

OCTOBER 2023

Leveraging MQTT for edge to cloud

Best practices and troubleshooting

Rickard Norin –Product Manager - operations control

Bob Hunter – Principal GCS Technical Account Manager



AVEVA



Rickard Norin

Product Manager – operations control

AVEVA

rickard.norin@aveva.com



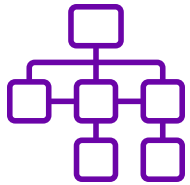
Bob Hunter

Principal GCS Technical Account Manager

AVEVA

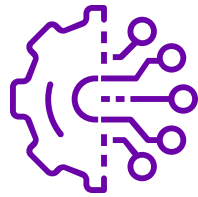
bob.hunter@aveva.com

MQTT from edge to cloud



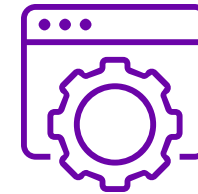
Architecture

- Introduction to the decoupled architecture of MQTT and what this means for secure, scalable, and performant integration of devices and systems



Data contracts

- Discussion of the relevance of standardized data contracts, given that MQTT is a messaging system that provides no rules or guidance to the structure of messages



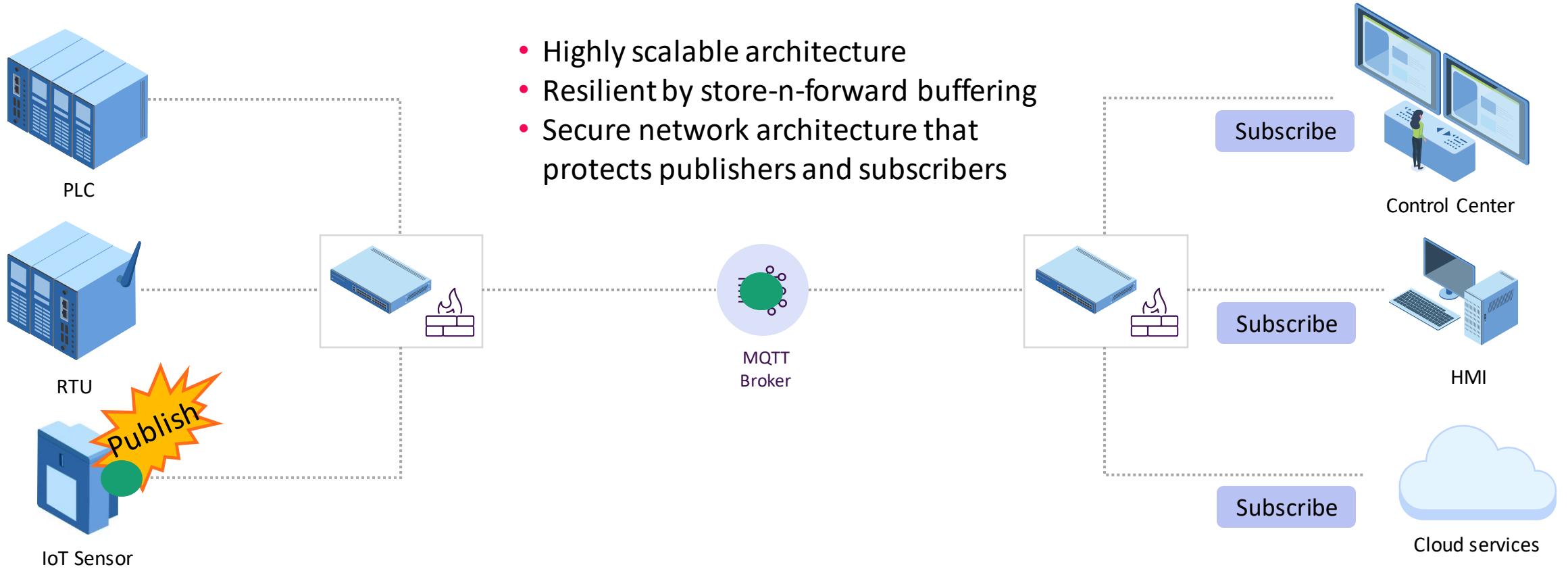
Usage & Troubleshooting

- Demonstrations and discussion about how to leverage MQTT with AVEVA HMI/SCADA and how to troubleshoot issues related to connectivity and messaging

MQTT is an OASIS standard messaging protocol for the Internet of Things (IoT). It is designed as an extremely lightweight publish/subscribe messaging transport that is ideal for connecting remote devices with a small code footprint and minimal network bandwidth. MQTT today is used in a wide variety of industries, such as automotive, manufacturing, telecommunications, oil and gas, etc.

<https://mqtt.org>

What is MQTT?



- Highly scalable architecture
- Resilient by store-n-forward buffering
- Secure network architecture that protects publishers and subscribers

The importance of data contracts

- MQTT is a publication and subscription mechanism, not too different from a notice board
- **There are no rules governing the formatting, shape, topic, language, terminology, context or order of what is posted**
- Depending on publishing format, the Broker may not always have a full record of all data points. Often, it can only provide the latest changes.



The importance of data contracts

- MQTT is a publication and subscription mechanism, not too different from a notice board
- **There are no rules governing the formatting, shape, language, terminology or order of what is posted**

Snapshot from test.mosquitto.org

- Values without encapsulation or context
- Endless variations of topic structures
- Endless variations of JSON formats
- Partially formed or malformed JSON
- Odd marriages of JSON/CSV
- Key-value pairs with “=” separator

```
Alarm_2_OnOff = 0
Alarm_2_OnOff_sal = 0
Alarm_2_Time = 55200000
Alarm_2_Time_sal = 56340000
Alarm_3_OnOff = 0
Alarm_3_Time = 55200000
▶ Alexa (1 topic, 1 message)
▶ Alpha530 (15 topics, 15 messages)
▶ Alpha530_530_19_3_Prod (15 topics, 15 messages)
▶ Altus2 (2 topics, 2 messages)
AmitTest = {"AmitTestVar1":true,"AmitTestVar2":1,"AmitTestVar3":2,"AmitTestVar4":3,"AmitTestVar5":4,"AmitTestVar6":5,"AmitTestVar7":6.000000,"AmitTestVar8"
Angle = 119
Angle1 = 0
Angle2 = 0
Angle3 = 0
Angle4 = 0
Anya = 0
Aownangtoday_saving = 633.9765625
Aownangyesterday_saving = 317.609375
ApexLoRaDemo = {"deviceIdField":36016,"deviceName":"Capteur Sense","deviceReference":null,"deviceSerialNumber":"0629CU0038","deviceTypeMark":"Nex
▼ Appelpweg
  ▼ Balkon
    Efficiency = 0.0
    ▶ Firmware (3 topics, 3 messages)
    PF_AC = 0.0
    Temp = 24.6
    YieldToday = 2.809
    YieldTotal = 622.253
    ▶ emeter (5 topics, 5 messages)
    ▶ emeter-dc (12 topics, 12 messages)
    time = 15.08.2023T20:39:44
    total_events = 1
Apple_01 = 4.423656928131721
▶ AqiX546jF4 (1 topic, 1 message)
▶ Area1 (2 topics, 2 messages)
▶ AroWstat (8 topics, 8 messages)
▶ Artikel (1 topic, 1 message)
Arusct1 = {"msg_type":"CHANNEL_UPDATE","if_type":1,"com_port":3,"module_no":1,"ch_type":"INPUT_REGISTERL","ch_addr":4354,"nickname":"","value":0.0
Arvind = 1
▶ AtEDBtY1y (1 topic, 1 message)
▶ Auto (1 topic, 1 message)
▶ AutomaticDeploymentSystem (12 topics, 12 messages)
AutomaticTest = {"deviceIdField":15171,"deviceName":"Capteur version d'essai","deviceReference":null,"deviceTypeMark":"Pyrescom","deviceTypeRef":"SYNO
▶ Avtoklav (9 topics, 9 messages)
▶ Axjd5KWool (1 topic, 1 message)
▶ B0501 (1 topic, 1 message)
▶ B0612 (1 topic, 1 message)
B6101794 = hello
▶ BERNEROBERLAND (1 topic, 1 message)
BETA_BOX_CUSTOM_MODE_SETVALUE = false
```



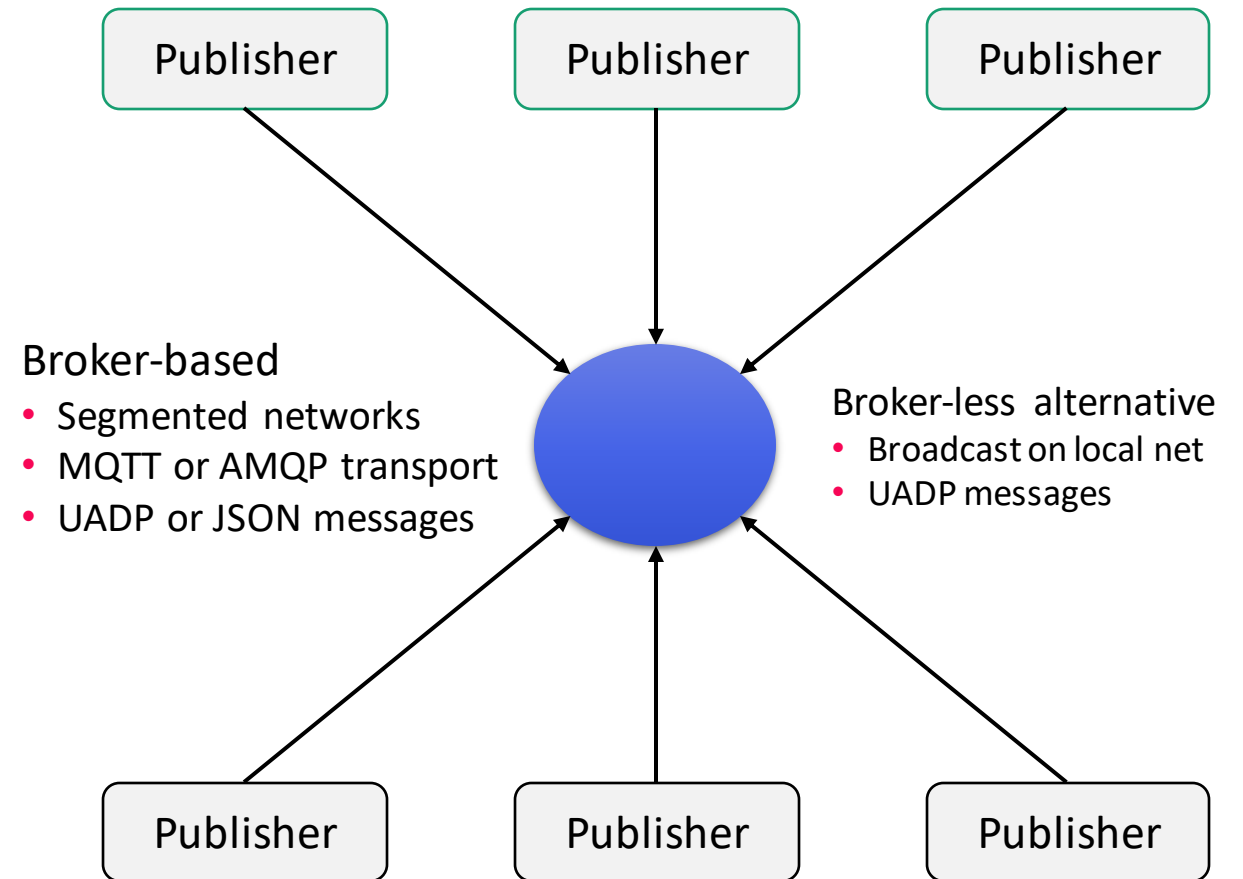
- **OPC UA Part 14: PubSub**

- Specifies indirect OPC UA communication via a Publisher/Subscriber model, using either UDP multicast or a broker-based architecture transport protocols:

- MQTT
- AMQP

- Supports a subset of the operations supported by client-server OPC UA. For instance, A&C and Methods are not supported with PubSub currently

- OPC UA PubSub is currently not supported by AVEVA Communication Drivers





“Sparkplug is an open software specification that provides MQTT clients the framework to seamlessly integrate data from their applications, sensors, devices, and gateways within the MQTT Infrastructure. It is specifically designed for use in Industrial Internet of Things (IIoT) architectures to ensure a high level of reliability and interoperability.”

[Frequently Asked Questions | The Eclipse Foundation](#)

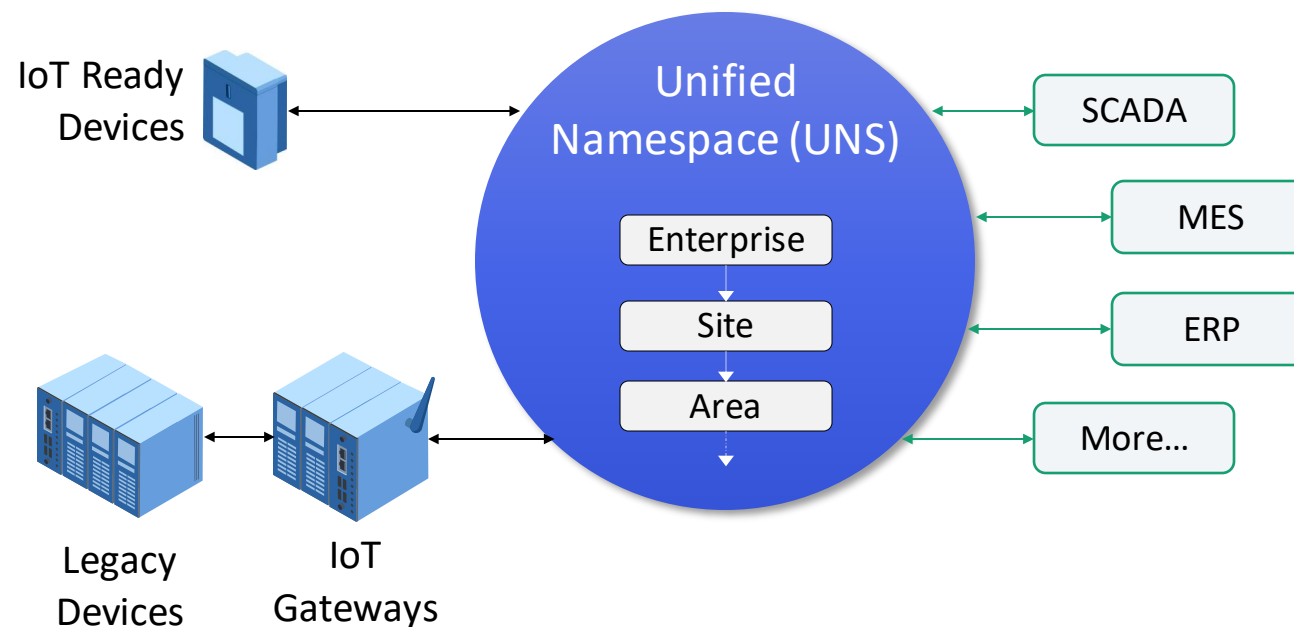
Supported by

- AVEVA Edge
- AVEVA Communication Drivers Pack

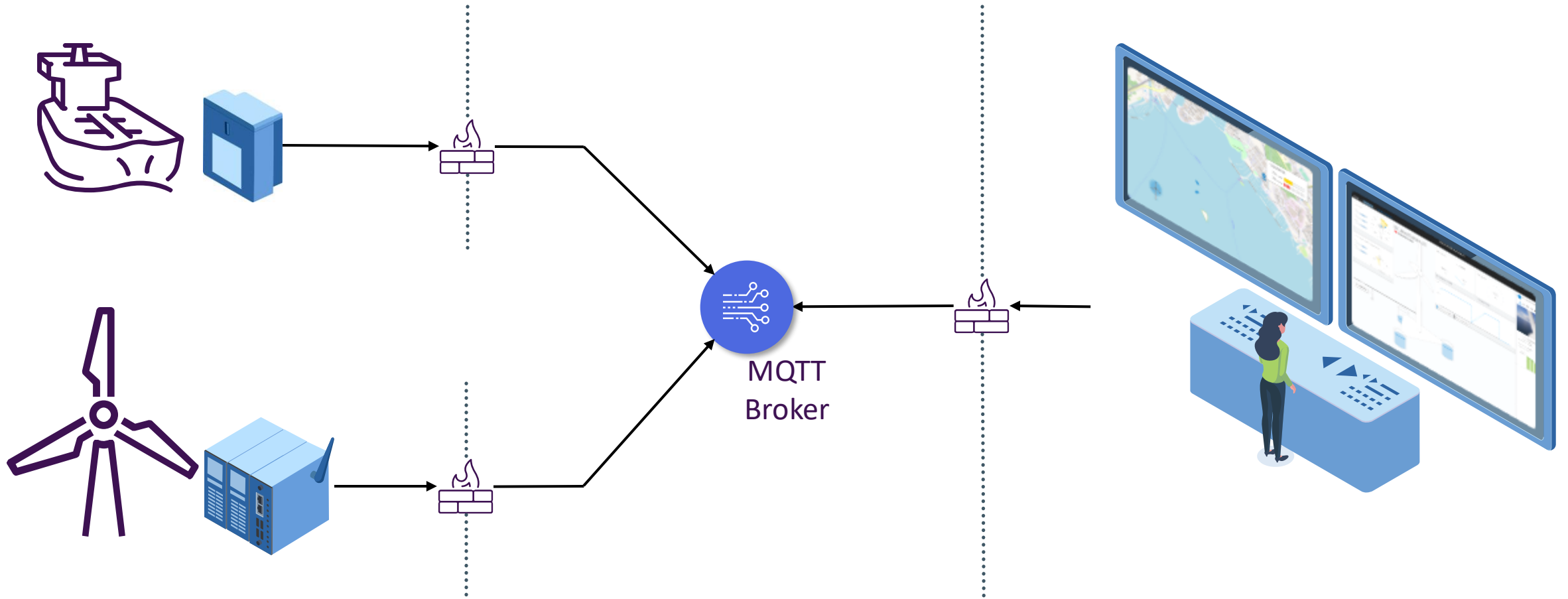
- Standardized topic structure and message format to ensure interoperability between systems and devices from different vendors
- Encoding of payloads with Protocol Buffers, to reduce message size
- State awareness, providing subscribing clients with confidence in data validity
- Discovery of devices, assets, and process variables, providing subscribing clients with an evergreen asset model and enabling automatic provisioning

Unified Namespace (UNS)

- A single standardized real-time namespace
- Serving and served by multiple systems
- ..and multiple types of systems
- ..and multiple vendors
- Realized by broker-based architecture paired with industrial standards for interoperability
 - De facto: MQTT + Sparkplug



MQTT Demo





- Operations Control Management Console (BETA)
- > Historian
 - > Galaxy Database Manager
 - > Operations Integration Server Manager
 - > Default Group
 - > Local
 - > [Admin] Operations Integration Supervisory Servers
 - > SVENDORNAMES - MyOwnOIServer
 - > Allen-Bradley - ABCIP
 - > Allen-Bradley - ABTCP
 - > Beckhoff - TWINCAT
 - > General Electric - GESRTP
 - > Internal - SIM
 - > Mitsubishi - MELSEC
 - > Modicon - MBTCP
 - > Omron - OMRONFINS
 - > Schneider-Electric - SOMAC
 - > Siemens - SIDIRECT
 - > Standards - BACLITE
 - > Standards - CODESYS
 - > Standards - Gateway
 - > Standards - MQTT
 - > OI.MQTT.1
 - > Configuration
 - > Standards - SNMP
 - > Standards - WEBSVC
 - > Texas Instruments - TI500
 - > Tutorials
 - > Log Viewer
 - > Platform Manager

Component	Version	Build Date
MQTT	2023.0412.4484.1	April 12, 2023
MQTT [Shell]	2023.0322.4463.1	April 12, 2023
PluginPCSDII	2023.0412.4484.1	April 12, 2023
PluginMQTT	2023.0412.4484.1	April 12, 2023
PluginOPC	2023.0412.4484.1	April 12, 2023
PluginDDESL	2023.0412.4484.1	April 12, 2023

Supported JSON formats

JSON-VTQ1

- Each process variable is its own topic
- One message per transmitted value
- Suitable for few data points and low update rates

```
// Topic structure: <group>/<item name>
{
  "d": 34.0,
  "dt": 4,
  "ts": "2023-10-24T16:30:00",
  "q": 192
}
```

JSON-VTQ2

- Up to 1,000 process variables per topic
- One message may contain multiple updates
- Suitable for larger systems and high update rates

```
{
  "timestamp": 1698157800,
  "values": [
    {
      "id": "Bearing1.Temperature",
      "v": 34.0,
      "dt": 4,
      "t": 1698157793,
      "q": 192
    },
    { ...item 2... },
    { ...item n }
  ]
}
```

JSON is JSON

- While JSON may appear as text, it is not
- Common pitfalls by treating JSON as text
 - Injecting unnecessary whitespace into messages for readability with Notepad or other text editors
 - ✓ Use a proper JSON editor/viewer instead
 - Improper or incomplete enclosing
 - Improper escaping of special characters
 - Illegal formatting of data and time
 - ✓ Must be UNIX Epoch or ISO 8601 string format
 - Illegal decimal separators with non-US locales
 - ✓ Must use dot (.) as decimal separator

Problematic

```
// Subject to locale-specific formatting
timeStamp.ToString();
temperature.ToString();
```

Better

```
// Output an ISO-8601 formatted string
timeStamp.ToString("yyyy-MM-ddTHH:mm:ss");
timeStamp.ToString("s");

// Use a JSON serializer to convert data
Newtonsoft.Json.JsonConvert.ToString(temperature);
```

Troubleshooting

Tools for troubleshooting

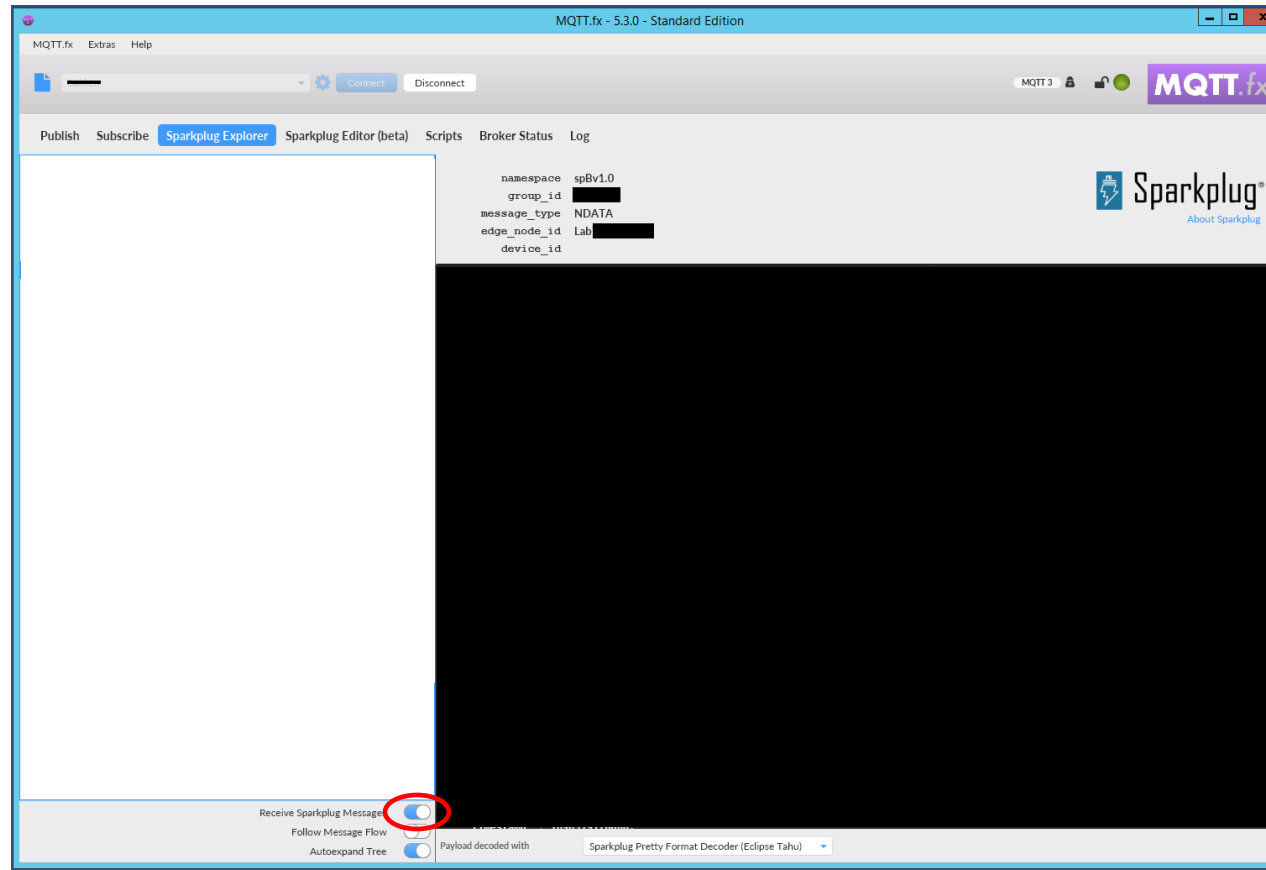


AVEVA

- Communication Drivers Pack – Standards-MQTT Driver

MQTT.FX

SpBV – Finding the Topics



MQTT.FX

Subscribe to Topics

The screenshot displays the MQTT.fx 5.3.0 Standard Edition interface. The main window is titled "MQTT.fx - 5.3.0 - Standard Edition". The interface includes a menu bar (MQTT.fx, Extras, Help), a toolbar with "Connect" and "Disconnect" buttons, and a status bar showing "MQTT 3" and the MQTT.fx logo.

The main workspace is divided into several sections:

- Subscription List:** On the left, there is a list of subscribed topics. The topics "spBv1.0/#", "spBv1.0/#", and "spBv1.0/#NDATA/#" are highlighted with red circles. Each topic has a "Subscribe" button and a "Dump Messages (JSON)" button.
- Message Log:** A central table displays received messages. The table has columns for "Topic Filter", "QoS", "Time", "Topic", "QoS", and "Action". The messages are filtered by the topic "spBv1.0/#".
- Message Viewer:** At the bottom right, a message viewer shows the details of a received message. The message is from "spBv1.0/#NDATA/#" and is a "Sparkplug" message. The payload is decoded using the "Sparkplug Pretty Format Decoder".

Topic Filter	QoS	Time	Topic	QoS	Action
spBv1.0/#	0	09:25:30.33930240	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930240	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930240	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930402	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930402	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930402	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930516	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930516	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930516	spBv1.0/I	4/NDATA/L	RL
spBv1.0/#	0	09:25:30.33930530	spBv1.0/I	4/NDATA/J	L,RL
spBv1.0/#	0	09:25:30.33930530	spBv1.0/I	4/NDATA/J	L,RL
spBv1.0/#	0	09:25:30.33930530	spBv1.0/I	4/NDATA/J	L,RL
spBv1.0/#	0	09:25:30.33930671	spBv1.0/I	4/NDATA/F	BFM,RL
spBv1.0/#	0	09:25:30.33930671	spBv1.0/I	4/NDATA/F	BFM,RL
spBv1.0/#	0	09:25:30.33930671	spBv1.0/I	4/NDATA/F	BFM,RL

MQTT.FX

Checking values

The screenshot shows the MQTT.fx 5.3.0 Standard Edition interface. The main window displays a list of messages with columns for ID, Time, Topic, and Payload. A red arrow points to the 'RL' payload in the message log. Below the log, a detailed view of a message is shown, including a 'Name' field and a 'Value' field. A red arrow points to the 'Payload decoded with' dropdown menu, which is set to 'Sparkplug Pretty Format Decoder (Ed...)'.

ID	Time	Topic	Payload
7893	09:25:30.33930240	spBv1.0/I/4/NDATA/L	RL
7896	09:25:30.33930240	spBv1.0/I/4/NDATA/L	RL
7897	09:25:30.33930240	spBv1.0/I/4/NDATA/L	RL
7898	09:25:30.33930402	spBv1.0/I/4/NDATA/L	RL
7899	09:25:30.33930402	spBv1.0/I/4/NDATA/L	RL
7899	09:25:30.33930530	spBv1.0/I/4/NDATA/J	RL
7899	09:25:30.33930530	spBv1.0/I/4/NDATA/J	RL
7899	09:25:30.33930530	spBv1.0/I/4/NDATA/J	RL
7899	09:25:30.33930671	spBv1.0/I/4/NDATA/F	BFM_RL
7899	09:25:30.33930671	spBv1.0/I/4/NDATA/F	BFM_RL
7899	09:25:30.33930671	spBv1.0/I/4/NDATA/F	BFM_RL

Unix timestamp

```
{  
  "timestamp" : 1696519531000,  
  "metrics" : [ {  
    "alias" : 4005,  
    "timestamp" : 1696519531000,  
    "dataType" : "Int32",  
    "value" : 31  
  } ],  
  "seq" : 92  
}
```

<https://www.unixtimestamp.com/>



- Communication Drivers Pack – Standards - MQTT Driver

User Guide

- Chapter 3 Diagnostic System Items
 - Standard System Items
 - Global System Items.
 - Device-Specific System Items.
 - Device Group-Specific System Items.
 - MQTT Communication Driver-Specific Diagnostics
 - Global Diagnostic Items.
 - Subscriber Diagnostic Items.
 - Publisher Diagnostic Items.

Questions?

Please wait for the microphone.
State your name and company.



Please remember to...

Navigate to this session in the mobile app to complete the survey.



Thank you!

This presentation may include predictions, estimates, intentions, beliefs and other statements that are or may be construed as being forward-looking. While these forward-looking statements represent our current judgment on what the future holds, they are subject to risks and uncertainties that could result in actual outcomes differing materially from those projected in these statements. No statement contained herein constitutes a commitment by AVEVA to perform any particular action or to deliver any particular product or product features. Readers are cautioned not to place undue reliance on these forward-looking statements, which reflect our opinions only as of the date of this presentation.

The Company shall not be obliged to disclose any revision to these forward-looking statements to reflect events or circumstances occurring after the date on which they are made or to reflect the occurrence of future events.

 [linkedin.com/company/aveva](https://www.linkedin.com/company/aveva)

 [@avevagroup](https://twitter.com/avevagroup)

ABOUT AVEVA

AVEVA is a world leader in industrial software, providing engineering and operational solutions across multiple industries, including oil and gas, chemical, pharmaceutical, power and utilities, marine, renewables, and food and beverage. Our agnostic and open architecture helps organizations design, build, operate, maintain and optimize the complete lifecycle of complex industrial assets, from production plants and offshore platforms to manufactured consumer goods.

Over 20,000 enterprises in over 100 countries rely on AVEVA to help them deliver life's essentials: safe and reliable energy, food, medicines, infrastructure and more. By connecting people with trusted information and AI-enriched insights, AVEVA enables teams to engineer efficiently and optimize operations, driving growth and sustainability.

Named as one of the world's most innovative companies, AVEVA supports customers with open solutions and the expertise of more than 6,400 employees, 5,000 partners and 5,700 certified developers. The company is headquartered in Cambridge, UK.

Learn more at www.aveva.com