OPC UA Enables Smart Manufacturing

Jouni Aro
CTO, Prosys OPC
Chairman, OPC Committee
Evangelist, OPC Foundation
OPC Foundation

- **Vision**
  - secure, reliable, multi-vendor, multi-platform, multi-domain interoperability from sensor to enterprise

- **International**
  - 500+ Companies from Automation & IT
  - International standard IEC62541
OPC Foundation: Board of Directors

- International board – democratic elections by members every year
  - Companies from Automation & IT
  - All over the world

North America
- Microsoft
- Honeywell
- Iconics

Europe
- SAP
- Siemens
- Beckhoff
- Ascolab

Japan
- Yokogawa
OPC Foundation: Key Persons

- President: Thomas Burke

- Vice President: Stefan Hoppe
OPC Foundation: Class A members

ABB  ALSTOM  AspenTech  azbil  BAKER HUGHES  BECKHOFF  Rexroth Bosch Group

CISCO SYSTEMS  DASSAULT SYSTEMES  EATON  EMERSON Process Management  FANUC

FESTO  Fuji Electric  GE  HITACHI Inspire the Next  Honeywell  IBM

JTEKT  KUKA  Lenze  Leuze electronic  LG CNS

KONGSBERG  METAWATER  METTLER TOLEDO  Microsoft  MITSUBISHI ELECTRIC

MHPS GROUP  NATIONAL INSTRUMENTS  OMRON  OSIsoft  PHOENIX CONTACT  RENESAS

Rockwell Automation  SAP  Schlumberger  Schneider Electric  SEW Eurodrive

SICK Sensor Intelligence  SIEMENS Solar Turbines  A Caterpillar Company  splunk  TOSHIBA

Valmet  WAGO  YOKOGAWA

OPC Day Finland 2017
World’s Largest Ecosystem for Interoperability

- OPC Statistics
- ARC analysis (Status 2016)
  - 35,000+ OPC Products
  - 4,200+ suppliers of OPC Products
  - 47 million+ OPC installations

- Projected for 2018
  - 52,000+ OPC Products
  - 6,000+ suppliers of OPC Products
  - 120 million OPC installations
OPC is de facto communication protocol in industrial systems since 1995 (OPC Classic)

- Originally: OLE for Process Control → OPC
- Microsoft DCOM based
- Separate protocols
  - Data Access (DA)
  - Alarms & Events (AE)
  - Historical Data Access (HDA)

OPC UA 1.0 released 2009

- Unified Architecture: DA, AC, HA, etc.
- Platform independent
- Built-in security
- Information modeling

IEC 62541 release 2010-2011

- Enables Secure Industrial Internet!
- Smart Manufacturing
- Smart Cities
- Etc.
OPC UA in the world

- IIC
- Industry 4.0
- MII 3.0
- Made in China 2025
North America: Industrial Internet Consortium (IIC)

Industrial Internet Reference Architecture (IIIRA), Connectivity Framework
https://www.iiconsortium.org/pdf/IIC_PUB_G5_V1.0_PB_20170228.pdf

Published on 28.02.2017

OPC UA listed with IoT‘s details

Today 3 testbeds with integrated OPC UA

- OPC UA + TSN in Manufacturing
- OPC UA Sensor in Brownfield environment
- OPC UA and AutomationML for factory
German Industrie 4.0 recommends OPC UA


- Approach for implementation of a Communication Layer
  - OPC UA: Basis IEC 62541

- Approach for implementation of an Information Layer
  - IEC Common Data Dictionary (IEC 61360 Series/ISO13584-42)
  - Characteristics, classification and tools to eCl@ss
  - Electronic Device Description (EDD)
  - Field Device Tool (FDT)

- Approach for implementation of a Functional and Information Layer
  - Field Device Integration (FDI) as integration technology

- Approach for end-to-end engineering
  - AutomationML
  - ProSTEP iViP
  - eCl@ss (characteristics)
German Industrie 4.0 requires OPC UA

There are 3 levels to reach: Basic / Ready / Full
- Industrie 4.0 Basic → 7 criteria – 2 of them are OPC UA

<table>
<thead>
<tr>
<th>2. Industrie 4.0 communication</th>
<th>Transfer of product data and data files for interpretation or simulation, for example; product data in standardised form. The product can be addressed via the network, supplies and accepts data, Plug &amp; Produce via Industrie 4.0-compliant services</th>
<th>T</th>
<th>M</th>
<th>Manufacturer makes data that is relevant for the customer available/accessible online with the aid of identification, e.g. PDF via http(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Product addressable online via TCP/UDP/IP with at least the information model from OPC-UA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Industrie 4.0 services and conditions</td>
<td>Definition still open (service system) General interface for loadable services and messages regarding statuses Essential basic services that an Industrie 4.0 product must support and provide</td>
<td>T</td>
<td>O</td>
<td>Description of the device interface available digitally</td>
</tr>
<tr>
<td>I</td>
<td>O</td>
<td>Information such as statuses, error messages, warnings, etc. available via OPC-UA information model in accordance with an industry standard</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
VDMA (Verband Deutscher Maschinen- und Anlagenbau, Mechanical Engineering Industry Association) represents more than 3,200 mostly medium-sized companies in the capital goods industry, making it the largest industry association in Europe.

New guideline „Industrie 4.0 Communication with OPC UA“ Available at Hanover Messe April 24th ISBN 978-3-8163-0709-9

English translation will follow

Adressing end users and integrators:
- Benefits of using OPC UA
- Example use cases
- Migration steps
OPC UA fits into Industrie 4.0

(Dr. Reinhard Heister)
Smart factory based on 'Manufacturing Industry Innovation 3.0 (MII3.0)' in response to the paradigm shift of the 4th Industrial Revolution.

MII3.0 is aiming for 3 achievements:
1) High productivity 2) High flexibility 3) High resource awareness through 3 technologies
1) Automation 2) Production 3) ICT

By 2020, it is working as a practical goal to spread smart factory technology to 10,000 enterprises in cooperation with major domestic and foreign companies. Especially, OPC UA will be used as an industrial standard to connect between OT (Operational Technology) and IT (Information Technology).
OPC Korea

SPS-IPC Drives 2016: Sign MoU with OPC Korea, Company KETI
opckorea@opcfoundation.org

Ceremony on March 30th 2017 in Seoul
TC124 started October 2016, working on the national standard

Formal release ceremony held
- Parts 1 - 8 have been completed and are released
- Parts 9 - 12 will be completed later in 2017

Government official speech's
- OPC UA is critical for factory automation “Made in China 2025”

Ceremony was attended by 120 people
China National Standard

In 2015, ITEI undertook 7 Intelligent Manufacturing Projects issued from MIIT, in which basic and common standards regarding to intelligent manufacturing body will be set. One project is "Industrial control networks standard research and verification platform", and one task of this project is to draft a national standard named "OPC UA-based unified architecture for interconnected networks in digital plant", which will provide a unified solution for interconnecting the networks among device level, control and management level in digital plant. This standard will promote, that the device manufacturers should provide OPC UA servers for their produced devices directly, and the software vendors should better to embed OPC UA clients. Therefore, for the device manufacturers and the software vendors, it is only needed to invest and develop once, while for the manufacturing enterprises and the system integrators, it will avoid case-by-case solutions, which will decrease integrating costs and cycles greatly.

Jinsong Ouyang,
President ,Instrumentation Technology & Economy Institute, P.R.China (ITEI)
Vice chairman of the committee ,National TC124 On Industrial Process Measurement,Control And Automation Of Sac

Industrial IoT can be viewed as the convergence of ICT and OT in the various industrial verticals. The resulting technology innovation has created an inflection point that will change how we think of, participate in and benefit from the industrial sector. In response to this inflection point, there is an emerging ecosystem that includes standards, best practices and reference architectures. This ecosystem includes both industry stakeholders and government initiatives across geographies and verticals.

OPC Foundation is an essential part of that emerging ecosystem. It defines OPC UA, a standard that is fundamental to linking the ICT and OT environments in a way that is both secure and forward looking, this enabling new innovations such a real time manufacturing, digital manufacturing and low latency/time sensitive industrial systems.

Wael William Diab,
Senior Director, Huawei Technologies Co., Ltd.
OPC Unified Architecture

- Platform Independent
- Standard Communication Protocols
- Built in Security
- Information Modeling
- Collaboration Platform
Communication Protocol

- OPC UA is based on TCP/IP
  - Client/Server-protocol
  - Session-based

- Alternative transport protocols
  - UA TCP
  - HTTPS
  - SOAP
  - Next: WebSocket (v1.04/2018)

- Full security
  - UA Secure Conversation
  - TLS (inside HTTPS)
  - (WS Secure Conversation: deprecated in OPC UA v1.03/2015)

- All parts flexible to accommodate changes as necessary!
New: Publisher/Subscriber

• To be released in OPC UA v1.04/2018
  1. Secure Multicast (UDP): towards hard real-time with TSN Ethernet extension
  2. Secure Publish/Subscribe in the Cloud (AMQP first – MQTT, XMPP, etc. later)
1. Optional Message Signing and Encryption (AES-128/256)
2. Applications authenticated with Application Instance Certificates (X.509)
3. Users authenticated with user name & password or X.509 certificates
4. Authorization on application level
OPC UA Security Analysis

Who: Federal Office for Information Security (German Government BSI)
Why: Because of relevance of OPC UA for German Industry

- Analysis of Specification / Analysis of Reference Implementation

Result: Available on BSI web and OPC web

Commented version available (English + German)
www.opcfoundation.org/security
### OPC UA Security Analysis

#### Recommendation: Use Security

<table>
<thead>
<tr>
<th>security Mode</th>
<th>Layer or Service</th>
<th>Denial of Service</th>
<th>Denial of Service</th>
<th>Message Spoofing</th>
<th>Message Alteration</th>
<th>Message Replay</th>
<th>Malformed Messages</th>
<th>Server Profiling</th>
<th>Session Hijacking</th>
<th>Rogue Server</th>
<th>Compromising User Credentials</th>
<th>Repudiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="Low Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="No Protection" /></td>
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<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="No Protection" /></td>
</tr>
<tr>
<td>Sign</td>
<td></td>
<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
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<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="No Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
</tr>
<tr>
<td>SignAndEncrypt</td>
<td></td>
<td><img src="#" alt="High Protection" /></td>
<td><img src="#" alt="High Protection" /></td>
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</table>

- No Protection
- Low Protection
- High Protection which restricts the possibilities of an attacker, but does not prevent this type of attack
- Effective protection (attacks of this type require cryptographic attacks)
Information Modeling

• Enable exchange of semantic information
  – Standard information models (ISA95, PLCopen, etc.)
  – Custom models
Collaboration: Information Models

- **Lower level modeling**
  - Profibus/NET, SERCOS, EtherCAT, CLPA, CAN, Powerlink, IO-Link, ...

- **Verticals**
  - MDIS, WITSML, PackML, IEC61850, MTConnect, VDMA (38 different!), ...

- **Enterprise levels**
  - ISA-95, MIMOSA, OpenFog, ...

- **Engineering**
  - PLCopen, AutomationML, DEXPI, ...
VDMA Collaboration: Target Fields of Industry

- Agricultural Machinery
- Air Conditioning and Ventilation
- Air Pollution Control
- Air-handling Technology
- Building Control and Management
- Cleaning Systems
- Compressors, Compressed Air and Vacuum Technology
- Construction Equipment and Building Material Machines
- Drying Technology
- Electrical Automation
- Electronics, Micro and Nano Technologies
- Engine Systems for Power and Heat Generation
- Engines and Systems
- Fire Fighting Equipment
- Fluid Power
- Food Processing Machinery and Packaging Machinery
- Foundry Machinery
- Gas Welding
- Hydro Power
- Integrated Assembly Solutions
- Large Industrial Plant Manufacturing
- Lifts and Escalators
- Machine Tools and Manufacturing Systems
- Machine Vision
- Materials Handling and Intralogistics
- Measuring and Testing Technology
- Metallurgical Plants and Rolling Mills
- Metallurgy
- Micro Technologies
- Mining
- Plastics and Rubber Machinery
- Power Systems
- Power Transmission Engineering
- Precision Tools
- Printing and Paper Technology
- Process Plant and Equipment
- Productronic
- Pumps + Systems
- Refrigeration and Heat Pump Technology
- Robotics
- Robotics + Automation
- Security Systems
- Software
- Surface Treatment Technology
- Textile Care, Fabric and Leather Technology
- Textile Machinery
- Thermal Turbines and Power Plants
- Thermo Process Technology
- Valves
- Waste Treatment and Recycling
- Wind Energy
- Woodworking Machinery

OPC UA CS under development

Awareness exists
New! OPC Product Certification Labs

- “OPC Foundation Europe Certification Lab” started 2017 Jan 2nd
- “OPC Foundation China Certification Lab” started 2017 Sept 1st

- New non-member test options (“Certification as a service”)
- OPC UA certification plus Companion Spec certifications
  - Certification of products
  - Script extensions of CTT for companion specs

First device in Europe Lab
Siemens RFID reader

Tom Burke (OPC), Jörg Allmendinger
New!
UA Logo Membership

Assumption:
- Worldwide OPC UA products are based on
  - minority provided by OPC members
  - majority provided by non OPC members using a toolkit

Till now:
- OPC UA logo is only available for OPC members and their products

Goal:
- Increase visibility of worldwide available OPC UA products
- Get in contact with non OPC members
Goal to offer paid services:
  - Certification as a (paid) service
  - Get them into full membership level
Trend: OPC UA between Services

Graphics: Prof. Zühlke, DFKI
Trend: OPC UA in Cloud

- Azure IoT Hub

On-Premise: Device Connectivity

Cloud: Data Ingest and Processing, Command & Control

Cloud: Presentation
Trend: OPC UA on Chip Level

- 2016: Commercial product with OPC UA on chip

- Intelligent multiprotocol module for field devices
- IoT communication via OPC UA and MQTT bypassing the PLC
- Central „build process“ with intelligent engineering tool
- Protocol independent object interface to the application
- Customized device description file & source code for integration into the application

(Hilscher)
OPC UA Videos

- **Basics**
  - OPC UA Vision, Thomas Burke
    [https://youtu.be/7mUmfg0M29U](https://youtu.be/7mUmfg0M29U)
  - OPC UA Technical Introduction, Uwe Steinkrauss
    [https://youtu.be/nYMbQiRgK74](https://youtu.be/nYMbQiRgK74)
  - OPC UA Security, Darek Kominek
    [https://youtu.be/NFQfZeU90Kw](https://youtu.be/NFQfZeU90Kw)

- **Companion specs**
  - AutomationML, Dr. Miriam Schleipen
    OPC UA and AutomationML, [https://youtu.be/i_simQ5Gu6c](https://youtu.be/i_simQ5Gu6c)
    OPC UA and AutomationML in 1 Minute [https://youtu.be/Nrzd-3Kbr9Q](https://youtu.be/Nrzd-3Kbr9Q)
  - AutoID (RFID, etc.), Olaf Wilmsmeier
    Result OPCF & AIM WG [https://youtu.be/C9q13sVRPA8](https://youtu.be/C9q13sVRPA8)
  - etc.
Thank you - Questions?

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