1.0.0

Operating instructions manual

netFIELD App PROFINET Device

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empowering communication

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1 Introduction

1.1 Description of the contents

This document describes the netFIELD App PROFINET Device from Hilscher. The netFIELD App PROFINET Device application container enables host devices with a container engine to function as a PROFINET IO-Device and making the exchanged I/O process data accessible on an MQTT message bus.

The application and related documentation are available on the netFIELD App PROFINET Device page.

1.2 List of revisions

Index	Date	Author	Revision
1	2024-12-04	NAM	Document created

Table 1. List of revisions

1.3 Conventions in this document

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

Notes

IMPORTANT | <important note>

NOTE | <simple note>

TIP | <note, where to find further information>

User instructions

User instructions in documents have the following structure:

Condition

1. Step 1
   a. Further step
2. Step 2

   → Intermediate result
3. Step n

⇒ Result

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2 Overview

2.1 Brief description

The platform-independent container, netFIELD App PROFINET Device, allows host devices with netX network controller support, such as edge gateways, to exchange cyclic input and output process data with a PROFINET controller in real-time, while providing user applications access to the data through an MQTT message bus.

The PROFINET IO configuration is based on a GSDML file uploaded by the user. This file defines the available IO modules the app can represent on PROFINET, as well as PROFINET-specific parameters such as DeviceID, VendorID, VendorName, and others. The final PROFINET IO data exchanged with the controller is configured by the user through the app's integrated UI. The maximum amount of PROFINET IO process data that can be transmitted forth and back is 1436 bytes in each data direction.

For MQTT communication, the app functions as an MQTT client, converting the PROFINET data in two MQTT topics it is publishing data to and subscribing data for, while en-/decoding the data JSON formatted in the topics payload. The data is published to an MQTT broker whenever a change is detected in the PROFINET outputs, and for subscriptions, the inputs are updated in the next PROFINET cycle if data updates are published by the broker.

The app is ideal for upgrading PROFINET network-equipped systems with IIoT or smart services by utilizing the field and control data from the PROFINET controller. This enables valuable insights into real-time physical processes, allowing for quicker responses in predictive maintenance scenarios and boosting productivity through enhanced decision-making with real-time data tracking and monitoring.

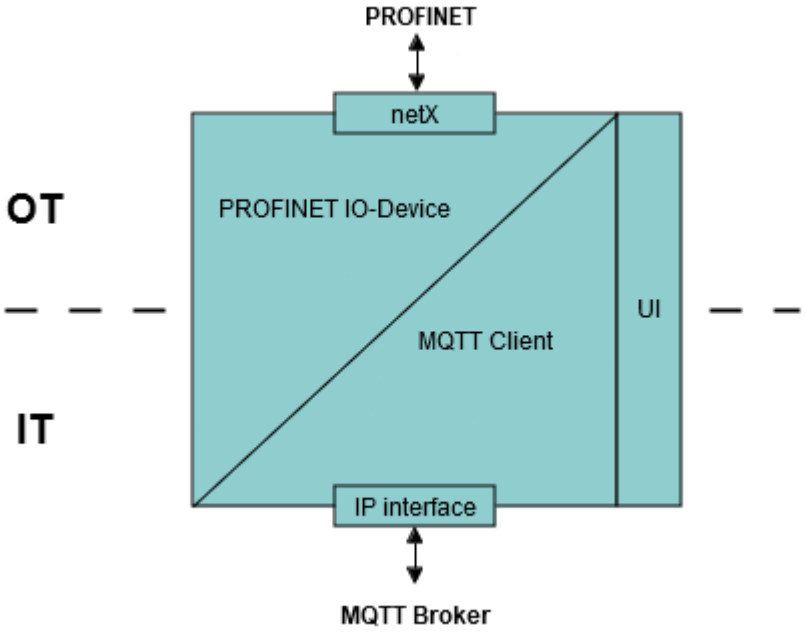

Figure 1. PROFINET device topology

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2.2 Requirements

Hardware requirements

The following hardware requirements apply for netFIELD App PROFINET Device application container:

- Host system with the following characteristics:
  - ARM64, AMD64 CPU architecture based Linux OS
  - netX "cifX Device Driver" included in the Linux OS kernel
  - Active container engine
  - Physical netX controller interface such as cifX, comX or plain netX chip with PROFINET IO-Device firmware

Software requirements

The application requires an MQTT Broker in a reachable network to which the app can publish the data from the connected devices.

2.2.1 Memory

The application requires approximately 200 MB of memory.

2.2.2 MQTT broker

The *netFIELD App PROFINET Device* container publishes or subscribes to the acquired data via MQTT and thus requires an MQTT broker for operation. The MQTT broker can run locally on the same host or on a remote host device in your local IT network.

2.2.3 Licensing and limitations

The application can be used without a license for 30 minutes. After this time has elapsed the following limitations are applied:
The last sampled values are retained indefinitely. Publishing stops.

2.2.3.1 Licensed operation

A license is required to use the full functionality of the app. Hilscher uses the CodeMeter licensing technology from Wibu-Systems. If you are not already a user of the CodeMeter ecosystem, you have two options for running a license server:

1. **netFIELD App License Server container**

   You can use the free-of-charge netFIELD App License Server container from Hilscher, which can be pulled from https://hub.docker.com/r/hilscherautomation/netfield-app-license-server.

2. **CodeMeter license server (CodeMeter User Runtime)**

   Alternatively, 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 application via TCP/IP connection.
   Note that for you as an end-user, the CodeMeter technology is free-of-charge, you only have to pay for the application license from Hilscher.

For either option you will need to activate a CodeMeter license ticket in the respective license server. For purchasing the license ticket, please contact your Hilscher sales representative.

Floating license

The provided 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 altogether or by deleting the corresponding license server endpoint on the **License Server Settings** page of the app). Other instances of the container (e.g. a container running on another device) can then "take over" the "freed" license by simply connecting to the corresponding license server.

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Maintenance period

The provided 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. 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.

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3 Use case

The app operates on a host device, such as an edge gateway, equipped with an Industrial Ethernet interface (e.g., netX, cifX, comX)

Key facts

- The app's host is physically connected to an active PROFINET network through the OT Ethernet ports of the netX network controller.
- The data exchanged with the PROFINET controller is made available through MQTT messages as the user interface.
- Operating as an MQTT client, the app is compatible with any MQTT broker that acts as a central hub for user data.
- The MQTT broker can either run locally on the app's host or externally, accessible via an IT network.
- One or more MQTT clients can access the PROFINET process data through the central MQTT broker.

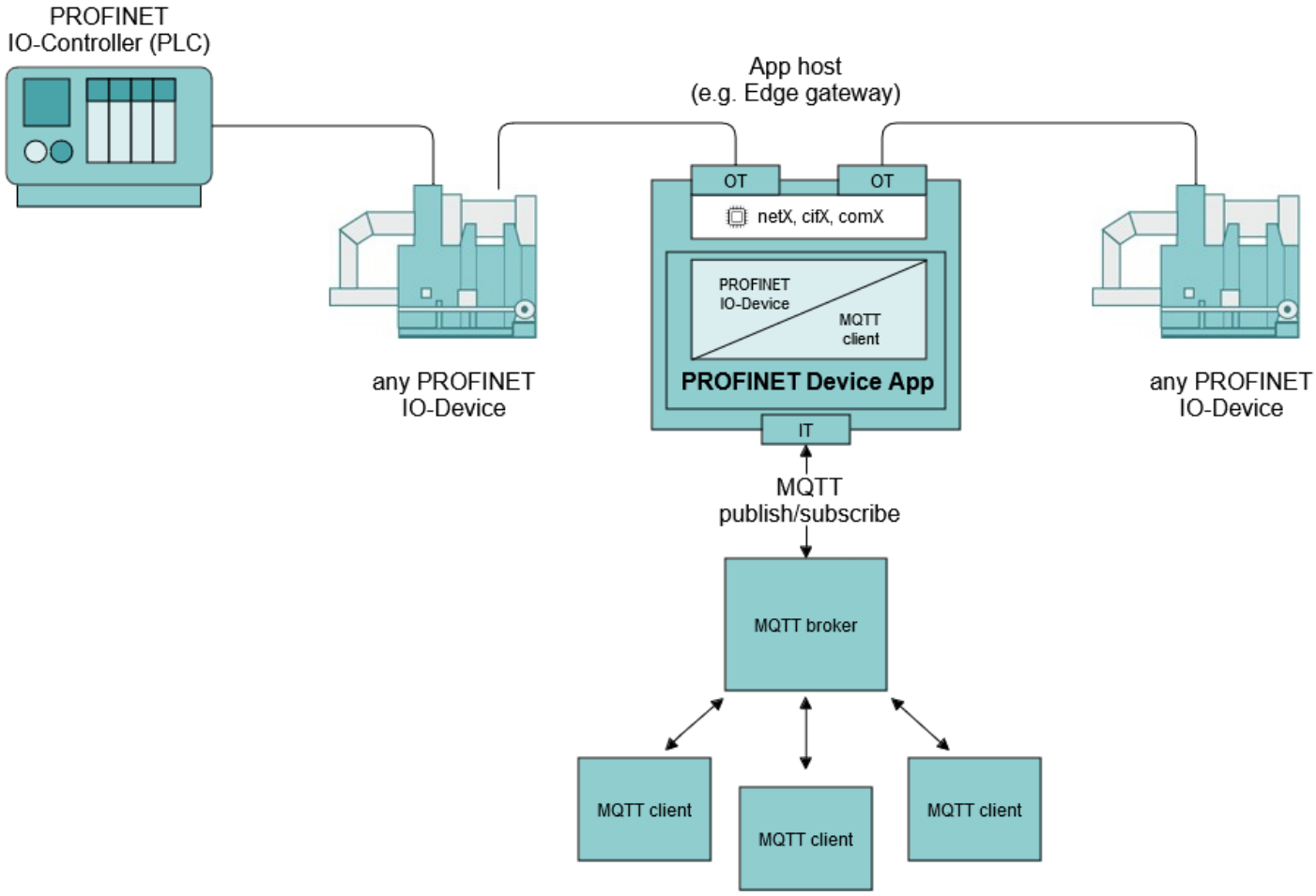

Figure 2. netFIELD App PROFINET Device Use case

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4 Start parameters of the container

Start-up parameters, compose files and instructions on how to deploy the container with container runtimes are provided in the Hilscher Knowledge base:

- Go to the netFIELD App PROFINET Device page
- On the netFIELD App PROFINET Device page, click on the link under **Current release**.
- On the current release page, you will find the start-up parameters and links to the compose files for the different uses cases under the **Release Notes**.
- Please use the compose files as a reference to adapt to your respective runtime environment.

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5 Quickstart

This list shows an overview of the steps to complete to deploy the netFIELD App PROFINET Device container.

1. Activate license
   a. Licensing and limitations
2. Deploy container
   a. Deploy from netFIELD Portal (requires subscription) or
   b. Deploy with the Start parameters of the container
3. Login to web GUI
   a. – On a device supporting netFIELD OS

      Login

   b. – Other OCI runtime

      Hilscher Knowledge Base:

      How do I expose Web UI's of netFIELD App containers in a secure way when running on hosts that are not supporting netFIELD OS (e.g.using nginx)?
4. Configure License server
5. Optional: Update GSDML device configuration to suit your requirements
6. Configure IO Configuration
7. Configure Publications
8. Configure Subscriptions
9. Optional: Reconfigure MQTT connection MQTT client settings
10. Connect to MQTT broker with a third party MQTT client or application (e.g. MQTT Explorer) to consume the sensor data.

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6 Configuration

6.1 Login

The netFIELD App PROFINET Device 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 support for 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 Device entry **(1)** in the navigation panel (side bar) of the Local Device Manager.

NOTE Note that it might take a few minutes after deployment before the netFIELD App PROFINET Device entry becomes visible in the navigation panel. You may also have to reload the web page in your browser by pressing F5 on your keyboard.

6.2 Start screen

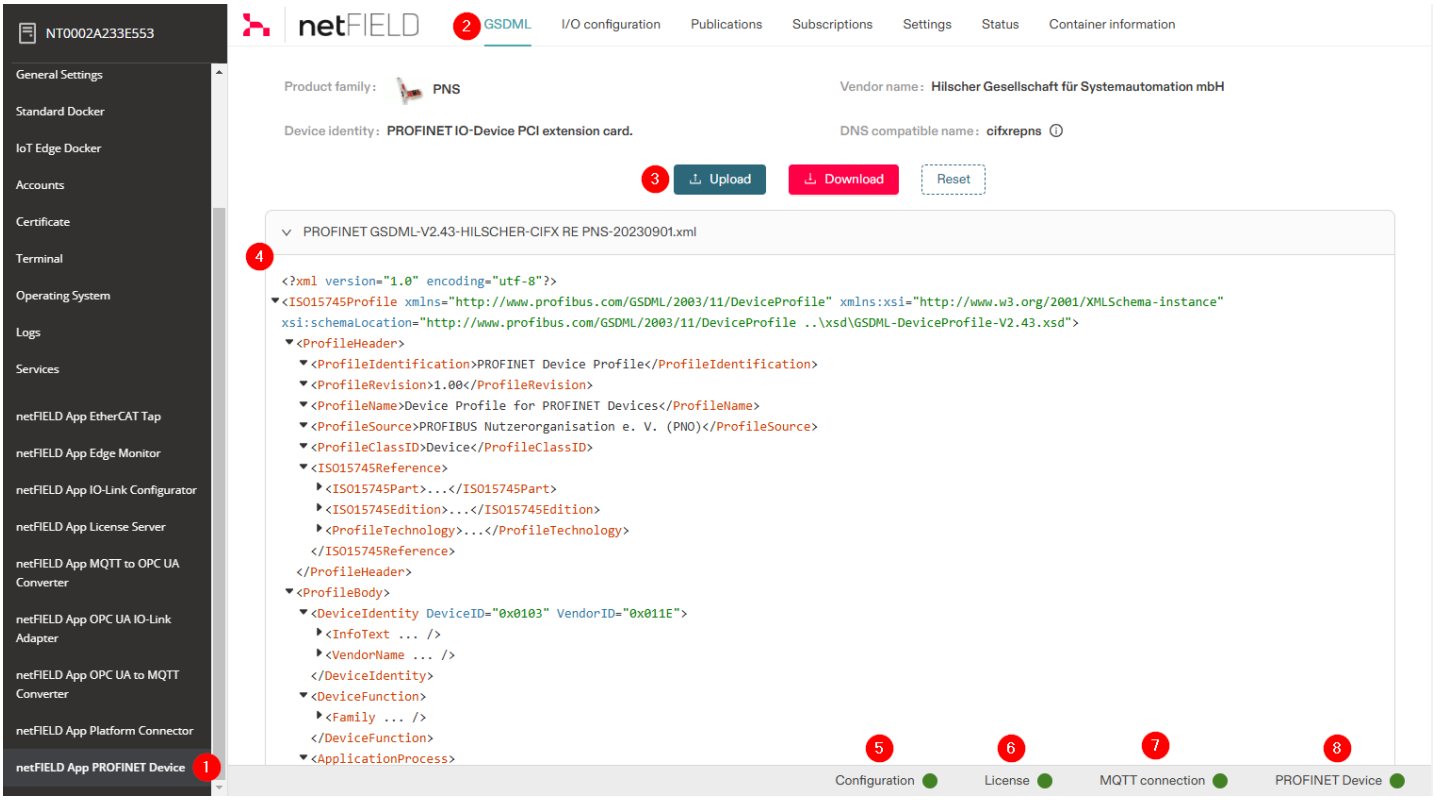

Figure 3. Application overview

You can navigate through the configuration options by selecting an item in the toolbar **(2)**. The main screen shows the controls **(3)** and overview for the GSDML description **(4)**.

The current status of the deployed configuration **(5)** is displayed in the status bar on the bottom. There you will also find information on the application license **(6)**, MQTT connection status **(7)**, and the connection to the PROFINET device **(8)** is displayed on the status bar on the bottom.

Error or confirmation messages will be displayed as pop-up modals above the PROFINET status in the bottom right corner.

NOTE **PROFINET Name of Station**

In the factory setting of the edge gateway the PROFINET device name (Name of station) is an empty string as prescribed by the PROFINET specification. You must assign the PROFINET device name with with a PROFINET controller's engineering tool over the PROFINET network using the DCP protocol.

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Item	Description
Upload	Upload a new GSDML file or archive containing product image and GSDML. The uploaded GSDML file must be based on the built-in default GSDML file: `PROFINET GSDML-V2.43-HILSCHER-CIFX RE PNS-20230901.xml`
Download	Downloads the current GSDML file including a product image as a ZIP archive. This GSDML file is used to configure the PROFINET IO-Controller.
Reset	Reset the current GSDML file to the built-in default.

Table 2. Controls on the Overview page

6.2.1 GSDML device configuration

For PROFINET, it is essential to configure a PROFINET controller and the corresponding device. The exchange data is defined in a device description file known as GSDML. This file must be uploaded to both the controller and the device. Since the app represents a PROFINET IO-Device on PROFINET, a GSDML file is provided along with the app by default. It can be downloaded to configure the PROFINET controller.

You can also download this GSDML file and customize it to fit your needs by modifying parameters such as the VendorID, DeviceID, or manufacturer information and upload it to the app again.

The data exchange modules are separately configured in the PROFINET controller. Make sure to configure the modules identically in the PROFINET controller and the app.

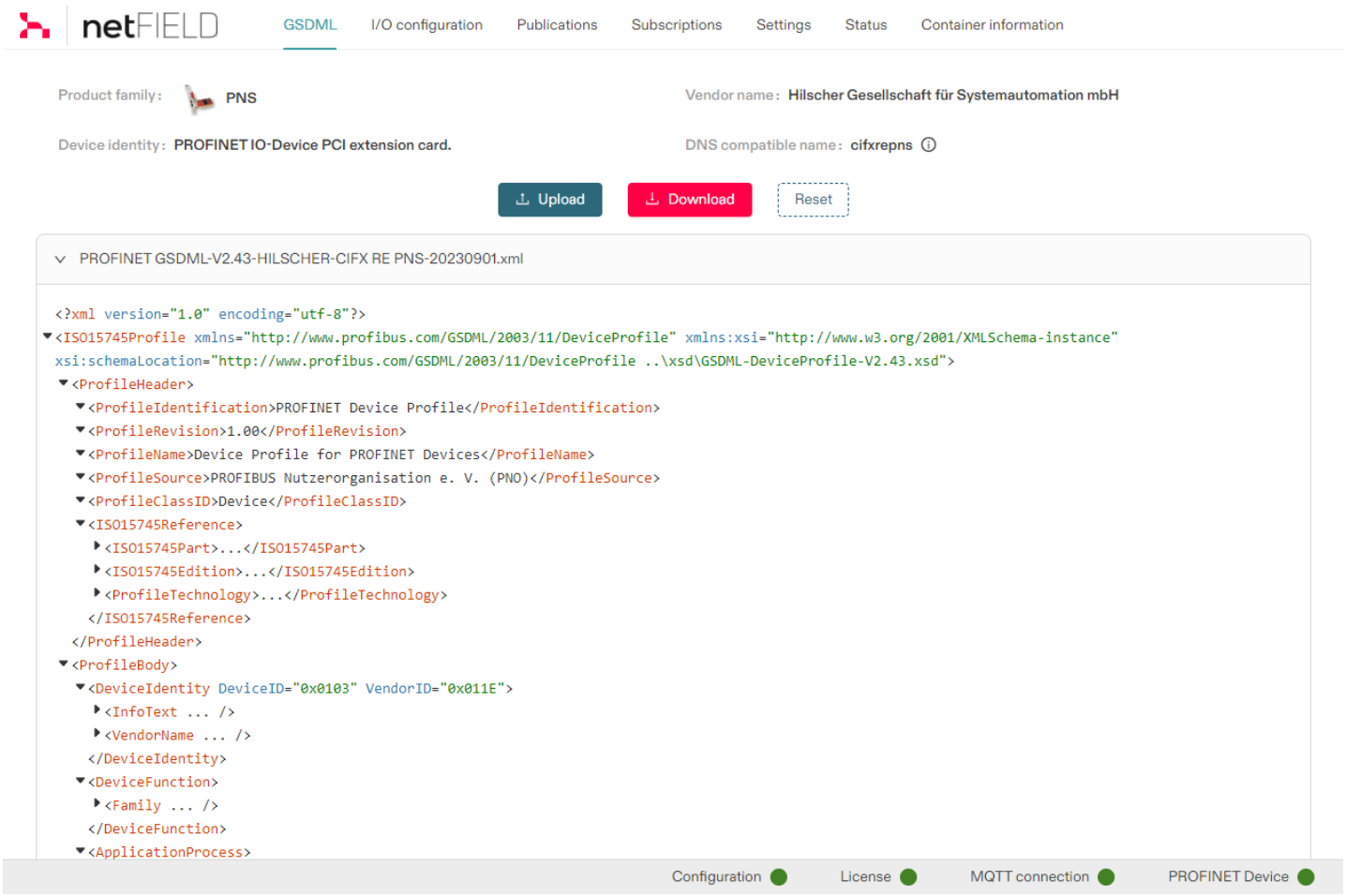

Figure 4. Application start view

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6.3 IO Configuration

In this tab you can add PROFINET modules and define the signal configuration. The configured modules are the basis for the signal definition. You can define as many signals as fit in the selected length of the selected modules.

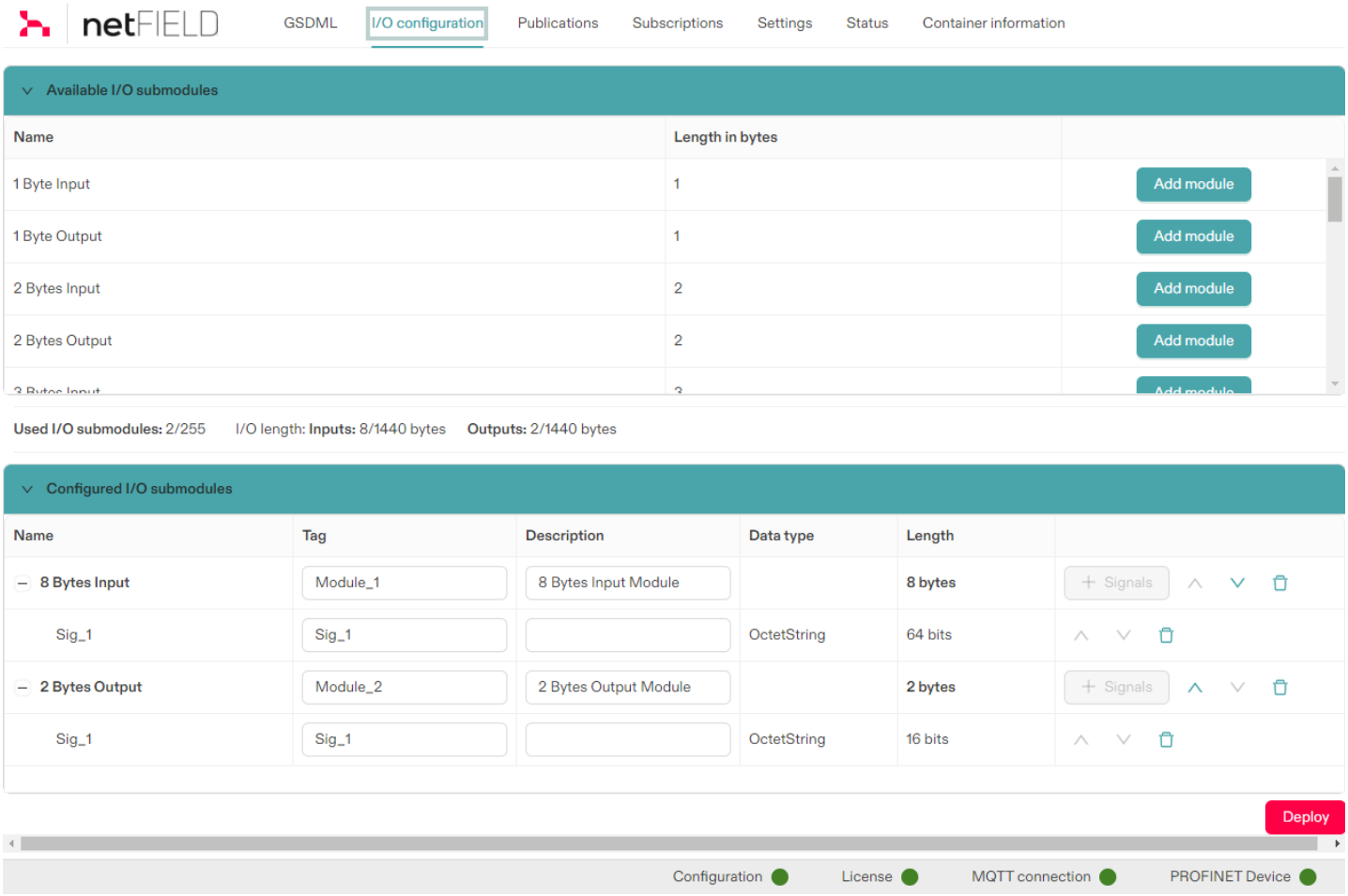

Figure 5. IO Configuration tab

Available I/O submodules

The app supports 1436 bytes of PROFINET input and output data for each direction that can be exchanged with a PROFINET controller.

You can pick up to 255 modules that define how the remaining 1436 bytes are distributed for input and output.

The possible data lengths of PROFINET modules are 1, 2, 3, 4, 8, 12, 16, 20, 32, 64, 128 and 256 bytes.

Deployment status

When the default configuration has been changed, the indicator "Configuration" in the status bar changes color. When there are undeployed changes, the indicator icon will be yellow. Once the configuration has been deployed, the indicator icon will change to green.

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6.3.1 Configuring signals procedure

The PROFINET modules come predefined with signals. If you wish to adjust the signals that are processed for each module, you must remove the existing signal definition and add your own.

1. Select an input or output module from the list and click **Add Module**.

   → The module is added to the **Configured I/O submodules** section.
2. Click ＋ to expand the module and show the list of available signals.
3. Click 🗑 to remove the current (predefined) signal definition.
4. Click ＋ Signals and select a signal size, data type and Tag name base from the popup menu.

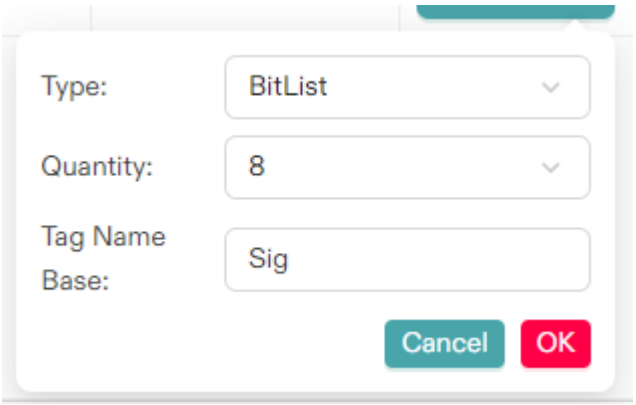

Figure 6. Add signal dialog

> **NOTE** For some data types the size is predefined (e.g. 8 bits for BitList). The dialog will adjust to allow adding only as many items as will fit in the module.

5. Define a unique Tag for each module and signal
   a. (Optional): Define descriptions for the modules and signals
6. Click **Deploy**

Tag considerations

The *Tag* is editable for each module and signal. The *Tag* is an essential part of the signal name in the MQTT topic. The strings representing *Tag* are therefore limited to:

- Upper-case letters (A-Z)
- Lower-case letters (a-z)
- Numbers (0-9)
- Underscore (maximum one underscore in a row)

6.3.2 Configured I/O submodules

The **Configured Modules** section contains the list of modules and their corresponding signals added to the configuration.

Column name	Description
Name	Shows the name of the module.
Tag	Editable short name required for the signal name. The signal name addresses the data.
Description	Editable description of the module
DataType	Type of data the configured signal is displaying
Length	Shows the module length in bytes.

Table 3. Contents of the "Configured Modules" section

Control	Description
＋ / －	Expand or collapse the signals list for the selected module.

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Control	Description
+ Signals	Add custom signal definition to the current module.
	Moves the marked item upward by one line.
	Moves the marked item downward by one line.
	Deletes the marked IO item (module or signal).
Deploy	Deploy the current configuration to the device.

Table 4. Controls of the "Configured Modules" section

IMPORTANT Changing the arrangement of signals, changes the PROFINET configuration. This has to be taken into account when configuring the PROFINET controller.

6.3.3 Data types for signals

Data type	Length (in Bits)	Value range	Description
Bit list	1	0 (false), 1 (true)	List of individual bits. The number of bits in a list must be a multiple of 8.
OctetString	8 * n		Character sequence
Real32	32	≈ -/+ 10^{38}	Floating point
Double	64	≈ -/+ 10^{308}	Floating point (Double precision)
Unsigned8	8	0 ... 255	Unsigned short integer
Unsigned16	16	0 ...65535	Unsigned integer / Word
Unsigned32	32	0 ... +2^{32} -1	Unsigned double integer
Unsigned64	64	0 ... +2^{64} -1	Unsigned integer (64 bit)
Signed8	8	-128 ... 127	Signed short integer
Signed16	16	-32768 ... 32767	Signed integer
Signed32	32	-2^{31} ... +2^{31} -1	Signed double integer
Signed64	64	-2^{63} ... +2^{63} -1	Signed integer (64 bit)

Table 5. Data types for signals

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6.4 Publication and subscription of signals

The published signals can be inspected in the Publications tab.

The configured "input" signals must be manually activated for subscription in the Subscriptions tab.

6.4.1 Publications

This tab contains the overview of all published signals.

> **NOTE** All configured "output" signals will automatically be published on each change and delivered to the MQTT broker "at most once" (MQTT QoS0).

Each module is assigned a numbered index. You can expand/collapse the configured modules by clicking on the + / – button. The configured signals are listed under each module. The table contains information about the respective module/signal.

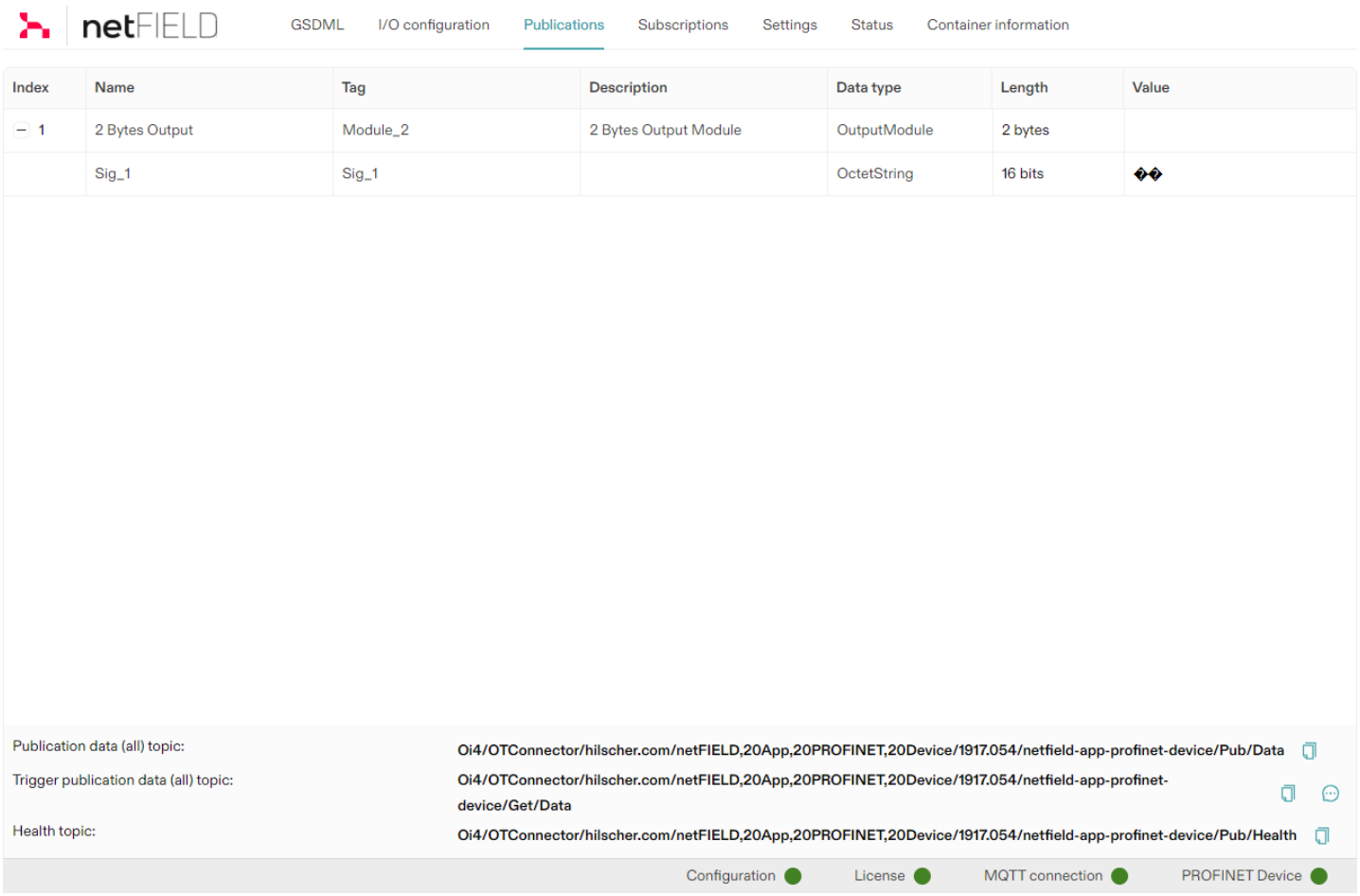

Figure 7. Publications tab

Element	Description
+ / –	Expand/Collapse the current module.
	Copy topic URL for the selected publication stream.

Table 6. Controls in the Publications tab

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Published topics

On the bottom of the page you will find the two main topics published by the application:

The `/Data` topic contains the messages with actual data of the signals.

The `/Health` topic contains messages with metadata about the health of the signals

The `/Get/Data` topic is used to request the current data of the signals. For this topic, you can click to copy a JSON example of the message pattern to the clipboard.

The respective module and signal data is published as sub-topics of these two main topic streams. You can click on to copy the URL into the clipboard.

Snippet 1. Example message for `/Get/Data` topic

```
{
  "MessageId": "1639693510000-OTConnector/hilscher.com/netFIELD,20App,20PROFINET,20Device/1917.054/netfield-app-profinet-device",
  "MessageType": "ua-data",
  "PublisherId": "OTConnector/hilscher.com/netFIELD,20App,20PROFINET,20Device/1917.054/netfield-app-profinet-device",
  "Messages": []
}
```

Column name	Description
Index	Numbered index of the configured modules.
Name	Shows the name of the module.
Tag	Editable short name required for the signal name. The signal name addresses the data.
Description	Editable description of the module.
DataType	Type of data the configured signal is displaying.
Length	Shows the module length in bytes.
Value	Shows the last transmitted value.

Table 7. Columns in the Publications overview

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6.4.2 Subscriptions

NOTE All subscribed input signals will be updated on PROFINET "onChange" triggered by a publication of the MQTT broker".

This tab contains the overview of all subscribed signals.

Each module is assigned a numbered index. You can expand/collapse the configured modules by clicking on the + / – button. The configured signals are listed under each module. The table contains information about the respective module/signal.

Click on to copy the topic for the selected module subscription to the clipboard. By clicking on you can download an example message.

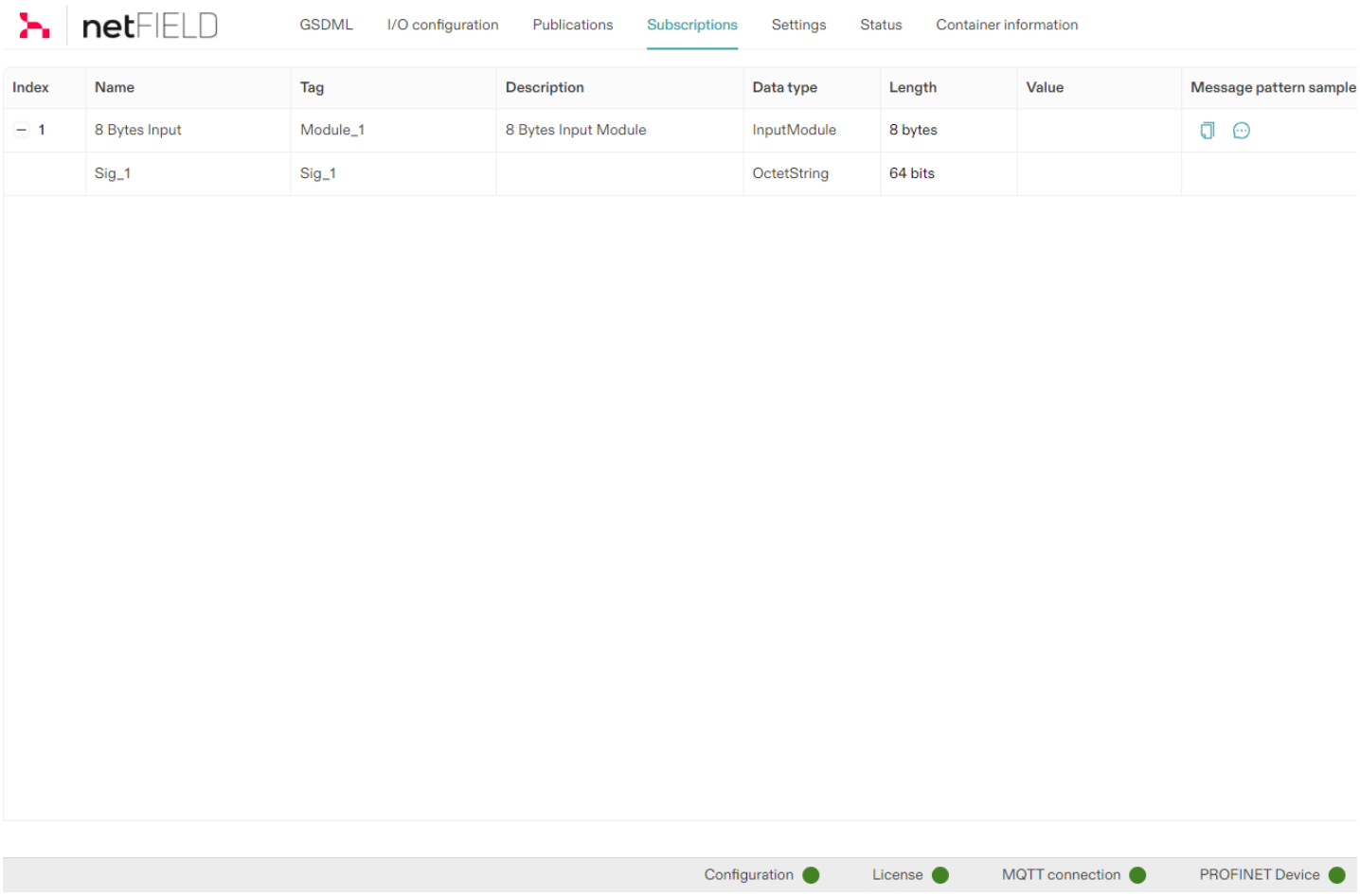

Figure 8. Subscriptions tab

Element	Description
+ / –	Expand/Collapse the current module.
	Copy topic URL for the current module.
	Copy example message data (JSON) for the current module topic.

Table 8. Controls in the Subscriptions tab

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Column name	Description
Index	Numbered index of the configured modules.
Name	Shows the name of the module.
Tag	Editable short name required for the signal name. The signal name addresses the data.
Description	Editable description of the module
DataType	Type of data the configured signal is displaying.
Length	Shows the module length in bytes.
Message pattern samples	Download a JSON example of the message pattern for the selected module.

Table 9. Columns in the Subscriptions overview

Snippet 2. Example message for `8 Bytes Input / OctetString`


```
{
  "MessageId": "1639693510000-OTConnector/hilscher.com/netFIELD,20App,20PROFINET,20Device/1917.054/netfield-app-profinet-device",
  "MessageType": "ua-data",
  "PublisherId": "OTConnector/hilscher.com/netFIELD,20App,20PROFINET,20Device/1917.054/netfield-app-profinet-device",
  "Messages": [
    {
      "DataSetWriterId": 93,
      "Filter": "Module_1",
      "Source": "hilscher.com/PROFINET,20IO-Device,20PCI,20extension,20card./1250.100/21218",
      "SequenceNumber": 3985,
      "Timestamp": "2021-12-16T22:25:10.000Z",
      "Payload": {
        "Sig_1": ""
      }
    }
  ]
}
```


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6.5 Settings

In the settings tab you will find two sub-tabs for configuring the connection to the MQTT broker connection and the license server.

6.5.1 MQTT client settings

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

If you want to use different settings for your PROFINET Device app – e.g. if you want to use a different broker than the preset local broker – you can toggle **Override current settings** to on ( ) and enter your new values in the configuration fields that are now displayed:

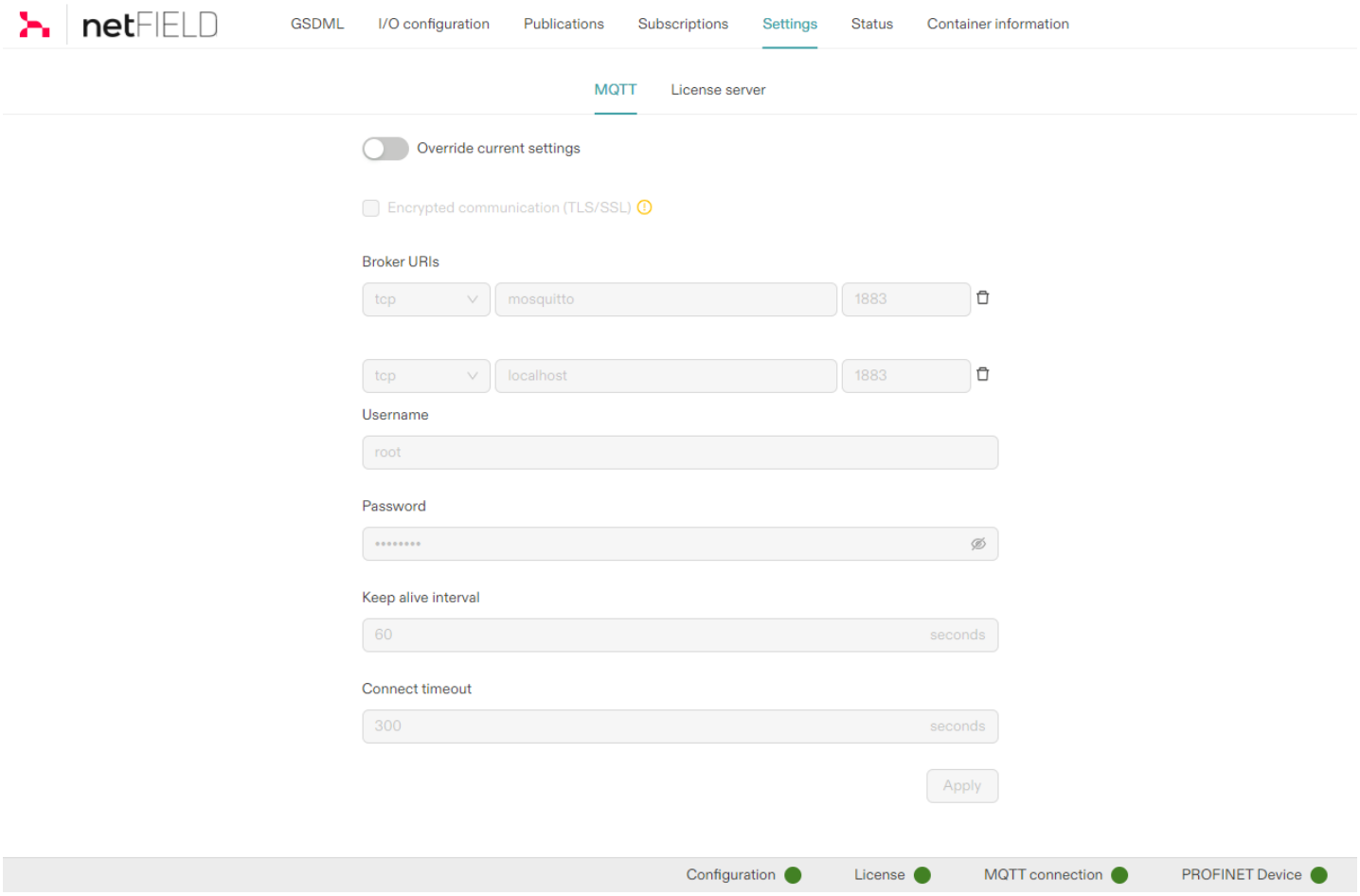

Figure 9. MQTT client settings tab

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

Table 10. MQTT client settings

a. Click the **Apply** to save your new MQTT client settings.

6.5.2 License server

In this view you can configure the list of license servers.

Enter the IP address(es) of the license servers and click **Add**.

To remove a server, click in the respective row. Clicking the remove icon in the header row, removes *all* servers in the list.

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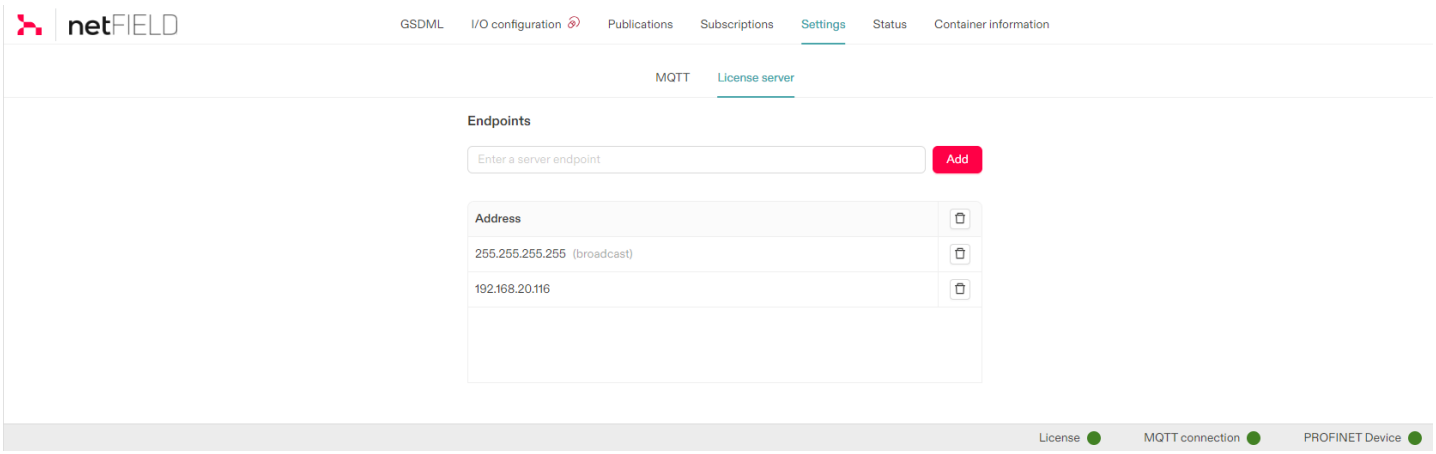

Figure 10. License server settings tab

www.hilscher.com
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7 Status tab

In this tab you can find more information regarding the status of the container.

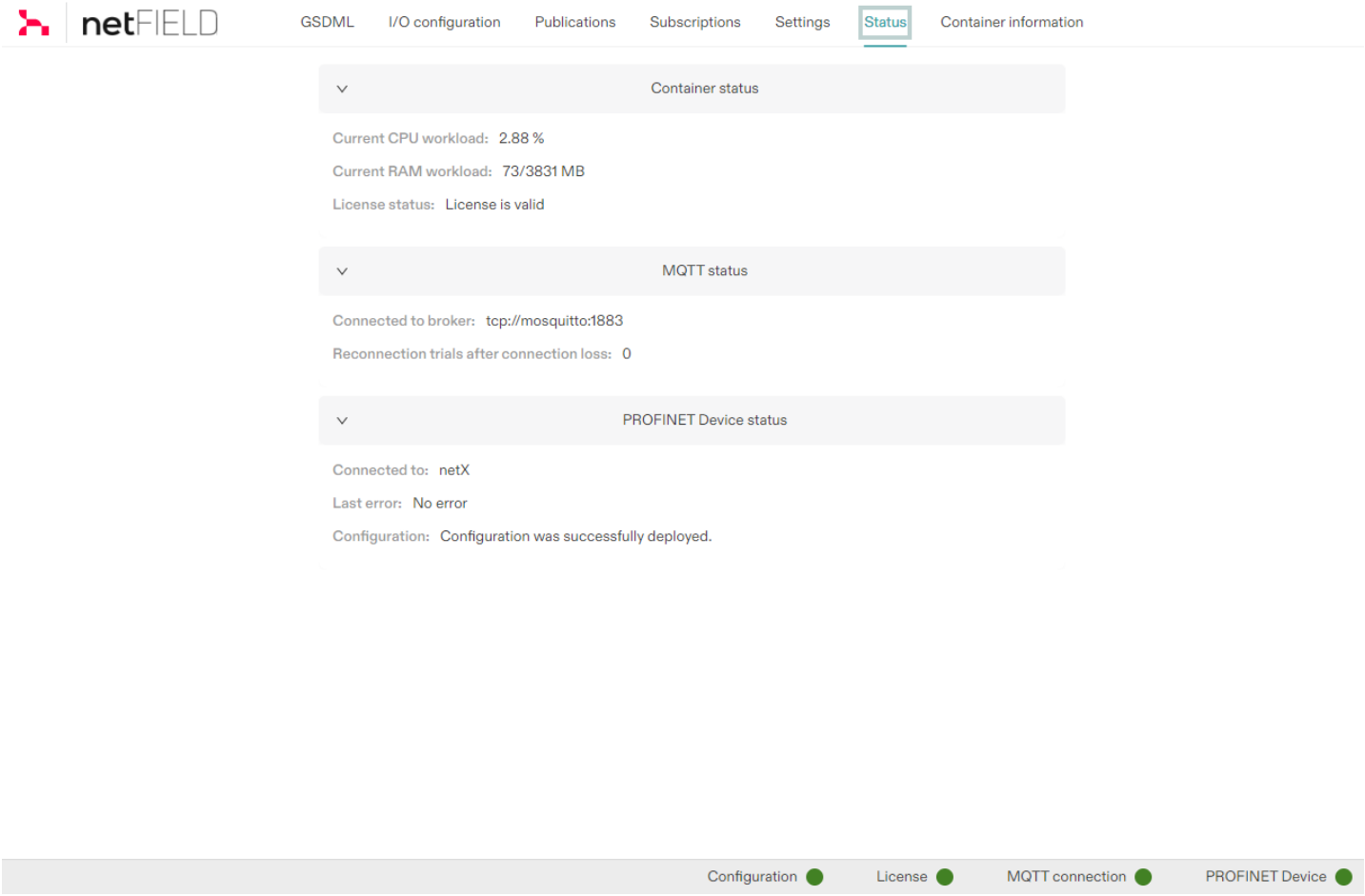

Figure 11. Status tab

Field	Description
Container status	Displays CPU and RAM usage on the host and the license status.
MQTT status	Displays the status of the MQTT connection and the number of retried connections.
PROFINET Device status	Shows the type of connected device, the last error and the status of the deployed configuration.

Table 11. Container status information

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8 Container information

This tab displays information about the application container.

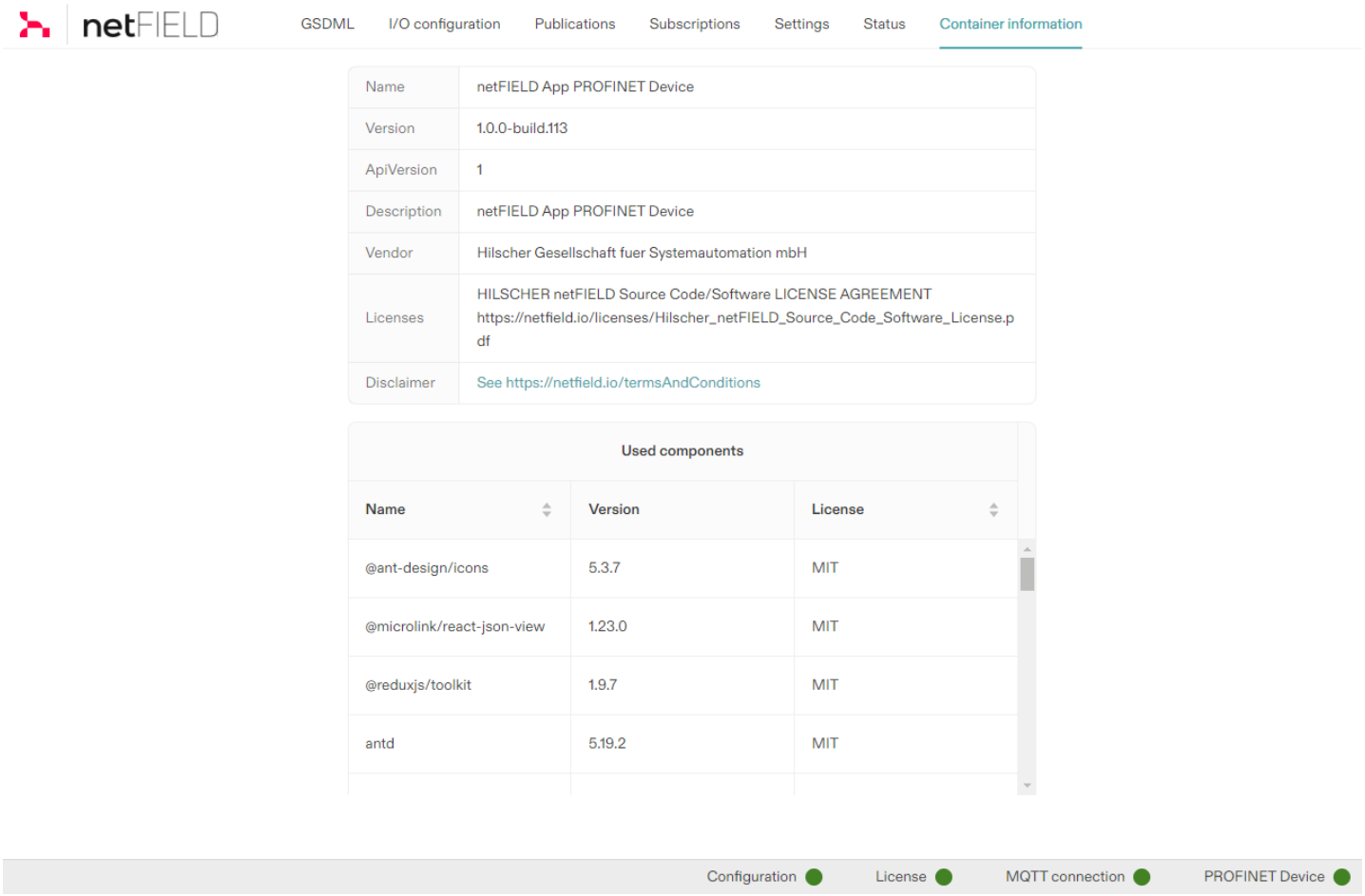

Figure 12. Container information tab

Item	Description
Name	The name of the app: netFIELD App PROFINET Device.
Version	The current version number of the app.
ApiVersion	The current version number of the api used within the app.
Description	A text describing the function and intended use of the app.
Vendor	Name of the container vendor.
Licenses	The license which is applicable for the use of this app.
Disclaimer	Web address where to find the valid disclaimer and legal information.
Used Components	This list specifies the 3rd party components used by the application.

Table 12. Container information

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9 Technical data

Category	Parameter	Value
Product	Product name	NFA-PND-OTP
	Part number	1917.054
	Description	netFIELD App PROFINET Device
	Software type	Container As A Single Service (CAASS)
	Repository	https://hub.docker.com/r/hilscherautomation/netfield-app-profinet-device
	Accounting model	One-time payment for a license
	License delivery	Via e-mail as a hyperlink
	Updates	Included for free within 1 year after license activation
	Limitation	App runs without license 30 minutes fully featured and then stops
Hardware requirements	Processor architecture	AMD64, ARM64
	Container size	400 MByte, decompressed
	Memory requirements	Minimum 200 MByte
	Data interface	2x Industrial Ethernet ports (implemented via netX, cifX, comX)
Software requirements	Operating system	Linux
	Container runtime environment	Required, e.g. Docker
	Data interface	Any MQTT broker, e.g. Mosquitto (accessible within the container network context)
Runtime properties	Primary communication protocol	PROFINET IO (PROFINET IO-Device, RT mode)
	Secondary communication protocol	MQTT (as client)
	Process data	PROFINET: 1436 bytes input data / 1436 bytes output data (less the bytes used for IOPS and IOCS)
	MQTT topics	Payload: JSON
	Data throughput	100 ms (internal conversion cycle time)
Licensing	Container protection	CodeMeter Licensing Technology (a product of Wibu-Systems)
	License type	Floating license (may be used by a single application at a time)
	Product activation	License key
	Network license server	Required for license storage and retrieval (Windows or container)

Table 13. Technical data NFA-PND-OTP

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10 Appendix

10.1 CodeMeter License Technology

CodeMeter from WiBu-Systems is a protection, licensing, and security ecosystem that gives software publishers, vendors as well as intelligent device manufacturers a complete arsenal of tools and services to countermeasure cyber threats of their intellectual property.

10.1.1 CodeMeter and Hilscher

Protecting software

As the licensor of software, we utilize **CodeMeter** technology primarily to protect selected software from reverse engineering.

Additionally, we use **CodeMeter** to prevent unauthorized software reproduction and to enable specific software features based on licensing authorization.

For this reason, **CodeMeter**-protected software conducts a license-based verification process during its startup phase

Dealing licenses

A license (also called ticket) enabling a specific software function is generated by us individually based on the customer's order.

We provide the license file to you as a customer via a hyperlink for download.

To activate the license, the you have to install the license file on a license server you manage.

Hosting licenses

For proper licensing it is required to operate a license server to host activated license files.

We offer a license server as a container compatible with embedded devices here https://hub.docker.com/r/hilscherautomation/netfield-app-license-server

Additionally, server installers for various OS platforms are available from WiBu-Systems here https://www.wibu.com/us/support/user/downloads-user-software.html.

Checking license(s)

The IP address (concrete IP address of broadcast address for auto-detection) of the license server must be configured in the software that is protected by CodeMeter once.

During the startup phase, the software will check for a valid license initially and then continue to do so at regular intervals during operation.

Based on the result of the license check, the software will determine how to proceed (running fully featured/running limited).

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Appendix A: Content listing

10.A.1 List of tables

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Appendix B: Legal Notes

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

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

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