OPC Unified Architecture
OPC UA PubSub
PubSub Use Cases

- Publisher and Subscriber (Clients and Servers) behind firewalls (Message broker is Relay)
- Controller to controller communication
- Integration with message brokers
- Cloud connectivity
- Large scale
Subscription in OPC UA Client / Server Model

Subscription in C/S

> Selection of data and events streams per client
> Configuration and consumption of streams in band
> Individual configuration per client
> Reliable, one time data and event delivery

Constrain

> Model does not scale
Client / Server vs. Publish / Subscribe

Pub-Sub = optimized Subscription

- Best effort high speed data streaming (UDP)
- Real-time with TSN
- Cloud connectivity with AMQP and MQTT
- Offloading of message distribution to broker

Constraints

- Only preconfigured data and event streaming
- Configuration requires Client-Server
- Load moved to Subscriber (UDP multicast)
OPC UA Publish / Subscribe – Big Picture

Publisher

DataSetWriter

DataSet

Information Space

Register

Exchange independent of messages

DataSetMetaData

Message Oriented Middleware

Transport

Subscribers

DataSetReader

GetSecurityKeys

Security Key Server

© Unified Automation GmbH – All rights reserved.
Protocol Options

Peer-to-peer Binding

- UADP Messages over UDP
  - Ethernet Frame, IP and UDP header
  - Standard Port 4840
  - UADP Message Mapping
- UADP Messages over Ethernet Layer 2
  - Ethernet Frame header with EtherType 0xB62C
  - UADP Message Mapping

Broker Binding

- JSON Messages over AMQP
- UADP Messages over AMQP
- JSON Messages over MQTT
- UADP Messages over MQTT
What Information gets Published?

Conceptual Model and Configuration Model
Client / Server Model can be used to configure Publisher / Subscriber

- PublishSubscribe
- PubSubConnection
- WriterGroup
- DataSetWriter
- ReaderGroup
- DataSetReader
- Transport Protocol
- NetworkMessage
- DataSetMessage
- PublishedDataSet
- DataSet
- DataSetMetaData
- Published DataSet
- DataSetWriter

**PubSubConnection:**
Network addressing setting
Protocol selection

**WriterGroup:**
Combines several DataSet Messages to one Network Message
Timing settings for the creation of Network Messages
Security Settings (Security managed per group)
MessageRepeatCount (Datagram)
- How often one message is send out

**DataSet:**
List of named data values (DataSet Fields)

**DataSetMetaData:**
Message contract between Publisher and Subscriber
- Meta data for data values
  (Name, DataType, Properties)
- ConfigurationVersion (if configuration changes)
- DataSetClassId (Standardized DataSets)

**Published DataSet:**
Configuration of data acquisition
- List of variables
- Event filter
- Application-specific messages
DataSetMetaData

**DataSetWriter:**
Content Mask
- Status (per value / message / none)
- Timestamp (per value / message / none)
- Raw values (fixed size without type information)
Encoding of Messages (JSON or UADP)
KeyFrameCount
- Cyclic or exception-based comunication
RequestedDeliveryGuarantee (Broker)
NetworkMessage with DataSetMessages

**UADP Message Mapping**
- UA Binary encoded
- Message security

**NetworkMessage**
- Contains list of DataSetMessages (Payload)
- Payload can be encrypted

**DataSetMessage**
- Data in encrypted Payload
- DataSetWriterId in unencrypted header

---

**NetworkMessage Header**

- Payload Header
- Security Header
- Payload
- Padding
- Signature

**Data to Encrypt**

**Data to Sign**

---

**JSON Message Mapping**
- Has similar layout of information in JSON encoding
- No message security
OPC UA Publish / Subscribe Security

> Client-Server Security
  > PKI and asymmetric algorithms to exchange session keys
  > Session keys are used for communication with symmetric algorithms
  > Session keys are frequently rotated

> Pub-Sub Security (end to end security)
  > Session keys must be shared between Publishers and Subscribers
  > Keys are managed for a security group
  > Messages are sent in the context of a security group
  > Key distribution is done with OPC UA Client-Server security
  > Authentication and Authorization during access to security group at key server

Options:
  > Publisher is Key Server
  > Central Key Server
Configured Controller to Controller Communication

- Existing OPC UA Server can be extended
- Configuration through OPC UA Clients

OPC UA Client

Configure

Services over UA TCP / UA Binary

Configure

OPC UA Server

Product specific address space and data integration

Publisher

Send

UADP over UDP

Subscriber

Receive

OPC UA Server

Product specific address space and data integration
Controller to Controller Real-time Communication

- UADP over UDP provides
  - Thin and efficient protocol stack for message handling
  - Allows cyclic data exchange
  - Base for device side real-time handling
- Standard Ethernet is not real-time capable today
- TSN (Time Sensitive Network) can solve this
  - TSN work in IEEE 802 working group – will be part of standard Ethernet
  - IEEE 802.1AS-Rev/D2.0 Timing & synchronization for time sensitive applications
  - IEEE 802.1Qbv Enhancement for scheduled traffic
  - IEEE 802.1CB Frame Replication and Elimination for Reliability
  - IEEE 802.1Qbu Frame preemption
  - Directly benefit from Ethernet speed enhancements (Gb+)
- Open Issues to be solved
  - System wide configuration of endpoints and switches
## Conclusion on OPC UA PubSub

<table>
<thead>
<tr>
<th>PubSub offers</th>
<th>Characteristics</th>
<th>Options for Companion Specifications</th>
</tr>
</thead>
</table>
| - Large Scale: Small publisher for large amount of subscribers  
- Integration into existing message infrastructure  
- Cloud connectivity  
- Controller-to-Controller connectivity | - Different protocol options  
  - Broker: AMQP and MQTT  
  - Broker-less: UDP or Ethernet Layer 2 (with TSN)  
- Different encodings  
  - UADP: High performance and message-based security  
  - JSON: Interoperable to OPC-UA-unaware AMPQ/MQTT applications | - Reference to OPC UA profiles to require specific PubSub settings  
- DataSetClassId for standardized DataSets |

© Unified Automation GmbH – All rights reserved.