



Automatic Asset Onboarding

Using WoT and ChatGPT for Automatic Asset Onboarding in Industrial IoT Projects

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The Biggest Challenge: Vendor Lock-In

...happens when...

you are forced to use a closed-source **SDK** in your product.

you are forced to use a proprietary **interface** to communicate.

you are forced to use a proprietary **communication protocol**.

you are forced to use a vendor-specific **data model**.

you are forced to run your solution in a specific **software platform**.

you are forced to run your solution on specific **hardware**.

The Key to Reducing Costs: Interoperability

We need...

1. A common **Interface** (Analogy: A Book)
2. A common **Data Format** (Analogy: Latin Alphabet)
3. A common **Data Model** (Analogy: English)
4. Common **Semantics** (Analogy: "Moby Dick")

Only when all 4 things are present can we truly understand each other!

An Interoperability Example for OPC UA-enabled Assets

1. **Interface:** OPC UA Client/Server
2. **Data Format:** OPC UA Binary
3. **Data Model:** OPC UA Information Model
4. **Semantics:** OPC UA Robotics Companion Spec



An Interoperability Example for non-OPC UA-enabled Assets

1. **Interface:** Modbus (later mapped to OPC UA)
2. **Data Format:** JSON-LD
3. **Data Model:** Web of Things Thing Description
4. **Semantics:** Modbus Protocol Binding





IEC 62541 - The Industrial Interoperability Standard

Microsoft is a member of the OPC Foundation since 1996, >900 members

Microsoft supports OPC UA on Azure since 2016

Microsoft has contributed over 5M lines of open-source code to the OPC Foundation

Interoperability

Vendor, Protocol, Platform and OS Independent



Open Source on GitHub (>4.5M source lines contributed by Microsoft)

Scalable from sensor to Cloud, Services Oriented Architecture (SOA)

Owned by a Non-Profit (OPC Foundation)

>100M installed base and exponential growth

Data Modelling

Discoverable, supports complex data types

Graph support, preserves source context

Vendor extendable

Domain-specific Companion Specifications:

- Discrete: Robotics, Machine Vision, ...
- Process: FDI, FDT, PA-DIM, MDIS, NOA..
- Energy: IEC61850, ..

Security

Secure Design from group-up

Based on open security standards

Auditing, Authentication & Encryption

Evolves as security technologies evolve

Vendors can choose level of security

Acceptable by IT departments

Semantic Interoperability via Companion Specs

The VDMA has over 3200 member companies, over 600 are involved in building OPC UA Companion Specs

» Agricultural Machinery

» Air Conditioning & Ventilation

» Air Pollution Control

» Automated Guided Vehicles

» Battery Production

» Building Control and Management

» Building Materials

» Ceramic Machinery

» Cleaning Systems

» Compressors, Compressed Air and Vacuum Technology

» Construction Equipment

» Continuous Conveyors

» Cranes

» Die & Mould

» Drying Technology

» Electrical Automation

» Electronics, Micro & Nano Technologies

» Engines

» Engines & Systems

» Fire Fighting Equipment

» Fluid Power

» Food Processing and Packaging Machinery

» Foundry Machinery

» Glass Machinery

» Hydro Power Plants

» Industrial Trucks

» Integrated Assembly Solutions

» Intralogistic Systems

» Length Measurement Technology

» Lifts & Escalators

» Machine Tools and Manufacturing Systems

» Machine Vision

» Metallurgical Plants and Rolling Mills

» Micro Technologies

» Mining

» Photovoltaic Equipment

» Plastics & Rubber Machinery

» Power Transmission Engineering

» Precision Tools

» Printing & Paper Technology

» Process Plant & Equipment

» Productronic

» Pumps & Systems

» Refrigeration & Heat Pump Technology

» Robotics

» Security Systems

» Software & Digitalization

» Surface Technology

» Testing Technology

» Textile Care, Fabric and Leather Technology

» Textile Machinery

» Thermal Power Plants

» Thermo Process Technology

» Valves

» Waste Treatment & Recycling

» Weighing Technology

» Welding & Pressure Gas Equipment

» Wind Power Plants

» Woodworking Machinery

OPC UA CS Released

OPC UA CS Release Candidate

Joint Working Group with OPC Foundation

OPC UA CS in Progress

OPC UA CS in Planning

























Industrial Connectivity



Industrial IoT Edge Partnerships



Normalized, standardized,
open data model & telemetry
stream for all machines,
including security!

 Matrikon Data Broker By Honeywell System Integrators (SIs), engineers, and IT professionals, use Matrikon® Data Broker to easily setup, manag... Get it now 	 ThingWorx Kepware Edge for Azure By PTC Inc. PTC's ThingWorx Kepware Edge is a Linux-based connectivity platform providing a single source of industrial... Get it now 	 OPC Router – The Communication... By Inray Industriesoftware GmbH The central Industry 4.0 platform enables data exchange in your networked production processes to be automa... Get it now 	 edgeConnector 840D By Softing Industrial Automation GmbH Run the IoT Edge Module and connect up to 20 Siemens SINUMERIK 840D SolutionLine and PowerLine Controllers... Get it now 	 edgeConnector Siemens By Softing Industrial Automation GmbH Run the IoT Edge Module and connect up to 20 Siemens S7-300/400 or S7-1200/1500 PLCs. Acts as OPC UA server... Get it now 	 edgeConnector Modbus By Softing Industrial Automation GmbH Softing edgeConnector Modbus is a containerized Modbus TCP connectivity module adding OPC UA Server and MQT... Get it now 
 zenon on IoT Edge: Free Trial By COPA-DATA zenon on IoT Edge brings the data acquisition and processing power of the zenon Runtime to your IoT Edge de... Get it now 	 edgeAggregator By Softing Industrial Automation GmbH Container-based flexible OT/IT integration solution built on OPC UA with MQTT connectivity to IoT solutions Get it now 	 Kalki.io Edge (IoT Module) By Kalkitech.com Kalki.io Edge simplifies data acquisition at the edge from field devices such as Sensors, Controllers, PLC,... Get it now 	 ogamma Visual Logger for OPC IoT Edge Module By One-Way Automation Inc. Integration tool to collect, store and forward, visualize, analyze OPC UA data. Get it now 	 IcoEdgeAgent By ICONICS IcoEdgeAgent for IoT Edge devices is a required module to be deployed as part of a complete ICONICS IoTWorX... Get it now 	 edgeConnector FANUC CNC By Softing Industrial Automation GmbH Run the IoT Edge Module and connect up to 20 FANUC CNC Controllers. Acts as OPC UA server on Azure IoT Edge... Get it now 

[All products – Microsoft Azure Marketplace](#)

Industrial Asset Data Model Kinds and how to Map to OPC UA (Estimated WW Numbers!)

1. Discoverable (~10%)

- a) OPC UA-enabled (PLC) (~4%) -> No ind. conn. software required!
- b) Non-OPC UA-enabled (PLC) (~6%) -> Automatic mapping by ind. conn. software

2. Non-Discoverable (~90%)

- a) Fixed function/data model (~63%) -> Automatic mapping based on WoT Thing Description sent to ind. conn. software
- b) Programmable (PLC) (~27%) -> Manual mapping via ind. conn. software

Web of Things Thing Description

Standardized machine and human readable device descriptions

```
1 {
2   "@context": "https://www.w3.org/2019/wot/td/v1",
3   "id": "urn:siemens:pac4200",
4   "base": "modbus://192.168.10.100:1502",
5   "title": "Siemens SENTRON PAC4200",
6   "description": "Multifunctional energy metering device",
7   "properties": {
8     "VoltageL1-N": {
9       "@type": "opcua_30141:AcVoltagePe_UL1N",
10      "type": "number", "readOnly": true,
11      "forms": [{
12        "href": "/1?offset=3&length=4", "op": ["readproperty", "observeproperty"]
13      }]
14    },
15    "VoltageL2-N": { ...
32  }
33  },
34  "actions": {
35    "changeRate": {
36      "@type": "opcua_30141:metering_rate",
37      "input": {
38        "type": "number", "enum": [0, 1],
39        "description": "0 for high rate, 1 for low rate"
40      },
41      "forms": [{
42        "href": "/1?offset=60006&length=1", "op": "invokeaction"
43      }]
44    }
45  },
46  ...
}
```



W3C Recommendation

Web of Things (WoT) Thing Description

W3C Recommendation 9 April 2020 (Link errors corrected 23 June 2020)



This version:

<https://www.w3.org/TR/2020/REC-wot-thing-description-20200409/>

Latest published version:

<https://www.w3.org/TR/wot-thing-description/>

Latest editor's draft:

<https://w3c.github.io/wot-thing-description/>

Implementation report:

<https://w3c.github.io/wot-thing-description/testing/report.html>

Previous version:

<https://www.w3.org/TR/2020/PR-wot-thing-description-20200130/>

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Participate:

[GitHub w3c/wot-thing-description](#)
[File a bug](#)
[Commit history](#)
[Pull requests](#)

Contributors:

[In the GitHub repository](#)

Repository:

[We are on GitHub](#)
[File a bug](#)

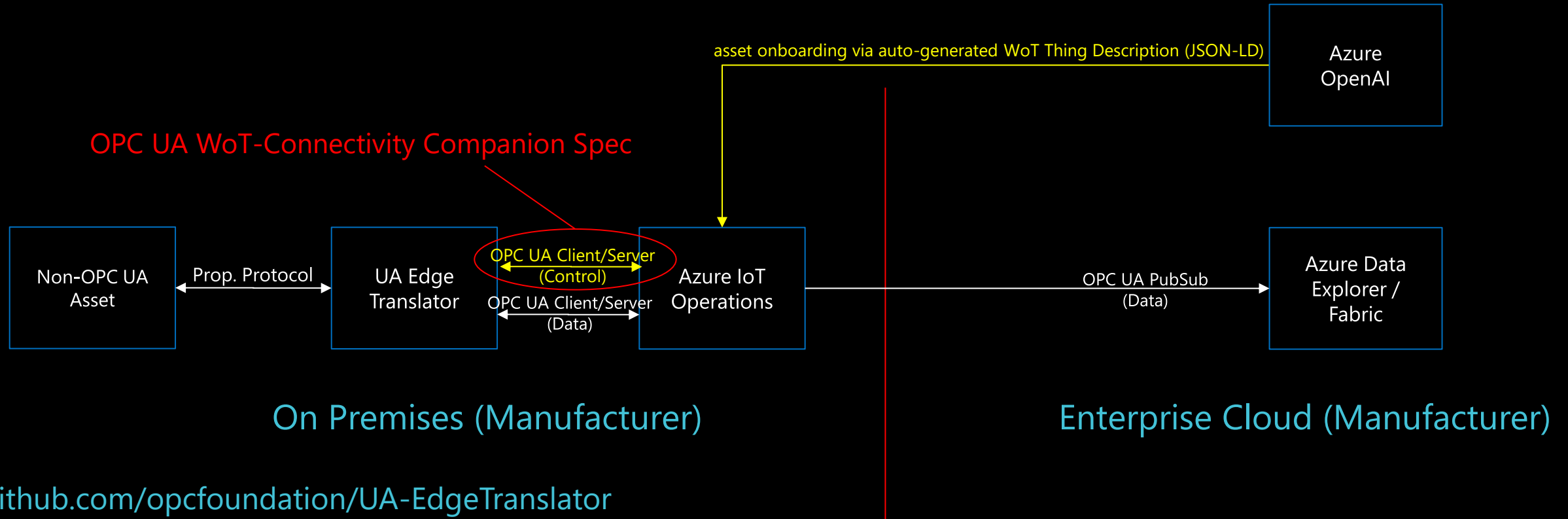
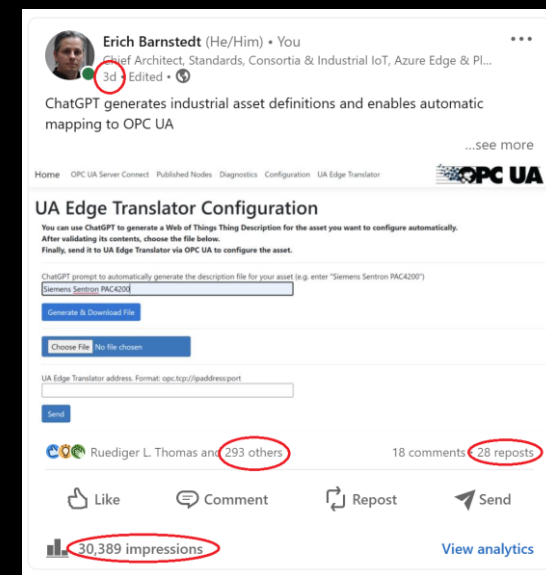
Please check the [errata](#) for any errors or issues reported since publication.

See also [translations](#).

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Abstract

UA Edge Translator Standardized Industrial Connectivity Integration & OpenAI-Powered Automatic Asset Onboarding in 3 Steps!

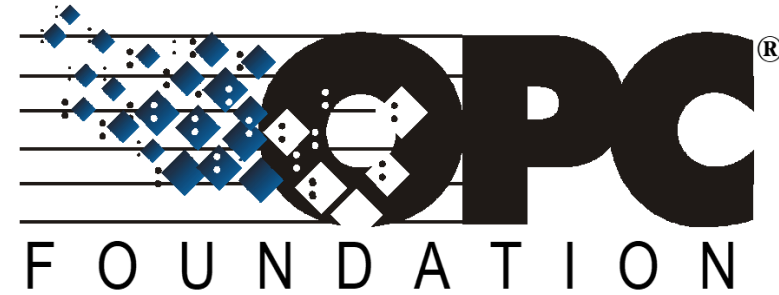


In V1.0:

- CreateAsset()
- (WoT) File Upload()
- DeleteAsset()

In V1.1 (all optional):

- ConnectionTest()
- DiscoverAssets()
- CreateAssetForEndpoint()
- SupportedBindings
- Configuration (key-value pairs)
- License




OPC 10100-1

OPC UA for WOT Connectivity Part 1: API Definition

Release V1.01

1. User enters make and model of asset in Chat prompt

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UA Edge Translator Configuration

You can use the **Azure OpenAI** service to generate and download a Web of Things (WoT) Thing Description for the asset you want to configure automatically.
[Here](#) is a good online editor for WoT files.
After validating its contents, choose the file below.
Finally, send it to UA Edge Translator via OPC UA to configure the asset.

1. ChatGPT prompt to automatically generate the description file for your asset (e.g. enter "Siemens Sentron PAC4200"):

Generate & Download File

2. Load the manually validated asset description file:

Choose File

No file chosen

3. Send the loaded asset description file to UA Edge Translator. UA Translator address format: opc.tcp://ipaddress:port

Send

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Asset Copilot - Azure OpenAI auto-generated WoT TD File

Including support for OPC UA Companion Specifications



```
pac4200.jsonld
Schema: https://json.schemastore.org/jsonld.json

1 {
2   "@context": [
3     "https://www.w3.org/2019/wot/td/v1",
4     "https://si-ra.github.io/ontologies/td-context.jsonld",
5     "http://opcfoundation.org/UA/PNEM/"
6   ],
7   "id": "urn:pac4200",
8   "securityDefinitions": {
9     "nosec_sc": {
10       "scheme": "nosec"
11     }
12   },
13   "security": [
14     "nosec_sc"
15   ],
16   "@type": [
17     "Thing"
18   ],
19   "name": "modbus-pac4200-sn324",
20   "base": "modbus://192.168.10.100:502",
21   "title": "Siemens SENTRON PAC4200",
22   "properties": {
23     "VoltageL1-N": {
24       "type": "number",
25       "readOnly": true,
26       "observable": true,
27       "forms": [
28         {
29           "href": "/1?address=1&quantity=2",
30           "op": [
31             "readproperty",
32             "observeproperty"
33           ],
34           "opcua:type": "nsu=http://opcfoundation.org/UA/PNEM/;i=6098",
35           "modbus:type": "float",
36           "modbus:entity": "holdingregister",
37           "modbus:pollingTime": 2000
38         }
39       ]
40     },
41     "VoltageL2-N": {
42       "type": "number",
43       "readOnly": true
44     }
45   }
46 }
```

2. User edits auto-generated WoT Thing Description

The screenshot displays the Eclipse WoT Editor (editDor) interface. The top bar shows the application name and navigation buttons: GPT, Share, Discover, New, Open, Save, and Persist As File. The left sidebar contains a 'JSON Validation' section with checkmarks for 'JSON Validation' and 'JSON Schema Validation'. Below this, the 'SiemensSENTRONPAC4200' Thing Description is shown with fields for id, @context, name, mlfb, base, securityDefinitions, and security. The right sidebar displays the JSON code for the Thing Description. At the bottom, an 'Ask Your AI Assistant' chat window is visible, showing a message from the user and a response from the AI assistant.

JSON Validation ✓
JSON Schema Validation ✓

SiemensSENTRONPAC4200

id urn:pacPVDAS1

@context >

name Pac4200

mlfb 7KM3220-1BA01-1EA0

base modbus://host:port

securityDefinitions >

security nsec_sc

> Forms

> Links

Properties

- > VoltageL1-N
- > VoltageL2-N
- > VoltageL3-N

Actions

Properties: 3 Actions: 0 Events: 0 Size: 1.034 KiB

SiemensSENTRONPAC4200

```
1 {
2   "@context": ["https://www.w3.org/2019/wot/td/v1"],
3   "title": "SiemensSENTRONPAC4200",
4   "id": "urn:pacPVDAS1",
5   "name": "Pac4200",
6   "mlfb": "7KM3220-1BA01-1EA0",
7   "base": "modbus://host:port",
8   "securityDefinitions": {
9     "nsec_sc": {
10       "scheme": "nsec"
11     }
12   }
13 }
```

Ask Your AI Assistant

Send a message and it will be forwarded to a GPT instance. It will assist you in writing your TDs

Generate me a Thing Description for a Siemens Sentron PAC 4200


```
{
  "@context": ["https://www.w3.org/2019/wot/td/v1"],
  "title": "SiemensSENTRONPAC4200",
  "id": "urn:pacPVDAS1",
  "name": "Pac4200",
  "mlfb": "7KM3220-1BA01-1EA0",
  "base": "modbus://host:port",
  "securityDefinitions": {
    "nsec_sc": {
      "scheme": "nsec"
    }
  },
  "security": "nsec_sc",
  "properties": {
    "VoltageL1-N": {
      "description": "voltage between L1 and N IV1"
    }
  }
}
```

Copy last message to editor

Start typing...

You have unsaved changes. - version: 0.0.3 | [view on Github](#)

3. User sends edited WoT Thing Description to UA Edge Translator

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2. Load the manually validated asset description file:

Choose File

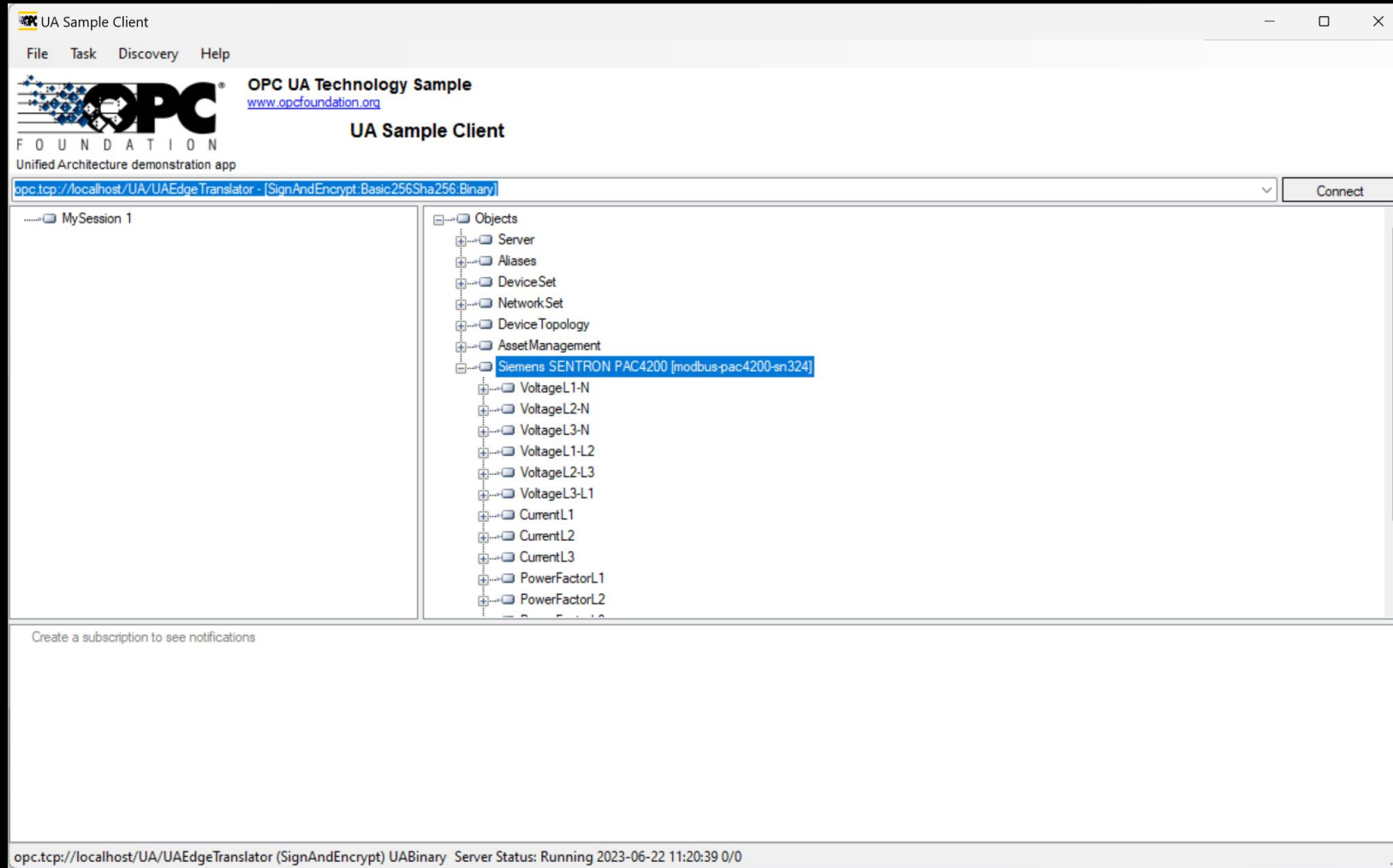
No file chosen

3. Send the loaded asset description file to UA Edge Translator. UA Translator address format: opc.tcp://ipaddress:port

Send

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UA Edge Translator Automatically Maps the Modbus I/F to OPC UA

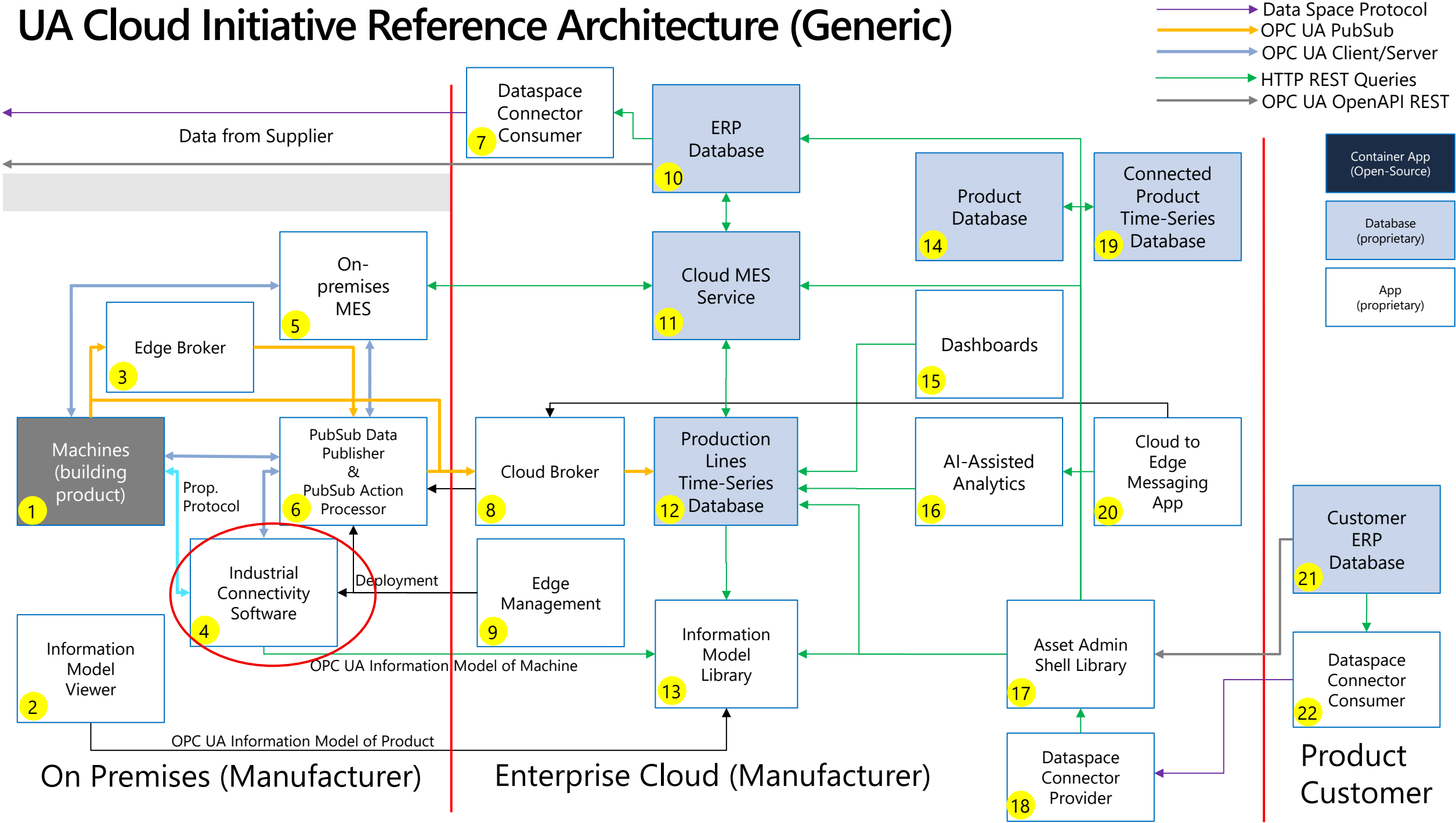


github.com/OPCFoundation/UA-EdgeTranslator

OPC Foundation Cloud Initiative: How

- ▶ Create a **pre-competitive environment** for collaboration.
- ▶ **Replicate best-practices** established in the OPC Foundation Field Level Communications Initiative, bringing cloud architects together with the technology experts from the OPC Foundation.
- ▶ **Harmonize existing cloud-related working groups** under the roof of a single steering committee.
 - **UA Cloud Library** – A query-able online store of OPC UA Information Models
 - **OPC UA over MQTT** – secure transport from edge to cloud and cloud to cloud.
 - **OPC UA REST Interface** – cloud-based OPC UA server access
 - **OPC UA WoT Connectivity** – standardized industrial connectivity software configuration
 - **OPC UA Industrial Metaverse** – reference architecture to combine the virtual and the physical world
 - **OPC UA AI** - Leveraging Large Language Models
- ▶ Bring **actionable manufacturer challenges** and opportunities for enhancement to cloud applications to the table.
- ▶ Initiate **new working groups** to develop OPC UA technology for cloud-centric applications.

UA Cloud Initiative Reference Architecture (Generic)



UA Cloud Initiative Reference Architecture (Open-Source)

