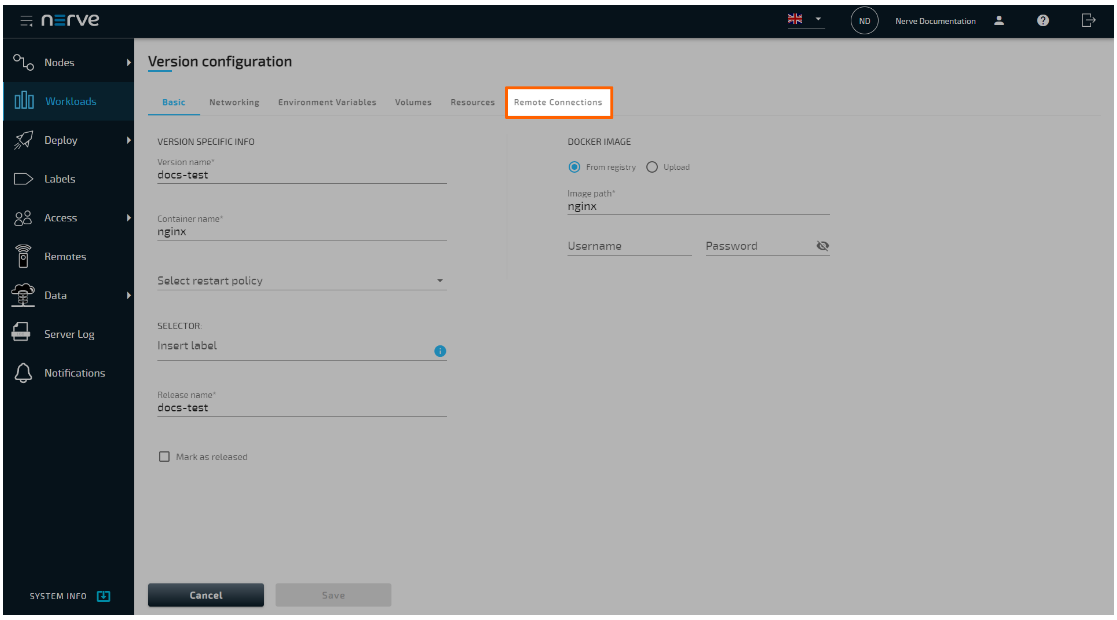
Rows per page: 10   1

3. Select the workload version to which the remote connection will be added.

NOTE

Note that the configured remote connection will only be available for the version that was selected.

4. Select the **Remote Connections** tab.



Version configuration

VERSION SPECIFIC INFO

Version name* docs-test

Container name* nginx

Select restart policy

SELECTOR: Insert label

Release name* docs-test

□ Mark as released

DOCKER IMAGE

● From registry ○ Upload

Image path* nginx

Username

Password

5. Select **Add Remote Screen** under **REMOTE CONNECTIONS**.

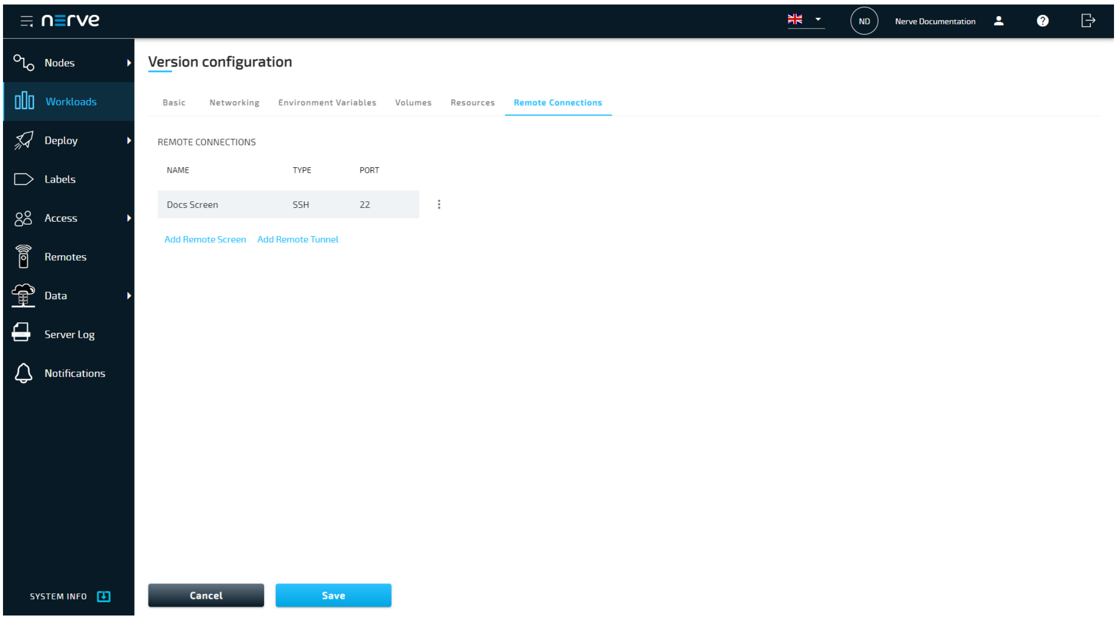
6. Follow steps 4 to 9 in the instructions above for SSH, VNC, or RDP connections.

NOTE

Note that adding the hostname is not required when configuring a remote screen to a Docker workload. The system automatically detects the hostname when the workload is deployed.

In case of Virtual Machine workloads, the hostname entry is not displayed for VNC connections. For SSH and RDP connections, enter the IP address or hostname under **VM hostname / IP**.

The connection is saved and now displayed in the **Remote Connections** tab, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Version configuration

Basic | Networking | Environment Variables | Volumes | Resources | Remote Connections

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs Screen	SSH	22

Add Remote Screen Add Remote Tunnel

7. Select **Save** to save the changes.

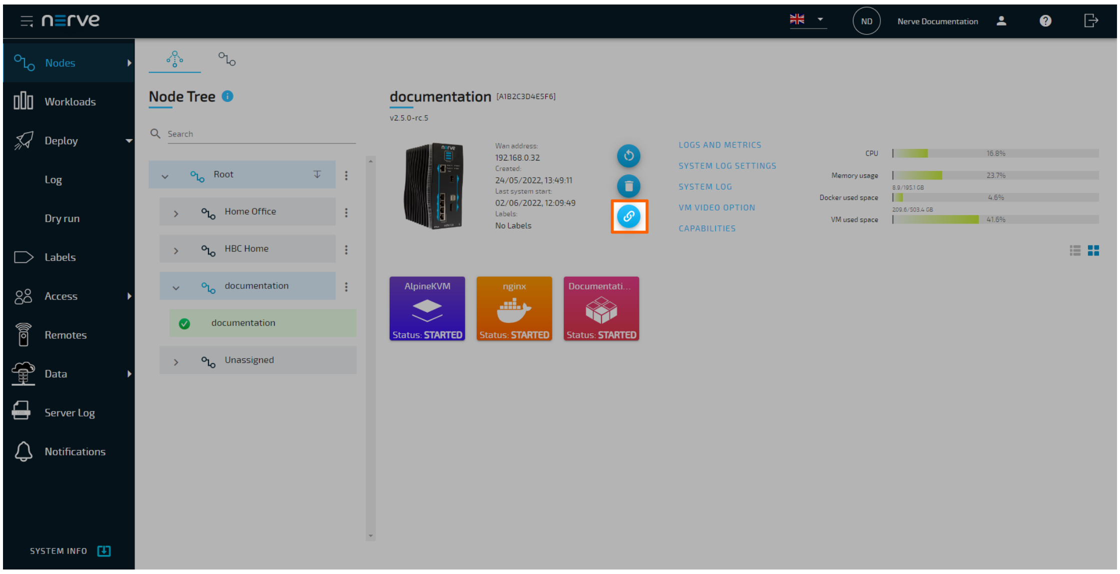
Using a remote screen to a node or external device

Configured remote connections are used from the target element in the Management System. So for remote connections established to the node, the remote connection is opened from the node details screen.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab

   on the right to display registered nodes in the node tree.
3. Select a node with a remote screen from the node tree.

4. Select the **Connect** symbol in the node details on the right.

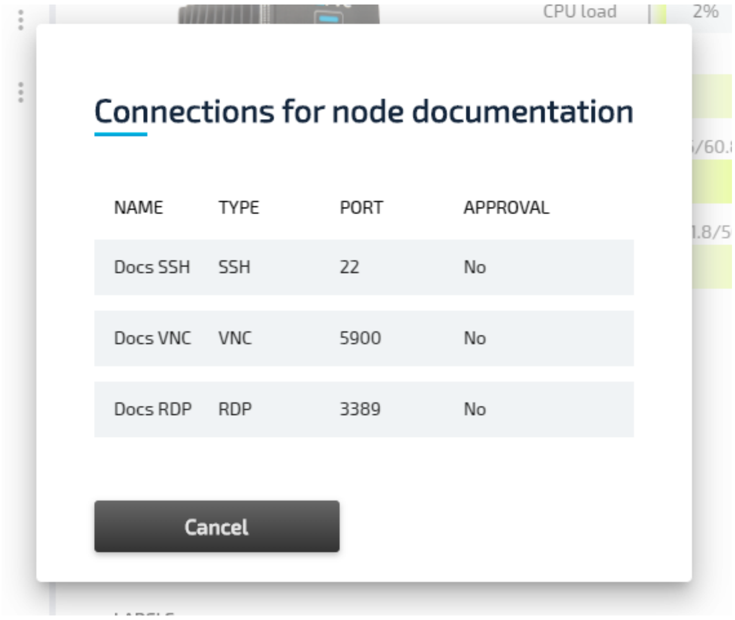


documentation [A1B2C3D4E5F6]
v2.5.0-rc.5

Wan address:
192.168.0.32
Created:
24/05/2022, 13:49:11
Last system start:
02/06/2022, 12:09:49
Labels:
No Labels

CPU 16.8%
Memory usage 23.7%
8.9/195.1 GB
Docker used space 4.6%
209.6/503.4 GB
VM used space 41.6%

5. Select the remote connection from the list in the new window.



Connections for node documentation

NAME	TYPE	PORT	APPROVAL
Docs SSH	SSH	22	No
Docs VNC	VNC	5900	No
Docs RDP	RDP	3389	No

The remote screen will be opened and displayed in a new browser tab after a few seconds if **Local acknowledgement** has been set to **No**. If set to **Yes**, the remote connection has to be approved in the Local UI. Refer to Approving a remote connection for more information.

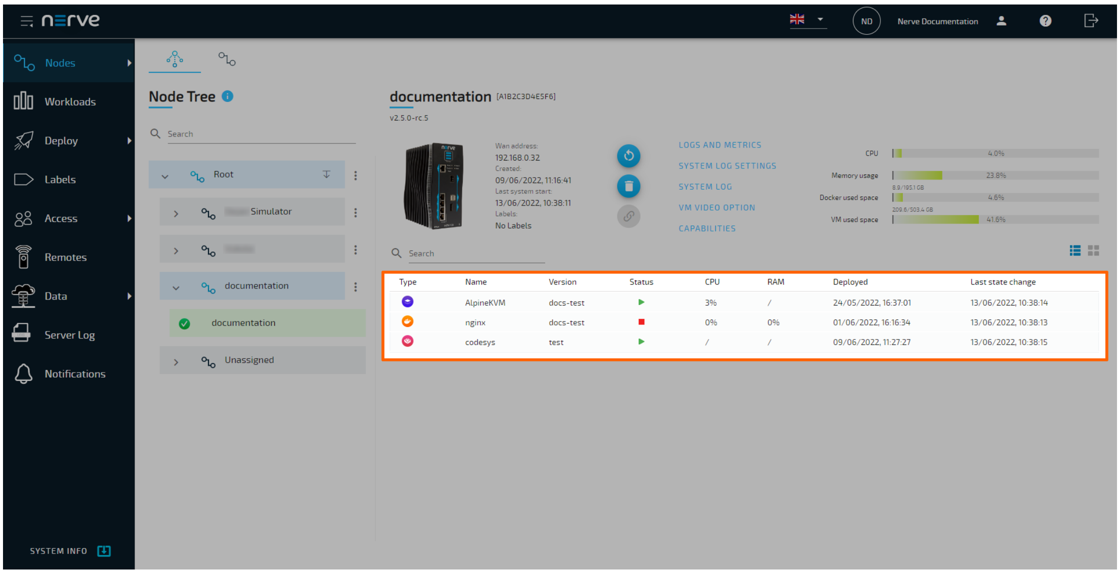
NOTE

Make sure not to exceed the defined number of connections of the same remote screen. This causes an error and the connection has to be terminated and established again. If there is a connection error, close the tab, terminate and re-establish the connection.

Using a remote screen to a workload

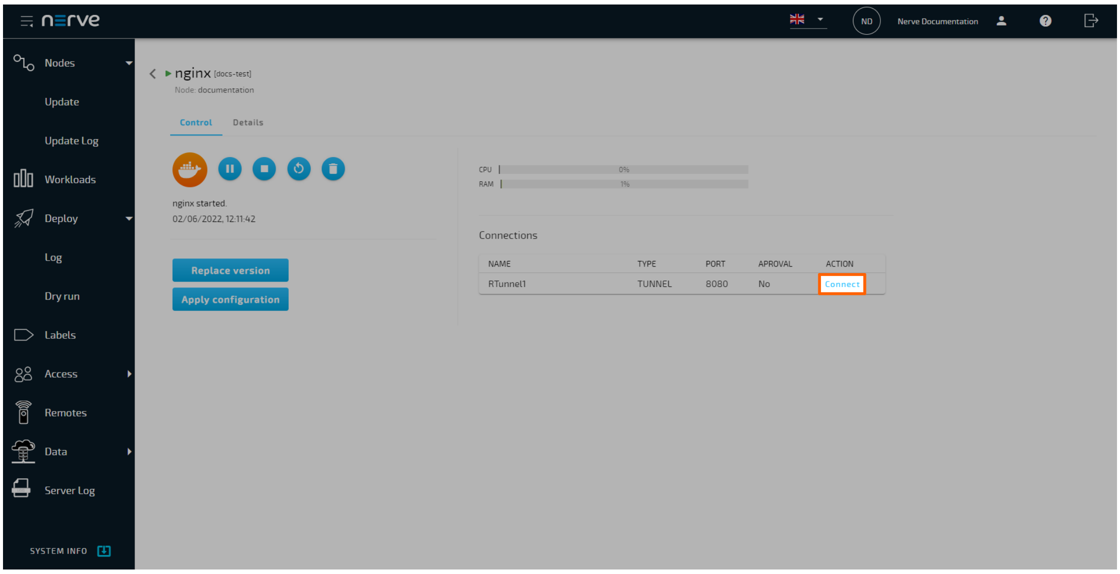
Configured remote connections are used from the target element in the Management System. So for remote connections established to a workload, the remote connection is opened from the workload control screen.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab
   on the right to display registered nodes in the node tree.
3. Select the node that has a deployed workload with a remote connection.
4. Select the workload.



Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

5. Select **Connect** from the **Connections** list.



NAME	TYPE	PORT	APROVAL	ACTION
RTunnel1	TUNNEL	8080	No	Connect

The remote screen will be opened and displayed in a new browser tab after a few seconds if **Local acknowledgement** has been set to **No**. If set to **Yes**, the remote connection has to be approved in the Local UI. Refer to Approving a remote connection for more information.

> **NOTE**
>
> Make sure not to exceed the defined number of connections of the same remote screen. This causes an error and the connection has to be terminated and established again. If there is a connection error, close the tab, terminate and re-establish the connection.

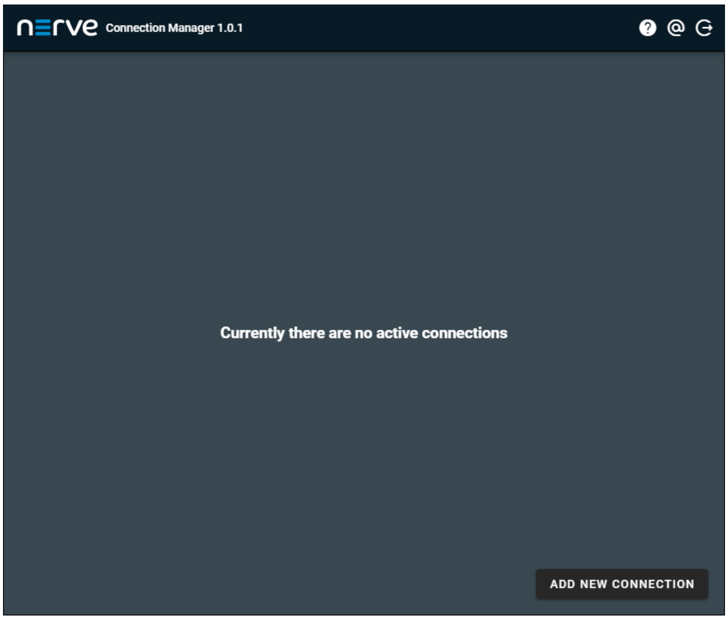
Remote tunnels

The Nerve Connection Manager is an application that is installed locally on the workstation. It is required for establishing and using remote connections from the local workstation. Download the Nerve Connection Manager from the Nerve Software Center first.

The Nerve Connection Manager installation file is an executable file. Open the installation file and follow the installation process. The installation file is available in EXE and DEB formats for Windows or Linux.

NOTE

- The Nerve Connection Manager might trigger warnings from antivirus software. This is due to a library that was used in development and a known issue.
- The Nerve Connection Manager requires additional packages to work on Debian Bullseye or Ubuntu 22.04. The packages are: `libappindicator1_0.4.92-7_amd64.deb`, `libindicator7_0.5.0-4_amd64.deb`, `libgbm1` and `libasound2`.



Currently there are no active connections

Once installed, the Nerve Connection Manager will be associated with `nerverm://` links that are generated in the Management System. Selecting such a link will automatically open the Nerve Connection Manager.

NOTE

If the target of the remote connection is the host of the Nerve system, use the IP address of the host: `172.20.2.1`. Using `localhost` is not supported.

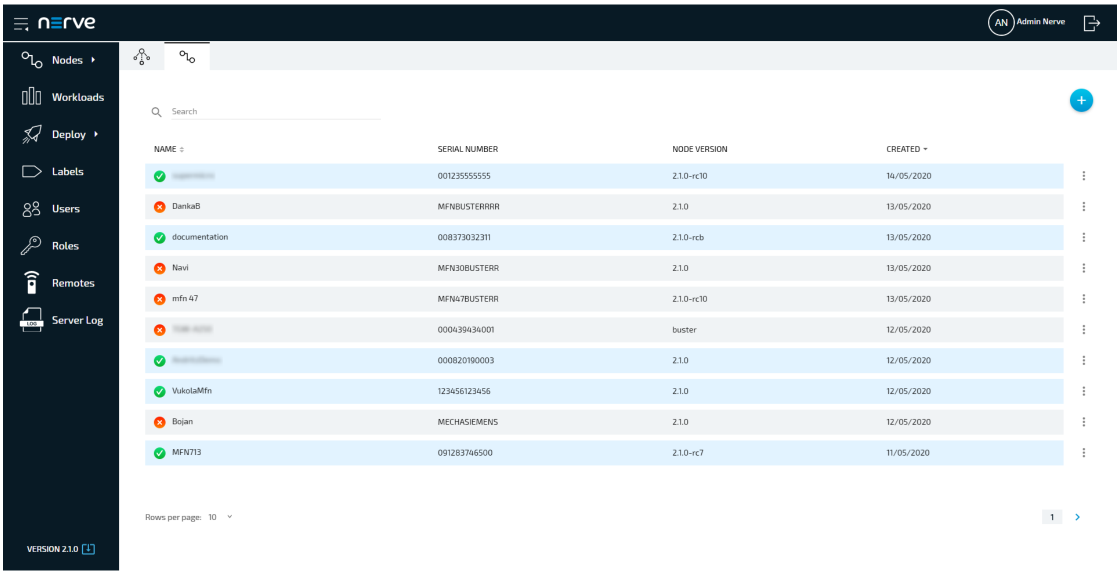
Configuring a remote tunnel to a node

Depending on the target, a remote tunnel to a node can be used in a web browser, with SSH clients, or with remote desktop applications, for example.

1. Select **Nodes** in the navigation on the left.
2. Select the nodes tab

on the right to display the list of registered nodes.

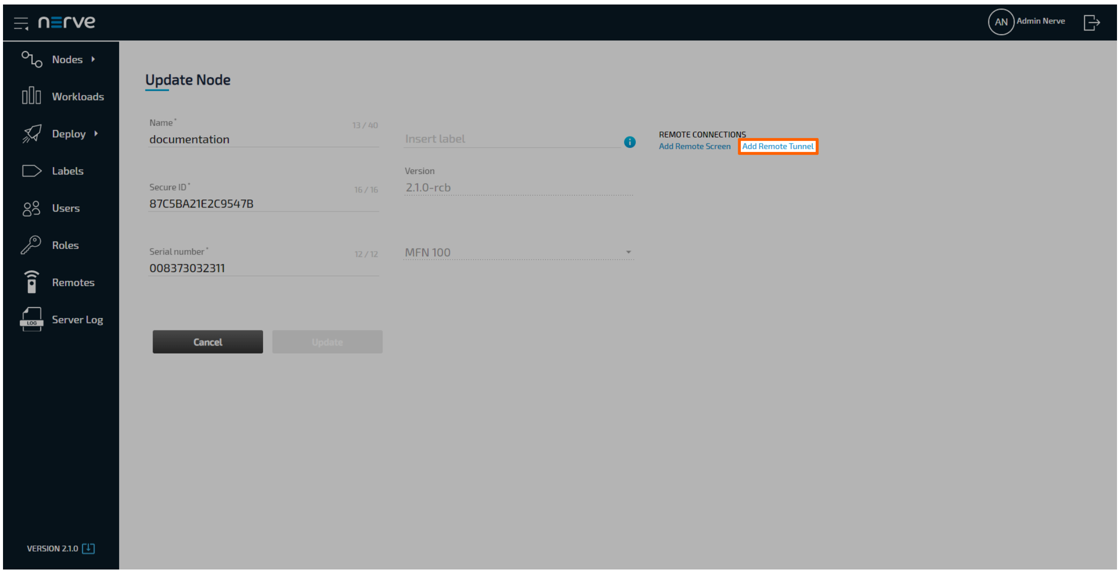
3. Select a node from the list.



NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓ [redacted]	001235555555	2.1.0-rc10	14/05/2020
✗ DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓ documentation	008373032311	2.1.0-rcb	13/05/2020
✗ Navi	MFN30BUSTERR	2.1.0	13/05/2020
✗ mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✗ [redacted]	000439434001	buster	12/05/2020
✓ [redacted]	000820190003	2.1.0	12/05/2020
✓ VukolaMfn	123456123456	2.1.0	12/05/2020
✗ Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓ MFN713	091283746500	2.1.0-rc7	11/05/2020

Rows per page: 10

4. Select **Add Remote Tunnel** under **REMOTE CONNECTIONS** on the right side.



Name* 13 / 40
documentation

Insert label

Secure ID* 16 / 16
87C5BA21E2C9547B

Version
2.1.0-rcb

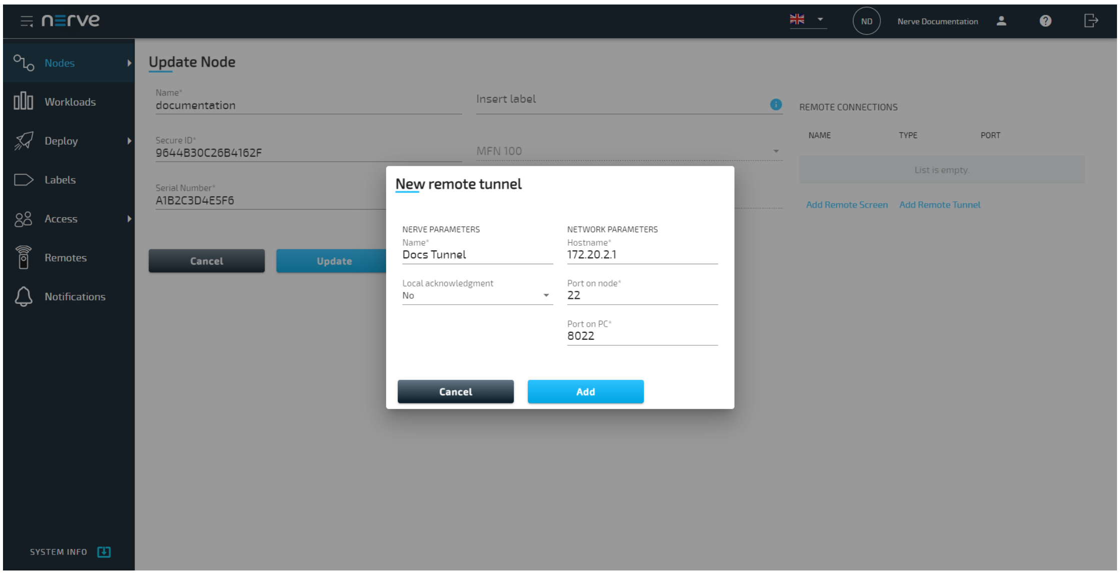
Serial number* 12 / 12
008373032311

MFN 100

5. Enter the following information:

NERVE PARAMETERS	**Name** Enter a name for the remote connection. Make sure to use a unique name for every connection on a node to avoid confusion. **Local acknowledgment** Select **Yes** or **No** from the drop-down menu. Selecting **Yes** will require approval of the remote connection in the Local UI before the connection can be established. If **No** is selected, the settings in the Local UI do not apply. Refer to Approving a remote connection for information on how to approve remote connections in the Local UI.
NETWORK PARAMETERS	**Hostname** Enter the IP address or the hostname of the target here. **Port on node** Enter the port the target listens on. **Port on PC** Enter the port that will be used for communication on the local workstation. The port entered here serves as a default port that can be changed in the Nerve Connection Manager in case it is already in use. Note that some systems might restrict usage of ports under 1024. This is true for Linux systems especially. Enter port numbers higher than 1024 to avoid possible port conflicts.

6. Select **Add** to save the remote connection configuration.



Update Node

Name* documentation

Insert label

Secure ID* 9644B30C26B4162F

MFN 100

Serial Number* A1B2C3D4E5F6

REMOTE CONNECTIONS

NAME	TYPE	PORT
List is empty.		

New remote tunnel

NERVE PARAMETERS

Name* Docs Tunnel

Local acknowledgment No

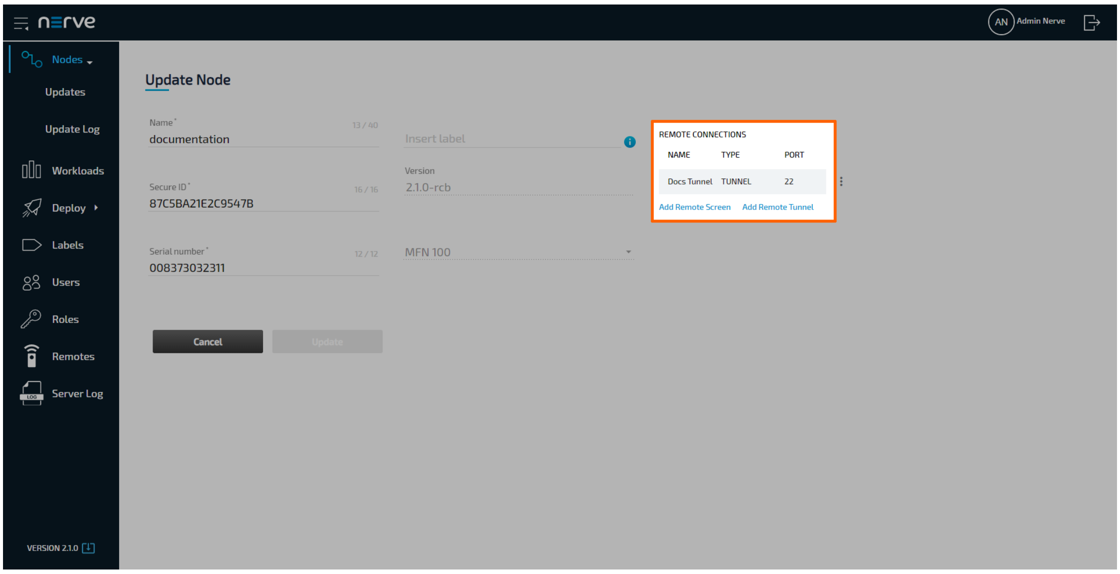
NETWORK PARAMETERS

Hostname* 172.20.2.1

Port on node* 22

Port on PC* 8022

The connection is saved and now displayed under **REMOTE CONNECTIONS** on the right side, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Update Node

Name * documentation 13 / 40

Insert label

Secure ID * 87C5BA21E2C9547B 16 / 16

Version 2.1.0-rcb

Serial number * 008373032311 12 / 12

MFN 100

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs Tunnel	TUNNEL	22

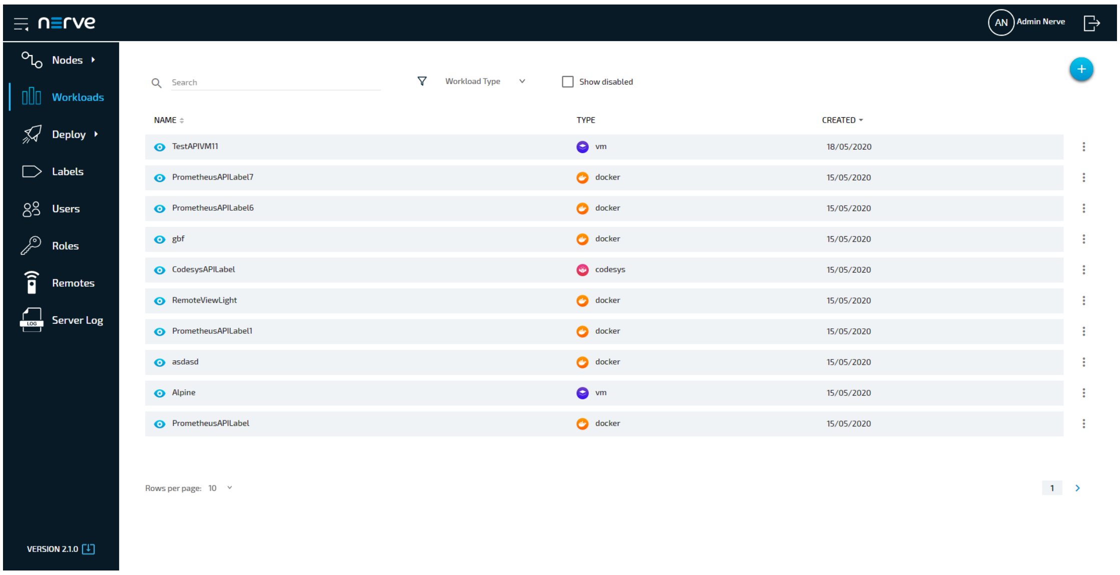
7. Select **Update** to save the changes.

Configuring a remote tunnel to a workload

A remote tunnel to a workload can be configured, regardless of a workload being deployed or not. Configuring a remote tunnel for a workload will immediately add the remote tunnel to the workload on all nodes that it has been deployed to. Depending on the target, a remote tunnel to a workload can be used in a web browser, with SSH clients, or with remote desktop applications, for example.

1. Select **Workloads** in the navigation on the left.

2. Select a workload from the list.



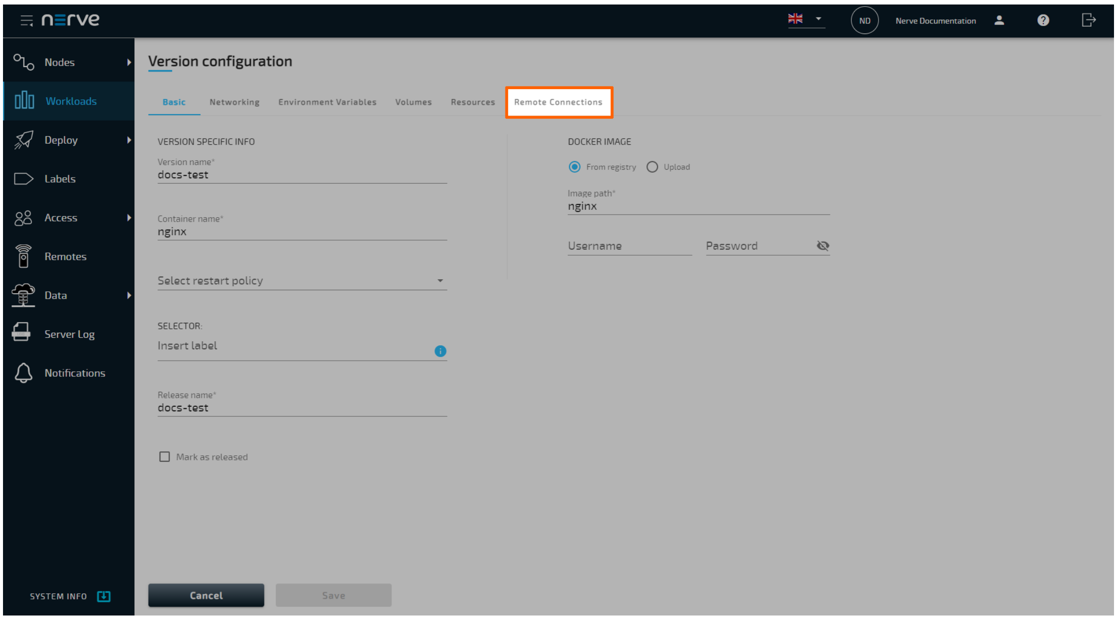
NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

3. Select the workload version to which a remote connection will be established.

NOTE

Note that the configured remote connection will only be available for the version that was selected.

4. Select the **Remote Connections** tab.



Version configuration

VERSION SPECIFIC INFO

Version name* docs-test

Container name* nginx

Select restart policy

SELECTOR: Insert label

Release name* docs-test

☐ Mark as released

DOCKER IMAGE

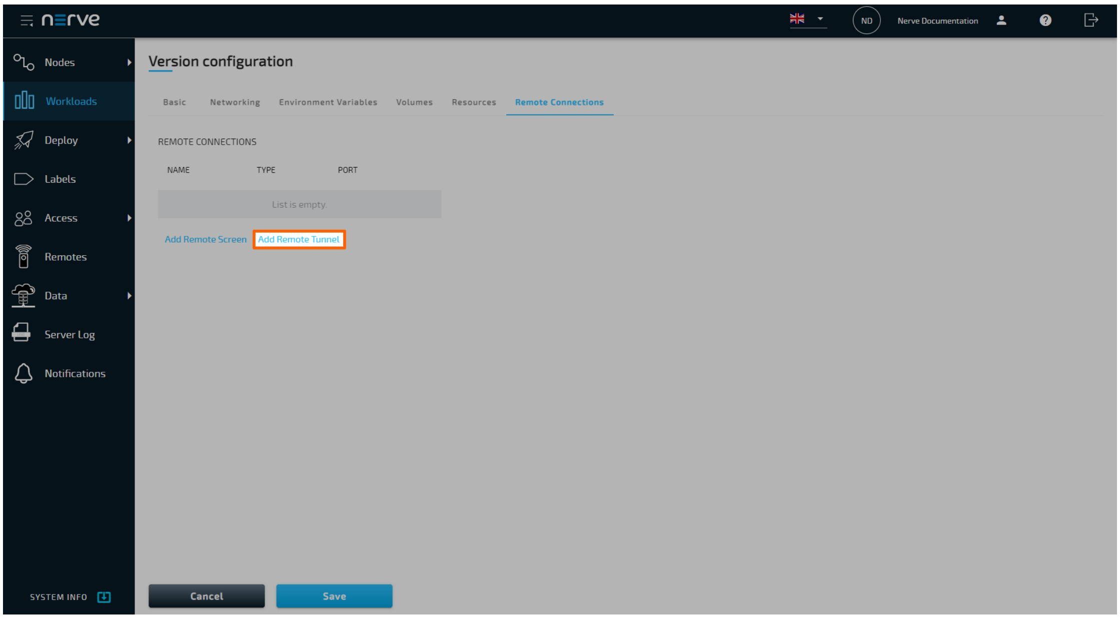
● From registry ○ Upload

Image path* nginx

Username

Password

5. Select **Add Remote Tunnel**.



Version configuration

REMOTE CONNECTIONS

NAME	TYPE	PORT
List is empty.		

6. Enter the following information:

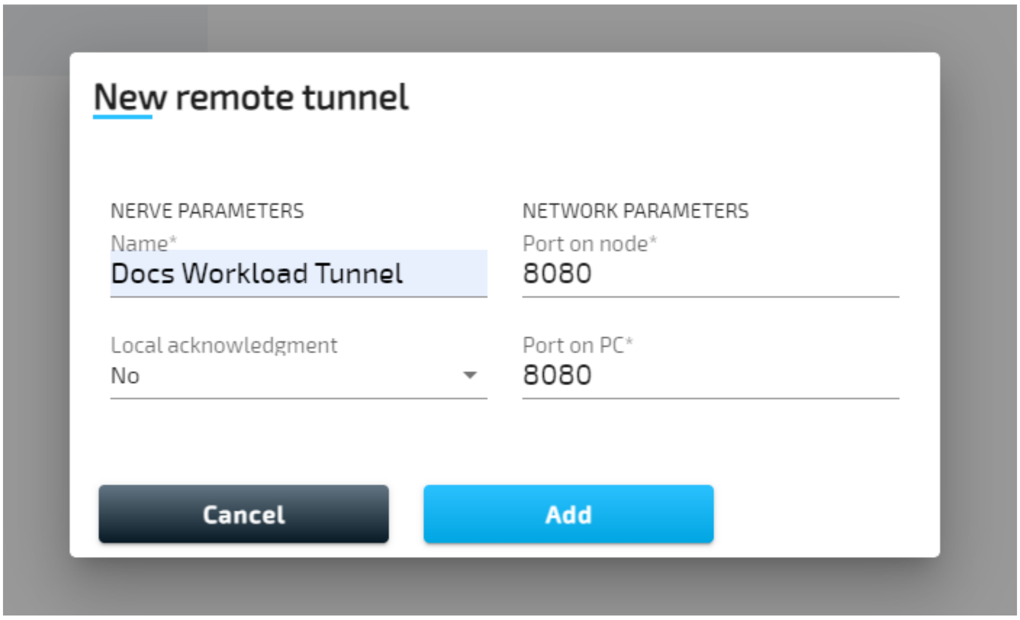
NERVE PARAMETERS	**Name** Enter a name for the remote connection. Make sure to use a unique name for every connection on a node to avoid confusion. **Local acknowledgment** Select **Yes** or **No** from the drop-down menu. Selecting **Yes** will require approval of the remote connection in the Local UI before the connection can be established. If **No** is selected, the settings in the Local UI do not apply. Refer to Approving a remote connection for information on how to approve remote connections in the Local UI.
NETWORK PARAMETERS	**Port on node** Enter the port the target listens on. **Port on PC** Enter the port that will be used for communication on the local workstation. The port entered here serves as a default port that can be changed in the Nerve Connection Manager in case it is already in use. Note that some systems might restrict usage of ports under 1024. This is true for Linux systems especially. Enter port numbers higher than 1024 to avoid possible port conflicts.

NOTE

Note that adding the hostname is not required when configuring a remote tunnel to a Docker workload. The system automatically detects the hostname when the workload is deployed.

For CODESYS workloads, the **Hostname** and **Port on node** fields are filled in by the default. They contain the IP address and default port of the CODESYS runtime.

7. Select **Add** to save the remote connection configuration.



New remote tunnel

NERVE PARAMETERS

Name*: Docs Workload Tunnel

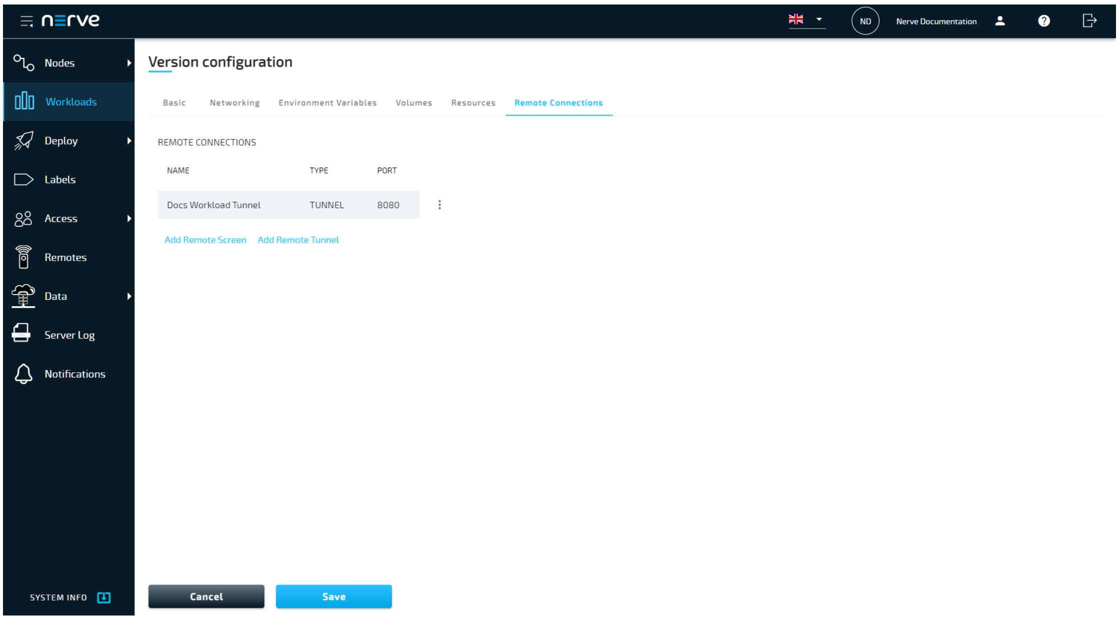
Local acknowledgment: No

NETWORK PARAMETERS

Port on node*: 8080

Port on PC*: 8080

The connection is saved and now displayed in the **Remote Connections** tab, showing the **NAME**, **TYPE** and **PORT** of the remote connection.



Version configuration

REMOTE CONNECTIONS

NAME	TYPE	PORT
Docs Workload Tunnel	TUNNEL	8080

8. Select **Save** to save the changes.

Using a remote tunnel to a node or external device

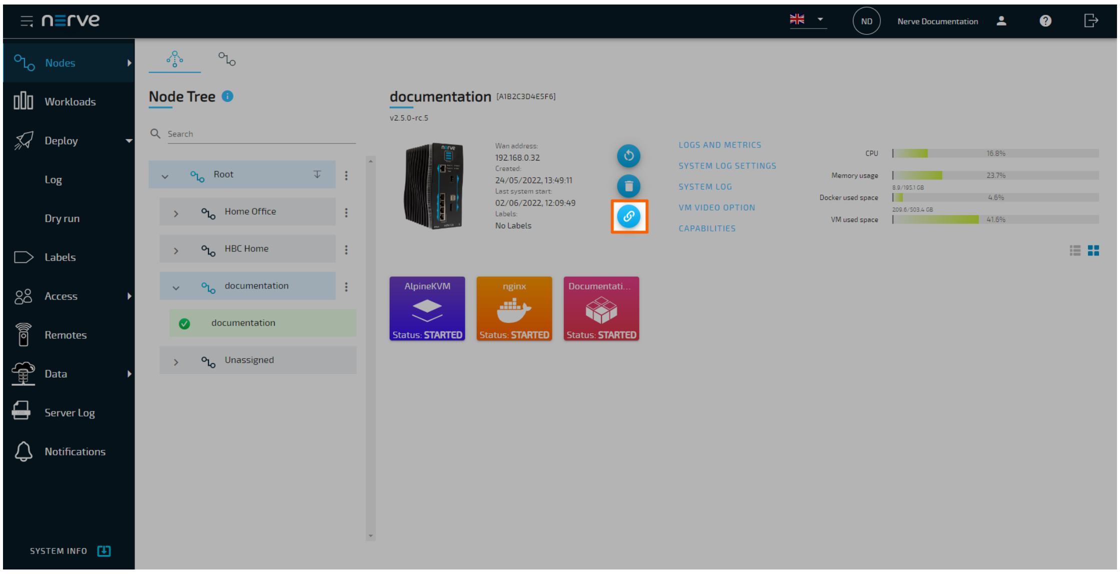
Note that the Nerve Connection Manager is required to use a remote tunnel. Download the Nerve Connection Manager from the Nerve Software Center and install it first.

Configured remote connections are used from the target element in the Management System. So for remote connections established to the node, the remote connection is opened from the node details screen.

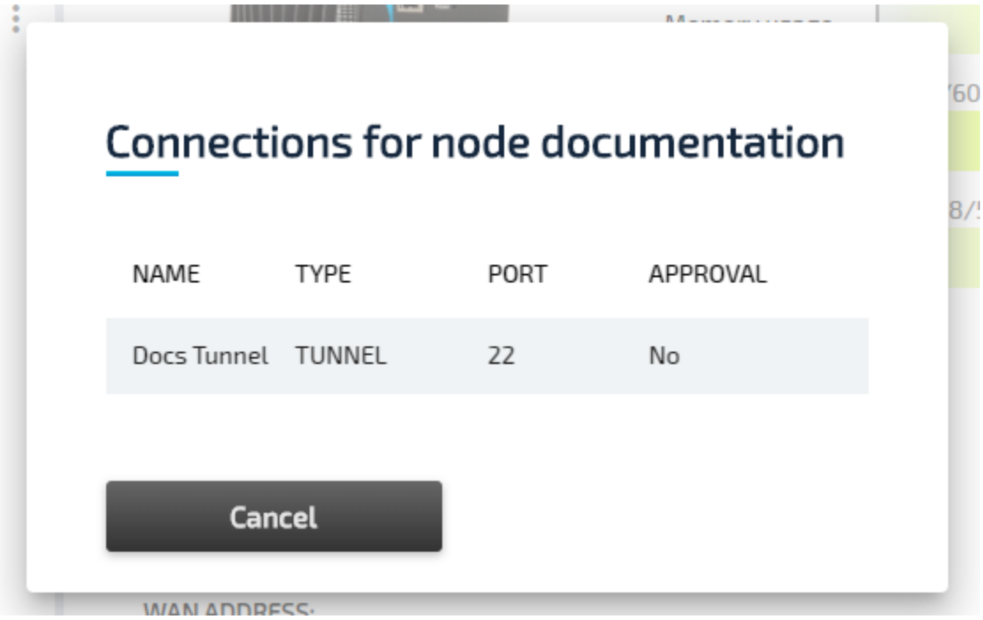
1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab

on the right to display registered nodes in the node tree.

3. Select a node with a remote tunnel from the node tree.
4. Select the **Connect** symbol in the node details on the right.



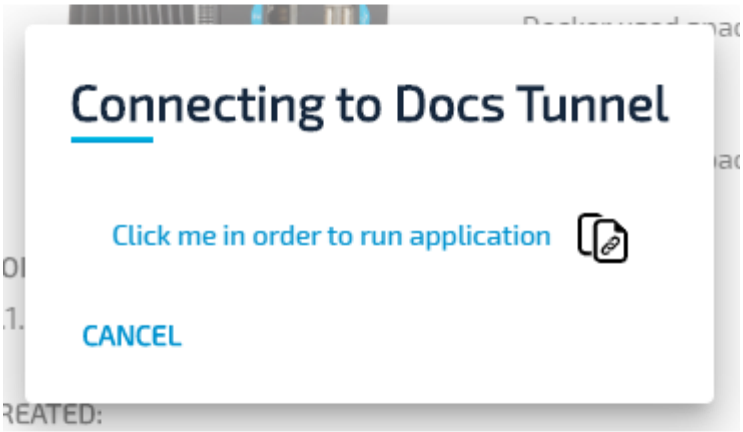
5. Select the remote connection from the list in the new window. Note that remote tunnels have the type **TUNNEL**.



Connections for node documentation

NAME	TYPE	PORT	APPROVAL
Docs Tunnel	TUNNEL	22	No

6. Select **Click me in order to run application** in the new window.

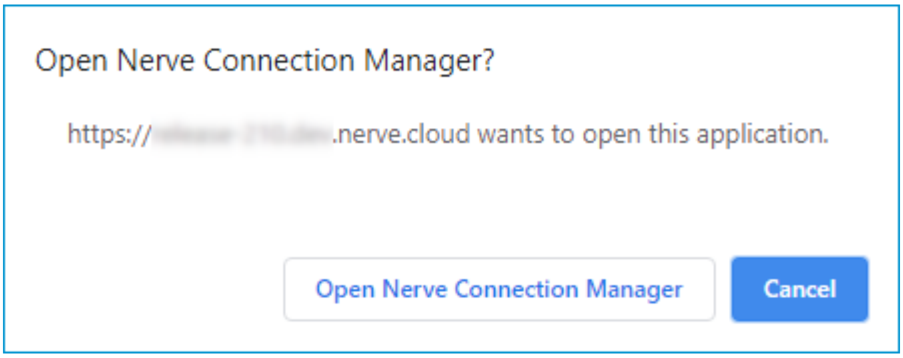


Connecting to Docs Tunnel

NOTE

If **Local acknowledgment** is set to **Yes**, the Management System will wait for approval until the remote connection has been locally approved before displaying the window above. Refer to Approving a remote connection for more information.

7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
   Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.

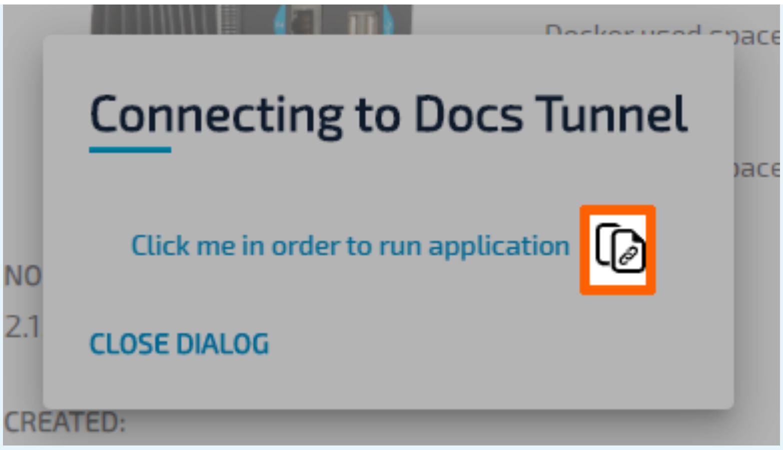


Open Nerve Connection Manager?

https://[illegible].nerve.cloud wants to open this application.

NOTE

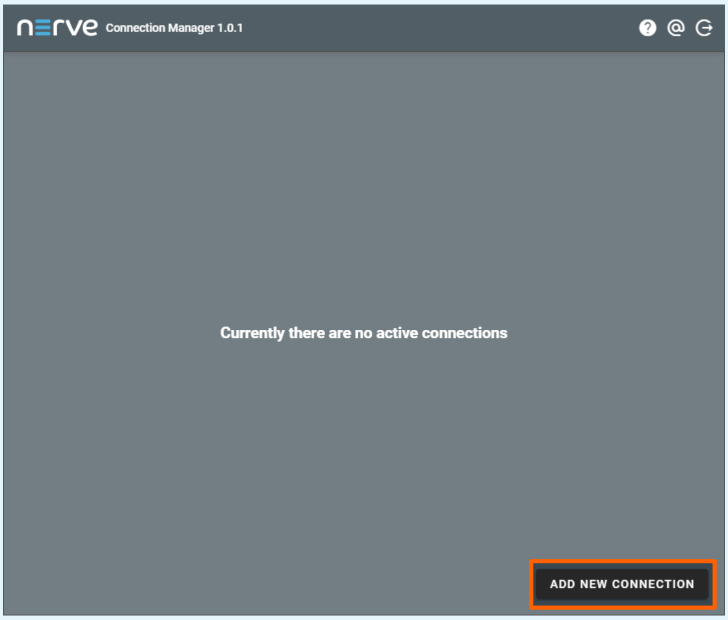
If the Nerve Connection Manager does not start automatically, select the copy to clipboard symbol next to **Click me in order to run application** in the Management System. This copies the remote connection URL.



Connecting to Docs Tunnel

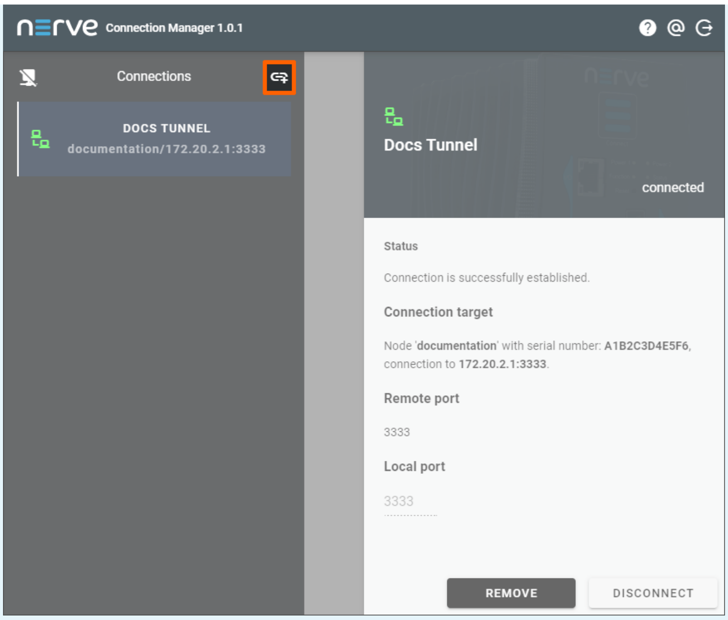
Click me in order to run application

Start the Nerve Connection Manager manually and add the new connection by selecting **ADD NEW CONNECTION** in the lower right and pasting the URL.



Currently there are no active connections

If an established connection already exists in the Nerve Connection Manager, select the **Add new connection** symbol next to **Connections** on the left side of the window.



Status

Connection is successfully established.

Connection target

Node 'documentation' with serial number: A1B2C3D4E5F6, connection to 172.20.2.1:3333.

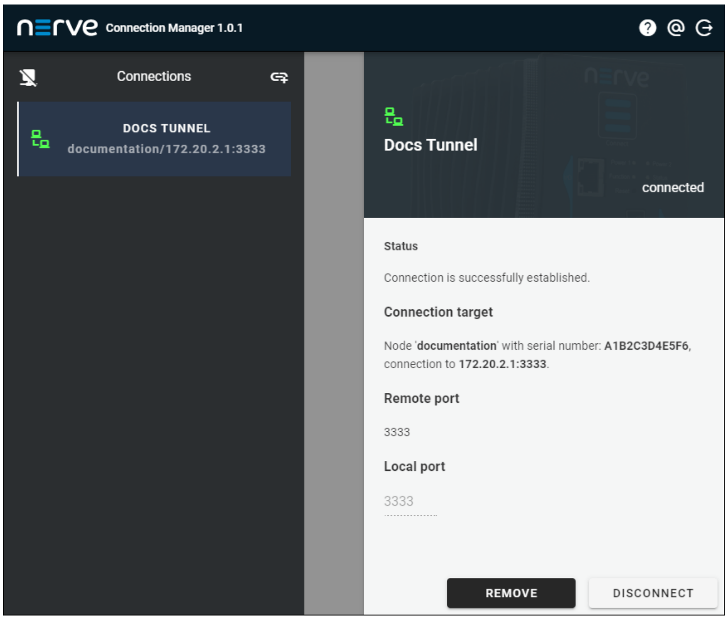
Remote port

3333

Local port

3333

The remote connection will be established once the Nerve Connection Manager starts.



Status

Connection is successfully established.

Connection target

Node 'documentation' with serial number: A1B2C3D4E5F6, connection to 172.20.2.1:3333.

Remote port

3333

Local port

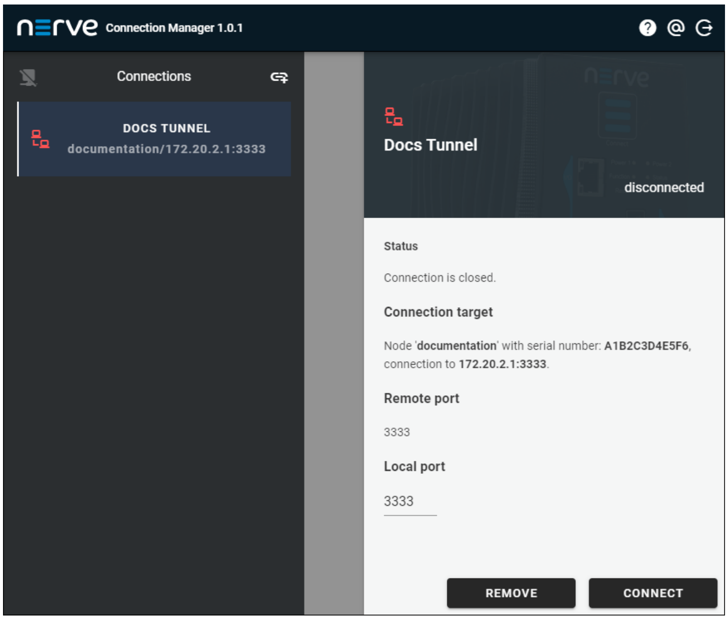
3333

Data about the establish remote tunnel is displayed on the right half of the Nerve Connection Manager window, showing the **Status**, **Connection target**, **Remote port** and **Local port** with a summary on the left side under the remote tunnel name.

NOTE

If the local port on the local workstation is already in use or occupied by the system, the Nerve Connection Manager will not establish a connection. **Local port** will be marked on the right. Enter a different port in this field that is not used on the workstation in order to establish the remote tunnel.

The connection can now be used from the local workstation by using `localhost:<localport>` through PuTTY in order to establish an SSH connection or in a web browser. Disconnect by selecting **DISCONNECT** in the lower right corner.



Status

Connection is closed.

Connection target

Node '**documentation**' with serial number: **A1B2C3D4E5F6**, connection to **172.20.2.1:3333**.

Remote port

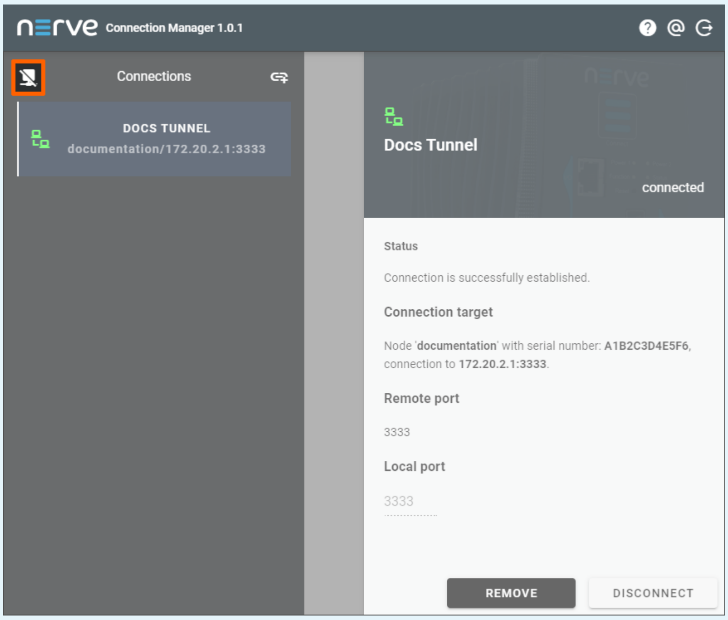
3333

Local port

3333

NOTE

Alternatively, all remote connections can be disconnected at once by selecting the **Disconnect all** symbol on the left side next to **Connections**.



Status

Connection is successfully established.

Connection target

Node '**documentation**' with serial number: **A1B2C3D4E5F6**, connection to **172.20.2.1:3333**.

Remote port

3333

Local port

3333

Note that disconnecting does not terminate the connection. The connection will stay established until it is terminated in the Nerve Connection Manager, the Local UI or the Management System.

Using a remote tunnel to a workload

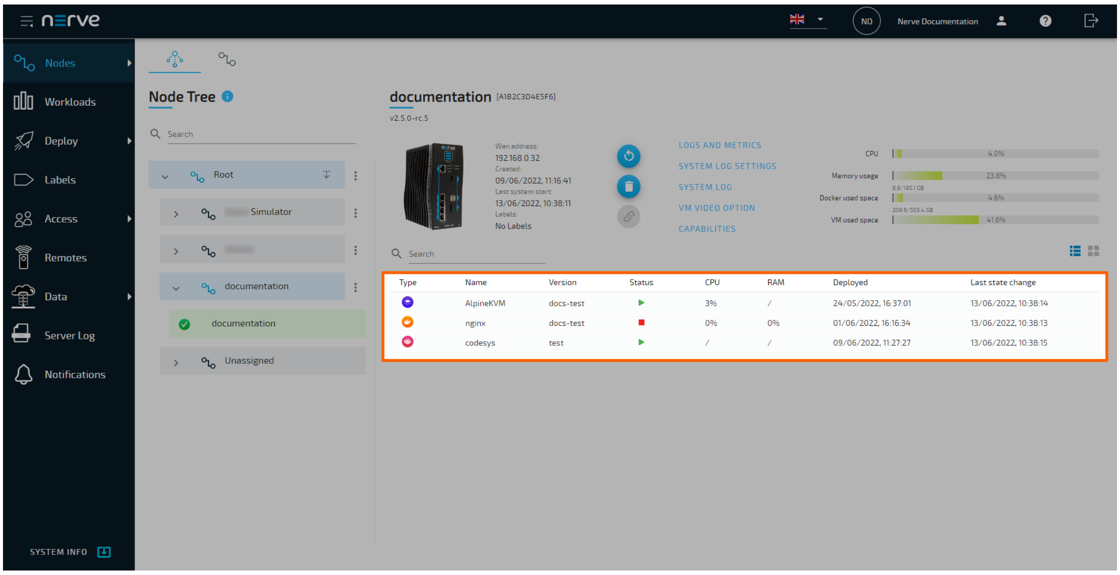
Note that the Nerve Connection Manager is required to use a remote tunnel. Download the Nerve Connection Manager from the Nerve Software Center and install it first.

Configured remote connections are used from the target element in the Management System. So for remote connections established to a workload, the remote connection is opened from the workload control screen.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab

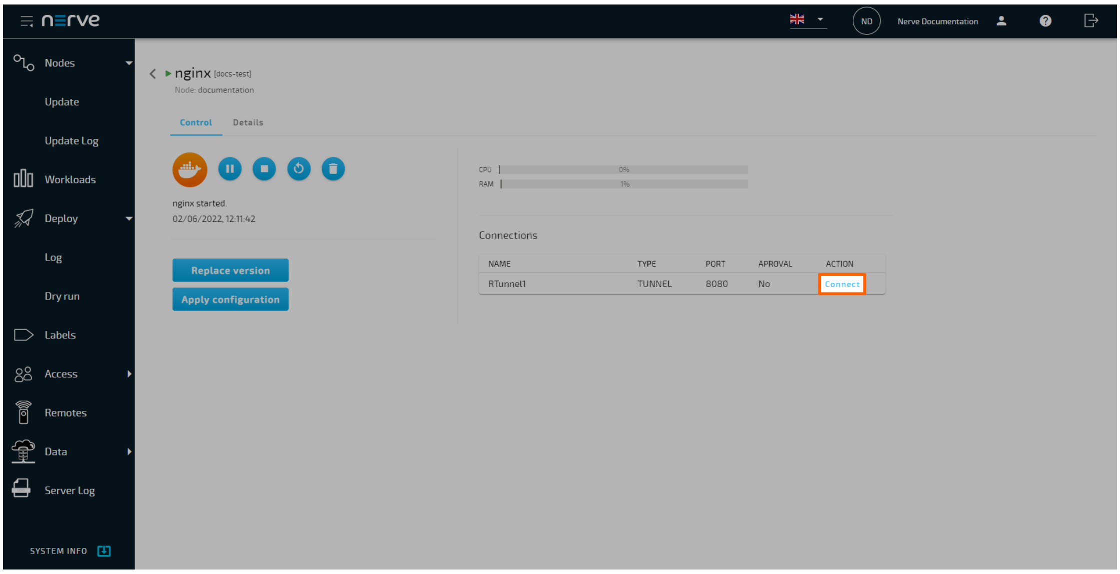
   on the right to display registered nodes in the node tree.
3. Select the node that has a deployed workload with a remote connection.

4. Select the workload.



Type	Name	Version	Status	CPU	RAM	Deployed	Last state change
●	AlpineKVM	docs-test	▶	3%	/	24/05/2022, 16:37:01	13/06/2022, 10:38:14
●	nginx	docs-test	■	0%	0%	01/06/2022, 16:16:34	13/06/2022, 10:38:13
●	codesys	test	▶	/	/	09/06/2022, 11:27:27	13/06/2022, 10:38:15

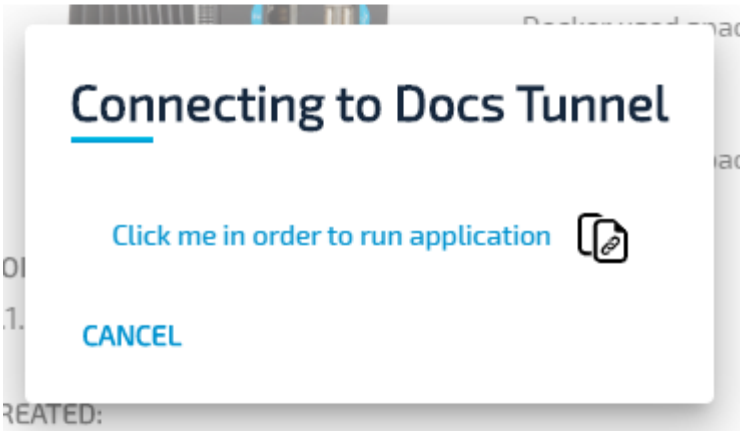
5. Select **Connect** from the **Connections** list.



Connections

NAME	TYPE	PORT	APROVAL	ACTION
RTunnel1	TUNNEL	8080	No	Connect

6. Select **Click me in order to run application** in the new window.



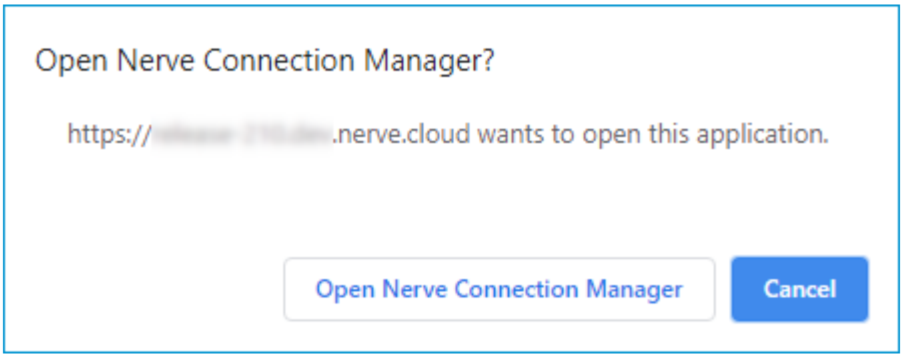
Connecting to Docs Tunnel

Click me in order to run application

NOTE

If **Local acknowledgment** is set to **Yes**, the Management System will wait for approval until the remote connection has been locally approved before displaying the window above. Refer to Approving a remote connection for more information.

7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
   Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.

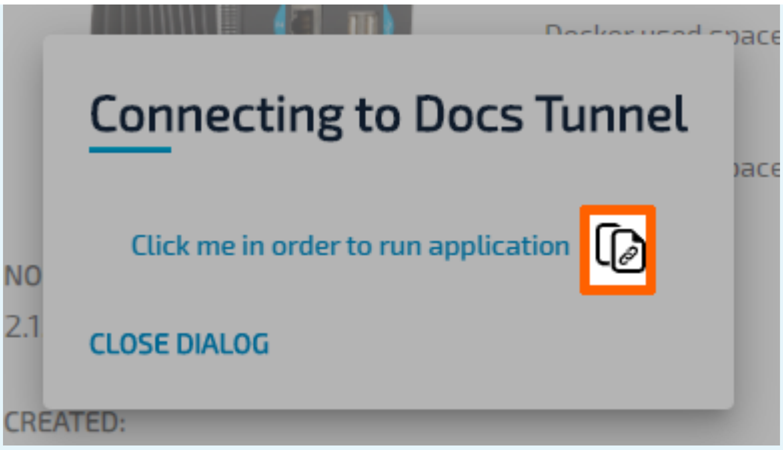


Open Nerve Connection Manager?

https://.nerve.cloud wants to open this application.

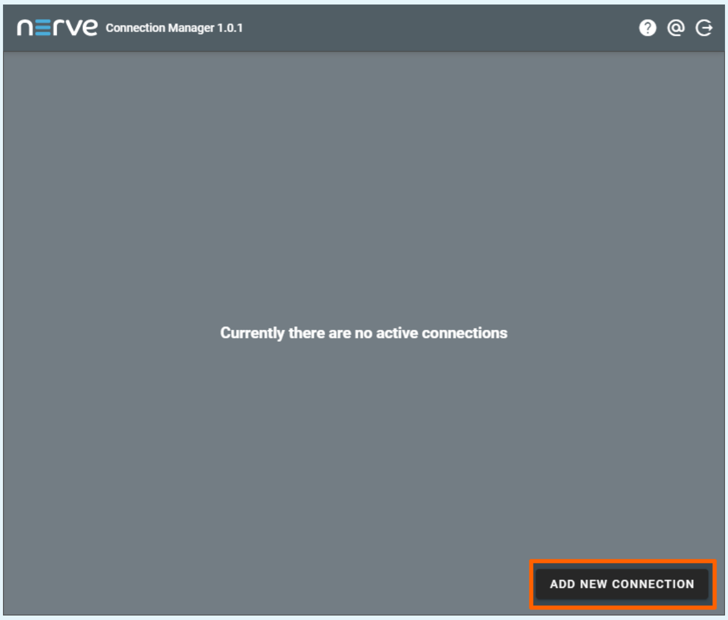
NOTE

If the Nerve Connection Manager does not start automatically, select the copy to clipboard symbol next to **Click me in order to run application** in the Management System. This copies the remote connection URL.



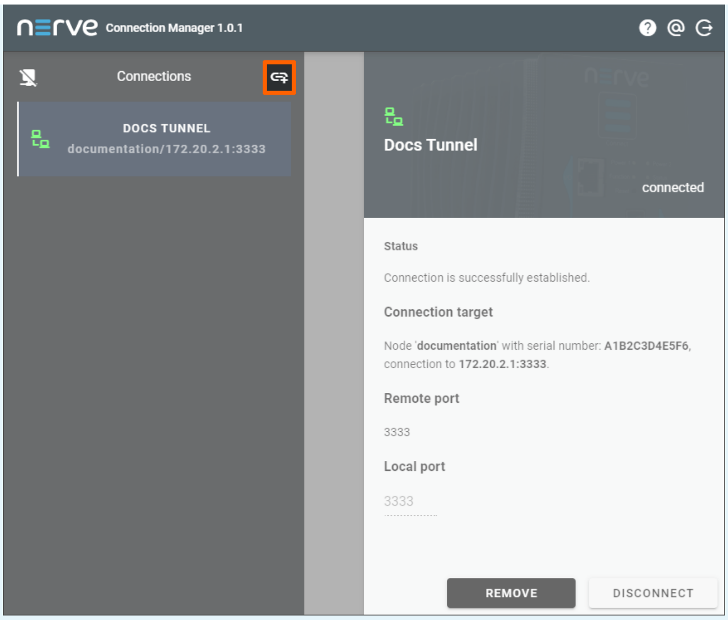
Connecting to Docs Tunnel
Click me in order to run application
CLOSE DIALOG
NO
2.1
CREATED:

Start the Nerve Connection Manager manually and add the new connection by selecting **ADD NEW CONNECTION** in the lower right and pasting the URL.



nerve Connection Manager 1.0.1
Currently there are no active connections
ADD NEW CONNECTION

If an established connection already exists in the Nerve Connection Manager, select the **Add new connection** symbol next to **Connections** on the left side of the window.



Status

Connection is successfully established.

Connection target

Node 'documentation' with serial number: A1B2C3D4E5F6, connection to 172.20.2.1:3333.

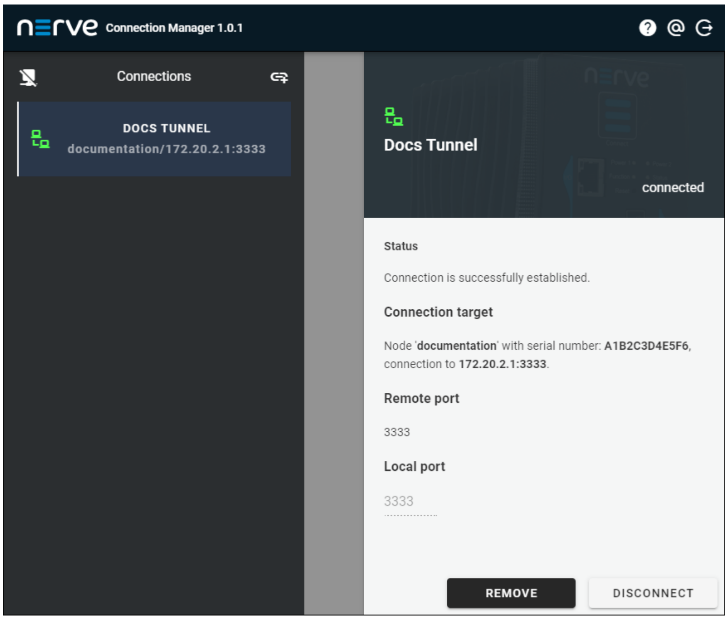
Remote port

3333

Local port

3333

The remote connection will be established once the Nerve Connection Manager starts.



Status

Connection is successfully established.

Connection target

Node 'documentation' with serial number: A1B2C3D4E5F6, connection to 172.20.2.1:3333.

Remote port

3333

Local port

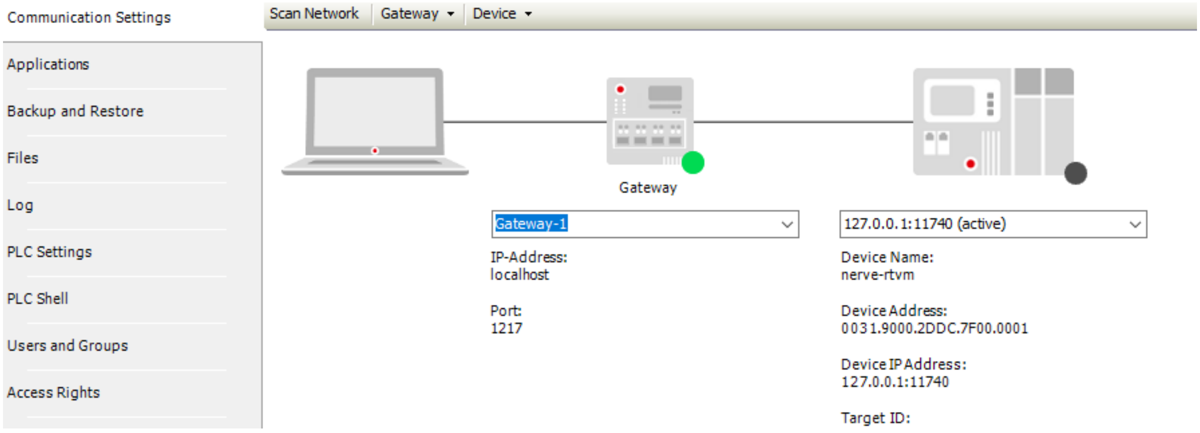
3333

Data about the establish remote tunnel is displayed on the right half of the Nerve Connection Manager window, showing the **Status**, **Connection target**, **Remote port** and **Local port** with a summary on the left side under the remote tunnel name.

NOTE

If the local port on the local workstation is already in use or occupied by the system, the Nerve Connection Manager will not establish a connection. **Local port** will be marked on the right. Enter a different port in this field that is not used on the workstation in order to establish the remote tunnel.

The connection can now be used from the local workstation by using `localhost:<localport>` through PuTTY in order to establish an SSH connection or in a web browser. The screenshot below shows how to connect to a node through a remote tunnel using the CODESYS Development System. In an open project, double-click **Device (Nerve_MFN_100)** in the tree view on the left. Go to **Communication Settings** in the middle of the window and enter `127.0.0.1:<portonpc>` in the text box under the device on the right. Replace `<portonpc>` with the port number that was defined under **Port on PC** in the Management System.



Gateway-1

IP-Address:
localhost

Port:
1217

127.0.0.1:11740 (active)

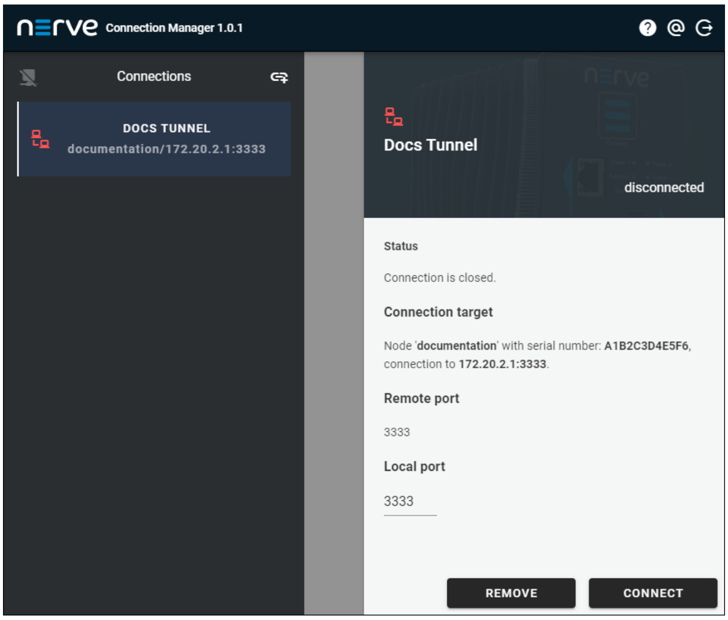
Device Name:
nerve-rtvm

Device Address:
0031.9000.2DDC.7F00.0001

Device IP Address:
127.0.0.1:11740

Target ID:

Disconnect from the remote tunnel by selecting **DISCONNECT** in the lower right corner of the Nerve Connection Manager.



DOCS TUNNEL
documentation/172.20.2.1:3333

Docs Tunnel
disconnected

Status
Connection is closed.

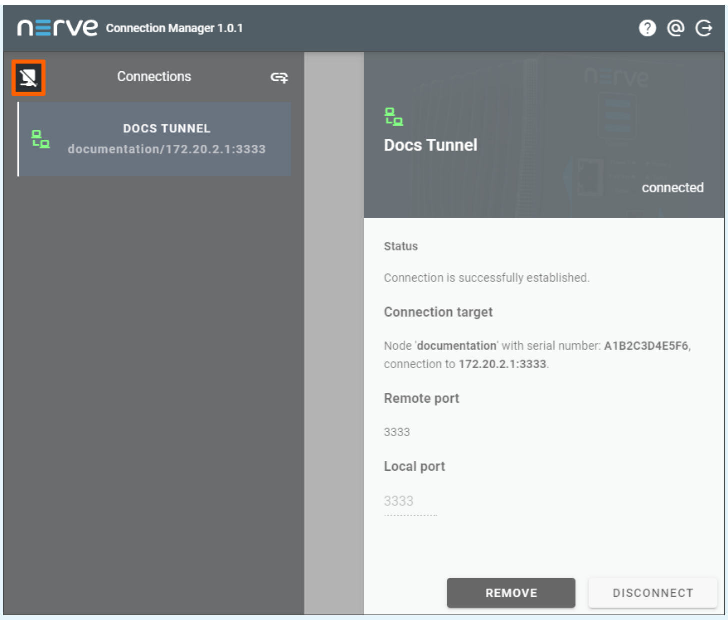
Connection target
Node 'documentation' with serial number: A1B2C3D4E5F6, connection to 172.20.2.1:3333.

Remote port
3333

Local port
3333

NOTE

Alternatively, all remote connections can be disconnected at once by selecting the **Disconnect all** symbol on the left side next to **Connections**.



Status

Connection is successfully established.

Connection target

Node '**documentation**' with serial number: **A1B2C3D4E5F6**, connection to **172.20.2.1:3333**.

Remote port

3333

Local port

3333

Note that disconnecting does not terminate the connection. The connection will stay established until it is terminated in the Nerve Connection Manager, the Local UI or the Management System.

Terminating remote connections

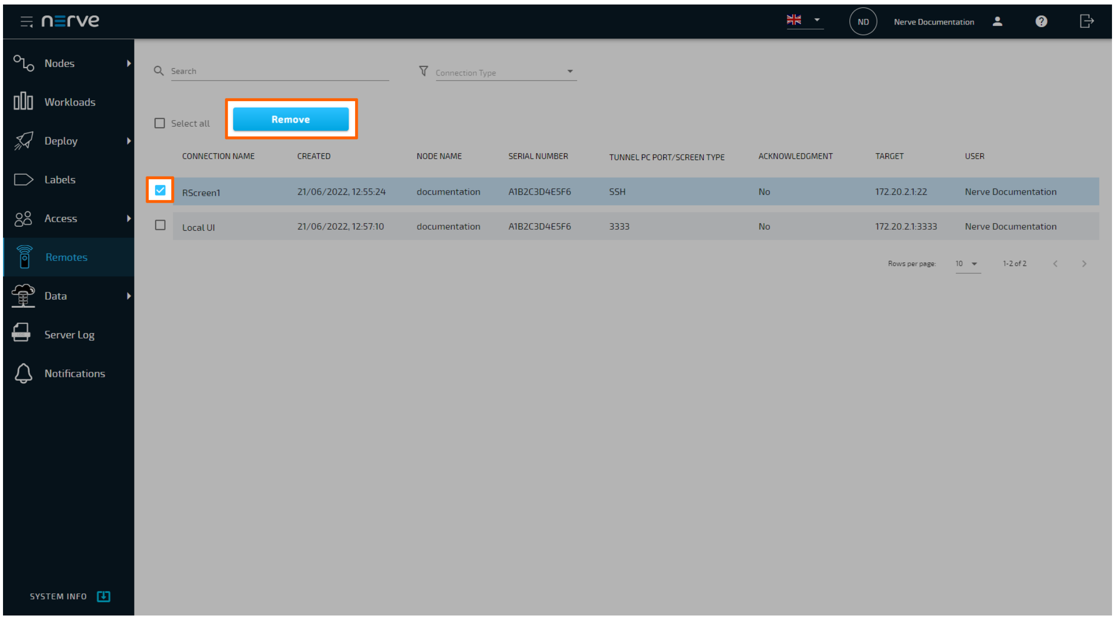
Remote connections can be used as long as they are not terminated. A remote connection can be terminated from the Management System, in the Local UI or in the Nerve Connection Manager. Also, remote connections terminate automatically after 30 minutes of inactivity. Once a connection has been terminated, it has to be established again.

Terminating an active remote connection in the Management System

Note that terminating an open remote connection does not remove the configuration of the remote connection from the node or workload. If a remote connection is terminated, it has to be re-established in the Management System to be used again.

1. Connect to the Management System.
2. Select **Remotes** in the navigation on the left.
3. Tick the checkbox next to the remote connection.

4. Select the **Remove** button.



	CONNECTION NAME	CREATED	NODE NAME	SERIAL NUMBER	TUNNEL PC PORT/SCREEN TYPE	ACKNOWLEDGMENT	TARGET	USER
☑	RScreen1	21/06/2022, 12:55:24	documentation	A1B2C3D4E5F6	SSH	No	172.20.2.1:22	Nerve Documentation
□	Local UI	21/06/2022, 12:57:10	documentation	A1B2C3D4E5F6	3333	No	172.20.2.1:3333	Nerve Documentation

5. Select **Yes** in the new window.

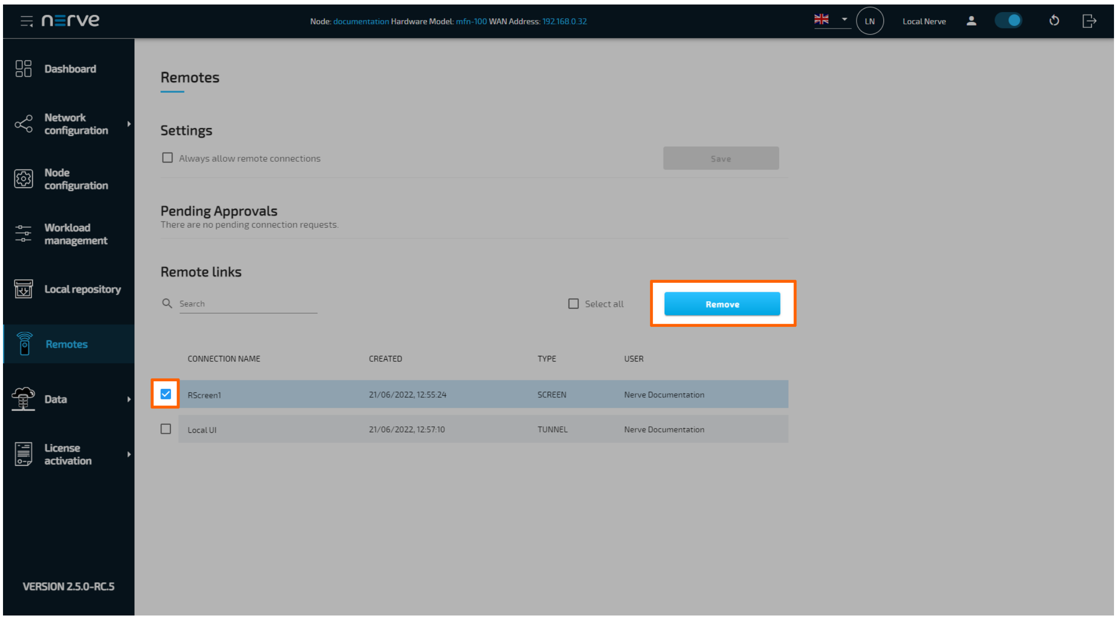
NOTE

Once a remote screen has been terminated while the browser tab is still open, a pop-up window will appear that offers the option to reconnect. Selecting **Reconnect** in the pop-up window has no effect. Close the window and re-established the connection in the Management System.

Terminating an active remote connection in the Local UI

Note that terminating an open remote connection does not remove the configuration of the remote connection from the node or workload. If a remote connection is terminated, it has to be re-established in the Management System to be used again.

1. Connect to the Local UI.
2. Select **Remotes** in the navigation on the left.
3. Tick the checkbox next to the remote connection.
4. Select the **Remove** button.



☐ Always allow remote connections

There are no pending connection requests.

☐ Select all

	CONNECTION NAME	CREATED	TYPE	USER
☑	RScreen1	21/06/2022, 12:55:24	SCREEN	Nerve Documentation
☐	Local UI	21/06/2022, 12:57:10	TUNNEL	Nerve Documentation

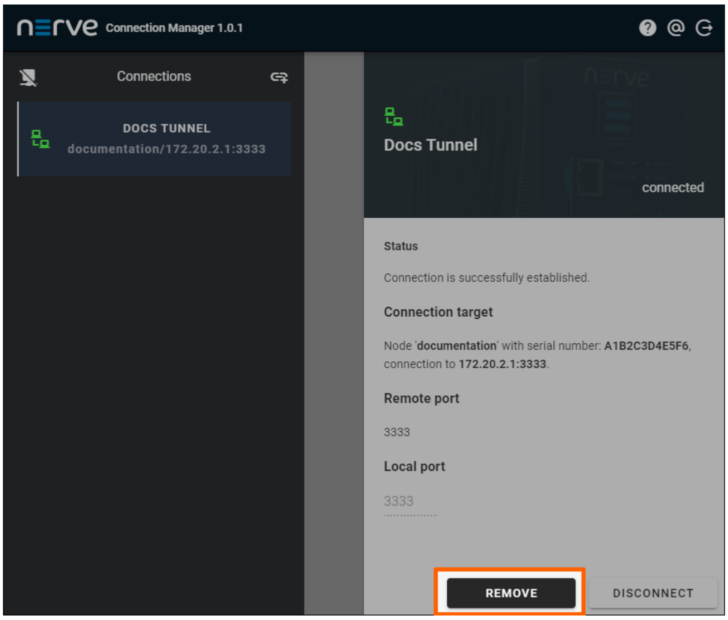
5. Select **Yes** in the new window.

Terminating a remote connection in the Nerve Connection Manager

Note that terminating an open remote connection does not remove the configuration of the remote connection from the node or workload. If a remote tunnel is terminated, it has to be re-established in the Management System to be used again.

1. Open the Nerve Connection Manager. Note that the Nerve Connection Manager will already be open if a remote tunnel has been established.
2. Select a remote connection that will be terminated in the list on the left.

3. Select **REMOVE** in the lower-right.



Status

Connection is successfully established.

Connection target

Node '**documentation**' with serial number: **A1B2C3D4E5F6**, connection to **172.20.2.1:3333**.

Remote port

3333

Local port

3333

4. Select **YES** in the overlay that appeared.

Note that exiting the Nerve Connection Manager terminates all remote tunnels.

Common error cases and known issues

Below is a list of most common error cases and known limitations. Hints how to avoid them or solve them the easiest way are given where applicable.

Remote screens

- When trying to connect to a suspended workload, long loading times might occur. The connection can also seem established but the user will not be able to act in the remote screen window. The reason might be that a remote screen to a suspended workload was attempted. This is not supported.

  Close the browser tab and terminate the connection in the Management System in that case. Make sure the workload is in the started state and re-establish the remote screen. If the behavior persists, investigate the workload settings or the node.

- Remote screens to workloads will be shown as active under **Remotes** if the workload is undeployed while the remote screen is being used.

Remote tunnels

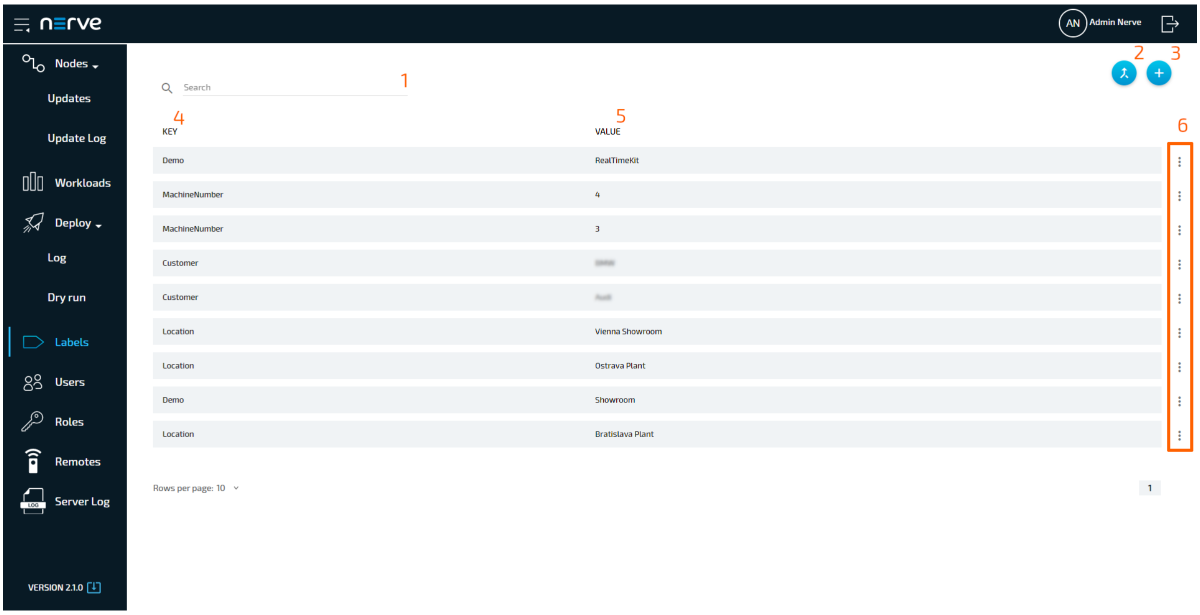
- Using two remote tunnels to two nodes, accessing the Local UI of each node at the same time is not possible. This is due to authentication conflicts.

  Use the incognito mode of the current browser for the second tab or a second browser if both Local UIs have to be operated at the same time.

- Some systems might restrict usage of local ports lower than 1024. This is true for Linux systems especially. Enter ports higher than 1024 under **Port on PC** when configuring a remote tunnel to avoid port conflicts.

Labels

Labels are a useful feature that help with the organization of nodes and workloads. They can be defined and used freely. All labels that have been created are listed in the labels menu.



KEY	VALUE
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

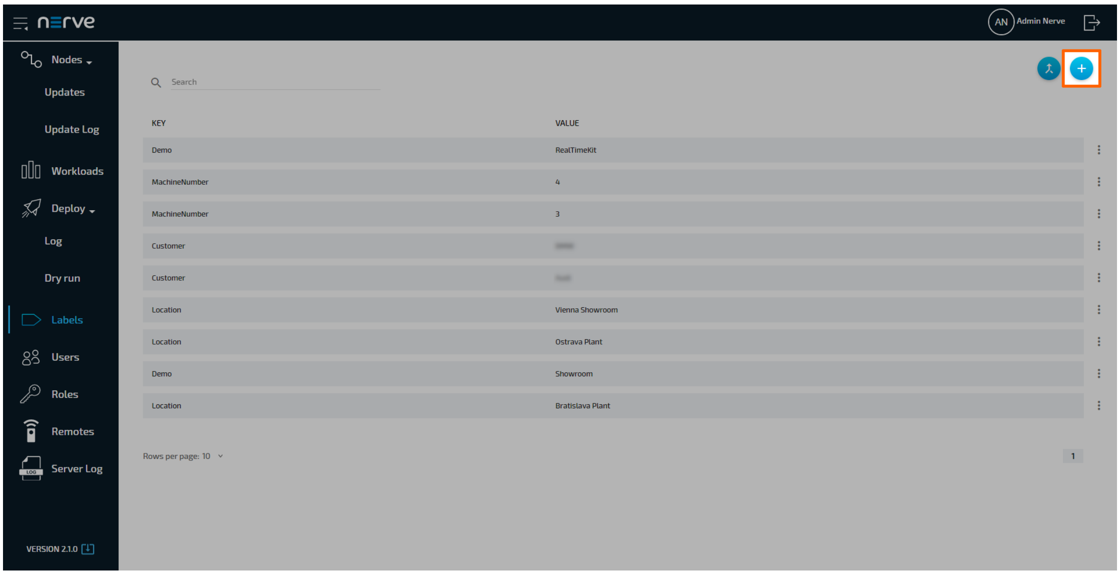
Item	Description
Search bar (1)	Use the search bar to filter labels by key.
Merge labels (2)	Clicking here leads to a page that allows to merge existing labels.
Add new label (3)	Click here to add a new label consisting of label key and label value.
KEY (4)	This is the key of the label. It can be understood as the "category" of the label. Examples of label keys are location, machine number or hardware.
VALUE (5)	This is the value of the label. It corresponds to the key of the label. Examples are Vienna, Machine 1 or MFN 100.
Ellipsis menu (6)	Clicking here opens an overlay that allows the deletion of labels.

Adding a new label

Labels can be defined with any key and value. Note that labels are displayed in the <key>:<value> format in the Management System. The key of a label can be understood as the category of a label with the value being an item in that category. Example: `Location:Vienna`.

1. Select **Labels** in the menu on the left side.

2. Click the **Add new label** icon in the upper-right corner.



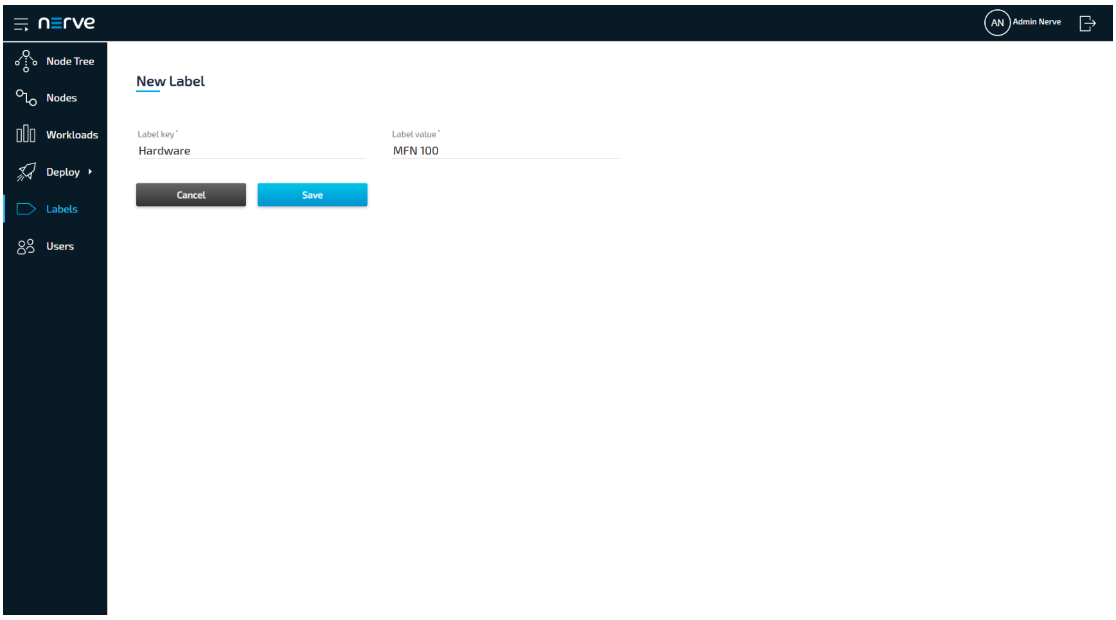
KEY	VALUE
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

3. Enter the following information:

Item	Description
Label key	Enter the "category" of the label. Example: **Hardware**.
Label value	Enter the value for the label here. Example: **MFN 100**.

> **NOTE**
>
> Label keys must consist of one word only. Use `-` and `_` as separators.
> Also, only use alphanumeric characters (`a-z`, `A-Z`, `0-9`) and underscore (`_`). Any other special characters are not allowed.

4. Click **Save** to add the new label.



Label key*: Hardware

Label value*: MFN 100

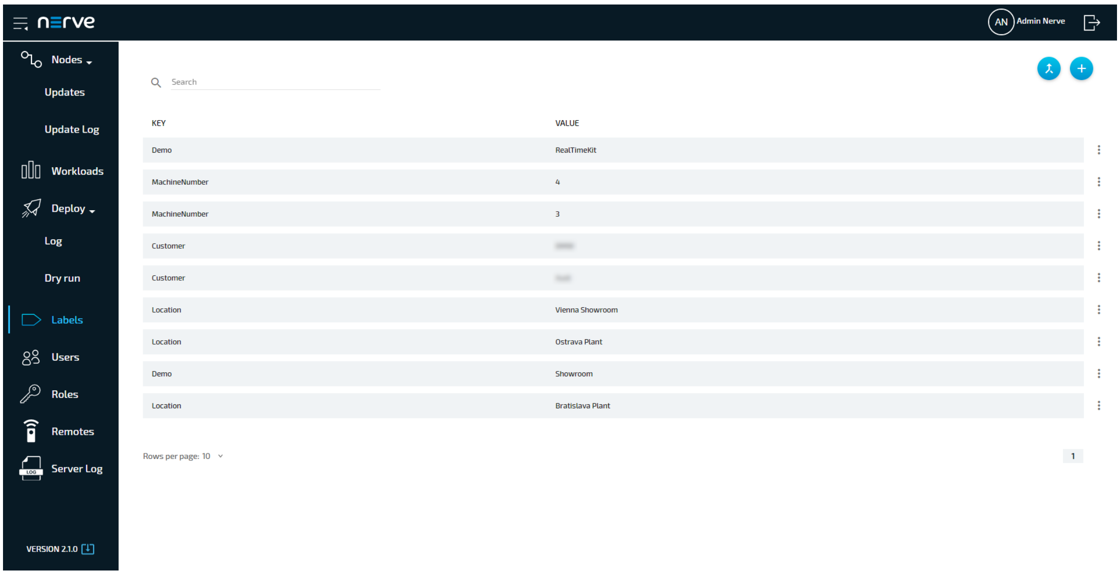
The label now appears in the label list and can be used in the Management System. Labels can be assigned to nodes when node details are edited. In the workload provisioning process they can be chosen as selectors.

Editing a label

Editing a label is virtually identical to the process of creating a new label. Note that labels will be edited even if they are currently assigned to nodes or used as selectors by workloads.

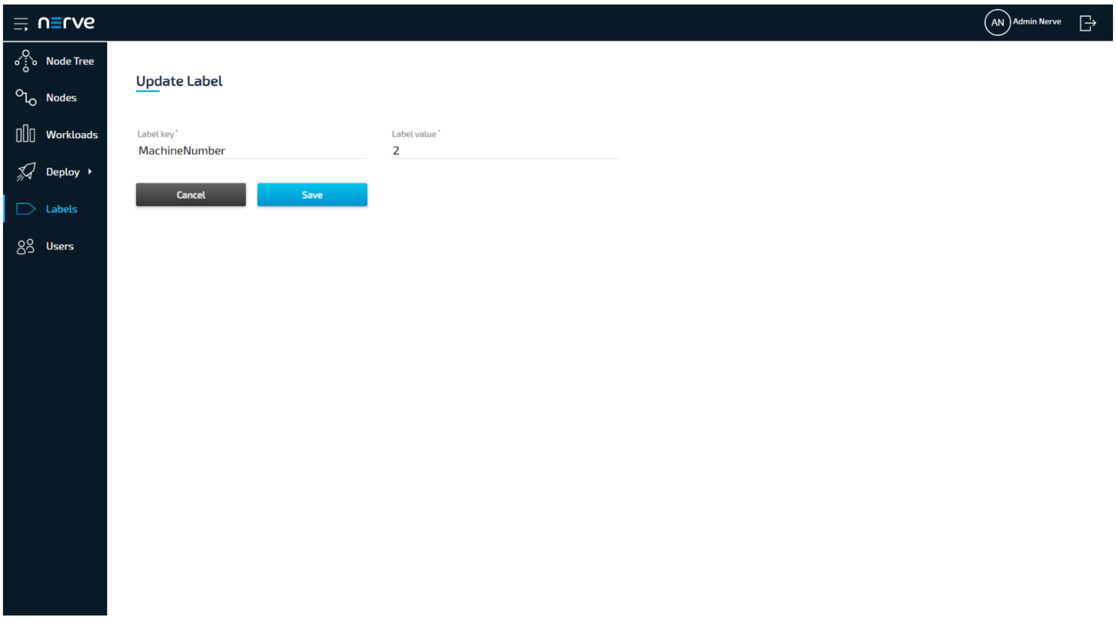
1. Select **Labels** in the menu on the left side.

2. Select a label to edit.



KEY	VALUE
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

3. Edit **Label key** and **Label value**.



Label key*: MachineNumber

Label value*: 2

NOTE

Label keys must consist of one word only. Use `-` and _ as separators.
Also, only use alphanumeric characters (`a-z`, `A-Z`, `0-9`) and underscore (_). Any other special characters are not allowed.

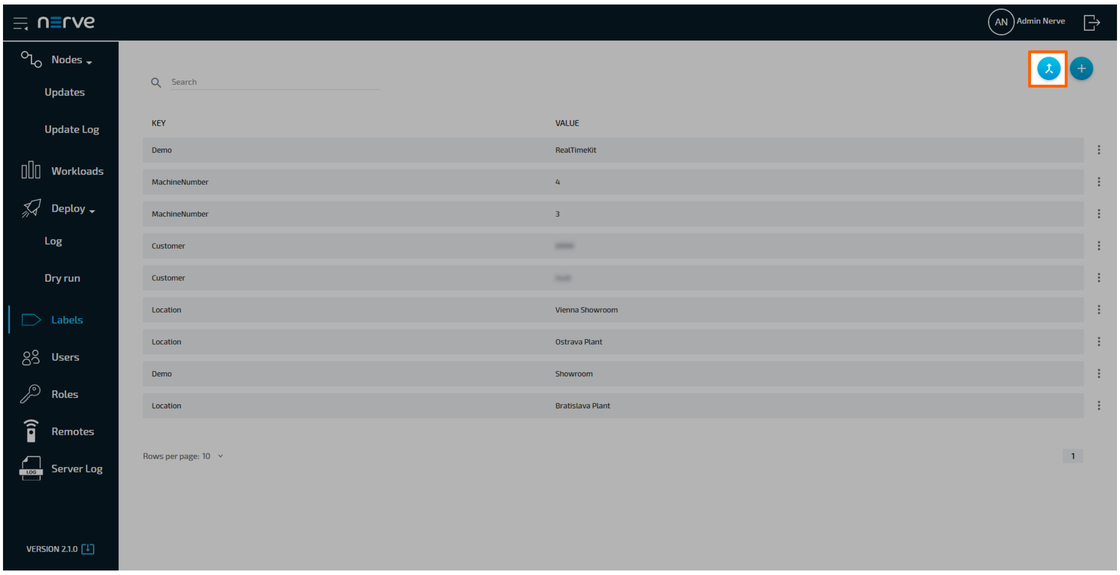
4. Click **Save** to update the label.

Merging labels

Labels with overlapping information or typos can be merged into one. However, only label keys are merged. The label values are left untouched and assigned to the new label key.

1. Select **Labels** in the menu on the left side.

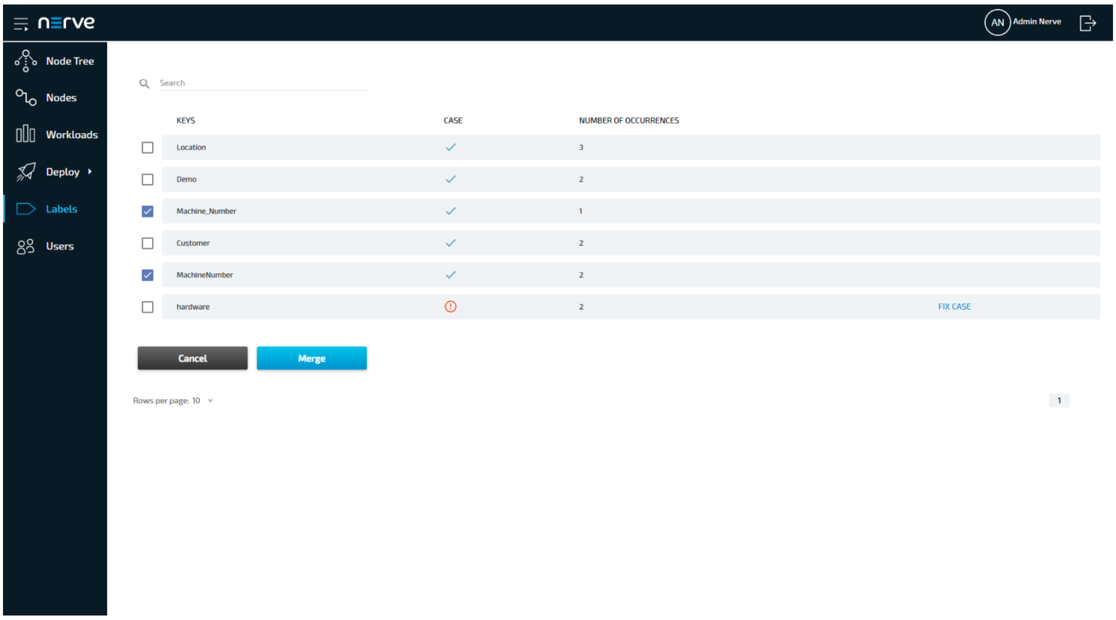
2. Click the **Merge labels** icon in the upper-right corner.



KEY	VALUE
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

3. Tick the checkboxes left of the labels that will be merged. Multiple labels can be selected.

4. Select **Merge**.



	KEYS	CASE	NUMBER OF OCCURRENCES	
☐	Location	✓	3	
☐	Demo	✓	2	
☑	Machine_Number	✓	1	
☐	Customer	✓	2	
☑	MachineNumber	✓	2	
☐	hardware	!	2	FIX CASE

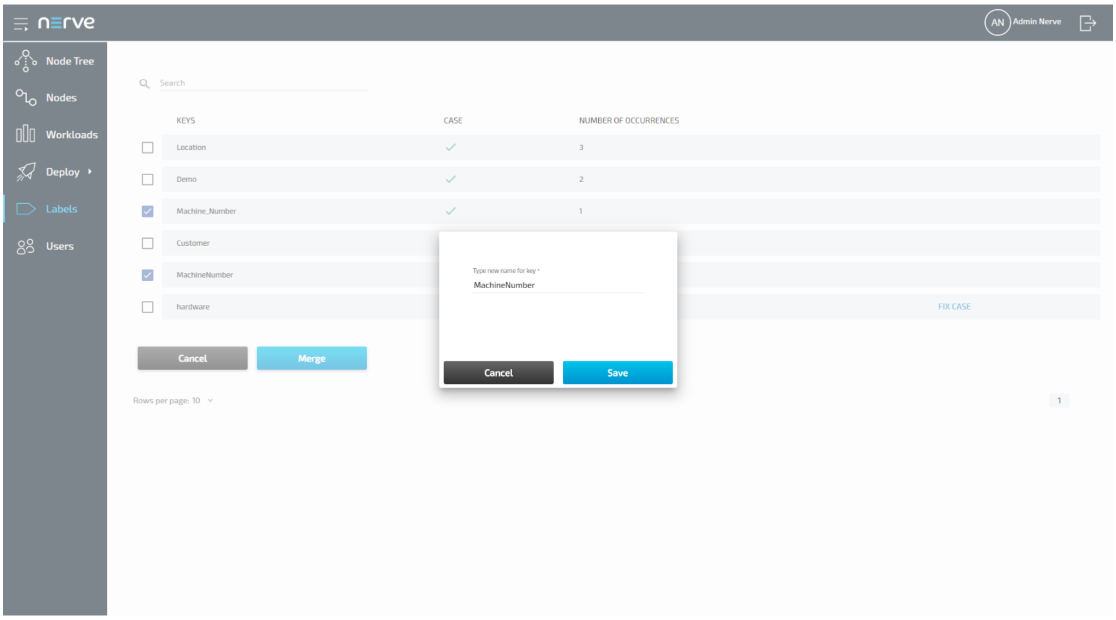
NOTE

The table here gives the following information:

- **CASE**
  The system checks if labels that use the same characters are also written in the same case. A green check mark indicates that the case matches. A circled red exclamation mark appears if the case does not match.

- **NUMBER OF OCCURRENCES**
  The number here indicates how many labels have been defined with the same label key.

5. Type in the new name for the label key.

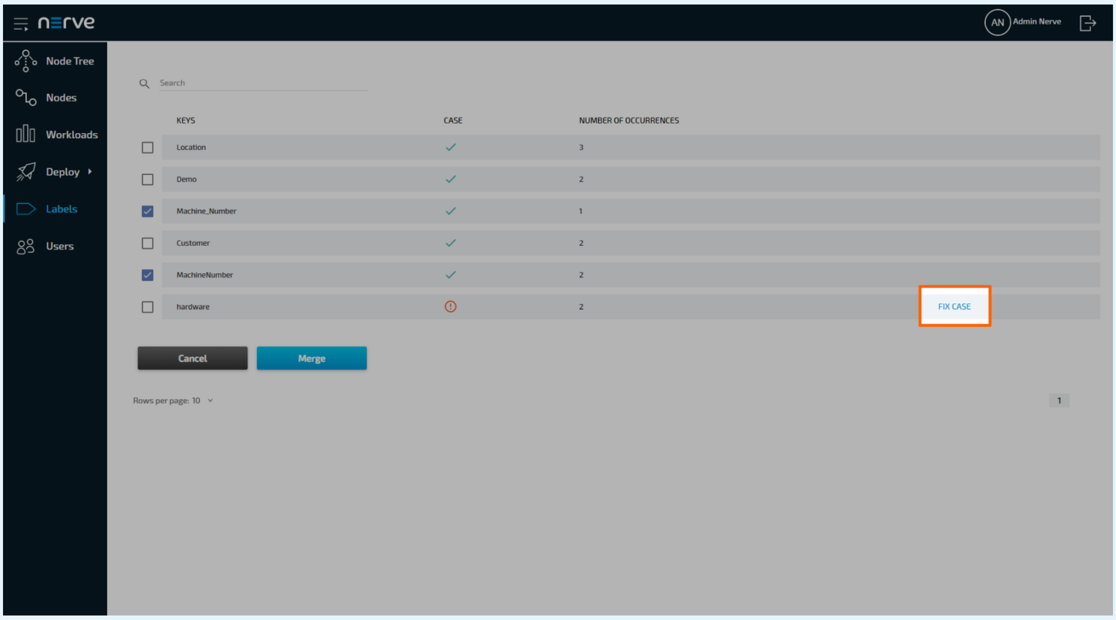


Type new name for key *: MachineNumber

6. Click **Save** to save the new label.

NOTE

If labels have the same label key but are not written in the same case, the Management System will recognize it. In this case, select **FIX CASE** in the list, type in the new name for the label key and select **Save**.

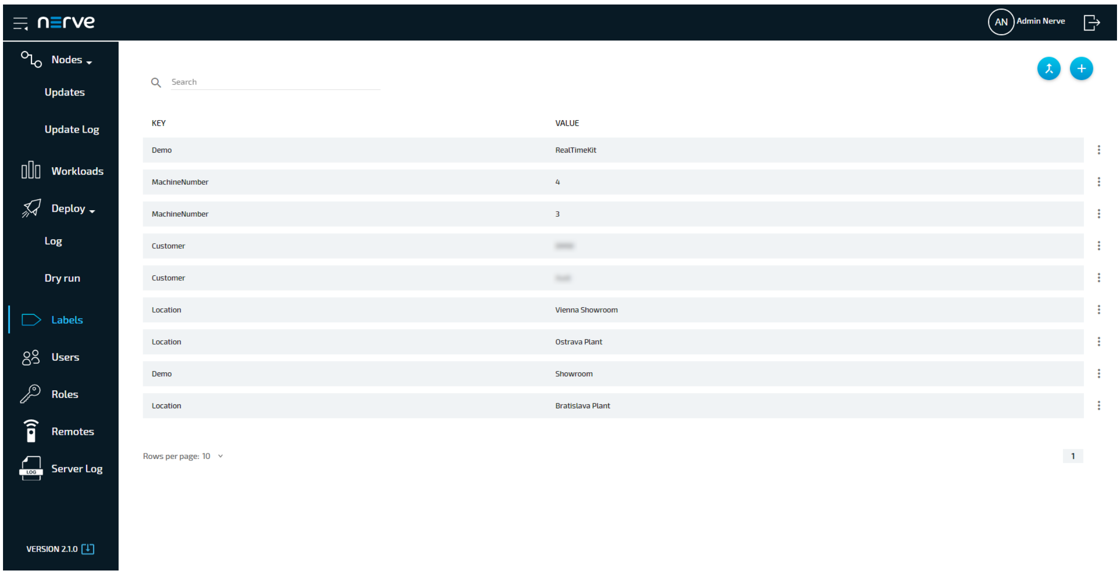


	KEYS	CASE	NUMBER OF OCCURRENCES
□	Location	✓	3
□	Demo	✓	2
☑	Machine_Number	✓	1
□	Customer	✓	2
☑	MachineNumber	✓	2
□	hardware	!	2

Deleting a label

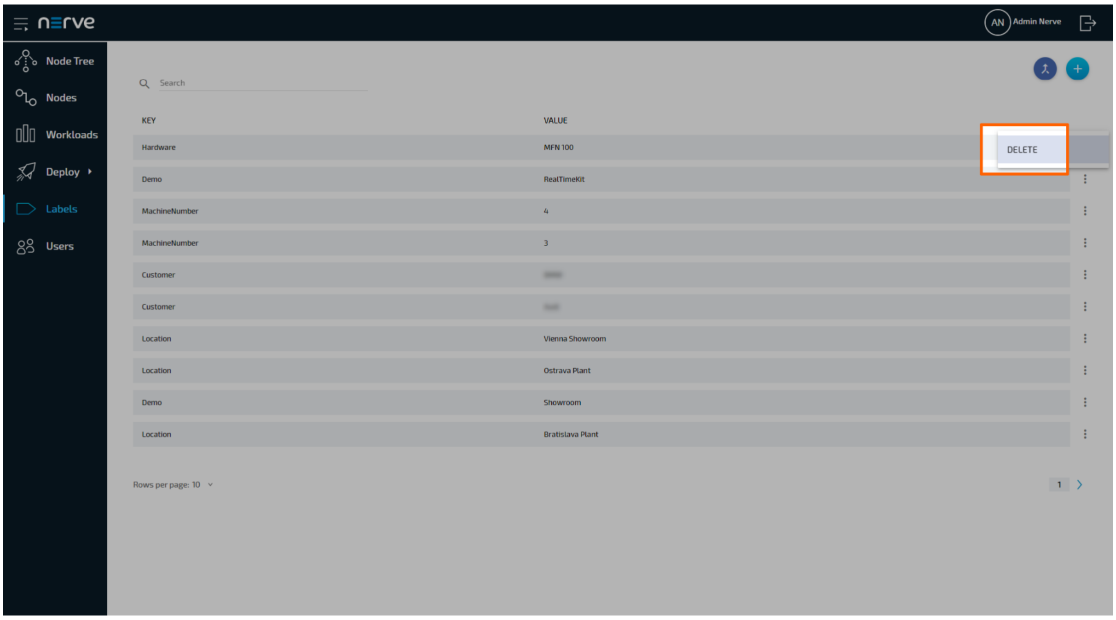
Note that when a label is deleted from the list, it will also be deleted from any node or workload that had the label assigned.

1. Select **Labels** in the menu on the left side.
2. Choose a label to delete.



KEY	VALUE
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

3. Click the ellipsis menu on the right side of the label.
4. Select **Delete** in the overlay that appeared.



KEY	VALUE
Hardware	MFN 100
Demo	RealTimeKit
MachineNumber	4
MachineNumber	3
Customer	[redacted]
Customer	[redacted]
Location	Vienna Showroom
Location	Ostrava Plant
Demo	Showroom
Location	Bratislava Plant

5. Click **OK** to delete the label.

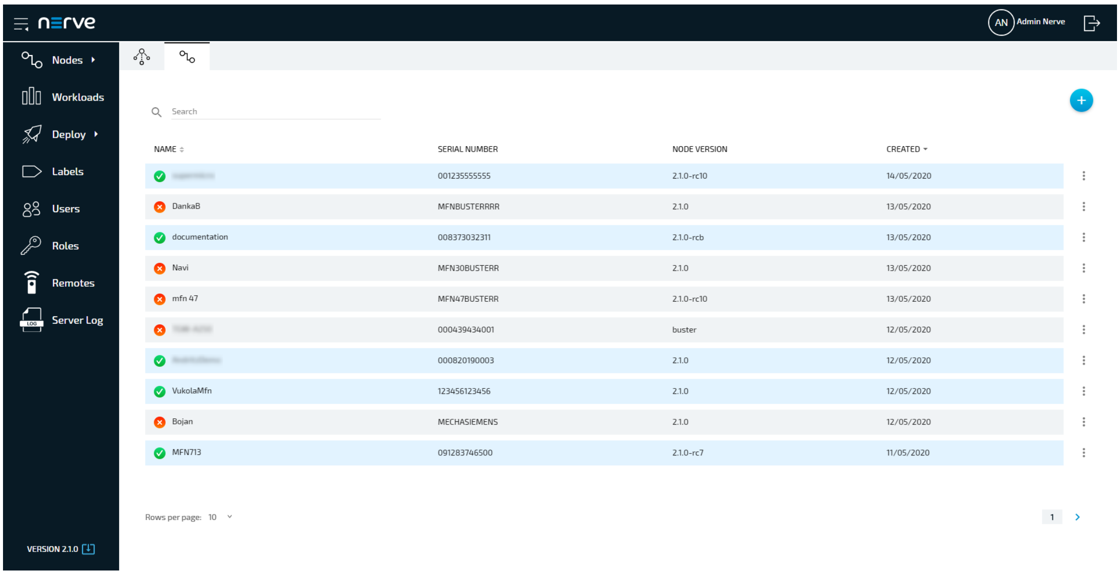
Adding a label to a node

Adding a label to a node is done in the node menu. It is recommended to create labels before they are added to nodes.

1. Select **Nodes** in the navigation on the left.
2. Select the nodes tab

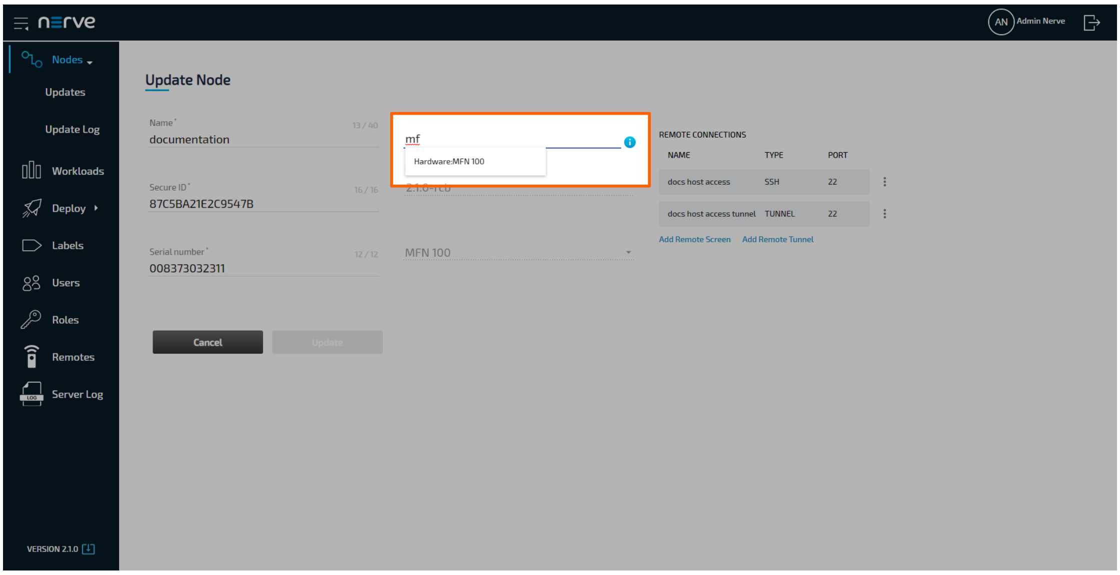
   on the right to display the list of registered nodes.

3. Select a node to which a label will be assigned.



NAME	SERIAL NUMBER	NODE VERSION	CREATED
✓ [redacted]	001235555555	2.1.0-rc10	14/05/2020
✕ DankaB	MFNBUSTERRRR	2.1.0	13/05/2020
✓ documentation	008373032311	2.1.0-rcb	13/05/2020
✕ Navi	MFN30BUSTERR	2.1.0	13/05/2020
✕ mfn 47	MFN47BUSTERR	2.1.0-rc10	13/05/2020
✕ [redacted]	000439434001	buster	12/05/2020
✓ [redacted]	000820190003	2.1.0	12/05/2020
✓ VukolaMfn	123456123456	2.1.0	12/05/2020
✕ Bojan	MECHASIEMENS	2.1.0	12/05/2020
✓ MFN713	091283746500	2.1.0-rc7	11/05/2020

4. Start typing in the **Insert label** field. Available labels will be displayed if they match the typed string.



Update Node

Name* 13 / 40
documentation

Secure ID* 16 / 16
87C5BA21E2C9547B

Serial number* 12 / 12
008373032311

mf
Hardware:MFN 100

2.1.0-rcb

MFN 100

REMOTE CONNECTIONS

NAME	TYPE	PORT
docs host access	SSH	22
docs host access tunnel	TUNNEL	22

Add Remote Screen Add Remote Tunnel

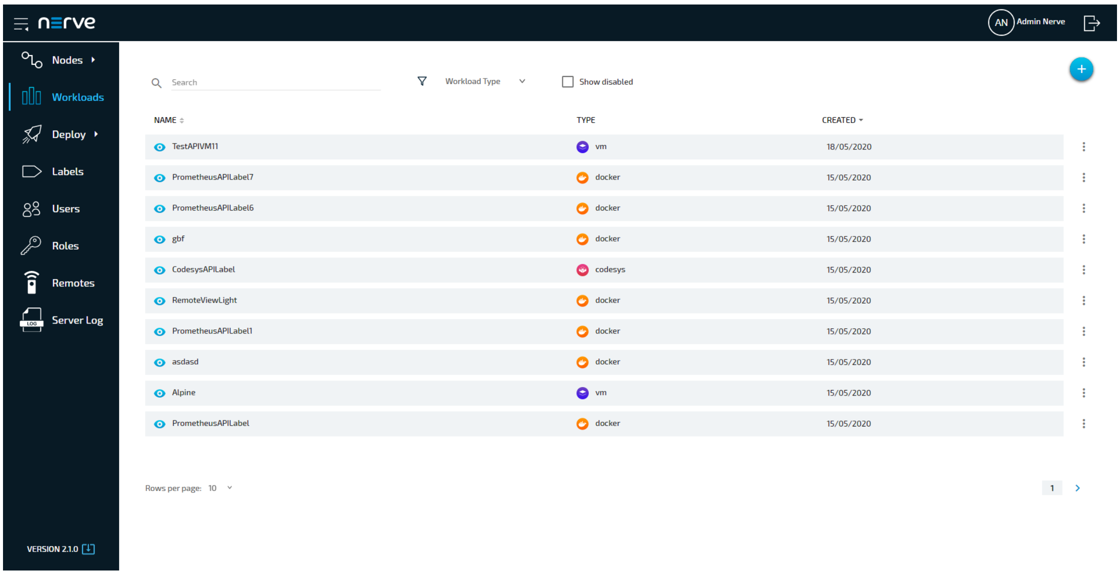
Cancel Update

5. Select a label from the suggestions.
6. Select **Update** to save the changes to the node.

Adding a label to a workload

Adding a label to a workload is done in the workloads menu. It is recommended to create labels before they are added to workloads. Note that only pre-defined labels can be added to workloads.

1. Select **Workloads** in the navigation on the left.
2. Select a workload to which a label will be assigned.



NAME	TYPE	CREATED
TestAPIVM11	vm	18/05/2020
PrometheusAPILabel7	docker	15/05/2020
PrometheusAPILabel6	docker	15/05/2020
gbf	docker	15/05/2020
CodesysAPILabel	codesys	15/05/2020
RemoteViewLight	docker	15/05/2020
PrometheusAPILabel1	docker	15/05/2020
asdasd	docker	15/05/2020
Alpine	vm	15/05/2020
PrometheusAPILabel	docker	15/05/2020

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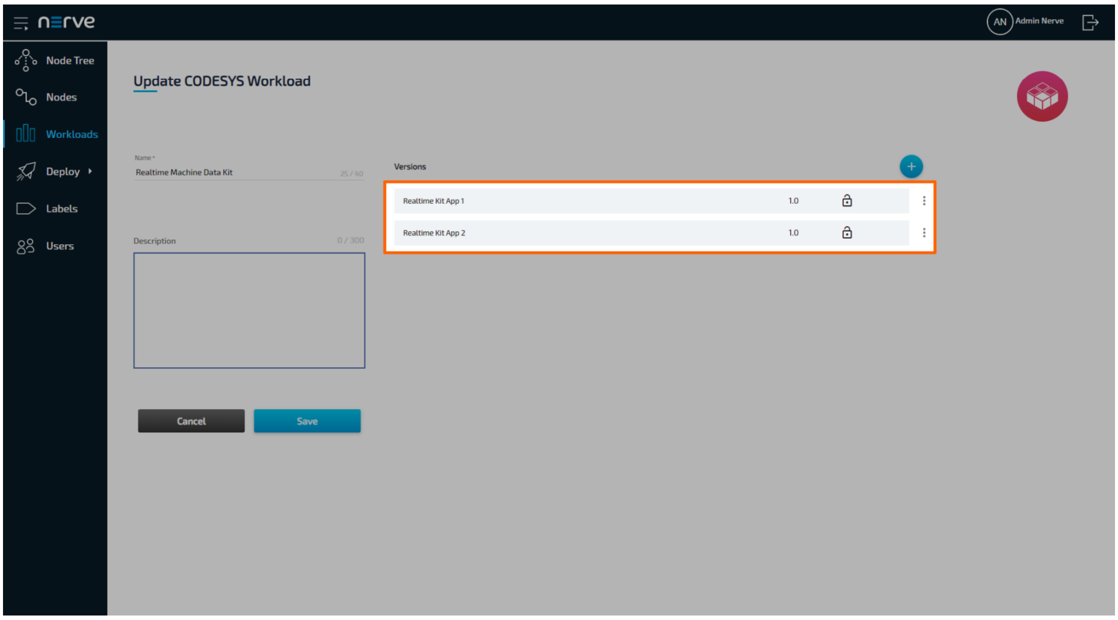
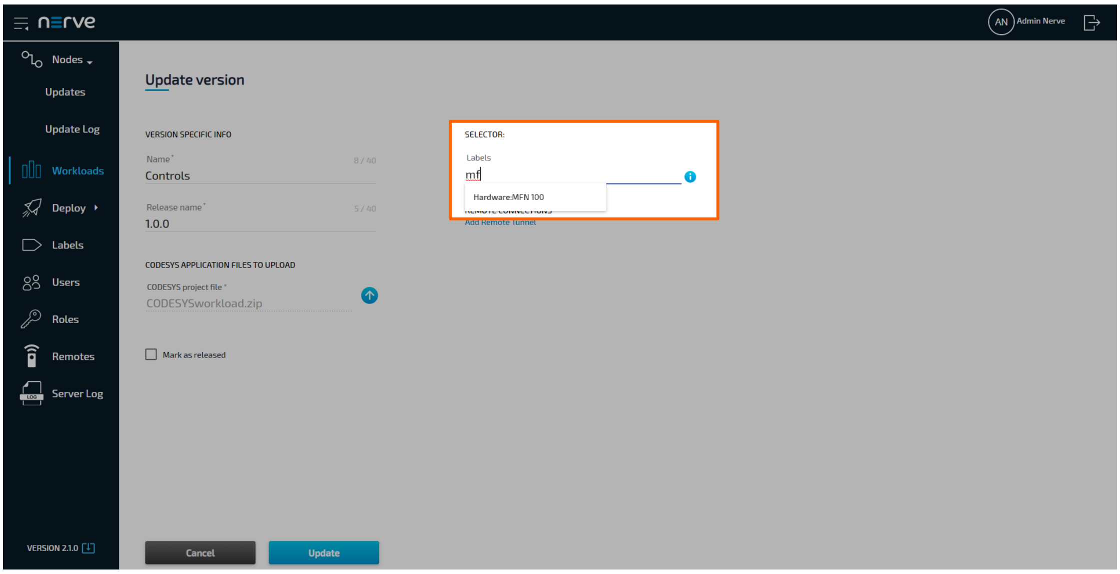
3. Select the workload version to which a label will be assigned.



4. Start typing in the **Insert label** field. Available labels will be displayed if they match the typed string.



5. Select a label from the suggestions.

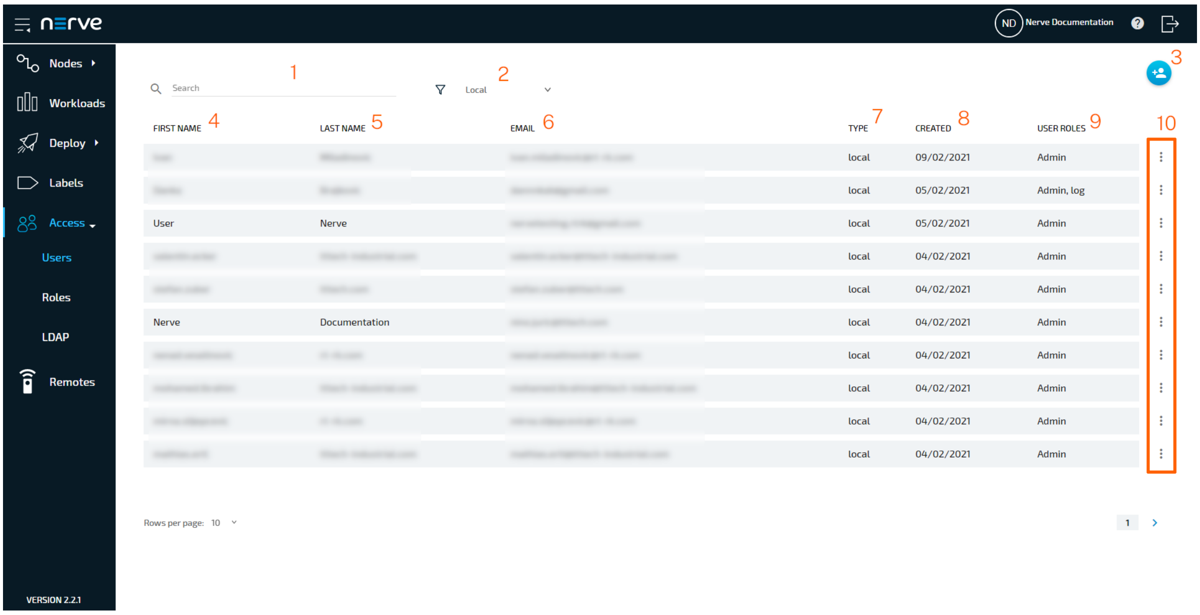
6. Select **Update** to save the changes to the node.

Users

NOTE

This page describes the standard user management in the Nerve Management System. When LDAP authentication is active, user attributes and details are carried over from an LDAP server. Refer to LDAP for more information on LDAP synchronization.

This menu offers a list of all registered users. Every user has their own user profile with details about the user. There is one default user that is created with the Management System. The credentials for this user can be found in the customer profile.

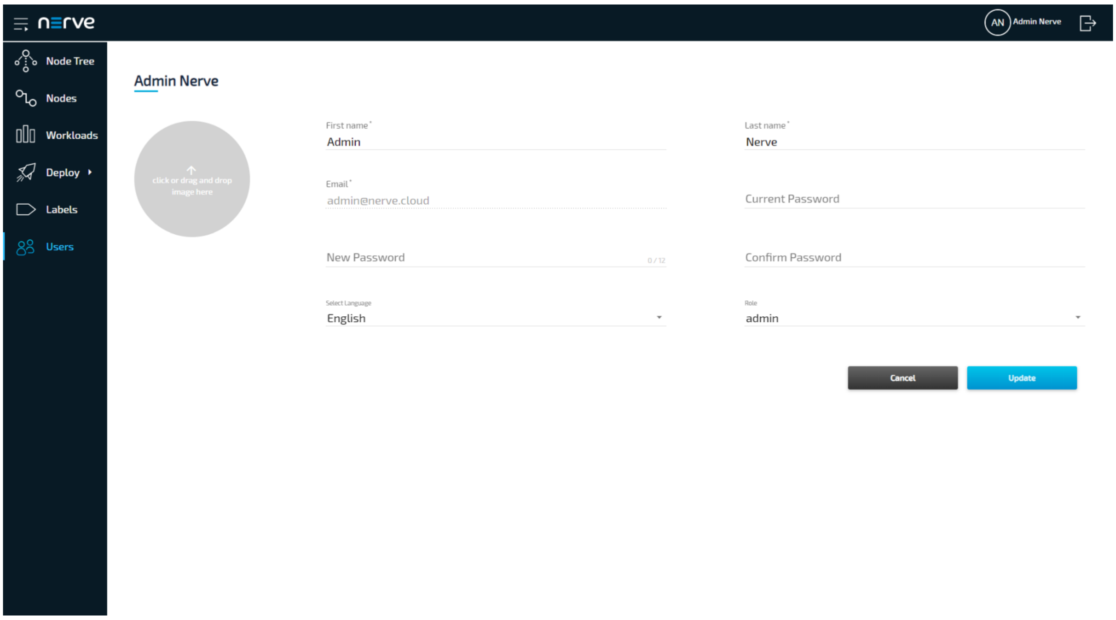


FIRST NAME	LAST NAME	EMAIL	TYPE	CREATED	USER ROLES
[redacted]	[redacted]	[redacted]	local	09/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	05/02/2021	Admin, log
User	Nerve	[redacted]	local	05/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
Nerve	Documentation	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin

Item	Description
Search bar (1)	Use the search bar to filter the list of users. The columns **FIRST NAME**, **LAST NAME** and **EMAIL** are the targets of the search.
Type filter (2)	Filter the list of users by authentication method. The target of the filter is the **TYPE** column and the options are **Local**, **LDAP** and **All**.
Add new user (3)	Select this icon to add a new user. Note that new users cannot be added when LDAP synchronization is active.
FIRST NAME (4)	This is the first name of the registered user. It is displayed in the upper-right corner when the user is logged in.
LAST NAME (5)	This is the last name of the registered user. It is displayed in the upper-right corner when the user is logged in.

Item	Description
EMAIL (6)	This is the e-mail address of the user. It is used as the username for logging in to the Management System in case of local authentication. When LDAP authentication is active, the username attribute that is carried over from LDAP synchronization is used to log in. The system also uses this e-mail for sending the activation link and the instructions on how to reset the login password. Note that passwords cannot be changed or reset if LDAP authentication is active.
TYPE (7)	This column shows the type of the user according to the authentication method used: • **Local** This describes users that are created locally through the Management System. They authenticate against the Management System itself when logging in. • **LDAP** This describes users that are created following an LDAP synchronization. They authenticate against the defined LDAP server when logging in.
CREATED (8)	This is the date the user was created. The date format is DD/MM/YYYY.
USER ROLES (9)	The roles that are assigned to a user are displayed in this column.
Ellipsis menu (10)	Clicking here opens an overlay that allows the deletion of users.

Clicking any of the users leads to their user profile. An admin can edit the details of any user profile if local authentication is active. This includes **First name**, **Last name**, **Select language** and **Role**. The e-mail address of a user cannot be changed. The password for an account can only be changed by the respective user. Note that users cannot be edited when LDAP authentication is active.



First name* Admin

Last name* Nerve

Email* admin@nerve.cloud

Current Password

New Password 0 / 12

Confirm Password

Select Language English

Role admin

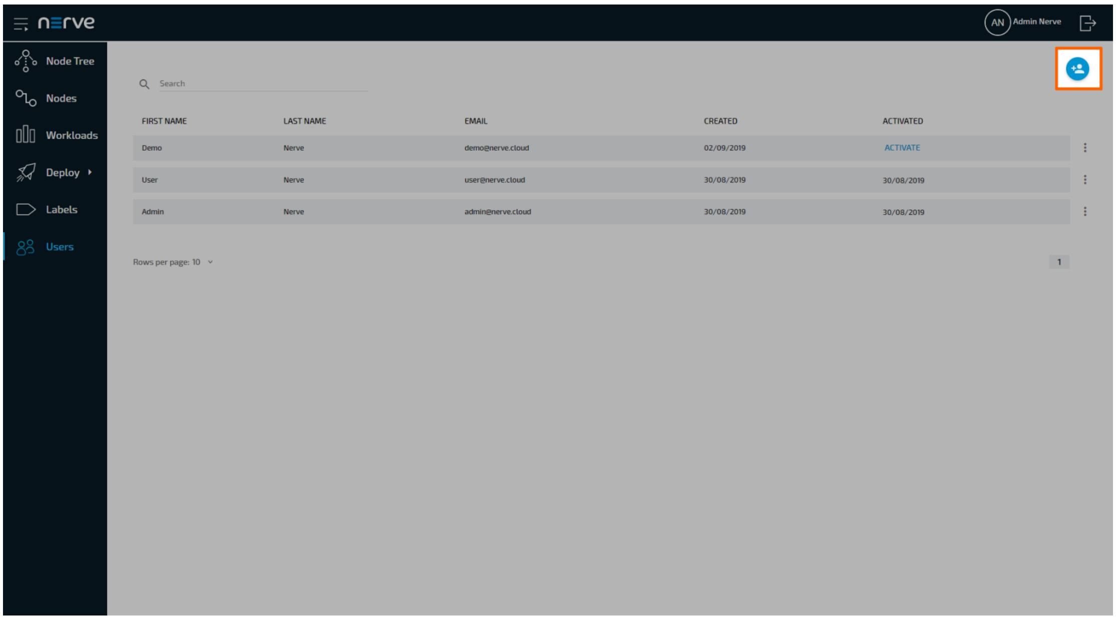
Item	Description
Profile Picture	Click here or drag and drop an image into the gray circle to upload a profile picture for the user. It is displayed in the upper-right corner when the user is logged in. Note that a profile picture cannot be set for users coming from LDAP synchronization.
FIRST NAME	This is the first name of the registered user. It is displayed in the upper-right corner when the user is logged in.
LAST NAME	This is the last name of the registered user. It is displayed in the upper-right corner when the user is logged in.
EMAIL	This is the e-mail address of the user. It is used as the username for logging in to the Management System in case of local authentication. When LDAP authentication is active, the username attribute that is carried over from LDAP synchronization is used to log in. The system also uses this e-mail for sending the activation link and the instructions on how to reset the login password. Note that passwords cannot be changed or reset if LDAP authentication is active.
Current Password	Enter the current password here when changing the password. This can only be done by the active user when local authentication is active.
New Password	Enter the new password here when changing the password. This can only be done by the active user when local authentication is active.
Confirm Password	Enter the new password again when changing the password. This can only be done by the active user when local authentication is active.
Select Language	Select the Management System language from the drop-down menu.
Role	This defines the role of the user. Refer to Roles and Permissions for more information.

Adding a new user

Admin users or users having the **UI_USER:CREATE** permission assigned in a role need to create new users before these can set a password and log in to the Management System. Note that new users cannot be added when LDAP authentication is active.

1. Select **Users** in the menu on the left side.

2. Click the **Add new user** symbol in the upper-right corner.



FIRST NAME	LAST NAME	EMAIL	CREATED	ACTIVATED
Demo	Nerve	demo@nerve.cloud	02/09/2019	ACTIVATE
User	Nerve	user@nerve.cloud	30/08/2019	30/08/2019
Admin	Nerve	admin@nerve.cloud	30/08/2019	30/08/2019

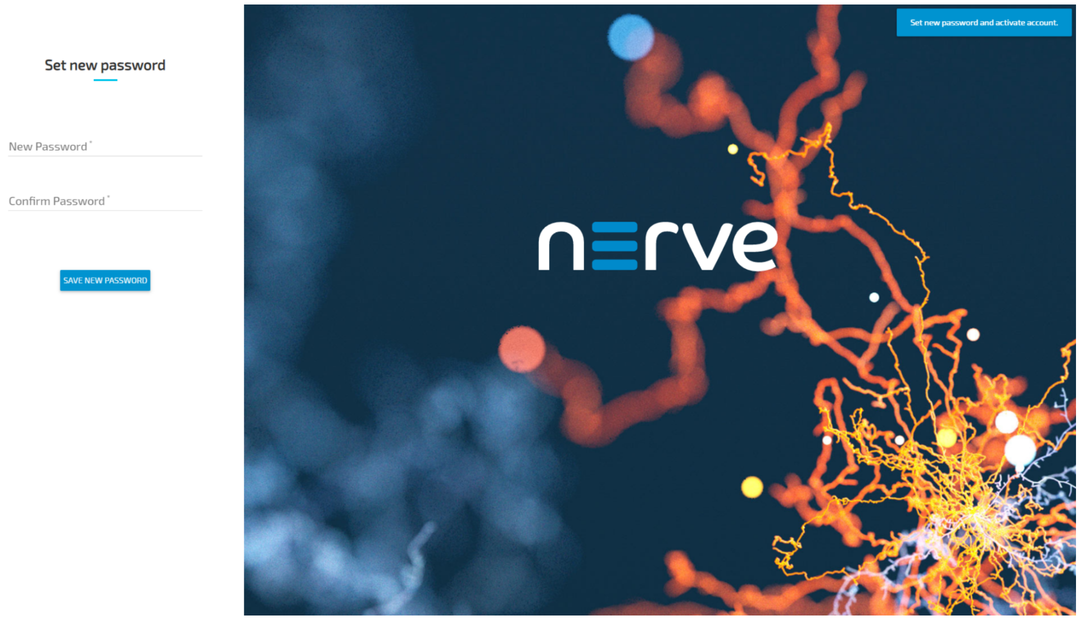
3. Enter the required information: **First name**, **Last name** and **Email**.
4. Select one or more roles from the drop-down menu under **Role**.
5. Select **Save** to create the user.

The user account needs to be activated after it has been created by clicking an activation link. The activation link is sent to the e-mail address that was specified during the creation of the user. The activation e-mail is sent automatically by the Management System shortly after the user is created.

Activating a user

Newly created users are sent an activation link to the specified e-mail address when the user was created. Following the link, the user will need to set their password in order to be activated and to be able to log in to the Management System.

1. Follow the activation link that was sent to the specified e-mail address.
2. Enter the new password to use for Management System access under **New Password** and **Confirm Password**.



NOTE

The password must contain at least one uppercase letter, one lowercase letter and one number. It must be at least 7 characters.

3. Select **SAVE NEW PASSWORD**.

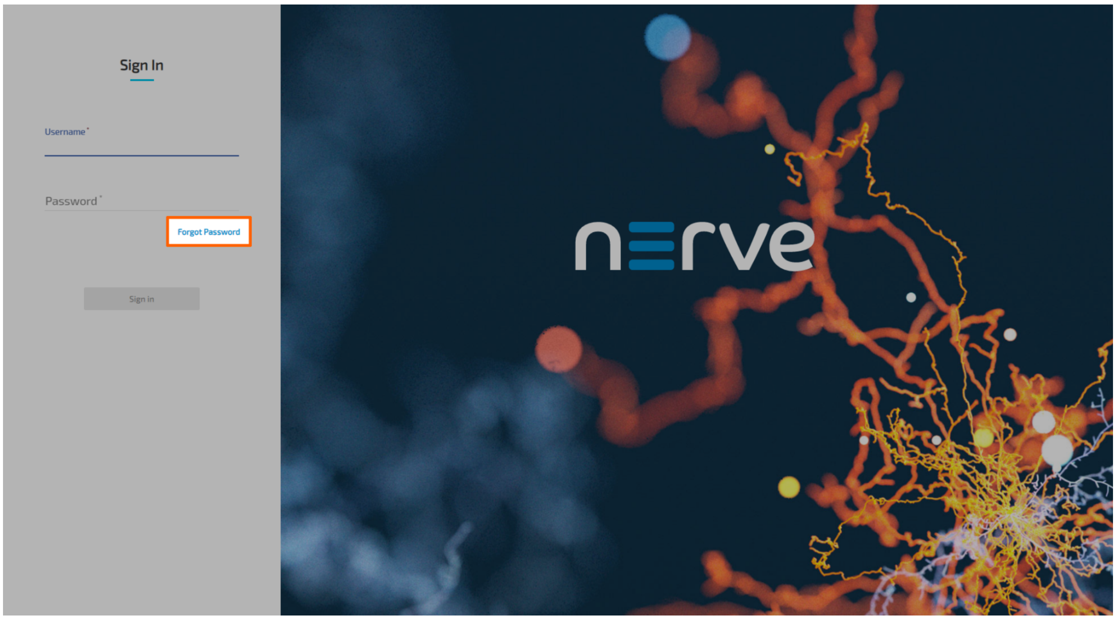
The new user is now activated and can log in immediately with their e-mail address and the password they have defined.

Resetting the password

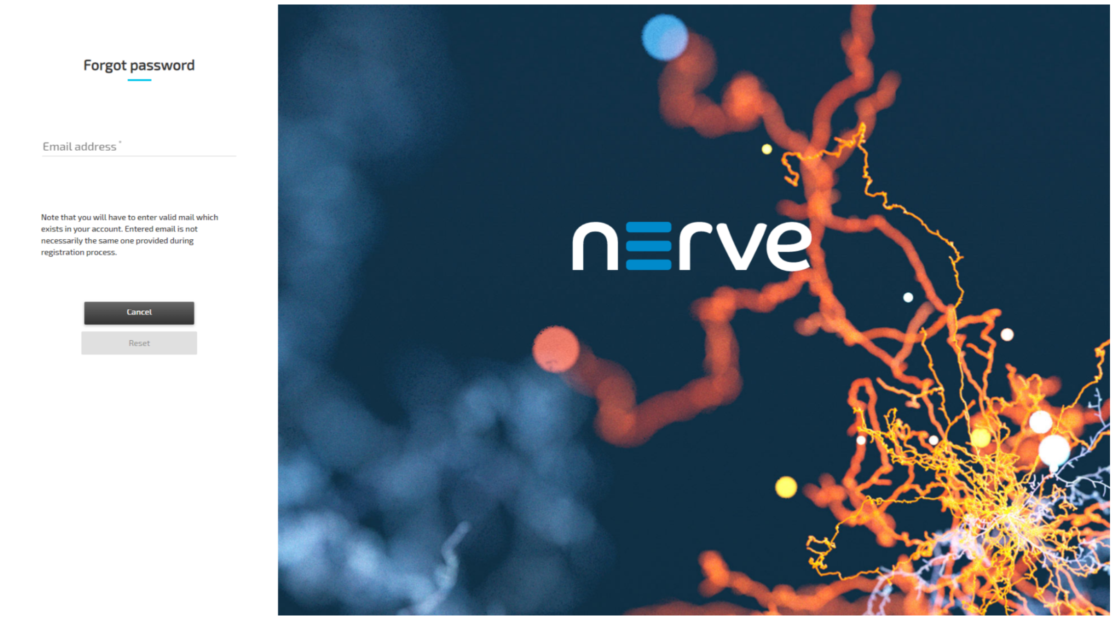
In case a user does not remember their password, a request to reset the password can be sent from the login page of the Management System.
Note that passwords cannot be reset if LDAP authentication is active.

1. Enter the URL of the Management System in a browser.

2. Select **Forgot Password**.



3. Enter the e-mail address of the account that needs to reset the password.

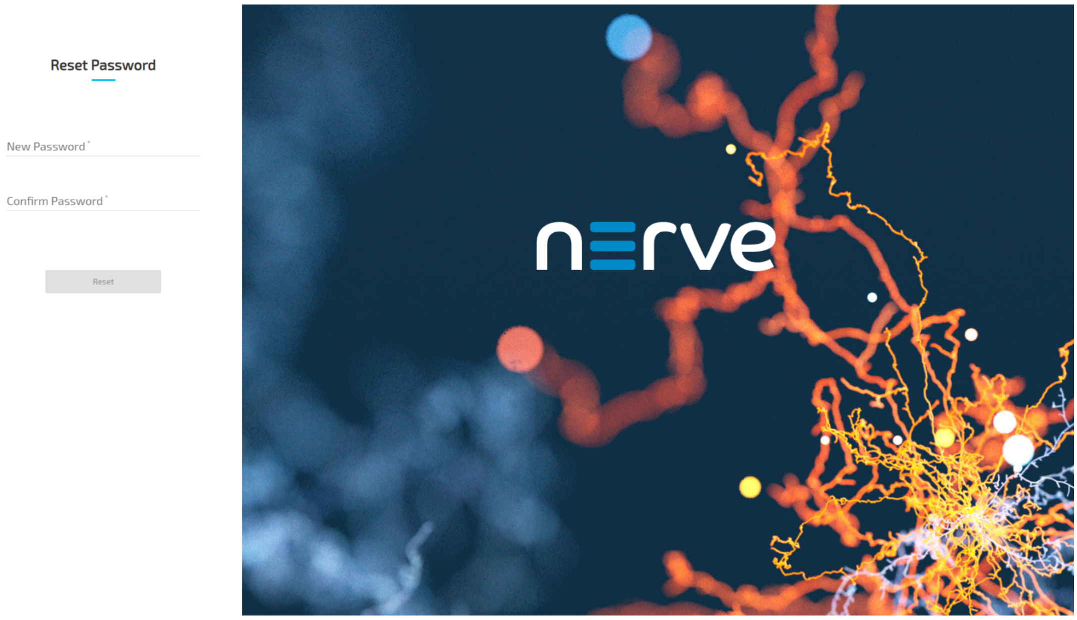


Note that you will have to enter valid mail which exists in your account. Entered email is not necessarily the same one provided during registration process.

4. Select **Reset**. An e-mail with instructions is sent to the e-mail address of the account.

5. Follow the link from the e-mail to reset the password.

6. Enter the new password for Management System access under **New Password** and **Confirm Password**.



7. Select **Reset** to save the new password.

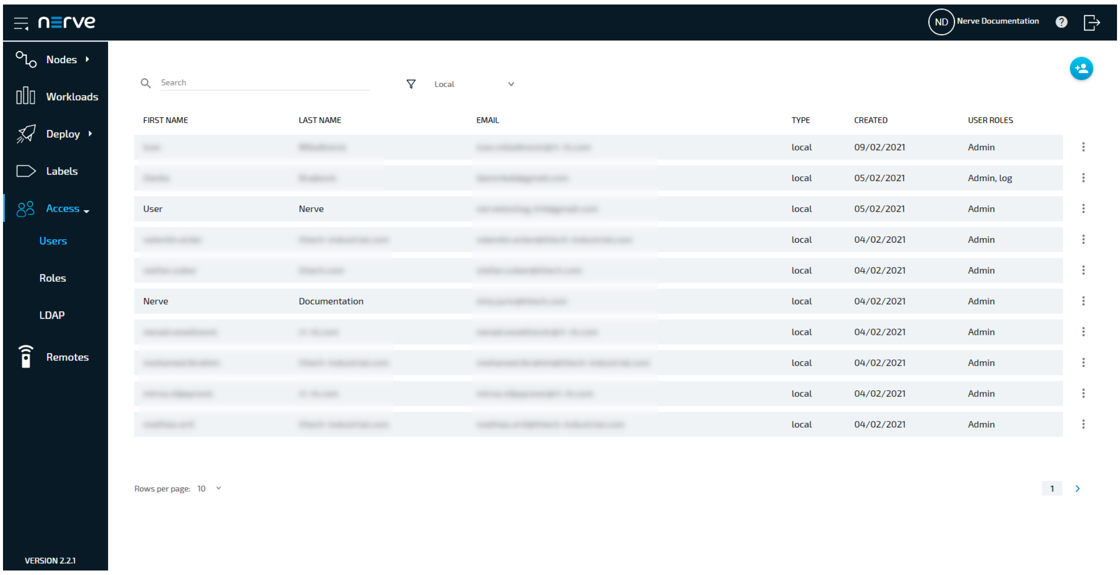
The password has been changed and the user can log in immediately with their e-mail address and the new password.

Deleting a user

Admin users or users having the **UI_USER:DELETE** permission assigned in a role can delete any user that is registered in the Management System.
Note that users cannot be deleted when LDAP authentication is active.

1. Select **Users** in the menu on the left side.

2. Choose the user to delete.

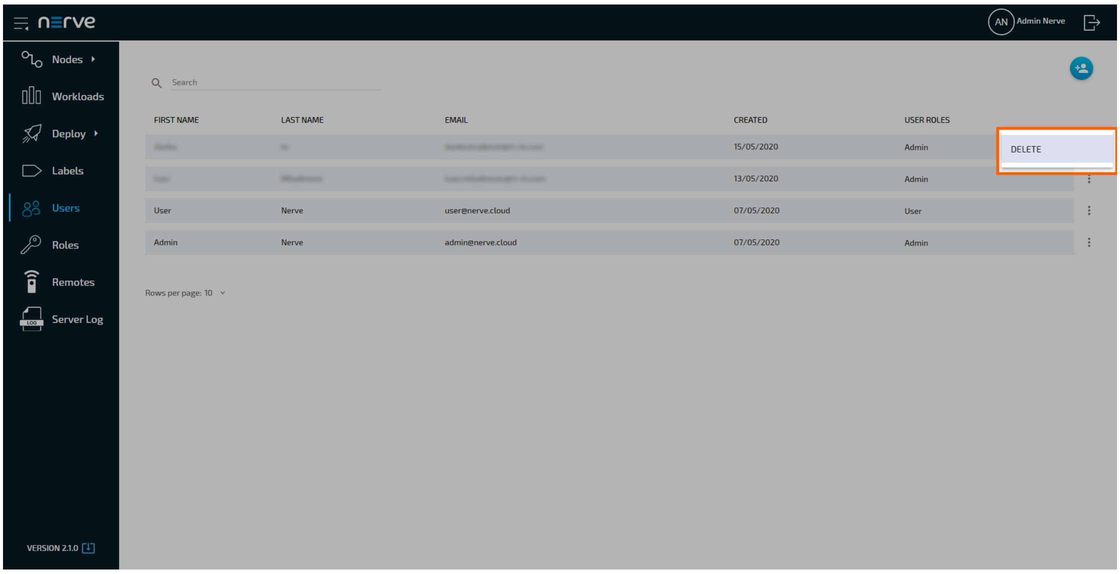


FIRST NAME	LAST NAME	EMAIL	TYPE	CREATED	USER ROLES
[redacted]	[redacted]	[redacted]	local	09/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	05/02/2021	Admin, log
User	Nerve	[redacted]	local	05/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
Nerve	Documentation	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin

Rows per page: 10 1

3. Select the ellipsis menu to the right of the user in the list.

4. Select **DELETE** from the overlay that appeared.



FIRST NAME	LAST NAME	EMAIL	CREATED	USER ROLES
[redacted]	[redacted]	[redacted]	15/05/2020	Admin
[redacted]	[redacted]	[redacted]	13/05/2020	Admin
User	Nerve	user@nerve.cloud	07/05/2020	User
Admin	Nerve	admin@nerve.cloud	07/05/2020	Admin

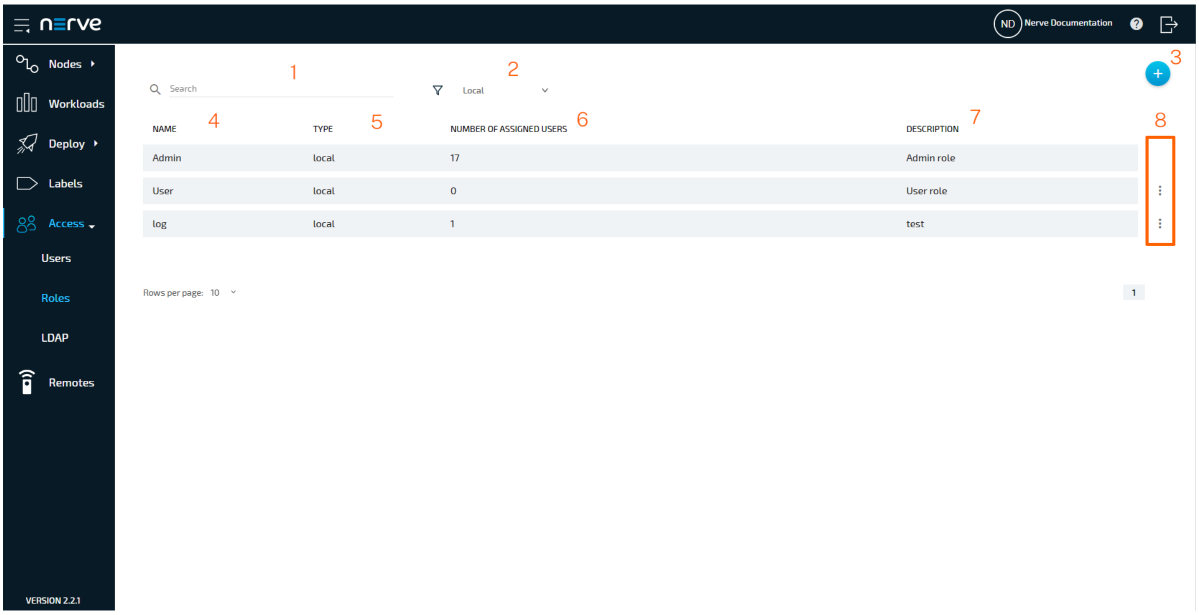
5. Click **OK** to confirm the deletion of the user.

Roles and permissions

NOTE

This page describes the standard roles and permission management in the Nerve Management System. When LDAP authentication is active, roles and permissions are applied according to the LDAP synchronization settings. Refer to LDAP for more information on LDAP synchronization.

Usage of the Management System is restricted by role-based access control (RBAC), meaning that users in the Management System are assigned roles. These roles are assigned a set of UI permissions and API permissions. Two user roles — **Admin** and **User** are available by default. Multiple roles can be assigned to one user. A user that is assigned multiple roles is granted the combined permissions of each role. Select **Roles** in the navigation on the left to reach a list of all available roles:



NAME	TYPE	NUMBER OF ASSIGNED USERS	DESCRIPTION
Admin	local	17	Admin role
User	local	0	User role
log	local	1	test

Item	Description
Search bar (1)	Use the search bar to filter roles by name.
Type filter (2)	Filter the list of roles by authentication method. The target of the filter is the **TYPE** column and the options are **Local**, **LDAP** and **All**.
Add new role (3)	Click here to add a new role.
NAME (4)	This is the name of the role that was defined when it was created. This name is also used when the role is assigned to users.
TYPE (5)	This column shows the type of the role according to the authentication method used: • **Local** This describes roles that are created locally through the Management System. • **LDAP** This describes roles that are created following an LDAP synchronization.
NUMBER OF ASSIGNED USERS (6)	The number of users that this role has been assigned to is displayed here.
DESCRIPTION (7)	This is a description that gives more information about each user role.
Ellipsis menu (8)	Clicking here opens an overlay that allows deleting roles.

The **Admin** role has all permissions assigned and cannot be edited. The **User** role has limited permissions. A user that has the **User** role assigned is not allowed to perform changes to the system such as adding or removing nodes, creating workloads or establishing remote connections among others. Users with the **User** role can work with the node tree and deploy workloads to nodes.

UI permissions

UI permissions reflect the permissions of the frontend. They are relevant for a users interaction with the Management System. Below is the list of available UI permissions with descriptions.
As some actions depend on other actions, the system automatically selects and deselects permissions, including API permissions that are required for these actions.
When creating a new role for a regular user that will operate the Management System, use the UI permissions as a starting point and change API permissions only if necessary. However, note that changes to API permissions should only be done by users with expert knowledge.

The tables below are separated by the part of the Management System the permissions affect.

Workload deployment

Permission	Name	Description
Deploy workload	**UI_DEPLOY:DEPLOY**	Permission that grants the user the rights to deploy a workload to a node.
Force stop campaign task	**UI_DEPLOY:FORCE_CANCEL_ONE**	Permission that grants the user access to see the force stop button for a deployment campaign.
Delete workload deploy log	**UI_DEPLOY:LOG_DELETE**	Permission that grants the user the rights to delete a log entry in the workload deployment log.
Reset deployment task	**UI_DEPLOY:LOG_RESET**	Permission that grants the user the rights to reset a task in the workload deployment log.
Reset all deployment tasks	**UI_DEPLOY:LOG_RESET_ALL**	Permission that grants the user the rights to reset all tasks in the workload deployment log.
Preview workload deploy log	**UI_DEPLOY:LOG_VIEW**	Permission that grants the user the rights to view a log entry in the workload deployment log.

Permission	Name	Description
Access "Deploy" -> "Dry run"	**UI_SUBNAV_DEPLOY_DRY_RUN:VIEW**	Permission that grants the user the rights to see the dry run entry in the navigation menu and the rights to perform the dry run action with workloads to nodes.
Access "Deploy" -> "Log"	**UI_SUBNAV_DEPLOY_LOG:VIEW**	Permission that grants the user the rights to see the deployment log entry in the navigation menu and the rights to view the workload deployment log.

Labels

Permission	Name	Description
Create new label	**UI_LABEL:CREATE**	Permission that grants the user the rights to create new labels.
Delete label	**UI_LABEL:DELETE**	Permission that grants the user the rights to delete labels.
Edit existing label	**UI_LABEL:EDIT**	Permission that grants the user the rights to edit labels.
Group labels by key	**UI_LABEL:GROUP**	Permission that grants the user the rights to group labels by key.
Merge labels to one	**UI_LABEL:MERGE**	Permission that grants the user the rights to merge multiple labels.
Preview list of labels	**UI_LABEL:VIEW**	Permission that grants the user the rights to view the details of a label.

LDAP

Permission	Name	Description
Show edit button	**UI_LDAP:MANAGE_LDAP**	Permission that grants the user the rights to edit the LDAP configuration.

Navigation menu

Permission	Name	Description
Access Data services Feature Preview	**UI_NAV_DATA_SERVICES:VIEW**	Permission that grants the user access to the Data Services feature.

Permission	Name	Description
"Deploy" section	**UI_NAV_DEPLOY:VIEW**	Permission that grants the user the rights to view the deployment menu.
"Labels" section	**UI_NAV_LABELS:VIEW**	Permission that grants the user the rights to see the labels entry in the navigation menu and the rights to list labels.
Show default ldap configuration	**UI_NAV_LDAP:VIEW**	Permission that grants the user the rights to see the LDAP entry in the navigation menu.
"Nodes" section	**UI_NAV_NODES:VIEW**	Permission that grants the user the rights to see the nodes entry in the navigation menu and the rights to list nodes.
"Remotes" section	**UI_NAV_REMOTE_CONNECTIONS:VIEW**	Permission that grants the user the rights to view active remote connections.
"Roles" section	**UI_NAV_ROLES:VIEW**	Permission that grants the user the rights to see the roles entry in the navigation menu and the rights to list roles.
Access "Server Log"	**UI_NAV_SERVER_LOGS:VIEW**	Permission that grants the user the rights to list internal server logs.
"Users" section	**UI_NAV_USERS:VIEW**	Permission that grants the user the rights to see the users entry in the navigation menu and the rights to list users.

Permission	Name	Description
"Workloads" section	**UI_NAV_WORKLOADS:VIEW**	Permission that grants the user the rights to see the workloads entry in the navigation menu and the rights to list workloads.

Nodes

Permission	Name	Description
Create new node	**UI_NODE:CREATE**	Permission that grants the user the rights to create new nodes.
Delete node	**UI_NODE:DELETE**	Permission that grants the user the rights to delete nodes.
Edit existing node	**UI_NODE:EDIT**	Permission that grants the user the rights to edit nodes.
Node logging and monitoring settings	**UI_NODE:LOGGING_AND_MONITORING_SETTINGS**	Permission that grants the user the rights to access the logging and monitoring settings of a node.
Node reboot	**UI_NODE:REBOOT**	Permission that grants the user the rights to reboot a node.
Show logs of node	**UI_NODE:SHOW_LOGS**	Permission that grants the user the rights to view internal node logs.

Permission	Name	Description
Preview node	**UI_NODE:VIEW**	Permission that grants the user the rights to view details of a node.
Change a Node logging level configuration	**UI_NODE_LOG_LEVEL:MANAGE_LOG_LEVELS**	Permission that grants the user the rights to change the logging level settings of a node.
Delete node update log	**UI_NODE_UPDATE:LOG_DELETE**	Permission that grants the user the rights to delete a log entry in the node update log.
Show node update log	**UI_NODE_UPDATE:LOG_VIEW**	Permission that grants the user the rights to view the details of a node update log entry.
Update node	**UI_NODE_UPDATE:UPDATE**	Permission that grants the user the rights to update a node.
Access "Nodes" -> "Updates"	**UI_SUBNAV_NODE_UPDATE:VIEW**	Permission that grants the user the rights to see the updates sub-entry in the navigation menu.
Access "Nodes" -> "Log"	**UI_SUBNAV_NODE_UPDATE_LOG:VIEW**	Permission that grants the user the rights to see the log sub-entry in the navigation menu.

Node tree

Permission	Name	Description
Add new tree item	**UI_NODE_TREE:ADD**	Permission that grants the user the rights to add new elements in the node tree.
Delete tree item	**UI_NODE_TREE:DELETE**	Permission that grants the user the rights to delete an element of the node tree.
Edit tree item	**UI_NODE_TREE:EDIT**	Permission that grants the user the rights to edit an element of the node tree.
Node tree manipulation	**UI_NODE_TREE:MANIPULATE**	Permission that grants the user the rights to manipulate the elements of the node tree structure, i.e perform changes to position and order.
Preview node details in Node tree	**UI_NODE_TREE:NODE_DETAILS**	Permission that grants the user the rights to view the node details of a node in the node tree.

System notifications

Permission	Name	Description
Create notification	**UI_NOTIFICATION:CREATE**	Permission that grants the user the rights to create a system notification.
Delete notification	**UI_NOTIFICATION:DELETE**	Permission that grants the user the rights to delete a system notification.
Edit notification	**UI_NOTIFICATION:EDIT**	Permission that grants the user the rights to edit an existing system notification.
View notification	**UI_NOTIFICATION:VIEW**	Permission that grants the user the rights to view system notifications.

Remote connections

Permission	Name	Description
Connect over remote connection	**UI_REMOTE_CONN:CONNECT**	Permission that grants the user the rights to connect to a host through a remote connection.

Permission	Name	Description
Create remote connection	**UI_REMOTE_CONN:CREATE**	Permission that grants the user the rights to establish a new remote connection.
Delete remote connection	**UI_REMOTE_CONN:DELETE**	Permission that grants the user the rights to delete remote connections.
Edit remote connection	**UI_REMOTE_CONN:EDIT**	Permission that grants the user the rights to edit existing remote connections.
List all remote connections	**UI_REMOTE_CONN:LIST**	Permission that grants the user the rights to list all remote connections in the node and workload details.
Preview remote connection	**UI_REMOTE_CONN:VIEW**	Permission that grants the user the rights to view the details of a remote connection.
Terminate remote connection	**UI_REMOTE_CONNECTIONS:TERMINATE**	Permission that grants the user the rights to terminate active remote connections.

Roles

Permission	Name	Description
Create new role	**UI_ROLE:CREATE**	Permission that grants the user the rights to create new roles.
Delete role	**UI_ROLE:DELETE**	Permission that grants the user the rights to delete roles.
Edit role	**UI_ROLE:EDIT**	Permission that grants the user the rights to edit roles.
Preview role	**UI_ROLE:VIEW**	Permission that grants the user the rights to view the details of a role.

Server log

Permission	Name	Description
Preview server logs	**UI_SERVER_LOGS:VIEW**	Permission that grants the user the rights to list internal server logs.

Usage reports

Permission	Name	Description
Access Usage Report Feature Preview	**UI_USAGE_REPORT:VIEW**	Permission that grants the user the rights to access the usage report page.

User menu

Permission	Name	Description
Create new user profile	**UI_USER:CREATE**	Permission that grants the user the rights to create new users.
Delete user profile	**UI_USER:DELETE**	Permission that grants the user the rights to delete users.
Edit user profile	**UI_USER:EDIT**	Permission that grants the user the rights to edit the profiles of other users.
Preview user profile	**UI_USER:VIEW**	Permission that grants the user the rights to view the details of a user.
Edit user settings	**UI_USER_SETTINGS:UPDATE**	Permission that grants the user the rights to update their user settings.
Preview user settings	**UI_USER_SETTINGS:VIEW**	Permission that grants the user the rights to view their user settings.

Management System update

Permission	Name	Description
List available Cloud app versions	**UI_VERSION:LIST**	Permission that grants the user the rights to list all available versions of the Management System.
Upload Cloud app versions	**UI_VERSION:UPDATE**	Permission that grants the user the rights to update the Management System.

Workload management

Permission	Name	Description
Create new workload	**UI_WORKLOAD:CREATE**	Permission that grants the user the rights to create new workloads.

Permission	Name	Description
Delete workload	**UI_WORKLOAD:DELETE**	Permission that grants the user the rights to delete workloads.
Disable workload	**UI_WORKLOAD:DISABLE**	Permission that grants the user the rights to disable workloads.
Edit workload	**UI_WORKLOAD:EDIT**	Permission that grants the user the rights to edit workload details (name and description).
Preview workload	**UI_WORKLOAD:VIEW**	Permission that grants the user the rights to view the details of a workload.
Create workload version	**UI_WORKLOAD:VERSION_CREATE**	Permission that grants the user the rights to create new workload versions.
Delete workload version	**UI_WORKLOAD:VERSION_DELETE**	Permission that grants the user the rights to delete workload versions.
Edit workload version	**UI_WORKLOAD:VERSION_EDIT**	Permission that grants the user the rights to edit workload versions.

Permission	Name	Description
Preview workload version	**UI_WORKLOAD:VERSION_VIEW**	Permission that grants the user the rights to view workload versions.
Apply workload configuration	**UI_WORKLOAD_CONFIGURATION:APPLY**	Permission that grants the user the rights to apply configuration files to a deployed workload.
Update workload resources	**UI_WORKLOAD_CONFIGURATION:UPDATE_RESOURCES**	Permission that grants the user the rights to change the allocated resources of a deployed workload.
Control deployed workload	**UI_WORKLOAD_CONTROL:CONTROL**	Permission that grants the user full control over status and life cycle of workloads deployed to nodes.
List deployed workloads	**UI_WORKLOAD_CONTROL:LIST**	Permission that grants the user the rights to list workloads that are deployed to a node.
Preview deployed workloads	**UI_WORKLOAD_CONTROL:VIEW**	Permission that grants the user the rights to view the details of a workload deployed to a node.

API permissions

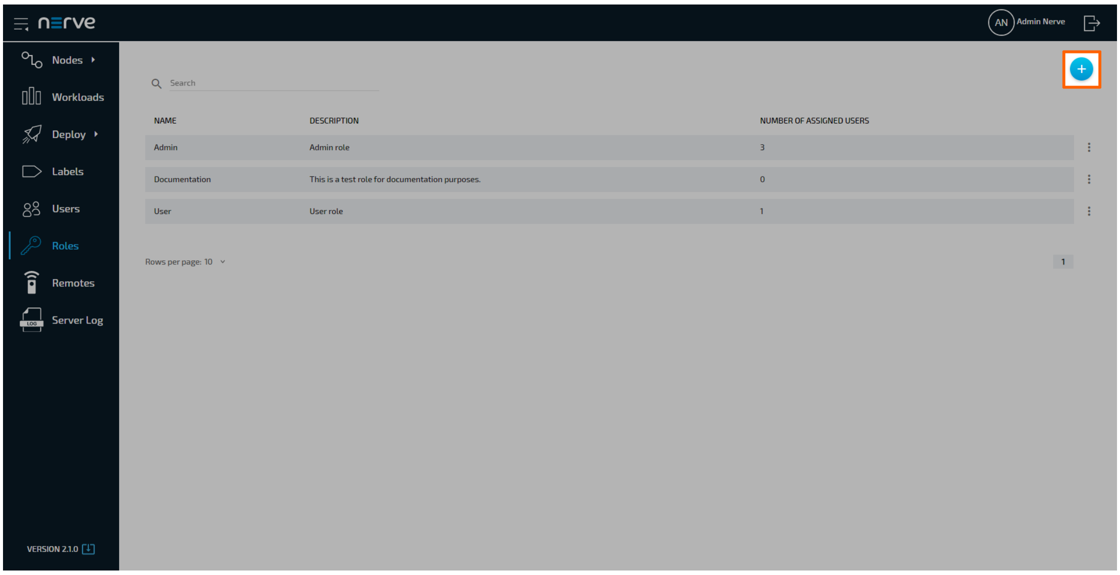
API permissions reflect the permissions of the server backend. They are primarily relevant for automating the Management System through API calls. When creating a role in the Management System for a program, they can be selected without selecting UI permissions beforehand. When creating a new role for a regular user that will operate the Management System, use the UI permissions as a starting point and change API permissions only if necessary. Note that API permissions should only be handled by persons with expert knowledge.

Adding a new role

When adding a new role, it depends whether the role is going to be created for regular users or programs. When creating a new role for a regular user that will operate the Management System, use the UI permissions as a starting point and change API permissions only if necessary. When creating a role for a program, API permissions can be selected without selecting UI permissions beforehand. Note that API permissions should only be handled by persons with expert knowledge.

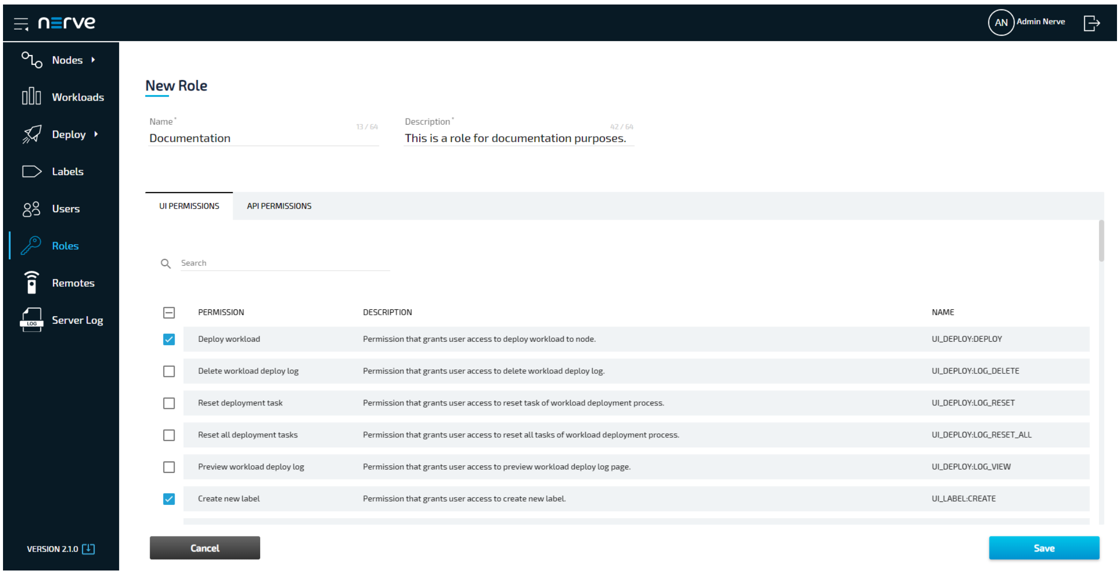
Selecting one permission might automatically select other permissions, which are needed to perform the task indicated by the selected permission. An example: if a user is permitted to deploy a workload, then the same user is also permitted to view the list of workloads. Associated API permissions will also be selected. Note that deselecting a permission might also deselect linked permissions.

1. Select **Roles** in the navigation on the left.
2. Click the plus symbol (**Add new role**) in the upper-right corner.



NAME	DESCRIPTION	NUMBER OF ASSIGNED USERS
Admin	Admin role	3
Documentation	This is a test role for documentation purposes.	0
User	User role	1

3. Enter a **Name** and a **Description** at the top.
4. Select the **UI PERMISSIONS** tab.
5. Tick the checkboxes next to the desired permissions.



New Role

Name* Documentation 13 / 64

Description* This is a role for documentation purposes. 42 / 64

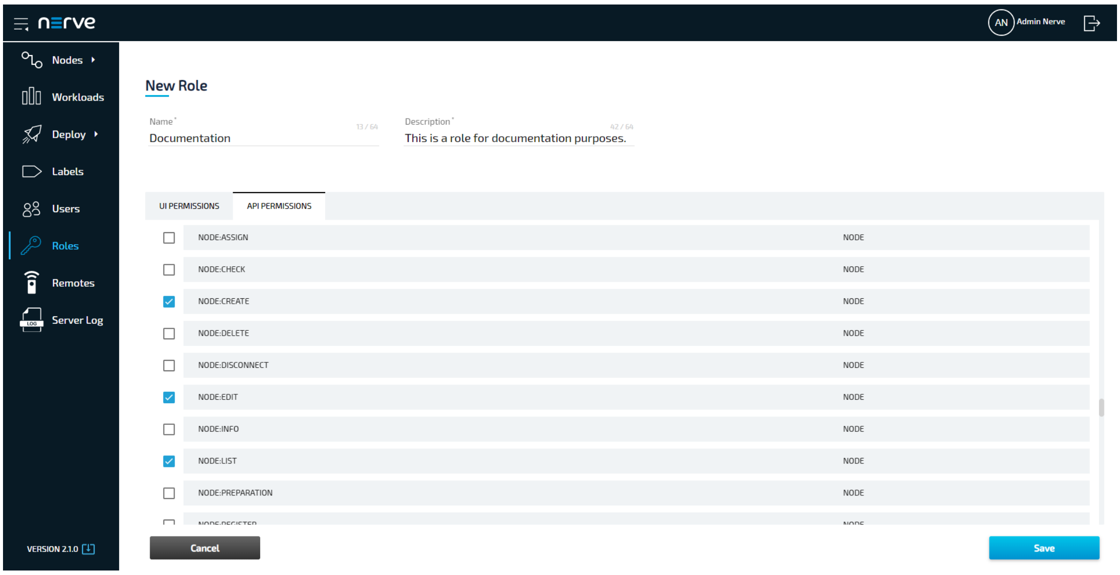
UI PERMISSIONS | API PERMISSIONS

Search

☐	PERMISSION	DESCRIPTION	NAME
☑	Deploy workload	Permission that grants user access to deploy workload to node.	UI_DEPLOY:DEPLOY
☐	Delete workload deploy log	Permission that grants user access to delete workload deploy log.	UI_DEPLOY:LOG_DELETE
☐	Reset deployment task	Permission that grants user access to reset task of workload deployment process.	UI_DEPLOY:LOG_RESET
☐	Reset all deployment tasks	Permission that grants user access to reset all tasks of workload deployment process.	UI_DEPLOY:LOG_RESET_ALL
☐	Preview workload deploy log	Permission that grants user access to preview workload deploy log page.	UI_DEPLOY:LOG_VIEW
☑	Create new label	Permission that grants user access to create new label.	UI_LABEL:CREATE

6. Select the **API PERMISSIONS** tab.

7. Tick or untick the permissions that need to be changed.



New Role

Name* Documentation 13 / 64

Description* This is a role for documentation purposes. 42 / 64

UI PERMISSIONS | API PERMISSIONS

☐	NODE:ASSIGN	NODE
☐	NODE:CHECK	NODE
☑	NODE:CREATE	NODE
☐	NODE:DELETE	NODE
☐	NODE:DISCONNECT	NODE
☑	NODE:EDIT	NODE
☐	NODE:INFO	NODE
☑	NODE:LIST	NODE
☐	NODE:PREPARATION	NODE
☐	NODE:REGISTER	NODE

NOTE

Make sure to review the selected permissions for completeness before saving the role. The system automatically selects and deselects permissions that are linked and might have added or removed desired permissions when permissions where selected or deselected.

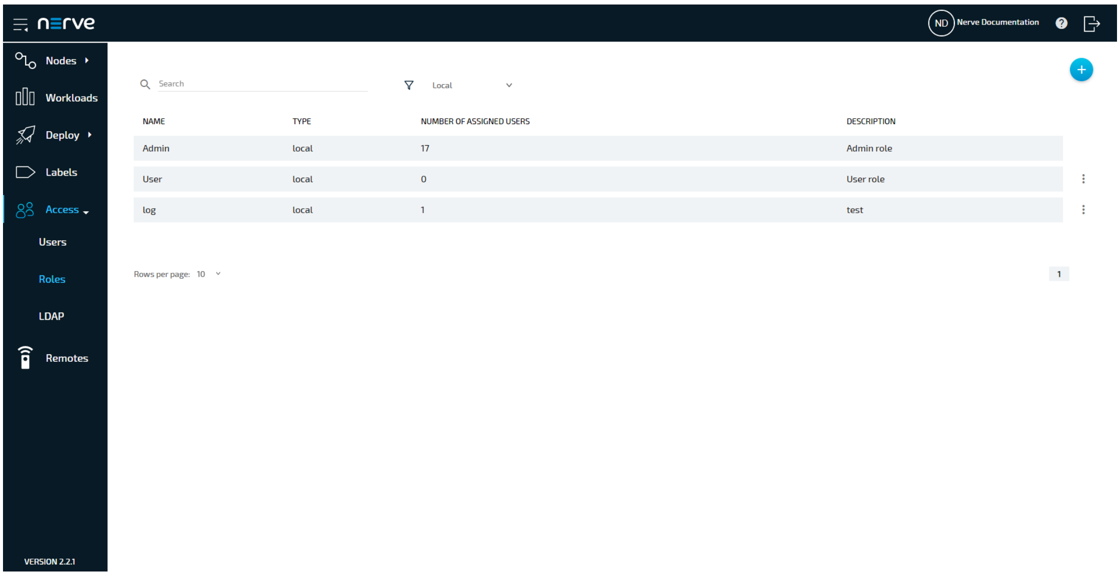
8. Click **Save**.

Editing a role

Note that editing the permissions of a role changes the permissions for users who are already assigned this role. Also, note that editing of roles coming from LDAP synchronization is limited. The name and description of a role cannot be edited. Permissions, however, can be edited.

1. Select **Roles** in the navigation on the left.

2. Select a role from the list.

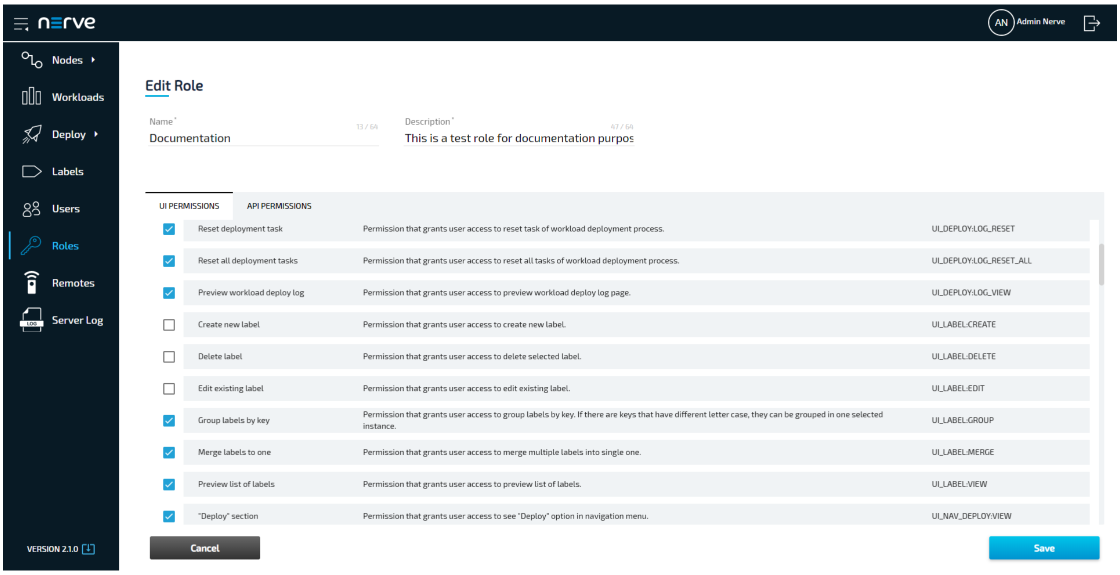


NAME	TYPE	NUMBER OF ASSIGNED USERS	DESCRIPTION
Admin	local	17	Admin role
User	local	0	User role
log	local	1	test

3. Edit **Name** and **Description** at the top.

4. Select the **UI PERMISSIONS** tab.

5. Tick or untick the permissions that need to be changed.



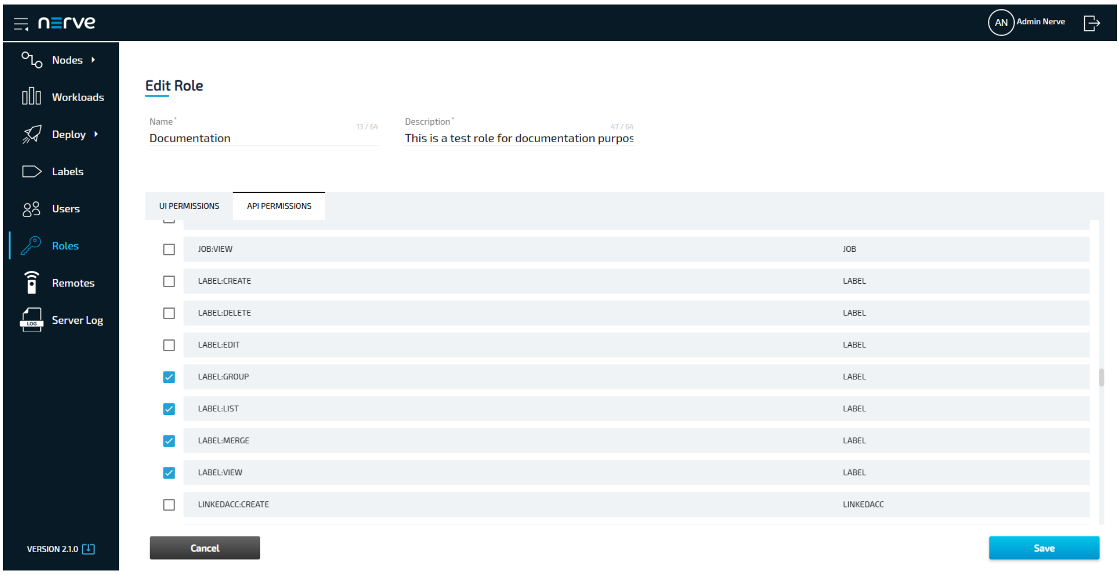
Name* 13 / 64
Documentation

Description* 47 / 64
This is a test role for documentation purpos

☑	Reset deployment task	Permission that grants user access to reset task of workload deployment process.	UI_DEPLOY:LOG_RESET
☑	Reset all deployment tasks	Permission that grants user access to reset all tasks of workload deployment process.	UI_DEPLOY:LOG_RESET_ALL
☑	Preview workload deploy log	Permission that grants user access to preview workload deploy log page.	UI_DEPLOY:LOG_VIEW
□	Create new label	Permission that grants user access to create new label.	UI_LABEL:CREATE
□	Delete label	Permission that grants user access to delete selected label.	UI_LABEL:DELETE
□	Edit existing label	Permission that grants user access to edit existing label.	UI_LABEL:EDIT
☑	Group labels by key	Permission that grants user access to group labels by key. If there are keys that have different letter case, they can be grouped in one selected instance.	UI_LABEL:GROUP
☑	Merge labels to one	Permission that grants user access to merge multiple labels into single one.	UI_LABEL:MERGE
☑	Preview list of labels	Permission that grants user access to preview list of labels.	UI_LABEL:VIEW
☑	"Deploy" section	Permission that grants user access to see "Deploy" option in navigation menu.	UI_NAV_DEPLOY:VIEW

6. Select the **API PERMISSIONS** tab.

7. Tick or untick the permissions that need to be changed.



Name* 13 / 64
Documentation

Description* 47 / 64
This is a test role for documentation purpos

☐	JOB:VIEW	JOB
☐	LABEL:CREATE	LABEL
☐	LABEL:DELETE	LABEL
☐	LABEL:EDIT	LABEL
☑	LABEL:GROUP	LABEL
☑	LABEL:LIST	LABEL
☑	LABEL:MERGE	LABEL
☑	LABEL:VIEW	LABEL
☐	LINKEDACC:CREATE	LINKEDACC

NOTE

Make sure to review the selected permissions for completeness before saving the role. The system automatically selects and deselects permissions that are linked and might have added or removed desired permissions when permissions where selected or deselected.

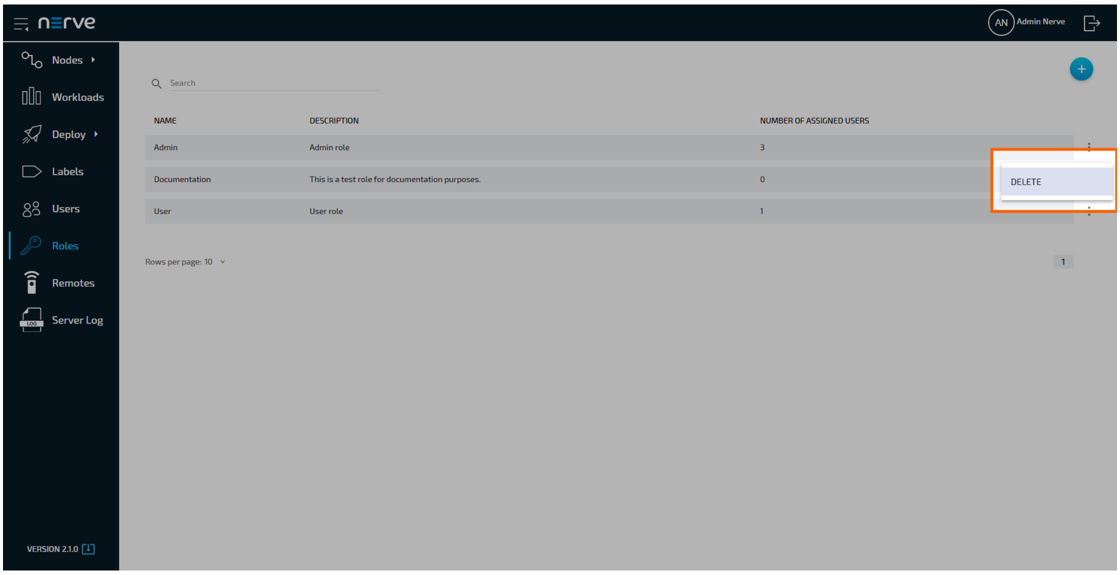
8. Click **Save**.

Deleting a role

Note that a role cannot be deleted if it is assigned to a user. Also, note that roles coming from LDAP synchronization cannot be deleted.

1. Select **Roles** in the navigation on the left.
2. Choose a role from the list.
3. Click the ellipsis menu next to the role.

4. Select **DELETE** in the overlay that appeared.



NAME	DESCRIPTION	NUMBER OF ASSIGNED USERS
Admin	Admin role	3
Documentation	This is a test role for documentation purposes.	0
User	User role	1

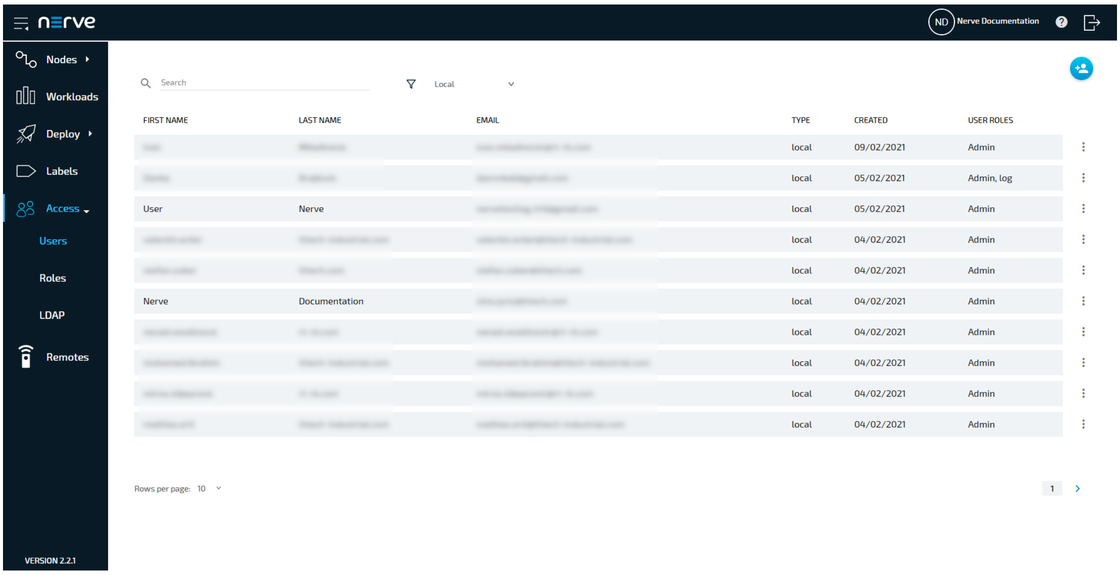
5. Select **OK** to delete the role.

Assigning a role to a user

Assigning a role is done in the users menu. Users can be assigned multiple roles. A user that is assigned multiple roles is granted the combined permissions of each role.

1. Select **Users** in the navigation on the left.

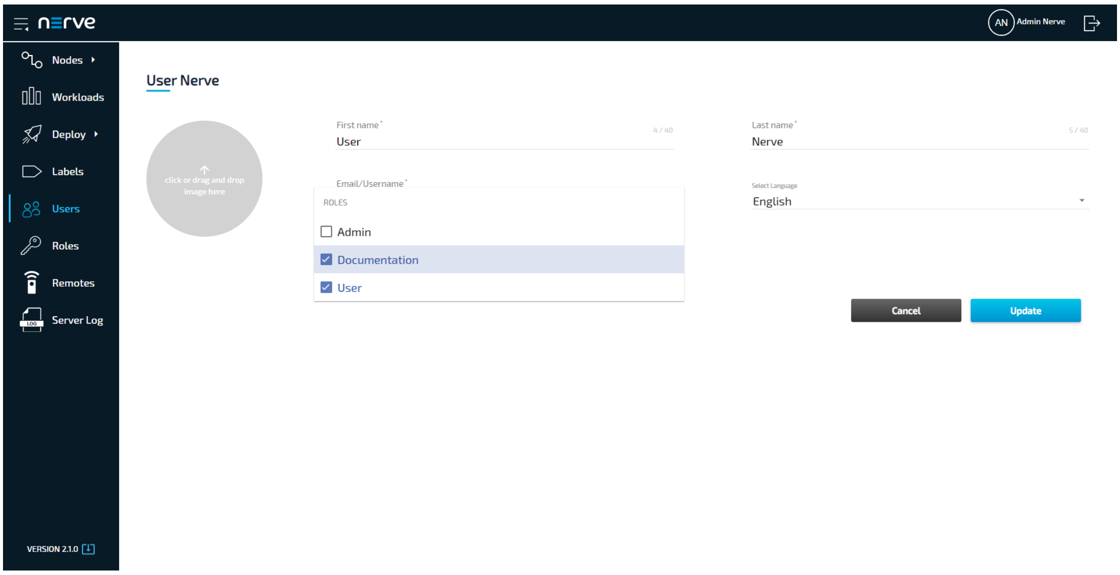
2. Select a user from the list.



FIRST NAME	LAST NAME	EMAIL	TYPE	CREATED	USER ROLES
[redacted]	[redacted]	[redacted]	local	09/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	05/02/2021	Admin, log
User	Nerve	[redacted]	local	05/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
Nerve	Documentation	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin
[redacted]	[redacted]	[redacted]	local	04/02/2021	Admin

3. Click the field under **Role** to open a drop-down menu.

4. Tick one or more roles that will be assigned to this user. Note that at least one role must be selected.



User Nerve

First name* User 4 / 40

Last name* Nerve 5 / 40

Email/Username*

ROLES

☐ Admin

☑ Documentation

☑ User

Select Language English

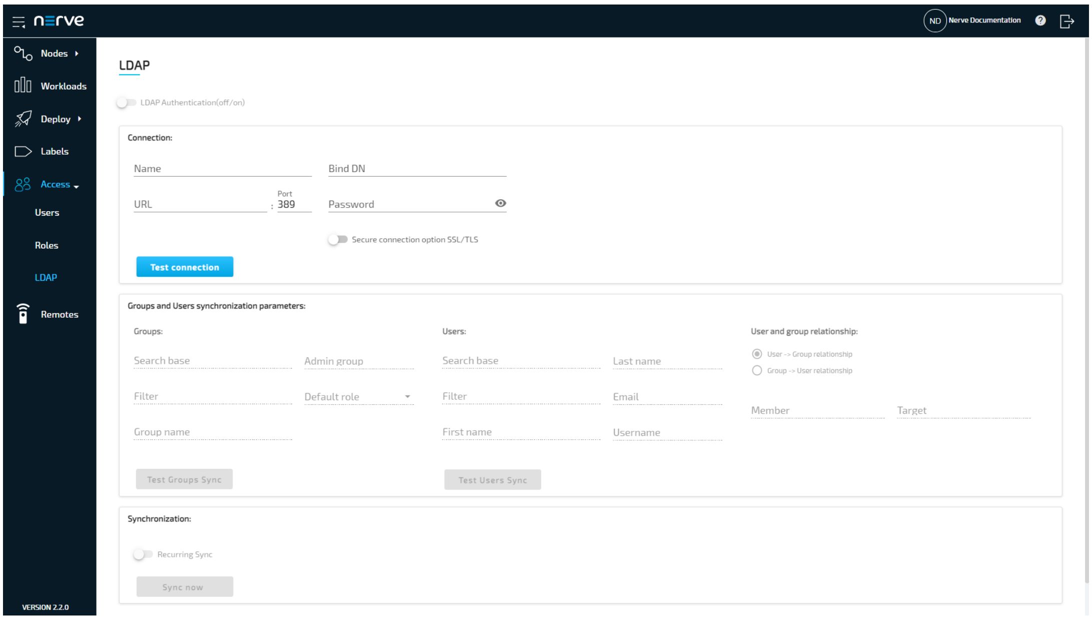
5. Select **Update** in the lower-right.

Enabling access management with LDAP in the Management System

The Nerve Management System allows the import of users and roles for access management through its LDAP integration. Data is synchronized with an LDAP server and the authentication of users is done against this LDAP server instead of the Management System itself. The user authentication provided is LDAP Simple Authentication (username and password) with the option to enable SSL/TLS for a secure connection between the LDAP server and the Management System.

An existing LDAP server is required to enable active directory access management. The configuration of the LDAP synchronization in the Management System requires expert knowledge. It is recommended that the configuration is performed by an LDAP admin.

Expand **Access > LDAP** to reach the LDAP configuration. It is separated into three sections.



Item	Description
LDAP Authentication(off/ on)	Toggle this to activate or deactivate access management with LDAP once the configuration on this page has been completed.
Connection:	This section contains the required parameters to connect to an LDAP server. **Name** This is a user defined name for the configuration. Enter any name that accurately describes the connection. **URL** This can be either an IP address or the hostname of the LDAP server. **Port** Enter the port used for the LDAP service. Note that the standard port 389 is automatically filled in. Also, port 636 is automatically filled in if **Secure connection option SSL/TLS** is activated. **Bind DN** Enter the user in LDAP that is used for establishing the connection. This is either a user that is used for external connections or an admin user. The user needs to be entered in the form of a distinguished name. **Password** Enter the password of the **Bind DN** user. **Secure connection option SSL/TLS** Toggle to enable a secure connection here. The secure connection is implicitly accepted and certificates are exchanged by enabling this option. The standar port 636 for secure connections over SSL/TLS is filled in automatically in the **Port** field. **Test connection** This button is only available after the required fields have been filled in. Once clicked, a green check mark signifies a successful connection while a red cros signifies an unsuccessful connection attempt.

Groups and Users synchronization parameters:

Specify the required parameters for users and groups synchronization here. T options are grayed out by default. Once a connection to an LDAP server has been tested successfully, marked by a green check mark, the options will become available. Two query buttons are available here to test each configuration.

Groups:

- **Search Base**
  This is the directory point where the groups synchronization is started from.
- **Filter**
  Enter a logical expression here to filter for desired groups. The filter has to be in the format that is used in LDAP. Hover over the text field to see the full filter displayed in a quick tip. An example filter could look like th
  `(&(cn=Nerve*)( objectClass=groupOfNames)))`
- **Group name**
  Enter the LDAP attribute that is used as a group name.
  Example: If cn is entered, roles in the Management System receive the value of the cn attribute as their name.
- **Admin group**
  Enter the group name from LDAP that will receive the Admin role in the Nerve Management System.
- **Default role**
  Specify a role in the Management System that is used as a permission template for all groups coming from LDAP. The only exception is the **Admin group**.
  Note that it is recommended to create a new role first. Refer to Adding a new role if roles have not been defined yet.
- **Test Groups Sync**
  Test whether the filter and settings for groups synchronization work with this button. A pop-up window opens where it is possible to check a preview list of groups that will be synchronized.

Users:

- **Search Base**
  This is the directory point where the users synchronization is started from.
- **Filter**
  Enter a logical expression here to filter for desired users. The filter has t be in the format that is used in LDAP. Hover over the text field to see th full filter displayed in a quick tip. An example filter could look like this:
  `(&(objectClass=person)(memberOf:`
  `1.2.840.113556.1.4.1941:=cn=Nerve,cn=Roles,dc=example,dc=com`
- **First name**
  Enter the LDAP attribute that will be used as the first name for users.
- **Last name**
  Enter the LDAP attribute that will be used as the last name for users.
- **Email**
  Enter the LDAP attribute that will be used as the email for users.
- **Username**
  Enter the LDAP attribute that will be used as the username for authentication.
- **Test Users Sync**
  Test whether the filter and settings for users synchronization work with this button. A pop-up window opens where it is possible to check a preview list of users that will be synchronized.

User and group relationship:

- **User -> Group relationship**
  Tick this option to select users as the source and groups as the target fo synchronization.
- **Group -> User relationship**

Item	Description
Synchronization:	**Recurring sync** Activate **Recurring sync** to set an exact time or interval for recurring synchronization between the Management System and the LDAP server. This can be done in two ways: • **Exact time of day** If an exact time is specified, the process is executed once a day at the specified time. • **Interval in hours** Selecting an interval in hours executes the synchronization after the specified time has passed. **Sync now** Select **Sync now** to perform an actual synchronization of users and groups. A result message is shown in the upper right corner at the end of the synchronization process.

NOTE

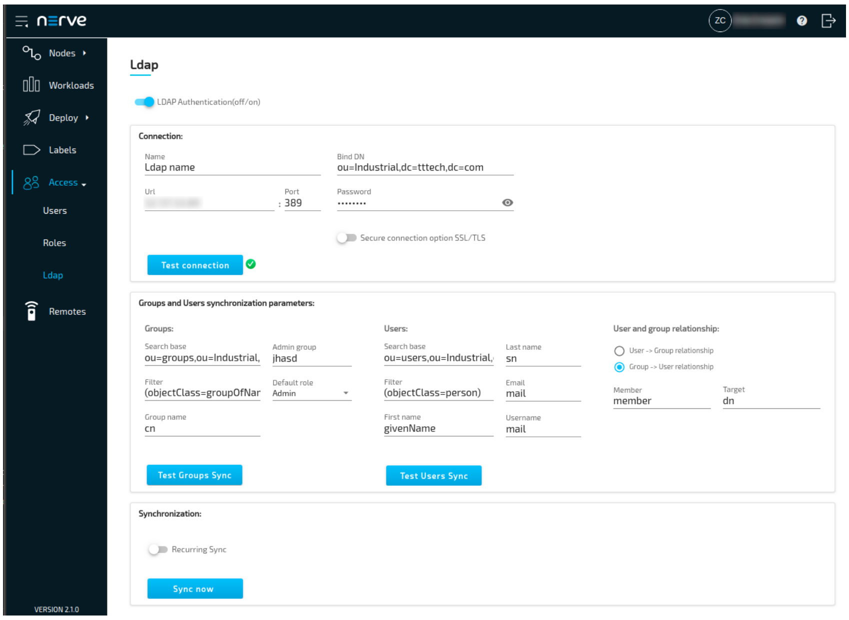
The configuration above is dependent on the LDAP server configuration. Consult the LDAP admin when configuring the LDAP integration in the Management System.

Recommended workflow

As there are many fields and buttons that serve different purposes, consult the summarized workflow below for a quick overview.

1. Enter the required information in the **Connection** fields.
2. Select **Test connection**. If a green check mark appears, the connection was successful.
3. Fill in the **Groups** parameters under **Groups and Users synchronization parameters**.
4. Select **Test Groups Sync**. A pop-up window will appear.
5. Check the preview list of groups that will be synchronized.
6. Fill in the **Users** parameters under **Groups and Users synchronization parameters**.
7. Select **Test Users Sync**. A pop-up window will appear.
8. Check the preview list of users that will be synchronized.
9. Select **Sync now** to apply the configuration.
10. *Optional: Toggle **LDAP synchronization(off/on)** at the top.*
11. Select **Save** at the bottom to save the configuration.

Toggling the **LDAP synchronization(off/on)** switch is marked as optional here, as it can also be toggled at a later time. Save the configuration and toggle the switch to use the LDAP integration when desired. Below is an example configuration:



Ldap

LDAP Authentication(off/on): on

Connection:

Name: Ldap name
Bind DN: ou=Industrial,dc=tttech,dc=com
Url: [redacted]
Port: 389
Password: ••••••••
Secure connection option SSL/TLS: off

Groups and Users synchronization parameters:

Groups:
Search base: ou=groups,ou=Industrial,
Admin group: jhasd
Filter: (objectClass=groupOfNar
Default role: Admin
Group name: cn

Users:
Search base: ou=users,ou=Industrial,
Last name: sn
Filter: (objectClass=person)
Email: mail
First name: givenName
Username: mail

User and group relationship:
○ User -> Group relationship
● Group -> User relationship
Member: member
Target: dn

Synchronization:

Recurring Sync: off

Differences in user and role management when LDAP authentication is activate

When LDAP authentication is active, editing of users and roles is disabled or limited. The differences are:

- The LDAP username is used for authentication instead of the email address.
- Passwords cannot be changed or reset.
- New users cannot be added.
- Existing users, LDAP or local, cannot be edited or deleted.
- Profile pictures cannot be set.
- Names and descriptions of roles cannot be edited.
- Permissions of roles can be edited.
- Roles coming from LDAP synchronization cannot be deleted.

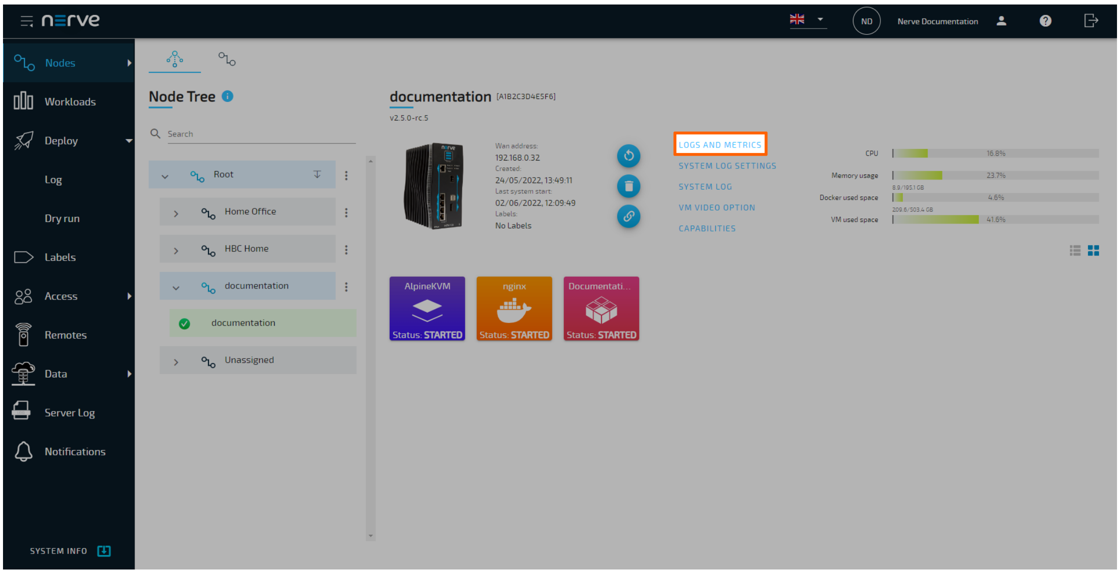
All changes to users are taken over from the LDAP server after a synchronization is performed. Once LDAP synchronization is deactivated, local users can be edited again. LDAP users, however, still cannot be edited. Note that LDAP users stay in the list of users even when LDAP synchronization is deactivated. However, the users and roles lists can be filtered by local or LDAP. Refer to Users and Roles and permissions for more information on local user and role management in the Management System.

Logging and monitoring

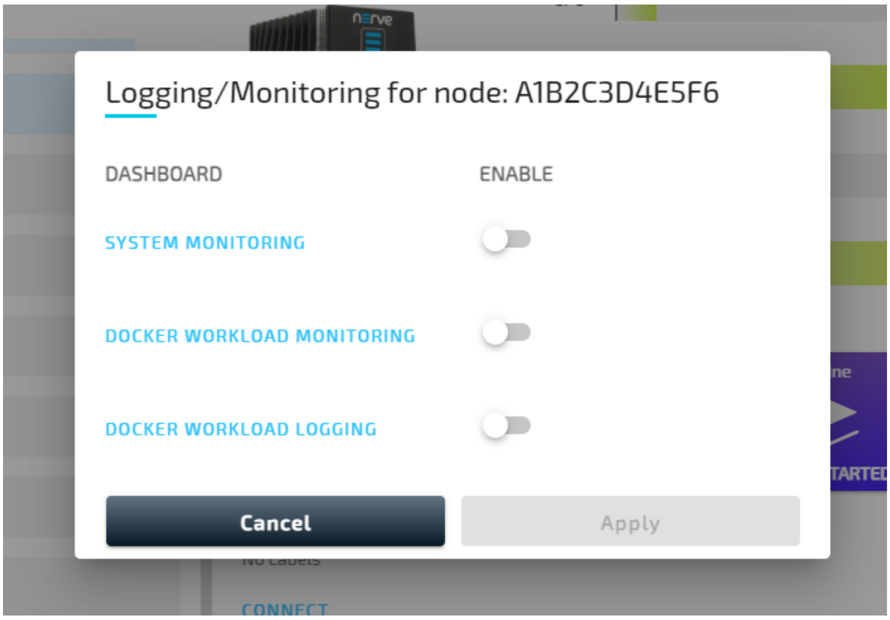
Data is gathered for Docker workloads and system parameters regarding resource usage. Metrics are then sent to OpenSearch in the Management System and visualized in OpenSearch Dashboard. Logging and monitoring options can be configured for each node in the node details screen in the Management System:

1. Log in to the Management System.
2. Select **Nodes** in the navigation on the left.
3. Select the node tree tab.
4. Select a node in the node tree.

5. Select **LOGS AND METRICS**.



From here, toggle the corresponding slider of a dashboard on the right and select **Apply** to enable logging or monitoring on that node. The dashboards can be accessed by selecting the dashboard name on the left. A new browser tab opens, displaying the selected dashboard. Note that all dashboards are also available if the node is offline.



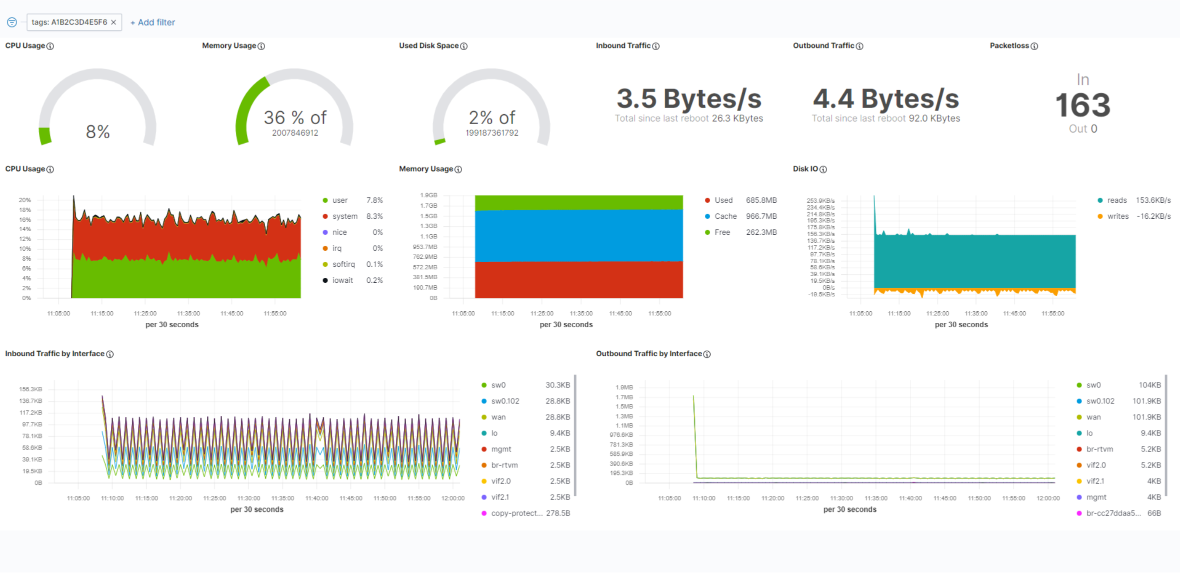
Logging/Monitoring for node: A1B2C3D4E5F6
DASHBOARD
ENABLE
SYSTEM MONITORING
DOCKER WORKLOAD MONITORING
DOCKER WORKLOAD LOGGING
Cancel
Apply

NOTE

Some OpenSearch knowledge could be beneficial when working with the dashboards. Refer to the official OpenSearch documentation for more information on OpenSearch.

System monitoring

Resource utilization of the system as a whole is tracked when system monitoring is enabled. Refer to the screenshot and the table below for more information on the data that is gathered and displayed. Toggle the **SYSTEM MONITORING** slider to enable the tracking of system data.

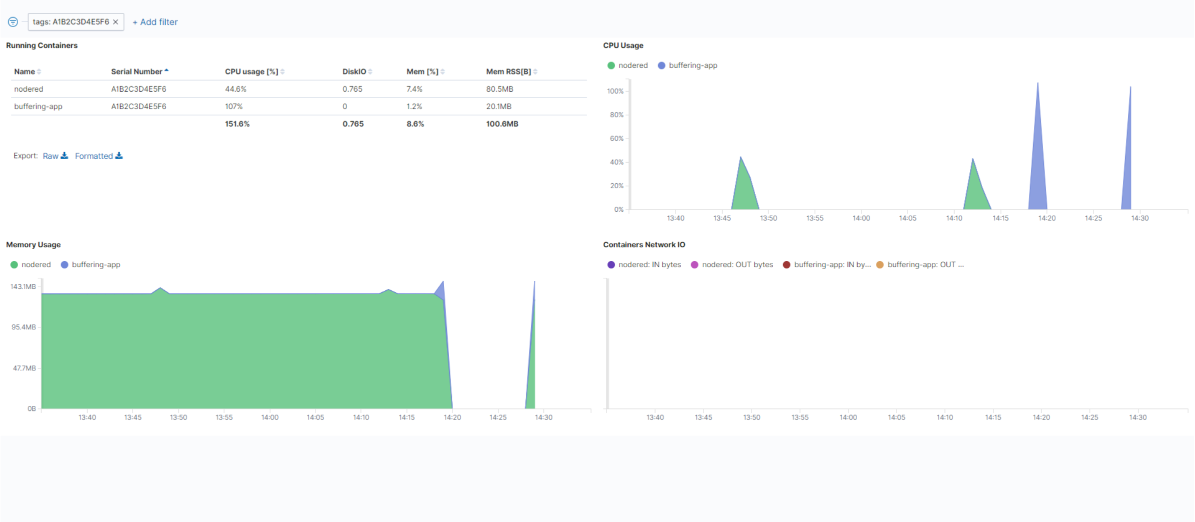


Item	Description
CPU Usage	**Gauge chart** This chart displays the currently used total percentage of the CPU. **Line graph** The line graph displays the CPU usage in percent over time. Data is displayed scaled over time. In general, the data displayed here is according to how CPU usage is understood in Linux. For an explanation on how CPU usage is handled in Linux, refer to this link.
Memory Usage	**Gauge chart** This chart displays the currently used total percentage of memory, as well as the total memory available in byte. Memory used for virtualization is not included. **Line graph** The line graph displays the total amount of memory used over time. Data is displayed scaled over time. Memory used for virtualization is not included.
Used Disk Space	This graph displays the currently used total percentage of disk space on the host, as well as the total disk space available in byte.
Inbound Traffic	This is the current amount of incoming data, as well as the total amount of data transferred since the last reboot.
Outbound Traffic	This is the current amount of outgoing data, as well as the total amount of data transferred since the last reboot.
Packetloss	Here the number of lost incoming packets and lost outgoing packets is displayed.
Disk IO	This graph displays the amount of reads and writes on the disk. Reads show how much data per second has been read while writes show the amount of data that has been saved or deleted.

Item	Description
Inbound Traffic by Interface	This is the amount of incoming data over time. The list to the right of the graph shows the average amount of traffic per interface. Note that this list also includes internal interfaces in this version.
Outbound Traffic by Interface	This is the amount of outgoing data over time. The list to the right of the graph shows the average amount of traffic per interface. Note that this list also includes internal interfaces in this version.

Docker workload monitoring

Metadata of the overall state of Docker workloads is gathered in the Management System. A list of installed containers and their resource utilization is displayed in this dashboard. Toggle the **DOCKER WORKLOAD MONITORING** slider to enable the tracking of Docker workload data.



tags: A1B2C3D4E5F6 × + Add filter

Running Containers

Name	Serial Number	CPU usage [%]	DiskIO	Mem [%]	Mem RSS[B]
nodered	A1B2C3D4E5F6	44.6%	0.765	7.4%	80.5MB
buffering-app	A1B2C3D4E5F6	107%	0	1.2%	20.1MB
		151.6%	0.765	8.6%	100.6MB

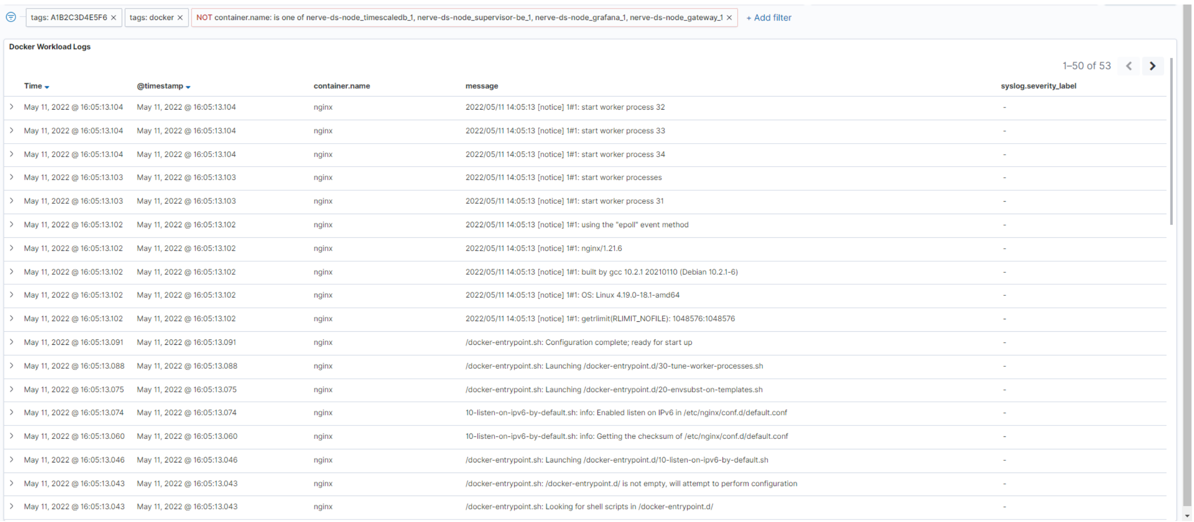
Export: Raw Formatted

Item	Description
Running Containers	This is a list of user-installed Docker containers with details. **Name** This is the name of the Docker container as defined with the **Container name** setting when provisioning the workload. **Serial Number** This is the serial number of the current node. **CPU usage [%]** This is an average value of how much of the total CPU a Docker workload has used. **DiskIO** This is the sum of reads and writes over the defined timespan. **Mem [%]** This is an average percentage of how much of the total memory a Docker workload has used. **Mem RSS[B]** This is an average value of how much resident set size (RSS) memory a Docker workload has used. Refer to this link for a general explanation on RSS.
CPU Usage	This is a graph of CPU usage in percentage over time. Note that the percentages here are in relation to the total amount of available CPU. Also, the display behaves according to standard OpenSearch Dashboard behavior, meaning that CPU usage might be displayed as being at zero even though the CPU is busy. This is due to the graph showing only new data coming in and disregarding values that stay constant over a certain amount of time.
Containers Network IO	This is a graph showing the incoming and outgoing data for each container over time. Inbound and outbound traffic are marked separately per container.
Memory Usage	This is a graph of the total amount of memory used over time.

Docker workload logging

The logs of the Docker workloads on a node are collected in the centralized logging system, allowing the analysis of logs from multiple workloads and nodes. Logs are collected from the standard Linux streams stdout (for debug messages) and stderr (for error messages). So for user created workloads this means that logs need to be sent to these streams to be collected. Note that the logs are most suitable to be read by developers with expert knowledge and should also be configured by developers. Toggle the **DOCKER WORKLOAD LOGGING** slider to enable the tracking of Docker workload logs.

To display logs of a certain workload, collected logs can be filtered in the Docker workload logging dashboard in OpenSearch.



tags: A1B2C3D4E5F6 × | tags: docker × | NOT container.name: is one of nerve-ds-node_timescaledb_1, nerve-ds-node_supervisor-be_1, nerve-ds-node_grafana_1, nerve-ds-node_gateway_1 × | + Add filter

Docker Workload Logs

1–50 of 53

Time	@timestamp	container.name	message	syslog.severity_label
May 11, 2022 @ 16:05:13.104	May 11, 2022 @ 16:05:13.104	nginx	2022/05/11 14:05:13 [notice] 1#1: start worker process 32	-
May 11, 2022 @ 16:05:13.104	May 11, 2022 @ 16:05:13.104	nginx	2022/05/11 14:05:13 [notice] 1#1: start worker process 33	-
May 11, 2022 @ 16:05:13.104	May 11, 2022 @ 16:05:13.104	nginx	2022/05/11 14:05:13 [notice] 1#1: start worker process 34	-
May 11, 2022 @ 16:05:13.103	May 11, 2022 @ 16:05:13.103	nginx	2022/05/11 14:05:13 [notice] 1#1: start worker processes	-
May 11, 2022 @ 16:05:13.103	May 11, 2022 @ 16:05:13.103	nginx	2022/05/11 14:05:13 [notice] 1#1: start worker process 31	-
May 11, 2022 @ 16:05:13.102	May 11, 2022 @ 16:05:13.102	nginx	2022/05/11 14:05:13 [notice] 1#1: using the "epoll" event method	-
May 11, 2022 @ 16:05:13.102	May 11, 2022 @ 16:05:13.102	nginx	2022/05/11 14:05:13 [notice] 1#1: nginx/1.21.6	-
May 11, 2022 @ 16:05:13.102	May 11, 2022 @ 16:05:13.102	nginx	2022/05/11 14:05:13 [notice] 1#1: built by gcc 10.2.1 20210110 (Debian 10.2.1-6)	-
May 11, 2022 @ 16:05:13.102	May 11, 2022 @ 16:05:13.102	nginx	2022/05/11 14:05:13 [notice] 1#1: OS: Linux 4.19.0-18.1-amd64	-
May 11, 2022 @ 16:05:13.102	May 11, 2022 @ 16:05:13.102	nginx	2022/05/11 14:05:13 [notice] 1#1: getrlimit(RLIMIT_NOFILE): 1048576:1048576	-
May 11, 2022 @ 16:05:13.091	May 11, 2022 @ 16:05:13.091	nginx	/docker-entrypoint.sh: Configuration complete; ready for start up	-
May 11, 2022 @ 16:05:13.088	May 11, 2022 @ 16:05:13.088	nginx	/docker-entrypoint.sh: Launching /docker-entrypoint.d/30-tune-worker-processes.sh	-
May 11, 2022 @ 16:05:13.075	May 11, 2022 @ 16:05:13.075	nginx	/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh	-
May 11, 2022 @ 16:05:13.074	May 11, 2022 @ 16:05:13.074	nginx	10-listen-on-ipv6-by-default.sh: info: Enabled listen on IPv6 in /etc/nginx/conf.d/default.conf	-
May 11, 2022 @ 16:05:13.060	May 11, 2022 @ 16:05:13.060	nginx	10-listen-on-ipv6-by-default.sh: info: Getting the checksum of /etc/nginx/conf.d/default.conf	-
May 11, 2022 @ 16:05:13.046	May 11, 2022 @ 16:05:13.046	nginx	/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh	-
May 11, 2022 @ 16:05:13.043	May 11, 2022 @ 16:05:13.043	nginx	/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration	-
May 11, 2022 @ 16:05:13.043	May 11, 2022 @ 16:05:13.043	nginx	/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/	-

Device Guide

Device Guide

The device guide is an extension of the user guide. It gives an overview of supported Nerve Devices and the device specific information that is required for operating Nerve software.

Each device chapter includes the following information:

- Links to documentation material from the manufacturer
- Hardware setup for getting the device Nerve ready
- A guide for installing Nerve on the device
- First steps after the installation
- Overview of physical ports and node internal networking

All devices share the base functionality of Nerve but differ in the extent of functionality.

> **NOTE**
>
> The device guide chapter for the MFN 100 contains more information as it is the flagship device for Nerve. Nerve can be used to its full extent when operating on the MFN 100.

MFN 100

The MFN 100 is a qualified Nerve Device that is optimized and tested for use with Nerve software. The device is designed for use in harsh industrial environments (-40°C to +70°C). It is based on an Intel Atom x5-E3940/50 CPU and offers 4 GB/8 GB RAM and up to 512 GB SSD storage. The MFN 100 offers one I/O port for Ethernet-based fieldbus connectivity, four GbE switch ports and one SFP port. Additional interfaces include two USB 2.0 ports and one DisplayPort.

Hardware information

Find information about the hardware like technical data and physical ports below.

Technical data

CPU	**Intel E3940** 4 cores, 1.8 GHz, 4 GB RAM **Intel E3950** 4 cores, 2.0 GHz, 8 GB RAM
Storage	64 GB SSD MLC 256 GB SSD MLC 512 GB SSD MLC
Performance	1 ms control cycle time achievable with Nerve
Interfaces	• 4 x< RJ 45 Ethernet (1000/100/10 Mbit/s) • 1 x SFP (1000 Mbit/s) Optical transceivers / OFCS modules may be used which are in compliance with Class I device acc. 21 CFR 1040 and IEC/EN 60825-1 • 1 x DP++ • 2 x USB 2.0 1 A combined current
Mounting	DIN rail or wall mount
Dimensions	(h x w x d): 179 x 87 x 143 mm

Weight	2.1 kg
Power	2 x 24 V redundant input, Average power consumption 12 W
Environmental Parameters	• Operating Temperature Range: -40°C to 70°C • Shock and Vibration: ISO 60068-2-27: 15 g peak, 11 ms ISO 60068-2-6: 5 Hz <= f < 8.4 Hz: 3.5 mm, 8.4 Hz <= f <= 150 Hz: 1.0 g • IP 40 according to IEC 60529 • Indoor use only, intended for use in control cabinets • Use up to pollution degree 3 • Use only in environments where no condensation will occur • Maximum relative humidity: 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C • Maximum altitude: 2000 msl
Certificates	CE and UL certified (EN 61000-6-2/4, IEC/UL 61010, CSA C22.2 NO. 61010-1-12)

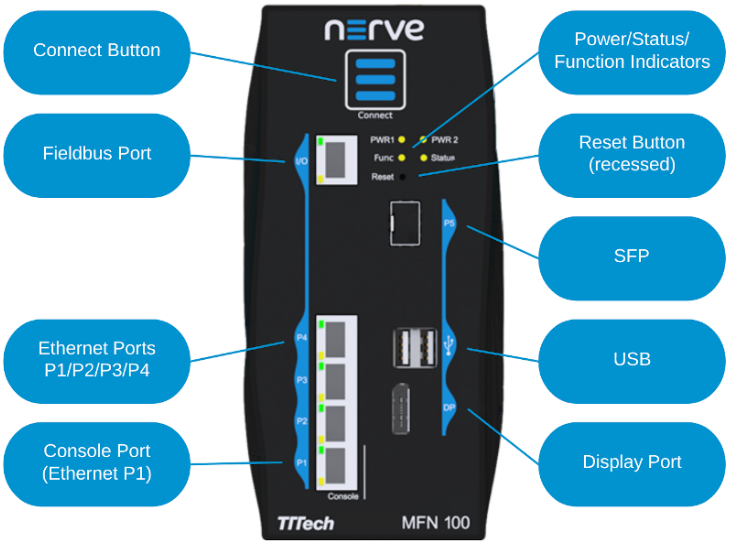
Identifying the MFN 100

The label of the MFN 100 can be found on the back of the device, close to the DIN rail clip. Exact identification is possible through the combination of product number (P/N), serial number (S/N) and version number (V/N) that are printed on the label. The model number of the MFN 100 details the variant of the MFN 100:

Letter or Number	Description
CODESYS indicator	This letter indicates whether the device has a CODESYS runtime pre-configured: • **C** — The CODESYS runtime is pre-configured • **X** — The CODESYS runtime is not pre-configured
SSD size	This number indicates the size of the SSD: • **6** — 64 GB SSD • **2** — 256 GB SSD • **5** — 512 GB SSD
CPU variant	This indicates the CPU variant of the device: • **4** — Intel E3940 (4 GB RAM) • **5** — Intel E3950 (8 GB RAM)

Front panel controls and indicators

Below is an overview of the front panel of the MFN 100, describing physical interfaces, indicators and their labels.



Label	Description
Connect Button	The connect button interrupts the connection on ports P2 to P5 of the MFN 100. This is the behavior in the standard configuration. The function is configurable on request. The button may be configured to change the network configuration.
Connection Indicator	The connection indicator is the first fin in the MFN 100 housing. It lights up blue when all required services are initiated and the connection to the Management System is configured.
Reset	Holding the button for 4-8 seconds initiates a power cycle. Use a tool with a rounded tip to press the button.
Power 1 **Power 2**	Indicators showing power active on the power supply.
Status	LED indicating system status • Green: All device functions are ready. • Not lit: Device functions are not ready or the device is booting.
Function	LED indicating CODESYS runtime status • Green: CODESYS runtime is operational. • Not lit: CODESYS runtime is not operational.
P1 Console	Ethernet port/console port. This port is typically used to connect a workstation to configure the MFN 100.
P2/P3/P4	Ethernet ports
P5	SFP port
I/O	Fieldbus interface

Label	Description
USB	Two USB 2.0 ports with 1.1 A maximum output current for both ports combined.
DP	DisplayPort supporting the DP++ standard.

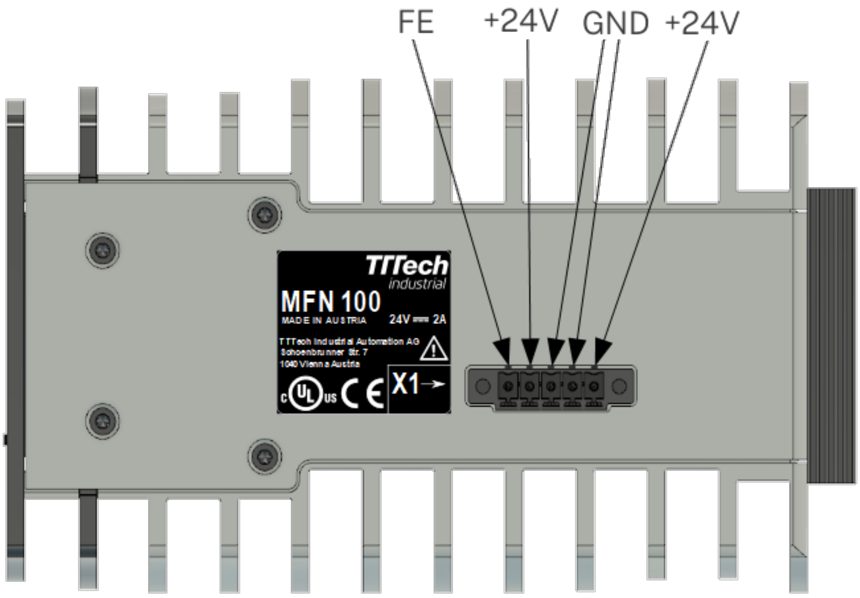
NOTE

P1 to **P5** are internally connected to a hardware switch and separated via VLAN tagging. This has two implications.

- Tagged VLAN frames cannot be used to communicate with any entity executed on the MFN 100.
- Do not connect two or more interfaces of the ports **P1** to **P5** to the same switch (or to the same Ethernet subnet), as this creates a loop.

Power connectors overview

The power connectors are located at the bottom of the MFN 100 next to the label. There are two separate 24 V inputs, two GND inputs and one Functional Earth (FE) input. The inputs are fused internally. The fuse cannot be replaced by the user. The power supply inputs are protected against reverse polarity.



Pin	Description
1	Power supply line 2
2	GND
3	GND
4	Power supply line 1
5	Functional Earth (FE)

NOTE

The GND and FE pins (pins 2, 3, and 5) are electrically connected to the housing.

Power supply details

Parameter	Value
Operating voltage	18 - 30 VDC
Start-up current	7 A max.
Consumption	1.4 A continuous 2.1 A peak
Dissipated power	33.6 W at 24 VDC

Setting up the MFN 100 for Nerve usage

When delivered, Nerve is already installed on the MFN 100. Two network cables and a +24 V DC power supply are required to finish the setup and use Nerve on the MFN 100. This includes connecting the power supply to the mating connector which is delivered with the MFN 100.

1. Connect pin 1 of the mating connector to +24 V DC.
2. Connect pin 2 of the mating connector to GND.
3. Plug the mating connector into the bottom side of the MFN 100.

4. Connect port 2 of the MFN 100 to the internet.

   NOTE

   Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. In general, physical port 2 is used for communication with the Management System over port 443 (HTTPS).
   If the MFN 100 does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System.
   If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network.

5. Plug in the power supply.

The MFN 100 will start after a few minutes and light up blue when all necessary services are initiated.

NOTE

- To connect the MFN 100 to a fieldbus, connect a network cable to the I/O port of the MFN 100 and to a fieldbus interface.

- A second power supply can also be connected to the MFN 100 as a backup. To do so, connect pin 3 of the mating connector to GND and connect pin 4 of the mating connector to +24 V DC.
- When connecting the MFN 100 to the internet through port 2, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated. The MAC address is located on the device.

Installation and removal on a DIN rail

The MFN 100 is intended for mounting on a DIN rail inside a closed cabinet. Due to its weight it should be installed on a strong DIN rail. No tool is required to install or remove the MFN 100.

Follow these steps to install the MFN 100 on a DIN rail:

1. Engage the DIN rail mounting clip of the MFN 100 with the upper edge of the DIN rail.
2. Push the MFN 100 down into the DIN rail.
3. Place the MFN 100 in a vertical position so that the mounting clip engages the lower edge of the DIN rail.

Follow these steps to remove the MFN 100 from a DIN rail:

1. Push the MFN 100 down.
2. Rotate the MFN 100 upwards so that the lower edge of the DIN rail disengages.
3. Lift the MFN 100 slightly to remove it.

Accessing the Local UI

As Nerve comes pre-installed on the MFN 100, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **P1**.

2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

   NOTE

   Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.

4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

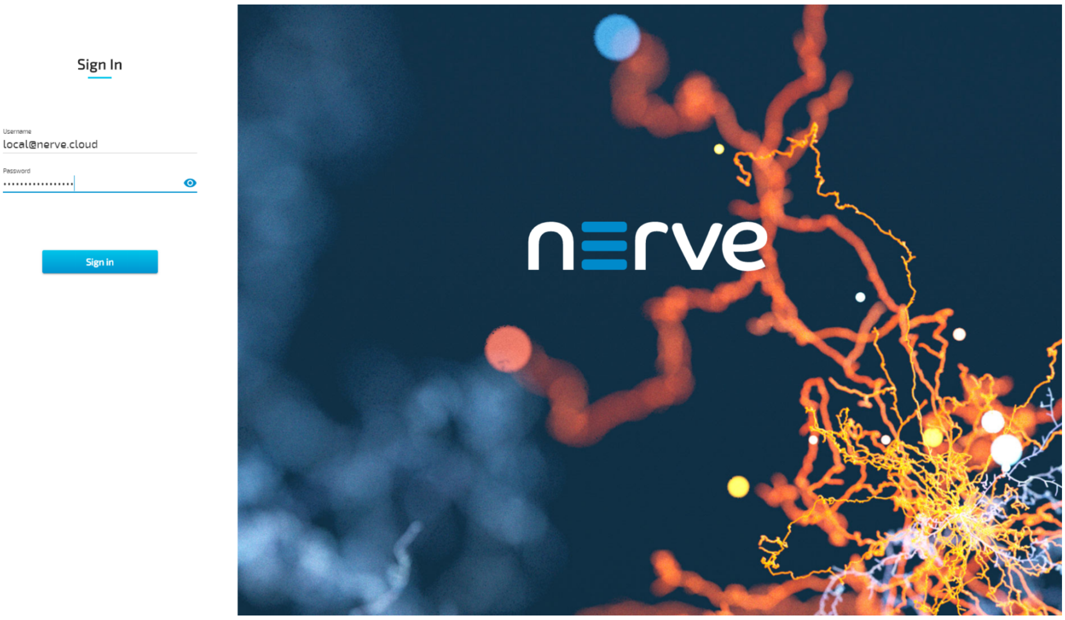
Refer to License activation in the user guide for more information and step by step instructions.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••••

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

Additional device specific information

The following information below is device specific information for use with Nerve.

CODESYS related information

For working with the CODESYS Development System, a device description for Nerve Devices is required. The device description can be downloaded from the Nerve Software Center.

The MFN 100 has an Ethernet port that is reserved for machine data acquisition. Connect a network cable to the I/O port of the MFN 100 and to a fieldbus interface to acquire machine data. The CODESYS runtime can be reached at `172.20.2.2`.

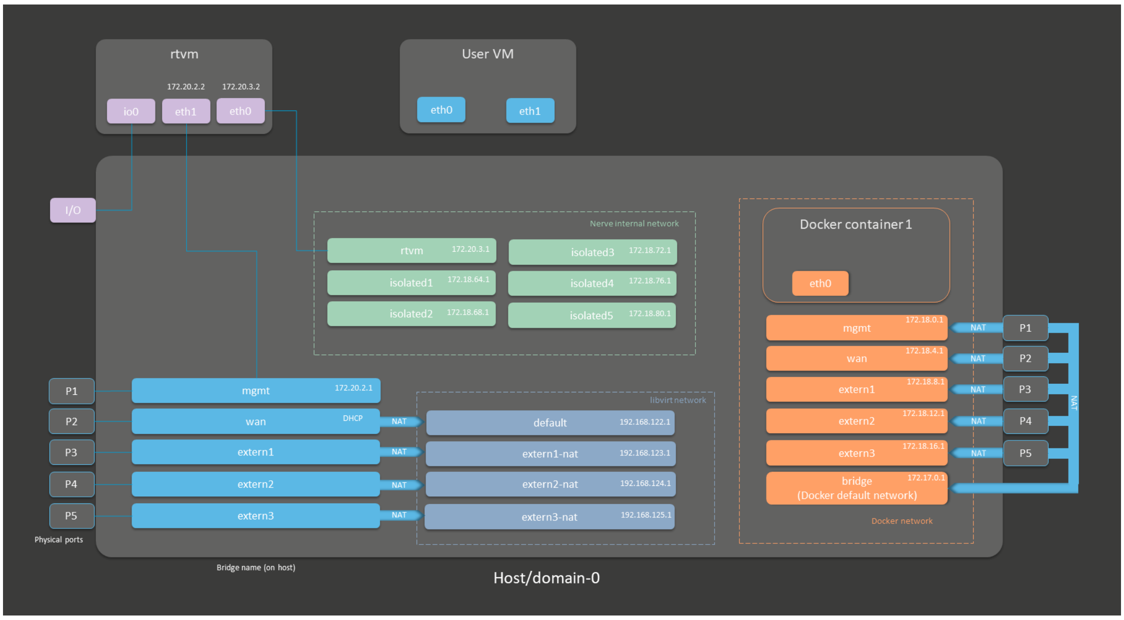
Physical ports and network interfaces

Below is a depiction of the node internal networking for the MFN 100. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the MFN 100.

Physical port	Network name
I/O	io0
P1	mgmt
P2	wan
P3	extern1
P4	extern2
P5	extern3

Below is a graphic that details the available interfaces of the MFN 100 for use with Nerve. Pictured is how the physical interfaces translate to the Host and the CODESYS runtime.

The image shows an example node and how the physical interfaces translate to the Host and the CODESYS runtime. The node consists of the **host/domain-0** and the real-time VM running the CODESYS runtime (labeled **rtvm**). It also has one Virtual Machine workload and two Docker workloads deployed. The virtual machine is located outside of the host and the Docker containers are located in the Docker network inside of the host. However, the workloads are not yet connected.

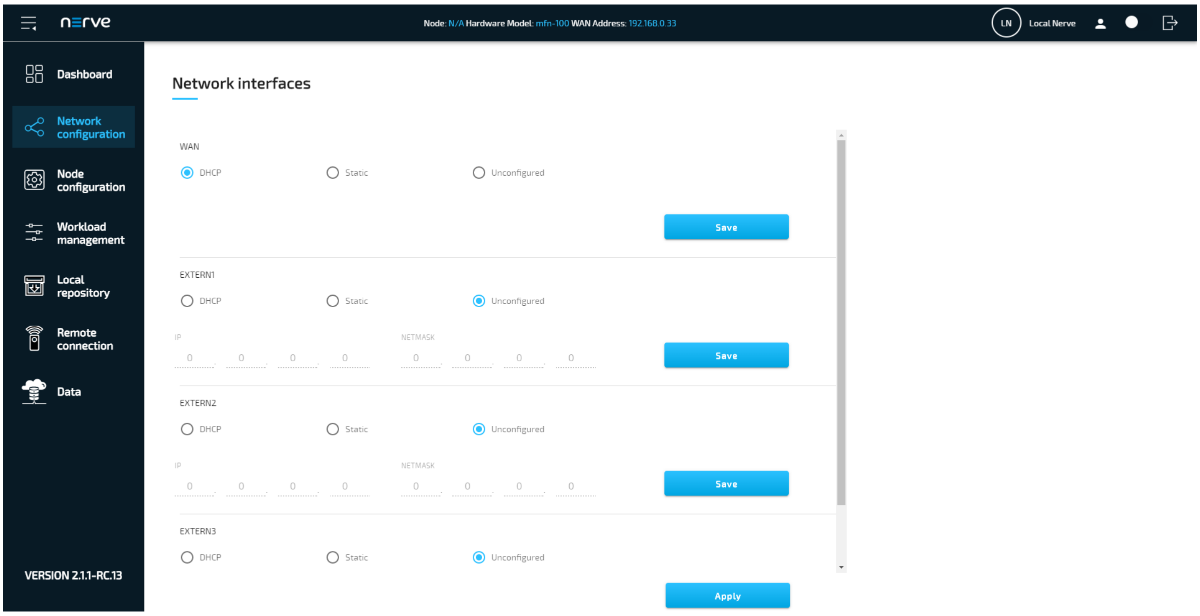


Notable IP Adresses	
Host access	172.20.2.1
CODESYS runtime access	172.20.2.2

Refer to Node internal networking for more information on networking in the Nerve system.

Network configuration

The Ethernet ports of the Nerve Devices can be configured from the Local UI. For the MFN 100, the interfaces in the Local UI represent the physical ports 2, 3, 4 and 5. The console port **P1** and the I/O port of the MFN 100 are reserved and cannot be modified. The console port is used solely for configuration purposes. The I/O port is connected to the CODESYS runtime and used for fieldbus communication. Select **Network configuration** in the navigation on the left to reach this menu.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.33

Network interfaces

WAN

● DHCP ○ Static ○ Unconfigured

EXTERN1

○ DHCP ○ Static ● Unconfigured

IP 0 . 0 . 0 . 0 NETMASK 0 . 0 . 0 . 0

EXTERN2

○ DHCP ○ Static ● Unconfigured

IP 0 . 0 . 0 . 0 NETMASK 0 . 0 . 0 . 0

EXTERN3

○ DHCP ○ Static ● Unconfigured

Manual image installation

In some cases Nerve images need to be installed or updated from a USB drive directly at the Nerve Device. Refer to the instructions below. First, here are the requirements for manually installing the Nerve image on the MFN 100:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the MFN 100.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press F7 when the device is booting to enter the boot menu.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Power on the device.
6. Press F7 to enter the boot menu. Make sure that the device will boot from the USB drive.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img.tar.gz
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_mfn-100.img bs=4M of=/dev/sd<drivena
   sync
   ```

   NOTE

   Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.
4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Kontron KBox A-150-APL

The KBox A-150-APL is an industrial computer platform for process control and optimization with the Intel Atom series processors. It offers DIN Rail mounting positions in limited space.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	EN00-03002-01
CPU	Intel Atom E3950
Cores	4
RAM	4 GB DDR3
Storage	128 GB 2.5" SATA SSD

Item	Description
TPM	TPM 2.0 included
Interfaces	• 2x GB LAN • 2x RS232/422/485 • 4x USB • 1x DisplayPort • 1x HDMI

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, update the BIOS on the KBox A-150-APL to the latest version. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Advanced > CPU Chipset Configuration > EIST	**Disabled**
Advanced > CPU Chipset Configuration > Active Processor Cores	**Enabled**
Advanced > CPU Chipset Configuration > Intel Virtualization Technology	**Enabled**
Advanced > CPU Chipset Configuration > VT-d	**Enabled**
Advanced > CPU Chipset Configuration > C-States	**Disabled**
Advanced > Network Stack > Network Stack	**Enabled**

Path	Setting
Security > Secure Boot > Attempt Secure Boot	**Disabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the KBox A-150-APL.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img` file. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz` file and transfer the extracted file to the USB drive:

```
tar xf Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img.tar.gz
sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-150-apl.img bs=4M of=
sync
```

NOTE

Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.
4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN 1** for this device. Connect an ethernet cable to **LAN 1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN 1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

NOTE

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN 1**, the device will receive an IP address through DHCP.

A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Kontron KBox A-150-APL. Therefore, the IP address of the **wan** interface that is mapped to physical port **LAN 1** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.

6. Edit the configuration the following way:

   ```
   auto wan
   iface wan inet static
     bridge_ports eth0
     address 172.20.2.1
     netmask 255.255.255.0
   ```

7. Enter Ctrl+S to save the configuration.

8. Enter Ctrl+X to exit the Nano editor.

9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

NOTE

Make sure to change the IP address again for communication with the Management System once the product license has been activated. This can be done through the Local UI.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN 1**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter `<wanip>:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

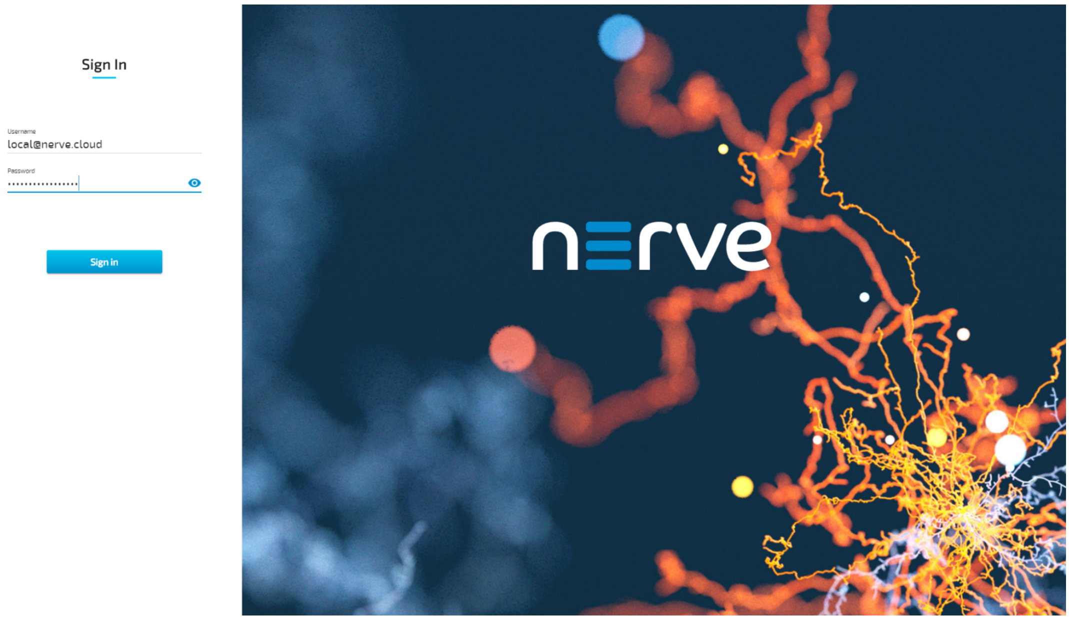
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.
3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Username: local@nerve.cloud

Password: ••••••••••••••••••

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

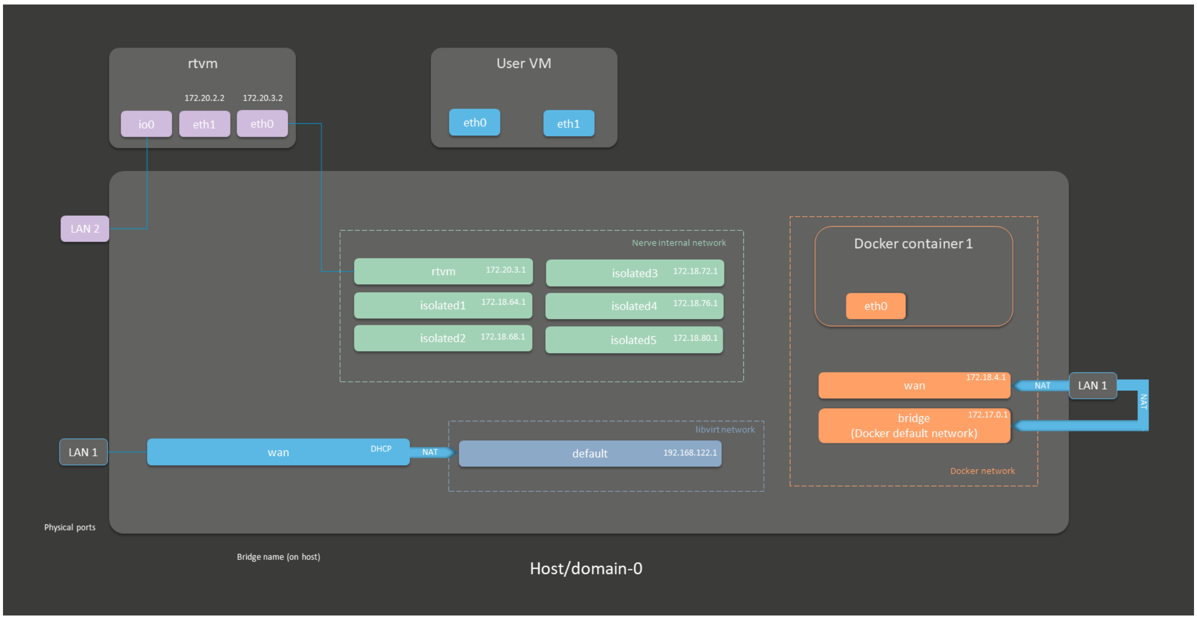
Additional device specific information

The following information below is device specific information for use with Nerve.

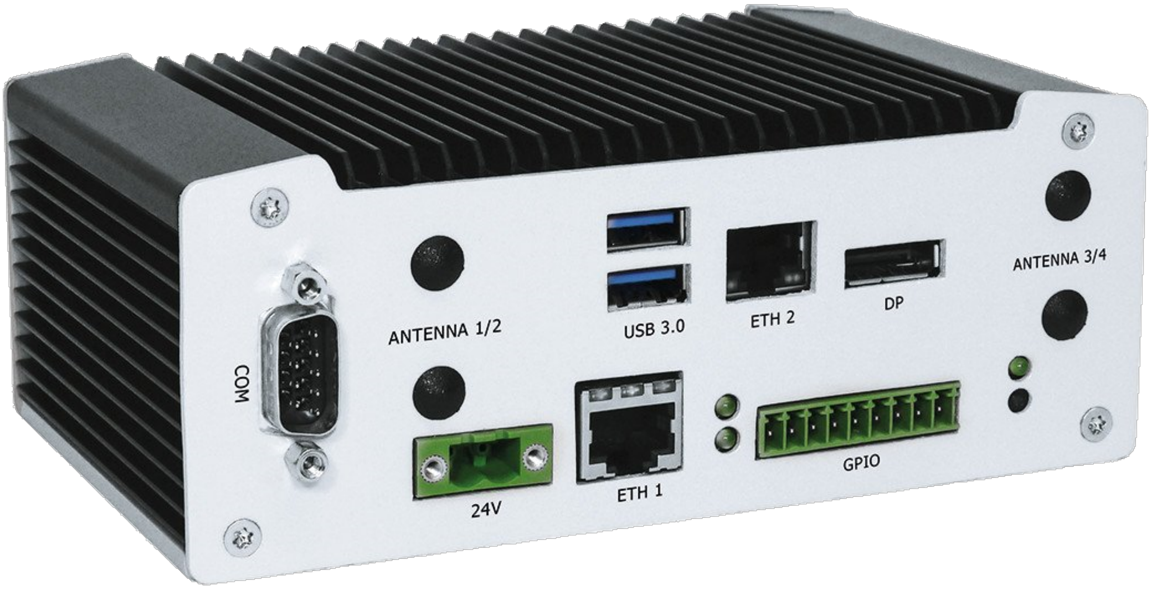
Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the KBox A-150-APL hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the KBox A-150-APL.

Physical port	Network name
LAN 1	wan
LAN 2	io0



Kontron KBox A-250



Based on a pITX-2.5“ SBC with Intel Atom processors of the E3900 family, the fanless KBox A-250 has been designed as a gateway for IoT-Edge applications. Its fields of application are primarily found in industrial automation.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the

device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	2-A0DM-009
CPU	Intel Atom E3950
Cores	4
RAM	4 GB DDR3L
Storage	128 GB M.2 MLC
TPM	TPM 2.0 included
Interfaces	• 2x GB LAN • 1x RS232/422/485 • 2x USB • 1x DisplayPort

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a DisplayPort input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, update the BIOS on the KBox A-250 to the latest version. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Advanced > ACPI Settings > Enable ACPI Auto Configuration	**Disabled**
Advanced > ACPI Settings > Enable Hibernation	**Disabled**
Advanced > ACPI Settings > ACPI Sleep State	**Suspend Disabled**
Advanced > CPU Configuration > Turbo Mode	**Disabled**
Advanced > CPU Configuration > Intel Virtualization Technology	**Enabled**
Advanced > CPU Configuration > VT-d	**Enabled**
Advanced > Network Stack Configuration > Network Stack	**Enabled**
Advanced > CSM Configuration > CSM Support	**Disabled**
Advanced > System Component > DDR SSC	**Disable**
Advanced > System Component > HighSpeed SerialIO SSC	**Disable**
Chipset > South Bridge > OS Selection	**Intel Linux**
Chipset > South Bridge > Real Time Option	**RT Enabled, Agent Disabled**
Security > Secure Boot > Attempt Secure Boot	**Disabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the KBox A-250.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz` file to retrieve the `Nerve_Blue_USB-`

`installer_2.5.0_for_kontron-kbox-a-250.img` file. Depending on the program used, the file might need to be extracted more than once.

3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img.tar.gz
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_kontron-kbox-a-250.img bs=4M of=/dev
   sync
   ```

   NOTE

   Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **ETH 2** for this device. Connect an ethernet cable to **ETH 2** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **ETH 2**. The **wan** interface will then receive an IP address from a DHCP server and

establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.

- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**
>
> Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **ETH 2**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Kontron KBox A-250. Therefore, the IP address of the **wan** interface that is mapped to physical port **ETH 2** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.
4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.
6. Edit the configuration the following way:

   ```
   auto wan
   iface wan inet static
     bridge_ports eth0
     address 172.20.2.1
     netmask 255.255.255.0
   ```

7. Enter Ctrl+S to save the configuration.
8. Enter Ctrl+X to exit the Nano editor.
9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **ETH 2**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter <wanip>`:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

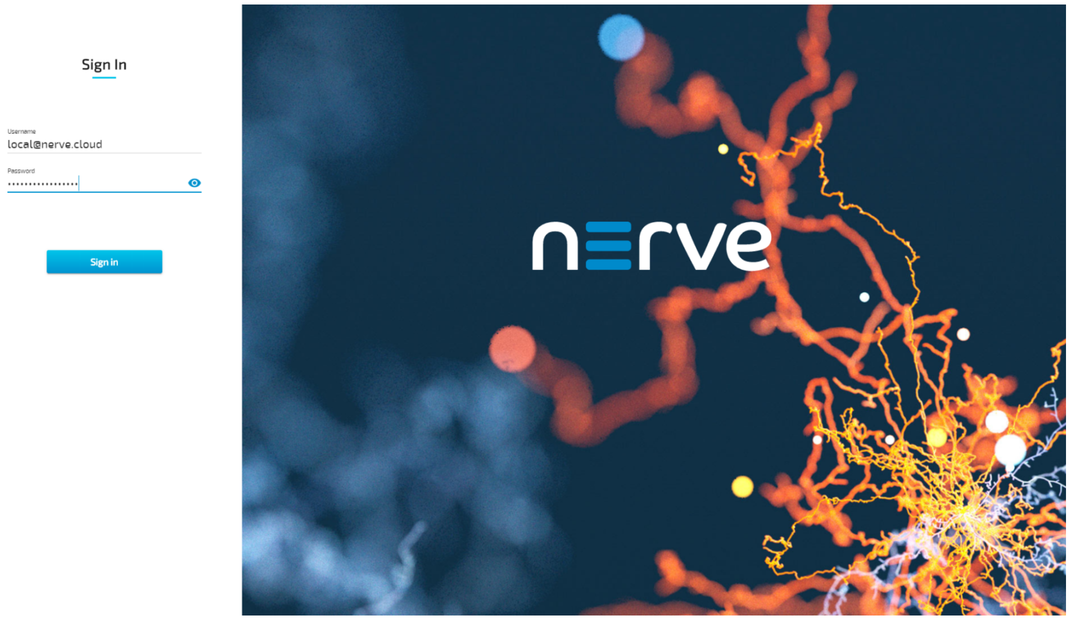
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.
3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••••

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

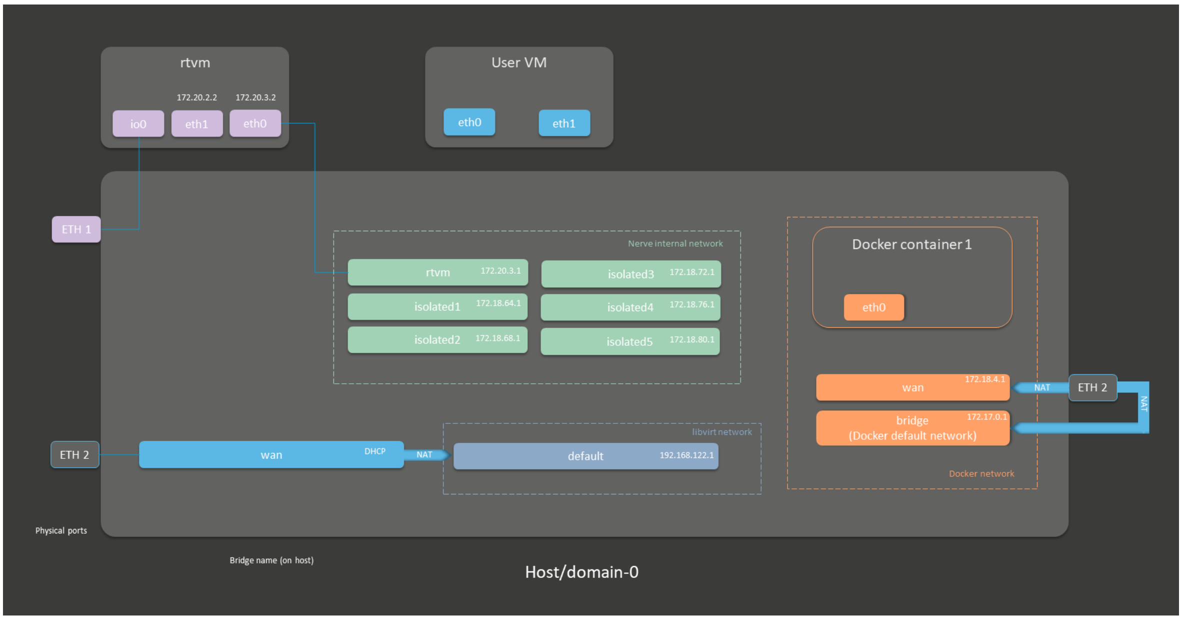
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the KBox A-250 hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the KBox A-250.

Physical port	Network name
ETH 2	wan
ETH 1	io0



Maxtang AXWL10-8665U

The AXWL-10 is a small form factor fanless embedded system, which makes it ideal for space-sensitive applications. This Whiskey Lake based system is designed for various application as, but not limited to, automation, network security, communication and transportation, health-care, and retail.

For more information refer to the information materials provided by the manufacturer:

- Product page
- Datasheet

Note that the manufacturer did not offer a dedicated manual at the time of writing. The device is based on the WL10 family of motherboards. Refer to the Manuals section on the manufacturers homepage for materials on the WL10 family or contact a Maxtang representative for more information.

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	AXWL10-8665U
CPU	Intel Core i7-8665U
Cores	4
RAM	32 GB
Storage	256 GB
TPM	TPM 2.0 included

Item	Description
Interfaces	• 2x GB LAN • 5x RS232 • 1x RS485 • 3x USB 3.0 • 2x USB 2.0 • 8x GPIO • 5x COM • 1x DisplayPort • 1x HDMI 1.4 • 1x VGA

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a DisplayPort, HDMI or VGA input • a keyboard • a USB drive formatted to FAT32

Refer to the materials of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, update the Setup Utility on the AXWL10-8665U to V2.20.1271 or later. Refer to the materials of the manufacturer for information on how to update the BIOS and Setup Utility versions.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.
3. Go to **Setup Utility**.

4. Change the following settings:

Path	Setting
Advanced > **CPU Configuration** > **Intel (VMX) Virtualization Technol**	**Enabled**
Advanced > **CPU Configuration** > **Hyper-Threading**	**Disabled**
Advanced > **CPU Configuration** > **Active Processor Cores**	**All**
Advanced > **CPU Configuration** > **C states**	**Disabled**

Path	Setting
Advanced > Network Stack Configuration > Network Stack	**Enabled**
Chipset > System Agent (SA) Configuration > VT-d	**Enabled**
To enable boot from USB stick from all USB sockets:	
Advanced > USB Configuration > Legacy USB Support	**Enabled**
Chipset > PCH-IO Configuration > USB Configuration > USB Port Override	**Select Per-Pin**

5. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort, HDMI or VGA input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the AXWL10-8665U.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img` file. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img.tar.gz
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_maxtang-axwl10-8665u.img bs=4M of=/d
   sync
   ```

   NOTE

   Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN1** for this device. Connect an ethernet cable to **LAN1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

NOTE

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Maxtang AXWL10-8665U. Therefore, the IP address of the **wan** interface that is mapped to physical port **LAN1** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.

6. Edit the configuration the following way:

```
auto wan
iface wan inet static
  bridge_ports eth0
  address 172.20.2.1
  netmask 255.255.255.0
```

7. Enter Ctrl+S to save the configuration.

8. Enter Ctrl+X to exit the Nano editor.

9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN1**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter <wanip>`:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

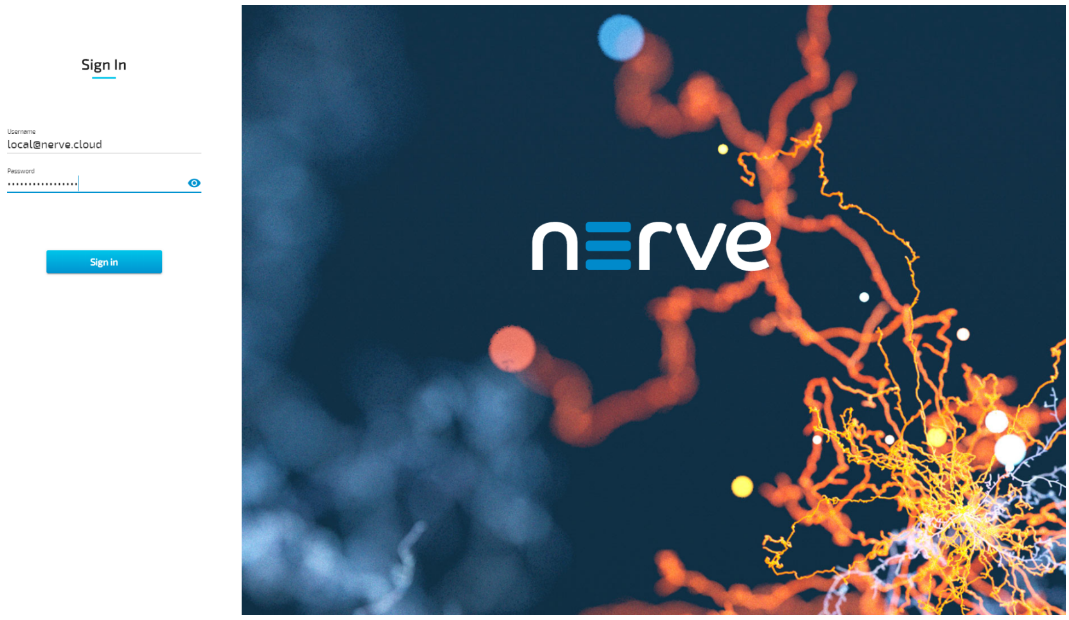
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.
3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••••

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

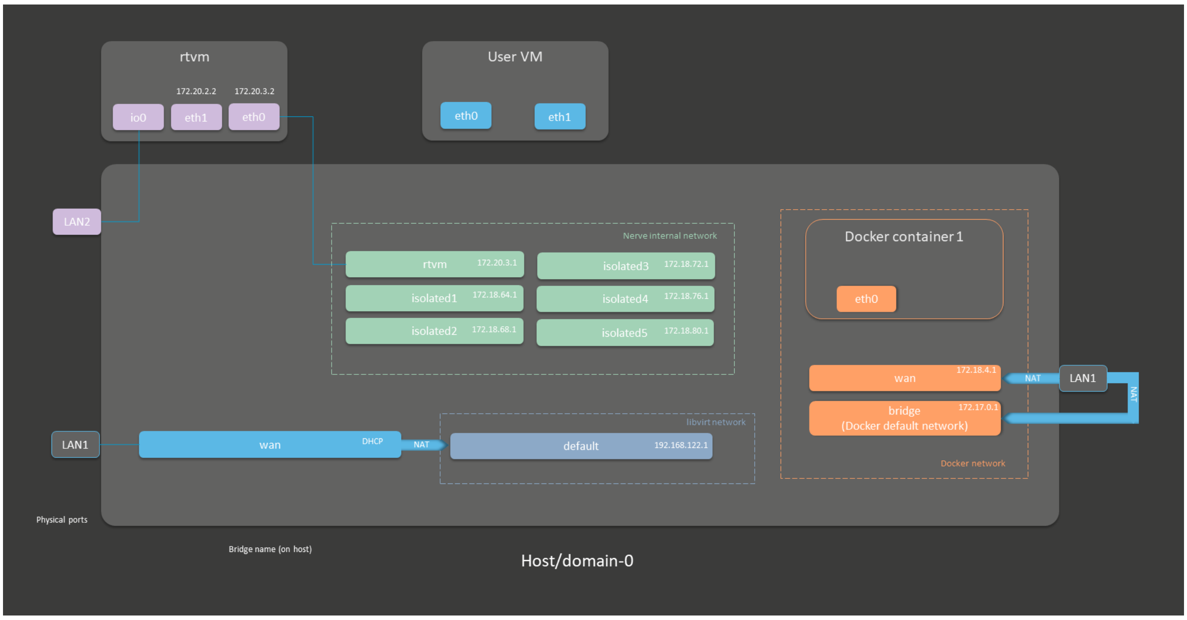
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the AXWL10-8665U hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the AXWL10-8665U.

Physical port	Network name
LAN1	wan
LAN2	io0



Siemens SIMATIC IPC127E

The SIMATIC IPC127E can be integrated into a control cabinet or directly on the machine with minimal space requirements to record, collect, process, and transfer data directly in the production environment.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the

device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	6AG4021-0AB12-1CA0 /SIMATIC IPC127
CPU	Intel Atom E3940
Cores	4
RAM	4 GB
Storage	128 GB
TPM	TPM 2.0 included
Interfaces	• 3x GB LAN • 4x USB 3.0 • 1x DisplayPort

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a DisplayPort input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the SIMATIC IPC127E needs to be version V27.01.03. or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Esc while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Power > Advanced CPU Control > VT-d	**Enabled**
Power > Advanced CPU Control > Active Processor Cores	**Disabled**
Power > Advanced CPU Control > C states	**Disabled**
Power > Advanced CPU Control > User Power Scenario	**Max Performance**
Power > Advanced CPU Control > Turbo Mode	**Disabled**
Boot > Network Stack	**Enabled**
Boot > USB Boot	**Enabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the SIMATIC IPC127E.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Esc when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img.tar.gz
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc127e.img bs=4M of
   sync
   ```

   NOTE

   Make sure to replace <`drivename`> with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **X2 P1** for this device. Connect an ethernet cable to **X2 P1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **X2 P1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is

necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**
>
> Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **X2 P1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **X1 P1**.
2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

   > **NOTE**
   >
   > Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.
4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.
- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download

files. This might be the way to activate the license if the Management System is hosted on premise.

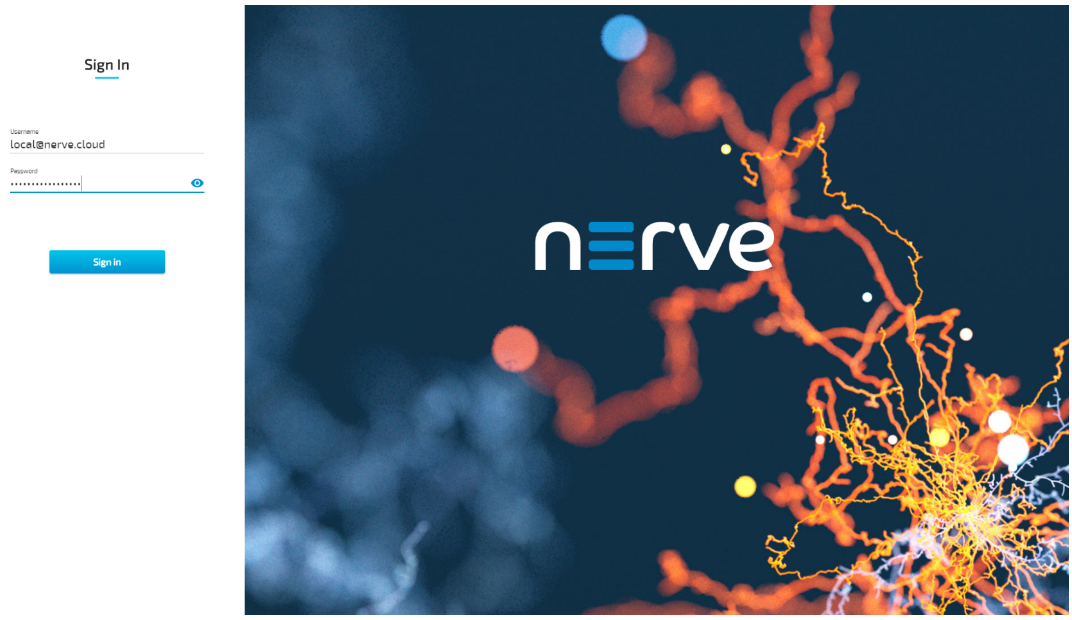
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

Additional device specific information

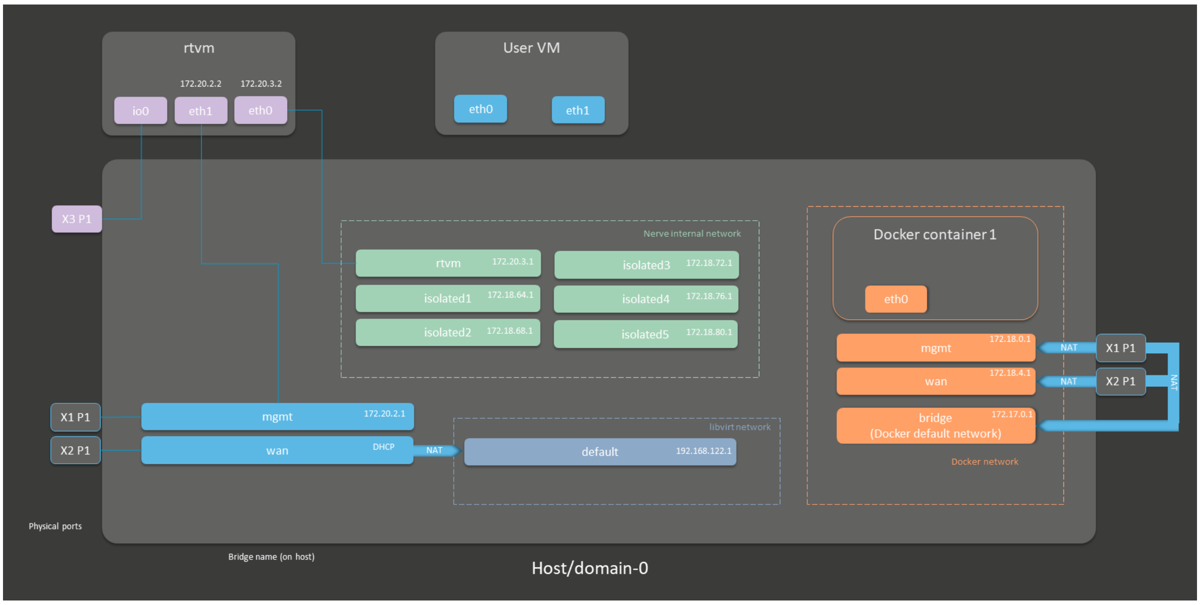
The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

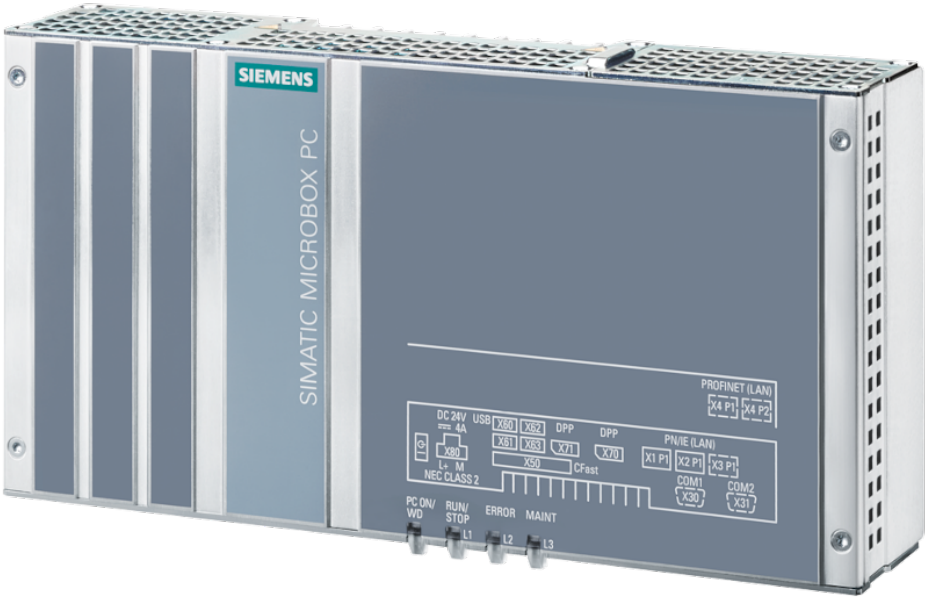
Below is a depiction of the node internal networking adapted to the SIMATIC IPC127E hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SIMATIC IPC127E.

Physical port	Network name
X1 P1	mgmt
X2 P1	wan

Physical port	Network name
X3 P1	io0



Siemens SIMATIC IPC427E



The SIMATIC IPC427E is an embedded IPC with 6th generation Intel Core-i processors that can be used for control, data collection, or communication tasks at the machine or process level. It offers low mounting depth and different mounting possibilities, with all interfaces on one side for easy integration in existing plants.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	6AG4141-5BC00-0GA8 /SIMATIC IPC427
CPU	Intel Core i5-6442EQ
Cores	4
RAM	16 GB
Storage	480 GB SATA SSD
TPM	TPM 2.0 included
Interfaces	• 3x GB LAN • 4x USB 3.0 • 2x DisplayPort

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a DisplayPort input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the SIMATIC IPC427E needs to be version 12 or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Esc while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Advanced > System Agent (SA) Configuration > VT-d	**Enabled**
Advanced > Active Management Technology Support > Intel AMT Configuration Screens	**Disabled**
Advanced > Memory Configuration > Max TOLUD	**2 GB**
Power > CPU Configuration > Intel (VMX) Virtualization Technology	**Enabled**
Power > Power & Performance > CPU - Power Management Control > CPU Power Level	**Standard**
Power > Power & Performance > CPU - Power Management Control > Intel (R) SpeedStep(tm)	**Disabled**
Power > Power & Performance > CPU - Power Management Control > Intel (R) Speed Shift Technology	**Disabled**
Power > Power & Performance > CPU - Power Management Control > C states	**Disabled**
Boot > Boot Type	**Dual Boot Type**
Boot > Add Boot Options	**Auto**
Boot > USB Boot	**Enabled**
Boot > EFI Device First	**Enabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the SIMATIC IPC427E.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Esc when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz` from the Nerve Software Center to a workstation.

2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img.tar.gz
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_siemens-simatic-ipc427e.img bs=4M of
   sync
   ```

   > **NOTE**
   >
   > Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **X2 P1** for this device. Connect an ethernet cable to **X2 P1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require

internet access. The easiest way of doing that is connecting an ethernet cable to **X2 P1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.

- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**
>
> Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **X2 P1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **X1 P1**.
2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

   > **NOTE**
   >
   > Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.
4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

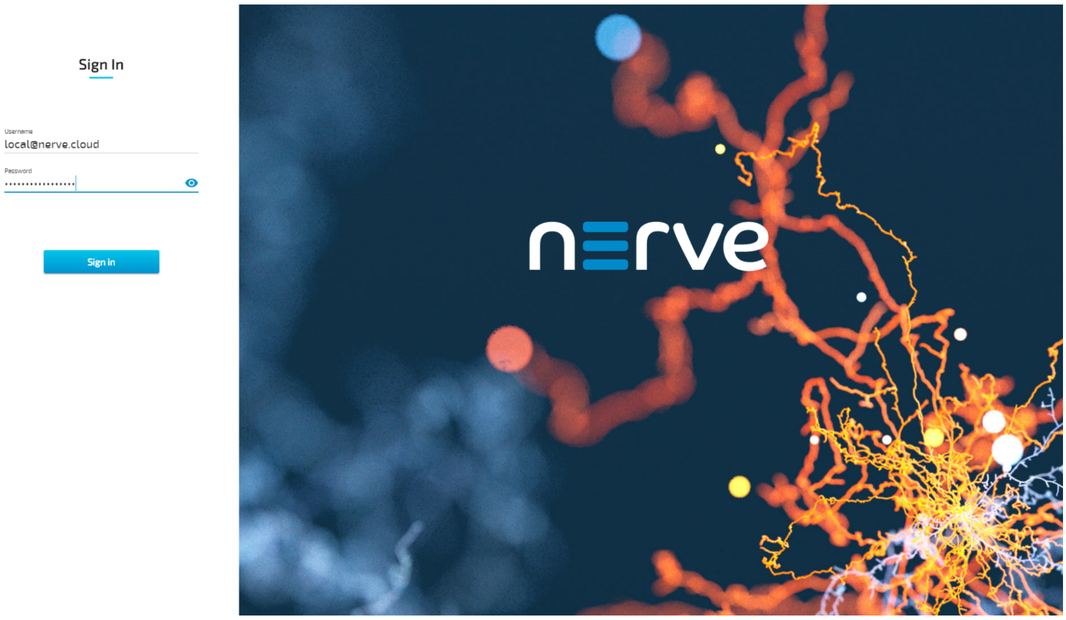
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Sign In

Username: local@nerve.cloud

Password: ••••••••••••••••••

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

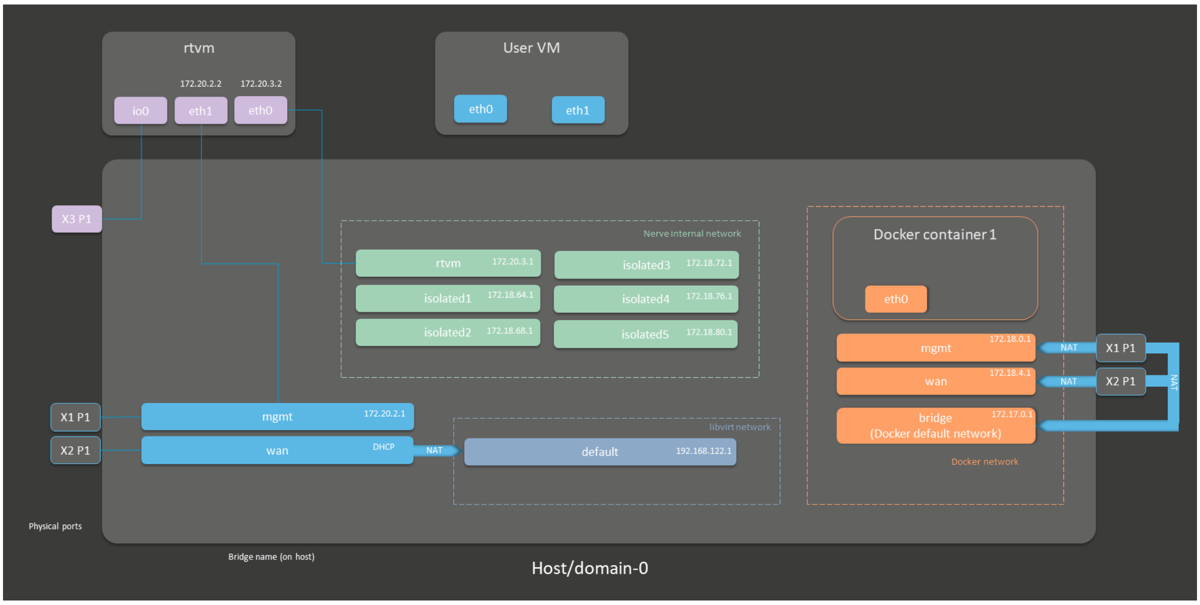
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the SIMATIC IPC427E hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SIMATIC IPC427E.

Physical port	Network name
X1 P1	mgmt
X2 P1	wan
X3 P1	io0



Supermicro SuperServer E100-9AP-IA

With an excellent price/performance ratio, the Supermicro Superserver devices offer a compact design with good connectivity, allowing optimal Nerve performance. The SuperServer E100-9AP-IA is a compact, Intel Atom class embedded IPC with many connection possibilities.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	SYS-E100-9AP-IA
CPU	Intel Atom x5-E3940
Cores	4
RAM	8 GB
Storage	128 GB
TPM	TPM 1.2 and TPM 2.0 included

Item	Description
Interfaces	• 2x GbE LAN ports via Intel I210-IT • 2x RS232 • 2x RS232/422/485 • 1x RS-485 • 1x DIO via DB9 • 4x USB 2.0 • 2x USB 3.0 • 1x VGA • 1x HDMI

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a VGA or HDMI input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the SuperServer E100-9AP-IA needs to be version 1.3 or later and Setup Utility needs to be V2.18.1263 or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.
3. Change the following settings:

Path	Setting
Advanced > CPU Configuration > Intel Virtualization Technology	**Enabled**
Advanced > Chipset Configuration > VT-d	**Enabled**
Advanced > CPU Configuration > Active Processor Cores	**Enabled**

Path	Setting
Advanced > ACPI Settings > ACPI Sleep State	**Suspend Disabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a VGA or HDMI input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the SuperServer E100-9AP-IA.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.tar.gz` file and transfer the extracted file to the USB drive:

```
tar xf Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.img.t
sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-e100-9ap-ia.i
sync
```

> **NOTE**
>
> Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN1** for this device. Connect an ethernet cable to **LAN1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**
>
> Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device

to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Supermicro SuperServer E100-9AP-IA. Therefore, the IP address of the **wan** interface that is mapped to physical port **LAN1** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.

6. Edit the configuration the following way:

   ```
   auto wan
   iface wan inet static
     bridge_ports eth0
   ```

```
    address 172.20.2.1
    netmask 255.255.255.0
```

7. Enter Ctrl+S to save the configuration.

8. Enter Ctrl+X to exit the Nano editor.

9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN1**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter <wanip>`:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

Refer to License activation in the user guide for more information.

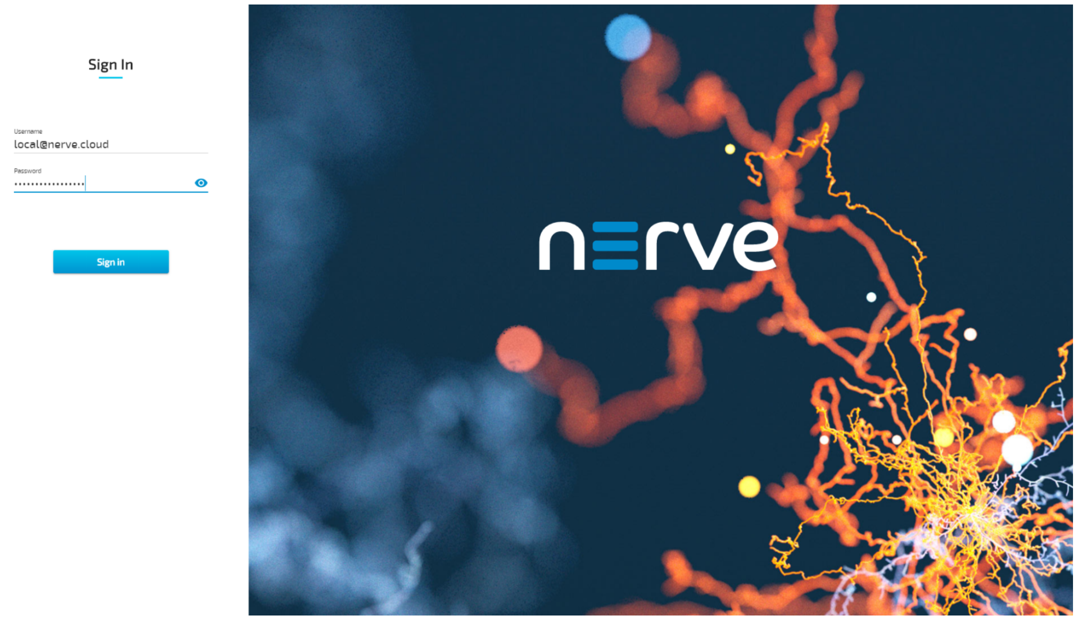
Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.

3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
•••••••••••••••••

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

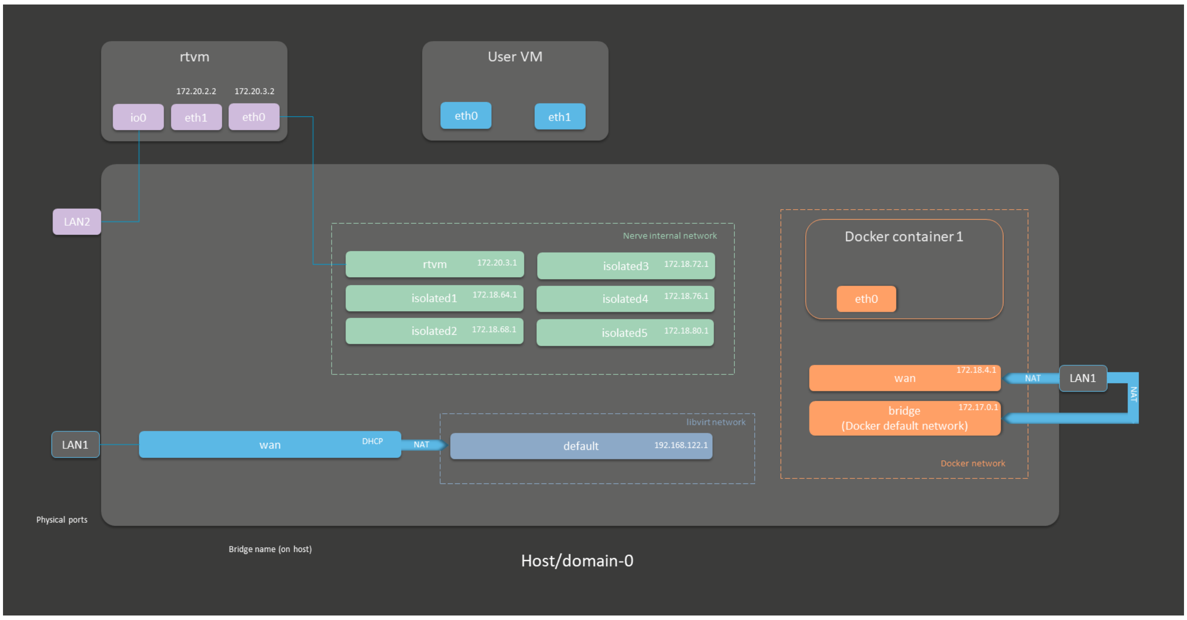
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the SuperServer E100-9AP-IA hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SuperServer E100-9AP-IA.

Physical port	Network name
LAN1	wan
LAN2	io0



Supermicro SuperServer 1019D-16C-FHN13TP

With an excellent price/performance ratio, the Supermicro Superserver devices offer a compact design with good connectivity, allowing optimal Nerve performance. The SuperServer 1019D-16C-FHN13TP features a 16 core Intel Xeon-D and a high count of Ethernet interfaces. It is 19" rack mountable, but still very compact.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	SYS-1019D-16C-FHN13TP

Item	Description
CPU	Intel Xeon D-2183IT
Cores	16
RAM	32 GB
Storage	2x 256 G
TPM	TPM 2.0 included
Interfaces	• 9x GbE • 2x 10GbE • 2x 10GbE SFP+ • 1 Dedicated IPMI LAN port • 1x COM RS-232/422/485 (ESD 8KV) • 1x COM via RJ45 • 2x USB 3.0 • 1x DisplayPort • 1x VGA

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

- a monitor with a DisplayPort or VGA input
- a keyboard
- a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. <!--Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the Superserver 1019D-16C-FHN13TP needs to be version 1.3 or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version. -->

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Advanced > CPU Configuration > Hyper-Threading [ALL]	**Disabled**

Path	Setting
Advanced > CPU Configuration > Intel Virtualization Technology	**Enabled**
Advanced > CPU Configuration > Advanced Power Management Configuration > Power Technology	**Disabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort or VGA input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the SuperServer 1019D-16C-FHN13TP.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp.img.tar.gz file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn13tp
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-1019d-16c-fhn
   sync
   ```

   > **NOTE**
   >
   > Make sure to replace <drivename> with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN4** for this device. Connect an ethernet cable to **LAN4** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN4**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN4**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN3**.
2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

   > **NOTE**
   >
   > Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.
4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

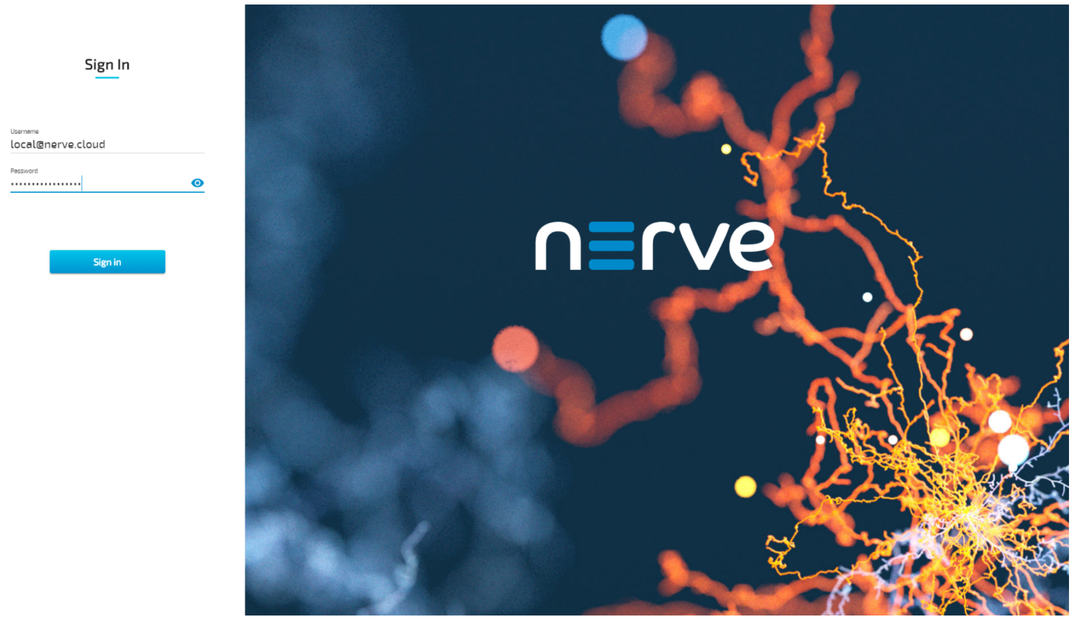
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Username
local@nerve.cloud
Password

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the SuperServer 1019D-16C-FHN13TP hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SuperServer 1019D-16C-FHN13TP.

Physical port	Network name
LAN1	extern1
LAN2	io0
LAN3	mgmt
LAN4	wan
LAN5	extern2

Physical port	Network name
LAN6	extern3
LAN7	extern4
LAN8	extern5
LAN9	extern6
LAN10	extern7
LAN11	extern8
LAN12	extern9
LAN13	extern10

NOTE

Due to the large number of network ports, contact TTTech Industrial customer support at support@tttech-industrial.com for any additional configuration requests.

Supermicro SuperServer 5029C-T

With an excellent price/performance ratio, the Supermicro Superserver devices offer a compact design with good connectivity, allowing optimal Nerve performance. The SuperServer 5029C-T is a compact, mini tower server system featuring an Intel Core i3, and a high number of SSD/HDD mounting options.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	SYS-5029C-T
CPU	Intel Core i3-8100
Cores	4
RAM	16 GB
Storage	HDD 2x 1 TB
TPM	TPM 2.0 included
Interfaces	• 1x PCI-E 3.0 x16 slot • 2x GbE • 1 Dedicated IPMI LAN port • 1x COM • 4x USB 3.1 • 2x USB 2.0 • 1x VGA

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

> **NOTE**
>
> The device needs to have a RAID controller installed to be used with Nerve. Consult the manufacturer's user manual on how to install a RAID controller before attempting to install Nerve.

Requirements for the instructions below:

• a monitor with a VGA input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the SuperServer 5029C-T needs to be version 1.3 or later and Setup Utility needs to be V2.20.1276 or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.

3. Change the following settings:

Path	Setting
Advanced > **CPU Configuration** > **Intel (VMX) Virtualization Technol**	**Enabled**
Chipset Configuration > **System Agent (SA) Configuration** > **VT-d**	**Enabled**
Advanced > **CPU Configuration** > **C states**	**Disabled**
Advanced > **CPU Configuration** > **Active Processor Cores**	**All**
Advanced > **PCIe/PCI/PnP Configuration** > **CPU SLOT1 PCI-E 3.0 X16 OPROM**	**EFI** (this option is needed when the RAID controller is installed)

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a VGA input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the SuperServer 5029C-T.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img`. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img.tar.g
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_supermicro-superserver-5029c-t.img b
   sync
   ```

   > **NOTE**
   >
   > Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN1** for this device. Connect an ethernet cable to **LAN1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

NOTE

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Supermicro SuperServer 5029C-T. Therefore, the IP address of the **wan** interface that is mapped to physical port **LAN1** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.
4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.
6. Edit the configuration the following way:

   ```
   auto wan
   iface wan inet static
     bridge_ports eth0
     address 172.20.2.1
     netmask 255.255.255.0
   ```

7. Enter Ctrl+S to save the configuration.
8. Enter Ctrl+X to exit the Nano editor.
9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN1**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter <wanip>`:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

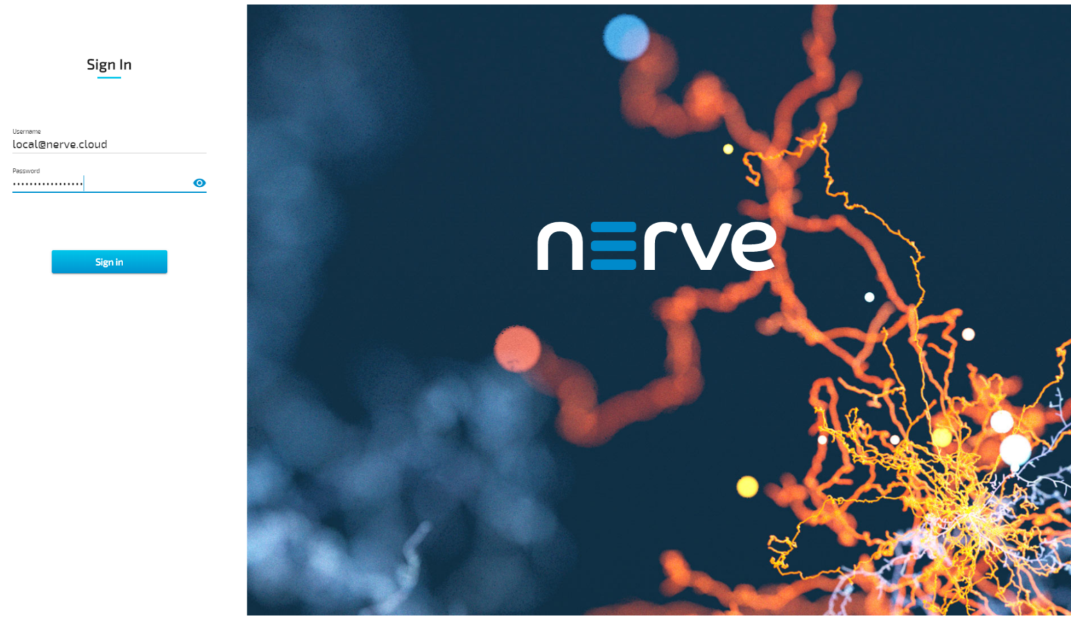
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.
3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••••

Sign in

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

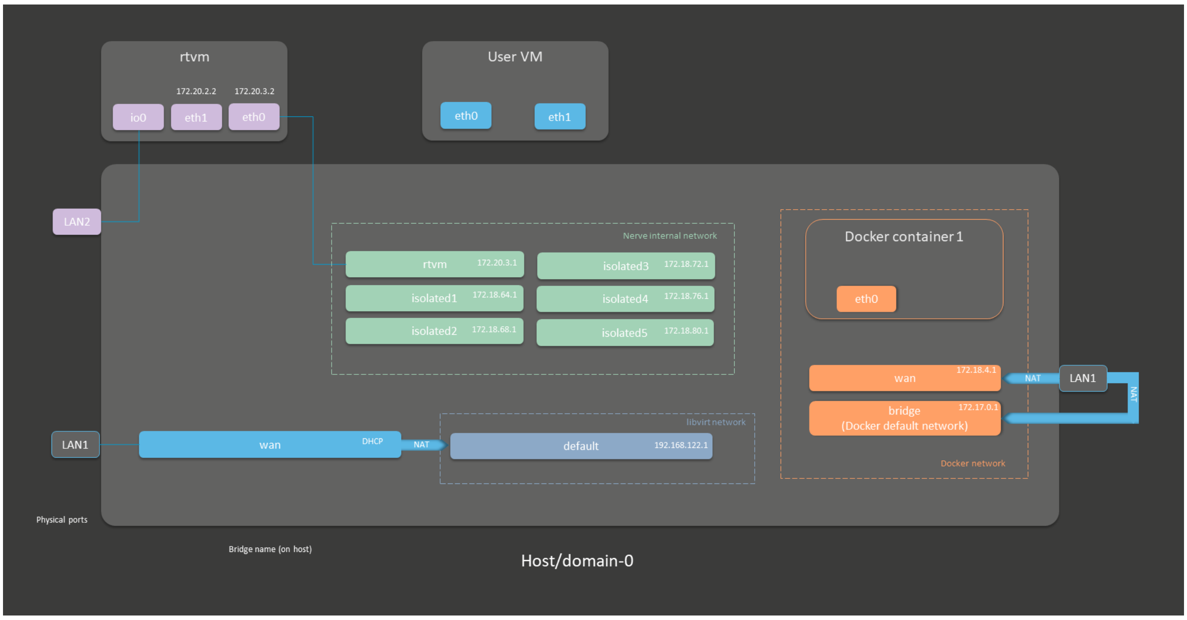
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the SuperServer 5029C-T hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SuperServer 5029C-T.

Physical port	Network name
LAN1	wan
LAN2	io0



Toshiba FA2100T-700

The FA2100T model 700 is robust and environmentally resistant IPC in a slim case. It employs an Intel® Xeon® processor E3-1268L v5 (2.4 GHz) and incorporates reliable memory with ECC, as well as other features to support 24-hour use and stable operation expected of an industrial computer.

For more information refer to the information materials provided by the manufacturer:

- Product page

Note that the manufacturer did not offer a dedicated manual at the time of writing. For more information, contact the manufacturer directly.

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	UA52719
CPU	Intel Xeon Processor E3-1268L v5
Cores	4
RAM	8 GB
Storage	2 TB, no SSD
Interfaces	• 3x GB LAN • 4x USB 2.0 in front • 2x USB 2.0 in rear • 2x RS232 • 1x DVI • 1x VGA

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

- a monitor with a DVI or VGA input
- a keyboard
- a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the FA2100T-700 needs to be version V01.00 or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press F2 while the device is booting to enter the BIOS menu.
3. Change the following settings:

Path	Setting
Advanced > System Agent Configuration > VT-d	**Enabled**
Power > CPU Configuration > Active Processor Cores	**All**
Power > Power and Performance > CPU Power Management Control > C states	**Disabled**
Power > Power and Performance > CPU Power Management Control > Turbo Mode	**Disabled**
Boot > Network Stack	**Enabled**
Boot > USB Boot	**Enabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DVI or VGA input
- a keyboard
- a USB drive
- the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the FA2100T-700.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press F2 when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz from the Nerve Software Center to a workstation.
2. Extract the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz file to retrieve the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz file from the Nerve Software Center.

2. Enter the following commands to extract the Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz file and transfer the extracted file to the USB drive:

```
tar xf Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img.tar.gz
sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_toshiba-fa2100t-700.img bs=4M of=/de
sync
```

> **NOTE**
>
> Make sure to replace <drivename> with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to the second Ethernet port in the rear of the device for this device (refer to below for a picture). Connect an ethernet cable to this port for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to the **wan** interface. The device will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.
- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

NOTE

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through the **wan** interface, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to the first Ethernet port in the rear of the device (refer to below for a picture).

2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

> **NOTE**
>
> Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.

4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

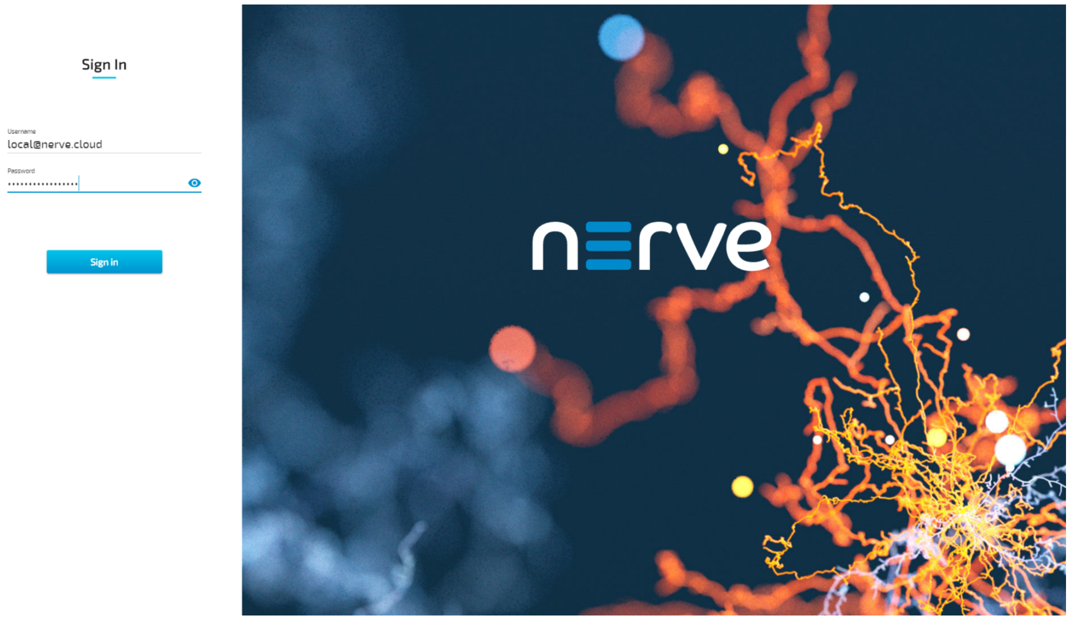
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
•••••••••••••••••

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

Additional device specific information

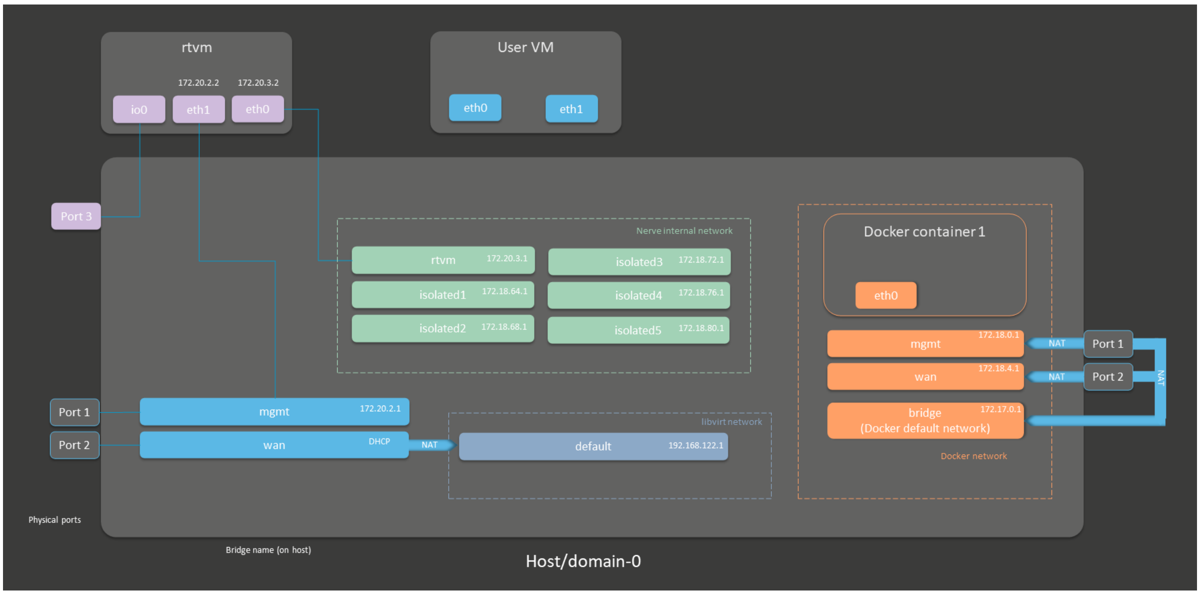
The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the FA2100T-700 hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the FA2100T-700.
However, the ports of the device are not labelled. Refer to the picture below for easier identification.

!Rear ports

Physical port	Network name
1	mgmt
2	wan
3	io0



Vecow SPC-5600-i5-8500

The Vecow SPC-5600 Series is powered by 8 Cores Intel® Core™ i5 and can be used for vehicle computing, smart manufacturing, in-vehicle infotainment, intelligent control or any IIoT application.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the

device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	SPC-5600A-8500T32
CPU	Intel Core i5-8500T
Cores	6
RAM	32 GB DDR4
Storage	512 GB 2.5" SATA SSD MLC
TPM	TPM 2.0 included
Interfaces	• 4x GB LAN • 4x COM RS-232/422/485 (ESD 8KV) • 4x USB 3.1 (external) 1x USB 2.0 (internal) • 2x DisplayPort

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

• a monitor with a DisplayPort input • a keyboard • a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, the BIOS version on the SPC-5600 needs to be version V27.01.03. or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Press Del while the device is booting to enter the BIOS menu.
3. Change the following settings:

Path	Setting
Advanced > CPU Configuration > Intel (VMX) Virtualization Technology	**Enabled**
Advanced > Power & Performance > CPU - Power Management Control > Boot performance mode	**Max Non-Turbo Performance**
Advanced > Power & Performance > CPU - Power Management Control > Intel (R) SpeedStep(tm)	**Disabled**
Advanced > Power & Performance > CPU - Power Management Control > Intel (R) Speed Shift Technology	**Disabled**
Advanced > Power & Performance > CPU - Power Management Control > C states	**Disabled**
Advanced > ACPI Settings > Enable Hibernation	**Disabled**
Advanced > ACPI Settings > ACPI Sleep State	**Suspend Disabled**
Advanced > Network Stack Configuration > Network Stack	**Enabled**
Chipset > System Agent (SA) Configuration > VT-d	**Enabled**
Security > Secure Boot > Secure Boot	**Disabled**

4. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with a DisplayPort input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the Vecow SPC-5600.

Before beginning with the installation, make sure that the device will boot from the USB drive. Press Del when the device is booting to enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img`. Depending on the program used, the file might need to be extracted more than once.

3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz` file and transfer the extracted file to the USB drive:

```
tar xf Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img.tar.gz
sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_vecow-spc-5600.img bs=4M of=/dev/sd<
sync
```

> **NOTE**
>
> Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface. This interface is mapped to **LAN 2** for this device. Connect an ethernet cable to **LAN 2** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN 2**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company

network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.

- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

> **NOTE**
>
> Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN 2**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN 1**.

2. Configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask.

   > **NOTE**
   >
   > Do not use `172.20.2.27` for the network adapter IP address. This IP address is used internally by the Nerve system.

3. Open a browser window or tab.

4. Enter http://172.20.2.1:3333/ to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

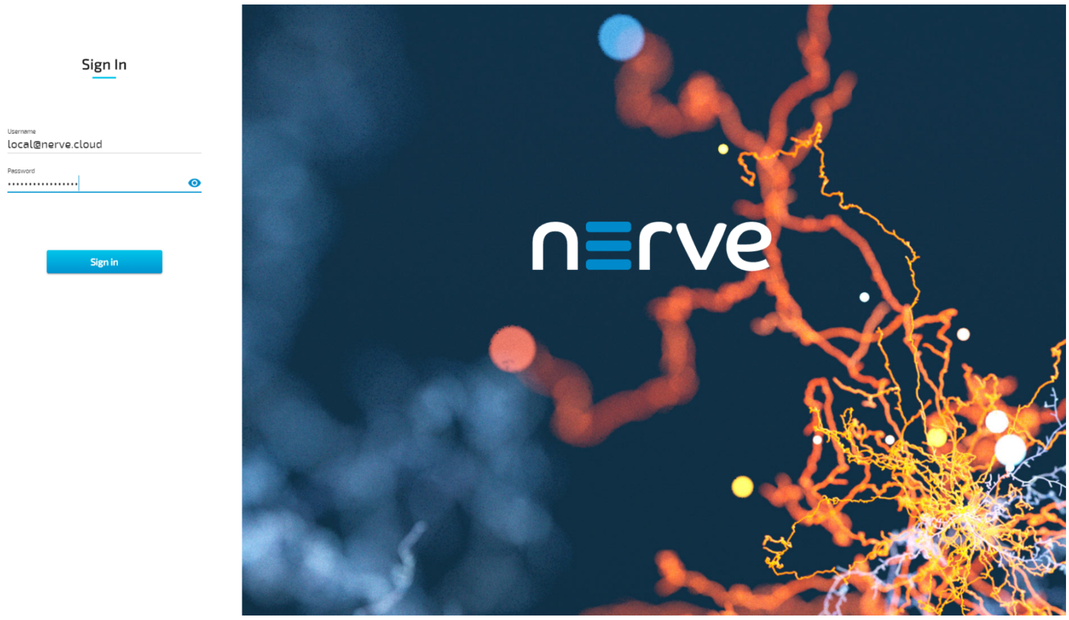
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Follow this link to connect to the Local UI: http://172.20.2.1:3333/

3. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
••••••••••••••••••

4. Refer to Node configuration for information on how to configure the device for use in the Management System.

5. Refer to Adding a node for information on how to register the node in the Management System.

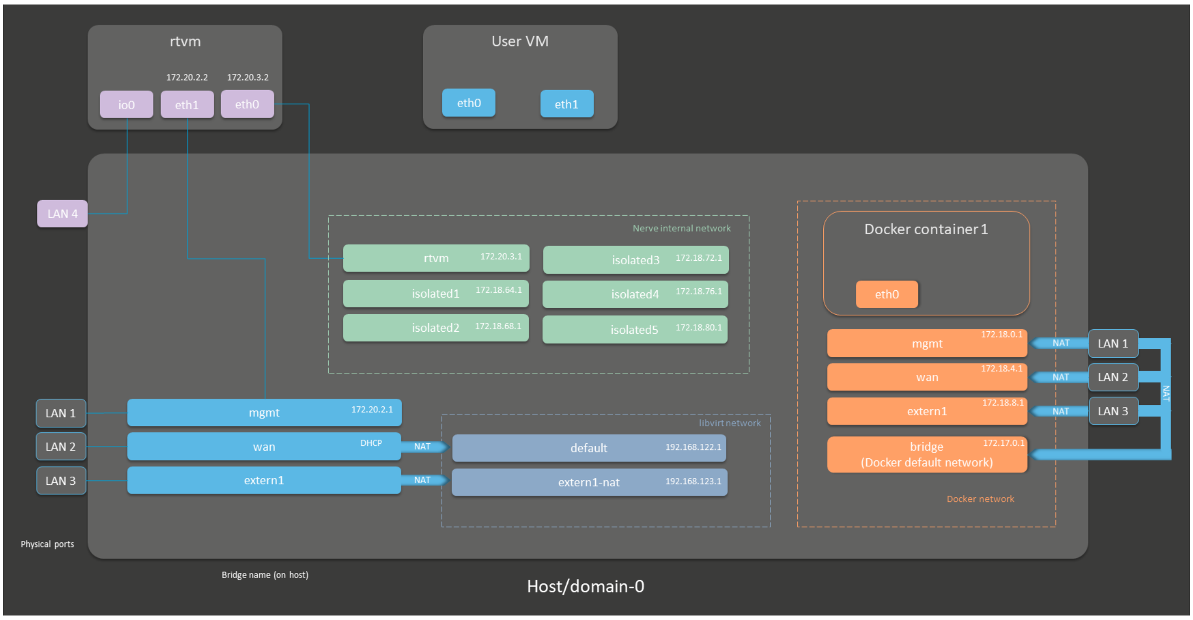
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the SPC-5600 hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the SPC-5600.

Physical port	Network name
LAN 1	mgmt
LAN 2	wan
LAN 3	extern1
LAN 4	io0



Winmate IoT Gateway EAC Mini EACIL20

The EAC series gateway's hardware has a compact design and is based on rugged, reliable, and long-lasting industrial technology. It is a plug & play IoT gateway that simplifies deployment with multi-connectivity, optimized thermal solution, and easy mounting.

For more information refer to the information materials provided by the manufacturer:

- Product page
- User manual

Device specifications

The table below contains the key specifications of the specific hardware model that has been certified for Nerve usage. Use the article number listed here when ordering the device from the manufacturer only. Note that other device variants are not supported as Nerve Devices.

If required, contact sales@tttech-industrial.com for help with ordering Nerve Devices.

Item	Description
Article number	• **Product Name** BOX PC • **Model No.** EACIL20-100-A412
CPU	Intel Pentium N4200
Cores	4
RAM	4 GB
Storage	128 GB
TPM	TPM 2.0 included
Interfaces	• 2x GB LAN • 2x USB 3.0 • 1x HDMI

Setting up the device for Nerve usage

Follow the instructions below to set up the hardware, install the Nerve software and make the node ready for use in the Management System. Note that the materials provided by the device manufacturer are also required to continue.

Requirements for the instructions below:

- a monitor with an HDMI input
- a keyboard
- a USB drive formatted to FAT32

Refer to the user manual of the manufacturer to set up the hardware. Connect a keyboard and a monitor to the device and make sure that the device is ready to be powered on. Also, prepare a USB drive in case the BIOS version of the device needs to be updated.

BIOS update

To avoid possible issues and complications, update the BIOS on the EACIL20 to InsydeH20 Setup Utility, rev. 5.0. or later. Refer to the user manual of the manufacturer for information on how to update the BIOS version.

Required BIOS settings for Nerve

Certain BIOS settings need to be changed to ensure the desired performance of the Nerve system.

1. Power on the device.
2. Enter **exit** to leave the EFI shell.
3. Go to **Setup Utility**.

4. Change the following settings:

Path	Setting
Power > **CPU Configuration** > **VT-d**	**Enabled**
Power > **CPU Configuration** > **CPU Power Management** > **C-States**	**Disabled**

5. Save the changes and exit BIOS.

Installing Nerve

Requirements for installing Nerve on the device:

- a monitor with an HDMI input
- a keyboard
- a USB drive
- the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img.tar.gz` which can be downloaded from the Nerve Software Center
- a tool for creating bootable USB drives like Rufus on Windows

In addition, a workstation is required to prepare the bootable USB drive. Connect the monitor and the keyboard to the EACIL20.

Before beginning with the installation, make sure that the device will boot from the USB drive. Enter BIOS and change the boot device settings.

On Windows

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img.tar.gz` from the Nerve Software Center to a workstation.
2. Extract the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img.tar.gz` file to retrieve the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img` file. Depending on the program used, the file might need to be extracted more than once.
3. Transfer the extracted `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img` file to the USB drive using Rufus.
4. Plug the USB drive into a USB port of the Nerve Device.
5. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

On Linux

1. Download the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img.tar.gz` file from the Nerve Software Center.

2. Enter the following commands to extract the `Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img.tar.gz` file and transfer the extracted file to the USB drive:

   ```
   tar xf Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20.img
   sudo dd if=Nerve_Blue_USB-installer_2.5.0_for_winmate-iot-gateway-eac-mini-eacil20
   sync
   ```

   NOTE

   Make sure to replace `<drivename>` with the system name of the USB drive.

3. Plug the USB drive into a USB port of the Nerve Device.

4. Make sure that the device will boot from the USB drive and power on the device.

The setup will start automatically and take a few minutes to complete. Select **OK** when the installation is complete and remove the USB drive. The device will reboot and reach a log in screen, asking for host access log in credentials. Make sure that the device will boot from the hard disk before rebooting the device.

Connecting the device to a network

The device needs to be connected to a network in order to communicate with the Management System and perform key features of Nerve. The Nerve system has a designated network interface for communication with the network — the **wan** interface.

This interface is mapped to **LAN1** for this device. Connect an ethernet cable to **LAN1** for establishing network access and communication with the Management System. Note that communication with the Management System is happening over port 443 (HTTPS).

When setting up the device, there are a few things to keep in mind regarding network access:

- **Where is the Management System hosted?**
  The Nerve Management System is either hosted in the cloud by TTTech Industrial or on premise in the internal company network.
  When the Management System is hosted in the cloud, the node will likely require internet access. The easiest way of doing that is connecting an ethernet cable to **LAN1**. The **wan** interface will then receive an IP address from a DHCP server and establish internet access automatically. However, contact the IT administrator on how to allow devices to connect to the internet inside of the internal company network. When the Management System is hosted on premise, nodes do not necessarily need internet access to communicate with the Management System. If that is the case, it is required to make sure that the Nerve Device and the Management System are located in the same network.

- **License activation**
  The license activation process is affected by the possible situations described above, making offline license activation necessary under certain conditions. If the Management System is hosted on premise, the node might not have internet access. If that is the case, a file-based offline license activation method is necessary to activate the Nerve license. However, a separate workstation with internet access is required to complete the license activation.

NOTE

Note that connecting the device to the internet is the best use case, as it enables the easiest way to activate the Nerve license and easy communication with a Management System hosted in the cloud. If the device does not have internet access and the Management System is hosted on premise, make sure to connect the device to the same network as the Management System. If neither can be guaranteed, ignore this step until after the node is configured for Management System connection in the Local UI. Also, contact the IT administrator for help on how to allow external devices to connect to the internet or internal network. When connecting the device to the internet through port **LAN1**, the device will receive an IP address through DHCP. A static IP address can also be configured but only after the Nerve software license has been activated.

Finding out the IP address of the device

Due to the limited availability of ethernet ports, Nerve does not offer a designated port and interface for host access and management purposes on the Winmate EACIL20. Therefore, the IP address of the **wan** interface that is mapped to physical port **LAN1** is required to start using Nerve. Depending on the network access the node has, this needs to be done differently.

The node has network access

If the node has network access, an IP address will be assigned to the **wan** interface by a DHCP server. Follow the instructions below to find out the IP address of the **wan** interface.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following command to display the IP address of the **wan** interface:

   ```
   ip a s wan
   ```

The IP address is displayed next to **inet** in the output the system gives. This IP address is required to access the Local UI in the instructions below.

The node does not have network access

In case of the node not having network access, the IP address of the **wan** interface has to be set manually. For simplicity, the IP address of the **wan** interface will be set to `172.20.2.1` — the IP address of the host.

1. Connect a keyboard and a monitor to the device.
2. Power up the device once Nerve is installed.
3. Enter the login credentials for host access once the system asks for host login. The login credentials can be found in the customer profile.

4. Enter the following commands to open the **wan** interface configuration:

   ```
   cd /etc/network/interfaces.d
   sudo nano wan
   ```

5. Enter the host access password if prompted.

6. Edit the configuration the following way:

   ```
   auto wan
   iface wan inet static
     bridge_ports eth0
     address 172.20.2.1
     netmask 255.255.255.0
   ```

7. Enter Ctrl+S to save the configuration.

8. Enter Ctrl+X to exit the Nano editor.

9. Enter the following command to apply the changes to the **wan** interface by restarting the networking services:

   ```
   /etc/init.d/networking restart
   ```

10. Enter the host access password if prompted.

With the **wan** interface IP address set to `172.20.2.1` the Local UI can be reached at http://172.20.2.1:3333/.

Accessing the Local UI

After the image installation, the device can be powered on after setup for product license activation. For that, a connection to the Local UI needs to be established.

1. Connect a workstation to port **LAN1**.
2. Configure the network adapter of the workstation. The IP address has to be in the same range as the IP address of the **wan** interface with a `255.255.255.0` subnet mask. Refer to the chapter above on how to find out this IP address.
3. Open a browser window or tab.
4. Enter `<wanip>:3333` to access the Local UI.

At first, only the required elements to activate the Nerve product license are shown in the Local UI. The full extent of the Local UI is unlocked after product license activation and requires a login. For first time log in use the credentials from the customer profile.

Activating the Nerve license

After logging in to the Local UI, the product license can be activated so that Nerve can be used on the device. Make sure that the Local UI can be accessed as described above. License activation can be done either online or offline.

- **Online activation**
  When the node has internet access, the node will automatically connect to the licensing server. This is the most straightforward way of activating licenses.

- **Offline activation**
  In case of the node not having internet access, the license can be activated with a file-based method. However, note that a workstation with an internet connection is required for connecting to the licensing server in order to upload and download files. This might be the way to activate the license if the Management System is hosted on premise.

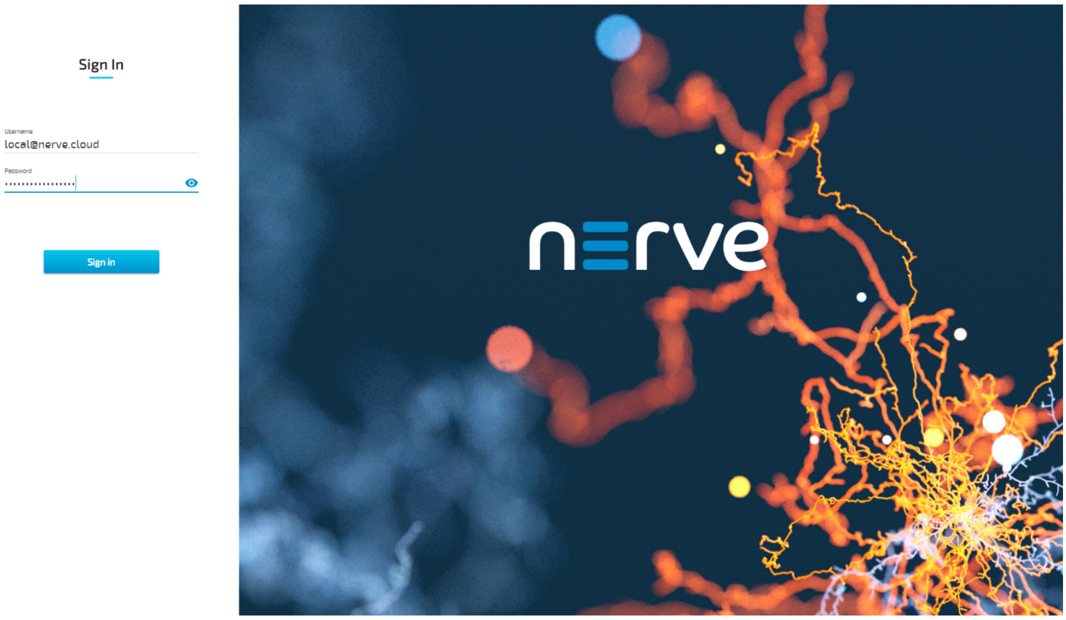
Refer to License activation in the user guide for more information.

Registering the device in the Management System

With the license activated, the node needs to be configured for use in the Management System through the Local UI. Afterwards the node needs to be registered in the Management System.

1. Make sure that the Local UI can be accessed as described above.
2. Open a browser window or tab.
3. Enter `<wanip>:3333` to access the Local UI.

4. Log in with the credentials from the customer profile.



Sign In

Username
local@nerve.cloud

Password
•••••••••••••••••

5. Refer to Node configuration for information on how to configure the device for use in the Management System.

6. Refer to Adding a node for information on how to register the node in the Management System.

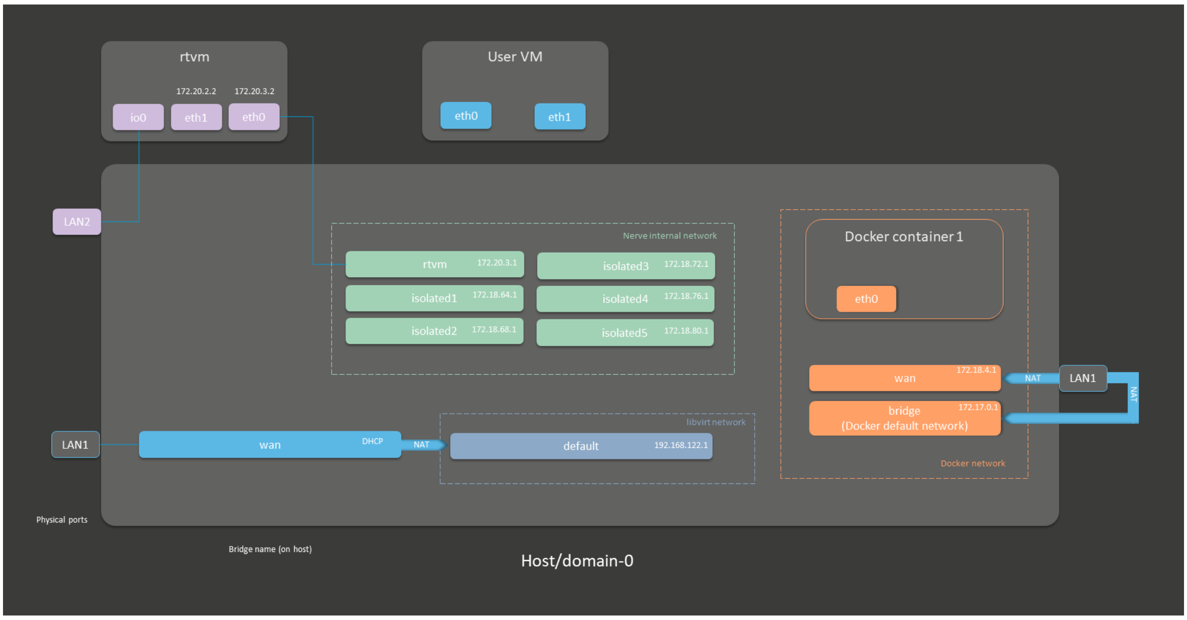
Additional device specific information

The following information below is device specific information for use with Nerve.

Physical ports and network interfaces

Below is a depiction of the node internal networking adapted to the EACIL20 hardware. Refer to Node internal networking for more information. The table offers a quick overview of the network interfaces that can be reached through the physical ports of the EACIL20.

Physical port	Network name
LAN1	wan
LAN2	io0



Developer Guide

Developer Guide

The developer guide is a continuation of the user guide. It aims to give support to developers with tasks going beyond the regular usage of the Nerve system. In this version of the Nerve documentation it offers support with the following topics:

- an overview of node internal networking in the Nerve system
- first steps to programming CODESYS applications on Nerve Devices
- an introduction to the usage of the Management System API for working with workloads
- a full guide for the Nerve Data Services

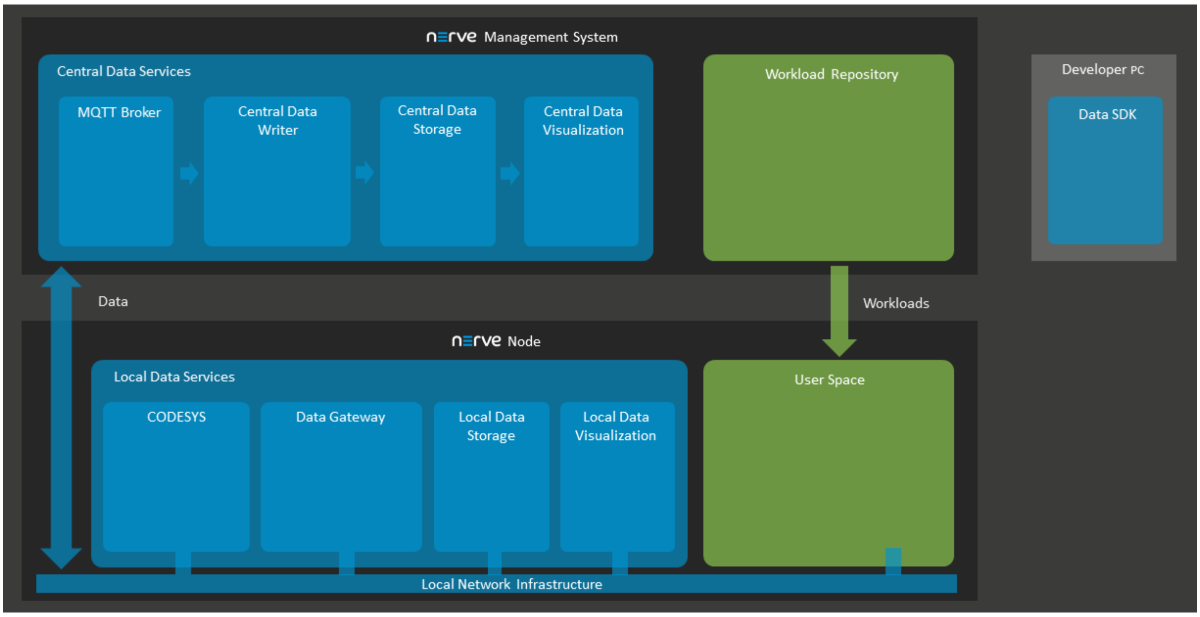
This guide will be expanded with future releases.

Nerve Data Services

Nerve Data Services

The Nerve Data Services are a collection of services and interfaces that allow to collect, store, analyze, visualize and distribute data. These services and interfaces are available on the Nerve node and in the Management System. Using Nerve Data Services, data can be collected at high speeds on the node and stored, processed or visualized locally at the Node or centrally in the Management System.

Elements of Nerve Data Services



Most of the above elements are individually configurable. This allows for an application in a large number of scenarios and use cases. However, this also implies deeper knowledge of the elements and their possible interactions. Further explanations of the elements can be found in separate chapters.

Features

The table below provides an overfiew of features in the Nerve Data Services.

Feature	Description
Nerve Data Services Gateway	The Gateway is the central application of the Data Services. Its purpose is receiving data from a source via a certain protocol on an input interface and forwarding it to a destination using a different protocol on an output interface. This behavior is reflected in the user configuration as well. In general, the configuration consists of inputs, outputs and connections between them.
Graphical configuration tool	The Gateway is configured through a graphical user interface. Inputs, outputs and connections have custom options available, where mandatory fields are marked. The configuration interface also allows the export of existing configurations and the import on the same node or different nodes.

Feature	Description
Supported protocols	The Nerve Data Services can collect data from multiple protocols and formats. This also includes multiple Ethernet-based fieldbus protocols. Data can also be distributed again in different formats via multiple protocols. Fieldbus protocols are read through the I/O port (if available, depending on the Nerve Device) while other inputs can be read through external inputs or installed workloads on the node. Here is a list of supported protocols: **Fieldbus protocols** • EtherCAT Master • ModbusTCP Server • ModbusTCP Client • PROFINET Device (IEC) • PROFINET Controller (IEC) **Inputs** • MQTT Subscriber (JSON) • OPC UA PubSub Subscriber • OPC UA Client • Modbus Server • S7 Server • ZeroMQ Subscriber (JSON) • Kafka Consumer (JSON) **Outputs** • MQTT Publisher (JSON) • OPC UA PubSub Publisher • OPC UA Server • ZeroMQ Publisher (JSON) • Azure IoT Hub Device • Kafka Producer (JSON) • NerveDB • TimescaleDB • Influx DB
Continuous data transfer	The Gateway can, under certain circumstances, ensure continuous operation for existing inputs and outputs when new configurations are applied. This is done through the application of a smart connection creation mechanism. When adding new data connections in the Gateway, existing inputs and outputs that are not affected by the changes will continue their operation uninterrupted while the Gateway creates the data connections. When applying the updated Gateway configuration, the configuration UI will give a warning message, including a list of connections affected by the update that will experience a short data flow interruption.

Feature	Description
Data buffering	Data buffering is a guarantee that data will always reach the Management System even when a node is connected to an unstable network. When this feature is enabled, data is buffered into persistent local storage first and then sent to the Management System in chunks. Once the connection to the Management System is restored, all locally stored data is sent to the Management System. This slows down the insert rate for very fast data sources but in exchange provides a strong guarantee that no data is lost. Refer to NerveDB with data buffering for an example on how to use the data buffering feature.
NerveDB	The NerveDB is a custom TimescaleDB that is pre-configured for use with Nerve. As such, it has minimal need for configuration. An instance of the NerveDB is available locally on the node and centrally in the Management System.
Visualization	Data stored in the Data Services can be visualized via Grafana, an open source web application which provides charts, graphs and alerts for data visualization. An instance of Grafana is available on each node and in the Management System to visualize data stored in databases on the node or in the Management System.
Sending data to third party clouds	The Nerve Data Services are designed to seamlessly communicate with other third party cloud environments. Microsoft Azure IoT Hub is supported out-of-the-box. It is also possible to configure the Nerve Data Services to provide data to other third party cloud providers.
High data ingestion	The Nerve Data Services allow a data ingestion rate into the local storage of up to 100,000 data points per second.
Custom JSON format	The Nerve Data Services Gateway supports receiving user defined JSON data formats on all receiving interfaces. Similarly, data can also be sent in custom JSON formats.
Data Services SDK	The Nerve Data Services SDK enables users to create applications that can be deployed as workloads on Nerve nodes. The implementation of the application is up to the user and can range from data analytics to protocol conversion or any other application implemented in Python. The SDK provides a command-line tool that allows creating, building, pushing and provisioning applications as Docker containers. It also includes an API implemented in Python that simplifies accessing data collected by the Nerve Data Services Gateway or inserting new data into the Nerve Data Services.

Workflow

The following section gives an overview of a typical workflow, presenting what can be done with the Nerve Data Services on a high level:

- Setting up data sources
- Configuring the Gateway to collect data and defining where to distribute it
- Configuring Grafana on the node for local data visualization
- Configuring Grafana in the Management System for central data visualization
- Implementing an analytics app and configuring the Gateway again to send data to the analytics app

- Reconfiguring Grafana to visualize the result of the processing performed by the analytics app

The paragraphs below give short explanations to each step.

Ingesting data on the node

When ingesting data on the node, the data is received by the Gateway which then distributes to various destinations. For data received from a fieldbus protocol, CODESYS will be used to translate it into OPC UA format. The Gateway then gets configured to collect the data from CODESYS and distribute it further.

Distributing data on the node

Data is distributed by the local Gateway to user defined consumers. Unless the respective protocol of a Gateway output defines a specific data format, all data received by the Gateway is normalized to the Nerve Data Services data format. Typical consumers of data are the local data storage on the node or the central data storage in the Management System, third party MQTT brokers or applications, or providing the data as OPC UA Server. To enable reuse of local Gateway configurations across multiple nodes, keywords can be used to abstract node specific information from the configuration.

Storage on the node

Data is stored in the NerveDB on the node, a dedicated TimescaleDB database. Any application running on the node can access data stored in there. A time window (data retention time) can be configured for how long data shall be kept before deleting it. For application development, a Python API is provided in the Data Services SDK that simplifies reading and writing data.

Visualization on the node

Visualization is available via Grafana which is pre-configured to allow access to data stored in the local data storage. It is also possible to configure access from Grafana to other user defined data sources without any restrictions, meaning that data not stored in the local database of the Data Services can also be visualized.

Using Data in analytics

A Python SDK is available for creating custom analytics applications. The API of the SDK simplifies reading data from the local storage or receiving it directly from the Gateway when it arrives there. The API also allows to write back analytics results to the local storage for visualization or send it to an MQTT broker to distribute it to other consumers. It is also possible to use third party applications such as NodeRed or Crosser for analytics together with the Nerve Data Services.

Storing and visualizing in the Management System

Data received on the Node can be forwarded to the Management for visualization. To allow this, the local Gateway and the central visualization must be configured. Each node is represented as a separate data source in the central visualization (Grafana).

Data Services UI

The Data Services are present on both the node and the Management System. However, the instance on the node is the single point of configuration. Connections to the

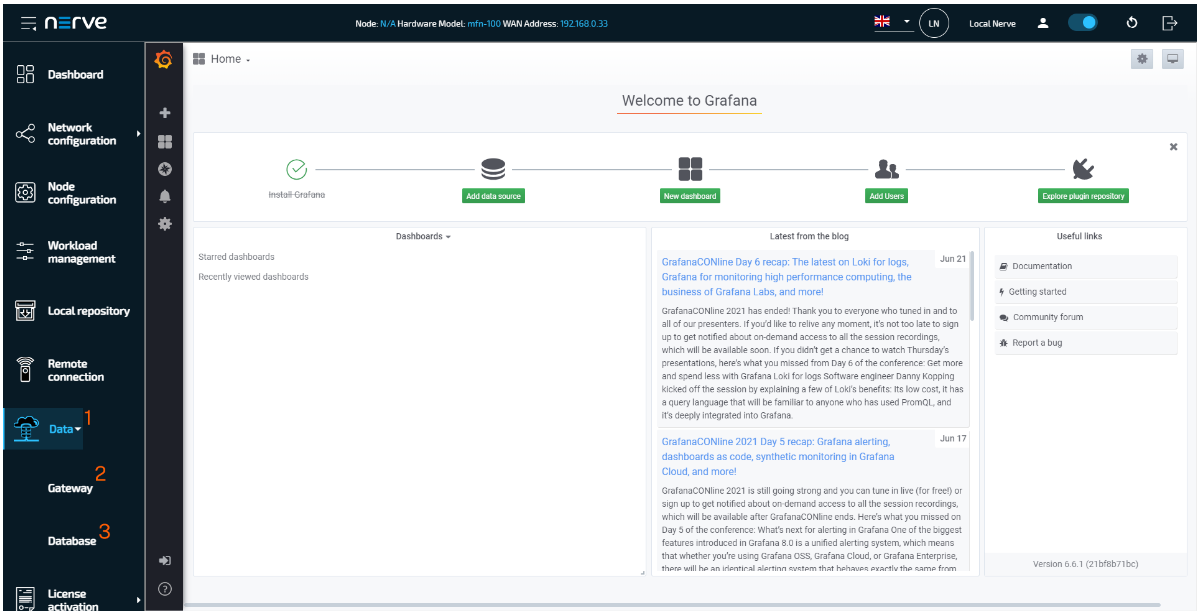
Management System components of the Data Services are configured automatically.
On the node, the UI consists of the Gateway configuration tool, the database configuration and the local visualization (Grafana). In the Management System, the Data Services UI includes the database configuration and the central visualization (Grafana).

Also, note that by default, the permission to access to Data Services in the Management System is not granted. Users that have the permission to create user roles can enable the Data Services entry in the navigation by adding the **UI_NAV_DATA_SERVICES:VIEW** permission to a user role. Refer to Users for information on how to create new users and to Roles and permissions for information on how to add a new role.

On the node, select the arrow next to **Data** in the navigation on the left to reach the Data Services UI. This will show the following items:

NOTE

Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left corner to expand the navigation menu again.



GrafanaCONline Day 6 recap: The latest on Loki for logs, Grafana for monitoring high performance computing, the business of Grafana Labs, and more! Jun 21

GrafanaCONline 2021 has ended! Thank you to everyone who tuned in and to all of our presenters. If you'd like to relive any moment, it's not too late to sign up to get notified about on-demand access to all the session recordings, which will be available soon. If you didn't get a chance to watch Thursday's presentations, here's what you missed from Day 6 of the conference: Get more and spend less with Grafana Loki for logs Software engineer Danny Kopping kicked off the session by explaining a few of Loki's benefits: Its low cost, it has a query language that will be familiar to anyone who has used PromQL, and it's deeply integrated into Grafana.

GrafanaCONline 2021 Day 5 recap: Grafana alerting, dashboards as code, synthetic monitoring in Grafana Cloud, and more! Jun 17

GrafanaCONline 2021 is still going strong and you can tune in live (for free!) or sign up to get notified about on-demand access to all the session recordings, which will be available after GrafanaCONline ends. Here's what you missed on Day 5 of the conference: What's next for alerting in Grafana One of the biggest features introduced in Grafana 8.0 is a unified alerting system, which means that whether you're using Grafana OSS, Grafana Cloud, or Grafana Enterprise, there will be an identical alerting system that behaves exactly the same from

Item	Description
Data (1)	Clicking here opens the visualization component of the Data Services and the Grafana landing page is displayed. For more information on visualization, refer to Data Visualization.
Gateway (2)	Select this to reach the Gateway configuration tool. The Gateway is the single point of configuration for data connectivity in the Nerve Data Services. Configure inputs, outputs and connections here. Refer to Nerve Data Services Gateway for more information.

Item	Description
Database (3)	Data from the Nerve Data Services database can be previewed here. Every node has a local NerveDB database. In the Management System, the NerveDB databases of the nodes are discerned by the serial numbers of the nodes. This view allows to get a basic preview of the data in the Nerve Data Services storage. It also allows to configure the data retention time for the data stored there. Refer to Database for more information.

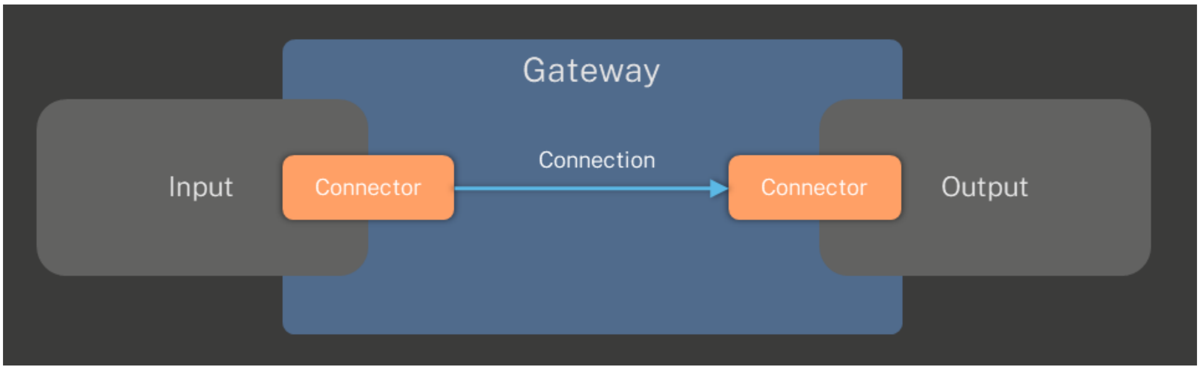
Since the single point of configuration in the Data Services is the instance on the node, the Data Services UI in the Management System does not show the configuration menu item.

Nerve Data Services Gateway

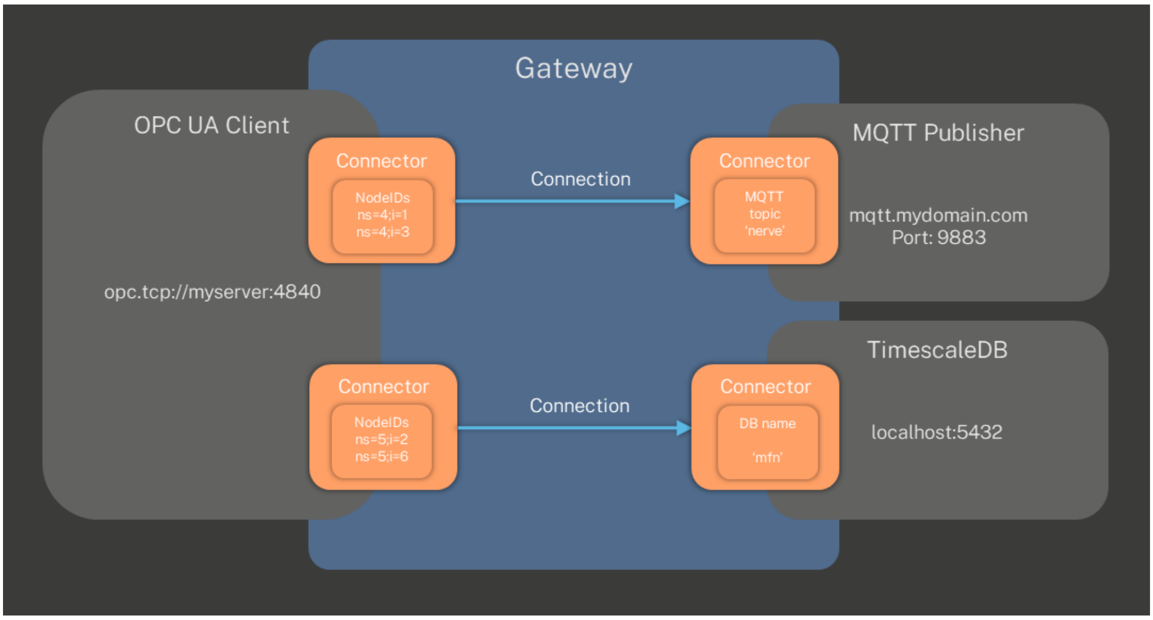
The Gateway is the central application of the Data Services. Its purpose is receiving data from a source via a certain protocol on an input interface and forwarding it to a destination using a different protocol on an output interface. This behavior is reflected in the user configuration as well. In general, the configuration file consists of inputs, outputs and connections between them:

- Inputs are collection interfaces where data is received.
- Outputs are providing interfaces where data can be received from.
- Connections are logical links between inputs and outputs.

Each input and output provides connectors where a connection can be attached to. A connector is a subset of the data available at an input. This subset is forwarded to the connector of an output where it is distributed further to the data receiver. On an abstract level, this concept is illustrated in the figure below.

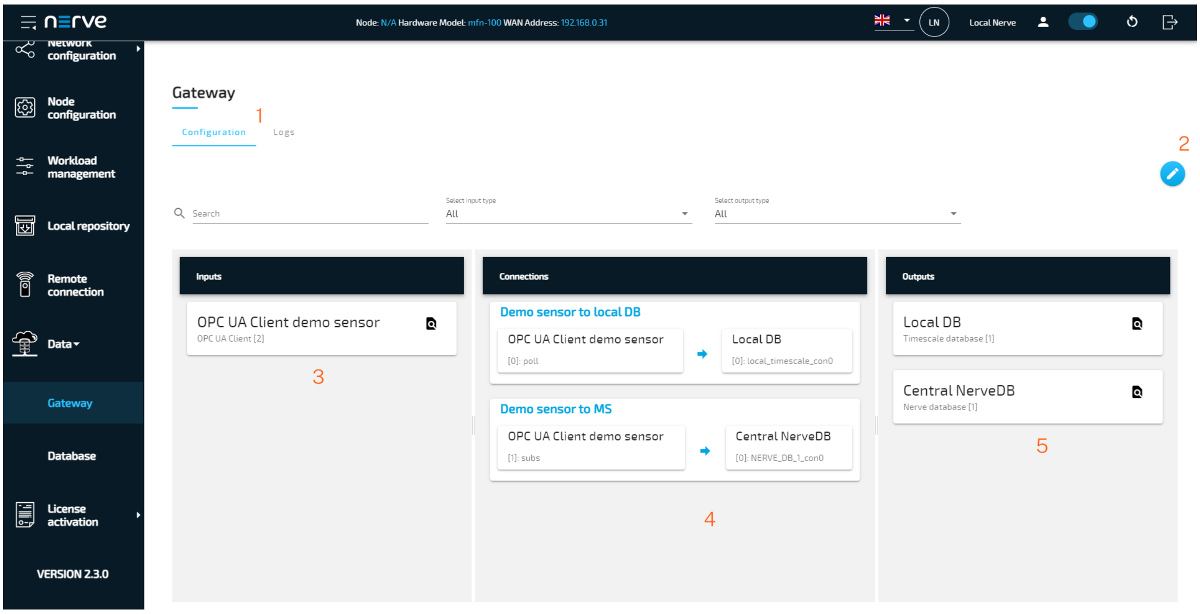


Inputs and outputs hold general configuration data for the protocol they implement. This can be a URL to a server, a port number or something related to timing. A connector of an input or output holds more specific information on how to get or where to send data, for example the node IDs of an OPC UA Server an OPC UA Client input connects to, or the name of a topic for an MQTT Publisher. Each input and output can provide multiple connectors at a time. Data from an input connector can also be connected to multiple output connectors at the same time to distribute data to multiple data consumers. The figure below shows a more specific example of that concept.

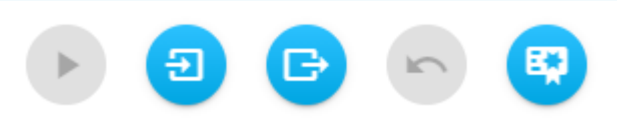


Gateway UI

The Gateway UI is the central page of the Data Services and can be reached by selecting **Data > Gateway** in the navigation on the left in either Local UI or Management System. Gateway configurations are applied through the interface in the middle, either through the graphical configuration tool or with a pre-written JSON file that is uploaded. When accessing this page, the panes of the configuration tool displays the last deployed configuration.



Item	Description
Configuration and Logs tabs (1)	The **Configuration** tab is displayed by default, displaying the graphical configuration tool. The latest logs can be viewed within the **Logs** tab. The entirety of the logs can be exported into a file using the **Download** button in this tab.

Item	Description
Edit configuration (2)	Select this button to enable editing mode and enter a configuration into the editor to configure the Gateway. In editing mode, the configuration with the graphical configuration tool is enabled, as well as options to import or export JSON configurations. After selecting the edit button, these buttons appear instead:  The following descriptions describe the buttons from left to right. • **Deploy** Select this to apply the current configuration to the Gateway. The button becomes active once changes have been performed. • **Import** Select this to upload a Gateway configuration as a JSON file from the workstation into the Gateway. Once the file is uploaded, the graphical configuration tool will reflect the configuration from the JSON file. • **Export** Select this to download the currently deployed Gateway configuration as a JSON file. • **Discard current changes** Discard all the changes that have been done in editing mode. This will revert everything to the state before the edit button was selected. • **Import certificates** Import certificates and keys from a workstation to be used by the Gateway. When configuring inputs and outputs, only the name of the certificates and key files is required. Note the following: ◦ All certificates are stored in the same directory on the node. Therefore, certificates must have unique names when imported. ◦ Certificates need to be in DER format. To exit editing mode, select the arrow on the left.
Inputs (3)	Configured inputs are displayed here. Details can be viewed by selecting the magnifying glass icon. Editing options appear when editing mode is active.
Connections (4)	Configured connections are displayed here. Details can be viewed by selecting the magnifying glass icon. Editing options appear when editing mode is active.
Outputs (5)	Configured outputs are displayed here. Details can be viewed by selecting the magnifying glass icon. Editing options appear when editing mode is active.

Applying a configuration to the Gateway

The configuration of the Gateway is applied through the graphical configuration tool in the Gateway section of the Data Services UI. The current configuration of the Gateway is displayed in the separate input, connection and output panes if there is a configuration present in the Gateway. The panes will be empty on initial startup. A new configuration can be entered using the GUI or imported from an existing JSON file. After applying a configuration, check the **Logs** tab for any warnings or errors.

The basic structure of the configuration consist of a list of inputs such as an OPC UA server or an MQTT subscriber, outputs such as a Timescale database or an MQTT publisher, and connections between these inputs and outputs. Refer to Gateway configuration parameter descriptions below for the exact syntax. While studying the syntax is required to write a Gateway configuration in JSON format, note that the syntax is also helpful if the graphical configuration tool is used.

The examples in the Examples section show step by step applications in common use cases.

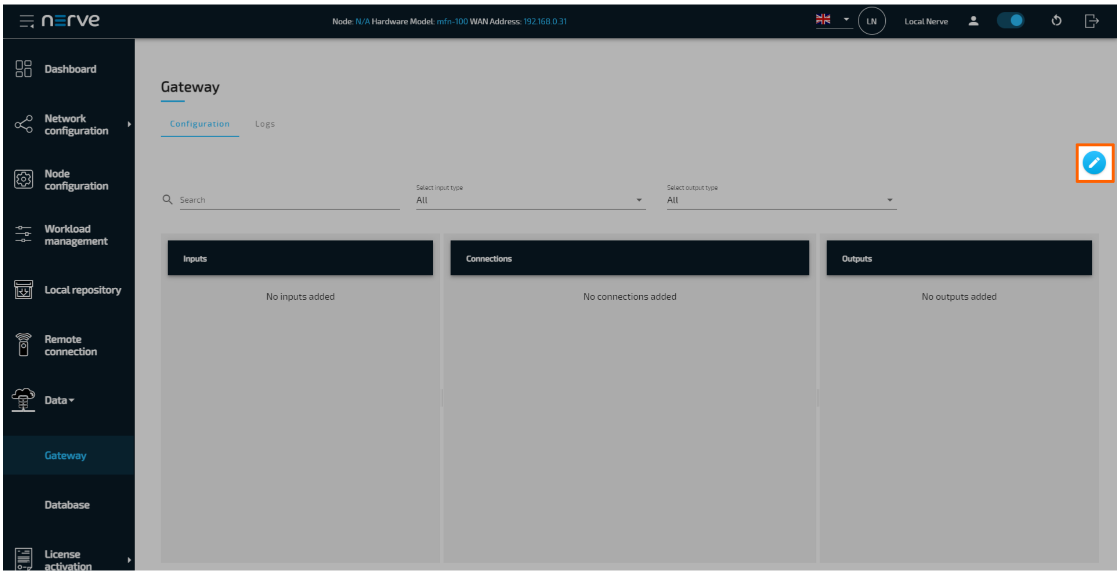
Applying a configuration through the GUI

The graphical configuration tool offers a guided way to configure the Gateway. Required fields are marked with a red asterisk. The recommended order is defining an input, defining an output and then defining the connections last.

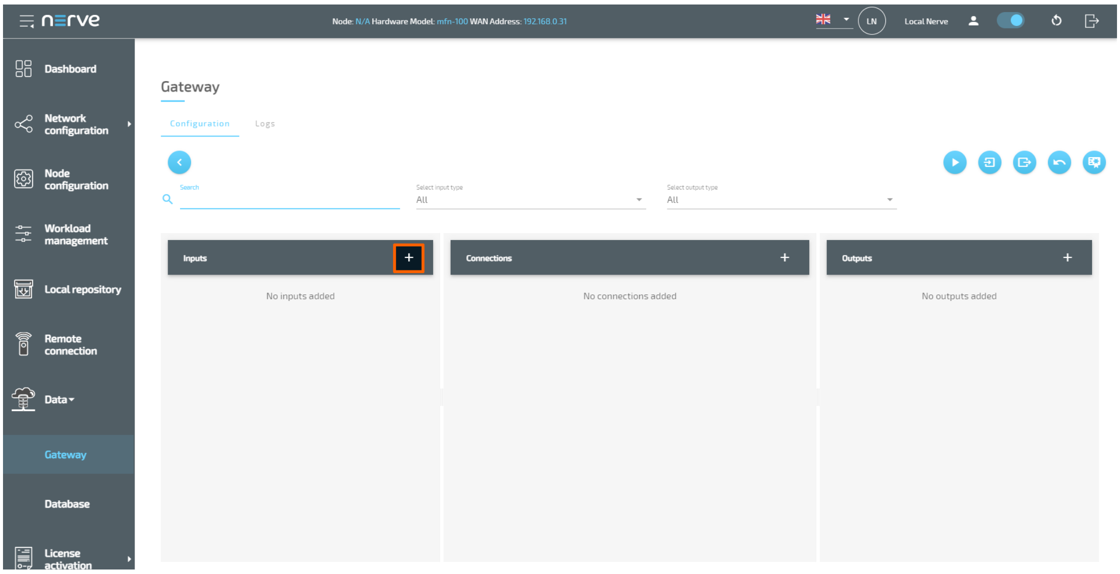
As a demonstration, the instructions below show how to recreate the pre-written JSON configuration file from the OPC UA Server to cloud for visualization example with the graphical configuration tool.

First, inputs need to be configured. This input will have two connectors configured that are required for connecting to two database outputs.

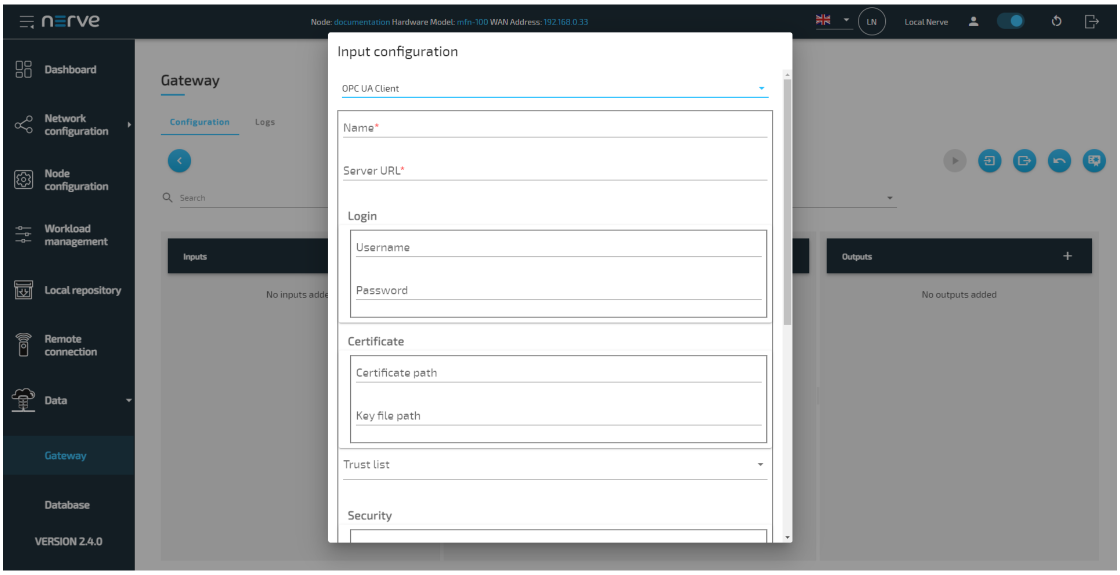
1. Select the **Edit configuration** icon on the right.



2. Select the plus icon next to **Inputs**.



3. Select **OPC UA Client** from the drop-down menu. A list of parameters will appear.

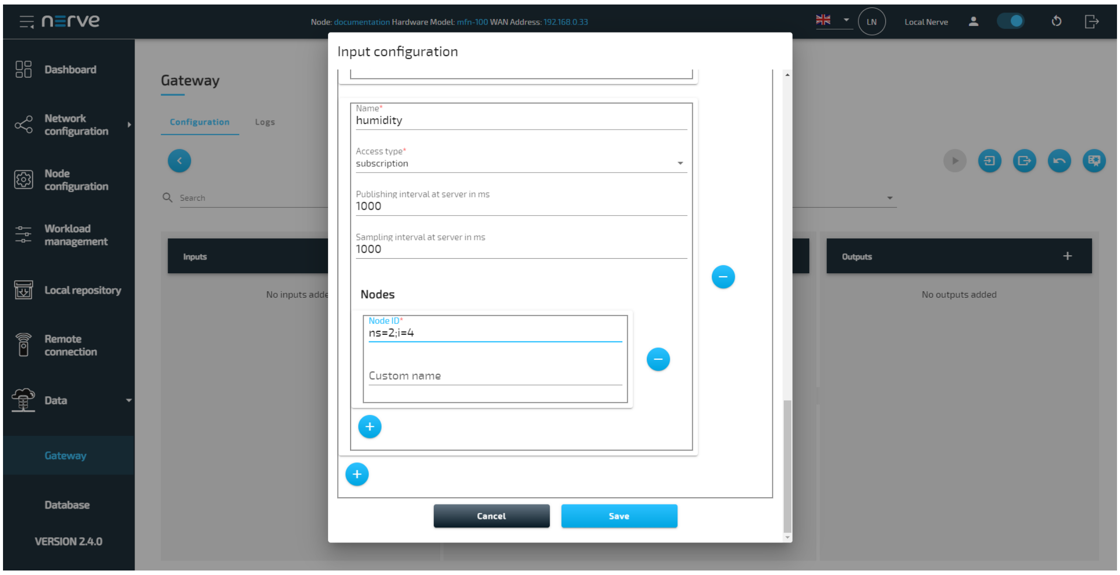


4. Enter the following information:

Setting	Value
Name	Enter any name, for example `OPC UA Client`.
Server URL	`opc.tcp://localhost:4848`
Polling interval in ms	1000

Setting	Value
Connector 1	Select the plus icon and enter the following information: **Name** Enter a name for the connector. This example uses `temperature`. **Access type** polling **Nodes** Select the plus icon and enter the following information: ◦ **Node ID** ns=2;i=2
Connector 2	Select the plus icon and enter the following information: **Name** Enter a name for the connector. This example uses `humidity`. **Access type** subscription **Publishing interval at server in ms** 1000 **Sampling interval at server in ms** 1000 **Nodes** Select the plus icon and enter the following information: ◦ **Node ID** ns=2;i=4

5. Select **Save**.



Input configuration

Name*: humidity

Access type*: subscription

Publishing interval at server in ms: 1000

Sampling interval at server in ms: 1000

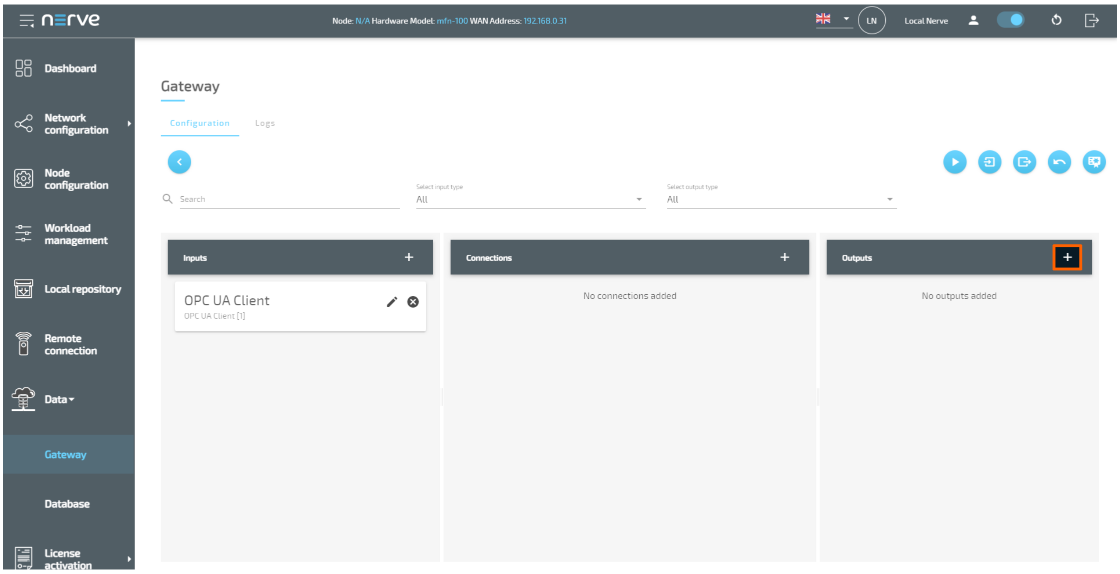
Nodes

Node ID*: ns=2;i=4

Custom name

The graphical configuration tool now reflects the configuration above, showing an OPC UA Client input. Next, it is required to define an output before defining connections. In the OPC UA Server to cloud example, two outputs are required, as temperature data from a demo sensor will be saved in the local NerveDB for visualization while humidity data from the same demo sensor will be saved in the central NerveDB in the Management System and be visualized there.

1. Select the plus icon next to **Outputs**.



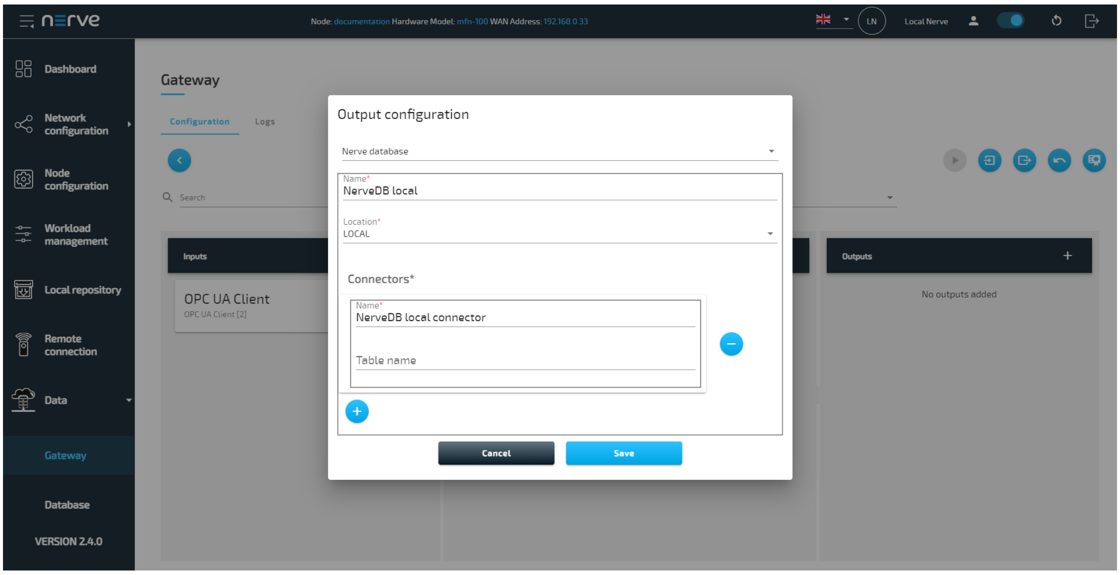
2. Select **Nerve database** from the drop-down menu. A list of parameters will appear.

3. Enter the following information:

Setting	Value
Name	Enter any name, for example `NerveDB local`.
Location	`LOCAL`

Setting	Value
Connector	Select the plus icon and enter the following information: **Name** Enter a name for the connector. This example uses `NerveDB local connector`. **Table name** Enter a name for the data table. If no table name is provided, the name of the connection will be used as a table name. Note that this field is optional when using the local NerveDB.

4. Select **Save**.



Output configuration

Nerve database

Name*
NerveDB local

Location*
LOCAL

Connectors*

Name*
NerveDB local connector

Table name

5. Select the plus icon next to **Outputs** to define a second output.

6. Select **Nerve database** from the drop-down menu. A list of parameters will appear.

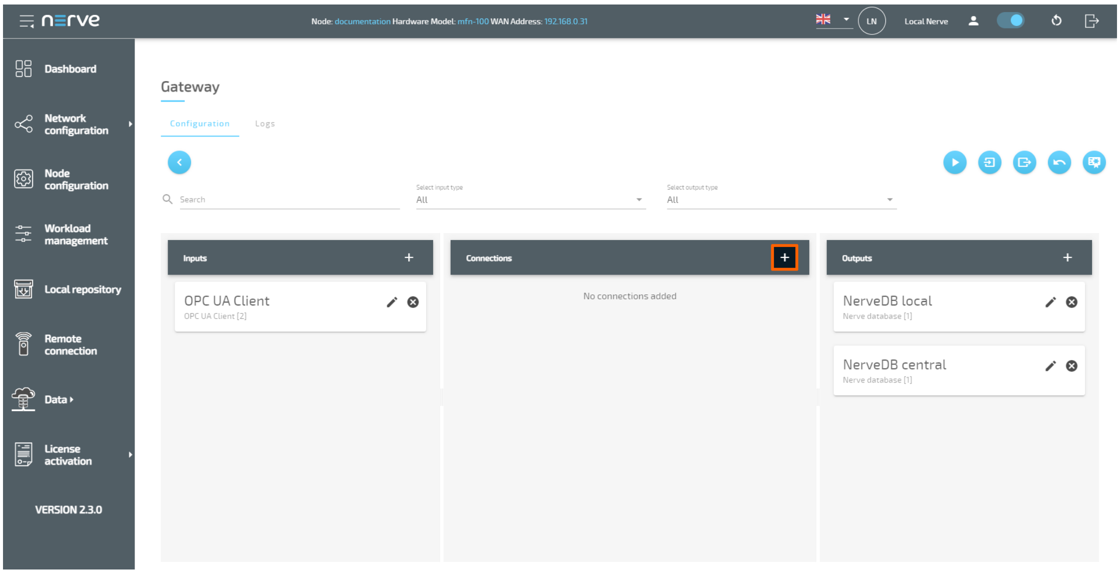
7. Enter the following information:

Setting	Value
Name	Enter any name, for example `NerveDB central`.
Location	CENTRAL
Connector	Select the plus icon and enter the following information: **Name** Enter a name for the connector. This example uses `NerveDB central connector`. **Table name** Enter a name for the data table. This example uses `Demo sensor to central NerveDB`.

8. Select **Save**.

The graphical configuration tool now reflects the configuration above, showing two database outputs in addition to the OPC UA Client input. With inputs, outputs and their respective connectors defined, connections can now be set up to finalize the Gateway configuration. In this example temperature data is sent to the local NerveDB and humidity data is sent to the central NerveDB.

1. Select the plus icon next to **Connections**.



2. Enter a connection name, for example **demo sensor to local NerveDB**.

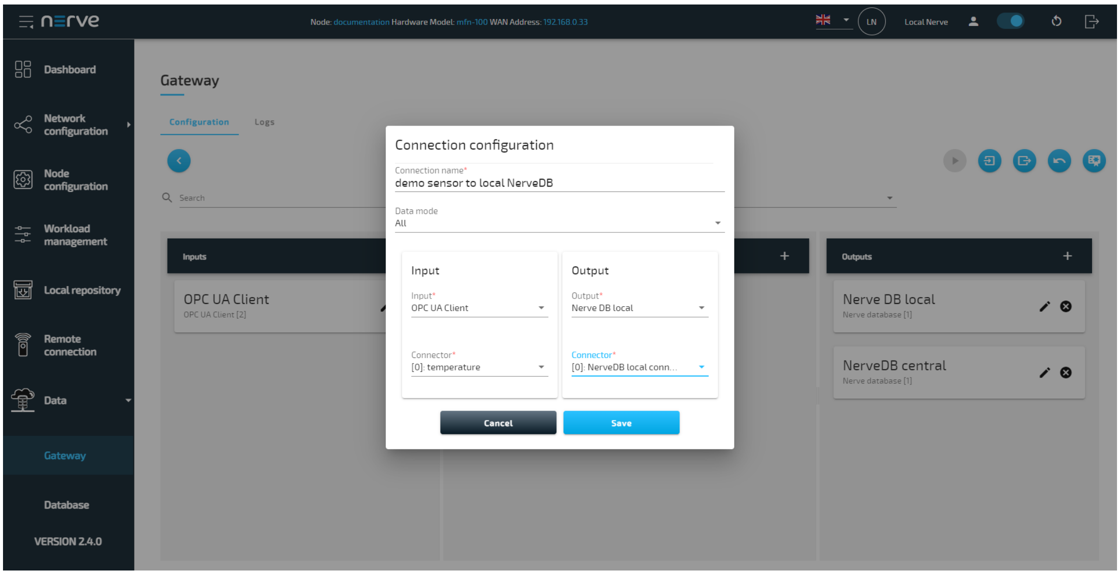
3. Select the following information from the drop-down menus under **Input**:

Setting	Value
Input	Select the OPC UA Client input, named **OPC UA Client** in this example.
Connector	Select the first connector, named **[0]: temperature** in this example.

4. Select the following information from the drop-down menus under **Output**:

Setting	Value
Output	Select the local NerveDB output, named **NerveDB local** in this example.
Connector	Select the connector, named **[0]: NerveDB local connector** in this example.

5. Select **Save**.



Connection configuration

Connection name*
demo sensor to local NerveDB

Data mode
All

Input

Input*
OPC UA Client

Connector*
[0]: temperature

Output

Output*
Nerve DB local

Connector*
[0]: NerveDB local conn...

6. Select the plus icon next to **Connections** to add the second connection.

7. Enter a connection name, for example **demo sensor to central NerveDB**.

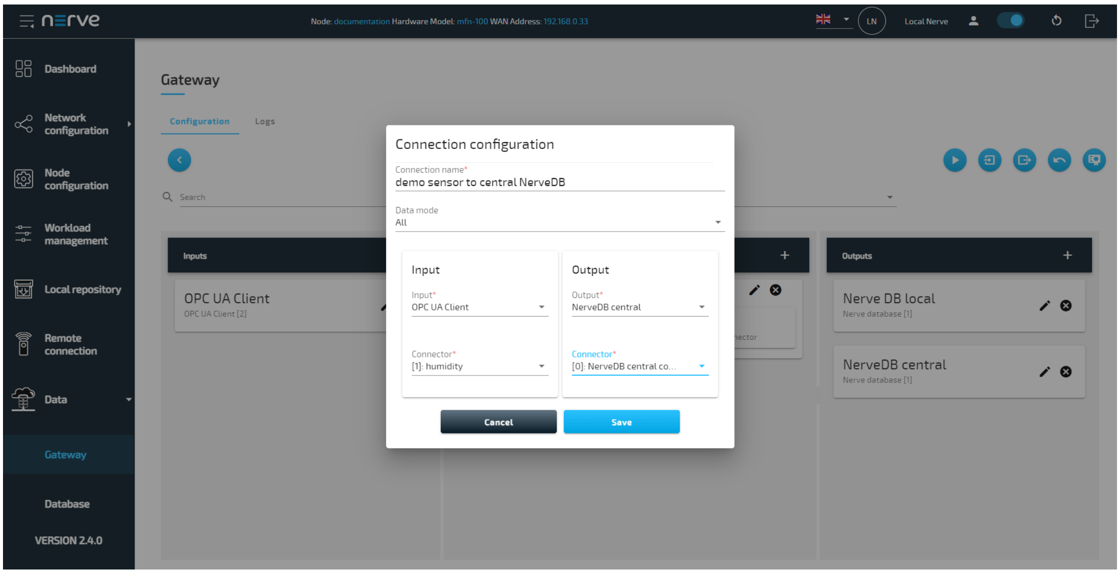
8. Select the following information from the drop-down menus under **Input**:

Setting	Value
Input	Select the OPC UA Client input, named **OPC UA Client** in this example.
Connector	Select the second connector, named **[1]: humidity** in this example.

9. Select the following information from the drop-down menus under **Output**:

Setting	Value
Output	Select the NerveDB output, named **NerveDB central** in this example.
Connector	Select the connector, named **[0]: NerveDB central connector** in this example.

10. Select **Save**.



Connection configuration

Connection name*: demo sensor to central NerveDB

Data mode: All

Input

Input*: OPC UA Client

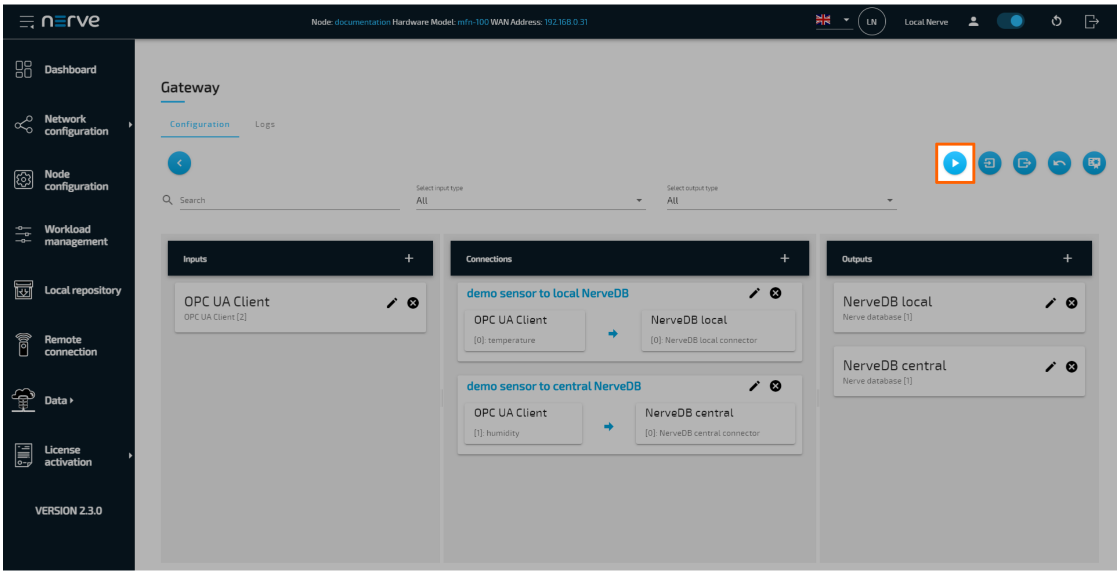
Connector*: [1]: humidity

Output

Output*: NerveDB central

Connector*: [0]: NerveDB central co...

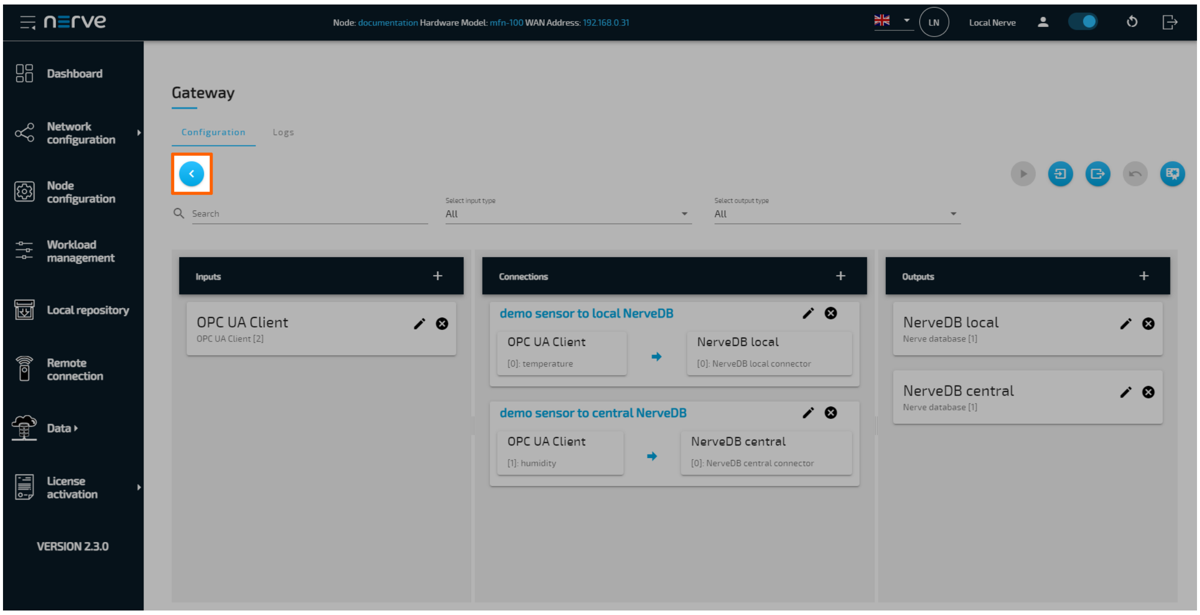
11. Select the **Deploy** button. A success message pops up in the upper-right corner.



NOTE

In case of an already existing configuration, the Gateway might give a warning about which connections will be affected by a short data flow interruption. All other connections will continue to operate and stay unaffected.

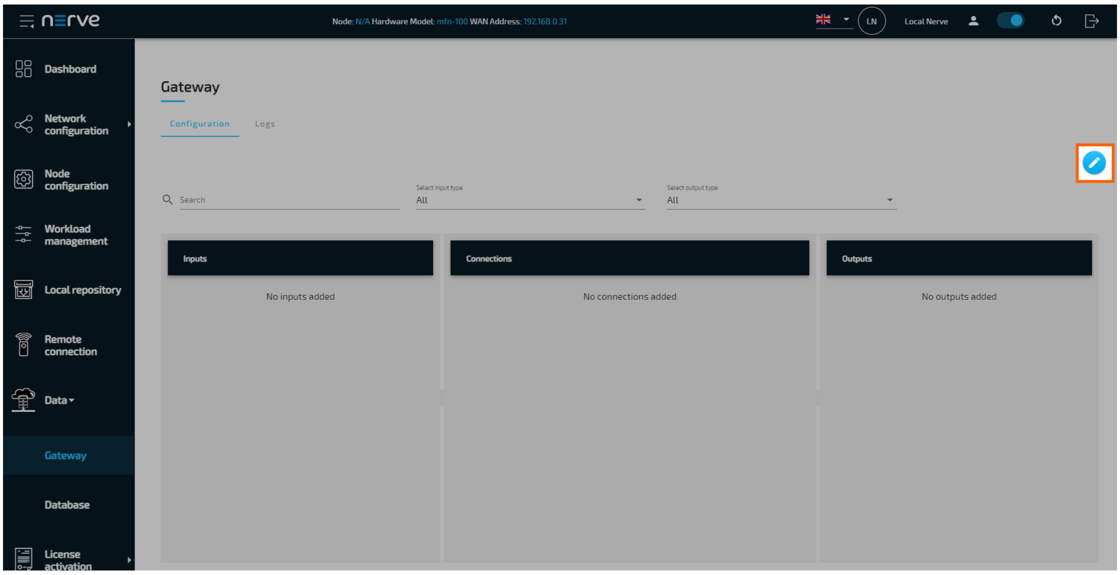
After deploying the configuration, the graphical configuration tool is still in editing mode. Select the arrow on the left side to exit editing mode.



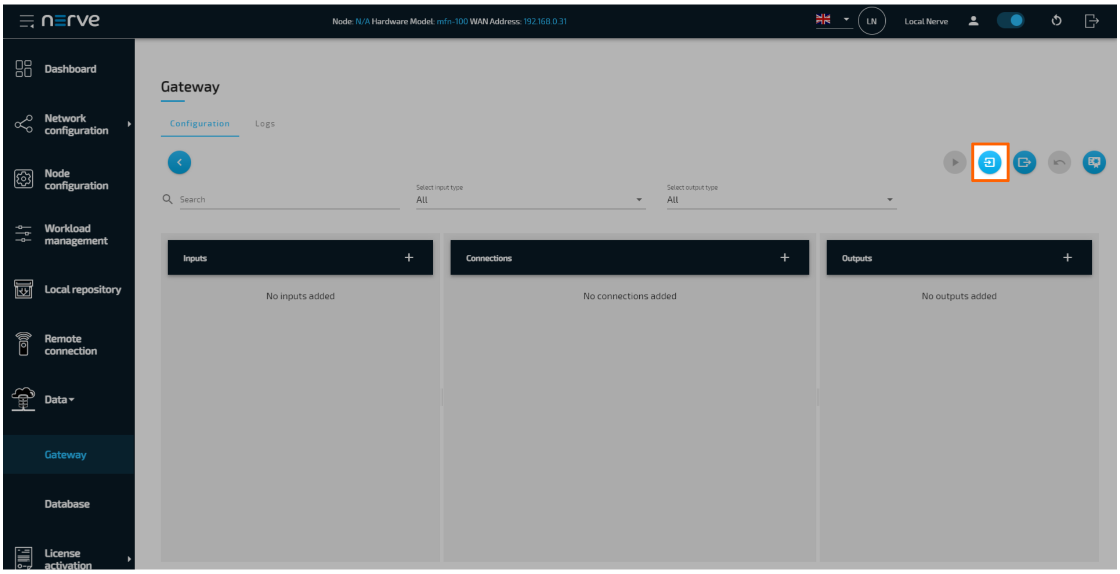
Uploading an existing JSON configuration file

If writing a JSON configuration file is the preferred method of configuring the Gateway, a pre-written JSON file can be uploaded and applied to the Gateway. This method is also useful when following any of the examples.

1. Log in to the Local UI.
2. Expand **Data > Gateway** in the navigation on the left.
3. Select the edit button on the right.

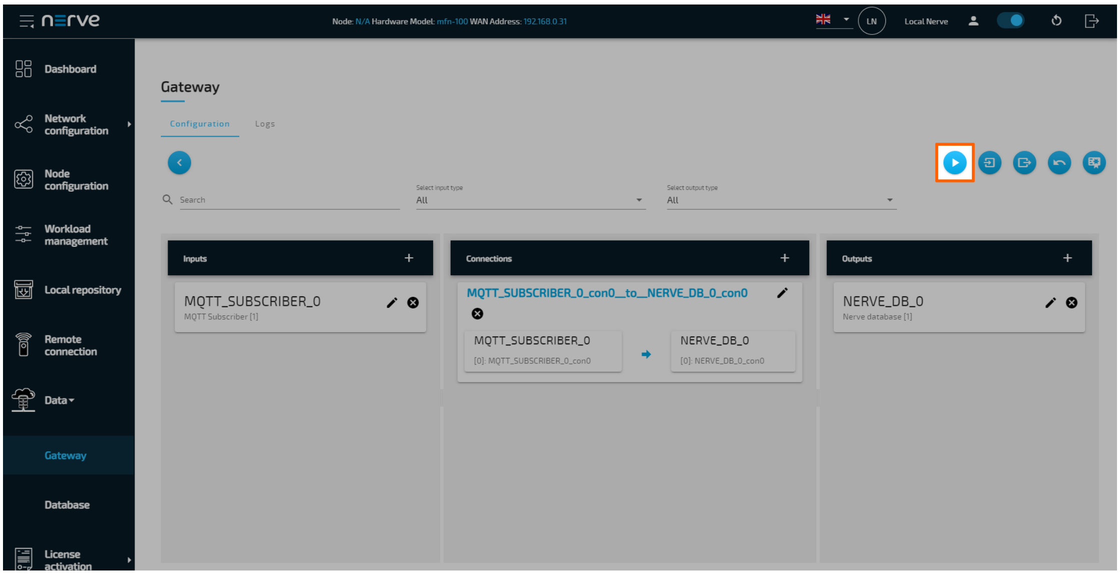


4. Select the **Import** button.

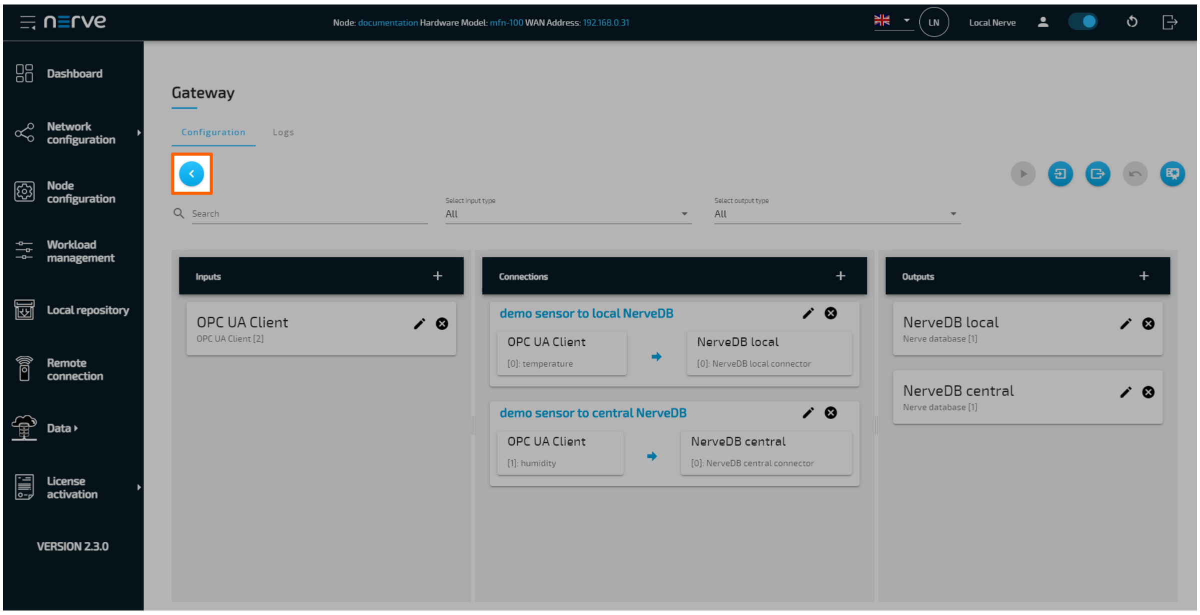


5. Add a pre-written JSON configuration file in the file browser.

6. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the settings from the JSON configuration file. Edit the elements in each pane by selecting the edit button in each element. Exit editing mode by selecting the arrow on the left.



For writing JSON configuration files, have a look at the Nerve Data Services Data Format below and consult the list of parameters for more information on all input, output and connection parameters.

Writing a Gateway configuration file in the Nerve Data Services data format

Inputs and Outputs at the local Gateway, using a protocol that does not define a data format (i.e. MQTT), send or receive data in JSON format. The same applies to the Python API in the Nerve Data Services SDK. As a result, data within the Nerve Data Services is normalized to this format.

The JSON schema below describes the data format in more detail. The JSON schema is also used to validate data upon reception. If a data frame is received that does not comply with the schema, it is silently dropped by the Nerve Data Services.

```
{
    "$schema": "http://json-schema.org/draft/2019-09/schema#",
    "$id": "https://nerve.cloud/dp/dp_data_model.schema.json",
    "title": "Nerve Data Services JSON data model schema",
    "description": "Schema that represents default data model that Nerve Data Services
    "type": "object",
    "properties": {
        "variables": {
            "type": "object",
            "additionalProperties": {
                "anyOf": [
                    {
                        "type": [ "boolean", "number", "string" ]
                    },
                    {
                        "type": "array",
                        "items": {
                            "type": "boolean"
                        }
                    },
                    {
                        "type": "array",
                        "items": {
                            "type": "number"
                        }
                    },
                    {
                        "type": "array",
                        "items": {
                            "type": "string"
                        }
                    }
                ]
            }
        },
        "timestamp": {
            "type": [ "number", "string", "array" ],
            "items": {
                "type": [ "number", "string" ]
            }
        }
    },
    "required": [ "variables" ],
    "additionalProperties": false
}
```

The schema defines and allows only two properties in the root object: timestamp and variables. Timestamp is optional, and can be a single value or an array of values. Variables is an object containing arbitrary number of properties, which can be single values or arrays of values.

Custom JSON format

In order to be able to fetch values from all kinds of JSON messages, the Nerve Data Services Gateway supports custom JSON data formats. The value of a field from a JSON message can be fetched using a so-called JSON path. A JSON path is comparable to a file path in a Unix-like file system. As an example, if a file is located in the following file structure:

- Documents
    - Personal
        - journal.txt

its file path would be: `/Documents/Personal/journal.txt`. Based on this analogy, a JSON field from the following JSON:

```
{
    "Values": {
        "Temperature": 20
    }
}
```

would have the following JSON path: `.Values.Temperature`. Arrays are represented with square brackets:

```
{
    "Values": {
        "Temperature": [ 20, 30, 40 ]
    }
}
```

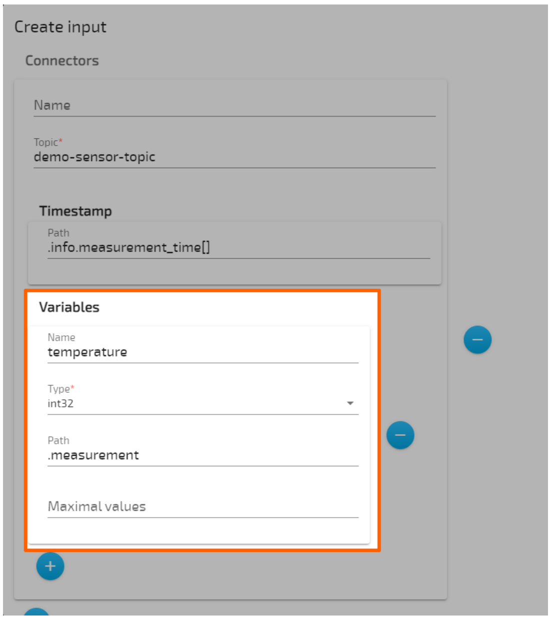
The third value of the Temperature field would be represented the following way: `.Values.Temperature[2]`

Gateway configuration for custom JSON formats

NOTE

Custom JSON formats are supported in all inputs using JSON messages.

The fields name and `path` of the `variables` array objects inside of the `connectors` object are used to construct the JSON path. The full JSON path is always constructed by adding name to `path`:



Create input

Connectors

Name

Topic*
demo-sensor-topic

Timestamp

Path
.info.measurement_time[]

Variables

Name
temperature

Type*
int32

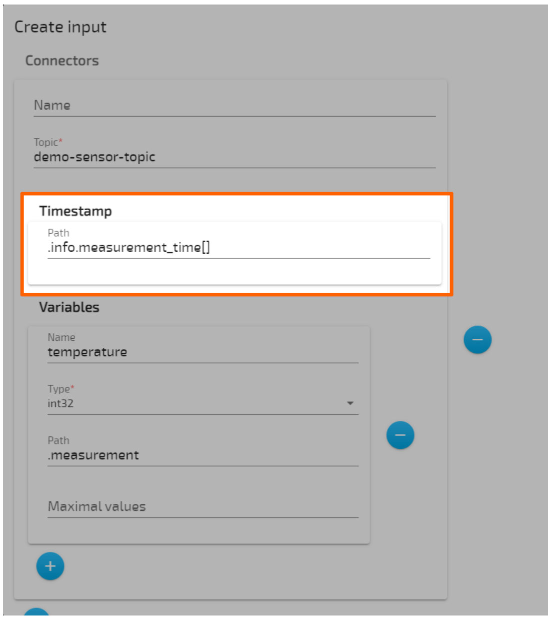
Path
.measurement

Maximal values

The example above will construct the following JSON path: `.measurement.temperature`

- The variable name through the rest of the Gateway will always be just the value of the name field. (`temperature` in the example above).
- If name is omitted, the value of `path` will become the name of the variable.
- If `path` is omitted, the value of `path` will be the default path `.variables`. This allows the Gateway to use the default Data Services data model JSON schema.
- To define a path for timestamps, a special `timestamp` object is used in the root of the input. The only field in the `timestamp` object is `path`, which is used to specify the path where to fetch timestamp values.
- This object is optional, and if omitted, the Gateway will look for timestamps under the default JSON path, `.timestamp`. This also allows the Gateway to use the default Data Services data model JSON schema.

Timestamp JSON path example



Create input

Connectors

Name

Topic*
demo-sensor-topic

Timestamp

Path
.info.measurement_time[]

Variables

Name
temperature

Type*
int32

Path
.measurement

Maximal values

The variable expansion operator [*] cannot be used in a timestamp path. All additional requirements from the section above still apply.

Extended JSON paths

The Gateway extends the JSON paths explained above with two new operators for fetching values, in order to reduce the need to write JSON paths for recurring fields. The following data is used for both expansion examples below:

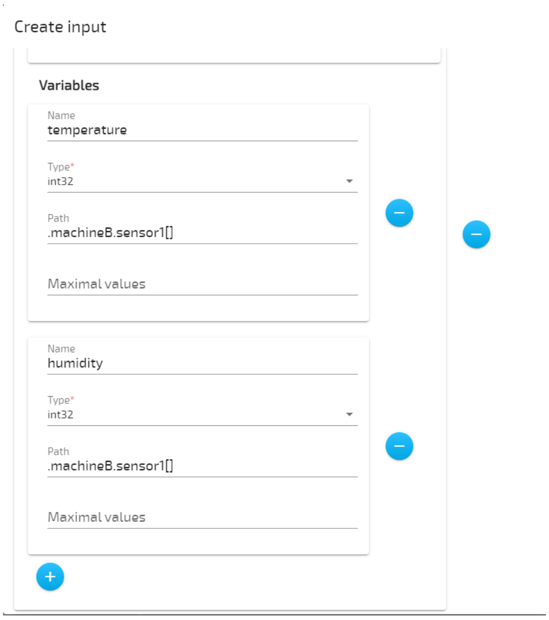
```
{
    "machineB": {
        "sensor1": [
            {
                "temperature": 10,
                "humidity": 51
            },
            {
                "temperature": 20,
                "humidity": 52
            },
            {
                "temperature": 30,
                "humidity": 53
            }
        ]
    }


}
```

Operator [] - List expansion

The list expansion is an operator used to fetch multiple values of the same variable. It allows processing large chunks of data in a simple way.

The data above, when received with the following configuration:



Create input

Variables

Name
temperature

Type*
int32

Path
.machineB.sensor1[]

Maximal values

Name
humidity

Type*
int32

Path
.machineB.sensor1[]

Maximal values

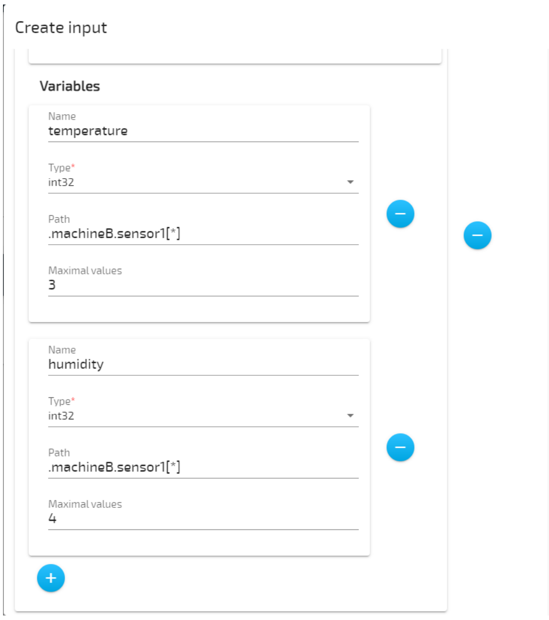
generates 3 entries on any Gateway output.

temperature	humidity
10	51
20	52
30	53

Operator [*] - Variable expansion

The variable expansion is an operator used to fetch multiple values of a variable as separate variables. It allows processing large chunks of data in a compact way.

The data above, when received with the following configuration:



Create input

Variables

Name
temperature

Type*
int32

Path
.machineB.sensor1[*]

Maximal values
3

Name
humidity

Type*
int32

Path
.machineB.sensor1[*]

Maximal values
4

generates all data in one entry. Note that in the configuration above, only the operator was changed from [ ] to [*].

temperature-0	temperature-1	temperature-2	humidity-0	humidity-1	humidity-2
10	20	30	51	52	53

An additional parameter is required when working with the variable expansion, `maxValues`. `maxValues` is required for outputs that need to know the exact number of data before actually receiving it (TimescaleDB, for example). If more values are received than specified in `maxValues`, the Gateway will simply ignore them. If less values than specified are received, the Gateway will write either the last known value at that position or a default value based on the variable type. In the example above, `humidity-3` is set to 0 because of this.

Gateway configuration parameter descriptions

The following list gives more information on the parameters that can be set when configuring the Gateway. Parameters are listed by available inputs and outputs in the list below. The description of each parameter also includes information on additional parameters. The following inputs and outputs are included in the list:

Inputs	Outputs
MQTT Subscriber	**MQTT Publisher**
OPC UA PubSub Subscriber	**OPC UA PubSub Publisher**
OPC UA Client	**OPC UA Server**
Modbus Server	**ZeroMQ Publisher**
S7 Server	**Azure IoT Hub Device**
ZeroMQ Subscriber	**Kafka Producer**
Kafka Consumer	**NerveDB**
	TimescaleDB
	Influx DB

Inputs

In the graphical configuration tool, mandatory fields are marked with a red asterisk.

OPC UA Client

NOTE

Do not use a few seconds or fractions of seconds as time values for **requestedSessionTimeout** and **secureChannelLifeTime** when configuring an OPC UA Server for the Gateway to connect to. When using those time values, the Gateway's OPC UA Client might not work properly, resulting in a loss of data sent by the server.

Object	Values and descriptions
Name	Enter a name for the input. This name is also used in log messages.

Object	Values and descriptions
Server URL	Enter the URL of the server the input will connect to, i.e. `opc.tcp://myserver.com:4840`. This requires an OPC UA Server source to be configured.
Login	Enter **Username** and **Password** of the source OPC UA Server if authentication parameters have been defined.
Certificate	Enter the file names of the certificate under **Certificate path** and key file under **Key file path** for client authentication. This requires a certificate and key file to be uploaded through the **Import certificates** button in the Gateway's edit mode. Certificates must be in DER format. Example: `certificate.der` or `keyfile.der`
Trust list	Enter the certificate file names of trusted OPC UA Servers here. With added certificates here, the Gateway will only connect to OPC UA Servers presenting these certificates. Note that this requires the certificates to be uploaded through the **Import certificates** button in the Gateway's edit mode. Certificates must be in DER format. Example: `server_a_cert.der, server_b_cert.der, server_c_cert.der`
Security	Choose the security mode and policy for the connection. The security mode defines if messages have to be cryptographically signed, or encrypted as well. The security policy determines the cryptographic algorithm used to sign and encrypt messages. **Security mode** Choices are `None`, `Sign`, `SignAndEncrypt`. **Security policy** Choices are `None`, `Basic128Rsa15`, `Basic256` and `Basic256Sha256`. Note that the following warning appears in the Gateway when using an OPC UA Client input with security settings: `WARNING: INTERNAL opcua_client: The configured ApplicationURI does not match the URI specified in the certificate for the SecurityPolicy http://opcfoundation.org/UA/SecurityPolicy#None` This is expected due to the OPC UA library the Gateway is based on.
Description	This is the description of the OPC UA Client. **Application URI** The application URI of the client is the globally unique identifier for the application instance, used in the secure connection certificate. If a certificate has been added earlier, this field must match the URI in the certificate. Example: `urn:myfactory.com:Machine54:UA Server` **Application Name** This is the OPC UA Client's string representation for a server. An OPC UA application delivers this when information on the client is requested. The default value will be used if this field is left empty. The default value of the Gateway OPC UA Client is `Nerve Data Services - Gateway OPC UA Client`.

Object	Values and descriptions
Force session to be kept alive	Tick this checkbox in order to force the server to keep the session alive by constantly polling an arbitrary server value. Some OPC UA servers have been observed having problems keeping the session alive.
Enable server rebrowsing to detect changes in the address space	Tick this checkbox to enable periodical rebrowsing in order to detect changes in the address space of the server. When the checkbox is ticked, a new field labeled **Rebrowsing interval in hours** is added. Specify the size of the interval in hours. Decimal values are possible, e.g. `0.5`. The default setting is 1.
Polling interval in ms	This is the interval at which the Gateway polls values from the server in milliseconds. This setting is in effect when the polling access type is used.
Include object path in variable name	Tick this checkbox to enable the full path in the variable name. This includes names of parent nodes separated by `.`. When the object is browsed, all information of the parent node is available. Therefore, the entire path can be added to the variable name. When browsing the node that represents variables though, there is only information of that given node. In this case, there is no information for including the path of the parent object and only the variable name will be read.

Connectors	Select the plus icon to add a connector. Note that adding a connector is required for establishing a connection between inputs and outputs. Add another connector by selecting the plus icon at the end of the **Connectors** field that opened. **Name** Enter a name for the connector. This makes the connector easy to identify when defining connections. **Access type** This is the access mode of the Gateway OPC UA Client. Options are `polling` and `subscription`. • **polling** When the polling access type is used, the Gateway OPC UA Client sends requests to the OPC UA server for reading values of variables. The interval at which the Gateway OPC UA Client sends requests is defined in the **Polling interval in ms** setting above. • **subscription** When the subscription access type is used, the Gateway OPC UA Client subscribes to notifications on changes of variable values at the OPC UA Server. The sampling and publishing intervals are set below. **Publishing interval at server in ms** Define the interval at which the server is publishing values in milliseconds. The publishing interval determines the interval at which the OPC UA server sends notification of changes in the values of variables, if there are any, to the Gateway OPC UA Client. **Sampling interval at server in ms** Define the sampling interval at which the server updates its values in milliseconds. The sampling interval determines the interval at which the OPC UA server internally checks the values of variables for changes that have occurred. **Nodes** Select the plus icon to add variable nodes: • **Node ID** Enter the Node ID string, e.g. `ns=4;i=1`, `ns=mynamespace;s=myvar.int0`. This string has to be entered according to the OPC UA Node ID string notation syntax. The format is `ns=<namespaceIndex>;<identifiertype>=<identifier>`. Refer to the official documentation for more information. • **Custom name** Enter the custom name of the variable node. In case of node name collisions, the custom name can be used to resolve those manually. The custom name can also be used to shorten a node’s name if it does not fit the requirements. If the Node ID of an object is provided, all variables of that object are used. To enable filtering of the node ID string, add the identifier `r` with a regex string in the format `r=<regexstring>`. Example: `ns=1;r=.*VariablesObjects`. The regex expression is used to match object nodes on the server. Note that this option is a Nerve Data Services feature and is not part of the OPC UA standard.

MQTT Subscriber

Object	Values and descriptions
Name	Enter a name for the input. This name is also used in log messages.
Client ID	Client ID of the MQTT_SUBSCRIBER.
Server URL	Protocol and URL of the server to connect to, i.e. `tcp://myserver.com:4840`. Possible or `wss`.
Username	Enter the username for the MQTT broker.
Password	Enter the password for the MQTT broker.
Keep alive interval	Define the maximum time allowed of no communication between client and server in
Clean session	Tick this checkbox to define whether the server should remember the state of the clie
QOS	Quality of Service value. Possible values are `0`, 1 or 2.
SSL Options	Secure connection options: **CA certificate path** Path to CA certificate file. **Certificate path** Path to certificate file. **Key file path** Path to key file. **Key password** Password for the given key. **Server authentication required** Tick this checkbox to activate server authentication.

Object	Values and descriptions
Connectors	Select the plus icon to add a connector. Note that adding a connector is required for e and outputs. Add another connector by selecting the plus icon at the end of the **Conn** connectors for the MQTT_SUBSCRIBER: **Name** Enter a name for the connector. This makes the connector easy to identify when defini **Topic** Enter the name of the MQTT topic that was defined in the MQTT Publisher. **Timestamp** Timestamp related options • **Path** JSON path pointing to the timestamp value(s). **Variables** Array of variables expected to be received: • **Name** Enter a variable name as found in the received message. If omitted, **Path** is req • **Type** Select the data type the Gateway uses for further processing. This type must ma Default type is `int64`. Possible values are `bool`, `sbyte`, `byte`, `int8`, `uint8`, `int16` `uint64`, `double`, `float`, `string`, `bytestring`, `datetime` or `guid`. • **Path** JSON path pointing to the value(s). If both **Name** and **Path** are provided, the pat • **Maximal values** Enter a maximum value that is required when using the expansion operator `[*]`

ZeroMQ Subscriber

Object	Values and descriptions
type	Type of input (ZEROMQ_SUBSCRIBER).
Name	Name of the ZEROMQ_SUBSCRIBER input used in log messages.
serverUrls	Array of server URLs for this subscriber instance to connect to, i.e. `[tcp://myserver:`

Object	Values and descriptions
Connectors	Array of connectors for ZEROMQ_SUBSCRIBER: **Name** Connector name. **topic** Name of the ZeroMQ topic to use. *timestamp* Timestamp related options. • **path** JSON path pointing to the timestamp value(s). **variables** Array of variables expected to be received: • **Name** Variable name as found in the received message. If omitted, path is required an • **type** Data type the Gateway uses for further processing. It must match the receiving `bool`, `sbyte`, `byte`, `int8`, `uint8`, `int16`, `uint16`, `int32`, `uint32`, `int64`, `uint64`, `datetime` or `guid`. • *path* JSON path pointing to the value(s). If both `name` and `path` are provided, `path` will • *maxValues* Maximum values required when using the expansion operator `[*]` in the path. O

OPC UA PubSub Subscriber

Object	Values and descriptions
type	Type of input (OPC_UA_PS_SUBSCRIBER).
Name	Name of the OPC_UA_PS_SUBSCRIBER input used in log messages.
mqttClientId	Client ID of the OPC_UA_PS_SUBSCRIBER when MQTT transport is used. Requi
networkAddressUrl	URL of the OPC UA PubSub connection to subscribe to.
networkInterface	Name of the network interface to use.
encoding	Type of message encoding (JSON/UADP).

Object	Values and descriptions
Connectors	Array of connectors for the OPC_UA_PS_SUBSCRIBER: **Name** Connector name. *publisherId* Publisher ID for the writer group. *writerGroupId* Writer group ID. *dataSetWriterId* Data set writer ID. *fieldsReversePublished* Some publishers send fields within a data set message in a reversed order co publisher. If this field is set to true, the user can use field indexes in the confi to these publishers. Must be set to `true` when connecting to a publisher usin *mqttTopic* Name of the MQTT topic if transport protocol is MQTT, ignored otherwise. Req **variables** Array of variables expected to be received: • *fieldIndex* Field index of the variable in the data set. • **name** Name of the variable as found in the received message. • **type** Data type of the variable. Possible values are `bool`, `sbyte`, `byte`, `int8`, `uint64`, `double`, `float`, `string`, `bytestring`, `datetime` or `guid`.

S7 Client

Object	Values and descriptions
type	Type of output (S7_CLIENT).
Name	Name of the S7_CLIENT instance used in log messages.
serverUrl	URL of the S7 server to connect to.
port	Port at which to connect to.
connectionType	Connection type (PG, OP, S7_BASIC).
localTsap	Local tsap, mandatory if s7 basic connection type.
remoteTsap	Remote tsap, mandatory if s7 basic connection type.
pollingInterval_ms	Interval for polling values from server in miliseconds.
rack	S7 device rack.
slot	S7 device slot.

Connectors

Array of connectors for S7_CLIENT:

Name
Connector name.

merkers
Array of S7 merkers:

- **name**
  S7 merker name.
- **offset**
  Address of first data.
- *quantity*
  Number of merkers to be read.
- **type**
  S7 merker data type.

inputs
Array of S7 inputs:

- **name**
  S7 input name.
- **offset**
  Address of first data.
- *quantity*
  Number of inputs to be read.
- **type**
  S7 input data type.

outputs
Array of S7 outputs:

- **name**
  S7 output name.
- **offset**
  Address of first data.
- *quantity*
  Number of outputs to be read.
- **type**
  S7 output data type.

timers
Array of S7 timers:

- **name**
  S7 timer name.
- **offset**
  Address of first data.
- *quantity*
  Number of timers to be read.

counters
Array of S7 counters:

- **name**
  S7 counter name.
- **offset**
  Address of first data.
- *quantity*
  Number of counters to be read.

datablocks
Array of S7 datablocks:

- **name**

Modbus Client

Object	Values and descriptions
type	Type of output (MODBUS_CLIENT).
Name	Name of the MODBUS_CLIENT instance used in log messages.
serverUrl	URL of the Modbus server to connect to.
port	Port at which to connect to.
pollingInterval_ms	Interval at which to poll values from the server in milliseconds.

Object	Values and descriptions
Connectors	Array of connectors for the MODBUS_CLIENT: **Name** Connector name. *coils* Array of Modbus coil type: • **name** Coil name, single string or an array of string. • **address** Starting address of first instance. • *quantity* Number of coils to be read. *discreteInputs* Array of Modbus discrete input type: • **name** Discrete input name, single string or an array of string. • **address** Starting address of first instance. • *quantity* Number of discrete inputs to be read. *inputRegisters* Array of Modbus input register type: • **name** Input register name, single string or an array of string. • **address** Starting address of first instance. • *quantity* Number of input registers to be read. • **type** Input register data type. *holdingRegisters* Array of Modbus holding register type: • **name** Holding register name, single string or an array of string. • **address** Starting address of first instance. • *quantity* Number of holding registers to be read. • **type** Holding register data type.

Kafka Consumer

Object	Values and description
type	Type of input (KAFKA_CONSUMER).
name	Name of the KAFKA_CONSUMER instance used in log messages.

Object	Values and description
bootstrapServers	Array of bootstrap servers URLs.
clientId	Client ID to use for the Kafka client.
groupId	ID of the group to which this consumer will join.
securityProtocol	Security protocol to use when connecting to the Kafka broker.
sslOptions	Object describing SSL options. Only relevant if securityProtocol is SSL. **sslCertificateLocation** Location of the certificate. **sslKeyLocation** Location of the certificate key. **sslKeyPassword** Key password. **sslCaLocation** CA certificate location. **sslCrlLocation** CRL location. **sslKeyStoreLocation** Location of the key store directory. **sslKeyStorePassword** Key store password.
connectors	Array of connectors for the KAFKA_CONSUMER: **name** Connector name. **topic** Name of the Kafka topic to use. **timestamp** Timestamp related options. • **path** JSON path pointing to the timestamp value(s). **variables** Array of variables expected to be received: • **name** Variable name as found in the received message. If omitted, path is requi • **type** Data type Gateway uses for further processing, must match receiving var `sbyte`, `byte`, `int8`, `uint8`, `int16`, `uint16`, `int32`, `uint32`, `int64`, `uint64`, `datetime` or `guid`. • **path** JSON path pointing to the value(s). If both name and path are provided, p • **maxValues** Maximum values required when using expansion operator (*) in the path.

Outputs

In the graphical configuration tool, mandatory fields are marked with a red asterisk.

TimescaleDB

Object	Values and descriptions
type	Type of output (DB_TIMESCALE).
Name	Name of the DB_TIMESCALE instance used in log messages.
url	URL of the TimescaleDB server to connect to.
port	Port at which to connect to.
dataRate_MBps	Hypertable data rate in MegaBytes per second.
chunkTimeInterval_s	Hypertable chunk time interval in seconds.
connectors	Array of connectors for DB_TIMESCALE: **Name** Connector name. *dbName* Database name to connect to. *tableName* Table name to write into. *user* Username for authentication. *password* Password for authentication. *booleanAsSmallint* Whether boolean should be represented as PostgreSQL small int data type.

InfluxDB

Object	Values and descriptions
type	Type of output (DB_INFLUX).
Name	Name of the DB_INFLUX instance used in log messages.
url	URL of the InfluxDB server to connect to.
port	Port at which to connect to.

Object	Values and descriptions
Connectors	Array of connectors for DB_INFLUX: **Name** Connector name. **dbName** Database name to connect to. *user* Username for authentication. *password* Password for authentication.

MQTT Publisher

Object	Values and descriptions
Name	Name of the MQTT_PUBLISHER instance used in log messages.
Client id	Client ID of the MQTT_PUBLISHER.
Server URL	Protocol and URL of the server to connect to, i.e. `tcp://myserver.com:4840`. Possible protocols are: `tcp`, `mqtt`, `mqtts`, `ssl`, `ws` or `wss`.
Username	MQTT broker authentication username.
Password	MQTT broker authentication password.
Keep alive interval in s	Maximum time allowed of no communication between client and server.
Clean session	Defines whether the server should remember state for the client across reconnect.
Qos	Quality of Service value (0-2).
SSL options	Secure connection options: **CA certificate path** Path to CA certificate file. **Certificate path** Path to certificate file. **Key file path** Path to key file. **Key password** Password for the given key. **Server authentication required** Defines whether server authentication is required.

Object	Values and descriptions
Connectors	Array of connectors for MQTT_PUBLISHER: **Name** Connector name. **Topic** Name of the MQTT topic to use. **Timestamp required** Defines whether a timestamp is added to each message or not. **Timestamp format** Format of the timestamp in a message, either `iso` (ISO 8601) or `unix_ns` (UNIX time in nanoseconds since Jan 01 1970 (UTC)). **Max list size** Maximum array size of variables, if sent as arrays. If size is larger than the max data will be sent in chunks of Max list size. **Timestamp** Timestamp options: • **Path** Timestamp JSON path in the outgoing message. **Variables** Array of variables for which a custom JSON path is desired: • **Name** Name of the variable. • **New name** New name of the variable. • **Path** JSON path of the variable. • **Default value** Default value of the variable which is being constantly sent until a value is received at the input. • **toCombine** Array of names of variables to combine into this one.

OPC UA PubSub Publisher

Object	Values and descriptions
type	Type of output (OPC_UA_PS_PUBLISHER).
Name	Name of OPC_UA_PS_PUBLISHER instance used in log messages.
networkAddressUrl	URL of the OPC UA PubSub connection to publish to.
networkInterface	Name of the network interface to use.
encoding	Type of message encoding (JSON/UADP).

Object	Values and descriptions
Connectors	Array of connectors for OPC_UA_PS_PUBLISHER: **Name** Connector name. **publisherId** Publisher ID of OPC UA PubSub connection. **writerGroupId** Writer group ID in the OPC UA PubSub connection. **dataSetWriterId** Data set writer ID in the writer group. *publishInterval_ms* Interval at which publisher publishes messages. *keyFrameCount* Key frame count for messages. *mqttTopic* Topic to publish to in case of MQTT connection. *mqttClientId* MQTT client ID for PubSub connection in case of MQTT connection. This must be unique for each connector. Required when MQTT is used.

OPC UA Server

Object	Values and descriptions
type	Type of output (OPC_UA_SERVER).
Name	Name of OPC_UA_SERVER instance used in log messages.
customHostname	Custom hostname of the server, used for discovery URL.
port	Port to listen at (defaults to 4840).
logins	Array of username/password pairs available for authentication: **username** Username for authentication. **password** Password for authentication.
securities	Array of available security modes and policies: **securityMode** Security Mode ("all" keyword is supported to create all available endpoints for chosen Security Policy). **securityPolicy** Security Policy ("all" keyword is supported to create all available endpoints for chosen Security Mode).

Object	Values and descriptions
certificate	Server's certificate: **certFilePath** Path to Server Instance Certificate. **keyFilePath** Path to private key.
description	Server Description: *applicationUri* Server Application URI. *applicationName* This is the client's string representation for a server.
trustList	Array of trusted certificates.
addressSpaceFolders	OPC_UA_SERVER address space tree: **browseName** OPC UA Folder browse name. *displayName* OPC UA Folder display name. *description* OPC UA Folder description. *namespaceURI* OPC UA Folder namespace URI. **identifier** OPC UA Folder nodeID identifier. *children* Array of OPC UA childFolders, same format as addressSpaceFolders field. *connectorIndicies* Array of indicies of connectors, placed in the OPC UA Folder.

Object	Values and descriptions
Connectors	Array of connectors for OPC_UA_SERVER: **Name** Connector name. **browseName** OPC UA node browse name. *displayName* OPC UA node display name. *description* OPC UA node description. *namespaceURI* OPC UA node namespace URI. **identifier** OPC UA node nodeID identifier.

OPC UA Client Output

Object	Values and descriptions
Name	Enter a name for the input. This name is also used in log messages.
Server URL	Enter the URL of the server the input will connect to, i.e. `opc.tcp://myserver.com:4840`. This requires an OPC UA Server source to be configured.
Login	Enter **Username** and **Password** of the OPC UA Server if authentication parameters have been defined.
Certificate	Enter the file names of the certificate under **Certificate path** and key file under **Key file path** for client authentication. This requires a certificate and key file to be uploaded through the **Import certificates** button in the Gateway's edit mode. Certificates must be in DER format. Example: `certificate.der` or `keyfile.der`
Trust list	Enter the certificate file names of trusted OPC UA Servers here. With added certificates here, the Gateway will only connect to OPC UA Servers presenting these certificates. Note that this requires the certificates to be uploaded through the **Import certificates** button in the Gateway's edit mode. Certificates must be in DER format. Example: `server_a_cert.der, server_b_cert.der, server_c_cert.der`

Object	Values and descriptions
Security	Choose the security mode and policy for the connection. The security mode defines if messages have to be cryptographically signed, or encrypted as well. The security policy determines the cryptographic algorithm used to sign and encrypt messages. **Security mode** Choices are `None`, `Sign`, `SignAndEncrypt`. **Security policy** Choices are `None`, `Basic128Rsa15`, `Basic256` and `Basic256Sha256`. Note that the following warning appears in the Gateway when using an OPC UA Client input with security settings: `WARNING: INTERNAL opcua_client: The configured ApplicationURI does not match the URI specified in the certificate for the SecurityPolicy http://opcfoundation.org/UA/SecurityPolicy#None` This is expected due to the OPC UA library the Gateway is based on.
Description	This is the description of the OPC UA Client. **Application URI** The application URI of the client is the globally unique identifier for the application instance, used in the secure connection certificate. If a certificate has been added earlier, this field must match the URI in the certificate. Example: `urn:myfactory.com:Machine54:UA Server` **Application Name** This is the OPC UA Client's string representation for a server. An OPC UA application delivers this when information on the client is requested. The default value will be used if this field is left empty. The default value of the Gateway OPC UA Client is `Nerve Data Services - Gateway OPC UA Client`.

Object	Values and descriptions
Connectors	Select the plus icon to add a connector. Note that adding a connector is required for establishing a connection between inputs and outputs. Add another connector by selecting the plus icon at the end of the **Connectors** field that opened. **Name** Enter a name for the connector. This makes the connector easy to identify when defining connections. **Variables** Select the plus icon to add variable nodes: • **Name** Enter the name of the variable node. This name needs to correspond to the name of a variable found in the dataset. • **Node ID** Enter the Node ID string that corresponds to the connected OPA UA server's variable node ID, e.g. `ns=4;i=1`, `ns=mynamespace;s=myvar.int0`. This string has to be entered according to the OPC UA Node ID string notation syntax. The format is `ns=<namespaceIndex>;<identifiertype>=<identifier>`. Refer to the official documentation for more information.

ZeroMQ Publisher

Object	Values and descriptions
type	Type of output (ZEROMQ_PUBLISHER).
Name	Name of the ZEROMQ_PUBLISHER instance used in log messages.
serverUrl	Server endpoint to publish to. Subscribers connect to it.

Object	Values and descriptions
Connectors	Array of connectors for ZEROMQ_PUBLISHER: **Name** Connector name. **topic** Name of the ZeroMQ topic to publish to. *timestampRequired* Defines whether a timestamp is added to each message or not. *timestampFormat* Format of the timestamp in a message, either `iso` (ISO 8601) or `unix_ns` (UNIX time in nanoseconds since Jan 01 1970 (UTC)). *maxListSize* Maximum array size of variables, if sent as arrays. If size is larger than the max data will be sent in chunks of maxListSize. *timestamp* Timestamp options: • *path* Timestamp JSON path in the outgoing message. *variables* Array of variables for which a custom JSON path is desired: • **Name** Name of the variable. • *newName* New name of the variable. • *path* JSON path of the variable. • *defaultValue* Default value of the variable which is being constantly sent until a value is received at the input. • *toCombine* Array of names of variables to combine into this one.

Azure IoT Hub Device

Object	Values and descriptions
type	Type of output (AZURE_IOT_HUB_DEVICE).
Name	Name of the AZURE_IOT_HUB_DEVICE instance used in log messages.
deviceConnectionString	Connection string of the device created in the MS Azure IoT Hub.
mqttOverWss	Determines if the AZURE_IOT_HUB_DEVICE instance should use MQTT over WSS (port 433) or regular MQTT over TLS/SSL (port 8883) to connect to the Azure IoT Hub broker.

Object	Values and descriptions
sslOptions	Secure connection options for MQTT transport: **certFilePath** Path to certificate file. **keyFilePath** Path to key file. *keyPassword* Password for the given key.

Object	Values and descriptions
connectors	Array of connectors for AZURE_IOT_HUB_DEVICE: **Name** Connector name. *timestampRequired* Defines whether a timestamp is added to each message or not. *timestampFormat* Format of the timestamp in a message, either `iso` (ISO 8601) or `unix_ns` (UNIX time in nanoseconds since Jan 01 1970 (UTC)). *maxListSize* Maximum array size of variables if sent as arrays. If size is larger than the maximum, data will be sent in chunks of `maxListSize`. *customProperties* Custom properties array that is included with every published message: • **name** Name of the custom property. • **value** Value of the custom property. May be a constant value, or the value from one of the input variables of the message, in which case it should be the variable name enclosed in `{ }`. *timestamp* Timestamp options: • *path* Timestamp JSON path in the outgoing message. *variables* Array of variables for which a custom JSON path is desired: • **Name** Name of the variable. • *newName* New name of the variable. • *path* JSON path of the variable. • *defaultValue* Default value of the variable which is being constantly sent until a value is received at the input. • *toCombine* Array of names of variables to combine into this one.

NerveDB

NOTE

When using the central NerveDB as an output for multiple data flows, make sure to use a single central NerveDB output with multiple connectors. Splitting the data flow by configuring more than one central NerveDB output might result in malfunction and a loss of data.

Object	Values and descriptions
type	Type of output (NERVE_DB).
Name	Name of the NERVE_DB instance used in log messages.
location	Location of the Nerve database. This can be `CENTRAL` or `LOCAL`.
connectors	Array of connectors for NERVE_DB: **Name** Connector name. *tableName* Table name to write into. *dataBuffer* Enables data buffering option. This is only usable if `location` is set to `CENTRAL`. **bufferExpTime** Data retention time of the buffer in minutes. This is mandatory if data buffering is enabled and the location is `CENTRAL`.

Kafka Producer

Object	Values and descriptions
type	Type of output (KAFKA_PRODUCER).
Name	Name of the KAFKA_PRODUCER instance used in log messages.
bootstrapServers	Array of bootstrap servers URLs.
clientId	Client ID to use for the Kafka client.
securityProtocol	Security protocol to use when connecting to the Kafka broker. Options are `plaintext` and `ssl`.

Object	Values and descriptions
sslOptions	Object describing SSL options. Only relevant if securityProtocol is SSL. *sslCertificateLocation* Path to the certificate. *sslKeyLocation* Path to the certificate key. *sslKeyPassword* Key password. *sslCaLocation* Path to the CA certificate. *sslCrlLocation* Path to the CRL. *sslKeyStoreLocation* Path to the key store directory. *sslKeyStorePassword* Key store password.

Object	Values and descriptions
Connectors	Array of connectors for KAFKA_PRODUCER: **Name** Connector name. **topic** Name of the Kafka topic to produce to. *compressionType* Compression algorithm to use to compress the outgoing messages. Options are none, `gzip`, `snappy`, `lz4` and `zstd`. *timestampRequired* Defines whether a timestamp is added to each message or not. *timestampFormat* Format of the timestamp in a message. Options are `iso` (ISO 8601) or `unix_ns` (UNIX time in nanoseconds since Jan 01 1970 (UTC)). *maxListSize* Maximum array size of variables, if sent as arrays. If size is larger than the max data will be sent in chunks of maxListSize. *timestamp* Timestamp options: • *path* Timestamp JSON path in the outgoing message. *variables* Array of variables for which a custom JSON path is desired: • **Name** Name of the variable. • *newName* New name of the variable. • *path* JSON path of the variable. • *defaultValue* Default value of the variable which is being constantly sent until a value is received at the input. • *toCombine* Array of names of variables to combine into this one.

Connections

Object	Values and descriptions
Name	Name of the connection, will define the name of the TABLE within TimescaleDB if `tableName` field is omitted.

Object	Values and descriptions
dataMode	Mode used by the output to handle data in the buffer. *ALL* This is the default mode. All variables that are in the data set are used by the output, regardless of the value having changed or not. If no new value has been received, the previous one is used. All inputs and outputs support this mode. *INCREMENTAL* Only variables for which new values were received are considered. Currently this is only supported by OPC UA Client, JSON inputs (Kafka Consumer, ZeroMQ Subscriber and MQTT Subscriber) and JSON outputs (ZeroMQ Publisher, MQTT Publisher and Kafka Producer).
input	Input of the connection. **index** Index in the array of INPUTs. **connector** Index in the array of connectors at the input.
output	Output of the connection. **index** Index in the array of OUTPUTs. **connector** Index in the array of connectors at the output.

Gateway configuration file keywords

Parts of the Gateway configuration are eased by the use of keywords. All keywords must be put in angled brackets, for example <SN>. To be able to use keywords. the node must be registered in the Management System.

Refer to the list below for keywords that can be used with usage examples right after. Note that keywords can also be used in the graphical configuration tool.

Keyword	Description
SN	Replaces the keyword with the serial number of the node.
SID	Replaces the keyword with the secure ID of the node.
LOCAL	• Replaces the keyword with `localhost`. • Used in `url` field of TimescaleDB output. • Adds `port` field to the TimescaleDB output. • Adds `connectors` array with a single connector to the TimescaleDB output if none exist. Adds or replaces `name`, `dbName`, `user` and `password` fields for all connectors. Note that the usage of this keyword is an old way for configuring a local database instance. Use the NerveDB output with location set to `LOCAL` instead for usage of a pre-configured local database. The TimescaleDB output should only be used for custom TimescaleDBs installed by users on the node or on an external device.

Examples of keyword usage

LOCAL

```
{
    "type": "DB_TIMESCALE",
    "name": "timescaledb_0",
    "url": "<LOCAL>"
}
```

SN and SID

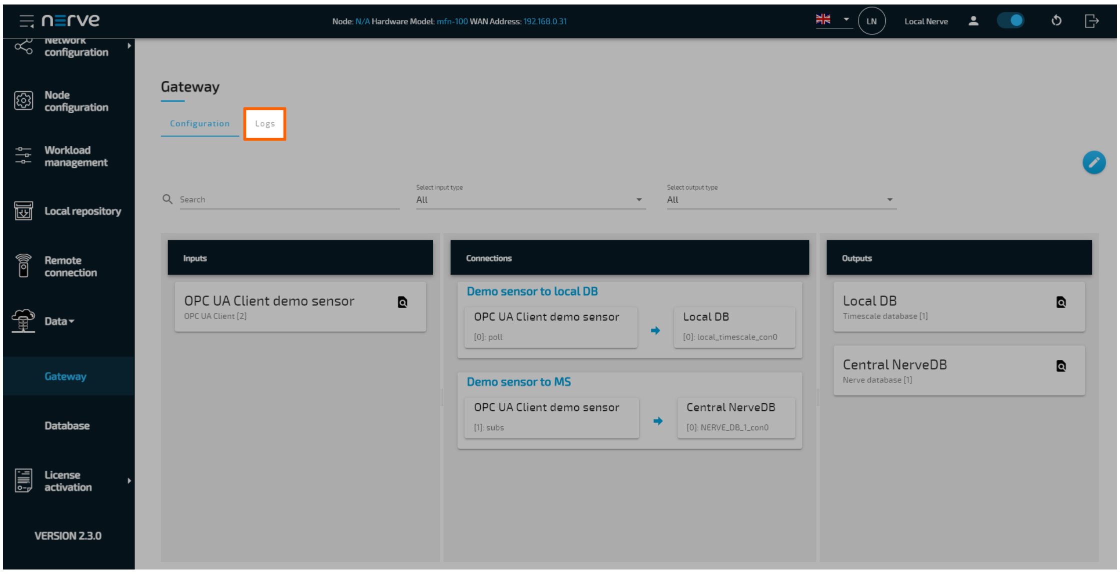
```
{
    "type": "MQTT_SUBSCRIBER",
    "serverUrl": "tcp://localhost:1883",
    "username": "<SN>",
    "password": "<SID>",
    "keepAliveInterval_s": 20,
    "qos": 1,
    "cleanSession": true,
    "connectors": [
        {
            "topic": "<SN>",
            "variables": [
                {
                    "name": "temperature",
                    "type": "uint64"
                }
            ]
        }
    ]
}
```

How to export a log file

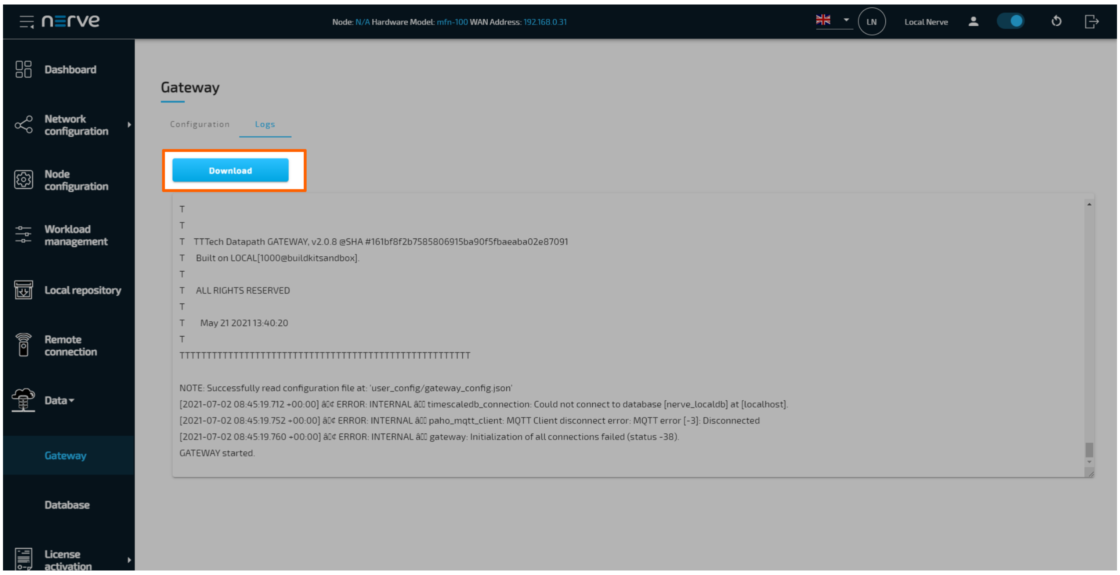
Every element of the Data Services is producing log files locally and centrally that can be viewed in the **Logs** tab. These logs can also be downloaded through the Data Services UI.

1. Select **Gateway** in the navigation on the left.

2. Select the **Logs** tab.



3. Select **Download** to export a LOG file.



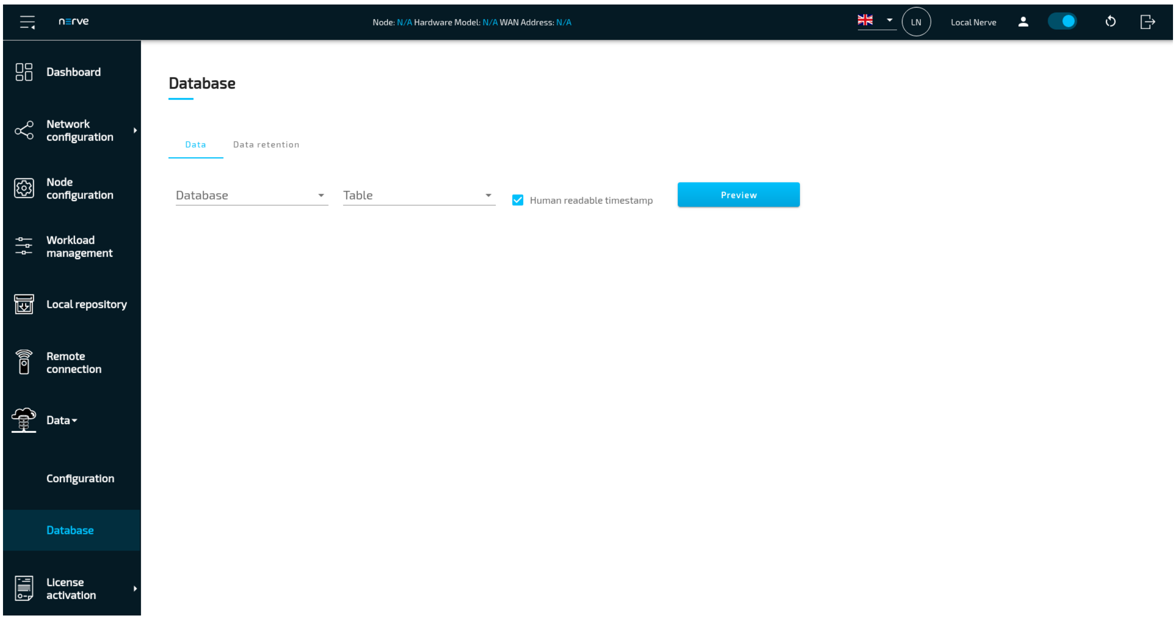
```
T
T
T   TTTech Datapath GATEWAY, v2.0.8 @SHA #161bf8f2b7585806915ba90f5fbaeaba02e87091
T    Built on LOCAL[1000@buildkitsandbox].
T
T    ALL RIGHTS RESERVED
T
T      May 21 2021 13:40:20
T
TTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT

NOTE: Successfully read configuration file at: 'user_config/gateway_config.json'
[2021-07-02 08:45:19.712 +00:00] â¢ ERROR: INTERNAL â timescaledb_connection: Could not connect to database [nerve_localdb] at [localhost].
[2021-07-02 08:45:19.752 +00:00] â¢ ERROR: INTERNAL â paho_mqtt_client: MQTT Client disconnect error: MQTT error [-3]: Disconnected
[2021-07-02 08:45:19.760 +00:00] â¢ ERROR: INTERNAL â gateway: Initialization of all connections failed (status -38).
GATEWAY started.
```

Nerve Data Services Database

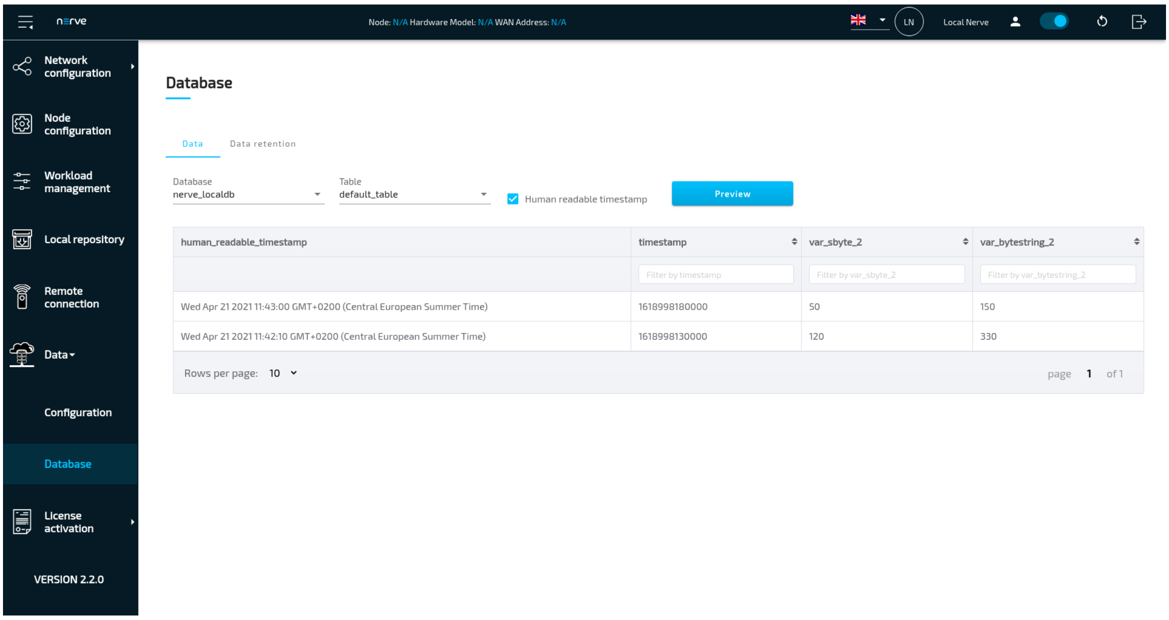
Every node has a local NerveDB database pre-configured. The local NerveDB is also the database that should be used if local database storage is required. In the Management System, databases are discerned by the serial numbers of the nodes and can be used to confirm the flow of data. Select the arrow next to **Data** in the navigation on the left in both the Local UI and the Management System and select **Database** to reach the database menu. The database menu can be used to preview data collected in the NerveDB of a node.

The **Data** tab is the first active tab when selecting the database menu in the navigation.



Item	Description
Database	Select a database from the drop-down menu. In the Local UI this will only contain the default database **nerve_localdb**. In the Management System, this will contain a list of the serial numbers of all registered nodes.
Table	Select a table containing data from the drop-down menu. The selection here depends on the configuration of the Gateway. Data needs to be written to **nerve_localdb** for something to be listed here.
Human readable timestamp	Tick the checkbox here to add a timestamp to the data preview of the data contained in the database.
Preview	Select this to show a preview of data. The data shown depends on the selections in the **Database** and **Table** drop-down menus.

Here is an example of a data preview.



Database: nerve_localdb

Table: default_table

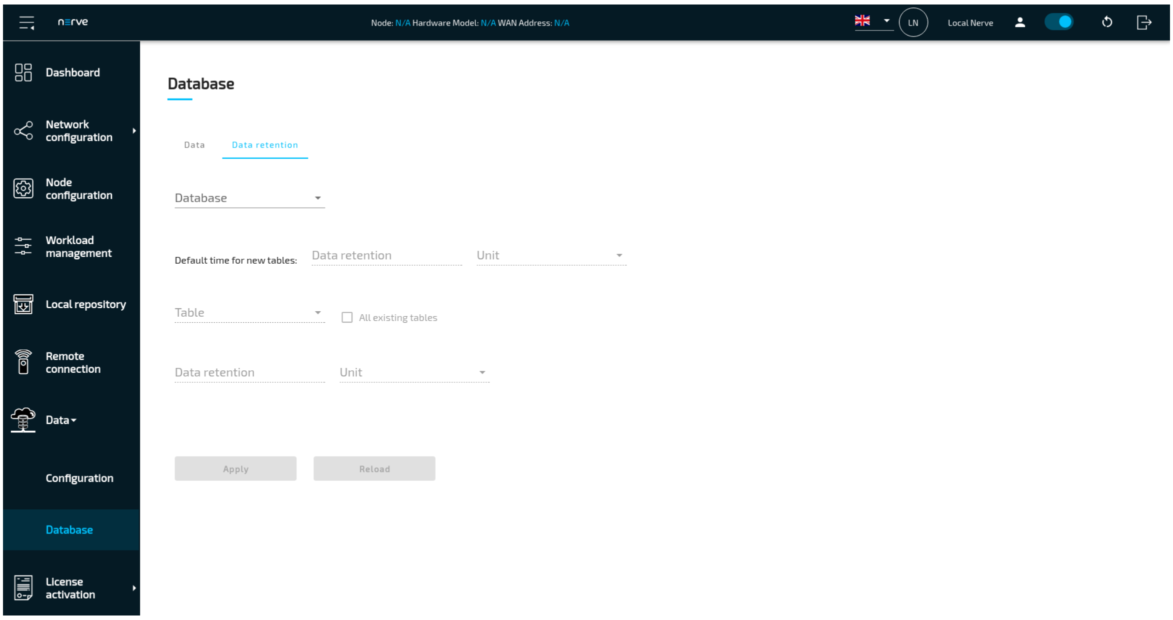
☑ Human readable timestamp

human_readable_timestamp	timestamp	var_sbyte_2	var_bytestring_2
	Filter by timestamp	Filter by var_sbyte_2	Filter by var_bytestring_2
Wed Apr 21 2021 11:43:00 GMT+0200 (Central European Summer Time)	1618998180000	50	150
Wed Apr 21 2021 11:42:10 GMT+0200 (Central European Summer Time)	1618998130000	120	330

Rows per page: 10 page 1 of 1

Data retention tab

Due to limitation in storage, a data retention policy is in place to delete old data after a certain amount of time. The default time is one day. Select the **Data retention** tab for settings. Refer to the table below for more information on the settings.



Item	Description
Database	Select a database from the drop-down menu. In the Local UI this will only contain the default database **nerve_localdb**. In the Management System, this will contain a list of the serial numbers of all registered nodes.

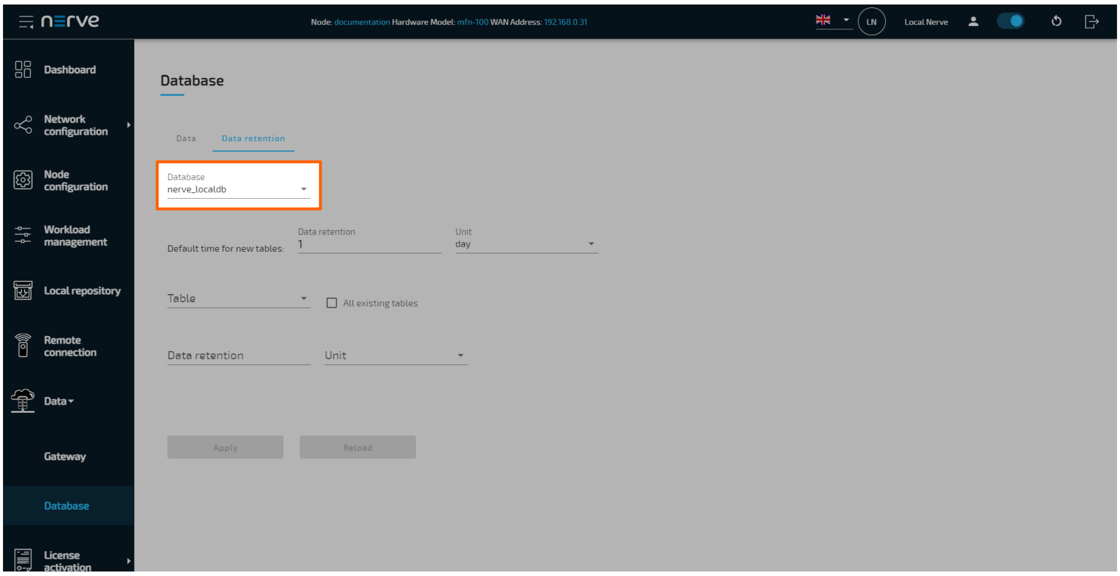
Item	Description
Default time for new tables	Set the data retention time for new tables here. Times can be set in **minutes**, **hours** and **days**. When setting the data retention parameters for the first time, the default value of 1 day is filled in automatically. This default value is also automatically applied to existing tables when the retention time is initially set. After that, this value applies to tables added in the future when the Gateway configuration is changed.
Table	Select a table from the drop-down menu to configure its data retention time. The drop-down menu contains table names defined in the Gateway configuration if data has been written into the database that was selected above.
All existing tables	Tick this checkbox to apply the data retention time to all tables in the drop-down menu.
Data retention	Set the data retention time for the selected tables here. Times can be set in **minutes**, **hours** and **days**.
Apply	Use this button to save the configuration.
Reload	Use this button to load the current settings of the selected tables into the UI.

Setting data retention time

The following example shows a possible way of setting different data retention settings for different tables in a database.

1. Apply a Gateway configuration.
2. Select **Data > Database** in the navigation on the left.
3. Select the **Data retention** tab.

4. Select a database from the drop-down menu.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.31

Database: nerve_localdb

Default time for new tables: Data retention: 1 Unit: day

Table

□ All existing tables

Data retention

Unit

NOTE

The drop-down menu is labelled **Database** in the Local UI and contains the **nerve_localdb** database

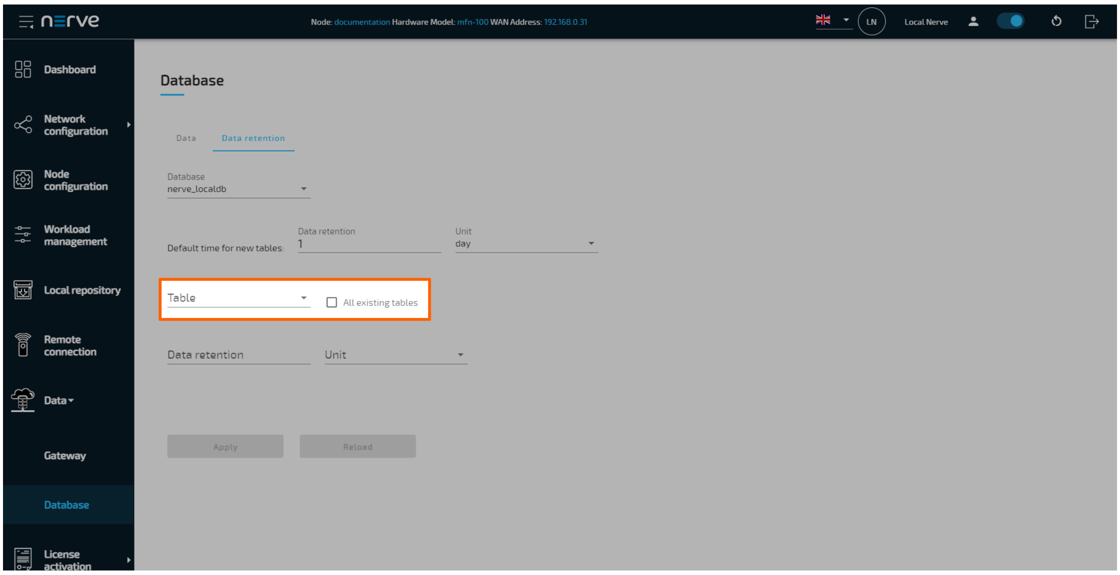
In the Management System, this drop-down menu is labelled **Nodes** and contains the serial numbers of all registered nodes.

5. Set the **Default time for new tables** to the desired value.

NOTE

When setting the data retention parameters for the first time, the default value of **1 day** is filled in automatically. This default value is also automatically applied to the currently existing tables. After that, this value applies to tables added in the future when the Gateway configuration is changed.
Example: If the value is changed from **1 day** to **2 days**, newly defined tables that are added with the next Gateway configuration will have a data retention time of **2 days** while the existing tables remain at a data retention time of **1 day**. Change this value to a desired value for future tables. The retention time of the existing tables is configured below.

6. Select a table from the drop-down menu or tick the checkbox next to **All existing tables**.


Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.31

Database

Database: nerve_localdb

Default time for new tables: Data retention 1 Unit day

Table □ All existing tables

Data retention Unit

7. Set the value to the desired amount of time.

NOTE

This setting allows the definition of retention time for existing tables. The time value below this selection is applied to table selected in step 6 above. The retention time of all currently available tables can be defined one by one by selecting each table from the drop-down menu, setting a data retention time below and selecting **Apply**. If all existing tables are to have the same data retention time, tick the checkbox next to **All existing tables**, set a data retention time below and select **Apply**.

After selecting **Apply**, data retention settings are applied. Note that the currently data retention time of an existing table is displayed in the settings when the table is selected from the drop-down menu.

Data Visualization

Data stored in the Data Services can be visualized via Grafana, an open source web application which provides charts, graphs and alerts for data visualization. An instance of Grafana is available on each node and in the Management System to visualize data stored in databases on the node or in the Management System. This chapter describes only how Grafana is configured and how it can be accessed. Refer to the Grafana documentation for general information on how to use Grafana.

> **NOTE**
>
> To use Grafana, the user must be logged in to the Local UI or the Management System respectively. When logged out, Grafana is no longer able to perform its internal operations and reports random errors. To continue working with Grafana, close the browser tab, log in again at either the Local UI or the Management System, depending on which Grafana instance is being accessed, and re-open Grafana.

Central Data Visualization in the Management System

In the Management System, each registered node is represented as a separate data source in Grafana. The data source is created during the registration of a node. A data source is named after the node it represents, formatted as `<nodename> (<serialnumber>)`. When creating a new panel, select the node which sent the data to be displayed as the data source. The name of the table must match the name provided in the Gateway configuration file.

1. Log in to the Management System.

2. Select **Data** in the navigation on the left.

> **NOTE**
>
> If the menu item **Data** is not available, make sure the logged in user has the permission to access the Data Services. Refer to Assigning a role to a user for more information.

The navigation on the left collapses to show the home screen of Grafana. Here dashboards can be created as described below. Select the burger menu in the top-left to expand the navigation again. Note that the Grafana UI theme is set to light by default.

Access levels for Data Visualization in the Management System

Management System users are assigned Grafana permissions when they receive permissions to access the Data Services. The roles can be either viewer, editor or admin:

- Viewers can view dashboards in Grafana.

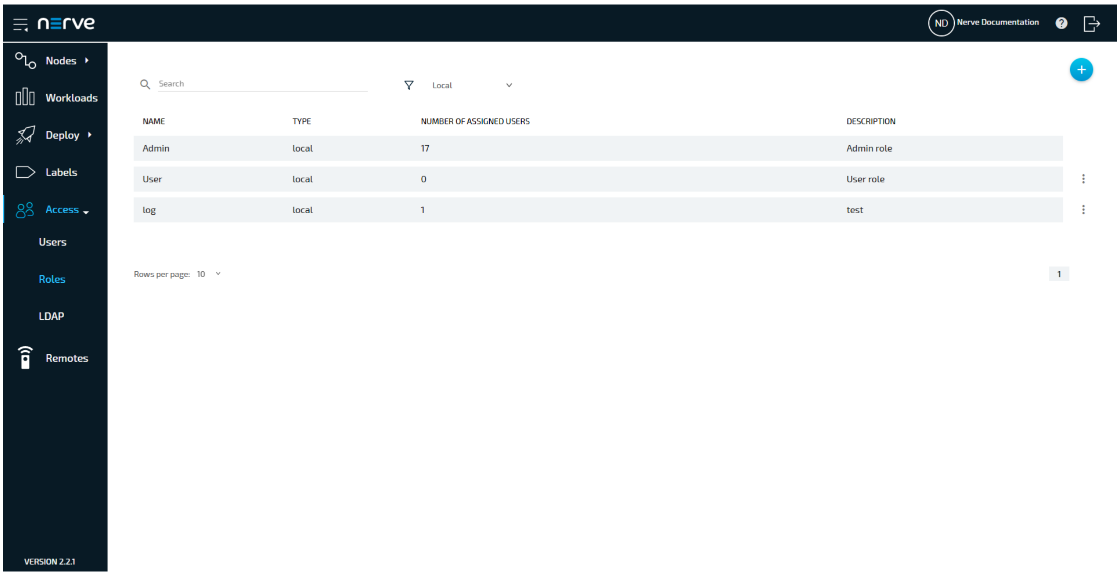
- Editors can view, create and edit dashboards.
- Admins can manage data sources and users.
  Note that this is not recommended to do as Nerve components do this automatically.

NOTE

Users with the **GRAFANA:ADMIN** permission shall not delete the default admin user, as the system relies on it. If the default admin user is deleted, the assigned roles from the Management System will not work.

The Grafana Viewer role is given by default. To give a user the editor or admin role:

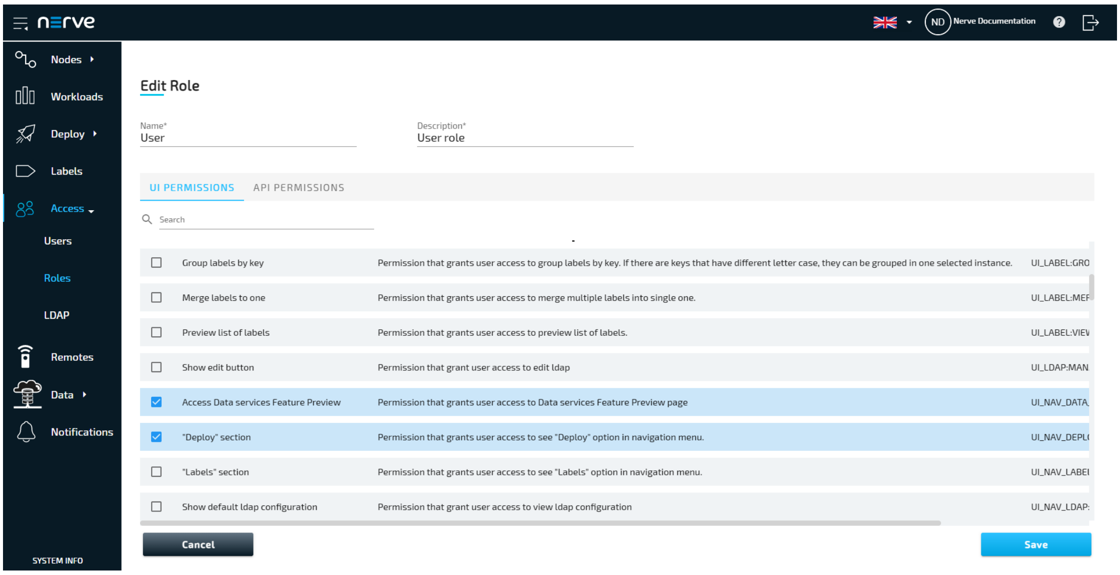
1. Log in to the Management System.
2. Select **Access > Roles** in the navigation on the left.



NAME	TYPE	NUMBER OF ASSIGNED USERS	DESCRIPTION
Admin	local	17	Admin role
User	local	0	User role
log	local	1	test

Rows per page: 10

3. Select the role that has permission to access the Data Services.
4. Make sure that **Access Data services Feature Preview** is checked.



Edit Role

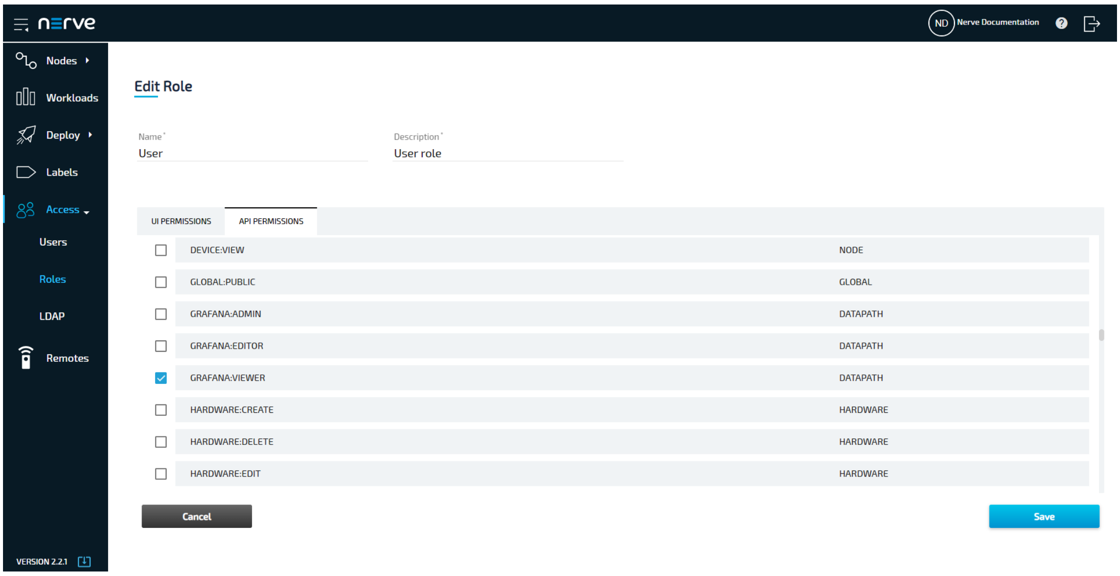
Name* User

Description* User role

□	Group labels by key	Permission that grants user access to group labels by key. If there are keys that have different letter case, they can be grouped in one selected instance.	UI_LABEL:GRO
□	Merge labels to one	Permission that grants user access to merge multiple labels into single one.	UI_LABEL:MEF
□	Preview list of labels	Permission that grants user access to preview list of labels.	UI_LABEL:VIEV
□	Show edit button	Permission that grant user access to edit ldap	UI_LDAP:MAN
☑	Access Data services Feature Preview	Permission that grants user access to Data services Feature Preview page	UI_NAV_DATA_
☑	"Deploy" section	Permission that grants user access to see "Deploy" option in navigation menu.	UI_NAV_DEPL(
□	"Labels" section	Permission that grants user access to see "Labels" option in navigation menu.	UI_NAV_LABEI
□	Show default ldap configuration	Permission that grant user access to view ldap configuration	UI_NAV_LDAP:

5. Select the **API PERMISSIONS** tab.

6. Look for **GRAFANA:ADMIN** and **GRAFANA:EDITOR**



Edit Role

Name* User

Description* User role

□	DEVICE:VIEW	NODE
□	GLOBAL:PUBLIC	GLOBAL
□	GRAFANA:ADMIN	DATAPATH
□	GRAFANA:EDITOR	DATAPATH
☑	GRAFANA:VIEWER	DATAPATH
□	HARDWARE:CREATE	HARDWARE
□	HARDWARE:DELETE	HARDWARE
□	HARDWARE:EDIT	HARDWARE

7. Select the desired permission.

8. Select **Save**

Local Data Visualization on the node

On the node, only a single data source exists in Grafana, formatted as `<serialnumber>`. Use this data source in all panels to visualize data received by the Data Services.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select **Data** in the navigation on the left.

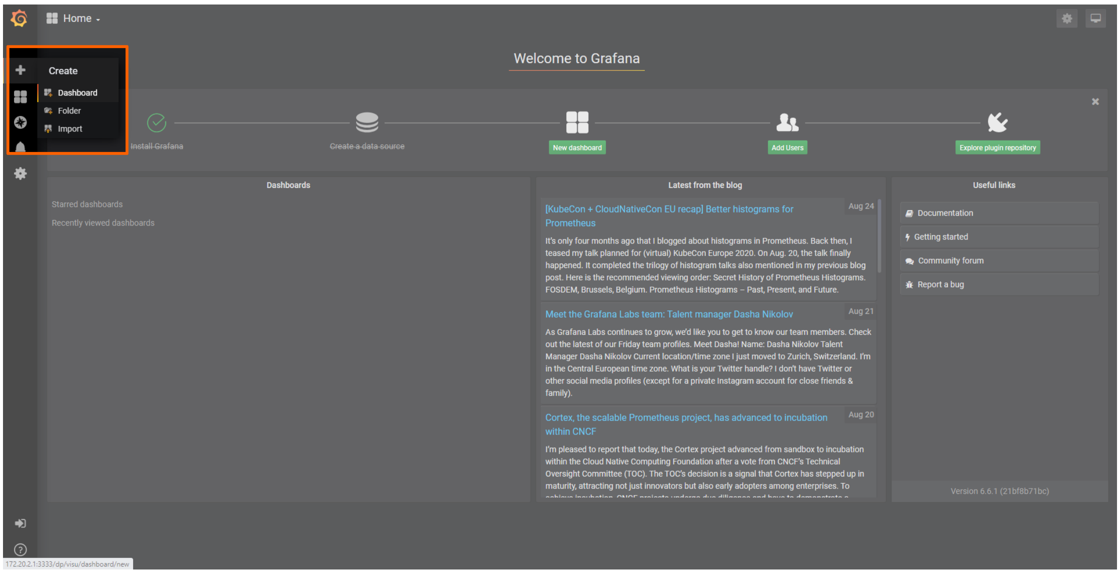
The navigation on the left collapses to show the home screen of Grafana. Here dashboards can be created as described below. Select the burger menu in the top-left to expand the navigation again. Note that the Grafana UI theme is set to light by default.

Creating a dashboard

The instructions below cover the general workflow of creating a dashboard. Refer to Examples for specific use cases.

1. Access the visualization element on either the node or in the Management System.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

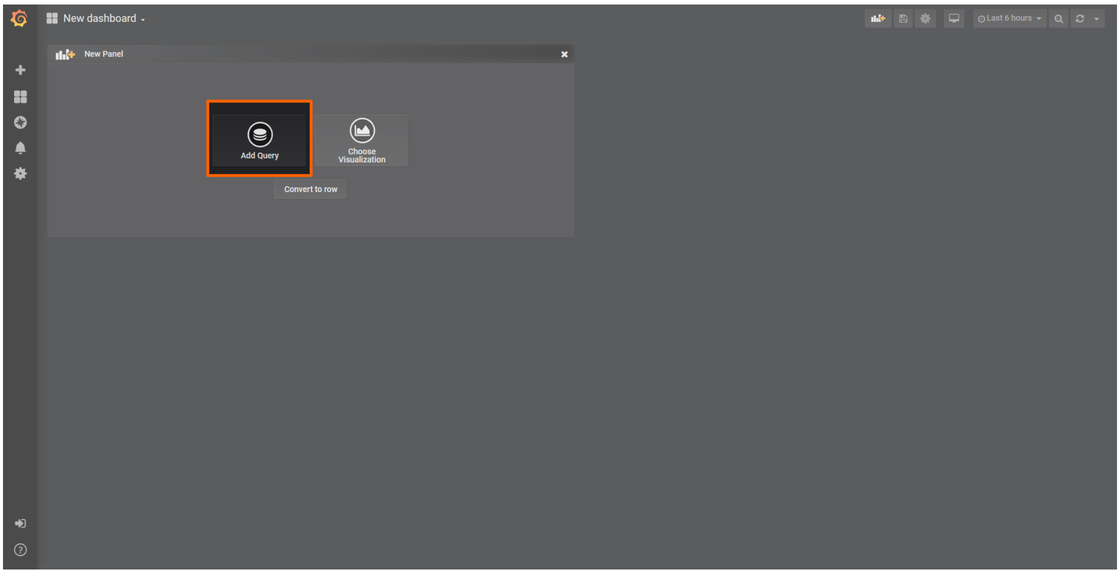
Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

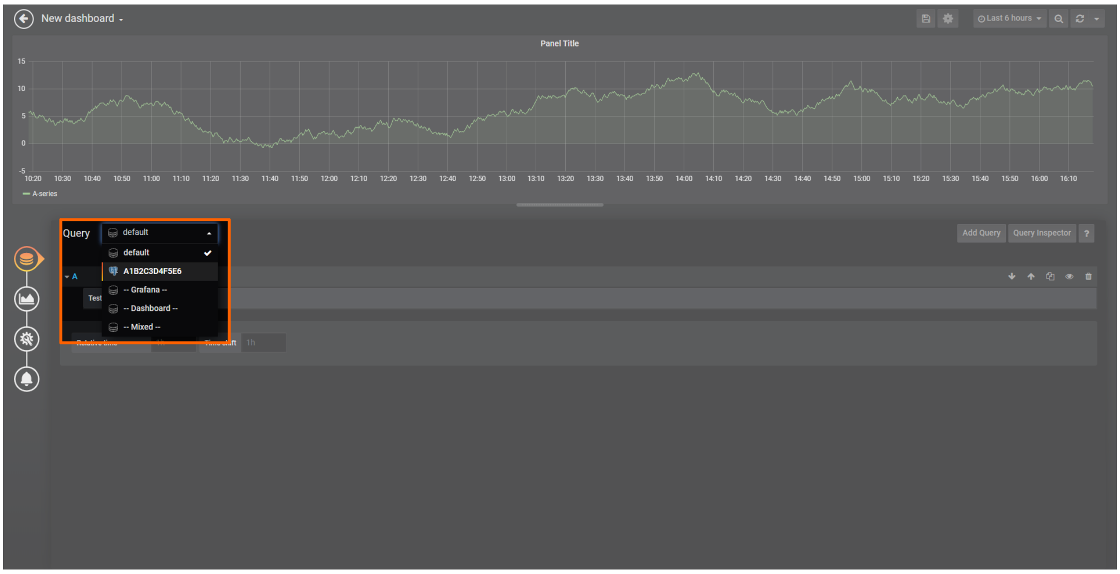
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF — Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



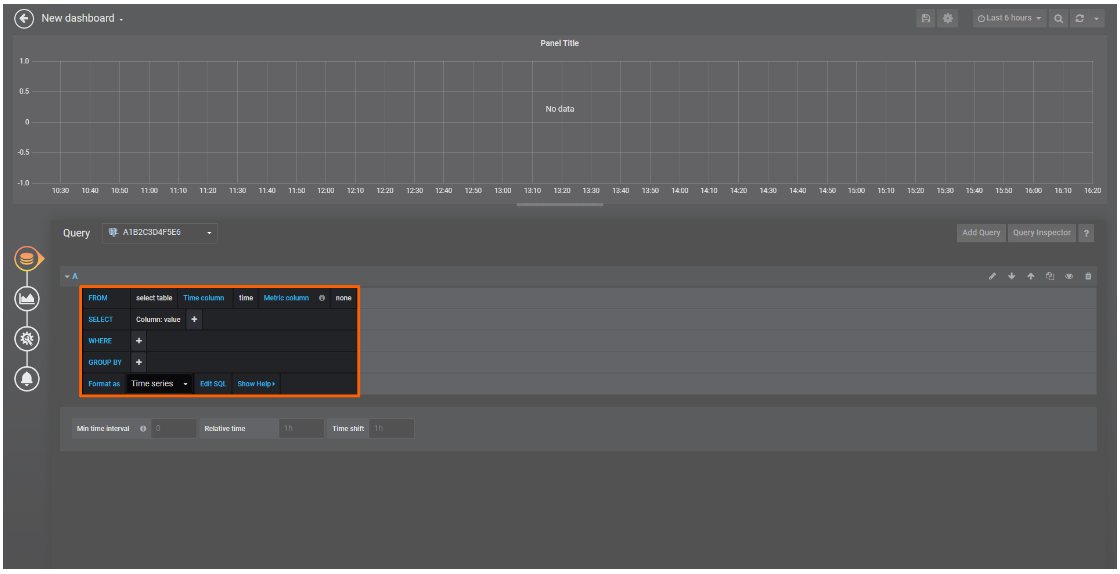
4. Select the data source from the drop-down menu. The name of the data source is the serial number of the node.



Query: default

- default ✓
- A1B2C3D4F5E6
- -- Grafana --
- -- Dashboard --
- -- Mixed --

5. Fill in the query information below that appears below. This information depends on the use case and the Gateway configuration.



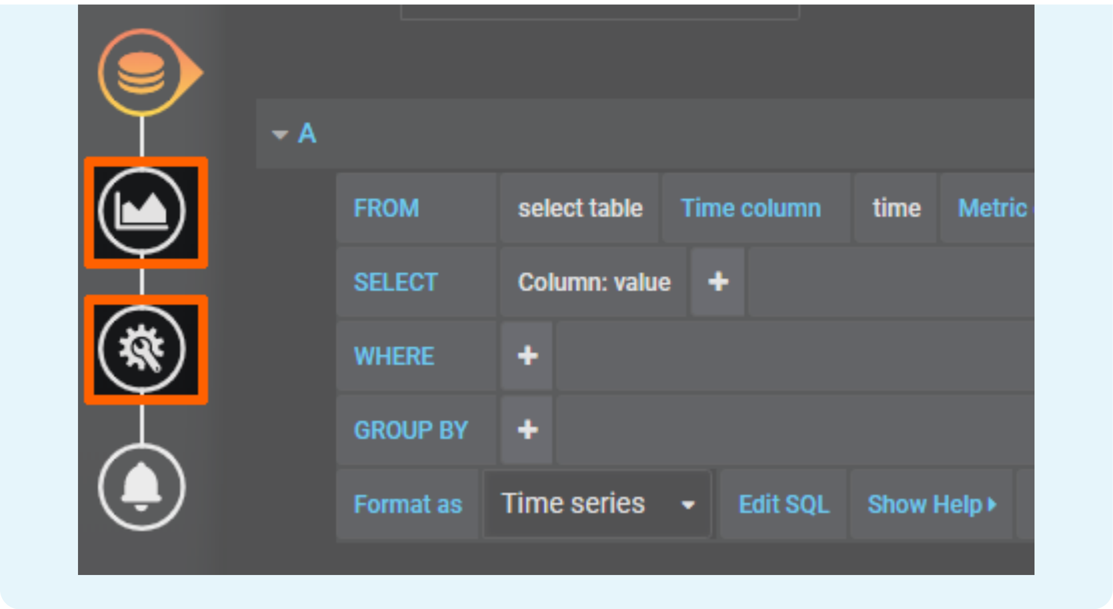
Query: A1B2C3D4F5E6

FROM: select table, Time column: time, Metric column: none
SELECT: Column: value +
WHERE +
GROUP BY +
Format as: Time series, Edit SQL, Show Help

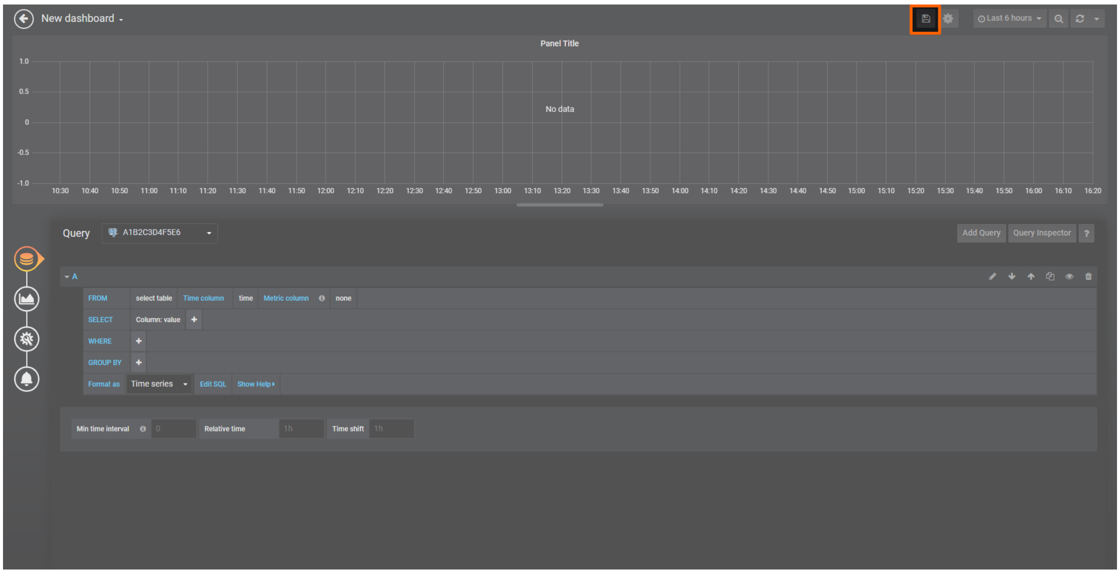
Min time interval: 0, Relative time: 1h, Time shift: 1h

NOTE

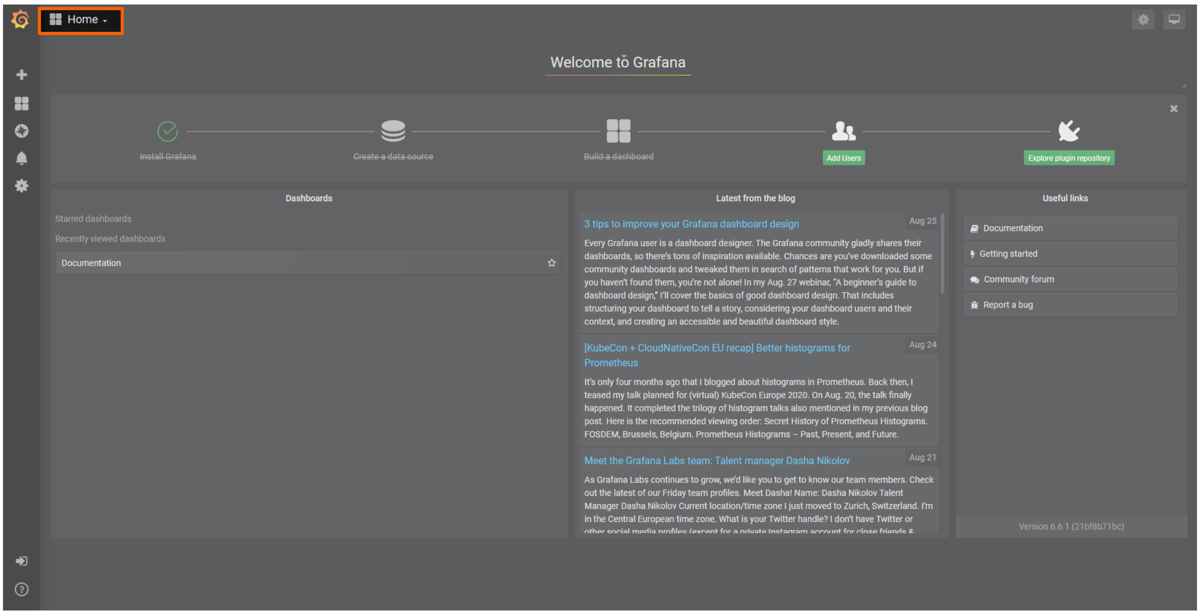
Customize general settings and visualization settings by selecting **General** and **Data** in the navigation on the left. Refer to the Grafana documentation for more information.



6. Select the save icon in the upper-right corner to save the dashboard.



Access the dashboard from the home menu.



3 tips to improve your Grafana dashboard design
Aug 25

Every Grafana user is a dashboard designer. The Grafana community gladly shares their dashboards, so there's tons of inspiration available. Chances are you've downloaded some community dashboards and tweaked them in search of patterns that work for you. But if you haven't found them, you're not alone! In my Aug. 27 webinar, "A beginner's guide to dashboard design," I'll cover the basics of good dashboard design. That includes structuring your dashboard to tell a story, considering your dashboard users and their context, and creating an accessible and beautiful dashboard style.

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For specific examples on how to use Grafana with Nerve Data Services, refer to Examples.

Setting a home dashboard

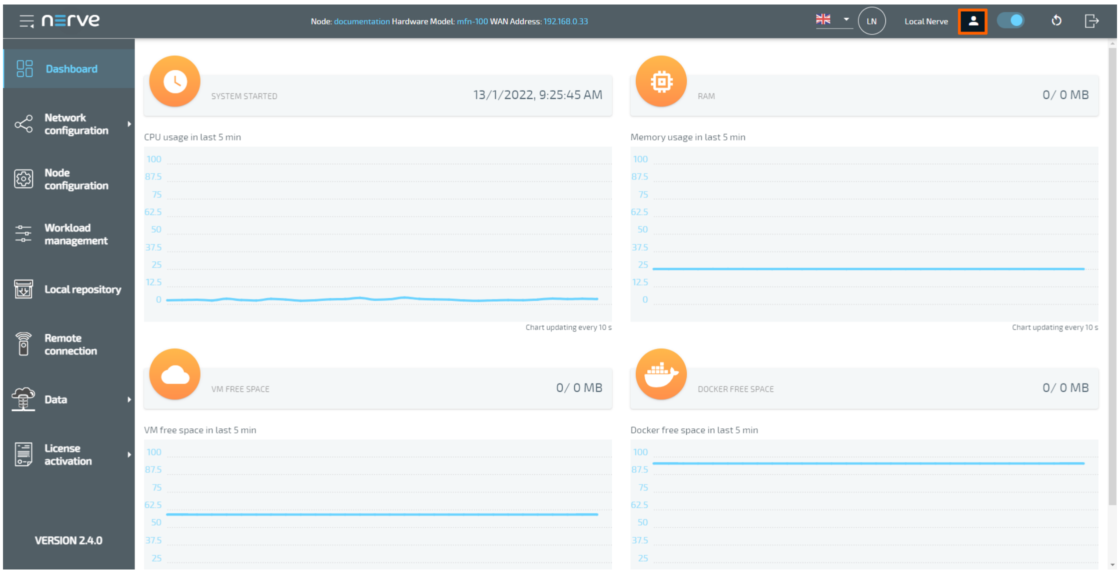
According to Grafana default behavior, the Grafana instance in the Nerve system displays the Grafana landing page when **Data** is selected in the navigation on the left. A dashboard can be set to be the landing page instead. This requires dashboards that have been created before. Also note that this setting is only available on the node for the local data visualization in the Local UI.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.

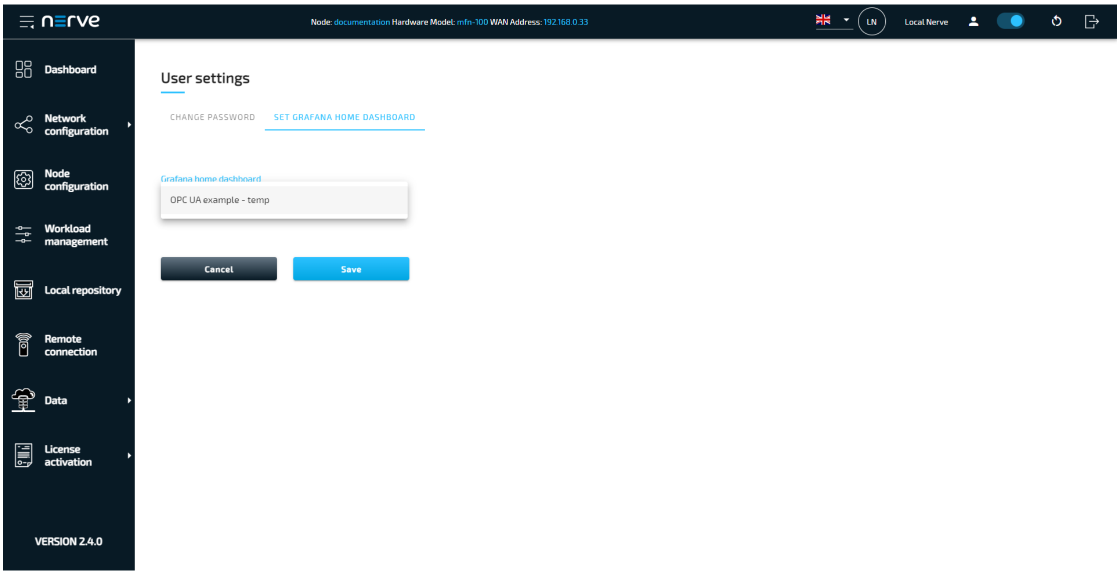
Nerve Device	Physical port	Local UI
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the **User settings** symbol in the upper-right.



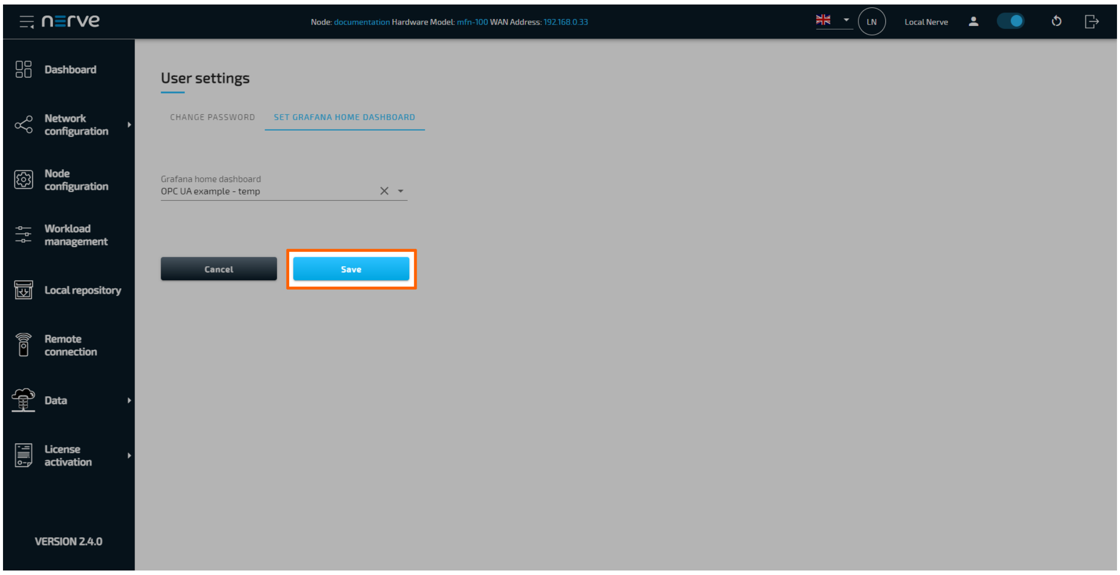
3. Select the **Set Grafana home dashboard** tab.

4. Select a dashboard from the **Grafana home dashboard** drop-down menu. All created dashboards will be shown in the list.



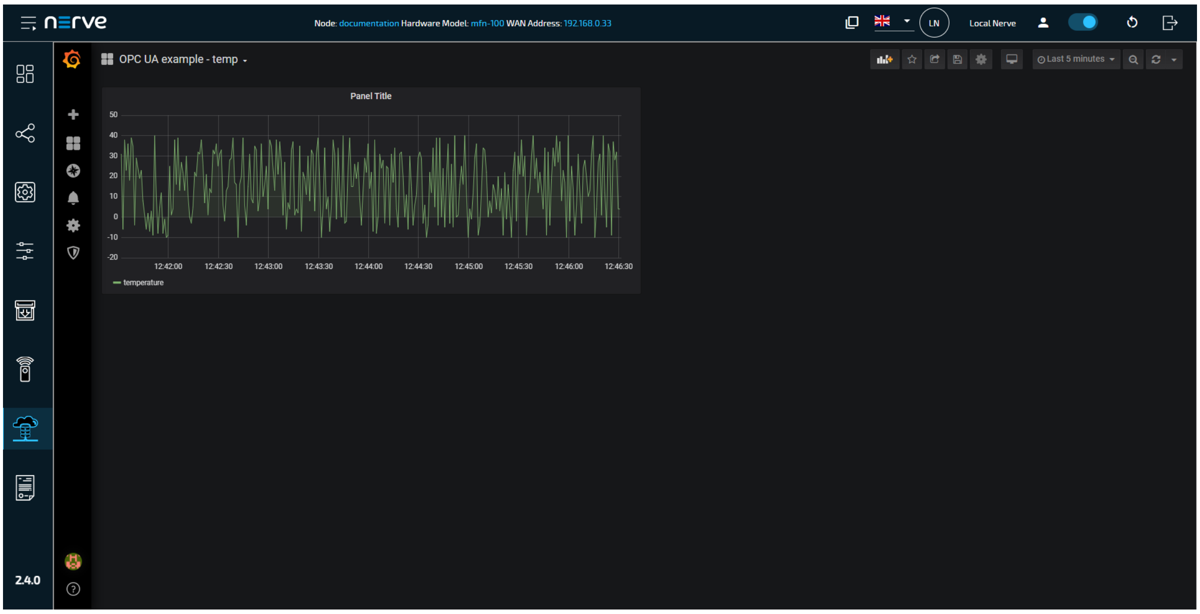
Grafana home dashboard
OPC UA example - temp

5. Select **Save**.



Grafana home dashboard
OPC UA example - temp

A green pop-up message will confirm the successful application of the Grafana home dashboard settings. Select **Data** in the navigation on the left to confirm that the landing page has been set to display the selected Grafana dashboard.



Detaching Grafana in kiosk mode

Grafana can be detached from the Local UI. This means that Grafana can be displayed and viewed without being subject to the timeout mechanism of the Local UI. Note that this setting is not available in the Management System.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
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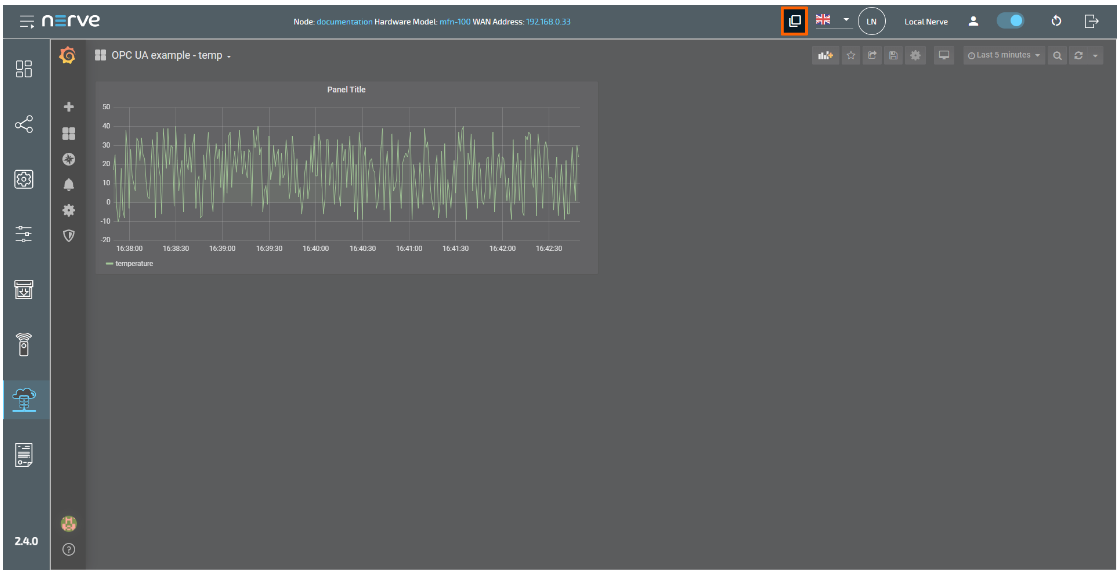
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select **Data** in the navigation on the left. A symbol will appear in the upper-right, next to the language selector.

3. Select the **Detach Grafana** symbol in the upper-right.


Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

A detached Grafana window will open in a new browser tab. Note that Grafana will be in admin mode when first detached. It will stay in admin mode as long as the Grafana window is not refreshed and a user is logged into the Local UI. If the active user is logged out of the Local UI and the Grafana browser tab is refreshed, Grafana will then be in viewer mode.

Accessing Grafana outside of the Local UI

Grafana can also be accessed without logging into the Local UI. Open a new browser tab and enter `http://<localui-ip>:3333/dp/visu/` to access Grafana outside of the Local UI. Note that Grafana will be in viewer mode when opening Grafana this way and will not be subjected to any session timeout. To have Grafana in admin mode, a user needs to be logged in to the Local UI and the Grafana browser tab needs to be refreshed.

As a reminder, take a look at the table below on how to access the Local UI according to the Nerve Device used:

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.

Nerve Device	Physical port	Local UI
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

Data analytics

The analytics element of the Nerve Data Services is primarily used for processing and analysis of data collected by the Gateway, and provides an easy way to collect and store that data. It consist of a Software Development Kit (SDK) and an Application Programming Interface (API) both written in Python. Analytics are supported on all operating systems based on Debian Buster (tested on Ubuntu 18.04 LTS and Ubuntu 20.04 LTS). The recommended Python version to use when writing analytics apps is 3.7 or later.

The release package contains:

- API documentation
- an installation script
- the installation script README file

- the SDK python wheel (containing the API python wheel)

The Nerve Data Services SDK can be downloaded from the Nerve Software Center.

Software Development Kit

> **NOTE**
>
> The Software Development Kit can only be used on Linux and requires `sudo`, `python` and `pip` for the installation.

The Data Services SDK is used to create, build, push and provision analytics apps as Docker images. These functions will be explained in detail in the following sections. The SDK is installed using the installation script. Navigate to the folder containing the installation script and execute the following command:

```
source ./nerve_dp_analytics_install.sh
```

Follow the instructions in the installation script. It will ask for confirmation before installing the following requirements:

- Docker
  - docker-ce
  - curl
  - apt-transport-https
  - ca-certificates
  - gnupg-agent
  - software-properties-common
- Miniconda

It will also add an official Docker GPG key to the system and the official Docker stable repository to apt repositories. The Conda environment `nerve-ds-analytics` will be created and activated upon installation of the Nerve Data Services SDK and API wheels, as well as all their dependencies.

> **NOTE**
>
> Before working with the SDK, make sure that the Conda environment is active. If the Conda environment is active it will be displayed in parentheses in front. Activate the Conda environment by entering the following command:
>
> ```
> source miniconda/bin/activate <environmentname>
> ```
>
> The Conda environment automatically deactivates after a restart.

Create command

The create command is used to initialize the environment for analytics app development.

Item	Description
Usage	`nerve-analytics create [-h] [-c [CLONE]] [-t {minimal,slim,standard,intel,custom}] app_name path`

Item	Description

Positional arguments	`app_name`
	The application name.
	
	`path`
	Path where to create the application.

Optional arguments	`-h` or `--help`
	Use this argument to show the help message in the command line.
	
	`-c [CLONE]` or `--clone [CLONE]`
	Clones base Nerve analytics environment into a new environment. If an environment name is not passed with the argument, the new environment name will be auto-generated.
	
	`-t {minimal,slim,standard,intel,custom}` or `--type {minimal,slim,standard,intel,custom}`
	Defines the project type to be created.

Using the create command will create a directory named after the app name. Inside, it will create a Dockerfile, a Python script, and add the analytics API wheel. If `type` is not provided, `standard` will be used.

Build command

The build command is used to build the analytics app Docker image.

Item	Description
Usage	`nerve-analytics build [-h] [-t TAG] [-p PATH]`

Optional arguments	`-h` or `--help`
	Use this argument to show the help message in the command line.
	
	`-t TAG` or `--tag TAG`
	Name of the Docker tag that will be used when tagging the Docker image.
	
	`-p PATH` or `--path PATH`
	Path to the application folder.

If `tag` is not provided, `latest` will be used. If `path` is not provided, the build command will look for a Dockerfile in the current directory.

Push command

The push command is used to push the previously built Docker image to a Docker registry.

Item	Description
Usage	`nerve-analytics push [-h] [-t TAG] [-r RE_TAG] [-n NEW_NAME] [-u USERNAME] [-e EMAIL] [-p PASSWORD] reg_path`
Positional arguments	`reg_path` Path of the Docker registry.

Item	Description
Optional arguments	-h or --help Use this argument to show the help message in the command line. -t TAG or --tag TAG Tag name of the Docker image to be pushed. -r RE_TAG or --re-tag RE_TAG Define tag name of the Docker image in the registry. -n NEW_NAME or --name NEW_NAME New name of the repository. -u USERNAME or --username USERNAME Username which is used to log in into registry. -e EMAIL or --email EMAILEmail which is used to log in into the registry. -p PASSWORD or --password PASSWORD Password which is used to log in into the registry.

If tag is not provided, latest will be used. If password is not provided, a prompt to enter it will be displayed to the user.

Provision command

The provision command is used to upload the previously built Docker image as a Docker workload to a Nerve Management System. The Docker image is also archived as a TAR.GZ file.

Item	Description

Usage	`nerve-analytics provision [-h] [-f CFG_FILE] -u URL -vn VERSION_NAME -rn RELEASE_NAME [-usr USERNAME] [-pas PASSWORD] [-n NAME] [-i IMAGE] [-d DEPLOYED_CONTAINER_NAME] [-net NETWORKS] [-desc DESCRIPTION] [-p PORT] [-e ENV] [-m MEM_LIMIT] [-cl CPU_LIMIT] [-r {no,on-failure,always,unless-stopped}] [-rel] [--verbose]`
	Arguments that start with `--` (eg. `--url`) can also be set in a config file (specified via `-f <filepath>`). The config file syntax accepts the following separated by line breaks:
	• key=value
	• flag=true
	• stuff={a,b,c}
	Example:
	`name=test-workload`
	`verbose=true`
	`restart={on-failure}`
	For details on the syntax refer to https://pypi.org/project/ConfigArgParse/. If an argument is specified in more than one place, then the command line values override the config file values which override the defaults.

Optional arguments	`-h` or `--help`
	Use this argument to show the help message in the command line.
	
	`-f CFG_FILE` or `--cfg-file CFG_FILE`
	Configuration file for the provision command.
	
	`-u URL` or `--url URL`
	URL of the Nerve Management System to which the workload will be uploaded. This flag is mandatory.
	
	`-vn VERSION_NAME` or `--version-name VERSION_NAME`
	Version name of the Docker workload. This flag is mandatory.
	
	`-rn RELEASE_NAME` or `--release-name RELEASE_NAME`
	Release name of the Docker workload. This flag is mandatory.
	
	`-usr USERNAME` or `--username USERNAME`
	Username which is used to log in to the Nerve Management System.
	
	`-pas PASSWORD` or `--password PASSWORD`
	Password which is used to log in to the Nerve Management System.
	
	`-n NAME` or `--name NAME`
	Name of the Docker workload which will be uploaded to the Nerve Management System.
	
	`-i IMAGE` or `--image IMAGE`
	This is the of the Docker image that has been created with the create and build commands and will be provisioned to the Nerve Management System.
	
	`-d DEPLOYED_CONTAINER_NAME` or `--deployed-container-name DEPLOYED_CONTAINER_NAME`
	Name of the Docker container upon deployment to a node.
	
	`-net NETWORKS` or `--networks NETWORKS`
	Docker network names. This is set to `nerve-ds` by default if not specified.
	
	`-desc DESCRIPTION` or `--description DESCRIPTION`
	Description for the Docker workload to be uploaded.
	
	`-p PORT` or `--port PORT`
	Port mapping for the container to be deployed, for example `5432:5432` or `123:234/udp`.
	
	`-e ENV` or `--env ENV`
	Environment variables for the container to be deployed, for example `VAR1=myval`.
	
	`-m MEM_LIMIT` or `--mem-limit MEM_LIMIT`
	Memory limit in MB for the workload on the node.
	
	`-cl CPU_LIMIT` or `--cpu-limit CPU_LIMIT`
	Max number of CPUs to be used by the workload on the node. 1 by default.
	
	`-r {no,on-failure,always,unless-stopped}` or `--restart {no,on-failure,always,unless-stopped}`
	Restart policy for the container to be deployed on the node.
	
	`-rel` or `--released`
	This sets the workload version to released. Released versions cannot be updated.

The user that is used to provision the analytics app must already exist in the Management System. All parameters used when uploading a workload from the Management System can also be specified in the provision command.

If `password` is not provided, a prompt to enter the password will be displayed. If a workload with the same name already exists in the Management System, it must be a Docker workload in order to add a new version to it. Otherwise, the provisioning cannot be done. When adding a new version to an existing Docker workload in the Management System, `version` must be different than that of the existing version.

Application Programming Interface

The Analytics API is used for writing Python applications that collect and store data from and to other elements of the Data Services. The recommended Python version to use when writing analytics apps is 3.7 or later. The Analytics API provides the following modules:

Module	Description
Batch Input TimescaleDB	Used to fetch data from a TimescaleDB database.
Batch Output TimescaleDB	Used to store data in a TimescaleDB database.
Stream Input ZeroMQ	ZeroMQ Subscriber used to collect data from a ZeroMQ Publisher. Can work in both asynchronous and synchronous modes. **NOTE** In order to connect the ZeroMQ Publisher output of the Gateway and the Stream Input ZeroMQ of the analytics, the IP address `172.20.10.1` must be used. This is the case only if the analytics container is running inside the Docker network `nerve-ds`. If the Docker network is `host`, `localhost` can be used.
Stream Output MQTT	MQTT Publisher used to send data to a MQTT broker.

More in depth documentation regarding the API modules can be found in the release package of the analytics element that has been downloaded from the Nerve Software Center.

Examples

Gateway configuration examples

This chapter covers use cases for the supported protocols of the Nerve Data Services, showcasing the usage of each Data Services element in the process. This section is subject to change and further examples will be added in the near future. Currently available examples are:

- OPC UA Server to cloud
- OPC UA Server security
- S7 Client to cloud
- MQTT Publisher to OPC UA Server at the node

- Receiving data via MQTT for Analytics and Visualization
- Custom JSON format example
- Sending data to MS Azure Iot Hub
- Modbus server data to InfluxDB for visualization
- NerveDB with data buffering

OPC UA Server to cloud for visualization

In this example, a sensor is providing temperature and humidity data as an OPC UA Server. Temperature data is displayed at the node while humidity data is presented at the Management System. Data is visualized with the visualization element of the Data Services.

The instructions below cover the following steps:

- Provisioning an OPC UA Server demo sensor as a Docker workload
- Deploying the provisioned Docker workload to the target node
- Configuring the Data Services Gateway
- Local data visualization at the node
- Central data visualization in the Management System

Provisioning and deploying an OPC UA Server at the node

First, the temperature sensor simulation OPC UA Server must be deployed to the node as a Docker workload. Download the **Data Services OPC UA demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload by following Provisioning a Docker workload. This example uses **TTTech OPC UA Server - demoSensor** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
DOCKER SPECIFIC INFO	Select **New port** and enter the following settings: ◦ **Protocol**: TCP ◦ **Host Port**: 4848 ◦ **Container Port**: 4848
Container name	`tttech-opcua-server-demosensor`
Network name	`bridge`

3. Deploy the provisioned Docker workload by following Deploying a workload.

Configuring the Data Services Gateway

The configuration defines the OPC UA Server demo sensor that was deployed above as a data input. The local NerveDB storage and the cloud NerveDB storage are defined as data outputs. An OPC UA Client connects to the OPC UA Server demo sensor and periodically reads the value of temperature and humidity. Temperature values are forwarded to the storage on the node and humidity values are sent to the Management System.

The configuration can be applied with the graphical configuration tool or by importing a pre-written JSON configuration file. In this example, a pre-written JSON configuration is used to configure the Gateway for the sake of simplicity.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

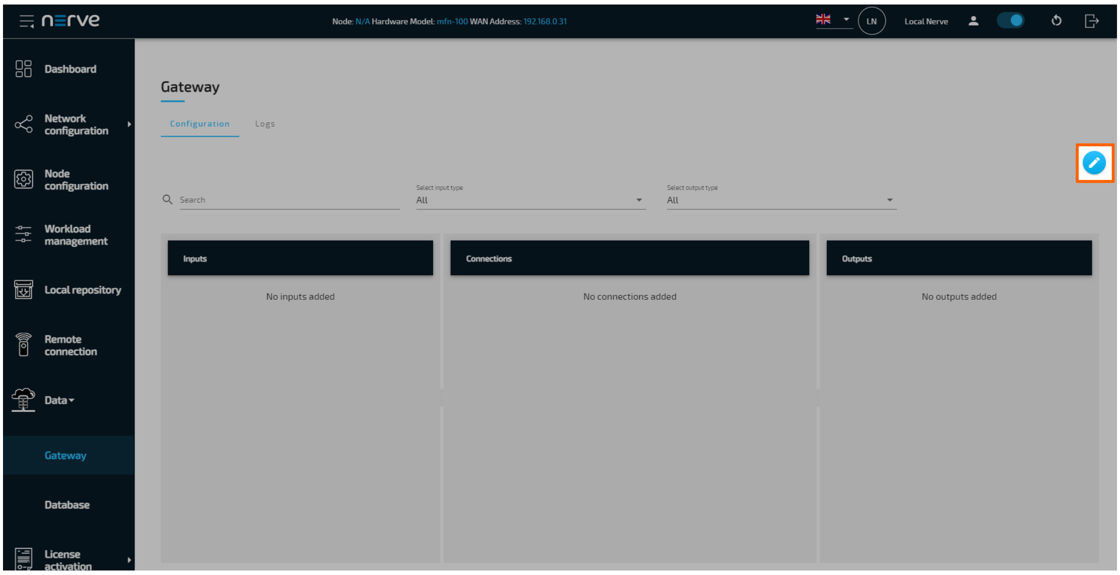
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

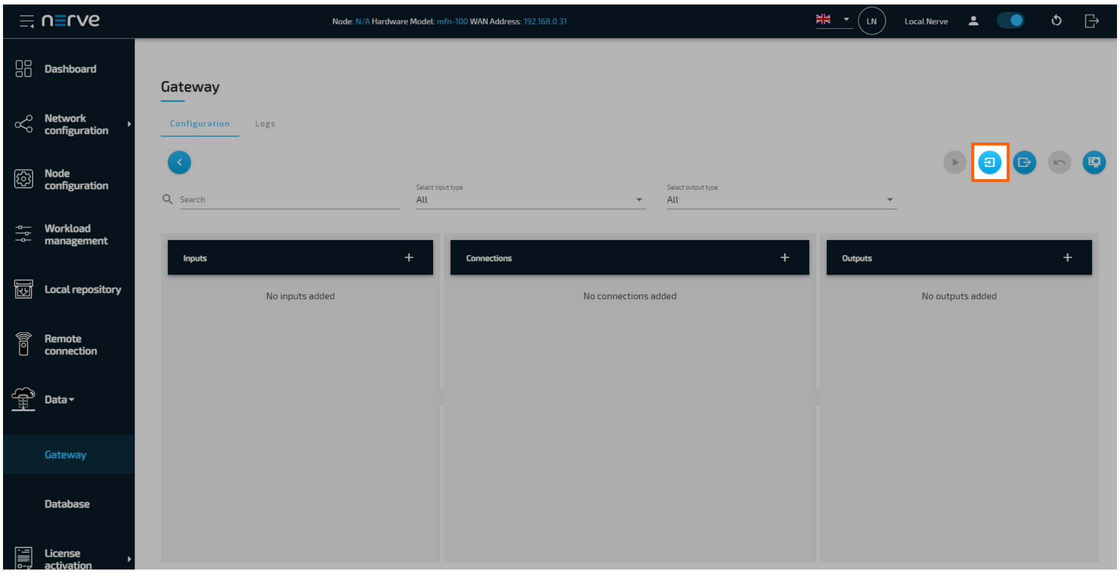
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

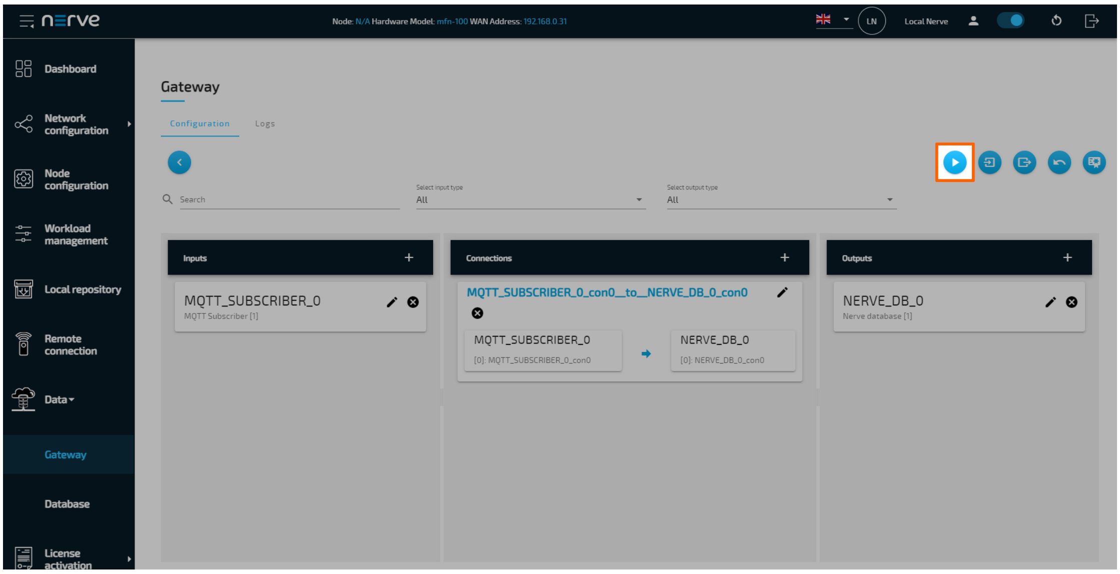
```
{
  "inputs": [
    {
      "name": "client_demo_sensor",
      "type": "OPC_UA_CLIENT",
      "serverUrl": "opc.tcp://localhost:4848",
      "pollingInterval_ms": 1000,
      "connectors": [
        {
          "name": "poll",
          "accessType": "polling",
          "nodes": [
            "ns=2;i=2"
          ]
        },
        {
          "name": "subs",
          "accessType": "subscription",
          "publishingIntervalAtServer_ms": 1000,
          "samplingIntervalAtServer_ms": 1000,
          "nodes": [
            "ns=2;i=4"
          ]
        }
      ]
    }
  ],
  "outputs": [
    {
      "type": "NERVE_DB",
      "location": "LOCAL",
      "connectors": [
        {
          "name": "default connector",
          "tableName": "default"
        }
      ]
    },
    {
      "type": "NERVE_DB",
      "location": "CENTRAL",
      "connectors": [
        {
          "tableName": "ms_mqtt_broker_to_cloud_timescale_db"
        }
      ]
    }
  ],
  "connections": [
    {
      "name": "demo_sensor_to_local_db",
      "input": {
        "index": 0,
        "connector": 0
      },
      "output": {
        "index": 0,
        "connector": 0
      }
    },
    {
      "input": {
        "index": 0,
        "connector": 1
      },
      "name": "demo_sensor_to_mgmtsys",
      "output": {
        "index": 1,
        "connector": 0
      }
    }
  ]
}
```

6. Select the **Import** button.



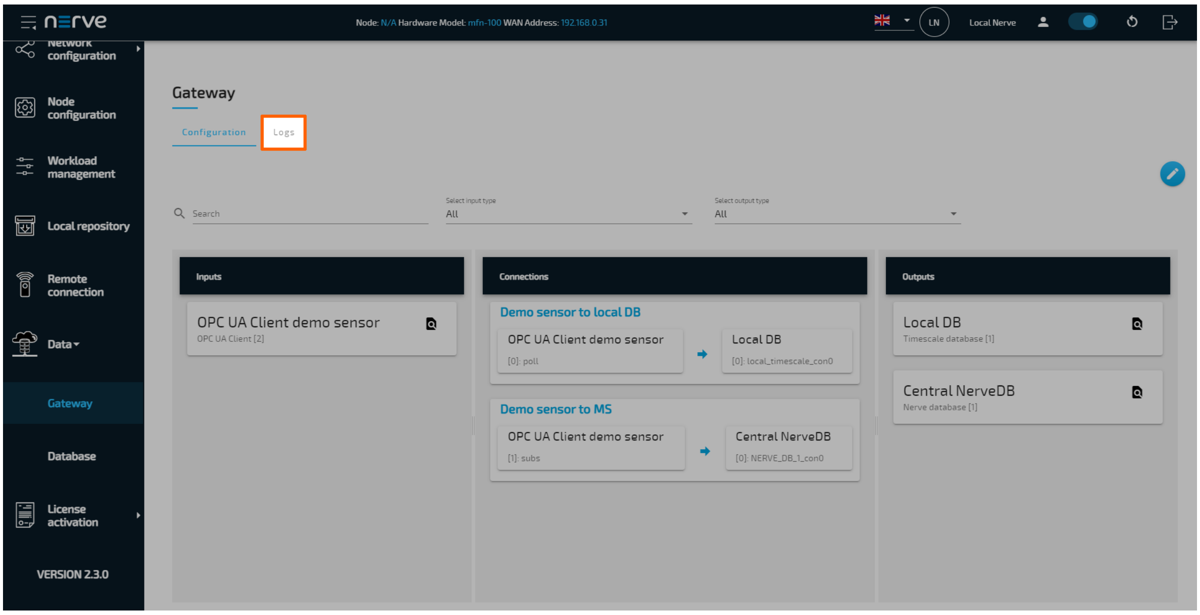
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



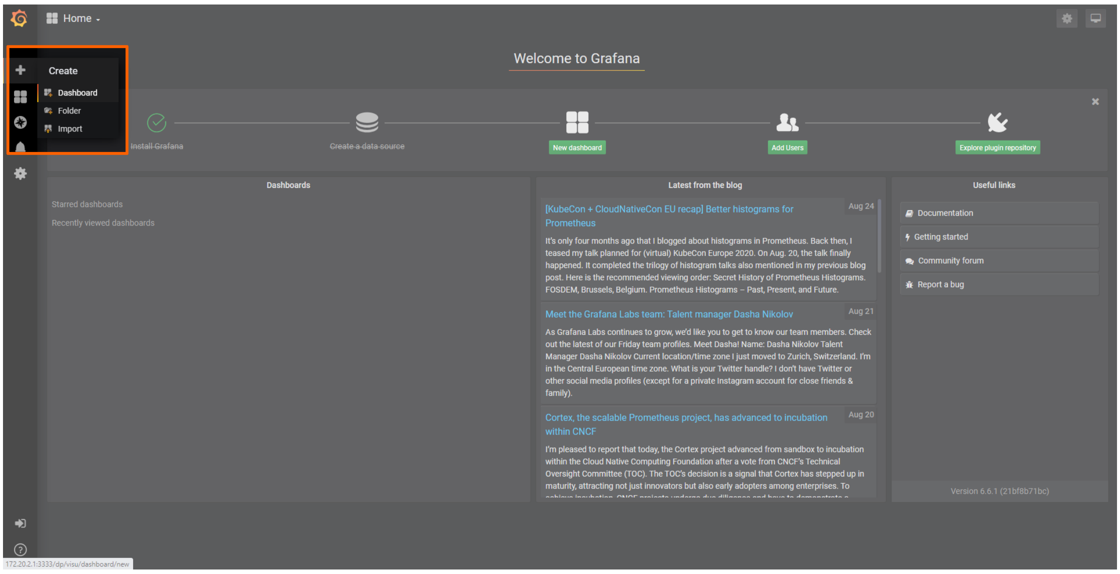
Local data visualization at the node

To visualize temperature data at the node, open the local data visualization element through the Data Services UI on the node.

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus
Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

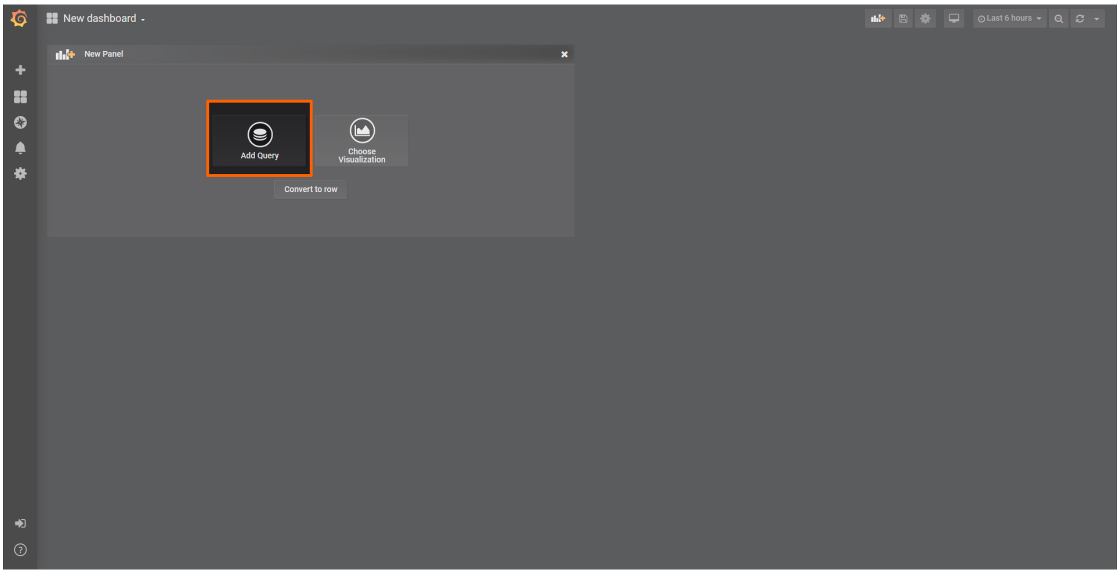
Meet the Grafana Labs team: Talent manager Dasha Nikolov
Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

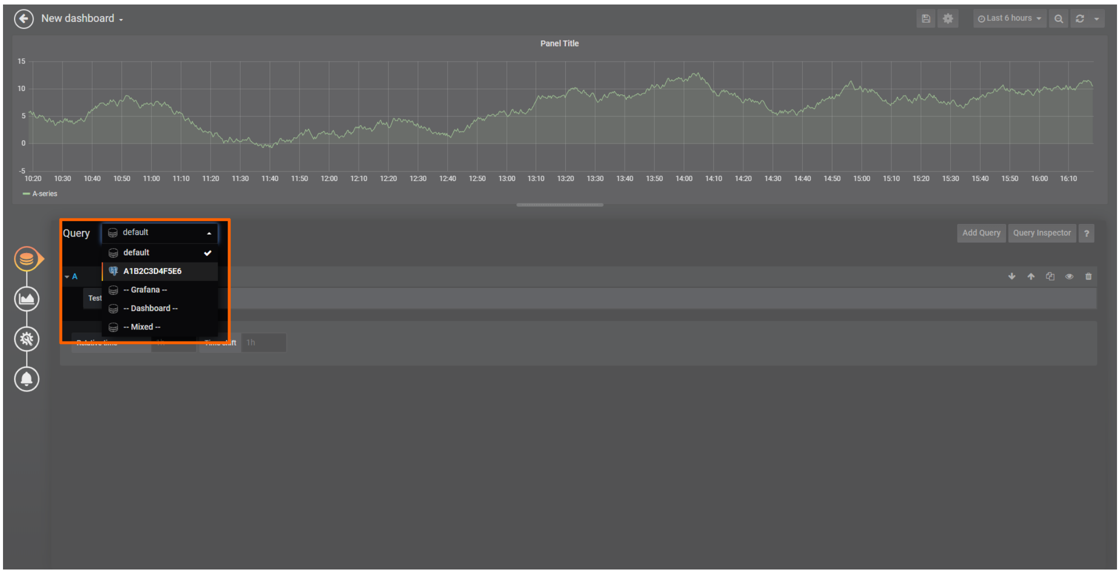
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF
Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



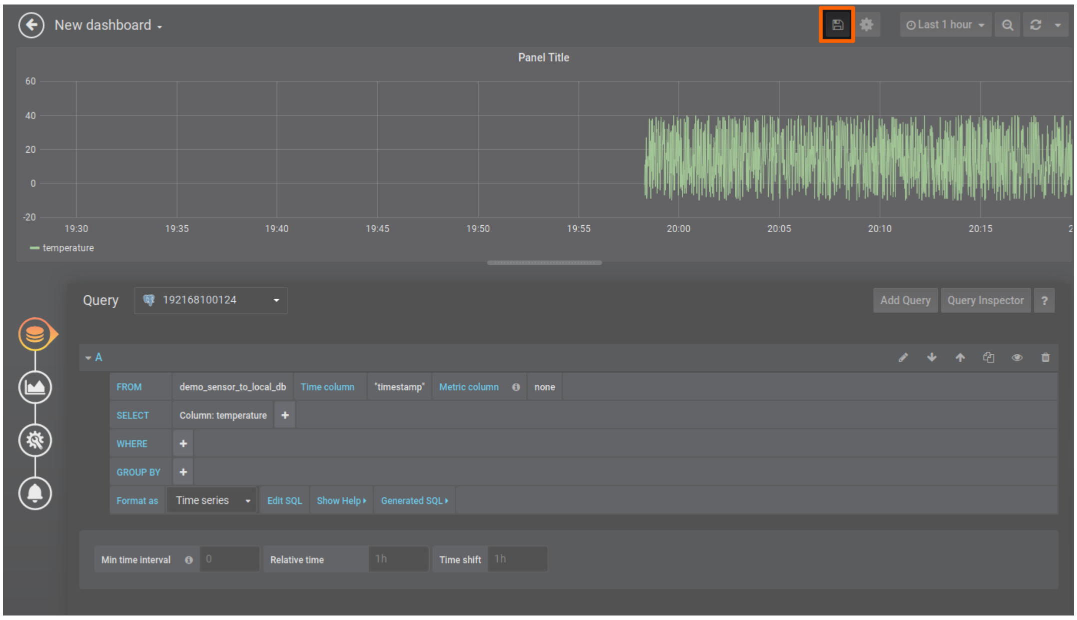
4. Select the data source from the drop-down menu. The name of the data source is the serial number of the node.



5. Fill in the following query information:

Setting	Value
FROM	`demo_sensor_to_local_db` **Time column**: "timestamp"
SELECT	Column: temperature
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.



Query: 192168100124

FROM demo_sensor_to_local_db Time column "timestamp" Metric column none

SELECT Column: temperature

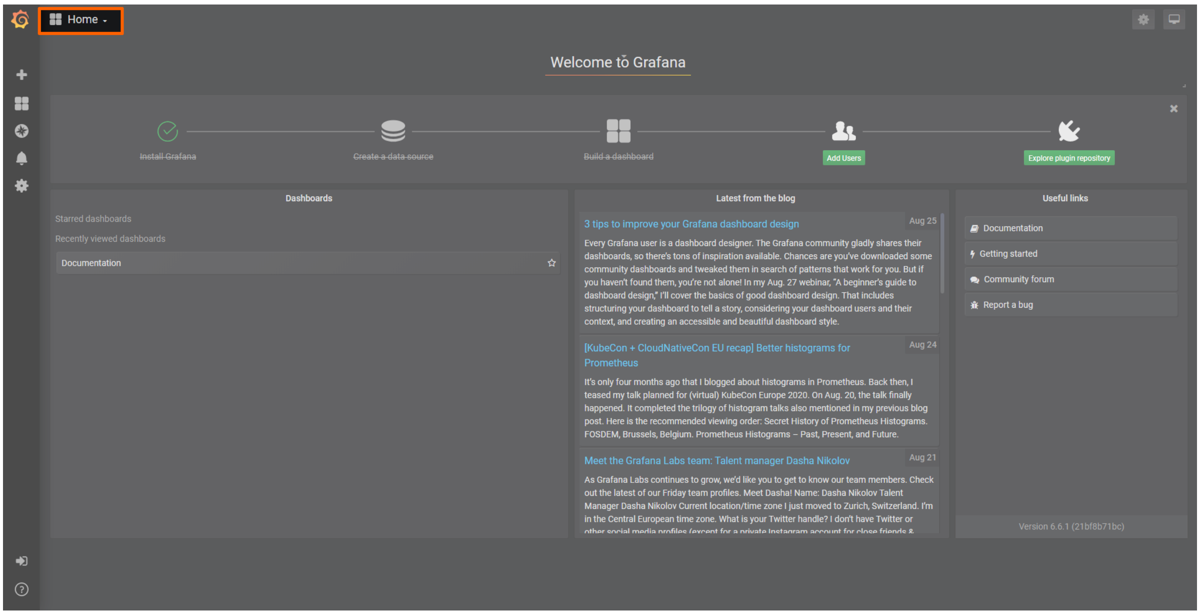
WHERE

GROUP BY

Format as Time series | Edit SQL | Show Help | Generated SQL

Min time interval 0 | Relative time 1h | Time shift 1h

The dashboard can be accessed from the Grafana home menu.



3 tips to improve your Grafana dashboard design — Aug 25

Every Grafana user is a dashboard designer. The Grafana community gladly shares their dashboards, so there's tons of inspiration available. Chances are you've downloaded some community dashboards and tweaked them in search of patterns that work for you. But if you haven't found them, you're not alone! In my Aug. 27 webinar, "A beginner's guide to dashboard design," I'll cover the basics of good dashboard design. That includes structuring your dashboard to tell a story, considering your dashboard users and their context, and creating an accessible and beautiful dashboard style.

[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends &

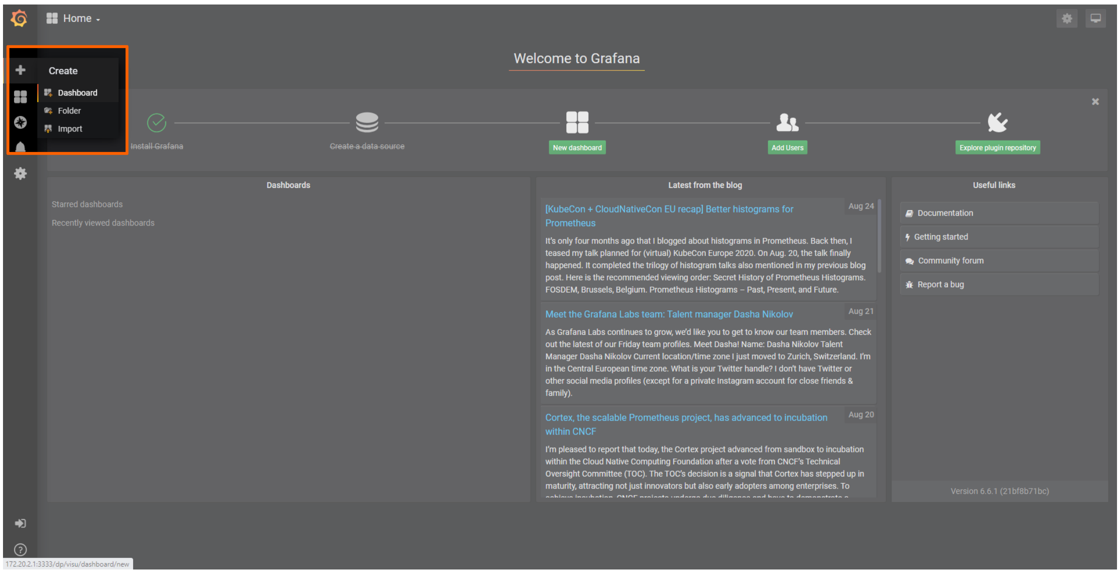
Central data visualization in the Management System

To visualize humidity data in the Management System, open the central visualization element through the Data Services UI in the Management System.

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

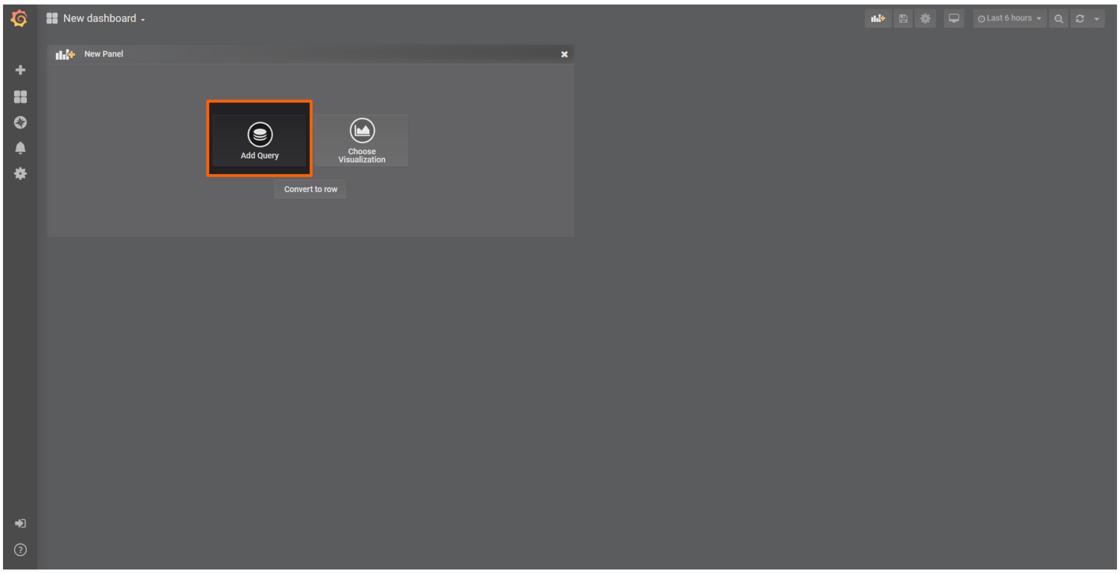
Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

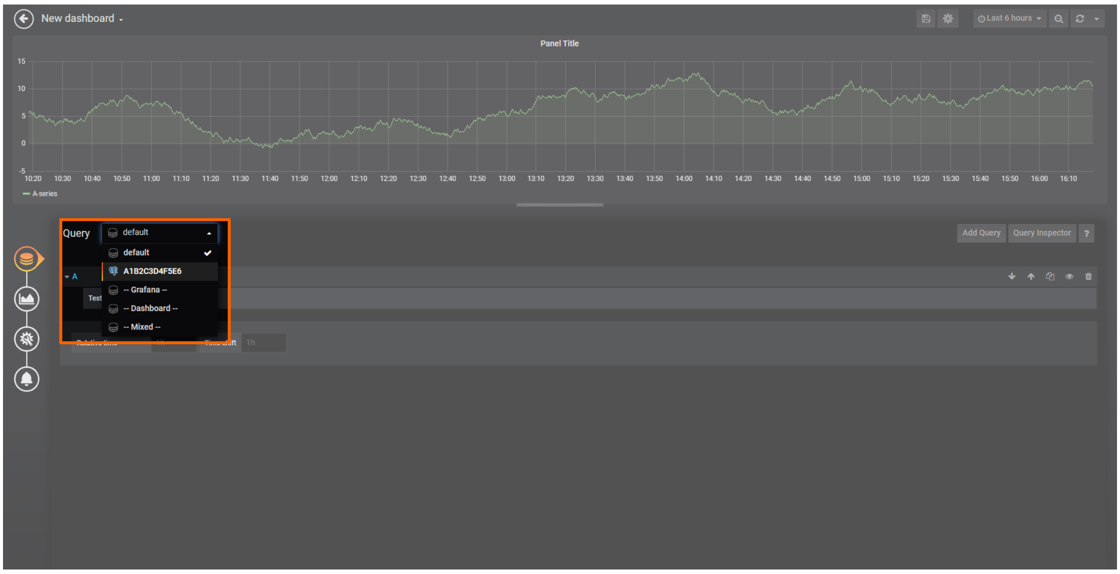
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF — Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



4. Select the data source from the drop-down menu. The name of the data source is the name and serial number of the node, formatted as <nodename> (<serialnumber>).



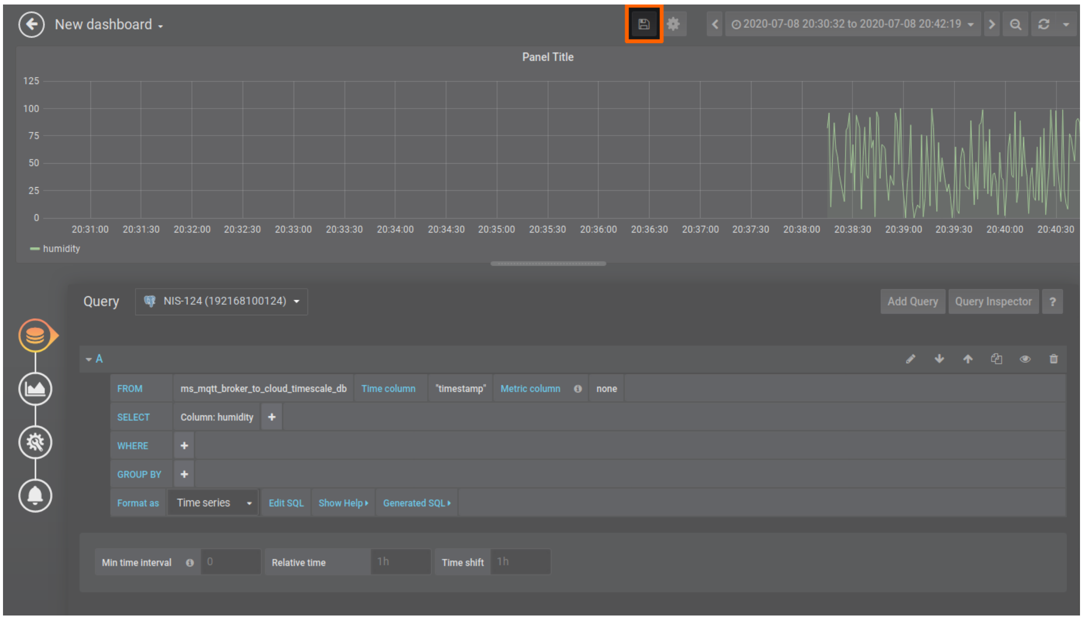
NOTE

Note that multiple data sources can be selected in the Grafana instance of the Management System, depending on the number of nodes that are registered. Make sure to remember the serial number of the node that was used for workload deployment before.

5. Fill in the following query information:

Setting	Value
FROM	`ms_mqtt_broker_to_cloud_timescale_db` **Time column**: "timestamp"
SELECT	Column: humidity
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.



Query: NIS-124 (192168100124)

FROM ms_mqtt_broker_to_cloud_timescale_db Time column "timestamp" Metric column none

SELECT Column: humidity

WHERE

GROUP BY

Format as Time series

Min time interval 0 Relative time 1h Time shift 1h

OPC UA Server security

The OPC UA Server security example demonstrates an OPC UA Server configuration with:

- all available security end-points configured (security mode and security policy), including unsecured end-points
- two users added (logins)
- certificates added for security connection
- application URI set
- the certificate of an external OPC UA client added to the trust list.

To try this example, an OPC UA Server and an OPC UA client are needed. This example uses UaExpert. The OPC UA Server temperature sensor simulation is deployed in form of a Docker workload next.

Provisioning and deploying an OPC UA Server at the node

First, the temperature sensor simulation OPC UA Server must be deployed to the node as a Docker workload. Download the **Data Services OPC UA demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload by following Provisioning a Docker workload. This example uses **TTTech OPC UA Server - demoSensor** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.

Setting	Value
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
DOCKER SPECIFIC INFO	Select **New port** and enter the following settings: ◦ **Protocol**: TCP ◦ **Host Port**: 4848 ◦ **Container Port**: 4848
Container name	`tttech-opcua-server-demosensor`
Network name	`bridge`

3. Deploy the provisioned Docker workload by following Deploying a workload.

Obtaining certificates

Once the OPC UA demo sensor is deployed, the certificate files have to be obtained and imported to the node. In this example, a script to generate a self-signed certificate key pair is used. The script can be downloaded under **Example Applications** from the Nerve Software Center. It uses the OpenSSL library in order to make the generation of the certificate more convenient. If preferred, other tools or certificates can be used. Consult the IT administrator before continuing.

The script can be used the following way. Note that Python version 3.7.0 or higher is required to run the script:

Item	Description
Usage	`create_ss_certificate.py [-h] [-k KeySize] [-a NetworkAddresses] [-d Duration] ApplicationURI CertificateName [OutputPath]`

Arguments	`-k`
	Key length, defaults to 2048
	
	`-a`
	Network addresses in comma separated list, defaults to empty list
	
	`-d`
	Number of days to certify the certificate for, defaults to 30
	
	`ApplicationURI`
	Enter the Application URI, mandatory argument
	
	`CertificateName`
	Enter the name of the generated files, mandatory argument.
	
	`OutputPath`
	Destination where certificate and private key files are placed after generation, defaults to current working directory

Enter the following command to generate a self-signed certificate and private key pair:

```
python create_ss_certificate.py -a 172.20.2.1 urn:gateway.server server <outputpath>
```

NOTE

- Note that a hostname can be used when creating a certificate. However, an entry in `/etc/hosts` must be created on the Linux machine so that the hostname can be resolved. The OPC UA Server output of the Gateway must be accessed with the hostname that was given when creating the self-signed certificate.
- Note that `172.20.2.1` applies to Nerve Devices that have a physical mgmt port like the MFN 100. If the used device does not have a mgmt port, refer to the device guide page of the device to find out which IP address to use.

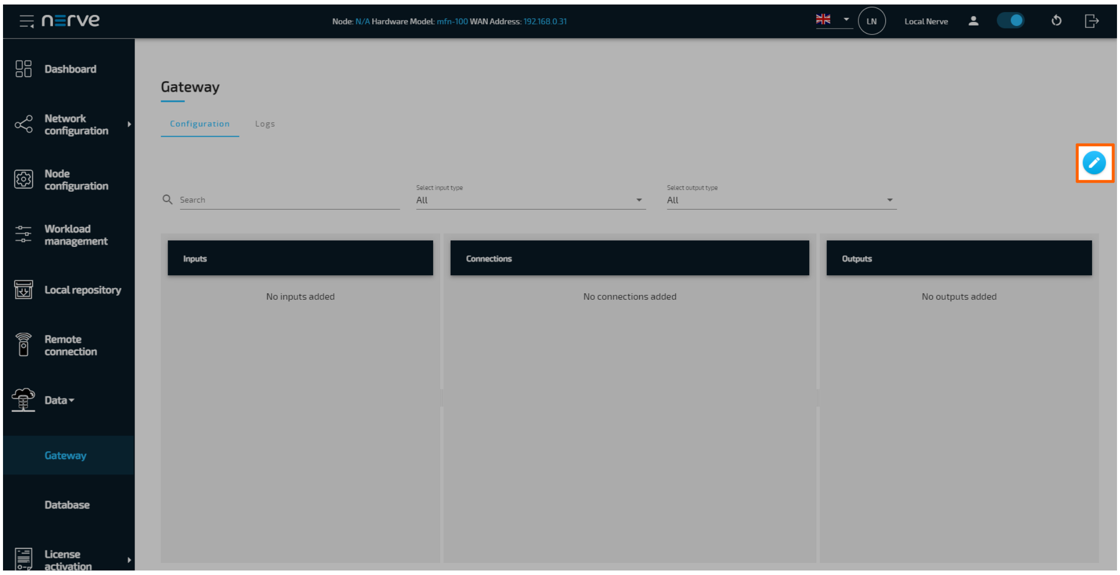
To obtain the certificate from UaExpert, start UaExpert and go to **Settings > Manage certificates**. There a list of current certificates and their location is displayed. The standard location of the `uaexpert.der` certificate is `.../unifiedautomation/uaexpert/PKI/own/certs/uaexpert.der`.

Importing certificates

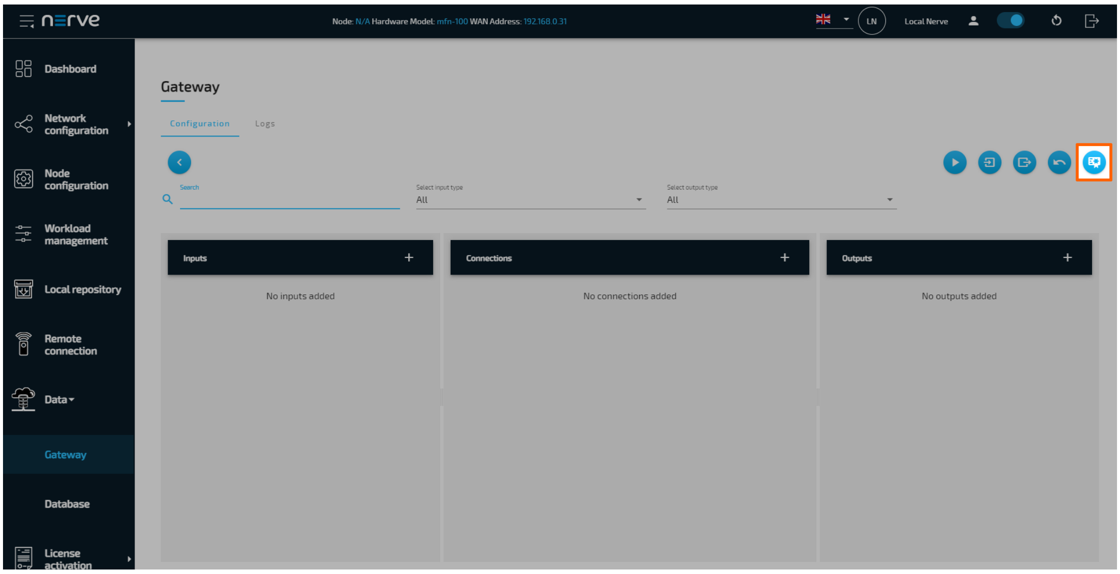
Importing certificates is done using the graphical configuration tool on the node. The instructions below show the import of the UaExpert certificate as well as the self-signed certificate and key. Note that the certificates have to be in the DER format. If other certificates are used, convert certificates first before importing. OpenSSL can be used for converting certificates. Also, note that this example uses the UaExpert client. Any OPC UA Client can be used. Import the corresponding certificate of the used OPC UA Client in DER format instead.

1. Log in to the Local UI.
2. Select the arrow next to **Data** to expand the sub menu.
3. Select **Gateway**.

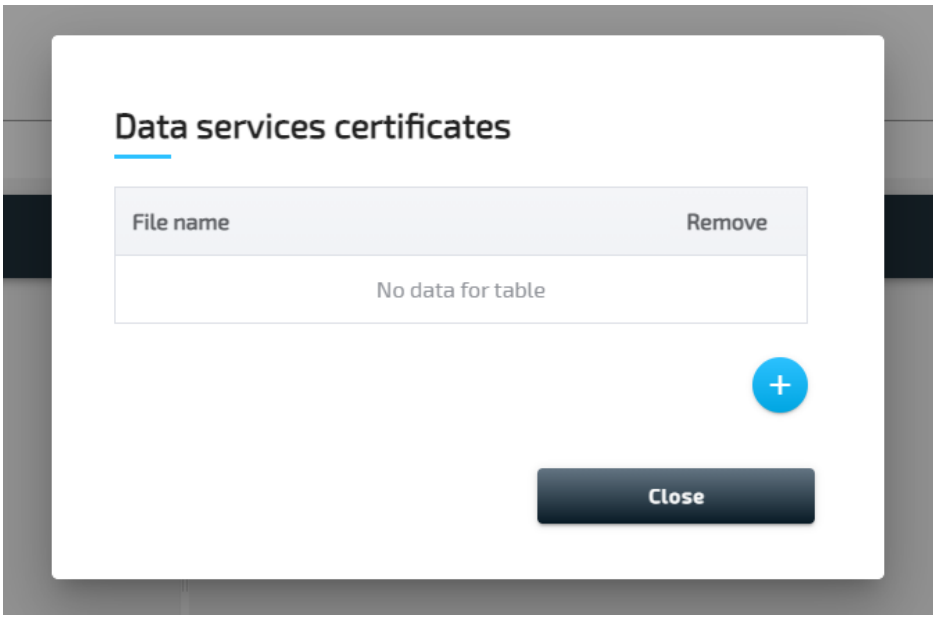
4. Select the **Edit configuration** symbol on the right to enter editing mode.



5. Select the **Import certificates** symbol.



6. Select the plus symbol in the overlay that appeared.

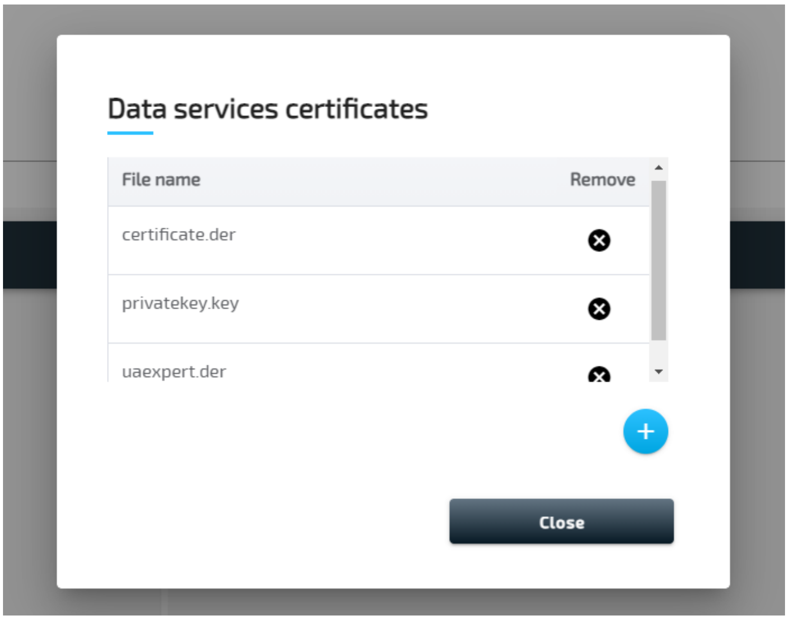


Data services certificates

File name	Remove
No data for table	

7. Add the UaExpert certificate as well as the self-signed certificate and key.

8. Select **Close**



Data services certificates

File name	Remove
certificate.der	⊗
privatekey.key	⊗
uaexpert.der	⊗

Configuring the Data Services Gateway

Through the JSON configuration below, the OPC UA Client connects to the OPC UA Server demo sensor and periodically reads the values of `temperature` and `humidity`. That data is published as an OPC UA Server output. In the OPC UA Server output configuration example, the following security settings are used:

- Two username/password entities are added for logging in to the server.
- `securityMode` and `securityPolicy` settings are both set to `all` to create security endpoints for all available combinations.
- Certificate and private key file names are set according to the files that were imported to the node earlier.
- `applicationUri` is set in the description section. It must comply with the application URI set in the certificate.
- The UaExpert client certificate is added to the trust list.

Follow the instructions below to apply the Gateway configuration.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

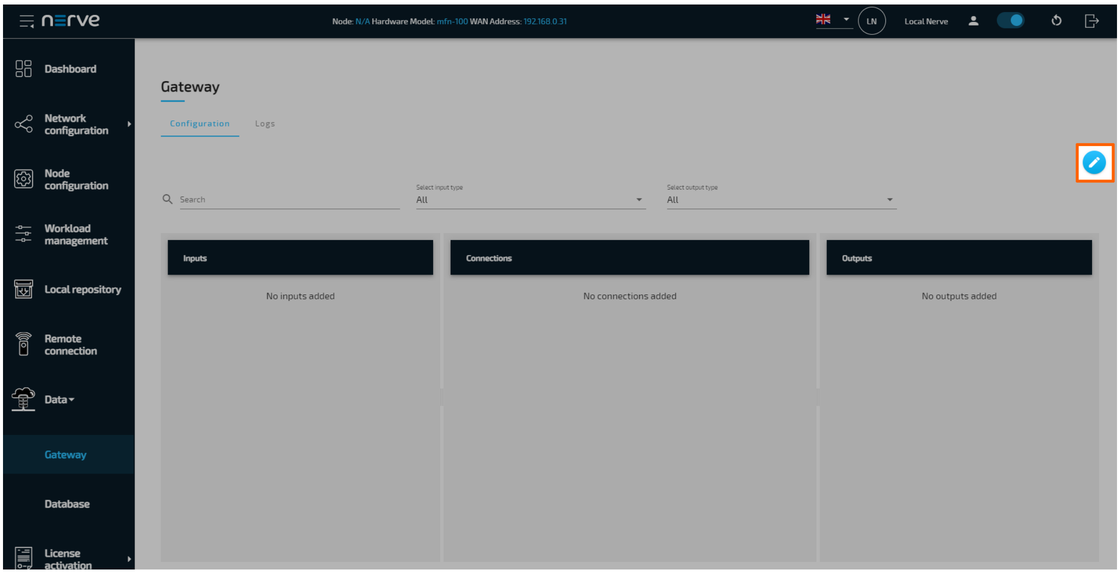
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.

Nerve Device	Physical port	Local UI
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

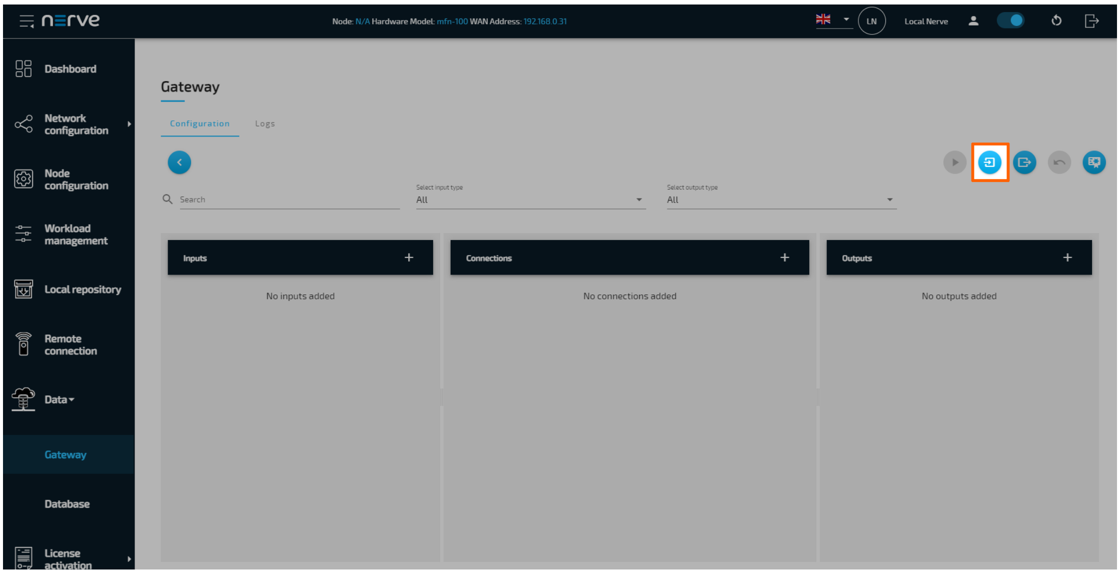
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

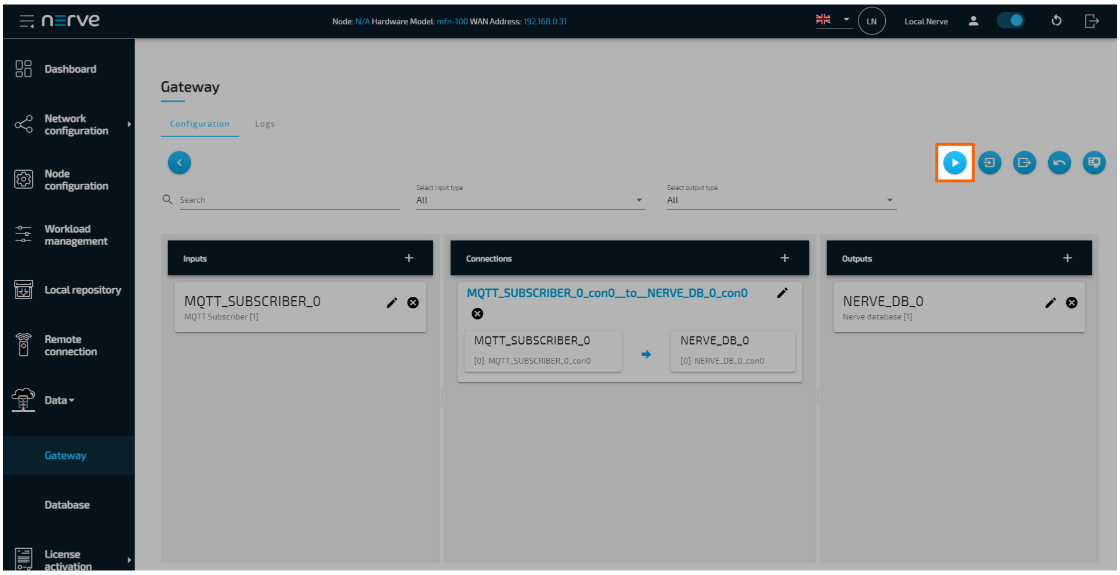
```
{
  "inputs": [
    {
      "name": "client_demo_sensor",
      "type": "OPC_UA_CLIENT",
      "serverUrl": "opc.tcp://localhost:4848",
      "pollingInterval_ms": 1000,
      "connectors": [
        {
          "name": "poll",
          "accessType": "polling",
          "nodes": [
            "ns=2;i=2",
            "ns=2;i=4"
          ]
        }
      ]
    }
  ],
  "outputs": [
    {
      "name": "output_opc_ua_server",
      "type": "OPC_UA_SERVER",
      "port": 4840,
      "logins": [
        {
          "username": "usr1",
          "password": "pwd1"
        },
        {
          "username": "usr2",
          "password": "pwd2"
        }
      ],
      "securities": [
        {
          "securityMode": "all",
          "securityPolicy": "all"
        }
      ],
      "certificate": {
        "certFilePath": "server_crt.der",
        "keyFilePath": "server_key.der"
      },
      "description": {
        "applicationUri": "urn:gateway.server"
      },
      "trustList": [
        "uaexpert.der"
      ],
      "connectors": [
        {
          "name": "OutputFromDemoSensor",
          "browseName": "OutputFromDemoSensor",
          "identifier": "s=OutputFromDemoSensor"
        }
      ]
    }
  ],
  "connections": [
    {
      "name": "opcua_client_to_opcua_server",
      "input": {
        "index": 0,
        "connector": 0
      },
      "output": {
        "index": 0,
        "connector": 0
      }
    }
  ]
}
```

6. Select the **Import** button.



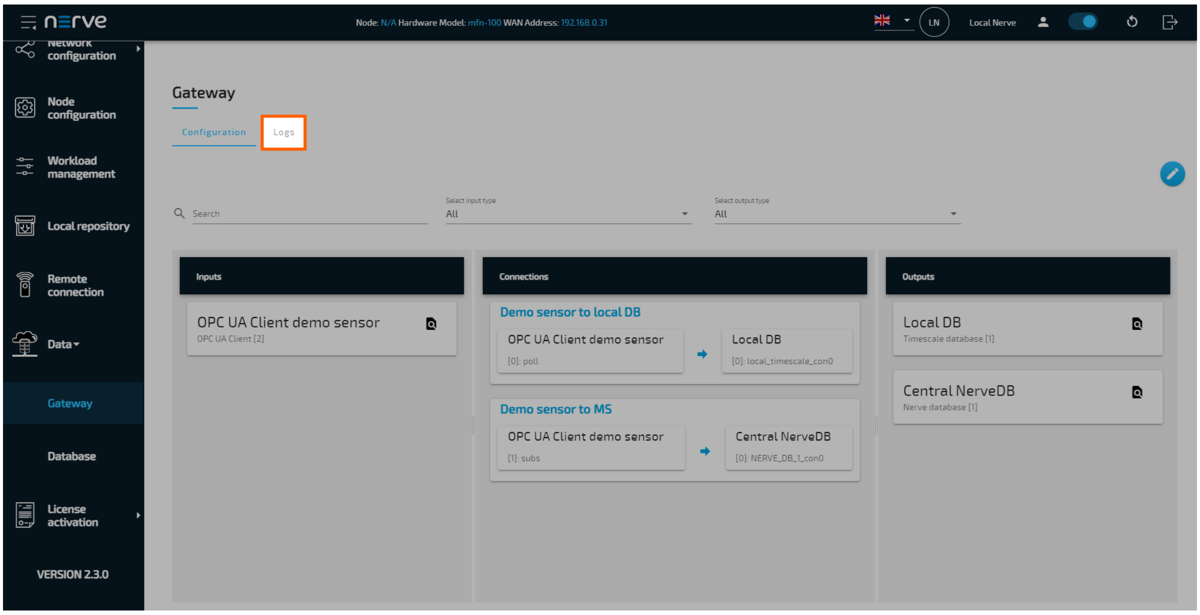
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



Verifying data with the UaExpert OPC UA Client

The temperature and humidity simulation data can be checked visually using a third party application. This example uses the UaExpert OPC UA Client. The desired variables are located in the address space, and by adding them to the data access view, their values can be observed.

NOTE

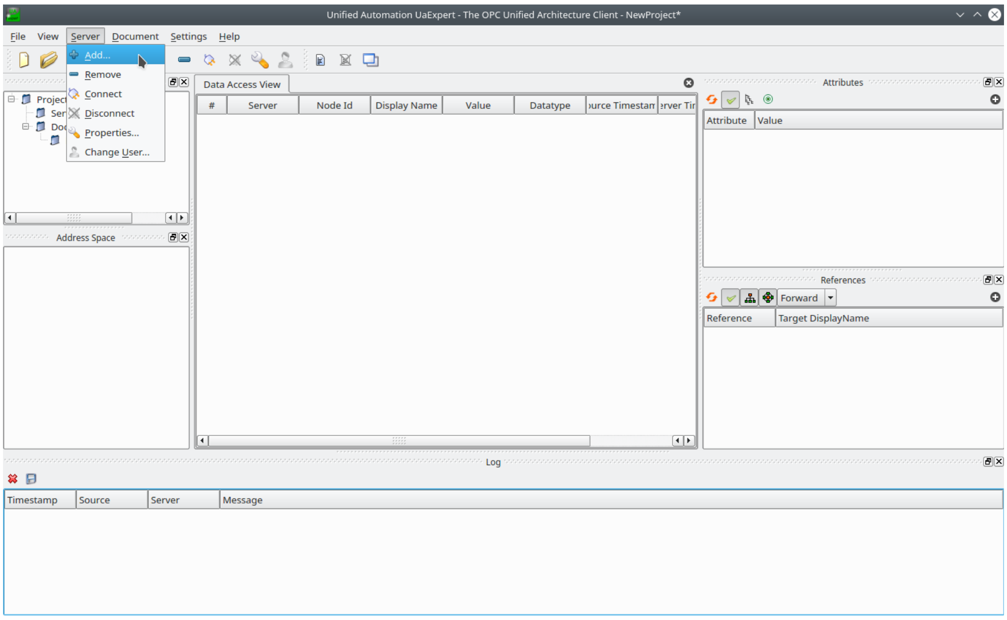
In order to download the UaExpert OPC UA Client, it is required to create a free account at unified-automation.com.

Before continuing, make sure to follow the UaExpert documentation through the first steps with the UaExpert client. Afterwards follow the instructions below:

NOTE

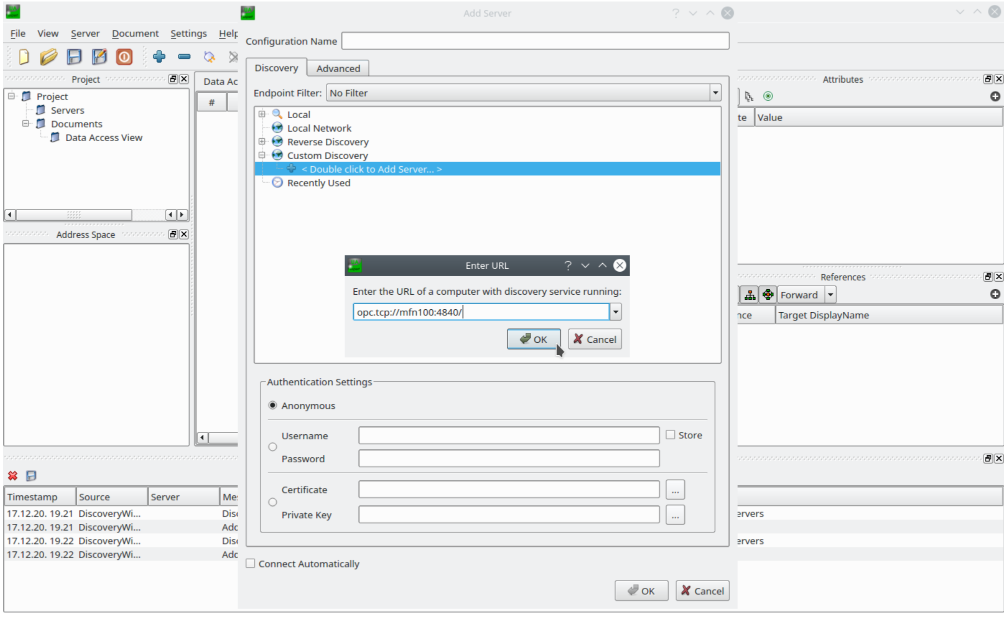
In the screenshots below, `opc.tcp://mfn100:4840` is used to connect to the OPC UA Server output of the Gateway, as `mfn100` had been defined as the hostname when the self-signed certificate was created. Use `172.20.2.1` if this example was followed or replace `mfn100` with the IP address or hostname that was used when creating the certificate earlier.

1. Select **Server > Add...** in the main menu or select the plus icon in the toolbar.



2. Select **Double click to Add Server...** under **Custom Discovery**.

3. Enter `opc.tcp://<hostname>:4840`. The new server now appears under **Custom Discovery**.

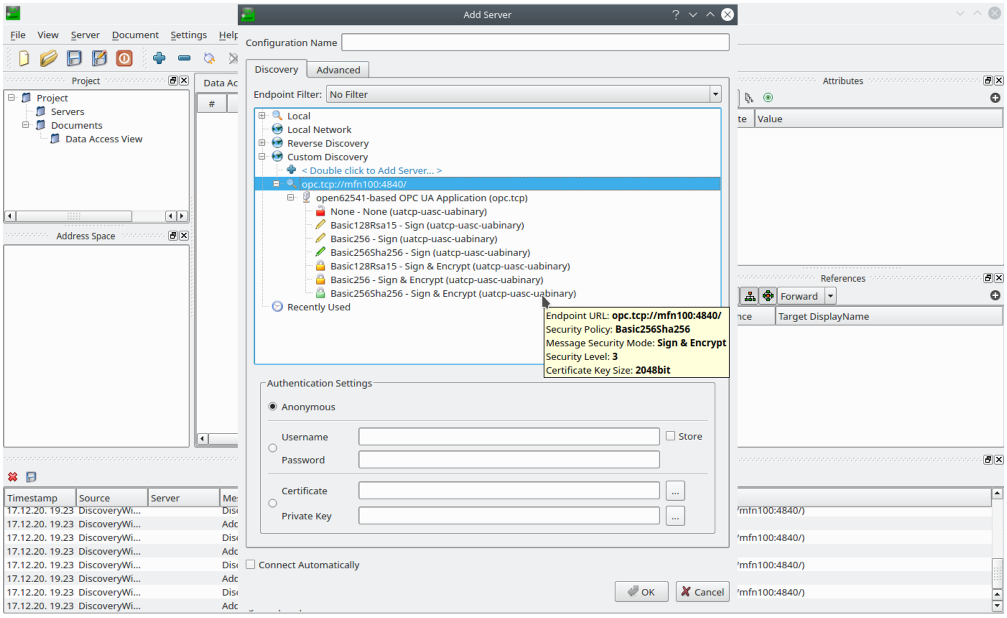


Enter the URL of a computer with discovery service running:

opc.tcp://mfn100:4840/

```
17.12.20. 19.21 DiscoveryWi...
17.12.20. 19.21 DiscoveryWi...
17.12.20. 19.22 DiscoveryWi...
17.12.20. 19.22 DiscoveryWi...
```

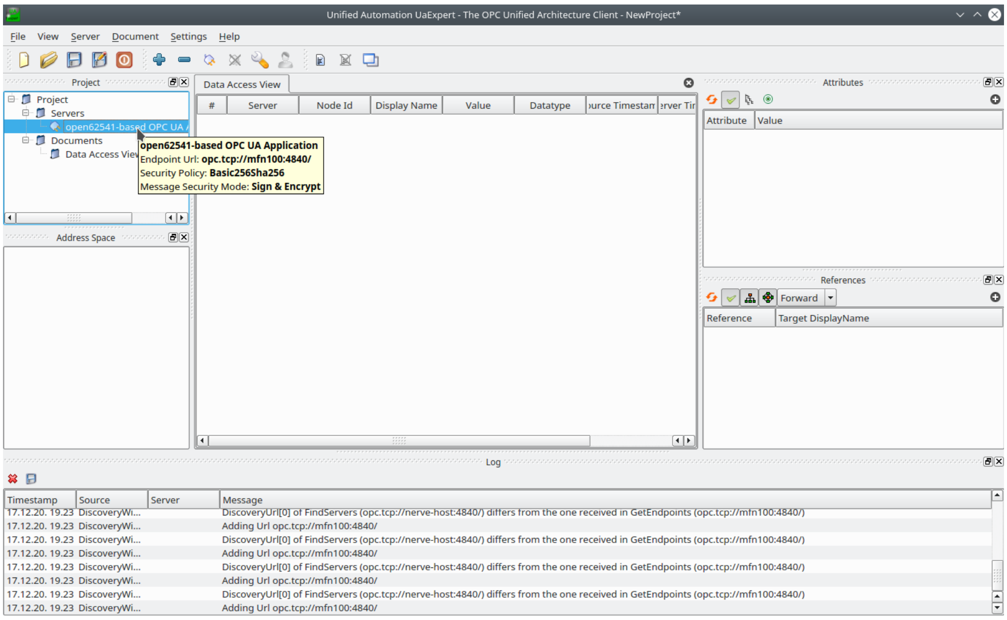
4. Expand the arrow next to the left of the new server to show all accessible endpoints of the server.



opc.tcp://mfn100:4840/
- open62541-based OPC UA Application (opc.tcp)
  - None - None (uatcp-uasc-uabinary)
  - Basic128Rsa15 - Sign (uatcp-uasc-uabinary)
  - Basic256 - Sign (uatcp-uasc-uabinary)
  - Basic256Sha256 - Sign (uatcp-uasc-uabinary)
  - Basic128Rsa15 - Sign & Encrypt (uatcp-uasc-uabinary)
  - Basic256 - Sign & Encrypt (uatcp-uasc-uabinary)
  - Basic256Sha256 - Sign & Encrypt (uatcp-uasc-uabinary)

Endpoint URL: **opc.tcp://mfn100:4840/**
Security Policy: **Basic256Sha256**
Message Security Mode: **Sign & Encrypt**
Security Level: **3**
Certificate Key Size: **2048bit**

5. Double-click the desired security policy from the list. This example uses the **Basic256Sha256** security policy. The server configuration now appears in the **Project** panel under **Servers** on the left side.



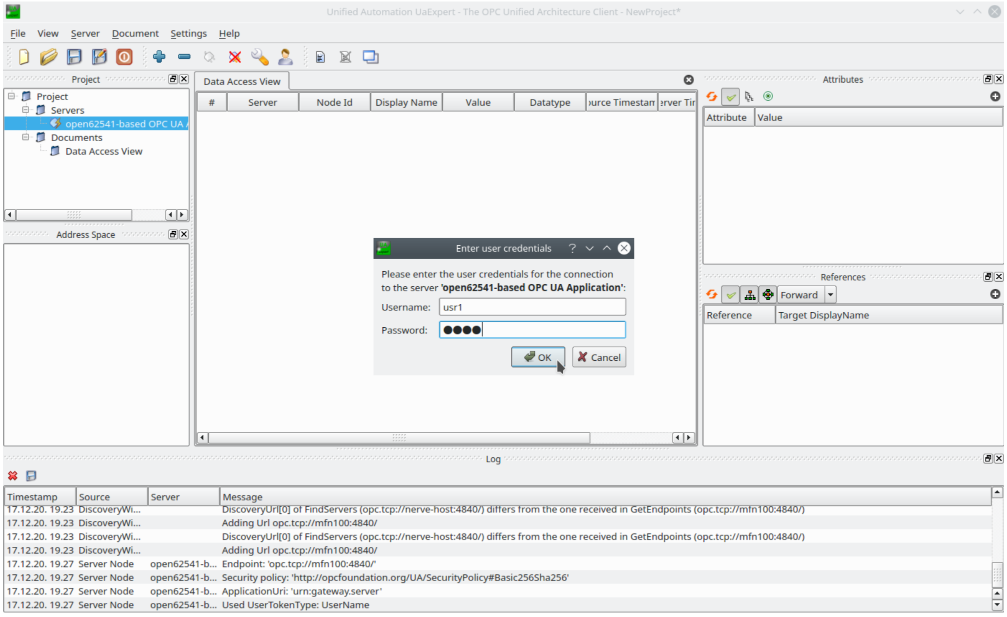
open62541-based OPC UA Application
Endpoint Url: **opc.tcp://mfn100:4840/**
Security Policy: **Basic256Sha256**
Message Security Mode: **Sign & Encrypt**

```
Timestamp       Source          Server  Message
17.12.20. 19.23 DiscoveryWi...          DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...          Adding Url opc.tcp://mfn100:4840/
17.12.20. 19.23 DiscoveryWi...          DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...          Adding Url opc.tcp://mfn100:4840/
17.12.20. 19.23 DiscoveryWi...          DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...          Adding Url opc.tcp://mfn100:4840/
17.12.20. 19.23 DiscoveryWi...          DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...          Adding Url opc.tcp://mfn100:4840/
```

6. Select the server configuration in the **Project** panel.

7. Select **Server > Connect** in the main menu or select the **Connect Server** icon in the toolbar to establish a connection to the server.

8. Enter the username and password that were set in the OPC UA Server output configuration.



Please enter the user credentials for the connection to the server **'open62541-based OPC UA Application'**:

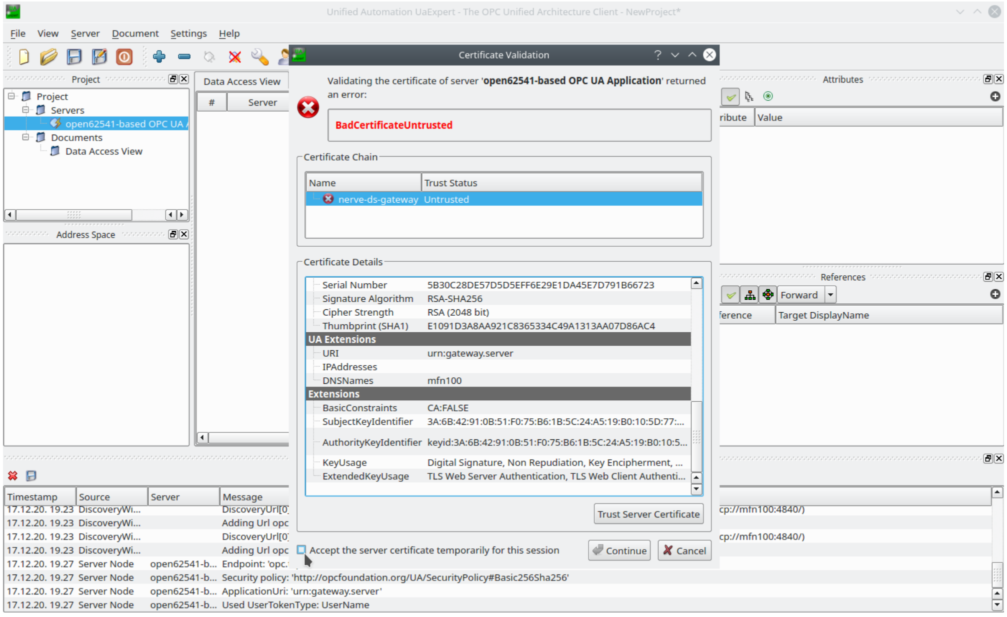
Username: usr1

Password: ●●●●

```
Timestamp       Source          Server          Message
17.12.20. 19.23 DiscoveryWi...                  DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...                  Adding Url opc.tcp://mfn100:4840/
17.12.20. 19.23 DiscoveryWi...                  DiscoveryUrl[0] of FindServers (opc.tcp://nerve-host:4840/) differs from the one received in GetEndpoints (opc.tcp://mfn100:4840/)
17.12.20. 19.23 DiscoveryWi...                  Adding Url opc.tcp://mfn100:4840/
17.12.20. 19.27 Server Node     open62541-b...  Endpoint: 'opc.tcp://mfn100:4840/'
17.12.20. 19.27 Server Node     open62541-b...  Security policy: 'http://opcfoundation.org/UA/SecurityPolicy#Basic256Sha256'
17.12.20. 19.27 Server Node     open62541-b...  ApplicationUri: 'urn:gateway.server'
17.12.20. 19.27 Server Node     open62541-b...  Used UserTokenType: UserName
```

9. Select **OK**. The OPC UA Server certificate is retrieved next. Details are shown in the **Certificate Validation** window.

10. Tick the checkbox next to **Accept the server certificate temporarily for this session**.



Unified Automation UaExpert - The OPC Unified Architecture Client - NewProject*
File View Server Document Settings Help
Project
Servers
open62541-based OPC UA
Documents
Data Access View
Address Space
Attributes
References
Forward

Certificate Validation

Validating the certificate of server '**open62541-based OPC UA Application**' returned an error:

BadCertificateUntrusted

Certificate Chain

Name	Trust Status
nerve-ds-gateway	Untrusted

Certificate Details

Serial Number	5B30C28DE57D5D5EFF6E29E1DA45E7D791B66723
Signature Algorithm	RSA-SHA256
Cipher Strength	RSA (2048 bit)
Thumbprint (SHA1)	E1091D3A8AA921C8365334C49A1313AA07D86AC4
UA Extensions	
URI	urn:gateway.server
IPAddresses	
DNSNames	mfn100
Extensions	
BasicConstraints	CA:FALSE
SubjectKeyIdentifier	3A:6B:42:91:0B:51:F0:75:B6:1B:5C:24:A5:19:B0:10:5D:77:...
AuthorityKeyIdentifier	keyid:3A:6B:42:91:0B:51:F0:75:B6:1B:5C:24:A5:19:B0:10:5...
KeyUsage	Digital Signature, Non Repudiation, Key Encipherment, ...
ExtendedKeyUsage	TLS Web Server Authentication, TLS Web Client Authenti...

Trust Server Certificate

□ Accept the server certificate temporarily for this session

Continue Cancel

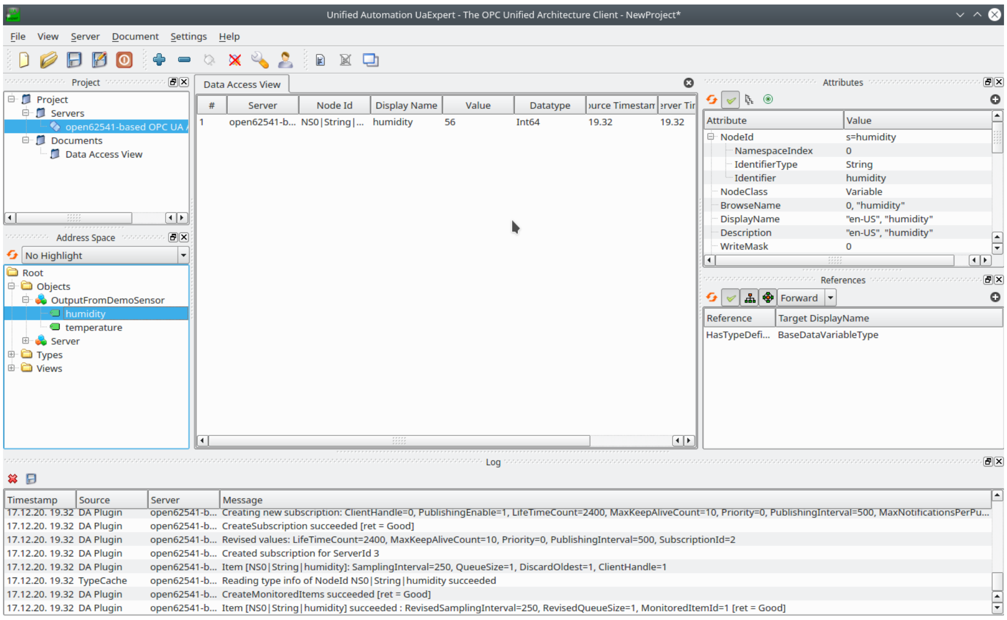
```
Timestamp        Source          Server           Message
17.12.20. 19.23  DiscoveryWi...                   DiscoveryUrl[0]                                   cp://mfn100:4840/)
17.12.20. 19.23  DiscoveryWi...                   Adding Url opc
17.12.20. 19.23  DiscoveryWi...                   DiscoveryUrl[0]                                   cp://mfn100:4840/)
17.12.20. 19.23  DiscoveryWi...                   Adding Url opc
17.12.20. 19.27  Server Node     open62541-b...   Endpoint: 'opc.
17.12.20. 19.27  Server Node     open62541-b...   Security policy: 'http://opcfoundation.org/UA/SecurityPolicy#Basic256Sha256'
17.12.20. 19.27  Server Node     open62541-b...   ApplicationUri: 'urn:gateway.server'
17.12.20. 19.27  Server Node     open62541-b...   Used UserTokenType: UserName
```

NOTE

Alternatively, select **Trust Server Certificate** to always trust this certificate in future sessions.

11. Select **Continue**.

All connection steps are logged in the **Log** panel at the bottom. Once connected, the OPC UA Server's address space appears in the **Address Space** panel on the left. Expand **Objects > OutputFromDemoSensor** in the **Address Space** panel on the left and drag-and-drop the temperature and humidity variables to the **Data Access View** in the middle to monitor their values.



Data Access View

#	Server	Node Id	Display Name	Value	Datatype	ource Timestam	erver Tir
1	open62541-b...	NS0|String|...	humidity	56	Int64	19.32	19.32

Attribute	Value
NodeId	s=humidity
NamespaceIndex	0
IdentifierType	String
Identifier	humidity
NodeClass	Variable
BrowseName	0, "humidity"
DisplayName	"en-US", "humidity"
Description	"en-US", "humidity"
WriteMask	0

Reference	Target DisplayName
HasTypeDefi...	BaseDataVariableType

```
Timestamp        Source      Server           Message
17.12.20. 19.32  DA Plugin   open62541-b...   Creating new subscription: ClientHandle=0, PublishingEnable=1, LifeTimeCount=2400, MaxKeepAliveCount=10, Priority=0, PublishingInterval=500, MaxNotificationsPerPu...
17.12.20. 19.32  DA Plugin   open62541-b...   CreateSubscription succeeded [ret = Good]
17.12.20. 19.32  DA Plugin   open62541-b...   Revised values: LifeTimeCount=2400, MaxKeepAliveCount=10, Priority=0, PublishingInterval=500, SubscriptionId=2
17.12.20. 19.32  DA Plugin   open62541-b...   Created subscription for ServerId 3
17.12.20. 19.32  DA Plugin   open62541-b...   Item [NS0|String|humidity]: SamplingInterval=250, QueueSize=1, DiscardOldest=1, ClientHandle=1
17.12.20. 19.32  TypeCache   open62541-b...   Reading type info of NodeId NS0|String|humidity succeeded
17.12.20. 19.32  DA Plugin   open62541-b...   CreateMonitoredItems succeeded [ret = Good]
17.12.20. 19.32  DA Plugin   open62541-b...   Item [NS0|String|humidity] succeeded : RevisedSamplingInterval=250, RevisedQueueSize=1, MonitoredItemId=1 [ret = Good]
```

S7 Client to cloud for visualization

This example demonstrates how to read data from an S7 demo server that provides temperature, revolutions and active digital inputs of a motor connected to an S7 PLC. The data is then visualized with the Central Data Services in the Management System.

The instructions below cover the following steps:

- Provisioning an S7 demo server as a Docker workload
- Deploying the provisioned Docker workload to the target node
- Configuring the Data Services Gateway
- Central data visualization in the Management System

Provisioning and deploying an S7 demo server at the node

First, the S7 demo server must be deployed to the node as a Docker workload. Download the **Data Services S7 demo server** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo server as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload by following Provisioning a Docker workload. This example uses **s7-demo** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the S7 demo sensor that has been downloaded from the Nerve Software Center.
DOCKER SPECIFIC INFO	Select **New port** and enter the following settings: ◦ **Protocol**: TCP ◦ **Host Port**: 102 ◦ **Container Port**: 102
Container name	`tttech-s7-server-demo`
Network name	`bridge`

3. Deploy the provisioned Docker workload by following Deploying a workload.

> **NOTE**
>
> Remember the node name and serial number of the target node. They are needed for the JSON configuration.

Configuring the Data Services Gateway

The configuration defines the S7 demo server that was deployed above as a data input and the NerveDB in the Management System as a data output. The S7 client will periodically read data from the S7 demo server and send it to the Management System. The temperature of the motor is stored in the datablock `0` with offset `0` and data type `float`. The number of revolutions of the motor is stored in the merker with offset `0` and data type `uint32`. Eight digital inputs from the demo server are also read as eight different boolean values.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

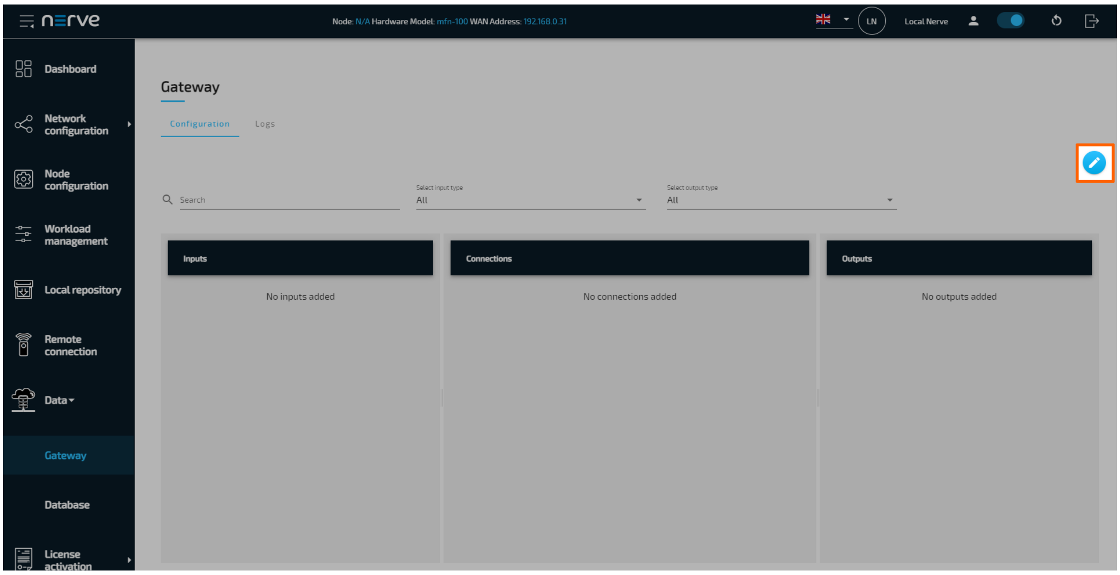
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

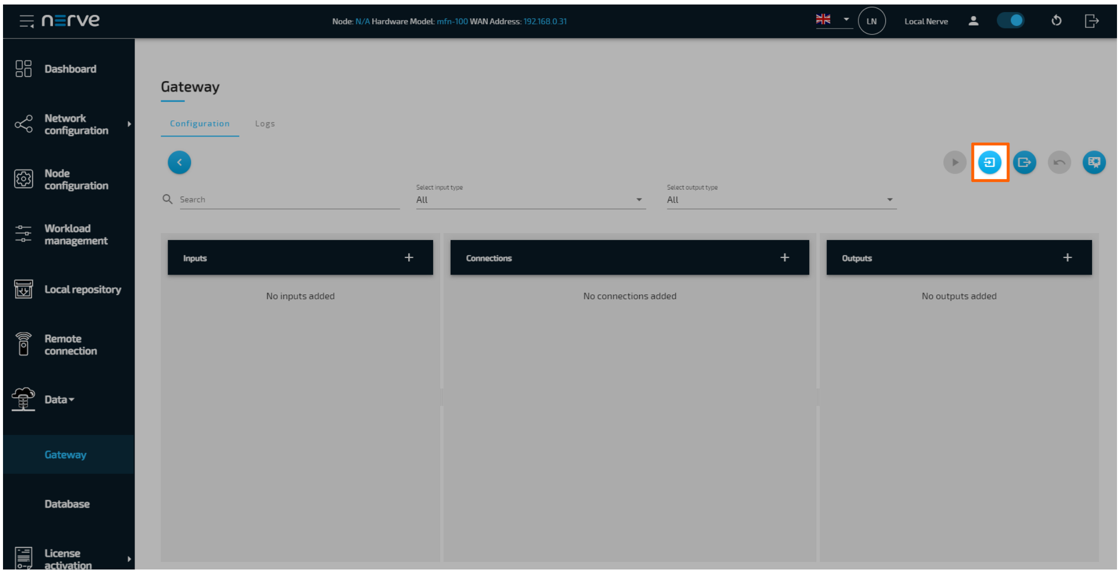
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

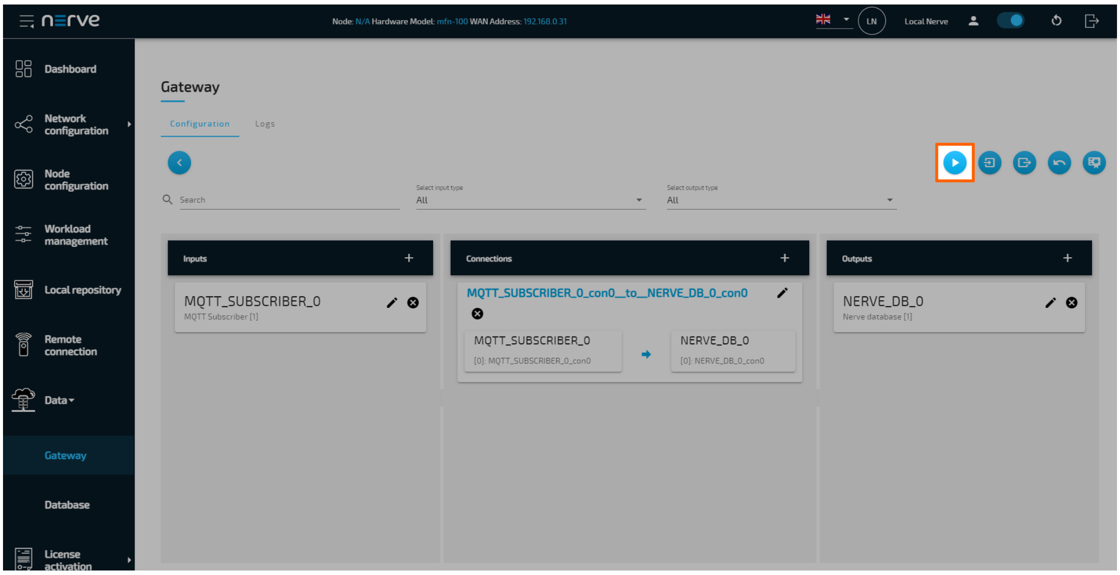
```
{
    "inputs": [
        {
            "type": "S7_CLIENT",
            "name": "s7_client_on_node",
            "serverUrl": "127.0.0.1",
            "port": 102,
            "connectionType": "PG",
            "pollingInterval_ms": 1000,
            "connectors": [
                {
                    "name": "s7_demo_connector",
                    "datablocks": [
                        {
                            "name": "motor_temperature",
                            "datablock": 0,
                            "offset": 0,
                            "type": "float"
                        }
                    ],
                    "merkers": [
                        {
                            "name": "motor_revolutions",
                            "offset": 0,
                            "type": "uint32"
                        }
                    ],
                    "inputs": [
                        {
                            "name": "motor_input",
                            "offset": 0,
                            "quantity": 8,
                            "type": "bool"
                        }
                    ]
                }
            ]
        }
    ],
    "outputs": [
        {
            "type": "NERVE_DB",
            "location": "CENTRAL",
            "connectors": [
                {
                    "tableName": "s7_data"
                }
            ]
        }
    ],
    "connections" : [
        {
            "name" : "s7_client_to_cloud",
            "input": { "index" : 0, "connector" : 0 },
            "output": { "index" : 0, "connector" : 0 }
        }
    ]
}
```

6. Select the **Import** button.



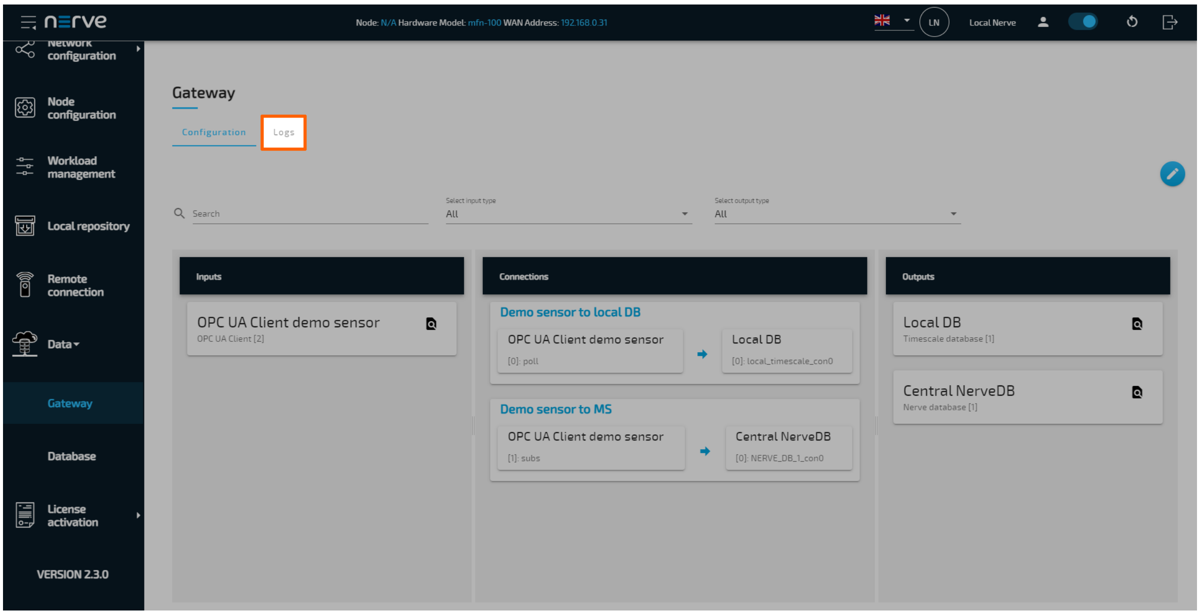
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



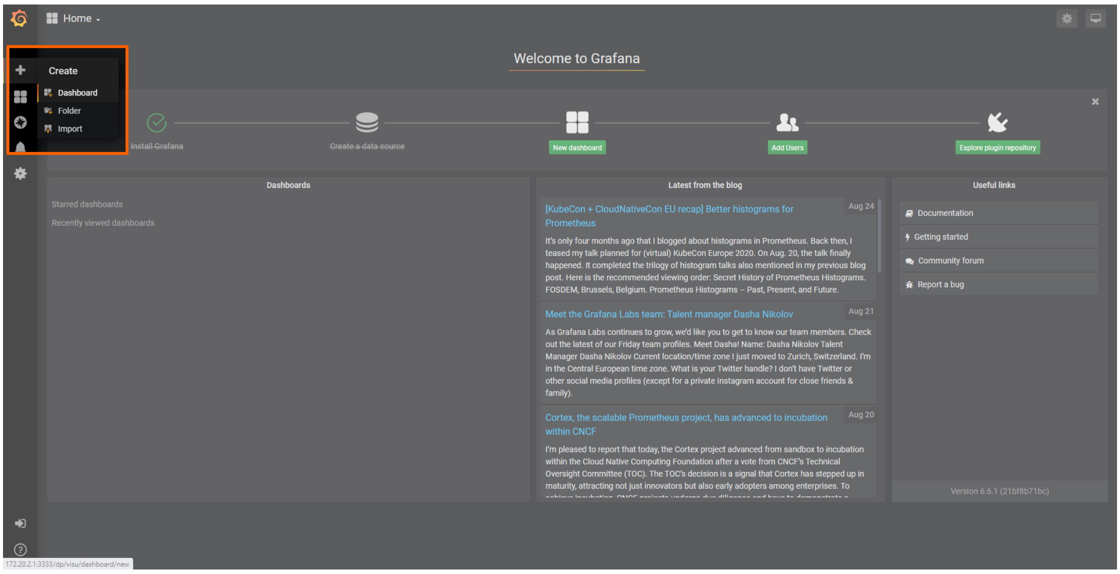
Central data visualization in the Management System

To visualize the motor temperature data in the Management System, open the central visualization element through the Data Services UI in the Management System.

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It’s only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

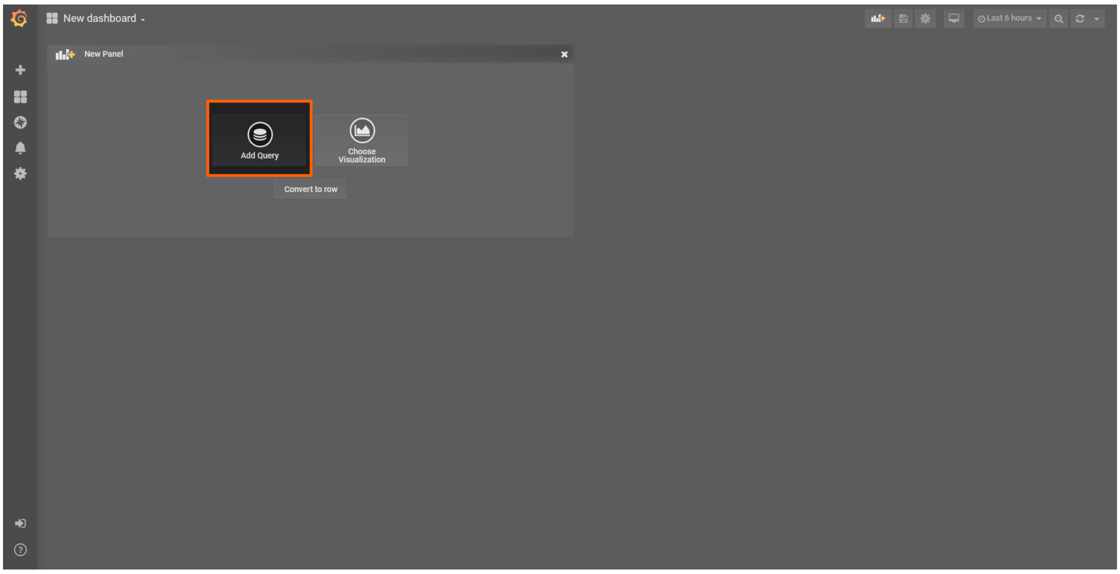
Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we’d like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I’m in the Central European time zone. What is your Twitter handle? I don’t have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

Cortex, the scalable Prometheus project, has advanced to incubation within CNCF — Aug 20

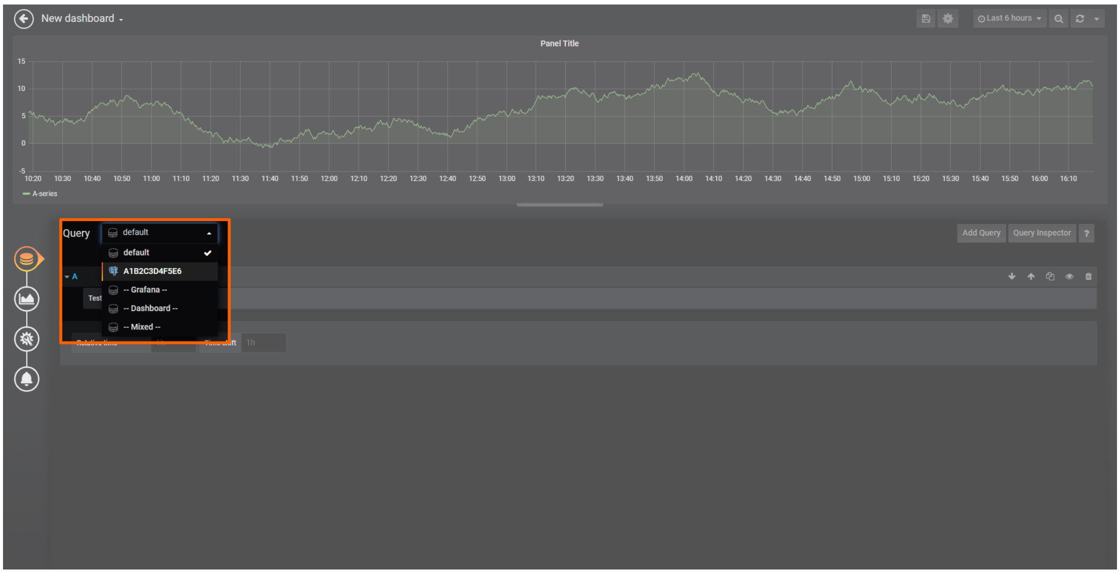
I’m pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF’s Technical Oversight Committee (TOC). The TOC’s decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



4. Select the data source from the drop-down menu. The name of the data source is the name and serial number of the node, formatted as `<nodename> (<serialnumber>)`.

> **NOTE**
>
> Note that multiple data sources can be selected in the Grafana instance in the Management System, depending on the number of nodes that are registered. Make sure to remember the serial number of the node that was used for workload deployment before.

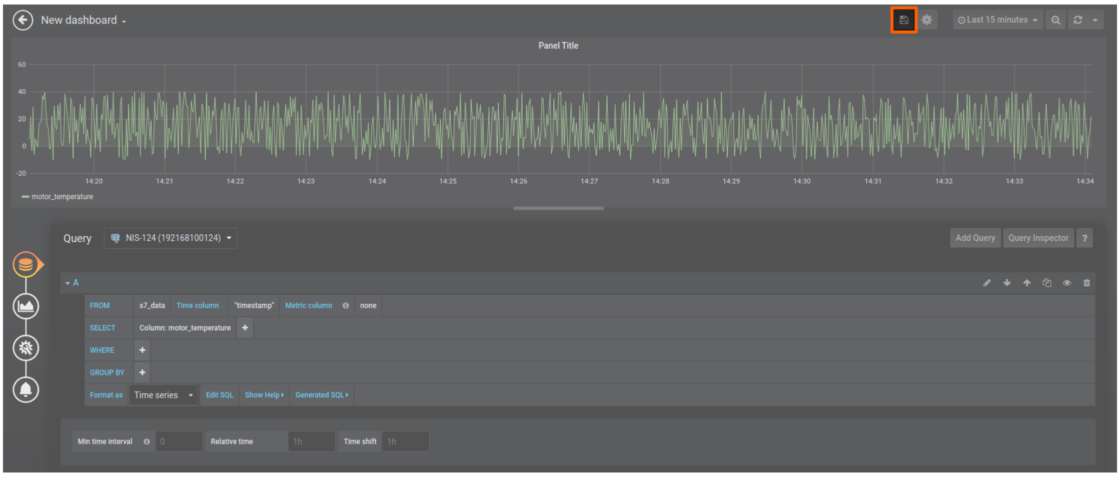


5. Fill in the following query information:

Setting	Value
FROM	`s7_data` **Time column**: "timestamp"

Setting	Value
SELECT	Column: motor_temperature
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.



Query NIS-124 (192168100124)

FROM s7_data Time column "timestamp" Metric column none

SELECT Column: motor_temperature

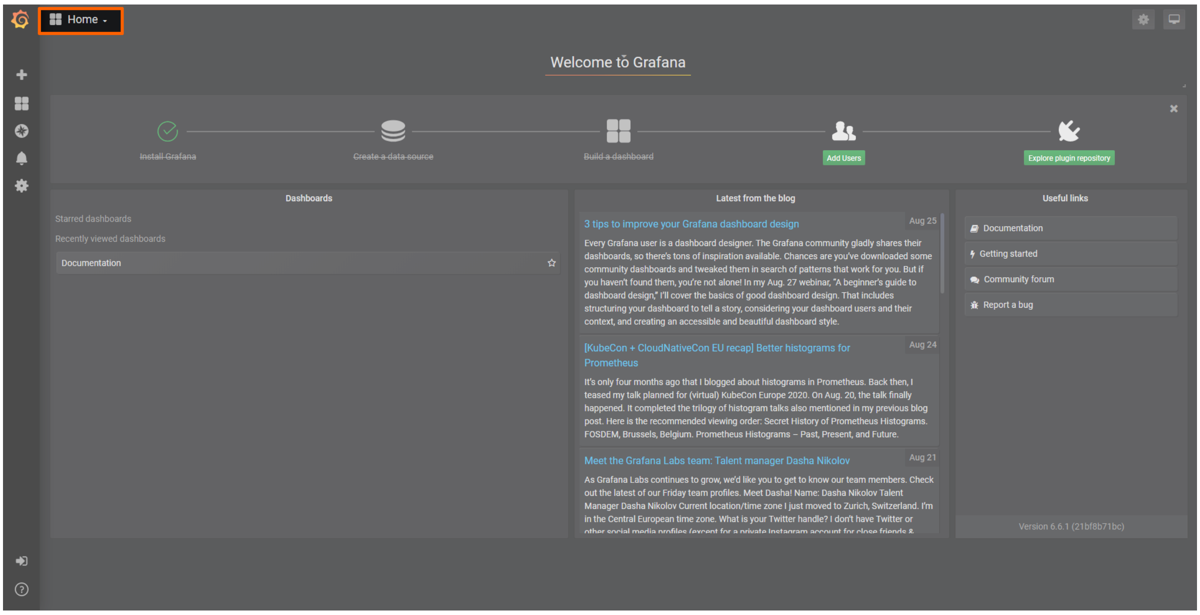
WHERE

GROUP BY

Format as Time series Edit SQL Show Help Generated SQL

Min time interval 0 Relative time 1h Time shift 1h

The dashboard can be accessed from the Grafana home menu.



3 tips to improve your Grafana dashboard design — Aug 25

Every Grafana user is a dashboard designer. The Grafana community gladly shares their dashboards, so there's tons of inspiration available. Chances are you've downloaded some community dashboards and tweaked them in search of patterns that work for you. But if you haven't found them, you're not alone! In my Aug. 27 webinar, "A beginner's guide to dashboard design," I'll cover the basics of good dashboard design. That includes structuring your dashboard to tell a story, considering your dashboard users and their context, and creating an accessible and beautiful dashboard style.

[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

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MQTT publisher to OPC UA Server at the node

In this example, temperature and humidity data is provided from a sensor simulation as an MQTT Publisher. The sensor simulation is running on the node. With the Data Services, the data is then provided as OPC UA Server on the node. A development PC with the UaExpert OPC UA Client is used to connect to the OPC UA Server on the node to read the data.

The instructions below cover the following steps:

- Provisioning an MQTT broker as a Docker workload
- Provisioning an MQTT Publisher simulation as a Docker workload
- Deploying the provisioned Docker workloads to the target node
- Configuring the Data Services Gateway
- Reading data with the UaExpert OPC UA Client on a development PC

Provisioning and deploying the sensor simulation and the MQTT broker

In the instructions below two Docker workloads will be provisioned and deployed:

An MQTT broker must to be deployed to the node first in order for the sensor simulation to function. The EMQX MQTT broker is used in this example that can be downloaded from the Docker Hub registry.

Afterwards the temperature and humidity sensors simulation MQTT publisher is deployed. Download the **Data Services MQTT demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload for the EMQX MQTT broker by following Provisioning a Docker workload. This example uses **emqx-4.1.0** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `emqx/emqx:v4.1.0`.
Container name	`emqx`
Network name	`host`

3. Provision a Docker workload for the sensor simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
New environment variable	Select the **+** icon and enter the following information: ◦ **Env. variable** `MQTT_PUB_TOPIC` ◦ **Variable value** `demo-sensor-topic`
Container name	`ttt-mqtt-demo-sensor-1.0`
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Configuring the Data Services Gateway

The input data is a subscription to temperature and humidity variables on the MQTT broker. An OPC UA Server is set up as data output. The input and output are linked in connections.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

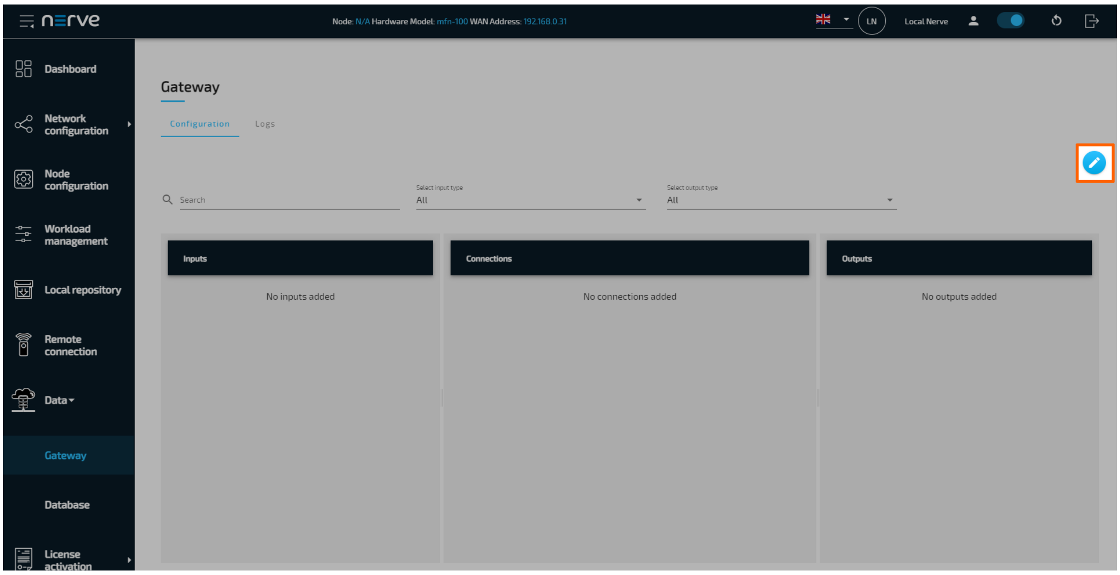
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

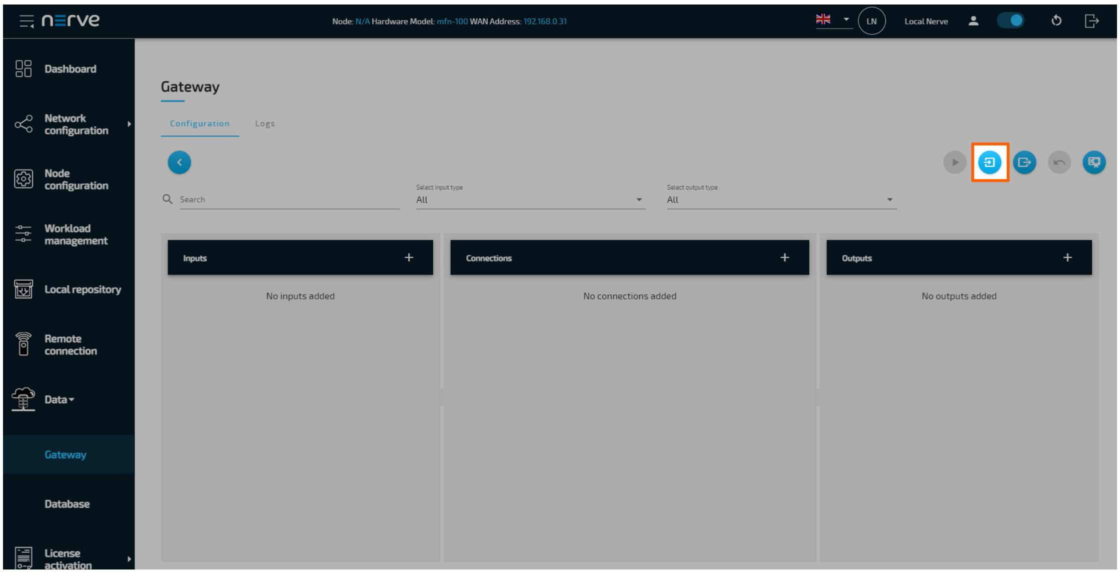
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

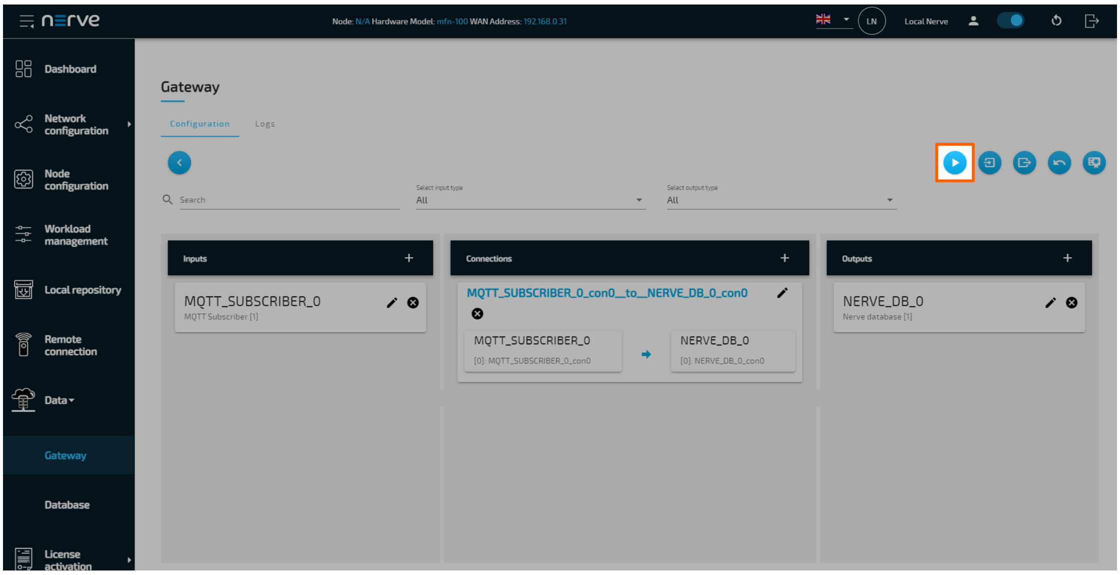
```
{
  "inputs": [
    {
      "type": "MQTT_SUBSCRIBER",
      "name": "emqx_broker_input",
      "clientId": "mqtt_subscriber_0",
      "serverUrl": "tcp://localhost:1883",
      "keepAliveInterval_s": 20,
      "cleanSession": false,
      "qos": 1,
      "connectors": [
        {
          "name": "demo_sensor_connector",
          "topic": "demo-sensor-topic",
          "variables": [
            {
              "name": "temperature",
              "type": "int16"
            },
            {
              "name": "humidity",
              "type": "uint16"
            }
          ]
        }
      ]
    }
  ],
  "outputs": [
    {
      "type": "OPC_UA_SERVER",
      "name": "opcua_server_output",
      "connectors": [
        {
          "name": "demo_sensor",
          "browseName": "demoSensor",
          "identifier": "s=demoSensor"
        }
      ]
    }
  ],
  "connections": [
    {
      "name": "mqtt_publisher_TO_opcua_server",
      "input": {
        "index": 0,
        "connector": 0
      },
      "output": {
        "index": 0,
        "connector": 0
      }
    }
  ]
}
```

6. Select the **Import** button.



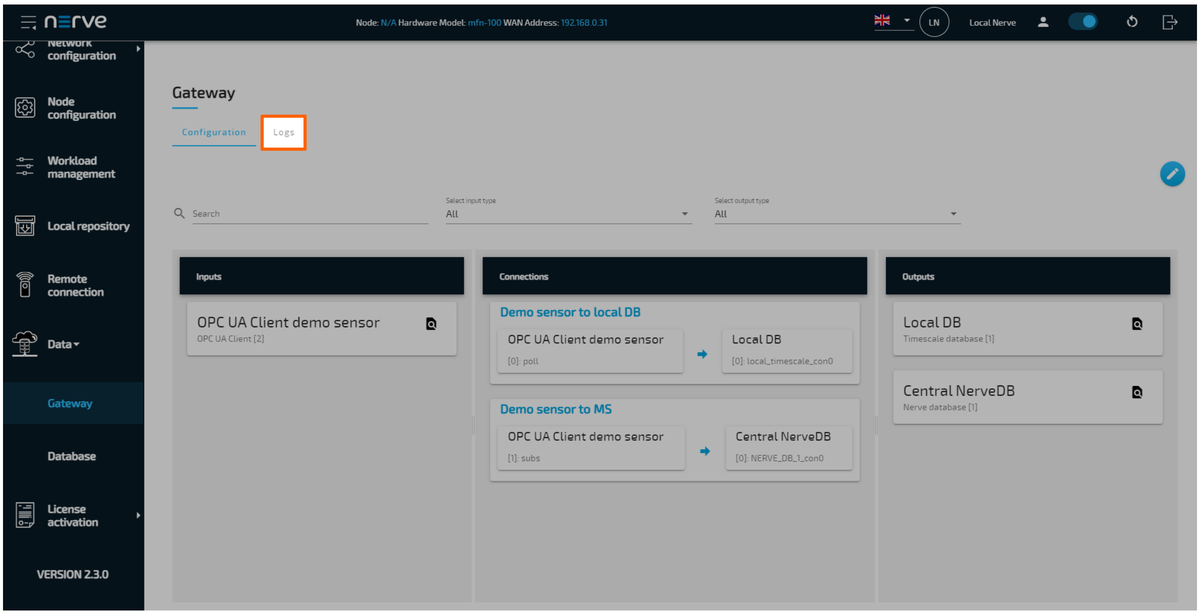
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



Reading data with the UaExpert OPC UA Client

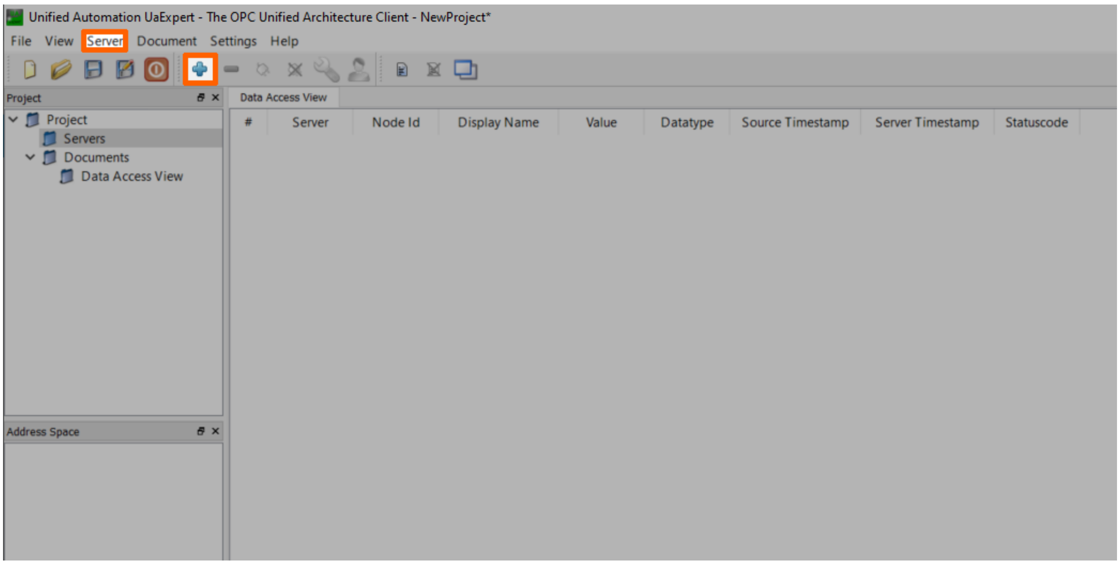
The temperature and humidity simulation data can be checked visually using a third party application. This example uses the UaExpert OPC UA Client. Add a new server with the address `opc.tcp://172.20.2.1:4840` (here port 4840 is specified as the default of the Gateway) and connect to it. The desired variables are located in the address space, and by adding them to the data access view, their values can be observed.

NOTE

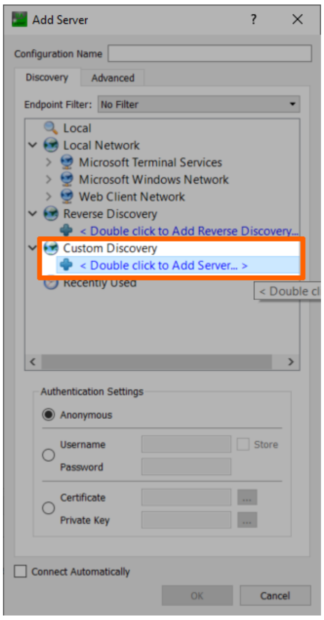
In order to download the UaExpert OPC UA Client, it is required to create a free account at unified-automation.com.

Before continuing, make sure to follow the UaExpert documentation through the first steps with the UaExpert client. Afterwards follow the instructions below:

1. Select **Server > Add...** in the main menu or select the plus icon in the toolbar.



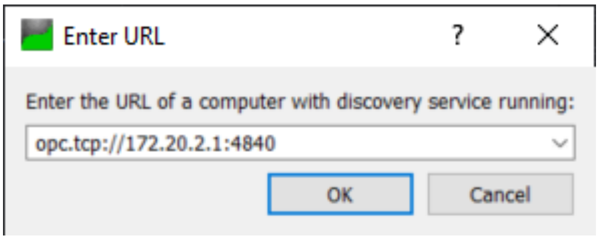
2. Select **Double click to Add Server...** under **Custom Discovery**.



Endpoint Filter: No Filter

● Anonymous

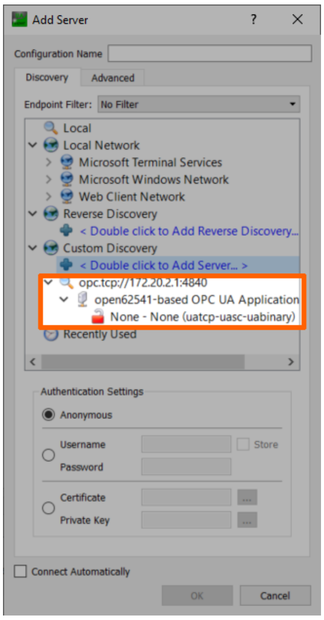
3. Enter `opc.tcp://172.20.2.1:4840`. The new server now appears under **Custom Discovery**.



Enter the URL of a computer with discovery service running:

opc.tcp://172.20.2.1:4840

4. Expand the arrow next to the left of the new server.



Add Server
Configuration Name
Discovery
Advanced
Local
Local Network
Microsoft Terminal Services
Microsoft Windows Network
Web Client Network
Reverse Discovery
< Double click to Add Reverse Discovery...
Custom Discovery
< Double click to Add Server... >
opc.tcp://172.20.2.1:4840
open62541-based OPC UA Application
None - None (uatcp-uasc-uabinary)
Recently Used
Authentication Settings
Username
Password
□ Store
Certificate
Private Key
OK
Cancel

Endpoint Filter: No Filter

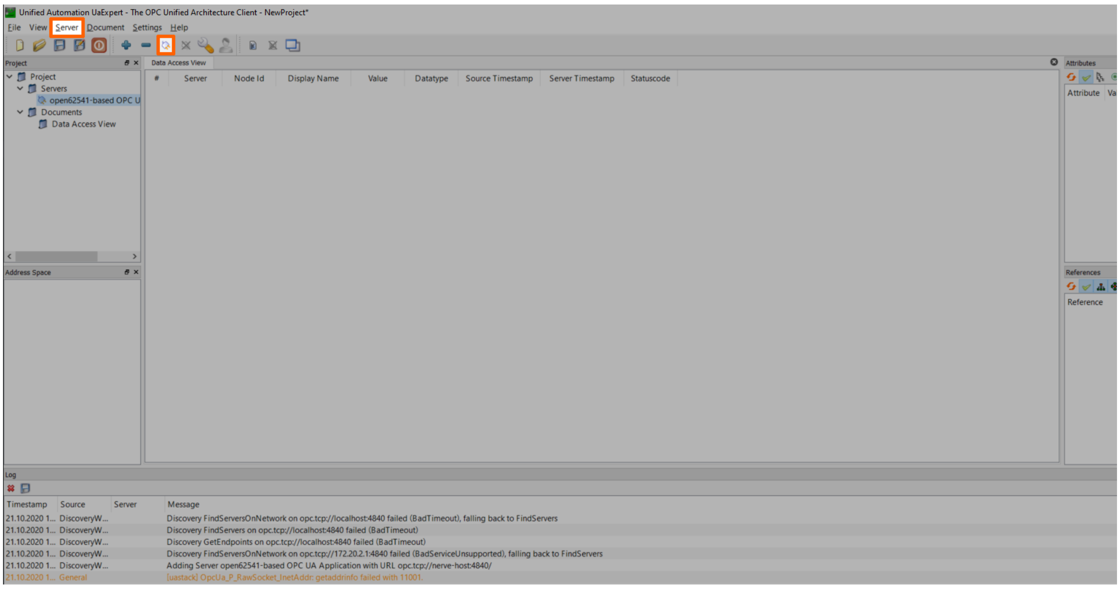
● Anonymous

□ Connect Automatically

5. Double-click the **None** security policy. The server configuration now appears in the **Project** panel under **Servers** on the left side.

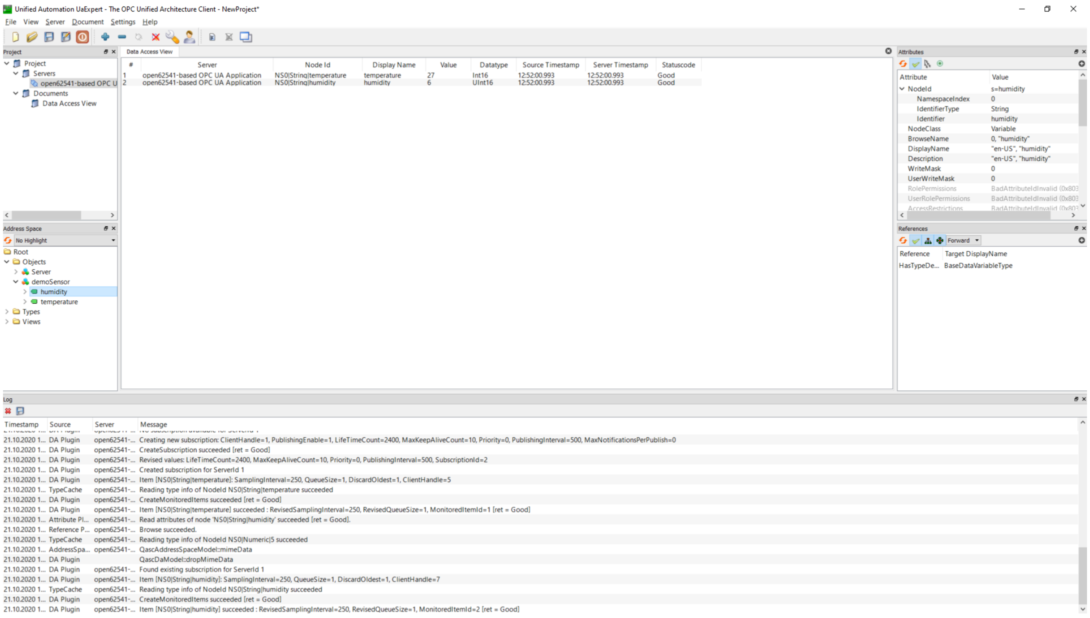
6. Select the server configuration in the **Project** panel.

7. Select **Server > Connect** in the main menu or select the **Connect Server** icon in the toolbar to establish a connection to the server.



```
Timestamp         Source        Server   Message
21.10.2020 1...   DiscoveryW...          Discovery FindServersOnNetwork on opc.tcp://localhost:4840 failed (BadTimeout), falling back to FindServers
21.10.2020 1...   DiscoveryW...          Discovery FindServers on opc.tcp://localhost:4840 failed (BadTimeout)
21.10.2020 1...   DiscoveryW...          Discovery GetEndpoints on opc.tcp://localhost:4840 failed (BadTimeout)
21.10.2020 1...   DiscoveryW...          Discovery FindServersOnNetwork on opc.tcp://172.20.2.1:4840 failed (BadServiceUnsupported), falling back to FindServers
21.10.2020 1...   DiscoveryW...          Adding Server open62541-based OPC UA Application with URL opc.tcp://nerve-host:4840/
21.10.2020 1...   General                [uastack] OpcUa_P_RawSocket_InetAddr: getaddrinfo failed with 11001.
```

All connection steps are logged in the **Log** panel at the bottom. Once connected, the OPC UA Server's address space appears in the **Address Space** panel on the left. Expand **Objects > demoSensor** in the **Address Space** panel on the left and drag-and-drop the temperature and humidity variables to the **Data Access View** in the middle to monitor their values.



Unified Automation UaExpert - The OPC Unified Architecture Client - NewProject*

#	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	Server Timestamp	Statuscode
1	open62541-based OPC UA Application	NS0|String|temperature	temperature	27	Int16	12:52:00.993	12:52:00.993	Good
2	open62541-based OPC UA Application	NS0|String|humidity	humidity	6	UInt16	12:52:00.993	12:52:00.993	Good

Attribute	Value
NodeId	s=humidity
NamespaceIndex	0
IdentifierType	String
Identifier	humidity
NodeClass	Variable
BrowseName	0, "humidity"
DisplayName	"en-US", "humidity"
Description	"en-US", "humidity"
WriteMask	0
UserWriteMask	0
RolePermissions	BadAttributeIdInvalid (0x803
UserRolePermissions	BadAttributeIdInvalid (0x803
AccessRestrictions	BadAttributeIdInvalid (0x803

Reference	Target DisplayName
HasTypeDe...	BaseDataVariableType

```
Timestamp     Source        Server          Message
21.10.2020 1... DA Plugin     open62541-... Creating new subscription: ClientHandle=1, PublishingEnable=1, LifeTimeCount=2400, MaxKeepAliveCount=10, Priority=0, PublishingInterval=500, MaxNotificationsPerPublish=0
21.10.2020 1... DA Plugin     open62541-... CreateSubscription succeeded [ret = Good]
21.10.2020 1... DA Plugin     open62541-... Revised values: LifeTimeCount=2400, MaxKeepAliveCount=10, Priority=0, PublishingInterval=500, SubscriptionId=2
21.10.2020 1... DA Plugin     open62541-... Created subscription for ServerId 1
21.10.2020 1... DA Plugin     open62541-... Item [NS0|String|temperature]: SamplingInterval=250, QueueSize=1, DiscardOldest=1, ClientHandle=5
21.10.2020 1... TypeCache     open62541-... Reading type info of NodeId NS0|String|temperature succeeded
21.10.2020 1... DA Plugin     open62541-... CreateMonitoredItems succeeded [ret = Good]
21.10.2020 1... DA Plugin     open62541-... Item [NS0|String|temperature] succeeded : RevisedSamplingInterval=250, RevisedQueueSize=1, MonitoredItemId=1 [ret = Good]
21.10.2020 1... Attribute Pl... open62541-... Read attributes of node 'NS0|String|humidity' succeeded [ret = Good].
21.10.2020 1... Reference P... open62541-... Browse succeeded.
21.10.2020 1... TypeCache     open62541-... Reading type info of NodeId NS0|Numeric|5 succeeded
21.10.2020 1... AddressSpa... open62541-... QascAddressSpaceModel::mimeData
21.10.2020 1... DA Plugin                   QascDaModel::dropMimeData
21.10.2020 1... DA Plugin     open62541-... Found existing subscription for ServerId 1
21.10.2020 1... DA Plugin     open62541-... Item [NS0|String|humidity]: SamplingInterval=250, QueueSize=1, DiscardOldest=1, ClientHandle=7
21.10.2020 1... TypeCache     open62541-... Reading type info of NodeId NS0|String|humidity succeeded
21.10.2020 1... DA Plugin     open62541-... CreateMonitoredItems succeeded [ret = Good]
21.10.2020 1... DA Plugin     open62541-... Item [NS0|String|humidity] succeeded : RevisedSamplingInterval=250, RevisedQueueSize=1, MonitoredItemId=2 [ret = Good]
```

Receiving data via MQTT for Analytics and Visualization

In this example, data from a sensor providing temperature and humidity as an MQTT Publisher is visualized and processed via the Data Services and the analytics element. Data will be displayed before and after processing.

The instructions below cover the following steps:

- Provisioning an MQTT broker as a Docker workload
- Provisioning an MQTT Publisher simulation as a Docker workload
- Deploying the provisioned Docker workloads to the target node
- Creating and provisioning an analytics app with the Nerve Data Services SDK
- Deploying the analytics app as a Docker workload
- Local Data Visualization of temperature data before and after processing

Provisioning and deploying the sensor simulation and the MQTT broker

In the instructions below two Docker workloads will be provisioned and deployed:

An MQTT broker must to be deployed to the node first in order for the sensor simulation to function. The EMQX MQTT broker is used in this example that can be downloaded from the Docker Hub registry.

After that the temperature and humidity sensors simulation MQTT publisher is deployed. Download the **Data Services MQTT demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload for the EMQX MQTT broker by following Provisioning a Docker workload. This example uses **emqx-4.1.0** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `emqx/emqx:v4.1.0`.
Container name	`emqx`
Network name	`host`

3. Provision a Docker workload for the sensor simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
New environment variable	Select the **+** icon and enter the following information: ◦ **Env. variable** `MQTT_PUB_TOPIC` ◦ **Variable value** `demo-sensor-topic`
Container name	`ttt-mqtt-demo-sensor-1.0`
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Preparing the Nerve Data Services SDK

The Nerve Data Services SDK is required for working with analytics apps. They are created, built and provisioned with it. Download the **Nerve Data Services SDK** found under **Nerve Tools** from the Nerve Software Center. Refer to Data analytics for more information.

Creating and provisioning an analytics app

Before working with the SDK, make sure that the Conda environment is active. If the Conda environment is active it will be displayed in parentheses in front. The default name of the Conda environment is `nerve-ds-analytics`. Activate the Conda environment by entering the following command:

```
source miniconda/bin/activate <environmentname>
```

The Conda environment automatically deactivates after a restart so it needs to be activated whenever it is used.

1. Enter the following command to create an analytics app. demo_sensor_analytics_app is the name used for this example:

```
nerve-analytics create demo_sensor_analytics_app .
```

2. Enter cd demo_sensor_analytics_app to navigate to the newly created folder.

3. Edit the demo_sensor_analytics_app.py file and insert the following code:

```
import signal
import sys

from nerve_dp_analytics.stream.inputs.input_zeromq import Stream_Input_Zeromq
from nerve_dp_analytics.batch.outputs.output_timescaledb import Batch_Output_Times

running = True

def sig_hdlr(signal, frame):
    global running
    running = False

    if siz:
        try:
            siz.clear()
        except Exception as e:
            print(e)

    if bot:
        try:
            bot.clear()
        except Exception as e:
            print(e)

    print('Exiting...')
    sys.exit(0)

# catch CTRL+C
signal.signal(signal.SIGINT, sig_hdlr)

def celsius_to_kelvin(value):
    return value + 273.15

def normalize_humidity(value):
    return value / 100

try:
    siz = Stream_Input_Zeromq('demo-sensor-analytics-app-siz',
                              host='172.20.10.1',
                              port=5555,
                              topic='demo-sensor-topic')

    bot = Batch_Output_Timescaledb('demo-sensor-analytics-app-bot',
                                   table_name='demo_sensor_analyzed_data',
                                   vars={'temperature': 'real',
                                         'humidity': 'real'})
    while(running):
        try:
            data = siz.receive(Stream_Input_Zeromq.DTYPE_LIST)
            new_data = list()

            for d in data:
                nd = dict()

                nd['timestamp'] = d['timestamp']
                nd['temperature'] = celsius_to_kelvin(d['temperature'])
                nd['humidity'] = normalize_humidity(d['humidity'])

                new_data.append(nd)

            for nd in new_data:
                bot.send(nd)
        except Exception as e:
            print(e)
except Exception as e:
    print(e)
```

This analytics app receives data from the Gateway through the ZeroMQ Stream Input, which is a default way of transferring data between the Gateway and analytics. Processed data is stored in a TimescaleDB via the TimescaleDB Batch Output. When only `table_name` is provided for this output, the analytics write data into the default database of the node that has the node serial number as a name.

In this example, basic processing is done on the data provided by the demo sensor. Temperature data is converted from Celsius to Kelvin while humidity data is normalized to a range between 0 and 1.

NOTE

The ZeroMQ Publisher output of the Gateway must publish messages on `172.20.10.1` if analytics are running on the node in the `nerve-ds` Docker network. Consequently, the ZeroMQ Stream Input of the analytics must listen on the same IP address.

4. Edit the `Dockerfile` and insert the following:

```
FROM python:3.8.3-slim-buster

WORKDIR /nerve

COPY nerve_dp_analytics_api-1.0-py3-none-any.whl .

RUN pip install wheel nerve_dp_analytics_api-1.0-py3-none-any.whl

WORKDIR /

COPY demo_sensor_analytics_app.py .

CMD [ "python", "-u", "demo_sensor_analytics_app.py" ]
```

5. Enter the following command to build the Docker image containing the analytics app. `nerve-ds-2.1.1` is used as the name in this example:

```
nerve-analytics build -t nerve-ds-2.1.1
```

6. Enter the following command to provision the analytics app as a Docker workload in the Management System:

   ```
   nerve-analytics provision -u https://<MS-URL> -n "Data Services Analytics - demoSe
   ```

   This will provision a Docker workload with the following settings:

Setting	Description
Workload name	Data Services Analytics - demoSensor App
Description	Docker container running a Nerve Data Services analytics app that processes temperature and humidity data.
Version name	nerve-ds-2.1.1
Release name	nerve-ds-2.1.1
CPU resource in percentage	1
Container name	analytics-demo-sensor-app
Network name	nerve-ds

   NOTE

   Due to version differences, the workload is created with a maximum of 1% of allowed CPU usage. Change this setting to a value between 10 and 25.

All settings except **Container name** and **Network name** in the command above or in the Management System are suggestions and can be changed freely.

With the analytics app provisioned in the Management System, the app needs to be deployed to the node to analyze data coming from the demo sensor. Deploy the app to the node that has the demo sensor and the MQTT broker deployed by following Deploying a workload.

Configuring the Data Services Gateway

The configuration below defines an MQTT Subscriber connection to a ZeroMQ Publisher. Upon receiving data from the `demo-sensor-topic` topic of the MQTT Subscriber, the Gateway forwards said data to the ZeroMQ Publisher. The ZeroMQ Publisher in turn publishes the data to the `demo-sensor-topic` ZeroMQ topic that the analytics app listens to. The configuration also defines a connection from the MQTT Subscriber to the TimescaleDB database, which means that the same data received at the MQTT Subscriber end is also written directly into the TimescaleDB.

NOTE

Note that both topics have the same name in this example. However, they are different as they are topics of two different protocols, MQTT and ZeroMQ.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

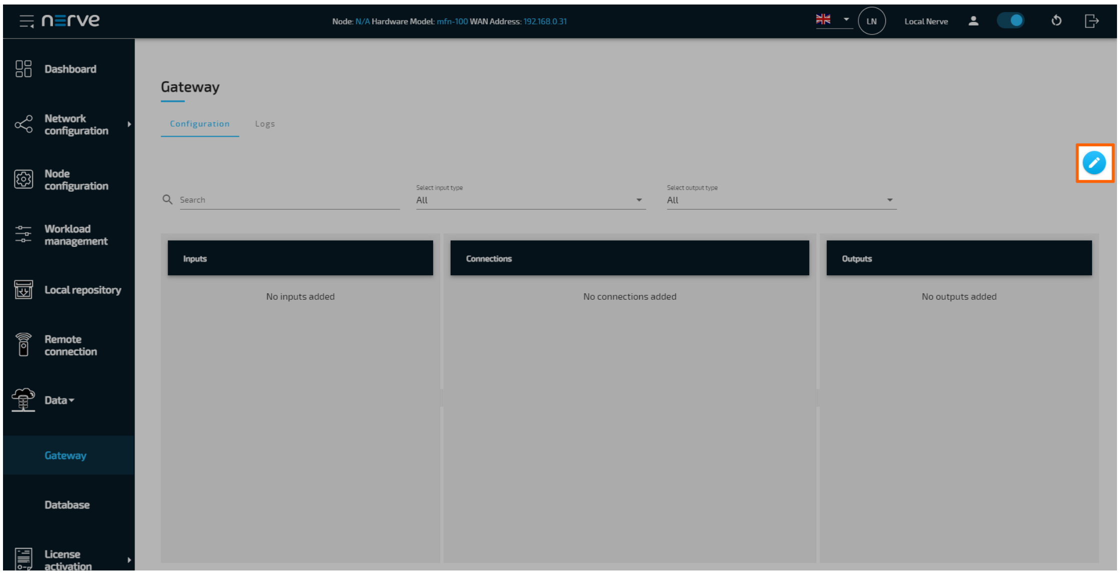
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

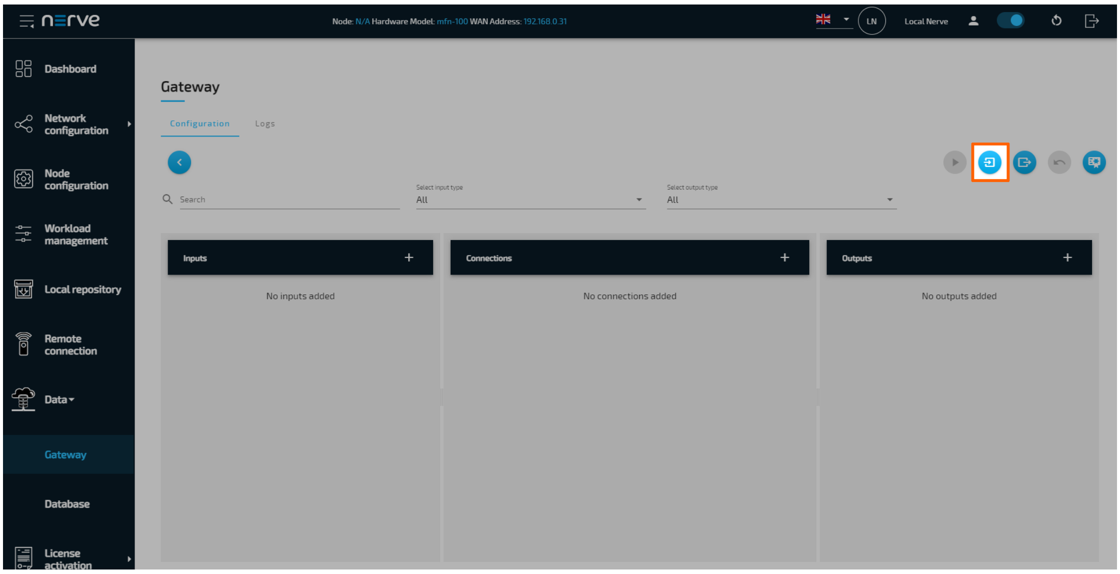
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

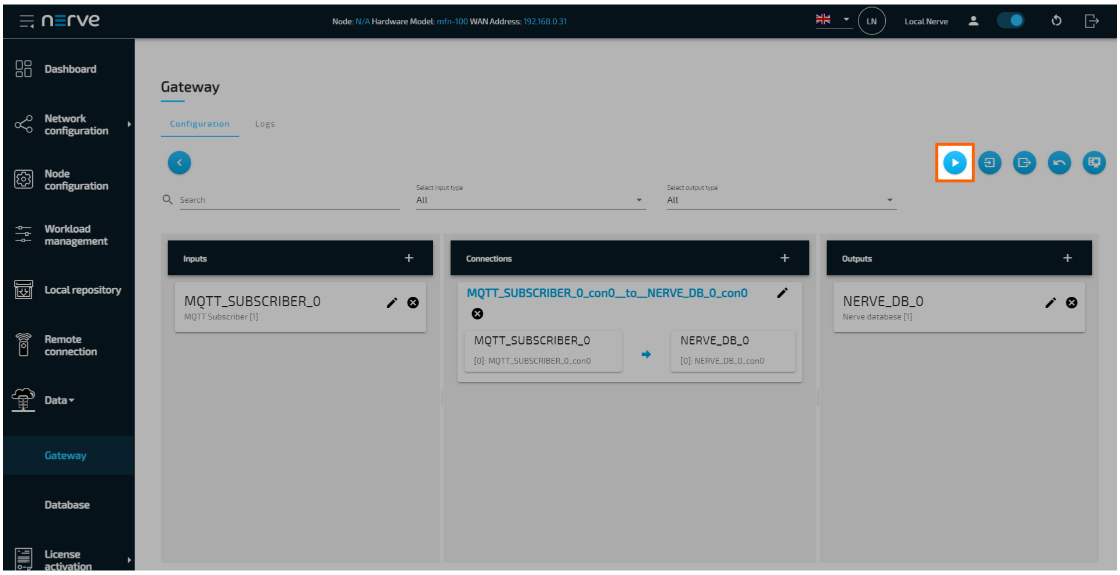
```
{
  "inputs": [
    {
      "type": "MQTT_SUBSCRIBER",
      "name": "mqtt_subscriber",
      "clientId": "mqtt_subscriber_0",
      "serverUrl": "tcp://localhost:1883",
      "keepAliveInterval_s": 20,
      "cleanSession": false,
      "qos": 1,
      "connectors": [
        {
          "name": "mqtt_subscriber_connector_0",
          "topic": "demo-sensor-topic",
          "variables": [
            {
              "name": "temperature",
              "type": "int16"
            },
            {
              "name": "humidity",
              "type": "uint16"
            }
          ]
        }
      ]
    }
  ],
  "outputs": [
    {
      "type": "ZEROMQ_PUBLISHER",
      "name": "zeromq_publisher_0",
      "serverUrl": "tcp://172.20.10.1:5555",
      "connectors": [
        {
          "name": "zeromq_publisher_connector_0",
          "topic": "demo-sensor-topic",
          "timestampRequired": true,
          "timestampFormat": "unix_ns"
        }
      ]
    },
    {
      "type": "DB_TIMESCALE",
      "name": "timescaledb_0",
      "url": "<LOCAL>"
    }
  ],
  "connections": [
    {
      "name": "mqttsub_zmqpub_0",
      "input": {
        "index": 0,
        "connector": 0
      },
      "output": {
        "index": 0,
        "connector": 0
      }
    },
    {
      "name": "mqttsub_timescaledb_0",
      "input": {
        "index": 0,
        "connector": 0
      },
      "output": {
        "index": 1,
        "connector": 0
      }
    }
  ]
}
```

6. Select the **Import** button.



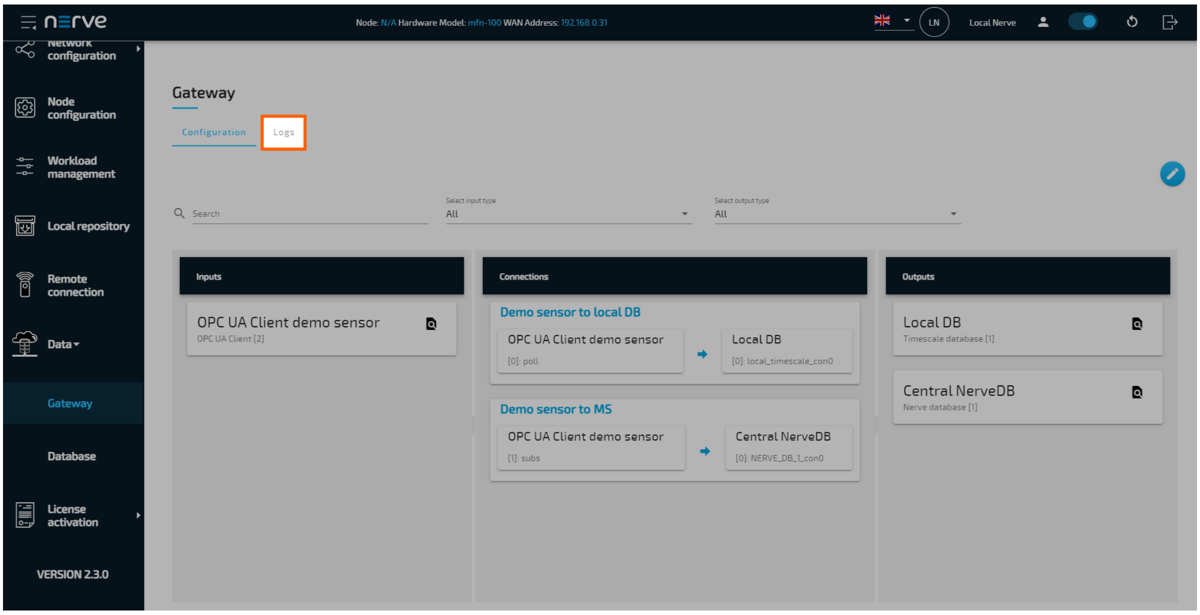
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



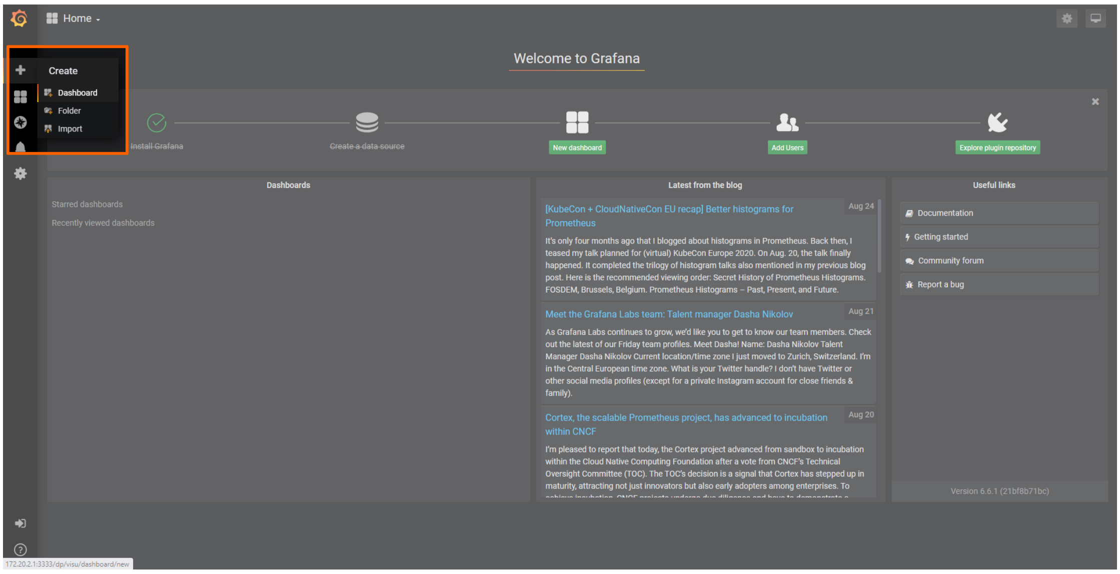
Local data visualization at the node

To visualize the data received by the Gateway and data processed by the analytics app, open the local data visualization element through the Data Services UI on the node. Two queries will be added in the instructions below.

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



Latest from the blog

[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

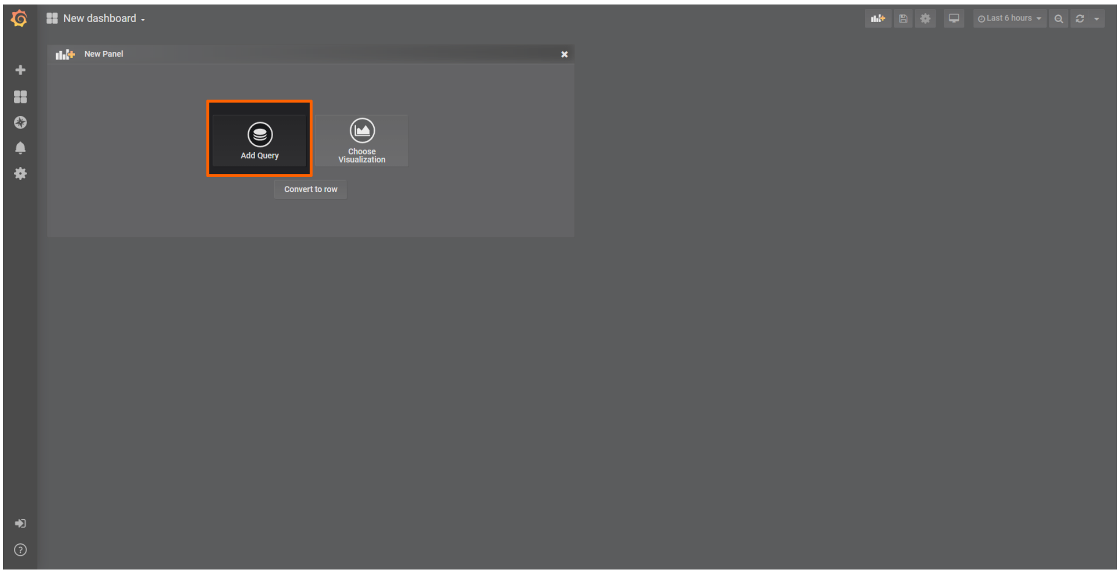
Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

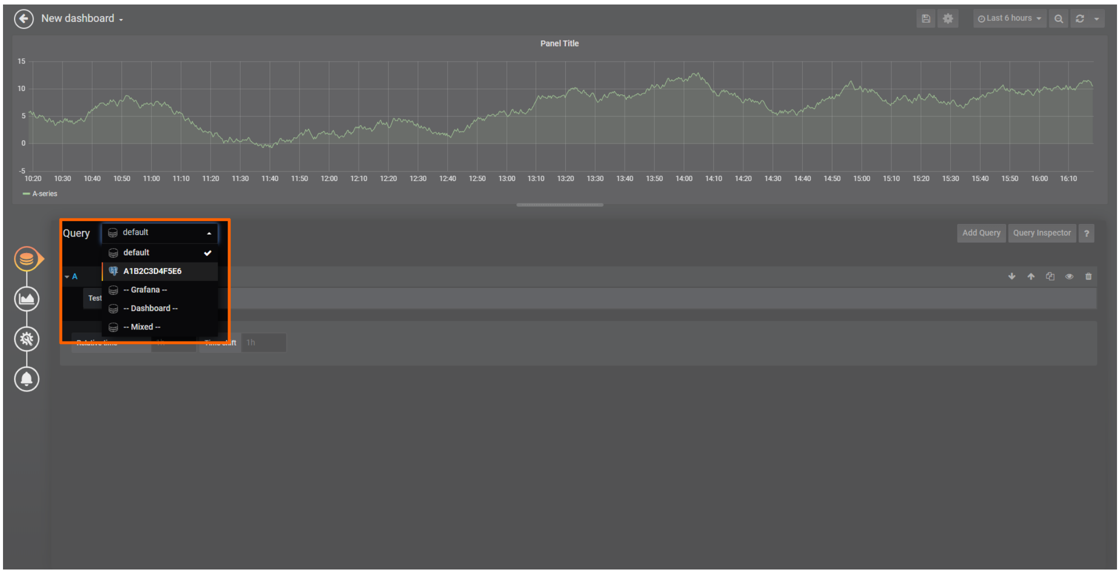
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF — Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



4. Select the data source from the drop-down menu. The name of the data source is the serial number of the node.



5. Fill in the following query information to add the temperature data from the MQTT Subscriber:

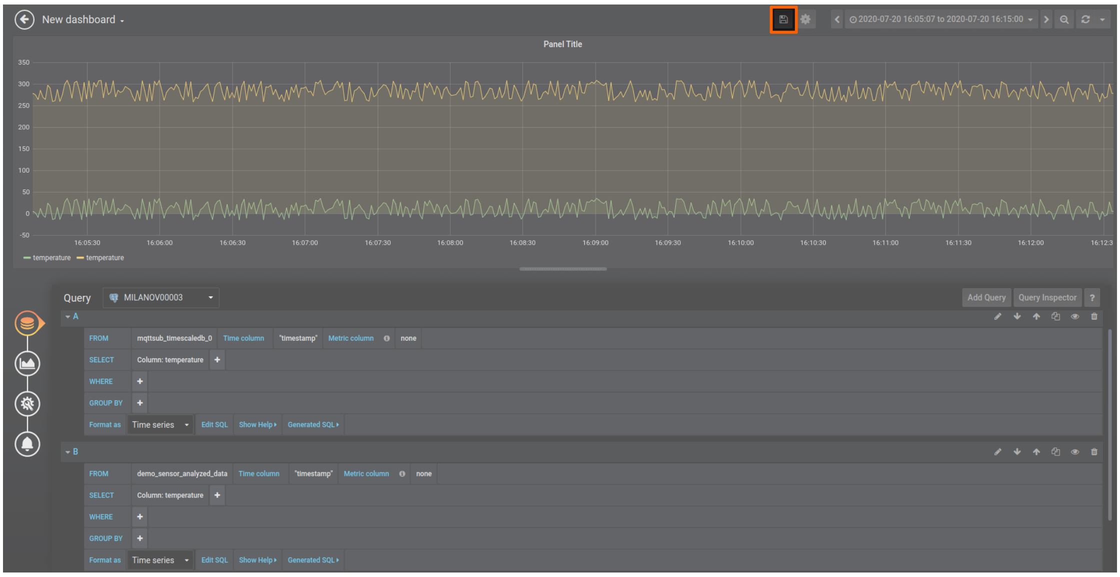
Setting	Value
FROM	mqttsub_timescaledb_0 **Time column**: "timestamp"
SELECT	Column: temperature
Format as	Time series

6. Select **Add Query** to the right to add query B for temperature data analyzed by the analytics app.

7. Fill in the following query information:

Setting	Value
FROM	`demo_sensor_analyzed_data` **Time column**: "timestamp"
SELECT	Column: temperature
Format as	Time series

8. Select the save icon in the upper-right corner to save the dashboard.



Query: MILANOV00003

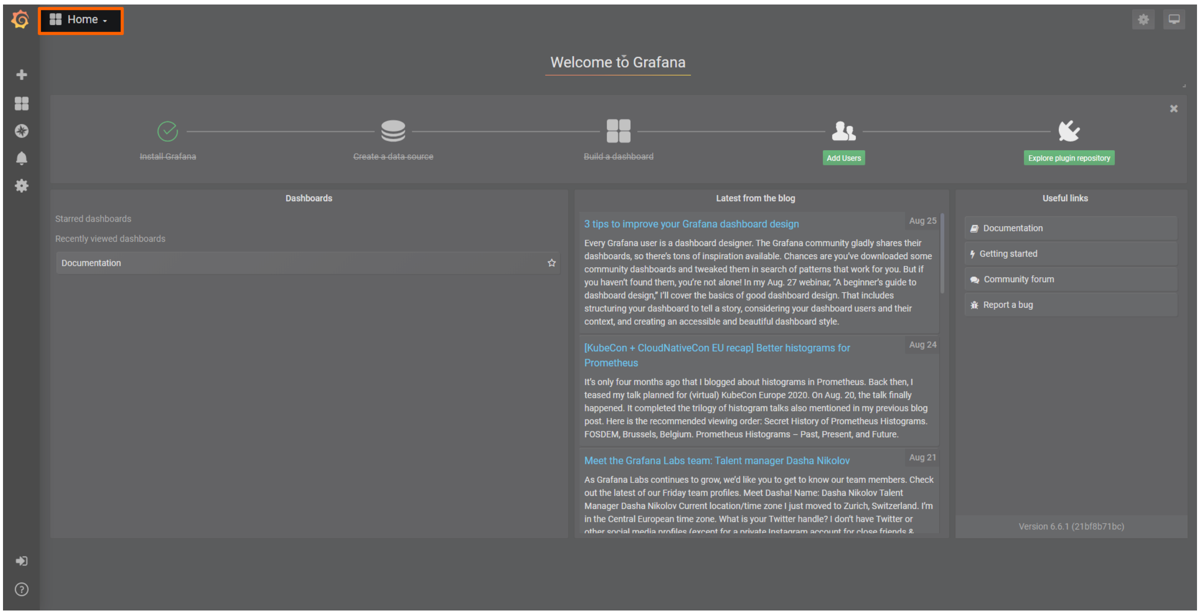
A

FROM	mqttsub_timescaledb_0	Time column	"timestamp"	Metric column	none
SELECT	Column: temperature	+			
WHERE	+				
GROUP BY	+				
Format as	Time series				

B

FROM	demo_sensor_analyzed_data	Time column	"timestamp"	Metric column	none
SELECT	Column: temperature	+			
WHERE	+				
GROUP BY	+				
Format as	Time series				

The dashboard can be accessed from the Grafana home menu.



3 tips to improve your Grafana dashboard design — Aug 25

Every Grafana user is a dashboard designer. The Grafana community gladly shares their dashboards, so there's tons of inspiration available. Chances are you've downloaded some community dashboards and tweaked them in search of patterns that work for you. But if you haven't found them, you're not alone! In my Aug. 27 webinar, "A beginner's guide to dashboard design," I'll cover the basics of good dashboard design. That includes structuring your dashboard to tell a story, considering your dashboard users and their context, and creating an accessible and beautiful dashboard style.

[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

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Custom JSON format example

In this example, data is provided to the Nerve Data Services Gateway in a custom JSON format. Compared to the previous version of the Gateway, data can be input more freely, as it was previously required to strictly adhere to the JSON format of the Gateway.

The data in the custom JSON format is provided by an MQTT Publisher in form of a demo sensor to be processed and stored by the Gateway for visualization at the node.

Provisioning and deploying the sensor simulation and the MQTT broker

In the instructions below two Docker workloads will be provisioned and deployed:

An MQTT broker must to be deployed to the node first in order for the sensor simulation to function. The EMQX MQTT broker is used in this example that can be downloaded from the Docker Hub registry.

Afterwards the temperature and humidity sensors simulation MQTT publisher is deployed. Download the **Data Services MQTT demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload for the EMQX MQTT broker by following Provisioning a Docker workload. This example uses **emqx-4.1.0** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `emqx/emqx:v4.1.0`.
Container name	`emqx`
Network name	`host`

3. Provision a Docker workload for the sensor simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
New environment variable	Select the **+** icon and enter the following information: ◦ **Env. variable** `MQTT_PUB_TOPIC` ◦ **Variable value** `demo-sensor-topic`
Container name	`ttt-mqtt-demo-sensor-1.0`

Setting	Value
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Configuring the Data Services Gateway

The Gateway configuration in the instructions below defines an MQTT subscriber as an input that receives data in a custom JSON format on four different topics. The output is a TimescaleDB database with four different tables, one per topic.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

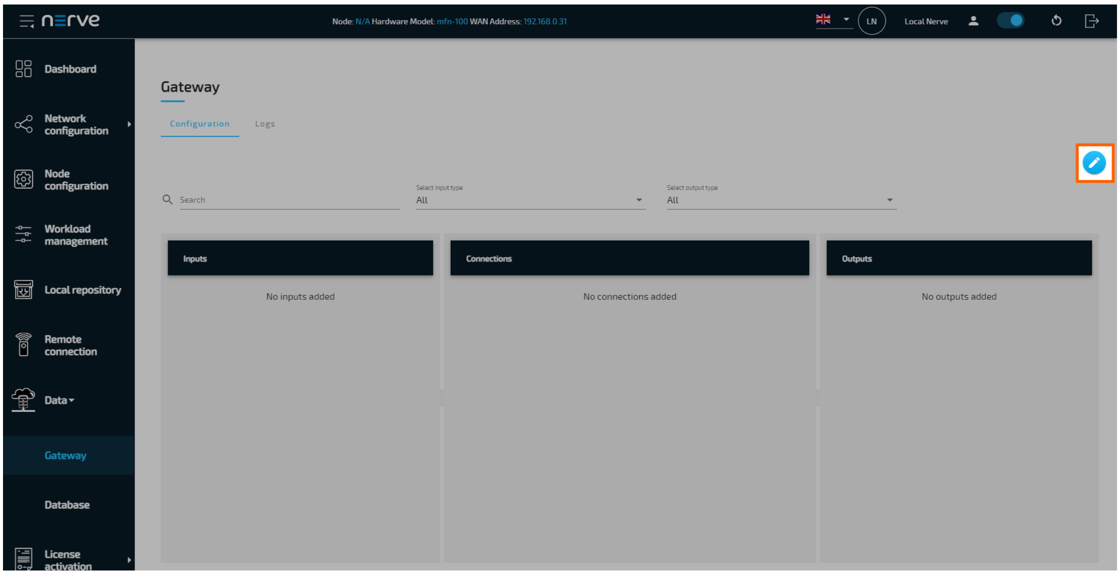
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

4. Select the **Edit configuration** icon on the right to enter editing mode.

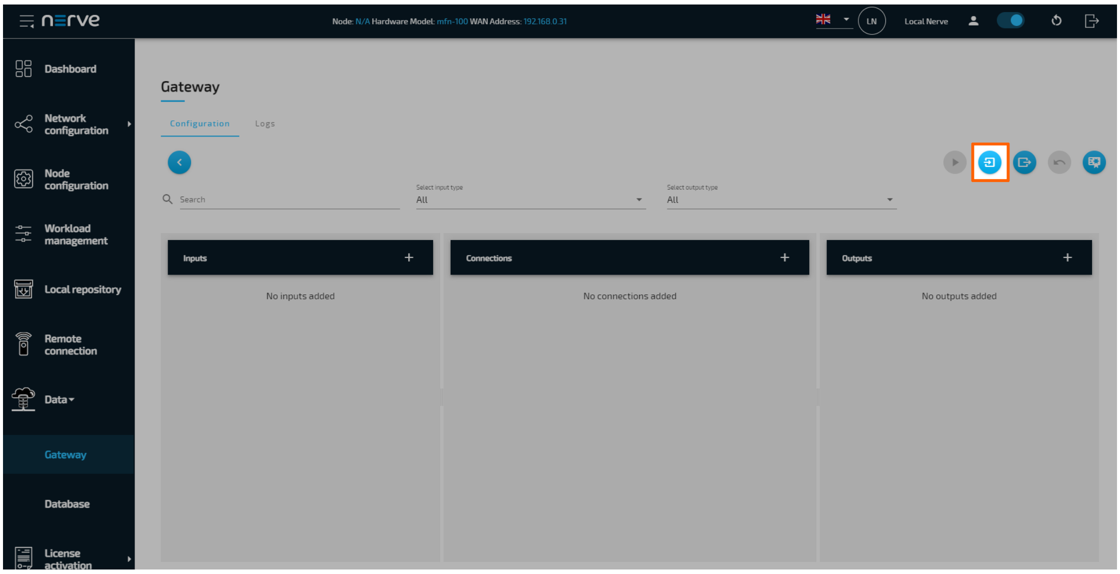


5. Create a JSON file out of the following Gateway configuration:

```
{
    "inputs": [
        {
            "type": "MQTT_SUBSCRIBER",
            "name": "mqtt_subscriber",
            "clientId": "mqtt_subscriber_0",
            "serverUrl": "tcp://localhost:1883",
            "keepAliveInterval_s": 20,
            "cleanSession": true,
            "qos": 1,
            "connectors": [
                {
                    "name": "mqtt_subscriber_connector_0",
                    "topic": "machineA",
                    "variables": [
                        {
                            "name": "temperature",
                            "type": "int32",
                            "path": ".machineA.temperatureSensor"
                        },
                        {
                            "name": "top-left.distance",
                            "type": "double",
                            "path": ".machineA.distance_sensors"
                        },
                        {
                            "name": "top-right.distance",
                            "type": "double",
                            "path": ".machineA.distance_sensors"
                        },
                        {
                            "name": "bottom-left.distance",
                            "type": "double",
                            "path": ".machineA.distance_sensors"
                        },
                        {
                            "name": "bottom-right.distance",
                            "type": "double",
                            "path": ".machineA.distance_sensors"
                        }
                    ]
                },
                {
                    "name": "mqtt_subscriber_connector_1",
                    "topic": "machineB",
                    "timestamp": {
                        "path": ".info.measurement_time[]"
                    },
                    "variables": [
                        {
                            "type": "int32",
                            "path": ".machineB.sensor1[].temperature"
                        },
                        {
                            "type": "uint32",
                            "path": ".machineB.sensor1[].humidity"
                        },
                        {
                            "type": "int32",
                            "path": ".machineB.sensor2[].temperature"
                        },
                        {
                            "type": "uint32",
                            "path": ".machineB.sensor2[].humidity"
                        }
                    ]
                },
                {
```

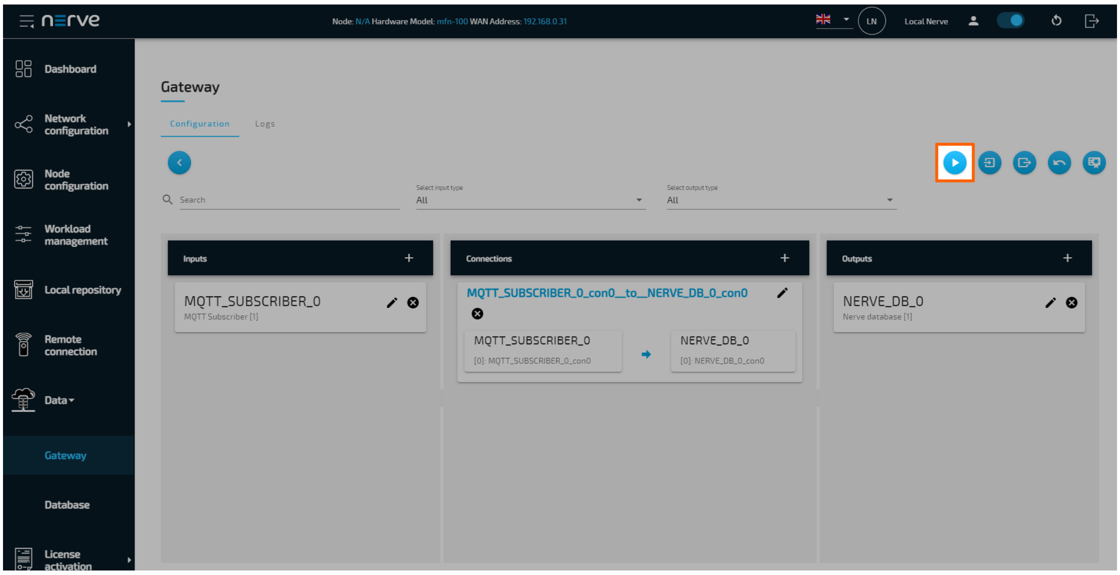
```
                        "name": "mqtt_subscriber_connector_2",
                        "topic": "machineC",
                        "variables": [
                            {
                                "type": "string",
                                "path": ".machineC[*].entry",
                                "maxValues": 4
                            }
                        ]
                    },
                    {
                        "name": "mqtt_subscriber_connector_3",
                        "topic": "all_combined",
                        "variables": [
                            {
                                "type": "uint8",
                                "path": "[*].[]",
                                "maxValues": 11
                            },
                            {
                                "type": "uint8",
                                "path": "[].[*]",
                                "maxValues": 11
                            }
                        ]
                    }
                ]
            }
        ],
        "outputs": [
            {
                "type":"DB_TIMESCALE",
                "name":"outp_timescale",
                "url":"<LOCAL>",
                "connectors": [
                    {
                        "tableName": "machineA_data"
                    },
                    {
                        "tableName": "machineB_data"
                    },
                    {
                        "tableName": "machineC_data"
                    },
                    {
                        "tableName": "all_combined_data"
                    }
                ]
            }
        ],
        "connections": [
            {
                "name": "connection_0",
                "input": { "index": 0, "connector": 0 },
                "output": { "index": 0, "connector": 0 }
            },
            {
                "name": "connection_1",
                "input": { "index": 0, "connector": 1 },
                "output": { "index": 0, "connector": 1 }
            },
            {
                "name": "connection_2",
                "input": { "index": 0, "connector": 2 },
                "output": { "index": 0, "connector": 2 }
            },
            {
                "name": "connection_3",
                "input": { "index": 0, "connector": 3 },
                "output": { "index": 0, "connector": 3 }
            }
        ]
    }
```

6. Select the **Import** button.



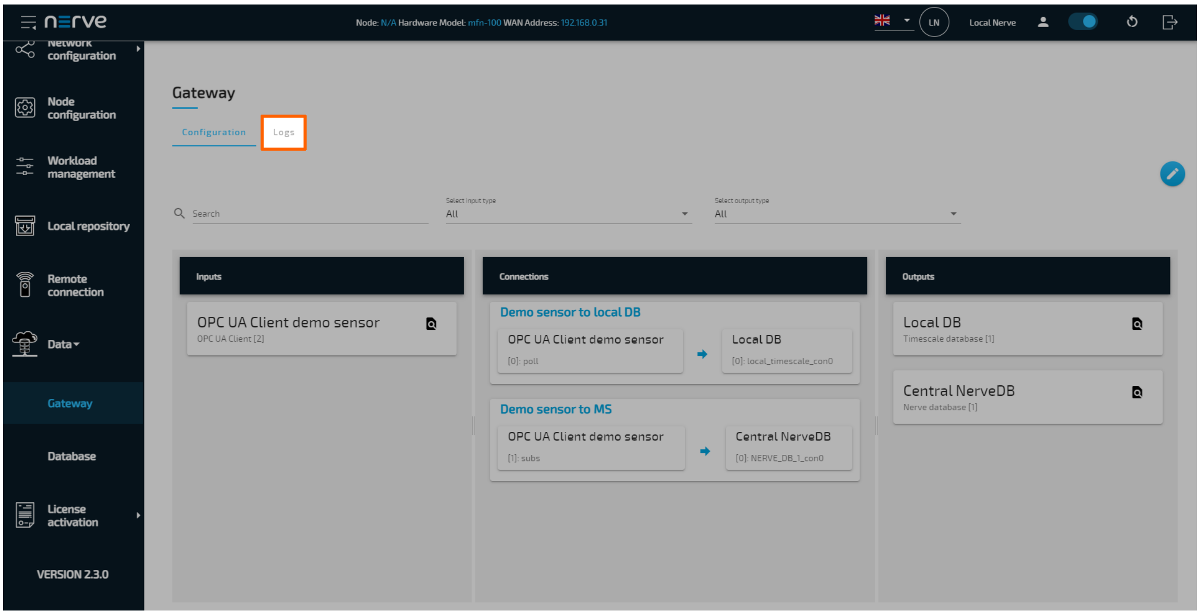
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



Taking a closer look at the data

The input is an MQTT Subscriber that receives data in custom JSON format on four different topics. The output is a TimescaleDB database with four different tables, one per topic or data.

First connector data

The first connector receives data from a simulation sensor:

```
{
    "machineA": {
        "type": "molding",
        "date_installed": "2018-07-03",
        "temperatureSensor": {
            "state": "MEASURING",
            "hasError": false,
            "temperature": 34
        },
        "distance_sensors": {
            "top-left": {
                "distance": 0.26210331244354845,
                "hasError": false
            },
            "top-right": {
                "distance": 0.26046464329587893,
                "hasError": false
            },
            "bottom-left": {
                "distance": 0.6323130733349438,
                "hasError": false
            },
            "bottom-right": {
                "distance": 0.8431831637166814,
                "hasError": false
            }
        }
    }
}
```

With the configuration above only data that is defined in the Gateway configuration is extracted and written into the database. By specifying exactly which fields value is required, all other data is eliminated. This gives flexibility to the Gateway to support all kinds of JSON formats.

Example data table

top-left.distance	top-right.distance	bottom-left.distance	bottom-right.distan
0.26210331244354845	0.26046464329587893	0.6323130733349438	0.8431831637166814

Second connector data

The second connector also receives data from a simulation server, but in batches:

```
{
    "info": {
        "measurement_time": [
            1611936105084752100,
            1611936105084770000,
            1611936105084773000
        ]
    },
    "machineB": {
        "sensor1": [
            {
                "temperature": 25,
                "humidity": 24
            },
            {
                "temperature": 26,
                "humidity": 100
            },
            {
                "temperature": 28,
                "humidity": 78
            }
        ],
        "sensor2": [
            {
                "temperature": -11,
                "humidity": 84
            },
            {
                "temperature": 33,
                "humidity": 5
            },
            {
                "temperature": -11,
                "humidity": 88
            }
        ]
    }
}
```

With the configuration for this connector, the Gateway extracts lists of data. For example, the `sensor1[].temperature` list expansion extracts all temperature field values from `sensor1`. Note that the `sensor1` array must have objects with the same fields. This also applies to `sensor1[].humidity`, `sensor2[].temperature` and `sensor2[].humidity`. Combining all list expansions for the data example above, the Gateway inserts three rows in the database. Each row is constructed by the field index in the JSON.

Example data table

.machineB.sensor1[].temperature	.machineB.sensor1[].humidity	.machineB.sensor2[].
25	24	-11
26	100	33
28	78	-11

Third connector data

The third connector also receives data in batches:

```
{
    "machineC": [
        {
            "entry": "mywclgbwcl"
        },
        {
            "entry": "ctuswukfqp"
        },
        {
            "entry": "maaqnyssvq"
        },
        {
            "entry": "usepjkpylg"
        }
    ]
}
```

Here only a single array of data is received to show the use of the variable expansion. The Gateway reads `machineC[*].entry` as a list of entries. However, instead of inserting four rows into the database, it inserts one row with four columns. Each column is labelled with the name of the values field and extended with an index of the field in the array. By supporting variable expansion, the Gateway can fetch multiple variables from a JSON without specifying them all.

Example data table

.machineC[*].entry-0	.machineC[*].entry-1	.machineC[*].entry-2	.machineC[*].entry-
mywclgbwcl	ctuswukfqp	maaqnyssvq	usepjkpylg

Fourth connector data

The last connector shows the use case of combining list and variable expansions in a single Gateway variable:

```
[
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
    [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
]
```

The first variable specifies the variable expansion first and the list expansion second (`[*].[]`). This means that a variable is each individual array and that array values are fetched as a list. Ten columns are created with ten rows inserted. Each row holds its respective value (first row, all 0, second row, all 1...).

[*].[]-0	[*].[]-1	[*].[]-2	[*].[]-3	[*].[]-4	[*].[]-5	[*].[]-6	[*].[]-7	[*].[]-8	[*].[]-9	[*].[]-10
0	0	0	0	0	0	0	0	0	0	
1	1	1	1	1	1	1	1	1	1	
2	2	2	2	2	2	2	2	2	2	
3	3	3	3	3	3	3	3	3	3	
4	4	4	4	4	4	4	4	4	4	
5	5	5	5	5	5	5	5	5	5	
6	6	6	6	6	6	6	6	6	6	
7	7	7	7	7	7	7	7	7	7	
8	8	8	8	8	8	8	8	8	8	
9	9	9	9	9	9	9	9	9	9	
10	10	10	10	10	10	10	10	10	10	

The second variable specifies the list expansion first and the variables expansion second (`[].[*]`). This means that a variable is a single element in an array and that values are fetched from all arrays for that element. Ten columns are created with ten rows inserted. Each column holds its respective value (first column, all 0, second column, all 1...).

[].[*]-0	[].[*]-1	[].[*]-2	[].[*]-3	[].[*]-4	[].[*]-5	[].[*]-6	[].[*]-7	[].[*]-8	[].[*]-9	[].[*]10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10

[]. [*]-0	[]. [*]-1	[]. [*]-2	[]. [*]-3	[]. [*]-4	[]. [*]-5	[]. [*]-6	[]. [*]-7	[]. [*]-8	[]. [*]-9	[]. [*]10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10
0	1	2	3	4	5	6	7	8	9	10

Local data visualization at the node

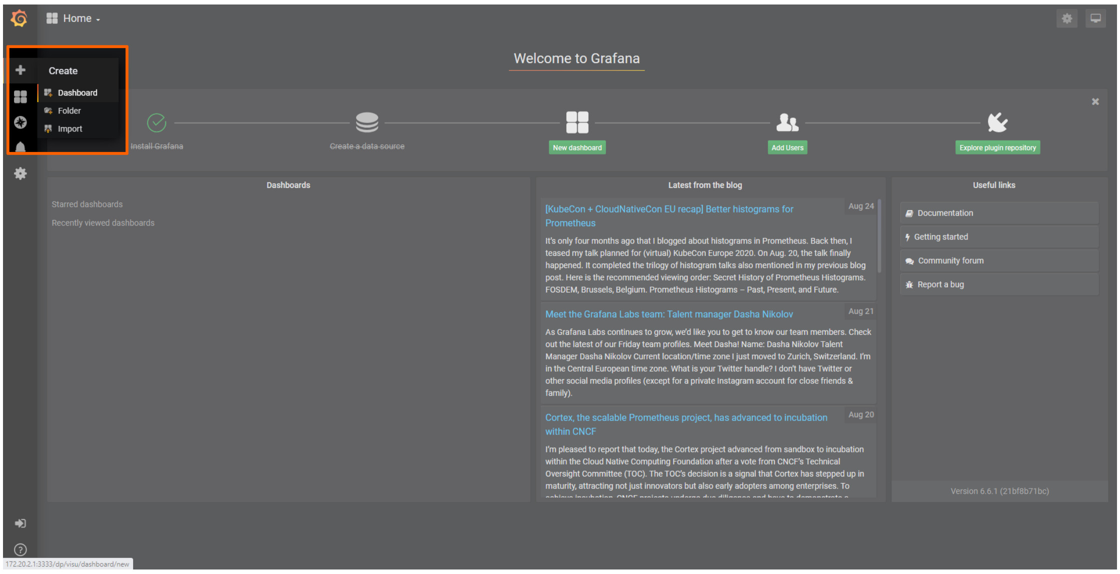
To visualize the data received by the Gateway, open the local data visualization element through the Data Services UI on the node. Two separate queries will be added in the instructions below.

Visualizing machineA data

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



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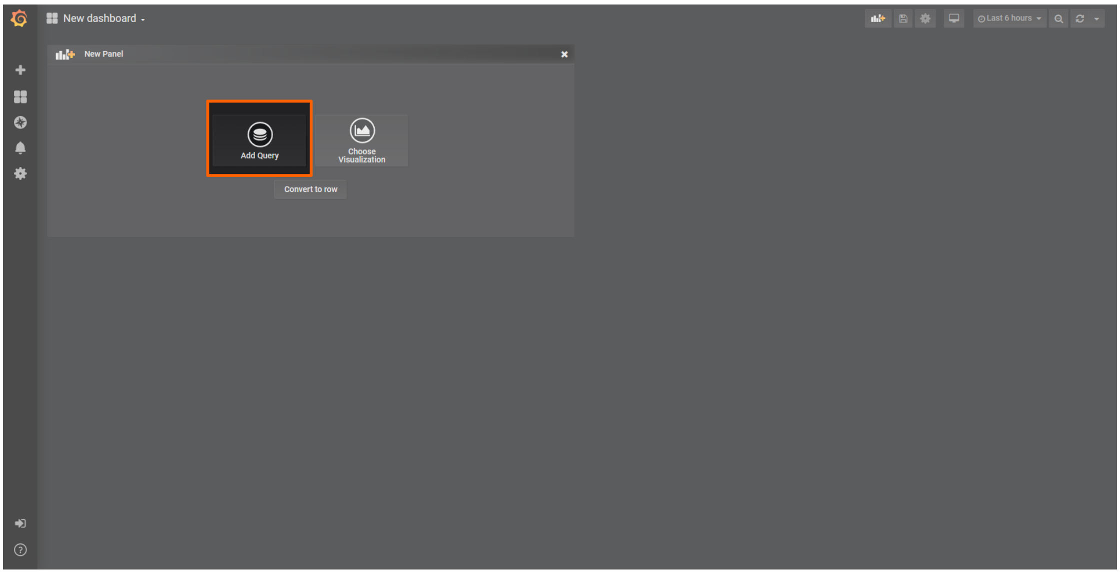
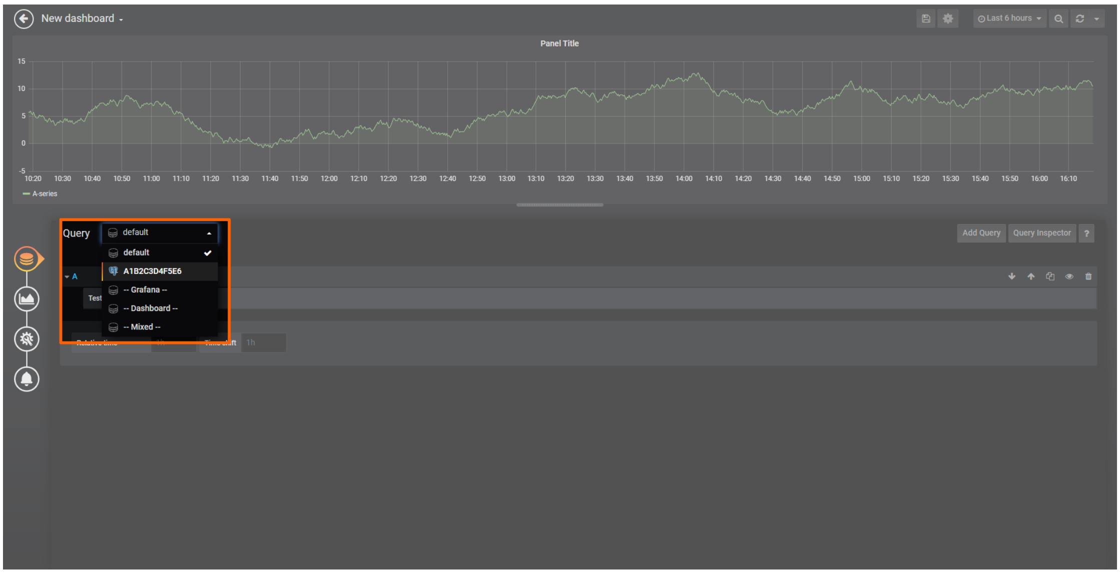
3. Select **Add Query** in the **New Panel** box.



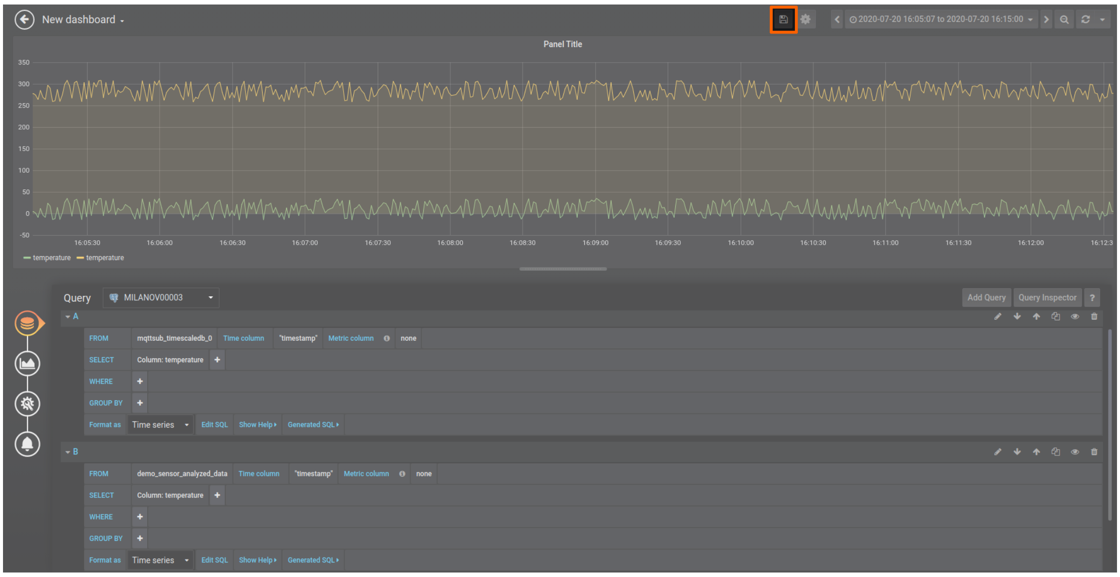
4. Select the data source from the drop-down menu. The name of the data source is the serial number of the node.



5. Fill in the following query information to add the data of Machine A:

Setting	Value
FROM	`machineA_data` **Time column**: "timestamp"
SELECT	Column: "bottom-left.distance" Column: "bottom-right.distance" Column: "top-left.distance" Column: "top-right.distance"
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.

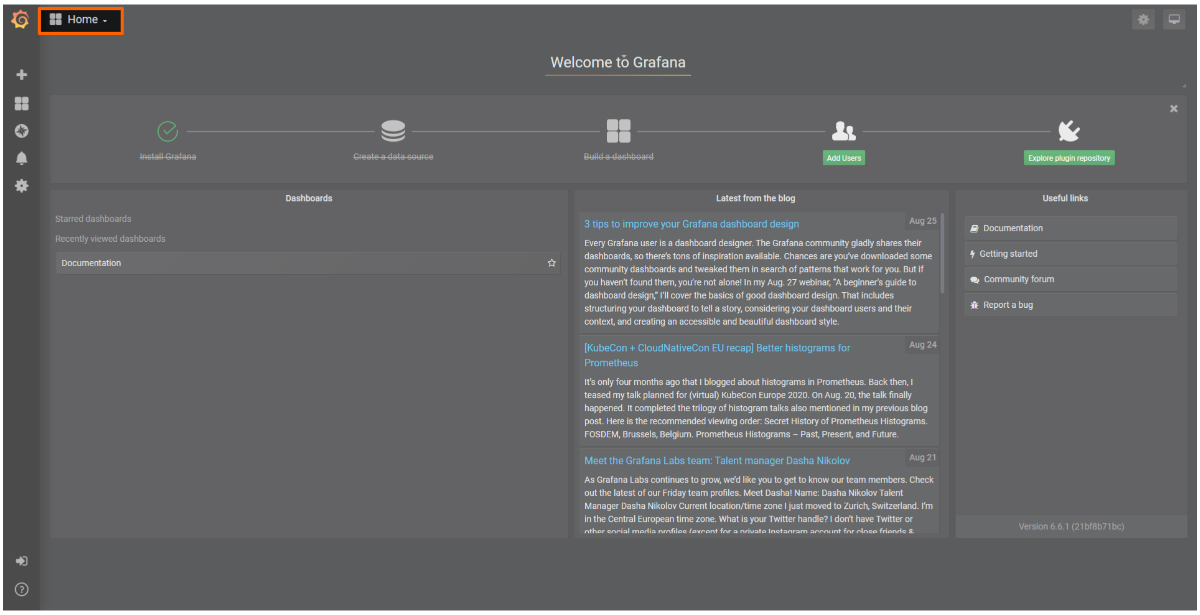


Query: MILANOV00003

A
FROM mqttsub_timescaledb_0 Time column "timestamp" Metric column none
SELECT Column: temperature +
WHERE +
GROUP BY +
Format as Time series Edit SQL Show Help Generated SQL

B
FROM demo_sensor_analyzed_data Time column "timestamp" Metric column none
SELECT Column: temperature +
WHERE +
GROUP BY +
Format as Time series Edit SQL Show Help Generated SQL

The dashboard can be accessed from the Grafana home menu.



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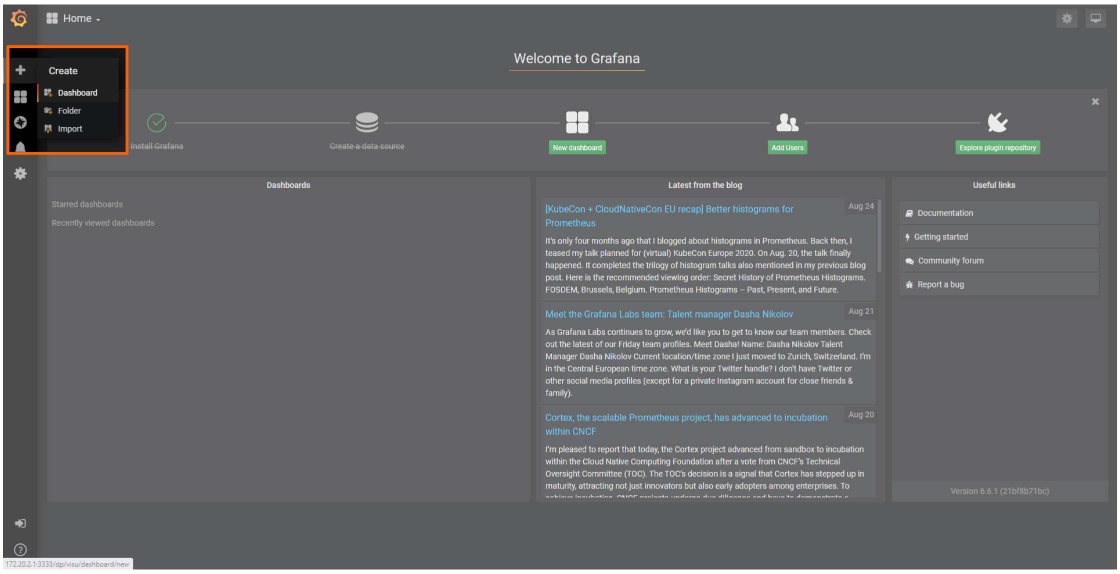

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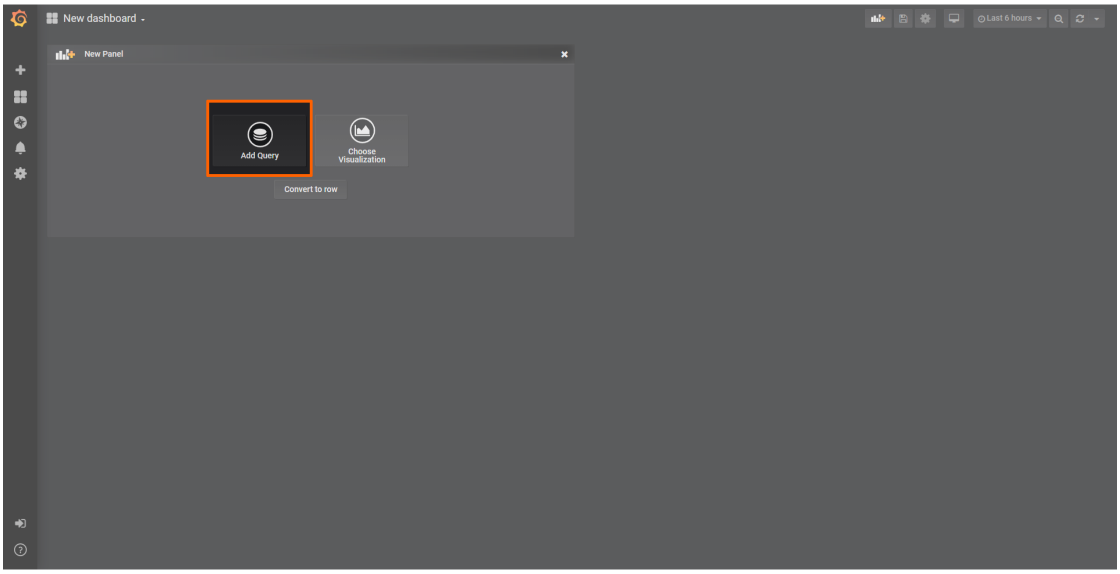

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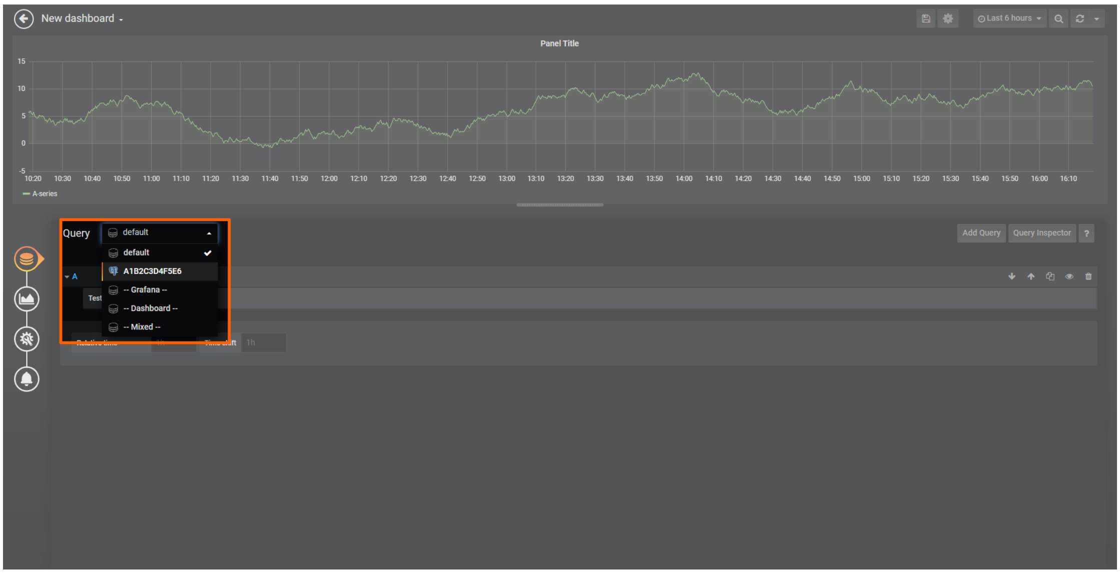
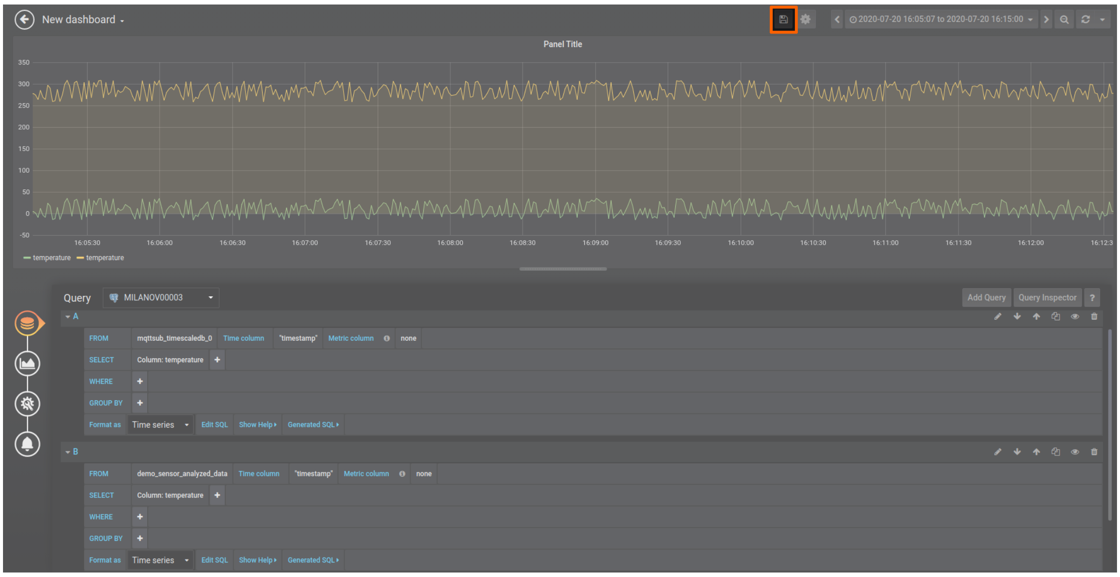


5. Fill in the following query information to add the data of Machine B:

Setting	Value
FROM	`machineB_data` **Time column**: "timestamp"
SELECT	Column: ".machineB.sensor1[].humidity" Column: ".machineB.sensor1[].temperature" Column: ".machineB.sensor2[].humidity" Column: ".machineB.sensor2[].temperature"
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.



Query: MILANOV00003

A
FROM mqttsub_timescaledb_0 Time column "timestamp" Metric column none
SELECT Column: temperature
WHERE
GROUP BY
Format as Time series

B
FROM demo_sensor_analyzed_data Time column "timestamp" Metric column none
SELECT Column: temperature
WHERE
GROUP BY
Format as Time series

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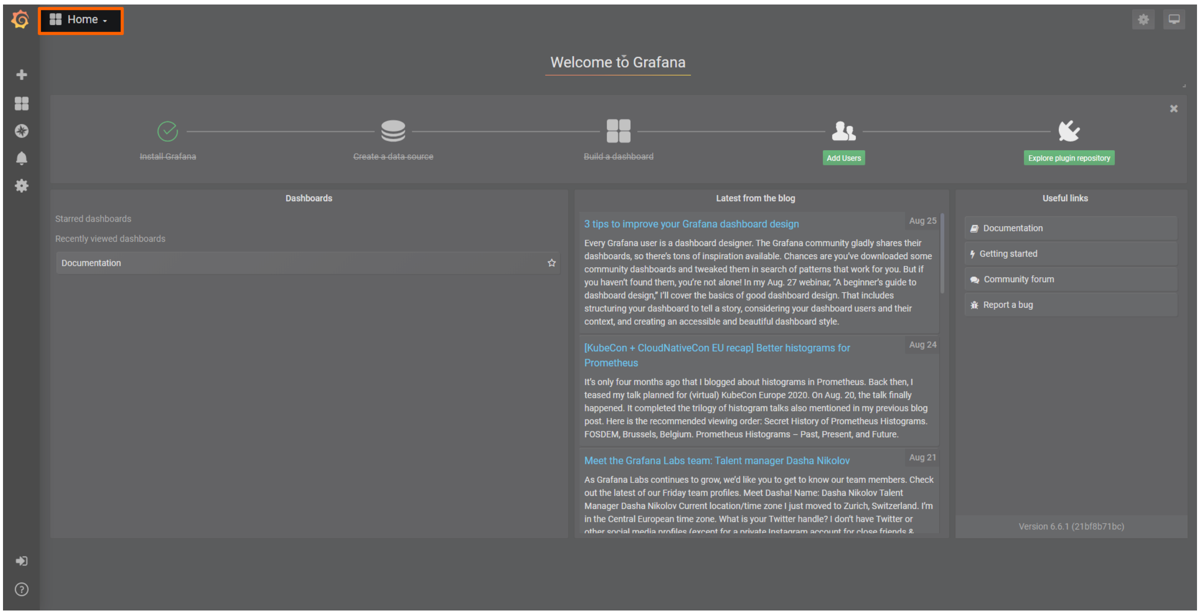

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Sending data to MS Azure IoT Hub

This example demonstrates the basic usage of the Gateway's Azure IoT Hub device output in order to show how to provide a bridge between Nerve and Microsoft's IoT infrastructure. The instructions below describe an easy-to-use way to send data from an MQTT demo sensor to an MS Azure IoT Hub device.

NOTE

An MS Azure IoT Hub device is required before attempting the following example. Refer to the official Microsoft Azure IoT Hub documentation in the section Create a hub using the Azure portal for more information.

Provisioning and deploying the sensor simulation and the MQTT broker

In the instructions below two Docker workloads will be provisioned and deployed:

An MQTT broker must to be deployed to the node first in order for the sensor simulation to function. The EMQX MQTT broker is used in this example that can be downloaded from the Docker Hub registry.

Afterwards the temperature and humidity sensors simulation MQTT publisher is deployed. Download the **Data Services MQTT demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.
2. Provision a Docker workload for the EMQX MQTT broker by following Provisioning a Docker workload. This example uses **emqx-4.1.0** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `emqx/emqx:v4.1.0`.
Container name	`emqx`
Network name	`host`

3. Provision a Docker workload for the sensor simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
New environment variable	Select the **+** icon and enter the following information: ◦ **Env. variable** `MQTT_PUB_TOPIC` ◦ **Variable value** `demo-sensor-topic`
Container name	`ttt-mqtt-demo-sensor-1.0`
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Configuring the Data Services Gateway

The example demonstrates the simplest configuration for the Azure IoT Hub Device output and omits any parameters that are not required. Since the definition of a connector has been omitted, the Gateway will generate a default connector at index 0 with the following fields:

- **name**: automatically generated name that is used in logs
- **timestampRequired**: `false`

Follow the instructions below to apply the Gateway configuration.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

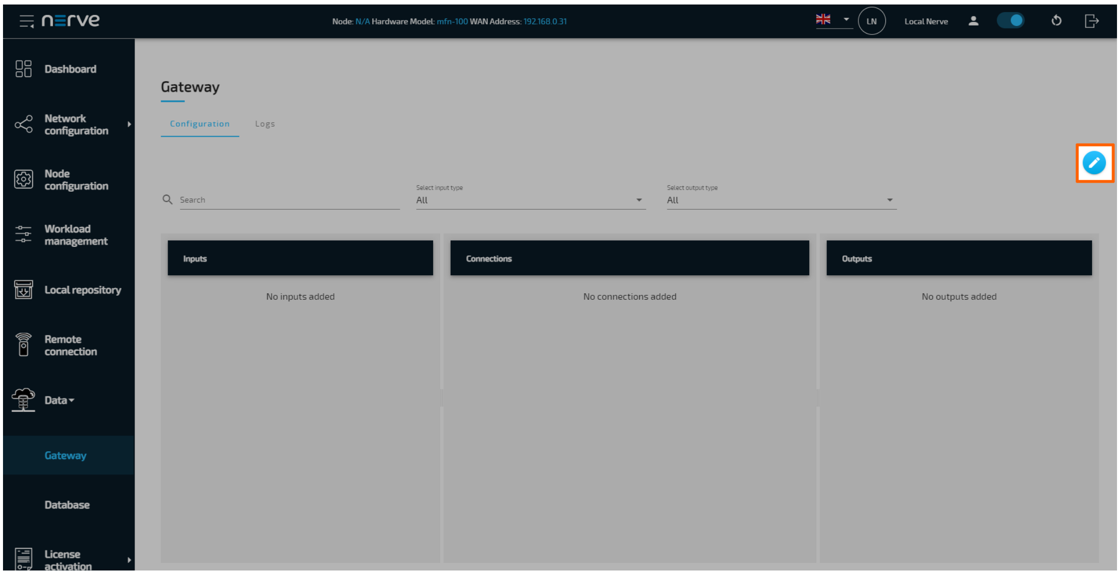
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

4. Select the **Edit configuration** icon on the right to enter editing mode.

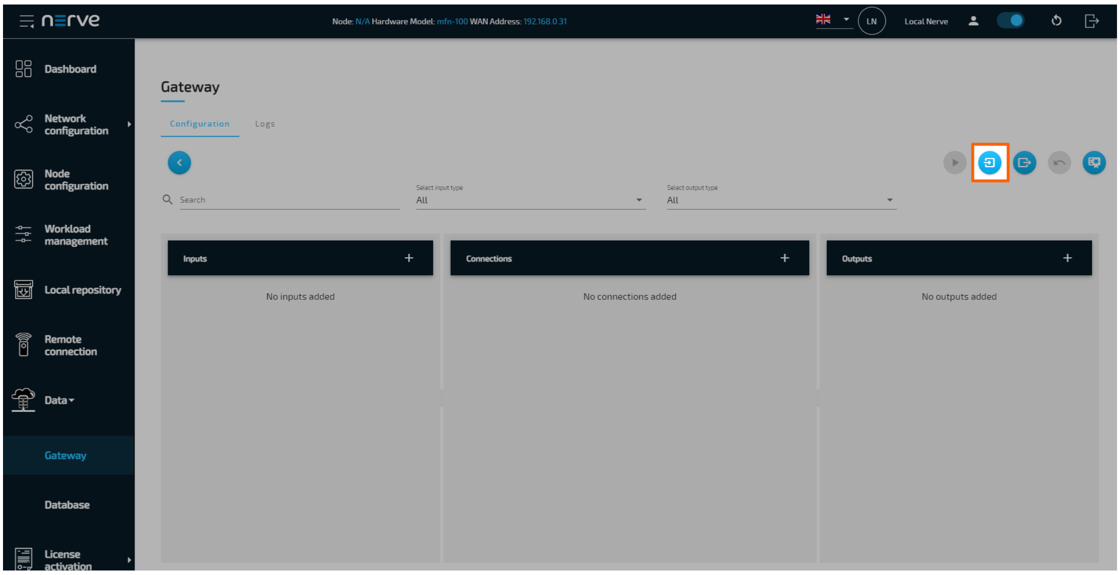


5. Create a JSON file out of the following Gateway configuration:

```
{
    "inputs": [
        {
            "type": "MQTT_SUBSCRIBER",
            "clientId": "mqtt_subscriber_0",
            "serverUrl": "tcp://localhost:1883",
            "keepAliveInterval_s": 20,
            "cleanSession": true,
            "qos": 1,
            "connectors": [
                {
                    "topic": "demo-sensor-topic",
                    "variables": [
                        {
                            "name": "temperature",
                            "type": "int16"
                        },
                        {
                            "name": "humidity",
                            "type": "uint16"
                        }
                    ]
                }
            ]
        }
    ],
    "outputs": [
        {
            "type": "AZURE_IOT_HUB_DEVICE",
            "deviceConnectionString": "HostName=<YOUR_IOT_HUB_HOSTNAME>;DeviceId=<
        }
    ],
    "connections" : [
        {
            "input": { "index" : 0, "connector" : 0 },
            "output": { "index" : 0, "connector" : 0 }
        }
    ]
}
```

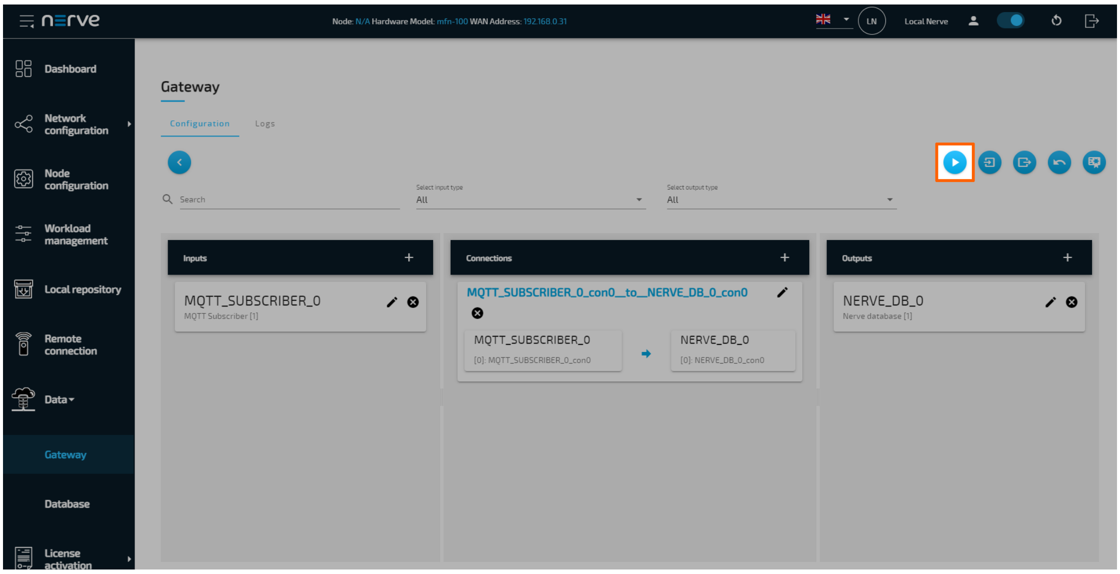
> **NOTE**
>
> Replace the value of `deviceConnectionString` in the configuration above with the connection string of the device that was created before in the MS Azure IoT Hub. Make sure to copy the string that is marked as PRIMARY. Refer to Register a new device in the IoT hub in the official Microsoft Azure IoT Hub documentation for more information.

6. Select the **Import** button.



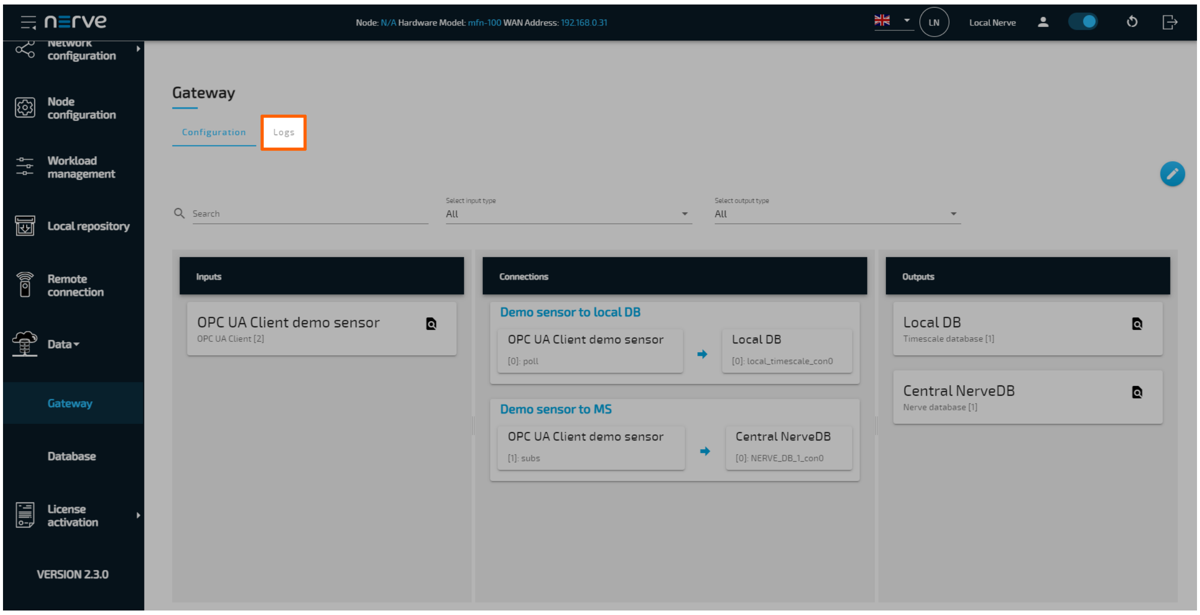
7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



Verifying the data transmission

The official Microsoft Azure IoT Hub documentation describes multiple ways of verifying if data is being sent from the Nerve node to the Azure IoT Hub device. This example uses a python script utilizing the built-in event hub that is available by default for every created Azure IoT Hub device. This method is valid for every type of Azure subscription, including the free or basic tier. The script is taken from the official Azure sample repository on GitHub. To get it, clone the repository by opening the terminal and running the following command. This requires Git to be installed on the workstation:

```
git clone https://github.com/Azure-Samples/azure-iot-samples-python
```

If Git is not installed, visit the repository page and select **Code > Download ZIP** to download the repository as a ZIP file.

NOTE

Python version 3.7.0 or higher is required to successfully run the example.

1. Navigate to `iot-hub/Quickstarts/read-d2c-messages/` inside the cloned repository.
2. Open the `Readme.md` file.
3. Read the instructions carefully.
4. Choose either the `read_device_to_cloud_messages_async.py` or `read_device_to_cloud_messages_sync.py`. This example works with both scripts.

5. Replace the placeholder variables below in the chosen script with information from the Event Hub-compatible connection string. This string is obtained when the Azure IoT Hub device is created.

EVENTHUB_COMPATIBLE_ENDPOINT
EVENTHUB_COMPATIBLE_PATH
IOTHUB_SAS_KEY

6. Enter the following command to install the `azure-eventhub` package:

```
pip install azure-eventhub
```

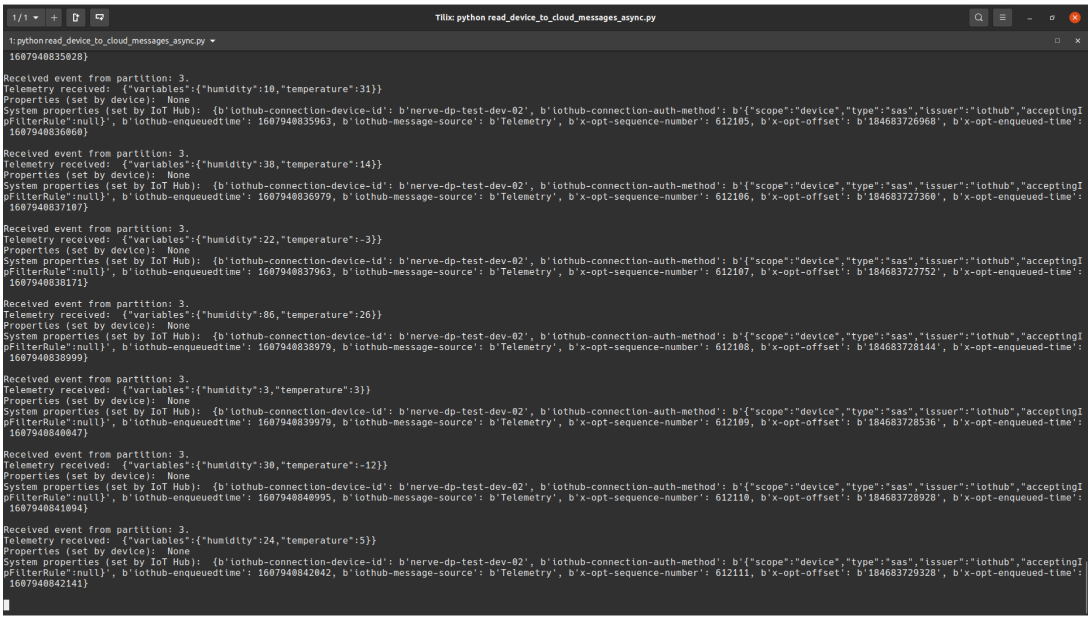
7. Run the script that was chosen earlier with one of the following commands or executing the file:

```
python read_device_to_cloud_messages_async.py
```

or

```
python read_device_to_cloud_messages_sync.py
```

The result of the script will look similar to the screenshot below:



1 / 1
Tilix: python read_device_to_cloud_messages_async.py
1: python read_device_to_cloud_messages_async.py

```
 1607940835028}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":10,"temperature":31}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940835963, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612105, b'x-opt-offset': b'184683726968', b'x-opt-enqueued-time':
 1607940836060}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":38,"temperature":14}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940836979, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612106, b'x-opt-offset': b'184683727360', b'x-opt-enqueued-time':
 1607940837107}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":22,"temperature":-3}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940837963, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612107, b'x-opt-offset': b'184683727752', b'x-opt-enqueued-time':
 1607940838171}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":86,"temperature":26}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940838979, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612108, b'x-opt-offset': b'184683728144', b'x-opt-enqueued-time':
 1607940838999}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":3,"temperature":3}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940839979, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612109, b'x-opt-offset': b'184683728536', b'x-opt-enqueued-time':
 1607940840047}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":30,"temperature":-12}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940840995, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612110, b'x-opt-offset': b'184683728928', b'x-opt-enqueued-time':
 1607940841094}

Received event from partition: 3.
Telemetry received:  {"variables":{"humidity":24,"temperature":5}}
Properties (set by device):  None
System properties (set by IoT Hub):  {b'iothub-connection-device-id': b'nerve-dp-test-dev-02', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","acceptingI
pFilterRule":null}', b'iothub-enqueuedtime': 1607940842042, b'iothub-message-source': b'Telemetry', b'x-opt-sequence-number': 612111, b'x-opt-offset': b'184683729328', b'x-opt-enqueued-time':
 1607940842141}
```

Modbus server data to InfluxDB for visualization

This example shows how to set up Modbus as an input for the Gateway. It uses a Modbus simulation server that holds temperature and humidity data inside its holding registers. This server is provided as a Docker container. Data is then written into an InfluxDB that is also provided as a Docker container and visualized at the node.

NOTE

Note that InfluxDB version 1.X is supported by the Data Services. In this version, InfluxDB 2.0 is not supported.

Provisioning and deploying the simulation server and the InfluxDB

In the instructions below two Docker workloads will be provisioned and deployed:

A Modbus simulation server is deployed to the node that holds temperature and humidity data inside its holding registers. The simulation server is provided as a Docker container and can be downloaded under **Example Applications** from the Nerve Software Center.

After that an InfluxDB that gathers data from the Modbus simulation server is deployed to the node. The InfluxDB is also provided as a Docker container.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload for the server simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the server simulation that has been downloaded from the Nerve Software Center.
Container name	`modbus-demo-server`
Network name	`host`

3. Provision a Docker workload for the InfluxDB by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `influxdb:1.8.3`.
Docker volumes for persistent storage	`influxdb:/var/lib/influxdb`
Container name	`influxdb`
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Creating a database over a remote connection

A database needs to be created first that will receive data from the Modbus simulation server. In this example this is done with a remote tunnel for port 8086. The connection is then established through the Nerve Connection Manager so that an HTTP requests can be sent to the InfluxDB.

1. Configure a remote tunnel by following Configuring a remote tunnel to a workload. Use the following settings:

Setting	Value
Name	Enter any name for the remote connection.
Local acknowledgment	Select **Yes** or **No** from the drop-down menu.
Port on node	8086
Port on PC	Enter a free port on the local workstation.

2. Use the remote tunnel by following Using a remote tunnel to a workload. Make sure to select the InfluxDB Docker workload.

3. Open a command-line interface.

4. Enter the following command to create a database in the InfluxDB. Note that this command requires cURL to be installed.

   ```
   curl -POST http://localhost:8086/query --data-urlencode "q=CREATE DATABASE data"
   ```

Configuring the Data Services Gateway

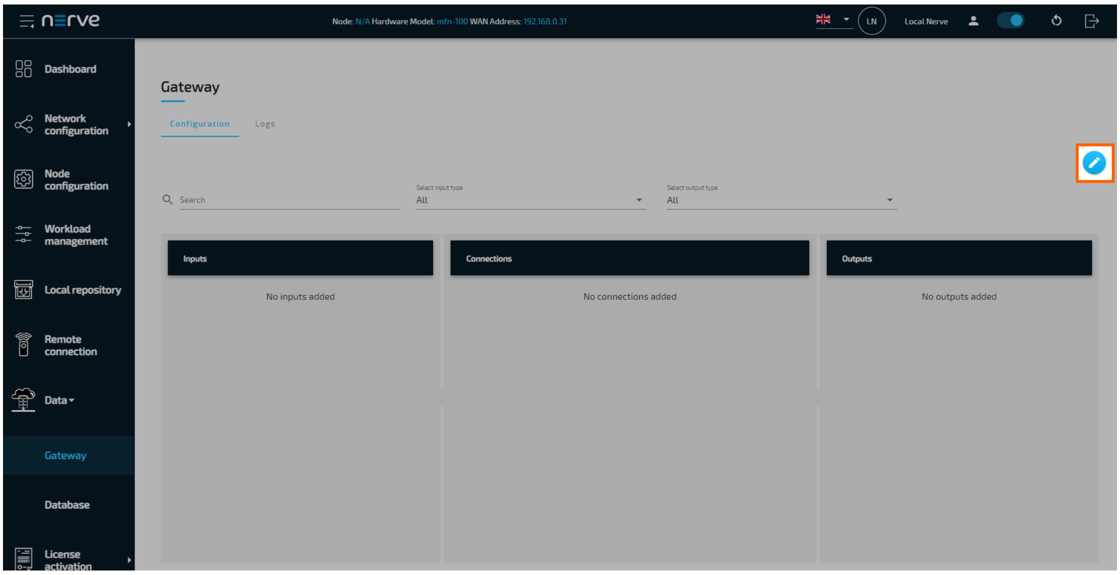
The configuration below defines the Modbus simulation as an input that delivers humidity and temperature data. The InfluxDB is defined as the output.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

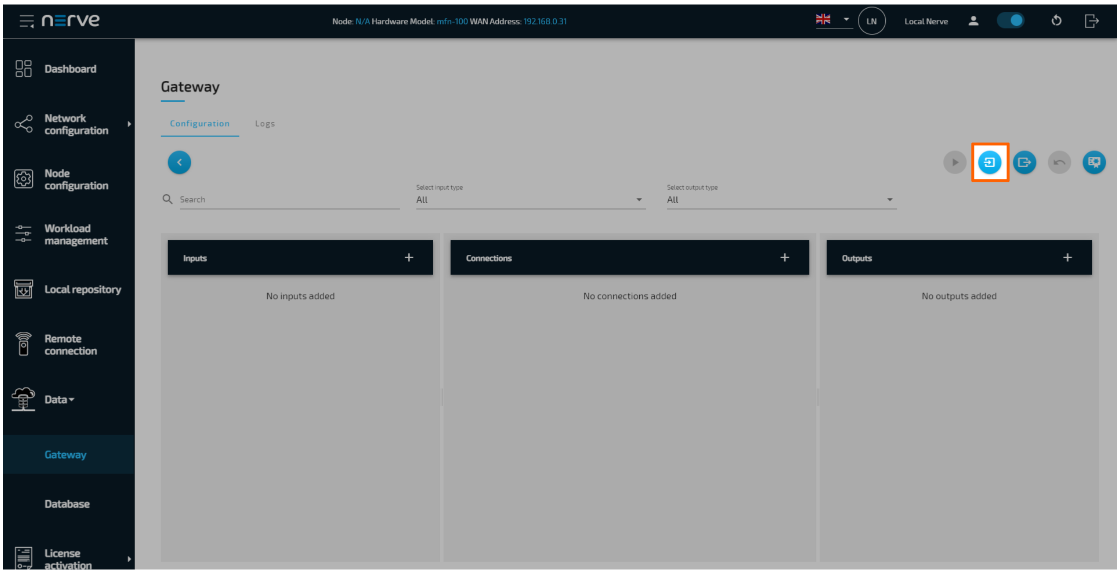
2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.
3. Select **Gateway**.
4. Select the **Edit configuration** icon on the right to enter editing mode.



5. Create a JSON file out of the following Gateway configuration:

```
{
    "inputs": [
        {
            "type": "MODBUS_CLIENT",
            "name": "modbus_client",
            "serverUrl": "127.0.0.1",
            "port": 10503,
            "pollingInterval_ms": 1000,
            "connectors": [
                {
                    "name": "modbus_connector_0",
                    "holdingRegisters": [
                        {
                            "name": "temperature",
                            "address": 0,
                            "type": "int16"
                        },
                        {
                            "name": "humidity",
                            "address": 4,
                            "type": "int16"
                        }
                    ]
                }
            ]
        }
    ],
    "outputs": [
        {
            "type": "DB_INFLUX",
            "name": "influxdb_output",
            "url": "localhost",
            "port": 8086,
            "connectors": [
                {
                    "name": "modbus_data",
                    "dbName": "data"
                }
            ]
        }
    ],
    "connections" : [
        {
            "name": "connection_0",
            "input": { "index" : 0, "connector" : 0 },
            "output": { "index" : 0, "connector" : 0 }
        }
    ]
}
```

6. Select the **Import** button.



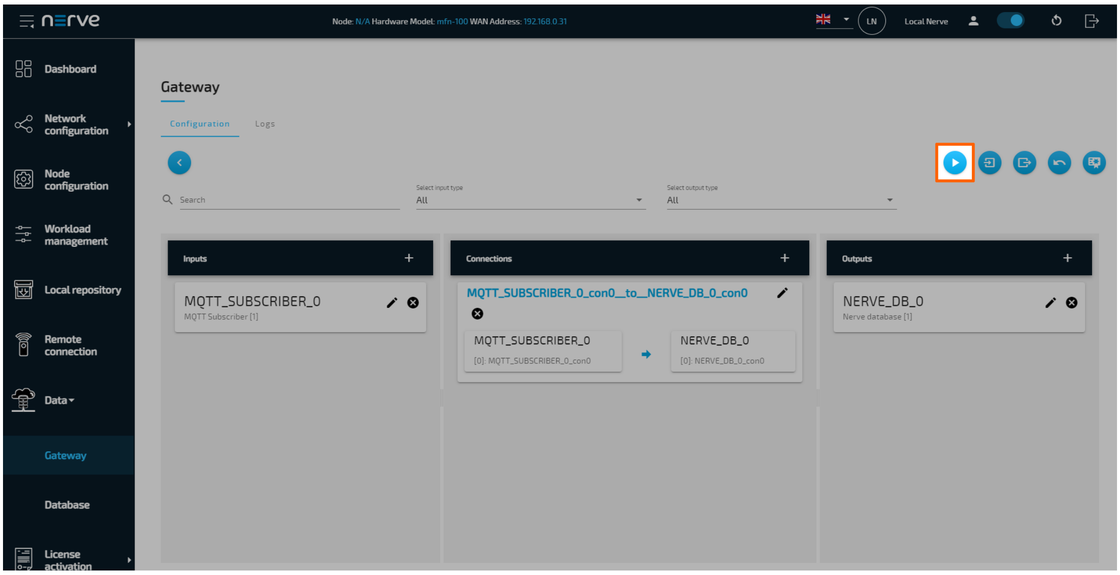
No inputs added

No connections added

No outputs added

7. Add the JSON configuration file containing the code above from the file browser.

8. Select the **Deploy** button. A success message pops up in the upper-right corner.



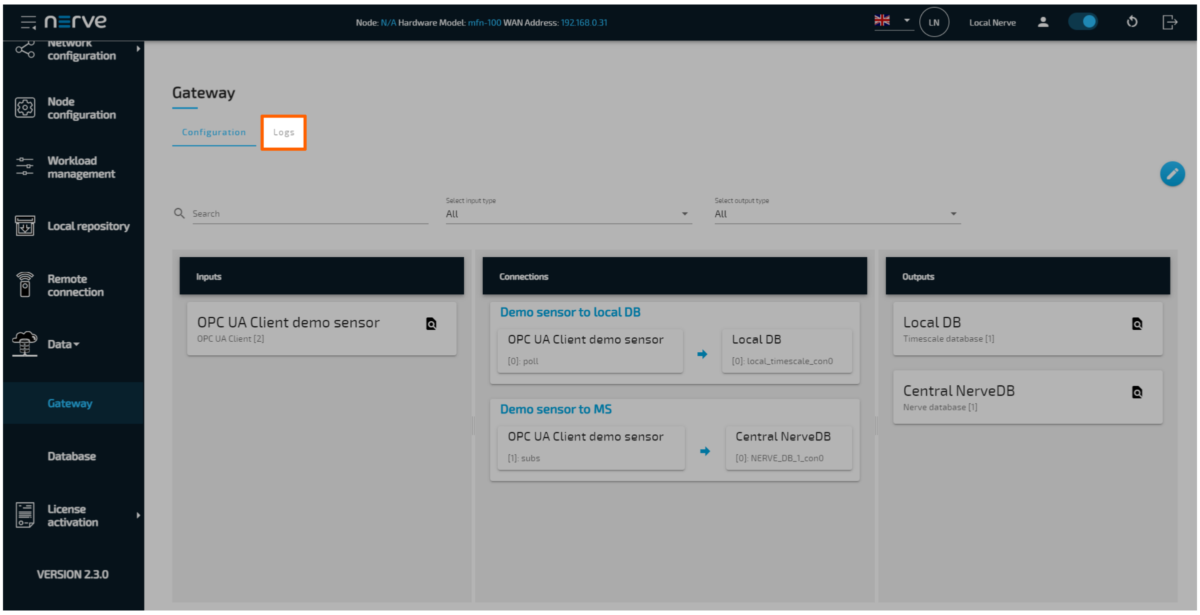
MQTT_SUBSCRIBER_0
MQTT Subscriber [1]

MQTT_SUBSCRIBER_0_con0__to__NERVE_DB_0_con0
MQTT_SUBSCRIBER_0
[0]: MQTT_SUBSCRIBER_0_con0
NERVE_DB_0
[0]: NERVE_DB_0_con0

NERVE_DB_0
Nerve database [1]

The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



Local data visualization at the node

The Gateway collects data from the Modbus simulation server and stores it inside the InfluxDB. The data can now be visualized at the node. Open the local data visualization element through the Data Services UI on the node by selecting **Data** on the left.

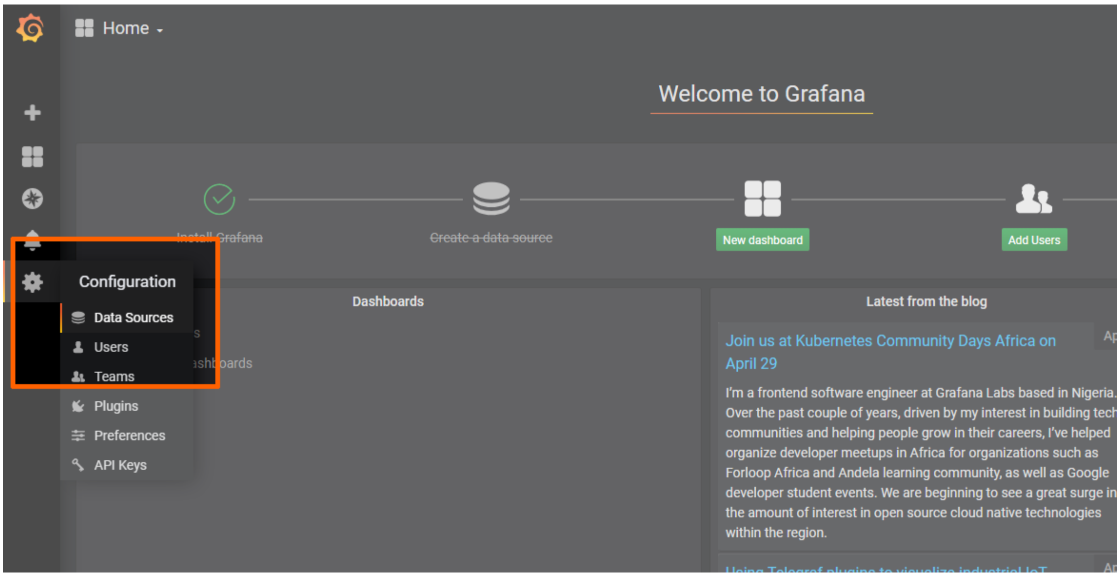
NOTE

Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

Configuring the InfluxDB as a data source

First, a new data source needs to be created since the data is collected into an InfluxDB.

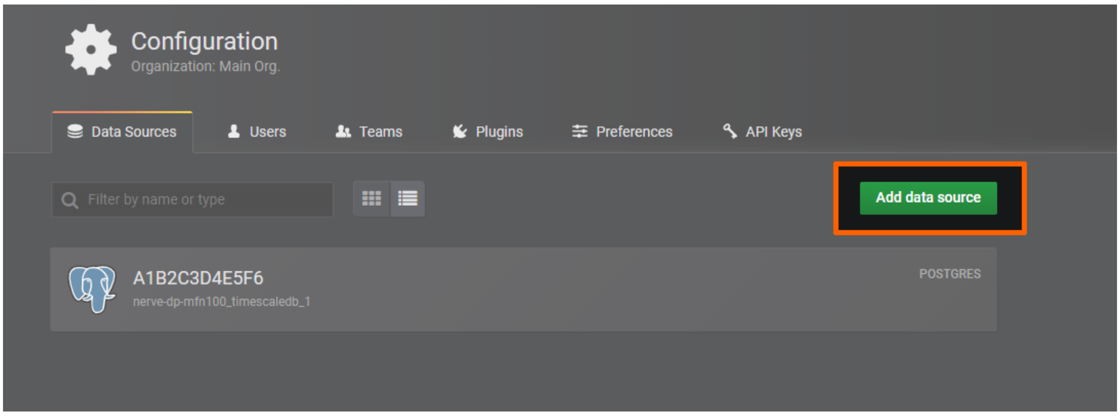
1. Select the gear symbol in the navigation on the left.
2. Select **Data Source**.



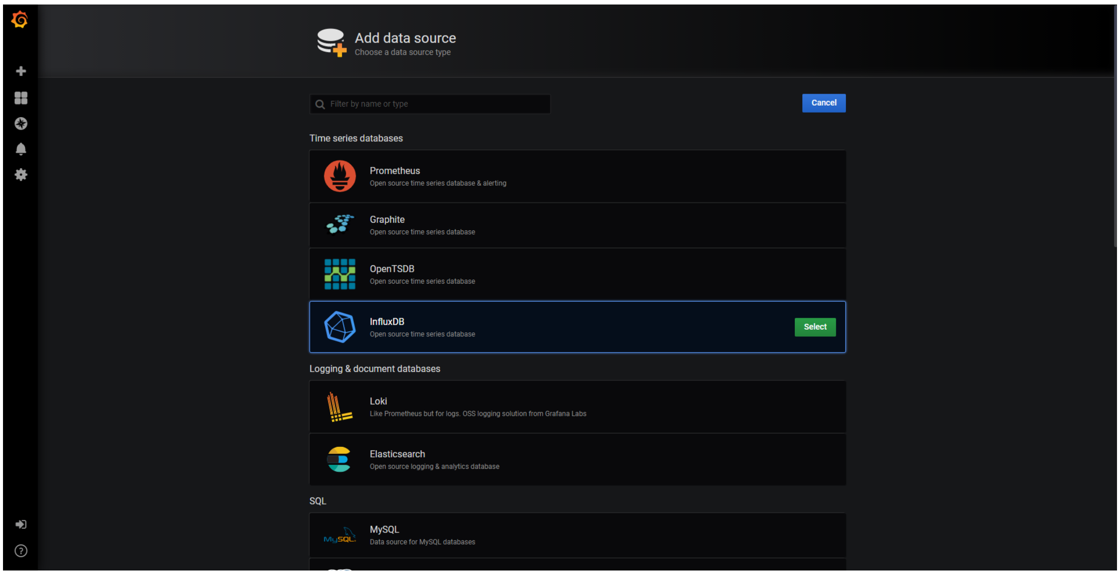
Join us at Kubernetes Community Days Africa on April 29

I'm a frontend software engineer at Grafana Labs based in Nigeria. Over the past couple of years, driven by my interest in building tech communities and helping people grow in their careers, I've helped organize developer meetups in Africa for organizations such as Forloop Africa and Andela learning community, as well as Google developer student events. We are beginning to see a great surge in the amount of interest in open source cloud native technologies within the region.

3. Select **Add data source** on the right.



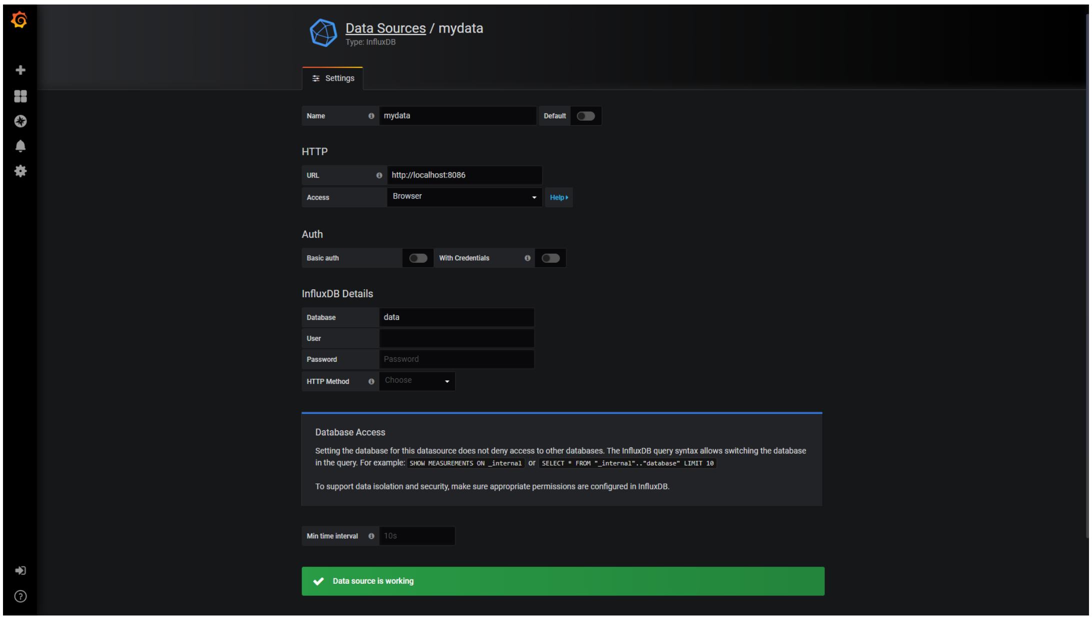
4. Select **InfluxDB**.


Add data source
Choose a data source type
Filter by name or type
Cancel
Time series databases
Prometheus
Open source time series database & alerting
Graphite
Open source time series database
OpenTSDB
Open source time series database
InfluxDB
Open source time series database
Select
Logging & document databases
Loki
Like Prometheus but for logs. OSS logging solution from Grafana Labs
Elasticsearch
Open source logging & analytics database
SQL
MySQL
Data source for MySQL databases

5. Enter the following settings:

Setting	Value
Name	Enter any name for the remote connection. This example uses `mydata`.
URL	`http://localhost:8086`
Access	Browser
Database	`data`

6. Select **Save & Test**. A green box will appear if the configuration was successful.



Data Sources / mydata
Type: InfluxDB

Settings

Name: mydata
Default

HTTP
URL: http://localhost:8086
Access: Browser
Help ▸

Auth
Basic auth
With Credentials

InfluxDB Details
Database: data
User
Password: Password
HTTP Method: Choose

Database Access

Setting the database for this datasource does not deny access to other databases. The InfluxDB query syntax allows switching the database in the query. For example: `SHOW MEASUREMENTS ON _internal` or `SELECT * FROM "_internal".."database" LIMIT 10`

To support data isolation and security, make sure appropriate permissions are configured in InfluxDB.

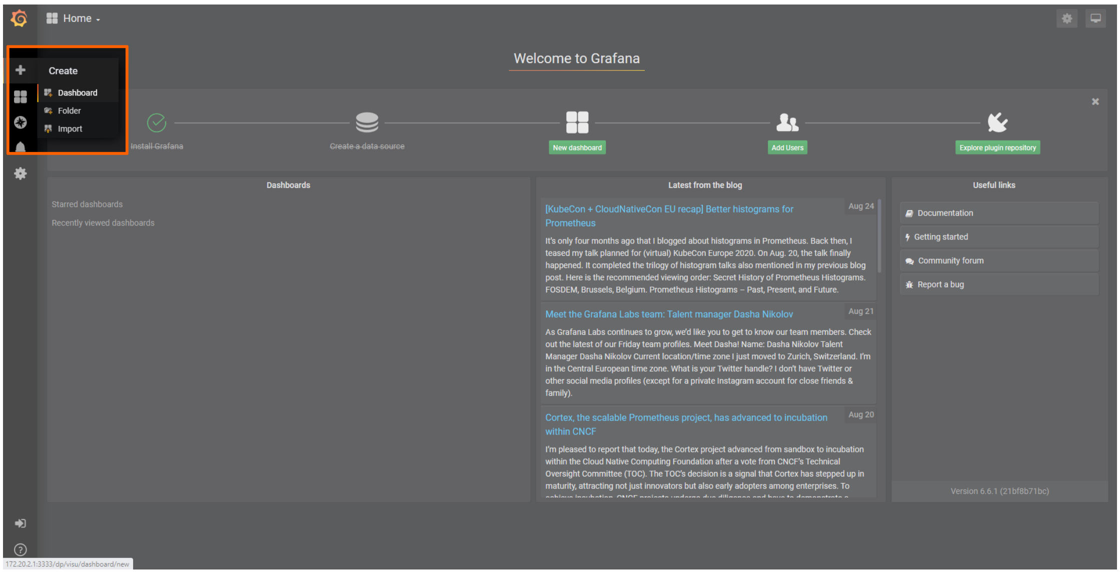
Min time interval: 10s

✓ Data source is working

Creating a dashboard for visualization

With the data source defined, temperature and humidity data can now be visualized in a dashboard.

1. Select **+ > Dashboard** in the navigation on the left. A box will appear.



[KubeCon + CloudNativeCon EU recap] Better histograms for Prometheus — Aug 24

It's only four months ago that I blogged about histograms in Prometheus. Back then, I teased my talk planned for (virtual) KubeCon Europe 2020. On Aug. 20, the talk finally happened. It completed the trilogy of histogram talks also mentioned in my previous blog post. Here is the recommended viewing order: Secret History of Prometheus Histograms. FOSDEM, Brussels, Belgium. Prometheus Histograms – Past, Present, and Future.

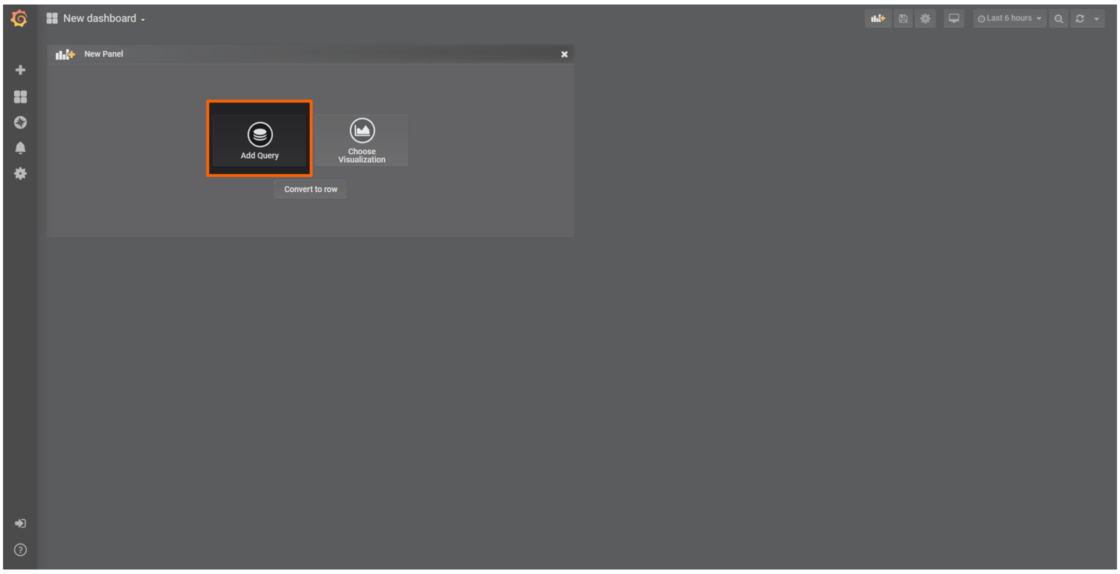
Meet the Grafana Labs team: Talent manager Dasha Nikolov — Aug 21

As Grafana Labs continues to grow, we'd like you to get to know our team members. Check out the latest of our Friday team profiles. Meet Dasha! Name: Dasha Nikolov Talent Manager Dasha Nikolov Current location/time zone I just moved to Zurich, Switzerland. I'm in the Central European time zone. What is your Twitter handle? I don't have Twitter or other social media profiles (except for a private Instagram account for close friends & family).

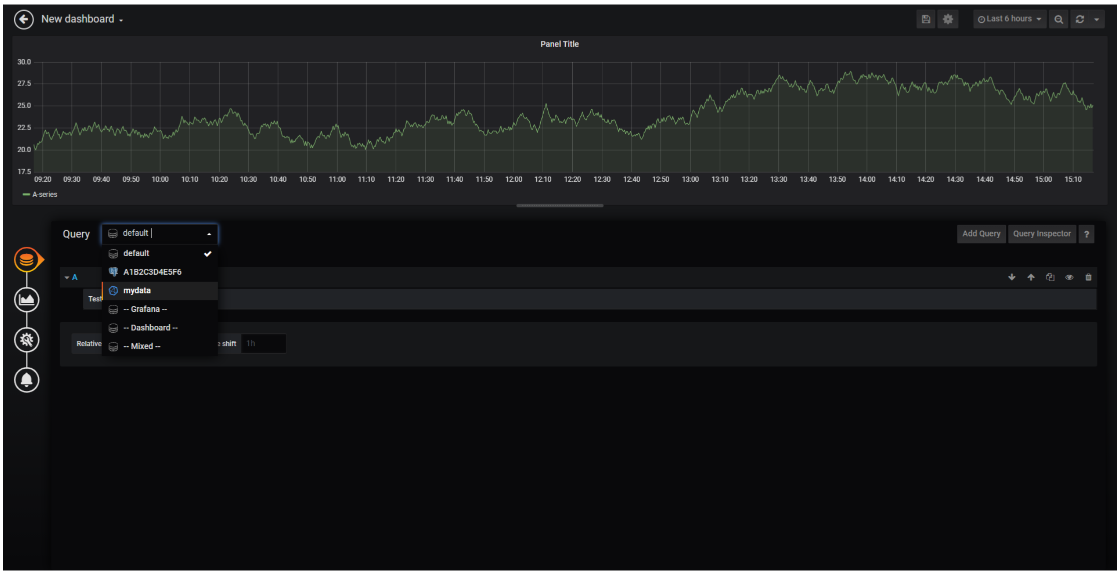
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF — Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

2. Select **Add Query** in the **New Panel** box.



3. Select the InfluxDB data source that was created before. This example uses **mydata** as the data source.



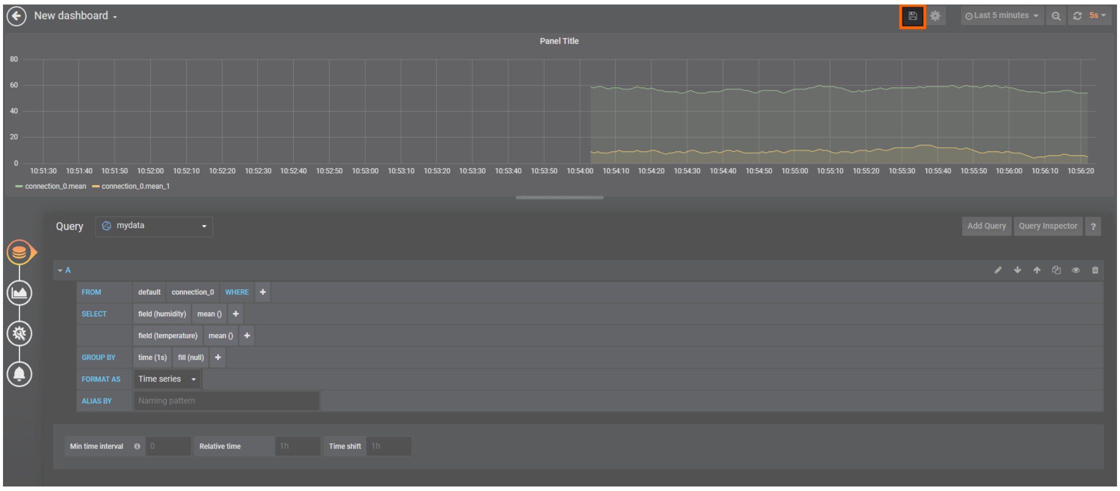
4. Fill in the following query information:

Setting	Value
FROM	`default connection`

SELECT	`field (humidity)`
	`field (temperature)`

GROUP BY	`time (1s)`
Format as	Time series

5. Select the save icon in the upper-right corner to save the dashboard.



Query mydata

A

FROM default connection_0 WHERE +

SELECT field (humidity) mean () +

field (temperature) mean () +

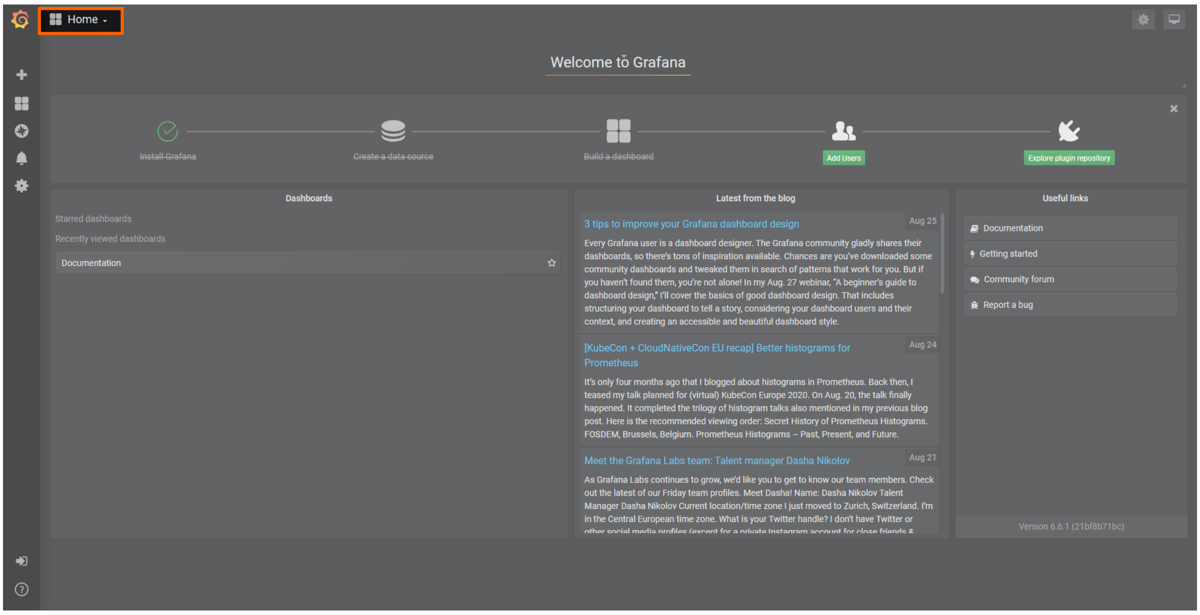
GROUP BY time (1s) fill (null) +

FORMAT AS Time series

ALIAS BY Naming pattern

Min time interval 0 Relative time 1h Time shift 1h

The dashboard can be accessed from the Grafana home menu.



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NerveDB with data buffering

NOTE

Note that the data buffering feature is only available when location is set to CENTRAL when using the NerveDB as an output.

Data buffering is a feature of the NerveDB output. Its purpose is to give a guarantee that data will always reach the Management System even when a node is connected to an unstable network. When this feature is enabled, data is buffered into persistent local storage first and then sent to the Management System in chunks. New chunks are not sent until it is confirmed that the previous chunk has been stored in a database in the Management System. After the confirmation, the chunk is removed from the persistent local storage. This slows down the insert rate for very fast data sources but in exchange provides a strong guarantee that no data is lost.

This example shows how to use the data buffering feature of the NerveDB output. It uses an MQTT sensor simulation as a data source. This also requires an MQTT broker. First, the sensor simulation and the broker need to be provisioned in the Management System and deployed to the node.

Provisioning and deploying the sensor simulation and the MQTT broker

In the instructions below two Docker workloads will be provisioned and deployed:

An MQTT broker must to be deployed to the node first in order for the sensor simulation to function. The EMQX MQTT broker is used in this example that can be downloaded from the Docker Hub registry.

After that the temperature and humidity sensors simulation MQTT publisher is deployed. Download the **Data Services MQTT demo sensor** found under **Example Applications** from the Nerve Software Center. This is the Docker image that is required for provisioning the demo sensor as a Docker workload.

1. Log in to the Management System. Make sure that the user has the permissions to access the Data Services.

2. Provision a Docker workload for the EMQX MQTT broker by following Provisioning a Docker workload. This example uses **emqx-4.1.0** as the workload name. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **From registry** and enter `emqx/emqx:v4.1.0`.
Container name	`emqx`
Network name	`host`

3. Provision a Docker workload for the sensor simulation by following Provisioning a Docker workload. Use the following workload version settings:

Setting	Value
Name	Enter any name for the workload version.
Release name	Enter any release name.
DOCKER IMAGE	Select **Upload** to add the Docker image of the sensor simulation that has been downloaded from the Nerve Software Center.
New environment variable	Select the **+** icon and enter the following information: ◦ **Env. variable** `MQTT_PUB_TOPIC` ◦ **Variable value** `demo-sensor-topic`
Container name	`ttt-mqtt-demo-sensor-1.0`
Network name	`host`

4. Deploy both provisioned Docker workloads above by following Deploying a workload.

Configuring the Data Services Gateway

The input data is a subscription to temperature and humidity variables on the MQTT broker. The NerveDB is set as an output, with location set to `CENTRAL` in order for the data buffering feature to be usable. The input and output are linked in connections.

The Gateway configuration below shows that data buffering is enabled on a table level. The table `demo-sensor-data` has data buffering enabled with a 60 minutes expiration time. This means that if the data point is not confirmed by the Management System side in 60 minutes, it will be dropped regardless if it is written into the Management System database. Expiration time is set in minutes and in theory can be any positive value.

Follow the instructions below to apply the Gateway configuration.

1. Access the Local UI on the node. This is Nerve Device specific. Refer to the table below for device specific links to the Local UI. The initial login credentials to the Local UI can be found in the customer profile.

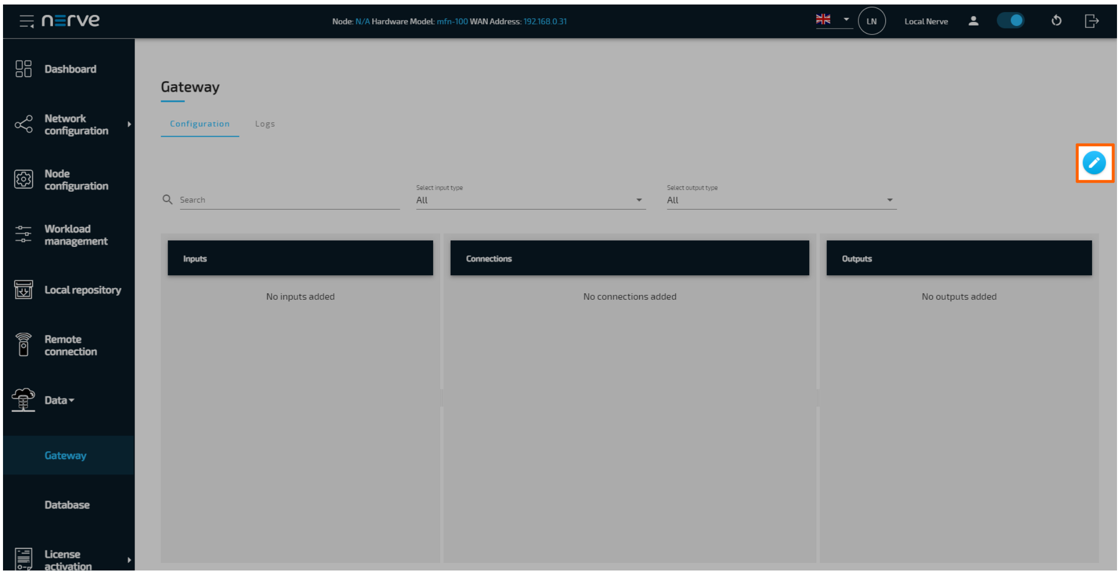
Nerve Device	Physical port	Local UI
MFN 100	P1	http://172.20.2.1:3333
Kontron KBox A-150-APL	LAN 1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-150-APL chapter of the device guide.
Kontron KBox A-250	ETH 2	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Kontron KBox A-250 chapter of the device guide.
Maxtang AXWL10	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Maxtang AXWL10 chapter of the device guide.
Siemens SIMATIC IPC127E	X1 P1	http://172.20.2.1:3333
Siemens SIMATIC IPC427E	X1 P1	http://172.20.2.1:3333
Supermicro SuperServer E100-9AP-IA	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer E100-9AP-IA chapter of the device guide.
Supermicro SuperServer 1019D-16C-FHN13TP	LAN3	http://172.20.2.1:3333

Nerve Device	Physical port	Local UI
Supermicro SuperServer 5029C-T	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Supermicro SuperServer 5029C-T chapter of the device guide.
Toshiba FA2100T-700	First rear port	http://172.20.2.1:3333
Vecow SPC-5600-i5-8500	LAN 1	http://172.20.2.1:3333
Winmate EACIL20	LAN1	`<wanip>:3333` To figure out the IP address of the WAN interface, refer to Finding out the IP address of the device in the Winmate EACIL20 chapter of the device guide.

2. Select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.

3. Select **Gateway**.

4. Select the **Edit configuration** icon on the right to enter editing mode.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.31

Gateway

Select input type: All

Select output type: All

No inputs added

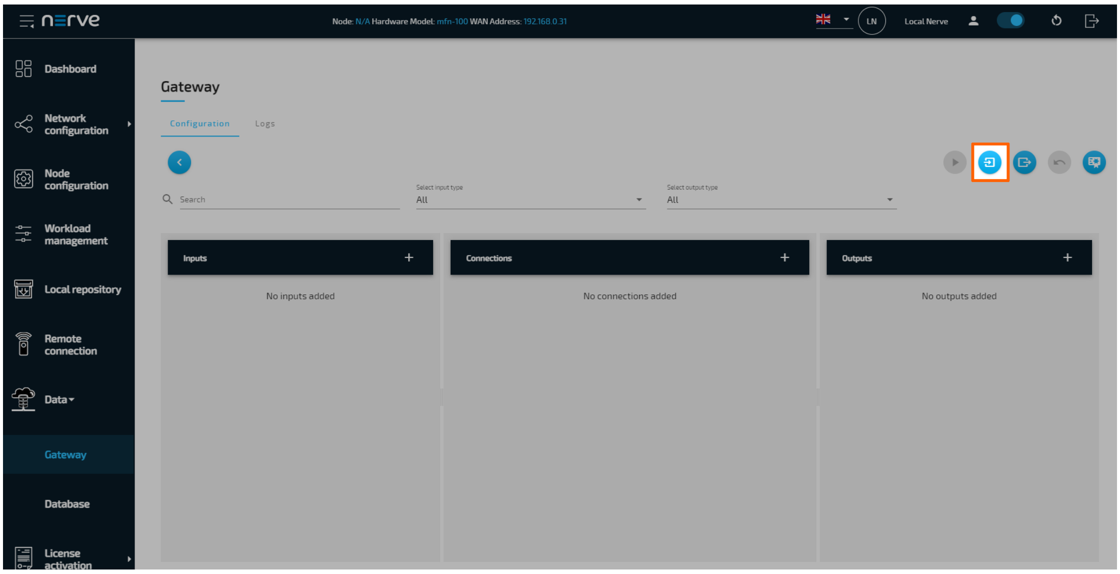
No connections added

No outputs added

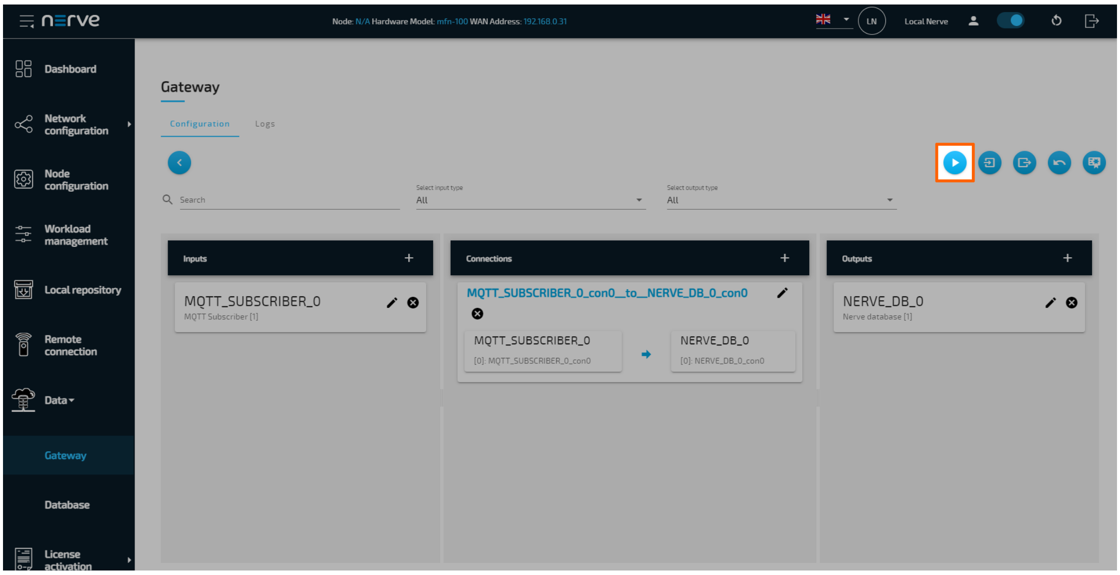
5. Create a JSON file out of the following Gateway configuration:

```
{
    "inputs": [
        {
            "type": "MQTT_SUBSCRIBER",
            "clientId": "mqtt_sub_dbuf-in",
            "serverUrl": "tcp://localhost:1883",
            "keepAliveInterval_s": 20,
            "cleanSession": true,
            "qos": 1,
            "connectors": [
                {
                    "topic": "demo-sensor-topic",
                    "variables": [
                        {
                            "name": "temperature",
                            "type": "int16"
                        },
                        {
                            "name": "humidity",
                            "type": "uint16"
                        }
                    ]
                }
            ]
        }
    ],
    "outputs": [
        {
            "type": "NERVE_DB",
            "location": "CENTRAL",
            "connectors": [
                {
                    "tableName": "demo-sensor-data",
                    "dataBuffer": true,
                    "bufferExpTime": 60
                }
            ]
        }
    ],
    "connections" : [
        {
            "input": { "index" : 0, "connector" : 0 },
            "output": { "index" : 0, "connector" : 0 }
        }
    ]
}
```

6. Select the **Import** button.

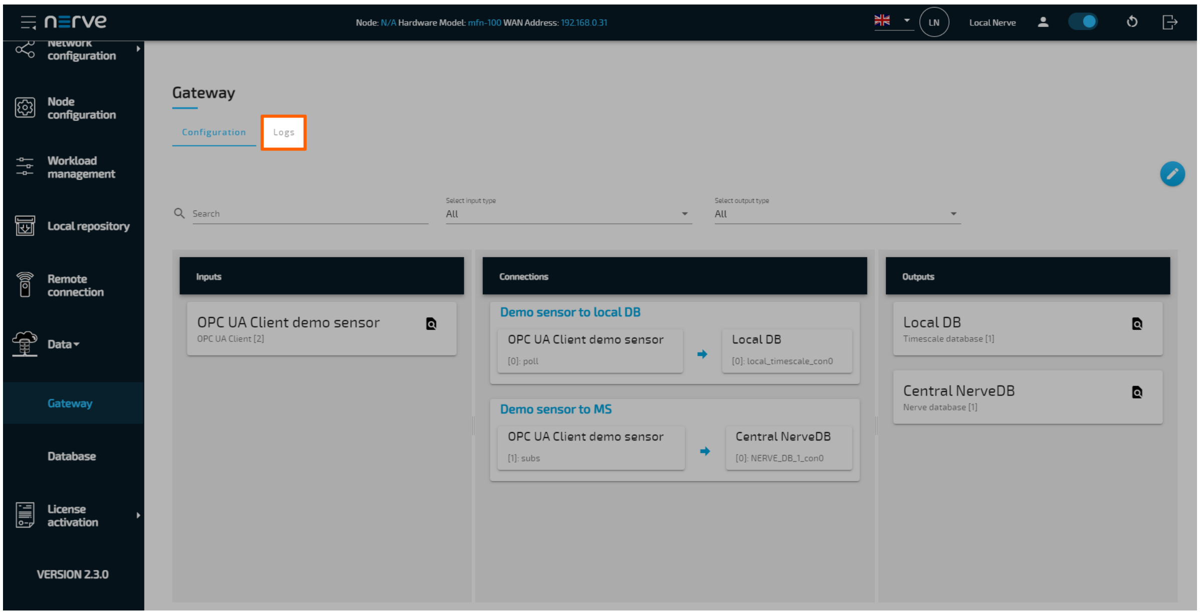


7. Add the JSON configuration file containing the code above from the file browser.
8. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

Select the **Logs** tab to view the Gateway logs for more information.



To test whether data buffering is working as intended a faulty network can be simulated, for example by unplugging the network cable of the device. Since the data source is deployed as a workload, it will not be affected by an outside connection and the data should keep flowing. Once the connection has been restored, depending on the amount of data that is buffered on the device it should reach the Management System in due time. This process can be repeated multiple times.

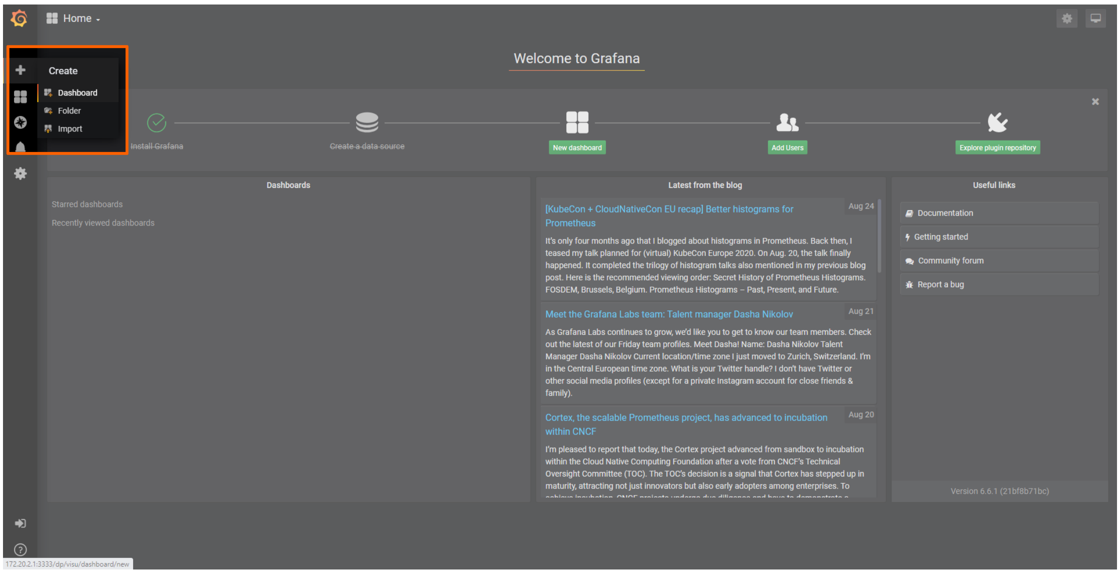
Central data visualization in the Management System

The arrival of data may be monitored in real time using Grafana. To visualize the data received by the Gateway, open the cental data visualization element through the Data Services UI in the Management System.

1. Select **Data** in the navigation on the left. The Grafana UI will open.

> **NOTE**
>
> Note that the navigation on the left collapses when **Data** is selected. Select the burger menu in the top-left to expand the navigation again.

2. Select **+ > Dashboard** in the navigation on the left. A box will appear.



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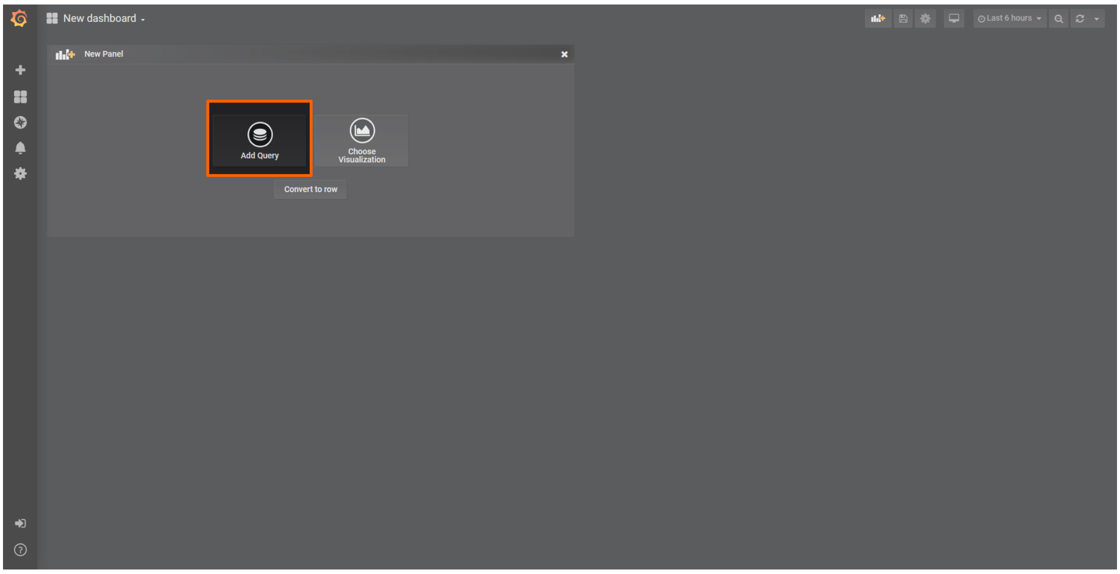
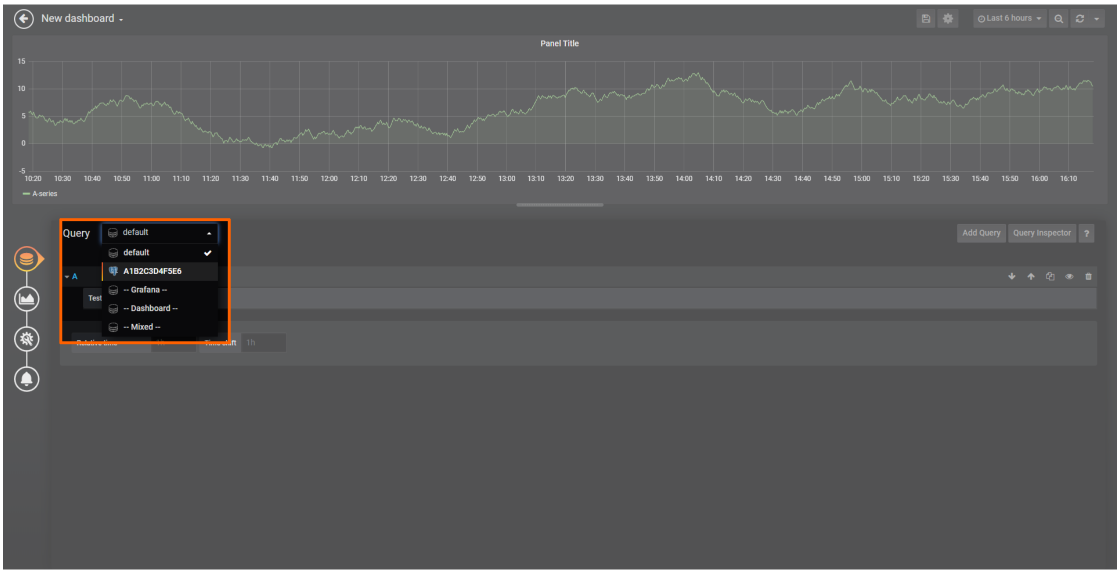
Cortex, the scalable Prometheus project, has advanced to incubation within CNCF Aug 20

I'm pleased to report that today, the Cortex project advanced from sandbox to incubation within the Cloud Native Computing Foundation after a vote from CNCF's Technical Oversight Committee (TOC). The TOC's decision is a signal that Cortex has stepped up in maturity, attracting not just innovators but also early adopters among enterprises. To

3. Select **Add Query** in the **New Panel** box.



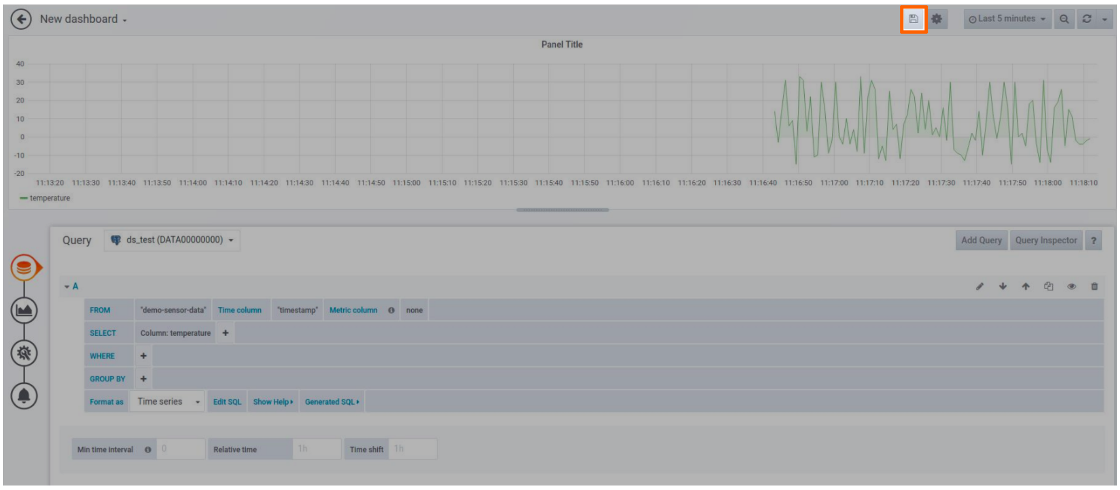
4. Select the data source from the drop-down menu. The name of the data source is the serial number of the node.



5. Fill in the following query information to add the temperature data from the MQTT Subscriber:

Setting	Value
FROM	`mqttsub_timescaledb_0` **Time column**: "timestamp"
SELECT	Column: temperature
Format as	Time series

6. Select the save icon in the upper-right corner to save the dashboard.


Query: ds_test (DATA00000000)

FROM "demo-sensor-data" Time column "timestamp" Metric column none

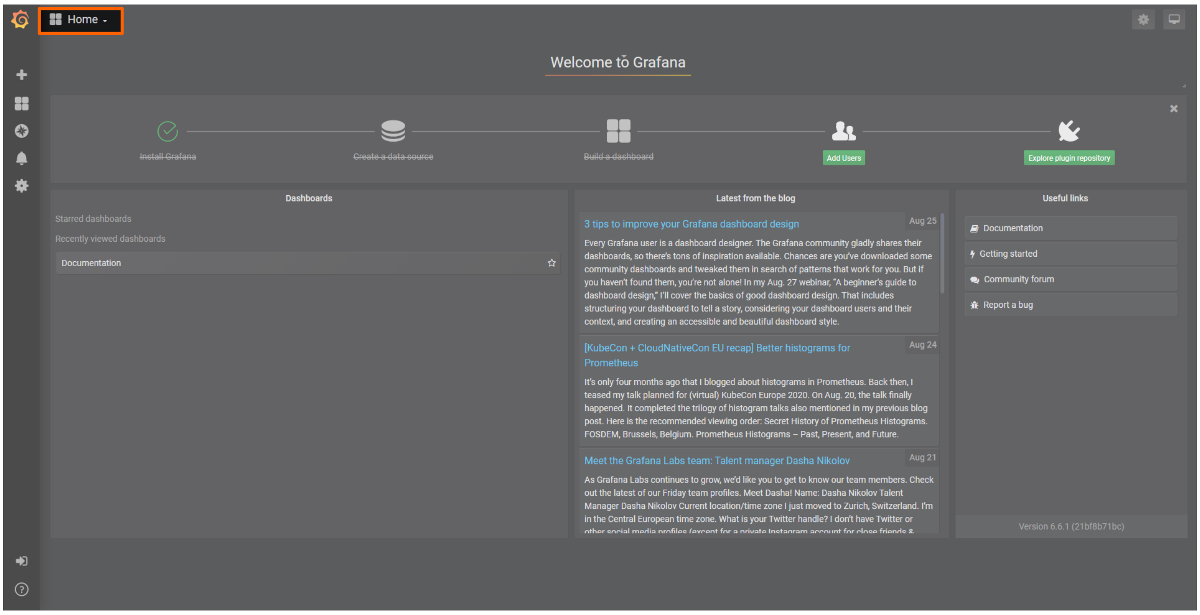
SELECT Column: temperature +

WHERE +

GROUP BY +

Format as Time series

The dashboard can be accessed from the Grafana home menu.



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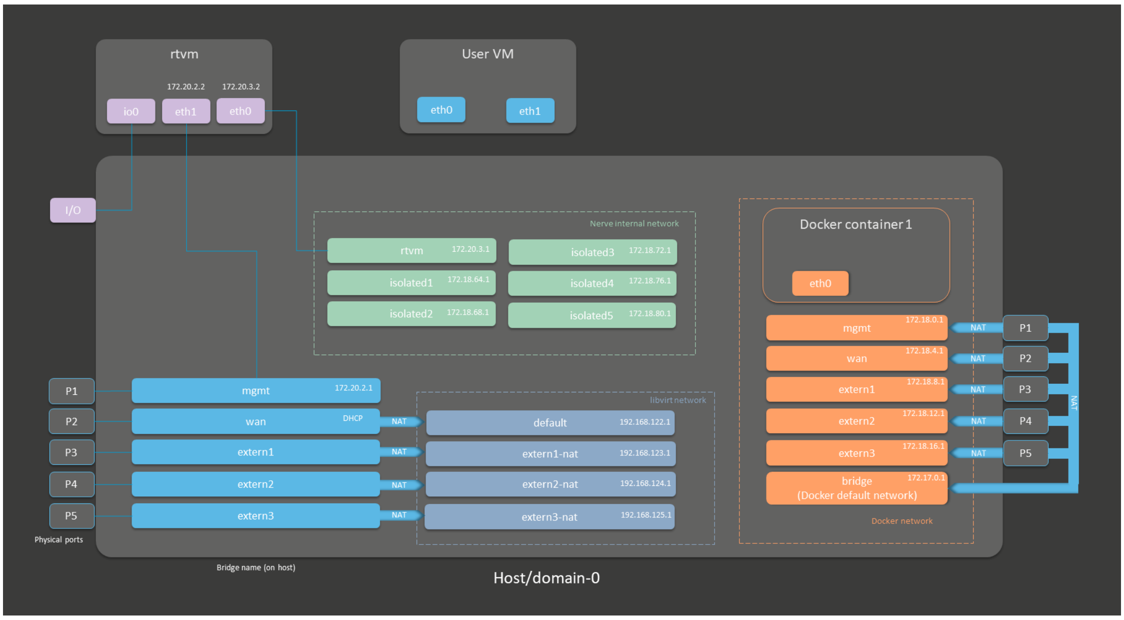
Node internal networking

This chapter explains how a user can connect workloads (VMs and Docker containers) to services and network ports of a node. In order to do this, it explains the internal networking concepts in detail. Most workloads will need to be connected to a network as networking is the main form of communication for workloads. They either want to connect to external servers or they are servers themselves, in which case they need to be made visible for their communication partners. The Nerve networking system enables both use cases.

The image below shows an example node consisting of the **host/domain-0** and the real-time VM running the CODESYS runtime (labeled **rtvm**). To further clarify the networking example it also has one Virtual Machine workload and one Docker workload deployed. The virtual machine is depicted outside of the host and the Docker container is depicted in the Docker network inside of the host. For the sake of explanation, however, the workloads are not yet connected. This is done in the examples further below.



Interface color	**Description**
Gray with **blue frame**	Physical network ports
Light blue	Linux network bridges displayed with their bridge names on the host
Dark blue	libvirt network interfaces for Virtual Machine workloads
Orange	Docker network bridges for Docker workloads
Green	Nerve internal network bridges shared between virtual machines, Docker containers and the host. They are not connected to any external, physical interface.
Purple	Interfaces related to the RTVM

The physical ports **P1** to **P5** and **I/O** of the Nerve Device (the MFN 100 in this case) are displayed on the left, touching the large dark rectangle that represents the host. The light blue interfaces connected to them inside the host are Linux bridged interfaces displayed with their names on the host. Highlighted by a dark blue dashed frame is the libvirt network with NAT interfaces. The system is set up so that the network bridges can be reached by connecting through the physical ports and that virtual machines can reach outside of the system through the NAT interfaces.

Highlighted by an orange dashed frame is the Docker network including the default Docker network (the orange interface labeled **bridge**), as well as Docker network equivalents of the Linux bridged interfaces. For the sake of easier representation, the physical ports **P1** to **P5** are duplicated to the right of the Docker network, again touching the host. This is done to show that Docker network interfaces can also be reached directly by connecting to the physical ports while also making sure to show that the libvirt network and the Docker network are separate from each other.

The Nerve internal network is highlighted by the green frame. It consists of the **rtvm** interface and the isolated interfaces. The isolated interfaces are designed for communication inside of the system, enabling communication between workloads. Using the isolated interfaces, communication can be established between Docker workloads, between Virtual Machine workloads, or between Docker and Virtual Machine workloads.

The **rtvm** interface is designed for communication with the RTVM and can be used to enable communication of the RTVM with Docker and Virtual Machine workloads.

All interfaces colored in purple are related to the RTVM. Interfaces labeled **eth** are symbolic representations of interfaces that are used by virtual machines and Docker containers for communication with the Nerve system. The actual used interfaces depend on the Docker container or virtual machine.

Connections are displayed in three ways. Blue lines are connections that are predefined by the system. Blue arrows are used between bridged interfaces and the libvirt network to indicate NAT. Further down below, green lines are used as example connections that can be defined by the user.

As mentioned above, the image above represents the MFN 100. Refer to the device guide for information on the Nerve Device as the physical ports and the connection to their respective interfaces differ.

See the tables below for more information on the interfaces, their usage and their IP ranges. The table is structured by workload type and shows which interface can be used for each workload type.

Networks for Virtual Machine workloads

Bridged Interfaces	To connect to any of the bridged interfaces below, select **Bridged** from the drop-down menu and enter the name of the interface when provisioning a Virtual Machine workload. • **mgmt** This interface is intended for the configuration of the system. There is no DHCP server present on this interface. To connect to it, configure the network adapter of the workstation. The IP address has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask. The **mgmt** interface is connected to the **eth1** interface of the RTVM. • **wan** This interface is designated for internet connection and configured as DHCP client by default. • **extern1, extern2, extern3** These interfaces can be used for customer specific external connections.

NAT Interfaces	To connect to any of the NAT interfaces below, select **NAT** from the drop-down menu and enter the name of the interface when provisioning a Virtual Machine workload.
	If a deployed virtual machine uses one of the predefined NAT interfaces, the IP address of the respective interface is assigned by a DHCP server with a subnet mask of `255.255.255.0`. The DHCP pool contains the lower half of the respective address space, e.g. `192.168.122.2` to `192.168.122.128`. The only exception is the **default** network.
	• **default**
	This network is the NAT interface of the **wan** bridged interface with an IP address in the range from `192.168.122.2` to `192.168.122.254`.
	• **extern1-nat, extern2-nat, extern3-nat**
	These networks are the NAT interfaces of the **extern1**, **extern2** and **extern3** bridged interfaces. The DHCP IP address ranges of these interfaces are the following:
	◦ **extern1-nat**
	`192.168.123.2` to `192.168.123.128`
	◦ **extern2-nat**
	`192.168.124.2` to `192.168.124.128`
	◦ **extern3-nat**
	`192.168.125.2` to `192.168.125.128`

Nerve internal network

To connect to any of the interfaces in the Nerve internal network below, select **Bridged** from the drop-down menu and enter the name of the interface when provisioning a Virtual Machine workload.

Isolated interfaces
Isolated interfaces can be used to allow Virtual Machine workloads to communicate with Docker workloads and other Virtual Machine workloads. These networks cannot communicate outside of the system. The IP addresses of these interfaces are assigned by DHCP servers in the following ranges:

- **isolated1**
  `172.18.64.2` to `172.18.67.254`
- **isolated2**
  `172.18.68.2` to `172.18.71.254`
- **isolated3**
  `172.18.72.2` to `172.18.75.254`
- **isolated4**
  `172.18.76.2` to `172.18.79.254`
- **isolated5**
  `172.18.80.2` to `172.18.83.254`

Note that when creating a VM on a Nerve Device according to Provisioning a Virtual Machine workload, these networks need to be specified as `br-isolated1`.

rtvm
Use this interface for communication with the RTVM and to establish connections between Virtual Machine workloads and the RTVM. The IP addresses are assigned in the range from `172.20.3.3` to `172.20.3.254`. `172.20.3.2` is reserved for **eth0** in the RTVM. Note that when creating a VM on a Nerve Device according to Provisioning a Virtual Machine workload, this network needs to be specified as `br-rtvm`.

Networks for Docker workloads

Docker network	Since interfaces in the Docker network are behind NAT by the default, there is no drop-down menu to select **Bridged** or **NAT** when provisioning a Docker workload. Enter the network name of one of the networks below to connect a Docker workload to an interface.
	• **bridge**
	This is the default Docker network designated for communication with Docker. Interfaces of Docker containers that are connected to the gateway receive IP addresses in the default Docker network, ranging from `172.17.0.2` to `172.17.0.244`. By default, this interface can be reached through any physical port (excluding **io0**).
	• **mgmt, wan, extern1, extern2, extern3**
	These interfaces are the Docker network equivalents of the bridged interfaces. They can be reached through the physical ports **P1** to **P5**. The DHCP IP address ranges of these interfaces are the following:
	◦ **mgmt**
	`172.18.0.2` to `172.18.3.254`
	◦ **wan**
	`172.18.4.2` to `172.18.7.254`
	◦ **extern1**
	`172.18.8.2` to `172.18.11.254`
	◦ **extern2**
	`172.18.12.2` to `172.18.15.254`
	◦ **extern3**
	`172.18.16.2` to `172.18.19.254`

Nerve internal network	Since there is no drop-down menu to select **Bridged** or **NAT** when provisioning a Docker workload, enter the network name of one of the networks below to connect a Docker workload to an interface.
	Isolated interfaces
	Isolated interfaces can be used to allow Docker workloads to communicate with Virtual Machine workloads and other Docker workloads. These networks cannot communicate outside of the system. The IP addresses of these interfaces are assigned by DHCP servers in the following ranges:
	• **isolated1**
	`172.18.64.2` to `172.18.67.254`
	• **isolated2**
	`172.18.68.2` to `172.18.71.254`
	• **isolated3**
	`172.18.72.2` to `172.18.75.254`
	• **isolated4**
	`172.18.76.2` to `172.18.79.254`
	• **isolated5**
	`172.18.80.2` to `172.18.83.254`
	rtvm
	Use this interface for communication with the RTVM and to establish connections between Docker workloads and the RTVM. The IP addresses are assigned in the range from `172.20.3.3` to `172.20.3.254`. `172.20.3.2` is reserved for **eth0** in the RTVM.

Physical ports, other interfaces and connections

Physical ports	The physical ports are device dependent. They are included here for clarification of the image above. The MFN 100 is used as an example. Refer to the device guide for information on the specific hardware model of the Nerve Device. • **P1 to P5** Ethernet ports of the MFN 100. Note that P5 is an SFP port. • **I/O** While also an Ethernet port, this port is reserved for communication of the RTVM with the fieldbus.
Other interfaces	**eth** These interfaces are symbolic representations of interfaces that are used by virtual machines and Docker containers for communication with the Nerve system. The actual interfaces used depend on the Docker container or virtual machine. The only exceptions are **eth0** and **eth1** for the RTVM as they are always defined with these names. **io0** This interface is defined for communication between the I/O port and the RTVM.
Connections	**Blue lines** Blue lines signify connections that are predefined by the Nerve system. **Green lines** Green lines are example connections that could be defined by a user to connect virtual machines or Docker containers to the network. **Blue arrows** Blue arrows indicate a NAT between bridged interfaces and the libvirt network.

The following sections are conceptual explanations. Workloads are attached to internal networks during the provisioning process. Refer to the provisioning chapters (Virtual Machine workloads and Docker workloads) in the user guide on how to provision workloads.

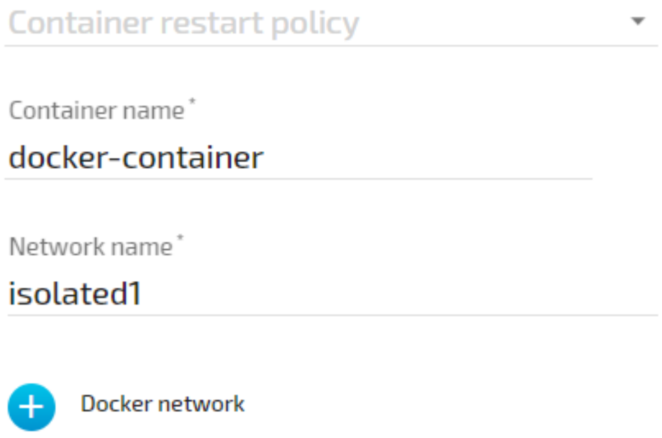
Addressing workloads by DNS name

Docker containers and virtual machines can be addressed by their DNS name, without the need of knowing the exact IP address. The DNS name of a Docker container and a virtual machine consists of the hostname or container name and the name of the network they are attached to. This behavior is explained further within the examples below, highlighting the DNS name that can be used where applicable.

Addressing a Docker workload by DNS name

The DNS name of a Docker workload is defined in the provisioning process of the workload. Following the Provisioning a Docker workload chapter, the DNS name is determined by the **Container name** and **Network name** settings formatted as

`<containername>.<networkname>`. As an example, the following screenshot shows these settings of a Docker workload:



Container restart policy

Container name *
docker-container

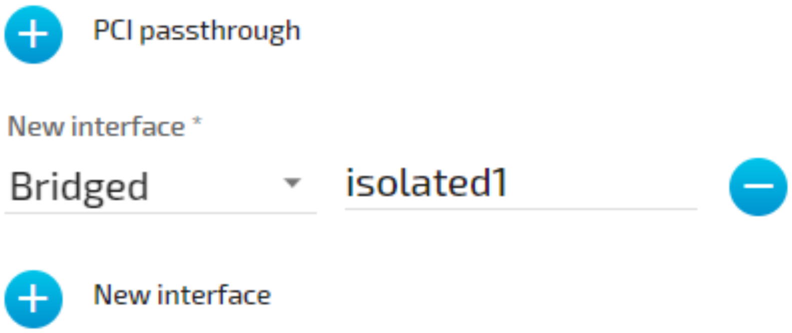
Network name *
isolated1

According to these settings, this Docker container can be reached under `docker-container.isolated1` after being deployed to a node.

Addressing a Virtual Machine workload by DNS name

For Virtual Machine workloads the same principle applies, but the hostname part of the DNS name does not come from the workload provisioning settings in the Management System. The hostname is defined within the virtual machine, usually at creation time. As an example, if a Windows VM is generated on a Nerve Device, the hostname that is defined during the installation process of the Windows OS is required for addressing the Virtual machine per DNS name, e.g. `DOCUMENTATION-PC`.

The network name is determined in the Management System by the **New interface** setting. As an example, the following shows this setting of a Virtual Machine workload:

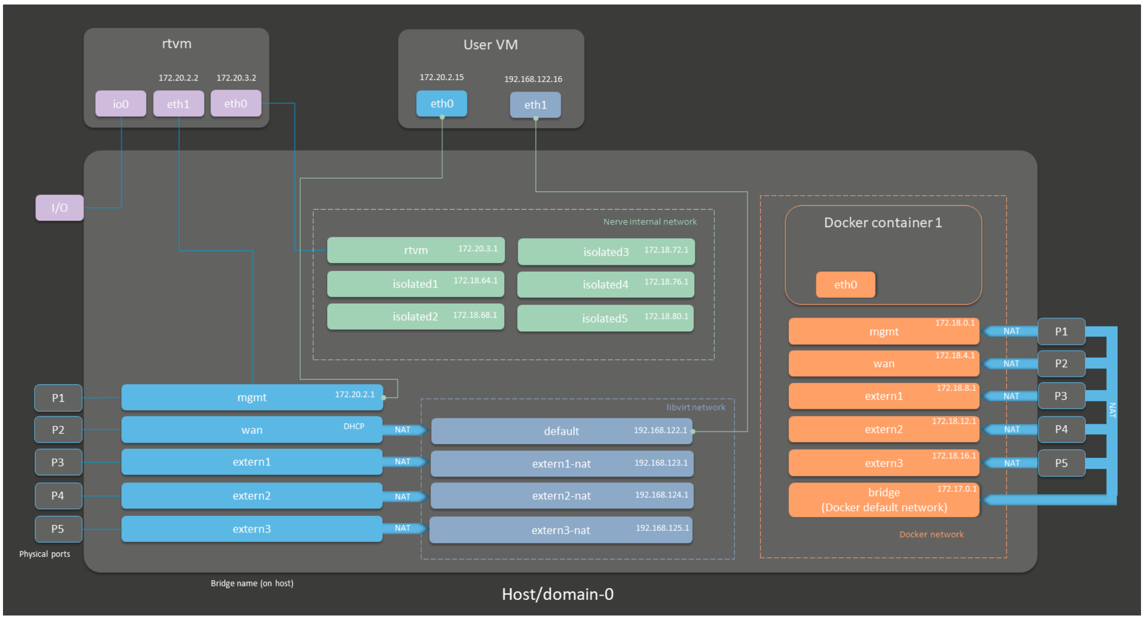


New interface *
Bridged isolated1

According to the machine name or hostname setting of the virtual machine and the network setting in the Management System, this virtual machine can be reached under `DOCUMENTATION-PC.isolated1`

Attaching virtual machines to a network

Virtual machine networking is comparable to installing a network card in the virtual machine and attaching it to the network with the network name given in the network drawing. For this example, there are two "network cards" installed in a user deployed virtual machine. They are located in the **User VM** and are labeled **eth0** and **eth1** in this example. Green lines indicate a user established connection.



There are two connections established here:

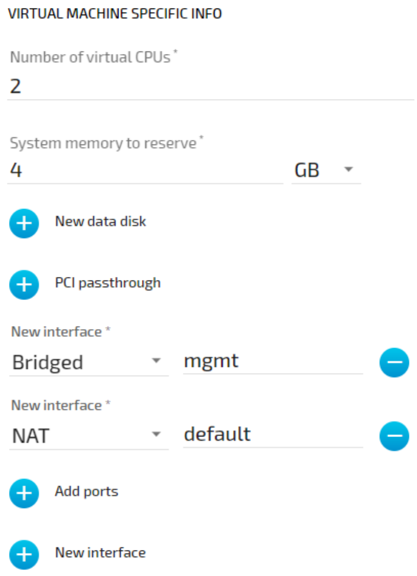
- **eth0** of the **User VM** is connected to the **mgmt** bridged interface so that the virtual machine can be reached through physical port **P1**. If the **User VM** has an SSH server set up, a service technician could gain access through **P1** of the MFN 100.
  Technically, the **User VM** could communicate with the RTVM through the **mgmt** network as well. However, it is recommended to use the Nerve internal network **rtvm** for communication with the RTVM.

- **eth1** of the **User VM** is connected to the **default** NAT interface for an internet connection protected by NAT on **P2** of the Nerve Device.

Both interfaces have IP addresses in the designated ranges. `172.20.2.15` for **eth0** was manually configured in the virtual machine and `192.168.122.16` for **eth1** was assigned by the DHCP server.

Settings example

To achieve the functionality above, configure the interfaces of the Virtual Machine workload the following way during the provisioning process in the Management System:



VIRTUAL MACHINE SPECIFIC INFO

Number of virtual CPUs *
2

System memory to reserve *
4 GB

New data disk

PCI passthrough

New interface *
Bridged mgmt

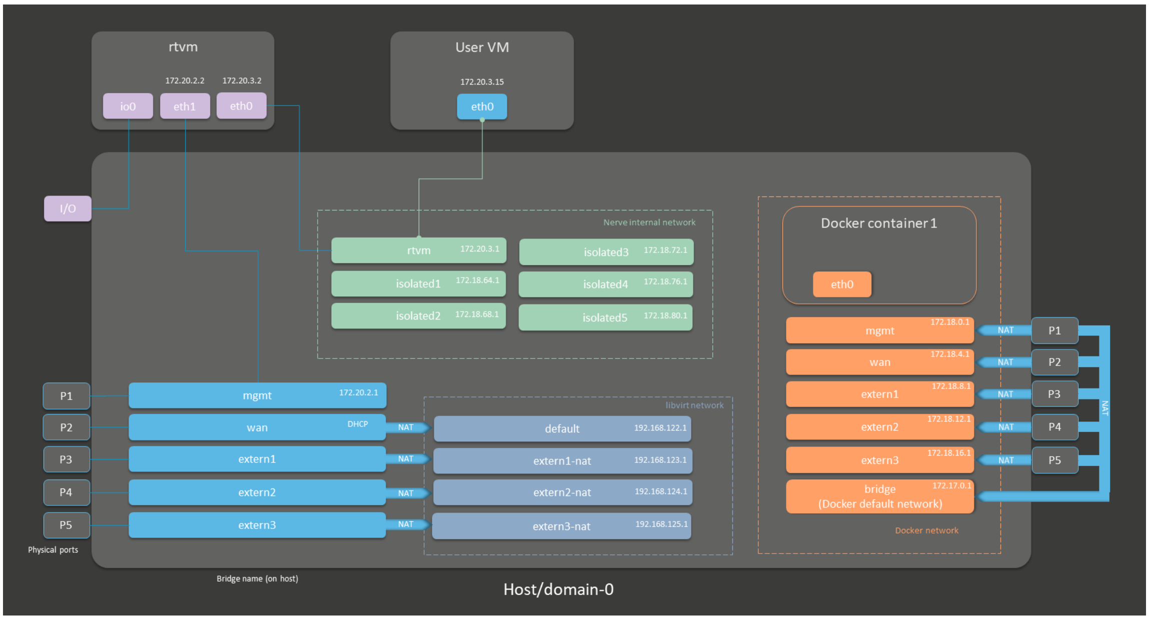
New interface *
NAT default

Add ports

New interface

Communication of a virtual machine with the RTVM

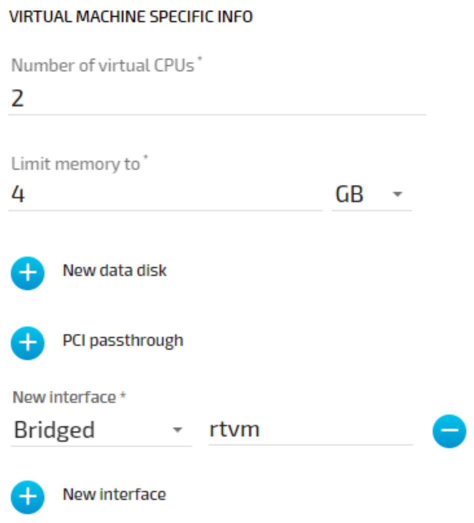
A virtual machine can communicate with the RTVM by connecting an interface to the bridged interface **rtvm** in the Nerve internal network. In the example below this is done with the interface **eth0** of the **User VM** that has the IP address `172.20.3.15`. The IP address was manually configured.



Assuming the virtual machine is a Windows virtual machine with a hostname `DOCUMENTATION-PC`, the virtual machine can be addressed with `DOCUMENTATION-PC.rtvm`.

Settings example

To achieve the functionality above, configure the interfaces of the Virtual Machine workload the following way during the provisioning process in the Management System:



VIRTUAL MACHINE SPECIFIC INFO

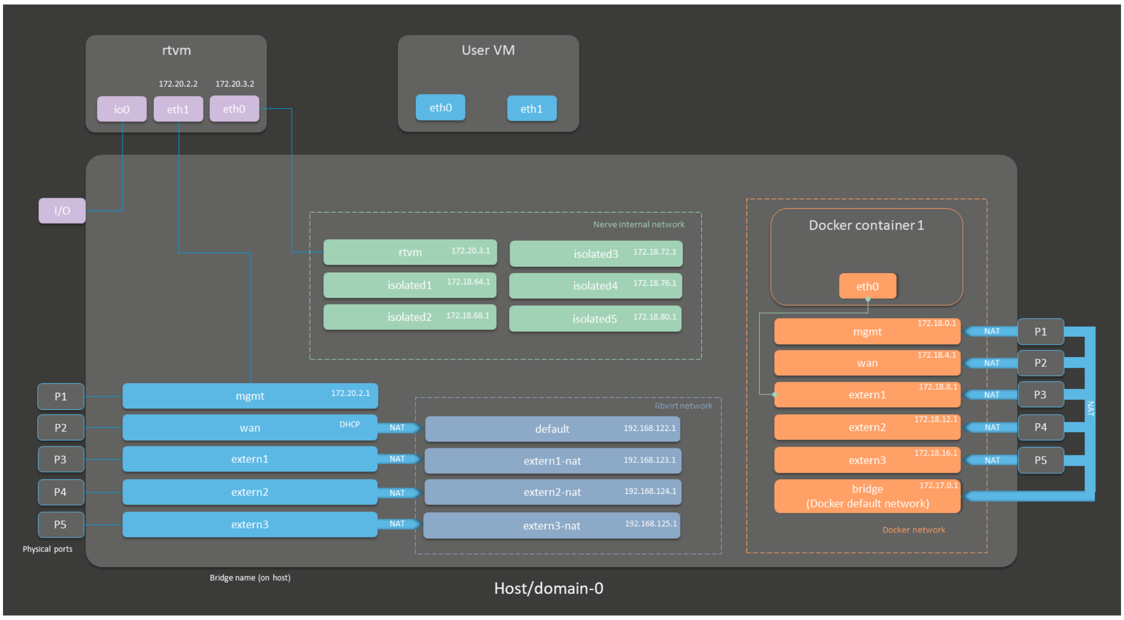
Number of virtual CPUs *
2

Limit memory to *
4 GB

New interface *
Bridged rtvm

Communication of a Docker container with external devices

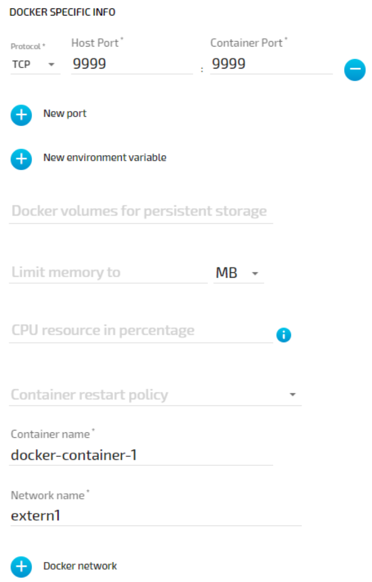
Docker containers can be attached to the Docker default network or respective Docker network interfaces to access other parts of the system or to communicate outside of the system. The Docker default network is called **bridge** and has the IP address `172.17.0.1` assigned. This interface is available on all physical ports (here **P1** to **P5**). Therefore, when a Docker is connected to the Docker default network, the forwarded ports, as defined during workload provisioning in the port mapping section, are exposed on all physical interfaces. For this example, the Docker container will be connected to the **extern1** interface. In order to make a Docker port accessible from outside, specify the port and protocol during workload provisioning in the port mapping section. The chosen network, here **extern1**, defines on which physical port the exported Docker port can be accessed. The Docker container is connected to the **extern1** interface in the Docker network, which makes the exported port available at physical port **P3** to external devices.



The Docker container can be reached from the outside by connecting to the specified, exported port on the IP address of the **P3** interface from an IP address in the range from `172.18.8.2` to `172.18.8.254`.

Settings example

To achieve the functionality above, configure the Docker network name the following way during the provisioning process in the Management System. The **Container name** and the port mapping settings are placeholders chosen for this example:



DOCKER SPECIFIC INFO

Protocol* TCP

Host Port* 9999 : Container Port* 9999

Docker volumes for persistent storage

Limit memory to MB

CPU resource in percentage

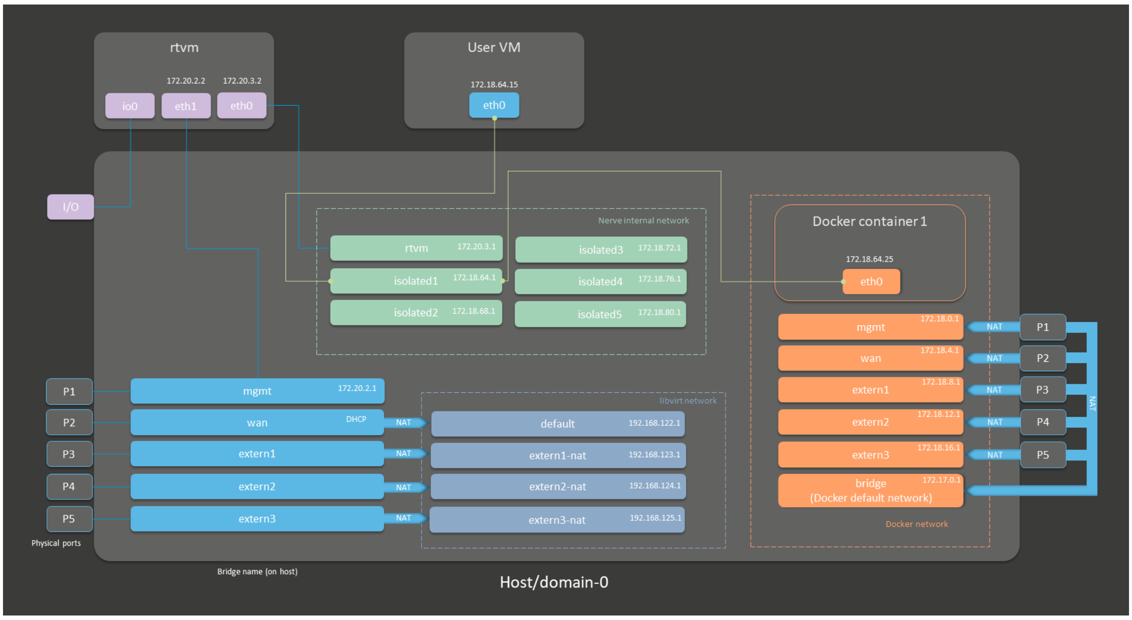
Container restart policy

Container name* docker-container-1

Network name* extern1

Communication of a Docker container and a virtual machine through isolated networks

Nerve offers isolated network interfaces in the Nerve internal network for communication of workloads inside of the system. They can be used to establish communication between Docker containers, between virtual machines, or as in this example, between a Docker container and a virtual machine. Note that these interfaces do not communicate outside of the system.

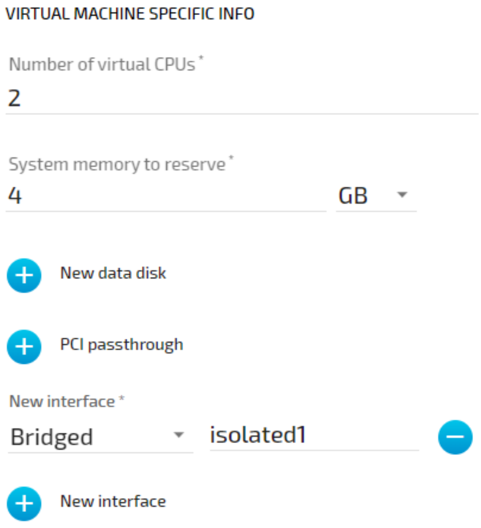


The virtual machine has a "network card" installed. **User VM 1** is connected to the **isolated1** interface through **eth0**. **Docker container 1** is connected through its interface **eth0** to the same network interface, **isolated1**. Each interface has been assigned an IP address by a DHCP server in the designated range: `172.18.64.15` for **eth0** of **User VM1** and `172.18.64.25` for **eth0** of **Docker container 1**.

Settings example

To achieve the functionality above, configure the interfaces of the Virtual Machine workload and the Docker workload the following way during the provisioning process in the Management System:

Virtual machine


VIRTUAL MACHINE SPECIFIC INFO

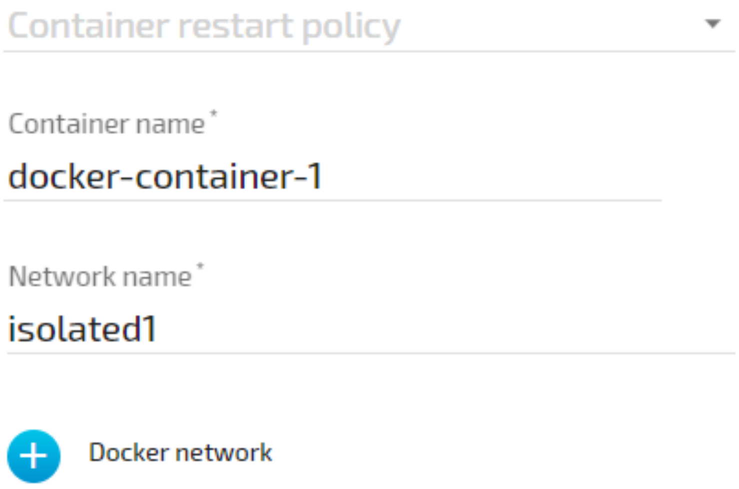
Number of virtual CPUs *
2

System memory to reserve *
4 GB

New interface *
Bridged isolated1

Assuming that the virtual machine is running Windows with the hostname `DOCUMENTATION-PC` which was defined in the creation process, the virtual machine can be reached under `DOCUMENTATION-PC.isolated1`.

Docker container



Container restart policy

Container name*

docker-container-1

Network name*

isolated1

The Docker container can be reached under `docker-container-1.isolated1` due to the **Container name** and the isolated network chosen in the Docker workload settings.

List of reserved TCP/UDP ports

In general, Nerve reserves the port range 47200 — 47399 on both TCP and UDP for internal usage. The following list states ports that are reserved in version 2.1.

Port	Interface	Protocol	Reserved for
22	none	TCP	SSH daemon
3000	172.20.2.1	TCP	Previous location of Local UI
3333	172.20.2.1	TCP	Local UI
47200	127.0.0.1	TCP/UDP	System Log
47201	127.0.0.1	UDP	Filebeat
47300	127.0.0.1	TCP	Local MQTT broker
47301	127.0.0.1	TCP	Local MQTT broker

First steps with CODESYS

NOTE

This chapter uses the MFN 100 as an example.

This chapter will give an introduction on how to start working with the integrated soft PLC in the MFN 100. First, some configuration and installation of files and libraries are required.

NOTE

- Download the CODESYS Development System V3 from store.codesys.com for this chapter.
  We recommend version 3.5 SP14 (32 bit) or newer.
- Connect the workstation to the console port **P1** of the MFN 100.

Installing the device descriptions

After downloading and installing the CODESYS Development System on the workstation, install the device description of the MFN 100 in the CODESYS Development System. The device description has the following filename:

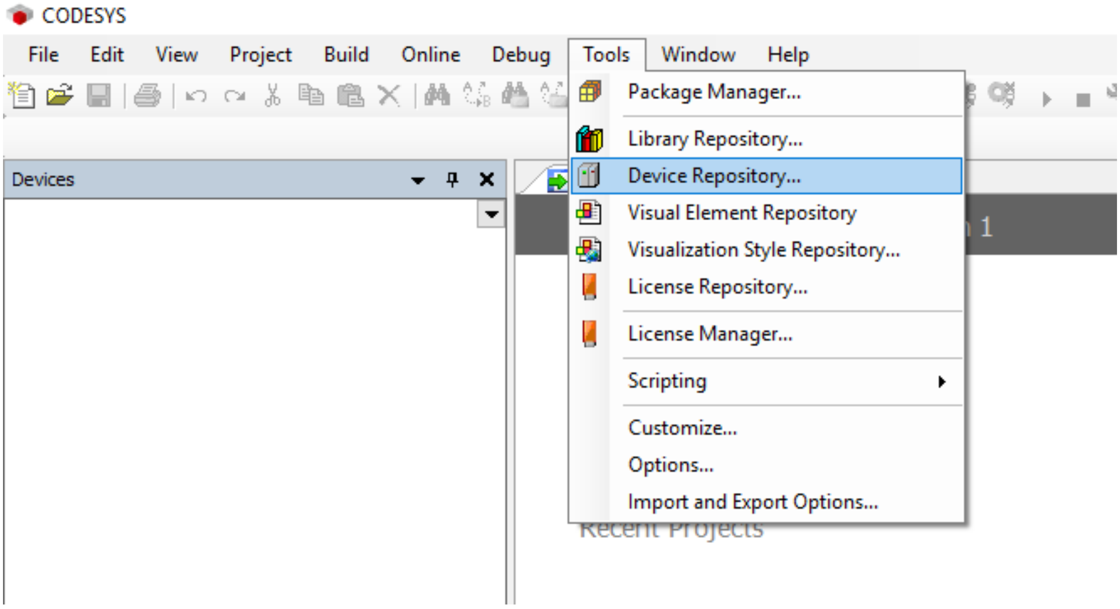
- Nerve_MFN_100_V3.5.XX.X.devdesc.xml

NOTE

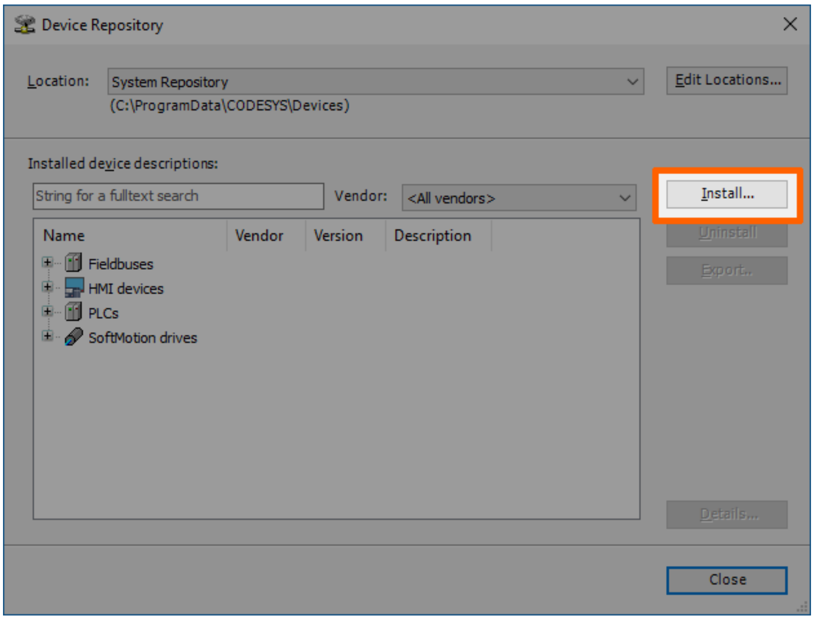
XX.X stands for the current version of the CODESYS Development System

The device description of the MFN 100 is available at the Nerve Software Center. Remember where the device description is saved for the following steps.

1. Start the CODESYS Development System.
2. Go to **Tools > Device Repository**.



3. Click **Install**.

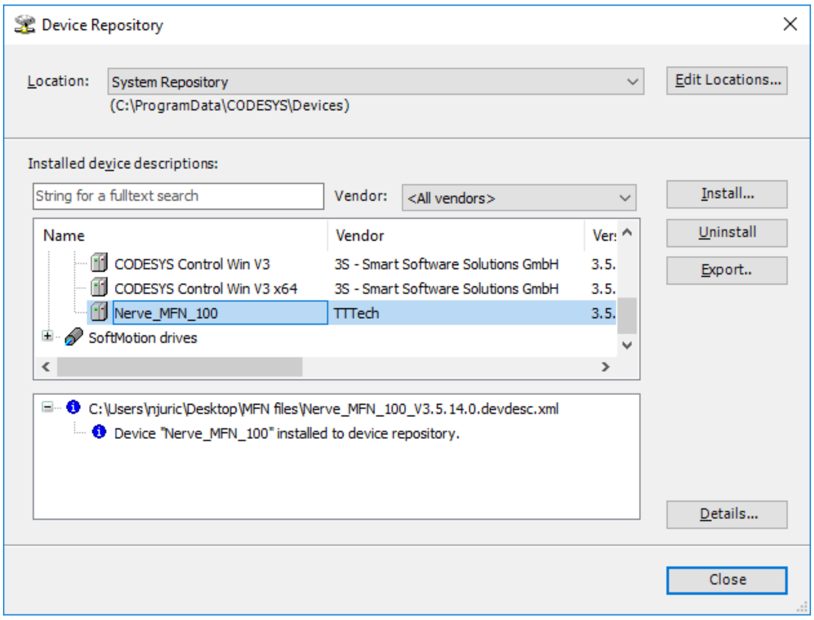


Location: System Repository
(C:\ProgramData\CODESYS\Devices)

4. Go to the directory of the previously downloaded device description.
5. Select the device description of the MFN 100.

   The device description will look like this: `Nerve_MFN_100_V3.5.XX.X.devdesc.xml`
6. Click **Open**.

When the installation was successful, the MFN 100 will appear in the list of device descriptions in the middle of the window.



Location: System Repository
(C:\ProgramData\CODESYS\Devices)

Name	Vendor	Ver:
CODESYS Control Win V3	3S - Smart Software Solutions GmbH	3.5.
CODESYS Control Win V3 x64	3S - Smart Software Solutions GmbH	3.5.
Nerve_MFN_100	TTTech	3.5.

C:\Users\njuric\Desktop\MFN files\Nerve_MFN_100_V3.5.14.0.devdesc.xml
Device "Nerve_MFN_100" installed to device repository.

After installing the device description, work with the CODESYS Development System can be started. However, libraries and device descriptions of generic devices might be missing so that the CODESYS Development System can work properly. The following chapters cover the download process.

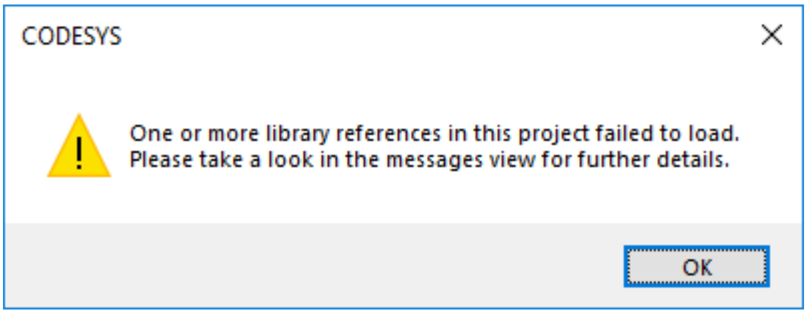
NOTE

The device description might need to be updated if this is not the first time working with MFN 100 and the CODESYS Development System:

1. Follow the steps above to install the newest device description.
2. Right-click **Device (Nerve_MFN_100)** on the left side.
3. Select **Update Device...**.
4. Select the current device description in the new window.
5. Click **Update Device** in the lower-right.

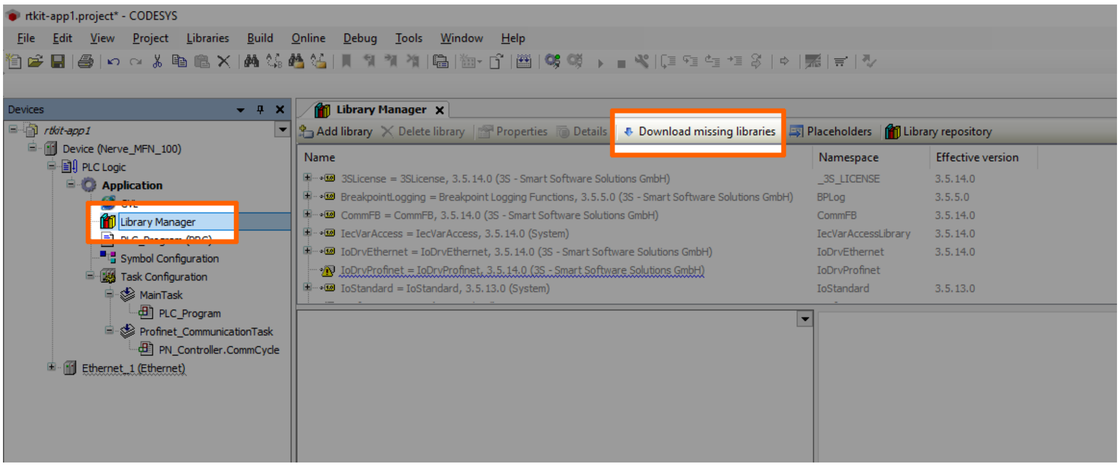
Downloading missing libraries

The error message for missing libraries might appear when opening or creating a CODESYS project. The CODESYS Development System identifies the missing libraries automatically but the following process might need to be repeated a few times.



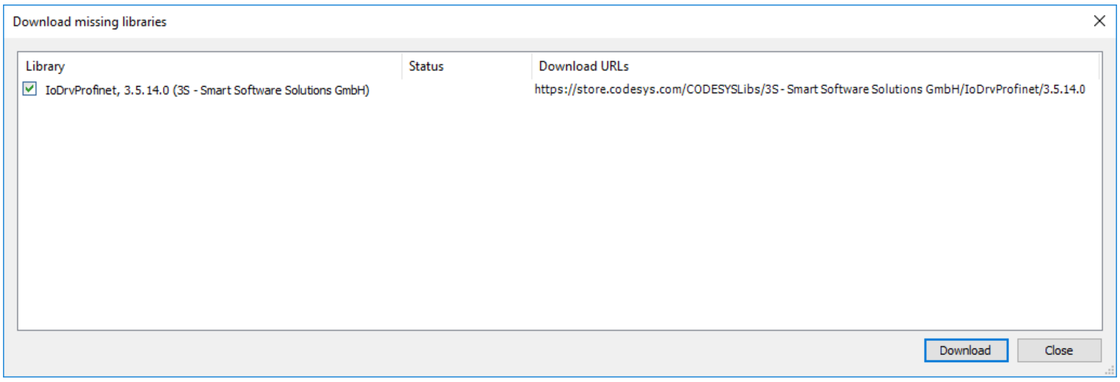
One or more library references in this project failed to load.
Please take a look in the messages view for further details.

1. Open or create a CODESYS project.
2. If the error message about missing libraries appears, click **OK**.
3. Double-click **Library Manager** in the tree view on the left.
4. Click **Download missing libraries**.



Name	Namespace	Effective version
3SLicense = 3SLicense, 3.5.14.0 (3S - Smart Software Solutions GmbH)	_3S_LICENSE	3.5.14.0
BreakpointLogging = Breakpoint Logging Functions, 3.5.5.0 (3S - Smart Software Solutions GmbH)	BPLog	3.5.5.0
CommFB = CommFB, 3.5.14.0 (3S - Smart Software Solutions GmbH)	CommFB	3.5.14.0
IecVarAccess = IecVarAccess, 3.5.14.0 (System)	IecVarAccessLibrary	3.5.14.0
IoDrvEthernet = IoDrvEthernet, 3.5.14.0 (3S - Smart Software Solutions GmbH)	IoDrvEthernet	3.5.14.0
IoDrvProfinet = IoDrvProfinet, 3.5.14.0 (3S - Smart Software Solutions GmbH)	IoDrvProfinet	
IoStandard = IoStandard, 3.5.13.0 (System)	IoStandard	3.5.13.0

5. Click **Download** in the new window.


Download missing libraries

Library	Status	Download URLs
☑ IoDrvProfinet, 3.5.14.0 (3S - Smart Software Solutions GmbH)		https://store.codesys.com/CODESYSLibs/3S - Smart Software Solutions GmbH/IoDrvProfinet/3.5.14.0

6. Click **Close** when the download is finished.

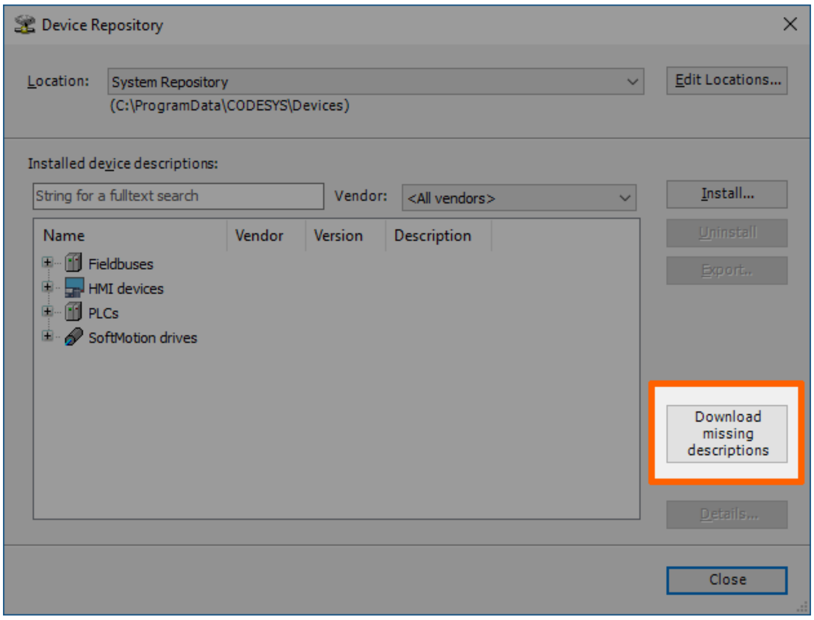
7. Repeat steps 3 to 5 until no more libraries appear in the download window.

Downloading missing device descriptions

Apart from the device description for the MFN 100 that have been installed manually before, device descriptions of generic devices may be missing for the CODESYS Development System to function as intended. The CODESYS Development System will identify the missing device descriptions automatically but this time it will not generate an error message unless a CODESYS application is being loaded into the MFN 100.

1. Click **Tools > Device Repository**.

2. Click **Download missing descriptions**.



NOTE

The button for downloading missing descriptions will not appear if no device descriptions of generic devices are missing. Close the window and continue if that is the case.

3. Click **Download** in the new window.

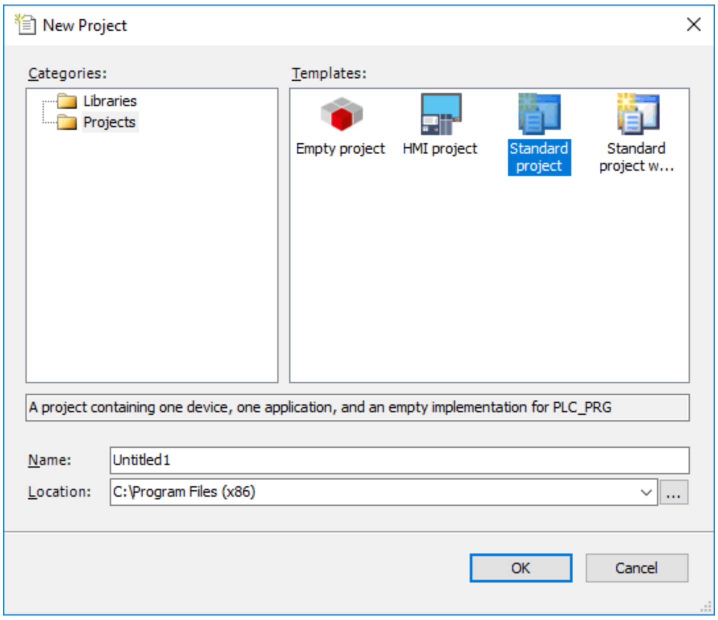
4. Click **Close** when the download is finished.

Creating a new CODESYS project

This example shows how to create a new project in the CODESYS Development System. The easiest way to get started is to create a **Standard project**.

1. Start CODESYS
2. Go to **File > New Project**.
3. Click **Standard project** on the right side among the templates.
4. Enter a name for the project.
5. Choose a **Location** where the project will be saved.

6. Click **OK** to save the project.

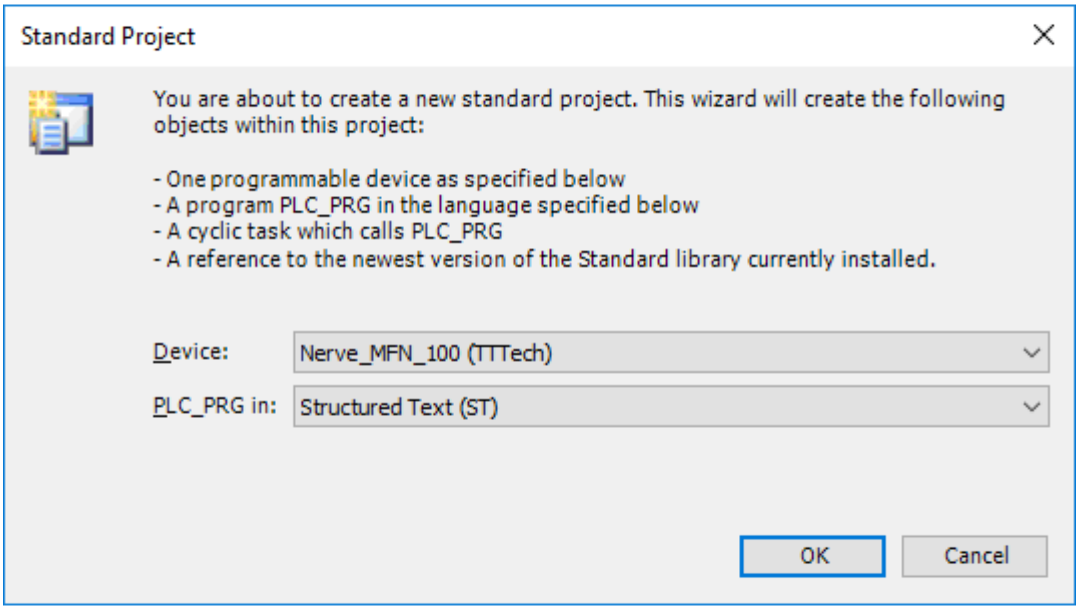


A project containing one device, one application, and an empty implementation for PLC_PRG

Name: Untitled1

Location: C:\Program Files (x86)

7. Select **Nerve_MFN_100 (TTTech)** as the device.



You are about to create a new standard project. This wizard will create the following objects within this project:

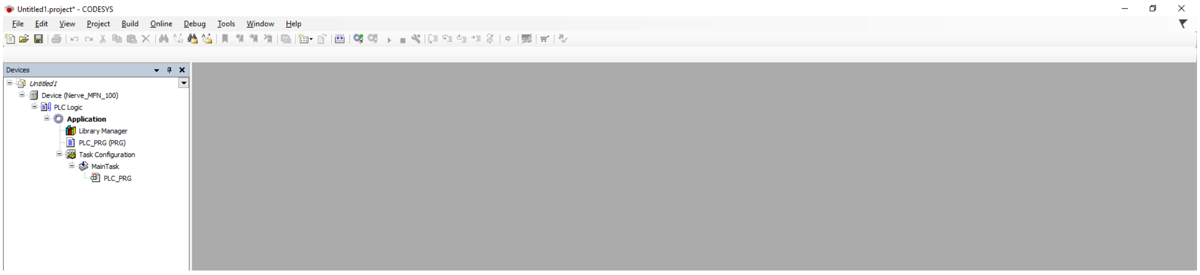
- One programmable device as specified below
- A program PLC_PRG in the language specified below
- A cyclic task which calls PLC_PRG
- A reference to the newest version of the Standard library currently installed.

Device: Nerve_MFN_100 (TTTech)

PLC_PRG in: Structured Text (ST)

8. Click **OK**.

The result is an empty project that is open in the main view of CODESYS.

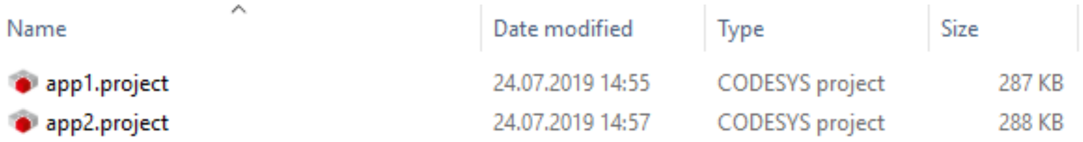


Working with the default applications

To work with existing applications first, modify the default applications `app1.project` and `app2.project`. They have been sent as part of the delivery.

1. Start CODESYS.
2. Go to **File > Open Project**.
3. Select the location where the default applications are saved.

4. Select the application to work with.



Name	Date modified	Type	Size
app1.project	24.07.2019 14:55	CODESYS project	287 KB
app2.project	24.07.2019 14:57	CODESYS project	288 KB

5. Click **Open**.

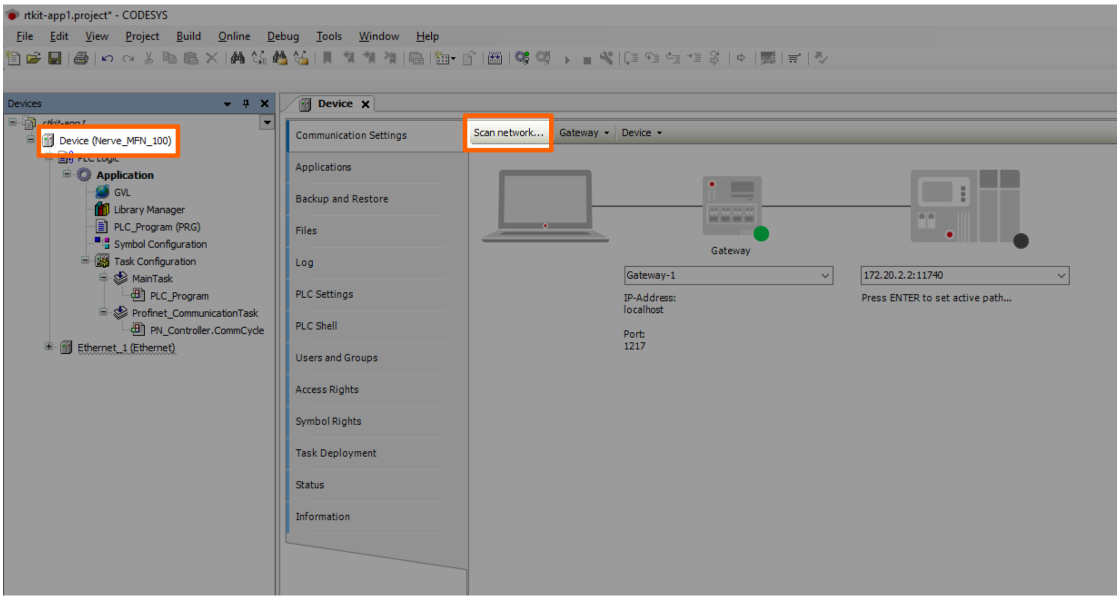
If the default applications are opened for the first time, some libraries and device descriptions will be missing. Follow the instructions above to see how to download the missing files.

Connecting to the MFN 100

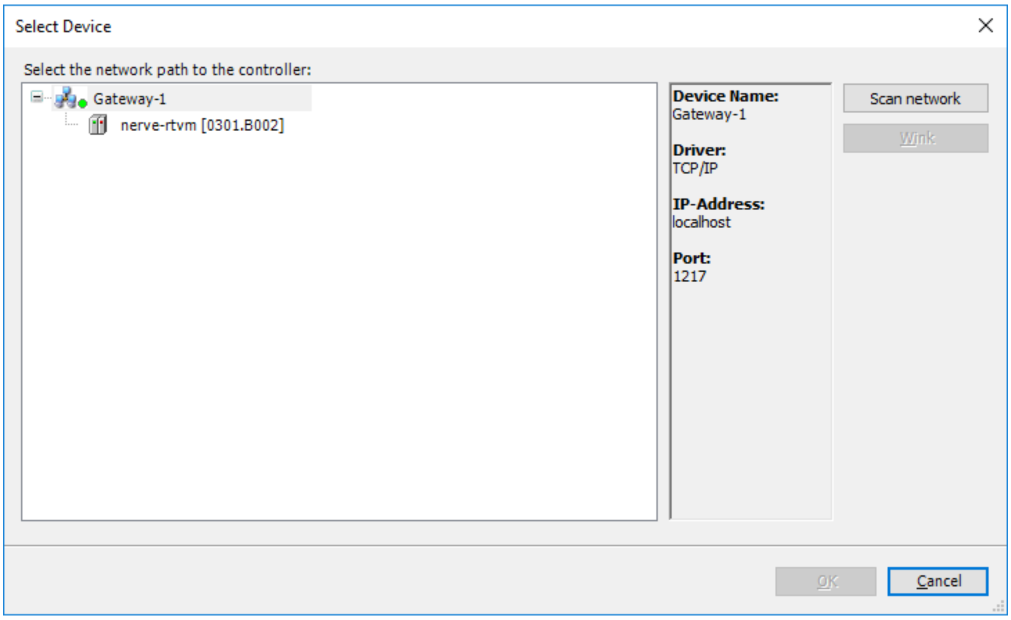
Before downloading CODESYS applications to the MFN 100, make sure that the device description of the MFN 100 is installed in the CODESYS Development System.

1. Open or create a CODESYS project.
2. Double-click **Device (Nerve_MFN_100)** in the tree view on the left.

3. Go to **Communication Settings > Scan network...**.



4. Select the MFN 100 (here **nerve-rtvm [XXXX.XXXX]**) in this window.



Select Device

Select the network path to the controller:

Device Name:
Gateway-1

Driver:
TCP/IP

IP-Address:
localhost

Port:
1217

NOTE

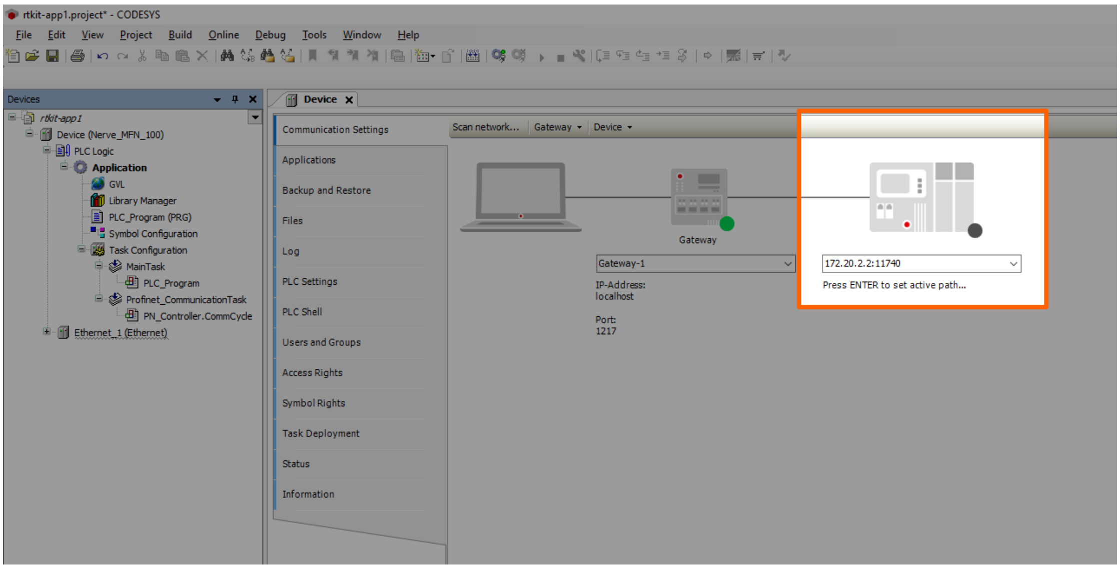
When more than one network is active on the workstation, it sometimes happens that the MFN 100 cannot be found. Continue reading if the MFN 100 does not appear in this window.

5. Click **OK**.

Typically the MFN 100 will be found automatically. If the MFN 100 cannot be found, enter the IP address and port of the CODESYS runtime manually.

1. Double-click **Device (Nerve_MFN_100)** in the tree view on the left.
2. Go to **Communication Settings** in the middle of the window.

3. Enter `172.20.2.2:11740` in the text box under the device on the right.



Gateway-1

IP-Address:
localhost

Port:
1217

172.20.2.2:11740

Press ENTER to set active path...

4. Press Enter.

The CODESYS Development System is now connected to the MFN 100 and applications can be downdloaded into the CODESYS runtime.

Downloading an application to the MFN 100

CODESYS applications can be loaded directly into the MFN 100. However, before downloading an application into the MFN 100 it needs to be free of errors.

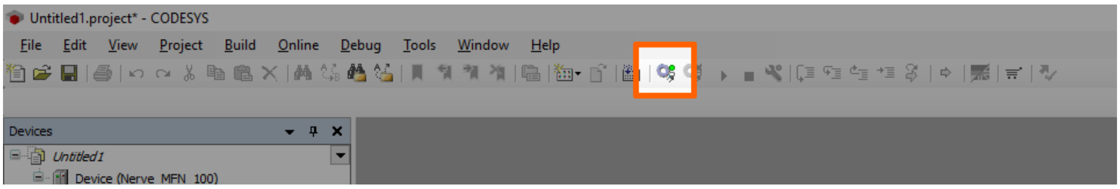
The process of downloading an application is slightly different if an entirely new application is downloaded into the MFN 100 or if an application is being updated that has already been downloaded into the MFN 100. If updating an application that has been downloaded to the MFN 100 before, continue with Downloading an Updated Application to the MFN 100 further down below.

Downloading a new application to the MFN 100

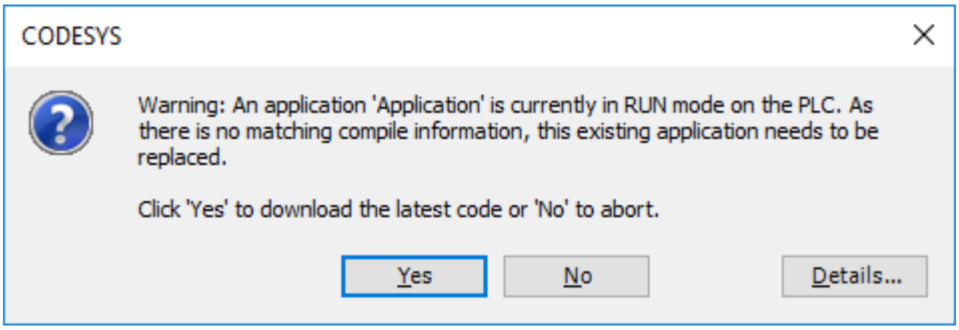
Once a project has been created and programming is finished, the CODESYS application can be downloaded to the MFN 100 directly.

1. Open the CODESYS project to load into the MFN 100.

2. Click the **Login** symbol in the CODESYS menu bar.


Untitled1.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
Untitled1
Device (Nerve_MFN_100)

3. Click **Yes** in the pop-up window.

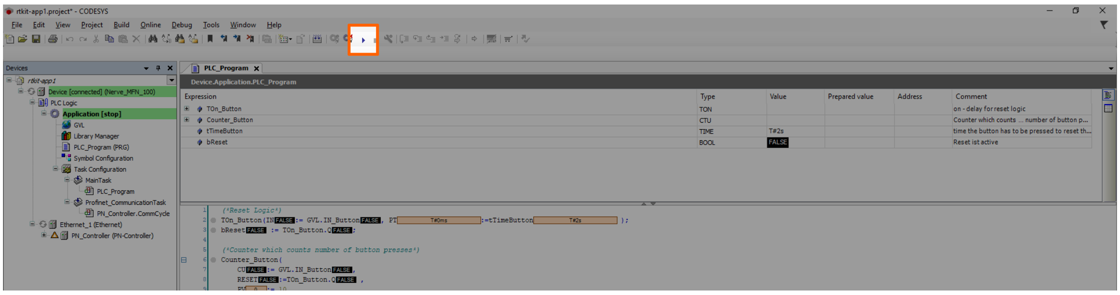


CODESYS

Warning: An application 'Application' is currently in RUN mode on the PLC. As there is no matching compile information, this existing application needs to be replaced.

Click 'Yes' to download the latest code or 'No' to abort.

4. The application is stopped now. Click the **Play** symbol in the CODESYS menu bar.



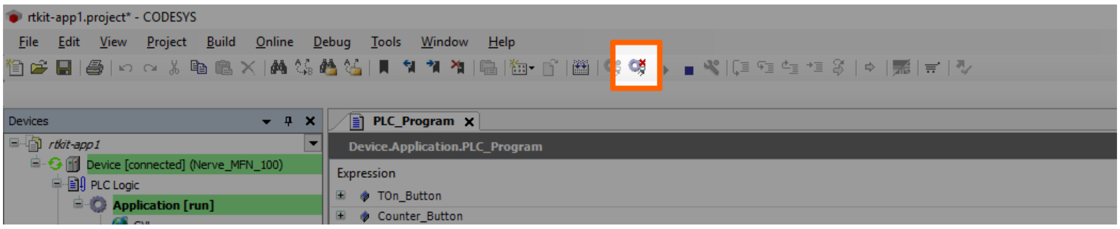
The application is now loaded to the MFN 100.

Downloading an updated application to the MFN 100

If updating an application after loading it into the MFN 100, it needs to be downloaded into the MFN 100 again. The download process is slightly different from downloading a new application into the MFN 100.

1. Stop the CODESYS application that has been loaded into the MFN 100 through the Local UI.

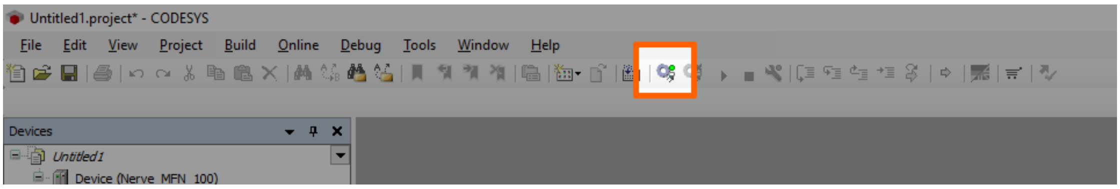
2. Click the **Logout** button in the CODESYS toolbar.


rtkit-app1.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
rtkit-app1
Device [connected] (Nerve_MFN_100)
PLC Logic
Application [run]
PLC_Program
Device.Application.PLC_Program
Expression
TOn_Button
Counter_Button

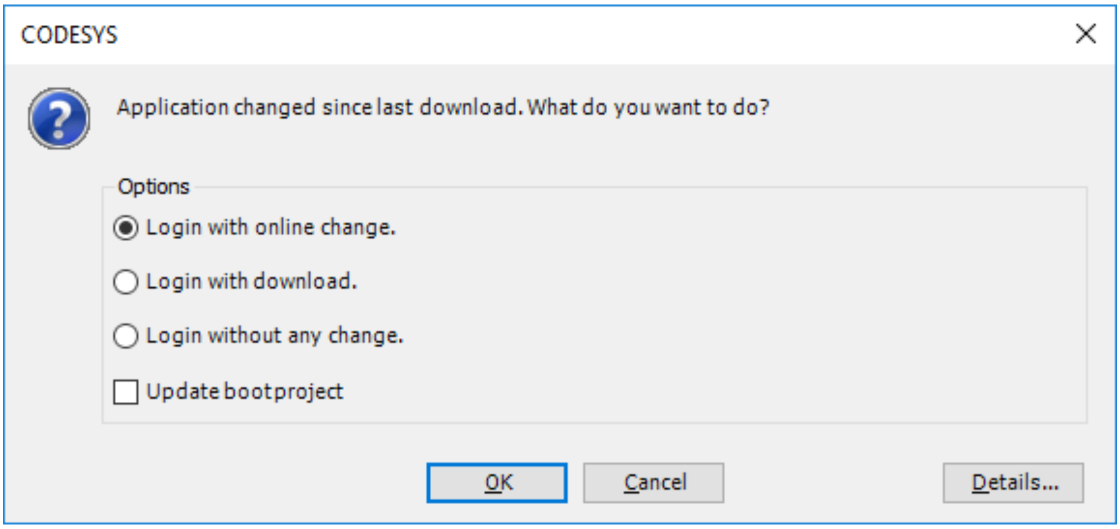
3. Expand **Device (Nerve_MFN_100) > PLC Logic > Application**.

4. Double-click **PLC_Program (PRG)**.
5. Perform changes.

6. Click the **Login symbol** in the CODESYS menu bar.


Untitled1.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
Untitled1
Device (Nerve_MFN_100)

7. In the pop-up window, select one of the options.



CODESYS

Application changed since last download. What do you want to do?

Options

● Login with online change.

○ Login with download.

○ Login without any change.

□ Update bootproject

Item	Description
Login with online change.	The updated application will be loaded into the MFN 100. Variable values will not be reset. If the application was running before, it will be running after the download.
Login with download.	The updated application will be loaded into the MFN 100. Variable values will be reset. The application is stopped.
Login without any change.	The updated application will not be loaded into the MFN 100 but the code will keep the changes.

8. Click **OK**.

The application is now loaded to the MFN 100.

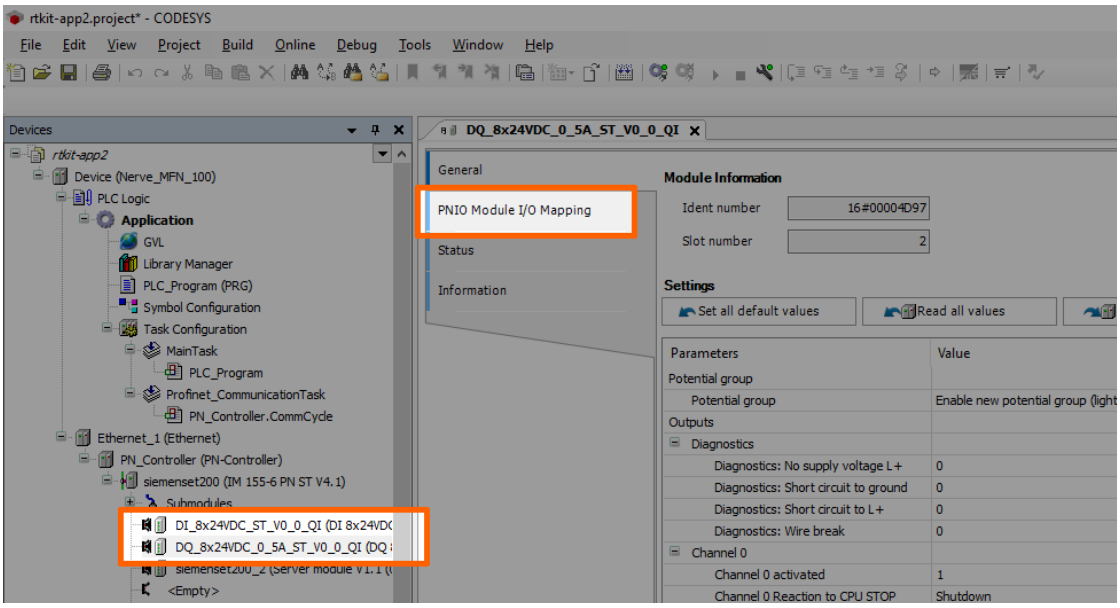
NOTE

For more help with programming PLC applications in the CODESYS Development System go to help.codesys.com.

Allocating variables to inputs or outputs

After connecting new sensors and actuators, assign variables to the I/O channel in CODESYS.

1. Open a CODESYS project.
2. Expand **Device (Nerve_MFN_100) > PLC Logic > Ethernet_1 > PN_Controller > siemenset200 (IM 155-6 PN ST V4.1)** in the tree structure on the left.
3. Double-click **DI_8x24VDC_ST_V0_0_QI (...)** for digital inputs.
   Double-click **DQ_8x24VDC_0_5A_ST_V0_0_QI (...)** for digital outputs.
4. Select **PNIO Module I/O Mapping**.



Ident number	16#00004D97
Slot number	2

Parameters	Value
Potential group	
Potential group	Enable new potential group (light
Outputs	
Diagnostics	
Diagnostics: No supply voltage L+	0
Diagnostics: Short circuit to ground	0
Diagnostics: Short circuit to L+	0
Diagnostics: Wire break	0
Channel 0	
Channel 0 activated	1
Channel 0 Reaction to CPU STOP	Shutdown

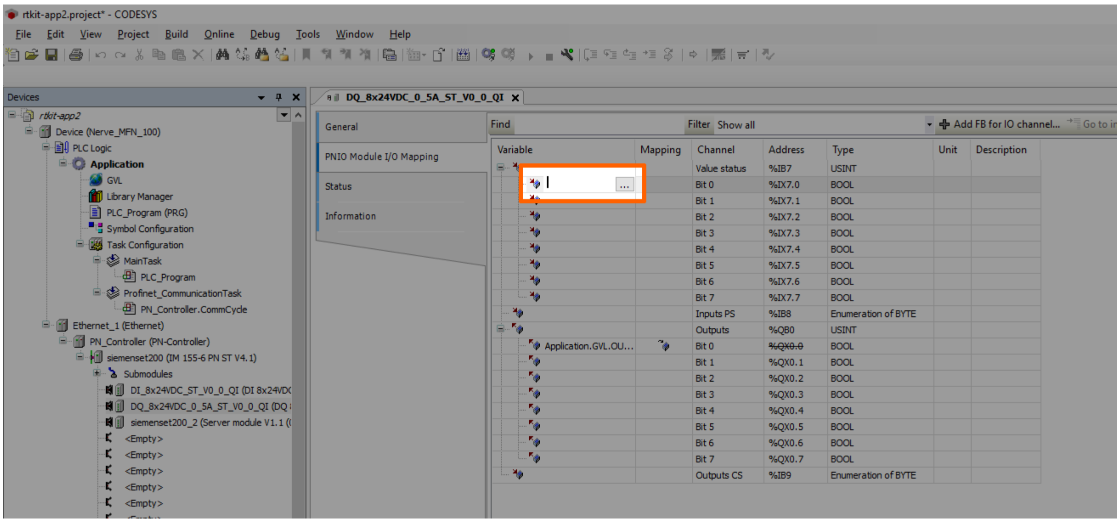
5. Fully expand the tree view.

6. Double-click the variable slot to assign.

NOTE

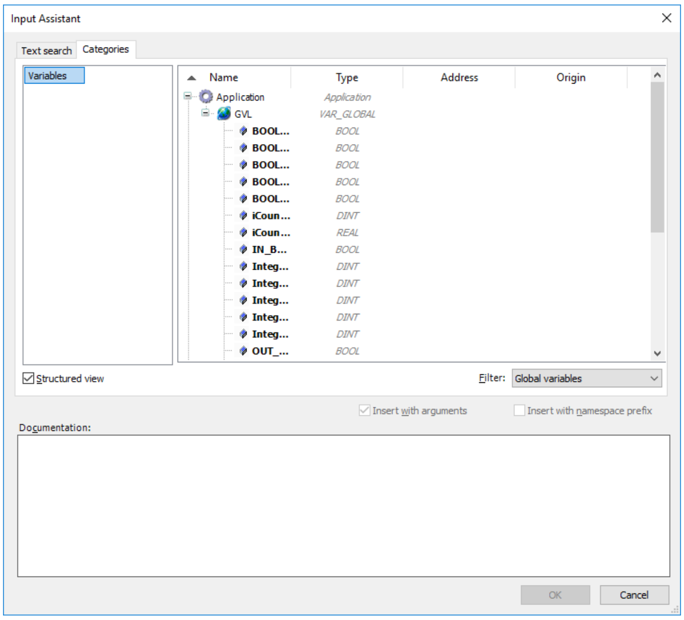
The inputs in this view do not match the physical inputs of the I/O module on the kit. The inputs here go from 0 to 7. The physical inputs go from 1 to 8. Therefore input 0 in this view represents the physical input 1 on the I/O module. This also applies to outputs.

7. Click the three dots next to the variable slot.



Variable	Mapping	Channel	Address	Type	Unit	Description
		Value status	%IB7	USINT		
...		Bit 0	%IX7.0	BOOL		
		Bit 1	%IX7.1	BOOL		
		Bit 2	%IX7.2	BOOL		
		Bit 3	%IX7.3	BOOL		
		Bit 4	%IX7.4	BOOL		
		Bit 5	%IX7.5	BOOL		
		Bit 6	%IX7.6	BOOL		
		Bit 7	%IX7.7	BOOL		
		Inputs PS	%IB8	Enumeration of BYTE		
		Outputs	%QB0	USINT		
Application.GVL.OU...		Bit 0	~~%QX0.0~~	BOOL		
		Bit 1	%QX0.1	BOOL		
		Bit 2	%QX0.2	BOOL		
		Bit 3	%QX0.3	BOOL		
		Bit 4	%QX0.4	BOOL		
		Bit 5	%QX0.5	BOOL		
		Bit 6	%QX0.6	BOOL		
		Bit 7	%QX0.7	BOOL		
		Outputs CS	%IB9	Enumeration of BYTE		

8. Expand **Application > GVL** in the new window.



Name	Type	Address	Origin
Application	Application		
GVL	VAR_GLOBAL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
iCoun...	DINT		
iCoun...	REAL		
IN_B...	BOOL		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
OUT_...	BOOL		

☑ Structured view

Filter: Global variables

☑ Insert with arguments □ Insert with namespace prefix

Documentation:

9. Select the variable to assign.

> **NOTE**
>
> Make sure to select a variable of the same type as the input, i.e., a **BOOL** variable for a **BOOL** input or output.

10. Click **OK**.

Use the assigned variables to read data from connected sensors or to control actuator functionality.

> **NOTE**
>
> For more help with programming PLC applications in the CODESYS Development System go to help.codesys.com.

Enabling retain variables

`NerveCodesysRetainVar` is a library for storage and restoration of retain variables with prevention of data loss in case of system crash (e.g. power outage). To prevent data loss, the retain variables are stored in two file copies under `/opt/data/var/lib/nerve-codesys/PlcLogic/`.

The retain variables library (`NerveCodesysRetainVar.compiled-library`) and an example project showcasing typical use (`demo.project`) are available at the Nerve Software Center. Follow the instructions below to install and import the retain variables library into a project.

Installing and importing the NerveCodesysRetainVar library

Download the retain variables library (NerveCodesysRetainVar.compiled-library) from the Nerve Software Center first before following the instructions below.

1. Open or create a CODESYS project.
2. Select **Tools > Library Repository** in the toolbar.
3. Click **Install...** in the new window.
4. Navigate to the folder containing the retain variables library and select the NerveCodesysRetainVar.compiled-library file.
5. Select **OK**.

The library will appear in the **Application** element after it has been installed. Close the library repository window by selecting **Close** in the lower right. Next the library needs to import into the project.

1. Double-click **Library Manager** in the tree view on the left.
2. Select **Add library** in the **Library Manager** tab that opened on the right.
3. Enter NERVE Retain in the search field to search for the library.
4. Select the **NERVE Retain Variables Library**.
5. Select **OK**.

The **Nerve Retain Variables Library** now appears in the **Library Manager** tab.

Example project and use

The example project (demo.project) is meant to show how the library functions can be used. It includes two variants of a simple program counting up multiple counters stored as permanent variables:

- **PLC_PRG1** stores and restores the retain variables just once based on a trigger activated by boolean flags (store and restore).
- **PLC_PRG2** shows a typical use case, where the retain variables are restored once during the initialization phase and then periodically stored every cycle after all the counters are updated.

The NerveCodesysRetainVar library provides two functions:

- StoreRetains to store retain variables
- RestoreRetains to restore retain variables

The namespace of the library is NerveCodesysRetainVar.

Functions have a return value of type RTS_IEC_RESULT defined in the **SysTypes Interfaces** library. It is required to either include this library or define the return variables as type NerveCodesysRetainVar.RTS_IEC_RESULT. The possible error codes are defined by CmpErrors2 Interfaces.

Note that RestoreRetains may fail with error code 0x32 when the application runs for the first time, before any retain variables were stored. This is because the files with stored retain variables do not exist yet.

During the startup of the device, the CODESYS application uses the function RestoreRetains. This loads the last stored state of retain variables.

During execution, the CODESYS application periodically saves the current state of retain variables with the function StoreRetains. This could be done in a periodically executed task or at certain points during calculations, when it is meaningful to store the current state.

In case of a sudden crash of the CODESYS application (e.g. power failure), the last saved state of the retain variables will be restored.

NOTE

The type of memory must be taken into consideration for periodical storing of retain variables. Writing too often for longer periods of time may result in damage to disks.

Integrating Nerve into the build system

The Management System can be controlled with the API. In this version of the Management System API documentation, the focus lies on working with workloads. As a demonstration, download the `Nerve_API_2.5.0.zip` from the Nerve Software Center. The login credentials for the download can be found in the customer profile.

With the Python script it is demonstrated how to:

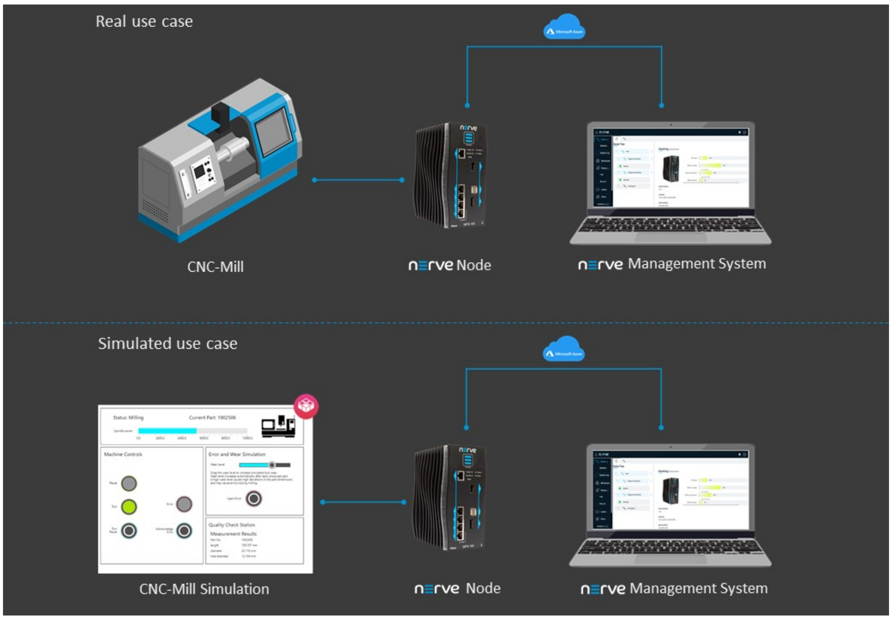
- provision CODESYS, Docker and Virtual Machine workloads
- deploy workloads
- undeploy workloads
- delete workloads

Full API documentation will be made available in future versions.

Tutorials

Tutorial: Machine efficiency insight

Nerve is a platform for applications running on machines and accessing machine data. This tutorial shows how to create an application to gain insight into production and machine efficiency. It shows how to use Nerve to measure and visualize overall equipment effectiveness (OEE) of a virtual CNC mill. In a real-life environment a CNC mill would be physically connected to a Nerve Node with Nerve installed. A remote connection is established to the Nerve Node via the Nerve Management System.



Going through this demo will take about 30 minutes and cover how to deploy container workloads, remotely access nodes and configure a Node-RED system to display an OEE and quality control dashboard.

Items needed for this tutorial are:

- a workstation or PC
- login credentials to the Nerve Management System and the filesharing server
- the Nerve Connection Manager app
- a flow file for Node-RED

All links, login credentials and the instructions to download files will be sent via emails. In case files or login credentials are missing, contact trynerve@tttech-industrial.com.

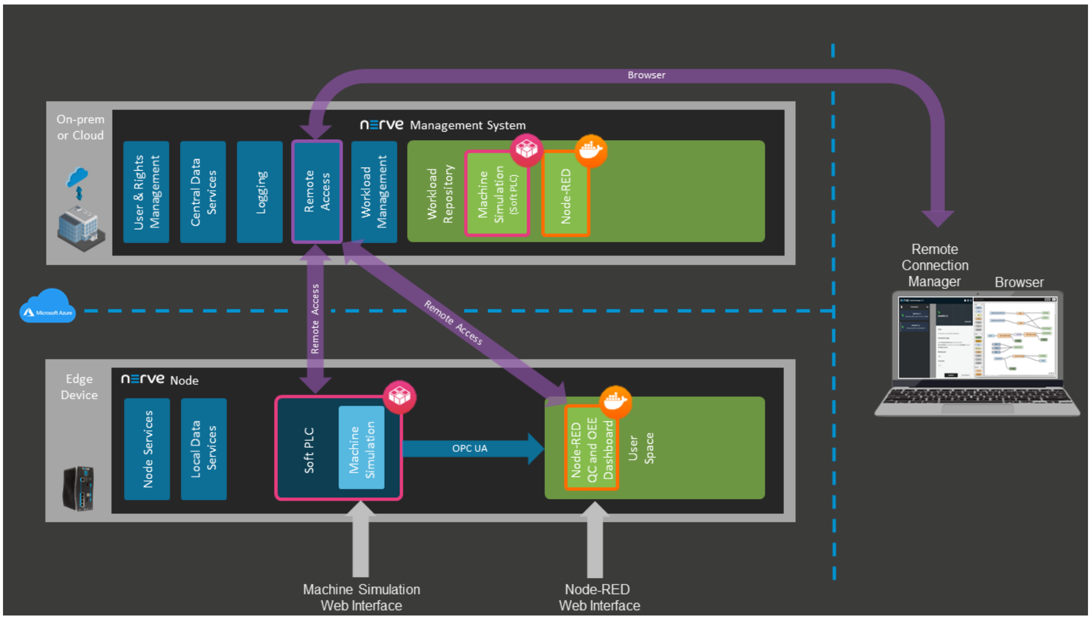
The tutorial environment is set up in the evaluation laboratory at TTTech Industrial in Vienna. The Nerve Device is an MFN 100 running an Intel Atom quad core CPU.

NOTE

In case the evaluation system is used, be aware that other users may access the same evaluation system, meaning that other nodes might be registered in the Management System. Information and workloads uploaded into the system may be visible to other users.

Tutorial architecture

In the course of this tutorial a simulation of a CNC machine (machine simulation) is installed on a Nerve Device. This machine simulation creates data which is read by the Node-RED application and visualized on a server running on the Nerve Device. The Node-RED application transforms the data received into an OEE and quality dashboard. The machine simulation, Node-RED and all dashboards are accessed on the Nerve Device directly, using the remote access feature of the Nerve cloud management platform called the Nerve Management System. In Nerve, applications managed by customers are called workloads.



Machine simulation

The simulation model simulates a machine which continuously creates parts and is subject to wear. The machine provides status information and Quality Control information through a built-in OPC UA server. The application is programmed in IEC 61131-3 and running in a soft PLC.

Node-RED

Node-RED is an open source programming tool for wiring together sensor inputs, APIs and online services. In this tutorial Node-RED reads data from the machine simulation through OPC UA, modifies it and displays it on an OEE and quality dashboard. The system is implemented based on predefined graphical modules, which are connected through drag and drop.

Refer to Node-RED documentation for more information on Node-RED. TTTech provides Node-RED as a supported third party application.

Initial setup

The Nerve Management System is set up so that the tutorial can be started straightaway. The necessary applications have already been configured and the remote connections are set up. The evaluation system does not limit experimentation to the extent of this tutorial. It is possible to create, deploy and test new workloads. However, the features of Local UI, Data Services and user management are not enabled in the standard evaluation system. Contact sales@tttech-industrial.com for information on how to obtain the full version.

To explore the Nerve system even further, refer to the user guide.

Viewing nodes in the node tree

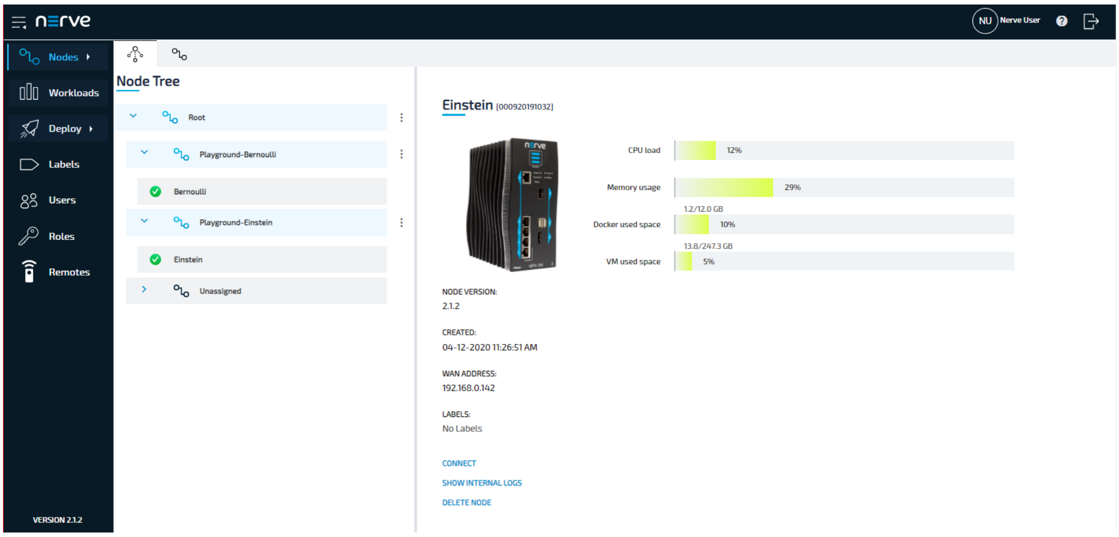
The node tree is the first visible page of the Management System after logging in. It presents a means of organization for nodes that are connected to the Management System. Nodes are embedded into elements of the node tree.

1. Log in to the Management System with your credentials.

2. Look for your node in the node tree. It is embedded in its own tree element.

NOTE

The node and the tree element are named after a scientist. The name has been sent in an email.



Einstein [000920191032]

CPU load 12%

Memory usage 29%

1.2/12.0 GB

Docker used space 10%

13.8/247.3 GB

VM used space 5%

NODE VERSION:
2.1.2

CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

LABELS:
No Labels

Be aware that other users may access the same evaluation system. Make sure to use the designated node that was mentioned in the instruction emails.

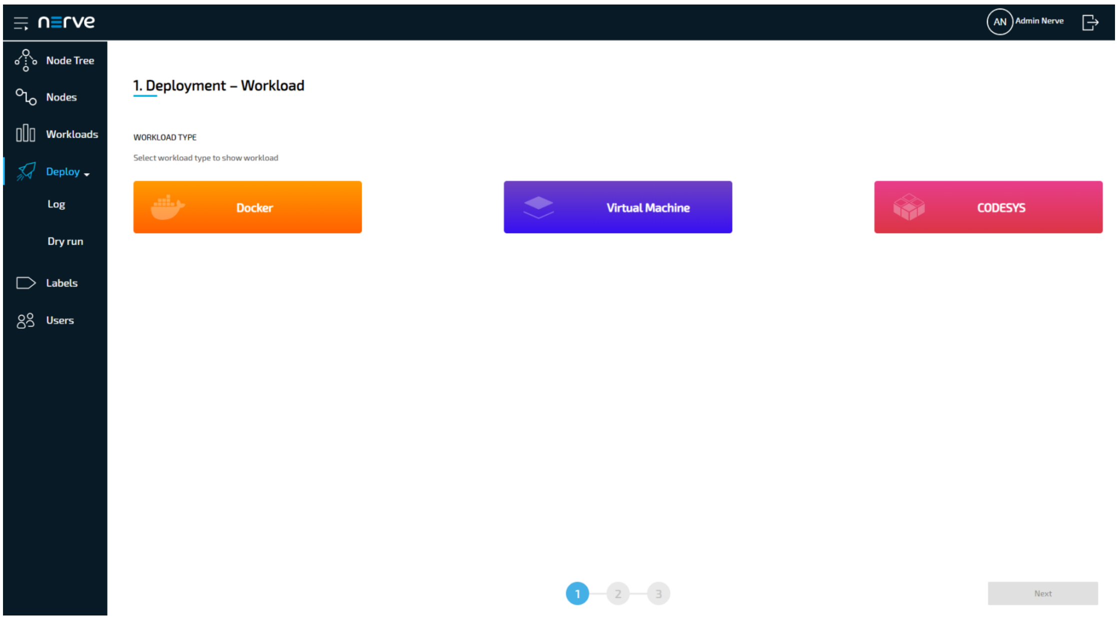
Step 1: Deploying the machine simulation and Node-RED workloads

Deployment is the process of downloading workloads to Nerve Devices through the Nerve Management System. With Nerve you can deploy and manage Docker containers, virtual machines and CODESYS applications. The instructions below show how to deploy the machine simulation as a CODESYS workload and Node-RED as a Docker workload.

Machine simulation

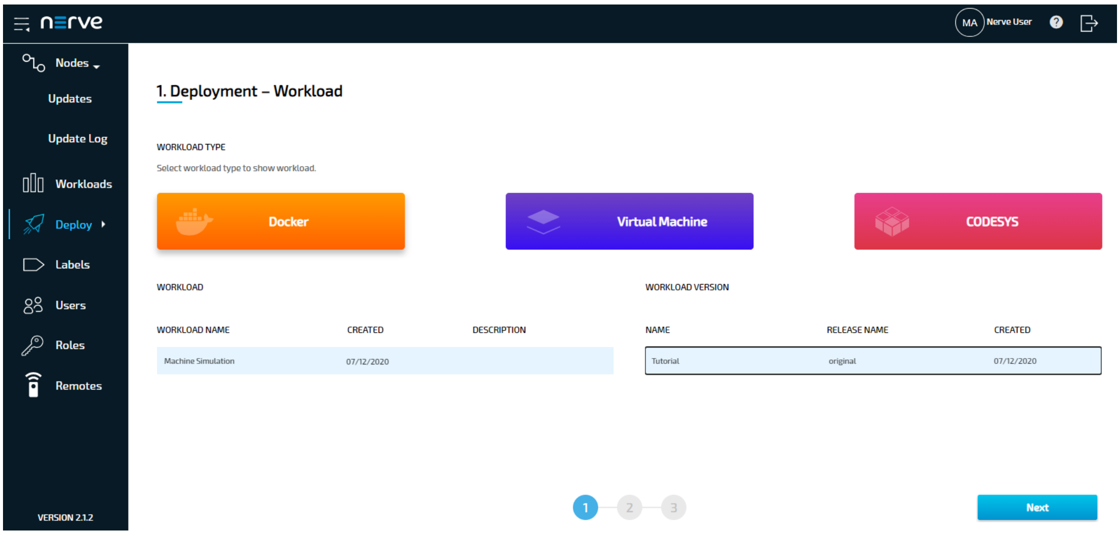
1. Log in to the Management System.

2. Select **Deploy** in the navigation on the left.



3. Select the red CODESYS tab. A list of CODESYS workloads will appear below.

4. Select **Machine Simulation** in the list of workloads. A list of versions of this workload will appear to the right.



WORKLOAD

WORKLOAD NAME	CREATED	DESCRIPTION
Machine Simulation	07/12/2020	

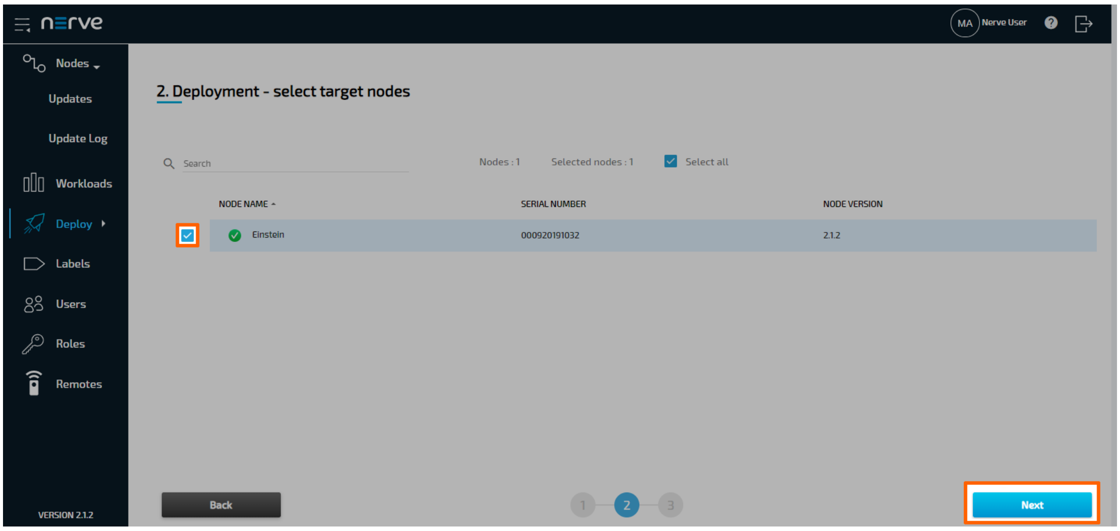
WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Tutorial	original	07/12/2020

5. Select the latest version of the workload on the right.

6. Click **Next** in the lower-right corner.
7. Tick the checkbox next to your node.

8. Select **Next** in the lower-right corner.



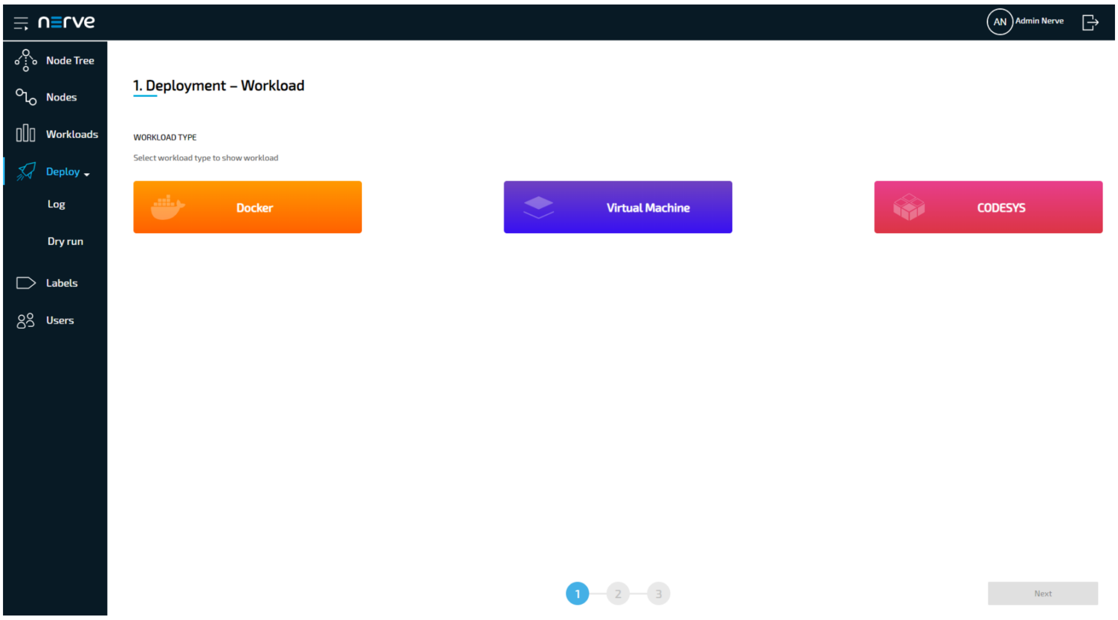
	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	Einstein	000920191032	2.1.2

9. Select **Deploy** to execute the deployment.
   Optional: Enter a Deploy name above the Summary of the workload to make this deployment easy to identify. A timestamp is filled in automatically.

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

Node-RED

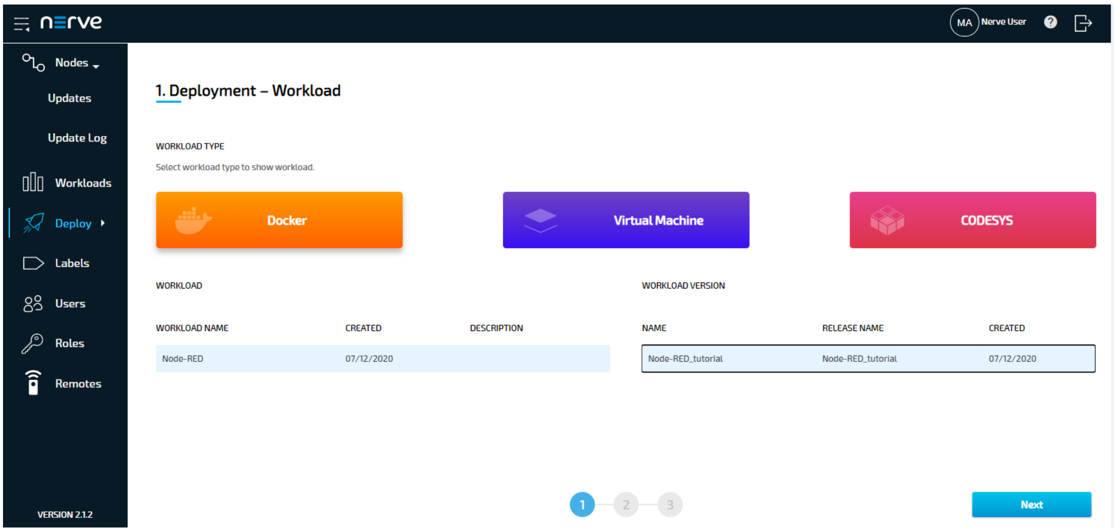
1. Select **Deploy** in the navigation on the left.



2. Select the orange Docker tab. A list of Docker workloads will appear below.

3. Select **Node-RED** in the list of workloads. A list of versions of this workload will appear to the right.

4. Select the latest version of the workload.



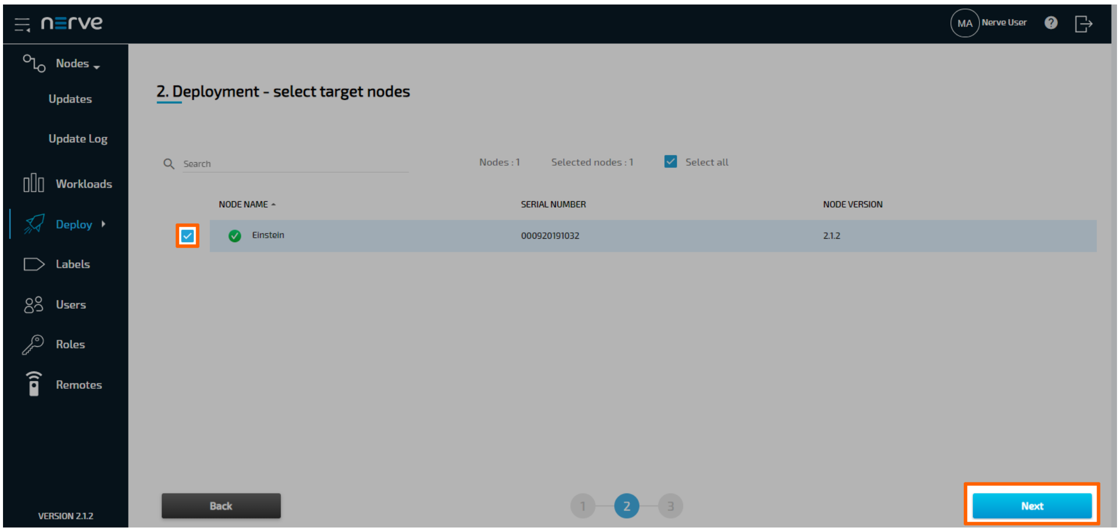
WORKLOAD

WORKLOAD NAME	CREATED	DESCRIPTION
Node-RED	07/12/2020	

WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Node-RED_tutorial	Node-RED_tutorial	07/12/2020

5. Select **Next** in the lower-right corner.
6. Tick the checkbox next to your node.
7. Select **Next** in the lower-right corner.



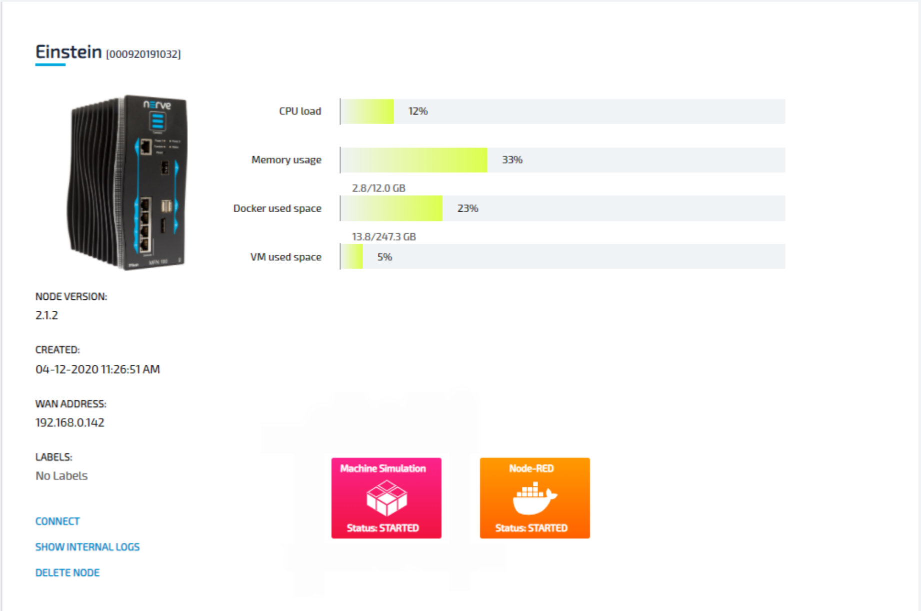
	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	Einstein	000920191032	2.1.2

8. Select **Deploy** to execute the deployment.
   Optional: Enter a Deploy name above the Summary of the workload to make this deployment easy to identify. A timestamp is filled in automatically.

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

To confirm if the workloads have been deployed successfully, select **Nodes** in the navigation on the left. Select your node in the node tree and confirm if two workload tiles are showing underneath the bar graph. The workloads should show the status **STARTED**.

> **NOTE**
>
> It can take a number of seconds until the status of workloads switches from **IDLE** to **STARTED** after deployment.



Einstein (000920191032)

CPU load 12%

Memory usage 33%

2.8/12.0 GB

Docker used space 23%

13.8/247.3 GB

VM used space 5%

NODE VERSION:
2.1.2

CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

LABELS:
No Labels

CONNECT

SHOW INTERNAL LOGS

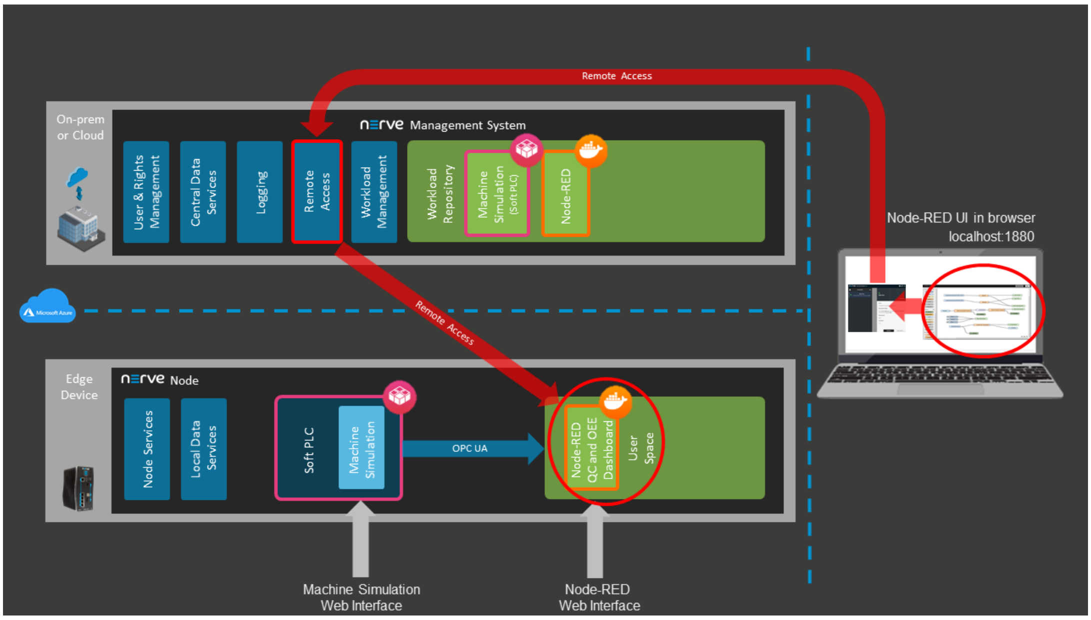
DELETE NODE

Machine Simulation
Status: STARTED

Node-RED
Status: STARTED

Step 2: Connecting to the workloads through remote access

To access the deployed workloads, it is required to create a connection between the computer used for this tutorial and the Management System, and from the Management System to the webservers of the workloads on the Nerve Device. This is done through the remote access feature, specifically through the use of remote tunnels. The remote tunnel connection has already been configured in the Management System and is ready for use. The image below illustrates the remote access feature, showing a connection to the deployed Node-RED workload on the Nerve Device.



Before continuing, install the Nerve Connection Manager that was part of the delivery, as it is required for using remote tunnels.

NOTE

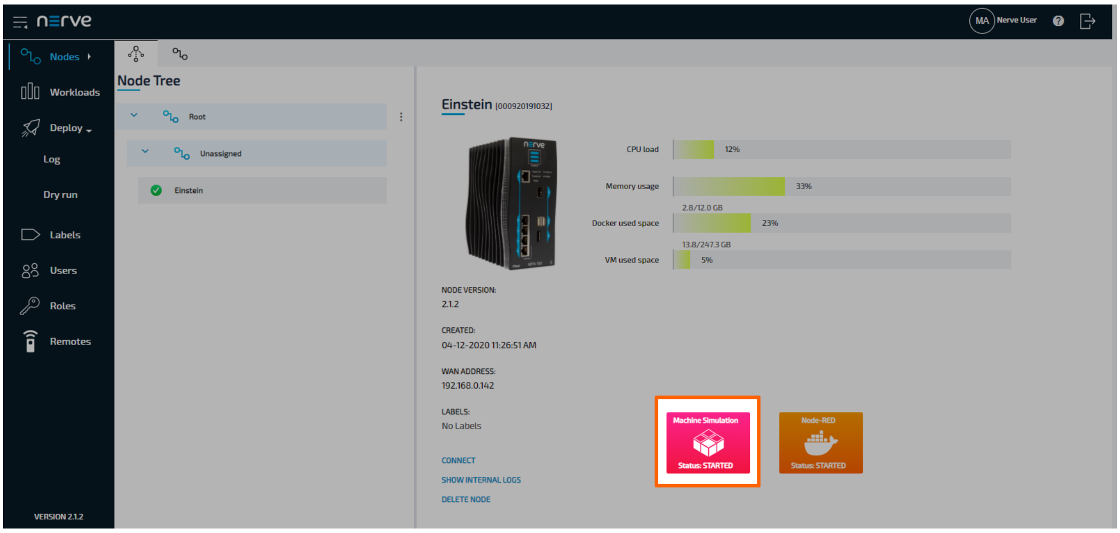
- The Nerve Connection Manager might trigger warnings from antivirus software. This is due to a certain library that was used in development and a known issue.
- Local admin rights might be required to successfully install the Nerve Connection Manager.

Connecting to the machine simulation

The machine simulation is accessible at port 8080 on the Nerve Device through a web user interface. The preconfigured remote tunnel will use this port and port 8080 on the local computer to create a connection between the computer and the Nerve Device to access the machine simulation.

1. Select **Nodes** in the navigation on the left.
2. Select your node in the node tree.

3. Select the Machine Simulation CODESYS workload.



Einstein [000920191032]

CPU load 12%

Memory usage 33%

2.8/12.0 GB

Docker used space 23%

13.8/247.3 GB

VM used space 5%

NODE VERSION:
2.1.2

CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

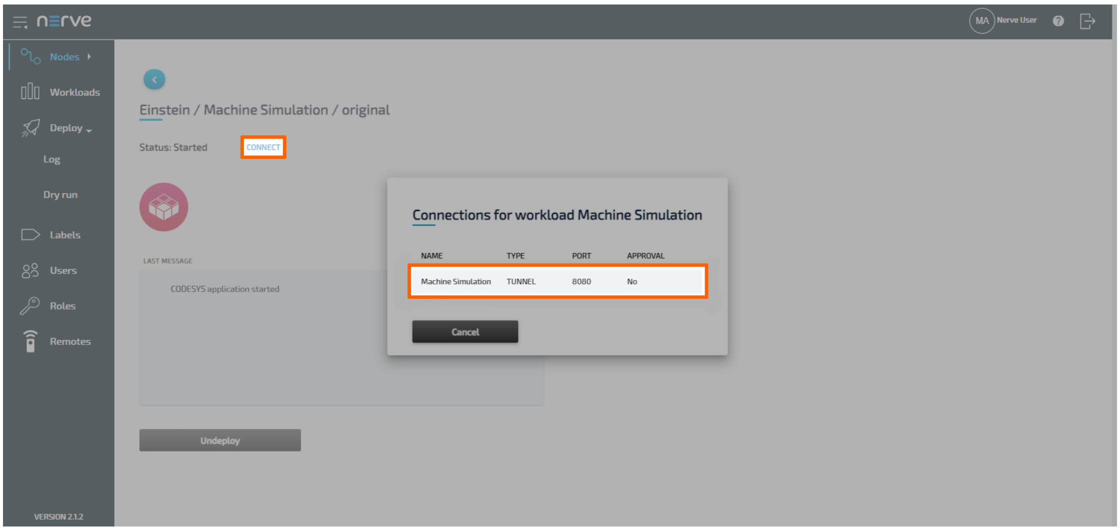
LABELS:
No Labels

Machine Simulation Status: STARTED

Node-RED Status: STARTED

4. Select **CONNECT** next to the workload status. Available connections will appear in a window.

5. Select the **Machine Simulation** remote tunnel from the list.

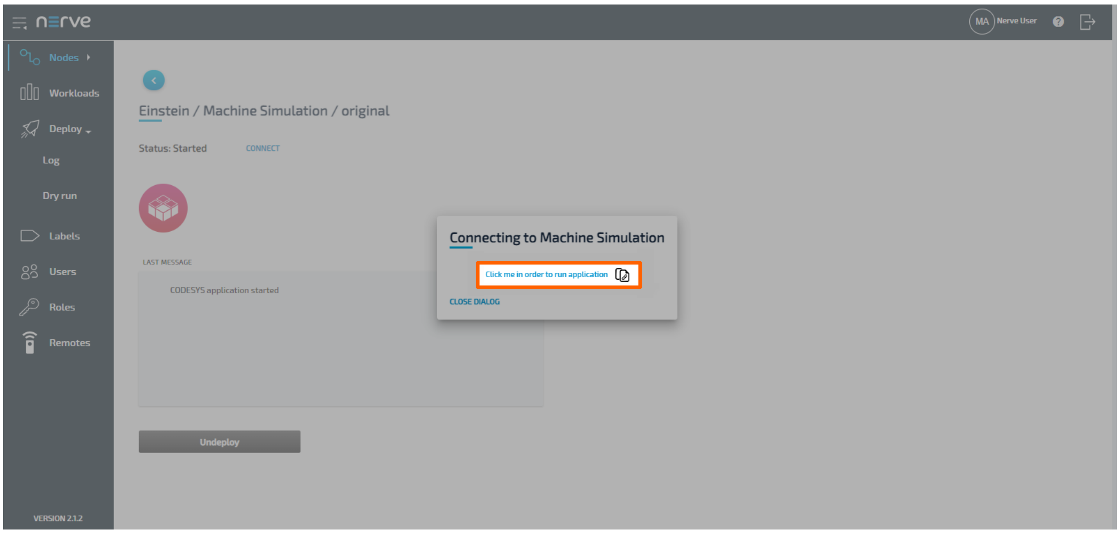


Connections for workload Machine Simulation

NAME	TYPE	PORT	APPROVAL
Machine Simulation	TUNNEL	8080	No

Cancel

6. Select **Click me in order to run application** in the new window.

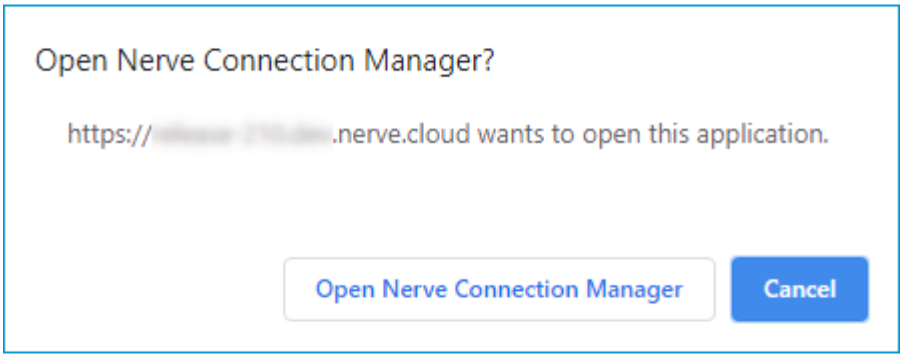


Connecting to Machine Simulation

Click me in order to run application

CLOSE DIALOG

7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
   Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.



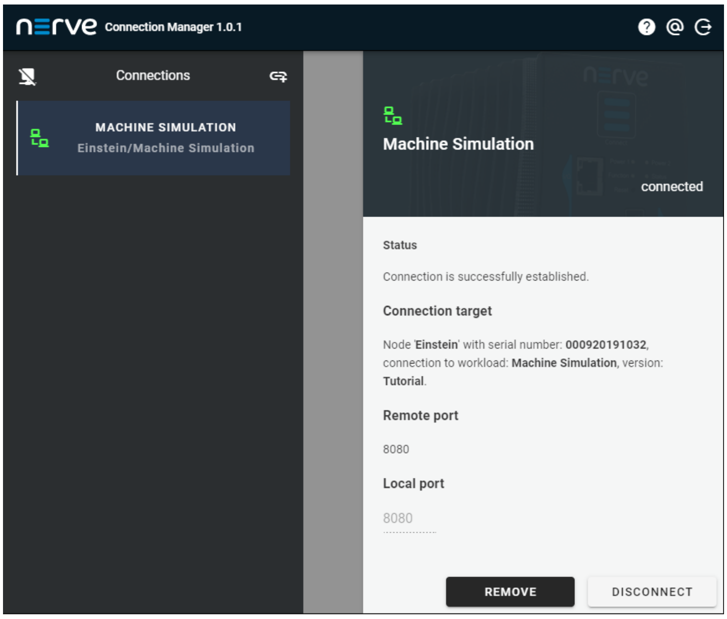
Open Nerve Connection Manager?

https://[redacted].nerve.cloud wants to open this application.

NOTE

If the Nerve Connection Manager does not start automatically, refer to Using a remote tunnel to a node or external device in the user guide.

The remote tunnel will be established once the Nerve Connection Manager starts and the remote connection will turn green in the Nerve Connection Manager. The remote tunnel is now ready to be used.



Status

Connection is successfully established.

Connection target

Node **Einstein** with serial number: **000920191032**, connection to workload: **Machine Simulation**, version: **Tutorial**.

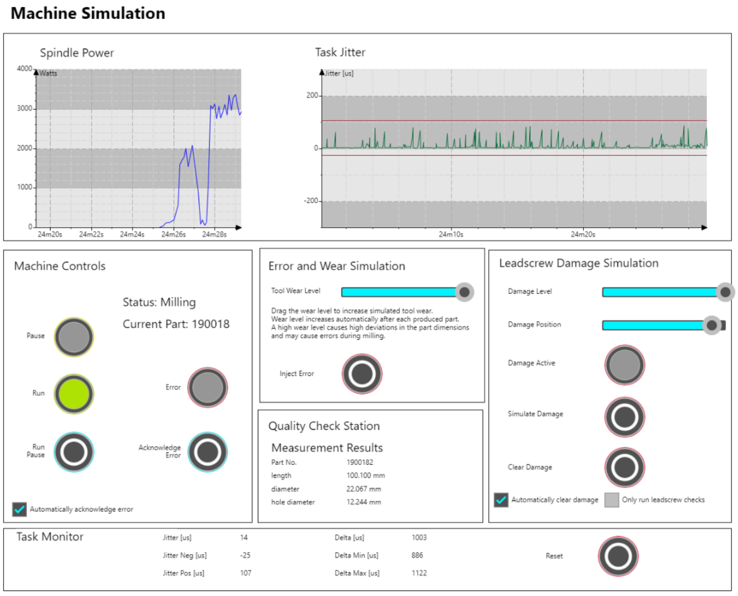
Remote port

8080

Local port

8080

Open a new browser tab and enter `localhost:8080` to open the machine simulation dashboard.



Status: Milling

Current Part: 190018

☑ Automatically acknowledge error

Drag the wear level to increase simulated tool wear.
Wear level increases automatically after each produced part.
A high wear level causes high deviations in the part dimensions and may cause errors during milling.

Quality Check Station

Measurement Results

Part No.	1900182
length	100.100 mm
diameter	22.067 mm
hole diameter	12.244 mm

☑ Automatically clear damage □ Only run leadscrew checks

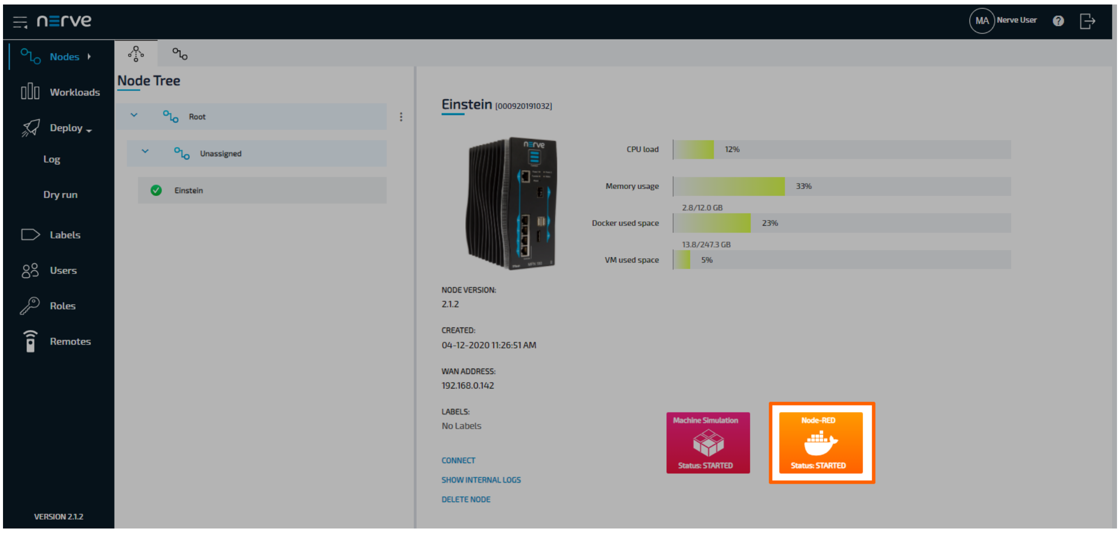
Task Monitor

Jitter [us]	14	Delta [us]	1003
Jitter Neg [us]	-25	Delta Min [us]	886
Jitter Pos [us]	107	Delta Max [us]	1122

Connecting to Node-RED

Node-RED is accessible at port 1880 on the Nerve Device through a web user interface. The preconfigured remote tunnel will use this port and port 1880 on the local computer to create a connection between the computer and the Nerve Device to access the interface of Node-RED.

1. Select **Nodes** in the navigation on the left.
2. Select your node in the node tree.
3. Select the Node-RED Docker workload.



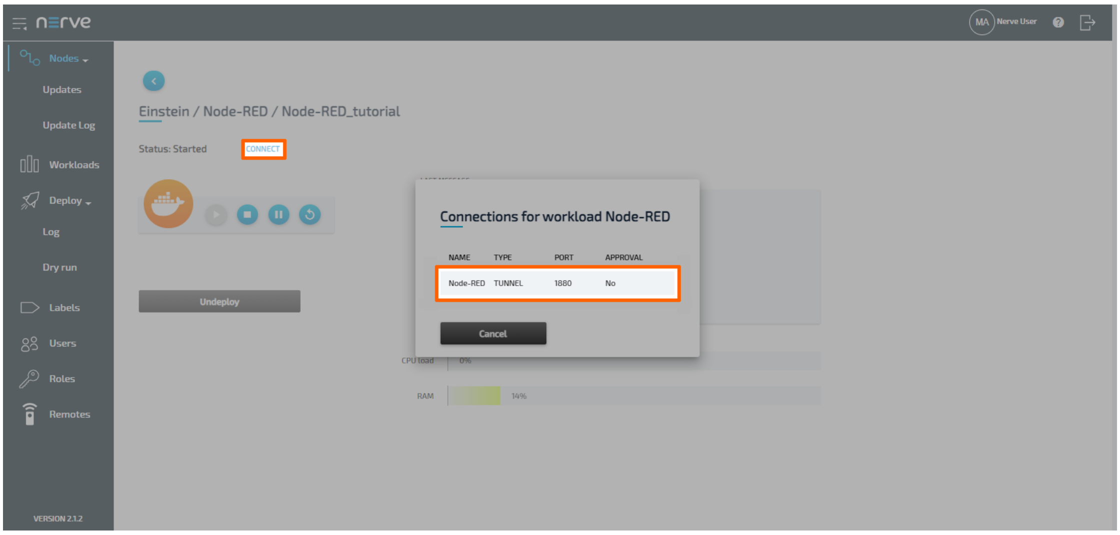
NODE VERSION:
2.1.2

CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

LABELS:
No Labels

4. Select **CONNECT** next to the workload status. Available connections will appear in a window.
5. Select the **Node-RED** remote tunnel from the list.

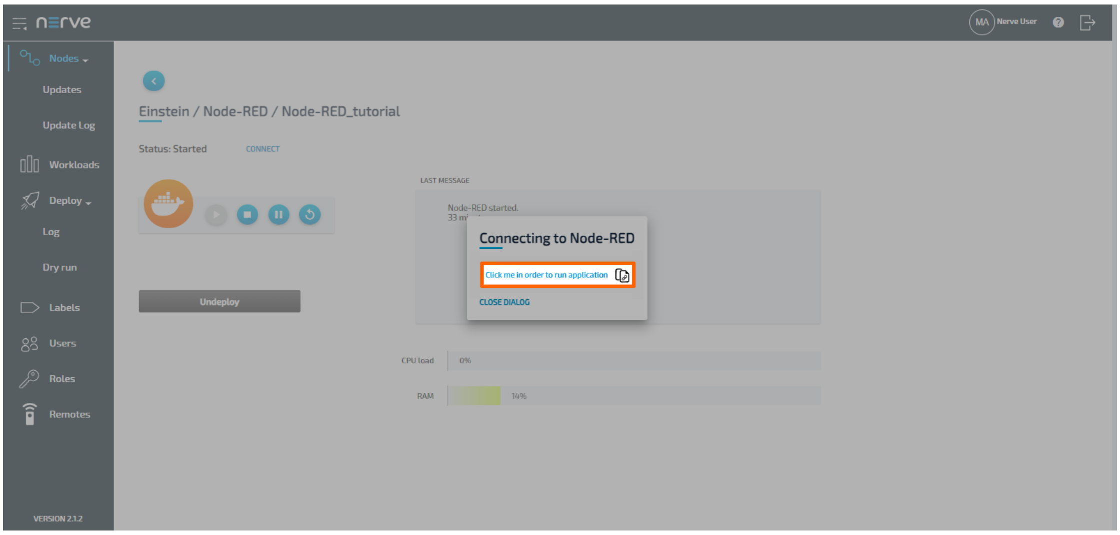


Status: Started

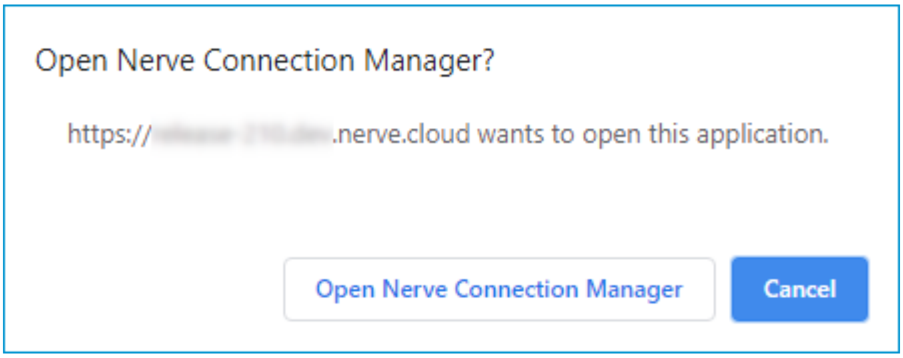
Connections for workload Node-RED

NAME	TYPE	PORT	APPROVAL
Node-RED	TUNNEL	1880	No

6. Select **Click me in order to run application** in the new window.



7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.



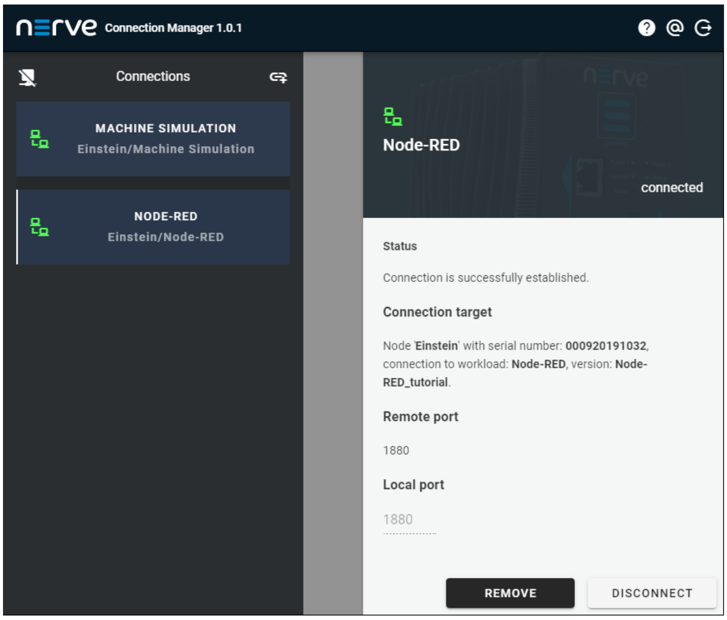
Open Nerve Connection Manager?

https://[redacted].nerve.cloud wants to open this application.

NOTE

If the Nerve Connection Manager does not start automatically, refer to Using a remote tunnel to a workload in the user guide.

The remote tunnel will be established once the Nerve Connection Manager starts and the remote connection will turn green in the Nerve Connection Manager. The remote tunnel is now ready to be used.



Status

Connection is successfully established.

Connection target

Node **Einstein** with serial number: **000920191032**, connection to workload: **Node-RED**, version: **Node-RED_tutorial**.

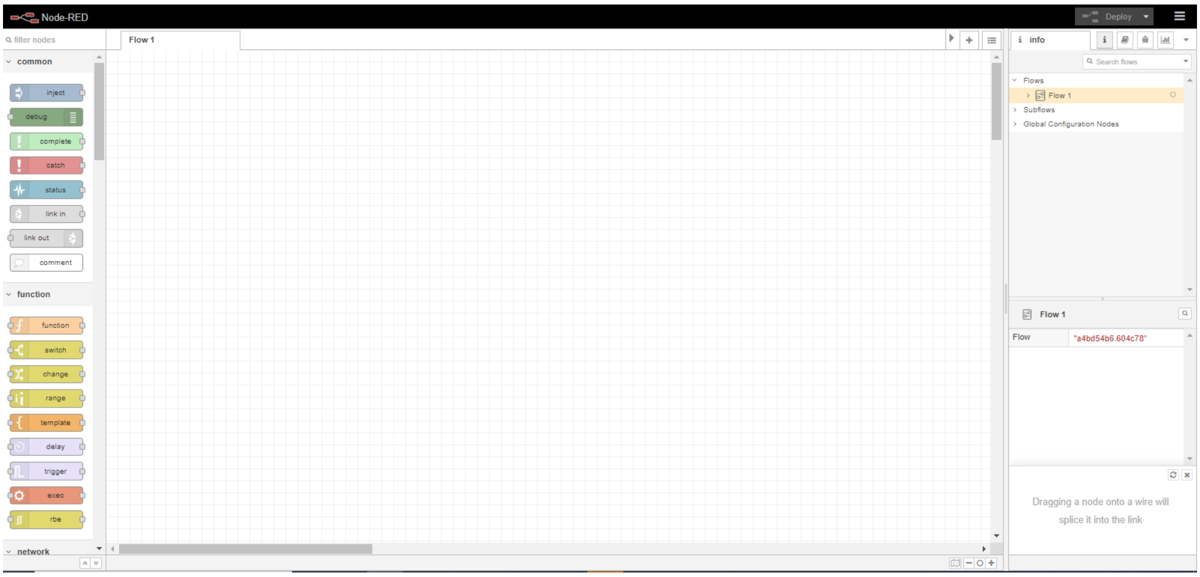
Remote port

1880

Local port

1880

Open a new browser tab and enter `localhost:1880` to open Node-RED.

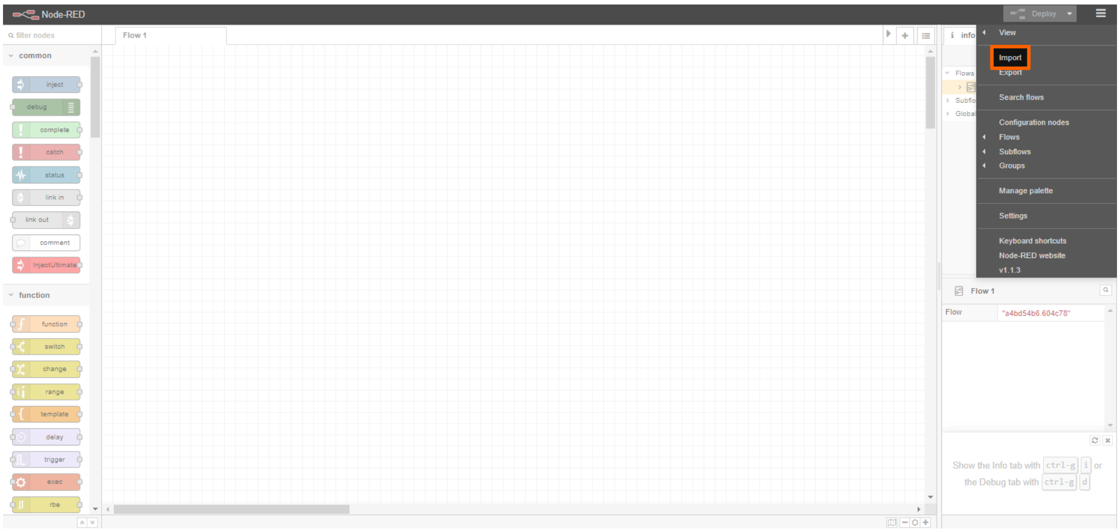


Step 3: Setting up Node-RED

Node-RED is running on the node and the workstation is connected to it through a remote tunnel. Switch to the browser tab that has Node-RED opened at `localhost:1880`. The flow is imported in the instructions below.

> **NOTE**
>
> Download the JSON file that has been part of the delivery and remember its download location.

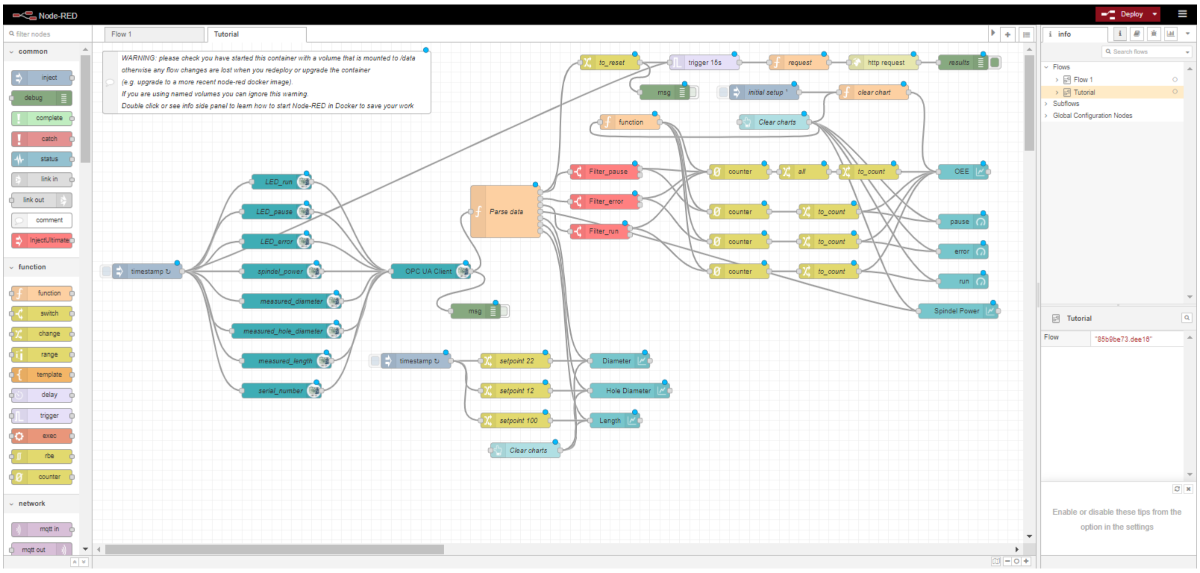
1. Select the burger menu in the top-right corner.
2. Select **Import**.



3. Select **select a file to import**.

4. Look for the JSON file that has been downloaded before.
5. Select **Open**.
6. Select **Import** in the lower-right corner.

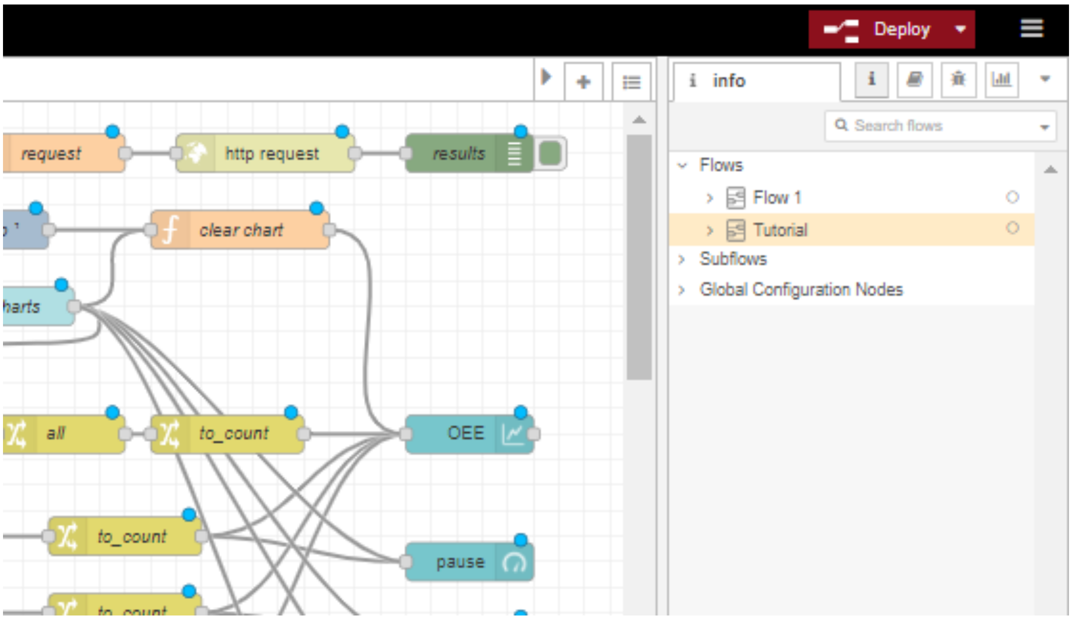
The flow will appear in a new tab inside of Node-RED labelled **Tutorial** in the top-left corner.


WARNING: please check you have started this container with a volume that is mounted to /data
otherwise any flow changes are lost when you redeploy or upgrade the container
(e.g. upgrade to a more recent node-red docker image).
If you are using named volumes you can ignore this warning.
Double click or see info side panel to learn how to start Node-RED in Docker to save your work

Step 4: Accessing the OEE and quality dashboard

After the Node-RED setup, data generated by the machine simulation can be viewed on the OEE and quality dashboard.

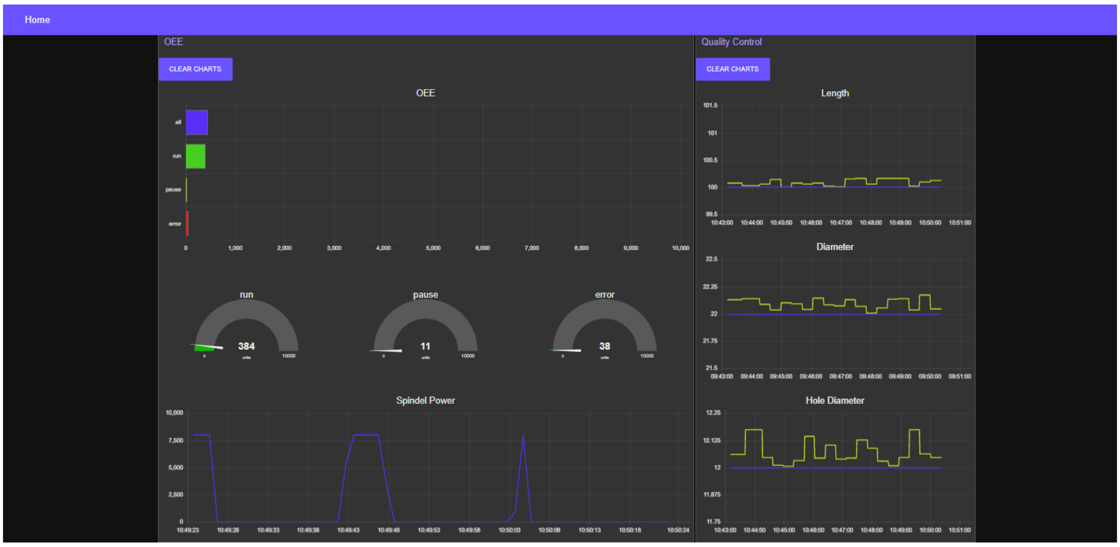
1. In the Node-RED browser tab select **Deploy** in the top-right corner to start the flow. Make sure that the **Tutorial** tab is active.



2. Open a new browser tab.

3. Enter `localhost:1880/ui` to open the OEE dashboard.

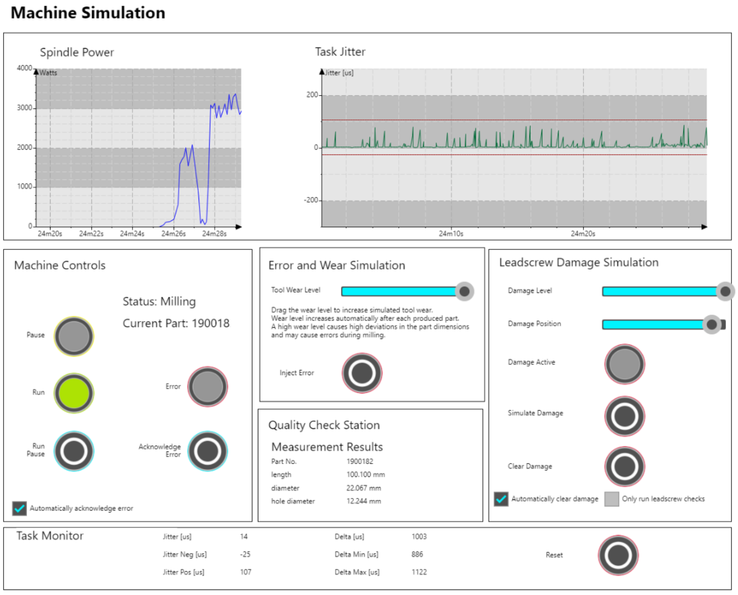
> **NOTE**
>
> It may take a moment for the dashboard to load.



Experimenting with the machine simulation

The machine simulation runs through a process of part production. The production of a part begins with the machine waiting for a part in order to load it. Once the part is loaded in, the machine starts milling and the spindle power goes up. After the machine is finished milling and the spindle power goes down again, the part is then unloaded and sent to a measuring station. The **Measurement Results** in the **Quality Check Station** are updated as soon as measuring is completed. The operation of the machine simulation and the measurements of the parts are impacted by the adjustable **Wear Level**.

The user interface of the machine simulation is split up into different parts.



Status: Milling

Current Part: 190018

☑ Automatically acknowledge error

Drag the wear level to increase simulated tool wear.
Wear level increases automatically after each produced part.
A high wear level causes high deviations in the part dimensions and may cause errors during milling.

Measurement Results

Part No.	1900182
length	100.100 mm
diameter	22.067 mm
hole diameter	12.244 mm

☑ Automatically clear damage ☐ Only run leadscrew checks

Jitter [us]	14	Delta [us]	1003
Jitter Neg [us]	-25	Delta Min [us]	886
Jitter Pos [us]	107	Delta Max [us]	1122

Item	Description
Status	This shows the current status of the machine simulation, the number of the current part and the spindle power when the machine is milling. The status of the machine cycles through the following way in regular operation: • **Waiting for Part** • **Loading** • **Milling** • **Unloading** • **Measuring** If the machine operation is stopped by an error or a pause, the status will display **Error** or **Pause** and the operation at which the pause or error occured in parentheses, e.g **Error (waiting for part)**.

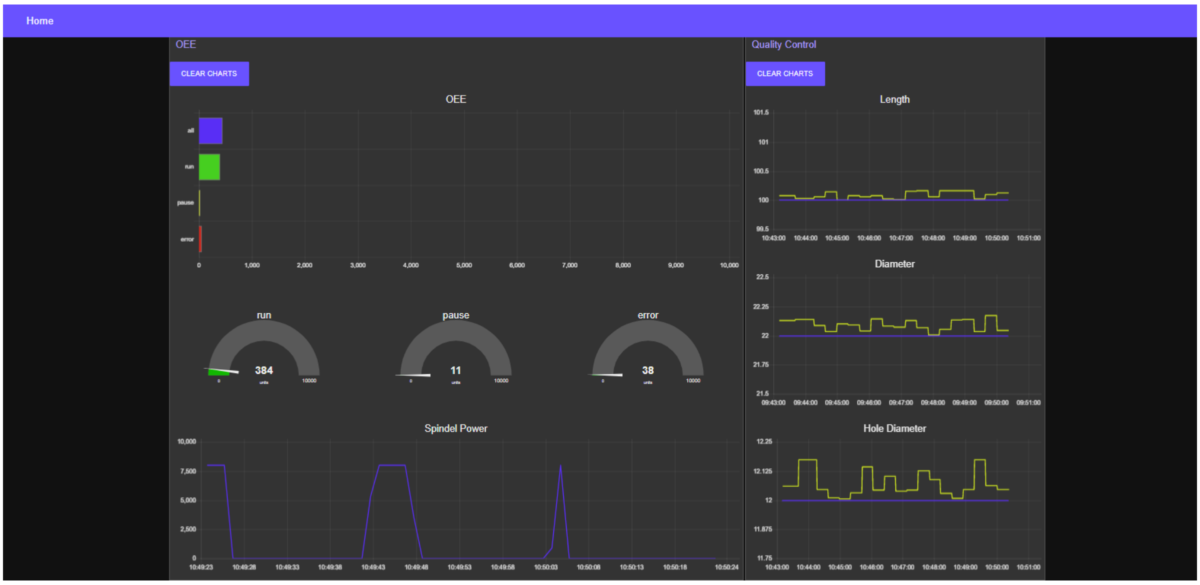
Item	Description
Machine Controls	The machine controls consist of three colored lights and two buttons. • **Run** This light is green if the machine is running as intended. • **Pause** This light is yellow if the machine has been paused by the user. • **Error** This light is red if the machine is in an error state, either caused by a high wear level or by injecting an error manually. • **Run/Pause** Use this button to pause and unpause the machine simulation. • **Acknowledge Error** If the machine is in an error state, this button must be pressed to acknowledge the error and have the machine resume its operation.
Error and Wear Simulation	The slider here emulates the wear of the system. It increases gradually when the machine is running. The higher the wear level, the higher the probability of an error occuring in the simulation. The slider can be adjusted to preference to simulate different levels of wear. Manually inject an error by pressing the **Inject Error** button.
Quality Check Station	After the completion of a part, the **Measurement Results** are updated, showing new values for the **Part No.**, **length**, **diameter** and **hole diameter** of a part. The higher the wear level, the higher are the deviations of the part measurements.

The data of the machine operation is amassed and displayed in an OEE dashboard by Node-RED.

Node-RED and the OEE dashboard

The data flow in Node-RED reads from an OPC UA Client and parses the data into the OEE statistics and quality check data. The dashboard consists of three parts:

- **OEE**
  This part of the dashboard shows the amount of the time the machine has spent in **run**, **pause** and **error** states in two different visualizations.
- **Spindle Power**
  This is a graph of how high spindle power is over time.
- **Quality Control**
  Length, **Diameter** and **Hole Diameter** are displayed in graphs, showing the measurements of the parts produced. Deviations caused by a high wear level can be analyzed here.



This concludes the tutorial for Nerve. For questions, requests and further evaluation, contact trynerve@tttech-industrial.com.

Tutorial: Real-time performance monitoring

Nerve is a platform to run applications in form of Docker containers and virtual machines on edge computers. It also contains a PLC runtime, executed as a virtual machine on the device. This tutorial shows how to measure the real-time performance of an IEC 61131-3 PLC application and therefore provides insight on the performance of the ACRN hypervisor and Intel TCC technologies supported by Intel’s Edge Controls for Industrial (ECI) included in Nerve. It will also show you how to manage software at the edge using Nerve and how to use the remote access features as well as the monitoring features of Nerve.

Going through this demo will take about 30 minutes and cover how to deploy container workloads, remotely access nodes, configure the Nerve Data Services and view data in an integrated version of Grafana in the Nerve Data Services.

Items needed for this tutorial are:

- a workstation or PC
- login credentials to the Nerve Management System and the filesharing server
- the Nerve Connection Manager app
- a Gateway configuration file
- a Grafana dashboard configuration file

All links, login credentials and the instructions to download files will be sent via emails. In case files or login credentials are missing, contact trynerve@tttech-industrial.com.

The tutorial environment is set up in the evaluation laboratory at TTTech Industrial in Vienna. The edge device is an MFN 100 or a Maxtang AXWL10 running an Intel Atom quad core CPU.

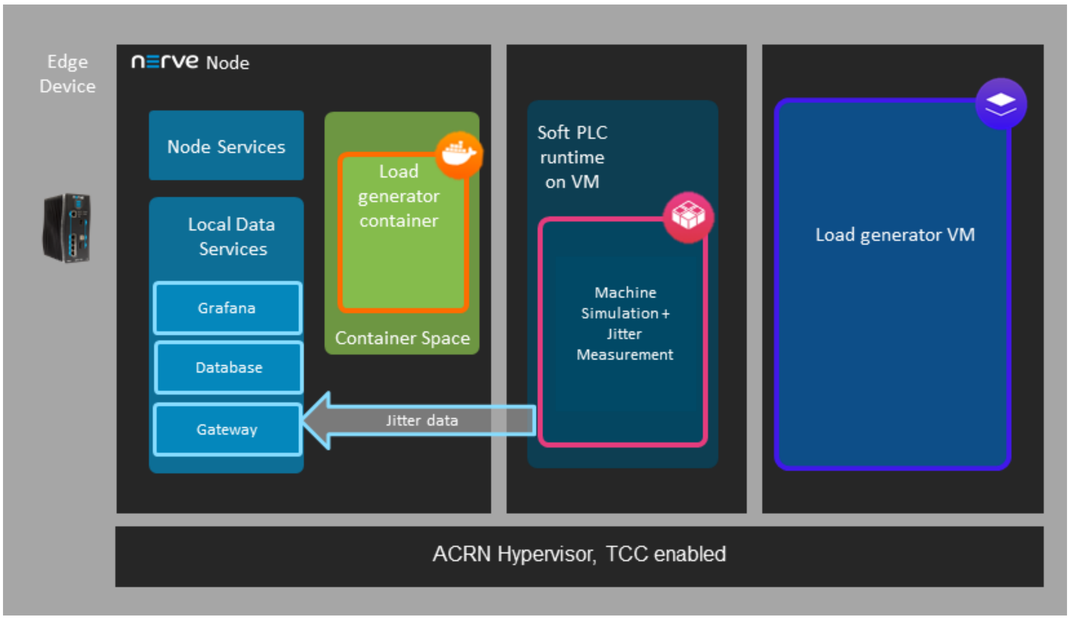
NOTE

In case the evaluation system is used, be aware that other users may access the same evaluation system, meaning that other nodes might be registered in the Management System. Information and workloads uploaded into the system may be visible to other users.

Architecture of the Edge Device

The consistent real-time performance of a PLC independent of all other influences on the same device is most important for controls or high-speed data acquisition. Nerve enables users to install many different types of applications on the same devices as the soft PLC. Therefore, it is important that those applications – Docker containers or virtual machines – do not influence real-time performance. Intel's TCC features and the ACRN hypervisor build the basis for the necessary performance and separation.

The graphic below shows the main components of a Nerve based edge device, which we call Nerve Device. The highlighted components are the relevant ones for this tutorial.



Machine Simulation

The machine simulation is a small program written in IEC-61131-3. It simulates the operation of a CNC mill and generates data in the process. The simulated machine as such is not of interest for this tutorial. Instead, the tutorial focuses on the real-time performance of the PLC application running this simulation. Besides creating the simulation data, the PLC application also measures and provides its internal task latencies and jitter values to proof performance and isolation achieved through virtualization. The measured simulation, latency and jitter data is provided through the integrated OPC UA server.

Load Generator applications

A VM and a Docker container are prepared as workloads to generate a load on the system. The small virtual machine is configured to take two CPU cores and load them heavily. It also tries to force cache flushes as much as possible to load the CPU and maximize interference with other CPU cores. The Docker container also loads the CPU heavily in terms of RAM consumption and calculation.

Gateway

The Gateway application is a multiprotocol translator integrated in Nerve which can read data from various sources and provide it with high performance to other systems like MQTT brokers, databases, Kafka or the Azure IoT Hub. In this tutorial it is used to read jitter and latency data from the OPC UA server and feed it to the Nerve integrated database.

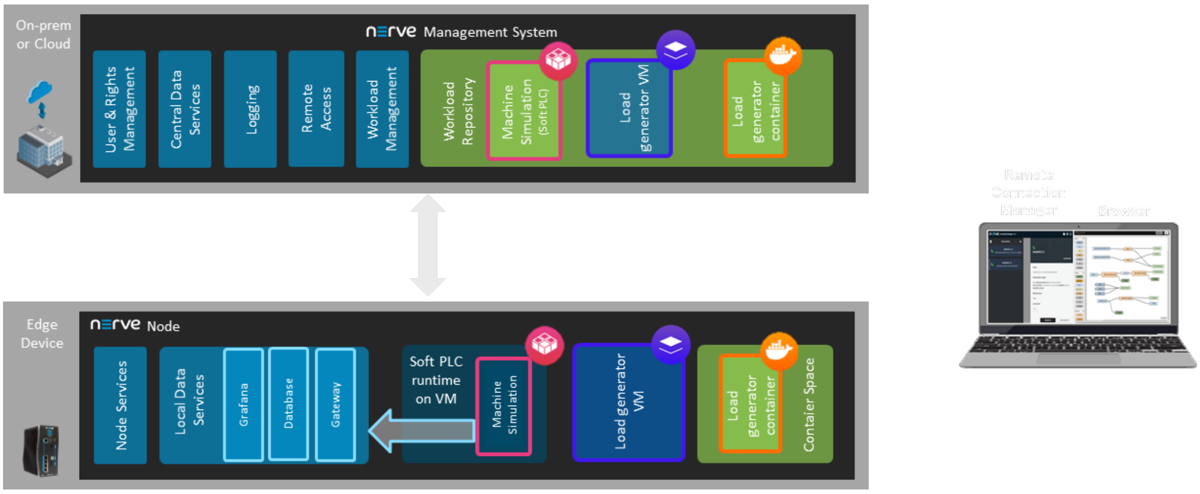
Database

The integrated database is designed to receive data from the Gateway for further analytics. It can be used by any application on Nerve as a general time-series database. In this tutorial it receives data from the Gateway and provides it to Grafana for display.

Grafana

Nerve integrates the open-source tool Grafana for visualizing data at the Nerve Device. In this tutorial it is used to display jitter and latency data.

System Architecture



The machine simulation, Grafana and Gateway configuration UI are accessed on the Nerve Device directly using the remote access feature of the Nerve cloud management platform called the Nerve Management System. In Nerve, applications managed by customers are called workloads. The Management System is a Software-as a Service hosted in Microsoft Azure. The device is located in TTTech Industrial's Nerve labs.

Initial setup

The Nerve Management System is set up so that the tutorial can be started straightaway. The necessary applications have already been configured and the remote connections are set up. The evaluation system does not limit experimentation to the extent of this tutorial. It is possible to create, deploy and test new workloads. However, the cloud instance of the Data Services and user management are not enabled in the standard evaluation system. Also note that this tutorial is designed to be done with Nerve Devices running an ACRN hypervisor, meaning that snapshots and backups of virtual machines are not available since they rely on the KVM hypervisor. Contact sales@tttech-industrial.com for information on how to obtain the full version.

To explore the Nerve system even further, refer to the user guide.

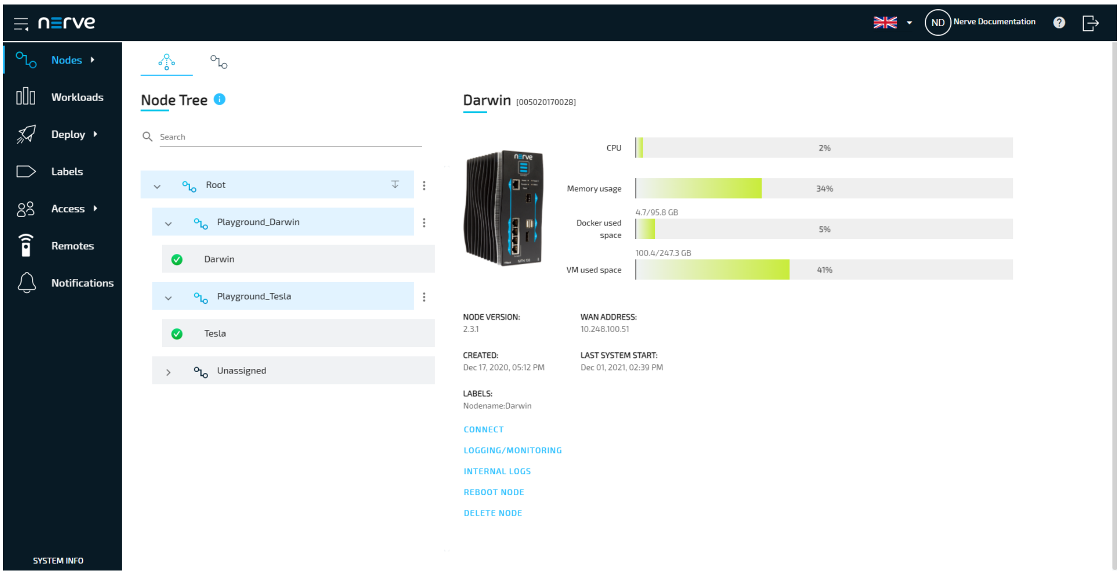
Viewing nodes in the node tree

The node tree is the first visible page of the Management System after logging in. It presents a means of organization for nodes that are connected to the Management System. Nodes are embedded into elements of the node tree.

1. Log in to the Management System with your credentials.

2. Look for your node in the node tree. It is embedded in its own tree element.

> **NOTE**
>
> The node and the tree element are named after a scientist. The name has been sent in an email.



Darwin [005020170028]

CPU 2%

Memory usage 34%

4.7/95.8 GB

Docker used space 5%

100.4/247.3 GB

VM used space 41%

NODE VERSION: 2.3.1

WAN ADDRESS: 10.248.100.51

CREATED: Dec 17, 2020, 05:12 PM

LAST SYSTEM START: Dec 01, 2021, 02:39 PM

LABELS: Nodename:Darwin

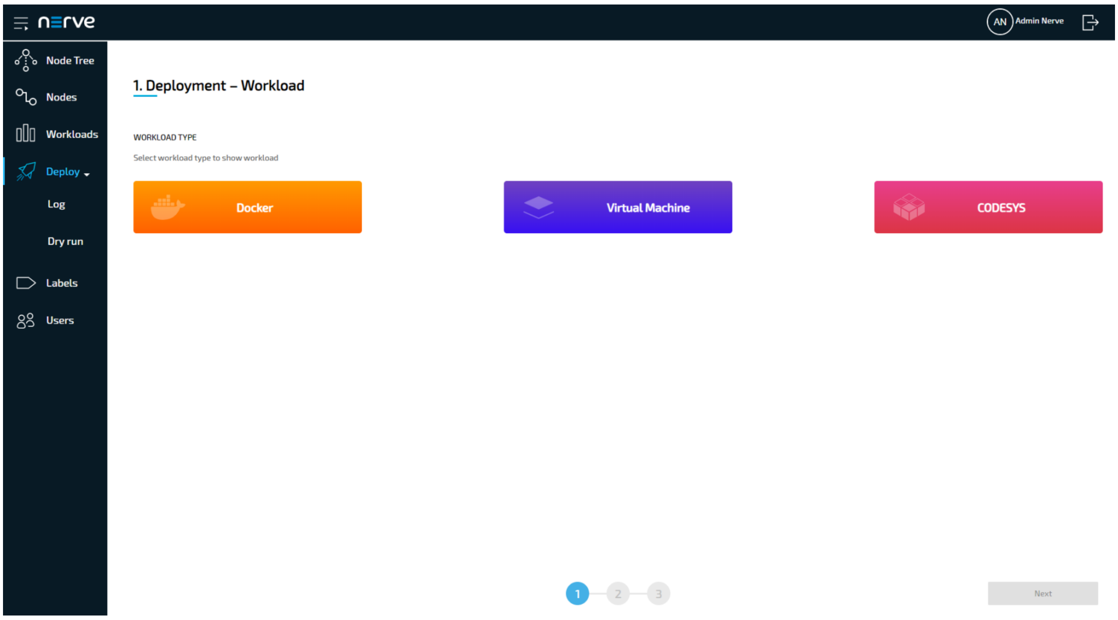
Be aware that other users may access the same evaluation system. Make sure to use the designated node that was mentioned in the instruction emails.

Step 1: Deploying the machine simulation

Deployment is the process of downloading workloads to Nerve Devices through the Nerve Management System. With Nerve you can deploy and manage Docker containers, virtual machines and CODESYS applications. The instructions below show how to deploy the machine simulation as a CODESYS workload.

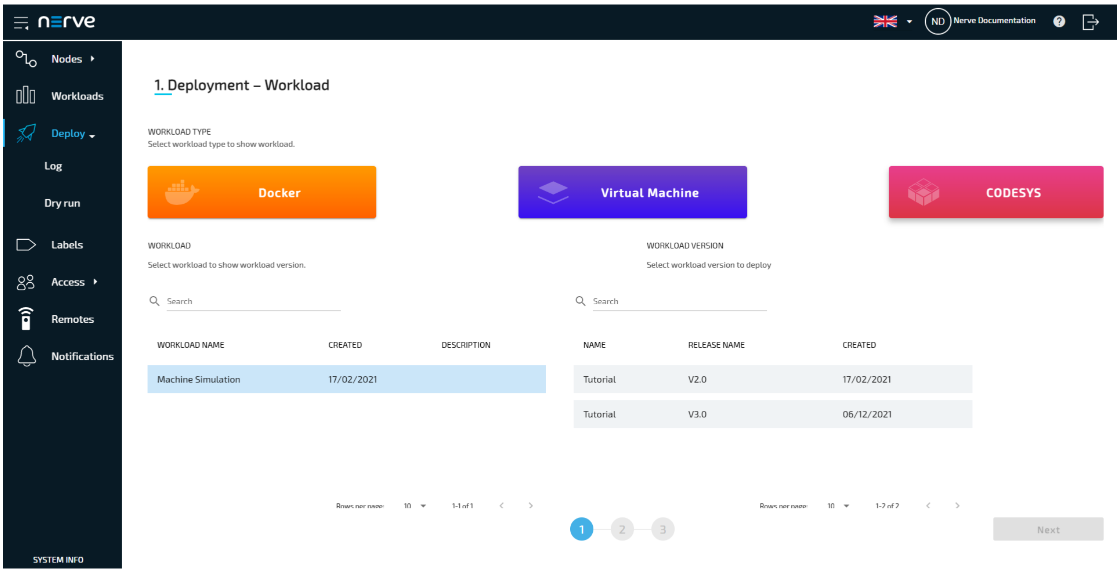
1. Log in to the Management System.

2. Select **Deploy** in the navigation on the left.



3. Select the red CODESYS tab. A list of CODESYS workloads will appear below.

4. Select **Machine Simulation** in the list of workloads. A list of versions of this workload will appear to the right.

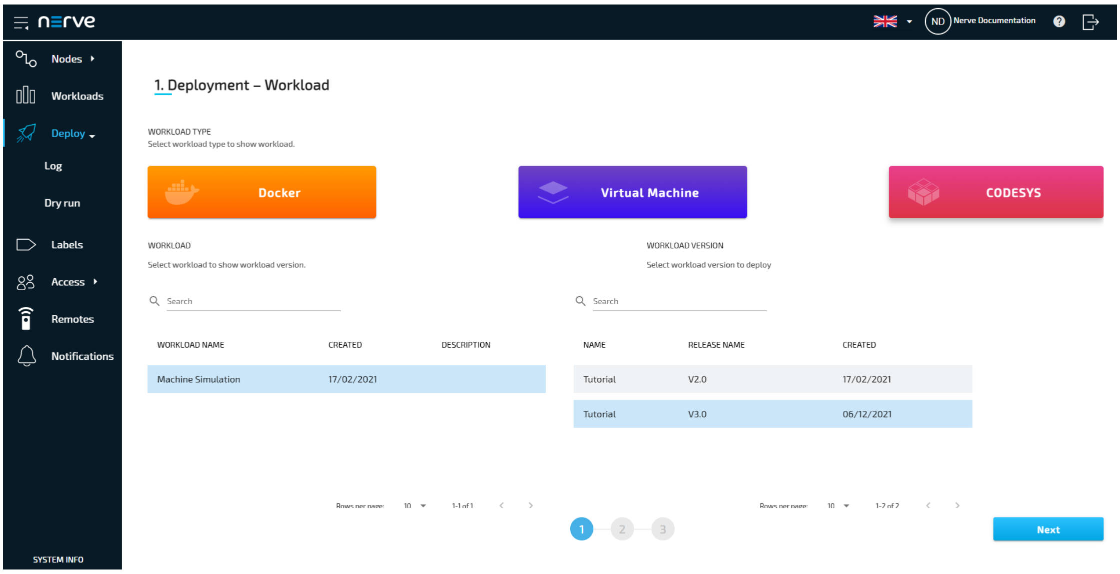


WORKLOAD NAME	CREATED	DESCRIPTION
Machine Simulation	17/02/2021	

NAME	RELEASE NAME	CREATED
Tutorial	V2.0	17/02/2021
Tutorial	V3.0	06/12/2021

5. Select **V3.0** on the right.

6. Select **Next** in the lower-right corner.



1. Deployment – Workload

WORKLOAD TYPE
Select workload type to show workload.

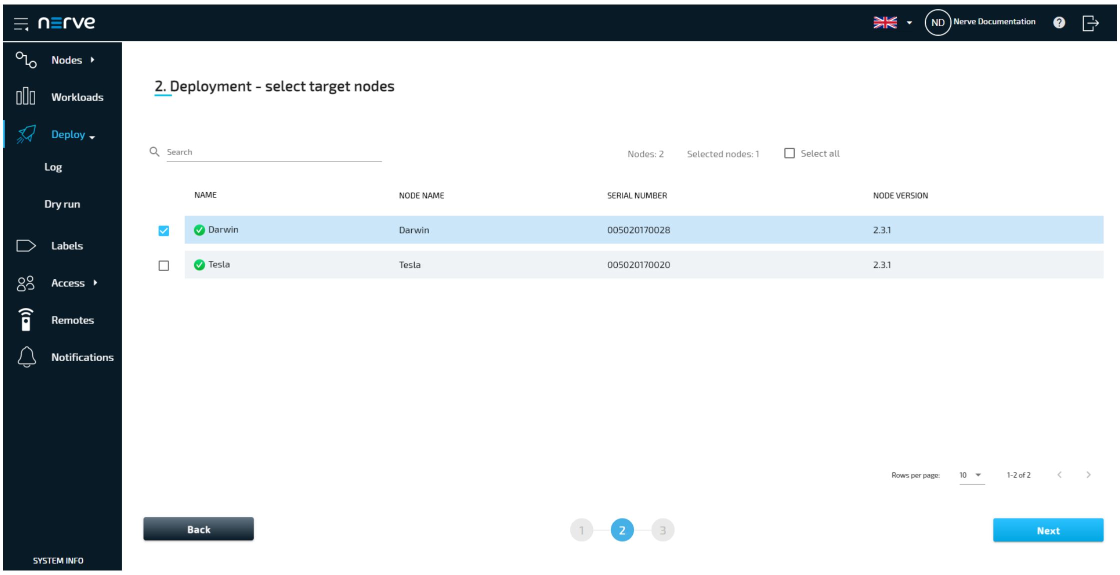
WORKLOAD
Select workload to show workload version.

WORKLOAD NAME	CREATED	DESCRIPTION
Machine Simulation	17/02/2021	

WORKLOAD VERSION
Select workload version to deploy

NAME	RELEASE NAME	CREATED
Tutorial	V2.0	17/02/2021
Tutorial	V3.0	06/12/2021

7. Tick the checkbox next to your node.
8. Select **Next** in the lower-right corner.



2. Deployment - select target nodes

Nodes: 2 Selected nodes: 1 □ Select all

	NAME	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	Darwin	Darwin	005020170028	2.3.1
□	Tesla	Tesla	005020170020	2.3.1

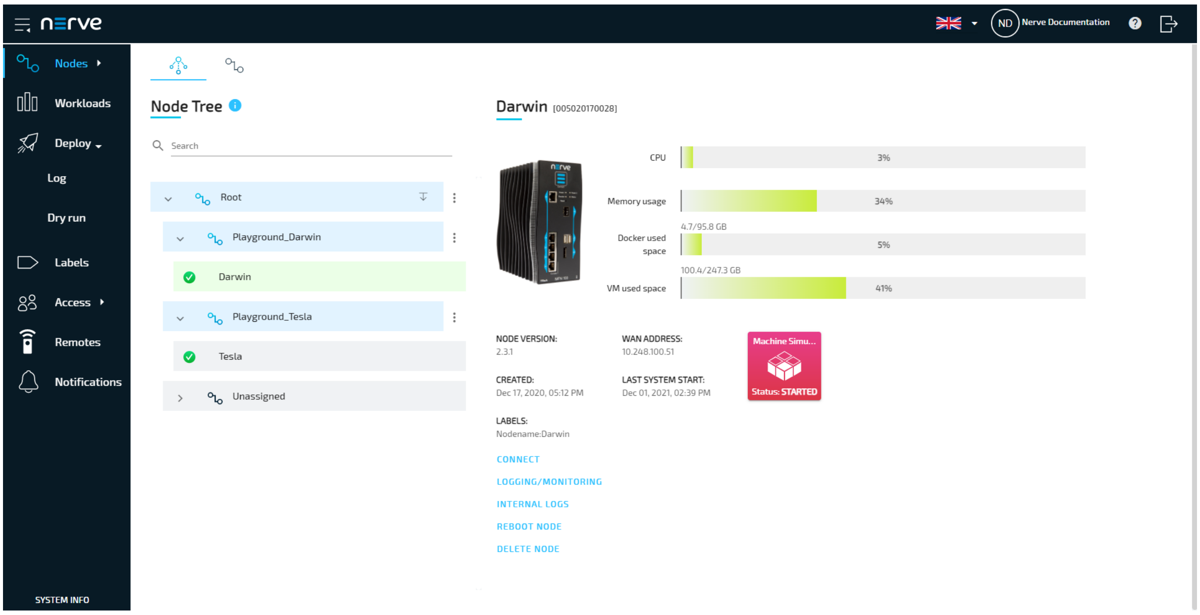
9. Select **Deploy** to execute the deployment.
   *Optional: Enter a **Deploy name** above the **Summary** of the workload to make this deployment easy to identify. A timestamp is filled in automatically.*

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

To confirm if the workload has been deployed successfully, select **Nodes** in the navigation on the left. Select your node in the node tree and confirm if a CODESYS workload tile is showing underneath the bar graph. The workload should show the status **STARTED**.

NOTE

It can take a number of seconds until the status of a workload switches from **IDLE** to **STARTED** after deployment.



Darwin [005020170028]

CPU 3%

Memory usage 34%

4.7/95.8 GB

Docker used space 5%

100.4/247.3 GB

VM used space 41%

NODE VERSION: 2.3.1

WAN ADDRESS: 10.248.100.51

CREATED: Dec 17, 2020, 05:12 PM

LAST SYSTEM START: Dec 01, 2021, 02:39 PM

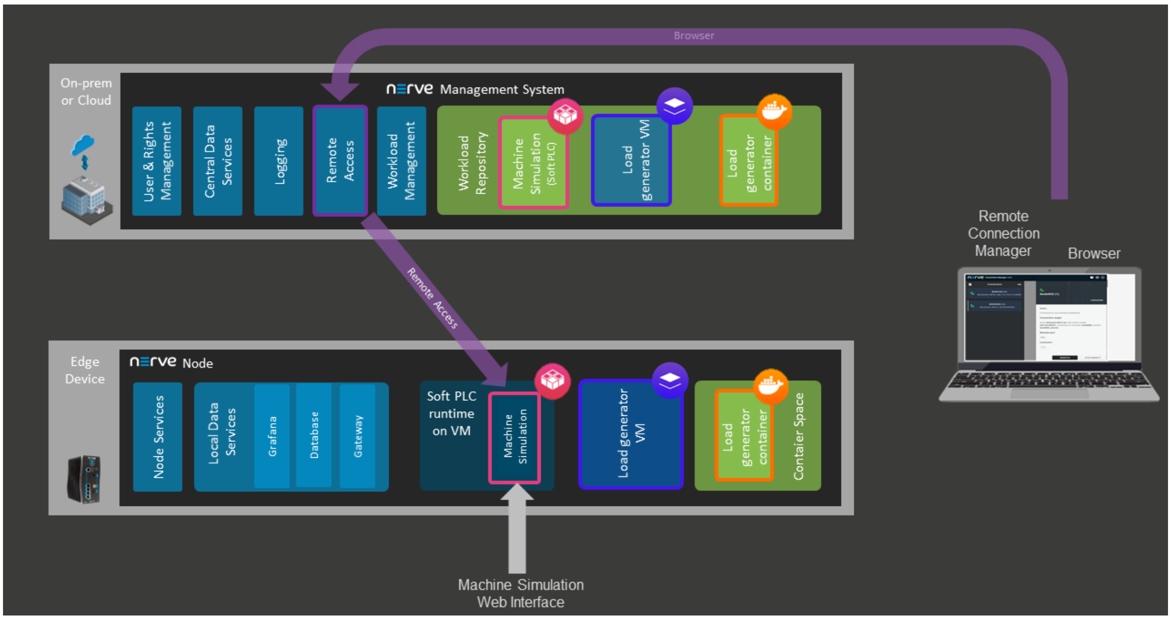
LABELS: Nodename:Darwin

Status: STARTED

Step 2: Connecting to the machine simulation through remote access

To access the machine simulation, it is required to create a connection between the computer used for this tutorial and the Management System, and from the Management System to the webserver of the machine simulation on the Nerve Device. This is done through the remote access feature, specifically through the use of remote tunnels. The remote tunnel connection has already been configured in the Management System and is ready for use. The image below illustrates the remote access feature, showing a connection to the deployed machine simulation on the Nerve Device.

The machine simulation is accessible at port 8080 on the Nerve Device through a web user interface. The pre-configured remote tunnel will use this port and port 8080 on the local computer to create a connection between the computer and the Nerve Device to access the machine simulation.



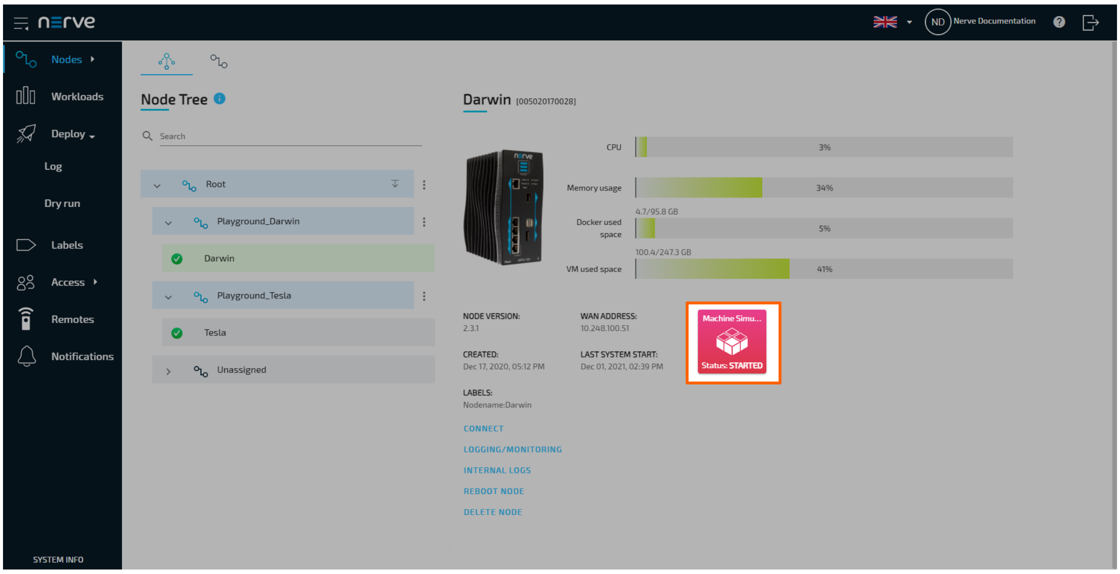
Before continuing, install the Nerve Connection Manager that was part of the delivery, as it is required for using remote tunnels.

NOTE

- The Nerve Connection Manager might trigger warnings from antivirus software. This is due to a certain library that was used in development and a known issue.
- Local admin rights might be required to successfully install the Nerve Connection Manager.

1. Select **Nodes** in the navigation on the left.
2. Select your node in the node tree.

3. Select the Machine Simulation CODESYS workload.



Darwin [005020170028]

CPU 3%

Memory usage 34%

4.7/95.8 GB

Docker used space 5%

100.4/247.3 GB

VM used space 41%

NODE VERSION: 2.3.1

WAN ADDRESS: 10.248.100.51

CREATED: Dec 17, 2020, 05:12 PM

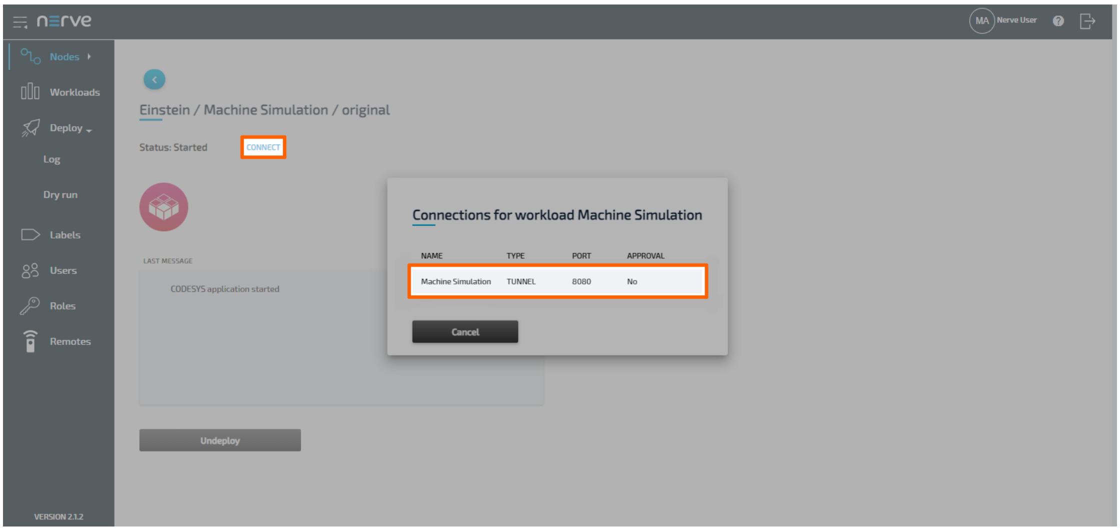
LAST SYSTEM START: Dec 01, 2021, 02:39 PM

LABELS: Nodename:Darwin

Machine Simu...

Status: STARTED

4. Select **CONNECT** next to the workload status. Available connections will appear in a window.
5. Select the **Machine Simulation** remote tunnel from the list.



Einstein / Machine Simulation / original

Status: Started

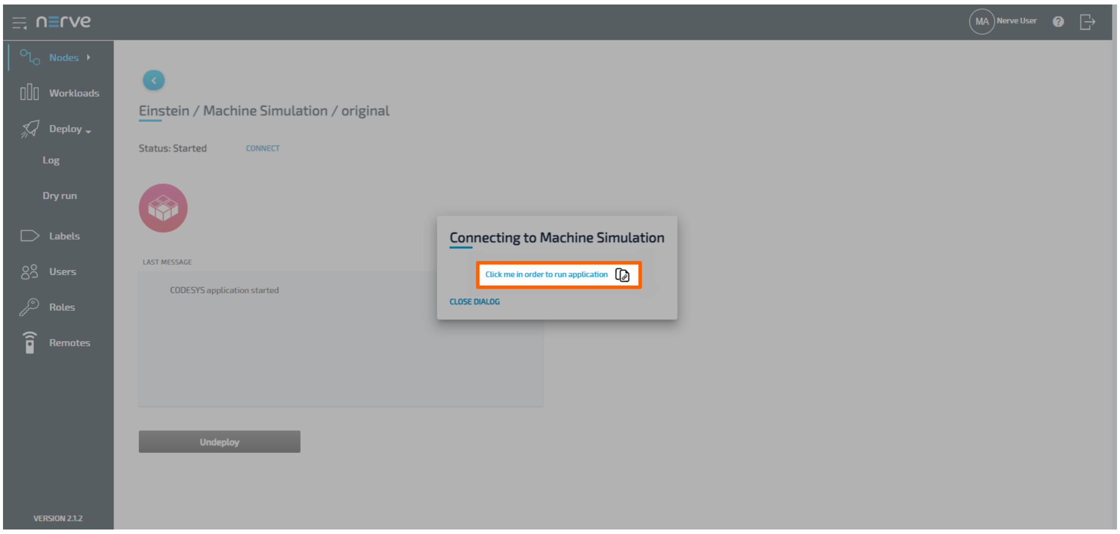
LAST MESSAGE

CODESYS application started

Connections for workload Machine Simulation

NAME	TYPE	PORT	APPROVAL
Machine Simulation	TUNNEL	8080	No

6. Select **Click me in order to run application** in the new window.



Einstein / Machine Simulation / original

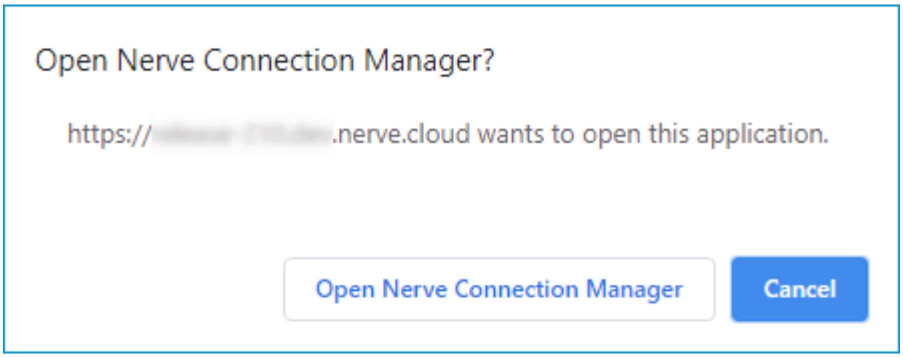
Status: Started

LAST MESSAGE

CODESYS application started

Connecting to Machine Simulation

7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
   Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.



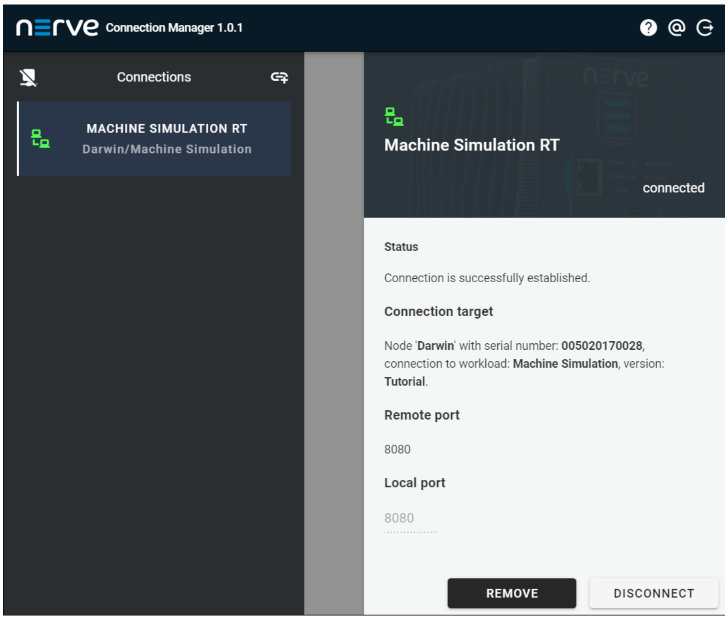
Open Nerve Connection Manager?

https://[redacted].nerve.cloud wants to open this application.

NOTE

If the Nerve Connection Manager does not start automatically, refer to Using a remote tunnel to a node or external device in the user guide.

The remote tunnel will be established once the Nerve Connection Manager starts and the remote connection will turn green in the Nerve Connection Manager. The remote tunnel is now ready to be used.



Status

Connection is successfully established.

Connection target

Node '**Darwin**' with serial number: **005020170028**, connection to workload: **Machine Simulation**, version: **Tutorial**.

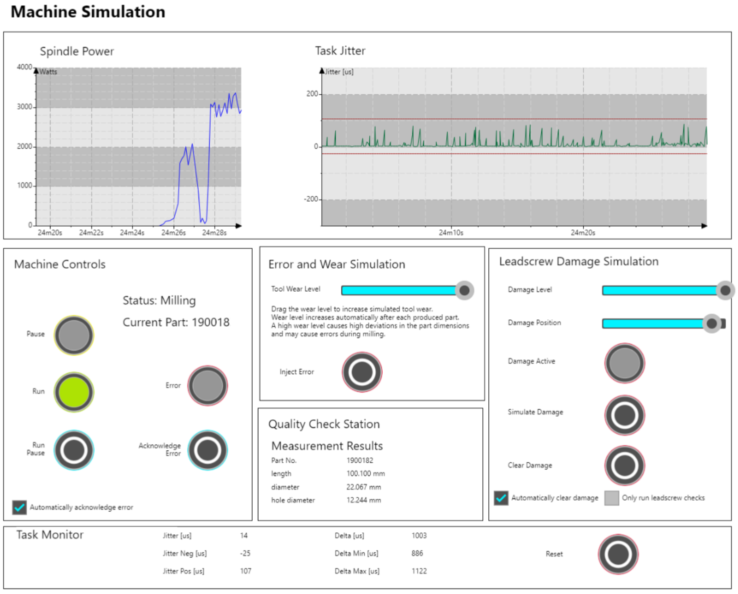
Remote port

8080

Local port

8080

Open a new browser tab and enter `localhost:8080` to open the machine simulation dashboard. The dashboard has two elements pertaining to jitter values, **Task Jitter** and **Task Monitor**.



Status: Milling

Current Part: 190018

☑ Automatically acknowledge error

Drag the wear level to increase simulated tool wear.
Wear level increases automatically after each produced part.
A high wear level causes high deviations in the part dimensions and may cause errors during milling.

Measurement Results

Part No.	1900182
length	100.100 mm
diameter	22.067 mm
hole diameter	12.244 mm

☑ Automatically clear damage □ Only run leadscrew checks

Jitter [us]	14	Delta [us]	1003
Jitter Neg [us]	-25	Delta Min [us]	886
Jitter Pos [us]	107	Delta Max [us]	1122

The **Task Jitter** is a visual presentation of the jitter values. The green line shows the value of jitter in microseconds over time, either positive or negative, while the red lines show the highest recorded positive and negative jitter values.

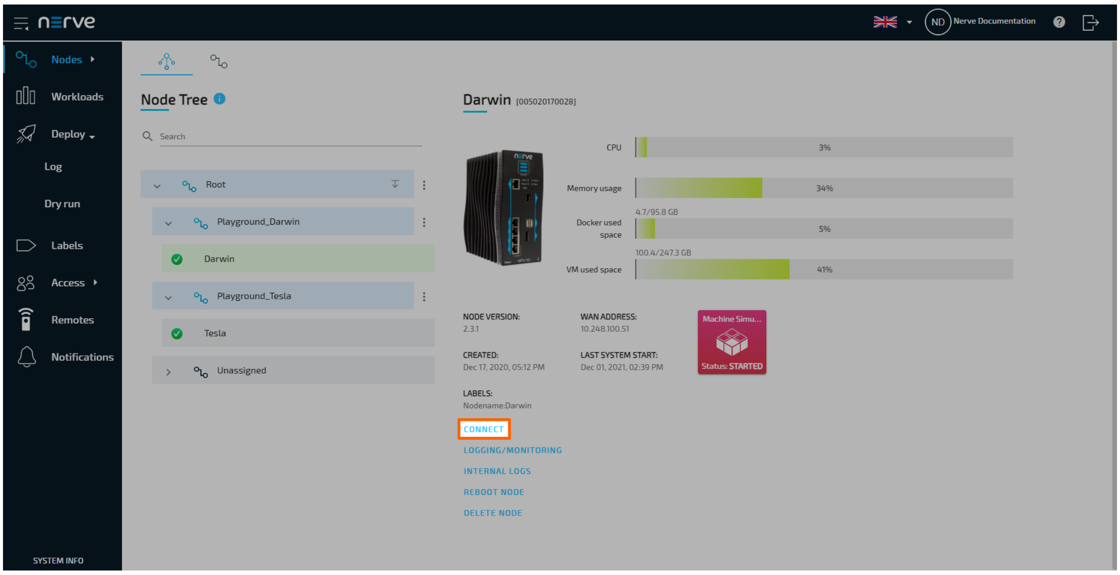
At the bottom of the machine simulation interface, the jitter values can be observed in numerical form in the **Task Monitor** element. Refer to the explanation of each value below:

Item	description
Jitter [us]	This is the currently recorded jitter value.
Jitter Neg [us]	This value shows the highest value recorded of how much earlier the task occured compared to the desired cycle. Example: -25 means that the task occurred 25 µs earlier as planned.
Jitter Pos [us]	This value shows the highest value recorded of how much later the task occured compared to the desired cycle. Example: 107 means that the task occurred 107 µs later than planned.
Delta [us]	This is the currently recorded cycle time in microseconds. The target is 1000 µs, i.e 1 ms.
Delta Min [us]	This is the lowest recorded cycle time in microseconds.
Delta Max [us]	This is the highest recorded cycle time in microseconds.

Step 3: Configuring the Gateway

In order to configure the Gateway, we need to access the local user interface which runs on the Nerve Device itself. To do this, we need to connect to the user interface using the remote connection. The process is similar to the remote connection that was established to the machine simulation above. This time we are not establishing a connection to a workload but to the node itself.

1. Select **Nodes** in the navigation on the left.
2. Select your node in the node tree.
3. Select **CONNECT** in the list of commands underneath the device image. Available connections will appear in a window.



Darwin [005020170028]

CPU 3%

Memory usage 34%

Docker used space 5% 4.7/95.8 GB

VM used space 41% 100.4/247.3 GB

NODE VERSION: 2.3.1

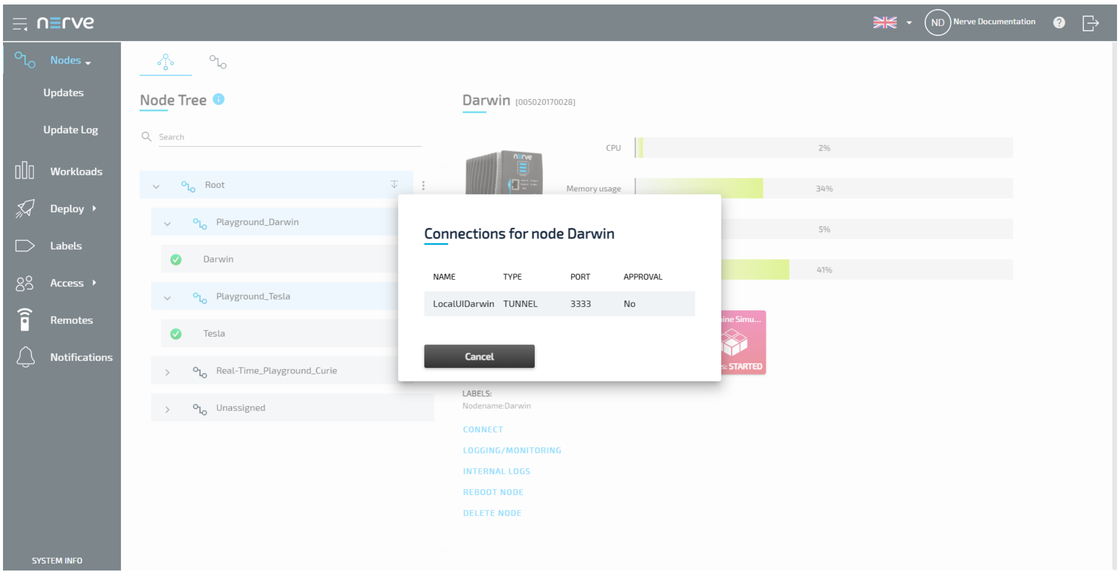
WAN ADDRESS: 10.248.100.51

CREATED: Dec 17, 2020, 05:12 PM

LAST SYSTEM START: Dec 01, 2021, 02:39 PM

LABELS: Nodename:Darwin

4. Select the **LocalUI<scientistname>** remote tunnel from the list.



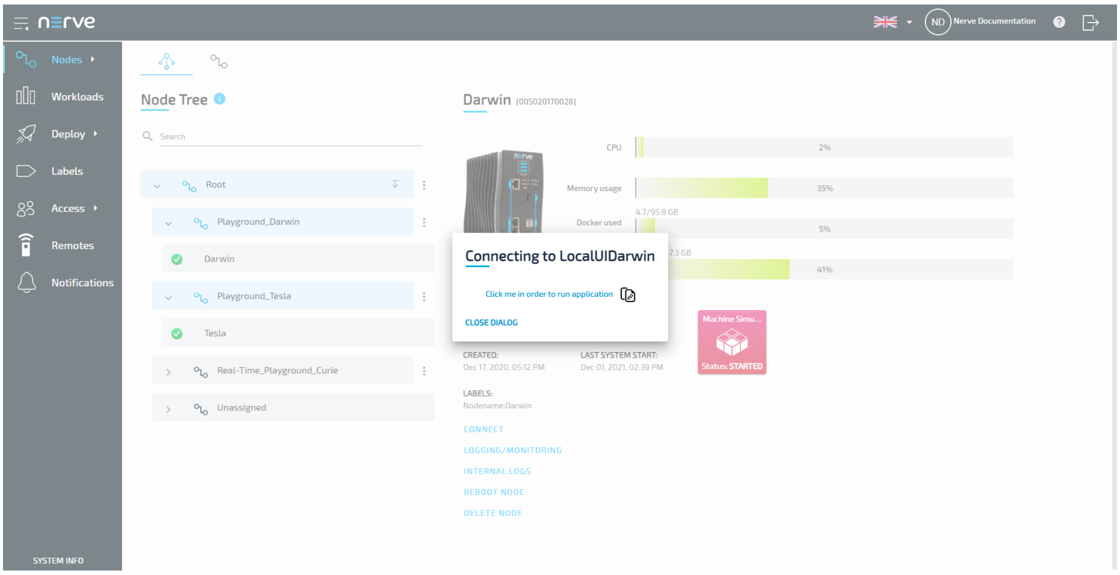
Connections for node Darwin

NAME	TYPE	PORT	APPROVAL
LocalUIDarwin	TUNNEL	3333	No

Cancel

LABELS:
Nodename:Darwin

5. Select **Click me in order to run application** in the new window.



Connecting to LocalUIDarwin

Click me in order to run application

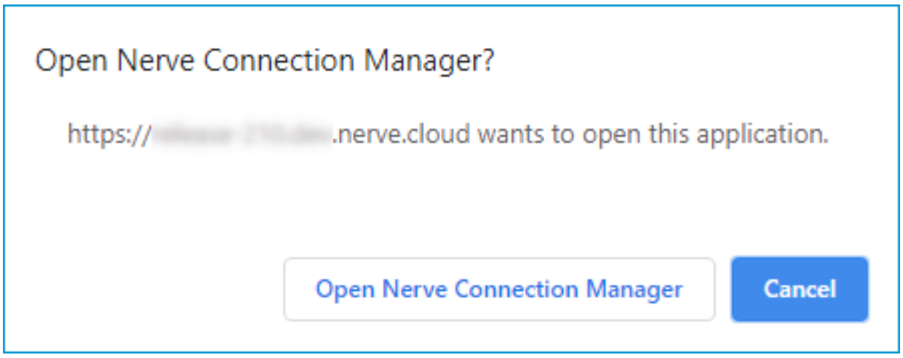
CLOSE DIALOG

CREATED:
Dec 17, 2020, 05:12 PM

LAST SYSTEM START:
Dec 01, 2021, 02:39 PM

LABELS:
Nodename:Darwin

6. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.



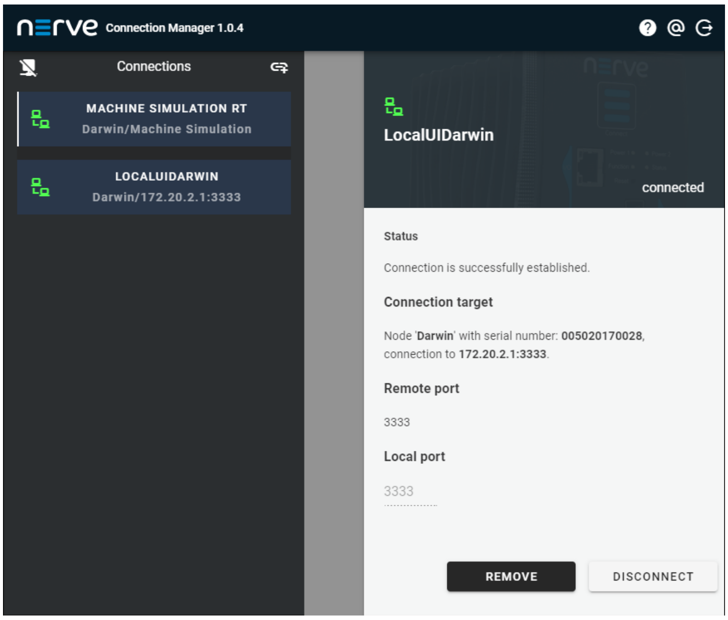
Open Nerve Connection Manager?

https://[redacted].nerve.cloud wants to open this application.

NOTE

If the Nerve Connection Manager does not start automatically, refer to Using a remote tunnel to a node or external device in the user guide.

The remote tunnel will be established once the Nerve Connection Manager starts and the remote connection will turn green in the Nerve Connection Manager. The remote tunnel is now ready to be used.



Status

Connection is successfully established.

Connection target

Node 'Darwin' with serial number: 005020170028, connection to 172.20.2.1:3333.

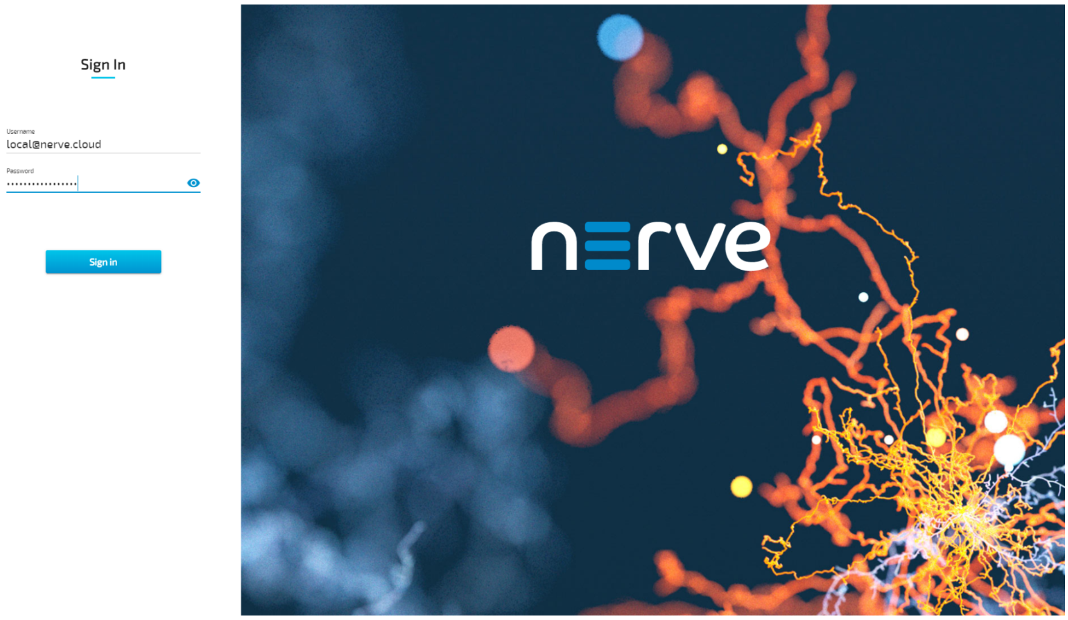
Remote port

3333

Local port

3333

Open a new browser tab and enter `localhost:3333` to open the Local UI of the Nerve Device. Log in to the Local UI. The login credentials to the Local UI have been sent by mail.



Username

local@nerve.cloud

Password

··················

Applying the Gateway configuration and previewing data

The Gateway can be either configured by entering the configuration parameters into the graphical configuration tool or through importing a pre-written JSON configuration file. In this tutorial we will upload the configuration file that has been sent to you by email for the sake of simplicity.

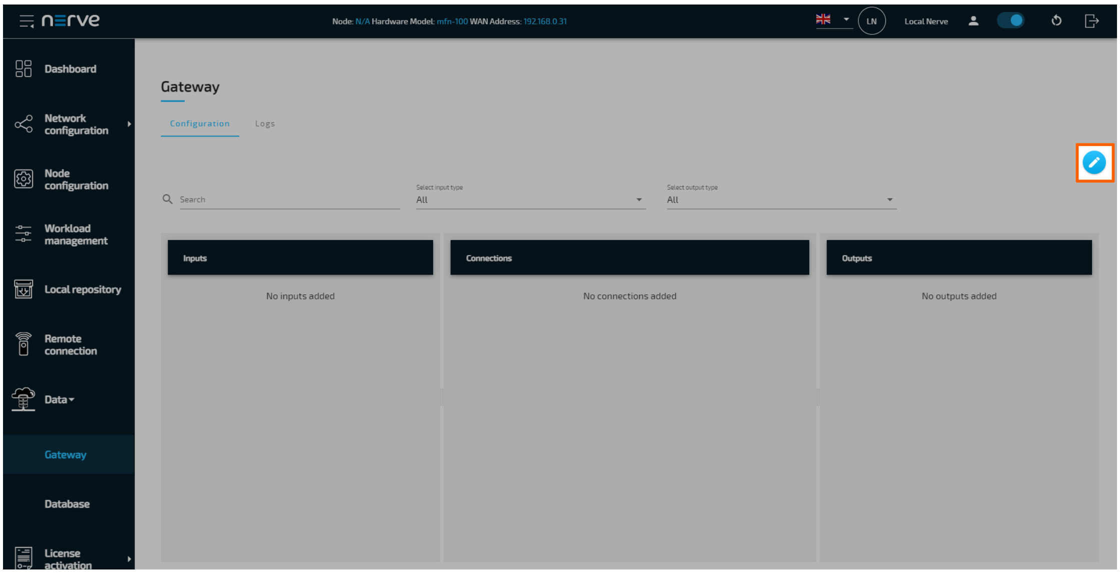
The JSON configuration file contains:

- the configuration of the input variables which the Gateway should read from the PLC’s OPC UA server
- the output location – in this case the integrated Nerve database
- a defined connection between input and output

The configuration file also tells the Gateway to create a table named **CodesysRealTimeData** in the integrated Nerve database.

1. In the Local UI, select the arrow next to **Data** to expand the Data Services sub menus in the navigation on the left.
2. Select **Gateway**.

3. Select the **Edit configuration** icon on the right to enter editing mode.



Node: N/A Hardware Model: mfn-100 WAN Address: 192.168.0.31

Select input type: All

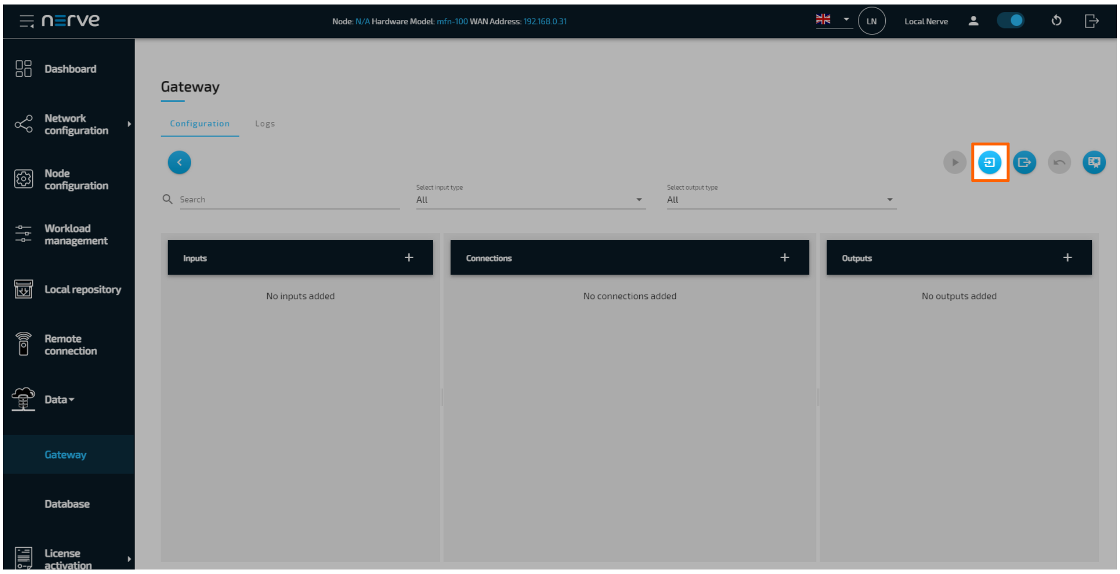
Select output type: All

No inputs added

No connections added

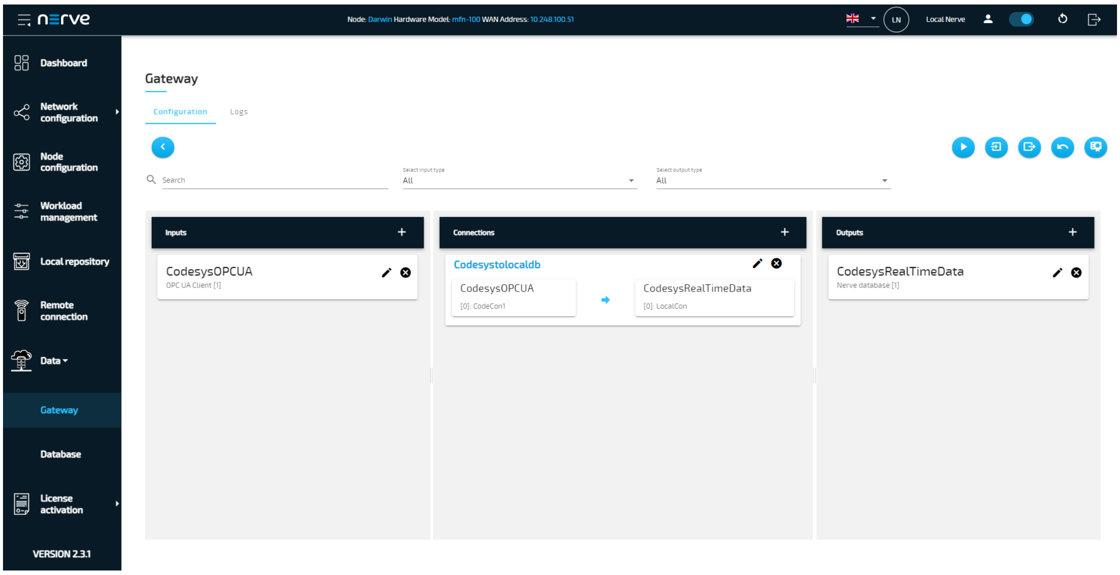
No outputs added

4. Select the **Import** button.



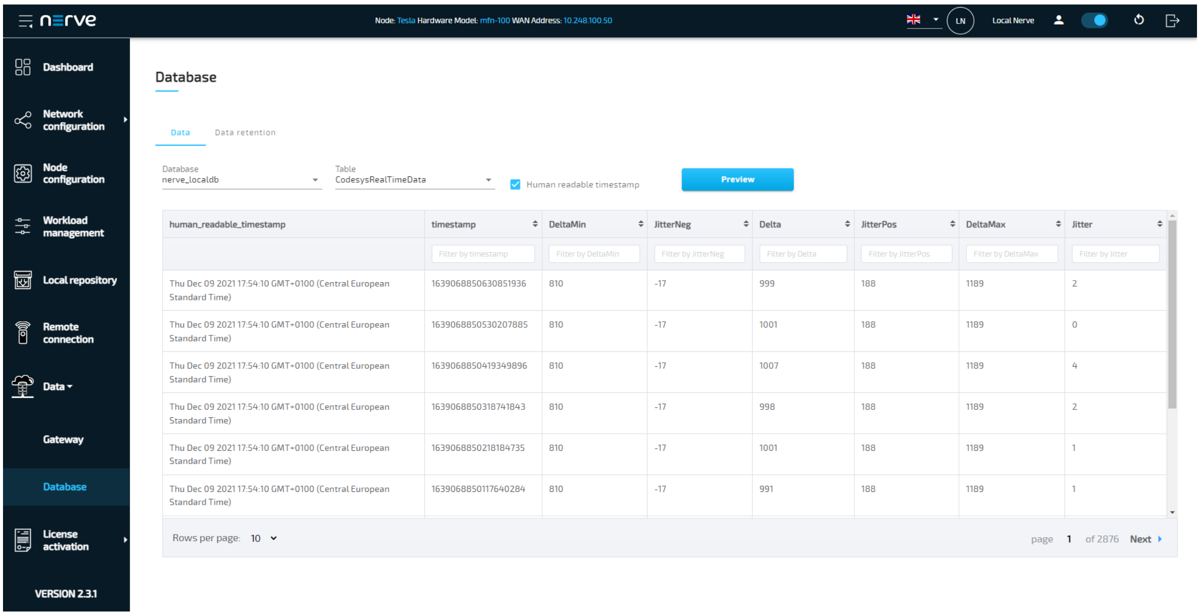
5. Import the Gateway configuration file that has been sent by mail.

6. Select the **Deploy** button. A success message pops up in the upper-right corner.



The configuration is now deployed. The graphical configuration tool now reflects the contents of the JSON file. Exit editing mode by selecting the arrow on the left. Details of each input and output can be opened by selecting the magnifying glass symbol next to each input and output.

The jitter values that are collected by the Data Services can be previewed in the integrated database viewer. Select **Data** in the navigation on the left and select **Database** from the sub menu. Select **nervedb_local** from the drop-down menu labeled **Database**. Then select **CodesysRealTimeData** from the drop-down menu labeled **Table**.



Node: Tesla Hardware Model: mfn-100 WAN Address: 10.248.100.50

Database: nerve_localdb

Table: CodesysRealTimeData

☑ Human readable timestamp

human_readable_timestamp	timestamp	DeltaMin	JitterNeg	Delta	JitterPos	DeltaMax	Jitter
	Filter by timestamp	Filter by DeltaMin	Filter by JitterNeg	Filter by Delta	Filter by JitterPos	Filter by DeltaMax	Filter by Jitter
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850630851936	810	-17	999	188	1189	2
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850530207885	810	-17	1001	188	1189	0
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850419349896	810	-17	1007	188	1189	4
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850318741843	810	-17	998	188	1189	2
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850218184735	810	-17	1001	188	1189	1
Thu Dec 09 2021 17:54:10 GMT+0100 (Central European Standard Time)	1639068850117640284	810	-17	991	188	1189	1

Rows per page: 10

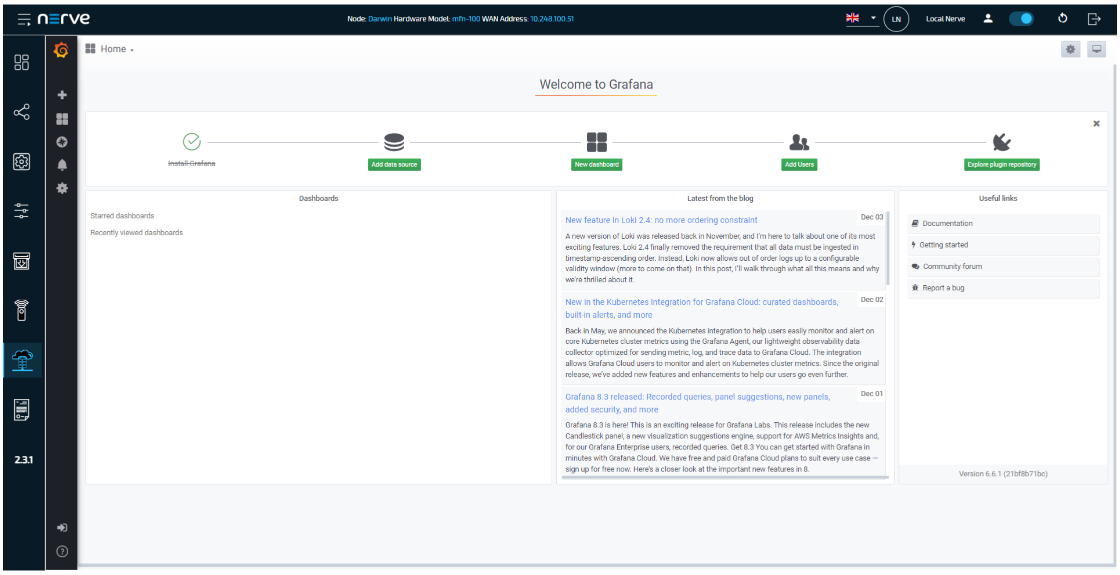
page 1 of 2876 Next

Step 4: Viewing jitter data in Grafana

After the deployment of the machine simulation and the configuration of the Gateway, jitter data is being collected. To view jitter data in Grafana, a dashboard needs to be created. For the sake of simplicity, we configured the dashboard beforehand. This file has been sent as part of the delivery. The instructions below cover how to import the dashboard.

1. Select **Data** in the navigation on the left.

2. Select **Home** in the Grafana window.



Node: Darwin Hardware Model: mfn-100 WAN Address: 10.248.100.51

New feature in Loki 2.4: no more ordering constraint — Dec 03

A new version of Loki was released back in November, and I'm here to talk about one of its most exciting features. Loki 2.4 finally removed the requirement that all data must be ingested in timestamp-ascending order. Instead, Loki now allows out of order logs up to a configurable validity window (more to come on that). In this post, I'll walk through what all this means and why we're thrilled about it.

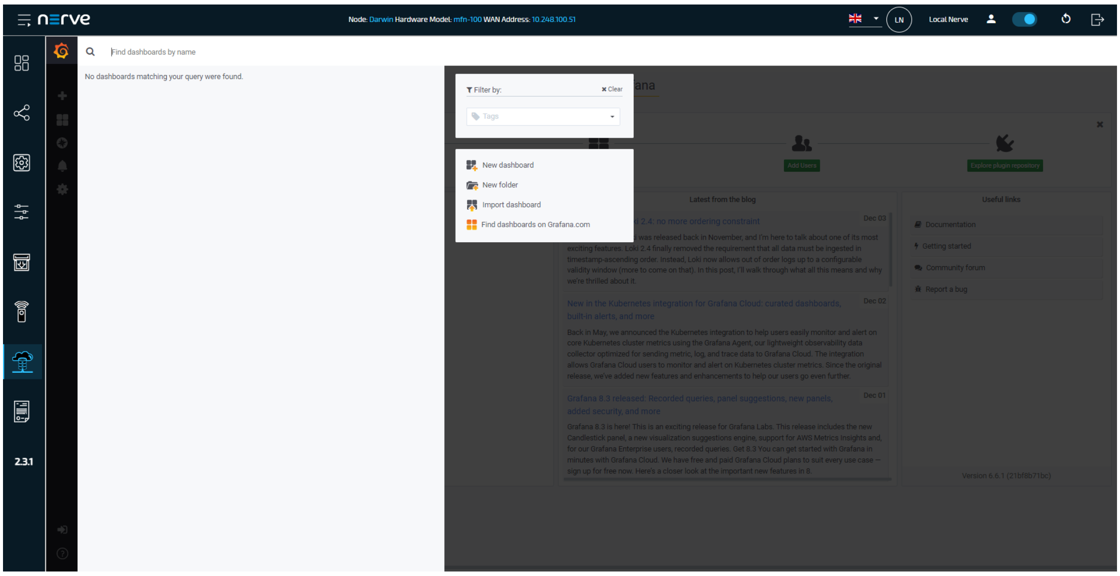
New in the Kubernetes integration for Grafana Cloud: curated dashboards, built-in alerts, and more — Dec 02

Back in May, we announced the Kubernetes integration to help users easily monitor and alert on core Kubernetes cluster metrics using the Grafana Agent, our lightweight observability data collector optimized for sending metric, log, and trace data to Grafana Cloud. The integration allows Grafana Cloud users to monitor and alert on Kubernetes cluster metrics. Since the original release, we've added new features and enhancements to help our users go even further.

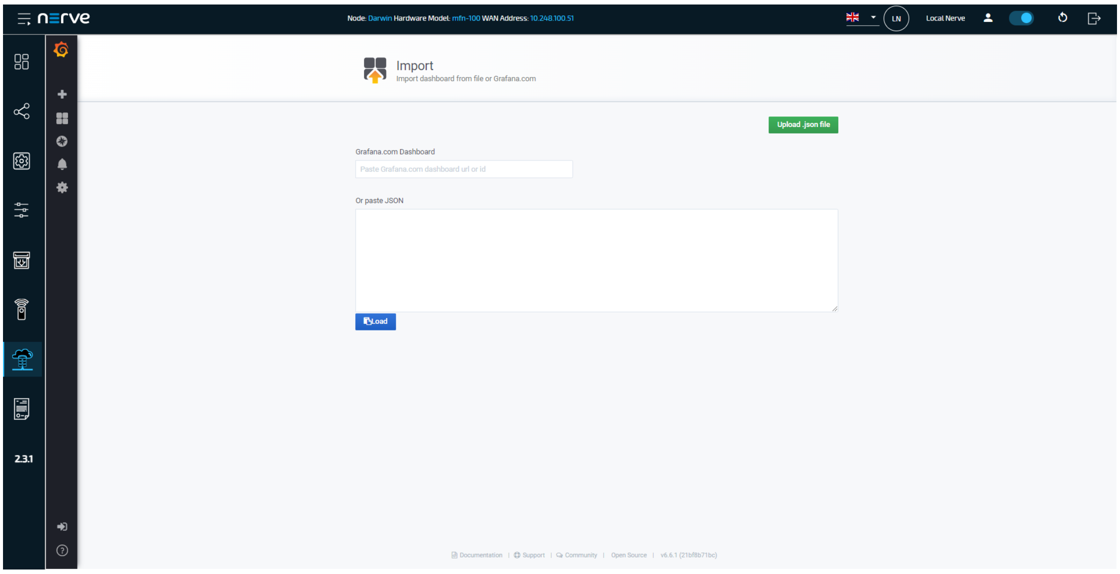
Grafana 8.3 released: Recorded queries, panel suggestions, new panels, added security, and more — Dec 01

Grafana 8.3 is here! This is an exciting release for Grafana Labs. This release includes the new Candlestick panel, a new visualization suggestions engine, support for AWS Metrics Insights and, for our Grafana Enterprise users, recorded queries. Get 8.3 You can get started with Grafana in minutes with Grafana Cloud. We have free and paid Grafana Cloud plans to suit every use case — sign up for free now. Here's a closer look at the important new features in 8.

3. Select **Import dashboard**.



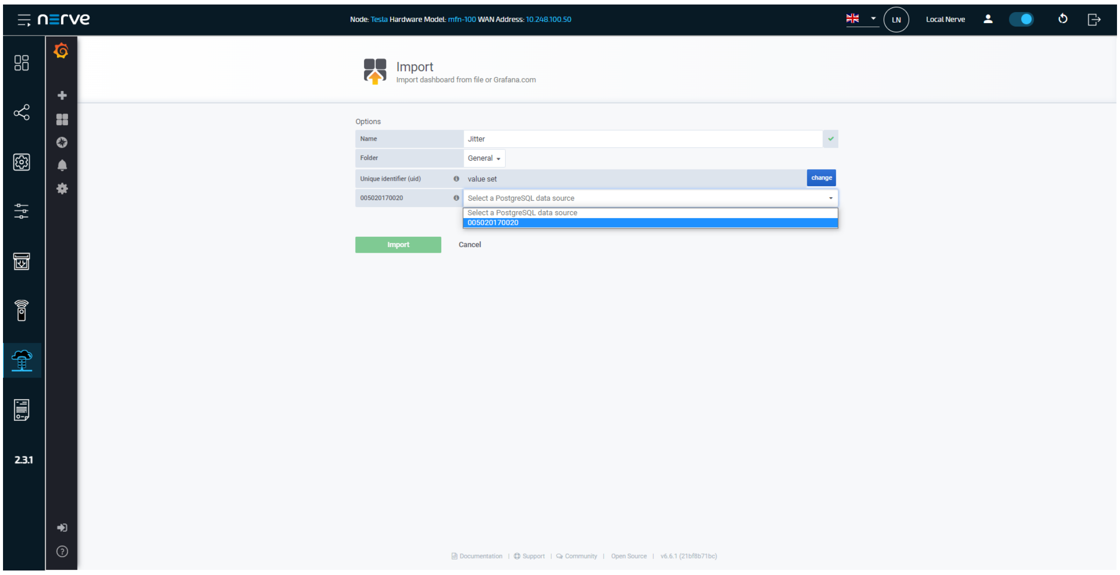
4. Select **Upload .json file** in the upper-right.


Node: Darwin Hardware Model: mfn-100 WAN Address: 10.248.100.51
Local Nerve
Import
Import dashboard from file or Grafana.com
Upload .json file
Grafana.com Dashboard
Paste Grafana.com dashboard url or id
Or paste JSON
Load
Documentation | Support | Community | Open Source | v6.6.1 (21bf8b71bc)
2.3.1

5. Select the jitter dashboard JSON file that was part of the delivery.

6. Select **Open**.

7. Select the only available item from the data source selector drop-down menu. The data source corresponds to the serial number of the node.



nerve
Node: Tesla Hardware Model: mfn-100 WAN Address: 10.248.100.50
Local Nerve
2.3.1

Import
Import dashboard from file or Grafana.com

Options

Name: Jitter

Folder: General

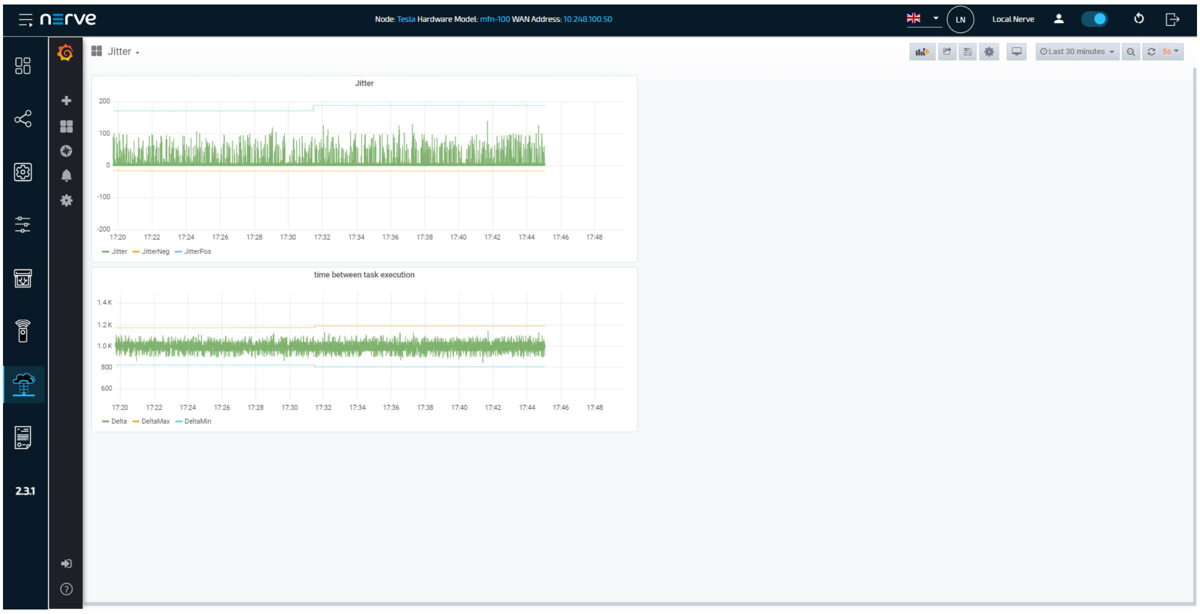
Unique identifier (uid): value set (change)

005020170020: Select a PostgreSQL data source
- Select a PostgreSQL data source
- 005020170020

Import   Cancel

8. Select **Import**.

The **Jitter** dashboard is now created, showing two graphs, **Jitter** and **time between task execution**.



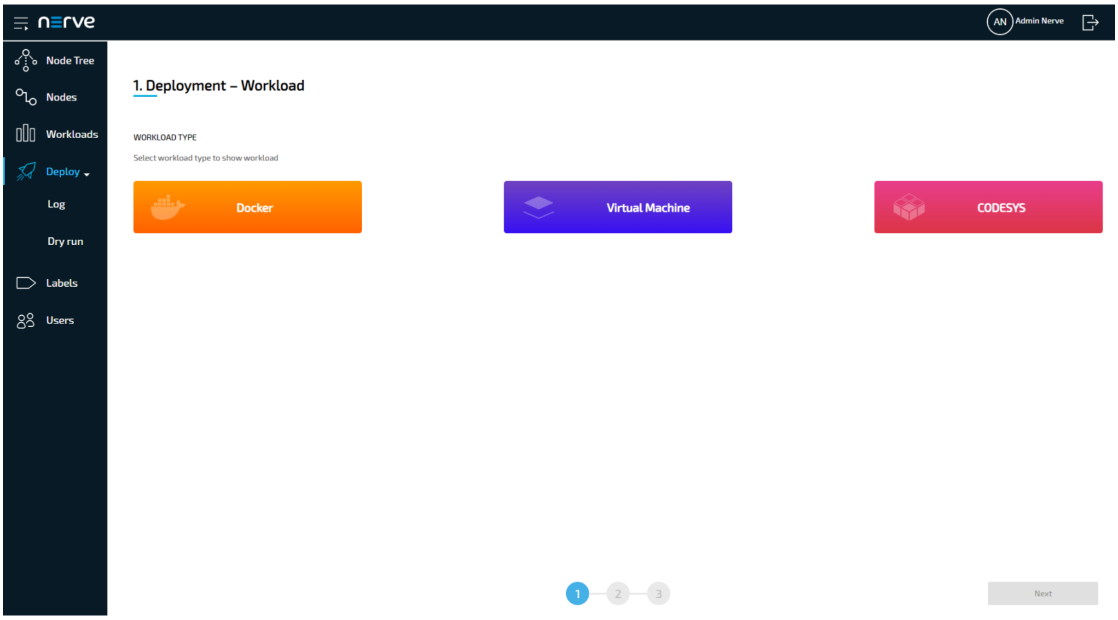
Similar to the machine simulation, the upper graph labeled **Jitter** shows the jitter value over time in microseconds (**Jitter**), the highest recorded positive jitter value (**JitterPos**) and the highest recorded negative jitter value (**JitterNeg**).

The lower graph labeled **time between task execution** shows the recorded cycle time values (**Delta**), the highest recorded cycle time (**DeltaMax**) and the lowest recorded cycle time (**DeltaMin**).

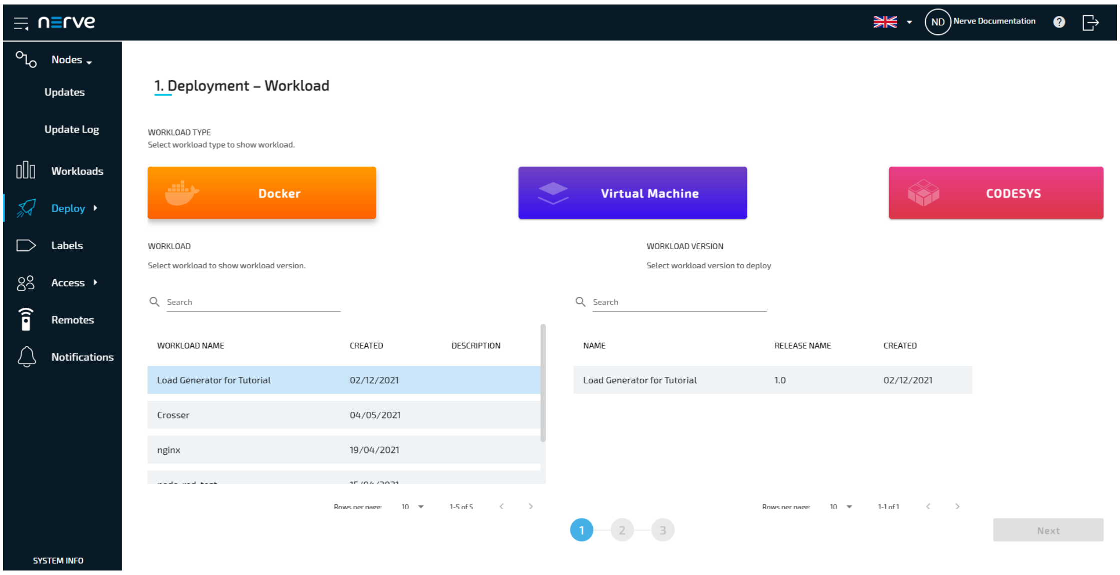
Step 5: Deploying the load generator workloads

In this step, we will deploy the aforementioned load generator workloads — a Docker container and a virtual machine. The instructions below will walk you through the deployment process for the Docker workload. Please repeat the process for the Virtual Machine workload.

1. In the Management System, select **Deploy** in the left-hand menu.



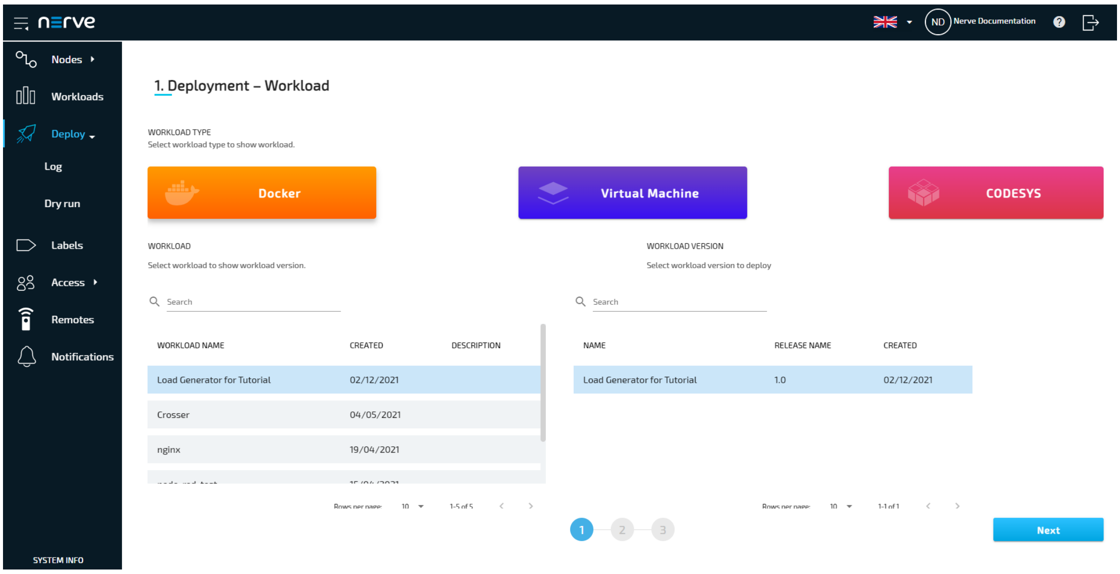
2. Select the orange Docker tab. A list of Docker workloads will appear below.
3. Select the **Load Generator for Tutorial** workload from the list. A list of versions of this workload will appear to the right.



WORKLOAD NAME	CREATED	DESCRIPTION
Load Generator for Tutorial	02/12/2021	
Crosser	04/05/2021	
nginx	19/04/2021	
node-red-test	15/04/2021	

NAME	RELEASE NAME	CREATED
Load Generator for Tutorial	1.0	02/12/2021

4. Select the latest version of the workload on the right.
5. Select **Next** in the lower-right corner.



1. Deployment – Workload

WORKLOAD TYPE
Select workload type to show workload.

WORKLOAD
Select workload to show workload version.

WORKLOAD NAME	CREATED	DESCRIPTION
Load Generator for Tutorial	02/12/2021	
Crosser	04/05/2021	
nginx	19/04/2021	

Rows per page: 10 1-5 of 5

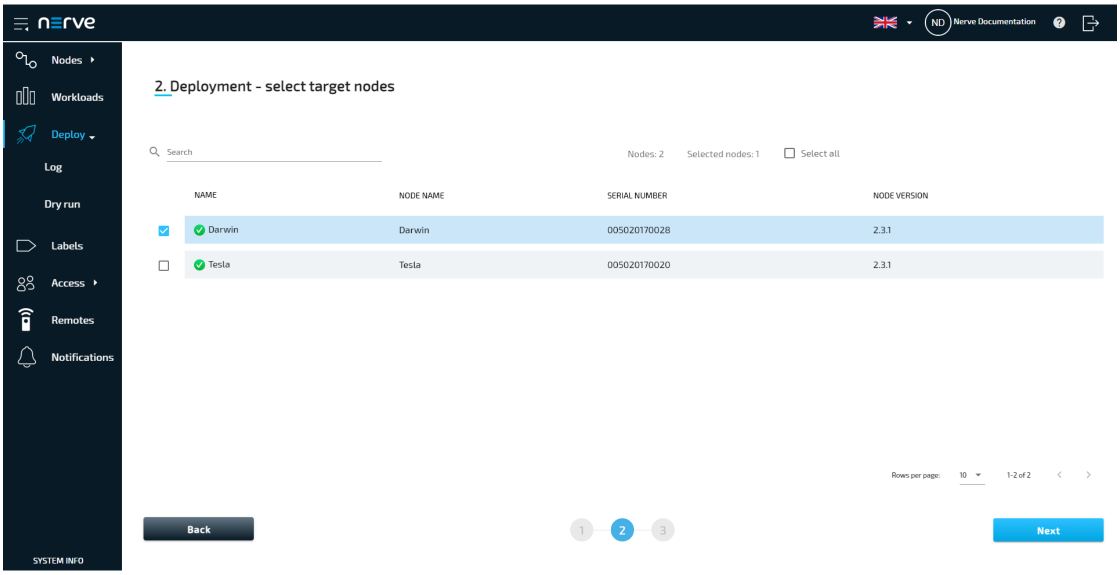
WORKLOAD VERSION
Select workload version to deploy

NAME	RELEASE NAME	CREATED
Load Generator for Tutorial	1.0	02/12/2021

Rows per page: 10 1-1 of 1

6. Tick the checkbox next to your node.

7. Select **Next** in the lower-right corner.



2. Deployment - select target nodes

Search Nodes: 2 Selected nodes: 1 □ Select all

	NAME	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	Darwin	Darwin	005020170028	2.3.1
□	Tesla	Tesla	005020170020	2.3.1

Rows per page: 10 1-2 of 2

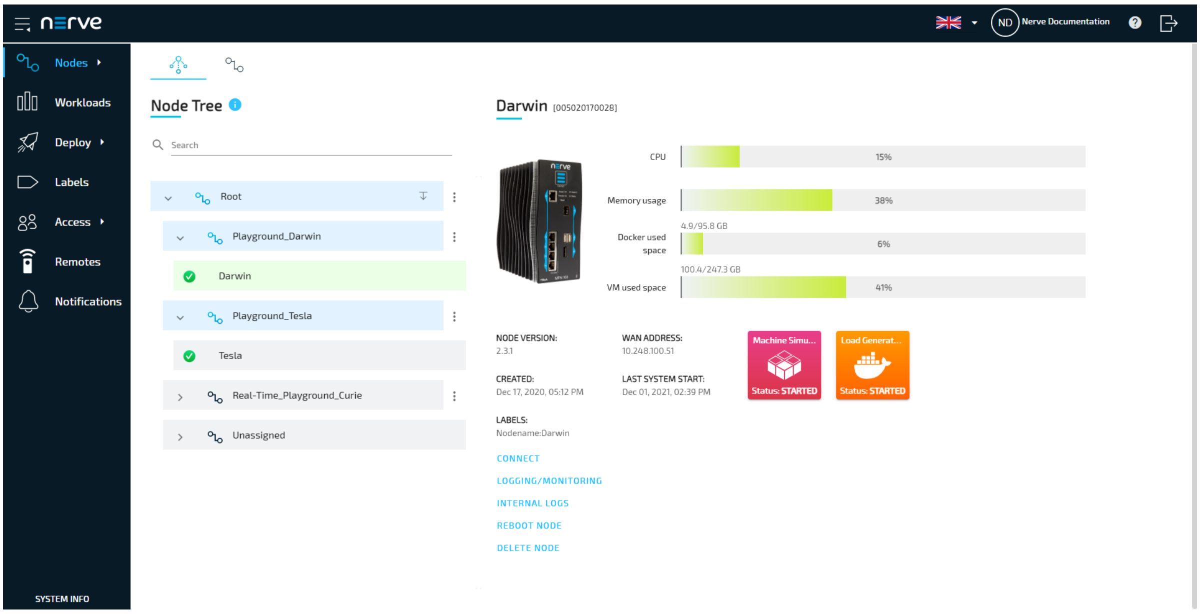
8. Select **Deploy** to execute the deployment.
   *Optional: Enter a **Deploy name** above the **Summary** of the workload to make this deployment easy to identify. A timestamp is filled in automatically.*

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

To confirm if the workload has been deployed successfully, select **Nodes** in the navigation on the left. Select your node in the node tree and confirm if a Docker workload tile is showing underneath the bar graph. The workload should show the status **STARTED**.

NOTE

It can take a number of seconds until the status of a workload switches from **IDLE** to **STARTED** after deployment.



Darwin [005020170028]

CPU 15%

Memory usage 38%

Docker used space 4.9/95.8 GB 6%

VM used space 100.4/247.3 GB 41%

NODE VERSION: 2.3.1

WAN ADDRESS: 10.248.100.51

CREATED: Dec 17, 2020, 05:12 PM

LAST SYSTEM START: Dec 01, 2021, 02:39 PM

LABELS: Nodename:Darwin

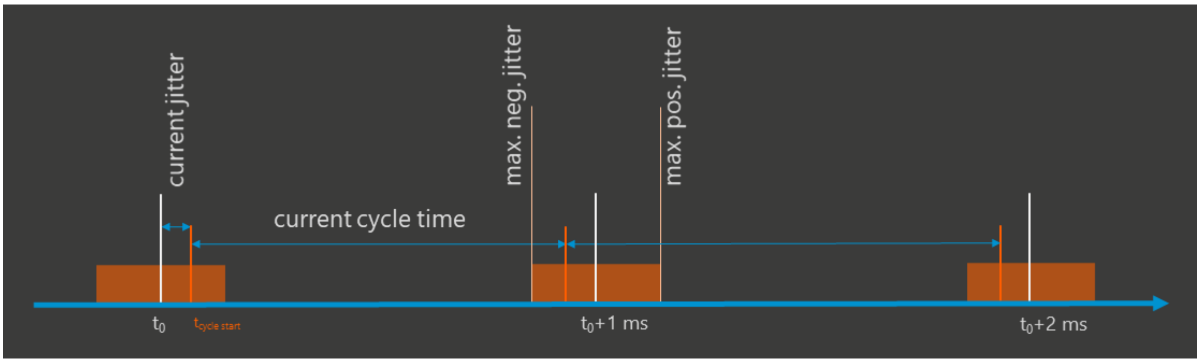
Machine Simu... Status: STARTED

Load Generat... Status: STARTED

To deploy the load generator VM, please repeat the steps above deploy the Virtual Machine workload. In step 2, select the blue Virtual Machine tab and pick the **Load Generator on Alpine** workload in its latest version. The remaining steps are identical.

Experiments and conclusion

What is jitter? Jitter is the deviation from the defined cycle time, and occurs when a task is performed earlier or later than planned. Take a look at the image below:



Starting from $\mathbf{t_0}$, tasks are targeted to occur every 1 ms. The planned task starts are symbolized by white lines in the image above. The actual task times, starting with $\mathbf{t_{cycle\ start}}$, are marked by orange lines and occur before or after the planned times. The difference between the planned and defined times is called jitter. Jitter values can therefore have positive and negative values, depending on when the cycle actually starts and finishes. Jitter values are negative if the cycle finishes before the planned time. Positive values occur when the cycle finishes later. In other words, this can be compared to a train schedule. If the train is too early or too late, jitter occurs.

The Nerve system guarantees a certain maximum jitter range to ensure real-time performance using the ACRN hypervisor, even when the system load is high. Now that the load generator workloads are deployed and operating, access the jitter dashboard in Grafana again to evaluate the difference in jitter data. Real-time performance should still be given. However, note that the load generator Docker container stops itself after 60 seconds. To have it generate system load again, start the Docker container again manually from the workload control screen in the node tree. To reach the workload control area, select the workload in the node details view in the node tree.

Supported Applications

Supported Applications

Nerve is a platform for applications running on machines and accessing machine data. Supported applications increase the functionality of Nerve to accustom a larger number of use cases. The applications are tested and regularly maintained. More applications will be added in the near future, as well as usage examples for each application.

Each section of an application below provides assistance in the usage of the supported application with Nerve. It offers an overview and an explanation of each application, as well as step-by-step examples and useful links.

Select an application from the table below for more information:

crosser	Node-RED

For questions and information not covered by the documentation, contact a sales representative or write an email to support@tttech-industrial.com

Crosser

Crosser designs and develops streaming analytics and integration software for edge, on-premise or cloud. The Crosser platform enables real-time processing of streaming or batch data for Industrial IoT, data transformation, analytics, automation and integration. The Crosser platform consists of two core parts.

- Crosser Cloud is the heart of the platform where all design and orchestration takes place. It is a multi-tenant SaaS service hosted by Crosser but also exists in an on-premise version that customers can run on a private cloud, inside the internal firewall.

- Crosser Node is the real-time engine that customers install where they need it and anywhere a Docker container can be used.

Refer to the official Crosser homepage for more information on Crosser.

Requirements for usage with Nerve

To use Crosser with Nerve, a Crosser Cloud account is required. Use one of the provided test options or get in touch with Crosser directly:

- Free trial
- Schedule a demo
- sales@crosser.io

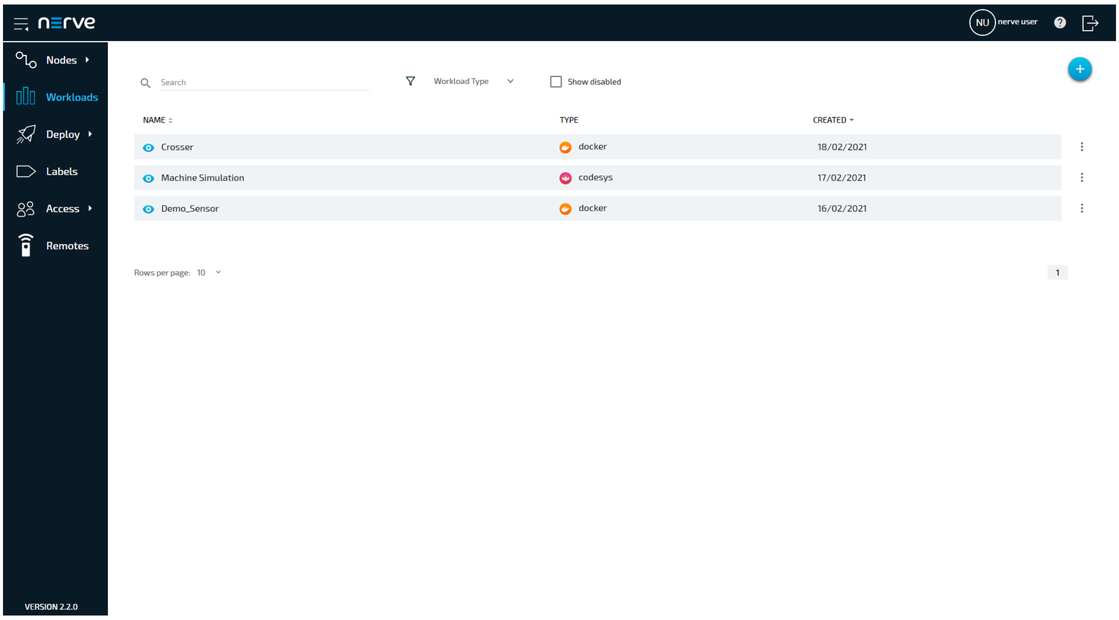
Getting started

The Crosser workload is pre-configured in the Nerve Management System as part of the delivery so that the application can be used once the account for the Crosser Cloud is set up. Follow the steps below to finalize the configuration. The pre-configured workload is set up with the following settings:

Setting	Value
Name	Crosser
Release name	2.2.4
DOCKER IMAGE	**From Registry** is selected with an **Image path** and login credentials to the Docker image.
Port settings	**Protocol** TCP **Host Port** 1883 **Container Port** 1883
Container name	Crosser_latest
Network name	bridge

1. Log in to the Nerve Management System. Note that the initial login credentials can be found in the customer profile.

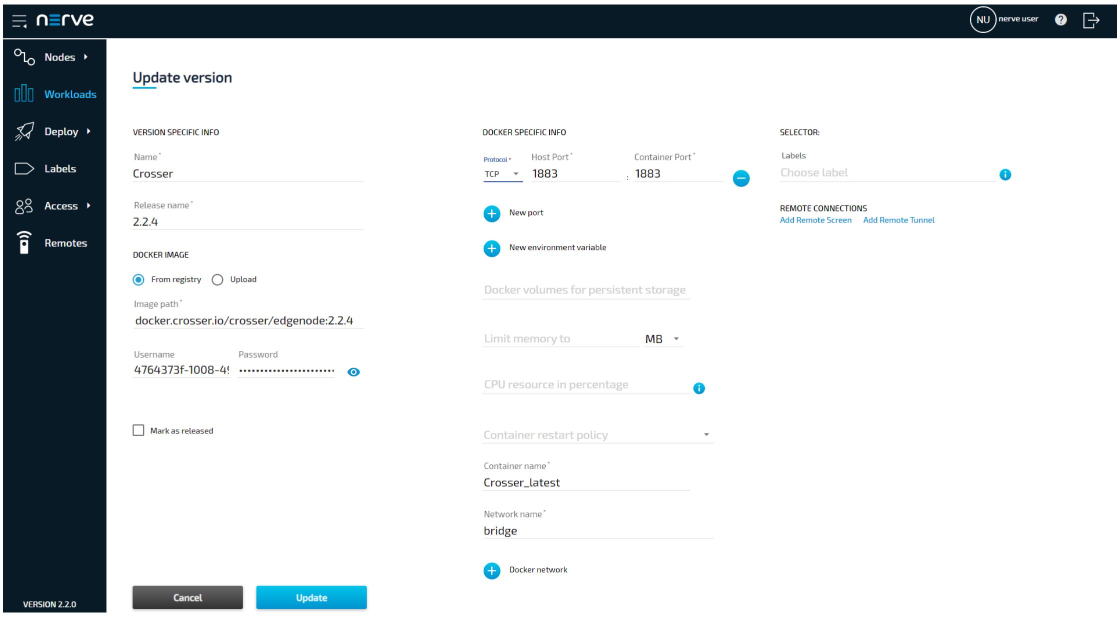
2. Select **Workloads** in the navigation on the left.



NAME	TYPE	CREATED
Crosser	docker	18/02/2021
Machine Simulation	codesys	17/02/2021
Demo_Sensor	docker	16/02/2021

3. Select the Crosser workload.

4. Select the latest version on the right to edit the settings of the version.



Update version

VERSION SPECIFIC INFO

Name: Crosser

Release name: 2.2.4

DOCKER IMAGE

● From registry ○ Upload

Image path: docker.crosser.io/crosser/edgenode:2.2.4

Username: 4764373f-1008-4!

Password: ••••••••••••••••••••••••

□ Mark as released

DOCKER SPECIFIC INFO

Protocol: TCP Host Port: 1883 Container Port: 1883

New port

New environment variable

Docker volumes for persistent storage

Limit memory to MB

CPU resource in percentage

Container restart policy

Container name: Crosser_latest

Network name: bridge

Docker network

SELECTOR:

Labels: Choose label

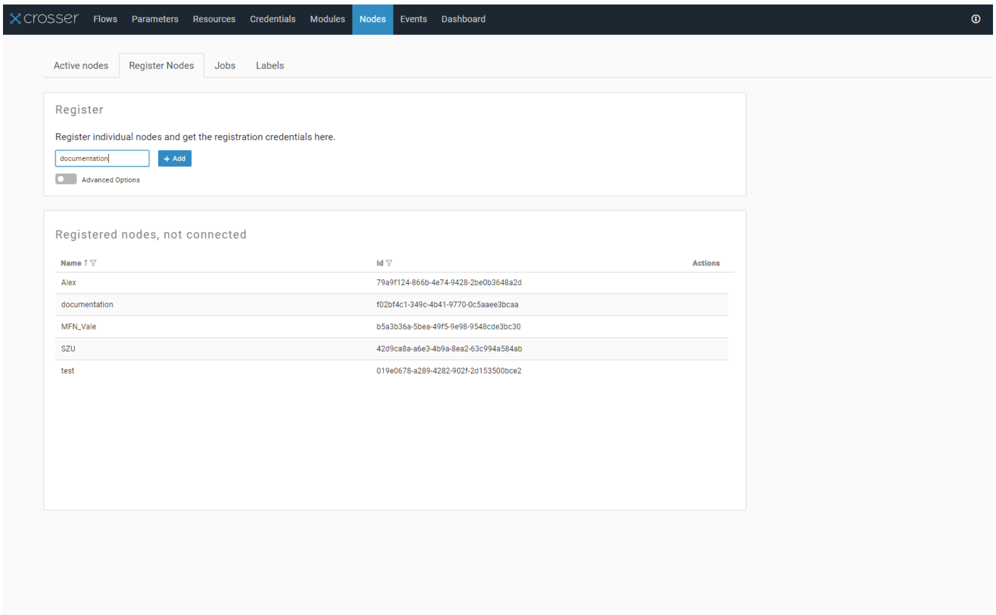
REMOTE CONNECTIONS

Add Remote Screen Add Remote Tunnel

5. Log in to Crosser Cloud.

6. Select **Nodes** in the navigation at the top.
7. Select the **Register Nodes** tab.

8. Enter a name for the node in the field.



Register

Register individual nodes and get the registration credentials here.

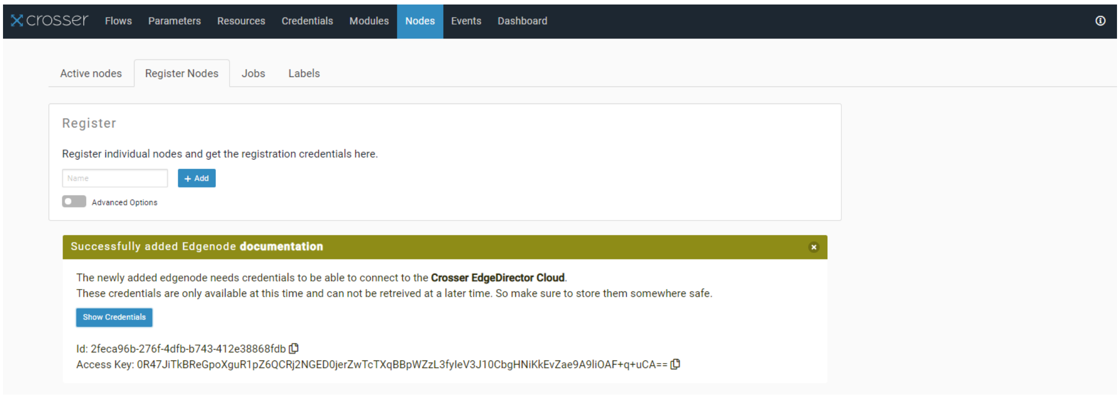
documentation

Registered nodes, not connected

Name	Id	Actions
Alex	79a9f124-866b-4e74-9428-2be0b3648a2d	
documentation	f02bf4c1-349c-4b41-9770-0c5aaee3bcaa	
MFN_Vale	b5a3b36a-5bea-49f5-9e98-9548cde3bc30	
SZU	42d9ca8a-a6e3-4b9a-8ea2-63c994a584ab	
test	019e0678-a289-4282-902f-2d153500bce2	

9. Select **+ Add**. A notification saying **Successfully added Edgenode** appears below when the registration is successful.

10. Select **Show Credentials** to display the NodeID and the Access Key. They are needed for the configuration of the Crosser workload.



Register

Register individual nodes and get the registration credentials here.

Successfully added Edgenode **documentation**

The newly added edgenode needs credentials to be able to connect to the **Crosser EdgeDirector Cloud**.
These credentials are only available at this time and can not be retreived at a later time. So make sure to store them somewhere safe.

Id: 2feca96b-276f-4dfb-b743-412e38868fdb
Access Key: 0R47JiTkBReGpoXguR1pZ6QCRj2NGED0jerZwTcTXqBBpWZzL3fyleV3J10CbgHNiKkEvZae9A9liOAF+q+uCA==

11. Switch back to the Management System.

12. Select **+** next to **New environment variable**.

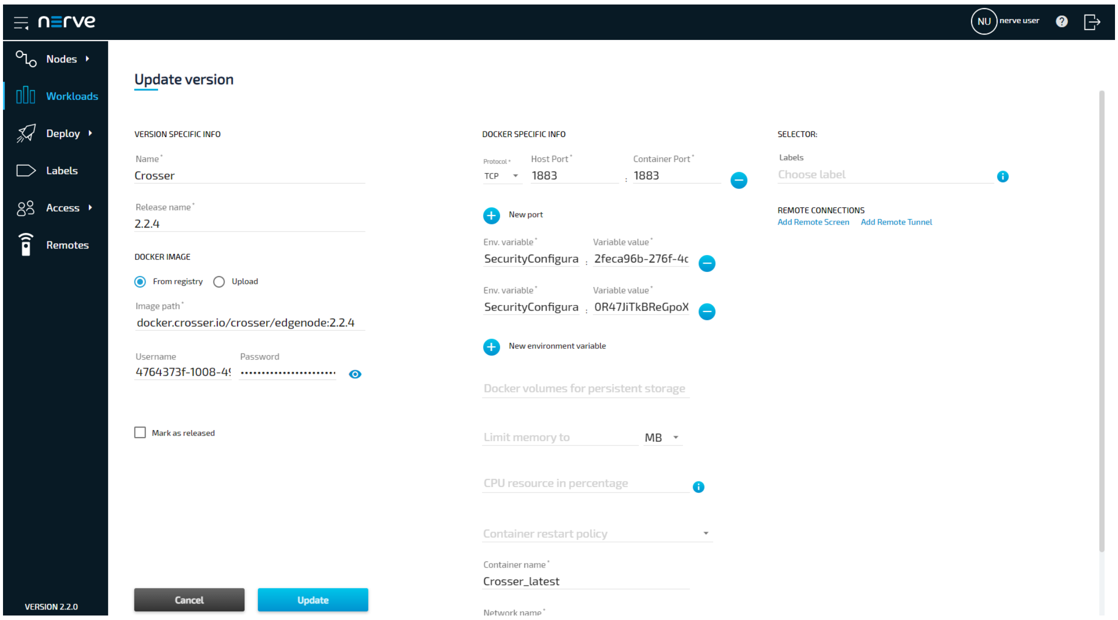
13. Enter the following values:

Field	Value
Env. variable	`SecurityConfiguration__Credentials__NodeId`
Variable value	Enter the value next to **Id** in the Crosser Cloud credentials window.

14. Select **+** next to **New environment variable** again.

15. Enter the following values:

Field	Value
Env. variable	`SecurityConfiguration__Credentials__AccessKey`
Variable value	Enter the value next to **Access Key** in the Crosser Cloud credentials window.



Update version

VERSION SPECIFIC INFO

Name*: Crosser

Release name*: 2.2.4

DOCKER IMAGE

● From registry ○ Upload

Image path*: docker.crosser.io/crosser/edgenode:2.2.4

Username: 4764373f-1008-4! Password: ••••••••••••••••••••••

□ Mark as released

DOCKER SPECIFIC INFO

Protocol*: TCP Host Port*: 1883 : Container Port*: 1883

Env. variable*: SecurityConfigura : Variable value*: 2feca96b-276f-4c

Env. variable*: SecurityConfigura : Variable value*: 0R47JiTkBReGpoX

Docker volumes for persistent storage

Limit memory to MB

CPU resource in percentage

Container restart policy

Container name*: Crosser_latest

Network name*

SELECTOR:

Labels: Choose label

REMOTE CONNECTIONS

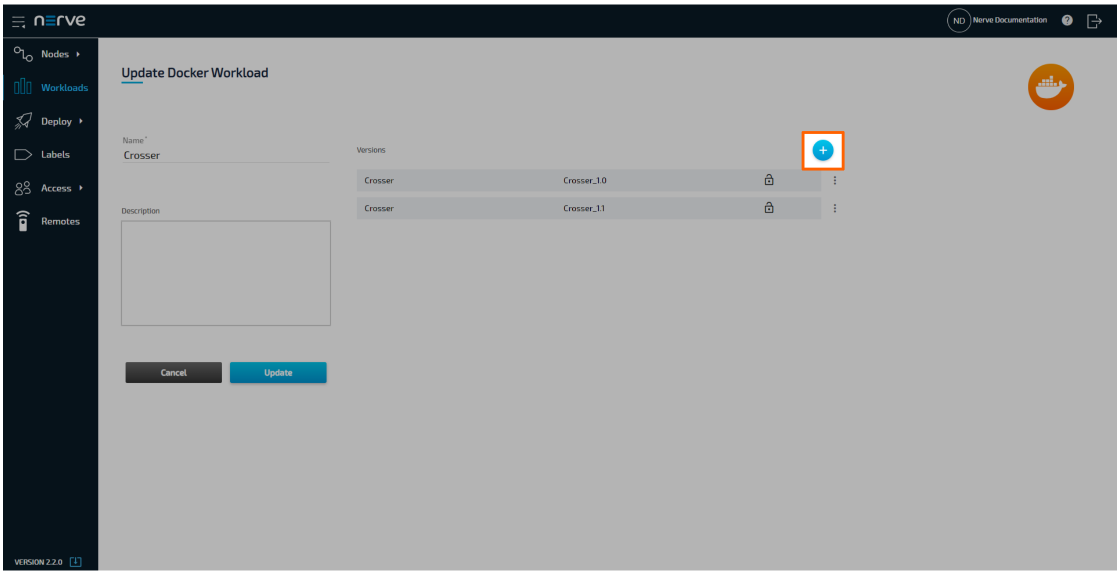
16. Select **Update**.

Onboarding more nodes to Crosser Cloud

In order to onboard further nodes to Crosser Cloud, a new version of the Crosser workload has to be created in the Management System.

1. Select **Workloads** in the navigation on the left.
2. Select the **Crosser** workload from the list of workloads.

3. Click the plus symbol on the right. The settings from the latest version are automatically filled in.



Update Docker Workload

Name*: Crosser

Description

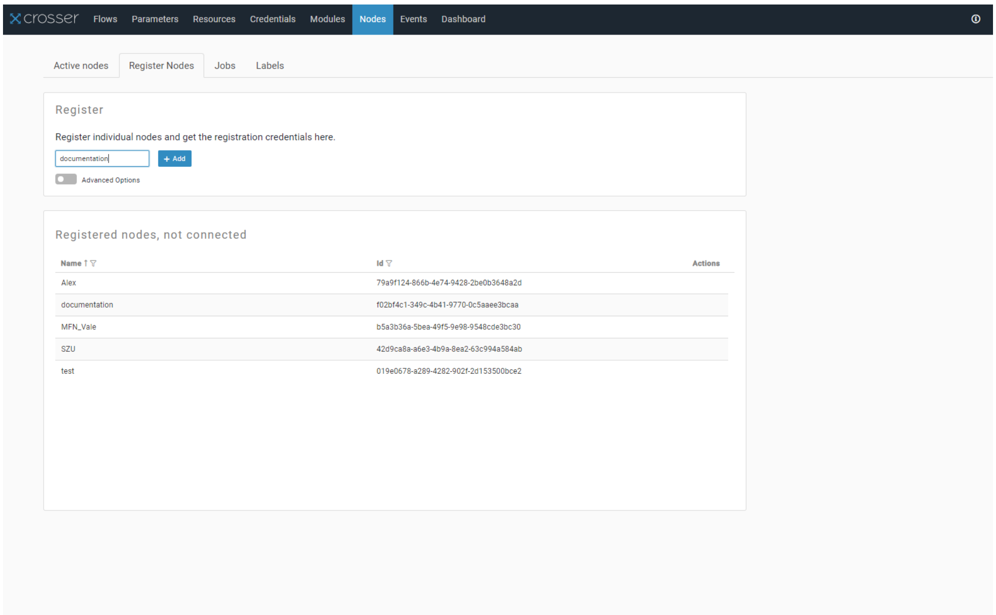
Versions

Crosser	Crosser_1.0	
Crosser	Crosser_1.1	

4. Switch to Crosser Cloud.

5. Select **Nodes** in the navigation at the top.
6. Select the **Register Nodes** tab.

7. Enter a name for the node in the field.



Register

Register individual nodes and get the registration credentials here.

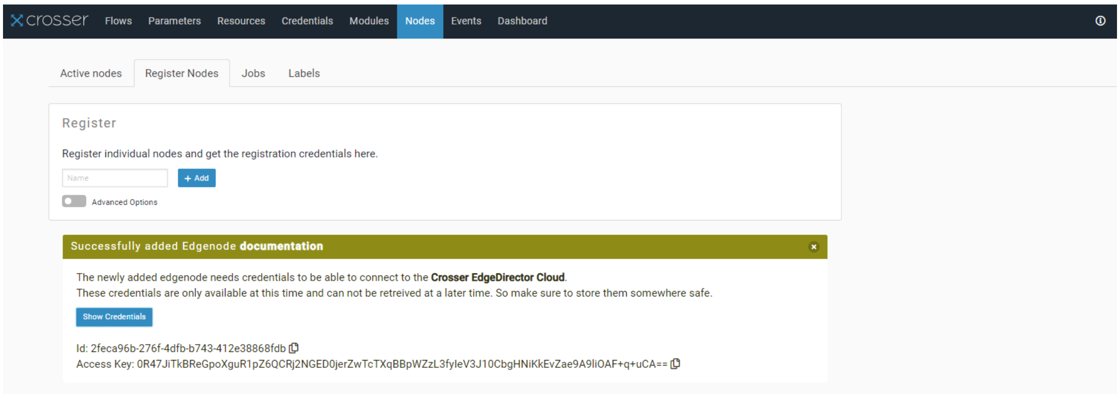
documentation

Registered nodes, not connected

Name	Id	Actions
Alex	79a9f124-866b-4e74-9428-2be0b3648a2d	
documentation	f02bf4c1-349c-4b41-9770-0c5aaee3bcaa	
MFN_Vale	b5a3b36a-5bea-49f5-9e98-9548cde3bc30	
SZU	42d9ca8a-a6e3-4b9a-8ea2-63c994a584ab	
test	019e0678-a289-4282-902f-2d153500bce2	

8. Select **+ Add**. A notification saying **Successfully added Edgenode** appears below when the registration is successful.

9. Select **Show Credentials** to display the NodeID and the Access Key.



Register

Register individual nodes and get the registration credentials here.

Name

Advanced Options

Successfully added Edgenode **documentation**

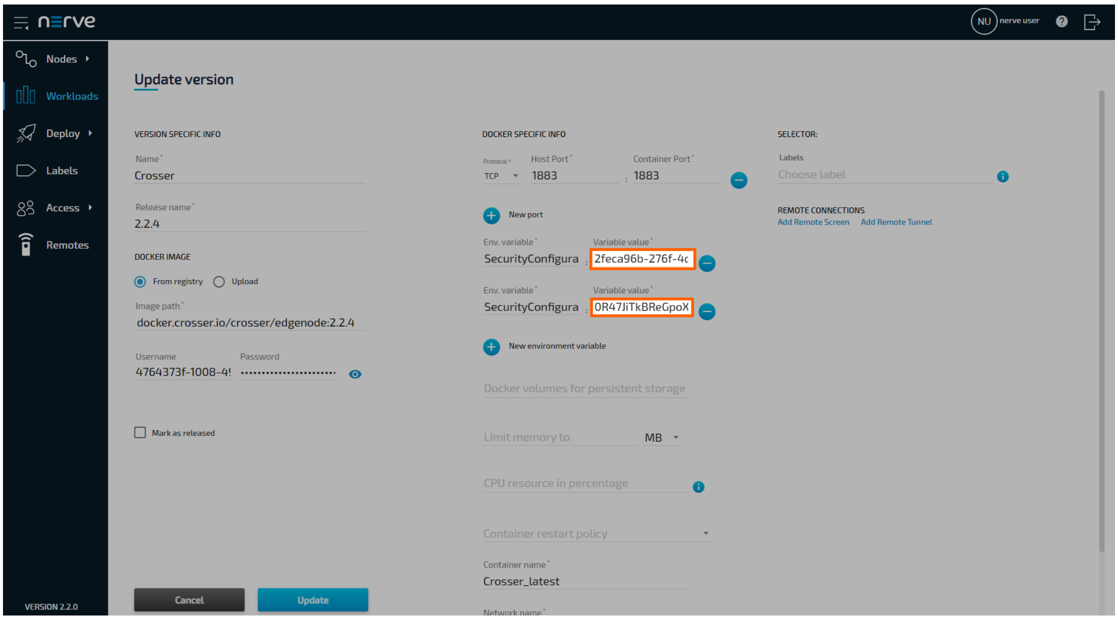
The newly added edgenode needs credentials to be able to connect to the **Crosser EdgeDirector Cloud**.
These credentials are only available at this time and can not be retreived at a later time. So make sure to store them somewhere safe.

Id: 2feca96b-276f-4dfb-b743-412e38868fdb
Access Key: 0R47JiTkBReGpoXguR1pZ6QCRj2NGED0jerZwTcTXqBBpWZzL3fyleV3J10CbgHNiKkEvZae9A9liOAF+q+uCA==

10. Switch back to the Management System.

11. Replace the value of the `SecurityConfiguration__Credentials__NodeId` environment variable with the new value of **Id** in the Crosser Cloud credentials window.

12. Replace the value of the `SecurityConfiguration__Credentials__AccessKey` environment variable with the new value of **Access Key** in the Crosser Cloud credentials window.



Update version

VERSION SPECIFIC INFO

Name*: Crosser

Release name*: 2.2.4

DOCKER IMAGE

● From registry ○ Upload

Image path*: docker.crosser.io/crosser/edgenode:2.2.4

Username: 4764373f-1008-4! Password: ••••••••••••••••••••••

□ Mark as released

DOCKER SPECIFIC INFO

Protocol*: TCP Host Port*: 1883 : Container Port*: 1883

Env. variable*: SecurityConfigura : Variable value*: 2feca96b-276f-4c

Env. variable*: SecurityConfigura : Variable value*: 0R47JiTkBReGpoX

Docker volumes for persistent storage

Limit memory to MB

CPU resource in percentage

Container restart policy

Container name*: Crosser_latest

Network name*

SELECTOR:

Labels: Choose label

REMOTE CONNECTIONS

13. Update the **Name** of the version.

> **NOTE**
>
> Choose the name of the node in Crosser Cloud for easy identification of the workload version.

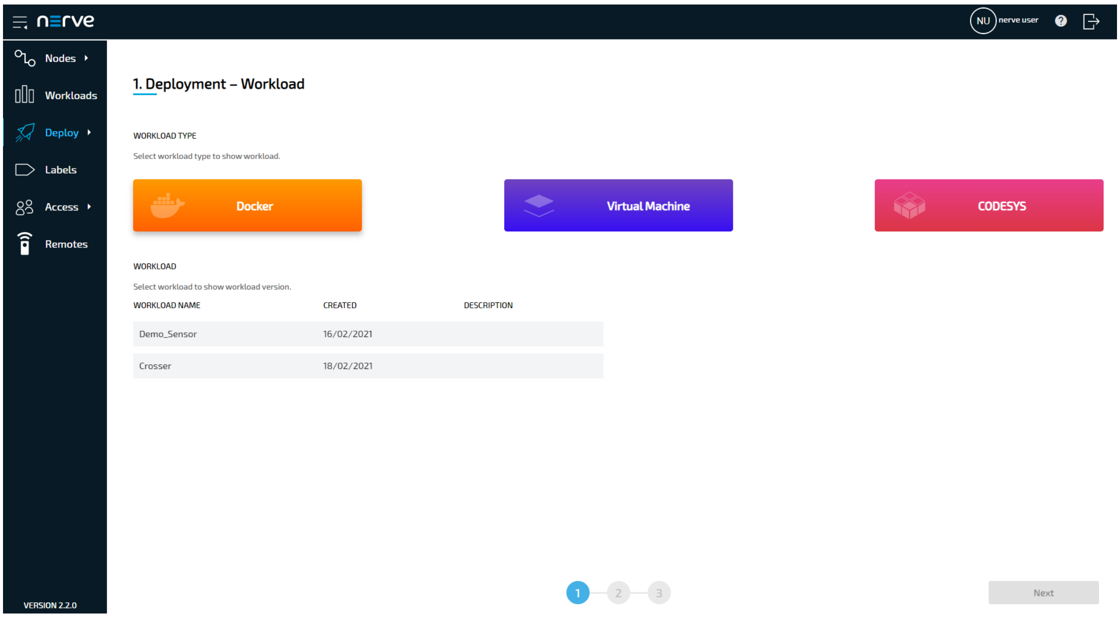
14. Click **Save** to save the new version of the workload.

15. Select **Update**.

Deploying the Crosser workload

After configuring the Crosser workload in both the Managament System and Crosser cloud, follow the instructions below to deploy the Crosser workload to a Nerve Node in order to start using Crosser with Nerve.

1. In the Management System select **Deploy** in the navigation on the left.
2. Select the orange Docker tab. A list of Docker workloads will appear below.



1. Deployment – Workload

WORKLOAD TYPE

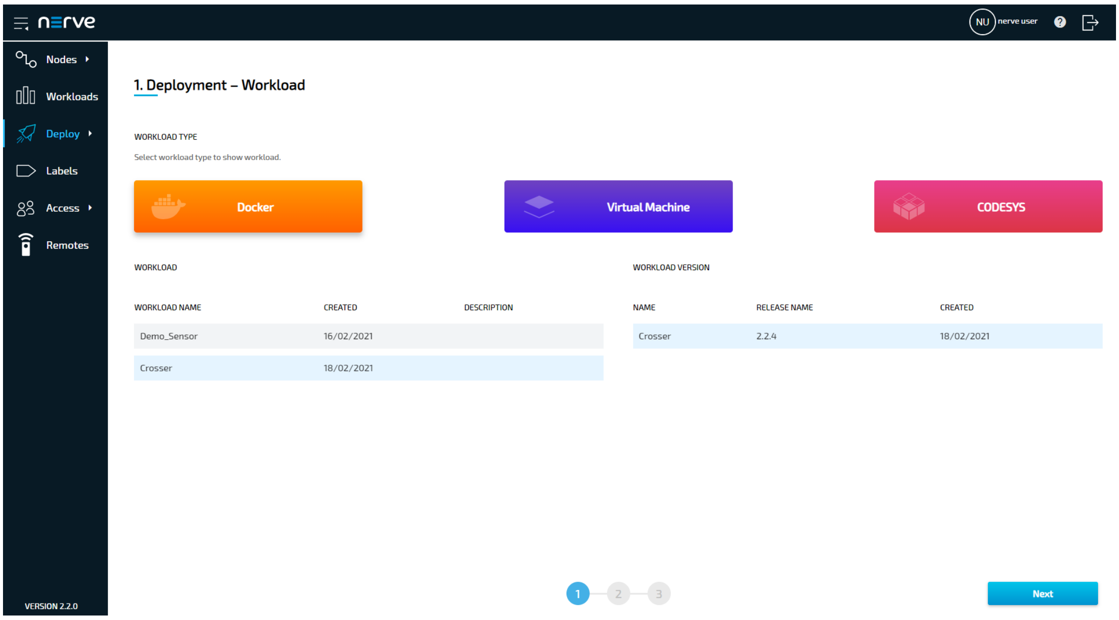
Select workload type to show workload.

WORKLOAD

Select workload to show workload version.

WORKLOAD NAME	CREATED	DESCRIPTION
Demo_Sensor	16/02/2021	
Crosser	18/02/2021	

3. Select **Crosser** in the list of workloads. A list of versions of this workload will appear to the right.
4. Select the corresponding version of the workload that is connected to a node in the Crosser Cloud.



1. Deployment – Workload

WORKLOAD TYPE

Select workload type to show workload.

WORKLOAD

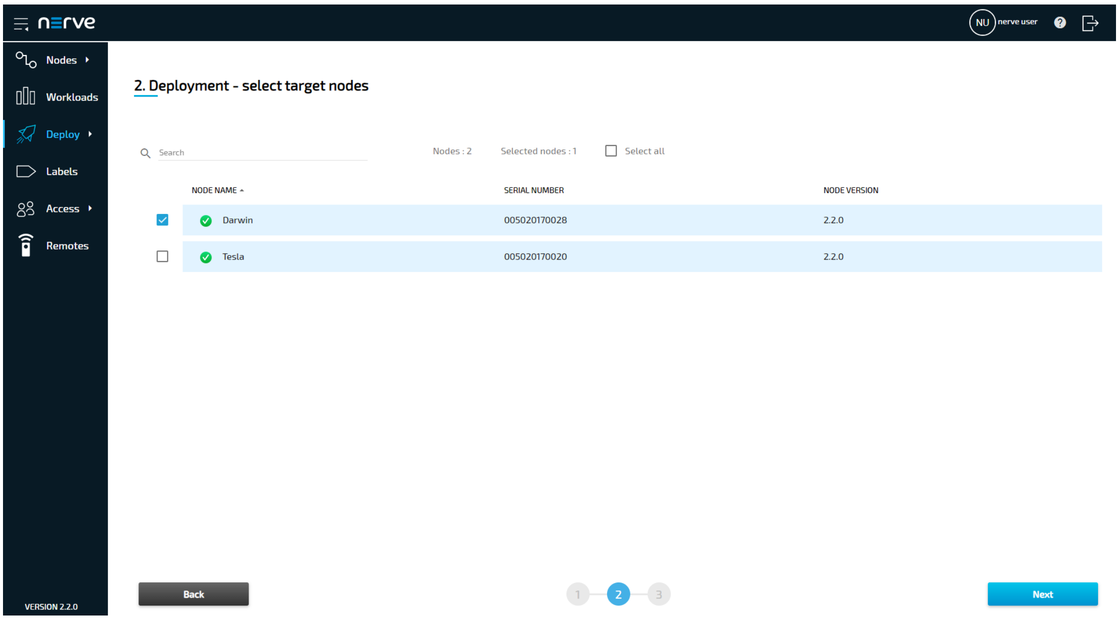
WORKLOAD NAME	CREATED	DESCRIPTION
Demo_Sensor	16/02/2021	
Crosser	18/02/2021	

WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Crosser	2.2.4	18/02/2021

5. Select **Next** in the lower-right corner.

6. Tick the checkbox next to the node that Crosser shall be deployed to.
7. Select **Next** in the lower-right corner.

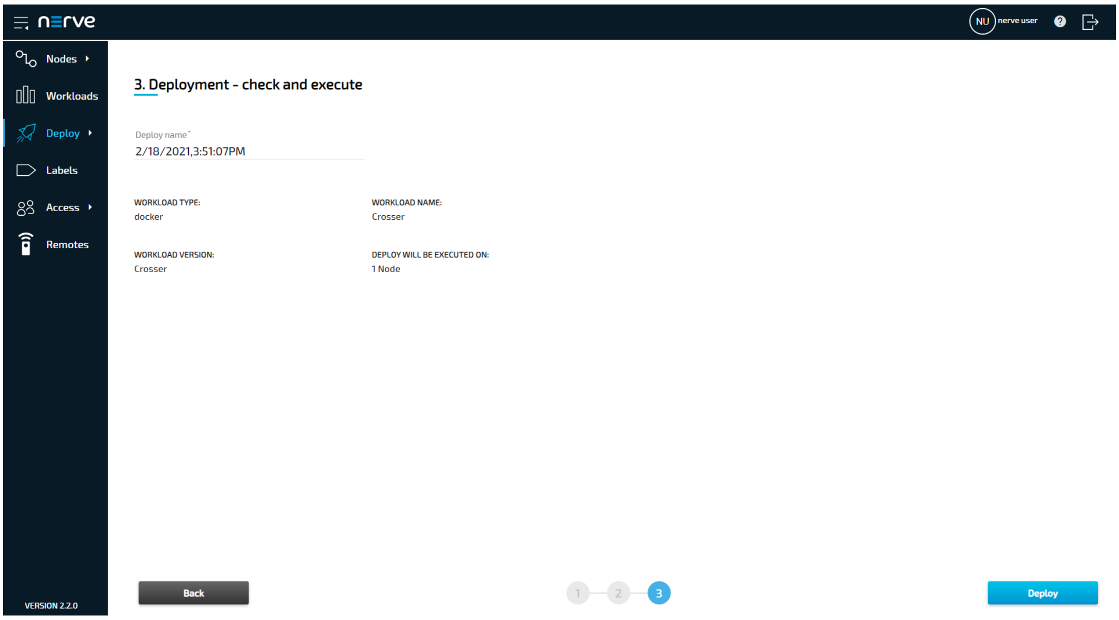


2. Deployment - select target nodes

Search   Nodes : 2   Selected nodes : 1   □ Select all

	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	✓ Darwin	005020170028	2.2.0
□	✓ Tesla	005020170020	2.2.0

8. Select **Deploy** to execute the deployment.
Optional: Enter a Deploy name above the Summary of the workload to make this deployment easy to identify. A timestamp is filled in automatically.



3. Deployment - check and execute

Deploy name*
2/18/2021,3:51:07PM

WORKLOAD TYPE:
docker

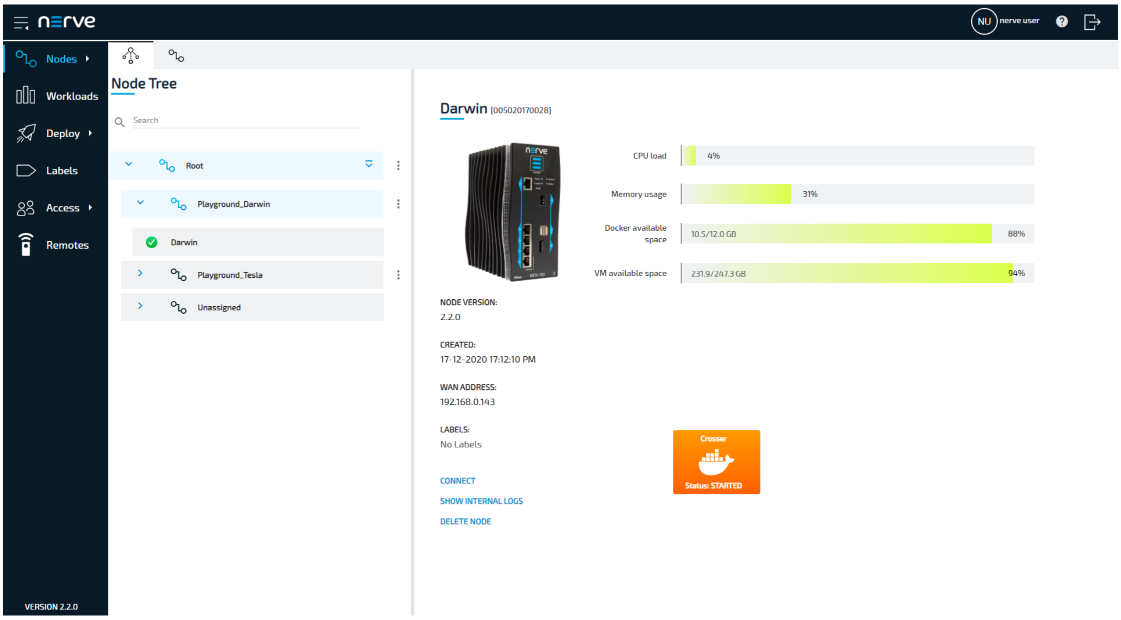
WORKLOAD NAME:
Crosser

WORKLOAD VERSION:
Crosser

DEPLOY WILL BE EXECUTED ON:
1 Node

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

To confirm if the workload has been deployed successfully, select **Nodes** in the navigation on the left. Select the corresponding node in the node tree and confirm if the orange Crosser workload tile is showing underneath the bar graph. The workload should show the status **STARTED**.



Darwin [005020170028]

CPU load 4%

Memory usage 31%

Docker available space 10.5/12.0 GB 88%

VM available space 231.9/247.3 GB 94%

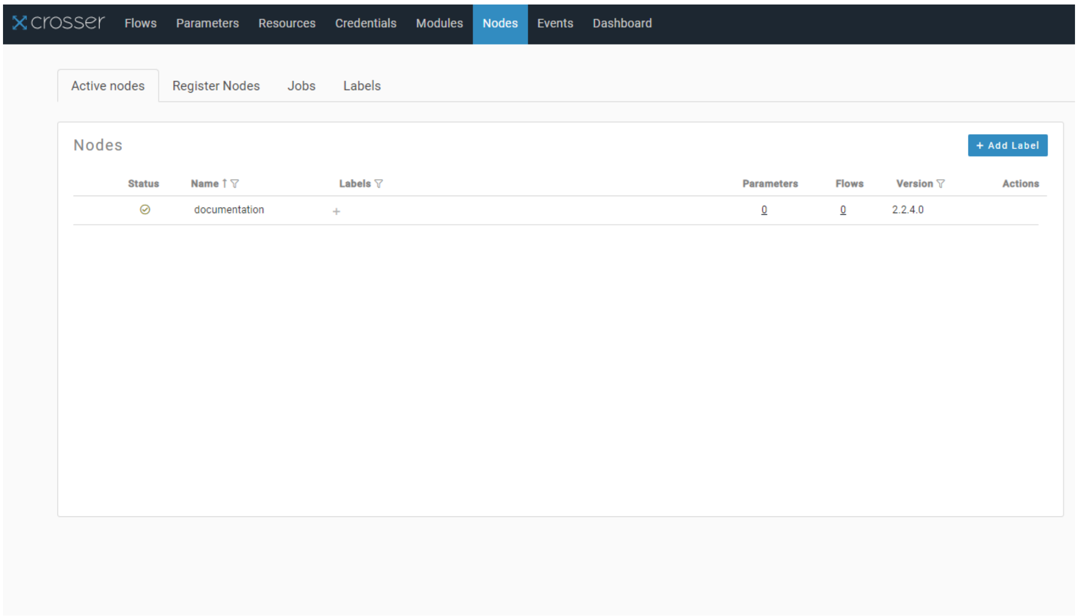
NODE VERSION:
2.2.0

CREATED:
17-12-2020 17:12:10 PM

WAN ADDRESS:
192.168.0.143

LABELS:
No Labels

To confirm if the workload has been successfully connected to the Crosser Cloud, select **Nodes** in the navigation at the top. The node appears in the **Active nodes** list and is marked with a check mark in the **Status** column.



Nodes

Status	Name	Labels	Parameters	Flows	Version	Actions
✓	documentation	+	0	0	2.2.4.0	

Node-RED

Node-RED is an open source programming tool for wiring together sensor inputs, APIs and online services. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single-click.

Refer to the official Node-RED homepage and the Node-RED documentation for more information on Node-RED.

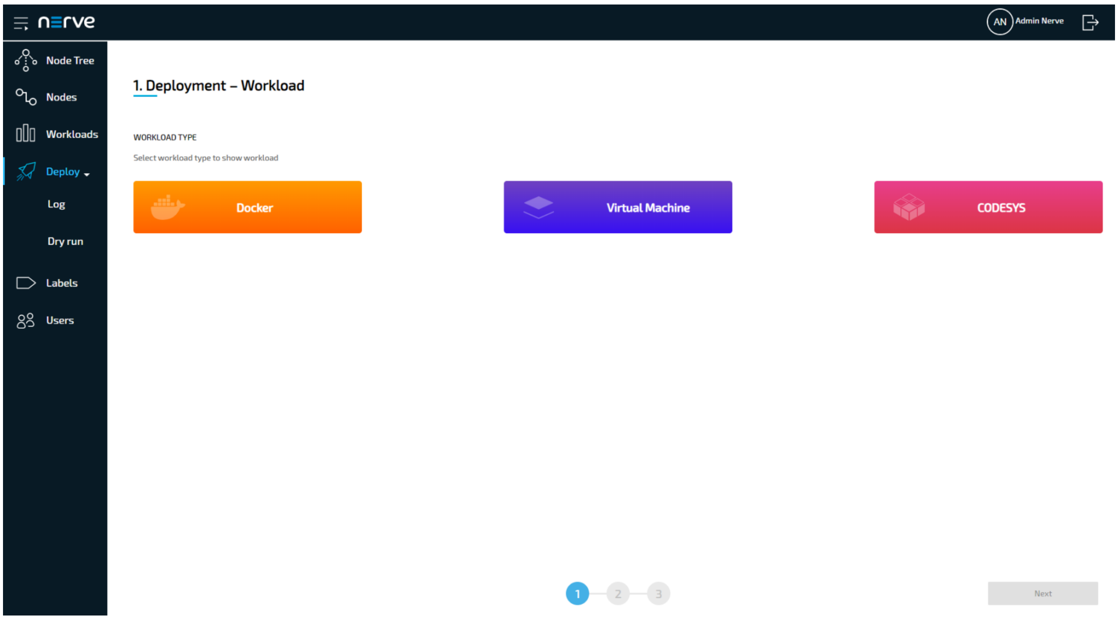
Deploying Node-RED

The Node-RED workload is pre-configured in the Nerve Management System as part of the delivery so that the application can be used out of the box. Follow the steps below to deploy Node-RED to a Nerve Node. The pre-configured workload is set up with the following settings:

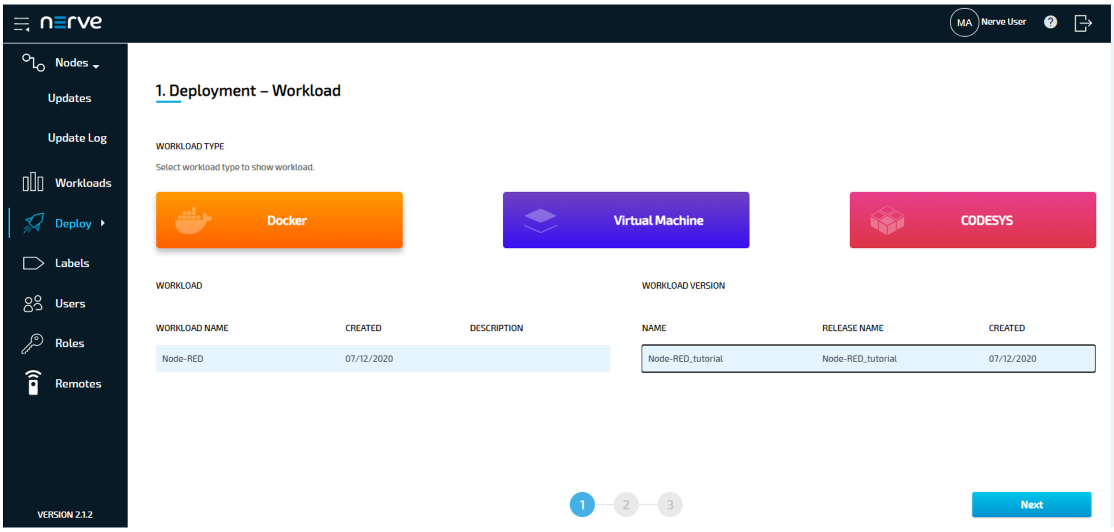
Setting	Value
Name	Node-RED_Tutorial
Release name	1.2.7-12
DOCKER IMAGE	**From Registry** is selected with an **Image path** to the Docker image.
Port settings	**Protocol** TCP **Host Port** 1880 **Container Port** 1880
Container name	Node-RED
Network name	wan
Network name	bridge
REMOTE CONNECTIONS	**NAME** Node-RED **TYPE** TUNNEL **PORT** 1880

1. Log in to the Management System.

2. Select **Deploy** in the navigation on the left.



3. Select the orange Docker tab. A list of Docker workloads will appear below.
4. Select **Node-RED** in the list of workloads. A list of versions of this workload will appear to the right.
5. Select the latest version of the workload.



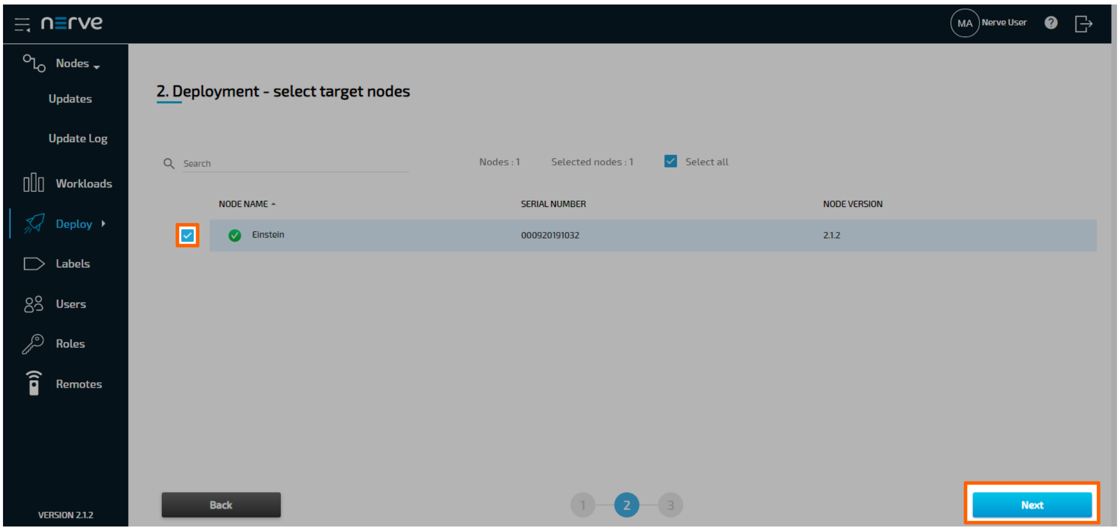
WORKLOAD

WORKLOAD NAME	CREATED	DESCRIPTION
Node-RED	07/12/2020	

WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Node-RED_tutorial	Node-RED_tutorial	07/12/2020

6. Select **Next** in the lower-right corner.
7. Tick the checkbox next to your node.
8. Select **Next** in the lower-right corner.



2. Deployment - select target nodes

Nodes : 1 Selected nodes : 1 ☑ Select all

	NODE NAME	SERIAL NUMBER	NODE VERSION
☑	Einstein	000920191032	2.1.2

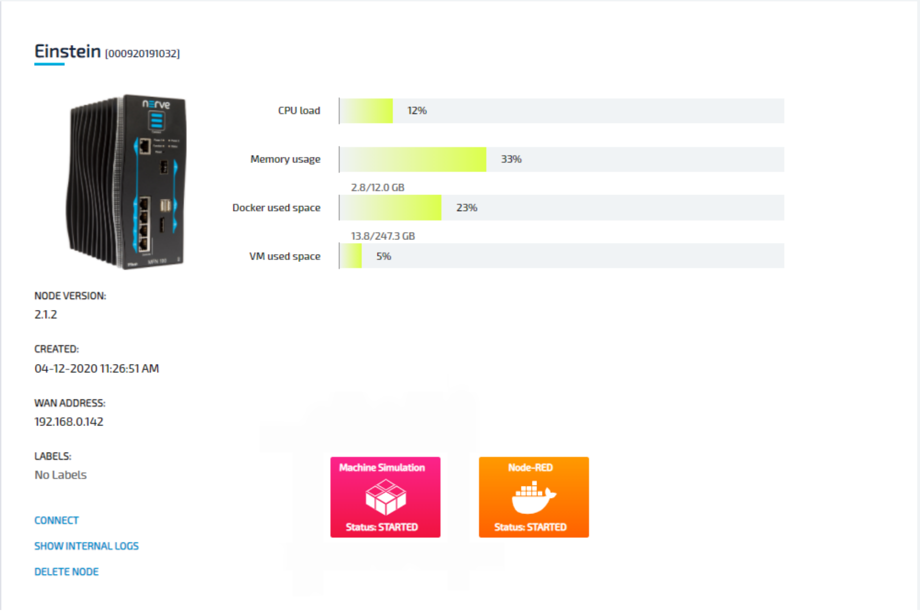
9. Select **Deploy** to execute the deployment.
   Optional: Enter a Deploy name above the Summary of the workload to make this deployment easy to identify. A timestamp is filled in automatically.

The deployment should now be visible at the top of the deployment log. Click the log entry of the deployment to see a more detailed view.

To confirm if the workloads have been deployed successfully, select **Nodes** in the navigation on the left. Select your node in the node tree and confirm if two workload tiles are showing underneath the bar graph. The workloads should show the status **STARTED**.

NOTE

It can take a number of seconds until the status of workloads switches from **IDLE** to **STARTED** after deployment.



Einstein [000920191032]

NODE VERSION:
2.1.2

CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

LABELS:
No Labels

Machine Simulation
Status: STARTED

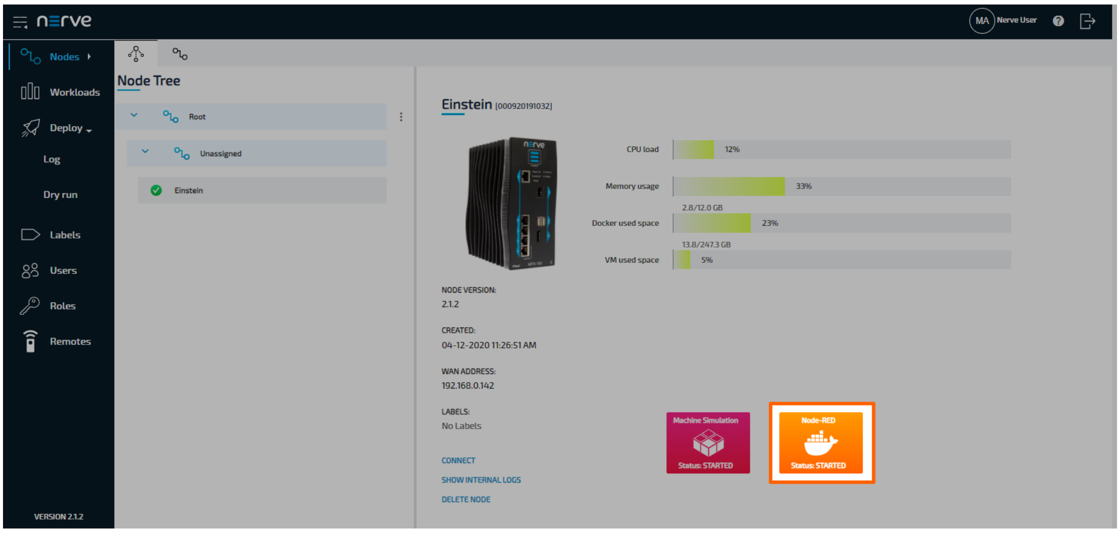
Node-RED
Status: STARTED

Connecting to Node-RED

After deployment, Node-RED is accessible at port 1880 on the Nerve Device through a web user interface. The pre-configured remote tunnel will use this port and port 1880 on the local computer to create a connection between the computer and the Nerve Device to access the interface of Node-RED. Before continuing, make sure the Nerve Connection Manager that was part of the delivery is installed, as it is required for using remote tunnels.

> **NOTE**
>
> Local admin rights might be required to successfully install the Nerve Connection Manager. In case a remote tunnel is not pre-configured, refer to Remote tunnels for more information on remote tunnels.

1. Select **Nodes** in the navigation on the left.
2. Select the node with the deployed Node-RED workload in the node tree.
3. Select the Node-RED Docker workload.



NODE VERSION:
2.1.2

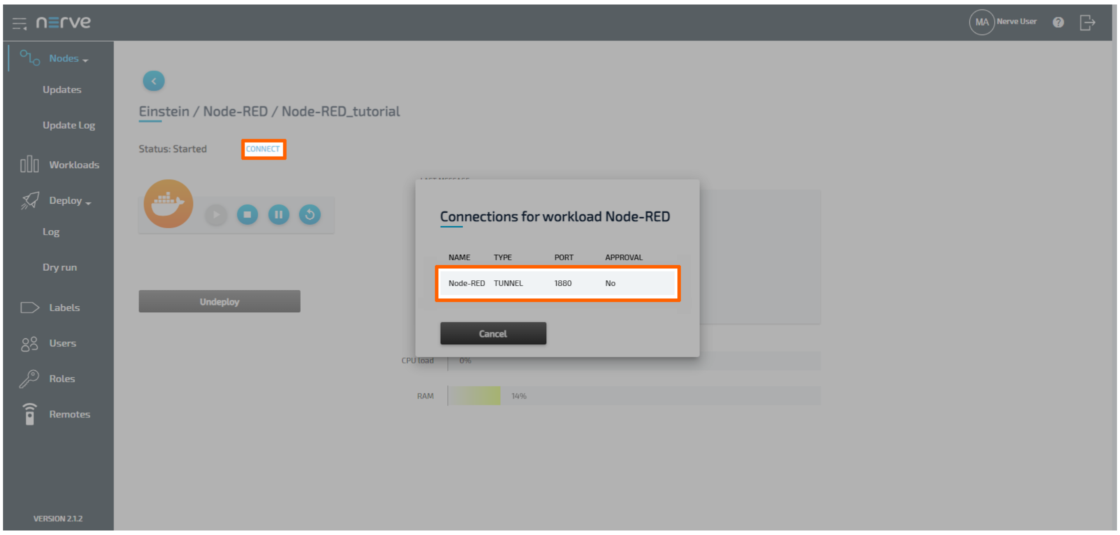
CREATED:
04-12-2020 11:26:51 AM

WAN ADDRESS:
192.168.0.142

LABELS:
No Labels

4. Select **CONNECT** next to the workload status. Available connections will appear in a window.

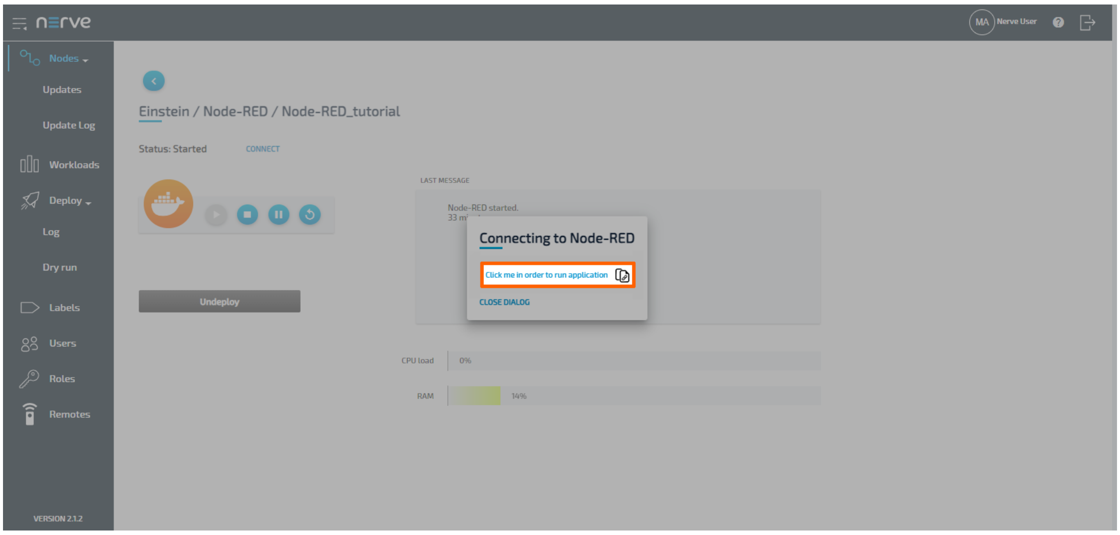
5. Select the **Node-RED** remote tunnel from the list.



Connections for workload Node-RED

NAME	TYPE	PORT	APPROVAL
Node-RED	TUNNEL	1880	No

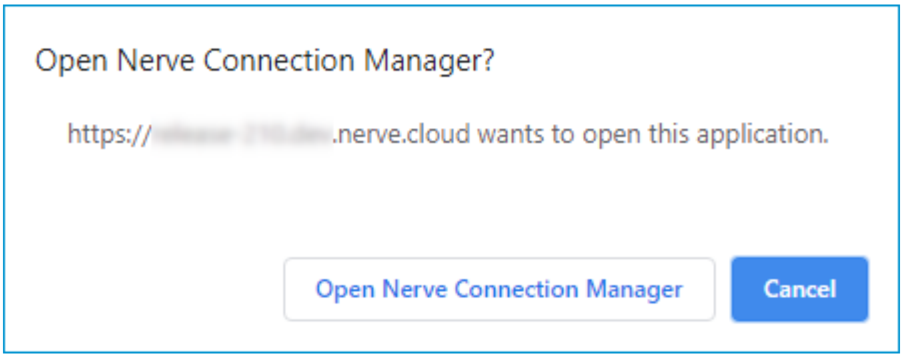
6. Select **Click me in order to run application** in the new window.



Node-RED started.
33 m

Connecting to Node-RED

7. If the Nerve Connection Manager installed correctly, confirm the browser message that the Nerve Connection Manager shall be opened.
Depending on the browser that is used, this message will differ. The Nerve Connection Manager will start automatically once the message is confirmed.



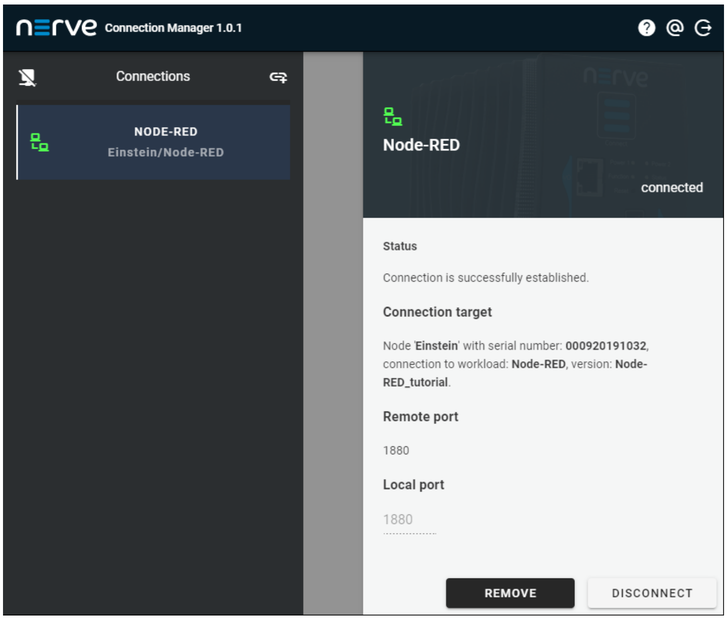
Open Nerve Connection Manager?

https://[redacted].nerve.cloud wants to open this application.

NOTE

If the Nerve Connection Manager does not start automatically, refer to Using a remote tunnel to a workload in the user guide.

The remote tunnel will be established once the Nerve Connection Manager starts and the remote connection will turn green in the Nerve Connection Manager. The remote tunnel is now ready to be used.



Status

Connection is successfully established.

Connection target

Node 'Einstein' with serial number: 000920191032, connection to workload: Node-RED, version: Node-RED_tutorial.

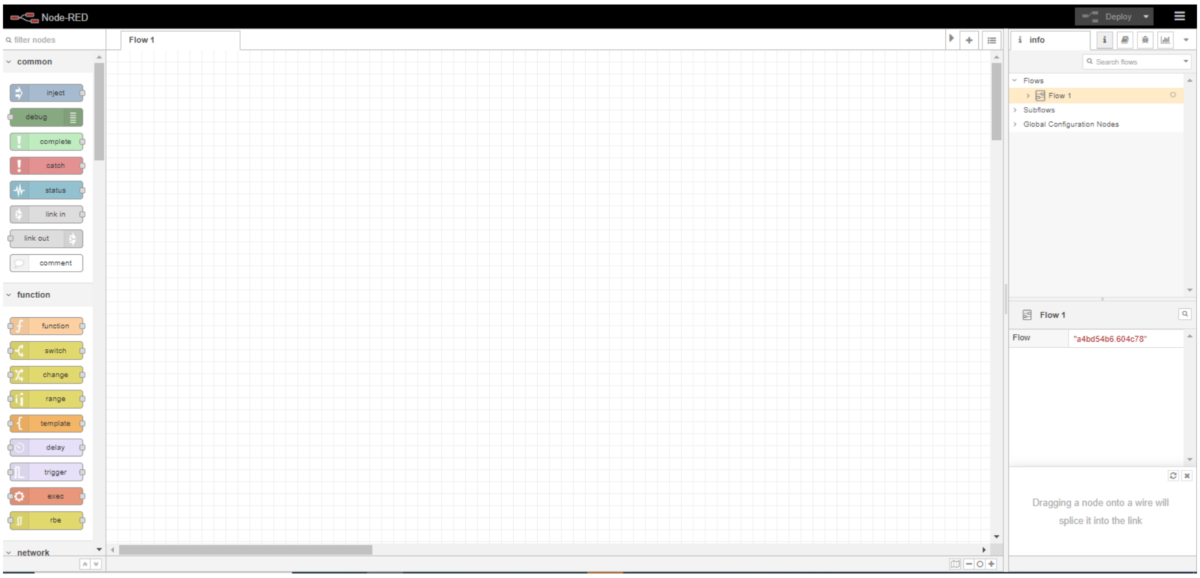
Remote port

1880

Local port

1880

Open a new browser tab and enter `localhost:1880` to open Node-RED.



Examples of using Node-RED with Nerve

The following is a list of documentation examples of how Node-RED is used with Nerve. New examples will be added in the near future.

Tutorial: Machine efficiency insight

Node-RED is part of the Nerve trial, which demonstrates how to gain insight on machine efficiency. There, Node-RED is used to analyze machine performance and display machine efficiency data in an OEE and quality dashboard. Refer to Machine efficiency insight for more information.

Security Recommendations

Security recommendations

In order for Nerve to operate in a secure manner, there is a set of measures that needs to be taken by implementers of Nerve. The information below is split into secure installation, operation and disposal, each focusing on the measures that need to be taken. The current state of the Nerve system in regards to the measure is also summarized.

Secure installation

The measures described here need to be taken into consideration in the planning phase of the environment.

Installation

Measure
Provide physical protection against physical access to the device to avoid an unauthorized user accessing sensible data on the disk.

Network connection

On the node the **wan** interface is used for the connection to the Management System. The communication towards the Management System uses HTTPS to ensure protection and is always initiated from the node, never from the Management System.

Measure
Place the node behind a firewall allowing access to port 443. If workloads provide access to additional ports, the workloads should be hardened to prevent unauthorized access and the firewall configuration should be adapted.

To ensure compatibility with fieldbus (Profinet, Modbus), communication towards the machine network is not encrypted.

Measure
Limit physical access to the network cables in order to protect the network within the machine. Whenever possible, select a secure connection to devices.

By default the networks in Nerve are isolated and no monitoring is implemented. Island mode can be achieved by resetting the network configuration on the node.

Measure

Ensure a process during network design to limit traffic crossing boundaries to the strict minimum.

Secure operation

The measures described here need to be taken into consideration when setting up the Nerve system for operation and during the operation of the system.

User management and permissions

In Nerve authentication is implemented in the Management System and on the node using email and password. The user accounts for the node and the Management System are not synchronized and must be managed separately.

The Management System can use its own user management system or can be connected to an LDAP server providing the necessary information for authentication and allowing the use of an already implemented password policy. In case of delegation, the LDAP groups can be mapped to the roles in the Management System. The nodes cannot be connected to an external user management system.

A minimum set of password requirements is used in the Management System. The lifetime of a password cannot be enforced in the Management System, as password lifetime restrictions are not considered best practice anymore. The Management System enforces the following password policy:

- At least one uppercase letter
- At least one lowercase letter
- At least one number
- Minimum length of seven characters

Stronger password requirements or lifetime restrictions can be done by delegating authentication to an LDAP or Active Directory server with the desired configuration. Also, support the use of long passwords by deploying appropriate password stores.

Measures

- Select local user management or LDAP server synchronization based on the available infrastructure, security policy and password policy.

- Periodically review all user accounts and remove the ones which are not needed anymore.

The Management System does not have a default password. When users are created they receive an email instructing them to create a new password on a dedicated page. Passwords are transmitted only over HTTPS and not stored in clear text.

The Nerve system implements user management, associated with a fine-grained Role Base Access Control system (RBAC). This is meant to prevent unauthorized operations by following the least privileged rule.

Measures

- Implement a process to define the roles as needed for operation (e.g. admin, operator, etc.) with the minimum possible number of access rights. The permissions for each role and the assignment of the roles to the different users should be reviewed periodically, at least once a year.
- Consider the necessity for user access to audit logs when defining roles and permissions.

Management System operations

The Management System needs certificates to encrypt communication with nodes over HTTPS. The node is based on Debian and only accepts the certificate authority root certificates provided by Debian. The certificates used by the Management System are provided by the user when deployed on premise or by LetsEncrypt when hosted by TTTech Industrial.

Measures

- Ensure a periodic (e.g. 90 days) and timely renewal of the certificates of the Management System if the Management System is hosted on premise.
- Develop and implement a backup mechanism for the Docker volumes of the Management System when operating the Management System on premise.

Node operations

Measure

Integrate the onboarding of a Nerve node into the machine commissioning procedure. Add a manual verification of the serial number to the procedure.

The node authenticates itself to the Management System using a serial number as the identifier and a secure ID as the password.

The number of remote sessions to the node can be limited. The limit of sessions is configurable per connection.

Measure

Implement a process to define and enforce a limited number of parallel sessions for each connection in the Management System.

The Nerve node can be configured to collect logs from Docker workloads.

Measure

Implement adequate logging when creating control workloads.

Secure disposal

The disk used by the Nerve node stores information in clear text, no encryption is used.

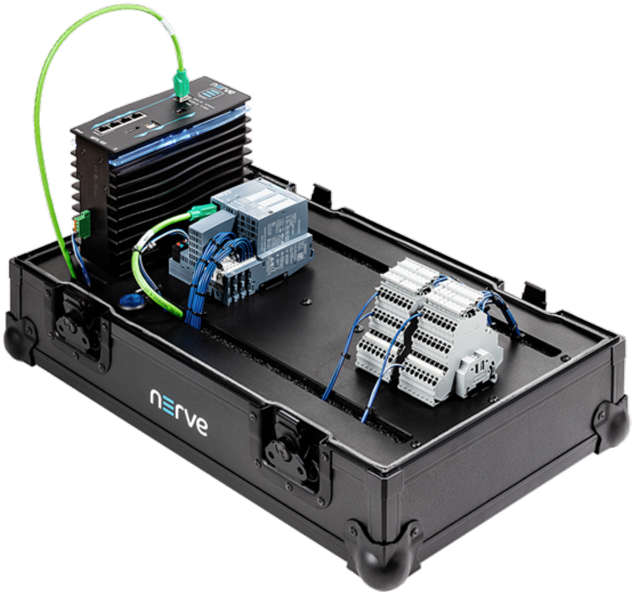
Measure

Remove the disk from the node before disposal and wipe it with adequate tools or ensure physical destruction.

Release Notes

Nerve Kit

Nerve Kit



The Nerve Kit is a ready-to-use hardware and software package, designed to support learning and training needs around digitalization. The kit provides everything needed to start collecting, storing and analyzing data, and can be expanded with custom sensors and IOs e.g. IO Link Master. Nerve provides a virtualized software environment, enabling the implementation and remote management of multiple containers or virtual machines for specific use case. In addition, the kit can be used to connect to real-time data sources and update real-time control applications remotely via the Management System.

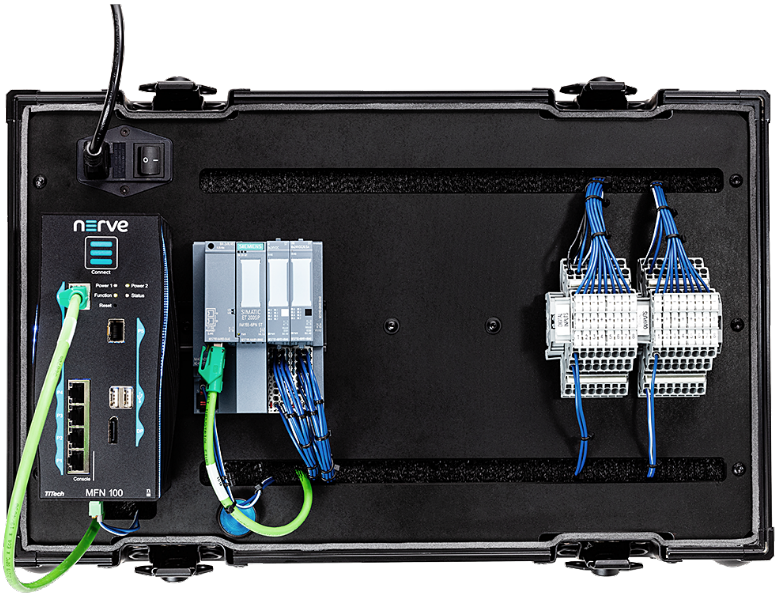
Key features

The Nerve Kit is fully integrated in a robust, portable case suitable for lab use and demonstrations. Start with default control applications, then develop and deploy custom applications and extend the kit's functionality by adding sensors and actuators.

Plug and play	Extendable
• Fully configured Data Services for ingesting PROFINET, MQTT and OPC UA data • Two pre-installed CODESYS control applications for demo purposes • Pre-configured Grafana dashboard for visualization of data (available locally and in the cloud) • Workloads (CODESYS programs) available for deployment from the Management System to the Nerve Device	• Extra digital I/Os available for adding sensors to extend functionality • Data Services can be configured for new data streams including EtherCAT and Modbus TCP/IP • Customizable Grafana dashboard for visualization of new sensor data • Newly created workloads (virtual machines / containers / CODESYS programs) can be deployed from the Management System to the Nerve Device

Nerve Kit contents

The contents of the kit are delivered in two separate boxes, a small box and a large box. The small box contains the MFN 100 including the Hardware Installation Guide and a mating connector. The large box has the remaining components of the kit: the mounting plate, the SIMATIC I/O module and the digital I/O terminal block.



A power cord and two network cables are also required to finish the setup.

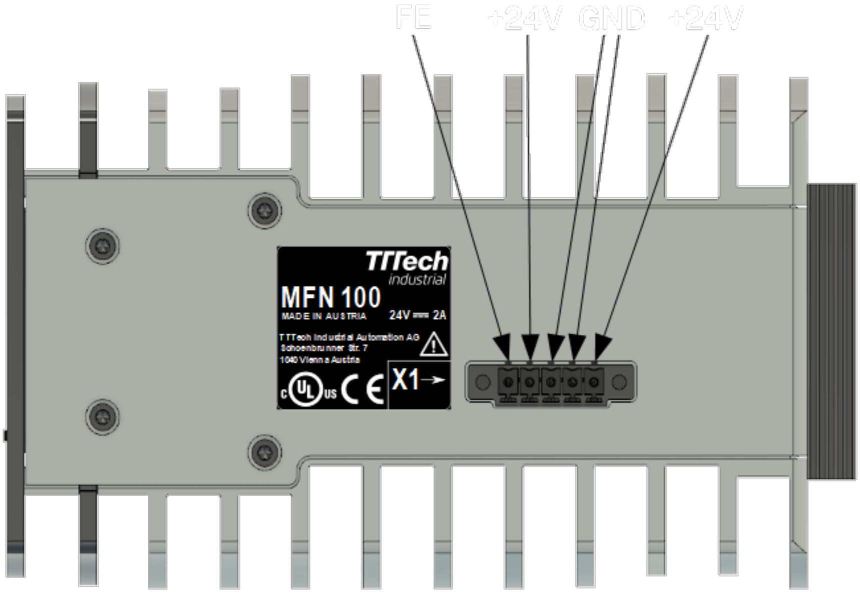
Content overview

Hardware	Software
• MFN 100-C64xx • SIMATIC ET200SP I/O system including: ◦ 1x SIMATIC ET 200SP bundle PROFINET IM, IM 155-6PN ST ◦ 1x SIMATIC ET 200SP 8x24V DC digital input ◦ 1x SIMATIC ET 200SP 8x24V DC digital output • Digital I/O terminal block • Illuminated push button • 24V DC Power supply • 1x Mating connector • 1x Network cable	• MFN 100-C64xx device description file • SIMATIC ET200SP I/O device description file • Two default CODESYS projects

The device descriptions and the default CODESYS applications can be downloaded from the Nerve Software Center. The login credentials for the Nerve Software Center can be found in the customer profile that has been sent as part of the delivery.

Power connectors overview

The power connectors are located at the bottom of the MFN 100 next to the label. There are two separate 24 V inputs, two GND inputs and one Functional Earth (FE) input. The inputs are fused internally. The fuse cannot be replaced by the user. The power supply inputs are protected against reverse polarity.



Pin	Description
1	Power supply line 2
2	GND

Pin	Description
3	GND
4	Power supply line 1
5	Functional Earth (FE)

NOTE

The GND and FE pins (pins 2, 3, and 5) are electrically connected to the housing.

Setup and default operation

This section covers the hardware setup, explains the default operation of the kit and gives an introduction to the Management System.

Setting up the hardware

The MFN 100 is delivered in a separate box and has to be mounted on the kit. A mating connector is already connected to the power supply. Also, the SIMATIC ET 200SP I/O module is already connected to the I/O port of the MFN 100 with a network cable. In order to completely set up the kit, a power cord and two network cables are also required.

1. Mount the MFN 100 on the DIN rail on the left side of the kit.

   NOTE

   For help with mounting the MFN 100 on the DIN rail, refer to the Hardware Installation guide enclosed in the box of the MFN 100.

2. Plug the mating connector that is connected to the power supply into the bottom side of the MFN 100.

3. Connect port 2 of the MFN to a DHCP-enabled network with access to the Management System or internet access if the Management System is hosted by TTTech Industrial.

   NOTE

   Contact the IT administrator for help on how to allow external devices to connect to the network.

4. Connect the power cord to the power supply and to a power outlet. Make sure the power supply is turned off.

5. Push the button to switch on the power supply.

The MFN 100 will start after a few minutes and the blue light will turn on. All necessary services are initiated and after that, data is sent to the Management System.

Default operation

The Nerve Kit comes with two default applications which can replicate scenarios found in industrial automation. The applications allow for data to be generated at the I/O, be acquired by the MFN 100 via Ethernet fieldbus, translated to OPC UA and be sent to the cloud for visualization. The data can be generated as a continuous flow throughout the cycle, as a regular data flow, or as irregular event based data flow. These different data flows mimic various types of industrial process and show the functionality of the Data Services from I/O to cloud.

The applications use the push button that is connected to the SIMATIC ET200 SP I/O module via the terminal block. Data is sent between the SIMATIC I/O module and the MFN 100 I/O port via PROFINET and the illumination of the button is controlled via the CODESYS soft PLC running on the MFN 100.

The two default CODESYS applications: **app1** and **app2** are used to alter flow of data from the I/O modules. Both apps control the illumination of the button and record two values: `iCountNumber` and `iCountButton`.

	app1	app2
iCountNumber (continuous data flow from the application to the Management System)	• Continuous count upwards from 0 to 1000. • Resets to 0 automatically when it has reached 1000.	• Continuous count downwards from 1000 to 0. • Resets to 1000 automatically when it has reached 0.
iCountButton (irregular and regular data flow from the application to the Management System)	• Counts the number of times that the button has been pressed (irregular data flow). • The push button lights up after 10 button presses. • The value resets to 0 when the button is held for two seconds. The light of the button goes out.	• Counts the duration that the button is held (regular data flow). • The counter continuously increases from 0. The push button lights up when the value reaches 25. • The value continuously decreases to 0 when the button is released.

In both application modes the calculated values are sent to the Management System and displayed in Grafana for visualization. The Management System allows users to deploy either of the default applications from the repository to the MFN 100. This demonstrates the ability to update CODESYS applications remotely and alter applications running on machines wherever they are in the world.

Beyond the two default applications, the kit can be used to develop custom CODESYS applications, which can be uploaded to the repository in the Management System and then deployed to the MFN 100. These applications can then be used in conjunction with corresponding actuators and/or sensors.

NOTE

The default application **app1** is loaded automatically during the initial startup of the MFN 100.

Connecting to the Management System

The Nerve Management System is a web-based service that permits management of Nerve nodes that are registered.

NOTE

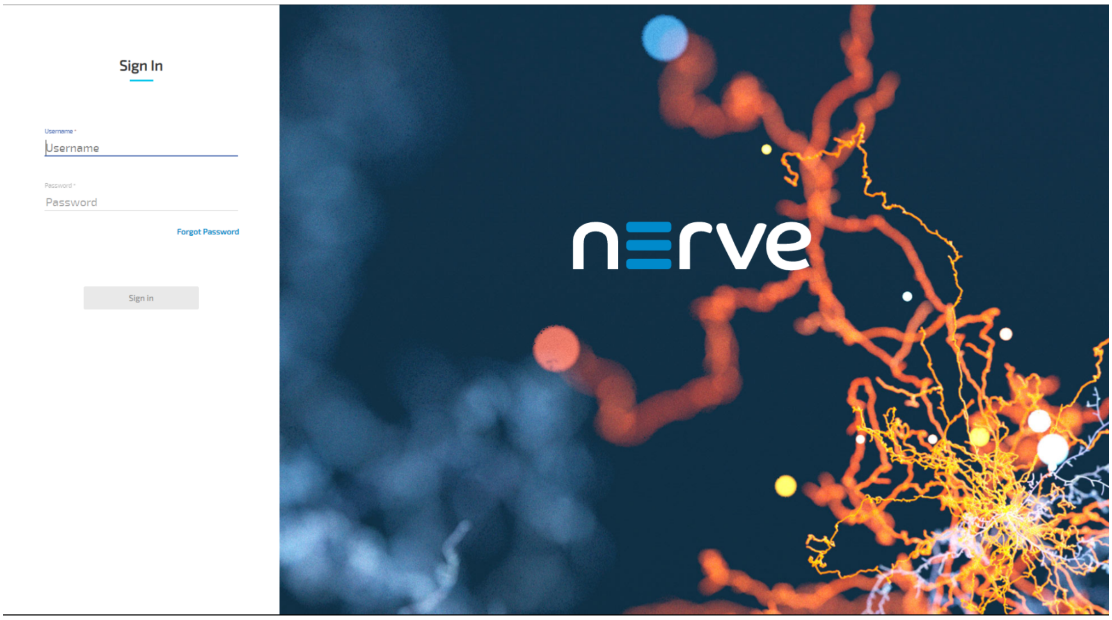
Google Chrome or Firefox Version 63 or later are recommended for the usage of the Management System.

Before connecting, make sure that the MFN 100 of the starter kit is connected to the network through port 2 and that an IP address has been assigned by the DHCP server. Contact the IT administrator for help with assigning an IP address.
The login credentials for the Management System are in the customer profile. The customer profile has been sent in form of a PDF as part of the delivery.

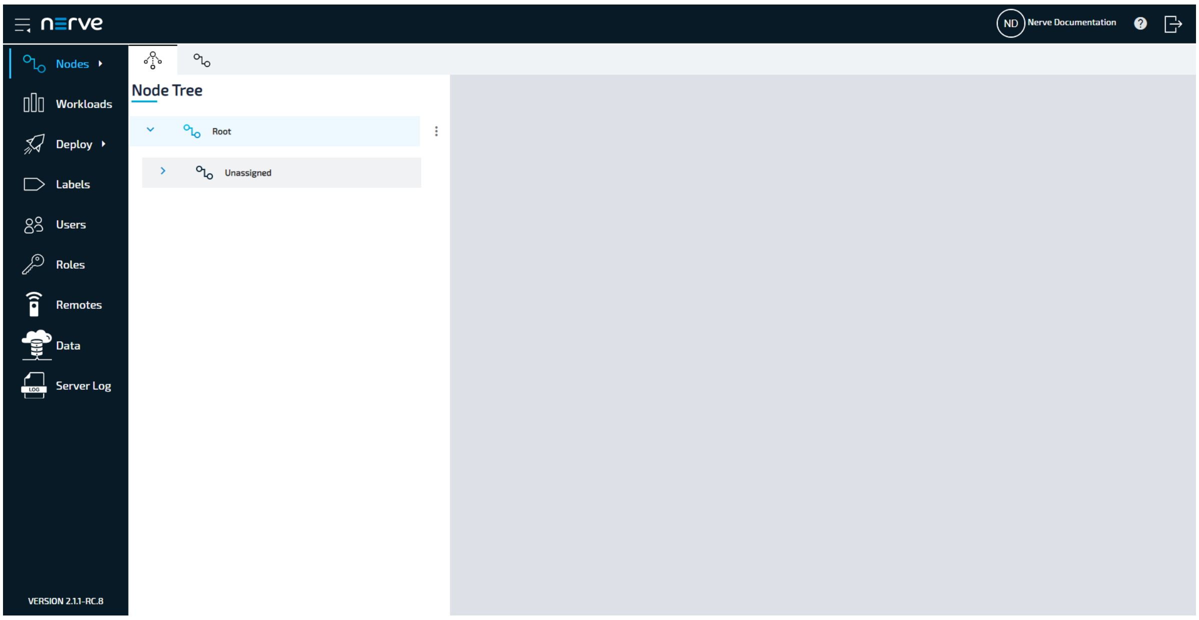
NOTE

If a customer profile has not been part of the delivery, contact a sales representative or TTTech Industrial customer support at support@tttech-industrial.com.

1. Go to the URL of the Management System in the customer profile.
2. Log in with the credentials provided in the customer profile.



The Management System will show the node tree by default.



One element in the node tree is already created at first login, containing the MFN 100 of the Nerve Kit. All newly registered nodes will be located under **Root > Unassigned** by default.

Manage nodes, provision workloads and deploy workloads among other options from here. Refer to the user guide for more information on the Management System.

> **NOTE**
>
> Port 443 (HTTPS) and port 8883 (MQTTS) of the corporate firewall have to be open for communication between nodes and the Management System.

Moving a node from one tree element to another

Moving nodes in the node tree is possible by drag and drop. Make sure to create a new tree element before attempting to move a node.

1. Select **Nodes** in the navigation on the left.
2. Select the node tree tab

   on the right.
3. Expand the tree element of the node that will be moved. The default element is **Root > Unassigned**.
4. Choose the node to move.
5. Drag and drop the node to the newly created element. Elements expand automatically when they are hovered over.
6. Select **APPLY CHANGES (n)** in the upper-right corner of the node tree.

NOTE

(n) is a placeholder for the number of changes made to the node tree. For three performed changes, (3) will be displayed in the button above the node tree.

The node has now been moved to the new element. Note that a node cannot be moved back to **Unassigned** once it has been moved to another element.

Viewing data in the Management System

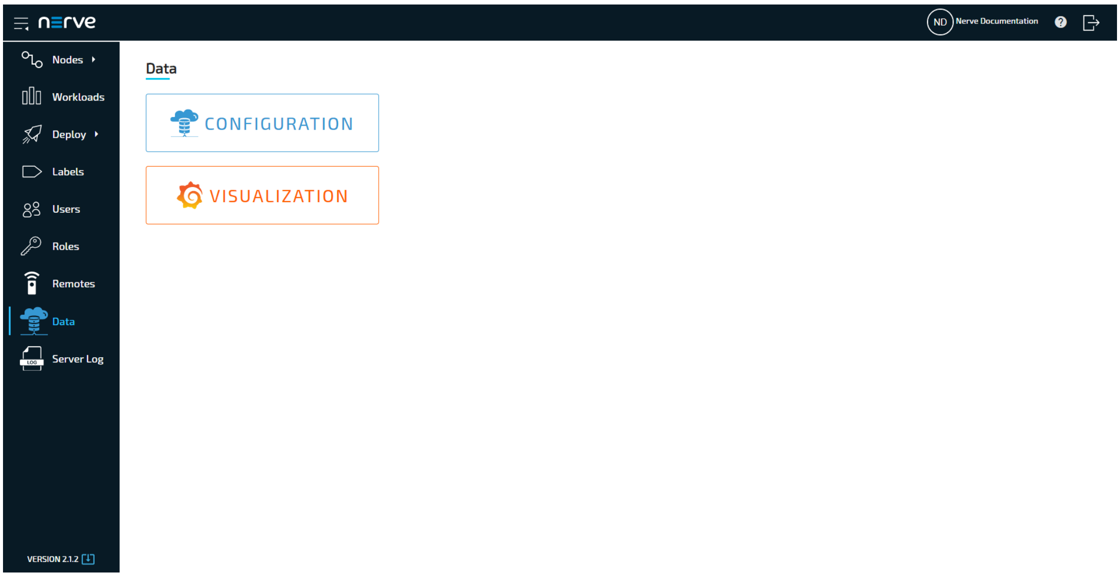
Data that is being sent to the Management System can be viewed through the Grafana element in the Data Services instance of the Management System. The default values `iCountNumber` and `iCountButton` are set up by default. The URL of the Management System and the login credentials can be found in the customer profile. It has been sent in form of a PDF as part of the delivery.

1. Log in to the Management System.
2. Select **Data** in the navigation on the left.

NOTE

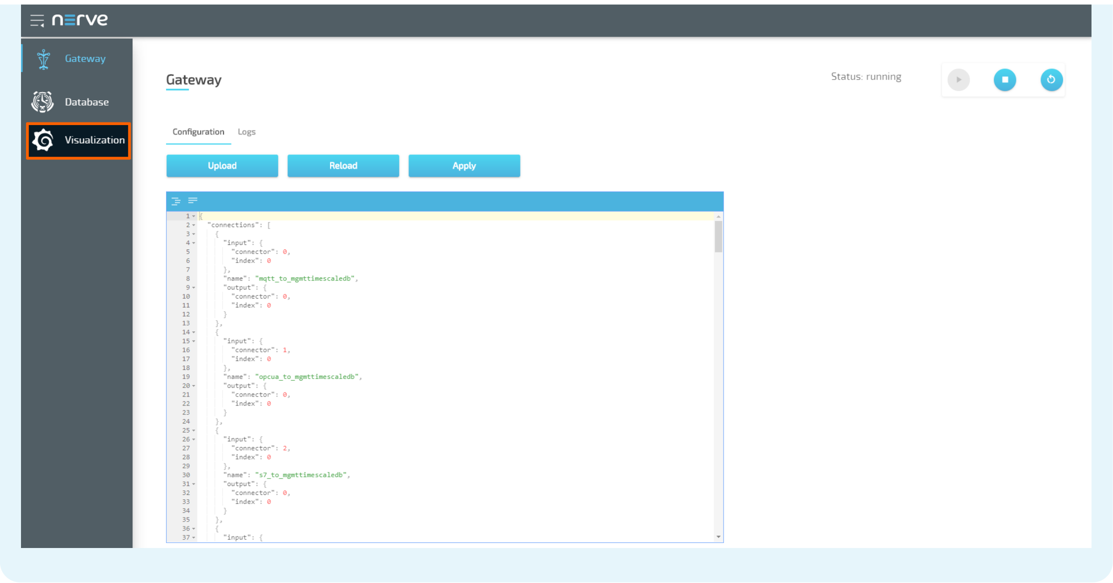
If the menu item **Data** is not available, make sure the logged in user has the permission to access the Data Services. Refer to Assigning a role to a user for more information.

3. Select **Data**.



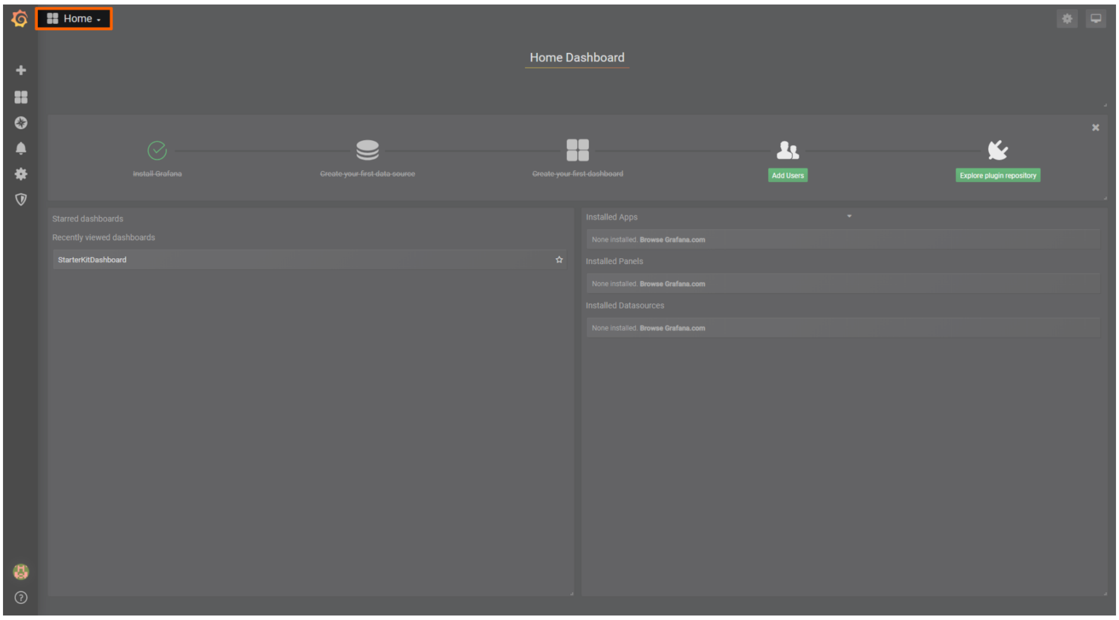
NOTE

The visualization element can also be reached from the Data Services UI. When in the Data Services UI, select **Data** in the navigation on the left and select **Open** to reach the Grafana UI.

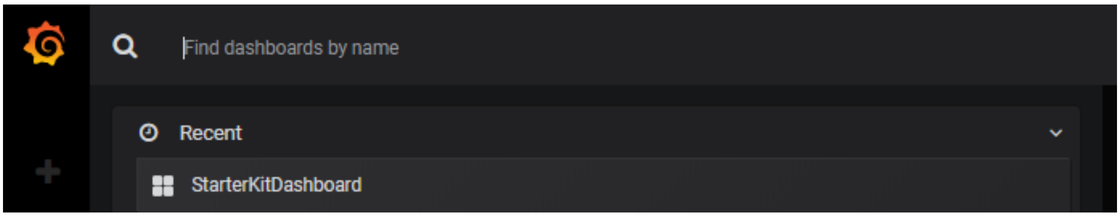


```
{
  "connections": [
    {
      "input": {
        "connector": 0,
        "index": 0
      },
      "name": "mqtt_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 1,
        "index": 0
      },
      "name": "opcua_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 2,
        "index": 0
      },
      "name": "s7_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
```

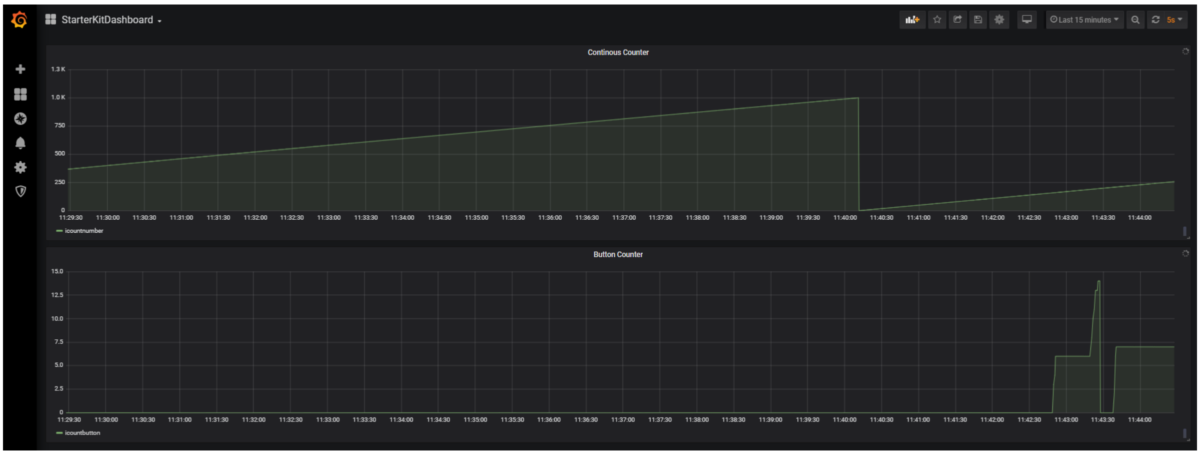
4. Select **Home** in the upper-left corner.


Home
Home Dashboard
~~Install Grafana~~
~~Create your first data source~~
~~Create your first dashboard~~
Add Users
Explore plugin repository
Starred dashboards
Recently viewed dashboards
StarterKitDashboard
Installed Apps
None installed. Browse Grafana.com
Installed Panels
None installed. Browse Grafana.com
Installed Datasources
None installed. Browse Grafana.com

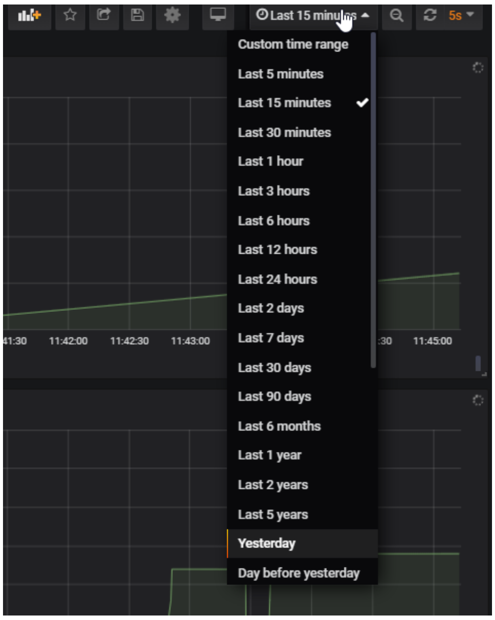
5. Select **Nerve Kit** underneath the search bar.



This is the visualization of live data from the MFN 100. The calculated values, `iCountNumber` and `iCountButton`, that are generated in the default CODESYS applications **app1** and **app2** are displayed here by default.



The data automatically updates every 5 seconds. To change the update rate and the visible time range, access the settings by clicking the clock symbol in the upper-right.



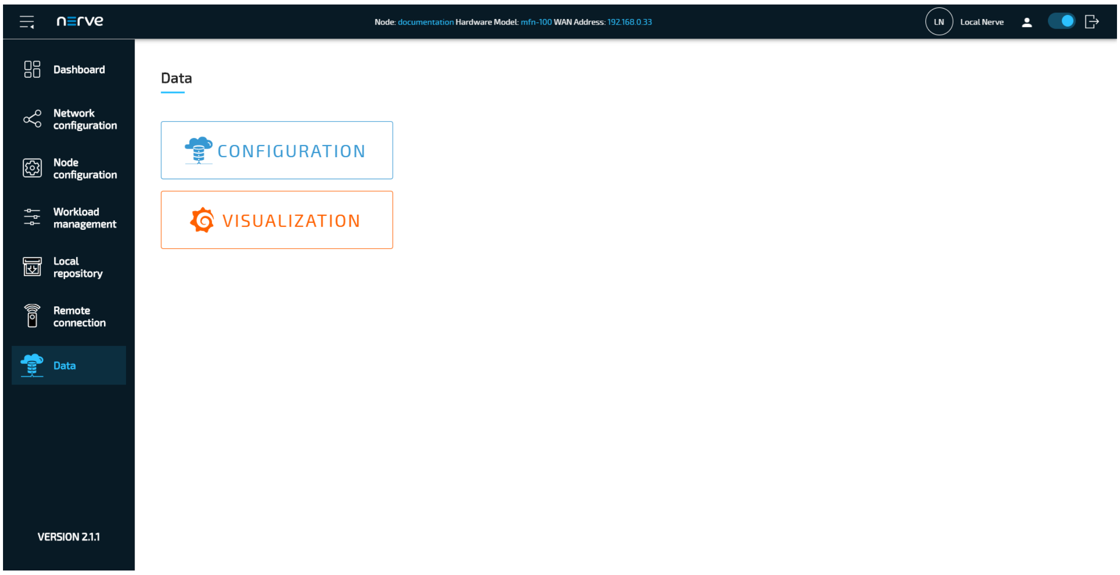
Viewing data on the Nerve Device

Data can also be viewed locally on the Nerve Device. The default values `iCountNumber` and `iCountButton` are set up by default.

1. Connect the workstation to the console port **P1** of the MFN 100.
2. Configure the network adapter through which the workstation is connected to the MFN 100 the following way:

IP address	`172.20.2.90`
Subnet mask	`255.255.255.0`

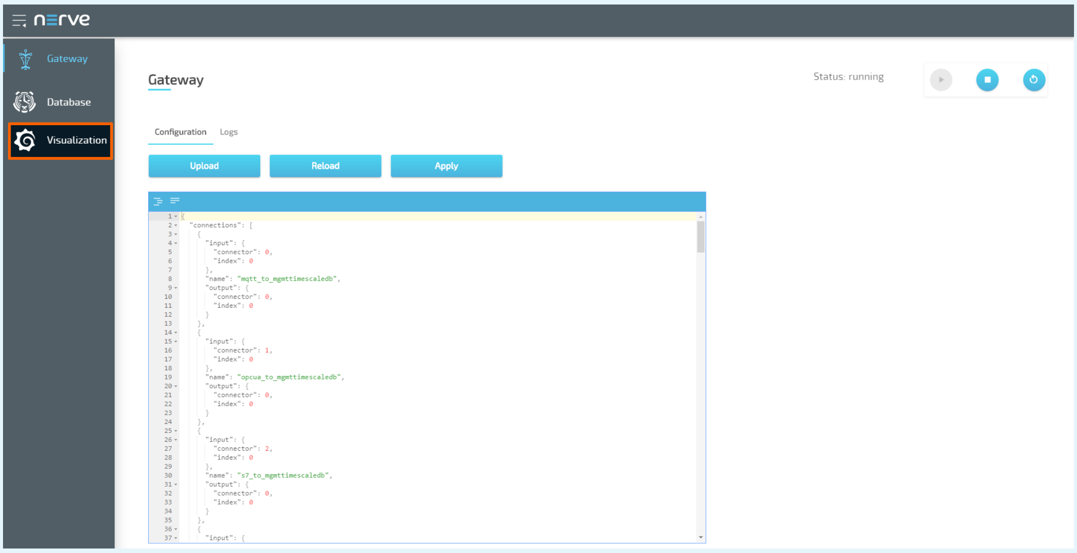
3. Follow this link to reach the Local UI: http://172.20.2.1:3333.
4. Log in with the credentials from the customer profile.
5. Select **Data** in the navigation on the left.
6. Select **Data**.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

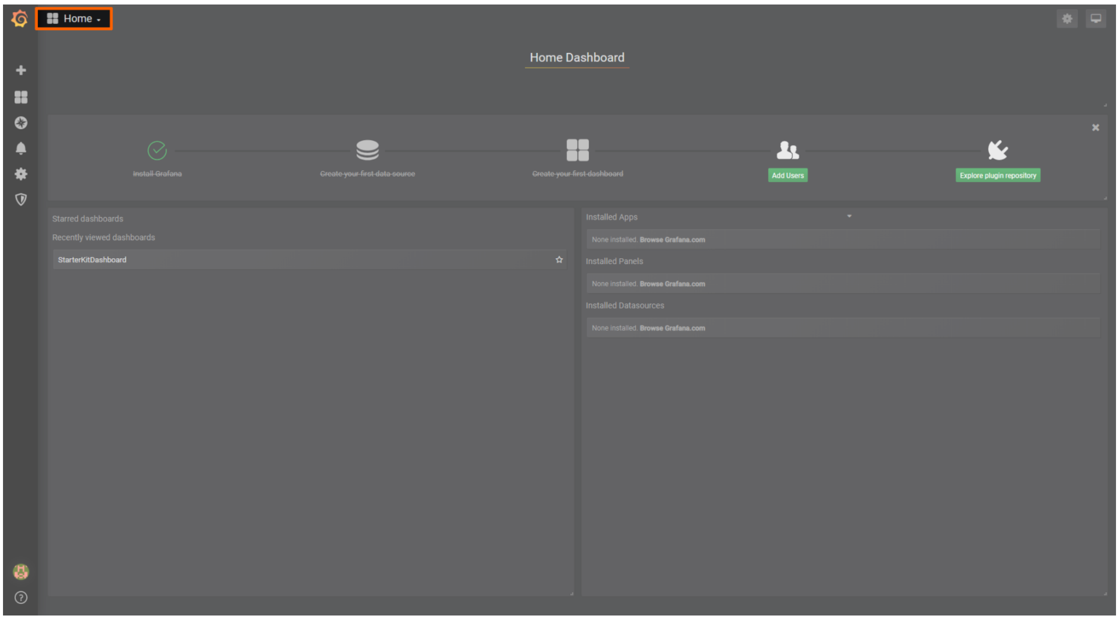
NOTE

The visualization element can also be reached from the Data Services UI. When in the Data Services UI, select **Data** in the navigation on the left and select **Open** to reach the Grafana UI.

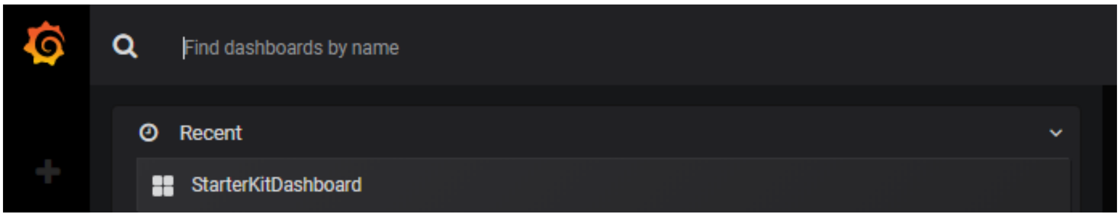


```
{
  "connections": [
    {
      "input": {
        "connector": 0,
        "index": 0
      },
      "name": "mqtt_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 1,
        "index": 0
      },
      "name": "opcua_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 2,
        "index": 0
      },
      "name": "s7_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
```

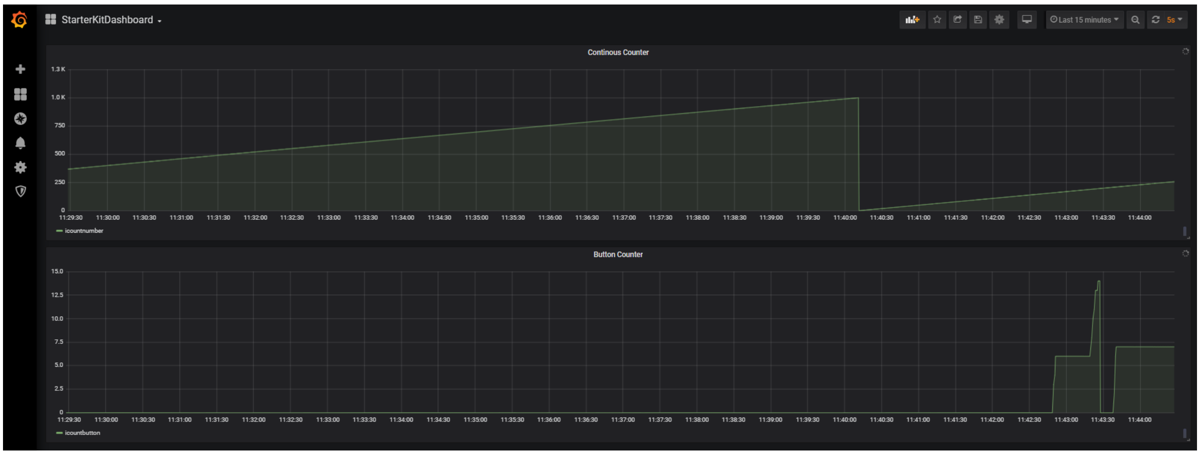
7. Select **Home** in the upper-left corner.


Home
Home Dashboard
~~Install Grafana~~
~~Create your first data source~~
~~Create your first dashboard~~
Add Users
Explore plugin repository
Starred dashboards
Recently viewed dashboards
StarterKitDashboard
Installed Apps
None installed. Browse Grafana.com
Installed Panels
None installed. Browse Grafana.com
Installed Datasources
None installed. Browse Grafana.com

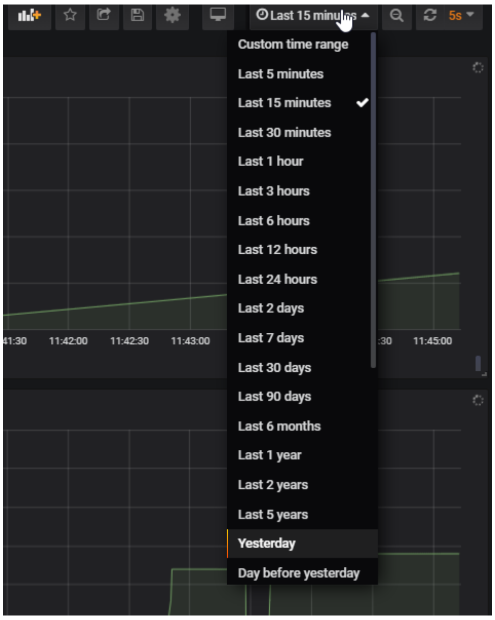
8. Select **Nerve Kit** underneath the search bar.



This is the visualization of live data from the MFN 100. The calculated values, `iCountNumber` and `iCountButton`, that are generated in the default CODESYS applications **app1** and **app2** are displayed here by default.



The data automatically updates every 5 seconds. To change the update rate and the visible time range, access the settings by clicking the clock symbol in the upper-right.



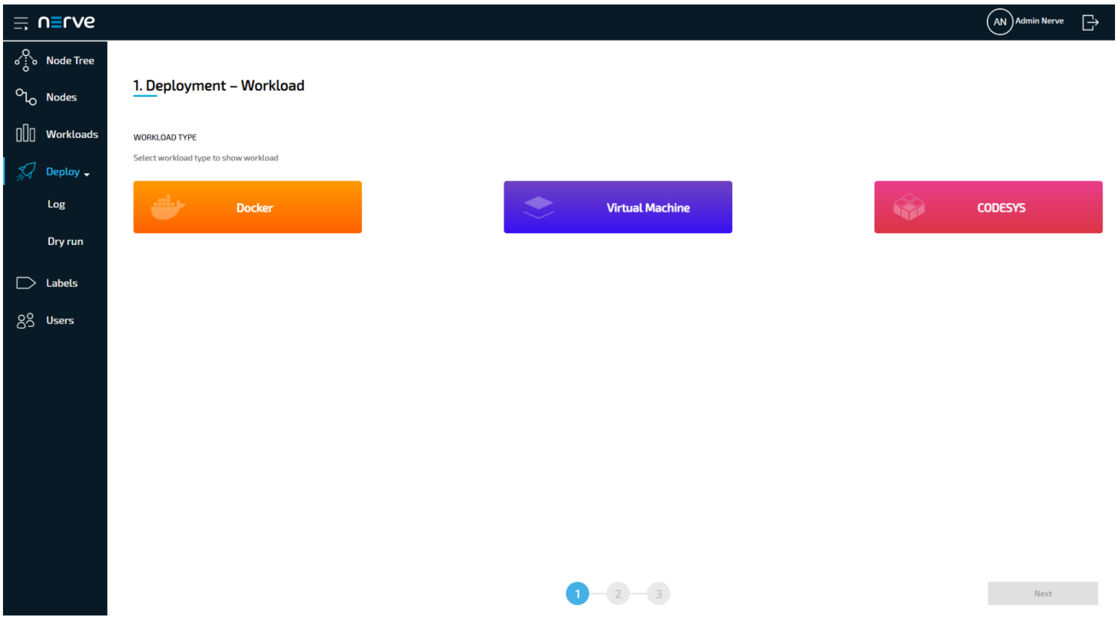
Downloading & uploading CODESYS applications from the Management System

With the kit CODESYS applications can be deployed from the Management System to the MFN 100. The two default CODESYS applications are already available in the Management System. Own applications can also be uploaded to the repository in the Management System and made ready for deployment.

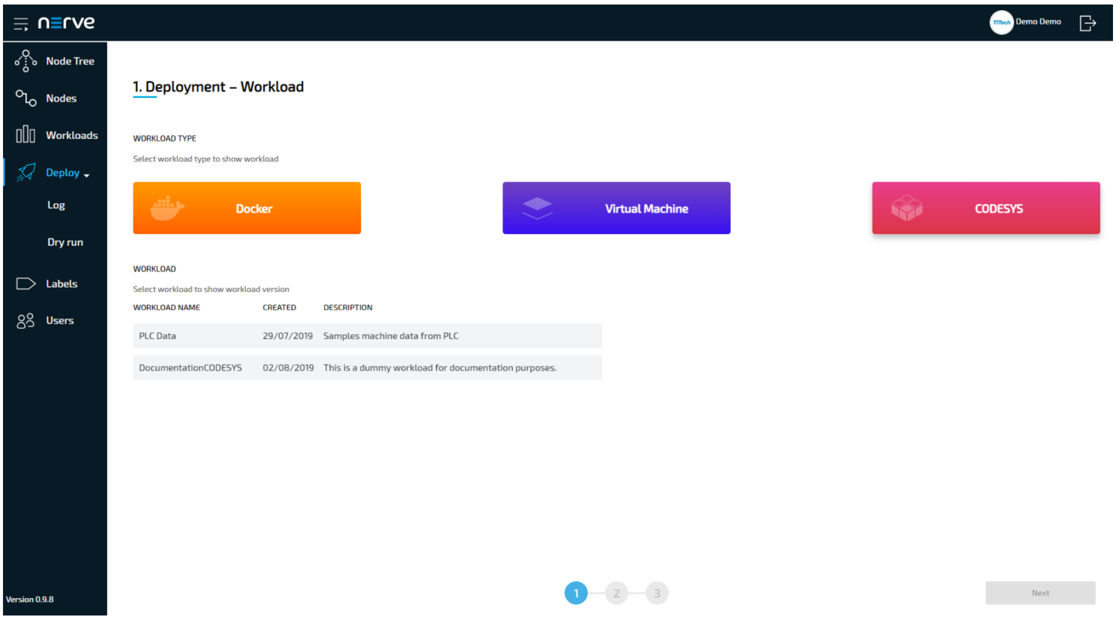
Deploying a CODESYS workload

One CODESYS workload is available with first login that can be used with the kit immediately. The workload is named **Nerve Kit** and it has two versions: **Nerve Starter Kit App1** and **Nerve Starter Kit App2**. For more information on the deployment process for all workload types refer to the user guide.

1. Select **Deploy** in the left-hand menu.

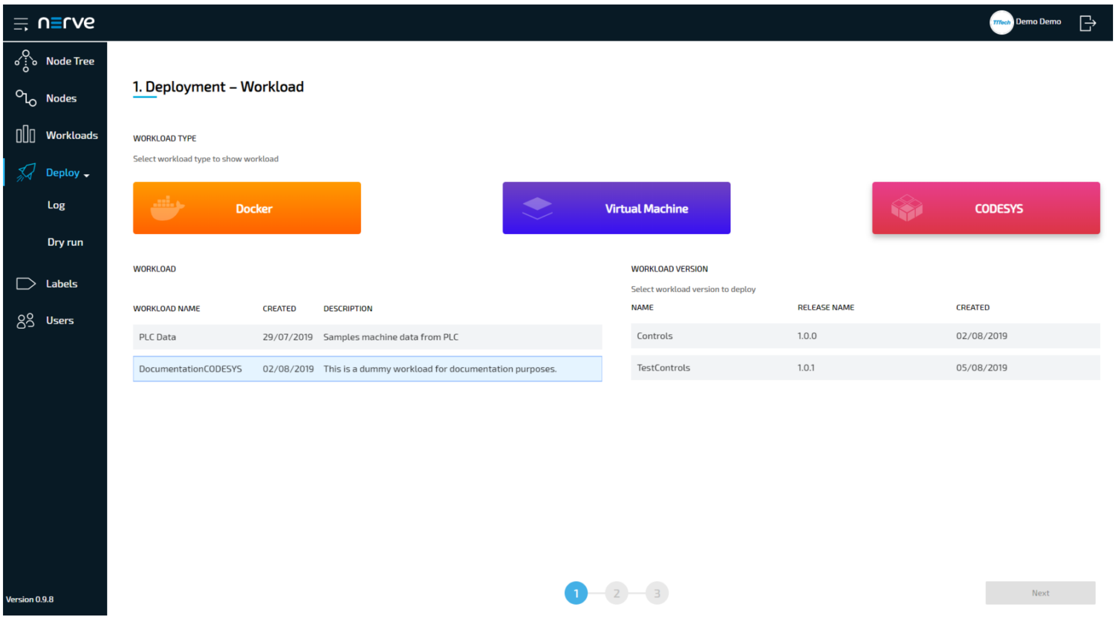


2. Select the CODESYS workload icon on the right. A list of CODESYS workloads will appear below.



WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

3. Select a workload from the list. A list of versions of this workload will appear to the right.



1. Deployment – Workload

WORKLOAD TYPE

Select workload type to show workload

WORKLOAD

WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

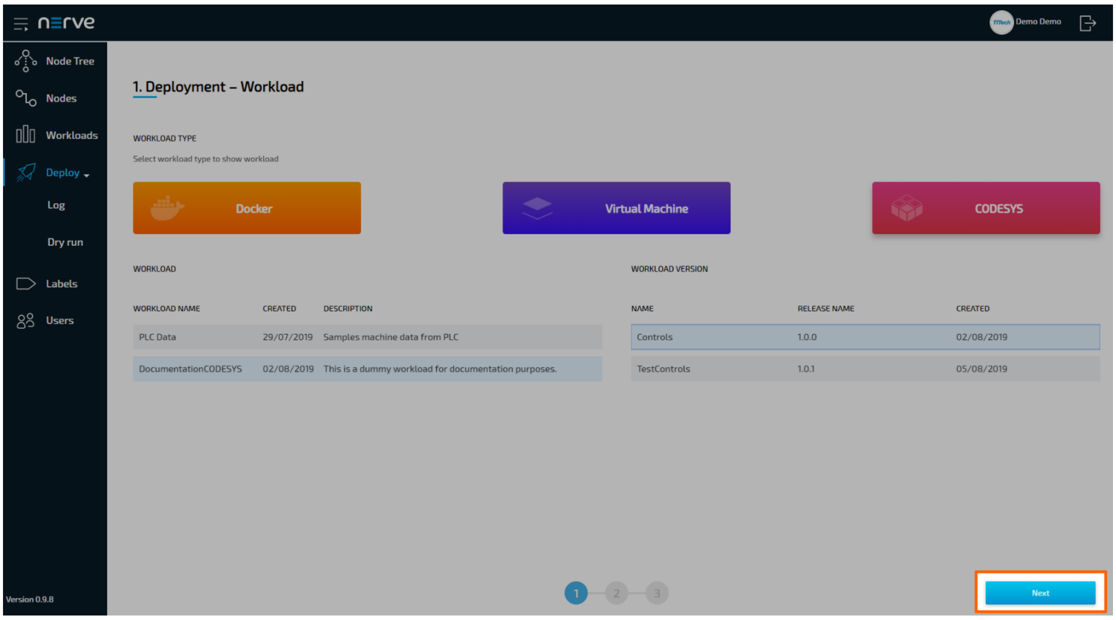
WORKLOAD VERSION

Select workload version to deploy

NAME	RELEASE NAME	CREATED
Controls	1.0.0	02/08/2019
TestControls	1.0.1	05/08/2019

4. Select the version of the workload.

5. Click **Next** in the bottom-right corner.



1. Deployment – Workload

WORKLOAD TYPE

Select workload type to show workload

WORKLOAD

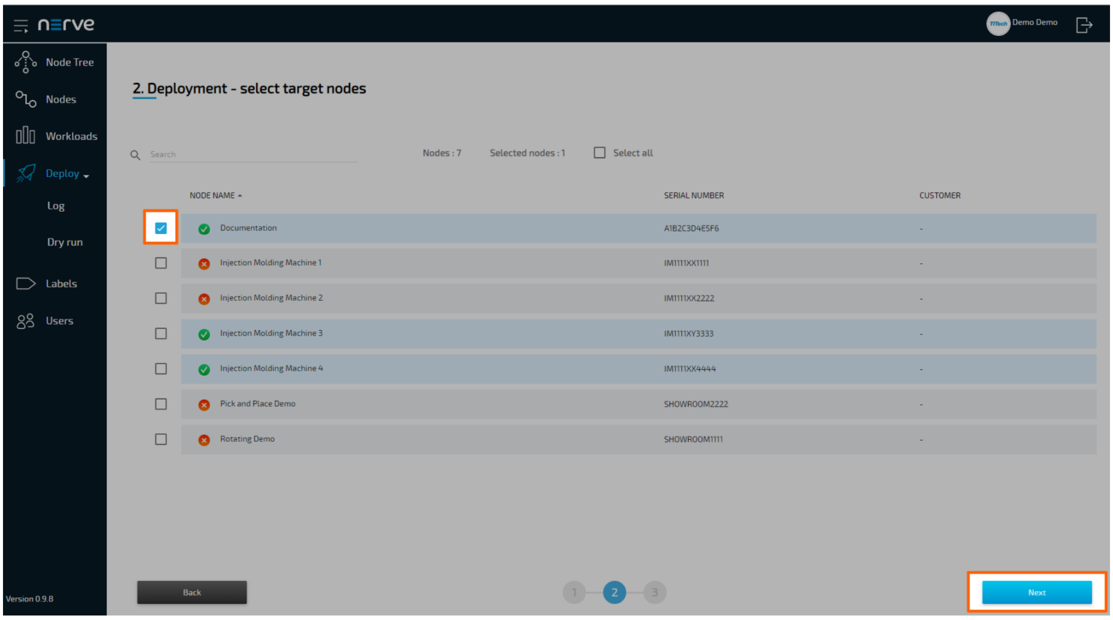
WORKLOAD NAME	CREATED	DESCRIPTION
PLC Data	29/07/2019	Samples machine data from PLC
DocumentationCODESYS	02/08/2019	This is a dummy workload for documentation purposes.

WORKLOAD VERSION

NAME	RELEASE NAME	CREATED
Controls	1.0.0	02/08/2019
TestControls	1.0.1	05/08/2019

6. In the next window, select one or more nodes from the list for deployment by ticking the checkboxes on the left.

7. Select **Next** in the lower-right corner.

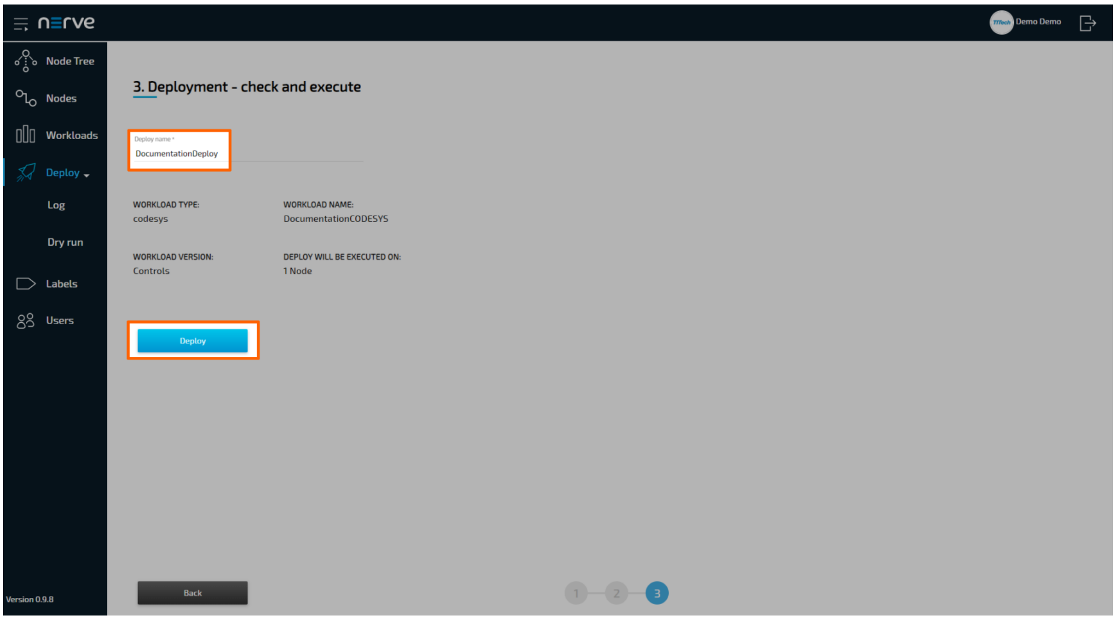


2. Deployment - select target nodes

Search   Nodes : 7   Selected nodes : 1   ☐ Select all

	NODE NAME	SERIAL NUMBER	CUSTOMER
☑	✓ Documentation	A1B2C3D4E5F6	-
☐	☒ Injection Molding Machine 1	IM1111XX1111	-
☐	☒ Injection Molding Machine 2	IM1111XX2222	-
☐	✓ Injection Molding Machine 3	IM1111XY3333	-
☐	✓ Injection Molding Machine 4	IM1111XX4444	-
☐	☒ Pick and Place Demo	SHOWROOM2222	-
☐	☒ Rotating Demo	SHOWROOM1111	-

8. Select **Deploy** to execute the deployment.
   Optional: Enter a **Deploy name** *above the* **Summary** *of the workload to make this deployment easy to identify. A timestamp is filled in automatically.*



3. Deployment - check and execute

Deploy name *
DocumentationDeploy

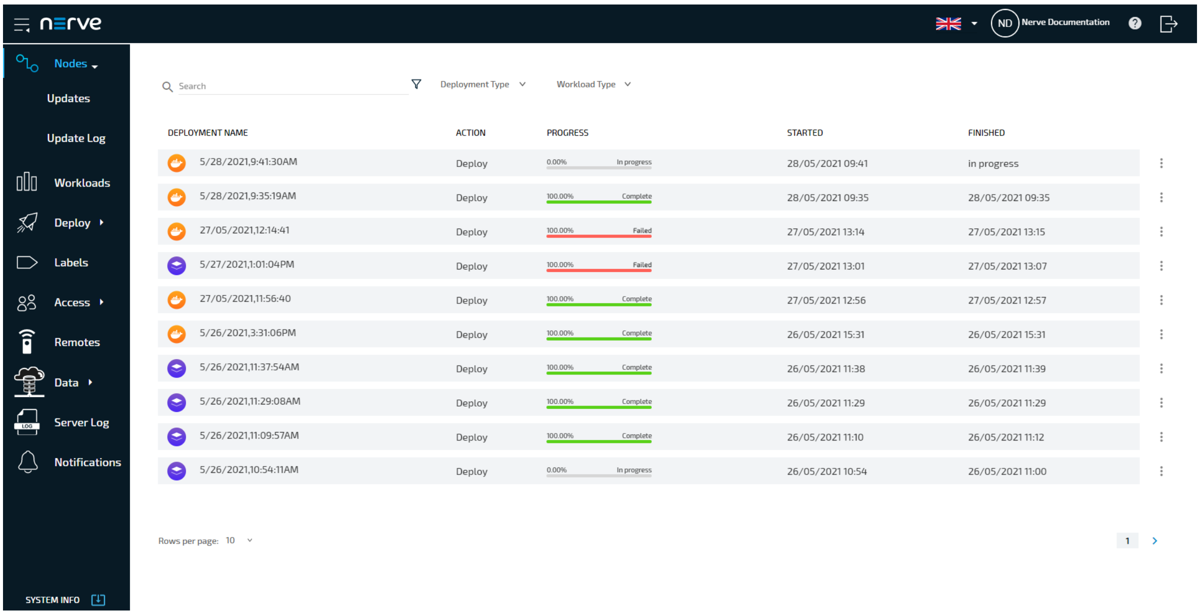
WORKLOAD TYPE:
codesys

WORKLOAD NAME:
DocumentationCODESYS

WORKLOAD VERSION:
Controls

DEPLOY WILL BE EXECUTED ON:
1 Node

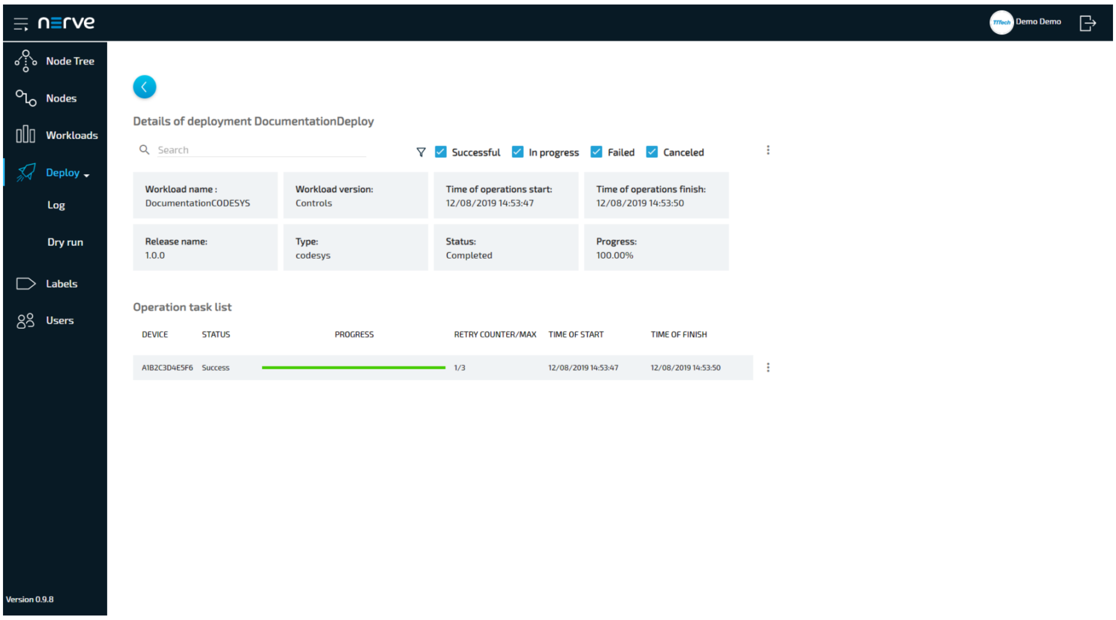
The Management System will deploy the log next. The current deployment is at the top of the list. The **Deploy name** chosen before is the name that identifies the deployment in the log.



DEPLOYMENT NAME	ACTION	PROGRESS	STARTED	FINISHED
5/28/2021,9:41:30AM	Deploy	0.00% In progress	28/05/2021 09:41	in progress
5/28/2021,9:35:19AM	Deploy	100.00% Complete	28/05/2021 09:35	28/05/2021 09:35
27/05/2021,12:14:41	Deploy	100.00% Failed	27/05/2021 13:14	27/05/2021 13:15
5/27/2021,1:01:04PM	Deploy	100.00% Failed	27/05/2021 13:01	27/05/2021 13:07
27/05/2021,11:56:40	Deploy	100.00% Complete	27/05/2021 12:56	27/05/2021 12:57
5/26/2021,3:31:06PM	Deploy	100.00% Complete	26/05/2021 15:31	26/05/2021 15:31
5/26/2021,11:37:54AM	Deploy	100.00% Complete	26/05/2021 11:38	26/05/2021 11:39
5/26/2021,11:29:08AM	Deploy	100.00% Complete	26/05/2021 11:29	26/05/2021 11:29
5/26/2021,11:09:57AM	Deploy	100.00% Complete	26/05/2021 11:10	26/05/2021 11:12
5/26/2021,10:54:11AM	Deploy	0.00% In progress	26/05/2021 10:54	26/05/2021 11:00

Rows per page: 10

Check the progress of the current deployment and click the workload to see a more detailed view.



Details of deployment DocumentationDeploy

☑ Successful ☑ In progress ☑ Failed ☑ Canceled

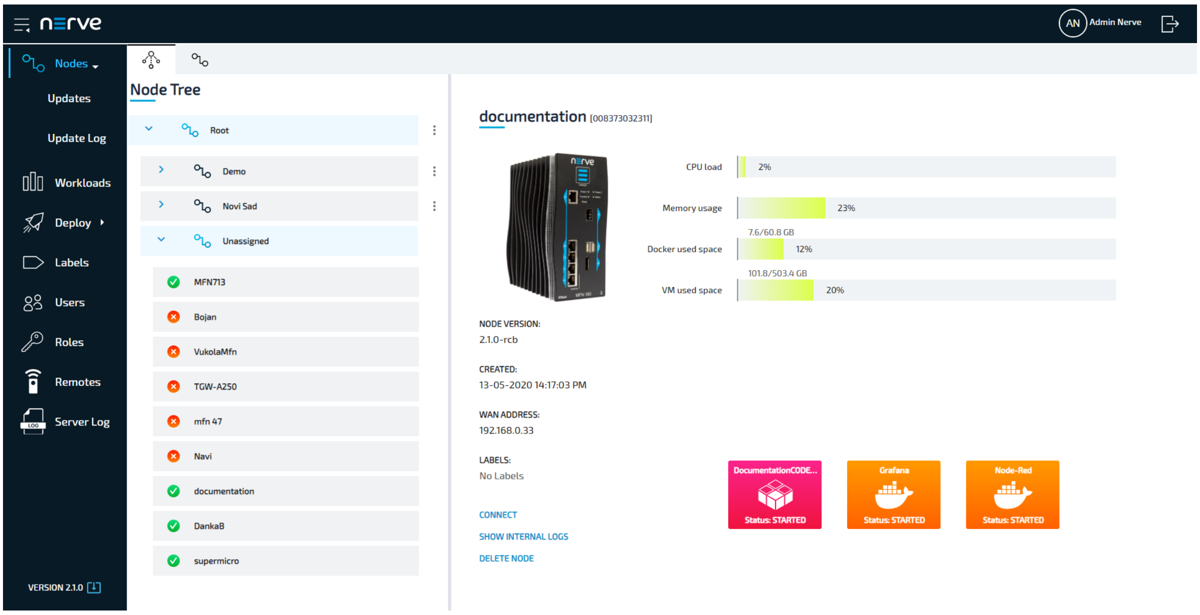
Workload name : DocumentationCODESYS	Workload version: Controls	Time of operations start: 12/08/2019 14:53:47	Time of operations finish: 12/08/2019 14:53:50
Release name: 1.0.0	Type: codesys	Status: Completed	Progress: 100.00%

Operation task list

DEVICE	STATUS	PROGRESS	RETRY COUNTER/MAX	TIME OF START	TIME OF FINISH
A1B2C3D4E5F6	Success		1/3	12/08/2019 14:53:47	12/08/2019 14:53:50

Confirm the deployment by viewing the workload in the node details view in the node tree. Select **Nodes** in the navigation on the left and select the node tree tab

on the right. Select the node that has workloads deployed.



documentation [008373032311]

CPU load 2%
Memory usage 23% 7.6/60.8 GB
Docker used space 12% 101.8/503.4 GB
VM used space 20%

NODE VERSION:
2.1.0-rcb

CREATED:
13-05-2020 14:17:03 PM

WAN ADDRESS:
192.168.0.33

LABELS:
No Labels

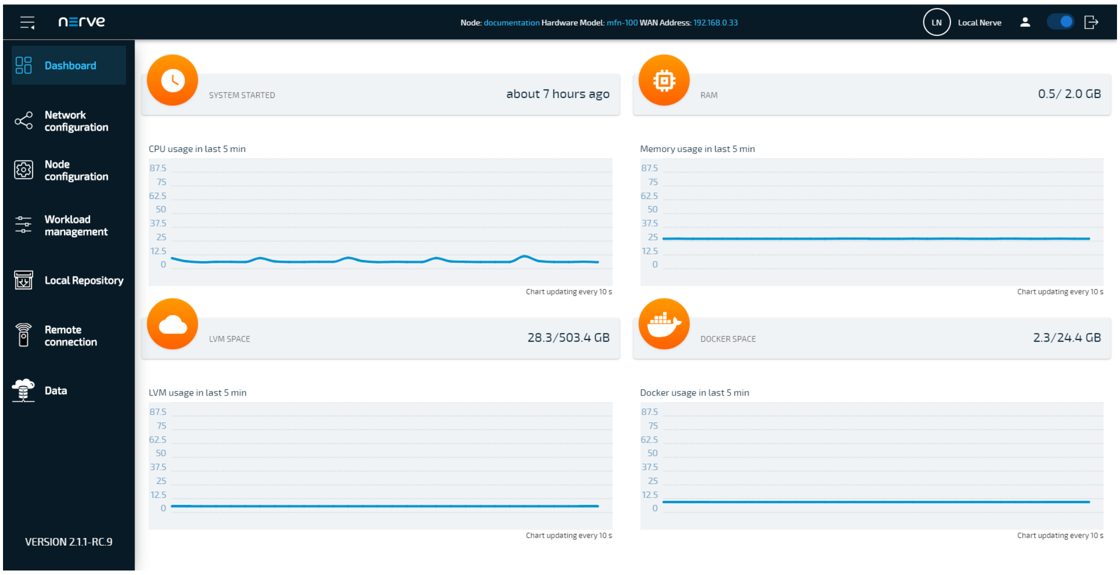
Status: STARTED
Status: STARTED
Status: STARTED

Selecting a workload leads to the workload control screen. This is where workloads can be controlled. However, CODESYS workloads can only be controlled through the Local UI. All workloads are started as soon as they are deployed.

Connecting to the Local UI

In order to access the Local UI, connect a workstation to the console port **P1** of the MFN 100 and configure the network adapter of the workstation. The IP address of the network adapter has to be in the range from `172.20.2.5` to `172.20.2.254` with a `255.255.255.0` subnet mask. The credentials for the Local UI found in the customer profile are also required.

1. Follow this link to connect to the Local UI: http://172.20.2.1:3333/
2. Log in with the credentials from the customer profile to reach the main page of the Local UI.



Node: documentation Hardware Model: mfn-100 WAN Address: 192.168.0.33

SYSTEM STARTED about 7 hours ago

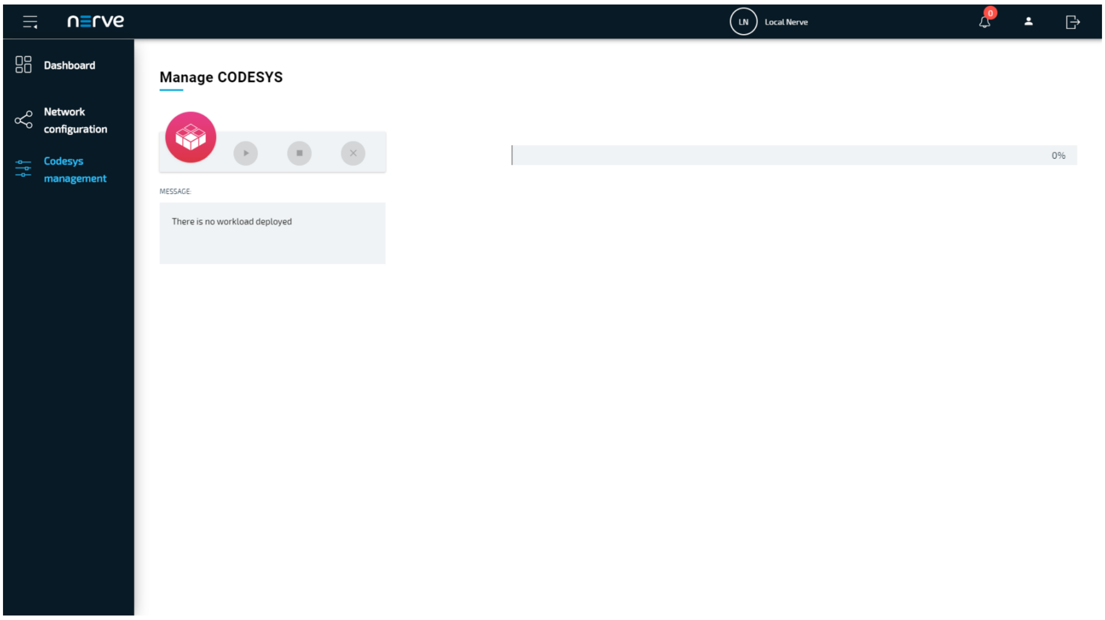
RAM 0.5/ 2.0 GB

LVM SPACE 28.3/503.4 GB

DOCKER SPACE 2.3/24.4 GB

Control of CODESYS applications

CODESYS workloads can only be controlled in the Local UI, as operation of a CODESYS workload may have an impact on machine operation and therefore should not be controlled remotely. Select **Workload management** in the menu on the left-hand side to reach the interface for controlling a CODESYS application running on the Nerve Device:



There is no workload deployed

Function Name	Description
Start	This starts the CODESYS application.
Stop	This stops the CODESYS application and it is reset to its initial values.
Remove	This removes the CODESYS application from the Nerve Device. To deploy the CODESYS application again, do so through the Management System.
Message	CODESYS workloads have the following set of messages: • "Preparing files for installation" • "Starting CODESYS application" • "CODESYS application started" • "Stopping CODESYS application" • "CODESYS application stoppped" • "Removing CODESYS application file" • "An unexpected error has occurred. <errormessage>" Here, <errormessage> is a message that is sent by the CODESYS Development System.

NOTE

It takes a moment before CODESYS applications are actually started, stopped or removed.

Uploading new CODESYS applications

In order to work with new CODESYS applications on the MFN 100, new CODESYS workloads need to be provisioned in the Management System. Here, provisioning is the creation of a workload and its storage in the workload repository of the Management System so that it can be deployed to nodes. This requires configuration of the workload and the upload of the required files to the Management System. After that, the workload can be deployed to nodes.

Before the workload can be provisioned, however, a CODESYS application has to be loaded into the CODESYS runtime first. Refer to the introduction to working with CODESYS and the MFN 100 first before continuing.

> **NOTE**
>
> Note that **app1** is already loaded into the CODESYS runtime by default.

Once a CODESYS application has been loaded into the MFN 100, the following steps have to be taken before provisioning a CODESYS workload:

- Creating the ZIP file of the CODESYS application
- Transferring the ZIP file to a local workstation

Also the workstation needs to be connected to the console port **P1** of the MFN 100 and the network adapter of the workstation needs to be configured. The IP address of the network adapter has to be in the range from `172.20.2.5` to `172.20.2.254`.

Creating the ZIP file on the Nerve Device

First, the CODESYS project needs to be zipped on the Nerve Device before it can be copied from the CODESYS runtime. This is done through the Local UI.

1. Connect to the Local UI as described above.
2. Select **Workload management** in the navigation on the left.
3. Click **Download CODESYS app archive**.
4. Select **YES** in the pop-up. Note that the CODESYS application will be stopped.

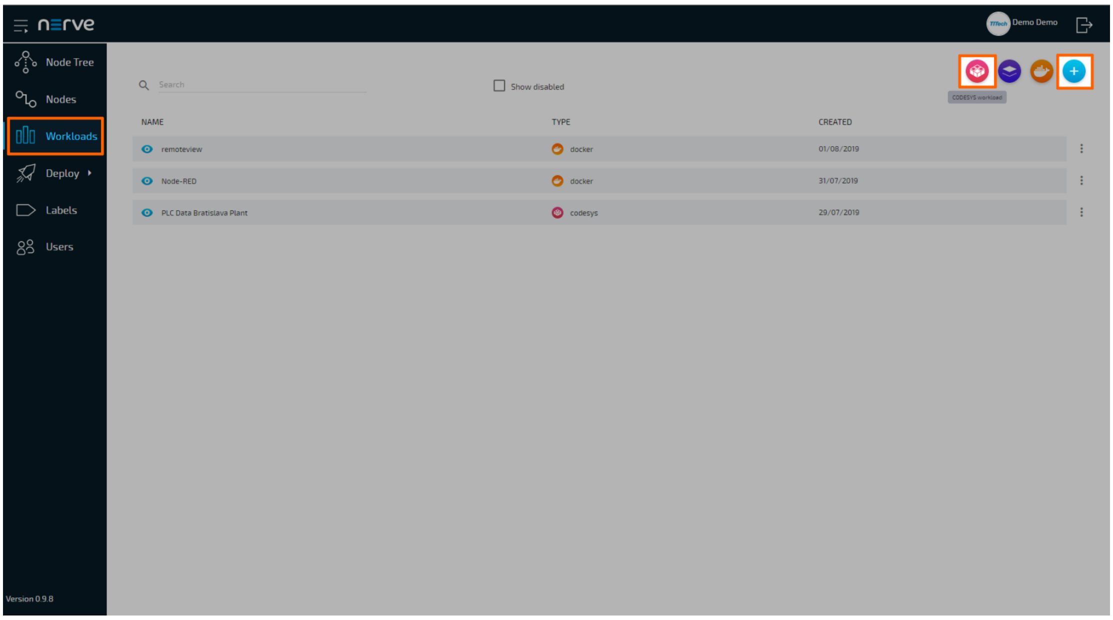
The ZIP file is automatically downloaded to the workstation and a CODESYS workload can now be provisioned in the Management System.

Provisioning a CODESYS workload

The following instructions cover the basic requirements for provisioning a CODESYS workload. Optional settings will be left out. Extended options are addressed in the user guide.

1. Log in to the Management System.
2. Select **Workloads** in the left-hand menu.
3. Select the plus symbol in the upper-right corner.

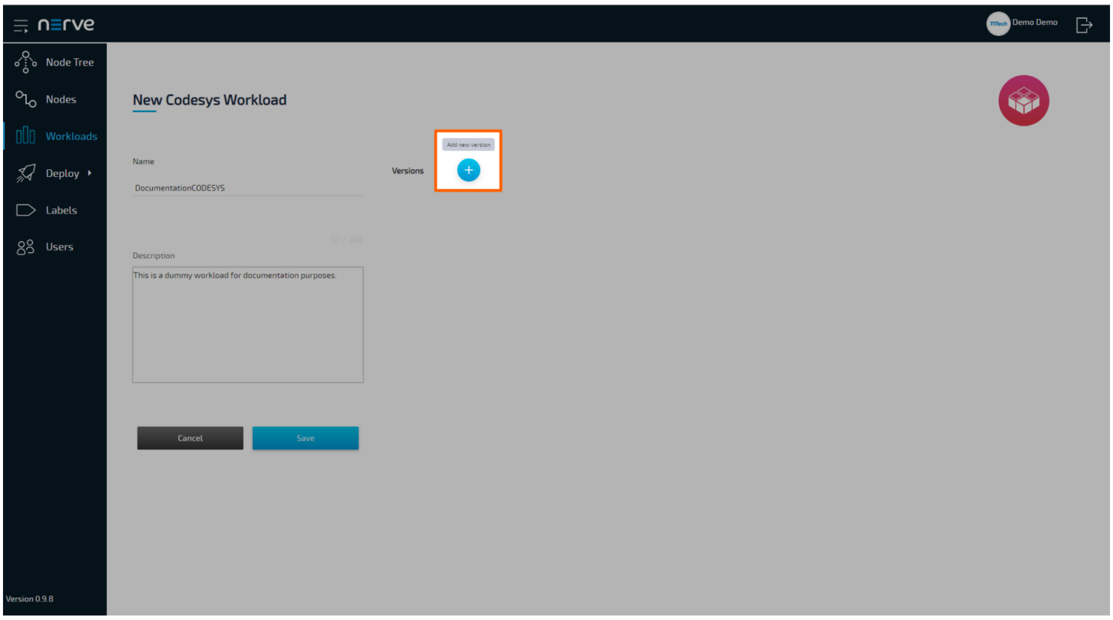
4. Select the CODESYS symbol (**CODESYS workload**) on the left of the three symbols that expanded.



NAME	TYPE	CREATED
remoteview	docker	01/08/2019
Node-RED	docker	31/07/2019
PLC Data Bratislava Plant	codesys	29/07/2019

5. Enter a name for the workload in the new window.

6. Select the plus symbol next to **Versions** to add a new version of the workload.



New Codesys Workload

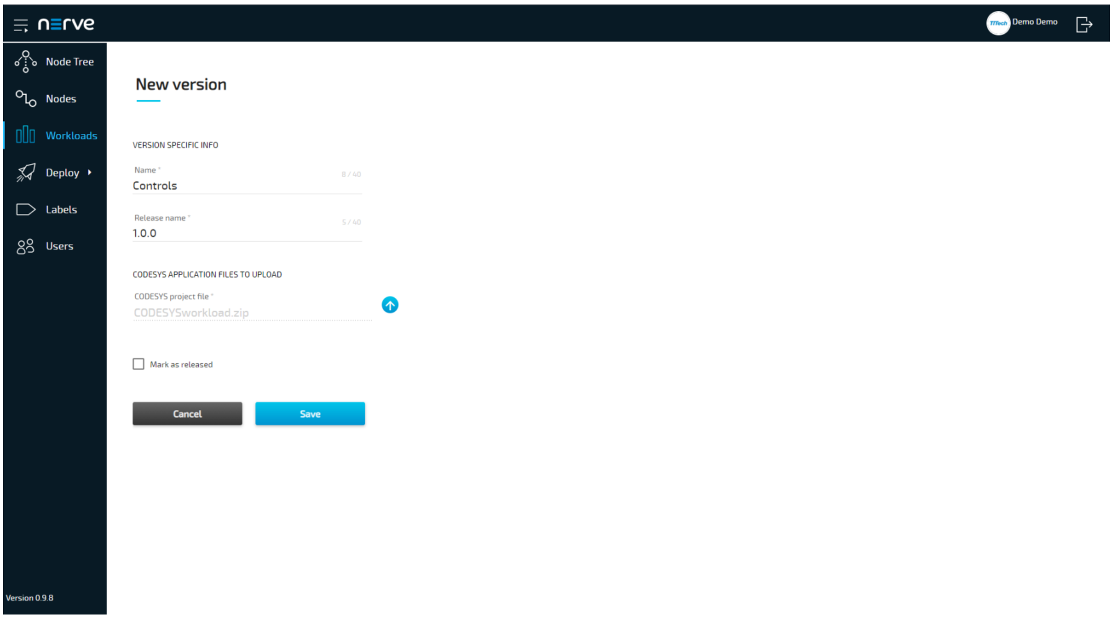
Name: DocumentationCODESYS

52 / 300

Description: This is a dummy workload for documentation purposes.

7. Enter the following information in the new window:

Item	Description
Name	Enter a **Name** for the version of this workload.
Release name	Enter a **Release name** for the version of this workload.
CODESYS project file	Click the **upward arrow** symbol to open the file browser and add the CODESYS application ZIP file. This is the ZIP file that has been created before.



New version

VERSION SPECIFIC INFO

Name * Controls (8 / 40)

Release name * 1.0.0 (5 / 40)

CODESYS APPLICATION FILES TO UPLOAD

CODESYS project file * CODESYSworkload.zip

☐ Mark as released

Cancel Save

8. Click **Save**.

The workload has now been provisioned and is ready to be deployed in the **Deploy** menu.

Connecting new sensors and actuators

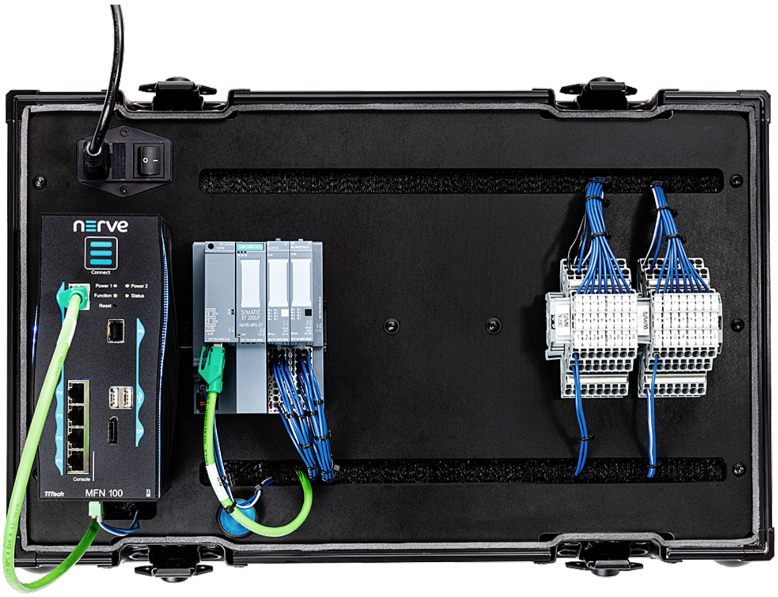
Add sensors and actuators to the kit to execute control applications and visualize the corresponding data. With the delivered set-up it is possible to add up to 7 additional inputs and outputs. I/O blocks can also be added to increase the number or type of inputs and outputs.

Wiring a new sensor or actuator

NOTE

- Before wiring any new components, review the Nerve Kit Circuit Diagram. Contact a sales representative for more information.
- Disconnect the power supply from the power outlet before wiring new I/O devices to prevent injury to persons or damage to equipment.
- Only staff with knowledge about electrical circuits should perform the tasks described in this section.

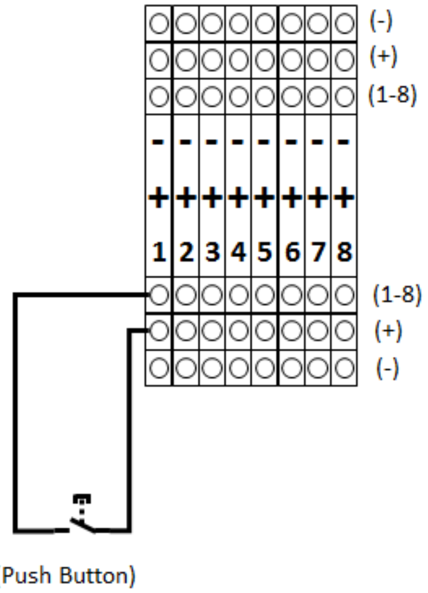
The inputs and outputs of the SIMATIC ET200 SP I/O module are wired to the terminal blocks on the right hand side of the kit. The left terminal block is used to connect digital inputs. The right terminal block is used to connect digital outputs.



Connecting a digital input

This section shows how to connect an additional digital input to the kit. A push button is used for demonstration purposes.

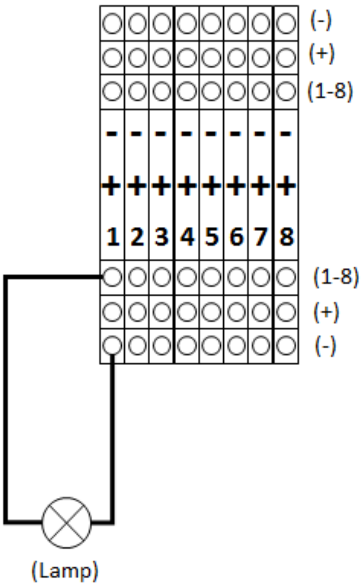
1. Connect the power supply of the button to the middle row of the I/O module (+24V).
2. Connect the input to the top row.



Connecting a digital output

This section shows how to connect an additional digital output to the kit. A lamp is used for demonstration purposes.

1. Connect the lamp to the top row of the I/O module.
2. Connect the common wire to the bottom row to close the electrical circuit.



After wiring the sensors or actuators to the inputs or outputs respectively switch the kit back on.

The next chapter describes how to assign variables to the inputs and outputs in order to read data from newly connected sensors or control actuator functionality.

First steps with CODESYS and the MFN 100

This chapter will give an introduction on how to start working with the integrated soft PLC in the MFN 100. First, some configuration and installation of files and libraries are required.

NOTE

- Download the CODESYS Development System V3 from store.codesys.com for this chapter.
  We recommend version 3.5 SP14 (32 bit) or newer.
- Connect the workstation to the console port **P1** of the MFN 100.

Installing the device descriptions

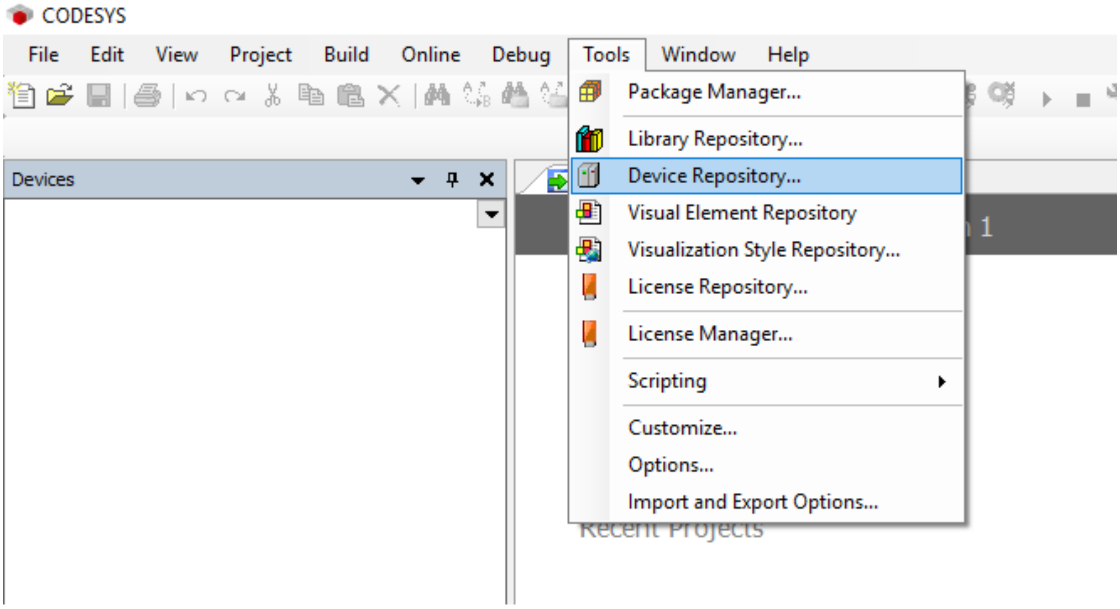
After downloading and installing the CODESYS Development System on the workstation, install the device descriptions of the MFN 100 and the SIMATIC ET200 SP I/O module in the CODESYS Development System. The device descriptions have the following filenames:

MFN 100	`Nerve_MFN_100_V3.5.XX.X.devdesc.xml`
SIMATIC ET200 SP	`GSDML-V2.34-Siemens-ET200SP-20180926.xml`

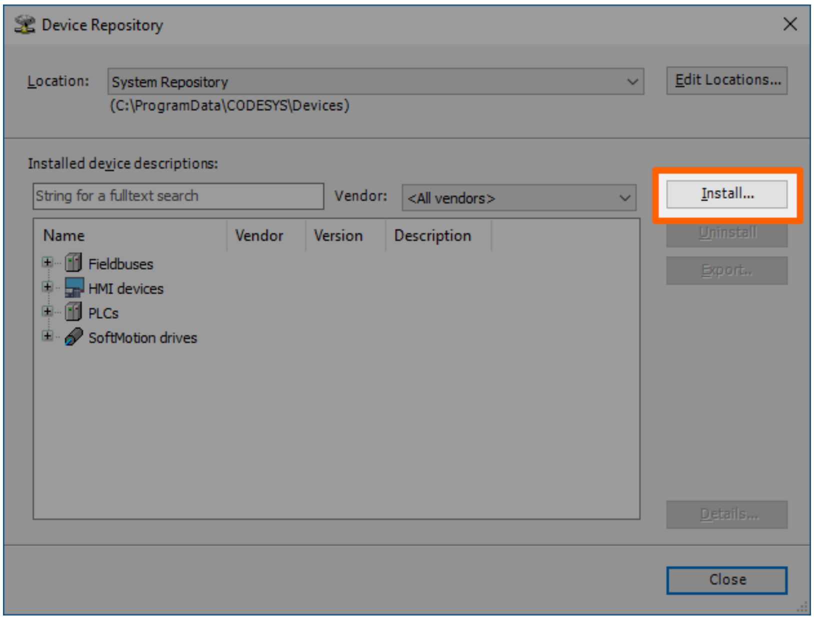
XX.X stands for the current version of the CODESYS Development System. The device descriptions of the MFN 100 and the SIMATIC ET200 SP I/O module are available at the Nerve Software Center.

1. Start the CODESYS Development System.

2. Go to **Tools > Device Repository**.



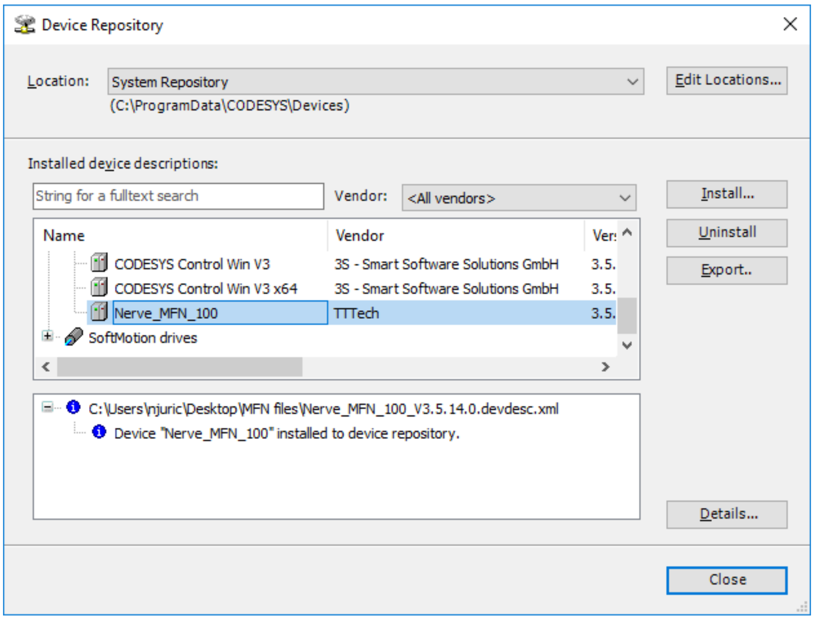
3. Click **Install**.



4. Go to the directory of the previously downloaded device description.

5. Select the device description of the MFN 100.
6. Click **Open**.
7. Repeat steps 3 to 6 to install the device description SIMATIC ET200 SP I/O module.

When the installation was successful, the MFN 100 and the SIMATIC ET200 SP I/O module will appear in the list of device descriptions in the middle of the window. Close the window afterwards.



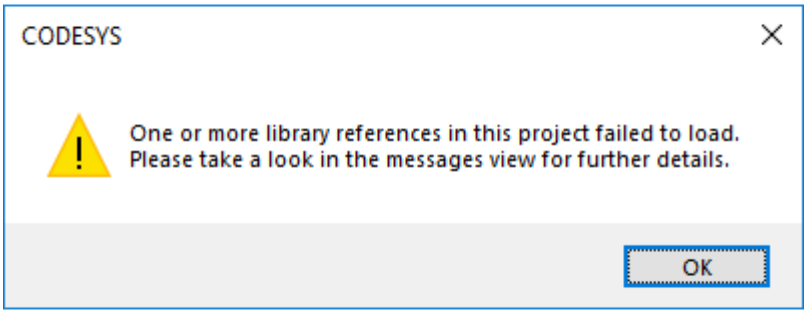
Name	Vendor	Ver:
CODESYS Control Win V3	3S - Smart Software Solutions GmbH	3.5.
CODESYS Control Win V3 x64	3S - Smart Software Solutions GmbH	3.5.
Nerve_MFN_100	TTTech	3.5.
SoftMotion drives		

```
C:\Users\njuric\Desktop\MFN files\Nerve_MFN_100_V3.5.14.0.devdesc.xml
    Device "Nerve_MFN_100" installed to device repository.
```

After installing the device description the CODESYS Development System can be worked with. However, libraries and device descriptions of generic devices might be missing so that the CODESYS Development System can work properly.

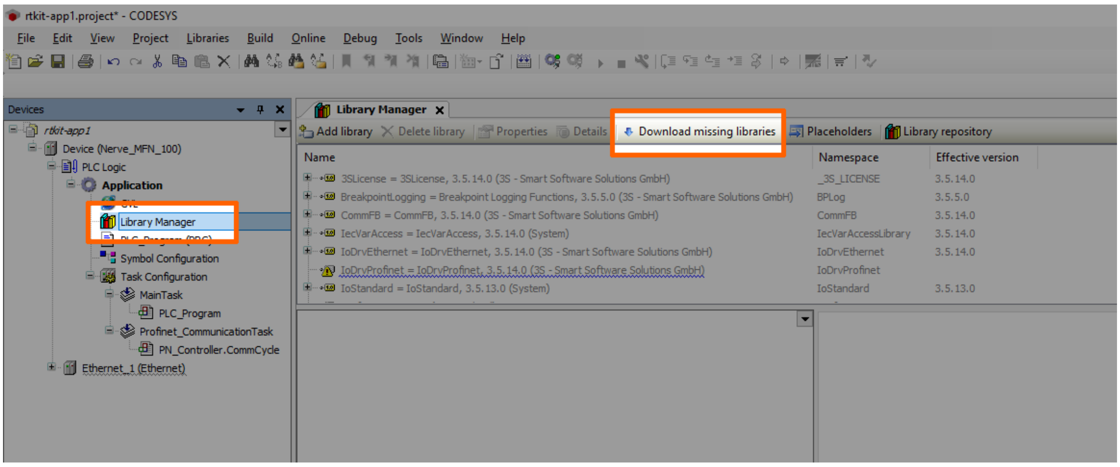
Downloading missing libraries

The error message for missing libraries might appear when opening or creating a CODESYS project. The CODESYS Development System identifies the missing libraries automatically but the following process might have to be repeated a few times.



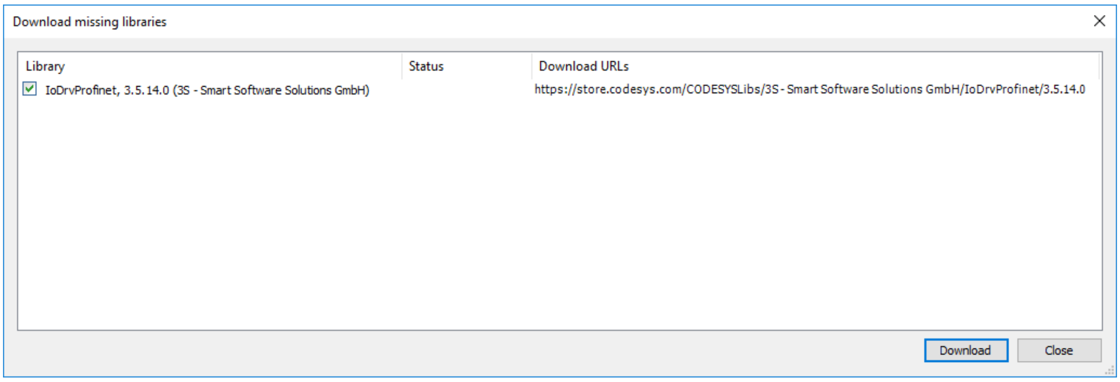
One or more library references in this project failed to load.
Please take a look in the messages view for further details.

1. Open or create a CODESYS project.
2. If the error message about missing libraries appears, click **OK**.
3. Double-click **Library Manager** in the tree view on the left.
4. Click **Download missing libraries**.



Name	Namespace	Effective version
3SLicense = 3SLicense, 3.5.14.0 (3S - Smart Software Solutions GmbH)	_3S_LICENSE	3.5.14.0
BreakpointLogging = Breakpoint Logging Functions, 3.5.5.0 (3S - Smart Software Solutions GmbH)	BPLog	3.5.5.0
CommFB = CommFB, 3.5.14.0 (3S - Smart Software Solutions GmbH)	CommFB	3.5.14.0
IecVarAccess = IecVarAccess, 3.5.14.0 (System)	IecVarAccessLibrary	3.5.14.0
IoDrvEthernet = IoDrvEthernet, 3.5.14.0 (3S - Smart Software Solutions GmbH)	IoDrvEthernet	3.5.14.0
IoDrvProfinet = IoDrvProfinet, 3.5.14.0 (3S - Smart Software Solutions GmbH)	IoDrvProfinet	
IoStandard = IoStandard, 3.5.13.0 (System)	IoStandard	3.5.13.0

5. Click **Download** in the new window.



Library	Status	Download URLs
☑ IoDrvProfinet, 3.5.14.0 (3S - Smart Software Solutions GmbH)		https://store.codesys.com/CODESYSLibs/3S - Smart Software Solutions GmbH/IoDrvProfinet/3.5.14.0

6. Click **Close** when the download is finished.

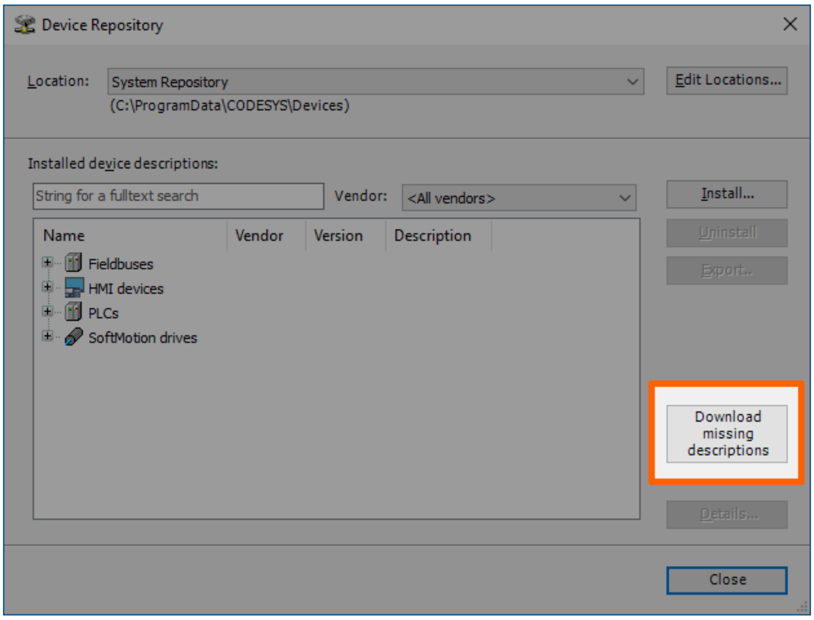
7. Repeat steps 3 to 5 until no more libraries appear in the download window.

Downloading missing device descriptions

Apart from the device description for the MFN 100, device descriptions of generic devices may be missing for the CODESYS Development System to function as intended. The CODESYS Development System will identify the missing device descriptions automatically but this time it will not generate an error message unless a CODESYS application is loaded into the MFN 100.

1. Click **Tools > Device Repository**.

2. Click **Download missing descriptions**.



NOTE

If no device descriptions of generic devices are missing, the button for downloading missing descriptions will not appear.

3. Click **Download** in the new window.

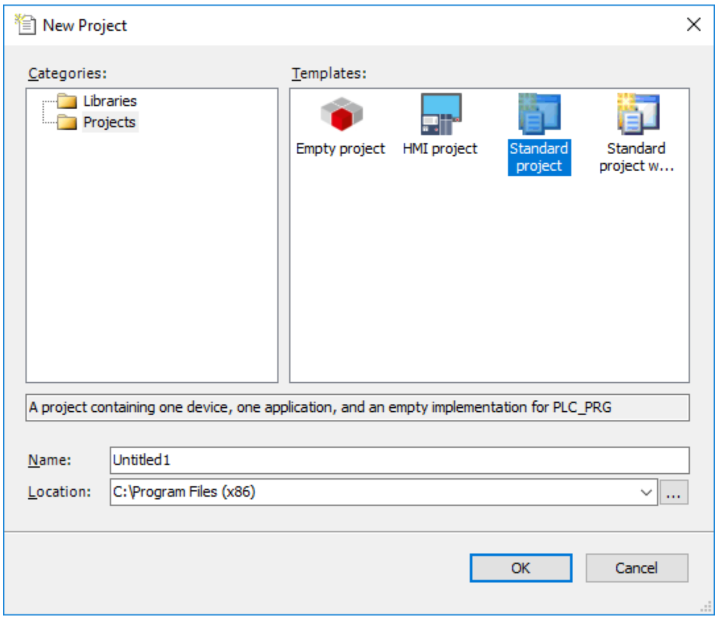
4. Click **Close** when the download is finished.

Creating a new CODESYS project

This example shows how to create a new project in the CODESYS Development System. The easiest way to get started is to create a **Standard project**.

1. Start CODESYS
2. Go to **File > New Project**.
3. Click **Standard project** on the right side among the templates.
4. Enter a name for the project.
5. Choose a **Location** where the project will be saved.

6. Click **OK** to save the project.

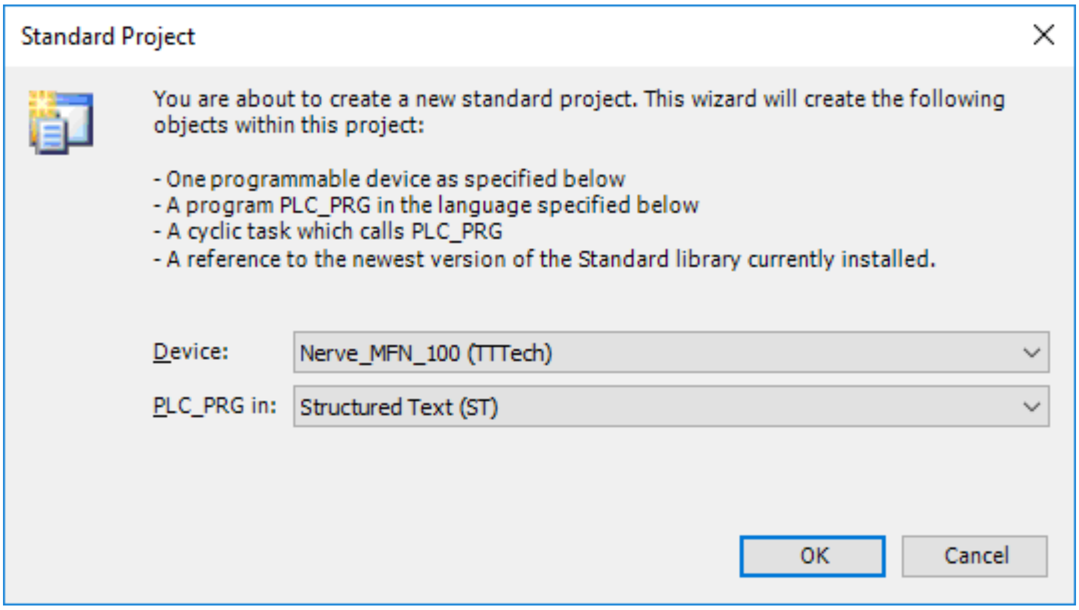


A project containing one device, one application, and an empty implementation for PLC_PRG

Name: Untitled1

Location: C:\Program Files (x86)

7. Select **Nerve_MFN_100 (TTTech)** as the device.



You are about to create a new standard project. This wizard will create the following objects within this project:

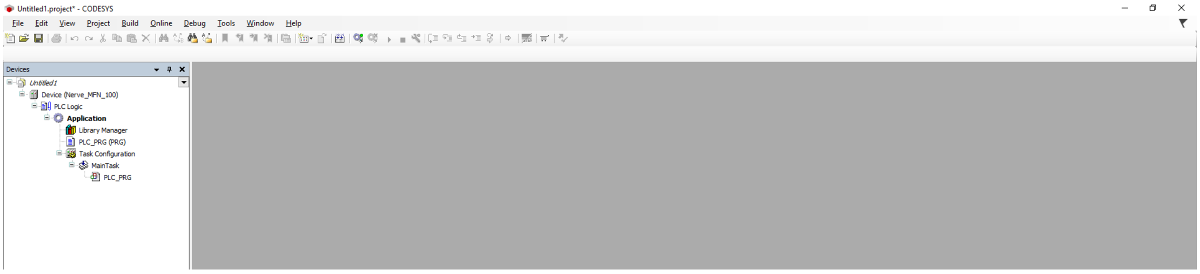
- One programmable device as specified below
- A program PLC_PRG in the language specified below
- A cyclic task which calls PLC_PRG
- A reference to the newest version of the Standard library currently installed.

Device: Nerve_MFN_100 (TTTech)

PLC_PRG in: Structured Text (ST)

8. Click **OK**.

The result is an empty project that is open in the main view of CODESYS.

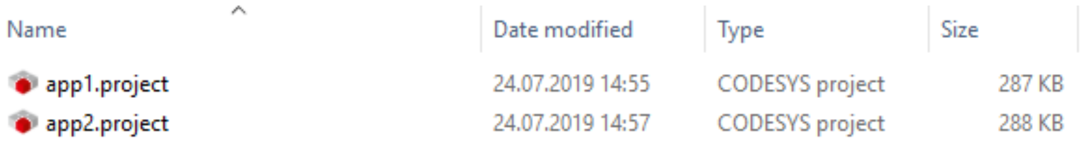


Working with the default applications

To work with existing applications first, modify the default applications `app1.project` and `app2.project`. They can be downloaded from the Nerve Software Center under **Example applications**.

1. Start CODESYS.
2. Go to **File > Open Project**.
3. Select the download location of the default applications.

4. Select the application to work with.



Name	Date modified	Type	Size
app1.project	24.07.2019 14:55	CODESYS project	287 KB
app2.project	24.07.2019 14:57	CODESYS project	288 KB

5. Click **Open**.

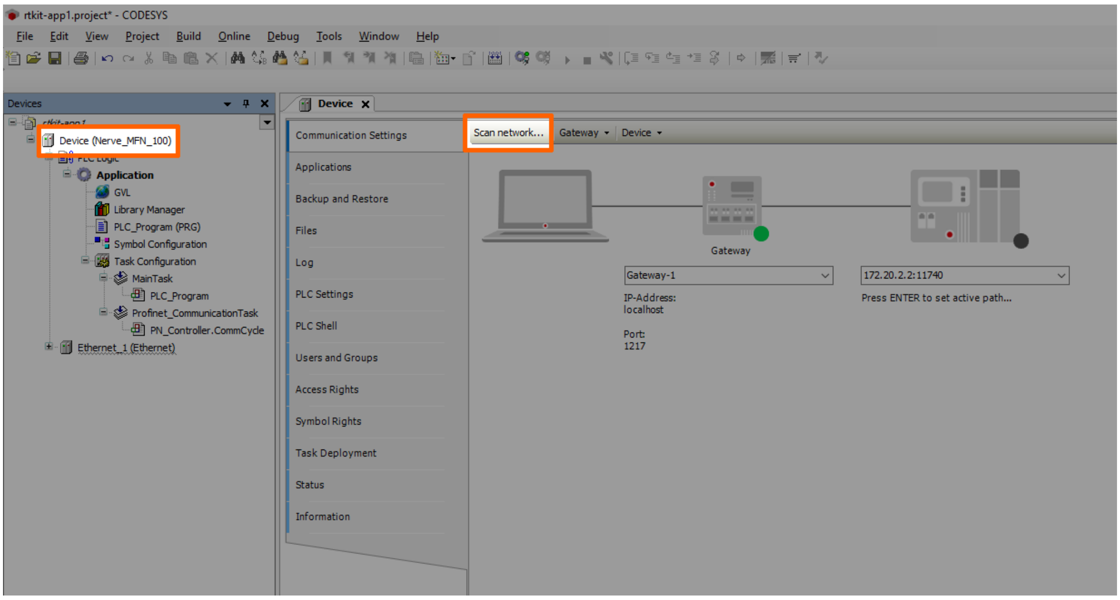
When opening the default applications for the first time, some libraries and device descriptions will be missing. Follow the instructions above to see how to download the missing files.

Connecting to the MFN 100

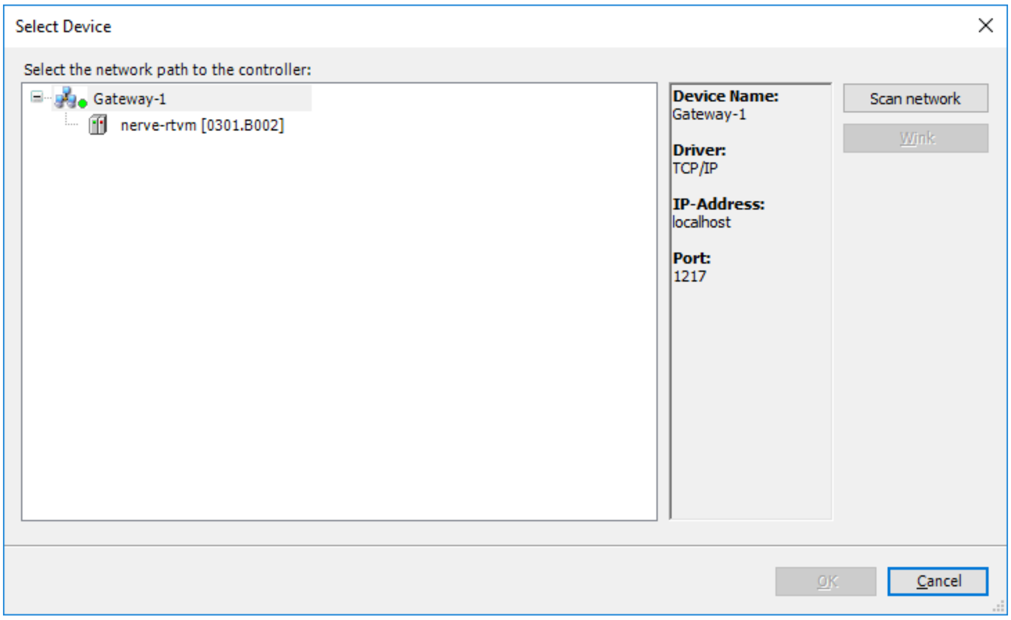
Before downloading CODESYS applications to the MFN 100, make sure that the device description of the MFN 100 is installed in the CODESYS Development System.

1. Open or create a CODESYS project.
2. Double-click **Device (Nerve_MFN_100)** in the tree view on the left.

3. Go to **Communication Settings > Scan network...**.



4. Select the MFN 100 (here **nerve-rtvm [XXXX.XXXX]**) in this window.



Select the network path to the controller:

- Gateway-1
  - nerve-rtvm [0301.B002]

Device Name:
Gateway-1

Driver:
TCP/IP

IP-Address:
localhost

Port:
1217

NOTE

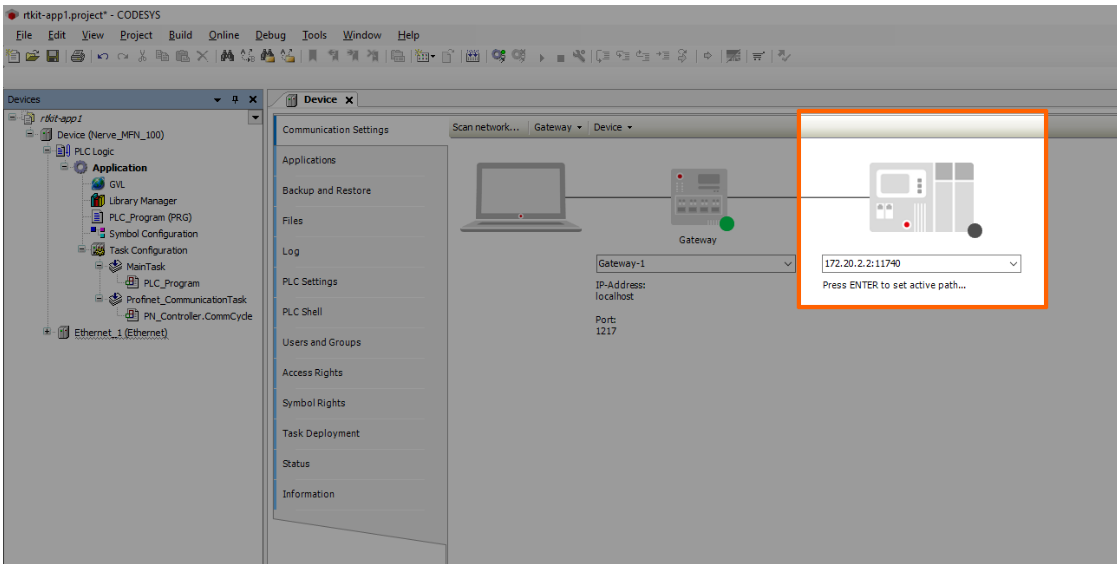
When more than one network is active on the workstation, it sometimes happens that the MFN 100 cannot be found. Continue reading if the MFN 100 does not appear in this window.

5. Click **OK**.

Typically the MFN 100 will be found automatically. If the MFN 100 cannot be found, enter the IP address and port of the CODESYS runtime manually.

1. Double-click **Device (Nerve_MFN_100)** in the tree view on the left.
2. Go to **Communication Settings** in the middle of the window.

3. Enter `172.20.2.2:11740` in the text box under the device on the right.



Gateway-1

IP-Address:
localhost

Port:
1217

172.20.2.2:11740

Press ENTER to set active path...

4. Press Enter.

The CODESYS Development System is now connected to the MFN 100 and applications can be downloaded into the CODESYS runtime.

Downloading an application to the MFN 100

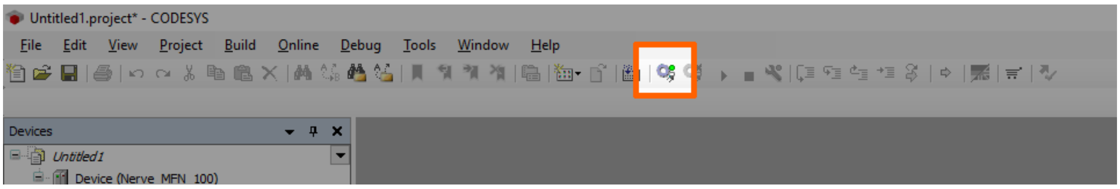
CODESYS applications can be loaded directly into the MFN 100. However, before downloading an application into the MFN 100 it needs to be free of errors.

The process of downloading an application is slightly different when downloading an entirely new application into the MFN 100 or updating an application that has already been downloaded into the MFN 100. Continue with Downloading an Updated Application to the MFN 100 further down below if an application is being updated.

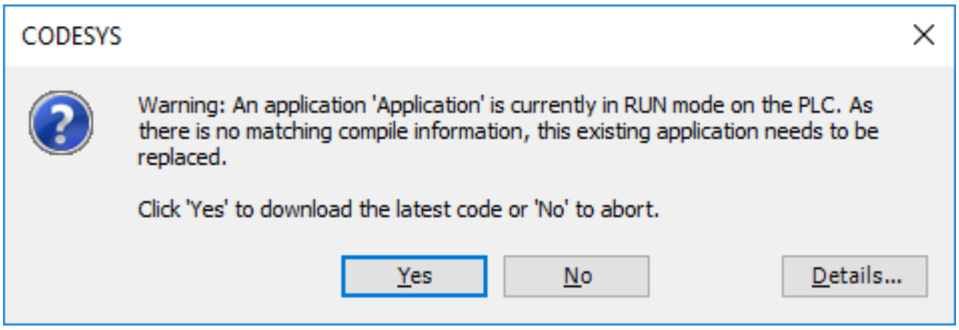
Downloading a new Application to the MFN 100

After creating a project and finishing with programming, the CODESYS application can be downloaded into the MFN 100 directly.

1. Open the CODESYS project to load into the MFN 100.
2. Click the **Login** symbol in the CODESYS menu bar.



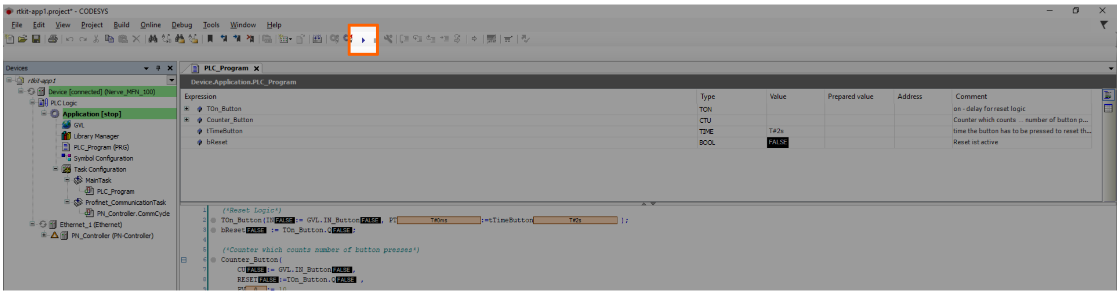
3. Click **Yes** in the pop-up window.



Warning: An application 'Application' is currently in RUN mode on the PLC. As there is no matching compile information, this existing application needs to be replaced.

Click 'Yes' to download the latest code or 'No' to abort.

4. The application is stopped now. Click the **Play** symbol in the CODESYS menu bar.



Expression	Type	Value	Prepared value	Address	Comment
TOn_Button	TON				on - delay for reset logic
Counter_Button	CTU				Counter which counts ... number of button p...
tTimeButton	TIME	T#2s			time the button has to be pressed to reset th...
bReset	BOOL	FALSE			Reset ist active

```
(*Reset Logic*)
TOn_Button(INFALSE:= GVL.IN_ButtonFALSE, PT T#0ms :=tTimeButton T#2s );
bResetFALSE := TOn_Button.QFALSE;

(*Counter which counts number of button presses*)
Counter_Button(
    CUFALSE:= GVL.IN_ButtonFALSE,
    RESETFALSE:=TOn_Button.QFALSE ,
```

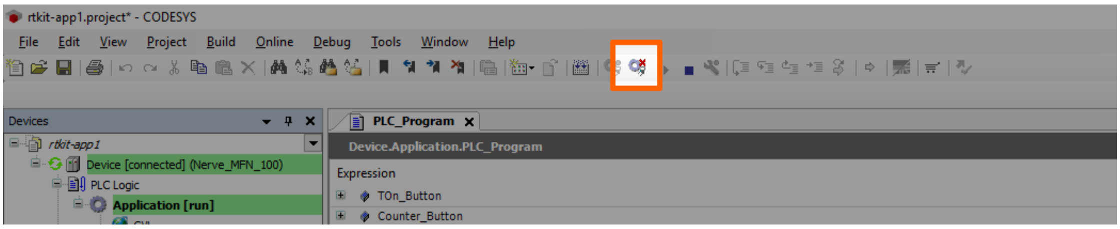
The application is now loaded to the MFN 100.

Downloading an updated application to the MFN 100

Updating an application after loading it into the MFN 100 requires another download into the MFN 100. The download process is slightly different from downloading a new application into the MFN 100.

1. Stop the CODESYS application that has been loaded into the MFN 100 through the Local UI.

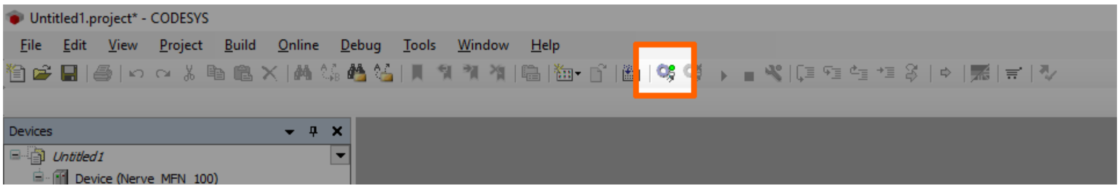
2. Click the **Logout** button in the CODESYS toolbar.


rtkit-app1.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
rtkit-app1
Device [connected] (Nerve_MFN_100)
PLC Logic
Application [run]
PLC_Program
Device.Application.PLC_Program
Expression
TOn_Button
Counter_Button

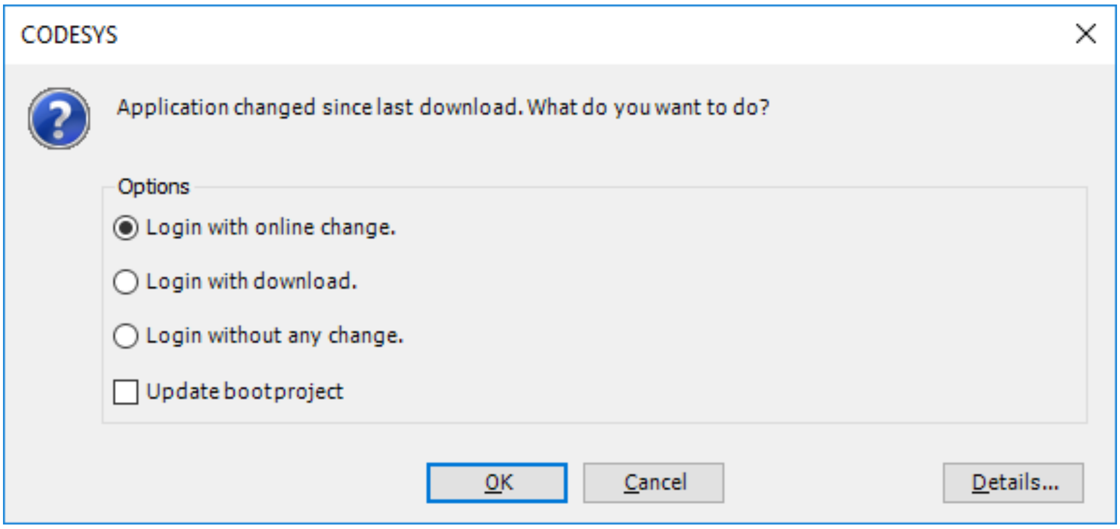
3. Expand **Device (Nerve_MFN_100) > PLC Logic > Application**.

4. Double-click **PLC_Program (PRG)**.
5. Perform the changes.

6. Click the **Login symbol** in the CODESYS menu bar.


Untitled1.project* - CODESYS
File Edit View Project Build Online Debug Tools Window Help
Devices
Untitled1
Device (Nerve_MFN_100)

7. In the pop-up window, select one of the options.



CODESYS

Application changed since last download. What do you want to do?

Options

● Login with online change.

○ Login with download.

○ Login without any change.

□ Update bootproject

Item	Description
Login with online change.	The updated application will be loaded into the MFN 100. Variable values will not be reset. If the application was running before, it will be running after the download.
Login with download.	The updated application will be loaded into the MFN 100. Variable values will be reset. The application is stopped.

Item	Description
Login without any change.	The updated application will not be loaded into the MFN 100 but the code will keep the changes.

8. Click **OK**.

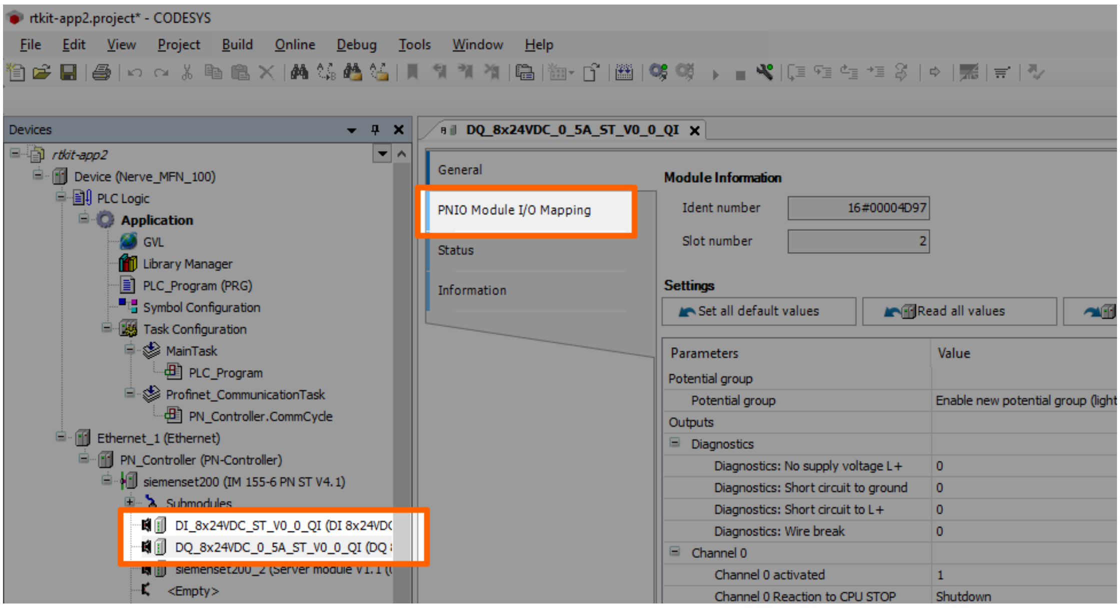
The application is now loaded to the MFN 100.

> **NOTE**
>
> For more help with programming PLC applications in the CODESYS Development System go to help.codesys.com.

Allocating variables to inputs or outputs

After connecting new sensors and actuators, variables need to be assigned to the I/O channel in CODESYS.

1. Open a CODESYS project.
2. Expand **Device (Nerve_MFN_100) > PLC Logic > Ethernet_1 > PN_Controller > siemenset200 (IM 155-6 PN ST V4.1)** in the tree structure on the left.
3. Double-click **DI_8x24VDC_ST_V0_0_QI (...)** for digital inputs.
   Double-click **DQ_8x24VDC_0_5A_ST_V0_0_QI (...)** for digital outputs.
4. Select **PNIO Module I/O Mapping**.



Ident number 16#00004D97

Slot number 2

Parameters	Value
Potential group	
Potential group	Enable new potential group (light
Outputs	
Diagnostics	
Diagnostics: No supply voltage L+	0
Diagnostics: Short circuit to ground	0
Diagnostics: Short circuit to L+	0
Diagnostics: Wire break	0
Channel 0	
Channel 0 activated	1
Channel 0 Reaction to CPU STOP	Shutdown

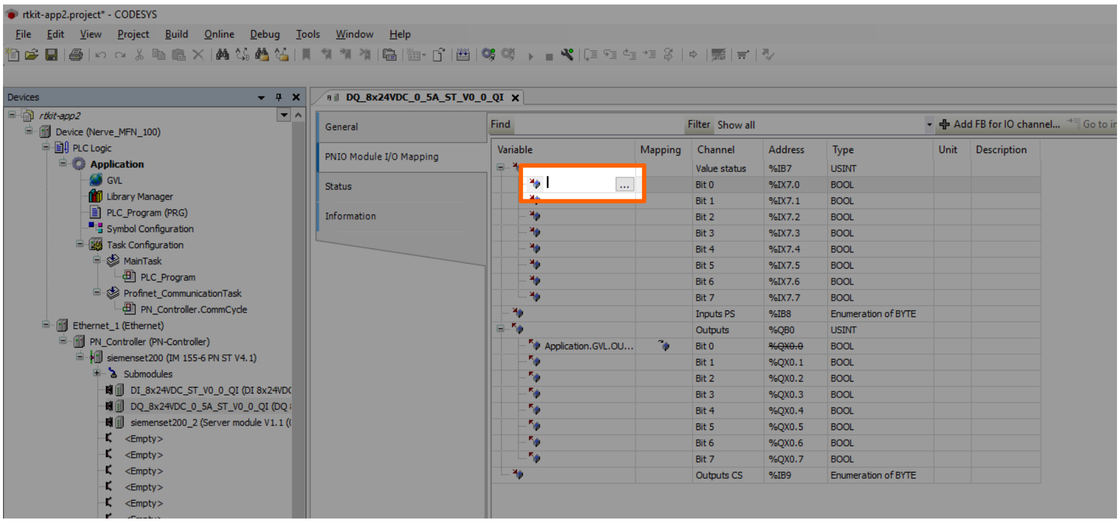
5. Fully expand the tree view.

6. Double-click the variable slot to assign.

> **NOTE**

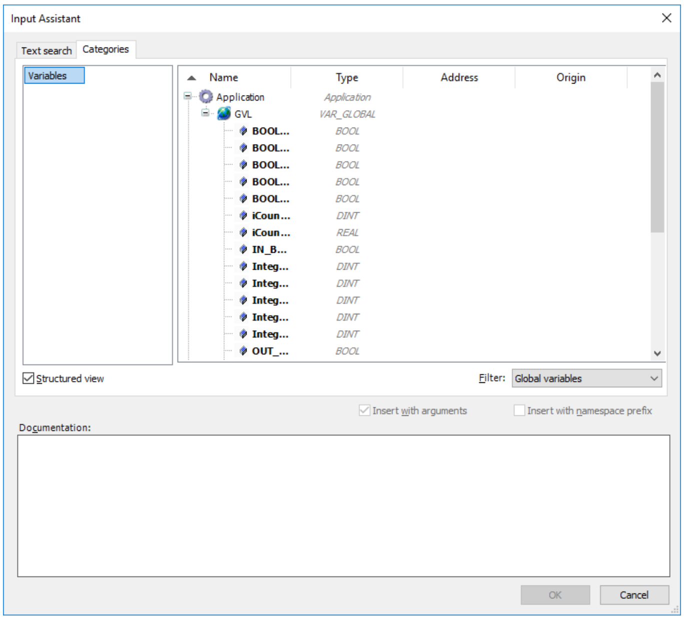
The inputs in this view do not match the physical inputs of the I/O module on the kit. The inputs here go from 0 to 7. The physical inputs go from 1 to 8. Therefore input 0 in this view represents the physical input 1 on the I/O module. This also applies to outputs.

7. Click the three dots next to the variable slot.



Variable	Mapping	Channel	Address	Type	Unit	Description
		Value status	%IB7	USINT		
I ...		Bit 0	%IX7.0	BOOL		
		Bit 1	%IX7.1	BOOL		
		Bit 2	%IX7.2	BOOL		
		Bit 3	%IX7.3	BOOL		
		Bit 4	%IX7.4	BOOL		
		Bit 5	%IX7.5	BOOL		
		Bit 6	%IX7.6	BOOL		
		Bit 7	%IX7.7	BOOL		
		Inputs PS	%IB8	Enumeration of BYTE		
		Outputs	%QB0	USINT		
Application.GVL.OU...		Bit 0	~~%QX0.0~~	BOOL		
		Bit 1	%QX0.1	BOOL		
		Bit 2	%QX0.2	BOOL		
		Bit 3	%QX0.3	BOOL		
		Bit 4	%QX0.4	BOOL		
		Bit 5	%QX0.5	BOOL		
		Bit 6	%QX0.6	BOOL		
		Bit 7	%QX0.7	BOOL		
		Outputs CS	%IB9	Enumeration of BYTE		

8. Expand **Application > GVL** in the new window.



Name	Type	Address	Origin
Application	Application		
GVL	VAR_GLOBAL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
BOOL...	BOOL		
iCoun...	DINT		
iCoun...	REAL		
IN_B...	BOOL		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
Integ...	DINT		
OUT_...	BOOL		

9. Select the variable to assign.

NOTE

Make sure to select a variable of the same type as the input, i.e., a **BOOL** variable for a **BOOL** input or output.

10. Click **OK**.

Use the assigned variables to read data from connected sensors or to control actuator functionality.

NOTE

For more help with programming PLC applications in the CODESYS Development System go to help.codesys.com.

Data transfer from CODESYS to the Management System

The kit sends data that is generated in CODESYS from the MFN 100 to the Management System using variables. The kit has a pre-configured Gateway configuration for the Data Services that can be further configured to send new values to the Management System. This chapter gives a quick overview on how to configure new variables.

Overview

The CODESYS runtime has an integrated OPC UA server which can be configured via the CODESYS Development System. The data from the OPC UA server is received by an OPC UA client, ingested by the Data Services and written into the database in the Management System.

The Data Services are pre-configured to transmit a set of different kinds of CODESYS variables to the Management System. Use the following global variables to transmit data to the Management System:

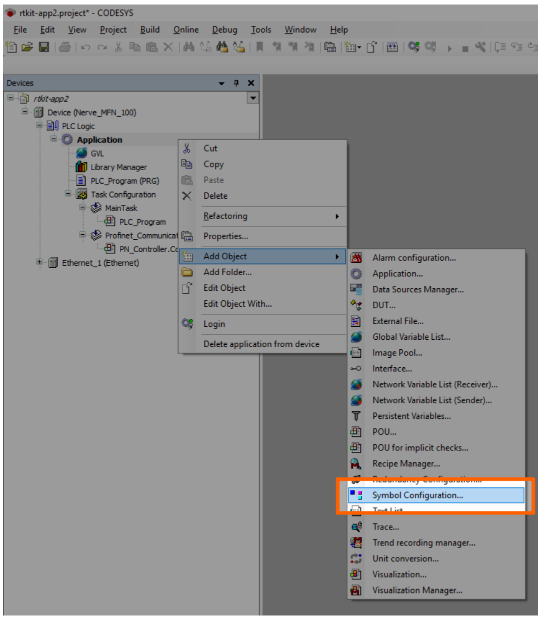
Global Variables			
BOOL_1	Integer_1	Real_1	STRING_1
BOOL_2	Integer_2	Real_2	STRING_2
BOOL_3	Integer_3	Real_3	STRING_3
BOOL_4	Integer_4	Real_4	STRING_4
BOOL_5	Integer_5	Real_5	STRING_5

The following instructions are only needed if new variables are added or a completely new CODESYS project is created.

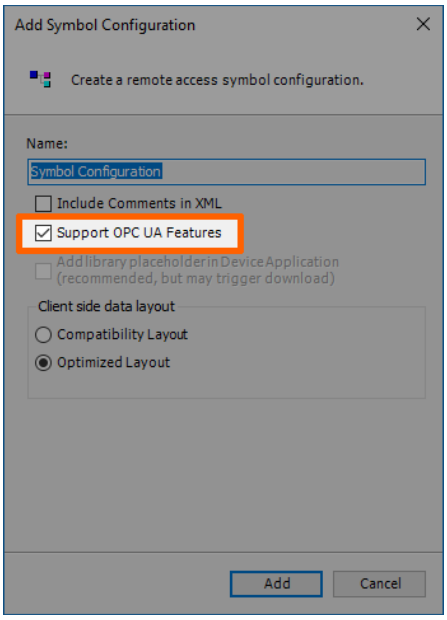
Configuring the CODESYS OPC UA server

In the CODESYS Development System it is possible to configure which variables are available in the OPC UA server. Configuring variables requires an object called **Symbol Configuration**.

1. Open a CODESYS project to configure variables.
2. Expand **Device (Nerve_MFN_100) > PLC Logic**.
3. Right click **Application**.
4. Select **Add Object**.
5. Click **Symbol Configuration...**



6. Tick **Support OPC UA Features**.


Add Symbol Configuration

Create a remote access symbol configuration.

Name: Symbol Configuration

☐ Include Comments in XML

☑ Support OPC UA Features

☐ Add library placeholder in DeviceApplication (recommended, but may trigger download)

Client side data layout

○ Compatibility Layout

● Optimized Layout

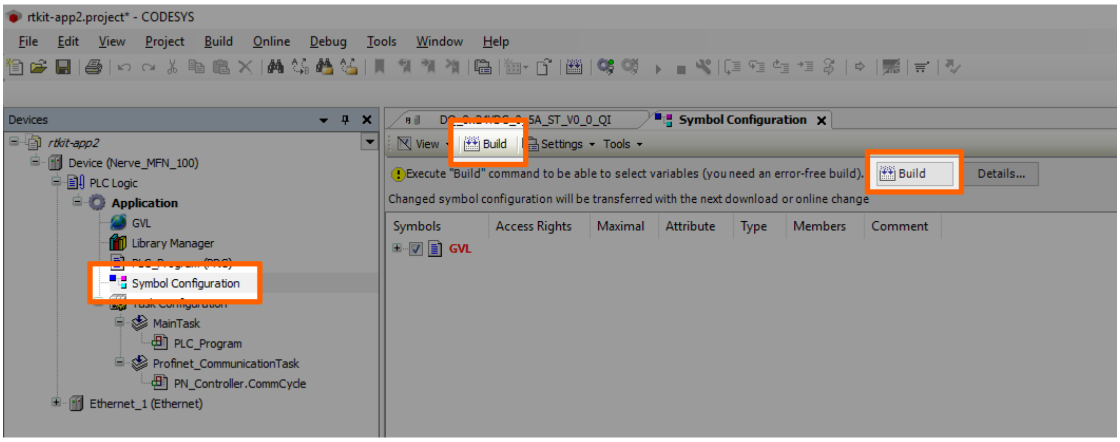
7. Click **Add**.

Adding variables to the OPC UA server

Before adding variables to the OPC UA server, add the object **Symbol Configuration** to the tree structure. Refer to the instructions above on how to add the Symbol Configuration to the tree structure.

1. Open a CODESYS project to configure variables.
2. Expand **Device (Nerve_MFN_100) > PLC Logic > Application**.
3. Double-click **Symbol Configuration**.

4. Click **Build**.

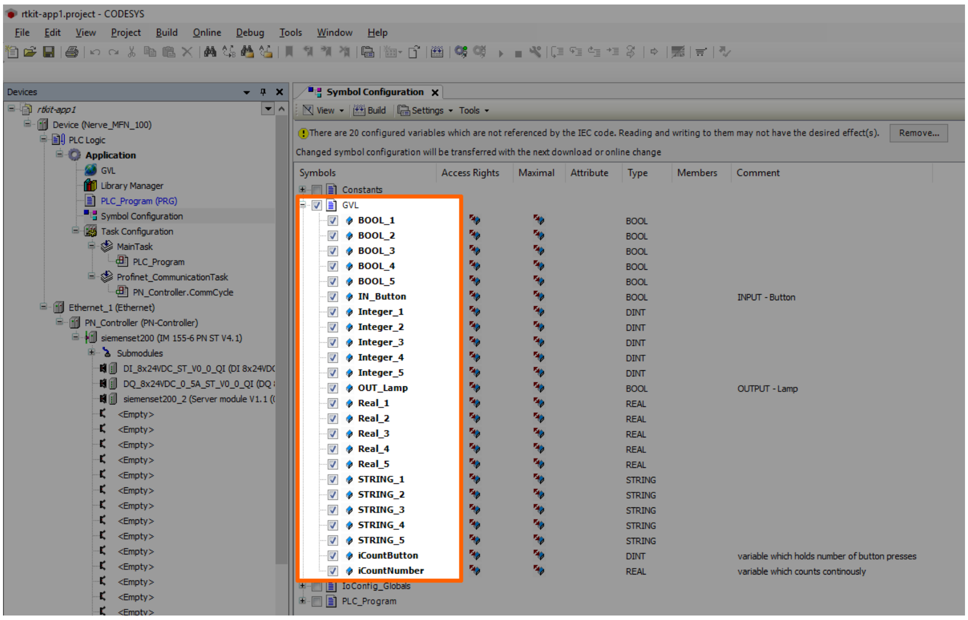

Execute "Build" command to be able to select variables (you need an error-free build).

Changed symbol configuration will be transferred with the next download or online change

Symbols	Access Rights	Maximal	Attribute	Type	Members	Comment
GVL						

5. Expand **GVL**.

6. Tick the variables to add to the OPC UA server.


There are 20 configured variables which are not referenced by the IEC code. Reading and writing to them may not have the desired effect(s).

Changed symbol configuration will be transferred with the next download or online change

Symbols	Access Rights	Maximal	Attribute	Type	Members	Comment
□ Constants						
☑ GVL						
☑ BOOL_1				BOOL		
☑ BOOL_2				BOOL		
☑ BOOL_3				BOOL		
☑ BOOL_4				BOOL		
☑ BOOL_5				BOOL		
☑ IN_Button				BOOL		INPUT - Button
☑ Integer_1				DINT		
☑ Integer_2				DINT		
☑ Integer_3				DINT		
☑ Integer_4				DINT		
☑ Integer_5				DINT		
☑ OUT_Lamp				BOOL		OUTPUT - Lamp
☑ Real_1				REAL		
☑ Real_2				REAL		
☑ Real_3				REAL		
☑ Real_4				REAL		
☑ Real_5				REAL		
☑ STRING_1				STRING		
☑ STRING_2				STRING		
☑ STRING_3				STRING		
☑ STRING_4				STRING		
☑ STRING_5				STRING		
☑ iCountButton				DINT		variable which holds number of button presses
☑ iCountNumber				REAL		variable which counts continously
□ IoConfig_Globals						
□ PLC_Program						

Adding variables to the Data Services Gateway

The Nerve Data Services Gateway has a pre-configured Gateway configuration loaded. This configuration needs to be adapted when new values are added through sensors, actuators and in the CODESYS Development System.

1. Connect the workstation to the console port **P1** of the MFN 100.

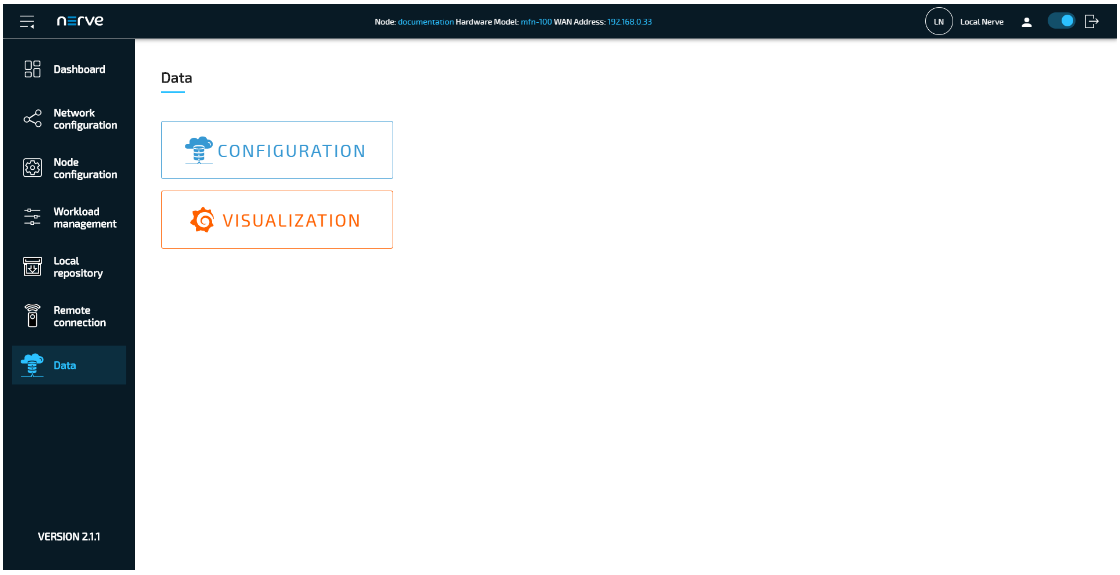
2. Configure the network adapter through which the workstation is connected to the MFN 100 the following way:

IP address	172.20.2.90
Subnet mask	255.255.255.0

3. Follow this link to reach the Local UI: http://172.20.2.1:3333.

4. Log in with the credentials from the customer profile.
5. Select **Data** in the navigation on the left.

6. Select **Gateway**.



7. Look for the following part of the currently loaded Gateway configuration:

```
"samplingIntervalAtServer_ms": 500,
 "nodes": [
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.iCountButton",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.iCountNumber",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.BOOL_1",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.BOOL_2",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.BOOL_3",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.BOOL_4",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.BOOL_5",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Integer_1",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Integer_2",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Integer_3",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Integer_4",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Integer_5",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Real_1",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Real_2",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Real_3",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Real_4",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.Real_5",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_1",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_2",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_3",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_4",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_5"
```

8. Edit the last line the following way to add a new variable called myVar1:

```
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_2",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_3",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_4",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.STRING_5",
    "ns=4;s=|var|Nerve_MFN_100 .Application.GVL.myVar1"
```

The variable is added as a fully qualified nodeId. Refer to Unified Automation for more information.

> **NOTE**
>
> This NodeId can be found out with an OPC UA Client such as UA Expert. Connect a workstation to **P1** of the MFN 100 and connect to `opc.tcp://172.20.2.2:4840` in the OPC UA Client.

9. Select **Apply** to save the Gateway configuration. The Gateway will restart automatically.

   ![[!Apply Gateway configuration]../img/data_opcua-ms01.png)

The data is automatically stored in the local TimescaleDB and also sent to the Management System. Refer to Nerve Data Services for more information.

Visualizing new variables

Newly added variables can also be visualized through the visualization element of the Data Services. The instructions below describe how to add new variables to the existing dashboard by adding a query. New dashboards can also be created for the new variables. Refer to Creating a dashboard for more information.

Adapting the local data visualization on the node

1. Connect the workstation to the console port **P1** of the MFN 100.

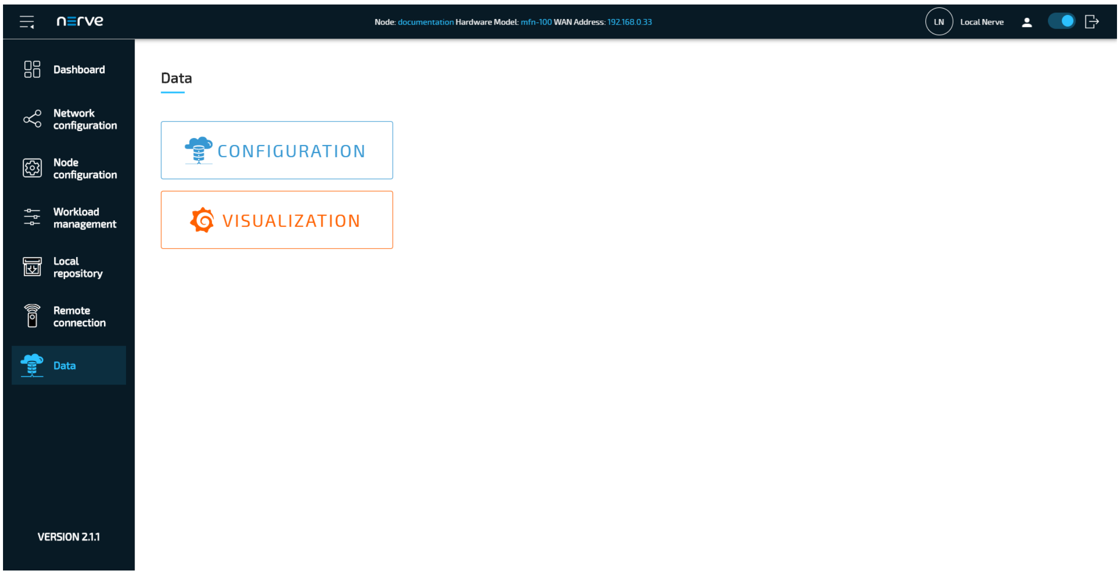
2. Configure the network adapter through which the workstation is connected to the MFN 100 the following way:

IP address	`172.20.2.90`
Subnet mask	`255.255.255.0`

3. Follow this link to reach the Local UI: http://172.20.2.1:3333.

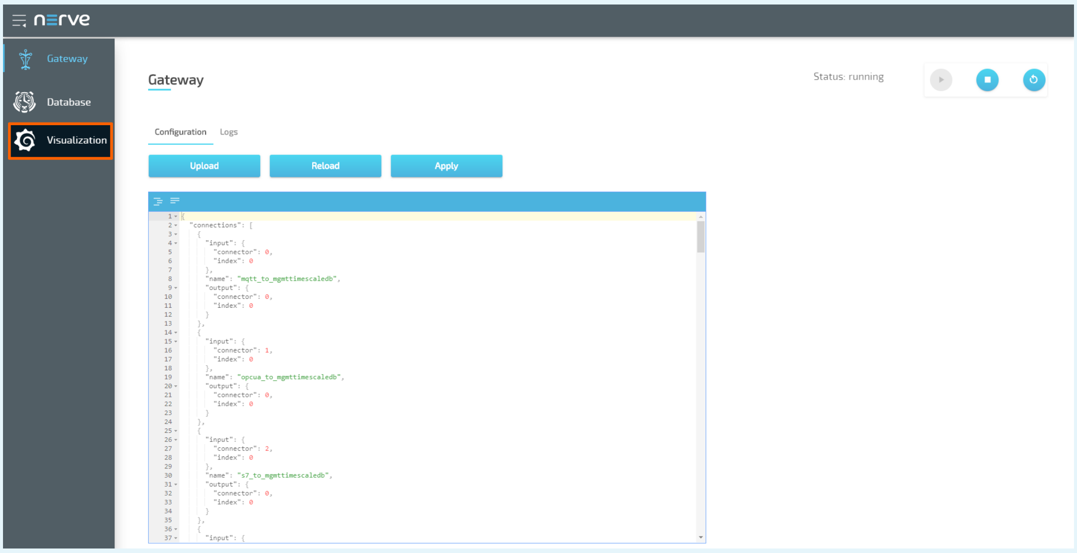
4. Log in with the credentials from the customer profile.
5. Select **Data** in the navigation on the left.

6. Select **Data**.



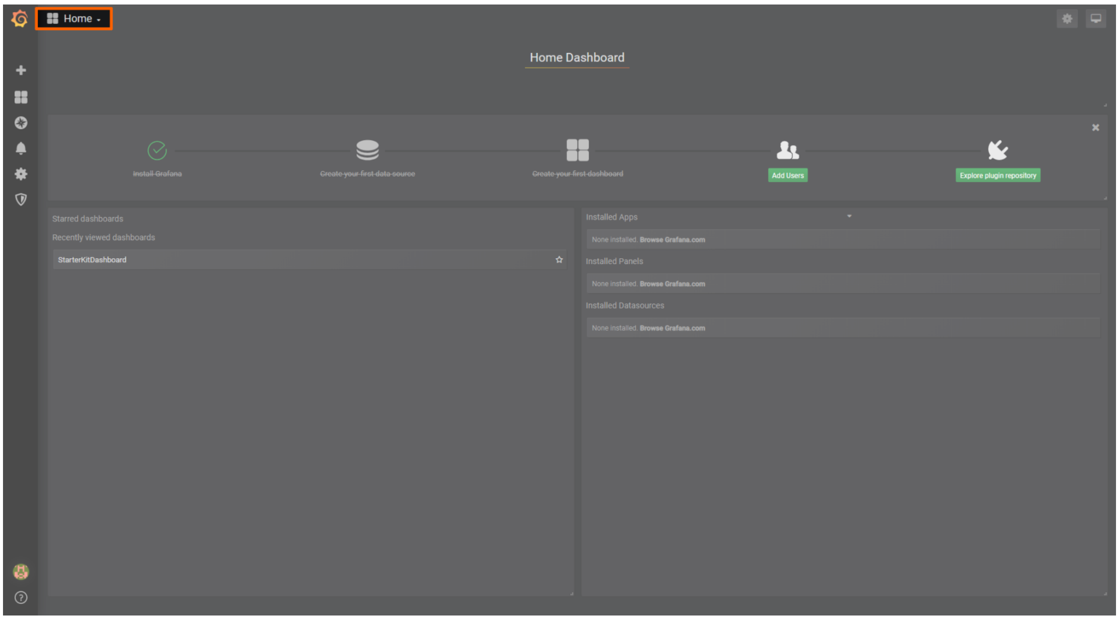
NOTE

The visualization element can also be reached from the Data Services UI. When in the Data Services UI, select **Data** in the navigation on the left and select **Open** to reach the Grafana UI.

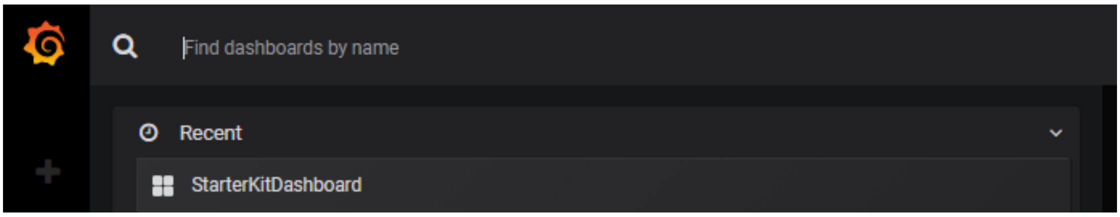


```
{
  "connections": [
    {
      "input": {
        "connector": 0,
        "index": 0
      },
      "name": "mqtt_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 1,
        "index": 0
      },
      "name": "opcua_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 2,
        "index": 0
      },
      "name": "s7_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
```

7. Select **Home** in the upper-left corner.


Home
Home Dashboard
Install Grafana
Create your first data source
Create your first dashboard
Add Users
Explore plugin repository
Starred dashboards
Recently viewed dashboards
StarterKitDashboard
Installed Apps
None installed. Browse Grafana.com
Installed Panels
None installed. Browse Grafana.com
Installed Datasources
None installed. Browse Grafana.com

8. Select **Nerve Kit** underneath the search bar.

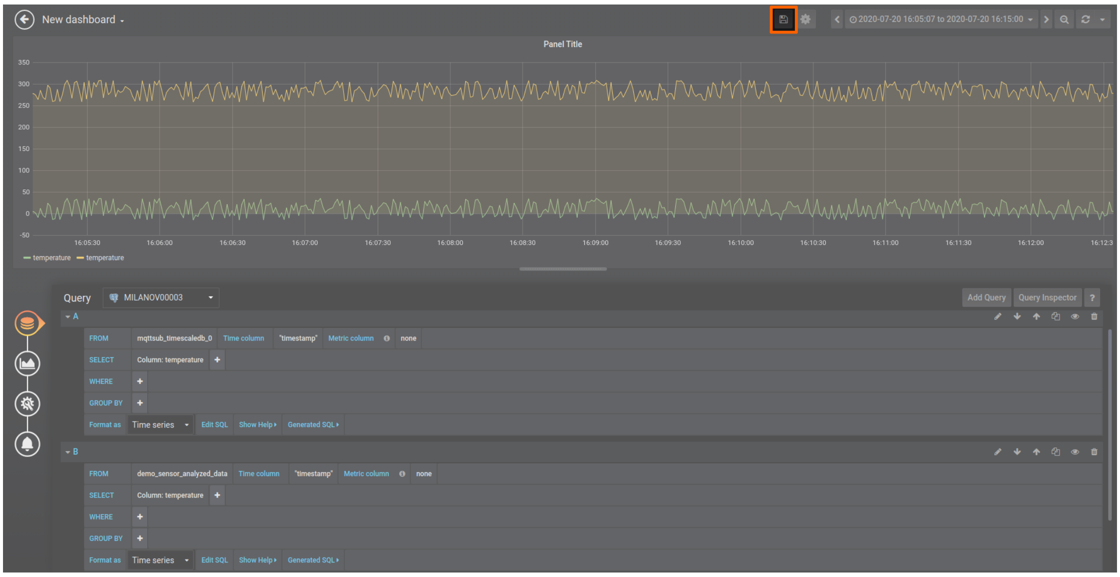


9. Select **Add Query** to the right to add a query for the new variable.

10. Fill in the following query information:

Setting	Value
FROM	`Codesys_to_localdb` **Time column**: "timestamp"
SELECT	Column: myVar1
Format as	Time series

11. Select the save icon in the upper-right corner to save the dashboard.



Query MILANOV00003

A
FROM mqttsub_timescaledb_0 Time column "timestamp" Metric column none
SELECT Column: temperature
WHERE
GROUP BY
Format as Time series Edit SQL Show Help Generated SQL

B
FROM demo_sensor_analyzed_data Time column "timestamp" Metric column none
SELECT Column: temperature
WHERE
GROUP BY
Format as Time series Edit SQL Show Help Generated SQL

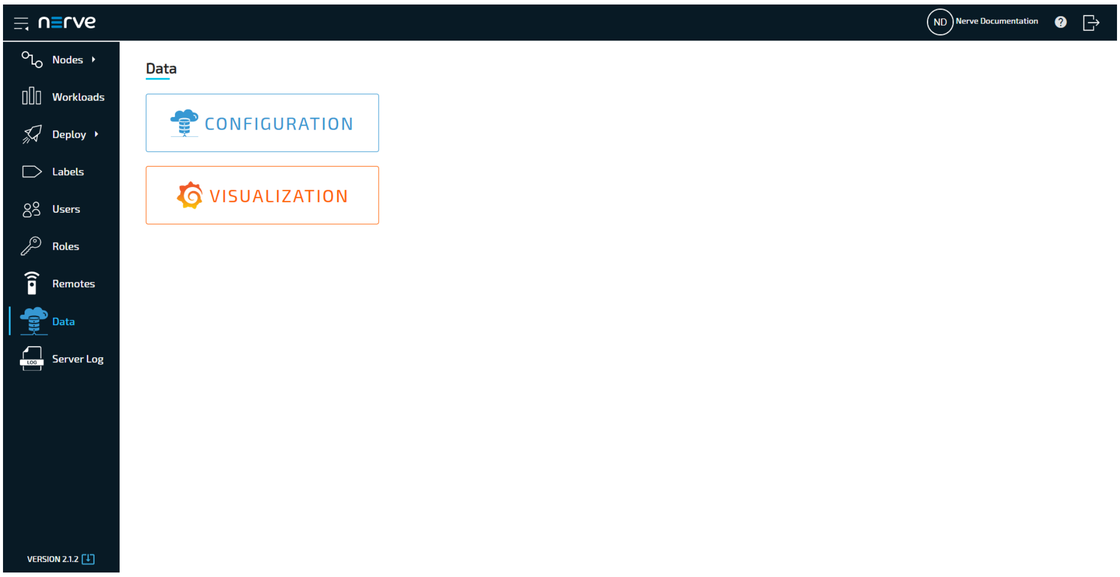
Adapting the central data visualization in the Management System

1. Log in to the Management System.

2. Select **Data** in the navigation on the left.

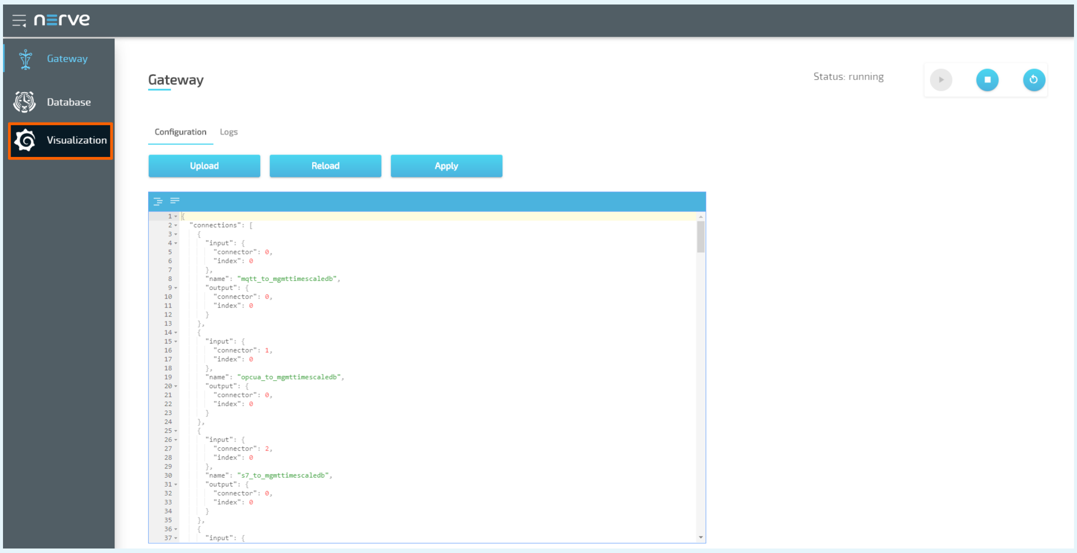
> **NOTE**
>
> If the menu item **Data** is not available, make sure the logged in user has the permission to access the Data Services. Refer to Assigning a role to a user for more information.

3. Select **Data**.



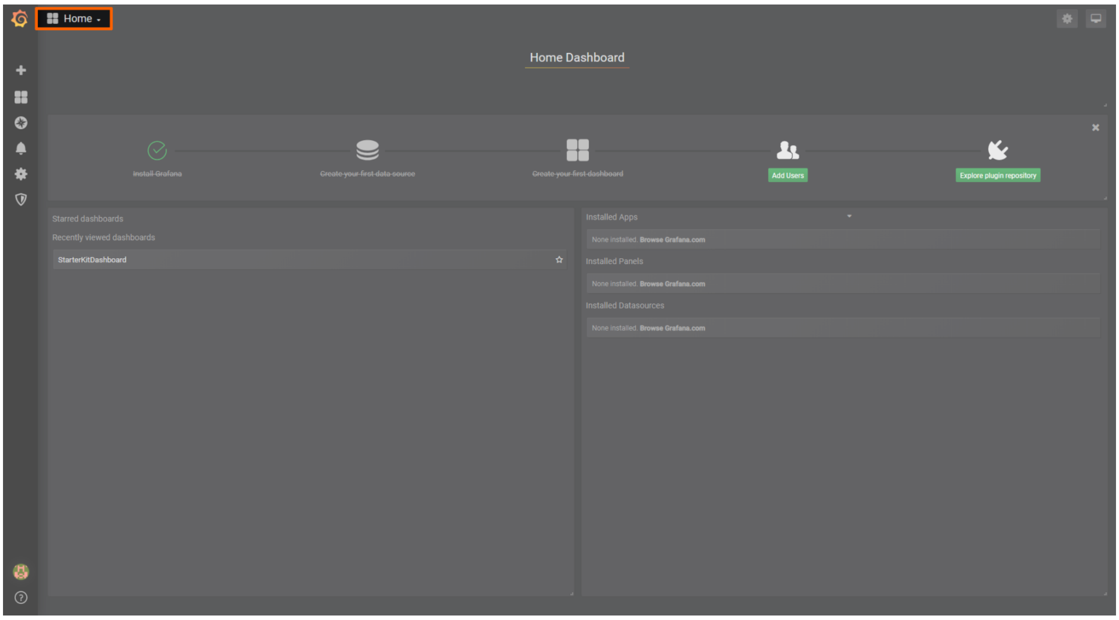
NOTE

The visualization element can also be reached from the Data Services UI. When in the Data Services UI, select **Data** in the navigation on the left and select **Open** to reach the Grafana UI.

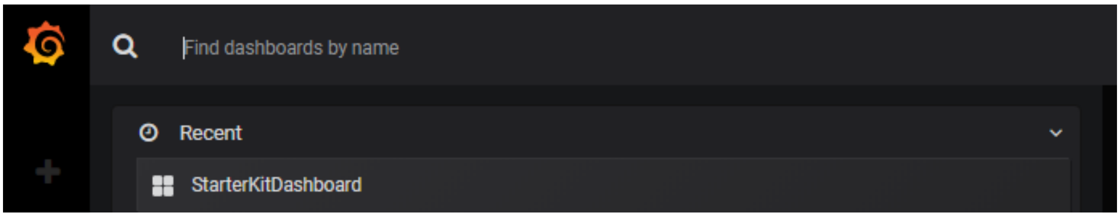


```
{
  "connections": [
    {
      "input": {
        "connector": 0,
        "index": 0
      },
      "name": "mqtt_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 1,
        "index": 0
      },
      "name": "opcua_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
        "connector": 2,
        "index": 0
      },
      "name": "s7_to_mgmttimescaledb",
      "output": {
        "connector": 0,
        "index": 0
      }
    },
    {
      "input": {
```

4. Select **Home** in the upper-left corner.


Home
Home Dashboard
~~Install Grafana~~
~~Create your first data source~~
~~Create your first dashboard~~
Add Users
Explore plugin repository
Starred dashboards
Recently viewed dashboards
StarterKitDashboard
Installed Apps
None installed. Browse Grafana.com
Installed Panels
None installed. Browse Grafana.com
Installed Datasources
None installed. Browse Grafana.com

5. Select **Nerve Kit** underneath the search bar.

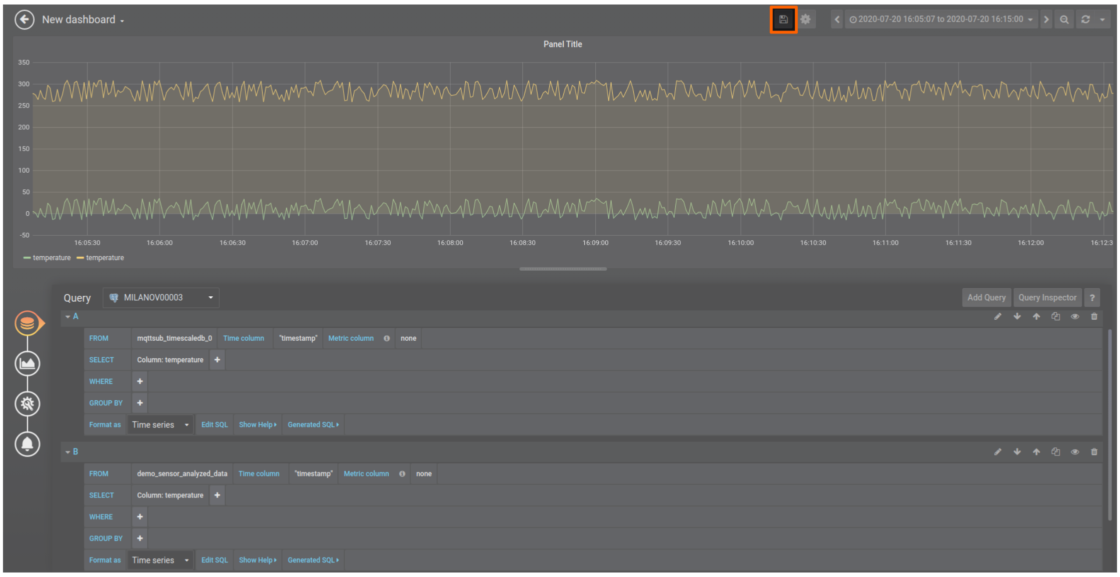


6. Select **Add Query** to the right to add a query for the new variable.

7. Fill in the following query information:

Setting	Value
FROM	`ms_mqtt_broker_to_cloud_timescale_db` **Time column**: "timestamp"
SELECT	Column: myVar1
Format as	Time series

8. Select the save icon in the upper-right corner to save the dashboard.



Query: MILANOV00003

A

FROM mqttsub_timescaledb_0 Time column "timestamp" Metric column none

SELECT Column: temperature +

WHERE +

GROUP BY +

Format as Time series Edit SQL Show Help Generated SQL

B

FROM demo_sensor_analyzed_data Time column "timestamp" Metric column none

SELECT Column: temperature +

WHERE +

GROUP BY +

Format as Time series Edit SQL Show Help Generated SQL