

# OPC DAY FINLAND 2020

4.11.2020, 1.00-4.30 PM (EET)

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## OPC UA PubSub: Experiences integrating existing AMQP based communication

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# Content

- Motivation: cyber-physical systems, IoT, making use of data
- Integrating existing AMQP messaging with OPC UA PubSub (AMQP)
- Adapter implementation and experiences

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# Cyber-physical systems, IoT and data

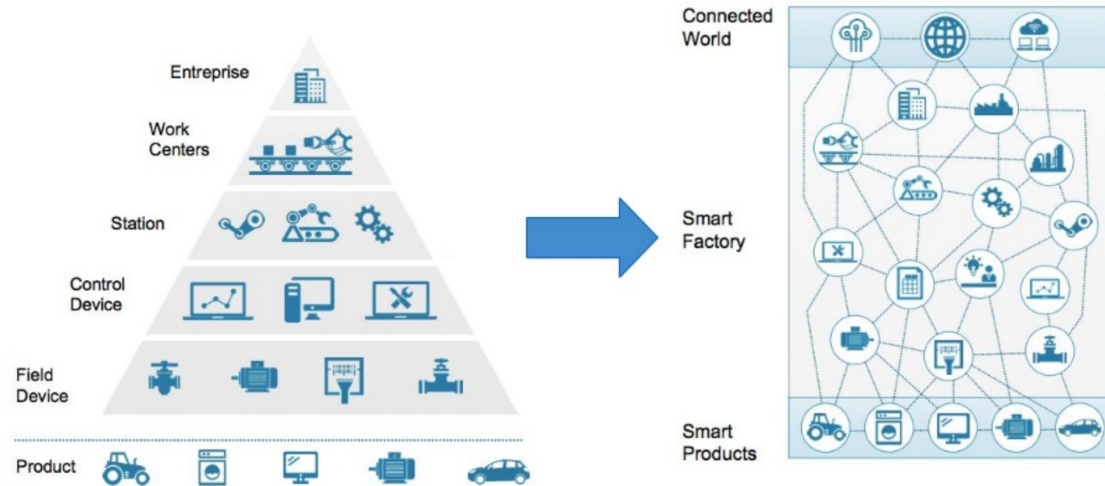


Figure: PrismTech,2015 Evolving Structure

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# Cyber-physical systems, IoT and data

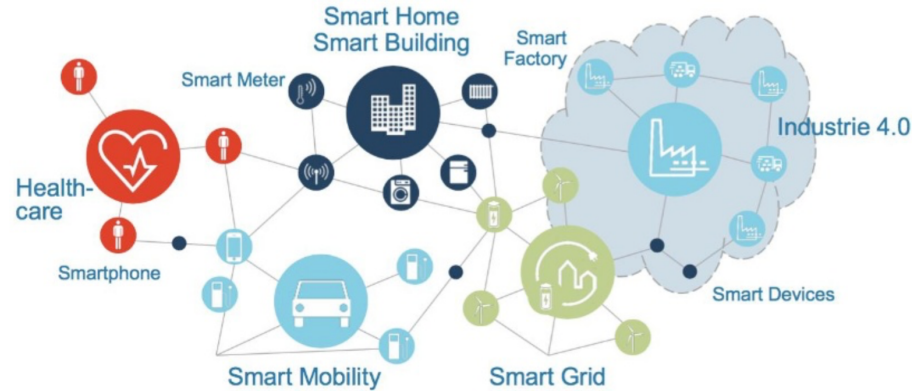


Figure: Bosch Rexroth AG

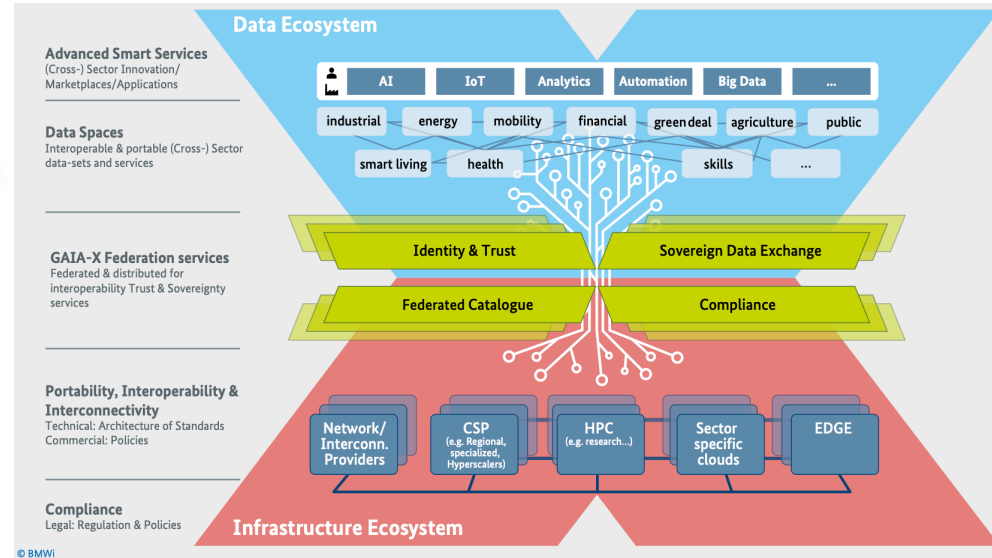


Figure: GAIA-X: Driver of digital innovation in Europe

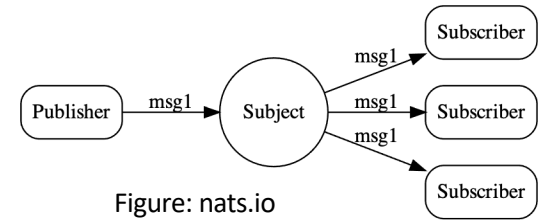
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# Asynchronous messaging and Publish/Subscribe

- Send messages between each other when they decide to and not when requested
  - Asynchronous communication is often necessary on the web, activities may take long (e.g. hours), or we do not have control of the other end or its load
- The Publish/Subscribe pattern allows distributing information to interested parties efficiently
  - The publisher sends its information only once to a publish/subscribe server that retransmits it to any subscribers



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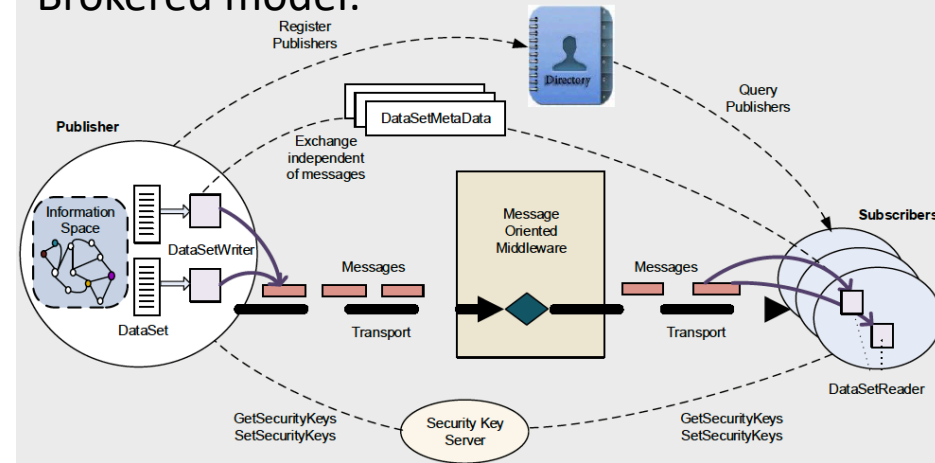
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# OPC UA PubSub quick introduction

- OPC UA PubSub has two main uses
  - Shop floor low-latency communications
  - Integration of OPC UA in cloud applications
- Multicast (incl. TSN) or broker based (e.g. MQTT, AMQP)
- UA Datagram Protocol (UADP) message or JSON

## Brokered model:

Figure: OPC Foundation



No requirement for the concept of an OPC UA Server or Client in order to perform OPC UA PubSub messaging

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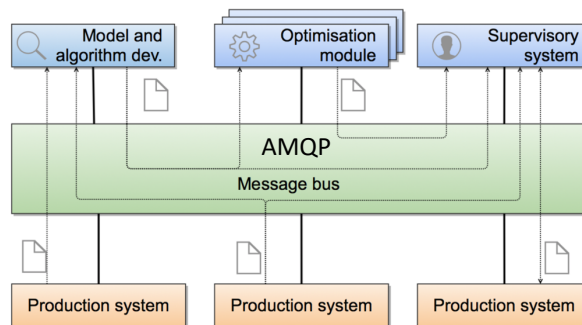
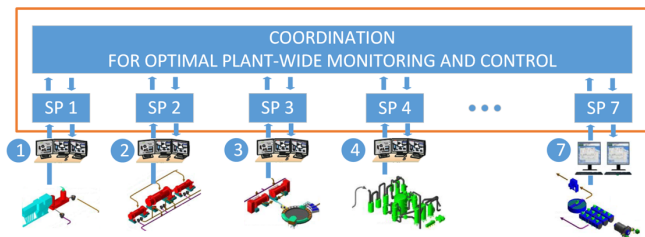
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# COCOP enabling plant-wide monitoring and control



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661.

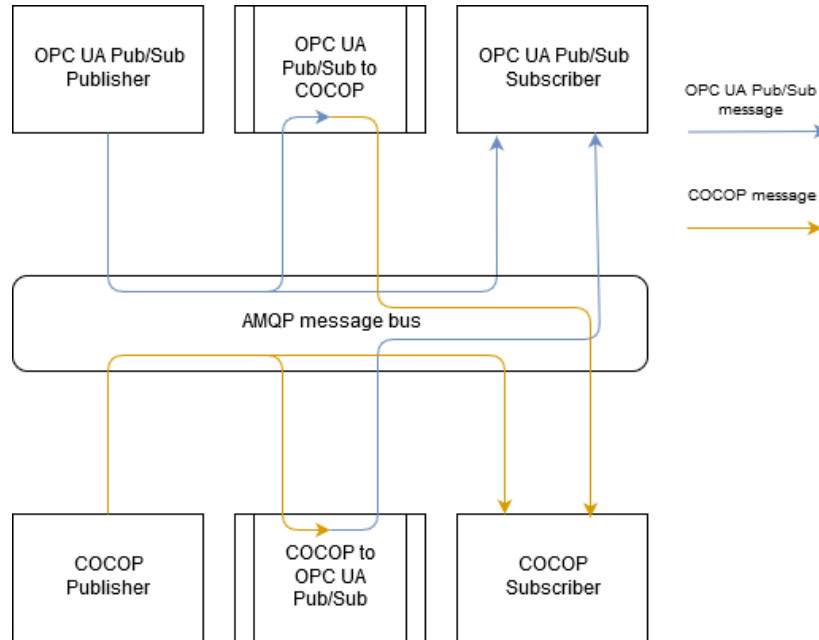
	Standard/specification	Purpose
B2MML	Business to Manufacturing Markup Language	In COCOP: schedules
GML	Geography Markup Language (2016)	Measurement values
O&M	Observations and Measurements (2013)	Metadata of measurements
SOS	Sensor Observation Service (2012)	Request-response delivery of measurements
SPS	Sensor Planning Service (2011)	Remote control of tasks
SWE	SWE Common Data Model Encoding (2011)	Measurement values
TSML	TimeseriesML (2016)	Time series

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# AMQP <-> OPC UA PubSub



Figures: Antti Kätkytniemi

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# COCOP messaging

```
<?xml version="1.0" encoding="UTF-8"?>
<om:OM_Observation
  gml:id="COTest3"
  xmlns:om="http://www.opengis.net/om/2.0"
  xmlns:swe="http://www.opengis.net/swe/2.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xsi:schemaLocation="http://www.opengis.net/om/2.0 http://schemas.opengis.net/om/2.0/observation.xsd
http://www.opengis.net/swe/2.0 http://schemas.opengis.net/sweCommon/2.0/swe.xsd"
  <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_ComplexObservation"/>
  <om:phenomenonTime>
    <gml:TimeInstant
      gml:id="ot1t">
      <gml:timePosition>2018-01-01T00:40:00Z</gml:timePosition>
    </gml:TimeInstant>
  </om:phenomenonTime>
  <om:resultTime>
    <gml:TimeInstant
      gml:id="ot2t">
      <gml:timePosition>2018-01-01T00:40:00Z</gml:timePosition>
    </gml:TimeInstant>
  </om:resultTime>
  <om:procedure xlink:type="simple" xlink:title="ProcessDataPublisher"/>
  <om:observedProperty xlink:type="simple" xlink:title=""/>
  <om:featureOfInterest xlink:type="simple" xlink:title="fsf-composition-matte"/>
```

```
<om:result xsi:type="swe:DataRecordPropertyType">
  <swe:DataRecord>
    <swe:field name="Cu">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>74.00</swe:value>
      </swe:Quantity>
    </swe:field>
    <swe:field name="Fe">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>10.00</swe:value>
      </swe:Quantity>
    </swe:field>
    <swe:field name="Ni">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>1.00</swe:value>
      </swe:Quantity>
    </swe:field>
    <swe:field name="S">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>15.00</swe:value>
      </swe:Quantity>
    </swe:field>
  </swe:DataRecord>
</om:result>
</om:OM_Observation>
```

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Figures: Antti Kattytäinen

# Mapping OPC UA PubSub and COCOP

[illegible]

```
Messages: [{
  DataSetWriterId: String,
  (Timestamp: DateTime,)
  (Status: StatusCode,)
  Payload: {
    Timestamp: DateTime,
    FeatureOfInterest: String,
    Composition: [{
      Name: String,
      UOM: String,
      Value: Double
    },
    ...
  ]
}]
}]
```

Figures: Antti Kätkytniemi

```

Messages: [{
  DataSetWriterId: String,
  (Timestamp: DateTime,)
  (Status: StatusCode,)
  Payload: {
    Timestamp: DateTime
    FeatureOfInterest: String
    Composition: [{
      Name: String
      UOM: String
      Value: Double
    },
    ...
  ]
}]

```

```

xsi:schemaLocation="http://www.opengis.net/om/2.0 http://schemas.opengis.net/om/2.0
http://www.opengis.net/swe/2.0 http://schemas.opengis.net/sweCommon/2.0/swe.xsd">

<!-- Mandatory element -->
<om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_Comp

<!-- Mandatory element -->
<!-- Timestamp of the sample in the database -->
<om:phenomenonTime>
  <gml:TimeInstant
    gml:id="ot1t">
      <gml:timePosition>2005-01-11T17:22:25.00+02:00</gml:timePosition>
    </gml:TimeInstant>
  </om:phenomenonTime>

<!-- Mandatory element -->
<!-- Timestamp of the sample in the database -->
<om:resultTime>
  <gml:TimeInstant
    gml:id="ot2t">
      <gml:timePosition>2005-01-11T17:22:25.00+02:00</gml:timePosition>
    </gml:TimeInstant>
  </om:resultTime>

<!-- Mandatory element -->
<om:procedure xlink:type="simple" xlink:title="ProcessDataPublisher"/>

<!-- Mandatory element -->
<om:observedProperty xlink:type="simple" xlink:title=""/>

<!-- Mandatory element -->
<om:featureOfInterest xlink:type="simple" xlink:title="fsf-composition-matte"/>

<om:result xsi:type="swe:DataRecordPropertyType">
  <swe:DataRecord>
    <swe:field name="Co">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>0.1</swe:value>
      </swe:Quantity>
    </swe:field>
    <swe:field name="Cu">
      <swe:Quantity>
        <swe:uom code="g"/>
        <swe:value>22.3</swe:value>
      </swe:Quantity>
    </swe:field>
    <!-- Other fields... -->

```

Figures: Antti Kätkyntiemi

# Example of mapping

⟷

```

<?xml version="1.0" encoding="UTF-8"?>
<om:OM_Observation
  gml:id="OCTest3"
  xmlns:om="http://www.opengis.net/om/2.0"
  xmlns:swe="http://www.opengis.net/swe/2.0"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xsi:schemaLocation="http://www.opengis.net/om/2.0 http://schemas.opengis.net/om/2.0/observation.xsd
http://www.opengis.net/swe/2.0 http://schemas.opengis.net/sweCommon/2.0/swe.xsd">
  <om:type xlink:href="http://www.opengis.net/def/observationType/OGC-OM/2.0/OM_ComplexObservation"/>
  <om:phenomenonTime>
    <gml:TimeInstant
      gml:id="ot1t">
      <gml:timePosition>2018-01-01T00:40:00Z</gml:timePosition>
    </gml:TimeInstant>
  </om:phenomenonTime>
  <om:resultTime>
    <gml:TimeInstant
      gml:id="ot2t">
      <gml:timePosition>2018-01-01T00:40:00Z</gml:timePosition>
    </gml:TimeInstant>
  </om:resultTime>
  <om:procedure xlink:type="simple" xlink:title="ProcessDataPublisher"/>
  <om:observedProperty xlink:type="simple" xlink:title=""/>
  <om:featureOfInterest xlink:type="simple" xlink:title="fsf-composition-matte"/>
  <om:result xsi:type="swe:DataRecordPropertyType">
    <swe:DataRecord>
      <swe:field name="Cu">
        <swe:Quantity>
          <swe:uom code="g"/>
          <swe:value>74.00</swe:value>
        </swe:Quantity>
      </swe:field>
      <swe:field name="Fe">
        <swe:Quantity>
          <swe:uom code="g"/>
          <swe:value>10.00</swe:value>
        </swe:Quantity>
      </swe:field>
      <swe:field name="Ni">
        <swe:Quantity>
          <swe:uom code="g"/>
          <swe:value>1.00</swe:value>
        </swe:Quantity>
      </swe:field>
      <swe:field name="S">
        <swe:Quantity>
          <swe:uom code="g"/>
          <swe:value>15.00</swe:value>
        </swe:Quantity>
      </swe:field>
    </swe:DataRecord>
  </om:result>
</om:OM_Observation>

```

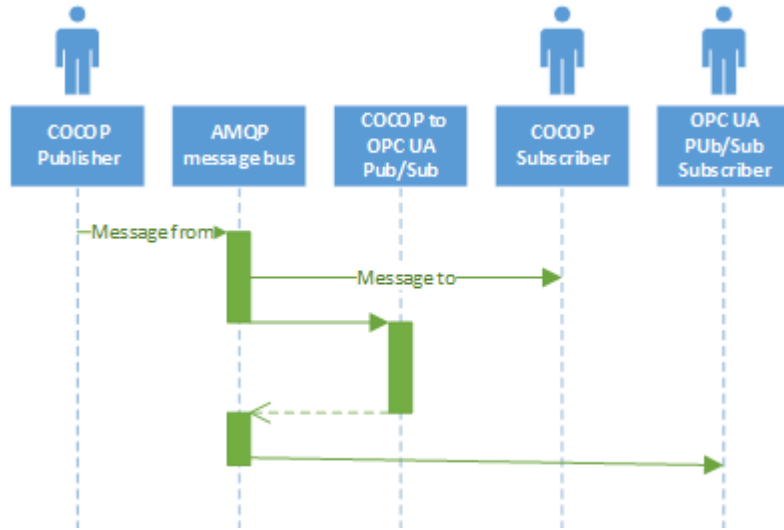
```

{
  DataSetWriterId: 'ProcessDataPublisher',
  Payload: {
    Timestamp: '2018-01-01T00:40:00Z',
    FeatureOfInterest: 'fsf-composition-matte',
    Composition: [
      {
        Name: 'Cu',
        UOM: 'g',
        Value: 74.00
      },
      {
        Name: 'Fe',
        UOM: 'g',
        Value: 10.00
      },
      {
        Name: 'Ni',
        UOM: 'g',
        Value: 1.00
      },
      {
        Name: 'S',
        UOM: 'g',
        Value: 15.00
      }
    ]
  }
}

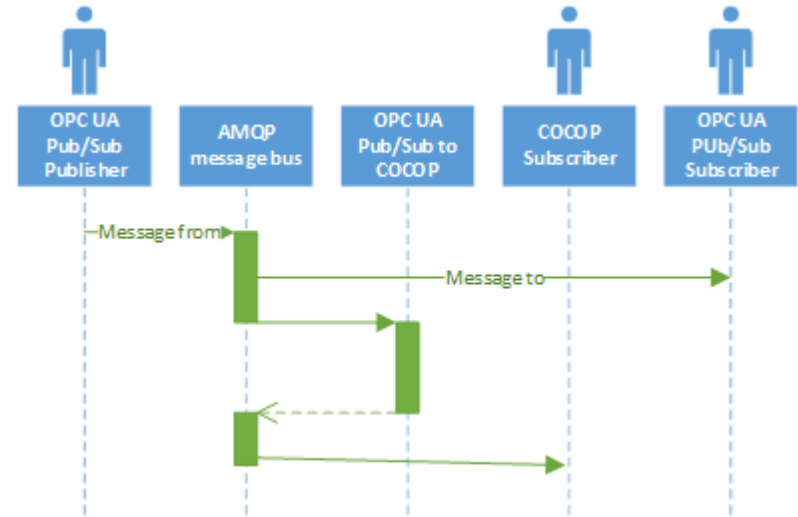
```



# XML AMQP to PubSub



# PubSub to XML AMQP



Figures: Antti Kätkytniemi

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# Summary and conclusion

- OPC UA PubSub and other AMQP based communications are easy to integrate
  - Decoupled systems by nature, easy to tap into data (shared meaning of data)
  - Security can be enforced end to end, signing and encryption
  - OPC UA PubSub using AMQP (or MQTT for that matter) is easy – any client can be an OPC UA PubSub party (as shown)
- PubSub can ease the burden on traditional OPC servers with many connections and yet unforeseen use cases (Internet and cloud-based applications)
  - Paves the way for broader use of data across domains in different data spaces

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# Thank you for your attention!



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## Thank you!



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