

## Webinar

# From PROFINET to the Cloud

Presented by  
Bastian Ziegler

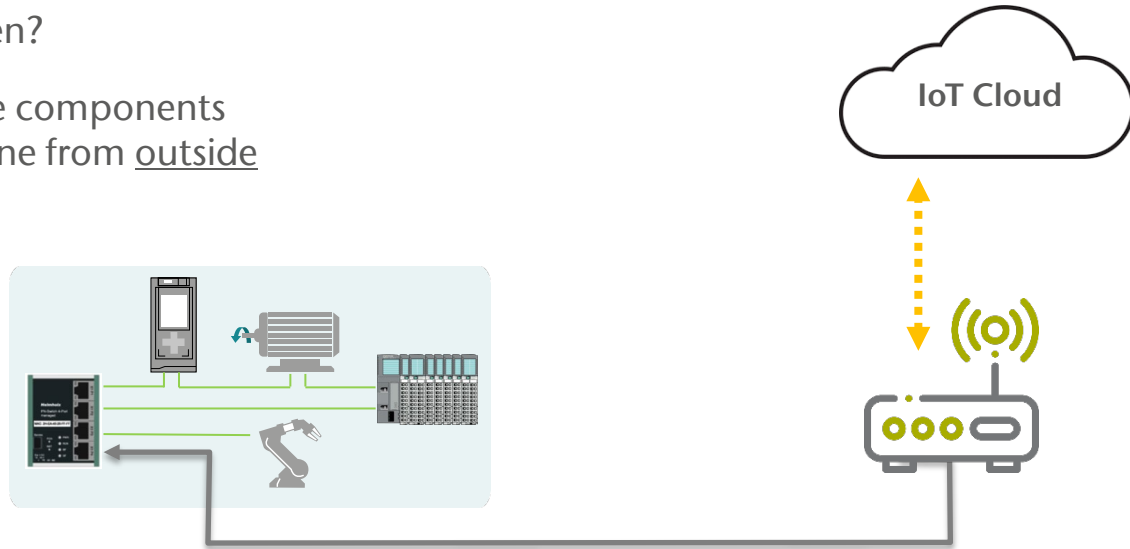
Explained by  
Carsten Bokholt



# CLOUD MACHINE DATA ACCESS

## Challenge

- External access to the machine
- Who can access which data?
- Which data can be written?
- Edge Gateways are active components with access to the machine from outside

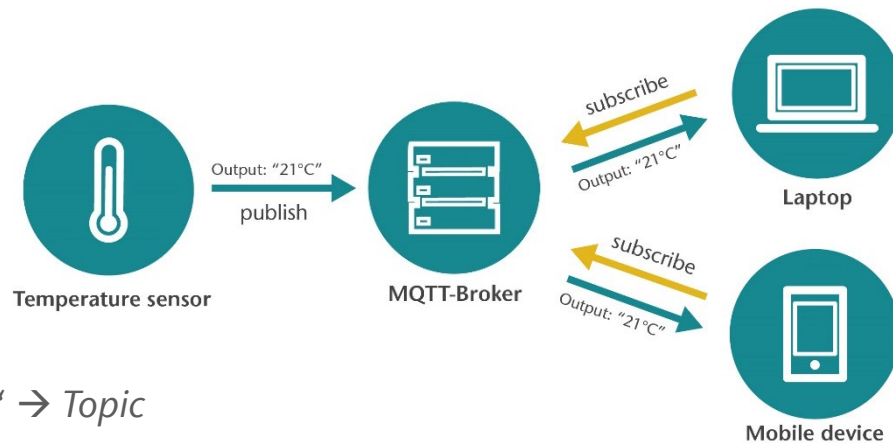


# PN/MQTT COUPLER

## MQTT Protocol



- Message Queue Telemetry Transport (IBM)
- OASIS Standard
- Publisher = Send data
- Broker collects and distributes data
- Subscriber = Receives/subscribes to data
- Data identification: “Livingroom/Light/Switch” → *Topic*
- Data presentation can be simple (just the value) or structured (JSON formatted)
- Encryption (SSL) and authentication possible

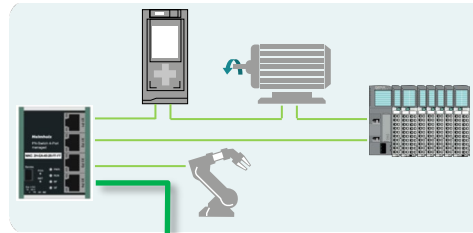


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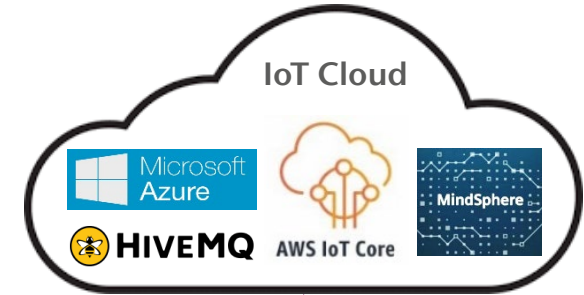
## Application

- Totally separate networks
- Only I/O data exchange
- MQTT Publish and Subscribe
- Easy configuration via GSDML
- Machine developer decides which data is allowed to be exchanged!

Machine with PROFINET



PROFINET®



MQTT

Local (on premise)



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## Device concept

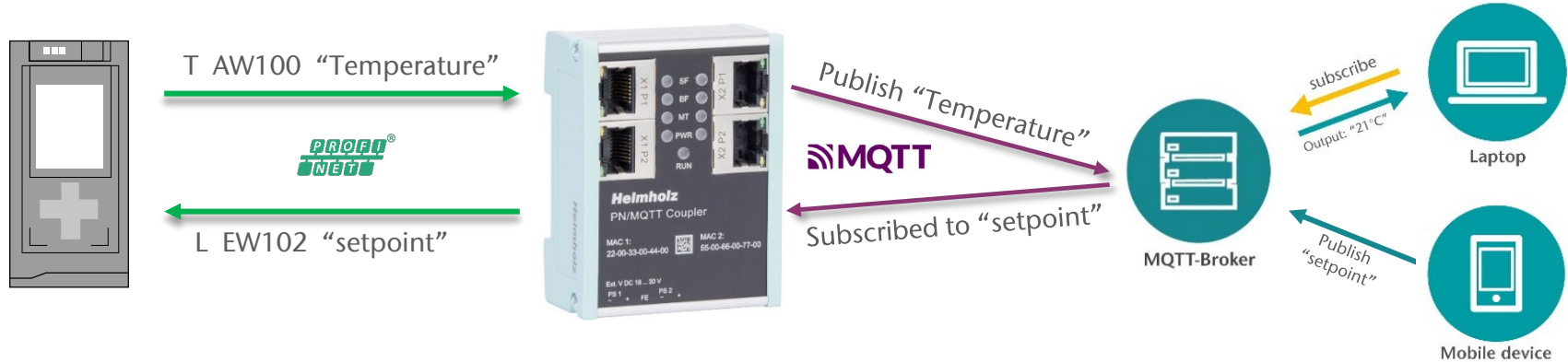
- Galvanic isolation of both machines
- 2 Ethernet ports per network side (switched)
- Redundant power supply
- Very compact design
- Firmware update via web interface
- PROFINET Conformance Class B



| PROFINET-Device (X1) | Internal Memory | MQTT Client (X2) |
|----------------------|-----------------|------------------|
| Outputs              | →               | Publish          |
| Inputs               | ←               | Subscribe        |

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## Concept of data exchange

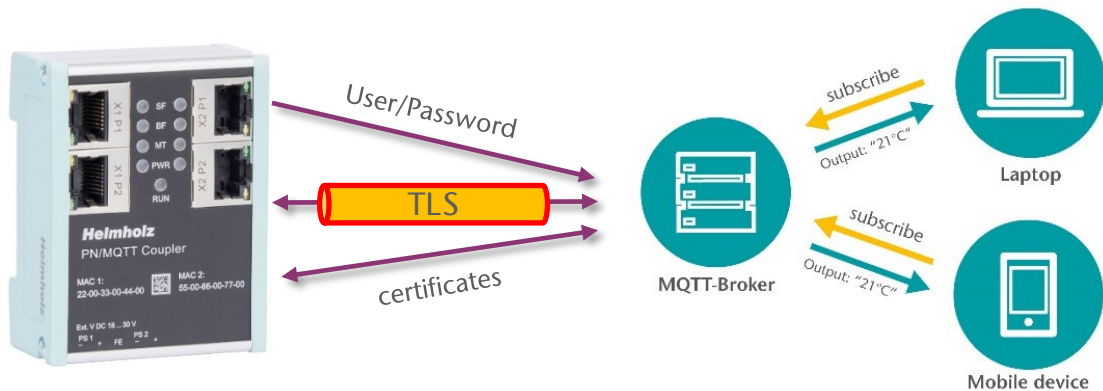


- Bits, Bytes, Words or Double Words can be transmitted
- Values are transmitted via MQTT in humanly readable form → „-1234“, „0xFCBE“ or “12.2345”
- Values will be automatically sent upon change (Outputs → Publish)
- upon receipt the new value is permanently available as input (Subscribe → Inputs)

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Content and transmission security

- Secure data exchange with broker:
  - User & Password when setting up connection → Rights management
  - TLS Encryption for transmission (TLS V1.2)
  - Authentication using certificates
  - All optional!



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## Data transmission concept – Configuration example

| Slot | Module                              | IO              | Type                  | Direction   | Topic name<br>(Example) | Value<br>(Example) |
|------|-------------------------------------|-----------------|-----------------------|-------------|-------------------------|--------------------|
| 1    | Output Byte (1 Byte, hex.)          | 1 Byte Output   | Byte                  | Publish →   | “Output AB10”           | “0x12”             |
| 2    | Output Unsigned Int (2 Bytes, dec.) | 2 Bytes Outputs | Unsigned Integer      | Publish →   | “RPM”                   | “65534”            |
| 3    | Output Signed dInt (4 Bytes, dec.)  | 4 Bytes Outputs | Signed double Integer | Publish →   | “Output AD14”           | “-12345678”        |
| 4    | Input Word (2 Bytes, hex.)          | 2 Bytes Inputs  | Word                  | ← Subscribe | „Control Word“          | „0xFFEE“           |
| 5    | Input Unsigned sInt (1 Bytes, dec.) | 1 Byte Input    | Unsigned short Int    | ← Subscribe | „setpoint“              | „255“              |
| 6    | Input Double Word ( 4 Byte, hex.)   | 4 Bytes Inputs  | Double Word           | ← Subscribe | „Configuration“         | „0x11223344“       |
| 7    | Output Signed Int (2 Byte, dec.)    | 2 Bytes Outputs | Signed Integer        | Publish →   | „Temperature“           | „25“               |
| ...  |                                     |                 |                       |             |                         |                    |

- The module types can be mixed, order is irrelevant
- Up to 100 slots configurable
- Up to 1024 bytes IO exchange

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## Data transmission concept – Configuration example

The screenshot displays the configuration interface for a PN/MQTT Coupler. The main window is titled "PN-MQTT-Coupler-Test" and shows the "Device overview" table. A red arrow points from the "temperature" module in the table to its configuration in the "Properties" pane.

| Module             | Rack | Slot | I address | Q address | Type                                | Article no.   |
|--------------------|------|------|-----------|-----------|-------------------------------------|---------------|
| PNMQTTcoupler_1    | 0    | 0    | 0...3     | 2         | PN/MQTT Coupler                     | 700-162-3MQ02 |
| PN-IO              | 0    | 0 X1 |           |           | PNMQTTcoupler                       |               |
| Output QB10        | 0    | 1    |           | 10        | Output Byte (1 Byte, hex.)          |               |
| speed              | 0    | 2    |           | 12...13   | Output Unsigned Int (2 Bytes, dec.) |               |
| Output QD14        | 0    | 3    |           | 14...17   | Output Signed dint (4 Bytes, dec.)  |               |
| control word       | 0    | 4    | 20...22   | 20        | Input Word (2 Bytes, hex.)          |               |
| set point          | 0    | 5    | 23...24   | 23        | Input Unsigned sint (1 Byte, dec.)  |               |
| configuration word | 0    | 6    | 25...29   | 25        | Input Double Word (4 Bytes, hex.)   |               |
| temperature        | 0    | 7    |           | 18...19   | Output Signed Int (2 Bytes, dec.)   |               |
|                    | 0    | 8    |           |           |                                     |               |
|                    | 0    | 9    |           |           |                                     |               |
|                    | 0    | 10   |           |           |                                     |               |

The "Properties" pane for the "temperature" module shows the following configuration:

- Module parameters
  - Parameter
    - Topic name: temperature
    - Quality of Service (QoS): transmission without acknowledge (0)
    - ☐ Retain

The "Hardware catalog" pane on the right shows the "Catalog" with various input and output modules. The "Output / Publish" section is expanded, and "Output Signed Int (2 Bytes, dec.)" is selected, which corresponds to the "temperature" module in the table.

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## Data transmission concept – Configuration example

- MQTT IP address: „Static IP“ / „DHCP“ / „Setting via website“
- Enable webpage

**Module parameters**

---

**Settings**

MQTT IP-address mode (X2): Static IP ▼

Static IP address: 192.168.128.82

Static IP subnet mask: 255.255.0.0

Static IP gateway: 192.168.2.250

Hostname mode: From PROFINET configuration ▼

DHCP hostname: PNMQTtcoupler

Webpage: on both network sides active ▼

☐ Diagnostic at PS1 failure

☐ Diagnostic at PS2 failure

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Configure the Broker connection via website

PN/MQTT  
COUPLER

Overview

MQTT-

Module status

System ▾

Helmholz<sup>®</sup>

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Overview

PN Configuration X1 (left)

MQTT Configuration X2 (right)

IP Settings

MQTT Client Settings

Advanced MQTT Settings

MQTT Encryption

Export/Import Configuration

Device name

pnmqttcoupler

Operating mode

Connected

LEDs

SF: BF: MT: PWR:

MAC address

24:ea:40:1b:00:20

IP address

172.17.0.82

Port 1 status

Link up, 100 MB/FD

Port 2 status

Link down, -/-

MQTT ClientID

PNMQTTCoupler

Operating mode

Connected to 192.168.128.42

LEDs

SF: BF: MT: PWR:

MAC address

24:ea:40:1b:00:23

IP address

192.168.128.82

Port 1 status

Link up, 100 MB/FD

Port 2 status

Link down, -/-

# PN/MQTT COUPLER

## MQTT Broker solutions

- Local Broker: Mosquitto
- Cloud Broker: HiveMQ
- IoT Cloud solutions using MQTT:
  - Amazon IoT Core
  - Microsoft Azure IoT Hub
  - IBM Watson IoT
  - Siemens Mindsphere
  - Google IoT
  - SAP IoT



# PN/MQTT COUPLER

Sample configuration Amazon IoT Core (AWS) connection

- Amazon IoT „Thing“ → the digital twin of the device

### MQTT Client Settings

|                            |                                                  |
|----------------------------|--------------------------------------------------|
| MQTT version               | 3.1.1                                            |
| ClientID                   | PNMQTTcoupler                                    |
| Prefix topic with ClientID | <input type="checkbox"/>                         |
| Username                   | Username                                         |
| Password                   | Password                                         |
| Broker address             | a3b8mq51kznrk-ats.iot.eu-central-1.amazonaws.com |
| Broker MQTT port           | 8883                                             |
| Keep alive [Seconds]       | 60                                               |

### MQTT Encryption Settings

Transport Layer Security (TLS) Encryption + Broker & Client authentication

Verify broker certificate (SNTP must be active) ☒

### TLS Certificates and Key for MQTT

Please upload TLS certificates and key for MQTT.

|                                       |                                                     |
|---------------------------------------|-----------------------------------------------------|
| <input type="button" value="Browse"/> | CA File (AmazonRootCA1.pem)                         |
| <input type="button" value="Browse"/> | Client Certificate (854435b24d-certificate.pem.crt) |
| <input type="button" value="Browse"/> | Client Key (854435b24d-private.pem.key)             |
| <input type="button" value="Submit"/> |                                                     |

- Step-by-step instructions in the PN/MQTT Coupler manual

# PN/MQTT COUPLER

## Sample configuration Amazon IoT Core (AWS) connection

AWS IoT

Monitor

Activity

Onboard

Manage

Things

Types

Thing groups

Billing groups

Jobs

Tunnels

Greengrass

Secure

Defend

Act

Rules

Destinations

Test

Software

Settings

Learn

AWS IoT > MQTT test client

MQTT test client

You can use the MQTT test client to monitor the MQTT messages being passed in your AWS account. Devices publish MQTT messages that are identified by topics to communicate their state to AWS IoT. AWS IoT also publishes MQTT messages to inform devices and apps of changes and events. You can subscribe to MQTT message topics and publish MQTT messages to topics by using the MQTT test client.

Subscribe to a topic

Publish to a topic

Topic name

The topic name identifies the message. The message payload will be published to this topic with a Quality of Service (QoS) of 0.

Q Setpoint

Message payload

123

Additional configuration

Publish

Subscriptions

Temperature

Cycle counter

Temperature

▼ Temperature

123

Pause

Clear

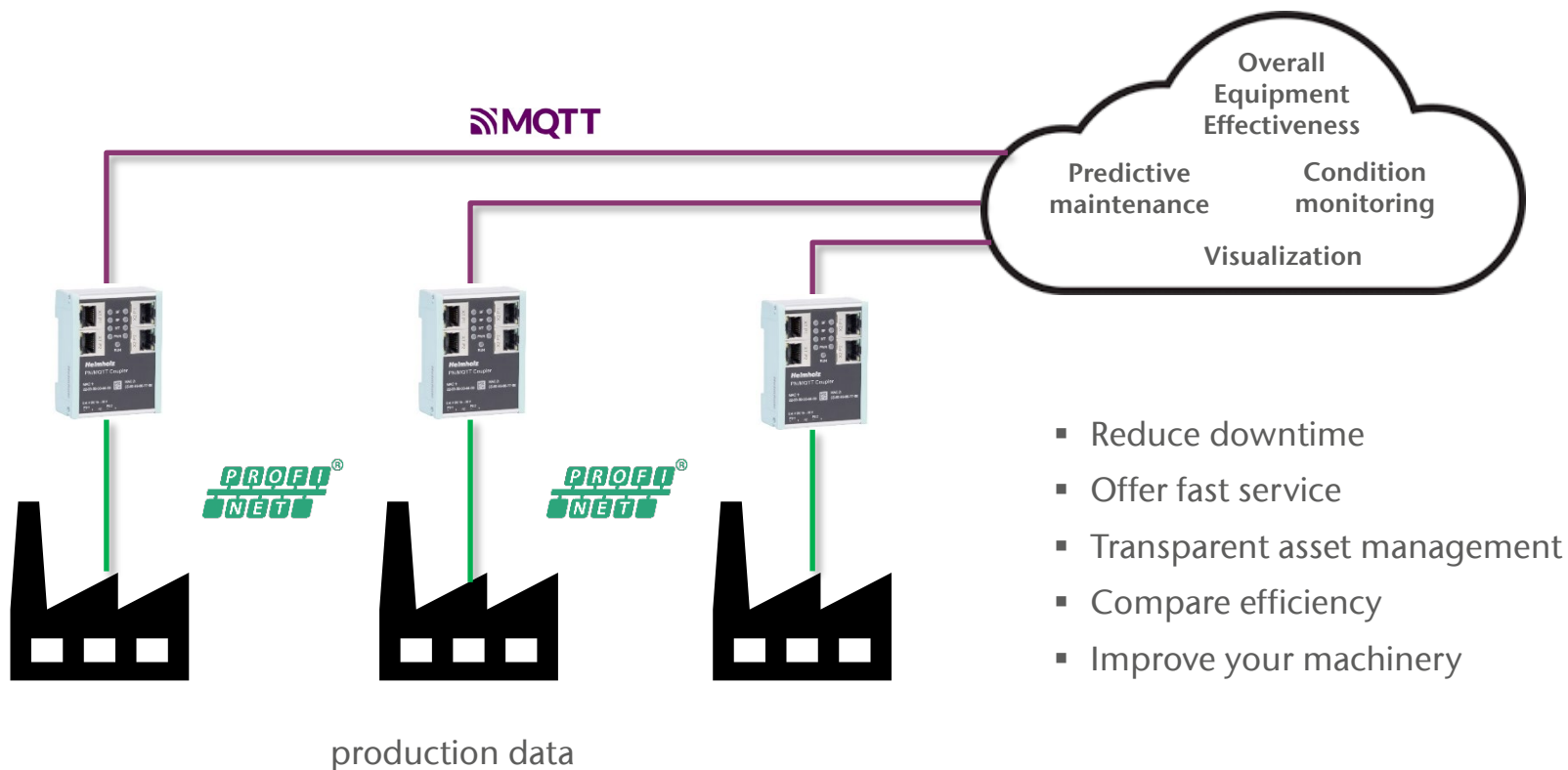
Export

Edit

April 12, 2021, 15:35:26 (UTC+0200)

# PN/MQTT COUPLER

IoT communication use-cases



# PN COUPLER

## Product overview

- PN/PN Coupler
- PN/DP Coupler



- PN/ModbusTCP Coupler
- PN/EtherNetIP Coupler
- PN/EtherCAT (in development)



EtherNet/IP™



# PN COUPLER

Still questions?

- Just ask...
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