Operating instruction manual

netFIELD App PROFINET Tap

Hilscher Gesellschaft für Systemautomation mbH
www.hilscher.com

DOC200502OI02EN | Revision 2 | English | 2020-09 | Released | Public

Table of contents

1 Introduction 4
1.1 Description of the contents 4
1.2 List of revisions 4
1.3 Conventions in this document 5
2 Overview 6
2.1 Brief description 6
2.2 Connecting the PROFINET Tap device to PROFINET 7
2.2.1 Overview 7
2.2.2 Connection via netMIRROR 7
2.2.3 Connection via mirror port of switch 10
2.2.4 Connection without hardware mirror 11
3 Deploying the container 13
3.1 Step-by-step instructions 13
3.2 Changing default Container settings in netFIELD Portal (experts only) 15
3.2.1 Overview 15
3.2.2 Container Create Options 17
3.2.3 Environment Variables 18
3.2.4 Container Twin 20
4 Configuring the PROFINET Tap in local Device Manager 21
4.1 Overview 21
4.2 “Status” tab 22
4.3 “About” tab 23
4.4 “Configuration Backup” tab 24
4.5 “Publisher Management” tab 26
4.6 MQTT Client Settings 28
4.7 OT Interface settings 30
4.8 PROFINET configuration 31
4.8.1 Overview 31
4.8.2 GSDML Management 39
4.8.3 AutomationML Management 42
4.8.4 How to configure the PROFINET Tap with GSDML file 46
4.8.5 How to configure the PROFINET Tap with AutomationML file 54
5 Good to know... 60
5.1 MQTT message format 60
5.2 Restrictions concerning AutomationML export from TIA Portal and mapping in PROFINET Tap 62
5.3 Mapping of TIA Portal data types to PROFINET Tap-supported data types 63
5.4 Using SSL/TLS encryption (optional) 65
6 Legal notes 66
List of Figures 70
List of Tables 72

Contacts..... 73

1 Introduction

1.1 Description of the contents

This document describes the netFIELD App **PROFINET Tap** from Hilscher.

1.2 List of revisions

Index	Date	Author	Revision
1	2020-06-04	MKE	Document created
2	2020-09-02	MKE	Document revised and updated to netFIELD App PROFINET Tap version 1.1.x Section *"Status" tab* [▷ page 22] added. Section *How to configure the PROFINET Tap with AutomationML file* [▷ page 54] added. Section *AutomationML Management* [▷ page 42] added. Section *Restrictions concerning AutomationML export from TIA Portal and mapping in PROFINET Tap* [▷ page 62] added. Section *Mapping of TIA Portal data types to PROFINET Tap-supported data types* [▷ page 63] added.

Table 1: List of revisions

1.3 Conventions in this document

Notes, operation instructions and results of operation steps are marked as follows:

Notes

Important:
<important note>

Note:
<simple note>

<note, where to find further information>

Operation instructions

1. <operational step>
   - ➢ <instruction>
   - ➢ <instruction>
2. <operational step>
   - ➢ <instruction>
   - ➢ <instruction>

Results

<intermediate result>

<final result>

2 Overview

2.1 Brief description

PROFINET Tap is a netFIELD application Docker container that monitors PROFINET traffic and publishes selected machinery process data via MQTT.
The container is to be deployed (i.e. installed) in the Standard Docker or in the IoT Edge Docker of the netFIELD Operating System (netFIELD OS) running on Hilscher Edge Devices (like e.g. the **netFIELD OnPremise** device).
The deployment of the container is described in chapter *Deploying the container* [page 13].

After connecting your Edge Device to your PROFINET network, the PROFINET Tap container allows you to “tap into” the process data and to run data analytics applications without interfering neither with your existing network setup nor with your PROFINET data exchange. Because there is no need to change the configuration of your PLC or machinery, it can thus be easily used in “brown-field” plants/automation networks.
Ways of connecting the PROFINET Tap to a network are described in section *Overview* [page 7].

PROFINET Tap features a plug-in configuration GUI for the netFIELD OS, which can be easily accessed via web-browser without having to install any additional software tools. The included “auto-mapping” function allows you to assign data semantics and symbols from GSDML and/or AutomationML files conveniently to your PROFINET Tap configuration.
This configuration GUI is described in chapter *Configuring the PROFINET Tap in local Device Manager* [page 21].

Note that the PROFINET Tap container publishes the acquired data via MQTT and thus requires an MQTT Broker for operation. The MQTT Broker can be running on the same Edge Device, or you can use an “external” Broker if you allow the PROFINET Tap to reach the external Broker via physical network.

Note also that publishing data to the netFIELD Platform respectively netFIELD Portal requires the netFIELD App *Platform Connector* (formerly known as *netFIELD Proxy* container) on the same netFIELD OS.

2.2 Connecting the PROFINET Tap device to PROFINET

2.2.1 Overview

The netFIELD App PROFINET Tap requires a host device that is equipped with the netFIELD OS, like e.g. the Hilscher **netFIELD OnPremise** Edge Device.
This section shows ways of connecting your netFIELD OS device (on which the PROFINET Tap container is running) to a PROFINET network, using the **netFIELD OnPremise** device as example.

Note that it is best practice to place the OnPremise device (respectively the “mirror” device [like netMIRROR device or a Switch-Mirror-Port] if you are using one) between the IO Controller and the first IO Device of the PROFINET, because this usually the position where all process data frames of all devices will be present for capturing.

2.2.2 Connection via netMIRROR

You can use the Hilscher **netMIRROR** (NMR-TFE-RE, part no. 7340.100) device as a hardware-based “tap” (test access point) in connection with your netFIELD OnPremise device. The netMIRROR device “mirrors” the Ethernet data traffic with virtually no delay (~1 ns) and without affecting the OT network. It can be placed easily between your IO Controller and the first IO Device (respectively switch) without further PLC “engineering”.
In addition, by using such a hardware mirror, you avoid the risk of traffic disruption if the OnPremise device is turned off or configured, or if a software update is performed on that device.

For technical information about the **netMIRROR** device, see user manual *netMIRROR – NMR-TFE-RE,* DOC161104UMxxEN.

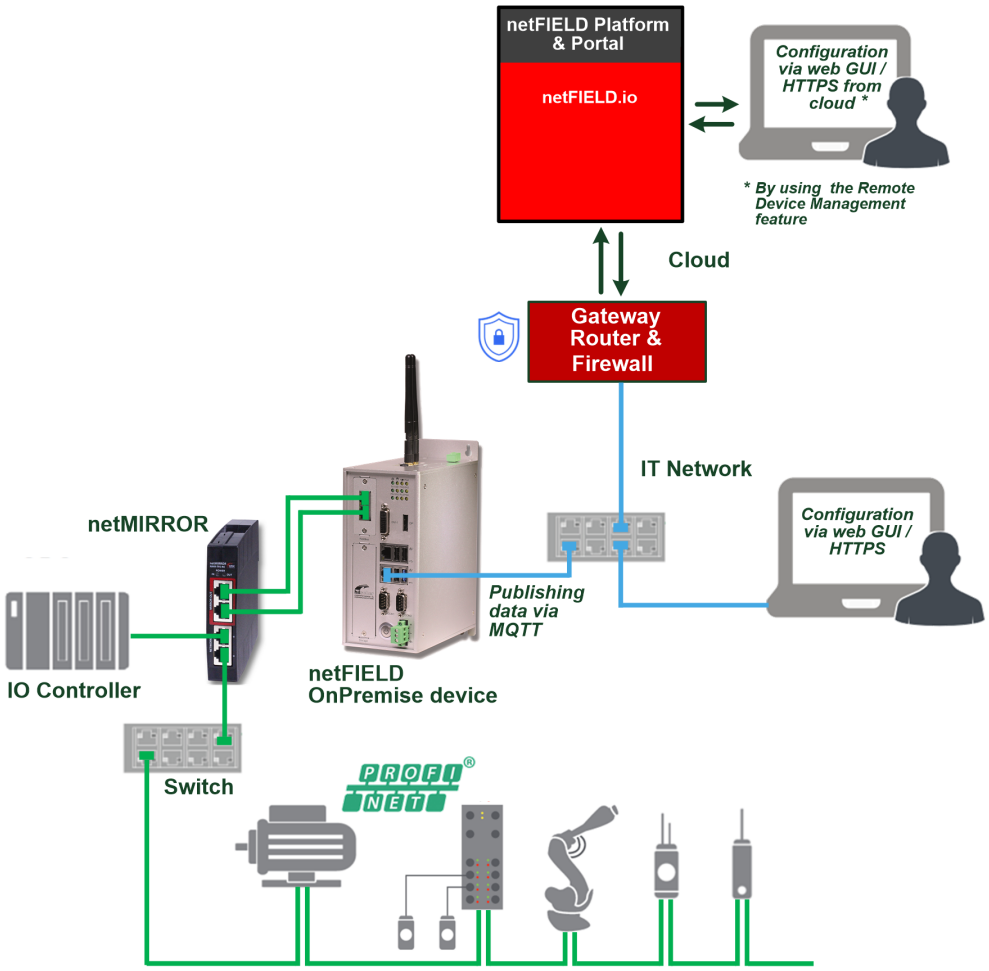

Figure 1: Connection via netMIRROR and OnPremise device

- Connect one of the **NETWORK** ports of the netMIRROR to the Controller. Connect the other **NETWORK** port of the netMIRROR to the switch (respectively to the first PROFINET Device).
- Connect *both* **MIRROR OUT** ports of the netMIRROR to the **Fieldbus** ports of the OnPremise device.
  You can use “patch” or “crossover” cables. We recommend you to use a *patch* cable for **MIRROR OUT** port **A**, and a *crossover* cable for **MIRROR OUT** port **B**.
  (If you change the cable type or the port of the netMIRROR, you may have to restart the OnPremise device in order to re-establish the Ethernet link with the netMIRROR.)
- For accessing the PROFINET Tap configuration GUI with your web browser, connect the LAN interface of the OnPremise device to your local IT network. You can login to the local Device Manager (featuring the configuration GUI) from your local PC (situated within your LAN), or from the netFIELD Portal via Remote Device Management (see section *Remote Control* in the *netFIELD Portal* manual, DOC190701OIxxEN).

Note:
Set the port speed of the PROFINET Ethernet interface of the OnPremise device to `100 MBit/s fixed`.
This can be done in the configuration GUI of the PROFINET Tap in the local Device Manager (see section *OT Interface settings* [page 30]).

2.2.3 Connection via mirror port of switch

You can connect the On-Premise device to the mirror port of a switch.

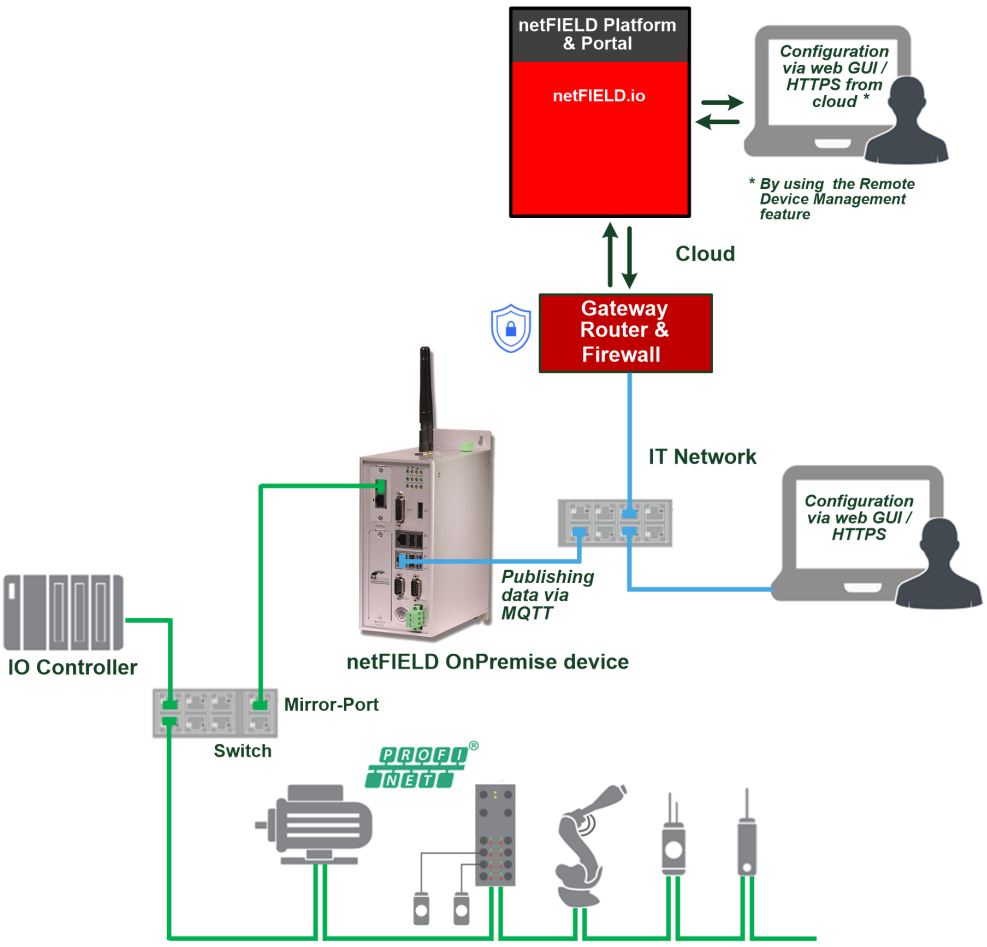

Figure 2: Connection via mirror port of switch

- Connect the mirror port of the switch to one of the **Fieldbus** ports of the OnPremise device.
- For accessing the PROFINET Tap configuration GUI with your web browser, connect the LAN interface of the OnPremise device to your local IT network. You can login to the local Device Manager (featuring the configuration GUI) from your local PC (situated within your LAN), or from the netFIELD Portal via Remote Device Management (see section *Remote Control* in the *netFIELD Portal* manual, DOC190701OIxxEN).

Note:

Set the port speed of the PROFINET Ethernet interface of the OnPremise device (`Automatic`, `100 MBit/s fixed` or `10 MBit/s fixed`) according to the configuration of the switch mirror port (typically: `Automatic`). This can be done in the configuration GUI of the PROFINET Tap in the local Device Manager (see section *OT Interface settings* [page 30]).

2.2.4 Connection without hardware mirror

In this setup you connect the OnPremise device directly to the IO Controller, without interposed "hardware mirroring".

Note:
This variant may disrupt traffic on the OT network in the following events:
– If the OnPremise device is turned off or configured
– If a firmware update is performed on the device
– If the PROFINET Tap container is stopped or restarted
– If the OT network settings are changed

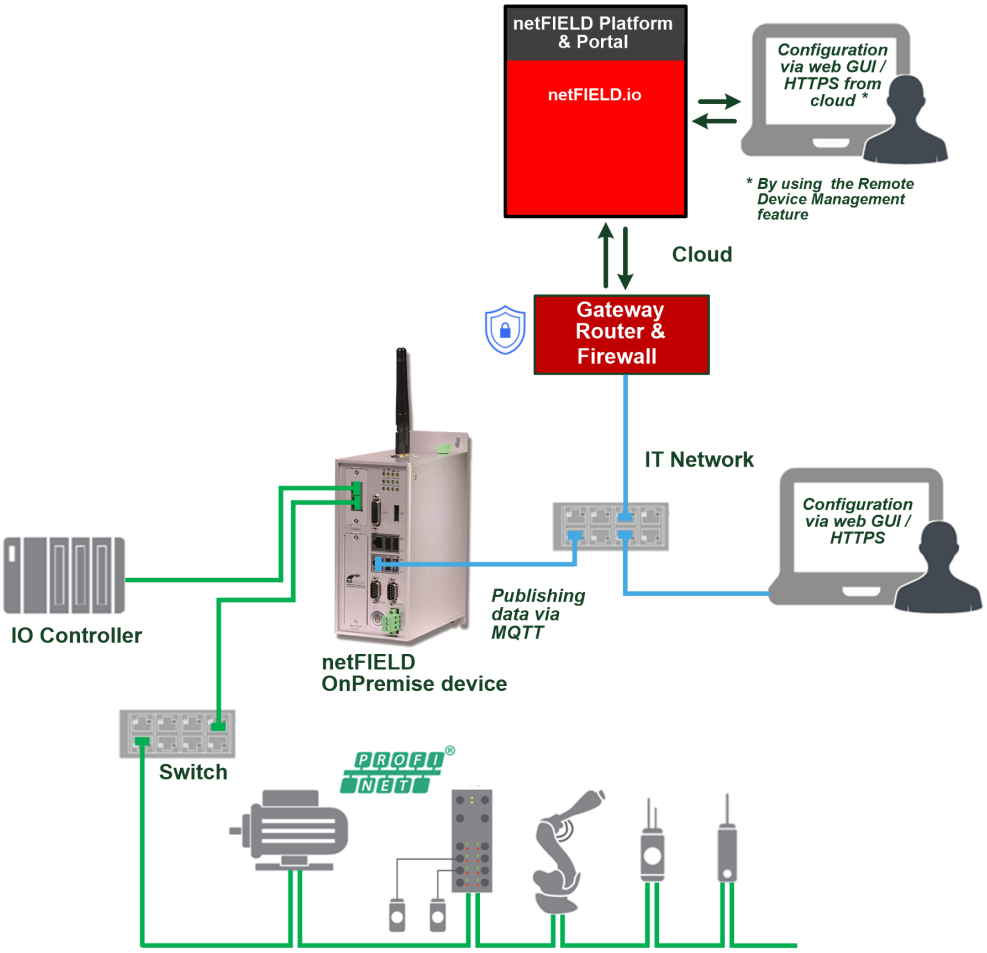

Figure 3: Connection without hardware mirror

- Connect the Controller to one of the **Fieldbus** ports of the OnPremise device. Connect the other **Fieldbus** port of the OnPremise device to the switch (respectively to the first PROFINET Device).
- For accessing the PROFINET Tap configuration GUI with your web browser, connect the LAN interface of the OnPremise device to your local IT network. You can login to the local Device Manager (featuring the configuration GUI) from your local PC (situated within your LAN), or from the netFIELD Portal via Remote Device Management (see section *Remote Control* in the *netFIELD Portal manual*, DOC190701OIxxEN).

Note:

Set the port of the PROFINET Ethernet interface of the OnPremise device speed (`Automatic`, `100 MBit/s fixed` or `10 MBit/s fixed`) according to the configuration of the Ethernet ports of the connected devices (typically: `Automatic`).
This can be done in the configuration GUI of the PROFINET Tap in the local Device Manager (see section *OT Interface settings* [page 30])

3 Deploying the container

3.1 Step-by-step instructions

This section describes how to deploy (“install”) the *netFIELD App PROFINET Tap* on your Edge Device (like e.g. netFIELD OnPremise).

Note:
This manual deployment is only necessary if the container has not already been deployed via *Deployment Manifest* during device onboarding.
Check the **Installed Containers** tab (Device Manager > [your device] > DEVICE NAVIGATION > Containers > Installed Containers) to see if the container has already been deployed and is running on the device.

➢ Select your device in the Portal’s **Device Manager** and open the **Available Containers** tab in the DEVICE NAVIGATION (DEVICE NAVIGATION > Containers > Available Containers).

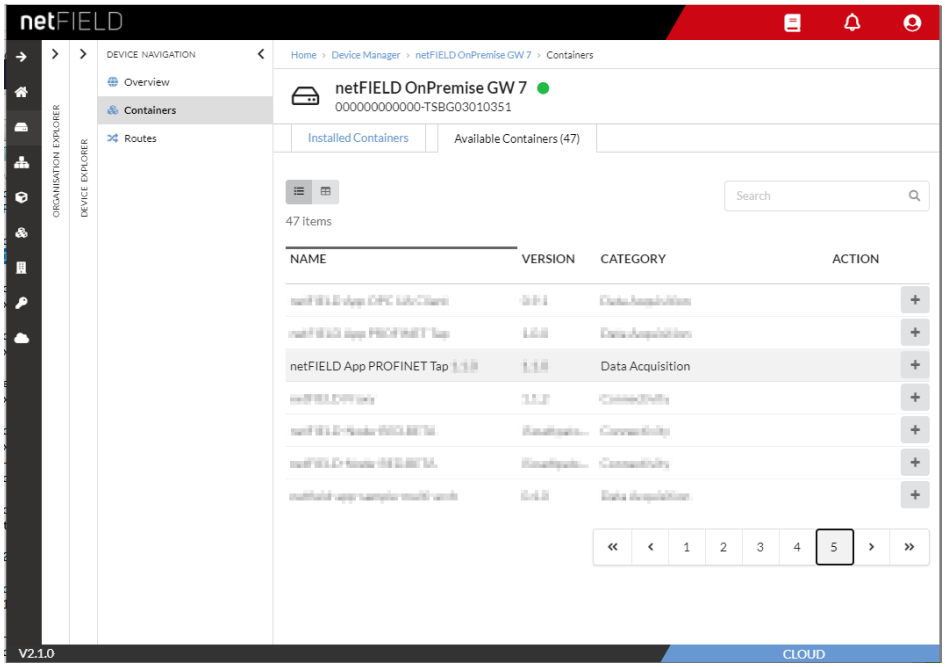

Figure 4: Available Containers tab

➢ Scroll through the list and look for the **netFIELD App PROFINET Tap** container.

➢ Click on the **netFIELD App PROFINET Tap** entry or on the **+** button.

The deployment dialog screen opens:

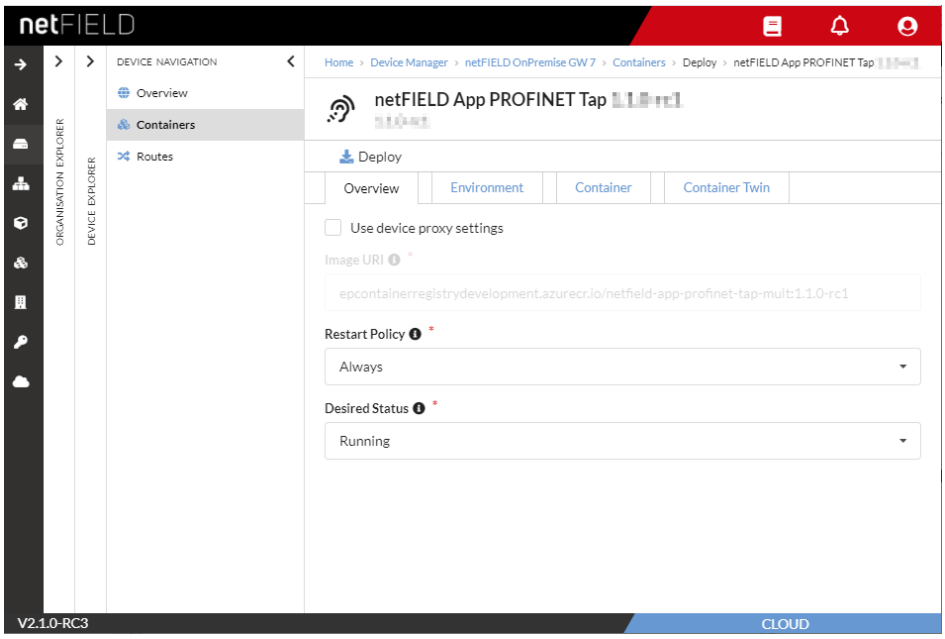

Figure 5: Deploy container

➢ In the **Overview** tab, keep the default settings; i.e. **Restart Policy** = **Always** and **Desired Status** = **Running**. This ensures that the container will be automatically started on the device after deployment. You can ignore the **Use device proxy settings** option (not relevant because the PROFINET Tap container does not establish any HTTP, HTTPS or FTP connections).

Important:

We strongly recommend you to keep also the default **Environment Variables**, **Container Create Options** and **Container Identity Twin** settings.
If necessary, these configuration settings can be changed later (i.e. after having deployed the container). The settings are described in section *Changing default Container settings in netFIELD Portal (experts only)* [page 15].
Note that only expert users should change these settings.

➢ Click **Deploy** button.

The container image is downloaded from the cloud to the device, and automatically started on the device. This may take a few minutes. After its deployment, the container will from now on be listed in the **Installed Containers** tab of your device.

Note:

Note that you must also deploy an MQTT Broker on your device. PROFINET Tap is pre-configured for the *Mosquitto* MQTT Broker, which is also available for deployment in the **Available Containers** tab.

3.2 Changing default Container settings in netFIELD Portal (experts only)

3.2.1 Overview

If you do not want to use the default container configuration settings, you can change them before deployment, or even retroactively after deployment (i.e. if the container has already been installed on the device) by using the **Update** button. After the new settings have been saved, they are automatically transferred to the container on the device.

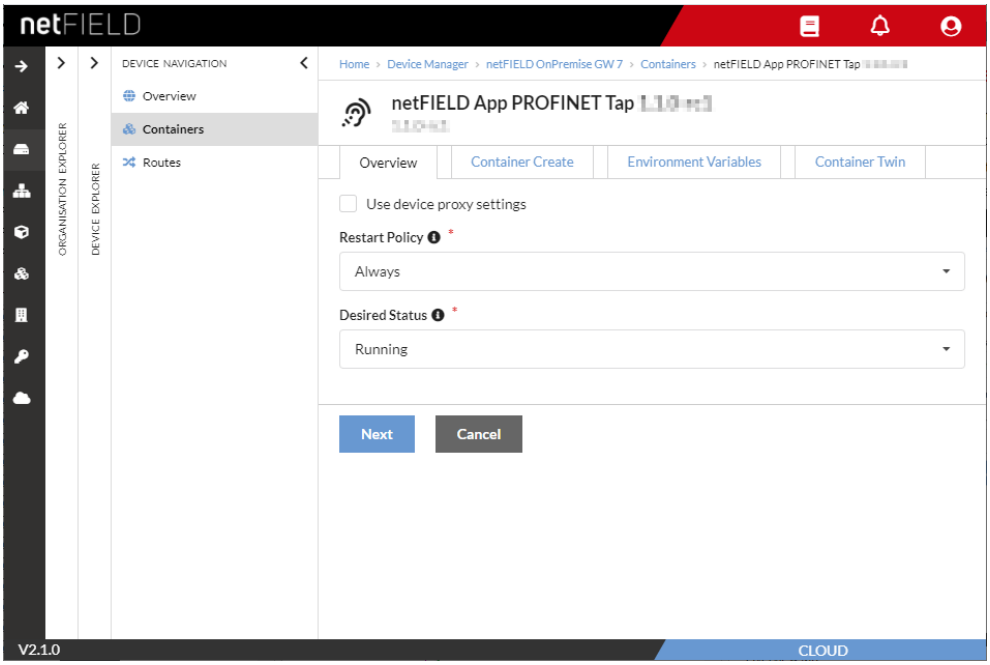

Figure 6: Overview tab

Elements	Description	
Use device proxy settings	If your device uses an HTTP or HTTPS proxy server in its local IT network you can choose here that the container should use the same proxy server settings that are stored for the device in the portal. **Note**: This option is not applicable for the PROFINET Tab because it does not establish any HTTP, HTTPS or FTP connections.	
Restart Policy	In the drop-down list, you can determine under which conditions the container on the device is to be restarted by the system. **Note**: This parameter was originally defined in the **Container Manager**, but can be changed and adapted here if necessary. Changes here have no effect on the original settings in the **Container Manager**.	
	Always	The container is always restarted, no matter why it was deactivated or crashed.
	Never	The container is never restarted.
	On-Failed	The container is restarted when it crashes, but not if it has been "properly" deactivated.
	On-Unhealthy	The container is restarted when it crashes or is diagnosed as "unhealthy" by the system.

Elements	Description	
Desired Status	In the drop-down list, you can determine the operating state in which the container shall be after its deployment. **Note**: This parameter was originally defined in the **Container Manager**, but can be changed and adapted here if necessary. Changes here have no effect on the original settings in the **Container Manager**.	
	Stopped	The system does not start the container until it receives the command to do so (locally on the device using CLI or by updating the configuration in the portal).
	Running	The system starts the container immediately (i.e. as soon as the image has been completely downloaded to the device).
Next	Opens the next **Update** tab. There you can save the changes with the **Save** button and transfer them to the container on the device.	
Cancel	Closes the **Update** tab without saving changes.	

Table 2: Elements in Overview tab

3.2.2 Container Create Options

The Container Create Options in stringified JSON format contain the initial configuration parameters of the container.

Important:
Do not change these parameters unless you are an expert user. Wrong settings may lead to malfunctions of the application container.

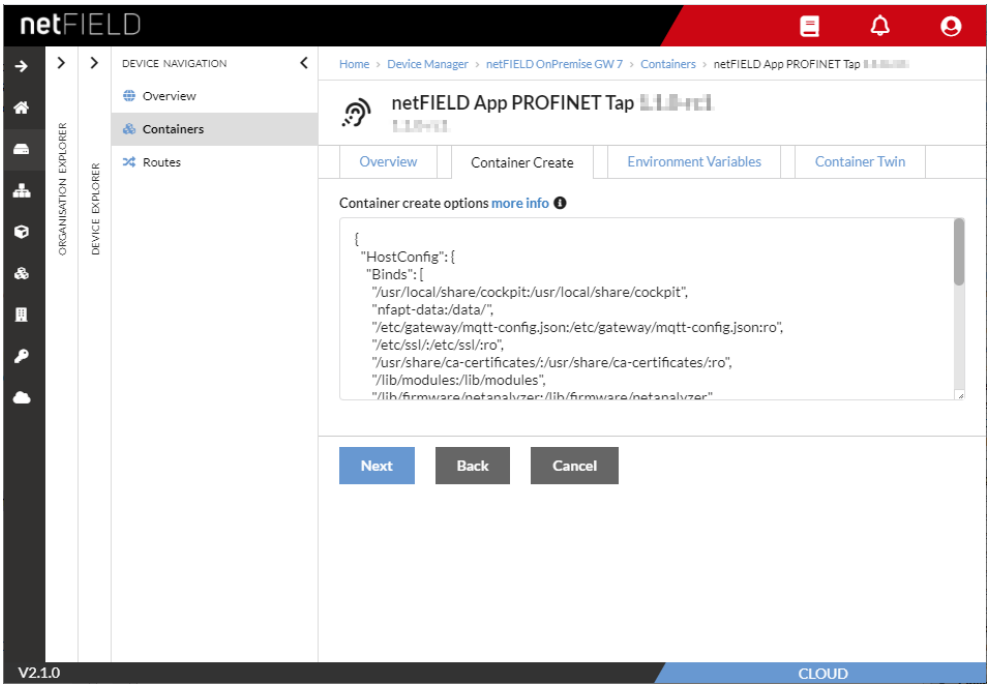

Figure 7: Container Create Options

Element	Description
Next	Opens the next **Update** tab.
Back	Opens the previous **Update** tab.
Cancel	Closes the **Update** tab without saving changes.

Table 3: Operating elements for Container Create Options

3.2.3 Environment Variables

With the environment variables, you can customize certain container configuration settings for your target device (i.e. the “environment”).

Important:
Do not change these parameters unless you are an expert user. Wrong settings may lead to malfunctions of the application container.

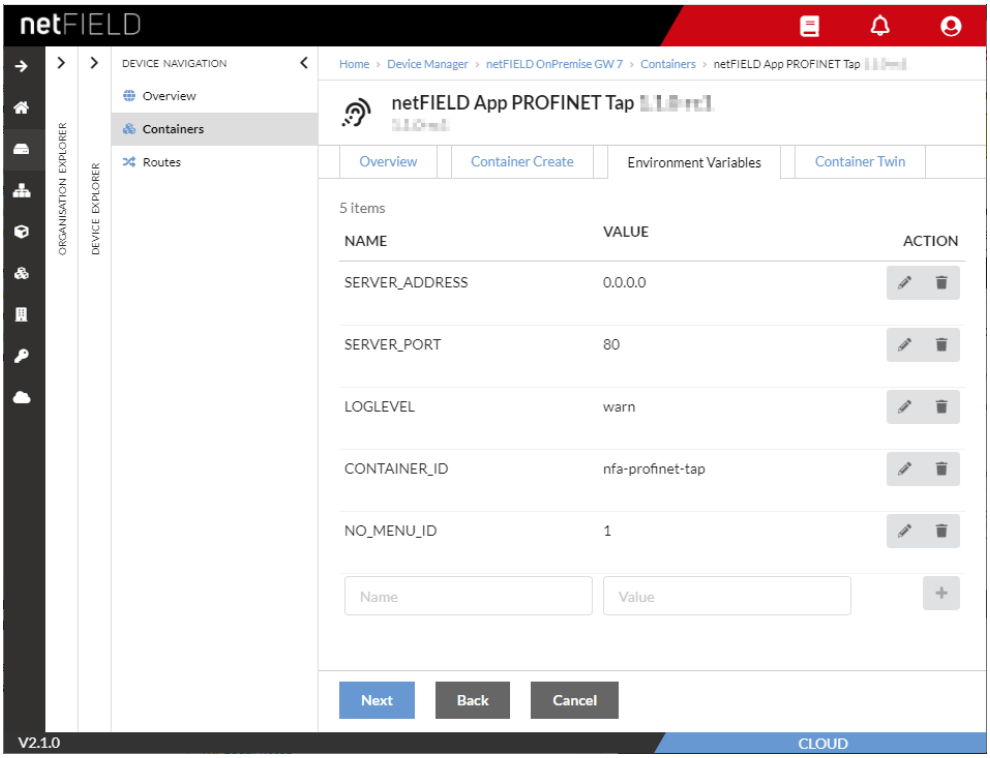

Figure 8: Environment Variables

Variable	Description
SERVER_ADDRESS	IP address of the internal web server of the container. Set by default to local host (`0.0.0.0`). This default setting ensures that the container can be accessed only by the local Device Manager of the netFIELD OS. **Important**: Do not change this parameter unless you are an expert user.
SERVER_PORT	Port of the internal web server of the container. Set by default on port `80`. **Important**: Do not change this parameter unless you are an expert user.
LOGLEVEL	Defines what kind of messages issued by container will be logged by the netFIELD OS. The preset `warn` level means that all messages belonging to the “severity level” **Warning and above** will be logged. **Important**: Do not change this parameter unless you are an expert user. Changing to a lower level can lead to the issuing of too many messages, which can cause log overflow.

Variable	Description
CONTAINER_ID	Additional ID for labelling individual containers. The ID is set by default to nfa-profinet-tap (for “netFIELD App PROFINET Tap”). It can be customized by the user, e.g. to distinguish between container instances that are to be deployed on different devices. This ID will be used in MQTT topics for distinction. It will also be displayed in the Name field of the configuration GUI of the container in the local Device Manager. If the NO_MENU_ID variable (see below) is set to 0, it will also be displayed in the navigation panel of the local Device Manager.
NO_MENU_ID	If the value is set to `0`, the CONTAINER_ID (see above) will be displayed behind the netFIELD App PROFINET Tap entry in the navigation panel of the local Device Manager (see position (1) in section *Overview* [▸ page 21]). If the value is `1` (i.e. ≠ `0`), the CONTAINER_ID will not be displayed in the navigation panel of the local Device Manager.

Table 4: Environment Variables

Element	Description
	Select this button to change name or value of the variable. Use the  button to save your changes for the time being.
	Deletes the variable.
	Adds a new variable. First fill-in the **NAME** and **VALUE** fields, then click  button to add the variable.
Next	Opens the next **Update** tab.
Back	Opens the previous **Update** tab.
Cancel	Closes the **Update** tab without saving changes.

Table 5: Operating elements for Environment Variables

3.2.4 Container Twin

Container Twin options are not applicable for this container.

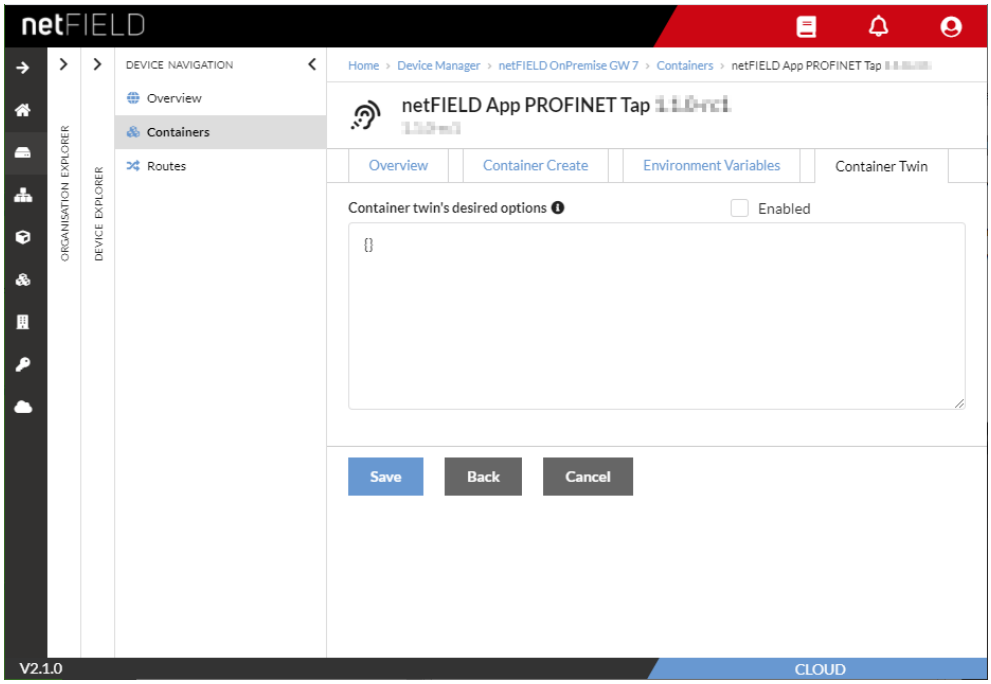

Figure 9: Container Twin

Element	Description
Enabled	Select the checkbox to edit this field.
Save	Saves your changes. The changes parameters are then automatically transferred to the container on the device. **Note**: The application of the changed parameters requires a restart of the container on the device.
Back	Opens the previous **Update** tab.
Cancel	Closes the **Update** tab without saving changes.

Table 6: Operating elements for Container Twin Options

4 Configuring the PROFINET Tap in local Device Manager

4.1 Overview

The PROFINET Tap container provides a configuration GUI in the local Device Manager of the netFIELD OS. This configuration GUI is automatically plugged-in when the container is deployed. After having established a connection to the local Device Manager (e.g. by Remote Control from the netFIELD Portal, see section *Remote Control* in the *netFIELD Portal* manual, DOC190701OIxxEN), the configuration GUI can be selected in the navigation panel (1) of the local Device Manager. Note that it might take a few minutes after deployment before the netFIELD App PROFINET Tap entry becomes visible in the navigation panel. You may also have to reload the web page in your browser by pressing F5 on your keyboard.

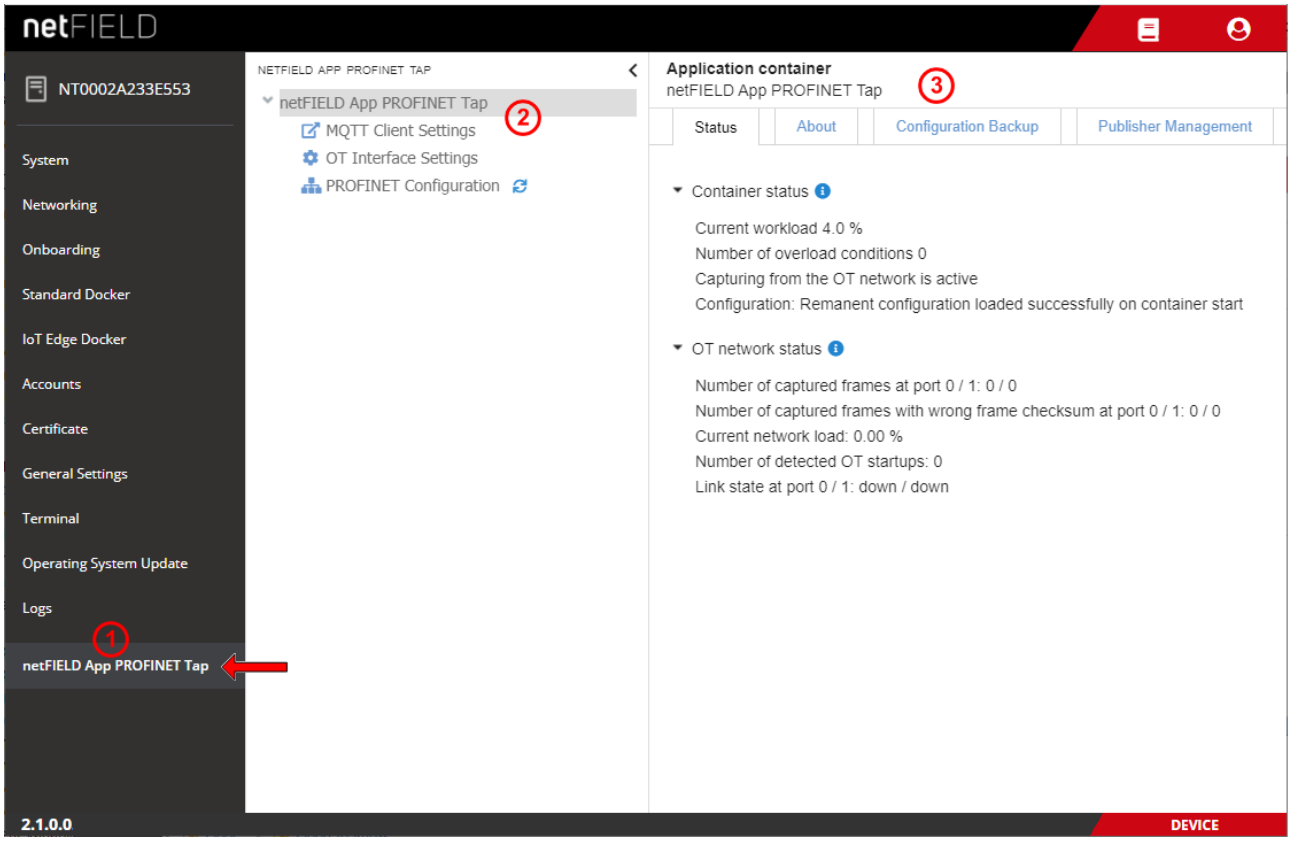

Figure 10: Configuration GUI plugin in local Device Manager

You can navigate through the configuration options by selecting an item in the navigation tree (2). Further parameters/configuration options can be selected in the tabs in the editor window (3) on the right side of the screen.

4.2 “Status” tab

The **Status** tab shows information about the operating state of the PROFINET Tap and of the PROFINET OT network.

To open the **Status** tab, first select the **netFIELD App PROFINET** Tap root element in the navigation tree, then the **Status** tab in the Editor window.

Hovering over an entry will display extra information in a tooltip.

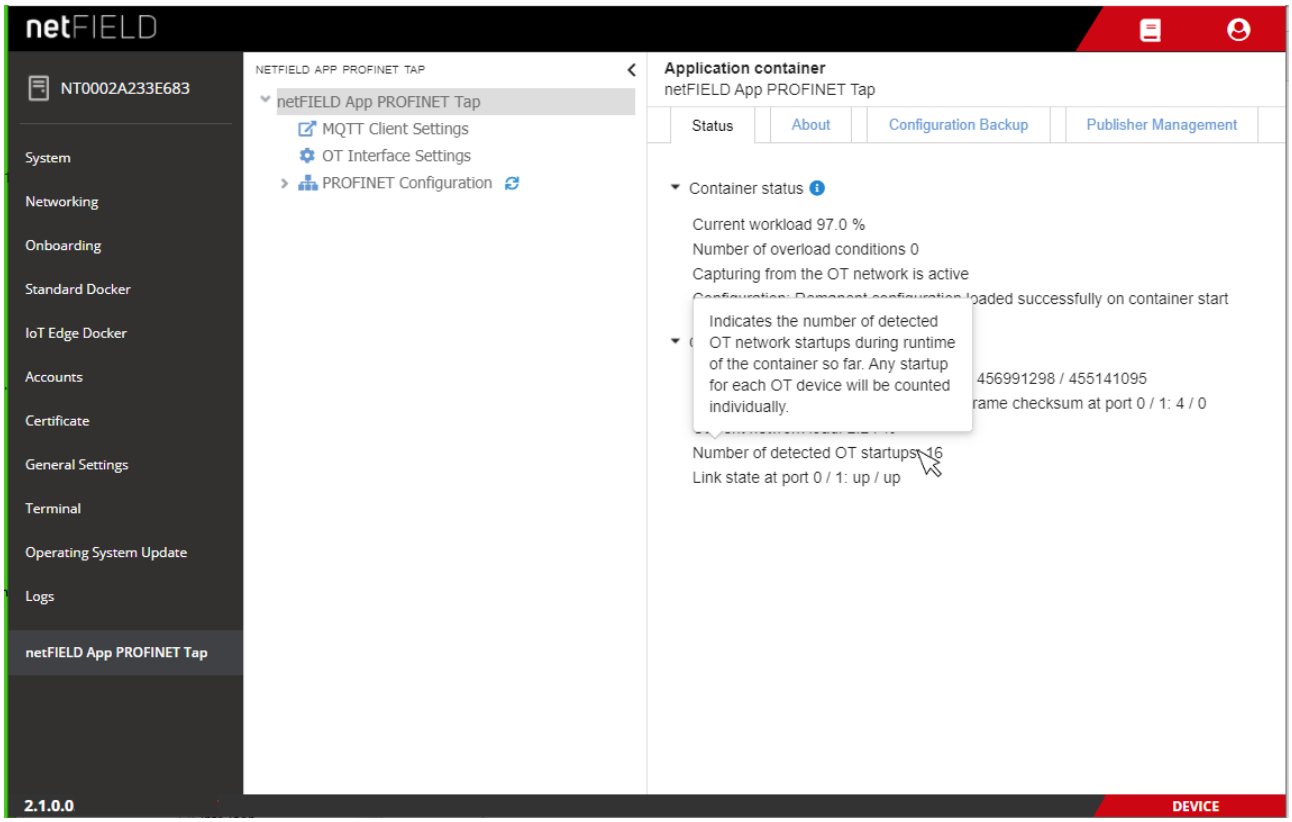

Figure 11: Status page

4.3 “About” tab

The **About** tab shows general information about the container.

To open the **About** tab, first select the **netFIELD App PROFINET** Tap root element in the navigation tree, then the **About** tab in the Editor window.

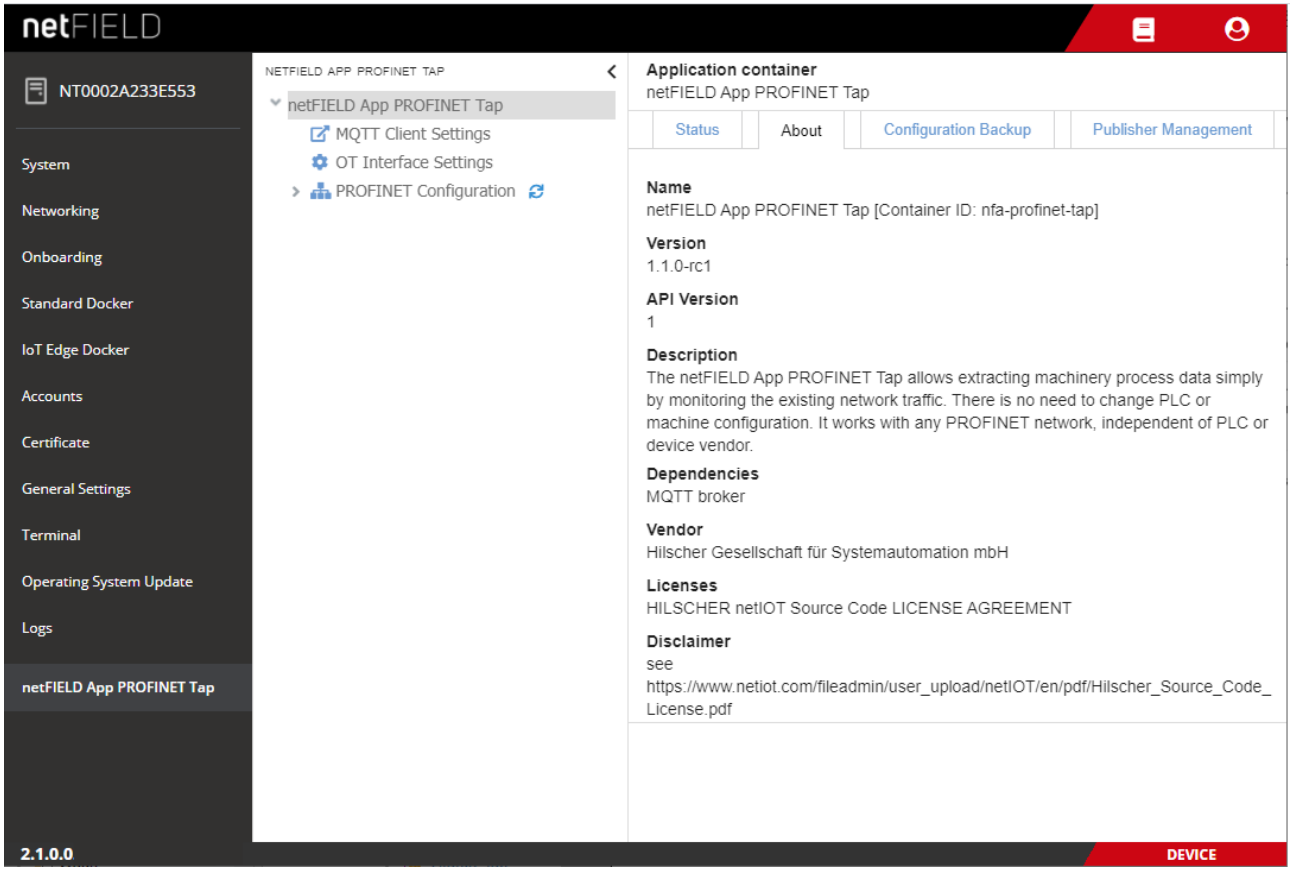

Figure 12: About tab

Category	Description
Name	Container name and Container ID **Note**: the Container ID can be customized in the Portal in the **Environment Variables** of the container (see chapter *Changing default Container settings in netFIELD Portal (experts only)* [page 15])
Version	Container software version
API Version	Version of the API connecting the GUI to the server
Description	Brief description of the function of the container
Dependencies	Other containers or components required for proper operation of the container
Vendor	Vendor of container
Licenses	Name of the software license(s), under which the container was published
Disclaimer	Path/link to the software license(s)

Table 7: About tab

4.4 “Configuration Backup” tab

In the **Configuration Backup** tab, you can save the PROFINET Tap configuration settings to your local PC. You can also restore a formerly saved configuration by uploading the configuration file.

To open the **Configuration Backup** tab, first select the **netFIELD App PROFINET** Tap root element in the navigation tree, then the **Configuration Backup** tab in the Editor window.

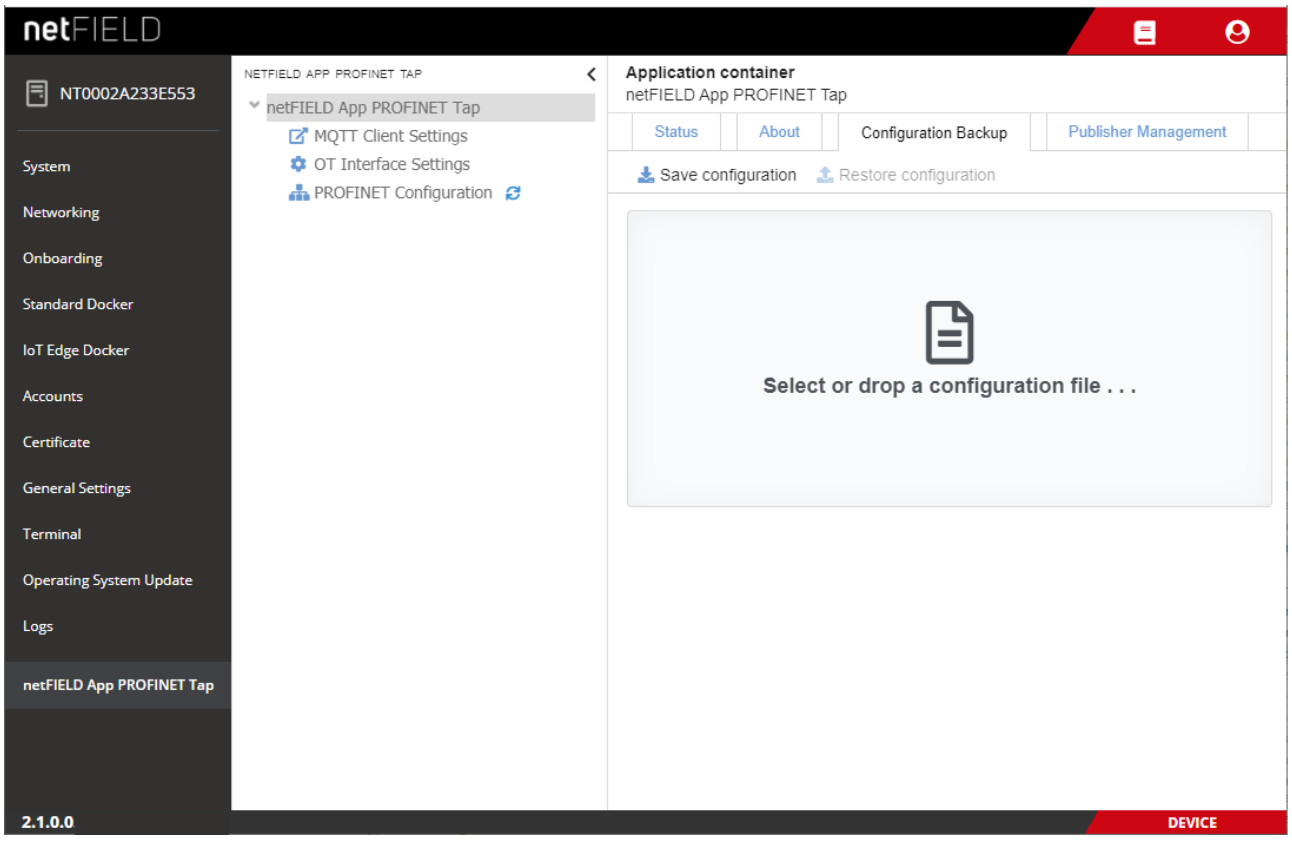

Figure 13: Configuration Backup

Save configuration

➢ To save your current configuration, click **Save configuration** button.

↬ The configuration settings are saved to your local PC as ZIP file. (The download path depends on the settings of your web browser.)
The name of the ZIP file is made up by Hardware ID, Container ID and date/time of the download.

Restore configuration

To restore a formerly saved configuration, you must first select the configuration ZIP file by dragging and dropping it from your desktop onto the grey field (as an alternative, you can open the standard Windows file selection dialog by clicking into the grey field).

After having selected the file, the **Restore configuration** button is enabled, and you can now “load” the configuration by clicking the button.

Important:

The **Restore configuration** function will overwrite the current configuration settings. We recommend you to save your current configuration before using this function.

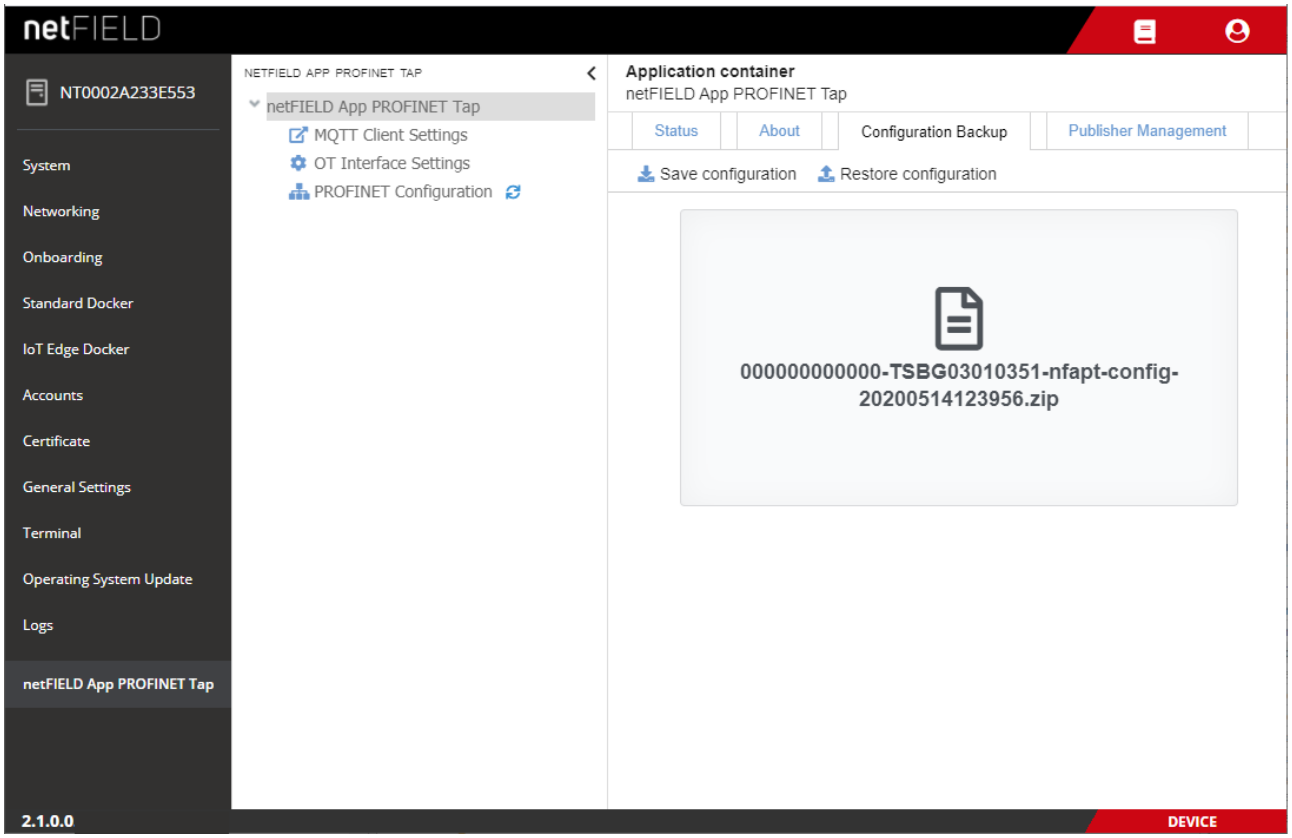

Figure 14: Restore configuration

4.5 “Publisher Management” tab

The **Publisher Management** tab shows the variables that the PROFINET Tap container publishes to the MQTT Broker.

Note that you cannot define here which variables are to be published. For publishing a variable, you have to select it in the **PROFINET Configuration** tree and then choose the **Publish data** option in the PROFINET Variable editor.
You can however delete a variable here if you do not want to publish it any longer.

To open the **Publisher Management** tab, first select the **netFIELD App PROFINET** Tap root element in the navigation tree, then the **Publisher Management** tab in the Editor window.

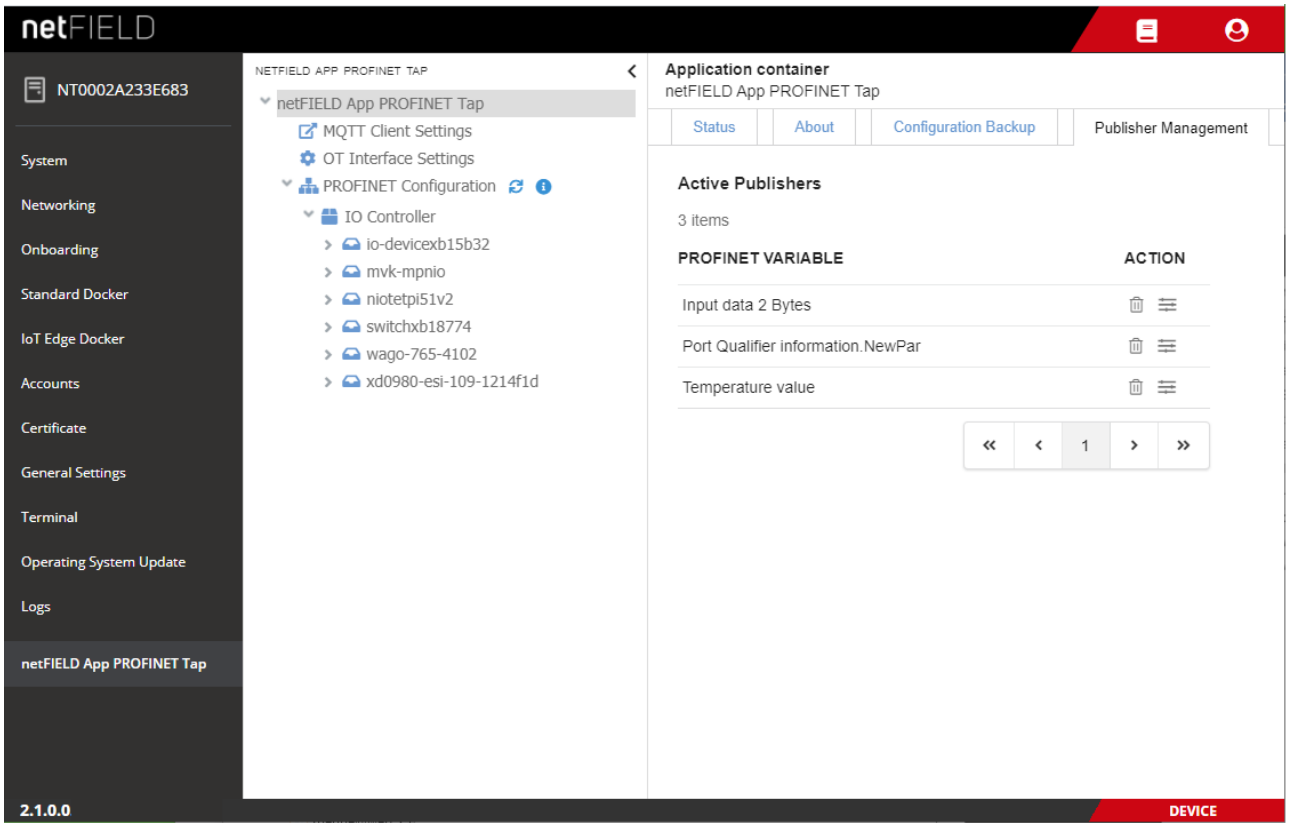

Figure 15: Publisher Management

Element	Description	
Active Publishers	Shows the number of variables that are being published.	
PROFINET VARIABLE	Name of the variable that is being published.	
ACTION		Deletes the variable
		Shows details of the variable (see table below)
	If the list contains more than ten entries, you can scroll here to display the next ten items	

Table 8: Elements of Publisher Management tab

➢ Click the button to open a window showing details of the variable like its MQTT Topic string and other configuration parameters.

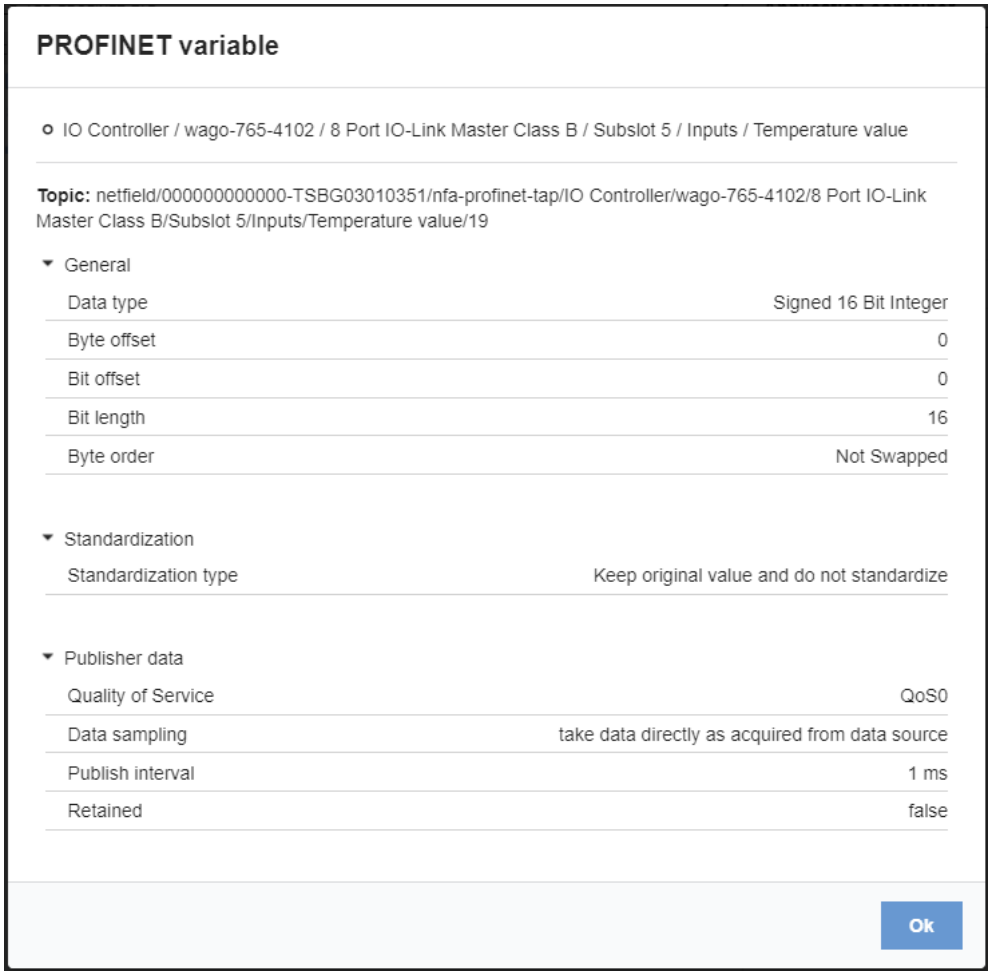

Figure 16: Parameters of PROFINET variable

Element	Description
	The first line shows the path to the variable (for unique identification) in the PROFINET network.
Topic	Shows the MQTT topic string under which the variable is published. By default, the PROFINET Tap uses the following string: `netFIELD/<gateway prefix>/<container id>/<controller name>/<device name>/<slot name>/<subslot name>/ <direction>/<variable name>/<node id>` If you do not want to use the default MQTT Topic string, you can define your own string when you select the variable in the PROFINET Configuration tree for publishing (**PROFINET Variable** > **Publish data** option > **Topic** field). Note that you are free to define the topic hierarchy and name according to your individual needs there. You are only restricted not to use the `#` and `+` characters and not to use `$` as very first character.
General	Shows data formats of the variable.
Standardization	Shows standardization settings for the variable.
Publisher data	Shows the MQTT publication settings for the variable.
Ok	Click this button to close the window.

Table 9: Elements Variable's details window

4.6 MQTT Client Settings

On the **MQTT Client Settings** page, you can customize the MQTT client settings of the PROFINET Tap container. By default, the PROFINET Tap uses the standard MQTT client settings of the netFIELD OS, which can be viewed (and changed) in the local Device Manager under **General Settings** > **Default MQTT Client Settings**.

If you want to use different settings for your PROFINET Tap, you can uncheck the **Use general settings** option and enter your new values in the configuration fields that are now displayed:

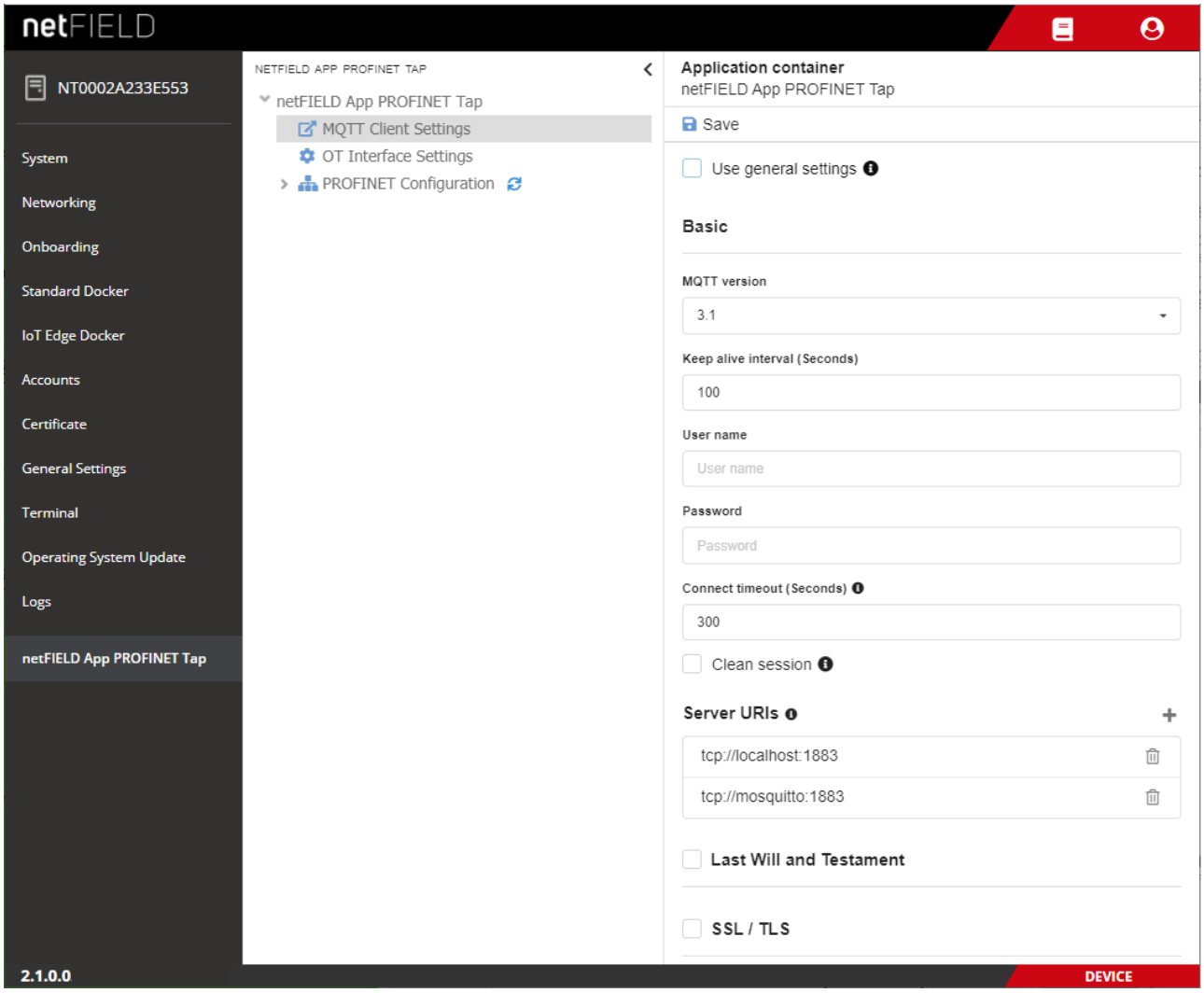

Figure 17: MQTT Client settings

Element	Description	
MQTT version	MQTT version to be used (depending on the MQTT Broker).	
Keep alive interval	Defines the maximum length of time in seconds that the broker and client may not communicate with each other.	
User name	User name for authentication at the Broker (if implemented and required by the Broker). Note that the Mosquitto Broker from the netFIELD Portal does not require login authentication.	
Password	Password for authentication at the Broker (if implemented and required by the Broker). Note that the Mosquitto Broker from the netFIELD Portal does not require login authentication.	
Connect timeout	Defines the maximum length of time in seconds that is allowed for completing the connection process.	
Clean session	If **Clean session** is selected, the client does not want a persistent session (meaning that if the client disconnects for any reason, all information and messages that are queued from a previous persistent session are lost. If **Clean session** is unchecked, the broker creates a persistent session for the client.	
Server URIs	Server URI of the MQTT Broker **Note**: When multiple server URIs are specified, the client will try to connect to each server one after the other, starting with the first server in the list. If a server connection was established successfully, only this connection will be used. The client will not open multiple connections to multiple servers simultaneously.	
Last Will and Testament	Select this option if you want to use the “last will and testament” (LWT) feature of MQTT. (I.e. to notify other clients about an unexpected loss of connection to the broker)	
	Topic name	Topic name of LWT message
	Retained	“Retained” flag of LWT message
	Quality of Service	QoS of LWT message
	Message	Message text, e.g. “unexpected loss of connection”
SSL / TLS	Select this option if you want to use SSL/TLS encryption for creating a secure connection to the MQTT Broker. **Note**: This option is for expert users only! In the standard use case, in which the Mosquitto Broker and the PROFINET Tap are running on the same device, a secure SSL/TLS connection is not necessary (the overhead of the secure connection can thus be avoided). If you want to use SSL/TLS encryption anyway, see section *Using SSL/TLS encryption (optional)* [page 65] for further information.	
	File name and path to private key in PEM format	Enter here the complete path to the private key on the device; e.g.: `/etc/ssl/private/client-key.pem`
	File name and path to certificate chains in PEM format	Enter here the complete path to the certificate chains on the device; e.g.: `/etc/ssl/services/client-cert.pem`
	Override the trusted CA certificates in PEM format	Enter here the complete path to override the trusted CA certificates on the device; e.g.: `/etc/ssl/services/ca-cert.pem`
	Enable verification of the server certificate	If this option is disabled, PROFINET Tap will also accept invalid certificates from the Broker (not recommended).

Table 10: MQTT Client Settings

➢ Click **Save** button to save your new MQTT Client Settings.

4.7 OT Interface settings

On the **OT Interface settings** page, you can configure the speed of the Ethernet port(s) that you are using to connect your device (respectively your “tap”) to the physical PROFINET network.

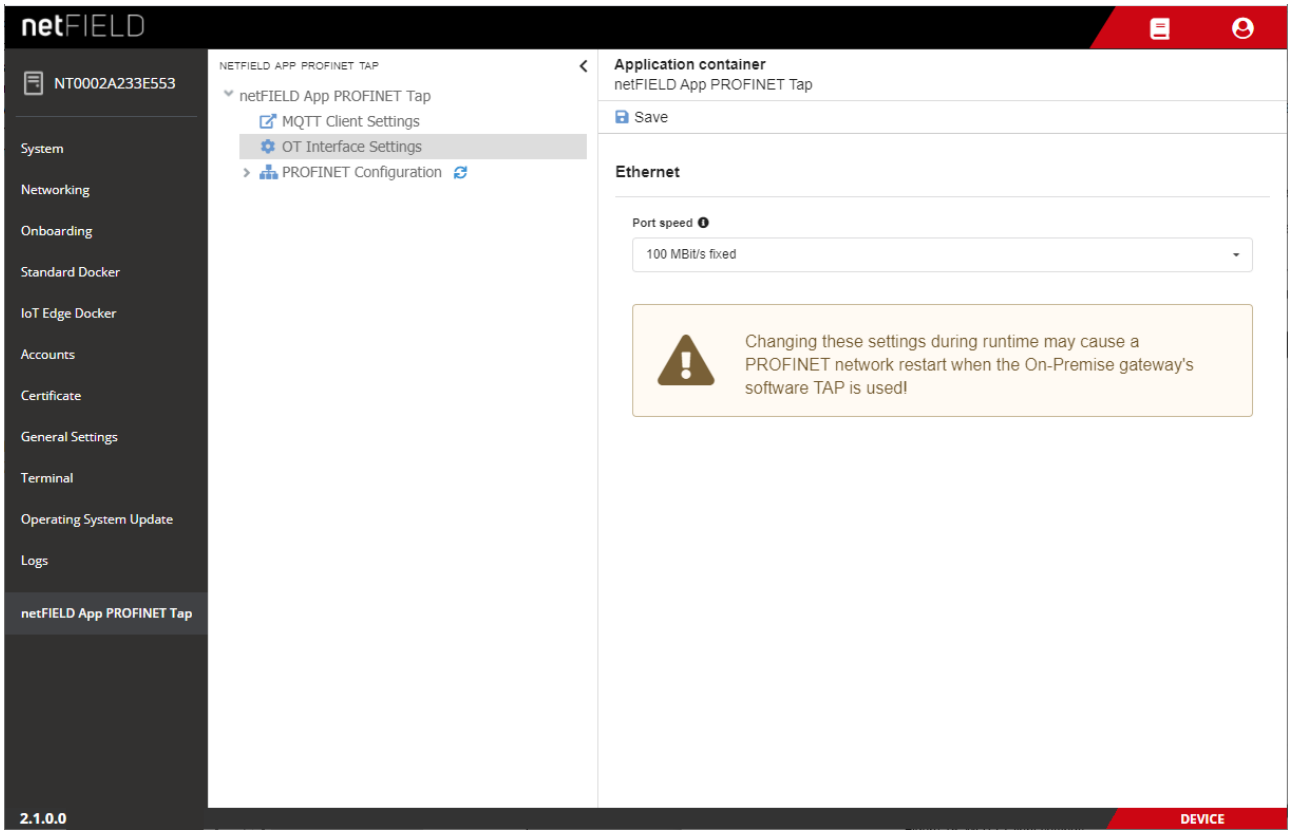

Figure 18: Physical settings

➢ Use the dropdown-list to select the port speed.

Value	Description
Automatic	Automatic synchronization. Use this setting if you have connected the netFIELD On-Premise device directly to the PROFINET; i.e. if you are not using a “hardware tap” (see section *Connection without hardware mirror* [page 11]). Note that when using automatic link speed negotiation in combination with a netMIRROR TAP, the PROFINET Tap (due to a little time delay caused by the negotiation process) might miss some of the first frames (and thus some of the configuration data) that are exchanged on the bus during the PROFINET startup phase.
10 MBit/s fixed	Not commonly used any longer.
100 MBit/s fixed	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR (see section *Connection via netMIRROR* [page 7]).

Table 11: Port speed settings

➢ Click **Save** button to save your new settings.

4.8 PROFINET configuration

4.8.1 Overview

In order to capture process data and re-publish it via MQTT, the PROFINET Tap must be “acquainted” with the participants, data points and certain parameters of your actual PROFINET network.

There are two ways to provide the necessary information for the Tap:

- Automatically by letting the Tap listen to the communication between IO Controller and IO Devices during the PROFINET start-up phase and by mapping GSDML and/or AutomationML file(s) to the recognized “raw” PROFINET configuration. .
- Manually by “rebuilding” the structure of your network by adding the IO Controller, IO Devices and their slots to the **PROFINET Configuration** tree, and then configure their parameters and variables “by hand”.

The structure of your network and the data points (that the Tap knows of) is represented in the navigation tree under **PROFINET Configuration**:

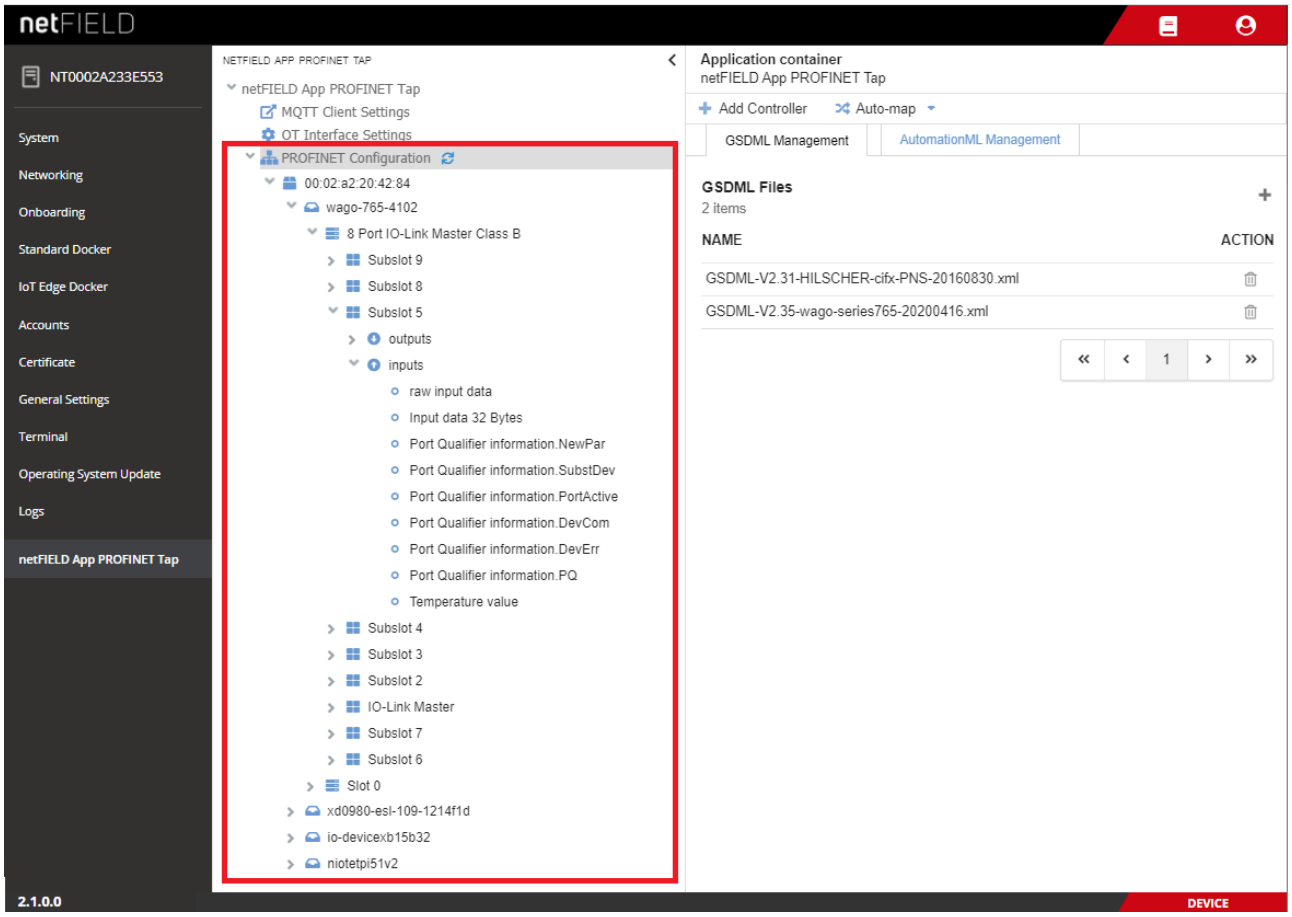

Figure 19: PROFINET Configuration tree

An arrow symbol › in front of an element in the PROFINET navigation tree indicates that the element contains further subordinate elements, like e.g. Submodules under a Module.

Clicking on an element will open and display the subordinate elements in the navigation tree.
Selecting an element will also display its parameters in the Editor window on the right side of the screen, where they can be changed if necessary:

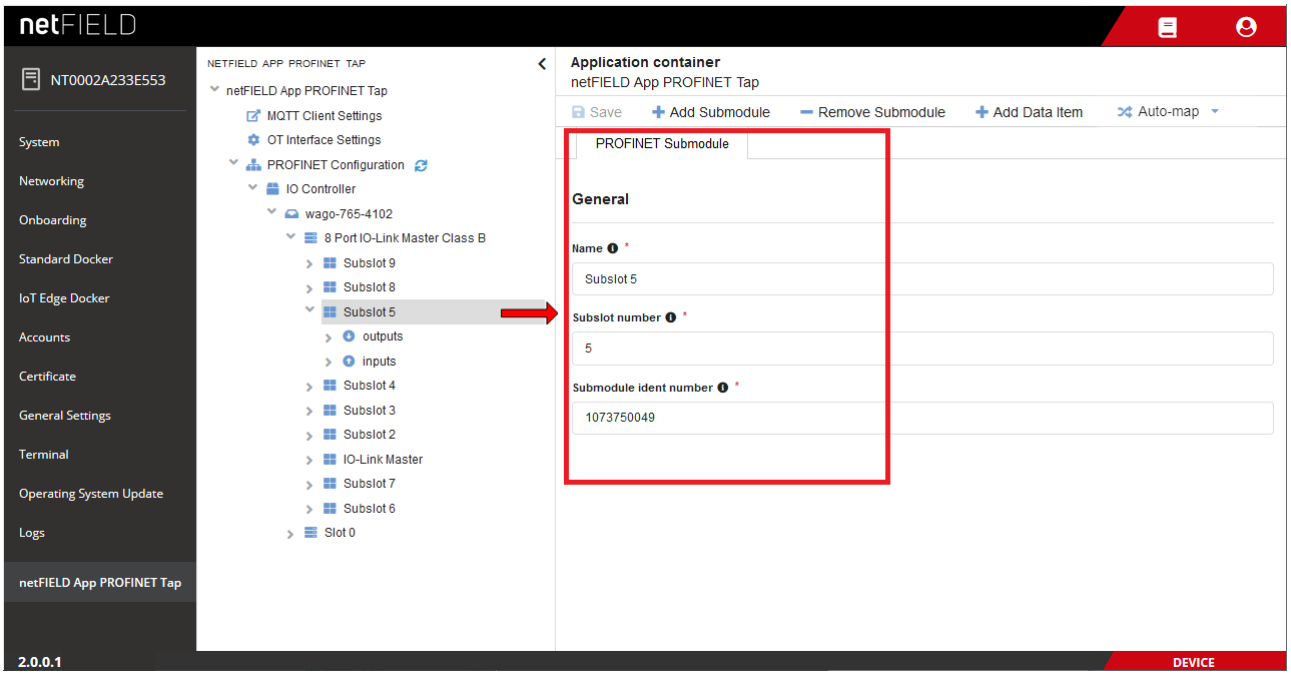

Figure 20: Parameters of selected PROFINET element in Editor window

The options in the menu bar on top of the Editor window are context sensitive and depend on the element that you have selected in the PROFINET navigation tree:

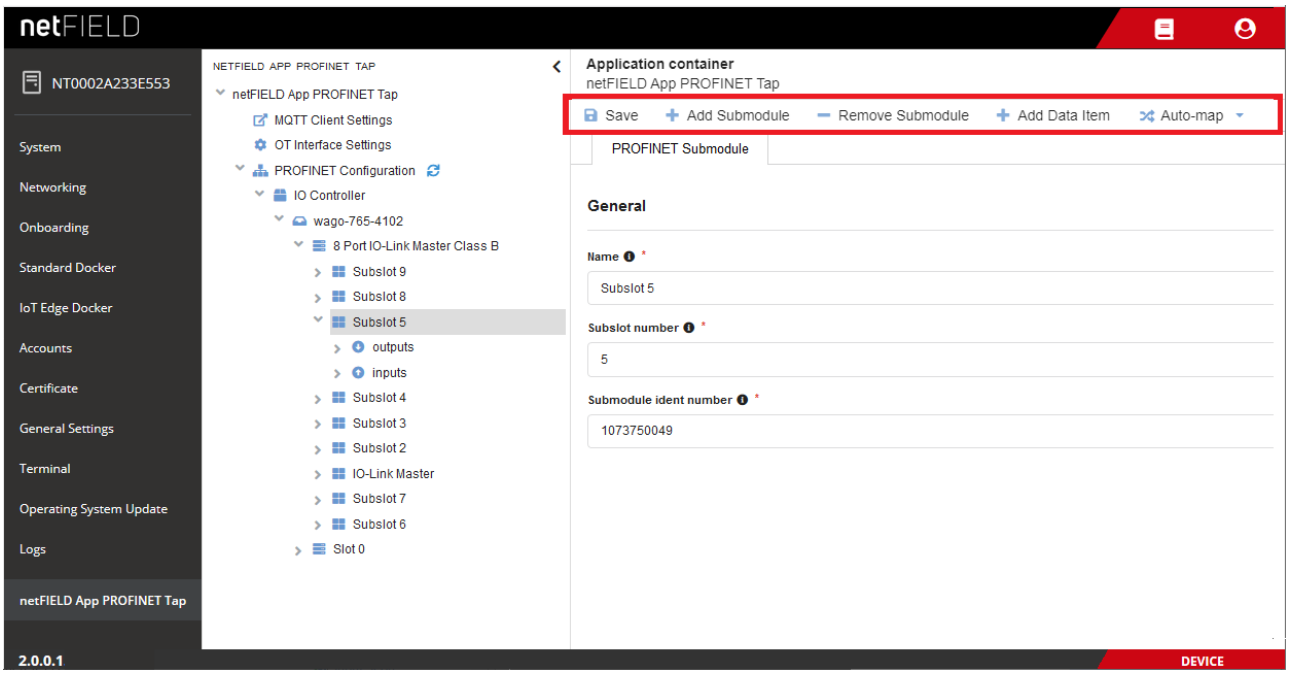

Figure 21: Menu bar

In the menu bar, you can save changes that you have made to the parameters of the selected element, or you can delete the selected element altogether. You can also add further elements on the same level (e.g. another Submodule next to a selected Submodule) or new elements on the subordinate level (e.g. a Data Item below a selected Submodule).
You can also start an “auto-mapping” process of parameters from GSDML and/or AutomationML files (if available) for the subordinate elements of the currently selected element. Note that must import the appropriate GSDML and AutomationML files in the **GSDML Management** tab respectively **AutomationML Management** tab before you can use the **Auto-map** function (see also sections *GSDML Management* [page 39] and *AutomationML Management* [page 42]).

The following table describes the options and parameters of the elements belonging to your PROFINET Configuration. Click on an element in the PROFINET Configuration tree to see the parameters and menu options:

Icon	Element	Parameter		Options in menu
	PROFINET	Reload button	Reloads the PROFINET configuration tree. Use this button after a new start-up of the PROFINET or of individual devices. Any new device information detected during start-up will thus be taken-over into the PROFINET configuration.	**Add Controller**: Adds Controller to the PROFINET configuration. **Auto-map** **Auto-map all devices from GSDML**: Opens the GSDML mapping wizard. **Auto-map all devices from AutomationML**: Opens the AutomationML mapping wizard.
		Info icon	Indicates an event that demands a reaction from the user (e.g. the Tap detected a start-up of a new device, which may require you to reload the configuration and/or re-map data semantics from GSDML or AutomationML). Click on the icon to display the information. In the Info window, click **Confirm** to acknowledge the message, which makes the Info icon disappear. If you click **Close**, the Info window closes but the Info icon remains visible.	
		GSDML Management	The PROFINET root element displays the *GSDML Management* [page 39] tab that allows you to manage the GSDML files of your PROFINET Devices.	
		AutomationML Management	The PROFINET root element displays the *AutomationML Management* [page 42] tab that allows you to manage the AutomationML files.	
	Controller	Name	Name of the controller. Can be freely defined by the user, but must not be empty (mandatory field). **Note**: If the configuration was automatically retrieved by the app during start-up phase, the app will use the MAC address as name.	**Save**: Saves changed parameters of selected Controller. **Add Controller**: Adds new Controller on same level. **Remove Controller**: Removes selected Controller. **Add Device**: Adds new Device under selected Controller. **Auto-map** **Auto-map all devices under this controller from GSDML**: Opens the GSDML mapping wizard. **Auto-map all devices under this controller from AutomationML**: Opens the AutomationML mapping wizard.
		MAC address	MAC Address of the controller. Mandatory field consisting of six groups of two hexadecimal values separated by colons. (E.g. `06:0A:3B:78:05:6C`)	
		IP address	IP address of the controller.	

Icon	Element	Parameter		Options in menu
	Device	Name	Name of the device. Can be freely defined by the user, but must not be empty (mandatory field). **Note**: If the configuration was automatically retrieved by the app during start-up phase, the app will use the “name of station” for the name.	**Save**: Saves changed parameters of selected Device. **Add Device**: Adds new Device on same level. **Remove Device**: Removes selected Device. **Add Module**: Adds new Module below selected Device. **Auto-map** **Auto-map all slots under this device from GSDML**: Opens the GSDML mapping wizard. **Auto-map all slots under this device from AutomationML**: Opens the AutomationML mapping wizard.
		MAC Address	MAC address of the device. Mandatory field consisting of six groups of two hexadecimal values separated by colons. (E.g. `06:0A:3B:78:05:6C`)	
		IP address	MAC address of the device. Assigned by the controller.	
		Name of station	PROFINET “name of station” of the device.	
		Vendor ID	ID containing the manufacturer-specific part of the device’s PROFINET identification number according to the rules specified in PNO document 2.712 “Application Layer Services”. Mandatory field. Must be a value between `0` and `65535`.	
		Device ID	ID containing the device-specific part of the PROFINET identification number of the PROFINET device. It is defined for each individual device by the manufacturer and uniquely identifies a device amongst all devices of this manufacturer. Mandatory field. Must be a value between `0` and `65535`.	
	Module	Name	Name of the module. Can be freely defined by the user, but must not be empty (mandatory field).	**Save**: Saves changed parameters of selected Module. **Add Module**: Adds new Module on same level. **Remove Module**: Removes selected Module. **Add Submodule**: Adds new Submodule below selected Module. **Auto-map** **Auto-map all subslots under this slot from GSDML**: Opens the GSDML mapping wizard. **Auto-map all subslots under this slot from AutomationML**: Opens the AutomationML mapping wizard.
		Slot number	Number of the slot this module is plugged in. Mandatory field. Must be unique within the scope of the project and must be a value between `0` and `4294967295`	
		Module ident number	Identification number of the module. Mandatory field. Must be a value between `0` and `4294967295`.	

Icon	Element	Parameter		Options in menu
	Submodule	Name	Name of the submodule. Can be freely defined by the user, but must not be empty (mandatory field).	**Save**: Saves changed parameters of selected Submodule. **Add Submodule**: Adds new Submodule on same level. **Remove Submodule**: Removes selected Submodule. **Add Data Item**: Adds new Data Item (output or input) below selected Submodule. **Auto-map** **Auto-map this subslot from GSDML**: Opens the GSDML mapping wizard. **Auto-map this subslot from AutomationML**: Opens the AutomationML mapping wizard.
		Subslot number	Number of the subslot this submodule is plugged in. Mandatory field. Must be unique within the scope of the project and must be a value between `0` and `65535`.	
		Submodule ident number	Identification number of the submodule. Mandatory field. Must be a value between `0` and `4294967295`.	
	Data Item (Output/ Input)	Name	Name of the PROFINET data item. Can be freely defined by the user, but must not be empty (mandatory field).	**Save**: Saves changed parameters of selected Data Item **Add Data Item**: Adds new Data Item on same level **Remove Data Item**: Removes selected Data Item **Add Variable**: Adds new variable below selected Data Item
		Direction	IO direction of the data item. Select **Output** for the data that the submodule receives from the Controller in order to forward it to an actor. Select **Input** for the data that the submodule receives from a sensor in order to forward it to the Controller.	
		Frame ID	Identification number of the cyclic PROFINET frame which carries the data item. Mandatory field. Must be a value between `0` and `65535`.	
		Byte offset	Byte offset of the data item within the cyclic PROFINET frame relative to the Ethernet payload start. Mandatory field. Must be a value between `0` and `65535`.	
		Data length	Length of the PROFINET data item in bytes.	

Icon	Element	Parameter				Options in menu
	Variable	Name	Name of the variable. Can be freely defined by the user, but must not be empty (mandatory field). This is the name of the PROFINET Variable that will be published via MQTT. It will also be added to the PROFINET Variable list in the Publisher Management tab (see section *"Publisher Management" tab* [page 26]). **Note**: Not to be confused with the MQTT **Topic** name (see **Topic** field under **Publish data**).			**Save**: Saves changed parameters of selected variable **Add Variable**: Adds new variable on same level **Remove Variable**: Removes selected variable **Clone Variable**: Adds a copy of the selected variable on same level, which you can use as a "template" for editing a new variable
		Data type	Supported types:	Bit length:	Description/ Value range:	
			Boolean	1	'0': FALSE '1': TRUE	
			Signed 8 Bit Integer	8	-128 … 127	
			Signed 16 Bit Integer	16	-32768 … 32767	
			Signed 32 Bit Integer	32	-2^{31} … $+2^{31}-1$	
			Signed 64 Bit Integer	64	-2^{63} … $+2^{63}-1$	
			Unsigned 8 Bit Integer	8	0 … 255	
			Unsigned 16 Bit Integer	16	0 … 65535	
			Unsigned 32 Bit Integer	32	0 … $+2^{32}-1$	
			Unsigned 64 Bit Integer	64	0 … $+2^{64}-1$	
			32 Bit Floating Point	32	Single precision floating point range	
			64 Bit Floating Point	64	Double precision floating point range	
			Visible String	8*n	UTF-8 / ASCII encoded string	
			Octet String	8*n	String containing a sequence of hex encoded octets in format 01ABF7	
		Byte offset	Offset (in bytes) of the variable relative to the beginning of the Data Item. Must be a value between 0 and 99.			
		Bit offset	Number of bits the variable is shifted at the byte offset of the Data Item. Must be a value between 0 and 7.			

Icon	Element	Parameter		Options in menu
	Variable	Bit length	Number of bits of the variable according to the selected data type. Corresponds by default to the maximum length allowed by the data type. You may specify a lower value. If this bit length is shorter than the above specified data type, the upper bits will be padded. For signed data types, a sign extension will be done in such a case.	**Save**: Saves changed parameters of selected variable **Add Variable**: Adds new variable on same level **Remove Variable**: Removes selected variable **Clone Variable**: Adds a copy of the selected variable on same level, which you can use as a “template” for editing a new variable
		Byte order	Byte order in a data word: Swapped Not swapped	
		Standardization type	Allows scaling of analog values. You can either **Keep original value and do not standardize** or select the **Scale linear by factor and offset** option. Selecting the **Scale linear**… option enables the **Factor** and **Offset** fields. The standardization value will be computed according to the formula: `raw value * factor + offset` **Note**: Standardization is supported only for integer data types.	

Icon	Element	Parameter			Options in menu
	Variable	Publish data	Select this option to publish the variable via MQTT. It will also be added to the **PROFINET Variable** list in the **Publisher Management** tab (see section *"Publisher Management" tab* [▷ page 26]). You can configure the following parameters for publishing the variable:		**Save**: Saves changed parameters of selected variable **Add Variable**: Adds new variable on same level **Remove Variable**: Removes selected variable **Clone Variable**: Adds a copy of the selected variable on same level, which you can use as a "template" for editing a new variable
			Topic	Enter here the MQTT Topic name string under which the variable will published. If left empty, the Tap uses the default string (see section *MQTT message format* [▷ page 60]). Note that you are free to define the topic hierarchy and name according to your individual needs. You are only restricted not to use the `#` and `+` characters and not to use `$` as the very first character.	
			Quality of service	Select the MQTT QoS from the drop-down list. **Note**: For performance reasons it is recommended to use `QoS0` whenever possible. Using `QoS1` or `QoS2` will increase performance requirements of the application container.	
			Publish interval	Define the publish interval in • Milliseconds • Seconds • Minutes • Hours **Note**: MQTT messages will be published approximately at this interval. If more than one process data sample has been acquired in this time-span, the message will contain an array of process data points. Keep in mind that messages should not grow endlessly in size. Therefore, choose this value according to your use case and in a way that provides a good trade-off between the publish interval and the number of samples coming from the data source in that time.	
			Data sampling	Define the conditions for the sampling: • Only take data if the data source value has changed • Take data directly as acquired from data source: Note that this option means OT network cycle accurate data sampling and may result in very high amount of data samples in a short time. • Sample the acquired data from data source by a fixed sample rate: Opens the **Sample rate in milliseconds** field in which you can specify the sample rate (between 1 and 1000 ms)	
			Retained	"Retained" flag of MQTT message	

Table 12: Elements PROFINET Configuration

4.8.2 GSDML Management

The **GSDML Management** tab allows you to upload the device description files to the PROFINET Tap. The device descriptions contained in these files can be mapped to the devices of your PROFINET configuration (by auto-mapping function).

To open the **GSDML Management** tab, select the **PROFINET Configuration** element in the navigation tree.

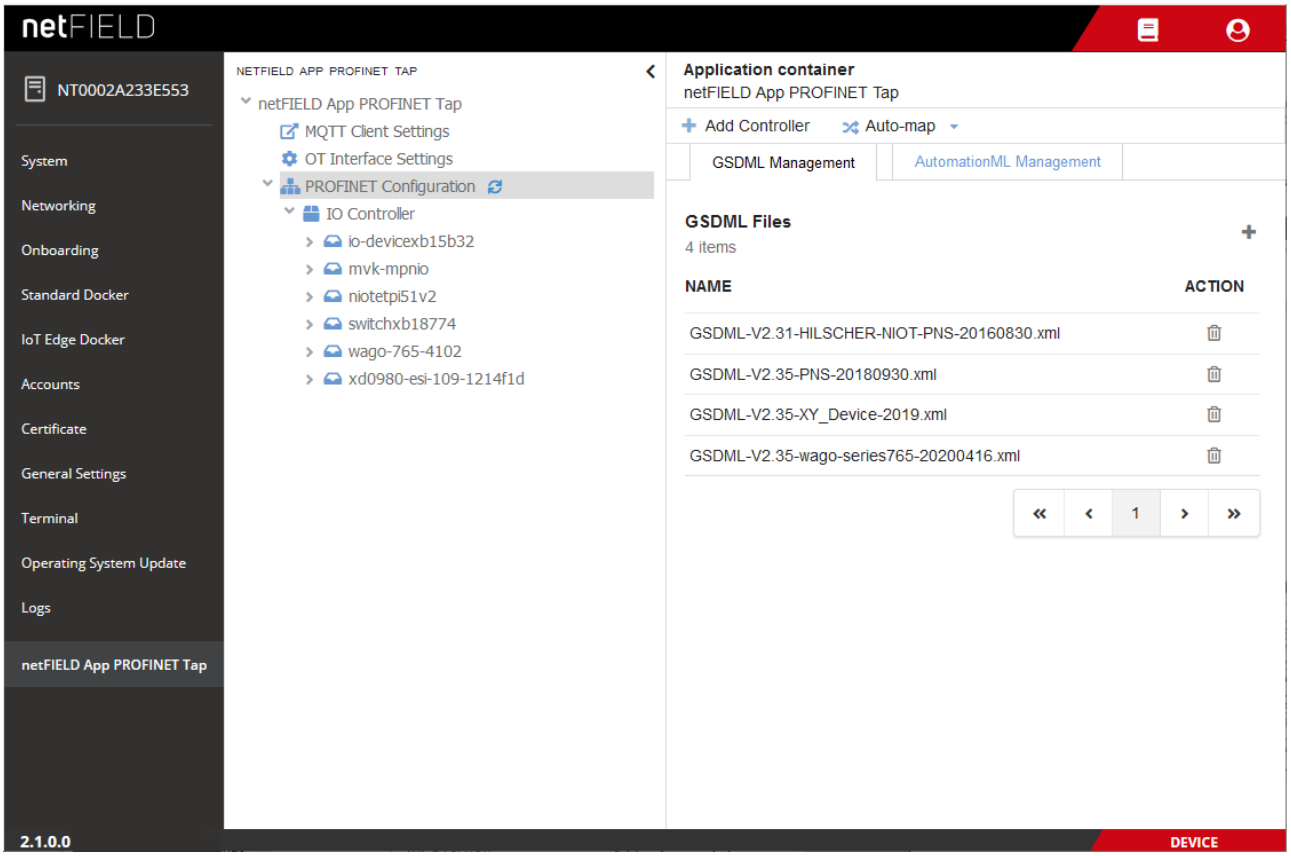

Figure 22: GSDML Management

Element	Description
GSDML Files	Shows the number of GSDML files that have been imported and are available for mapping.
+	Opens dialog for uploading GSDML files.
Name	Name of the GSDML file.
ACTION	Deletes the GSDML file.
« ‹ 1 2 › »	If the list contains more than ten entries, you can scroll here to display the next ten items.

Table 13: GSDML Management tab

Uploading GSDML file(s)

➢ Click the + button to open the **Upload** dialog window.

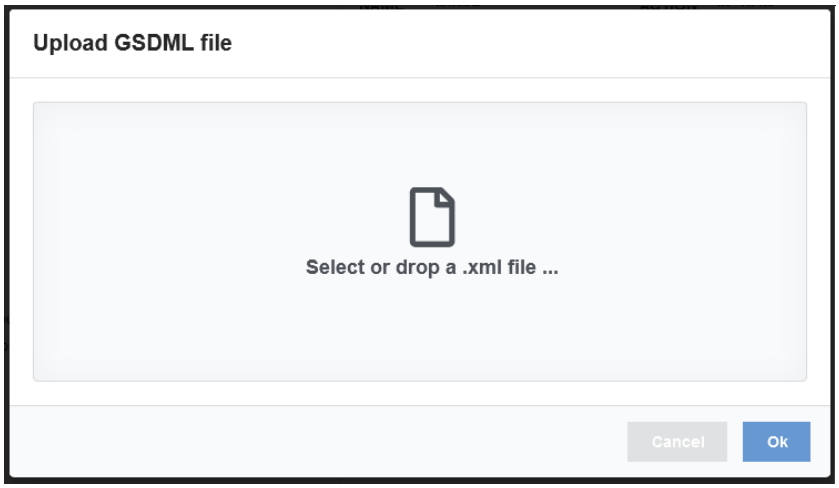

Figure 23: Upload GSDML file dialog

➢ Drag and drop your GSDML file from your PC onto the grey area of the dialog window, then click **Ok** button to start the upload.

➢ If you want to upload several files at once, click into the grey area to open the file upload dialog of your browser.

➢ In the **File Upload** dialog, select all files you want to upload, then click **Open** button.

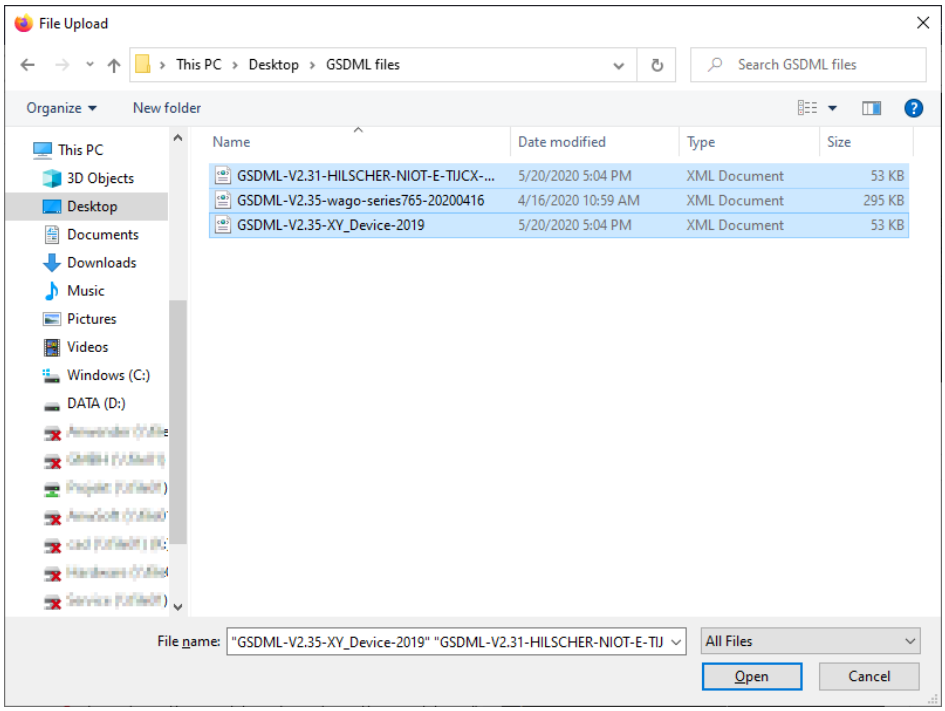

Figure 24: Multiple selection in File upload dialog

↬ The three dots in the **Upload GSDML file** dialog indicate that you have selected multiple files for upload:

Figure 25: Upload GSDML file dialog

➢ Click **Ok** button to start the upload.

⇨ The uploaded GSDML files are listed in the **GSDML Management** tab and can now be mapped to your PROFINET Configuration.

4.8.3 AutomationML Management

The **AutomationML Management** tab allows you to upload project engineering file(s) from the TIA Portal in AutomationML format (Automation Markup Language) to the PROFINET Tap. The information contained in the `.aml` file can then be mapped to the PROFINET configuration by using the **Auto-map** function.

Note:
If your PROFINET line features more than one IO Controller/PLC, you can, of course, import several AutomationML files – each containing the corresponding engineering project of an individual IO Controller/PLC – and map them later to the corresponding IO Controller element in the PROFINET Configuration tree.

To open the **AutomationML Management** tab, select the **PROFINET Configuration** element in the navigation tree, then click on the tab in the Editor window.

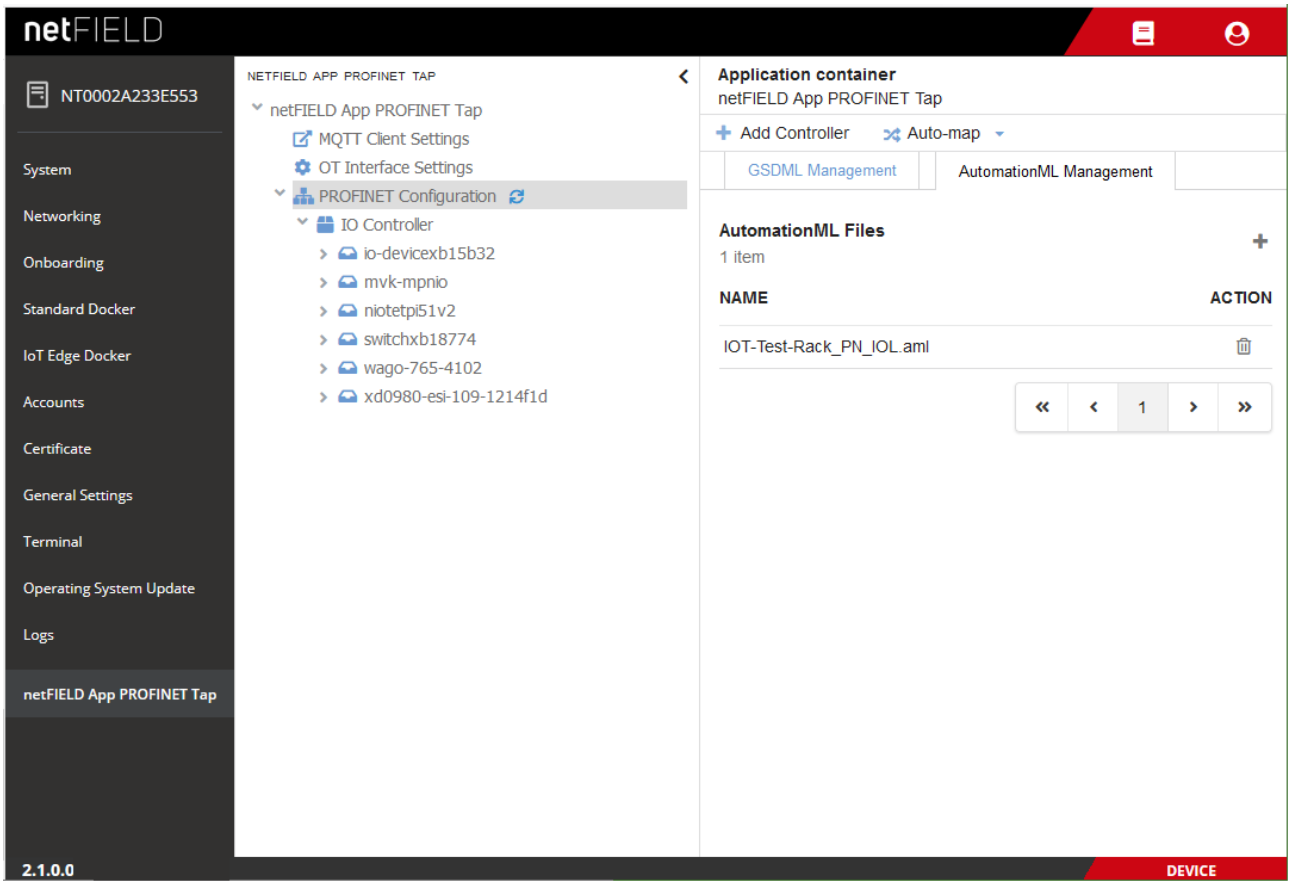

Figure 26: AutomationML Management

Element	Description
AutomationML Files	Shows the number of `.aml` files that were imported and are available for mapping.
+	Opens dialog for uploading `.aml` files.
Name	Name of the `.aml` file.
ACTION	Deletes the `.aml` file.
« ‹ 1 2 › »	If the list contains more than ten entries, you can scroll here to display the next ten items.

Table 14: AutomationML Management tab

Exporting PROFINET project as AutomationML file from TIA Portal

Before you can upload your AutomationML file to the PROFINET Tap, you must first export it from the TIA Portal.

➢ To do so, open your PROFINET engineering project in the TIA Portal , then choose **Tools** > **Export CAx data...** from the menu:

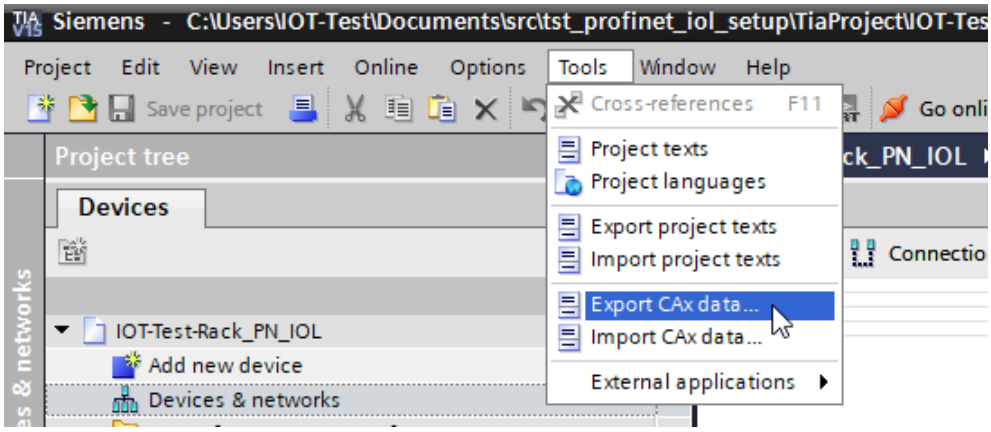

Figure 27: Export AutomationML file from Tia Portal

Note:
You must be logged in as member of the “Siemens TIA Openness” group in order to be allowed to use the **Export CAx data...** function in the TIA Portal.

Uploading AutomationML file(s) to the PROFINET Tap

➢ Click the + button to open the **Upload** dialog window.

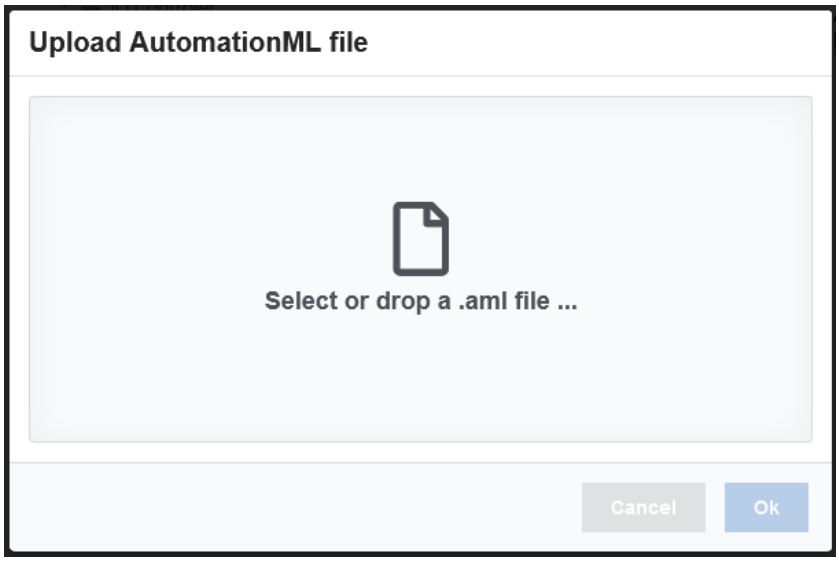

Figure 28: Upload AutomationML file dialog

➢ Drag and drop your `.aml` file from your PC onto the grey area of the dialog window, then click **Ok** button to start the upload.

➢ If you want to upload several files at once, click into the grey area to open the file upload dialog of your browser.

➢ In the **File Upload** dialog, select all files you want to upload, then click **Open** button.

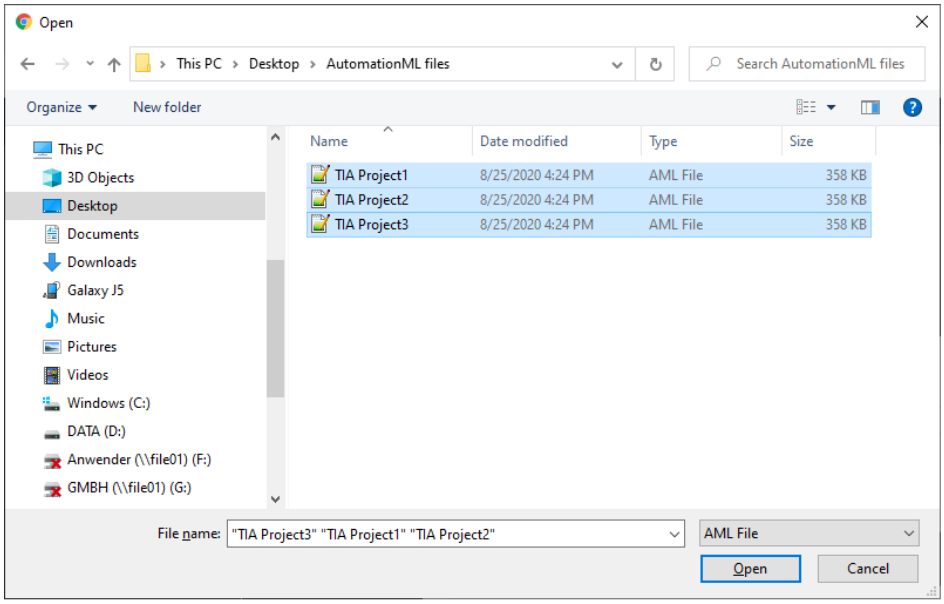

Figure 29: Multiple selection in File upload dialog

The three dots in the **Upload AutomationML file** dialog indicate that you have selected multiple files for upload:

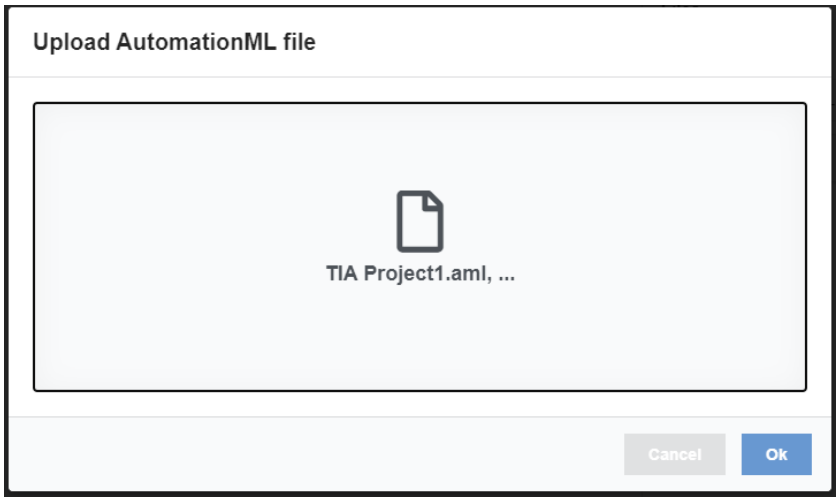

Figure 30: Upload AutomationML file dialog

- Click **Ok** button to start the upload.
- The uploaded files are listed in the **AutomationML Management** tab and can now be mapped to your PROFINET Configuration.

4.8.4 How to configure the PROFINET Tap with GSDML file

This section provides step-by-step instructions for creating a PROFINET Configuration by using GSDML file(s) and for defining a variable to be published via MQTT.

Requirements

- The Edge Device on which the PROFINET Tap is running is connected to your PROFINET network.
- You have access to the GSDML files of the IO Devices of your PROFINET network.

Step-by-step instructions

1. Set port speed according to your Tap's connection type (hardware vs. software tap).
   - ➢ In the **OT Interface Settings**, select the port speed.

     WARNING Warning of unsafe system operation!
     When using a "software TAP", changing this setting may lead to a temporary loss of the bus link and thus of the PROFINET communication. Take precautions that the temporary loss of the bus communication will not affect the safe operation of your plant!

   - Select **100 MBit/s fixed** if you are using a "hardware TAP" like e.g. netMIRROR (see section *Connection via netMIRROR* [page 7]).
   - Select **Automatic** if you have connected the Edge Device directly to the PROFINET; i.e. if you are using the built-in "software TAP" of the OnPremise device (see section *Connection without hardware mirror* [page 11]).
2. Gather information from PROFINET start-up.
   - ➢ Trigger a start-up of your PROFINET.

     WARNING Warning of unsafe system operation!
     If you have to stop a running PROFINET bus communication for this, take precautions that stopping the bus communication will not affect the safe operation of your plant!

PROFINET Tap listens to the “configuration” messages that are now exchanged between Controller and Devices during the PROFINET start-up phase, and extracts information from it.
After a few seconds, all recognized PROFINET participants and their subordinate elements (Modules, Submodules etc.) are listed in the PROFINET Configuration tree:

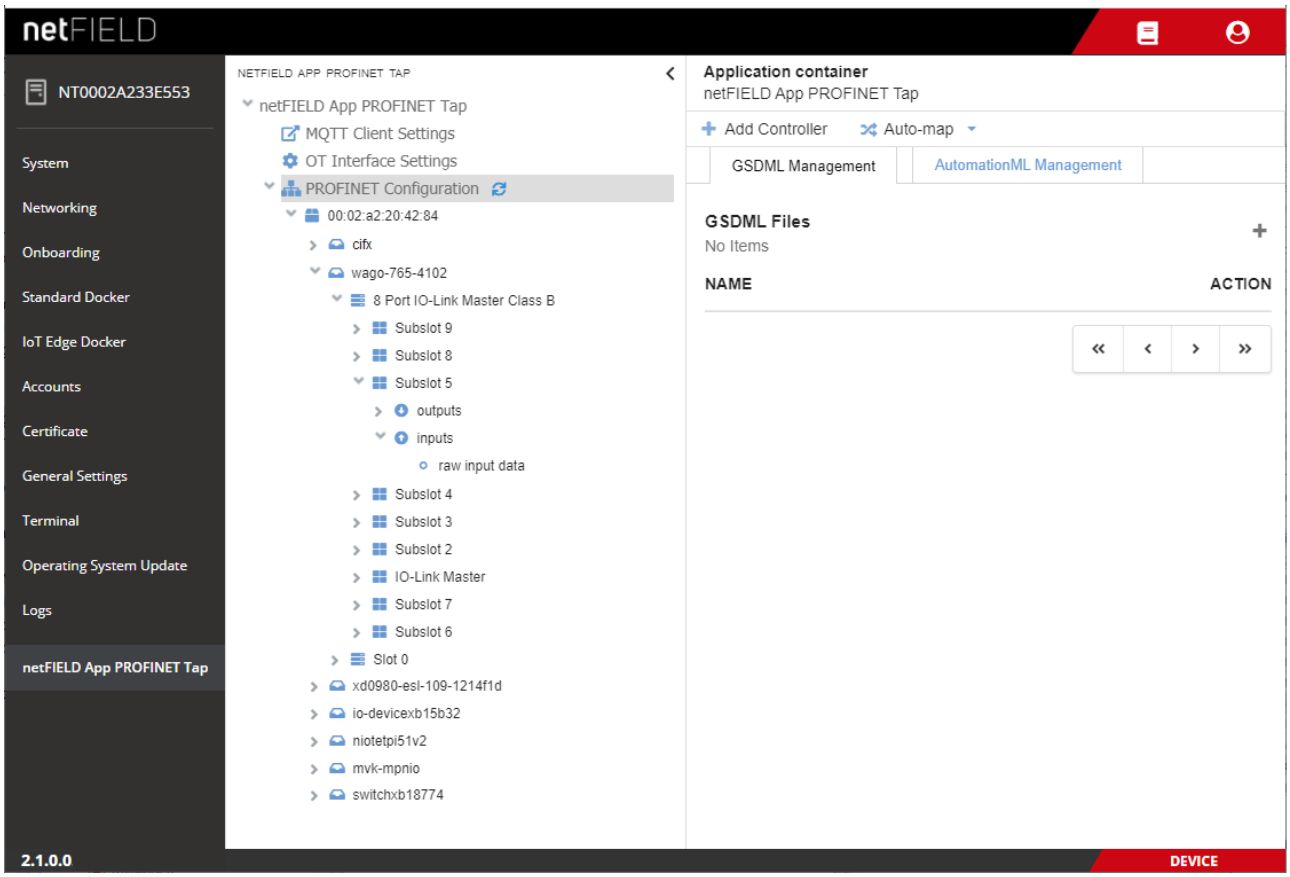

Figure 31: PROFINET configuration recognized during start-up

Note:

You may have to reload the page by clicking the icon next to the PROFINET Configuration element in order to display the recognized devices in PROFINET Configuration tree.

Note the following about the automatic device recognition during start-up:

- The order in which the devices and elements are represented in the PROFINET Configuration tree relates to the time sequence in which they were recognized; i.e. the first device in the tree is the device that was first recognized during start-up, and so forth. This means that the order of the devices in the tree does not reflect the actual positioning of the devices in the real PROFINET topology.
- The Controller’s name is represented in the tree by its MAC address, because its name is not part of the configuration information that is exchanged during start-up (and can thus not be picked up by the Tap). You can manually change its name later.
- The Tap adds “raw output/input data” as default variables below recognized Data items (i.e. outputs/inputs).

3. Enter name of Controller (optional)

➢ Select the Controller element in the tree (followed by MAC Address).

↬ The parameters of the selected Controller are displayed in the **PROFINET Controller** tab in the Editor screen.

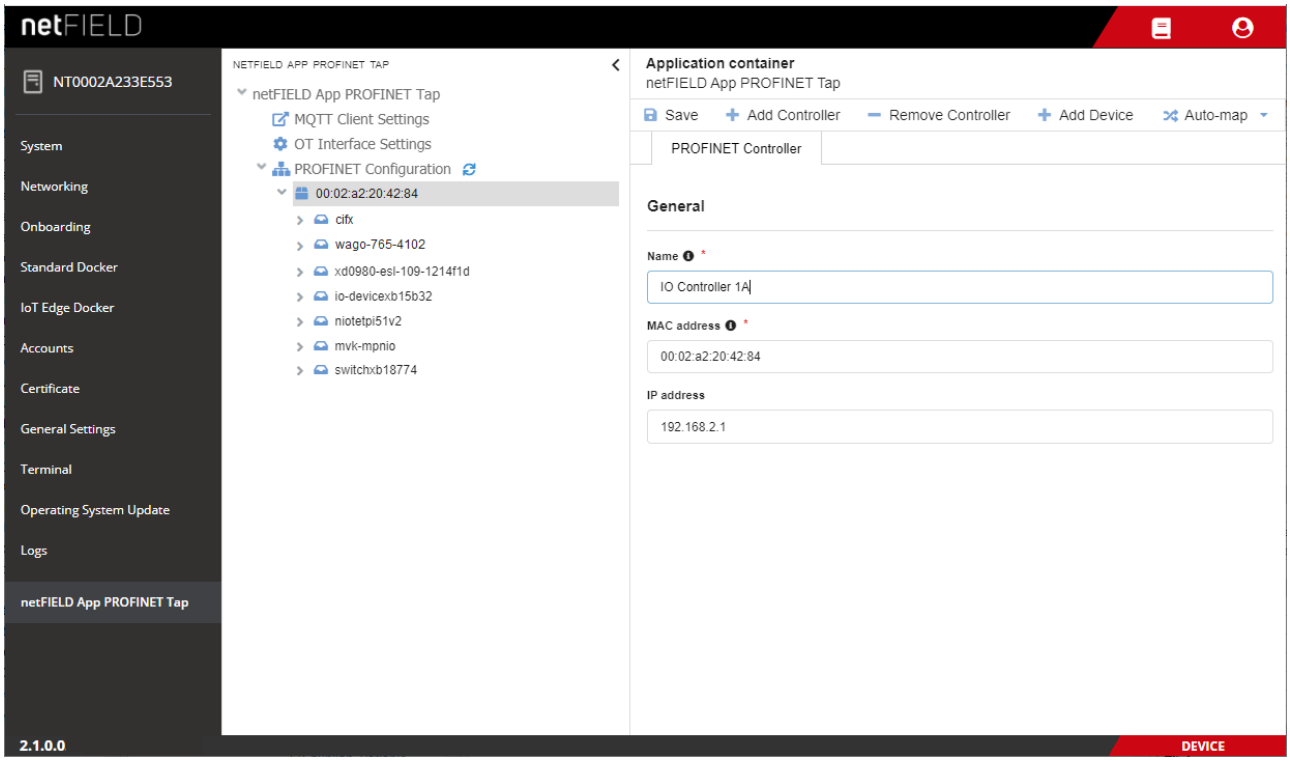

Figure 32: Change name of Controller

➢ Enter a name, e.g. “IO Controller 1A”, then click Save button.

↬ The ”Succeeded to save data” message appears and the tree now displays the new name of the controller:

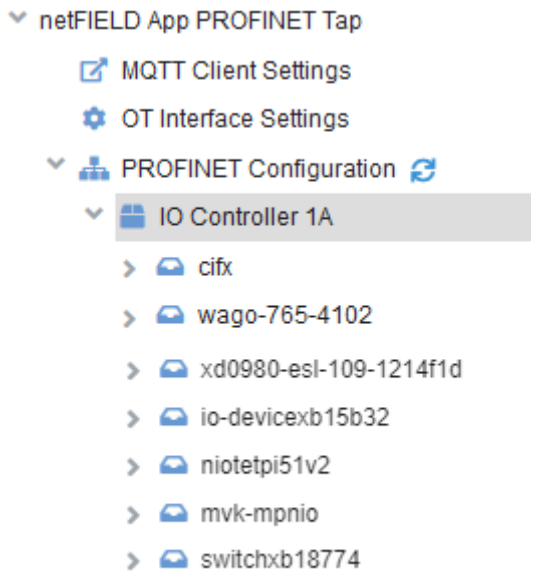

Figure 33: New Controller name

4. Map data semantics from GSDML file(s)

   ➢ Upload GSDML file(s) to the PROFINET Tap (see section *GSDML Management* [▷ page 39] for instructions).

   ➢ In the **PROFINET Configuration** tree, select the element that you want to map to your GSDML file(s). In this example, select the PROFINET Configuration root element, so that all devices will be mapped in one go.

Note:
Note that the mapping process is hierarchical: All sub-elements of a chosen element will also be mapped. This means that if you select e.g. the **PROFINET Configuration** root element, the auto-mapping wizard will try to map all devices of your PROFINET network to the GSDML files that you have uploaded (respectively to the descriptions it finds in the GSDML files). If you select a Controller in the tree (in case you have more than one Controller in your PROFINET line), all devices under this Controller will be mapped. If you select a Device, all Modules and Submodules of this Device will be mapped, and so forth.

   ➢ In the menu, select **Auto-map** > **Auto-map all devices from GSDML**.

   ↬ The Auto-map wizards opens and maps the Submodule (a.k.a. Subslot) definitions and variables it finds in the GSDML files to the Submodules of your PROFINET Configuration. Successfully mapped Submodules/ Subslots are marked with the green check mark symbol ✅:

Figure 34: Auto-mapping in progress

- Submodules for which the wizard cannot find the corresponding descriptions in the GSDML file(s) are marked with the **No matched subslot** symbol: . (If necessary, you can edit the Submodule and its variables manually later, after the auto-mapping process has been finished.)

Note:
The message “There are no data items defined for this submodule, mapping is not possible” could be caused e.g. by an IO-Link Master that has no IO-Link sensor attached to it.

- If the wizards cannot map a Submodule (e.g. because a GSDML file contains different Submodule descriptions that have the same Submodule ID), it prompts you to select the applicable Submodule description from a list:

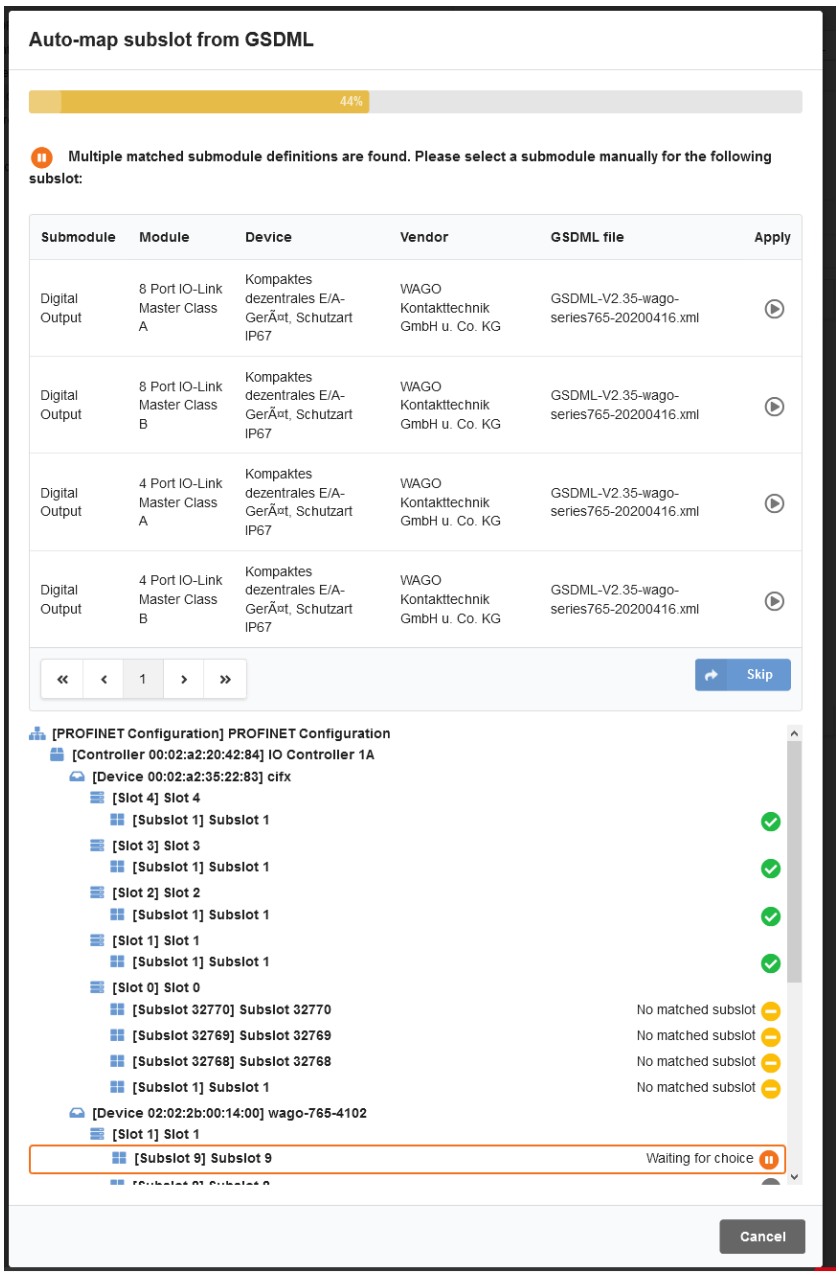

Figure 35: Select definition

➢ Click the **Apply** button to select the appropriate GSDML Submodule description for mapping.
If you do not know which description to choose, you can select the **Skip** option and edit the Submodule and its variables manually later (after the auto-mapping process has been finished).

➢ After finishing, the wizard shows a summary of the mapping process:

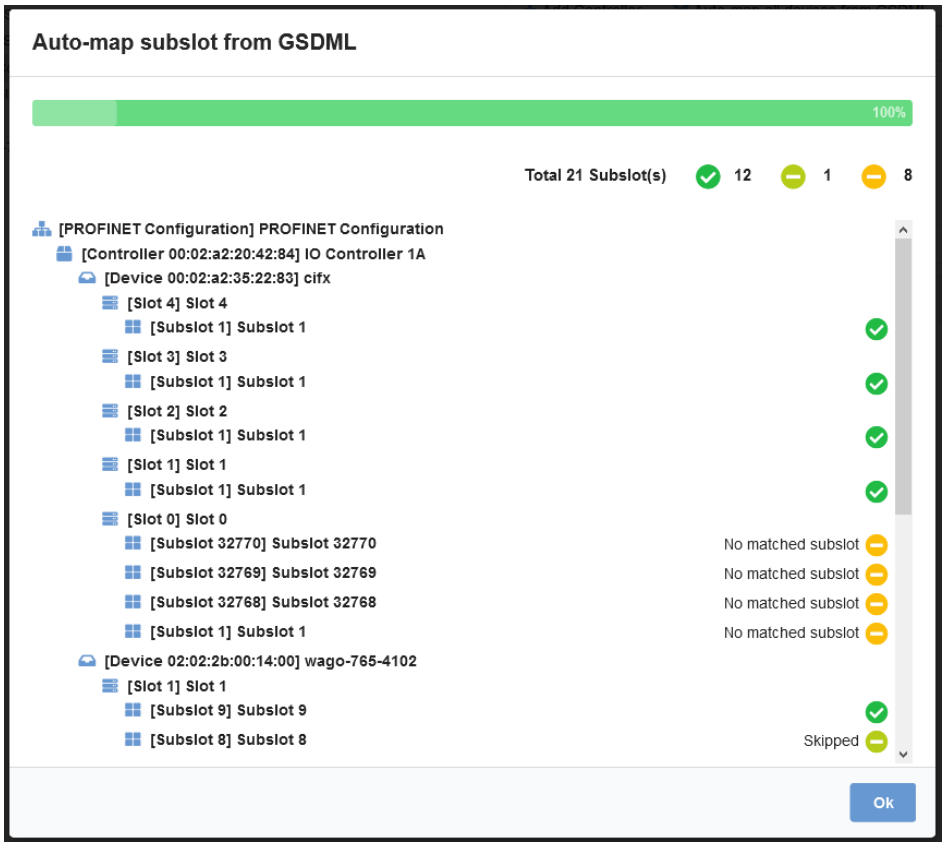

Figure 36: Finished

➢ Click **OK** button to close the wizard.

➢ The Devices in the **PROFINET Configuration** now contain the mapped information/parameters from the GSDML file(s).

5. Select Variables for publishing.
   - ➢ In the **PROFINET Configuration** tree, select the variable that you want to publish.
   - ➢ In the Editor screen of the selected variable, select the **Publish data** option and set the MQTT publication parameters, like Topic, MQTT Quality of Service, sampling rate etc.

Note:
If you do not enter a Topic here, the PROFINET Tap will use the following default string:
`netFIELD/<gateway prefix>/<container id>/<controller name>/<device name>/<slot name>/<subslot name>/<direction>/<variable name>/<node id>`
Note also that you are free to define the topic hierarchy and name according to your individual needs. You are only restricted not to use the `#` and `+` characters and not to use `$` as the very first character in the string.

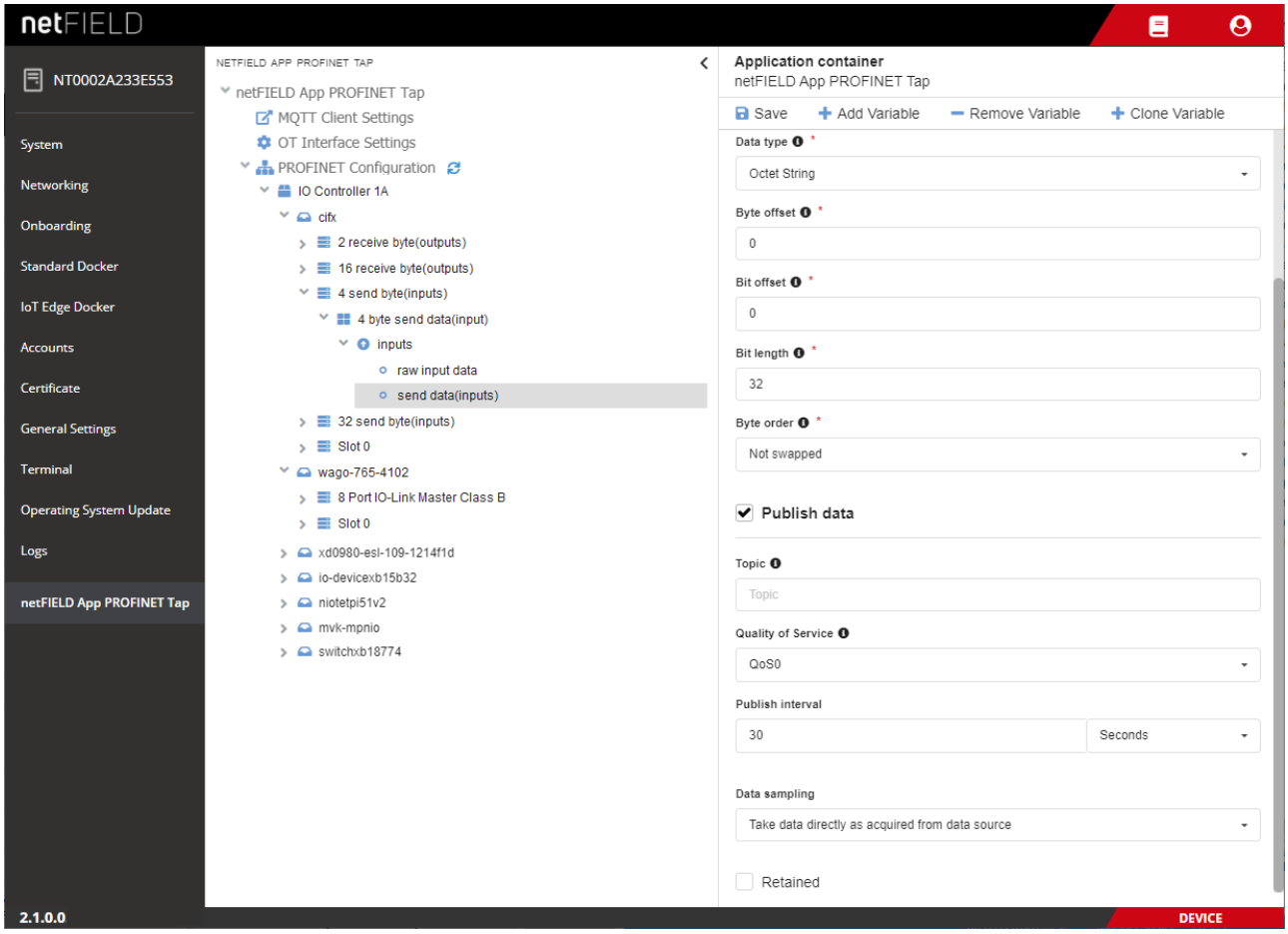

Figure 37: Publish variable

- ➢ You may also want to change the name of the variable into something that will be more intelligible for the subscribers who will consume the MQTT message, like e.g. “Temperature T1”.

➢ After having finished setting the publisher parameters, click **Save** in the menu.

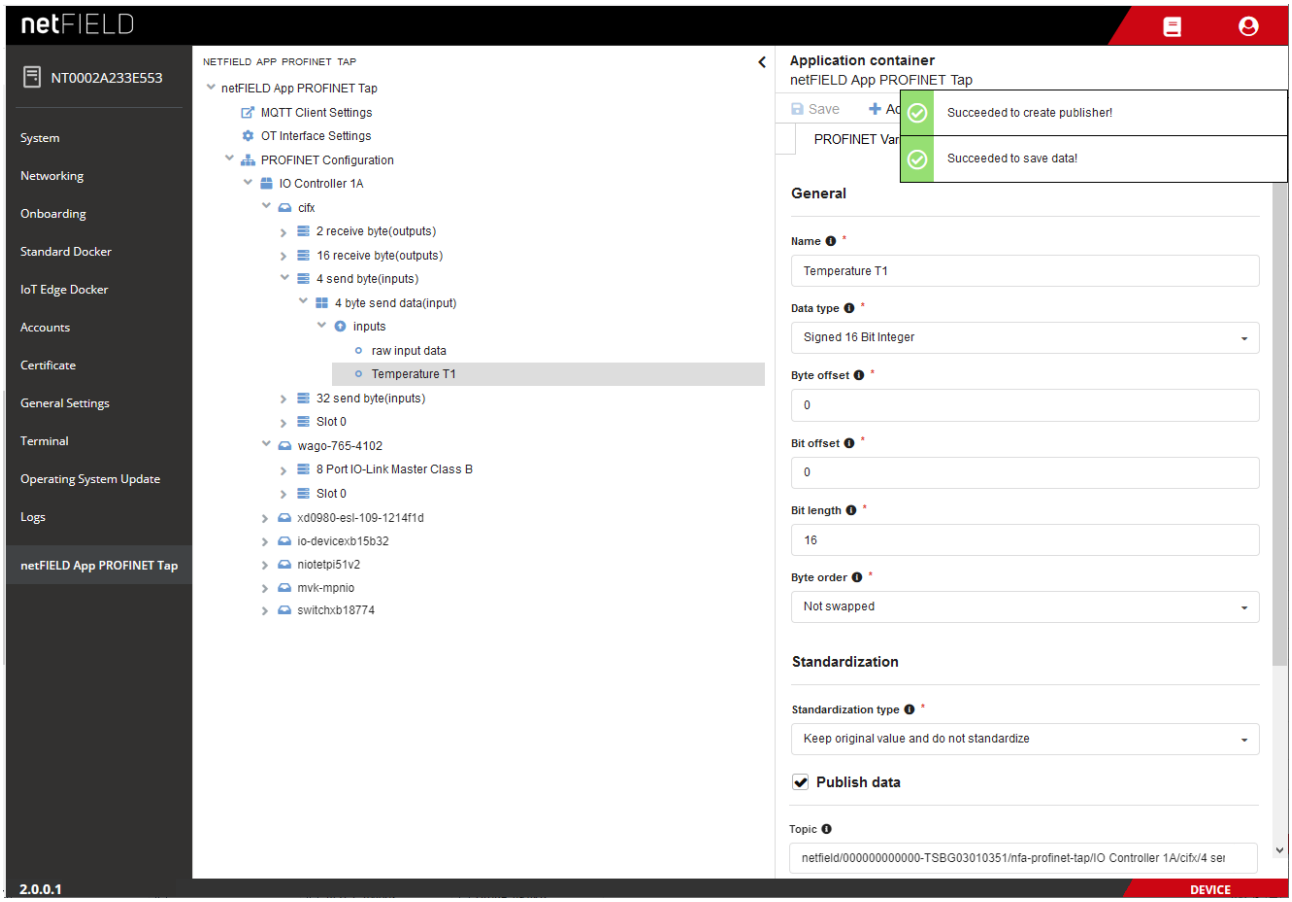

Figure 38: Publisher created

⇨ PROFINET Tap immediately starts to publish the variable to the MQTT Broker according to your settings.

4.8.5 How to configure the PROFINET Tap with AutomationML file

This section provides step-by-step instructions for creating a PROFINET Configuration by using an AutomationML file and for defining a variable to be published via MQTT.

Requirements

- The Edge Device on which the PROFINET Tap is running is connected to your PROFINET network.
- You have exported your PROFINET engineering project as AutomationML file from the TIA Portal und you have access to the file.

Step-by-step instructions

1. Set port speed according to your Tap's connection type (hardware vs. software tap).
   ➢ In the **OT Interface Settings**, select the port speed.

   WARNING Warning of unsafe system operation!
   When using a "software TAP", changing this setting may lead to a temporary loss of the bus link and thus of the PROFINET communication. Take precautions that the temporary loss of the bus communication will not affect the safe operation of your plant!

   - Select **100 MBit/s fixed** if you are using a "hardware TAP" like e.g. netMIRROR (see section *Connection via netMIRROR* [page 7]).
   - Select **Automatic** if you have connected the Edge Device directly to the PROFINET; i.e. if you are using the built-in "software TAP" of the OnPremise device (see section *Connection without hardware mirror* [page 11]).
2. Gather information from PROFINET start-up.
   ➢ Trigger a start-up of your PROFINET.

   WARNING Warning of unsafe system operation!
   If you have to stop a running PROFINET bus communication for this, take precautions that stopping the bus communication will not affect the safe operation of your plant!

PROFINET Tap listens to the “configuration” messages that are now exchanged between Controller and Devices during the PROFINET start-up phase, and extracts information from it.
After a few seconds, all recognized PROFINET participants and their subordinate elements (Modules, Submodules etc.) are listed in the PROFINET Configuration tree:

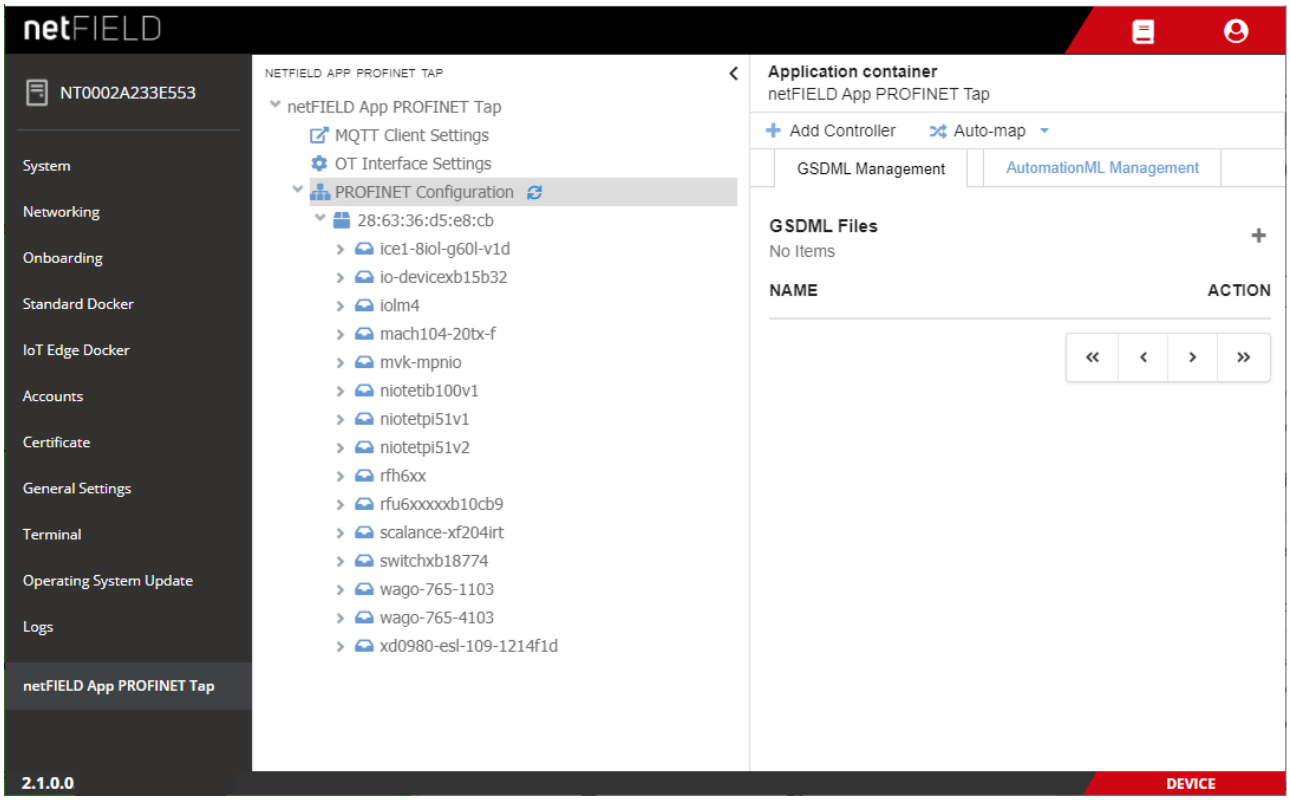

Figure 39: PROFINET configuration recognized during start-up

Note:

You may have to reload the page by clicking the icon next to the PROFINET Configuration element in order to display the recognized devices in PROFINET Configuration tree.

Note the following about the automatic device recognition during start-up:

- The order in which the devices and elements are represented in the PROFINET Configuration tree relates to the time sequence in which they were recognized; i.e. the first device in the tree is the device that was first recognized during start-up, and so forth. This means that the order of the devices in the tree does not reflect the actual positioning of the devices in the real PROFINET topology.
- The Controller’s name is represented in the tree by its MAC address, because its name is not part of the configuration information that is exchanged during start-up (and can thus not be picked up by the Tap). You can manually change its name later.
- The Tap adds “raw output/input data” as default variables below recognized Data items (i.e. outputs/inputs).

3. Map data semantics from AutomationML file.
   - ➢ Upload the AutomationML file to the PROFINET Tap (see section *AutomationML Management* [page 42] for instructions).
   - ➢ In the **PROFINET Configuration** tree, select the element that you want to map to your AutomationML file. In this example, select the PROFINET Configuration root element, so that all devices will be mapped in one go.

Note:
Note that the mapping process is hierarchical: All sub-elements of a chosen element will also be mapped. This means that if you select e.g. the **PROFINET Configuration** root element, the auto-mapping wizard will try to map all devices of your PROFINET network to the AutomationML file that you have uploaded (respectively to the descriptions it finds in the file). If you select a Controller in the tree (in case you have more than one Controller in your PROFINET line), all devices under this Controller will be mapped. If you select a Device, all Modules and Submodules of this Device will be mapped, and so forth.

   - ➢ In the menu, select **Auto-map** > **Auto-map all devices from AutomationML**.
   - ➢ The Auto-map wizards opens and maps the Submodule (a.k.a. Subslot) definitions and variables it finds in the AutomationML file to the PROFINET Configuration. Successfully mapped variables and subslots that do not have variables are marked with the green check mark symbol :

Figure 40: Auto-mapping in progress

- Submodules for which the wizard cannot find the corresponding descriptions in the AutomationML file are marked with the **No matching submodule found** symbol: . (If necessary, you can edit the Submodule and its variables manually later, after the auto-mapping process has been finished.)
- After finishing, the wizard shows a summary of the mapping process:

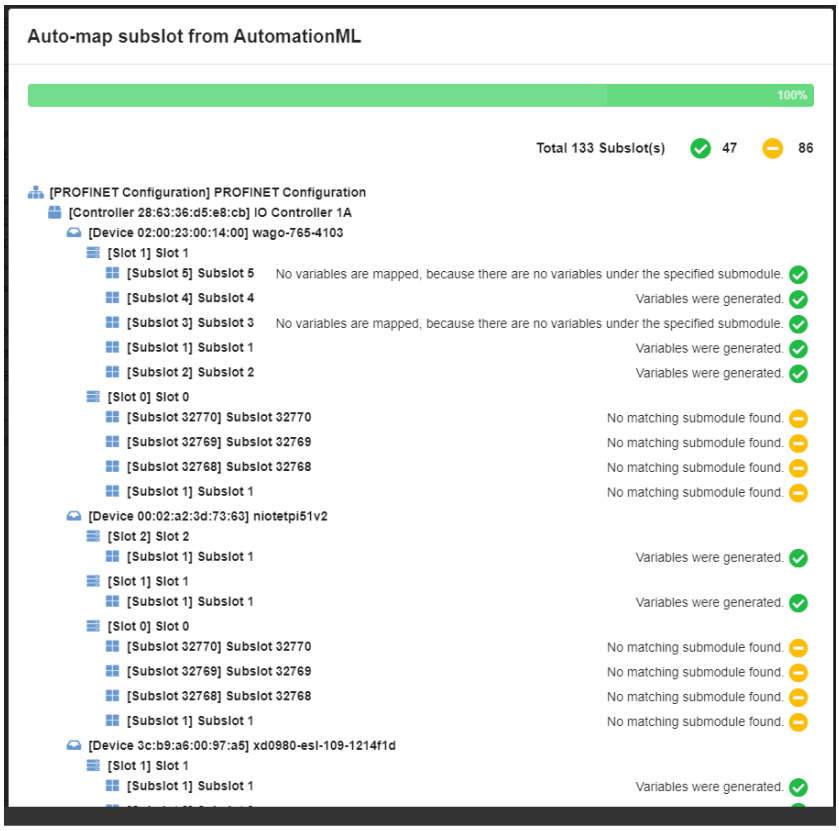

Figure 41: Mapping finished

- Scroll down to the bottom of the wizard, then click **OK** button to close the wizard.
- The Devices in the **PROFINET Configuration** now contain the mapped information/parameters from the AutomationML file.

4. Select Variables for publishing.
   - ➢ In the **PROFINET Configuration** tree, select the variable that you want to publish.
   - ➢ In the Editor screen of the selected variable, select the **Publish data** option and set the publication parameters, like Topic, MQTT Quality of Service, sampling rate etc.

Note:
If you do not enter a Topic here, the PROFINET Tap will use the following default string:
`netFIELD/<gateway prefix>/<container id>/<controller name>/<device name>/<slot name>/<subslot name>/<direction>/<variable name>/<node id>`
Note also that you are free to define the topic hierarchy and name according to your individual needs. You are only restricted not to use the `#` and `+` characters and not to use `$` as the very first character in the string.

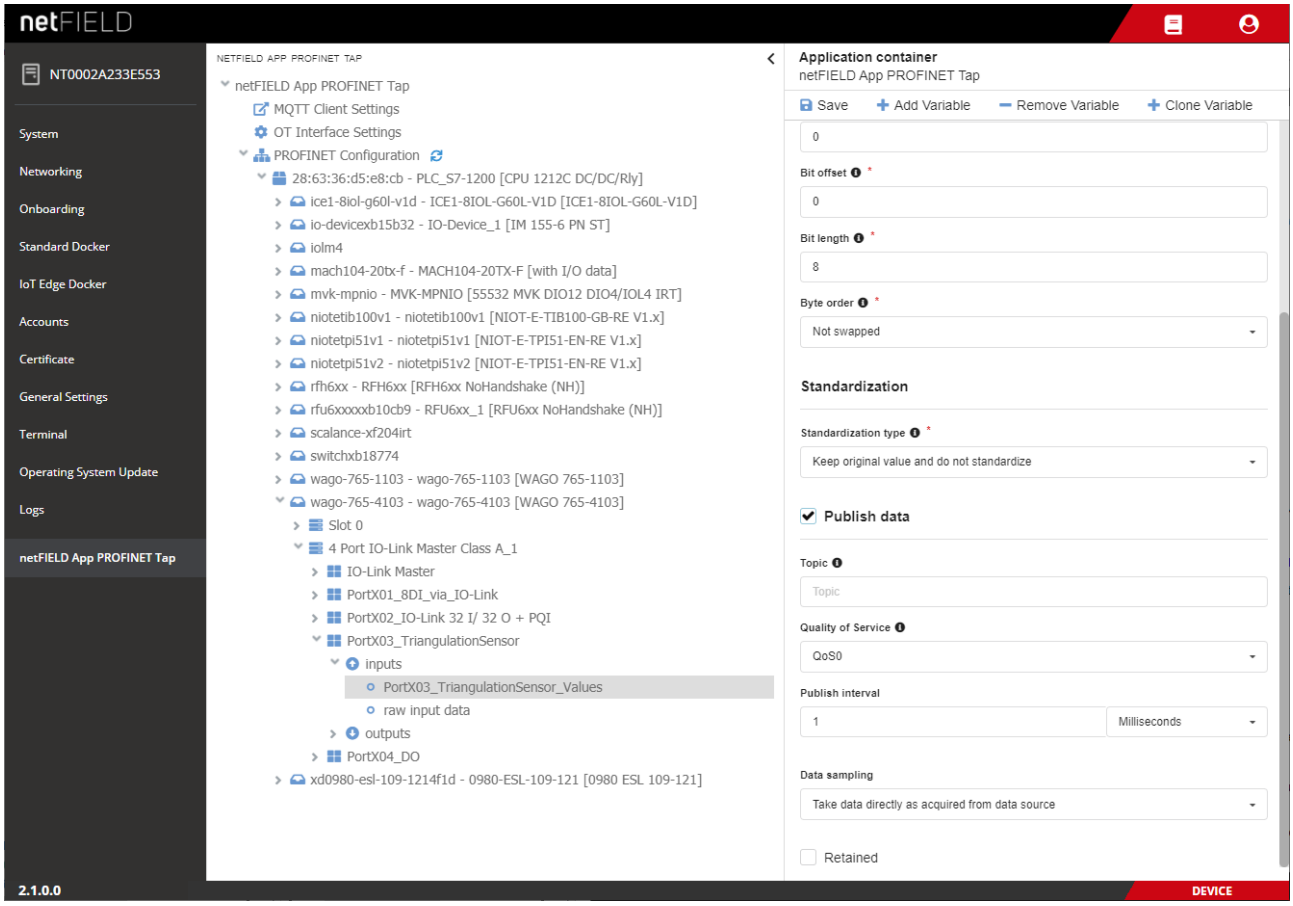

Figure 42: Publish variable

- ➢ You may also want to change the name of the variable into something that will be more intelligible for the subscribers who will consume the MQTT message, like "`TriangulationValue03`"

➢ After having finished setting the publisher parameters, click **Save** in the menu.

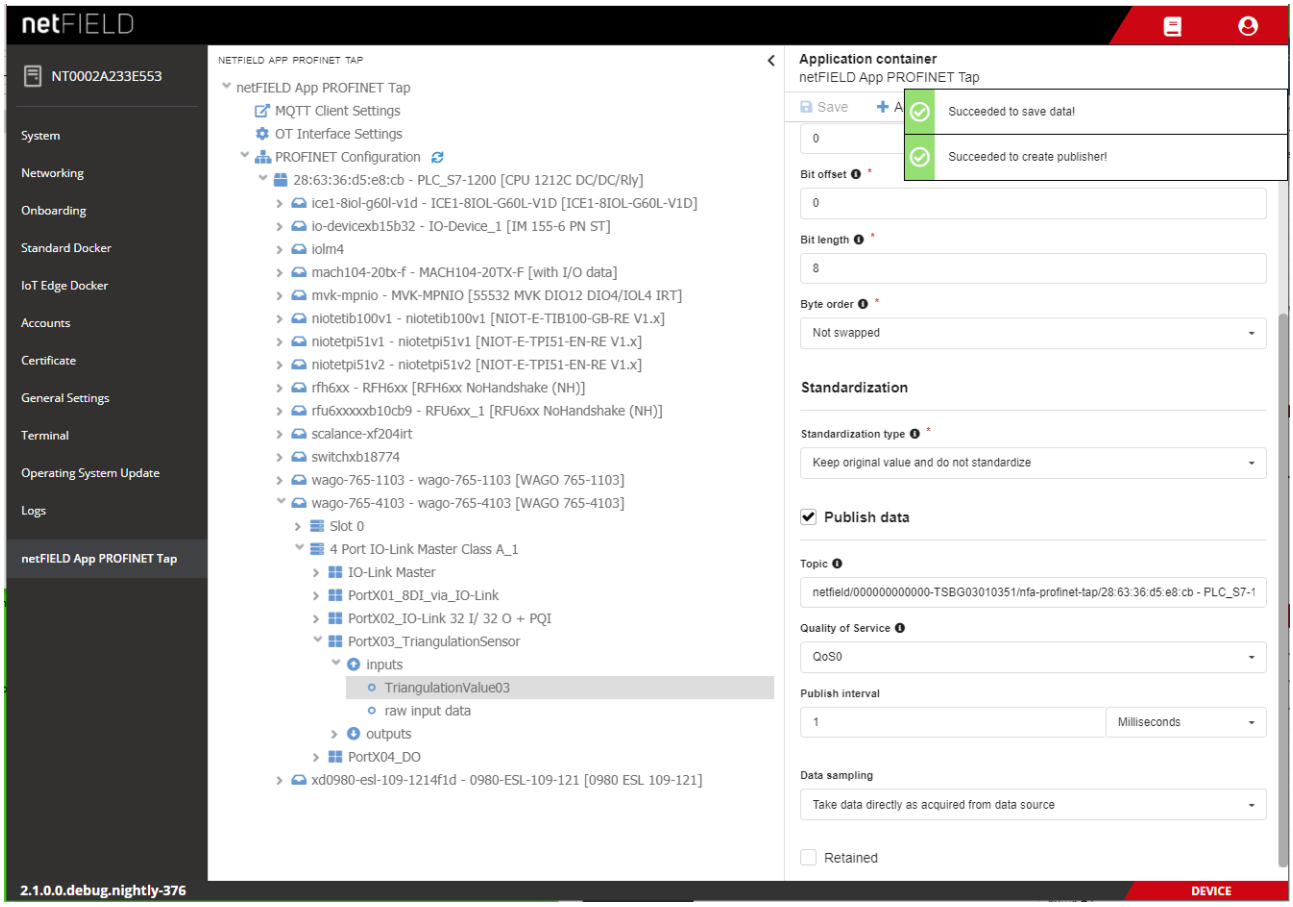

Figure 43: Publisher created

⇨ PROFINET Tap immediately starts to publish the variable to the MQTT Broker according to your settings.

5 Good to know...

5.1 MQTT message format

Structure of MQTT Topic (default)

Note:
This is the structure of the MQTT Topic string that will be used by default if you do not specify your own **Topic** string when you select a variable in the PROFINET Configuration tree for publishing (**PROFINET Variable** > **Publish data** option > **Topic** field).

Syntax:

```
netFIELD/<gateway prefix>/<container id>/<controller name>/<device name>/<slot name>/<subslot name>/<direction>/<variable name>/<node id>
```

Elements in topic:

Element in topic	Description
`<gateway prefix>`	Identifier according to global MQTT settings of the netFIELD OS. (General Settings > Default MQTT Client Settings > Gateway settings > Gateway prefix). **Note**: By default, the gateway prefix is identical with the Hardware ID of the Edge Device.
`<container id>`	Identifier according to `CONTAINER_ID` environment variable. **Note**: By default, the Container ID is `nfa-profinet-tap`, but can be changed by the user (see section *Environment Variables* [page 18]).
`<controller name>`	Name of the IO Controller (may be represented by default by its MAC address)
`<device name>`	Name of the IO Device
`<slot name>`	Name of the PROFINET Module
`<subslot name>`	Name of the PROFINET Submodule
`<direction>`	Specifies “inputs” or “outputs”
`<variable name>`	Name of the variable
`<node id>`	Unique number assigned to the variable when it was created in the configuration tree. Stays the same until deletion of the element (will not be changed by changing the name of the variable in the configuration GUI, or of any other element which is contained in the topic)

Table 15: Descriptions of elements in topic

Example:

```
netfield/000000000000-TSBH06005551/nfa-profinet-tap/28:63:36:d5:e8:cb/wago-765-1104/Slot 1/Subslot 1/outputs/raw output data/251
```

Structure of message content

```
{
  "schemaVersion": 1,
  "nodeId": "251",
  "messageType": "processdata",
  "dataType": "octetString",
  "data": [
    {
      "timestamp": "2020-05-28T13:28:55.514890874",
      "state": "valid",
      "value": "0000"
    },
    {
      "timestamp": "2020-05-28T13:28:55.522859992",
      "state": "valid",
      "value": "0100"
    },
    {
      "timestamp": "2020-05-28T13:28:55.530893872",
      "state": "valid",
      "value": "00AB"
    },
    {
      "timestamp": "2020-05-28T13:28:55.538880191",
      "state": "valid",
      "value": "FF00"
    },
    {
      "timestamp": "2020-05-28T13:28:55.546894711",
      "state": "valid",
      "value": "0123"
    }
  ]
}
```

Element	Note	
`schemaVersion`	Identifies the version of the JSON structure of the message (as depicted in the example above). The current structure version is “`1`”. If the structure changes in future, the `schemaVersion` will be incremented.	
`nodeId`	Is the same node ID as in the topic.	
`messageType`	Is always “`processdata`”.	
`dataType`	Is the data type of the variable as specified in the configuration GUI (“`octetString`” in this example).	
`data`	Is the array of one or multiple process data samples contained in this message. The amount may vary according to the sample and publish intervals. Each data element consists of:	
	`timestamp`	Point in time (in nanosecond resolution and in ISO 8601 format) when the data sample was acquired from the network.
	`state`	Shows if the data value is ensured to be valid, or may be invalid due to invalid provider state of the PROFINET data item.
	`value`	Actual data value according to data type, either as number, bool or string.

Table 16: Notes on message content

5.2 Restrictions concerning AutomationML export from TIA Portal and mapping in PROFINET Tap

This section lists the known restrictions concerning the export of project engineering data in AutomationML format from the TIA Portal, and its subsequent import and mapping in the PROFINET Tap.

- The PROFINET Tap supports only AutomationML files exported from the TIA Portal. Support of AutomationML files exported from EPLAN has not been tested or verified.
- You must be logged in as member of the “Siemens TIA Openness” group in order to be allowed to use the **Export CAx data...** function (= export in AutomationML format) in the TIA Portal.
- The TIA Portal does not support the **Export CAx data...** function for the following devices/items (therefore auto-mapping of variables for these devices/items by the PROFINET Tap is not possible):
  - Port-Port connections
  - Connections to and between extension racks
  - Multi-CPUs
  - H-devices
  - HMI devices except push button panels and key panels
  - Drives
  - Output mode and range of analog channels
  - Packed addresses
- The TIA Portal does not export the structure of complex data types like the PLC data type “`256ByteModuleStructured`”. Therefore mapping of complex data types is currently not supported.
- The PROFINET Tap does not support the mapping of variables which exceed the defined address range of a submodule

5.3 Mapping of TIA Portal data types to PROFINET Tap-supported data types

The following table shows the mapping of data types from the TIA Portal to data types supported by the PROFINET Tap.

Note:
For channels where no explicit data type is specified, PROFINET Tap will automatically select an unsigned integer data type of matching size. For example, a channel of size 8 bit will be selected as `unsigned8`, a channel of 32 bit size as `unsigned32`, and so on.

Category	TIA Portal data types	PROFINET Tap data types
Binary	BOOL	boolean
Bit sequences	BYTE	unsigned8
	WORD	unsigned16
	DWORD	unsigned32
	LWORD	unsigned64
Integers	SINT	integer8
	INT	integer16
	DINT	integer32
	USINT	unsigned8
	UINT	unsigned16
	UDINT	unsigned32
	LINT	integer64
	ULINT	unsigned64
Floating point numbers	REAL	real32
	LREAL	real64
Times	S5TIME	octetString
	TIME	octetString
	LTIME	octetString
Date and time	DATE	octetString
	TOD (TIME_OF_DAY)	octetString
	LTOD (LTIME_OF_DAY)	octetString
	DT (DATE_AND_TIME)	not supported
	LDT	octetString
	DTL	not supported
Strings	CHAR	visibleString
	WCHAR	octetString
	STRING	not supported
	WSTRING	not supported

Category	TIA Portal data types	PROFINET Tap data types
Hardware data types	REMOTE	not supported
	HW_ANY	unsigned16
	HW_DEVICE	unsigned16
	HW_DPMASTER	unsigned16
	HW_DPSLAVE	unsigned16
	HW_IO	unsigned16
	HW_IOSYSTEM	unsigned16
	HW_SUBMODULE	unsigned16
	HW_MODULE	unsigned16
	HW_INTERFACE	unsigned16
	HW_IEPORT	unsigned16
	HW_HSC	unsigned16
	HW_PWM	unsigned16
	HW_PTO	unsigned16
	EVENT_ANY	unsigned32
	EVENT_ATT	unsigned32
	EVENT_HWINT	unsigned32
	OB_ANY	integer16
	OB_DELAY	integer16
	OB_TOD	integer16
	OB_CYCLIC	integer16
	OB_ATT	integer16
	OB_PCYCLE	integer16
	OB_HWINT	integer16
	OB_DIAG	integer16
	OB_TIMEERROR	integer16
	OB_STARTUP	integer16
	PORT	unsigned16
	RTM	unsigned16
	PIP	unsigned16
	CONN_ANY	unsigned16
	CONN_PRG	unsigned16
	CONN_OUC	unsigned16
	CONN_R_ID	unsigned32
	DB_ANY	unsigned16
	DB_WWW	unsigned16
	DB_DYN	unsigned16

Table 17: Mapping of data types from TIA Portal

5.4 Using SSL/TLS encryption (optional)

Please note the following if you intend to use SSL/TLS encryption:
The certificates and key files that the MQTT Client in the PROFINET Tap container needs for establishing a secure SSL/TLS connection to the MQTT Broker are not managed by the PROFINET Tap container itself. Instead, they are to be stored on the Edge Device and mapped into the container from the netFIELD OS.
For this mapping, the following standard directories are mapped into the container if you use the default Container Create Options in the netFIELD Portal:

```
/etc/ssl/
/usr/share/ca-certificates/
```

Note:
If you require different directories for your use case, you may change the mapping of these “bind mounts” in the netFIELD Portal before deploying the container (see section *Container Create Options* [page 17]).

As a user, you can store your required keys and certificates in these directories. By selecting the **SSL / TLS** option on the **MQTT Client Settings** page, you can allow the MQTT Client in the PROFINET Tap container to use these files for establishing its secure SSL/TLS connection. Note that these keys and certificates must be stored in PEM format (a specific file format for storing this kind of data) and that you have to specify the full path to the appropriate PEM file in the corresponding fields of the **MQTT Client Settings** page. For example:

File name and path to private key in PEM format:
`/etc/ssl/private/client-key.pem`

File name and path to certificate chains in PEM format:
`/etc/ssl/services/client-cert.pem`

Override the trusted CA certificates in PEM format:
`/etc/ssl/services/ca-cert.pem`

Note also that if you intend to use more than one “secure” MQTT Broker (as listed in the **Server URIs** field), and thus require several different certificates, you have to store them *in one single* PEM file. This is because it is not possible to specify a list of multiple paths to separate PEM files for individual Brokers.

6 Legal notes

Copyright

Important notes

Utmost care was/is given in the preparation of the documentation at hand consisting of a user's manual, operating manual and any other document type and accompanying texts. However, errors cannot be ruled out. Therefore, we cannot assume any guarantee or legal responsibility for erroneous information or liability of any kind. You are hereby made aware that descriptions found in the user's manual, the accompanying texts and the documentation neither represent a guarantee nor any indication on proper use as stipulated in the agreement or a promised attribute. It cannot be ruled out that the user's manual, the accompanying texts and the documentation do not completely match the described attributes, standards or any other data for the delivered product. A warranty or guarantee with respect to the correctness or accuracy of the information is not assumed.

We reserve the right to modify our products and the specifications for such as well as the corresponding documentation in the form of a user's manual, operating manual and/or any other document types and accompanying texts at any time and without notice without being required to notify of said modification. Changes shall be taken into account in future manuals and do not represent an obligation of any kind, in particular there shall be no right to have delivered documents revised. The manual delivered with the product shall apply.

Under no circumstances shall Hilscher Gesellschaft für Systemautomation mbH be liable for direct, indirect, ancillary or subsequent damage, or for any loss of income, which may arise after use of the information contained herein.

Liability disclaimer

The hardware and/or software was created and tested by Hilscher Gesellschaft für Systemautomation mbH with utmost care and is made available as is. No warranty can be assumed for the performance or flawlessness of the hardware and/or software under all application conditions and scenarios and the work results achieved by the user when using the hardware and/or software. Liability for any damage that may have occurred as a result of using the hardware and/or software or the corresponding documents shall be limited to an event involving willful intent or a grossly negligent violation of a fundamental contractual obligation. However, the right to assert damages due to a violation of a fundamental contractual obligation shall be limited to contract-typical foreseeable damage.

It is hereby expressly agreed upon in particular that any use or utilization of the hardware and/or software in connection with

- Flight control systems in aviation and aerospace;
- Nuclear fission processes in nuclear power plants;
- Medical devices used for life support and
- Vehicle control systems used in passenger transport

shall be excluded. Use of the hardware and/or software in any of the following areas is strictly prohibited:

- For military purposes or in weaponry;
- For designing, engineering, maintaining or operating nuclear systems;
- In flight safety systems, aviation and flight telecommunications systems;
- In life-support systems;
- In systems in which any malfunction in the hardware and/or software may result in physical injuries or fatalities.

You are hereby made aware that the hardware and/or software was not created for use in hazardous environments, which require fail-safe control mechanisms. Use of the hardware and/or software in this kind of environment shall be at your own risk; any liability for damage or loss due to impermissible use shall be excluded.

Warranty

Hilscher Gesellschaft für Systemautomation mbH hereby guarantees that the software shall run without errors in accordance with the requirements listed in the specifications and that there were no defects on the date of acceptance. The warranty period shall be 12 months commencing as of the date of acceptance or purchase (with express declaration or implied, by customer's conclusive behavior, e.g. putting into operation permanently).

The warranty obligation for equipment (hardware) we produce is 36 months, calculated as of the date of delivery ex works. The aforementioned provisions shall not apply if longer warranty periods are mandatory by law pursuant to Section 438 (1.2) BGB, Section 479 (1) BGB and Section 634a (1) BGB [Bürgerliches Gesetzbuch; German Civil Code] If, despite of all due care taken, the delivered product should have a defect, which already existed at the time of the transfer of risk, it shall be at our discretion to either repair the product or to deliver a replacement product, subject to timely notification of defect.

The warranty obligation shall not apply if the notification of defect is not asserted promptly, if the purchaser or third party has tampered with the products, if the defect is the result of natural wear, was caused by unfavorable operating conditions or is due to violations against our operating regulations or against rules of good electrical engineering practice, or if our request to return the defective object is not promptly complied with.

Costs of support, maintenance, customization and product care

Please be advised that any subsequent improvement shall only be free of charge if a defect is found. Any form of technical support, maintenance and customization is not a warranty service, but instead shall be charged extra.

Additional guarantees

Although the hardware and software was developed and tested in-depth with greatest care, Hilscher Gesellschaft für Systemautomation mbH shall not assume any guarantee for the suitability thereof for any purpose that was not confirmed in writing. No guarantee can be granted whereby the hardware and software satisfies your requirements, or the use of the hardware and/or software is uninterruptable or the hardware and/or software is fault-free.

It cannot be guaranteed that patents and/or ownership privileges have not been infringed upon or violated or that the products are free from third-party influence. No additional guarantees or promises shall be made as to whether the product is market current, free from deficiency in title, or can be integrated or is usable for specific purposes, unless such guarantees or promises are required under existing law and cannot be restricted.

Confidentiality

The customer hereby expressly acknowledges that this document contains trade secrets, information protected by copyright and other patent and ownership privileges as well as any related rights of Hilscher Gesellschaft für Systemautomation mbH. The customer agrees to treat as confidential all of the information made available to customer by Hilscher Gesellschaft für Systemautomation mbH and rights, which were disclosed by Hilscher Gesellschaft für Systemautomation mbH and that were made accessible as well as the terms and conditions of this agreement itself.

The parties hereby agree to one another that the information that each party receives from the other party respectively is and shall remain the intellectual property of said other party, unless provided for otherwise in a contractual agreement.

The customer must not allow any third party to become knowledgeable of this expertise and shall only provide knowledge thereof to authorized users as appropriate and necessary. Companies associated with the customer shall not be deemed third parties. The customer must obligate authorized users to confidentiality. The customer should only use the confidential information in connection with the performances specified in this agreement.

The customer must not use this confidential information to his own advantage or for his own purposes or rather to the advantage or for the purpose of a third party, nor must it be used for commercial purposes and this confidential information must only be used to the extent provided for in this agreement or otherwise to the extent as expressly authorized by the disclosing party in written form. The customer has the right, subject to the obligation to confidentiality, to disclose the terms and conditions of this agreement directly to his legal and financial consultants as would be required for the customer's normal business operation.

Export provisions

The delivered product (including technical data) is subject to the legal export and/or import laws as well as any associated regulations of various countries, especially such laws applicable in Germany and in the United States. The products / hardware / software must not be exported into such countries for which export is prohibited under US American export control laws and its supplementary provisions. You hereby agree to strictly follow the regulations and to yourself be responsible for observing them. You are hereby made aware that you may be required to obtain governmental approval to export, reexport or import the product.

List of Figures

Figure 1: Connection via netMIRROR and OnPremise device ... 8
Figure 2: Connection via mirror port of switch ... 10
Figure 3: Connection without hardware mirror ... 11
Figure 4: Available Containers tab ... 13
Figure 5: Deploy container ... 14
Figure 6: Overview tab ... 15
Figure 7: Container Create Options ... 17
Figure 8: Environment Variables ... 18
Figure 9: Container Twin ... 20
Figure 10: Configuration GUI plugin in local Device Manager ... 21
Figure 11: Status page ... 22
Figure 12: About tab ... 23
Figure 13: Configuration Backup ... 24
Figure 14: Restore configuration ... 25
Figure 15: Publisher Management ... 26
Figure 16: Parameters of PROFINET variable ... 27
Figure 17: MQTT Client settings ... 28
Figure 18: Physical settings ... 30
Figure 19: PROFINET Configuration tree ... 31
Figure 20: Parameters of selected PROFINET element in Editor window ... 32
Figure 21: Menu bar ... 32
Figure 22: GSDML Management ... 39
Figure 23: Upload GSDML file dialog ... 40
Figure 24: Multiple selection in File upload dialog ... 40
Figure 25: Upload GSDML file dialog ... 41
Figure 26: AutomationML Management ... 42
Figure 27: Export AutomationML file from Tia Portal ... 43
Figure 28: Upload AutomationML file dialog ... 44
Figure 29: Multiple selection in File upload dialog ... 44
Figure 30: Upload AutomationML file dialog ... 45
Figure 31: PROFINET configuration recognized during start-up ... 47
Figure 32: Change name of Controller ... 48
Figure 33: New Controller name ... 48
Figure 34: Auto-mapping in progress ... 49
Figure 35: Select definition ... 50
Figure 36: Finished ... 51
Figure 37: Publish variable ... 52
Figure 38: Publisher created ... 53
Figure 39: PROFINET configuration recognized during start-up ... 55
Figure 40: Auto-mapping in progress ... 56

Figure 41: Mapping finished 57
Figure 42: Publish variable 58
Figure 43: Publisher created..... 59

List of Tables

Table 1: List of revisions 4
Table 2: Elements in Overview tab 15
Table 3: Operating elements for Container Create Options 17
Table 4: Environment Variables 18
Table 5: Operating elements for Environment Variables 19
Table 6: Operating elements for Container Twin Options 20
Table 7: About tab 23
Table 8: Elements of Publisher Management tab 26
Table 9: Elements Variable’s details window 27
Table 10: MQTT Client Settings 29
Table 11: Port speed settings 30
Table 12: Elements PROFINET Configuration 38
Table 13: GSDML Management tab 39
Table 14: AutomationML Management tab 43
Table 15: Descriptions of elements in topic 60
Table 16: Notes on message content 61
Table 17: Mapping of data types from TIA Portal 63

Contacts

HEADQUARTERS

Germany

Hilscher Gesellschaft für
Systemautomation mbH
Rheinstrasse 15
65795 Hattersheim
Phone: +49 (0) 6190 9907-0
Fax: +49 (0) 6190 9907-50
E-mail: info@hilscher.com

Support

Phone: +49 (0) 6190 9907-99
E-mail: de.support@hilscher.com

SUBSIDIARIES

China

Hilscher Systemautomation (Shanghai) Co. Ltd.
200010 Shanghai
Phone: +86 (0) 21-6355-5161
E-mail: info@hilscher.cn

Support

Phone: +86 (0) 21-6355-5161
E-mail: cn.support@hilscher.com

France

Hilscher France S.a.r.l.
69500 Bron
Phone: +33 (0) 4 72 37 98 40
E-mail: info@hilscher.fr

Support

Phone: +33 (0) 4 72 37 98 40
E-mail: fr.support@hilscher.com

India

Hilscher India Pvt. Ltd.
Pune, Delhi, Mumbai
Phone: +91 8888 750 777
E-mail: info@hilscher.in

Italy

Hilscher Italia S.r.l.
20090 Vimodrone (MI)
Phone: +39 02 25007068
E-mail: info@hilscher.it

Support

Phone: +39 02 25007068
E-mail: it.support@hilscher.com

Japan

Hilscher Japan KK
Tokyo, 160-0022
Phone: +81 (0) 3-5362-0521
E-mail: info@hilscher.jp

Support

Phone: +81 (0) 3-5362-0521
E-mail: jp.support@hilscher.com

Korea

Hilscher Korea Inc.
Seongnam, Gyeonggi, 463-400
Phone: +82 (0) 31-789-3715
E-mail: info@hilscher.kr

Switzerland

Hilscher Swiss GmbH
4500 Solothurn
Phone: +41 (0) 32 623 6633
E-mail: info@hilscher.ch

Support

Phone: +49 (0) 6190 9907-99
E-mail: ch.support@hilscher.com

USA

Hilscher North America, Inc.
Lisle, IL 60532
Phone: +1 630-505-5301
E-mail: info@hilscher.us

Support

Phone: +1 630-505-5301
E-mail: us.support@hilscher.com