

# OPC UA og MQTT implementeret i TIA-portalen



Hvad er mulighederne med de to standarder?



# Dagens værter

Jesper Kristiansen, Security Specialist  
Morten Kromann, Security Specialist



# Agenda

Hvordan kommunikerer vi i dag

MQTT - teknisk introduktion

OPC UA - teknisk introduktion

Workflow - MQTT

Workflow - OPC UA

Fremtiden

# Agenda

**Hvordan kommunikerer vi i dag**

MQTT - teknisk introduktion

OPC UA - teknisk introduktion

Workflow - MQTT

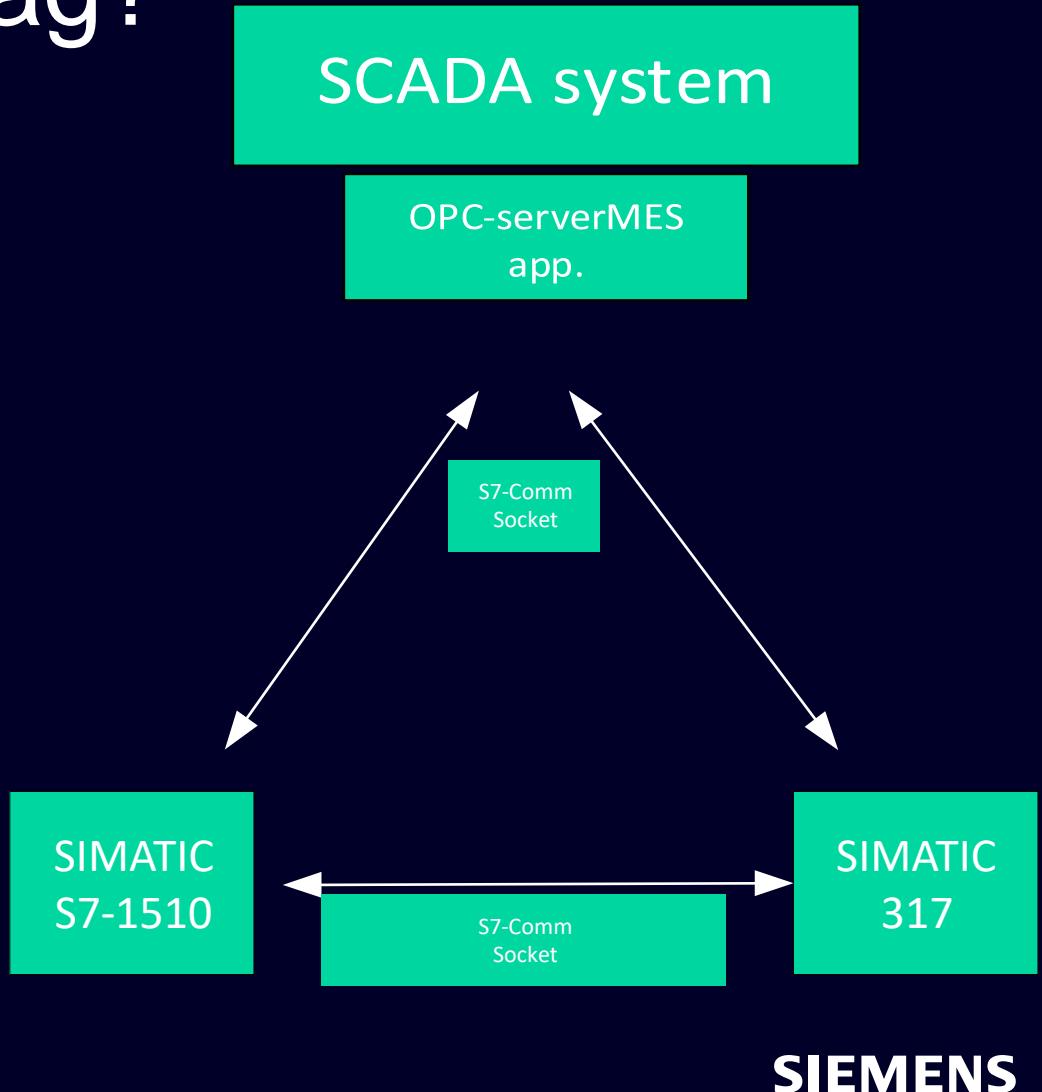
Workflow - OPC UA

Fremtiden

# Hvordan kommunikerer vi i dag?

Traditionelt setup:

- SCADA ↔ PLC er pollet kommunikation
- MES ↔ PLC er eventbaseret
- PLC ↔ PLC er cyklisk eller eventbaseret



# Agenda

Hvordan kommunikerer vi i dag

**MQTT - teknisk introduktion**

OPC UA - teknisk introduktion

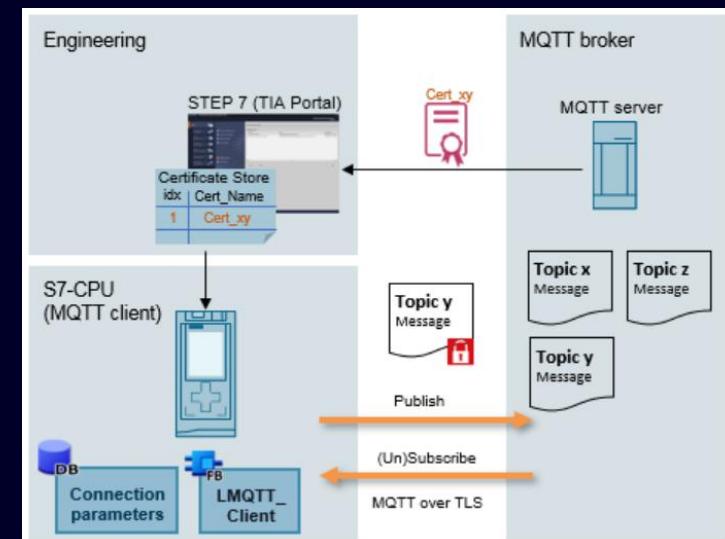
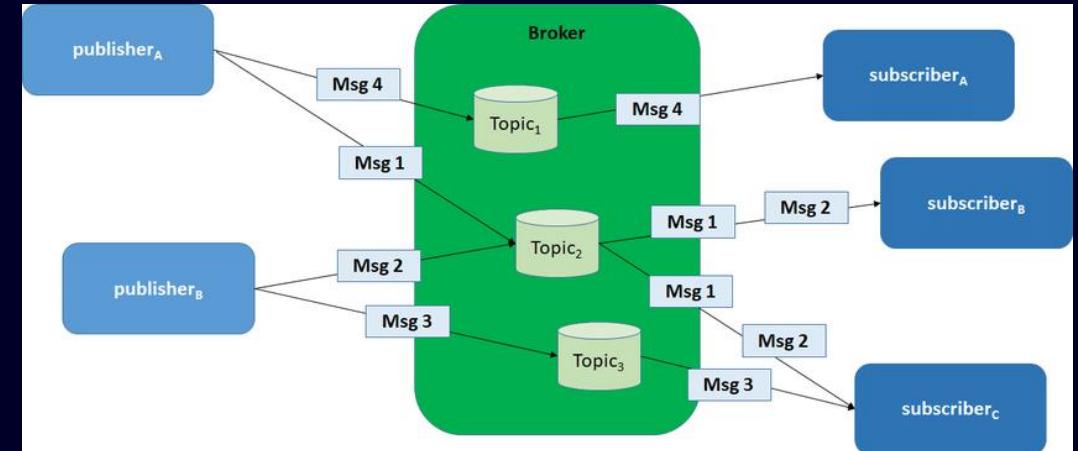
Workflow - MQTT

Workflow - OPC UA

Fremtiden

# MQTT - teknisk introduction Architecture

- Dekoblet kommunikation fra 1 til mange
- Publisher/Subscriber and Broker
- Topic's and Message's

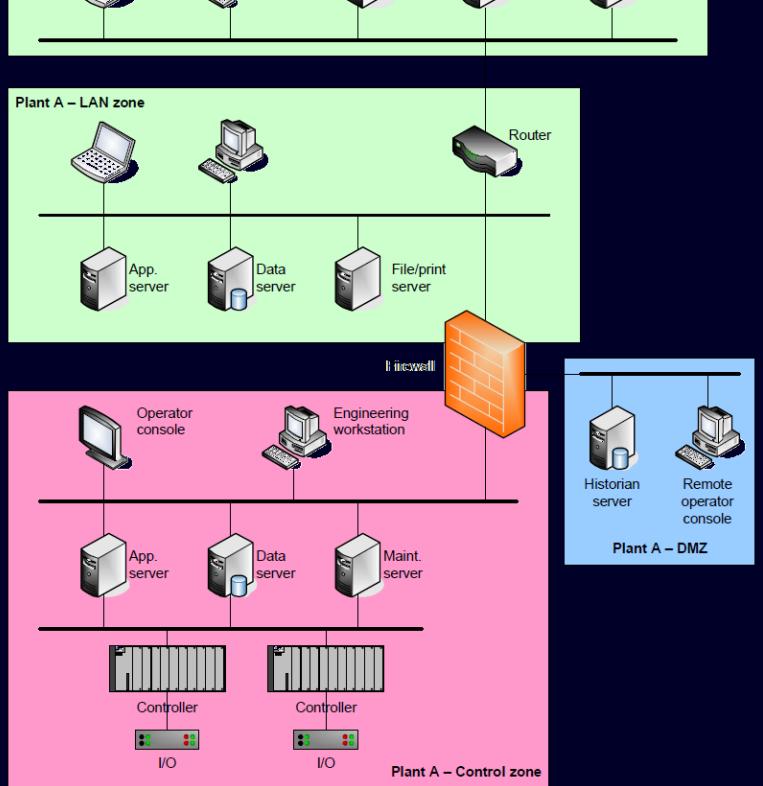


SIEMENS

# MQTT - teknisk introduction

## IEC62443 Security

- Broker i DMZ, hvis man vil lave OT/IT-kommunikation
- Mulighed for TLS transport kryptering
- Brugernavn, password, topic og beskyttelse



# MQTT - teknisk introduction

## Cool Stuff



### Last will...

- The broker detects an I/O error or network failure
- The client fails to communicate within the defined Keep Alive period
- The client does not send a DISCONNECT packet before it closes the network connection
- The broker closes the network connection because of a protocol error

# Agenda

Hvordan kommunikerer vi i dag

MQTT - teknisk introduktion

**OPC UA - teknisk introduktion**

Workflow - MQTT

Workflow - OPC UA

Fremtiden

# OPC UA - teknisk introduction

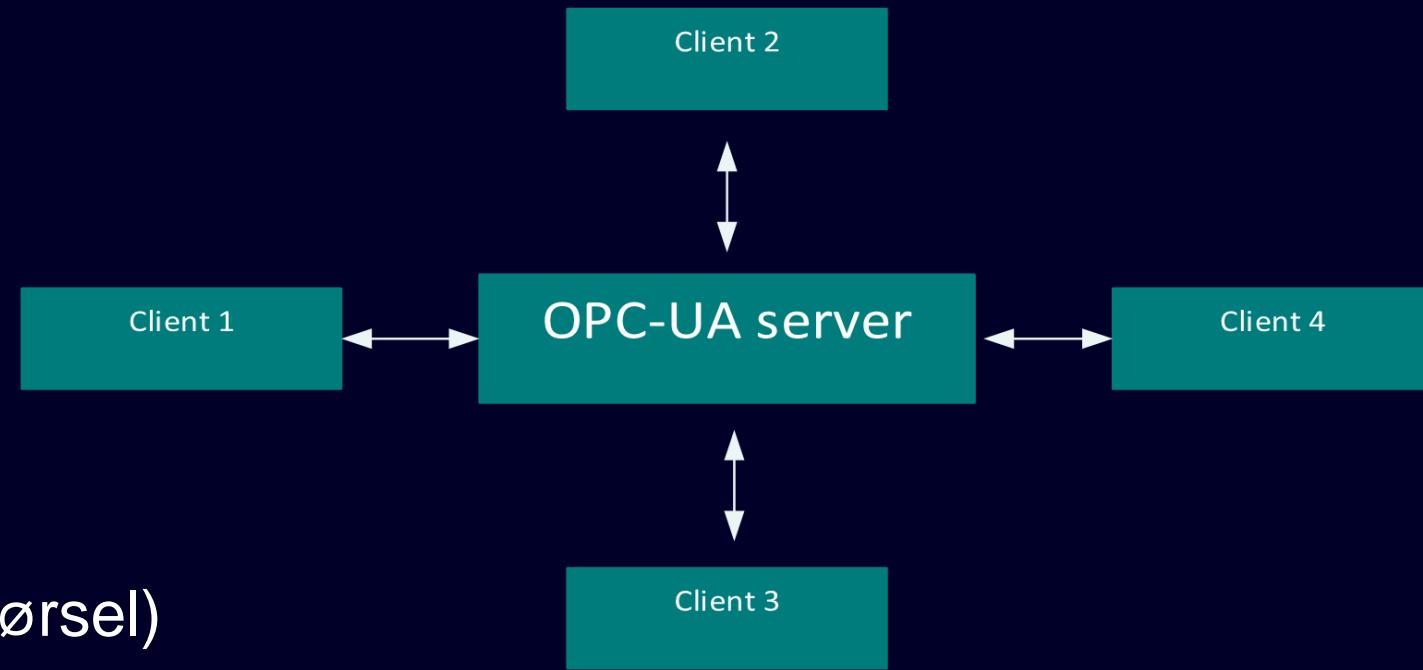
## Architecture

Kommunikation 1 til 1, eller 1 til mange (serverafhængig)

Client Server-baseret

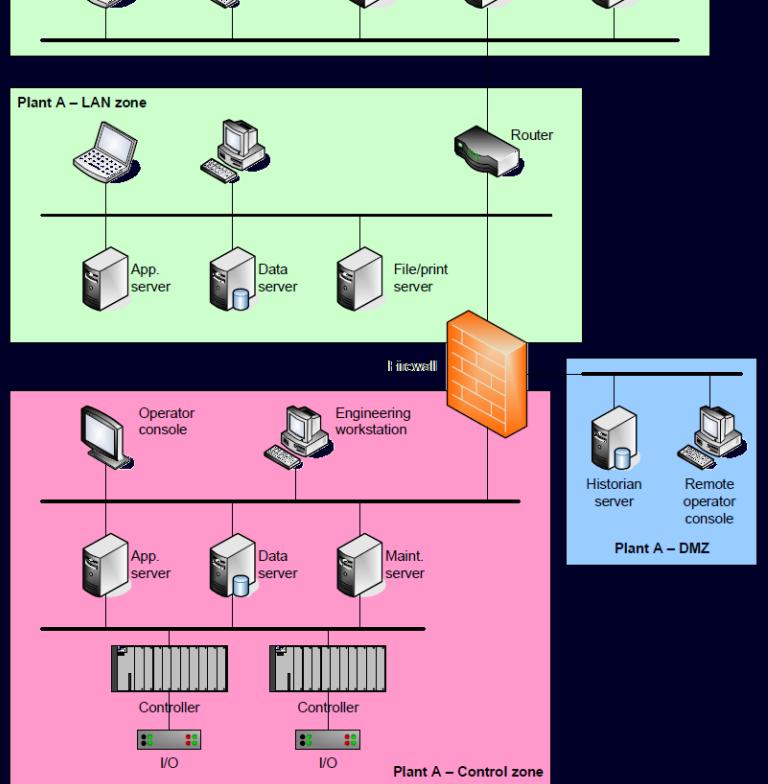
Forskellige måder at hente data på

- Read/Write
- Subscription
- Registered read/write
- Method call (konsistent dataoverførsel)



# OPC UA - teknisk introduction

## IEC62443 Security

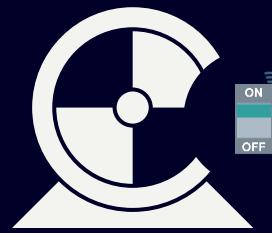


- OPC UA server i DMZ, hvis man vil lave OT/IT-kommunikation
- OPC UA server i OT-net ved ren OT-kommunikation
- Mulighed for TLS transport kryptering
- Brugernavn, password og beskyttelse

# OPC UA - teknisk introduction - Cool stuff

## OPC UA Alarms and Conditions – Technical terms

GENERATES EVENT

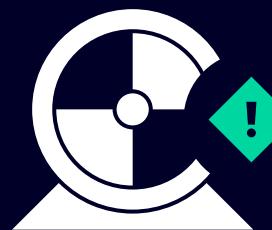


GENERATES ALARM

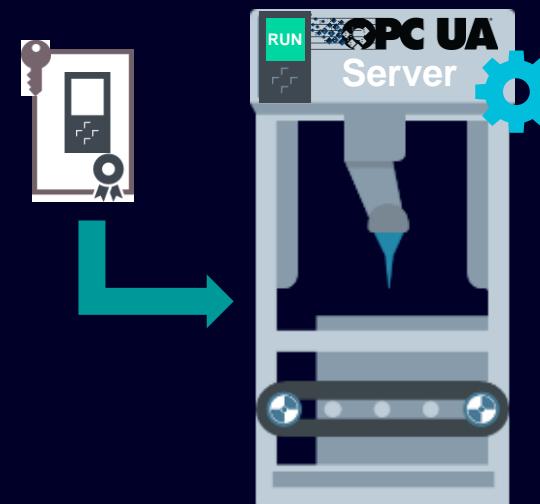
- Incoming (Acknowledged)
- Outgoing

GENERATES ALARM

- Incoming
- Outgoing
- Comment
- Acknowledge



## OPC UA GDS Change certificates “OnTheFly”

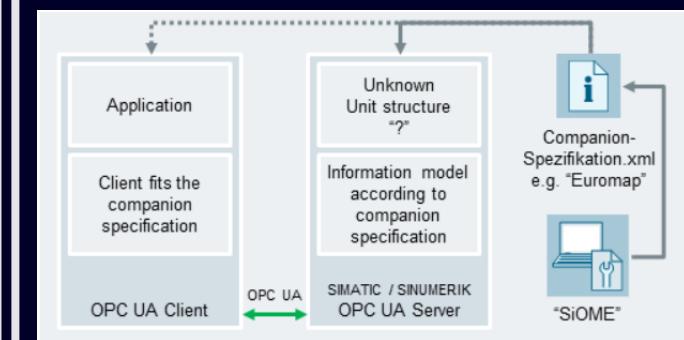


## SiOME modelling editor

### Siemens OPC UA Modeling Editor Functional Description

SiOME / OPC UA / TIA Portal

<https://support.industry.siemens.com/cs/ww/en/view/109755133>



SIEMENS

# OPC UA - teknisk introduction - GDS Push



IEC 62443-3-3

## 5.11 SR 1.9 – Strength of public key authentication

### 5.11.1 Requirement

For control systems utilizing public key authentication, the control system shall provide the capability to:

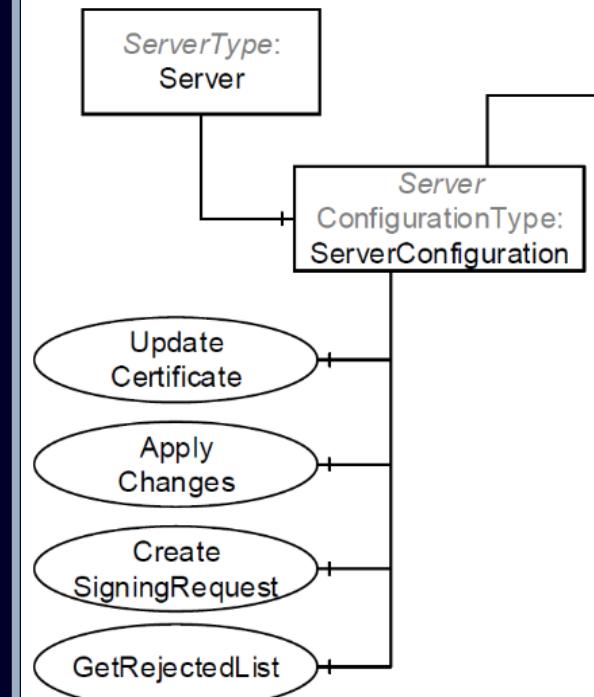
- a) validate certificates by checking the validity of the signature of a given certificate; ✓
- b) validate certificates by constructing a certification path to an accepted CA or in the case of self-signed certificates by deploying leaf certificates to all hosts which communicate with the subject to which the certificate is issued; ✓
- c) validate certificates by checking a given certificate's revocation status; ?
- d) establish user (human, software process or device) control of the corresponding private key; and ✓
- e) map the authenticated identity to a user (human, software process or device). ✓



TIA Portal V17 and S7-1500 FW 2.9 implements  
Certificate Push for the PLC's OPC UA server



Part 12 – Push Certificate Mgmt.



SIEMENS

# Agenda

Hvordan kommunikerer vi i dag

MQTT - teknisk introduktion

OPC UA - teknisk introduktion

**Workflow - MQTT**

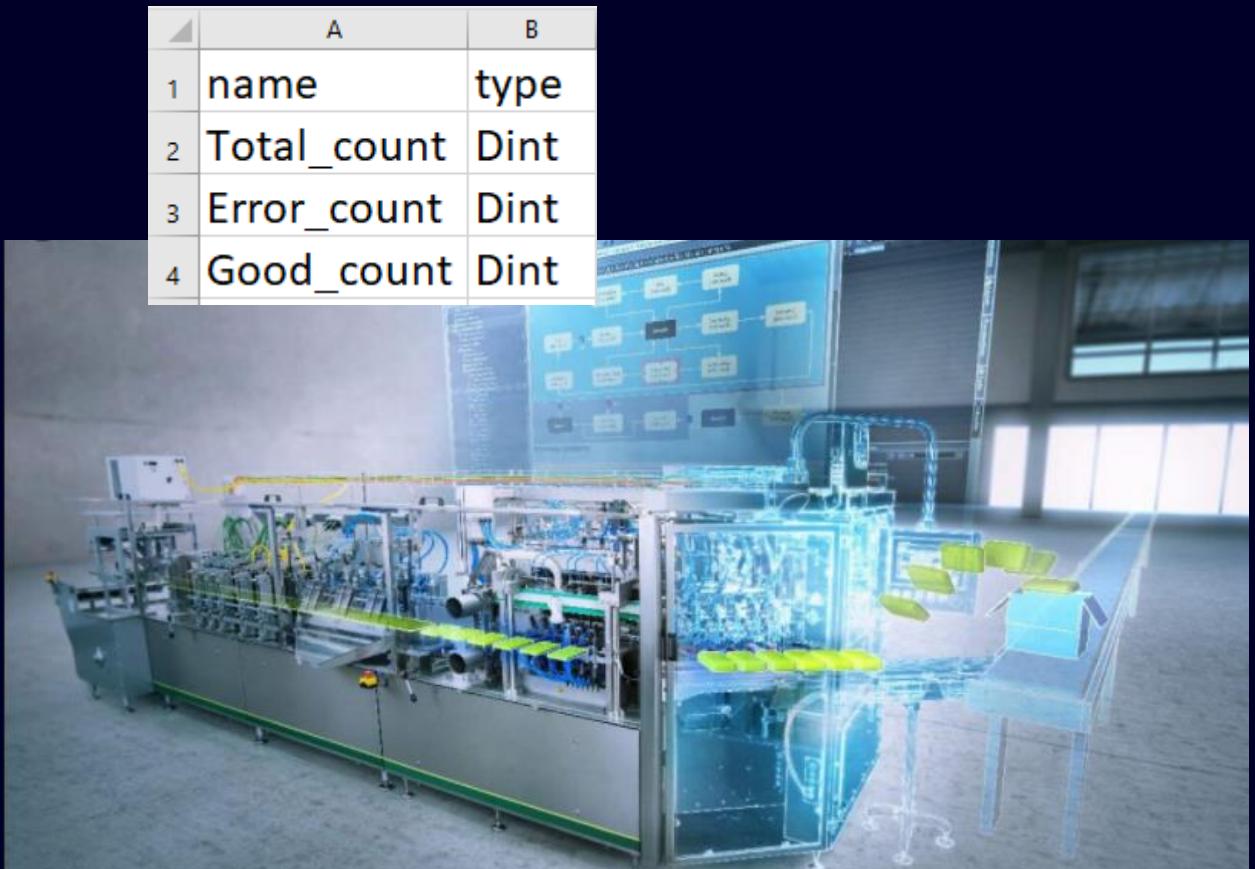
**Workflow - OPC UA**

Fremtiden

# Workflow MQTT vs OPC UA

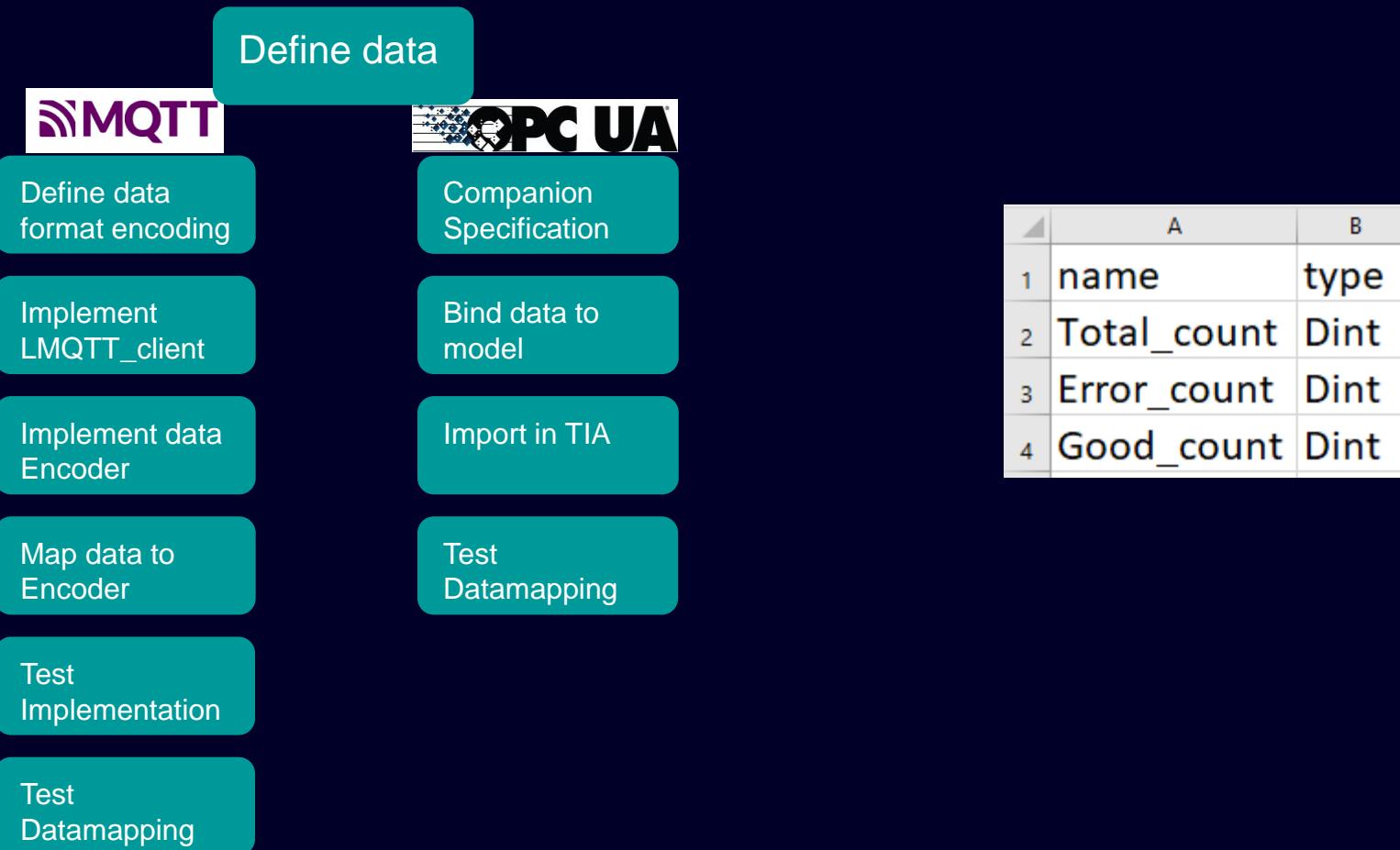
## Implementering

- Use case med data fra en standard maskine
- Hvordan implementerer vi løsningen? Fordeler og ulemper

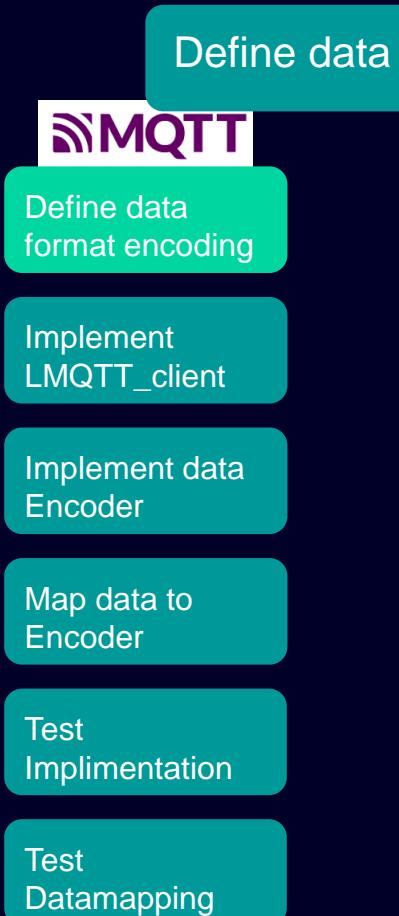


SIEMENS

# Workflow MQTT vs OPC UA



# Workflow MQTT



## Defining the data format

- MQTT is intended as a transport, not a protocol
- Encoding: XML, JSON, CSV....
- Format: “machine name”? - Object or Values

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_Client

Implement data  
Encoder

Map data to  
Encoder

Test  
Implementation

Test  
Datamapping



## Implement LMQTT\_Client

- Setup how often the PLC should send data
- Setup error logic

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_client

Implement data  
Encoder

Map data to  
Encoder

Test  
Implementation

Test  
Datamapping



## Implement LStream

- JSON
- Implement defined format

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_client

Implement data  
Encoder

Map data to  
Encoder

Test  
Implementation

Test  
Datamapping

OEEData						
	Name	Data type	Start value	Retain	Accessible from HMI/OPC UA/Web API	
1	Static			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Total_count	DInt	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	Error_count	DInt	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	Good_count	DInt	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

## Map data

- Find the datapoints and map them to the Encoder

### 2.2.6 LStream\_typeElement

The PLC data type "LStream\_typeElement" keeps the data/objects of the JSON and XML data streams in a format that can be used by the SIMATIC S7 Controller. The data is held in a key-value pair. In addition, there is the hierarchical depth of the object, as well as its type identifier.

Table 2-12: Parameters of LStream\_typeElement

Name	Data type	Value	Description
type	Sint	-1	Serves as the type identifier of the element. Where -1 is the initial value, which corresponds to an undefined type. When the UDT is used in the context of a JSON structure, 0 represents an object, 1 represents an array, 2 represents a string, 3 represents a number and 4 represents a Bool When the UDT is used in the context of an XML structure, 0 represents an element, 1 represents an attribute, and 2 represents a text.
key	String	"	Name of the key
value	String	'NULL'	Name of the key value
depth	Sint	-1	Hierarchical depth of the object

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_client

Implement data  
Encoder

Map data to  
Encoder

Test  
Implementation

Test  
Datamapping

## Tips & tricks with TIA Portal



TIA Portal Test Suite

Efficient application testing and verification of compliance with programming style guides

<https://www.youtube.com/watch?v=3H0Cnyvpcg0>

## Unit and integration test

- TIA Portal Test Suite Advance

SIEMENS

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_client

Implement data  
Encoder

Map data to  
Encoder

Test  
Implementation

Test  
Datamapping

```
{  
  "id" : "Machine01",  
  "ErrorCount" : 1,  
  "GoodCount" : 22,  
  "TotalCount" : 333  
}
```

The screenshot shows the SIMATIC Manager interface with the title bar "Demo\_v16 PLC06\_V17 ▶ PLC\_6 [CPU 1510SP F-1 PN] ▶ Program blocks ▶ MachineData [D...". Below the title bar is a toolbar with icons for "Keep actual values", "Snapshot", and "Copy snapshots to start values". The main area displays a table titled "MachineData" with the following data:

	Name	Data type	Start value	Monitor value	Retain
1	Static				
2	Machine01	MachineI			
3	ErrorCount	nt	0	1	
4	GoodCount	nt	0	22	
5	TotalCount	nt	0	333	
6	Machine02	MachineI			

# Workflow MQTT

Define data



Define data  
format encoding

Implement  
LMQTT\_client

Implement data  
Encoder

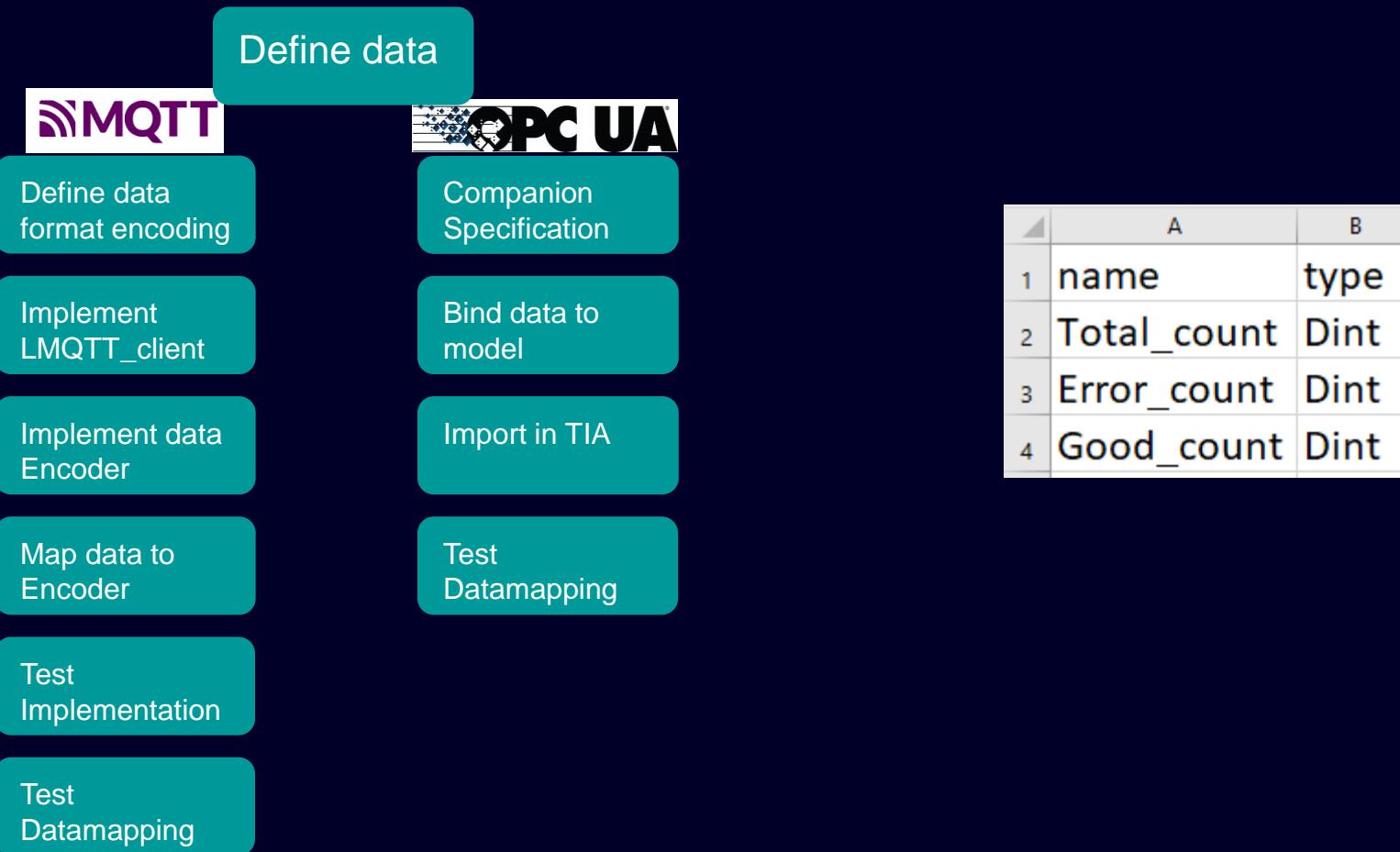
Map data to  
Encoder

Test  
Implementation

Test  
Datamapping

## Reuse of code

# Workflow MQTT vs OPC UA



# Workflow OPC UA

Define data



Companion  
Specification

Bind data to  
model

Import in TIA

Test  
Datamapping

**De forskellige steps for at  
lave modelleret interface**

# Workflow OPC UA

Define data



Companion  
Specification

Bind data to  
model

Import in TIA

Test  
Datamapping

## Siemens OPC UA Modeling Editor Functional Description

SiOME / OPC UA / TIA Portal

<https://support.industry.siemens.com/cs/ww/en/view/109755133>

**Her beskrives brug af SIOME. Det er databruger'en,  
som definerer de ønskede maskindata**

- SIOME er et gratis værktøj, som kan hentes på SIOS.
- SIOME skal ikke installeres. Det er bare en fil, som eksekveres.

SIEMENS

# Workflow OPC UA

Define data

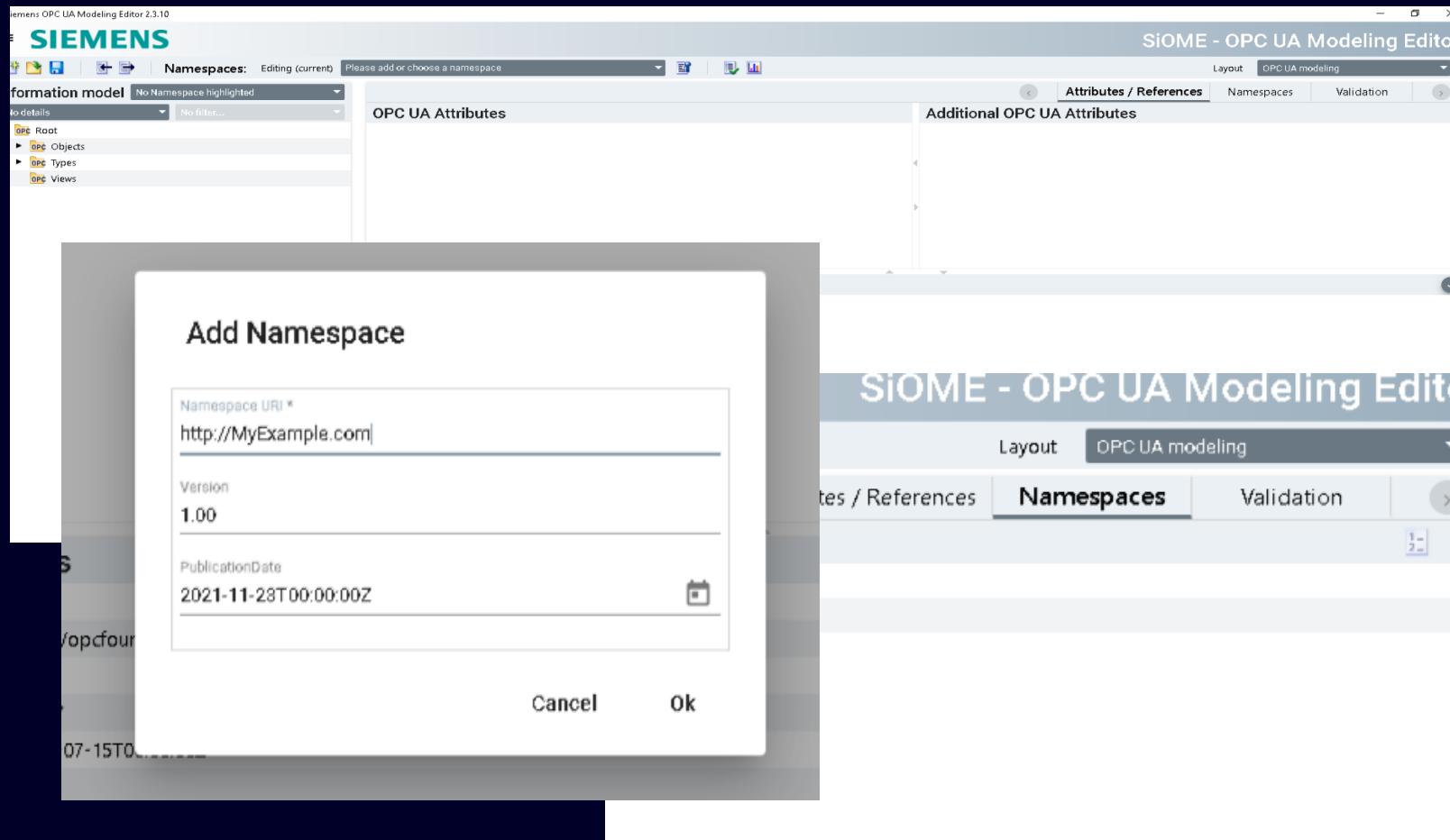


Companion Specification

Bind data to model

Import in TIA

Test Datamapping



SIEMENS

# Workflow OPC UA

Define data



Companion Specification

Bind data to model

Import in TIA

Test Datamapping

## Definition af ønsket interface og datatyper

- Her laves typen som en samlet datatype

- ▶ IdentityMappingRuleType
- ▶ KeyValuePair
- ▶ ModelChangeStructureDataType
- ▶ MonitoringFilter
- ▶ MyMachineData +
  - TotalCount (Int32)
  - ErrorCount (Int32)
  - GoodCount (Int32)
- ▶ NetworkAddressDataType
- ▶ NetworkGroupDataType

The screenshot shows the SIMATIC Manager interface. On the left, the 'BROWSE' tab is selected, displaying the 'OPC Namespaces' tree. It shows two entries: '0: http://opcfoundation.org/UA/' and '1: http://MyExample.com', with '1: http://MyExample.com' being the active namespace. On the right, there is a table with four rows, representing data mappings:

A	B
1 name	type
2 Total_count	Dint
3 Error_count	Dint
4 Good_count	Dint

# Workflow OPC UA

Define data



Companion Specification

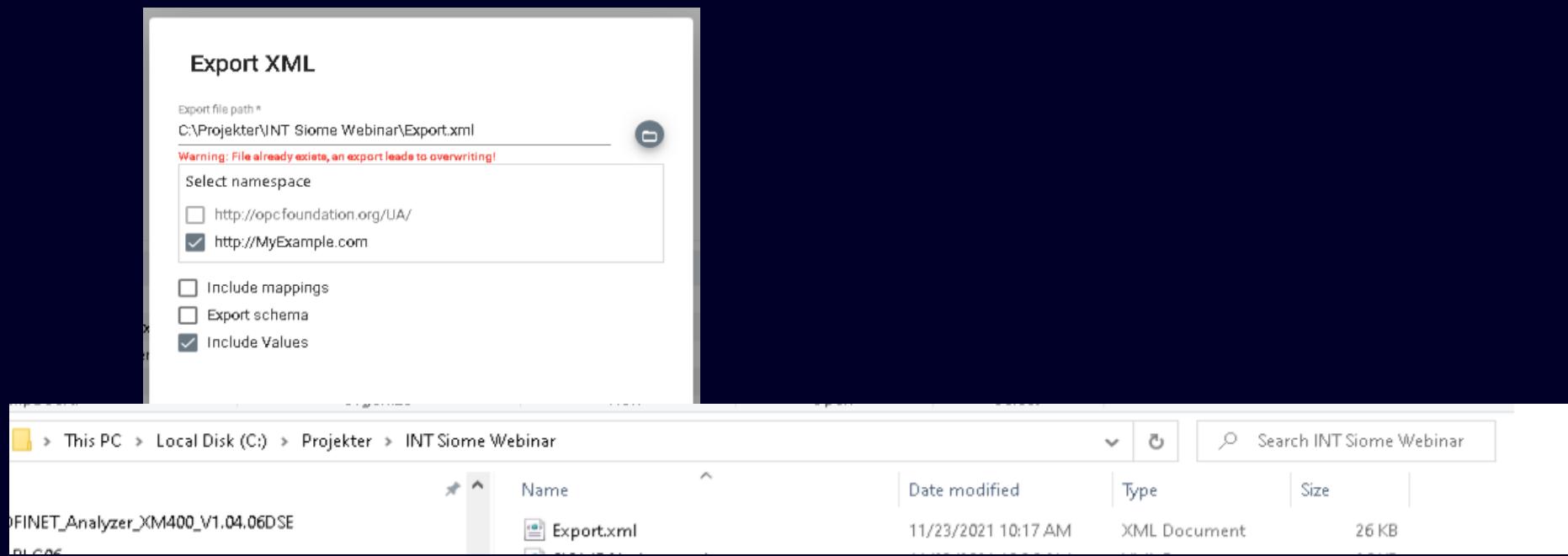
Bind data to model

Import in TIA

Test  
Datamapping

## Eksport af model fra SIOME

- Filen, som skal gives til maskinbygger eksporterer



SIEMENS

# Workflow OPC UA

Define data



Companion Specification

Bind data to model

Import in TIA

Test  
Datamapping

## Maskinbygger bruger modellen

- Der laves et antal instanser af typen, ift. antal maskiner
- Binding af data gøres i SIOME eller i TIA. Her benyttes SIOME

The screenshot shows two main windows side-by-side:

- Information model:** A tree view of the OPC UA information model. It includes nodes like 'Root', 'Objects' (containing 'Aliases', 'MyMachineInstance', and 'MachineData01' through 'MachineData07'), and 'Server'. Under 'MyMachineInstance', there are three leaf nodes: 'ErrorCount', 'GoodCount', and 'TotalCount'. A right-click context menu is open over the 'ErrorCount' node.
- TIA Portal:** A tree view of the SIMATIC Manager's TIA Portal. It shows a connection to 'Demo\_v16 PLC06\_V17.ap17'. Inside, it lists 'PLC\_6 (CPU 1510SP F-1 PN)', 'Software Units', 'Program blocks', and 'OPC test'. A right-click context menu is open over the 'OPC test' node.

The right-clicked nodes in both contexts are:

- For the 'ErrorCount' node in the information model:
  - "MachineData"."Machine01"
  - "MachineData"."Machine02"
  - "MachineData"."Machine03"
  - "MachineData"."Machine04"
  - "MachineData"."Machine05"
  - "MachineData"."Machine06"
  - "MachineData"."Machine07"
- For the 'OPC test' node in the TIA Portal:
  - "MachineData"."Machine01"
  - "MachineData"."Machine02"
  - "MachineData"."Machine03"
  - "MachineData"."Machine04"
  - "MachineData"."Machine05"
  - "MachineData"."Machine06"
  - "MachineData"."Machine07"
  - "MachineData"."Machine07"."ErrorCount"
  - "MachineData"."Machine07"."GoodCount"
  - "MachineData"."Machine07"."TotalCount"

SIEMENS

# Workflow OPC UA

Define data



Companion Specification

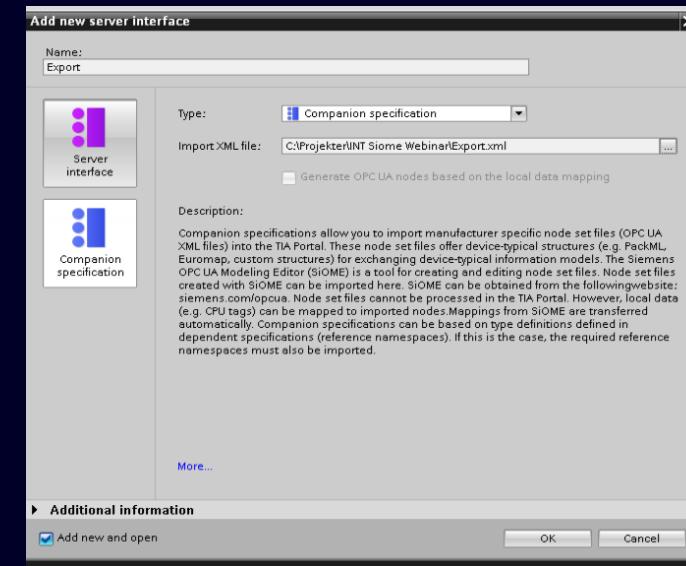
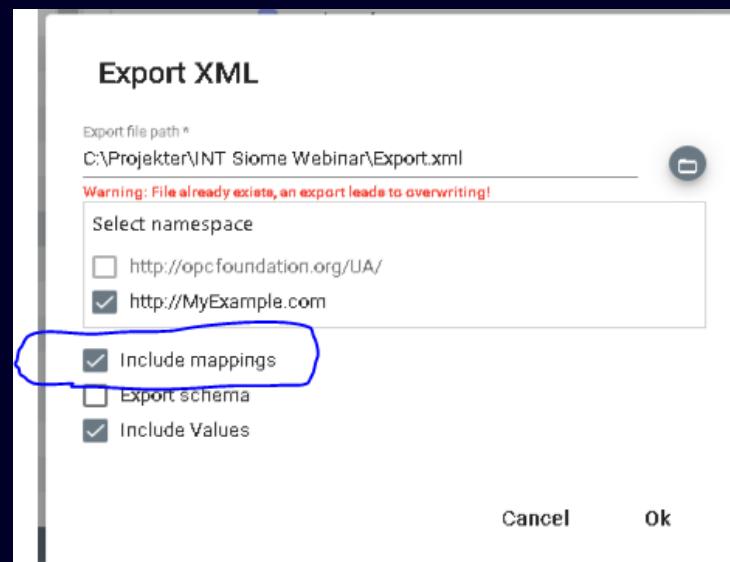
Bind data to model

Import in TIA

Test Datamapping

## Importer modellen i TIA

- Den mappede model skal eksporteres fra SIOME
- Efterfølgende importeres den i TIA



SIEMENS

# Workflow OPC UA

Define data



Companion Specification

Bind data to model

Import in TIA

Test Datamapping

## OPC UA setup

- Husk at aktivere og opsætte OPC-serveren i PLC

The screenshot shows the SIMATIC Manager interface for configuring OPC UA communication. The top navigation bar includes tabs for General, IO tags, System constants, and Texts. Under the General tab, the 'OPC UA' section is expanded, showing 'General' and 'Server' sub-sections. In the 'Server' sub-section, the 'Activate OPC UA server' checkbox is checked. Below this, there are sections for 'Accessibility of the server' and 'Alarms and Conditions'. The bottom part of the interface displays the 'OPC UA server interface' configuration table:

Browse name	Node type	Access level	Local data
1 MyMachineInstance	Object	---	
2 MachineData01	MyMachineData	RD/WR	"MachineData"."Machine01"
3 MachineData02	MyMachineData	RD/WR	"MachineData"."Machine02"
4 MachineData03	MyMachineData	RD/WR	"MachineData"."Machine03"
5 MachineData04	MyMachineData	RD/WR	"MachineData"."Machine04"
6 MachineData05	MyMachineData	RD/WR	"MachineData"."Machine05"
7 MachineData06	MyMachineData	RD/WR	"MachineData"."Machine06"
8 ErrorCount	DINT	RD/WR	"MachineData"."Machine06"."ErrorCount"
9 GoodCount	DINT	RD/WR	"MachineData"."Machine06"."GoodCou..."
10 TotalCount	DINT	RD/WR	"MachineData"."Machine06"."TotalCount"

SIEMENS

# Workflow OPC UA

Define data



Companion Specification

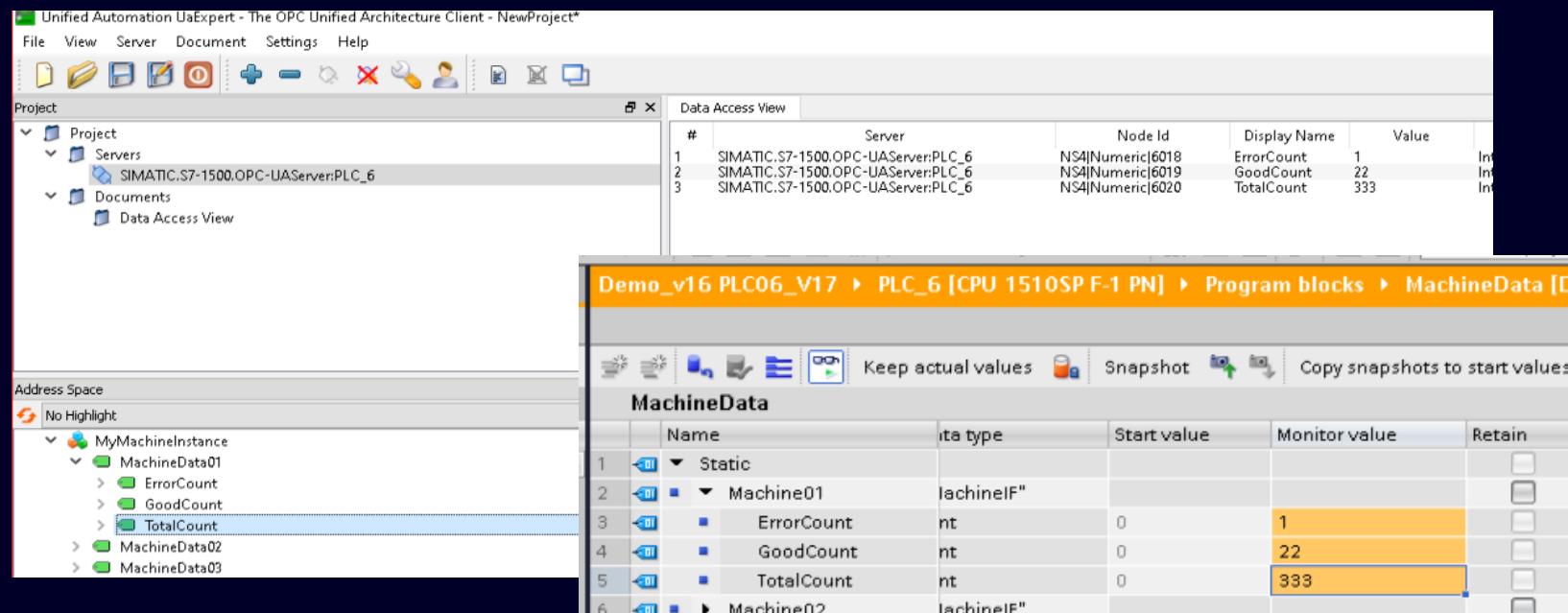
Bind data to model

Import in TIA

Test Datamapping

## Test interface

- Man kan med OPC UA Expert teste sit interface



SIEMENS

# Workflow OPC UA

Define data



Companion Specification

Bind data to model

Import in TIA

Test Datamapping

## Fejlkilder

- Hvis mapped data er forkerte, eksempelvis ved flere maskiner i samme PLC.

## Genbrug

- Modellen kan genbruges uden videre i flere PLC'er.
- Hvis navngivning af mappede data er ens, kan modellen med data genbruges.

# Agenda

Hvordan kommunikerer vi i dag

MQTT - teknisk introduktion

OPC UA - teknisk introduktion

Workflow - MQTT

Workflow - OPC UA

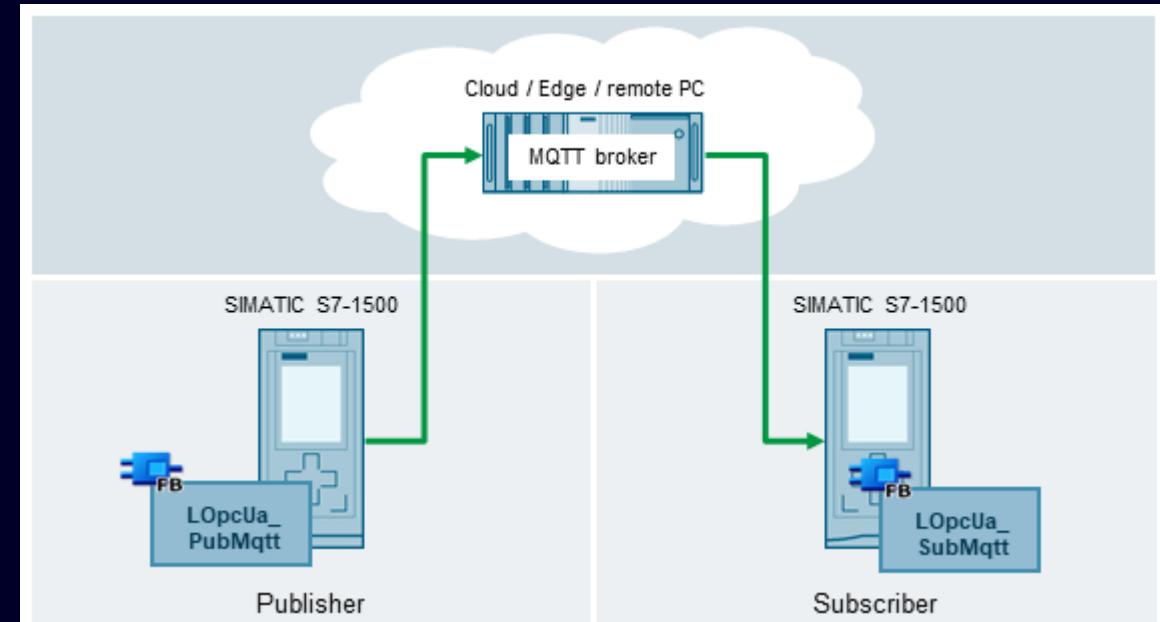
**Fremtiden**

# Hvad bringer fremtiden?

MQTT og OPC UA smelter sammen

- det bedste fra begge verdener

- Dekoplet kommunikation
- Standardiseret dataformater
- End-to-end encryption



SIEMENS

# | Kontakt

Jesper Kristiansen

[jesper.kristiansen@siemens.com](mailto:jesper.kristiansen@siemens.com)

Morten Kromann

[morten.kromann@siemens.com](mailto:morten.kromann@siemens.com)

**SIEMENS**



# SIEMENS

WEBINARER MED INSPIRATION, VIDEN OG VÆRDI

# Industry Information Live

Tilmeld dig, se og gense på  
[www.siemens.dk/di-webinarer](http://www.siemens.dk/di-webinarer)



A photograph of a man and a woman standing in front of a large digital screen. The screen displays various industrial and technological icons, including a 5G signal, a WiFi symbol, a brain, a gear, and a factory building. The man is gesturing with his hands while speaking, and the woman is listening attentively. A green call-to-action box is overlaid on the bottom right of the image, containing text in Danish.

NYHEDSBREVE TIL INDUSTRIEN  
UDKOMMER 8-10 GANGE OM ÅRET

# Industry Information News

TIPS OG TRICKS PÅ YOUTUBE

# Industry Information Demo

Find hurtigt playlisten og abonner via  
[www.siemens.dk/di-demo](http://www.siemens.dk/di-demo)

