Internet of Things & Industrie 4.0:
Their Differences and why OPC-UA is the Solution for Both!

Stefan Hoppe
BECKHOFF Automation
President OPC-Europe

Stefan Hoppe, s.hoppe@beckhoff.com
Agenda

- About
- IoT: Internet of Things
- Industrie 4.0
- IoT vs Industrie 4.0: What is different – what is common
- Trends
- Call for actions
- More Information
BECKHOFF: About us

- HQ located in Verl, Germany [www.beckhoff.com](http://www.beckhoff.com)
  HQ US located in Minneapolis area (Savage, MN)

- Solutions for Industrial Automation:
  - Motherboards, IPC, Ethernet Panels, I/Os
  - Various fieldbus solutions
  - EtherCAT Technology [www.ethercat.org](http://www.ethercat.org)
  - Scalable real-time extension for Windows
    DOS / NT / Win2K / XP / Win7 / Win8 / Windows Embedded
    IEC 61131-3 PLC / Motion Control / HMI

- High level of expertise in
  Embedded Automation

- OPC-UA committed!
BECKHOFF: OPC Commitment

Member
- 1998 May: Beckhoff becomes a Corporate Member of OPC Foundation

Products: Early adapter of technologies
- 1999 OPC-DA Server for IEC 61131-3-PLC
- 2006 OPC-DevCon: First OPC-UA Server embedded into PLC
- 2008 Product available: TwinCAT OPC-UA for Data Access
- 2011 Certified OPC-UA Server product
- 2012 First OPC UA Client embedded into PLC

Vision: Actively pushing OPC-UA
- 2008: Chair of working group “PLCopen & OPC-Foundation”
- 2010: President OPC-Europe
What is the Internet of Things?

“Connected world solutions combine sensors and technologies to enable objects and infrastructure to interact with monitoring, analytics and control systems over Internet-style networks.”

Source: Forrester
IoT - Definition

Information flow from connected devices...

- Optimize equipment and process performance
- Deliver proactive & predictive services (e.g., predictive maintenance)
- Capture granular data and monitor real-time performance

Product and Support Teams
- Design & Engineering
- Design optimization
- Remote Monitoring
- Customer Support
- New service capabilities
- Resource optimization

Equipment, Sensors & Devices
Microsoft delivers on the Internet of Things

**Devices and assets**
Connect new and existing devices using open-source agents or gateway technologies

**Cloud and infrastructure**
Store machine-generated data with data from other sources in the cloud

**Analytics Ready**
View data, administer devices, and configure rules, alerts, and other actions using out-of-box or custom portals

**Drive Insights**
Mine insights from your data to find gaps and opportunities to make better decisions and realize new business value
Industrie 4.0 – Definition

Industrie 4.0

- everyone is talking about it: politicians, organisations…
- in all journals are innumerable articles

→ Do you know what Industrie 4.0 means?
Industrie 4.0: 4 stages of the Industrial Revolution

1st: Power generation
   - Steam engine
   - Source: GB, 1782

2nd: Mechanical automation
   - Conveyor belt
   - Source: US, 1913

3rd: Electronic Automation
   - Computer, NC, PLC
   - Source: US/EU, 1954

4th: Smart Automation
   - ICT, Cyber Physical Systems
   - Source: EU, 2015

Drivers:
- Quality of life
- Engineering Sciences

Mobility:
- 1913 Industrialization

µelectronics

Source: Acatech, Final report of the Industrie 4.0 Working Group, April 2013
Industrie 4.0: Acatech report

Industrie 4.0 and smart factory as part of the Internet of Things and Services

Source: Acatech, Final report of the Industrie 4.0 Working Group, April 2013
The main focus from 2.10.2012

1. The creation of new forms of the intelligent production technology to be capable of generating innovative products for the world market and making regional factories more flexible and efficiently in dealing with resources.

2. The optimization of existing and the invention of new products of the automation technology to ensure Germany`s competitive advantage in it's automation competency.

3. The ensurance of location- and occupation with intelligent organization of the production, the engineers and the production environment, mainly in face of the demographic change and the challenges involved for an age-based work structuring.

4. The creation of new collaborative forms of the process organization in the Smart Factory which is oriented in the qualitative enhancement, interesting work context, increasing individual responsibility and self-development.
Germany is building up production again
Industrie 4.0: Individualized products require a factory floor managing itself

- Consumers expect
  - Order Products which they can individually modify
    Quantity „1“ manufacturing
  - Monitor Status of production
  - Cost Same for individualized products compared to high series
  - Delivery Quick, not after 6-8 weeks

- The production line has to be extremely flexible and located nearby
  - → bring home product lines
Industrie 4.0: Why?

Support of the mechanical and plant engineering to strengthen their competitiveness.

What should be achieved?

- flexible order processing
- efficient resource management
- connected, reliable production
- 100% traceability and quality assurance
- self-optimizing manufacturing and production
- consistent engineering
Challenge
The members of the BITKOM, VDMA and ZVEI called standardization as the greatest challenge to the implementation of industry

Source: Acatech, Final report of the Industrie 4.0 Working Group, April 2013
Today: Top down information flow

Direction “How”:
- Today: Top down of information flow:
  - upper level: always initiates communication (as client)
  - lower level: answers (as server)
- Next: OPC-UA client & server integrated into smallest device
  - Network of intelligent systems

Content “What”:
- Today: Multiple converters:
  - From “electrical signal”
  - -> via data -> via functions
  - -> to service”
- Next: Service to service
New: OPC-UA integrated into devices allow „From service to service“

Source: Prof. Zühlke, DFKI
Connection to the controller

Integrated: PLC and OPC-UA in embedded device
Mapping: Support official mapping IEC61131-3 to OPC-UA
Benefit: Secured, semantic interoperability
Use Case | MES to PLC

Success Story

- From shop floor (Beckhoff) controller to top floor (SAP)
- OPC-UA: Direct connection from MS into controller

Benefit

- Quick: due to OPC-UA done in 20min
- easy to use for PLC and MES team
- standardized interface layer
- fast connection, include security out of the box

Elster

- 7,000 employees, 38 major locations
- 200 million installations in the last 10 years
- Metering Gas, Water, Electricity
Services are running in IT or Automation real-time context – so 3 transitions:

B2B: Business to business (ms to minutes e.g. MES to ERP, to cloud)
B2M: Business to machine (ms to minutes e.g. from MES into controller)
M2M: machine to machine (µs to ms, e.g. robot to robot)
From Controller: PLCopen FB

Connection >from the controller < Controller initiating communication

- Vertical & Horizontal
- Fieldbus independent
- It’s fast – but not a fieldbus

Released April-2014
Use Case | Machine to Machine

Requests for process values and state changes

SCADA

level reached

stop pumping

due to problems at group 1 supplier of freshwater has changed to group 2

elevated reservoir

quality problems in freshwater

please overtake filling of elevated reservoir

Challenge:
500 devices
pumps
waterboilers
1400 km2

Requests for process values and state changes

pumping plant 1

water works 1

pumping plant 2

water works 2

Closed user group

Horizontal: M2M & IoT in decentral intelligent equipments

Challenge:
500 devices
pumps
waterboilers
1400 km2
Use Case | Machine to Machine

Effects saving costs

- Transmission of complex data structures -> there’s no configuration of every single datapoint required
- Replacement of a proprietary solution by a combined OPC UA client/server
  Standardization of data communication reduces interfaces, just OPC UA client and server
- A physical interruption of the connection does not lead to a loss of information
  -> automatically buffered in the OPC UA server for a time and can be retrieved as soon as the connection has been restored
- Using safety mechanisms authentication, signing and encryption integrated in OPC UA in addition to a closed mobile radio group to ensure the integrity of the confidential data

- solution provided us with a saving on the initial licensing costs of more than 90% per device
Where is the cloud? Here! From controller to cloud

Runtime: PLCoopen Function Blocks for OPC-UA method call

```plaintext
fb_OpcUaOpen(
    bExecute := TRUE,
    sUrl := 'opc.tcp://ew2013.cloudapp.net:4840',
    tTimeout := T#15s,
    hSession => hSessionHandle);
...

fb_OpcUaMethodCall(
    bExecute := TRUE,
    sParam := 'INSERT INTO table VALUES(ID, Time, Val)',
    tTimeout := T#15s,
    hSession := hSessionHandle,
    hMethod := hMethodHandle);
```
Use Case | Smart metering

Decentral measurement (optional local buffering of data), pushing into central databases for analytics and deploying results

- Smart metering project in Germany
- London Underground: measure vibration data
- Wish: better connection to cloud (like relay)
IoT vs Industrie 4.0

IoT: Simplified message:
- We provide an agent for all platforms
- IoT starts with data are in cloud
- New business with analytics in the cloud

Required:
- (Just) data transport
- Security

PC
MQTT/AMQP/…

- Agent
- Windows® Embedded
- Agent
- VxWorks
- QNX® SOFTWARE SYSTEMS
- Agent
- Agent
- Agent
- Agent
- Agent
- Agent
IoT vs Industrie 4.0

Industrie 4.0: Simplified message:
- Devices get more intelligent
- Communication „Service to Service“
- Cloud is an option as one service

Requirements higher
- Horizontal and vertical
- Ad hoc discovering services
- Modeling: Information Model
- Scalable: From sensor to the cloud
- Operating system and language independent
- Safe: authentication, signing, encryption
- International: IEC Standard
IoT or Industrie 4.0
OPC-UA is the enabler

- **Communication infrastructure**
  - Secure, interoperable, reliable, performant, scalable
  - Platform-independent (OS, language, vendor)
  - Technology:
    - Service-oriented
    - Provide technology independent from services
  - Small set of easy to use services
    - 37 operations
    - Grown up in Automation market - (e.g. time stamp, status) but neutral for other vertical markets

- **Information modelling**
  - Rich, object-oriented and extensible typmodel
  - Tybmodel in adress space
  - Full mashed network
  - Scalable:
    - Support simple and complex models
  - Standardized Information models based on OPC UA
    - PLCopen, BACnet, MTConnect…
Trends: SoA-PLC: IEC61131-3 and OPC-UA
RPC calls between IT and Automation

- “SoA PLC”: Service oriented architecture is the key for industrial communication
- IEC61131-3: Easy implementation of services
  FUNCTIONBLOCK can be invoked from outside from any OPC-UA client
- SoA-PLC: Remote-procedure-call (RPC)
  based on international standards: IEC61131-3 + OPC-UA

IEC61131-3
Define service

OPC-UA-Server
expose service

Controller

transport

OPC-UA-Client
invoke service
**Trends: SoA-PLC: IEC61131-3 and OPC-UA → Increase efficiency and data consistency**

- SOA-controller as enabler for IoT and M2M optimized communication
- Service oriented architecture: service calls instead of data (property) exchange

**Common practice:**
1. **MES:**
   - “I like to send recipe data”
2. **PLC:**
   - “OK”
3. **MES:**
   - “Here are recipe data 1”
   - “Here are recipe data 2…”
4. **MES:**
   - “Finished, please start production”
5. **PLC:**
   - “OK”

**Time consuming handshake mechanism**

**New: service calls**
1. **MES:**
   - “Here is new recipe”
2. **PLC:**
   - “OK”

**Increase efficiency**
- secure transport of inputs
- code execution and wait on result
- transport of outputs to caller
Trends: Filetransfer & Modelling

File transfer via OPC-UA

1. Easy file /folder deployment

   Download of
   - e.g. of PLC binary code
   - e.g. of recipes
   - e.g. Operating System components

2. Easy management for Upload

   - e.g. measurement data

Target markets
- Building automation
- Water treatment
- Wind parks
- General device management

Device management

OPC UA Client

I am a CNC machine

I am a energy sensor

I am a CNC machine

I am a energy sensor

OPC-UA
Call for action

- @ Microsoft, IBM, ...
  We understand you have to provide agents like IoT-SDK or MQTT

Options for Manufacturing and other industries:
1. Thousands+ companies would have to implement IoT and MQTT
2. You IT companies actively prepare for OPC-UA
   OPC-UA provides immediately connection to couple of verticals like
   Industrial Automation, Building Automation, MES, RFID / Auto-ID,
   Oil&Gas, MTConnect

- @ Microsoft:
  Thanks for help to get OPC-UA solutions better connection to Azure

- @ AT&T, Cisco, GE, Intel, IBM
  You started “Industrial Internet consortium” just started….
  …. OPC-UA is already an IEC standard and adopted
Call for action

- Join the technical conferences in Europe
  - OPC-Day Europe 2011 SAP, Walldorf, Germany
  - OPC-Day Europe 2012 Endress+Hauser, Basel, Switzerland
  - OPC-Day Europe 2013 Yokogawa, Amsterdam, Netherlands
  - OPC-Day Europe 2014 FESTO, Stuttgart, Germany
  - OPC-Day Europe 2015 Microsoft, Paris, France

May 19th/20th 2015 Conference Center, Microsoft Campus
More Information

- Addressing the IT audience
- Quotes from
  - Academic / Industry / Organizations
- Technology
- Scenarios
  - Scalability: UA in sensor level
  - Identification: UA in RFID
  - Controller: Semantic Interoperability
  - Vertical: From controller to SAP
  - Horizontal: UA as enabler for M2M and IoT
  - User&Machine: UA in browser
More Information

- **OPC Foundation**
  - [www.opcfoundation.org](http://www.opcfoundation.org)
  - All information about OPC-UA in general
  - Free download of PLCopen/OPC-UA specification
  - See Downloads → Specifications → OPC UA for IEC 61131-3

- **PLCopen**
  - [www.plcopen.org](http://www.plcopen.org)
  - Free download of introduction papers
  - See TC – Communication

- **BECKHOFF Automation**
  - [www.beckhoff.com](http://www.beckhoff.com)
  - Free downloads of trial versions
  - TwinCAT3: Automation integrated into Microsoft Visual Studio