



**Operating instruction manual  
netFIELD App PROFINET Tap**

**Hilscher Gesellschaft für Systemautomation mbH  
[www.hilscher.com](http://www.hilscher.com)**

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# 1 Introduction

## 1.1 About this document

### 1.1.1 Description of the contents

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

### 1.1.2 List of revisions

Index	Date	Revision
6	2023-02-27	Document completely revised

Table 1: List of revisions

### 1.1.3 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>

## 1.2 Brief description

**PROFINET Tap** is an application container that monitors PROFINET traffic and publishes selected machinery process data via MQTT.

It allows you to “tap into” the process data and 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.

The PROFINET Tap features a web-based configuration GUI that can be accessed via HTTP(S) browser connection without having to install any additional software tools. This configuration GUI is described in chapter *Configuration web pages of the PROFINET Tap* [▶ page 18].

The “auto-mapping” function of the PROFINET Tap allows you to assign data semantics and symbols from GSDML and/or AutomationML files conveniently to your configuration.

## 1.3 General requirements

### 1.3.1 MQTT broker

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 host or on a different host machine in your local IT network.

### 1.3.2 License

#### **CodeMeter licensing technology**

The netFIELD App PROFINET Tap is protected by the *CodeMeter* licensing technology from *Wibu-Systems*. In order to use the app properly, you need a *CodeMeter* license server (*CodeMeter User Runtime*) and the PROFINET Tap license key, which you must download and activate in the license server.

For purchasing the license key, please contact your Hilscher sales representative.

If you are not already a user of the *CodeMeter* ecosystem and have not implemented a *CodeMeter* license server yet, you can download the *CodeMeter User Runtime* from *Wibu-Systems* under <https://www.wibu.com/us/support/user/downloads-user-software.html> and install it on a local server/machine/PC that can be reached by the PROFINET Tap via TCP/IP connection. Exemplary instructions on how to install the license server and import and activate the PROFINET Tap license key are provided in section *Installing CodeMeter and activating license* [▶ page 73].

Note that for you as an end-user, the *CodeMeter* technology is free-of-charge, you only have to pay for the PROFINET Tap license key from Hilscher.

#### **Floating license**

The PROFINET Tap license is a “floating” license, which means that it is not bound to an individual instance of the app running on a particular device. Whichever instance of the app “grabs” the license from the *CodeMeter* server first, can use it until the instance itself closes the connection to the server again (either by the application container being shut down or by deleting the corresponding license server endpoint on the **License Server Settings** page of the app). Other instances of the PROFINET Tap (e.g. a PROFINET Tap container running on another device) can then “take over” the “freed” license by simply connecting to the corresponding license server.

### Maintenance period

Currently, the netFIELD App PROFINET Tap license is a “one-time payment license”, meaning that you can use the container license without time restriction, once you have paid the license fee.

The maintenance period, in which you are entitled to deploy software updates of the container, is one year (beginning on the day the license is activated). After this period, you can still use your last deployed container version indefinitely; however, for using higher container versions, you will have to acquire a new or updated license.

### License-free demo mode

Without a license, you can still deploy, configure and operate the PROFINET Tap for testing purposes; however, all acquired and published process data values will be invalidated (set to null), except for the first two variables of your **Active Publishers** list (see section “*Publisher Management*” tab [▶ page 23]), which will be available with “correct” values for 30 minutes. After 30 minutes, the first two variables will also be set to null.

## 1.3.3 Memory

The RAM needed by the PROFINET Tap depends on the amount of PROFINET data that you intend to capture and process in your application. We recommend you to provide at least **1 GB of free RAM** on your Edge Device/Datacenter (ideally 2 GB or more).

In use cases with a stable amount of little data processing, less than 1 GB RAM might be sufficient.

## 2 Use cases

### 2.1 Connecting PROFINET via netX-based interface

#### 2.1.1 Overview

The netX SoC is a multi-protocol communication controller from Hilscher, which is available as single chip, embedded module (like e.g. comX) or cifX PC card. You can use a netX-based Industrial Ethernet interface together with the netANALYZER driver as “capture interface” for your PROFINET Tap container.

The netANALYZER driver is included in the netFIELD Operating System (netFIELD OS), but will also be available as separate driver in the near future.

Being equipped with a netX-based cifX interface and the netFIELD OS (which features the required netANALYZER driver and a container engine), the netFIELD OnPremise edge gateway (NIOT-E-TIJCX-GB-RE/NFLD) is currently the ideal ready-to-use host device for your PROFINET Tap.

#### 2.1.2 Connecting PROFINET via netMIRROR (hardware TAP)

You can use the Hilscher **netMIRROR** (NMR-TFE-RE, part no. 7340.100) device as a hardware-based “tap” (test access point) for connecting the PROFINET to your host 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”.

By using such a hardware mirror, you also avoid the risk of traffic disruption if your host device is turned off or configured, or if a software update is performed on that device. It is therefore the implementation with the lowest risk of network failure.



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

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The requirements for this use case are:

- netMIRROR device
- Your host device is equipped with a netX-based Industrial Ethernet interface (e.g. *cifX* in OnPremise edge gateway)
- netFIELD Operating System (“netFIELD OS”, includes the required netANALYZER driver)  
or  
3<sup>rd</sup> party operating system with netANALYZER driver

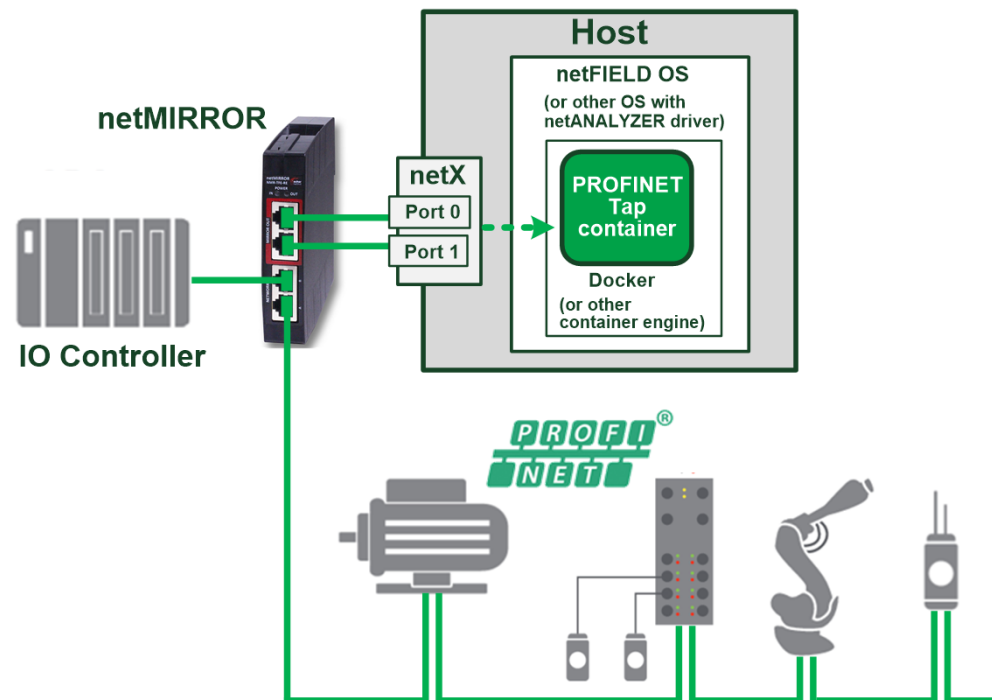


Figure 1: netX-based interface with netMIRROR

- Connect one of the **NETWORK** ports of the netMIRROR to the Controller. Connect the other **NETWORK** port of the netMIRROR to the first PROFINET Device.
- Connect *both* **MIRROR OUT** ports of the netMIRROR to the ports of the netX-based interface.

You can use “patch” or “crossover” cables. Note that you must set the **Crossover Mode** for the ports on the **OT Interface Settings** page accordingly (see section *netX-based OT Capture Interface* [▶ page 31]). Note also that the signals at MIRROR OUT Port A are already crossed. Therefore you must configure the OT Interface Settings as shown in the figures below:

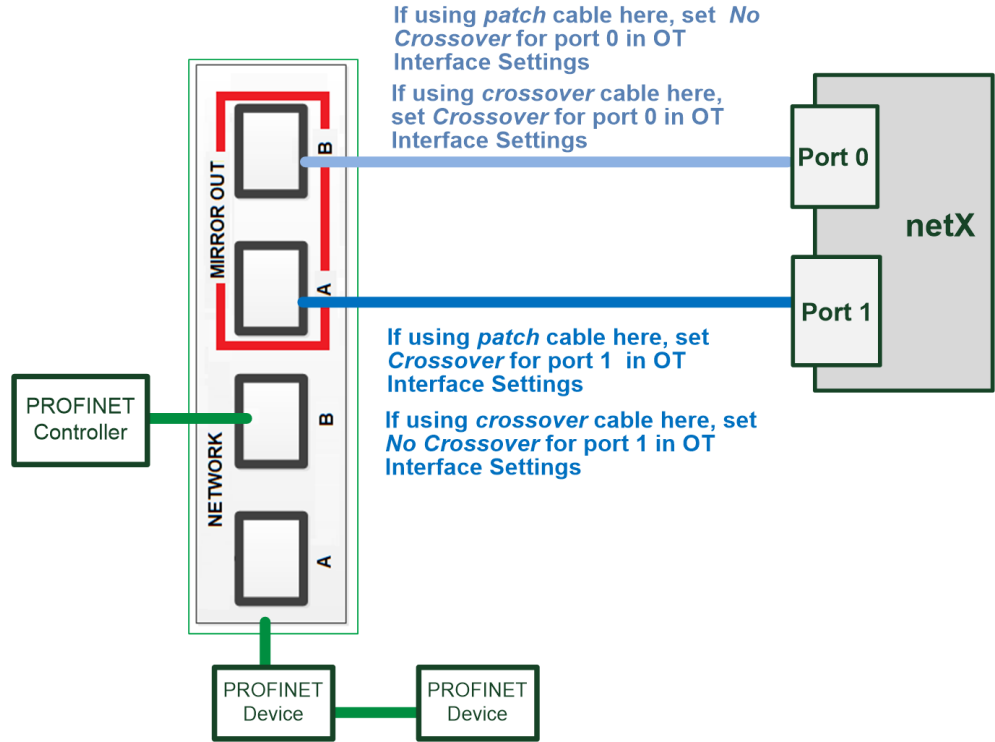


Figure 2: Connecting netMIRROR ports to netX ports: B to 0 and A to 1

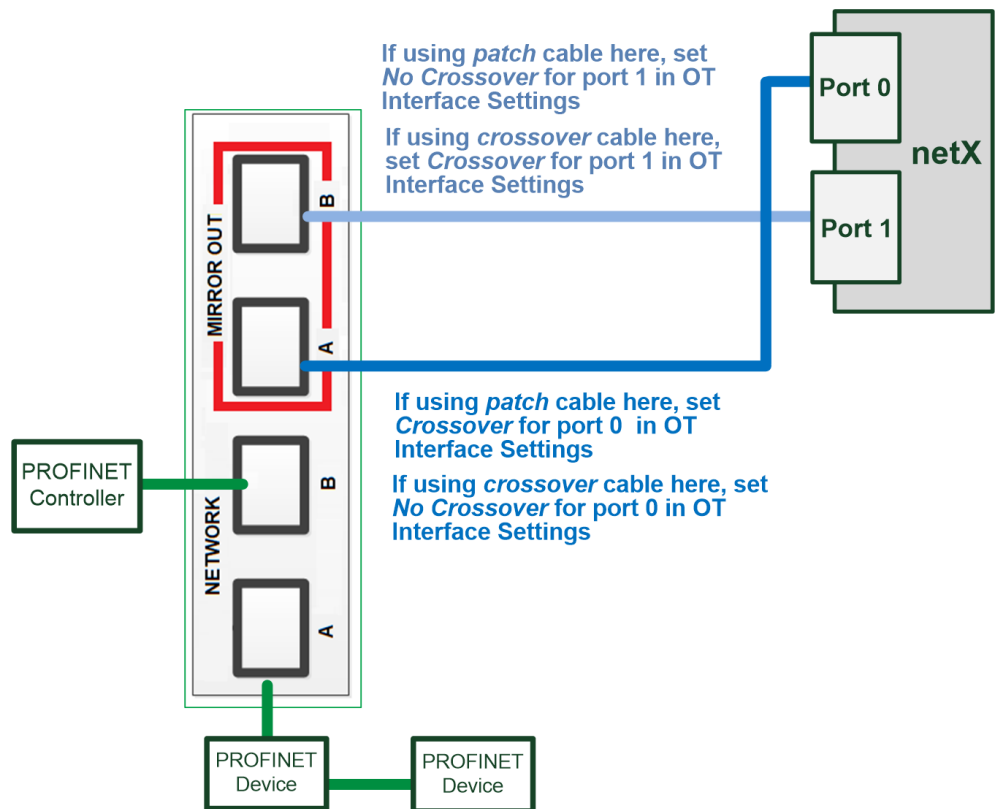


Figure 3: Connecting netMIRROR ports to netX ports: B to 1 and A to 0

- Set the Link Speed of the netX-based interface to 100 MBit/s fixed. This can be done in the configuration web GUI of the PROFINET Tap (see section *netX-based OT Capture Interface* [▶ page 31]).

Note that the netX-based interface allows only “passive” data capturing. The PROFINET Tap therefore also needs a “standard” LAN interface on the host for its TCP/IP, HTTP and MQTT communication. This LAN interface is necessary for deploying the container and for accessing its configuration web GUI. If your MQTT broker and your *CodeMeter* license server are running outside of your host, this interface will also allow the container to publish its MQTT data and to access the *CodeMeter* license server:

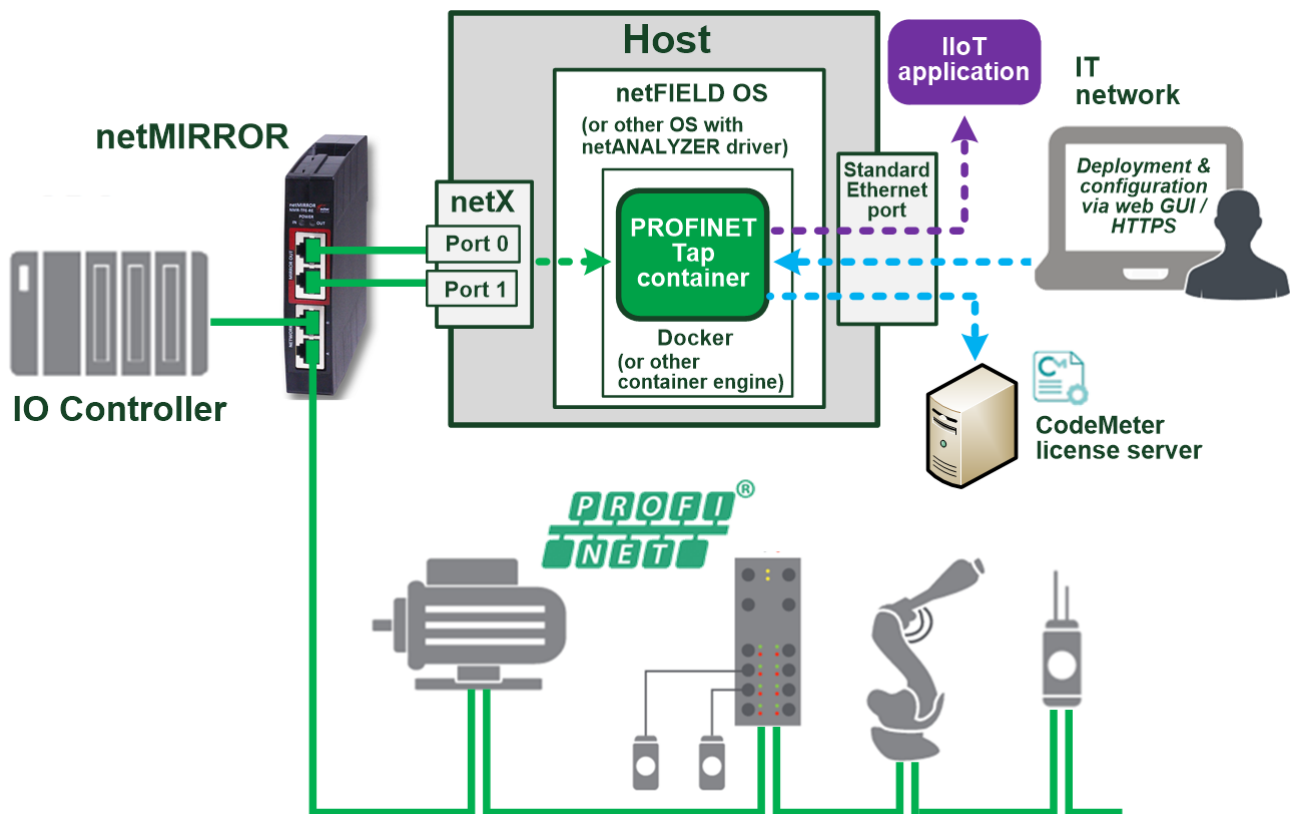


Figure 4: netX-based interface with netMIRROR and LAN connection

### 2.1.3 Connecting PROFINET as software TAP

You can connect the netX-based Industrial Ethernet interface of your host device directly to the IO Controller, without interposed "hardware mirror". This use case is also known as "software TAP".



#### Note:

Note the disadvantages of the software TAP: It may disrupt traffic on the OT network in the following events:

- If the host device is turned off or configured
- If the PROFINET Tap container is stopped or restarted
- If the OT network settings of the PROFINET Tap are changed

The requirements for this use case are:

- Your host device is equipped with a netX-based Industrial Ethernet interface (e.g. OnPremise edge gateway with *cifX*)
- netFIELD Operating System ("netFIELD OS", includes the required netANALYZER driver)  
or  
3<sup>rd</sup> party operating system with netANALYZER driver

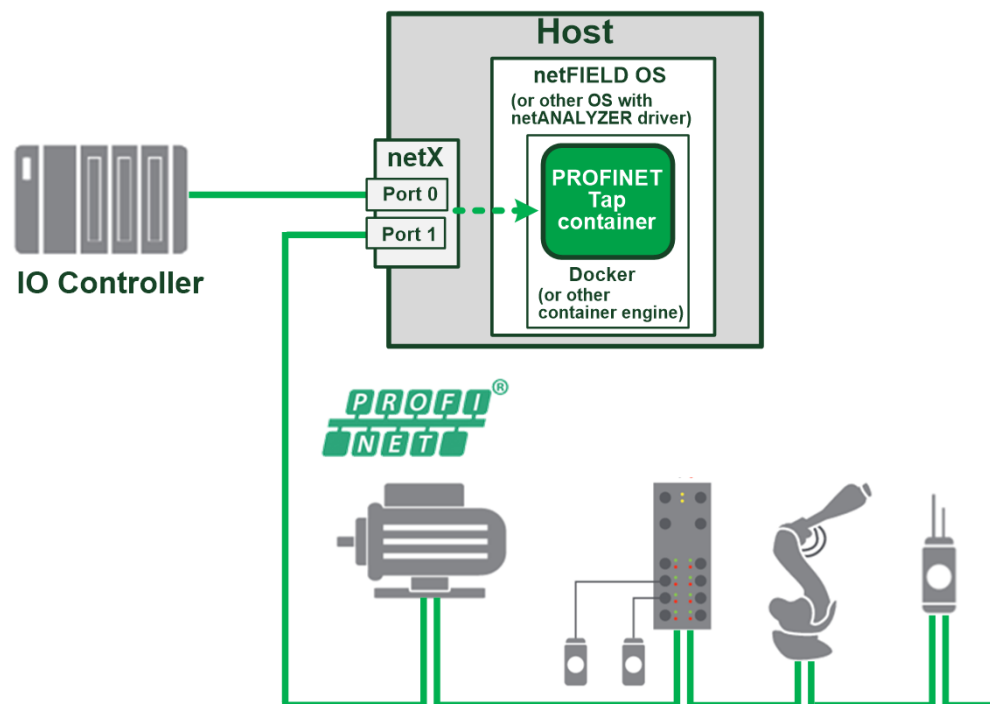


Figure 5: netX without netMIRROR

- Connect the IO Controller to one of the ports of the netX-based interface. Connect the other port of the netX-based interface to the first PROFINET Device.
- Set the port speed (Automatic, 100 MBit/s fixed or 10 MBit/s fixed) of the netX-based interface according to the configuration of the Ethernet ports of the connected IO Devices (typically: Automatic). This can be done in the configuration web GUI of the PROFINET Tap (see section *netX-based OT Capture Interface* [▶ page 31]).

Note that the netX-based interface allows only “passive” data capturing. The PROFINET Tap therefore also needs a “standard” LAN interface on the host for its TCP/IP, HTTP and MQTT communication. This LAN interface is necessary for deploying the container and for accessing its configuration web GUI. If your MQTT broker and your *CodeMeter* license server are running outside of your host, this interface will also allow the container to publish its MQTT data and to access the *CodeMeter* license server:

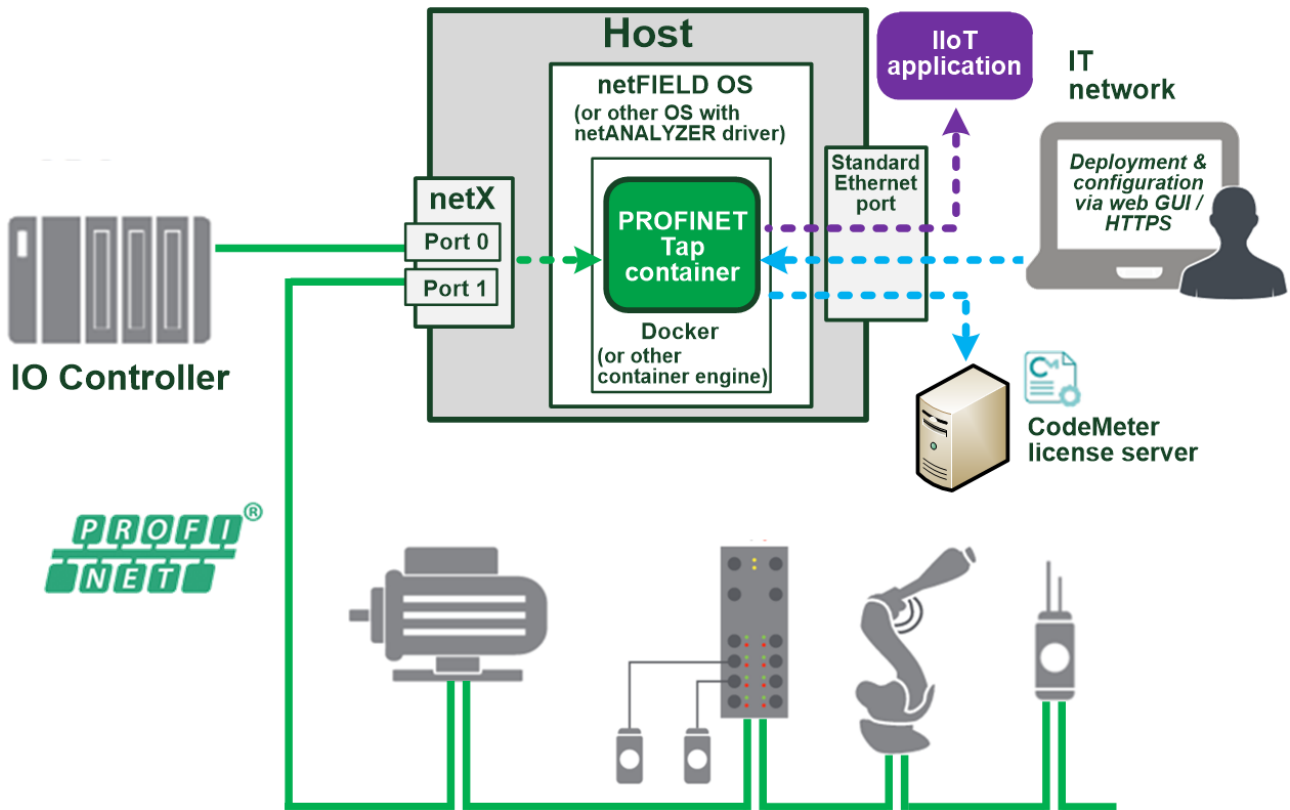


Figure 6: netX and LAN without netMIRROR

## 2.2 Connecting PROFINET via standard Ethernet port

You can connect the PROFINET via the mirror port of a PROFINET managed switch to a standard Ethernet port of your host device. This setup requires neither a netX-based Industrial Ethernet interface nor the netFIELD Operating System (netFIELD OS) nor the netANALYZER driver on your host.

### Connecting host directly to mirror port of PROFINET managed switch

If you connect the standard Ethernet port of your host *directly* to the mirror port, you do not need a VLAN:

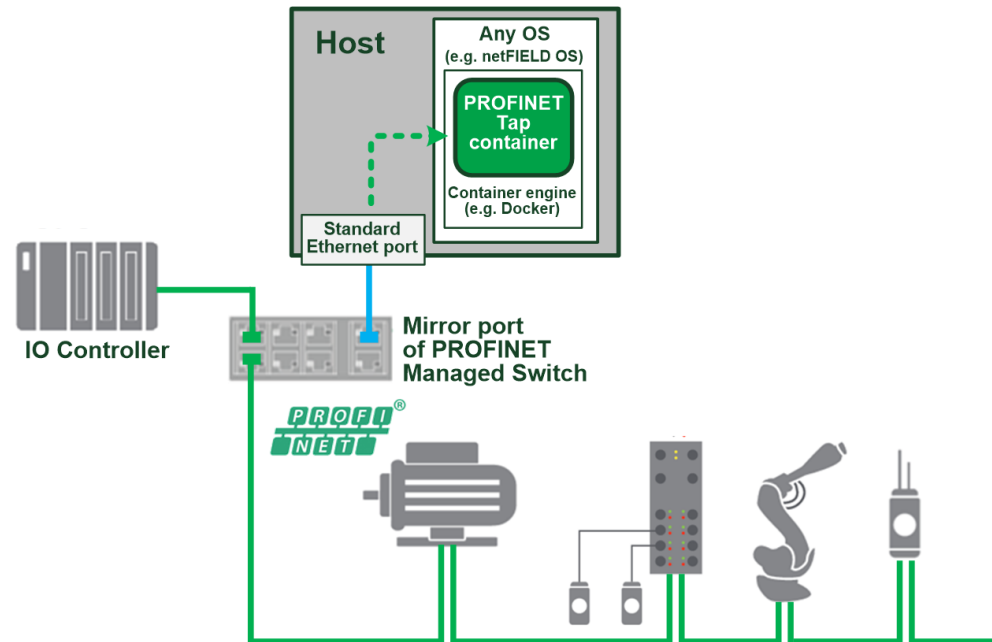


Figure 7: Direct connection of standard Ethernet port to PROFINET Managed Switch

## Connecting host to mirror port via VLAN

If you want to route the mirrored data from the PROFINET managed switch via other switches in your IT infrastructure to your host using RSPAN (Remote Switch Port Analyzer), you need a VLAN:

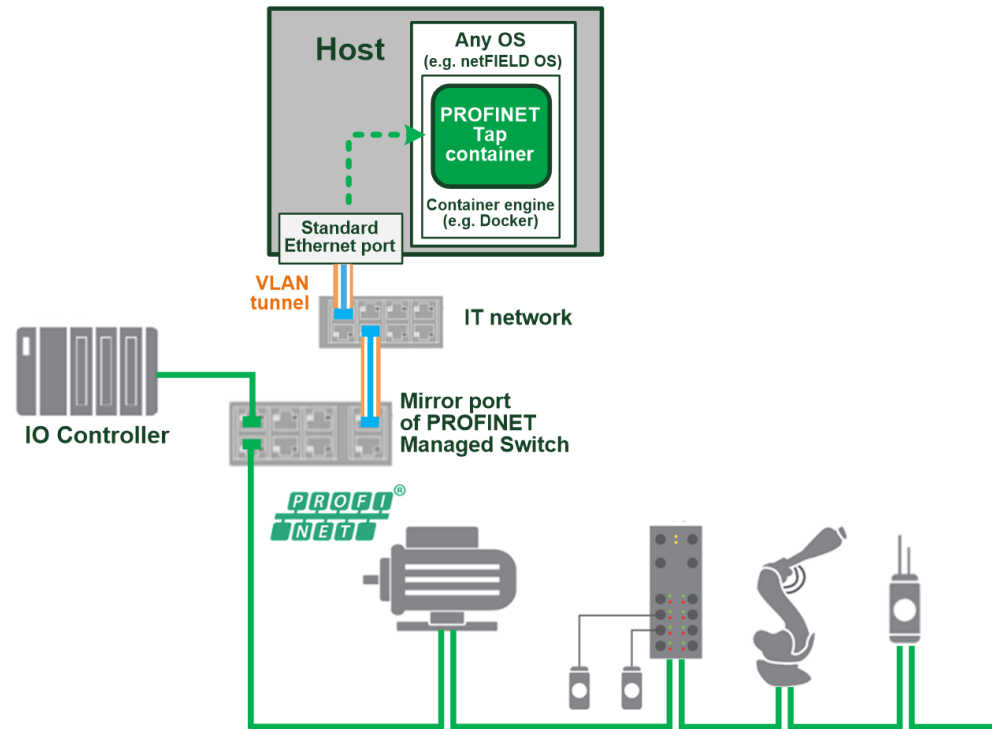


Figure 8: Connection via VLAN

Note that the capture interface allows only “passive” data capturing. The PROFINET Tap therefore also needs a second LAN interface on the host for its TCP/IP, HTTP and MQTT communication. This second interface is necessary for deploying the container and for accessing its configuration web GUI. If your MQTT broker and your *CodeMeter* license server are running outside of your host, this interface will also allow the container to publish its MQTT data and to access the *CodeMeter* license server:

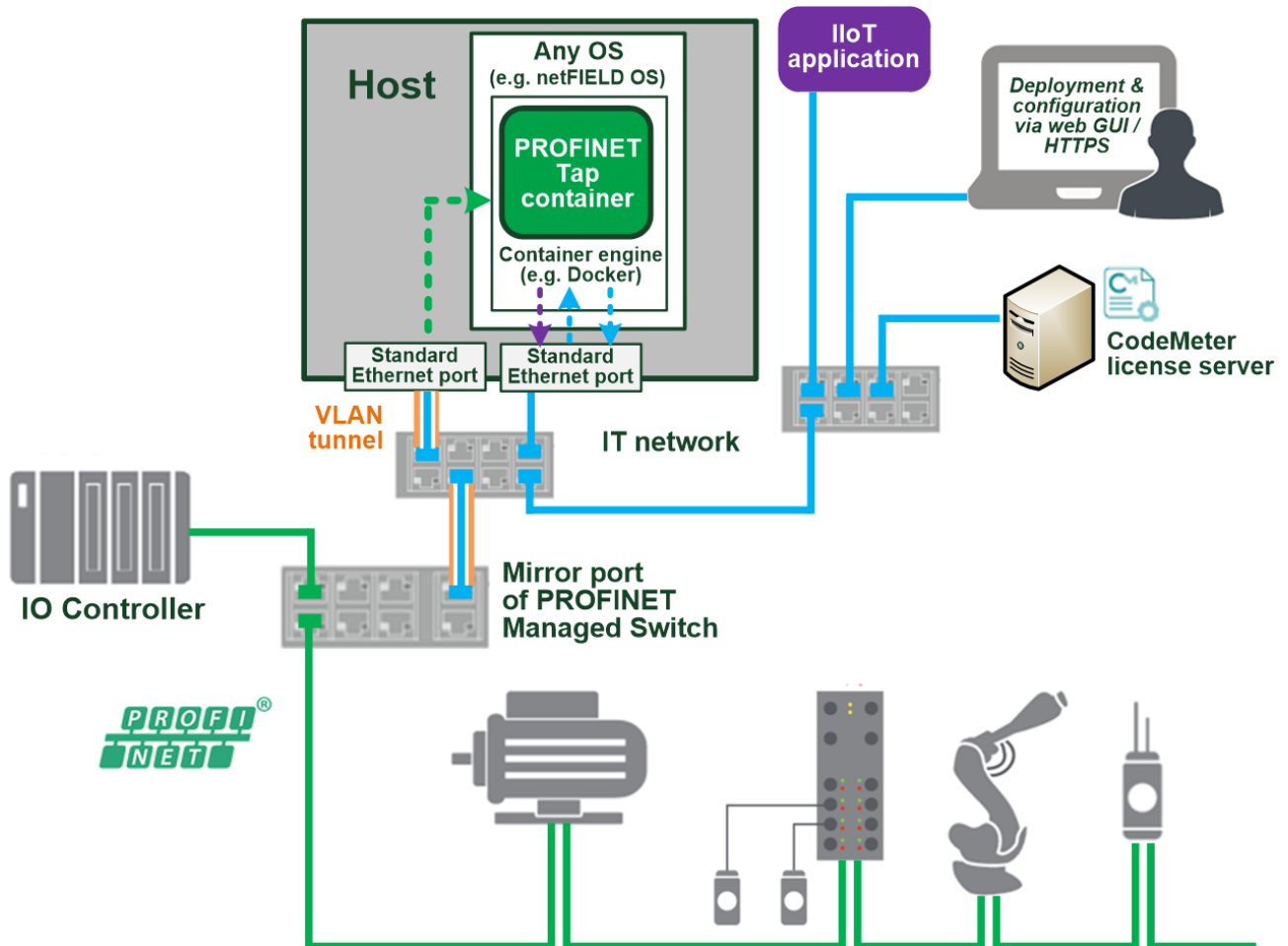


Figure 9: Connection via standard port and VLAN with LAN



### 3 Start parameters of the container

The start-up parameters and yaml files for the different use cases are provided in the Hilscher Knowledge base.

- Go to the [netFIELD App PROFINET Tap](https://kb.hilscher.com/x/_RUfBw) page (https://kb.hilscher.com/x/\_RUfBw).
- On the *netFIELD App PROFINET Tap* page, click on the link under **Current release**.
- On the current release page, you will find the start-up parameters and links to the yaml files under the **Release Notes**.

## 4 Configuration web pages of the PROFINET Tap

### 4.1 Overview

The PROFINET Tap container provides a configuration web GUI that can be accessed via port 80 of the container. Note that you have to make sure that this port can be accessed from the outside via web browser. We recommend you to use a reverse proxy or API gateway with HTTPS and authentication support for this. For testing purposes, you can temporarily expose the port, e.g. via Docker port expose.

**Note:**

If the container is deployed on a host with the netFIELD Operating System (netFIELD OS), the configuration web GUI is automatically plugged-into the **Local Device Manager** of the netFIELD OS, where it can be accessed via the **netFIELD App PROFINET Tap** entry in the navigation panel (side bar) of the Local Device Manager.

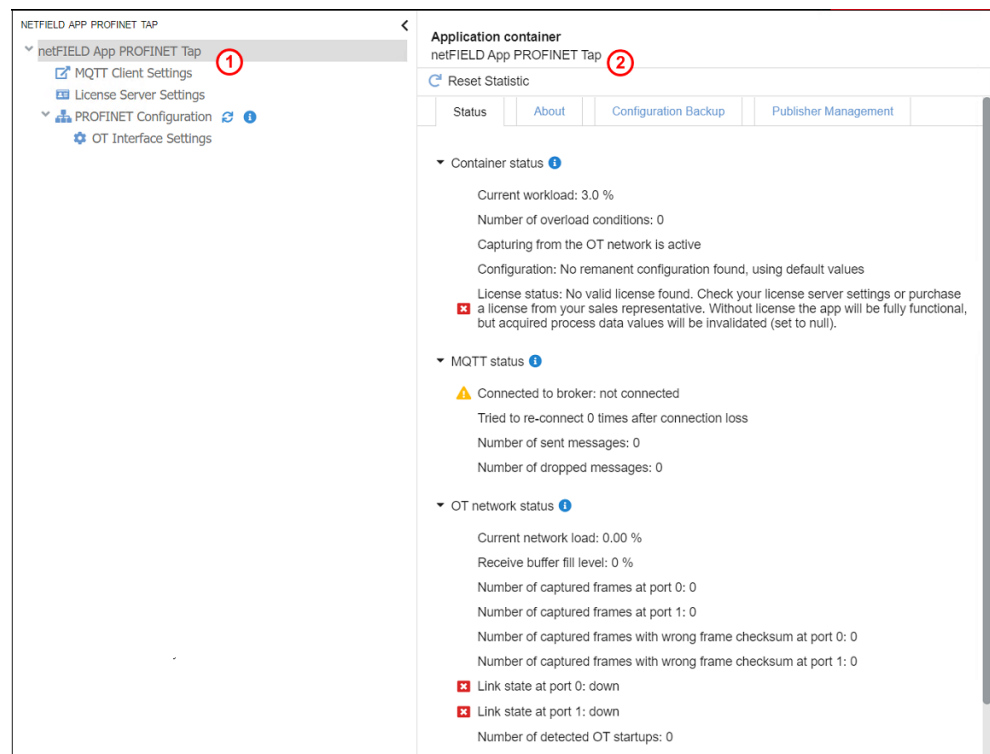


Figure 10: Configuration web GUI of PROFINET Tap

You can navigate through the configuration options by selecting an item in the navigation tree (1). Further parameters/configuration options can be selected in the tabs in the editor window (2) on the right side of the screen.

## 4.2 “Status” tab

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

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 additional information in a tooltip.

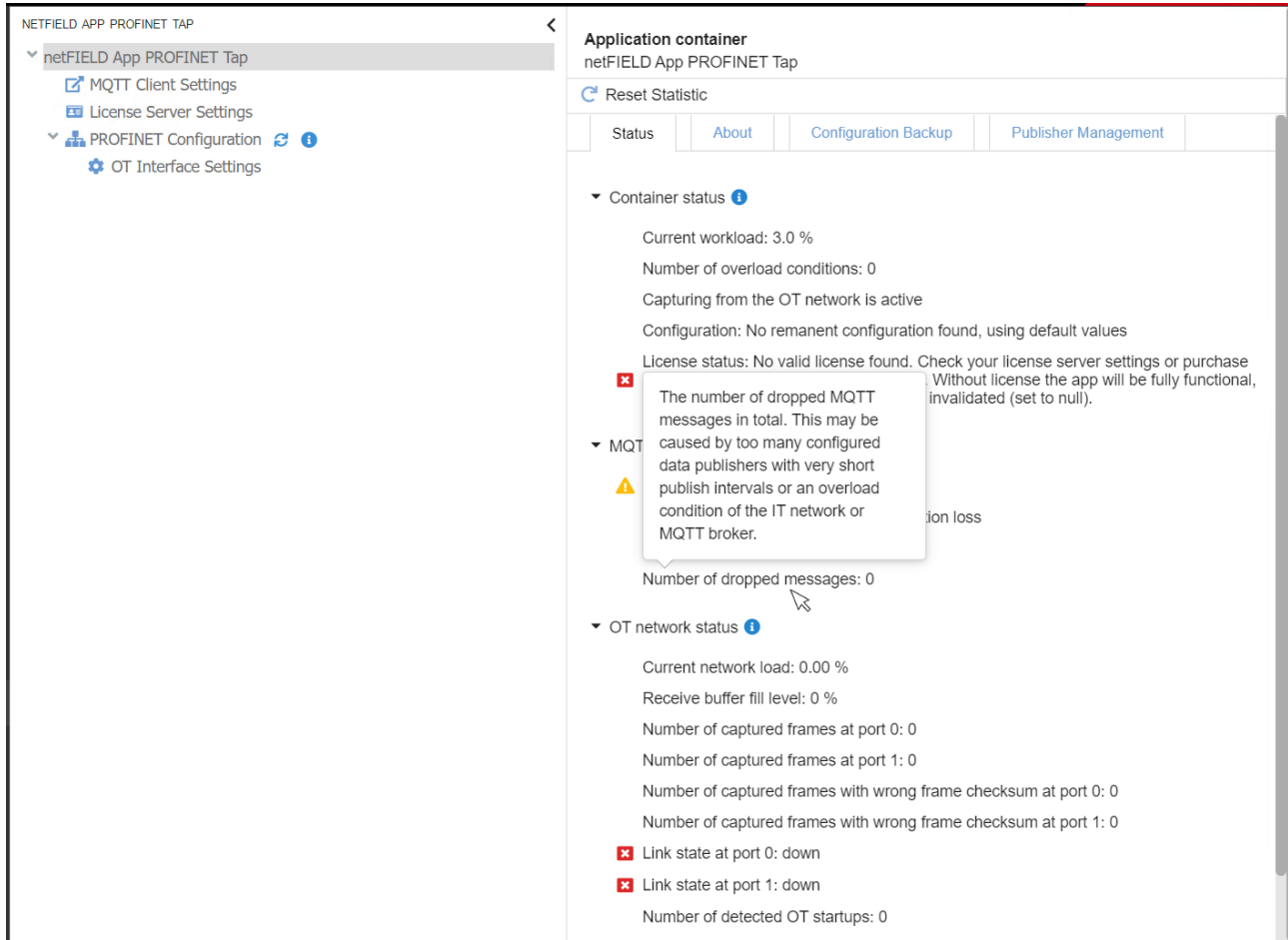


Figure 11: Status page

### 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.

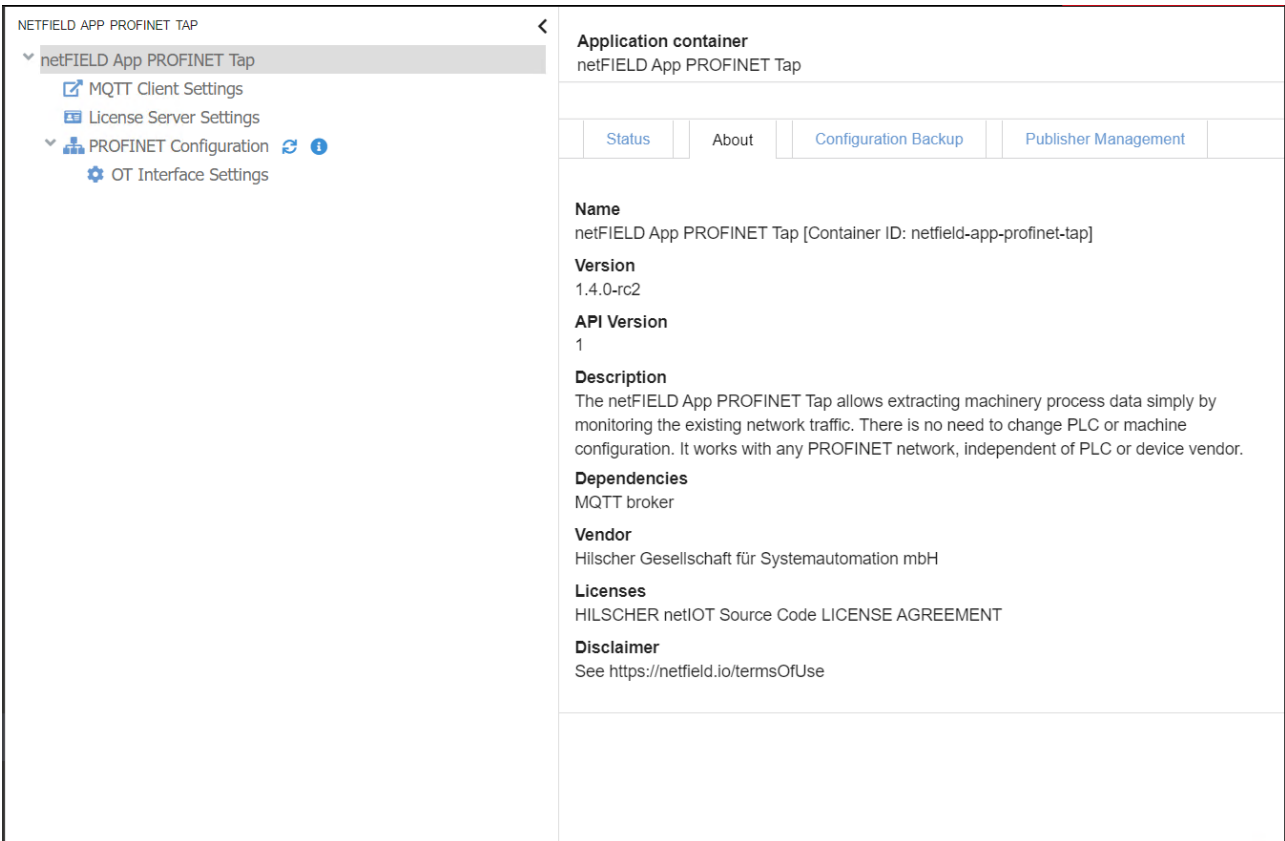


Figure 12: About tab

Category	Description
<b>Name</b>	Container name and Container ID
<b>Version</b>	Container software version
<b>API Version</b>	Version of the API connecting the GUI to the server
<b>Description</b>	Brief description of the function of the container
<b>Dependencies</b>	Other containers or components required for proper operation of the container
<b>Vendor</b>	Vendor of container
<b>Licenses</b>	Name of the software license(s), under which the container was published
<b>Disclaimer</b>	Path/link to the software license(s)

Table 2: About tab

## 4.4 “Configuration Backup” tab

In the **Configuration Backup** tab, you can save the current PROFINET Tap configuration settings to your device via your web browser’s download function. You can also restore a formerly saved configuration by uploading the configuration file via web browser.

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.

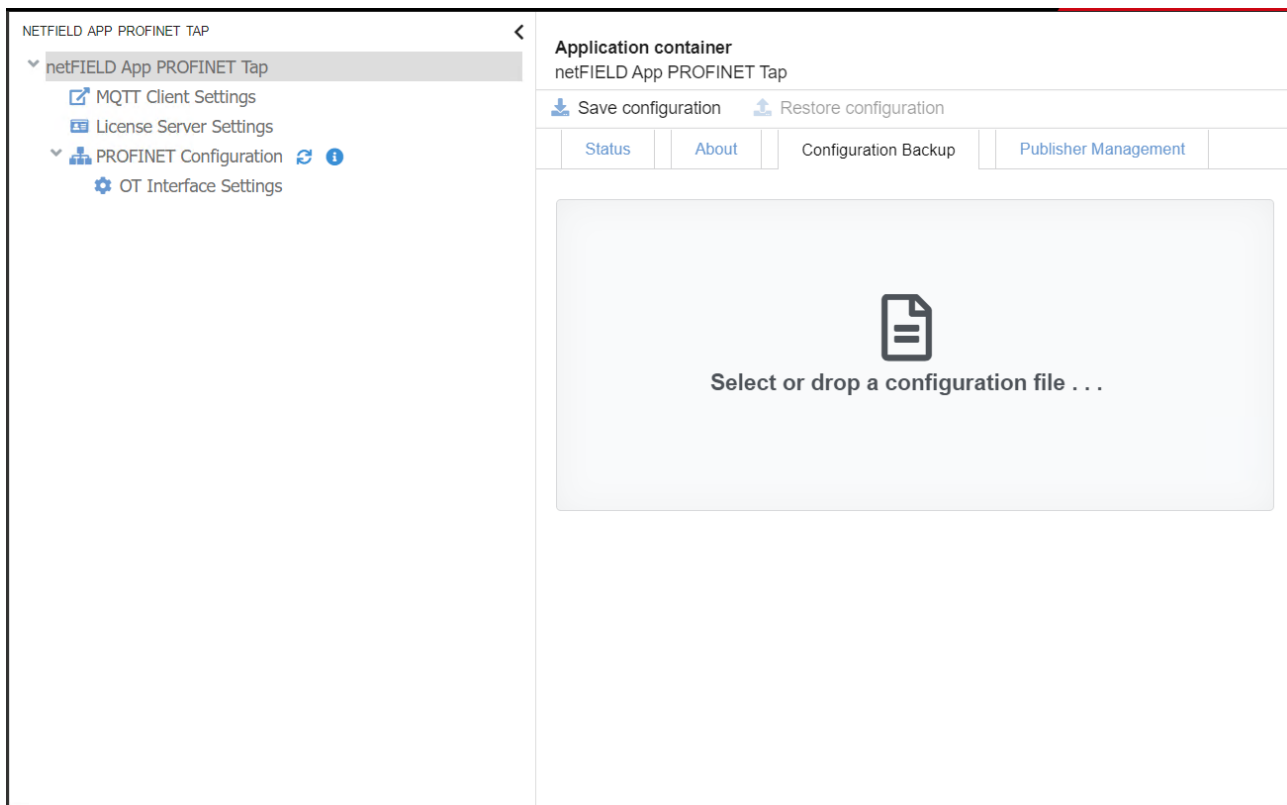


Figure 13: Configuration Backup

### Save configuration

- To save your current configuration, click **Save configuration** button.
- ↻ The configuration settings are saved to your device 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 your browser’s 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.

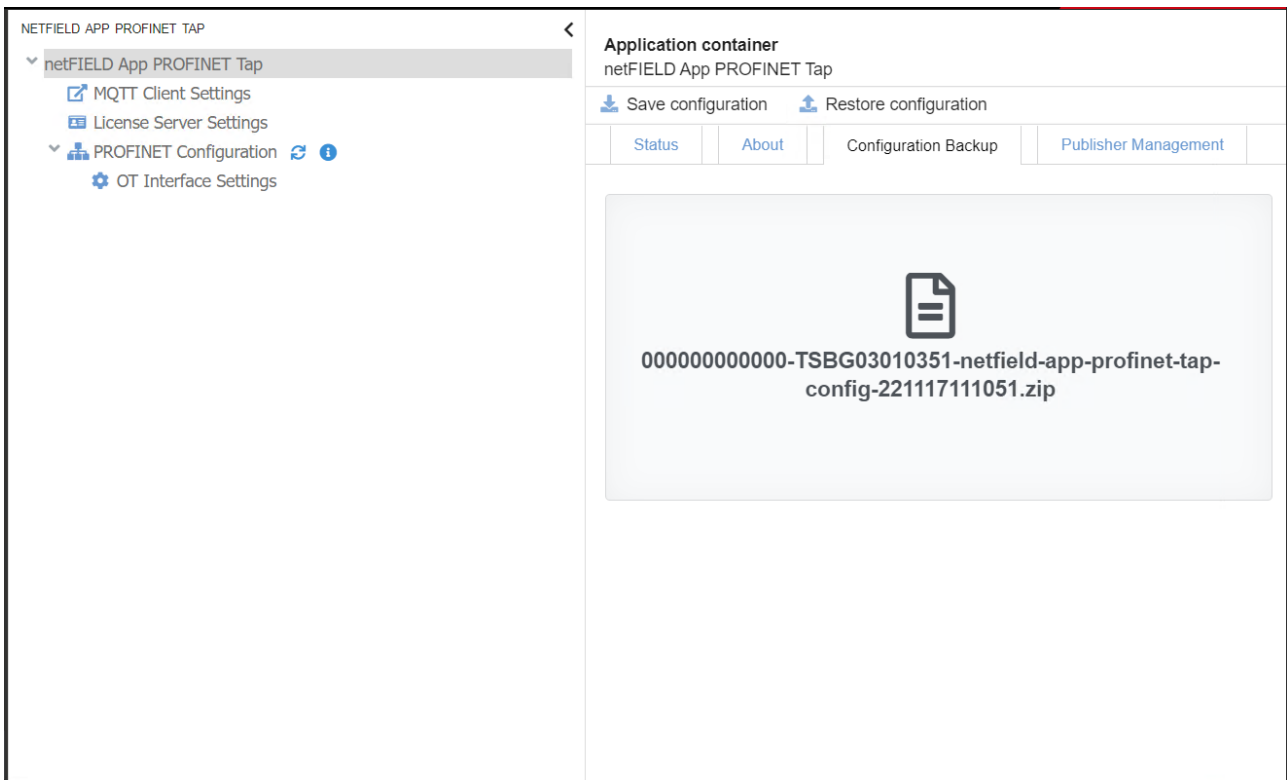


Figure 14: Restore configuration

## 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.

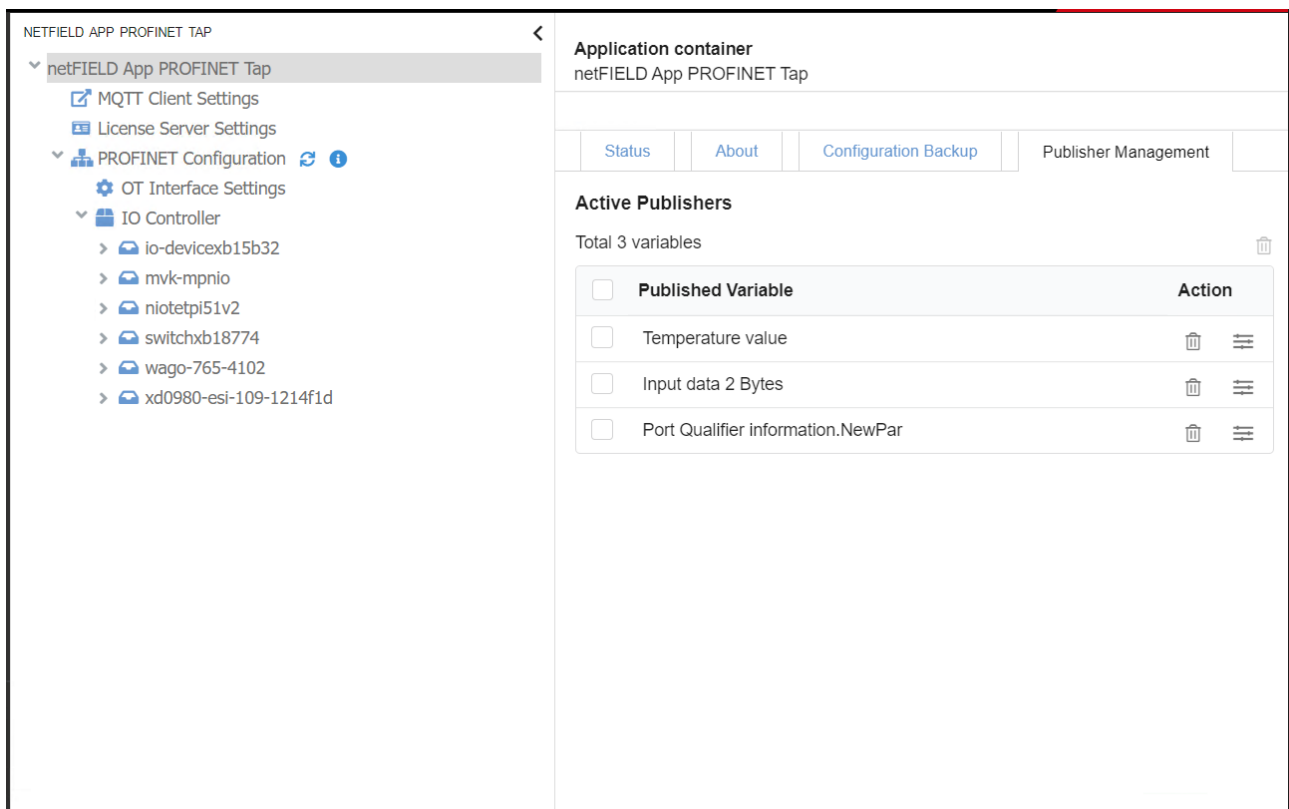


Figure 15: Publisher Management


Element	Description
Active Publishers	Shows the number of variables that are being published.
Published Variable	Name of the variable that is being published. You can select one or multiple variables by clicking the checkboxes, and then delete the selected variables at once by clicking the  button. <b>Note:</b> The order of the published variables in the list is determined by the chronological order in which they were selected for publishing in the PROFINET Variable editor.
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 3: Elements of Publisher Management tab



**Note:**


The maximum allowed size of a JSON message is 100 kB. When this size is reached, the message is sent immediately, disregarding the MQTT publishing interval configured for this variable (i.e. even if the set time interval has not yet been reached).

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

**Published Variable**

○ IO Controller / wago-765-4102 / 8 Port IO-Link Master Class B / Subslot 5 / Inputs / Temperature value

---

**Topic:** netfield/000000000000-TSBG03010351/netfield-app-profinet-tap/IO Controller/wago-765-4102/8 Port IO-Link Master Class B/Subslot 5/Inputs/Temperature value/19 

▼ General

Data type	Signed 16 Bit Integer
Byte offset	0
Bit offset	0
Bit length	16
Byte order	Not swapped

▼ Standardization


Standardization type	Keep original value and do not standardize
----------------------	--

▼ Publisher data

Quality of Service	QoS0
Data sampling	take data directly as acquired from data source
Publish interval	1 ms
Retained	false

Ok

Figure 16: Parameters of PROFINET variable

Element	Description
○	The first line shows the path to the variable (for unique identification) in the PROFINET network.
<b>Topic</b>	<p>Shows the MQTT topic string under which the variable is published. By default, the PROFINET Tap uses the following string:</p> <pre>netFIELD/&lt;gateway prefix or user-prefix&gt;/&lt;container id&gt;/&lt;controller name&gt;/&lt;device name&gt;/&lt;slot name&gt;/&lt;subslot name&gt;/&lt;direction&gt;/&lt;variable name&gt;/&lt;node id&gt;</pre> <p>(For a more detailed description, see section <i>MQTT message format</i> [▶ page 66].)</p> <p>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 (<b>PROFINET Variable</b> &gt; <b>Publish data</b> option &gt; <b>Topic</b> field).</p> <p>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.</p> <p>You can use the  icon to copy the topic string to your clipboard.</p>



Element	Description
<b>General</b>	Shows data formats of the variable.
<b>Standardization</b>	Shows standardization settings for the variable.
<b>Publisher data</b>	Shows the MQTT publication settings for the variable.
<b>Ok</b>	Click this button to close the window.

Table 4: Elements Variable's details window

## 4.6 MQTT Client Settings

On the **MQTT Client Settings** page, you can configure the MQTT client settings of the PROFINET Tap container.






**Note:**

If you use the PROFINET Tap container on a host with a netFIELD Operating System (netFIELD OS), this page features the **Use general settings** option, allowing you to use the standard MQTT client settings of the netFIELD OS.


These standard MQTT client settings can be viewed (and changed) in the Local Device Manager of the netFIELD OS under **General Settings > Default MQTT Client Settings**.

Figure 17: MQTT Client settings

Element		Description			
Basic	MQTT Version	MQTT version to be used (depending on the MQTT broker).			
	Keep Alive Interval (Seconds)	Defines the maximum length of time in seconds that the broker and client may not communicate with each other.			
	Username	User name for authentication at the broker (if implemented and required by the broker).			
	Password	Password for authentication at the broker (if implemented and required by the broker).			
	Connect Timeout (Seconds)	Defines the maximum length of time in seconds that is allowed for completing the connection process.			
	Clean Session	If <b>Clean session</b> 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 <b>Clean session</b> is unchecked, the broker creates a persistent session for the client.			
	Server URIs	<p>Server URI of the MQTT broker.  <b>Note:</b> 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 is successfully established, only this connection will be used. The client will not open multiple connections to multiple servers simultaneously.</p> <table border="1"> <tr> <td style="text-align: center;"><b>+</b></td> <td>Click this button to add a new server URI.</td> </tr> <tr> <td style="text-align: center;"></td> <td>Click this button to delete an existing server URI.</td> </tr> </table>	<b>+</b>	Click this button to add a new server URI.	
<b>+</b>	Click this button to add a new server URI.				
	Click this button to delete an existing server URI.				
Last Will and Testament	Use last will and testament options	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.) This opens the following fields for configuring the LWT parameters:			
		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”		

Element		Description
SSL / TLS	Use SSL / TLS	Select this option if you want to use SSL/TLS encryption for creating a secure connection to the MQTT broker. <b>Note:</b> This option is for expert users only! If the MQTT broker and the PROFINET Tap are running on the same host, a secure SSL/TLS connection is not necessary (because the connection is "internal" and the overhead of the secure connection can thus be avoided). Selecting this option opens the following fields for configuring the SSL / TLS parameters:
	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, the PROFINET Tap will also accept invalid certificates from the broker (not recommended).

Table 5: MQTT Client Settings

- Click  **Save** button in the header to save your new MQTT Client Settings.



**Note:**

After changing the settings – e.g. by defining a new MQTT Server (Broker) URI – you can check the state of the new MQTT connection on the **Status** tab (see section “*Status*” tab [▶ page 19]). For information on the structure of MQTT messages, see section *MQTT message format* [▶ page 66].

## 4.7 License Server Settings

On the **License Server Settings** page, you must specify the IP address or host name (“endpoint”) of your local license server.

**Note:**

You can specify more than one server endpoint here if multiple local license servers are available, e.g. as backup servers.

The app will try to retrieve a valid license from the first server endpoint in the list. If the first server is not available or if there is no valid license on this server, the PROFINET Tap will automatically try the next one, and so forth.

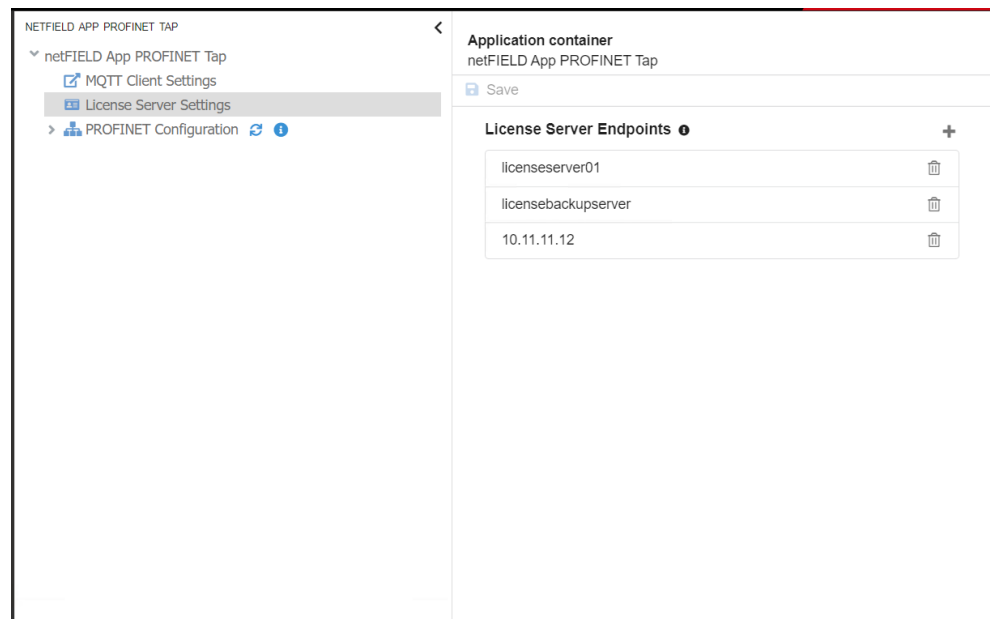


Figure 18: License Server Settings

1. Specify license server.
  - To specify a license server, click **+** button.
  - In the **License Server Endpoints** field, enter the IP address or the hostname of the machine on which your license server is running.
  - Click **Save** button.

- After the **Succeeded to save license server settings!** message appears, the PROFINET Tap immediately tries to connect to the server and retrieve its license.

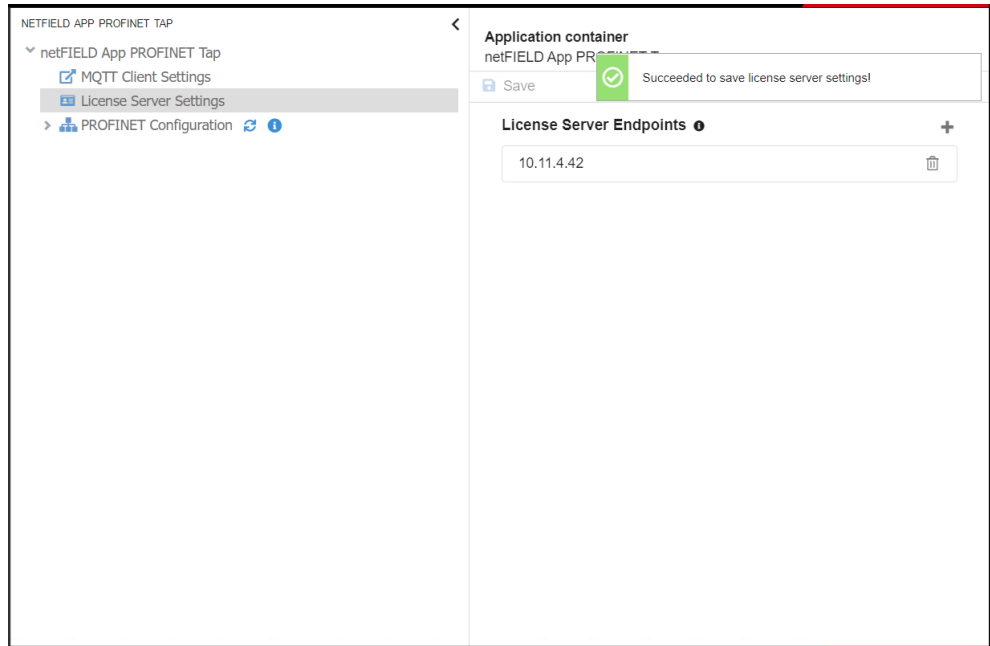


Figure 19: License Server Settings saved

2. Check the license state on the **Status** page.
  - 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.
  - Under **Container status**, check the license state:

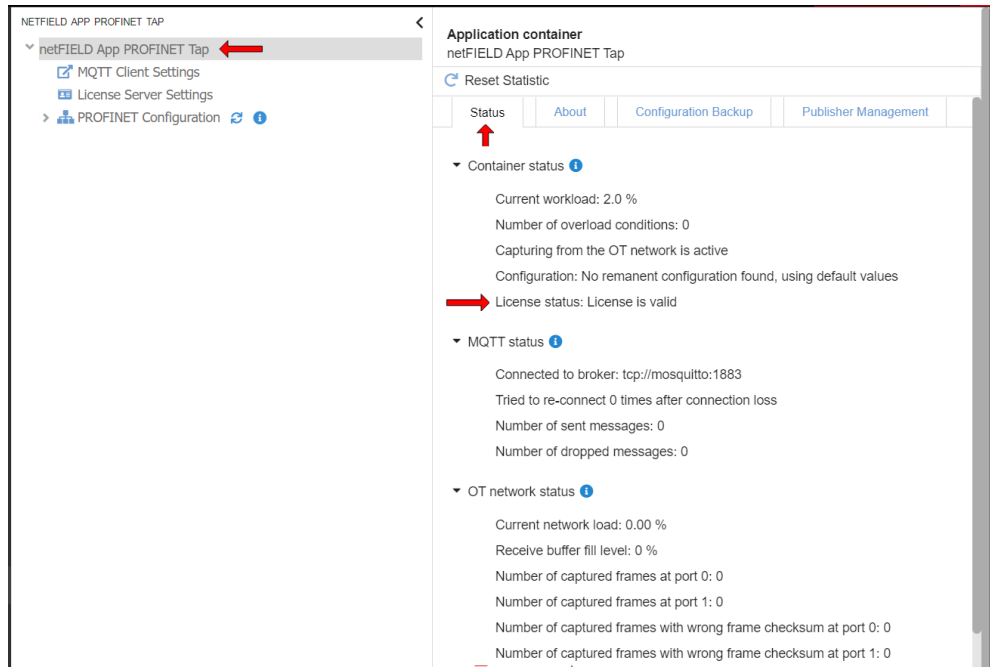


Figure 20: Check license status

## 4.8 PROFINET configuration

### 4.8.1 OT Interface settings

#### 4.8.1.1 Overview

On the **OT Interface settings** page, you must configure the interface that you are using to connect your PROFINET Tap to the physical PROFINET network.

Note that the parameters and options displayed on the OT Interface settings page depend on the interface that you are using for connecting the PROFINET Tap to the physical PROFINET; i.e. netX-based Industrial Ethernet interface or standard Ethernet port (via mirror port of PROFINET managed switch).

#### 4.8.1.2 netX-based OT Capture Interface

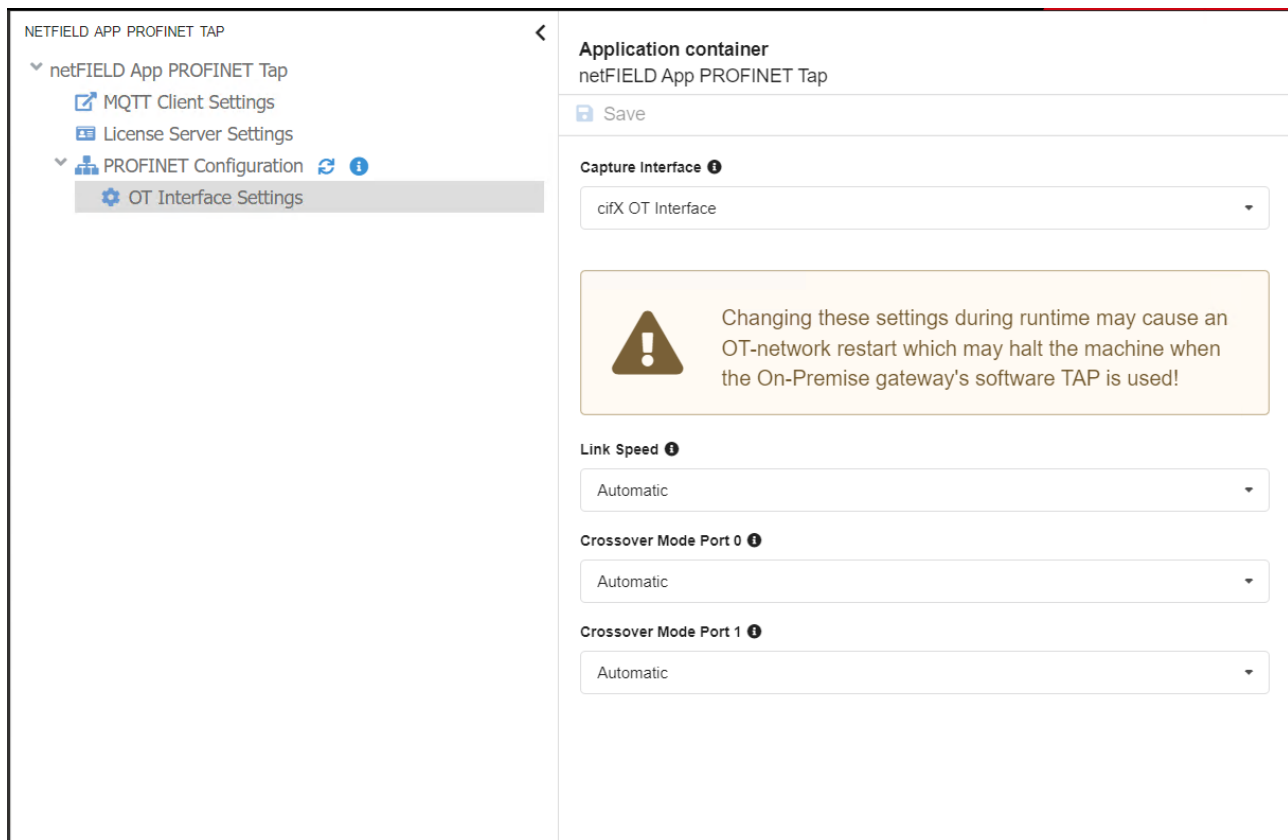


Figure 21: OT Interface Settings OnPremise device


Parameter/Element		Description
 Save		Click this button to save your new settings.
Capture Interface	cifX OT Interface	Preset to cifX OT interface. Cannot be changed. <b>Note:</b> cifX is a netX-based Industrial Ethernet interface card, which is e.g. included in the netFIELD OnPremise edge gateway.
Link Speed	Automatic	Automatic synchronization. Use this setting if you have connected the netX-based interface <i>directly</i> to the PROFINET; i.e. if you are <i>not</i> using a “hardware TAP” like e.g. netMIRROR.  Note that when using automatic link speed negotiation in combination with a netMIRROR, 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	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and the OT network operates at 10 MBit/s. <b>Note:</b> Rarely used.
	100 MBit/s fixed	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and the OT network operates at 100 MBit/s.
Crossover Mode Port 0	Automatic	Use this setting if you have connected the netX-based interface <i>directly</i> to the PROFINET (i.e. if you are <i>not</i> using a “hardware TAP” like e.g. netMIRROR) and have set the <b>Link Speed</b> to <i>Automatic</i> .
	No Crossover	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and: <ul style="list-style-type: none"> <li>• If port 0 is connected via “patch” cable to the MIRROR OUT port B</li> <li>• If port 0 is connected via “crossover” cable to the MIRROR OUT port A</li> </ul>
	Crossover	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and: <ul style="list-style-type: none"> <li>• If port 0 is connected via “crossover” cable to the MIRROR OUT port B</li> <li>• If port 0 is connected via “patch” cable to the MIRROR OUT port A</li> </ul>
Crossover Mode Port 1	Automatic	Use this setting if you have connected the netX-based interface <i>directly</i> to the PROFINET (i.e. if you are <i>not</i> using a “hardware tap” like e.g. netMIRROR) and have set the <b>Link Speed</b> to <i>Automatic</i> .
	No Crossover	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and: <ul style="list-style-type: none"> <li>• If port 1 is connected via “patch” cable to the MIRROR OUT port B</li> <li>• If port 1 is connected via “crossover” cable to the MIRROR OUT port A</li> </ul>
	Crossover	Use this setting if you are using a “hardware TAP” like e.g. netMIRROR and: <ul style="list-style-type: none"> <li>• If port 1 is connected via “crossover” cable to the MIRROR OUT port B</li> <li>• If port 1 is connected via “patch” cable to the MIRROR OUT port A</li> </ul>

Table 6: Parameters netX-based OT Interface settings



### 4.8.1.3 Standard Ethernet OT Capture Interface

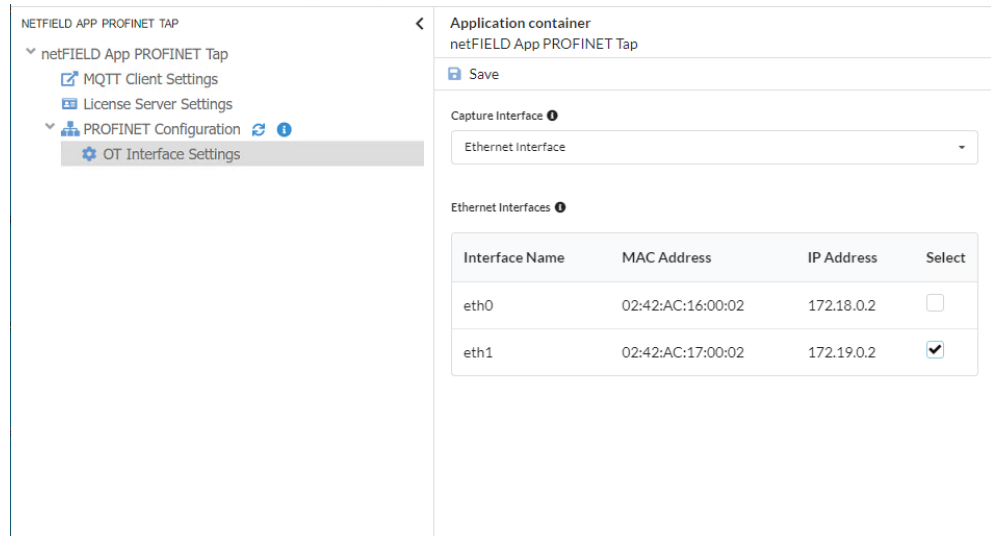


Figure 22: OT Interface Settings page standard Ethernet

- Select the virtual Ethernet interface that provides the PROFINET data that you want to capture.



**Important:**

Do not select **eth0** for capturing the PROFINET data. **eth0** is the standard interface that the PROFINET Tap uses for its IT network communication with other applications and/or the user (e.g. for publishing its MQTT data or for its configuration via web GUI). Select the **eth** interface whose IP address matches the IP address of the interface that was mapped to the `macvlan`.

Parameter/Element	Description	
Save	Click this button to save your new settings.	
Capture Interface	Ethernet Interface	Preset to <code>Ethernet interface</code> . Cannot be changed.
Ethernet Interfaces	The list displays the virtual Ethernet interfaces that are mapped into the PROFINET Tap container by your host. The number of interfaces depend on how many VLANs you have connected to the container.	
	Interface Name	Assigned to the PROFINET Tap container by the container engine (e.g. Docker).
	MAC Address	Assigned to the PROFINET Tap container by the container engine (e.g. Docker).
	IP Address	Assigned to the PROFINET Tap container by the container engine (e.g. Docker).
	Select	Select here the virtual Ethernet interface that provides the PROFINET data that you want to capture. Note that only one interface can be selected.

Table 7: Parameters OT Interface settings standard Ethernet

## 4.8.2 PROFINET Configuration node

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**:

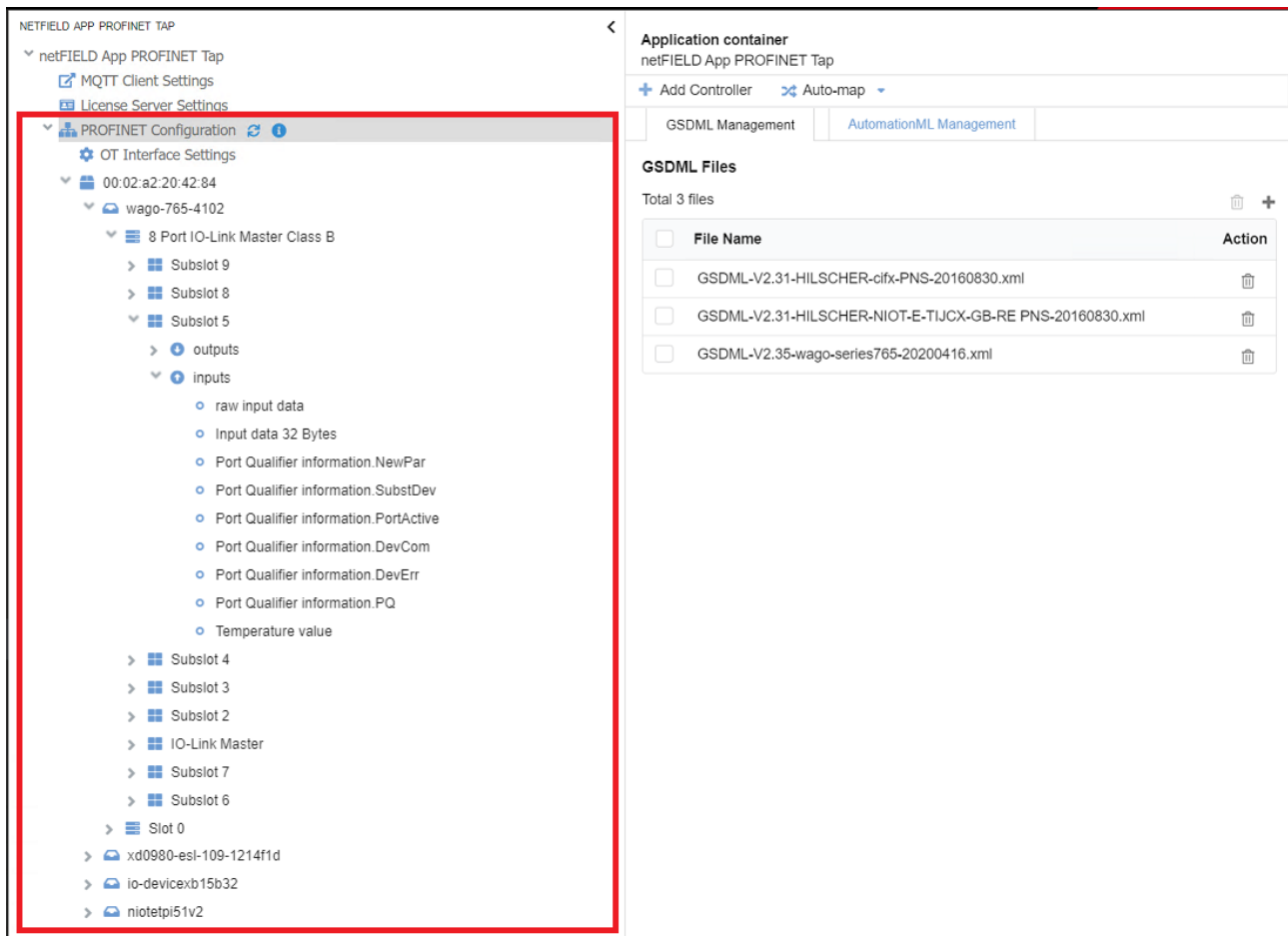


Figure 23: PROFINET Configuration tree

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 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:

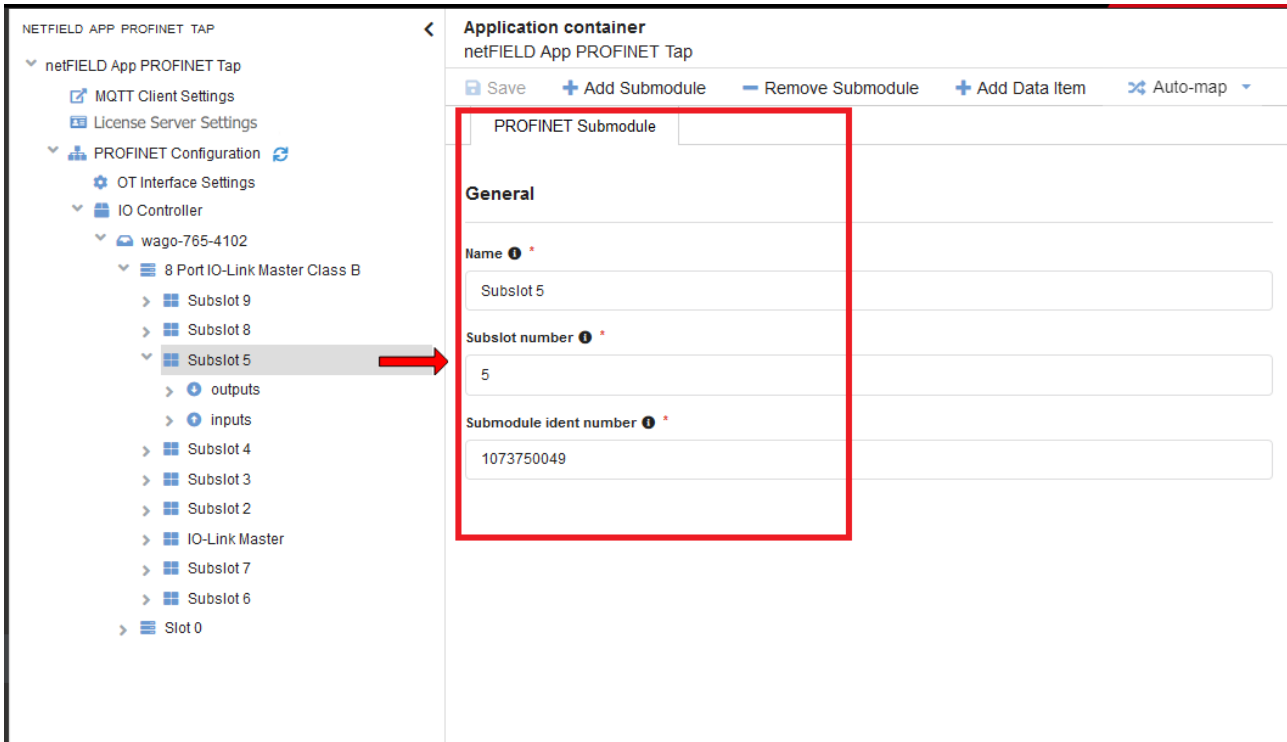


Figure 24: Parameters of selected PROFINET element in Editor window

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:

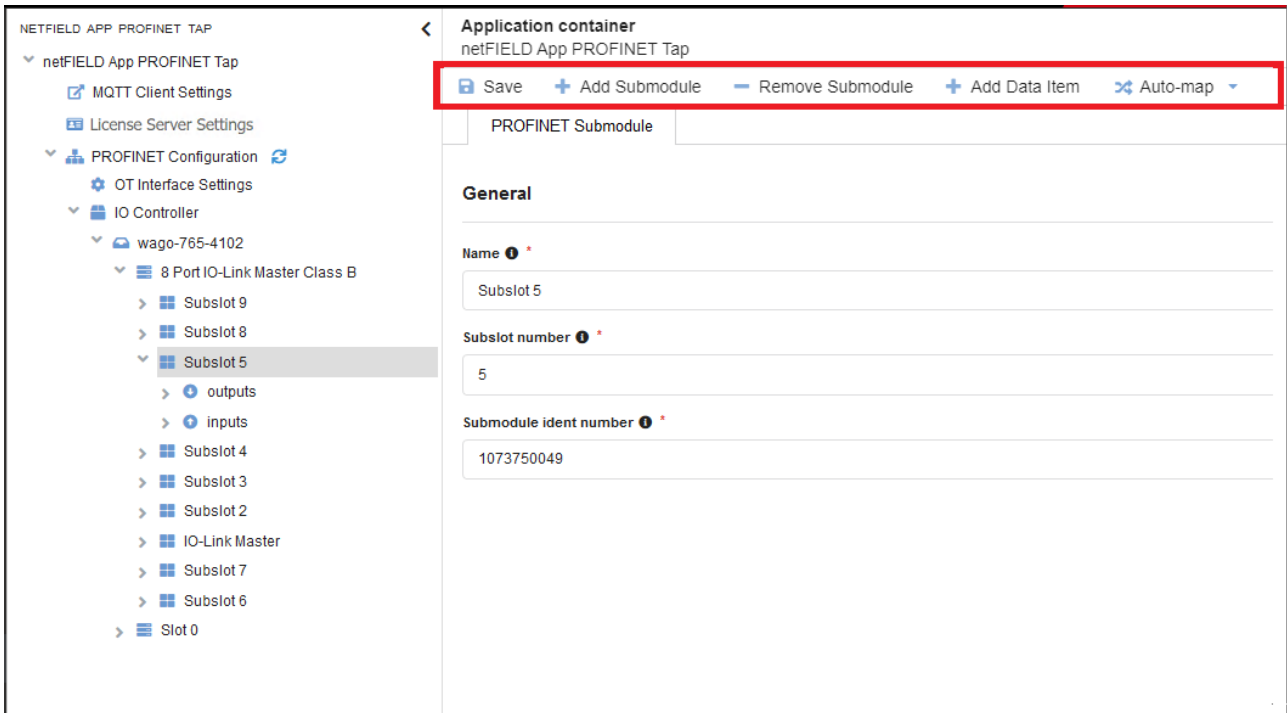






























Figure 25: Menu bar


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 42] and *AutomationML Management* [▶ page 45]).






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	<p><b>+ Add Controller:</b> Adds Controller to the PROFINET configuration.</p> <p><b>✕ Auto-map ▼</b></p> <p><b>Auto-map all devices from GSDML:</b> Opens the GSDML mapping wizard.</p> <p><b>Auto-map all devices from AutomationML:</b> Opens the AutomationML mapping wizard.</p>
		 Info icon	
		GSDML Management	
		AutomationML Management	
	Controller	Name	<p><b>💾 Save:</b> Saves changed parameters of selected Controller.</p> <p><b>+ Add Controller:</b> Adds new Controller on same level.</p> <p><b>- Remove Controller:</b> Removes selected Controller.</p> <p><b>+ Add Device:</b> Adds new Device under selected Controller.</p> <p><b>✕ Auto-map ▼</b></p> <p><b>Auto-map all devices under this controller from GSDML:</b> Opens the GSDML mapping wizard.</p> <p><b>Auto-map all devices under this controller from AutomationML:</b> Opens the AutomationML mapping wizard.</p>
		MAC address	
		IP address	

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). <b>Note:</b> If the configuration was automatically retrieved by the app during start-up phase, the app will use the "name of station" for the name.	<p> <b>Save:</b> Saves changed parameters of selected Device.</p> <p> <b>Add Device:</b> Adds new Device on same level.</p> <p> <b>Remove Device:</b> Removes selected Device.</p> <p> <b>Add Module:</b> Adds new Module below selected Device.</p> <p> <b>Auto-map</b> ▾</p> <p><b>Auto-map all slots under this device from GSDML:</b> Opens the GSDML mapping wizard.</p> <p><b>Auto-map all slots under this device from AutomationML:</b> Opens the AutomationML mapping wizard.</p>
		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).	<p> <b>Save:</b> Saves changed parameters of selected Module.</p> <p> <b>Add Module:</b> Adds new Module on same level.</p> <p> <b>Remove Module:</b> Removes selected Module.</p> <p> <b>Add Submodule:</b> Adds new Submodule below selected Module.</p> <p> <b>Auto-map</b> ▾</p> <p><b>Auto-map all subslots under this slot from GSDML:</b> Opens the GSDML mapping wizard.</p> <p><b>Auto-map all subslots under this slot from AutomationML:</b> Opens the AutomationML mapping wizard.</p>
		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).	<p> <b>Save</b>: Saves changed parameters of selected Submodule.</p> <p> <b>Add Submodule</b>: Adds new Submodule on same level.</p> <p> <b>Remove Submodule</b>: Removes selected Submodule.</p> <p> <b>Add Data Item</b>: Adds new Data Item (output or input) below selected Submodule.</p> <p> <b>Auto-map</b> ▾</p> <p><b>Auto-map this subplot from GSDML</b>: Opens the GSDML mapping wizard.</p> <p><b>Auto-map this subplot from AutomationML</b>: Opens the AutomationML mapping wizard.</p>
		Subslot number	Number of the subplot 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).	<p> <b>Save</b>: Saves changed parameters of selected Data Item</p> <p> <b>Add Data Item</b>: Adds new Data Item on same level</p> <p> <b>Remove Data Item</b>: Removes selected Data Item</p> <p> <b>Add Variable</b>: Adds new variable below selected Data Item</p>
		Direction	IO direction of the data item. Select <b>Output</b> for the data that the submodule receives from the Controller in order to forward it to an actor. Select <b>Input</b> 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 “ <i>Publisher Management</i> ” tab [▶ page 23]). <b>Note:</b> Not to be confused with the MQTT <b>Topic</b> name (see <b>Topic</b> field under <b>Publish data</b> ).			<b>Save:</b> Saves changed parameters of selected variable <b>+ Add Variable:</b> Adds new variable on same level <b>– Remove Variable:</b> Removes selected variable <b>+ Clone Variable:</b> 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	$-2^{31} \dots +2^{31}-1$		
		Signed 64 Bit Integer	64	$-2^{63} \dots +2^{63}-1$		
		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.	<p> <b>Save</b>: Saves changed parameters of selected variable</p> <p> <b>Add Variable</b>: Adds new variable on same level</p> <p> <b>Remove Variable</b>: Removes selected variable</p> <p> <b>Clone Variable</b>: Adds a copy of the selected variable on same level, which you can use as a "template" for editing a new variable</p>
		Byte order	Byte order in a data word: Swapped Not swapped	
		Standardization type	Allows scaling of analog values. You can either <b>Keep original value and do not standardize</b> or select the <b>Scale linear by factor and offset</b> option. Selecting the <b>Scale linear...</b> option enables the <b>Factor</b> and <b>Offset</b> fields. The standardization value will be computed according to the formula: $raw\ value * factor + offset$ <b>Note</b> : Standardization is supported only for integer data types.	








Icon	Element	Parameter	Options in menu
	Variable	<b>Publish data</b> Select this option to publish the variable via MQTT. It will also be added to the <b>PROFINET Variable</b> list in the <b>Publisher Management</b> tab (see section “ <i>Publisher Management</i> ” tab [▶ page 23]). You can configure the following parameters for publishing the variable:	 <b>Save:</b> Saves changed parameters of selected variable  <b>Add Variable:</b> Adds new variable on same level  <b>Remove Variable:</b> Removes selected variable  <b>Clone Variable:</b> Adds a copy of the selected variable on same level, which you can use as a “template” for editing a new variable
		<b>Topic</b> Enter here the MQTT Topic name string under which the variable will be published. If left empty, the Tap uses the default string (see section <i>MQTT message format</i> [▶ page 66]). 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.	
		<b>Quality of service</b> Select the MQTT QoS from the drop-down list. <b>Note:</b> For performance reasons it is recommended to use QoS0 whenever possible. Using QoS1 or QoS2 will increase performance requirements of the application container.	
		<b>Publish interval</b> Define the publish interval in <ul style="list-style-type: none"> <li>• Milliseconds</li> <li>• Seconds</li> <li>• Minutes</li> <li>• Hours</li> </ul> <b>Note:</b> 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. Note also that the maximum allowed size of a JSON message is 100 kB. When this size is reached, the message is sent immediately, disregarding the publish interval configured for this variable (i.e. even if the set time interval has not yet been reached).	
		<b>Data sampling</b> Define the conditions for the sampling: <ul style="list-style-type: none"> <li>• Only take data if the data source value has changed</li> <li>• Take data directly as acquired from data source:</li> </ul> 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. <ul style="list-style-type: none"> <li>• Sample the acquired data from data source by a fixed sample rate:</li> </ul> Opens the <b>Sample rate in milliseconds</b> field in which you can specify the sample rate (between 1 and 1000 ms)	
<b>Retained</b> “Retained” flag of MQTT message			

Table 8: Elements PROFINET Configuration

### 4.8.3 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.

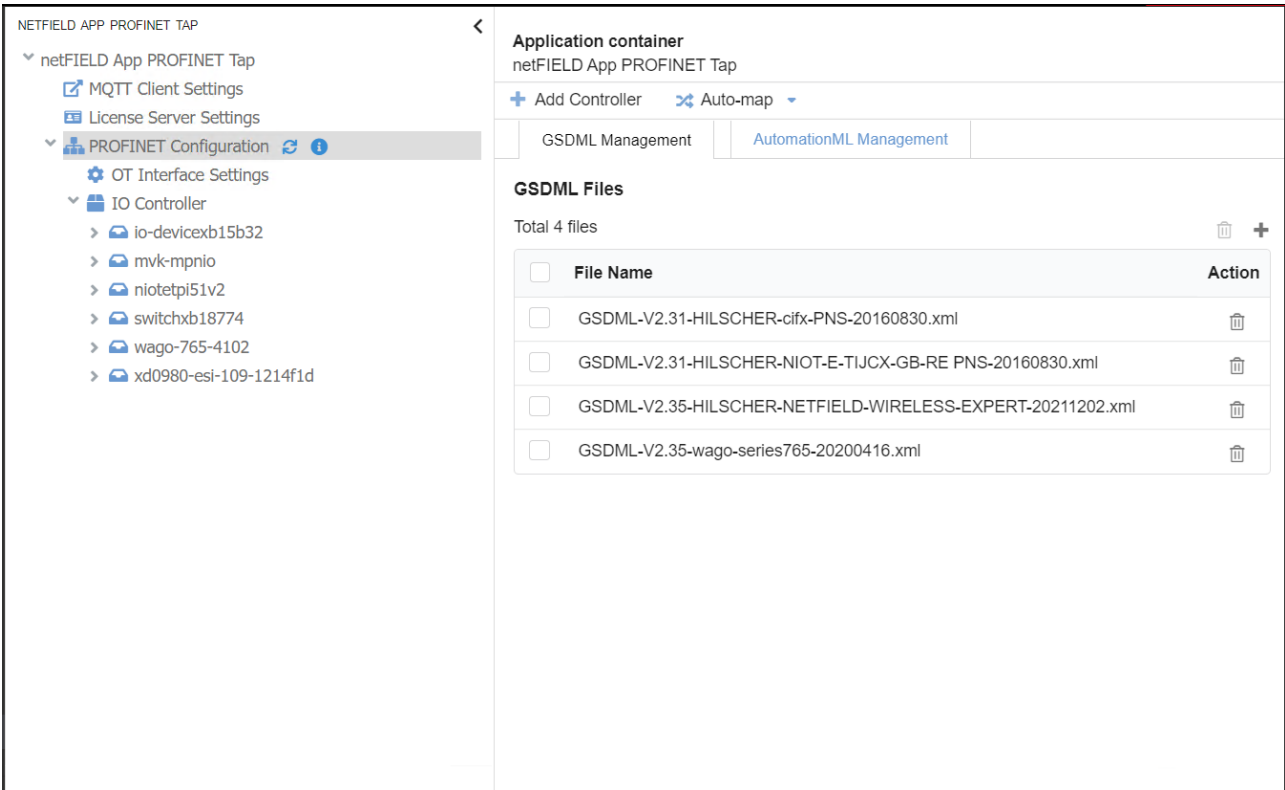


Figure 26: GSDML Management




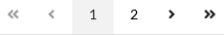
Element	Description
GSDML Files	Shows the number of GSDML files that have been imported and are available for mapping.
	Opens dialog for uploading GSDML files.
File Name	Name of the GSDML file. You can select one or multiple files by clicking the checkboxes, and then delete the selected file(s) at once by clicking the  button.
Action	 Deletes the GSDML file.
	If the list contains more than ten entries, you can scroll here to display the next ten items.

Table 9: GSDML Management tab

## Uploading GSDML file(s)

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

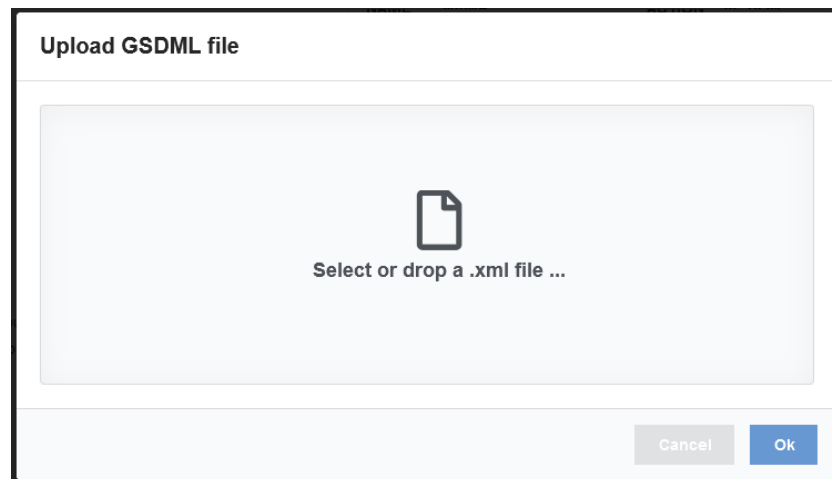


Figure 27: Upload GSDML file dialog

- 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.

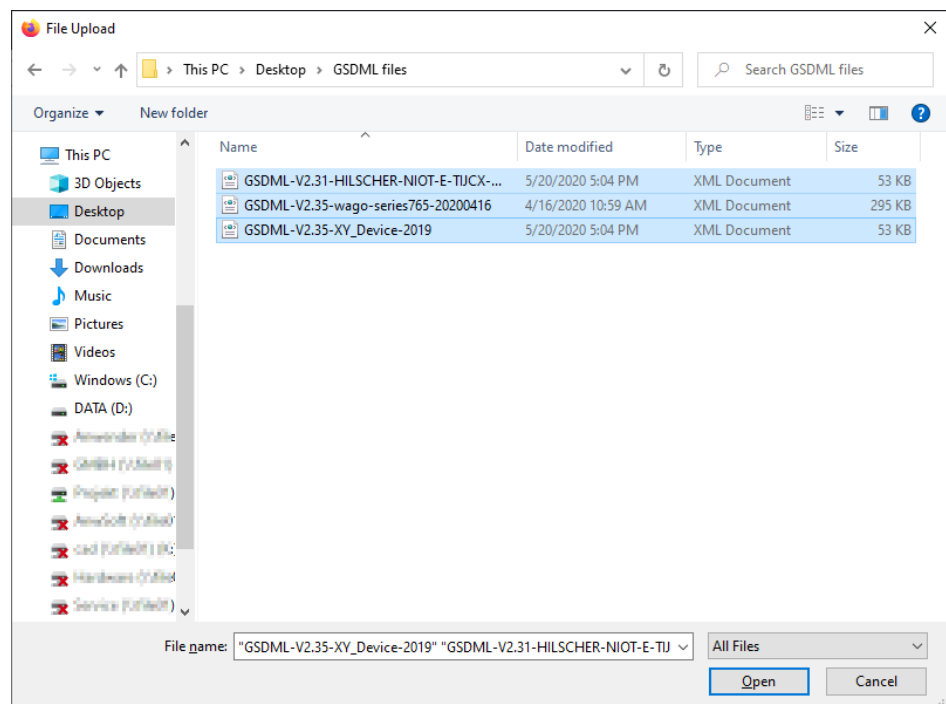


Figure 28: Multiple selection in File upload dialog

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

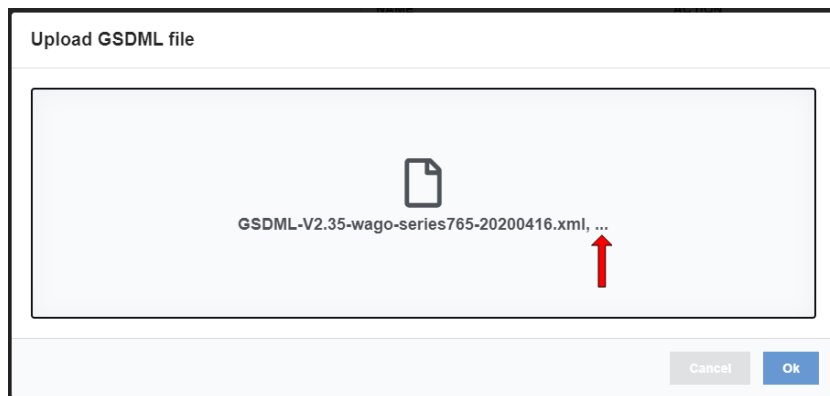


Figure 29: Upload GSDML file dialog

- 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.


### 4.8.4 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.

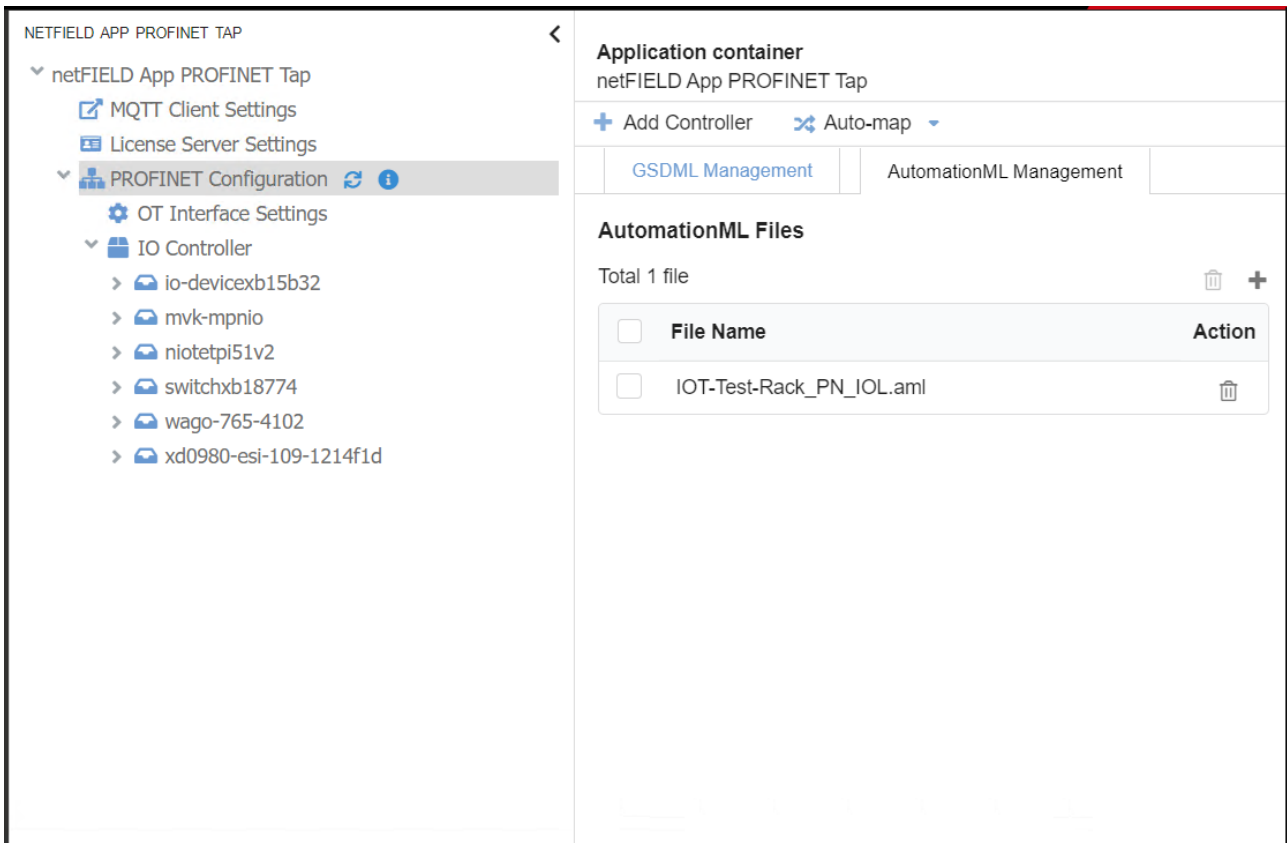


Figure 30: AutomationML Management

Element	Description
AutomationML Files	Shows the number of .aml files that were imported and are available for mapping.
	Opens dialog for uploading .aml files.
File Name	Name of the .aml file. You can select one or multiple files by clicking the checkboxes, and then delete the selected file(s) at once by clicking the  button.
Action	Deletes the .aml file.
	If the list contains more than ten entries, you can scroll here to display the next ten items.

Table 10: 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:

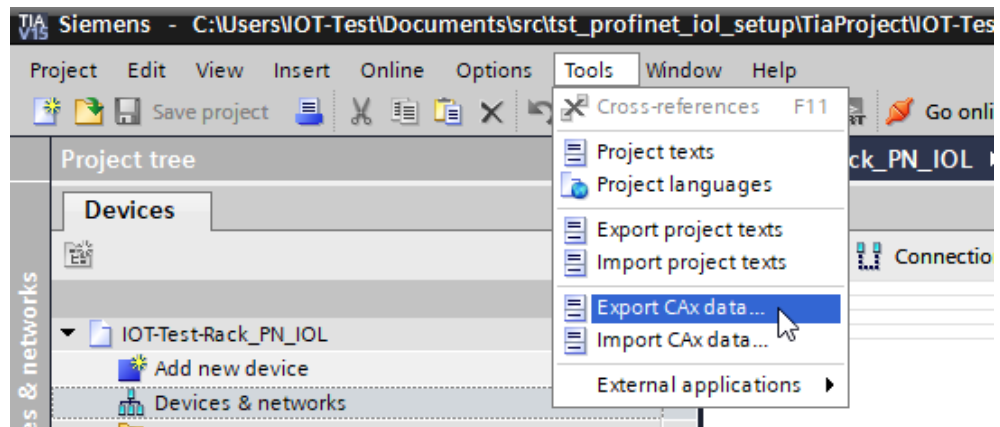


Figure 31: Export AutomationML file from Tia Portal



**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.

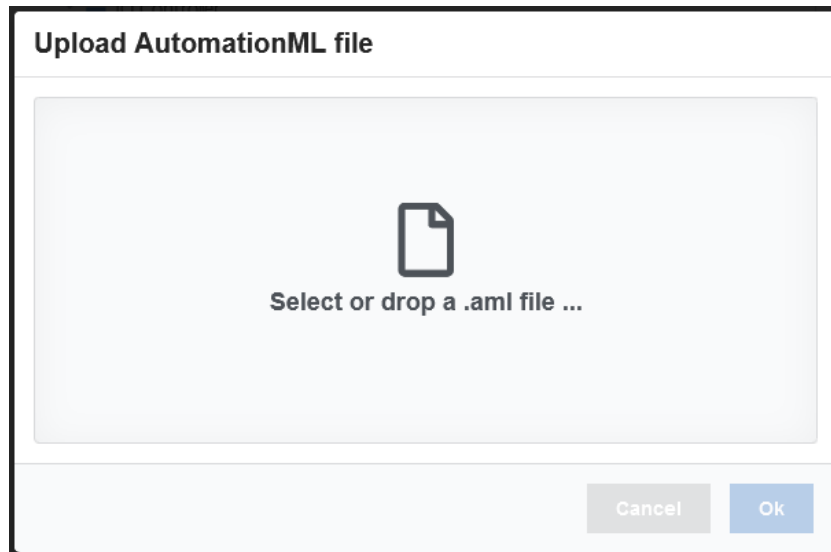


Figure 32: Upload AutomationML file dialog

- 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.

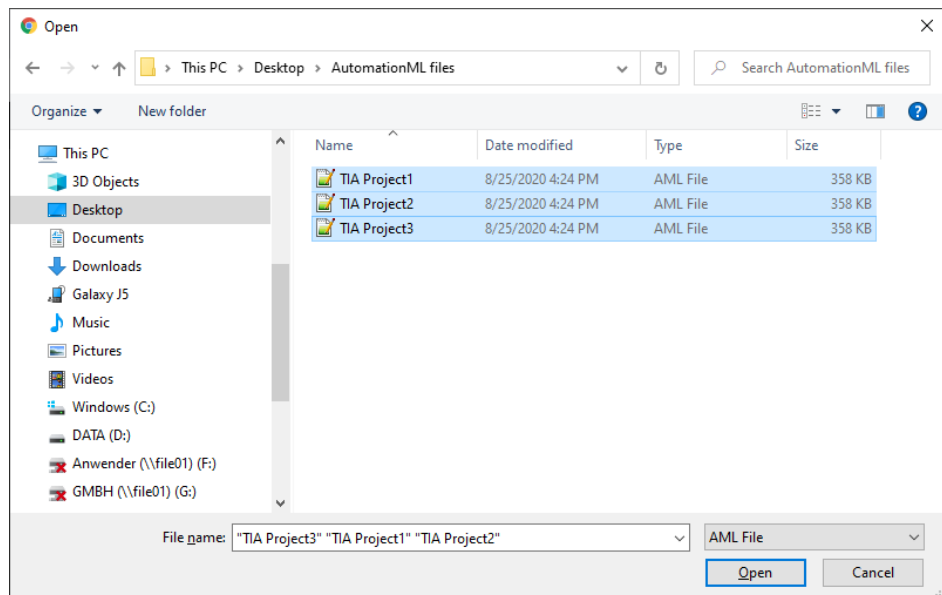


Figure 33: Multiple selection in File upload dialog

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

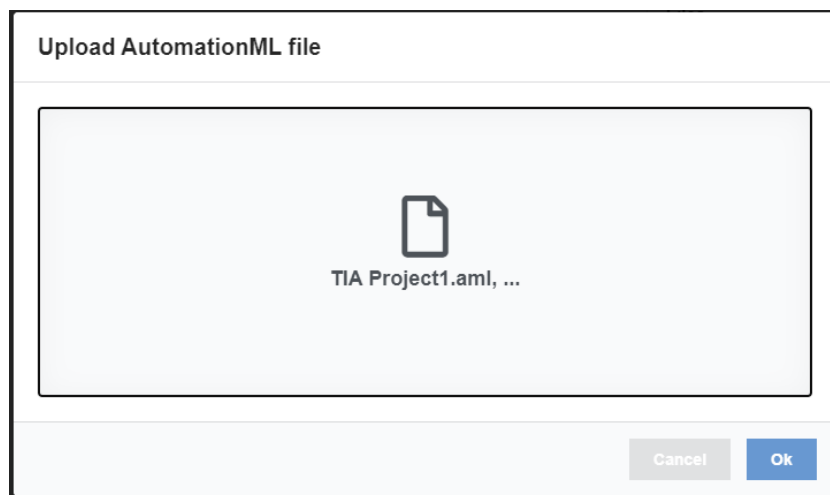


Figure 34: Upload AutomationML file dialog

- 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.



## 4.8.5 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/host 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 Link Speed according to your Tap's connection type (hardware vs. software tap).

**Note:** This is applicable for a netX-based capture interface only (**cifX OT Interface**).

- In the **OT Interface Settings**, select the Link 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.
- Select **Automatic** if you have connected the netX-based interface directly to the PROFINET; i.e. if you are using the built-in “software TAP” of the netX.

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:

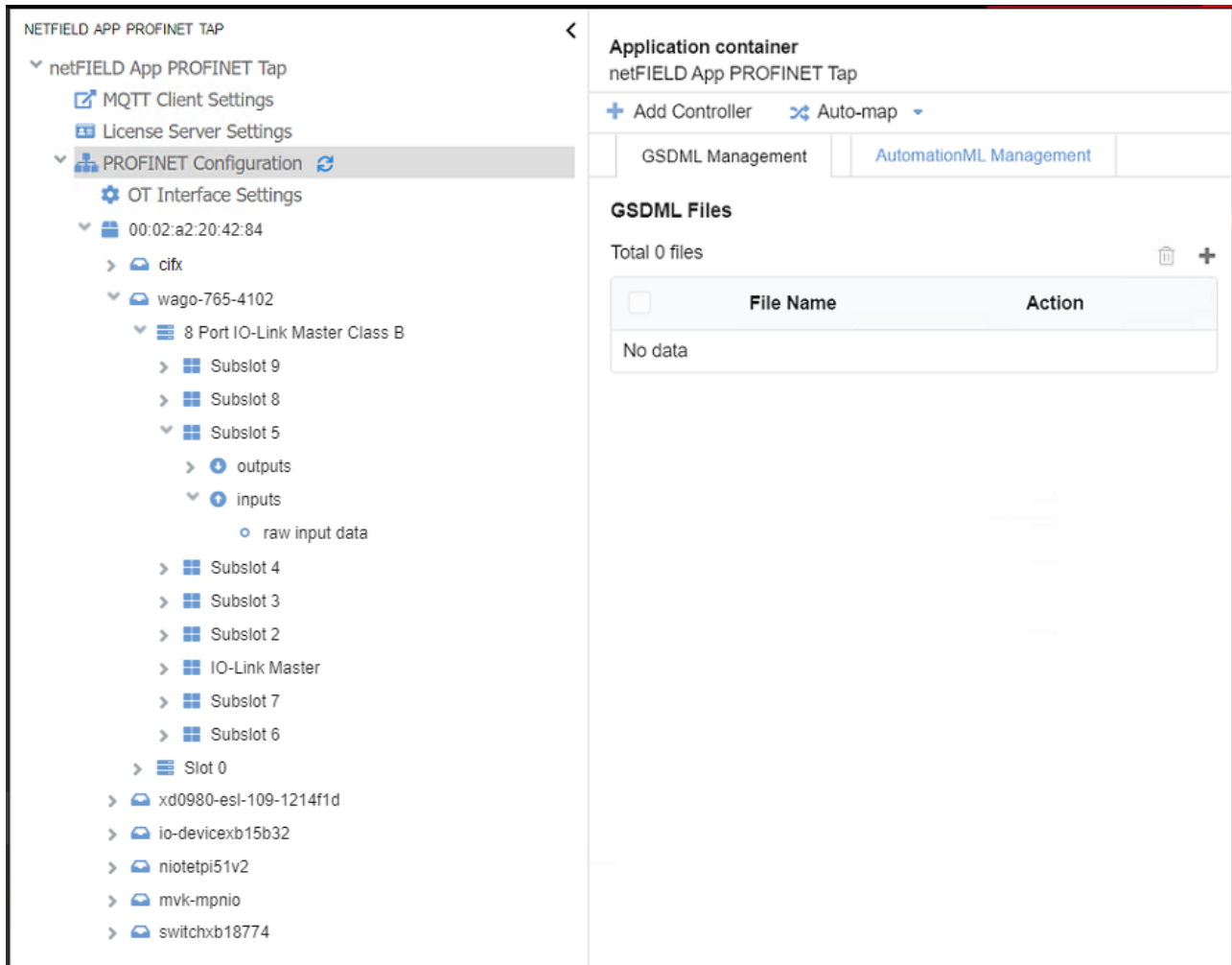



Figure 35: PROFINET configuration recognized during start-up




**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.

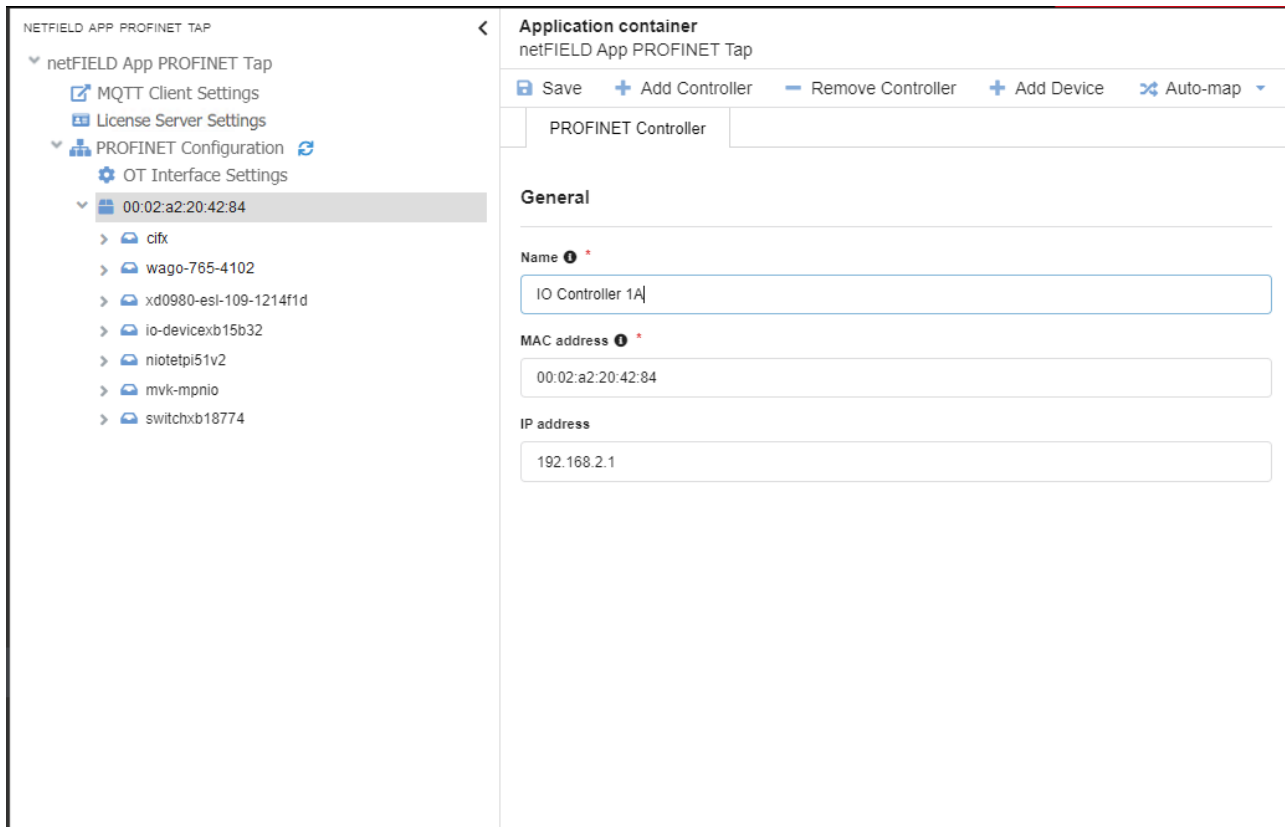


Figure 36: Change name of Controller

- 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:

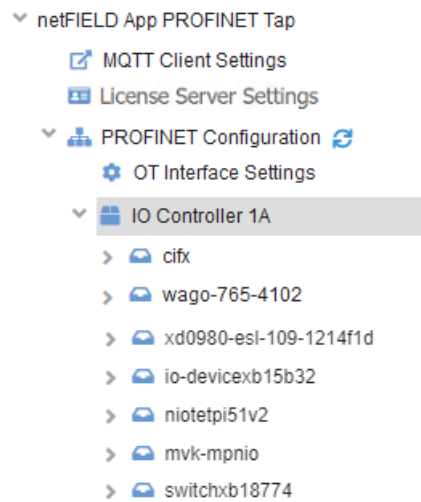


Figure 37: New Controller name

- Map data semantics from GSDML file(s)
  - Upload GSDML file(s) to the PROFINET Tap (see section *GSDML Management* [▶ page 42] 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 38: 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 subplot** 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:

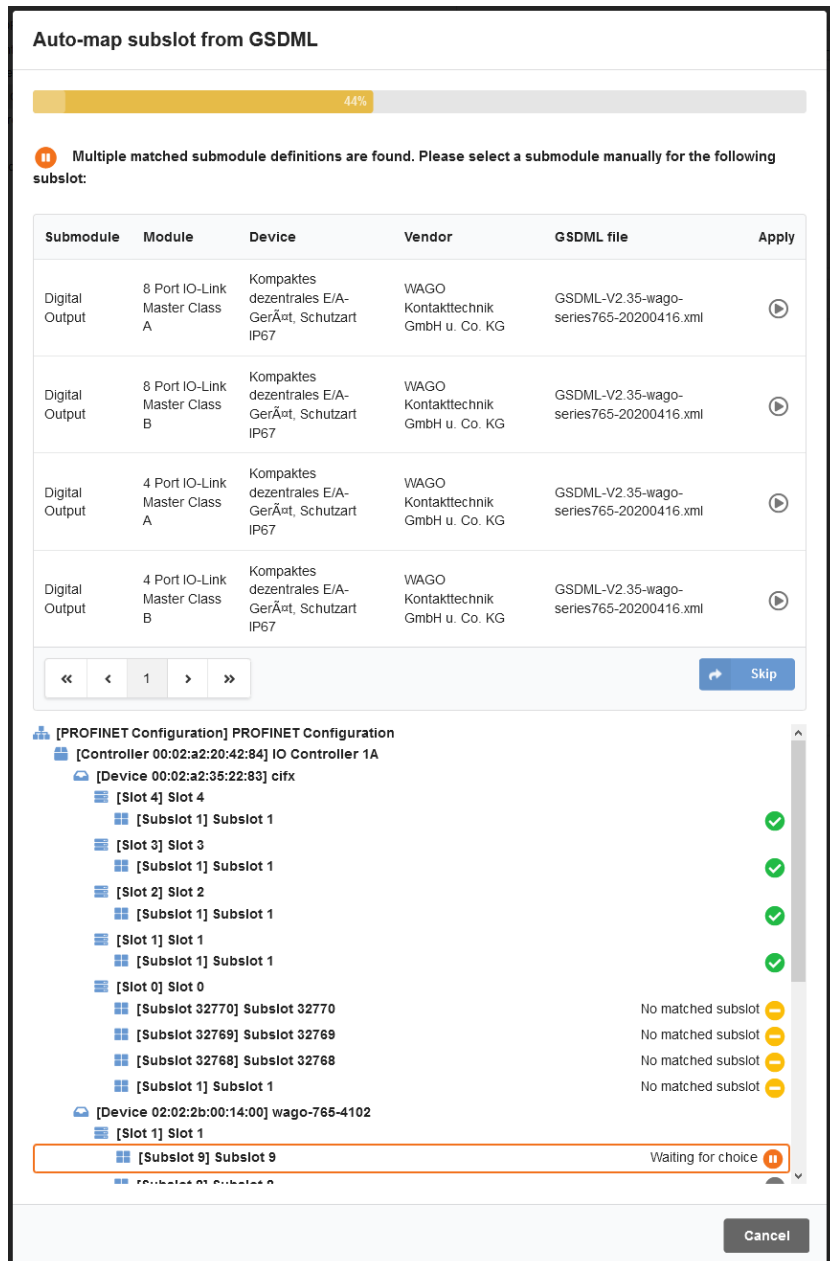


Figure 39: Select definition

- 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:

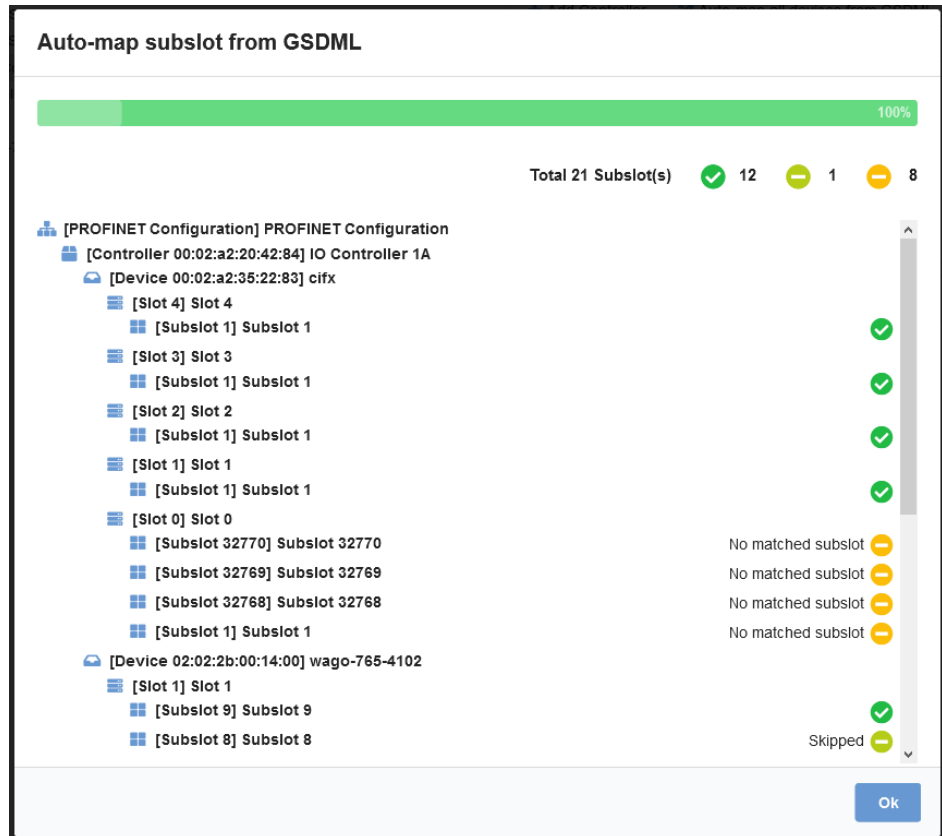


Figure 40: Finished

- 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 or user-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.

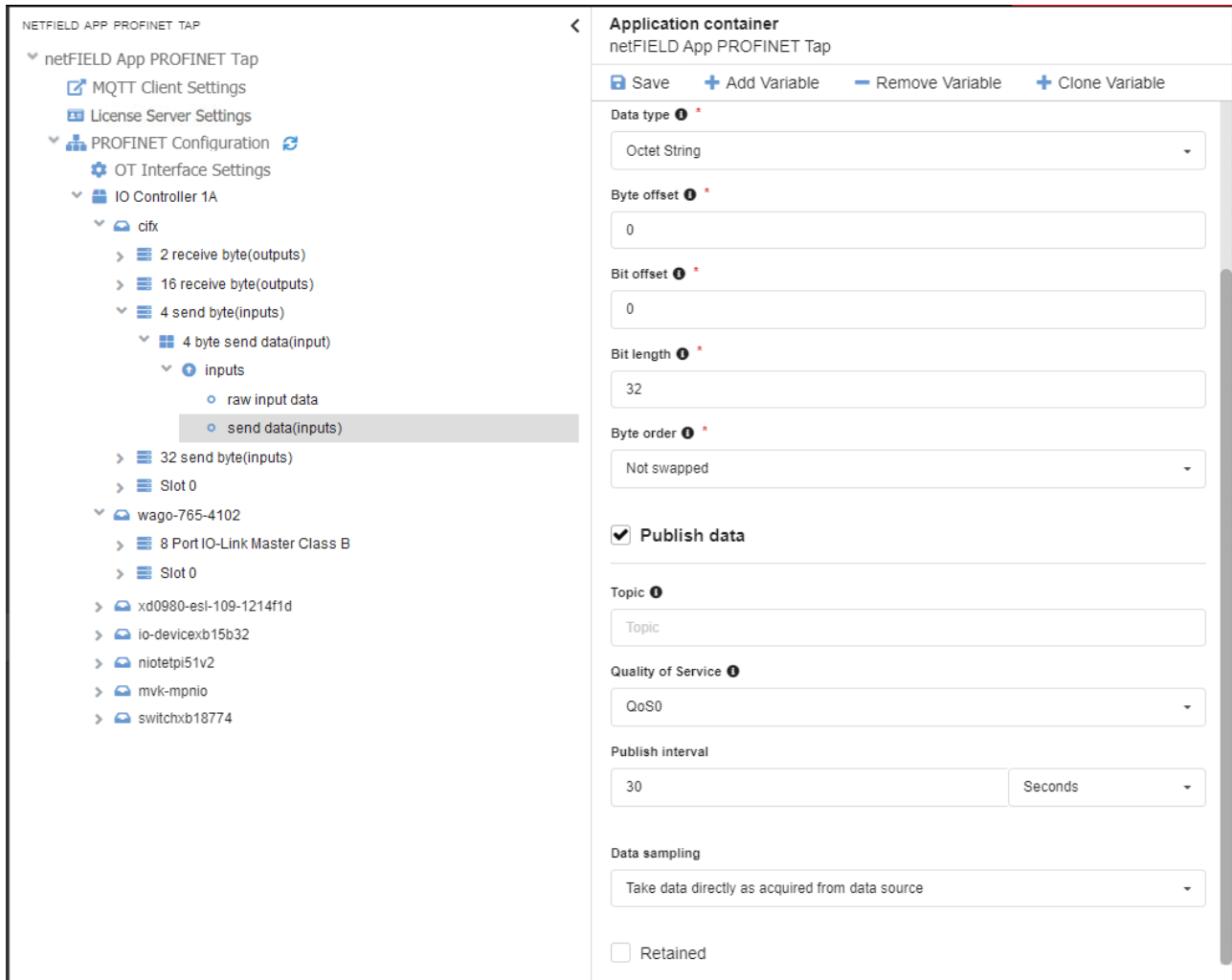
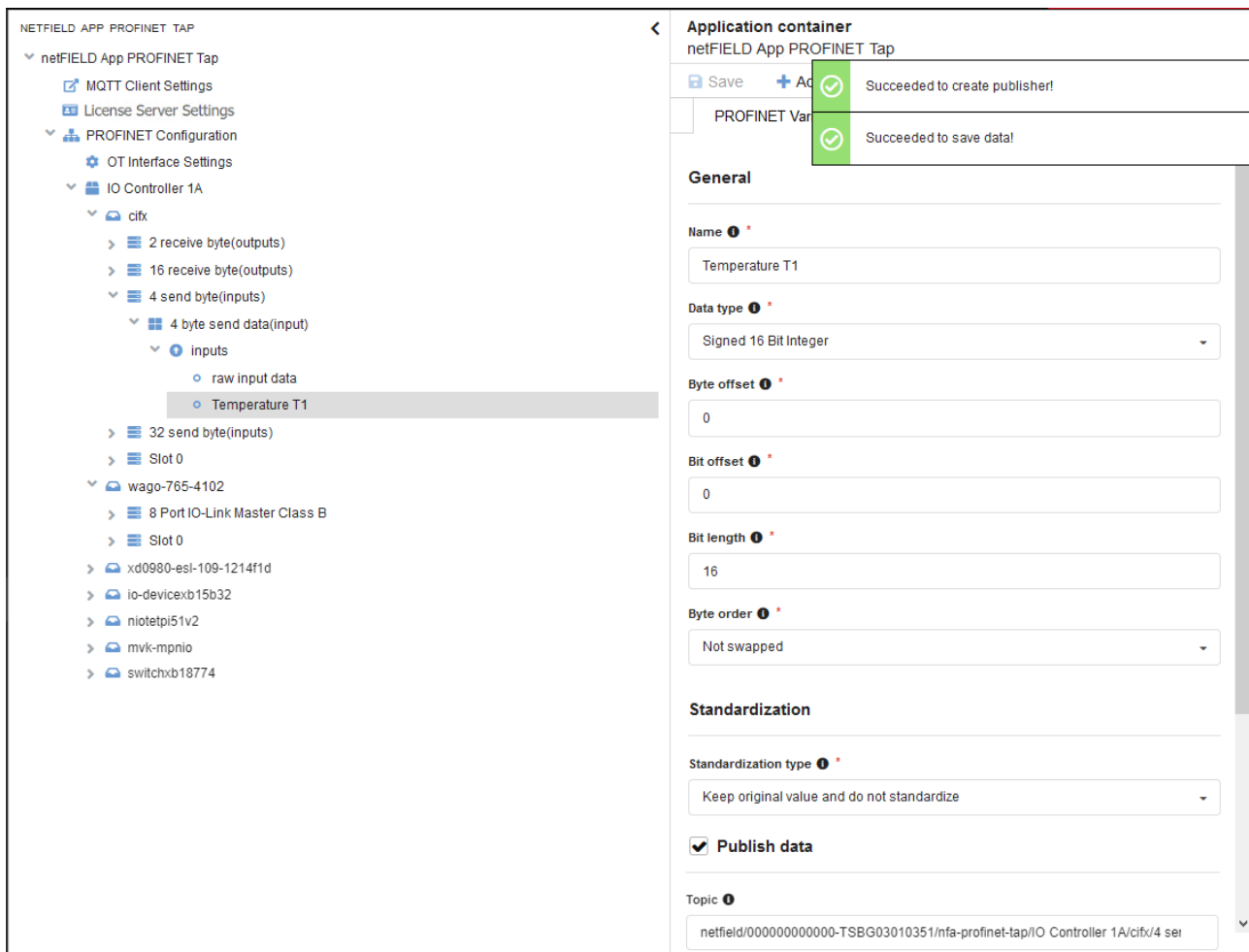


Figure 41: Publish variable

- 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.



The screenshot displays the configuration interface for the netFIELD App PROFINET Tap. On the left, a tree view shows the navigation structure, with 'Temperature T1' selected under 'IO Controller 1A' > 'cifx' > '4 byte send data(input)' > 'inputs'. The main panel shows the 'Application container' configuration for 'netFIELD App PROFINET Tap'. At the top, there are two notification boxes: 'Succeeded to create publisher!' and 'Succeeded to save data!'. Below these, the 'General' section includes fields for 'Name' (Temperature T1), 'Data type' (Signed 16 Bit Integer), 'Byte offset' (0), 'Bit offset' (0), 'Bit length' (16), and 'Byte order' (Not swapped). The 'Standardization' section has 'Standardization type' set to 'Keep original value and do not standardize' and a checked 'Publish data' checkbox. The 'Topic' field is populated with 'netfield/000000000000-TSBG03010351/nfa-profinet-tap/IO Controller 1A/cifx/4 ser'.

Figure 42: Publisher created

- ⇒ PROFINET Tap immediately starts to publish the variable to the MQTT broker according to your settings.

## 4.8.6 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 and you have access to the file.

### Step-by-step instructions

1. Set Link Speed according to your Tap's connection type (hardware vs. software tap).

**Note:** This is applicable for a netX-based capture interface only (**cifX OT Interface**).

- In the **OT Interface Settings**, select the Link 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.
- Select **Automatic** if you have connected the netX-based interface directly to the PROFINET; i.e. if you are using the built-in “software TAP” of the netX.

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:

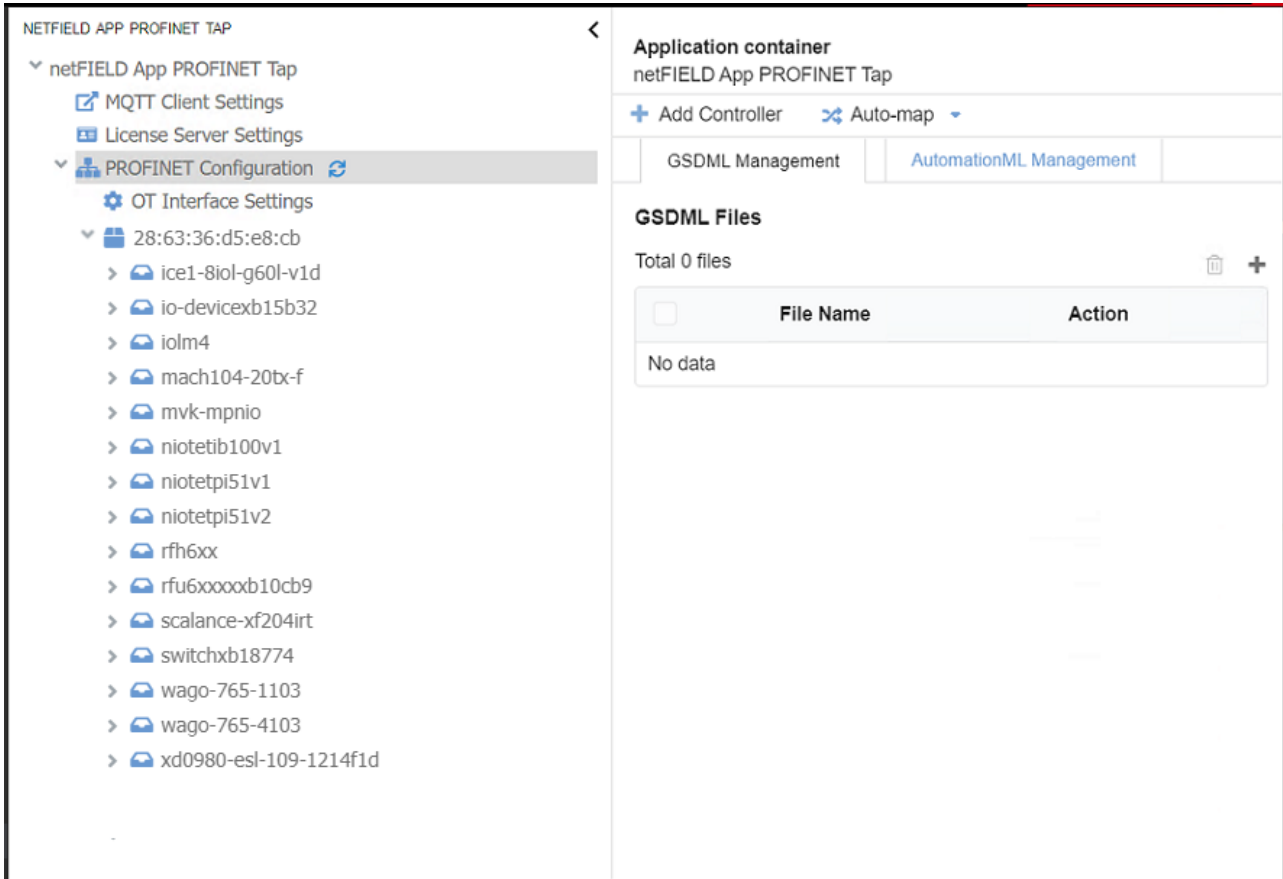



Figure 43: PROFINET configuration recognized during start-up



**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 45] 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 :

Auto-map subplot from AutomationML

Generating variables from AutomationML file ... [31 / 133]

[PROFINET Configuration] PROFINET Configuration

- [Controller 28:63:36:d5:e8:cb] IO Controller 1A
  - [Device 02:00:23:00:14:00] wago-765-4103
    - [Slot 1] Slot 1
      - [Subslot 5] Subslot 5 No variables are mapped, because there are no variables under the specified submodule.
      - [Subslot 4] Subslot 4 Variables were generated.
      - [Subslot 3] Subslot 3 No variables are mapped, because there are no variables under the specified submodule.
      - [Subslot 1] Subslot 1 Variables were generated.
      - [Subslot 2] Subslot 2 Variables were generated.
    - [Slot 0] Slot 0
      - [Subslot 32770] Subslot 32770 No matching submodule found.
      - [Subslot 32769] Subslot 32769 No matching submodule found.
      - [Subslot 32768] Subslot 32768 No matching submodule found.
      - [Subslot 1] Subslot 1 No matching submodule found.
  - [Device 00:02:a2:3d:73:63] niotetpi51v2
    - [Slot 2] Slot 2
      - [Subslot 1] Subslot 1 Variables were generated.
    - [Slot 1] Slot 1
      - [Subslot 1] Subslot 1 Variables were generated.
    - [Slot 0] Slot 0
      - [Subslot 32770] Subslot 32770 No matching submodule found.
      - [Subslot 32769] Subslot 32769 No matching submodule found.
      - [Subslot 32768] Subslot 32768 No matching submodule found.
      - [Subslot 1] Subslot 1 No matching submodule found.
  - [Device 3c:b9:a6:00:97:a5] xd0980-esl-109-1214f1d
    - [Slot 1] Slot 1
      - [Subslot 1] Subslot 1 Variables were generated.

Figure 44: 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:

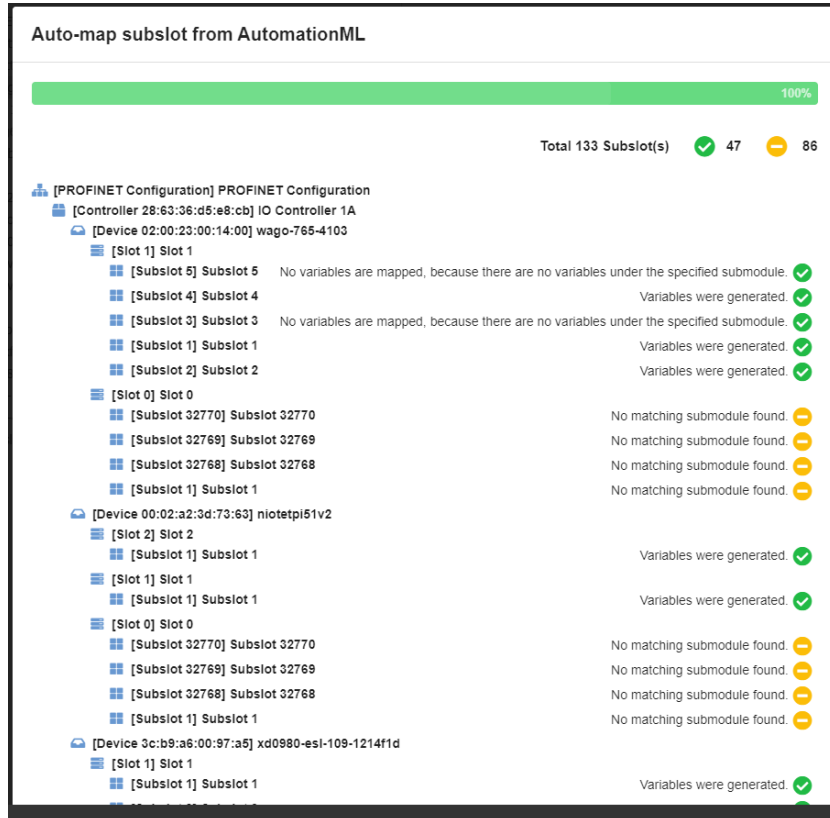


Figure 45: Mapping finished

- 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 or user-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.

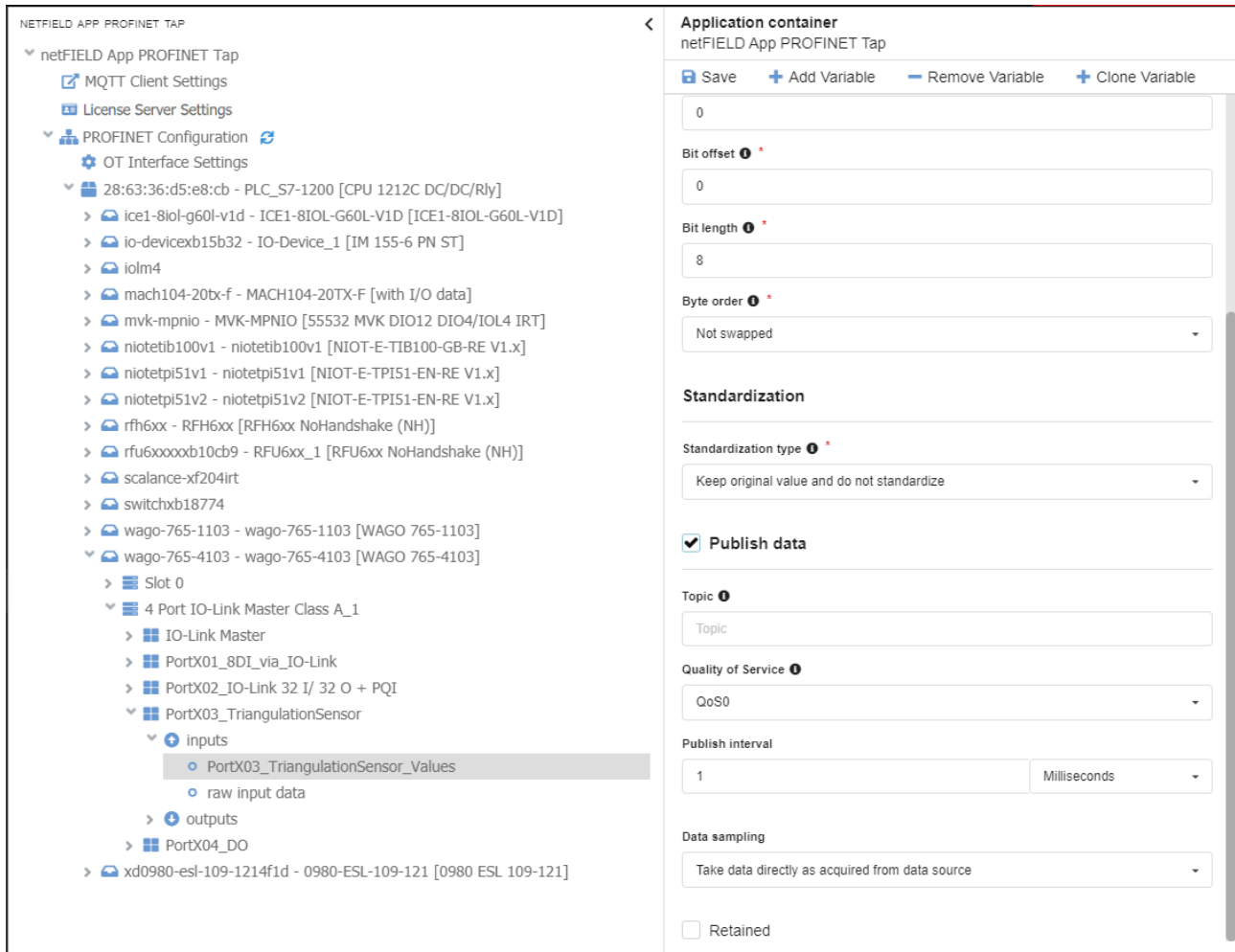


Figure 46: Publish variable

- 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.

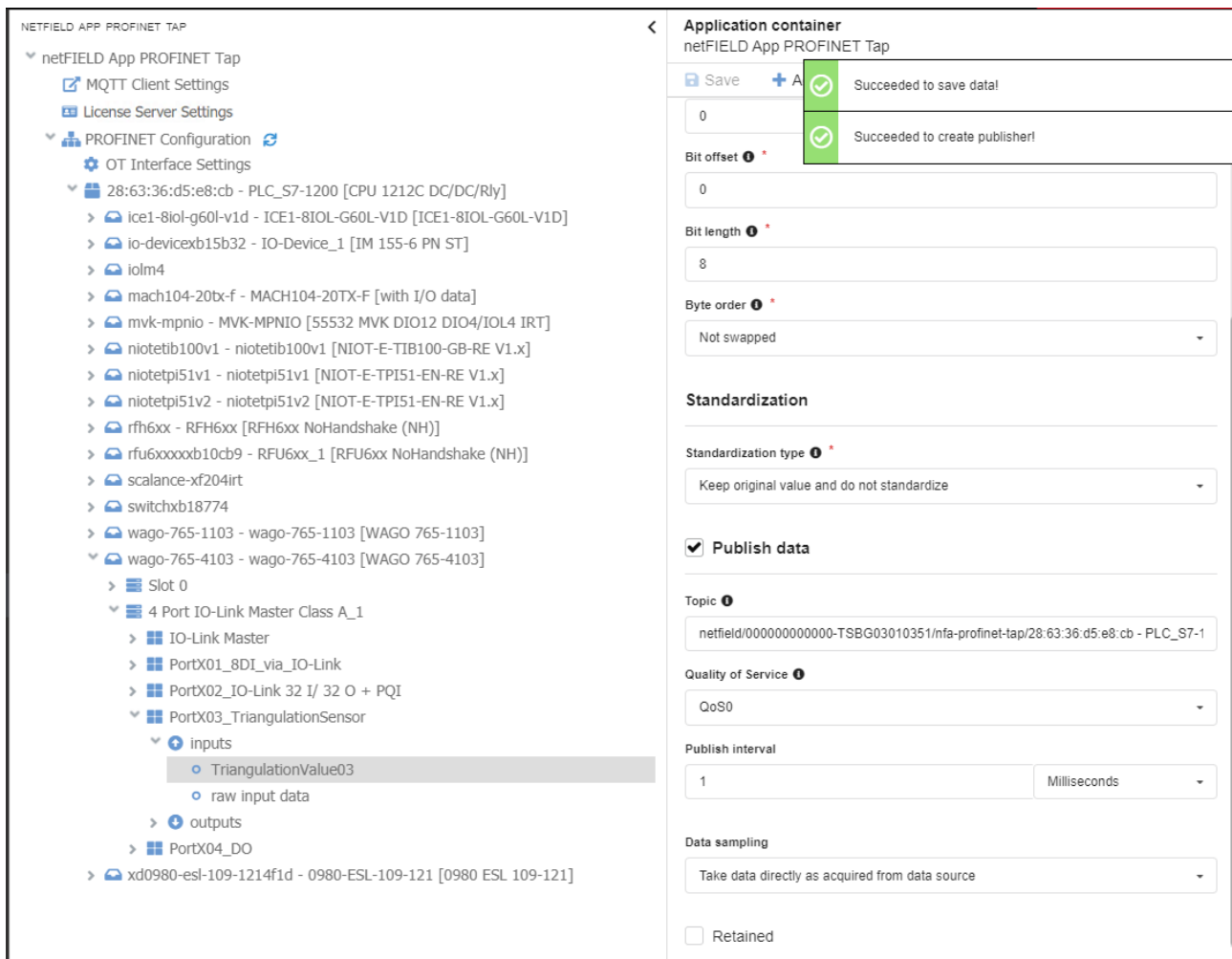


Figure 47: Publisher created

- ⇒ PROFINET Tap immediately starts to publish the variable to the MQTT broker according to your settings.

# 5 Good to know...

## 5.1 Hypervisor-specific switch/bridge configuration settings

### VMware

If you are using VMware, make sure that the virtual switch that connects to the PROFINET VLAN accepts **Promiscuous mode** and **MAC address change** in its security settings:

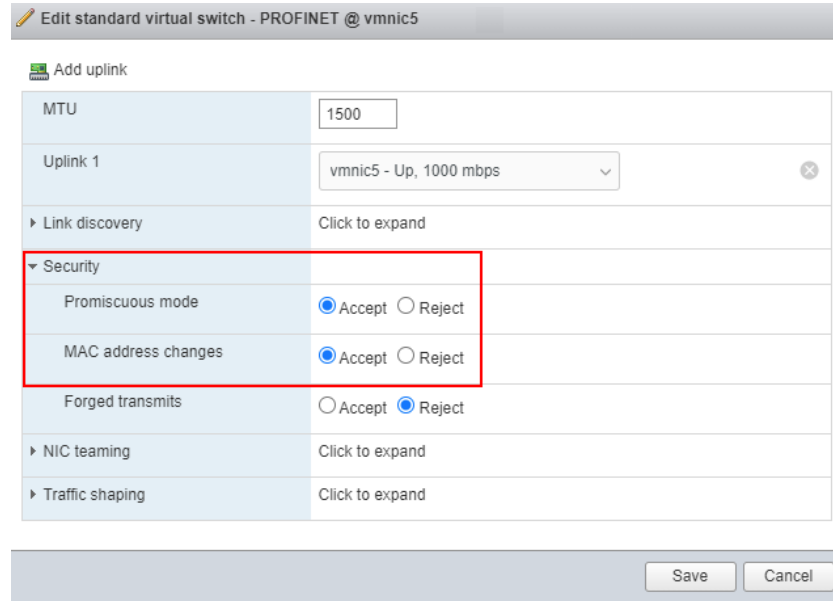


Figure 48: Security settings of virtual switch in ESXi

### Proxmox (KVM)

Proxmox Linux bridges (vbr\*) act like switches, thus they do not forward all traffic into the virtual machine. To set a bridge to hub-like behavior, do the following:

- Edit `/etc/network/interfaces.new` and add the line `bridge_ageing 0` in the relevant vbr\* block:

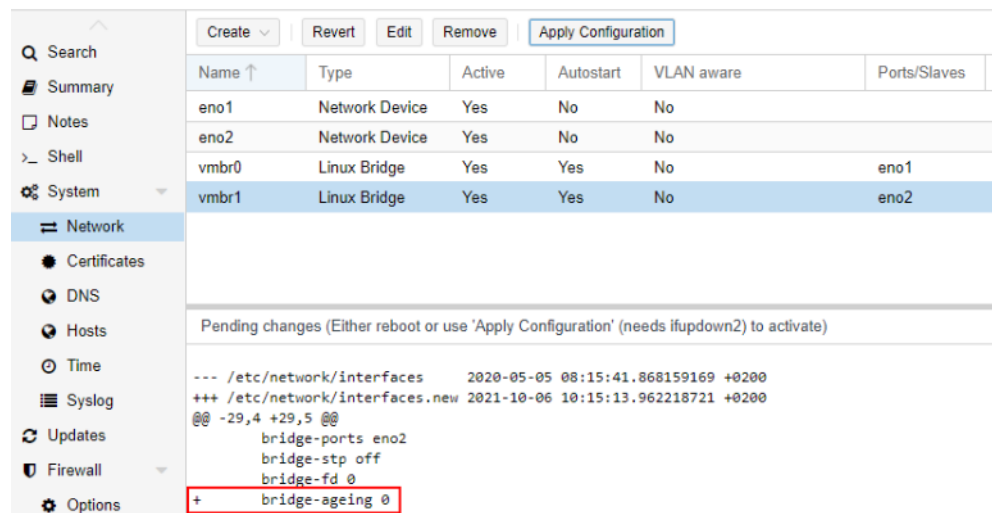


Figure 49: Edit Linux bridge in Proxmox



## 5.2 Replacement of PROFINET Device and Controller

### Replacing PROFINET Device

You can replace an IO Device in your PROFINET network without having to adapt the PROFINET Tap configuration.

The only conditions for this are:

- The new device has the same *Name Of Station* and the same IP address.
- You allow the PROFINET Tap to listen to a complete PROFINET startup sequence in which the new device is included.

### Replacing PROFINET Controller

In case of Controller replacement, you must adapt its MAC address in the PROFINET Tap configuration before starting up the PROFINET network again.

- Select the Controller in the PROFINET Configuration tree and enter the MAC address of the new Controller, then click **Save**.

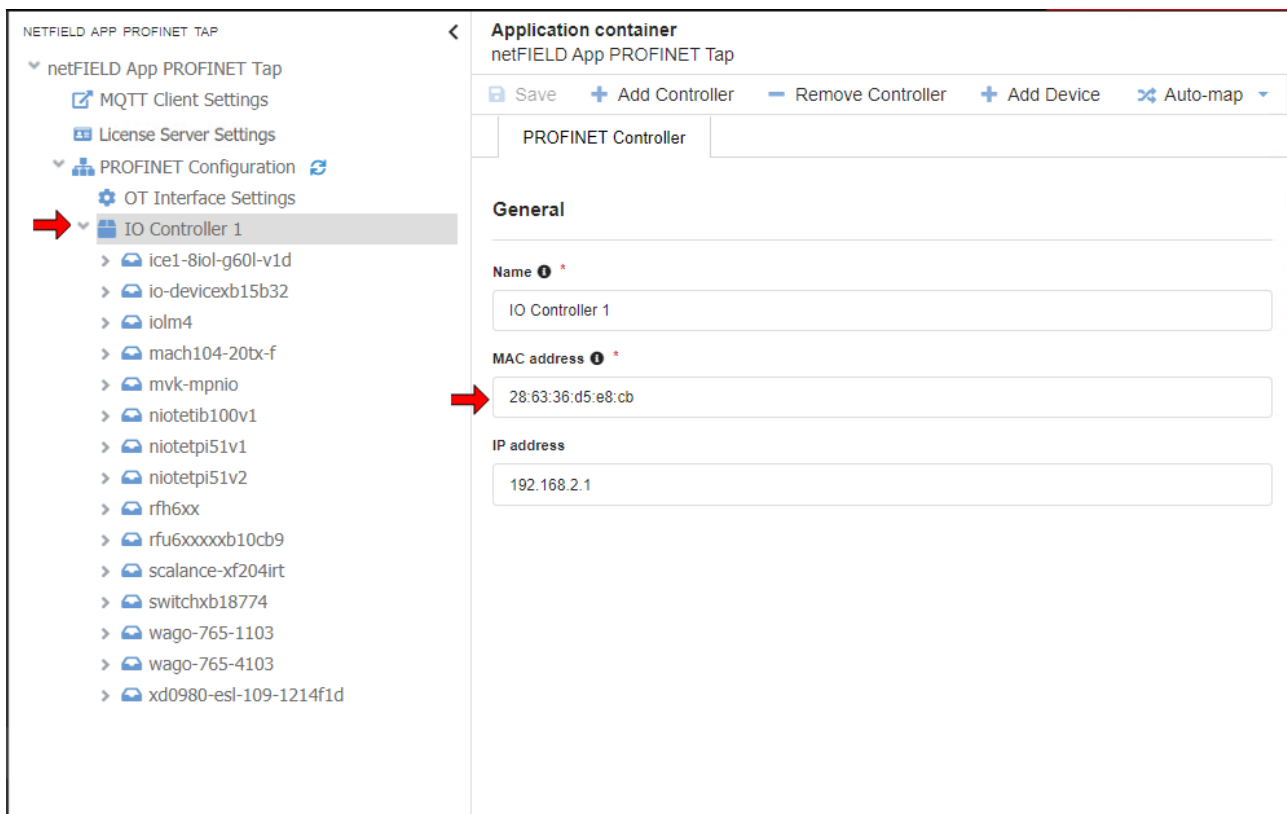


Figure 50: MAC address of Controller

- You then must allow the PROFINET Tap to listen to a complete PROFINET startup sequence in which the new Controller is included.

## 5.3 MQTT message format

### Structure of MQTT Topic (default)

This section describes 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 or user-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>	If the PROFINET Tap container is used on a netFIELD OS, the <code>gateway prefix</code> identifies the “source” (= gateway) of the MQTT message according to global MQTT settings of the netFIELD OS. (Local Device Manager > General Settings > Default MQTT Client Settings > Gateway settings > Gateway prefix). <b>Note:</b> By default, the <code>gateway prefix</code> is automatically determined to be identical with the Hardware ID of the netFIELD OS Device respectively of the netFIELD OS Datacenter.
<user-prefix>	If the PROFINET Tap container is used on a host without netFIELD OS, the proper <code>gateway prefix</code> (see above) cannot be automatically determined by the container, and is therefore substituted with the <code>user-prefix</code> default string. <b>Note:</b> In order to properly identify the “source” of the MQTT message, you can replace the default <code>user-prefix</code> string with a meaningful value via the <code>GATEWAY_PREFIX</code> environment variable. To do so, simply add <code>GATEWAY_PREFIX=&lt;my_source&gt;</code> under environment in the Docker Compose file, e.g.: <pre>environment: - CONTAINER_ID=netfield-app-profinet-tap - GATEWAY_PREFIX=Tap_machine3</pre>
<container id>	Identifier according to <code>CONTAINER_ID</code> environment variable. <b>Note:</b> By default, the Container ID is <code>netfield-app-profinet-tap</code> , but can be changed by the user. You can change it in the Docker Compose file or – if you are a netFIELD Cloud user – in the netFIELD Portal.
<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 11: Descriptions of elements in topic

**Example:**

```
netfield/Tap_machine3/netfield-app-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 12: Notes on message content

## 5.4 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-CPU's
  - 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.

## 5.5 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 13: Mapping of data types from TIA Portal

## 5.6 TLS encryption and netFIELD OS

Please note the following if you intend to use SSL/TLS encryption: The certificates and key files that the MQTT client embedded 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/ Datacenter and mapped into the container from the operating system. For this mapping, the following standard directories are mapped into the container when you use the netFIELD OS and the Docker Compose files from Hilscher (respectively when you deploy the container via netFIELD Portal using the default Container Create Options):

```
/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 Docker Compose file respectively in the netFIELD Portal before deploying the container.

Note also that the Docker Compose file for the Linux Datacenter use case (without netFIELD OS) does not specify any directories regarding TLS for MQTT by default.

---

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 embedded 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.

## 5.7 Container configuration data storage

The configuration data of the container is stored in the `netfield-app-profinet-tap-data` Docker volume.

Your whole application configuration data - such as your PROFINET configuration, activated publishers etc. - is stored here independently of the run state or the version of your netFIELD App PROFINET Tap container. When you stop and restart the container, the configuration will be loaded from this volume again.

Note that the configuration data in this volume will be automatically migrated to the latest version when you deploy a newer version of the netFIELD App PROFINET Tap.

Note also that only upgrading towards *higher* versions is possible. If you try to start a lower container version with a newer configuration volume, the configuration will not be loaded, but will be cleared instead.



## 5.8 Installing CodeMeter and activating license

For users who are new to the CodeMeter licensing technology, this section describes how to setup a CodeMeter server in your local network and activate your PROFINET Tap license key, using the **CodeMeter User Runtime for Windows** as an example.

1. Download license server from Wibu-Systems.
  - Go to the **CodeMeter User Software** page <https://www.wibu.com/us/support/user/downloads-user-software.html>
  - Under **CodeMeter User Download**, download the **CodeMeter User Runtime** according to the operating system of the server/machine/PC on which you want to install your license server, e.g. **CodeMeter User Runtime for Windows**:

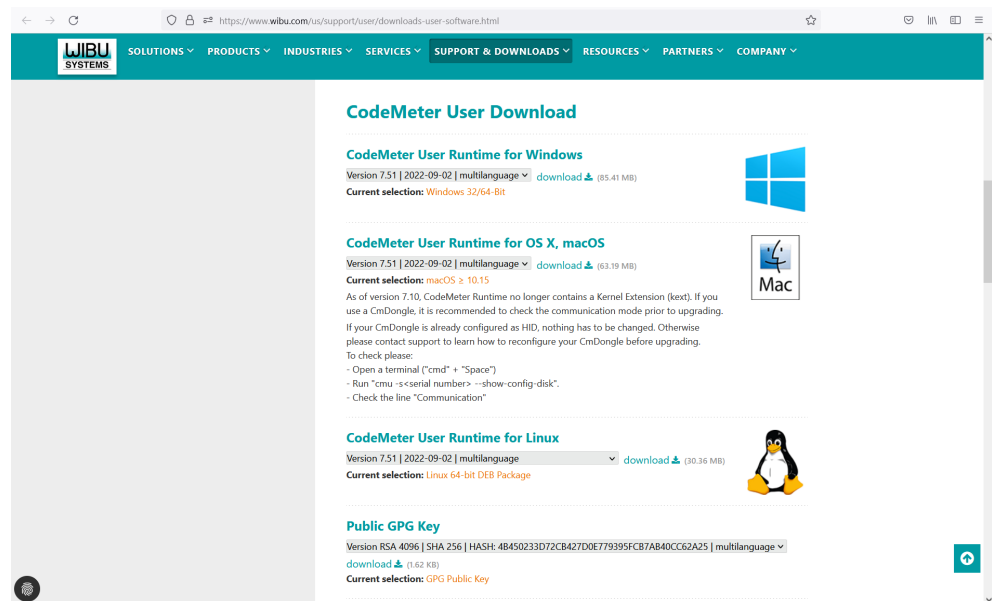


Figure 51: CodeMeter runtime download

2. Install the CodeMeter runtime on your server/machine/PC.
  - Install the license server via the downloaded **CodeMeterRuntime.exe** installer.
  - In the **Custom Setup** dialog of the setup wizard, make sure that the **Network Server** option is enabled:

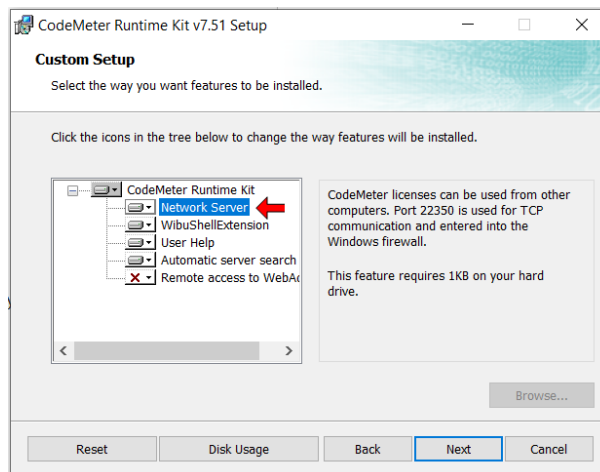


Figure 52: Enable network server option

- After installation, you will find the *CodeMeter Control Center* in the Windows taskbar:

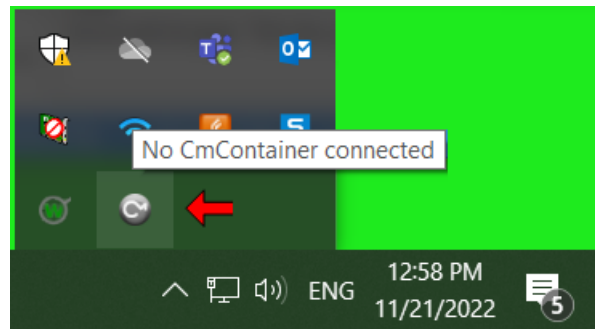


Figure 53: Installed CodeMeter server in taskbar

3. Obtain license PROFINET Tap license.
  - Contact your local Hilscher sales representative ([www.hilscher.com/company/offices](http://www.hilscher.com/company/offices)) to obtain a license key.
  - After purchasing the license, you will receive a download link for the license key.
4. Activate license key.
  - Open the link using a web browser on the server/machine/PC where the previously installed license server is running.
  - The link leads you to a Wibu-Systems **Available Licenses** web page:

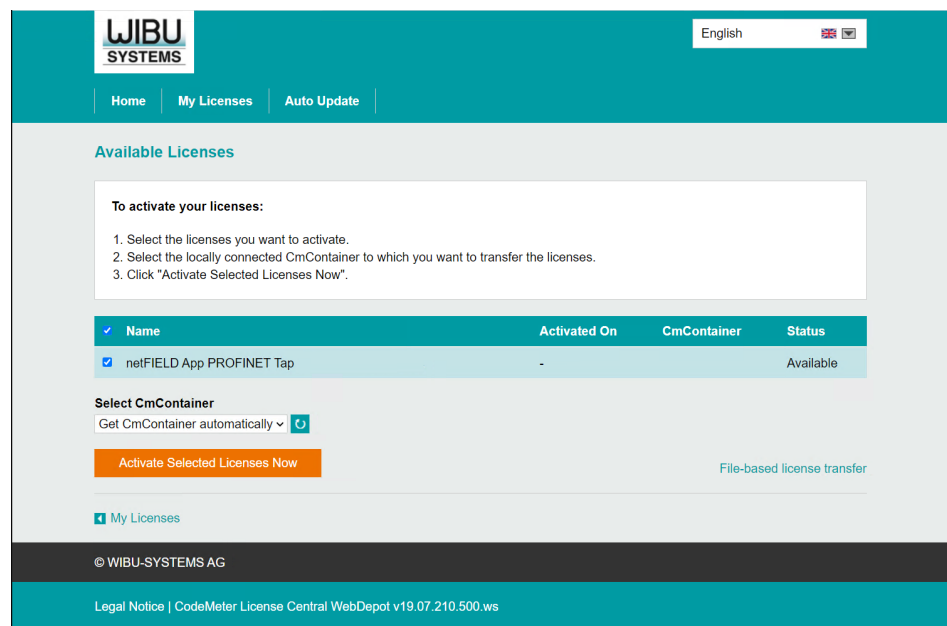


Figure 54: Activate license web page

- Make sure that the **netFIELD App PROFINET Tap** is selected (checked), then click **Activate Selected Licenses Now** button.
- The License key is now automatically downloaded, imported and activated in your local CodeMeter license server.

5. Check activation of license (optional).

- To check your license, open the *CodeMeter Control Center* in the Windows taskbar:

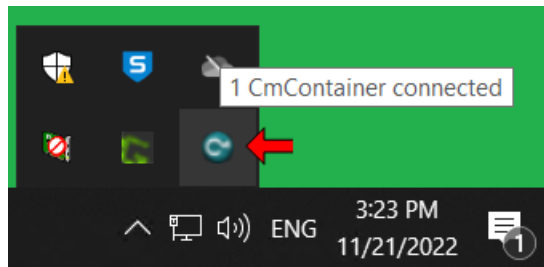


Figure 55: Open CodeMeter Control Center

- In the *CodeMeter Control Center*, you can also open the **WebAdmin** web interface for more details.

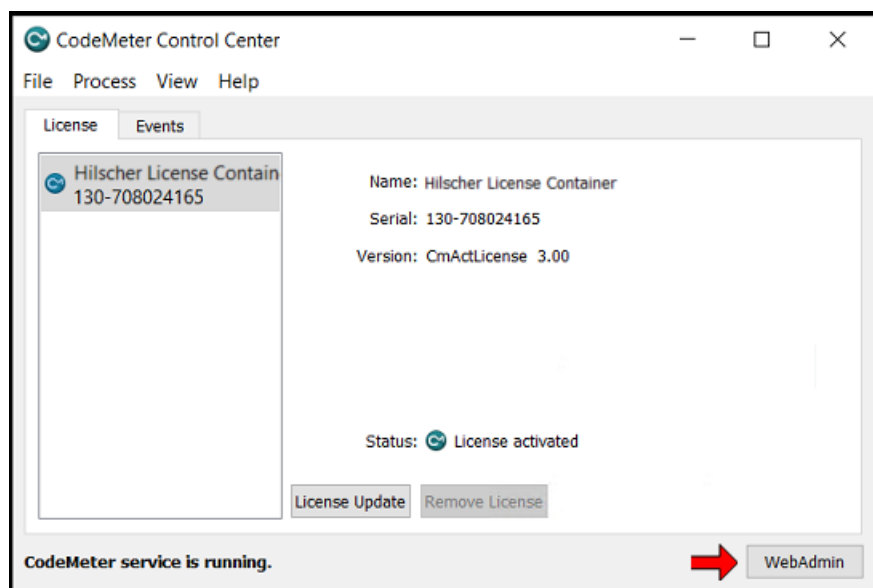


Figure 56: CodeMeter Control Center

- In the **WebAdmin** web interface, open **Container** tab > **Hilscher License Container** > **Licenses** to display information on the license:

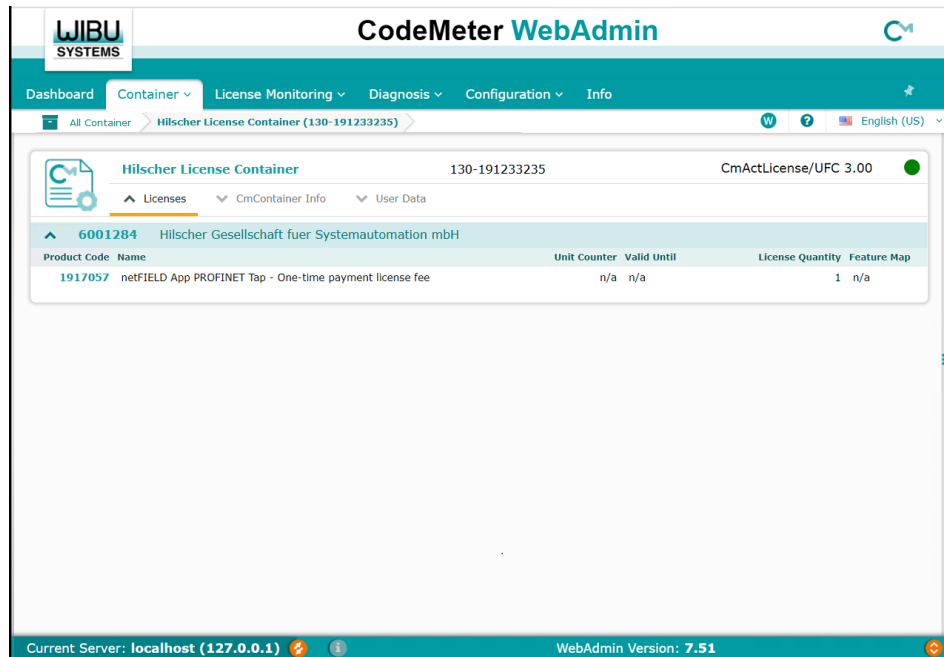


Figure 57: PROFINET Tap in WebAdmin

- Click on the **Product Code** to open the **Product Item Details** page, where you can find further details, like e.g. the **Maintenance Period**.

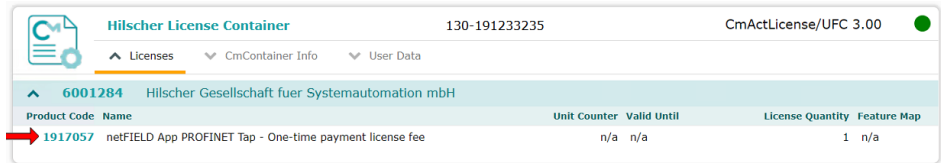


Figure 58: Click on Product Code

- The **Maintenance Period** on the **Product Item Details** page tells you for how long you can receive free updates for the app:

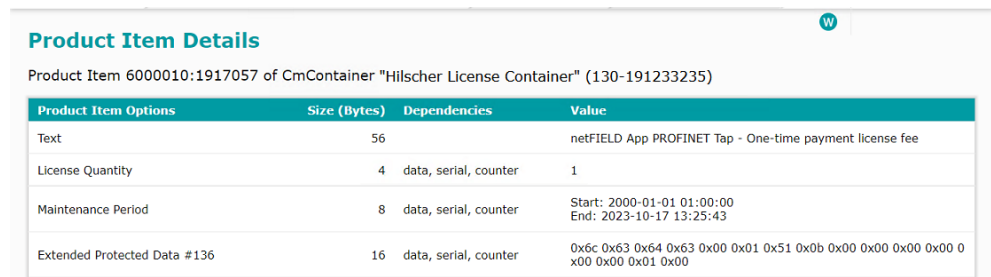


Figure 59: Product Item Details

6. Configure the CodeMeter license server endpoint in the PROFINET Tap.
  - To configure the CodeMeter license server endpoint in the PROFINET Tap, open the **License Server Settings** page of the PROFINET Tap's configuration web GUI:

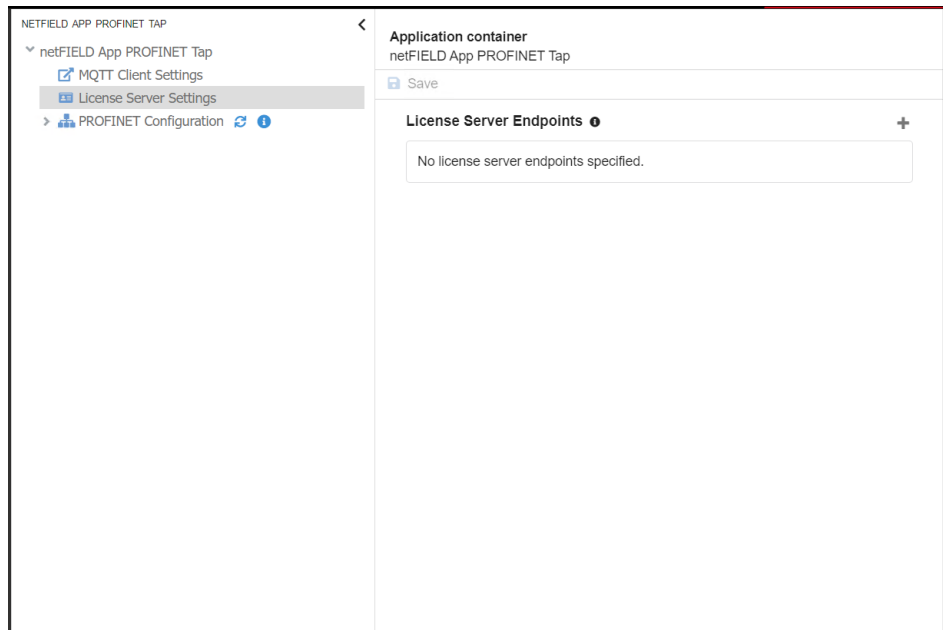


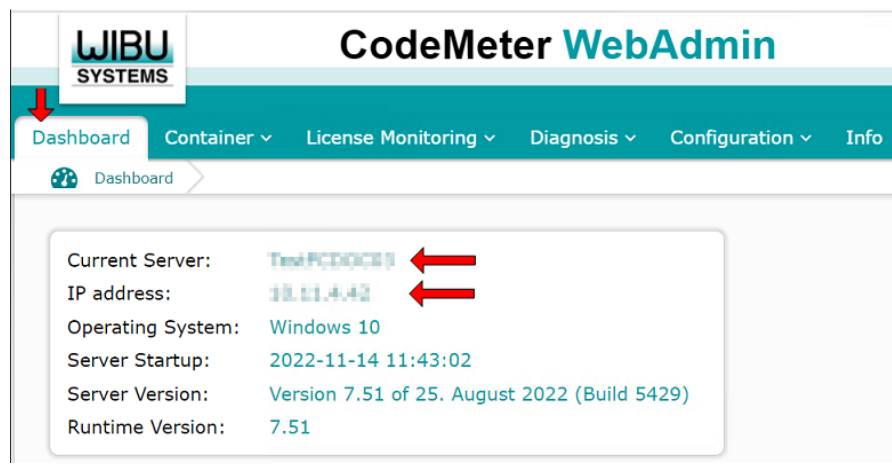
Figure 60: License Server Settings initial screen

- On the **License Server Settings** page, enter the host name or the IP address of the server/machine/PC where the license server is running.



**Note:**

Note that the required host name and IP address are displayed on the **Dashboard** tab of the CodeMeter **WebAdmin** web interface for reference:



- After clicking the **Save** button on the **License Server Settings** page, the PROFINET Tap immediately tries to connect to the server and retrieve its license.

## 7. Check the license state on the **Status** page.

- To check the state, first select the **netFIELD App PROFINET Tap** root element in the navigation tree, then open the **Status** tab:

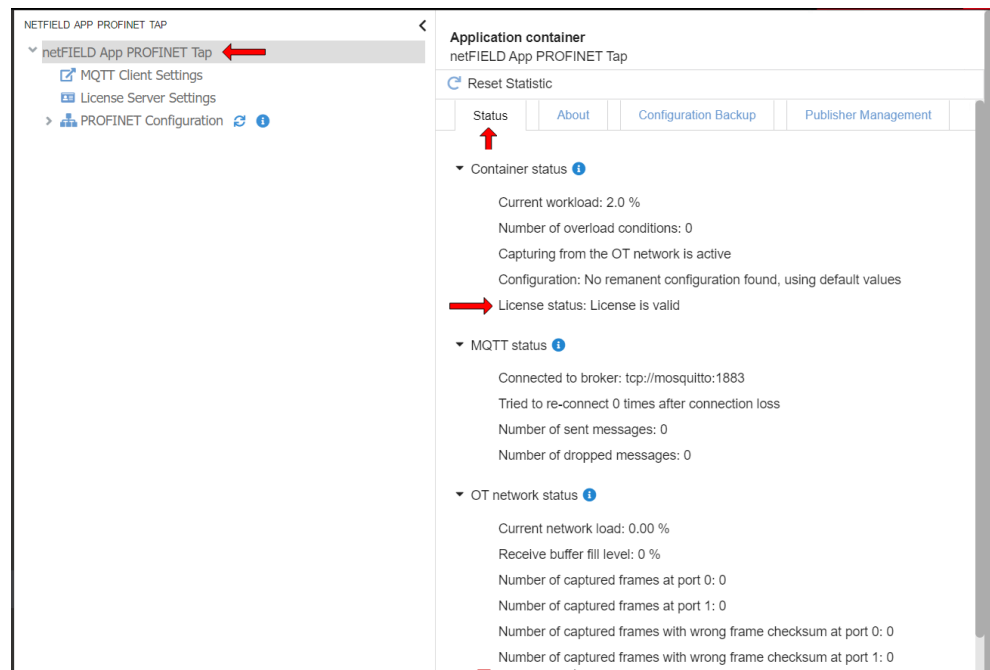


Figure 61: Check license status

## 6 Legal notes

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