Leveraging MQTT for edge to cloud
Best practices and troubleshooting

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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

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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
• **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 MQI TT 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
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

```json
// 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

```json
{
    "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**

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

**Better**

```csharp
// 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

- Communication Drivers Pack – Standards - MQTT Driver
MQTT.FX

SpBV – Finding the Topics
MQTT.FX

Subscribe to Topics
Checking values

Unix timestamp

```json
{
  "timestamp": 1696519531000,
  "metrics": [{
    "alias": 6085,
    "timestamp": 1696519531000,
    "dataType": "Int32",
    "value": 31
  }],
  "seq": 92
}
```
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!
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