Practical Implications of Web-Enabled Devices and Cloud-Based Services in Industrial Automation

Daymon Thompson
TwinCAT Product Specialist
Beckhoff Automation
d.thompson@beckhoff.com
IoT / Industry 4.0 in Industrial Automation

Agenda

1. The Smart Factory and Automation
   - Internet of Things
   - Industry 4.0
   - IoT vs Industry 4.0: What is different – what is similar?

2. Need for Standards
   - OPC UA

3. Application Examples

4. Industry 4.0 Technology Demo

Image Source: http://www.electronicproducts.com
The Big Shift – IoT

A big shift is already happening:

• During 2008, the number of things connected to the Internet surpassed the number of people on Earth. (Source)

• By 2017, the IoT market will surpass the PC, tablet, and phone market combined. (Source)

• 82% of companies will have IoT applications implemented into their business in some way by 2017. (Source)
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
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.
IoT: ThyssenKrupp connected their elevators to Microsoft Azure

- Collect data from their sensors and systems to improve operations
- Goal: predictive and preemptive maintenance

IoT / Industry 4.0 in Industrial Automation

The Smart Factory - Definition

- Flexible Manufacturing Lines
- Faster Machines
- More Accurate Machines
- Smarter Machines
- Efficient Machines with:
- Connectivity to IT World of ERP and MES
IoT / Industry 4.0 in Industrial Automation

Why Smart Factories?

• 94% of businesses see an ROI from M2M communication. (Source)

• An IDC (International Data Corporation) study commissioned by Microsoft concludes that, with help from the advanced data analytics that IoT provides, manufacturing stands to gain $371 billion in value in the next four 4 years. (Source)

• Unprecedented growth in industry through data insight.
Global Manufacturing Is Challenging:
Adapt Profitably, Quickly, and Consistently to Demand

- Can’t see production status
- Can’t measure performance
- Can’t improve execution
Industry 4.0 is:

- The fourth Industrial Revolution
- A future-oriented project which is part of the high tech strategy of the German Federal Government promotes the computerization of traditional industries such as manufacturing.
- The ambition is the intelligent factory (Smart Factory) which is marked by adaptility, resource efficiency and ergonomics as well as much more highly integrated and connected business processes.
- A technological concept that includes elements such as cyber-physical systems and the Internet of Things.

IoT / Industry 4.0 in Industrial Automation

Industry 4.0: 4 stages of Industrial Revolutions

1st
- Power generation
- Mechanical automation
- Drivers: Quality of life, Engineering Sciences
- 1782
- GB

2nd
- Industrialization
- Mobility
- conveyor belt
- 1913
- US

3rd
- Electrical automation
- Electronics
- Computer, NC, PLC
- 1954
- US/EU

4th
- Smart automation
- Cyber Physical Systems
- µelectronics
- 2015
- EU

Source: Acathe, Final report of the Industrie 4.0 Working Group, April 2013
IoT / Industry 4.0 in Industrial Automation

Germany is building up manufacturing production again

[Graph showing the development of Gross Value Added Manufacturing/Total Gross Value Added for Germany, Italy, UK, USA, and France from 1980 to 2010.]

Quelle: UNData: Gross Value Added Manufacturing/Total Gross Value Added
IoT / Industry 4.0 in Industrial Automation

Industry 4.0: 5 central research themes

- Horizontal integration through value networks
- End-to-end engineering across the entire value chain
- Vertical integration and networked manufacturing systems
- New social infrastructures in the workplace
- Cyber-Physical Systems technology
IoT / Industry 4.0 in Industrial Automation

Industry 4.0: Optimization by Cyber-Physical Systems

Vision for Industry 4.0

- The **product** to be manufactured contains all necessary information on its production requirements.
- **Self-organization of integrated production installations** considering the entire value chain (object-oriented).
- **Flexible decision on production process** on the basis of the current situation.
- Human beings remain essential as creative planners, controllers and decision-makers.

Source: Siemens at OPC@Microsoft: Industrial Revolution 2014
**“Smart” products**
- The product to be manufactured has all the necessary information for every step of its production

**Modular production units**
- Optimized organization of networked production facilities taking into account the entire value chain
- Production steps are configured flexibly in response to changing situations

**Reduction of complexity due to “smarter” structures**

Source: OPC@Microsoft: Industrial Revolution 2014
IoT / Industry 4.0 in Industrial Automation

Agenda

1. The Smart Factory and Automation
   - Internet of Things
   - Industry 4.0
   - IoT vs Industry 4.0: What is different – what is similar?

2. Need for Standards
   – OPC UA

3. Application Examples

4. Industry 4.0 Technology Demo

Image Source: http://www.electronicproducts.com
**Challenge**

The members of BITKOM, VDMA and ZVEI named **standardization** as the greatest challenge to the implementation of Industry 4.0

**Requirement**

Horizontal and vertical communication

- Discovering services
- Vertical, horizontal
- Modeling: Information Model
- Scalable: From sensor to the Cloud
- Operating system and language-independent
- Safe: authentication, signing, encryption
- International IEC Standard

Source: Acatech, Final report of the Industry 4.0 Working Group, April 2013
IoT / Industry 4.0 in Industrial Automation

**IoT: Summary (Communication Focus)**

IoT: Simplified message:
- IT companies provide agents for all OS platforms → Push data into their cloud systems
- IoT starts with data in the cloud
- New business with analytics in the cloud

Required:
- (Just) data transport
- Security?

![Diagram of IoT communication system](image-url)
Who: Federal Office for Information Security (German Government, BSI)
What: Security Evaluation of OPC-UA

Holger Junker
Head of Unit 'Cyber-Security in critical IT-Systems, Application and Architectures' within the German Federal Office for Information Security

“The only communication technology for industrial environments that I currently know of which provides integrated security functionalities and also offers performance potential to tackle the challenges of Industry 4.0 is OPC UA.”

(11.18.2014)
Overview

- OPC UA: Vendor **Independent** Protocol
- **Standardized** protocol for data communication (IEC 62541)
- Enables communication between **different vendors** and devices
- Features a detailed **information model** and **integrated security**
- Widely spread across multiple industrial domains / industries
## IoT / Industry 4.0 in Industrial Automation

### Convergence of AT and IT Technologies

<table>
<thead>
<tr>
<th>Automation Technology (AT)</th>
<th>Information Technology (IT)</th>
<th>PC based Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1986</strong> Special RTOS</td>
<td>+ Windows Embedded</td>
<td></td>
</tr>
<tr>
<td><strong>1996</strong> Stand Alone Automation Technologies</td>
<td>+ Ethernet</td>
<td>TwinCAT</td>
</tr>
<tr>
<td><strong>2003</strong> Special Automation Communication Protocols</td>
<td>+ Internet, Cloud, Big Data, Analytics</td>
<td></td>
</tr>
<tr>
<td><strong>2010</strong> Stand Alone Automation Technologies</td>
<td>+ Microsoft Visual Studio PARTNER</td>
<td>Industry 4.0 Control Architecture</td>
</tr>
</tbody>
</table>
IoT / Industry 4.0 in Industrial Automation

Architecture Overview

- **Standardized Access**
- Controller provides **Services**
  Discovery of Services
- Service Oriented Architecture (SOA)
  PLC:
- Support of:
  - **Interoperability**
  - **Security**: User and Role based Access
  - **Information-Modeling**
    Type and Data consistency
IoT / Industry 4.0 in Industrial Automation

SOA-PLC: Standardized Models IEC61131-3: UA Client

Connection >from the controller <
Controller initiating communication

- Vertical & Horizontal
- Fieldbus independent
- It’s fast – but not a fieldbus
PLCopen:
Content “WHAT”

---

All information about IEC61131-3 project:
- FBs
- POU's
- Structures
- Tasks / Resources...

... but semantically identical objects!

---

Beckhoff
“PLC1”

Bosch-Rexroth
“Logic”

Different entry point
Support UA-DA client...
- can initiate a connection to servers in field devices, in the cloud, etc.
- Support read / write of variables and **invoking method calls into UA servers**

```
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);
```
OPC-UA Server: MethodCall

- Typical use case: Make handshake communication more efficient

Common practice until now:

1. MES: “I want to send recipe data”
2. PLC: “OK”
3. MES: “Here is recipe data 1”
   “Here is recipe data 2…”
4. MES: “Finished, please start production”
5. PLC: “OK”

Time consuming handshake mechanism

- ONE data communication to handle
  - secure transport of inputs
  - code execution and wait on result
  - transport of outputs to caller

Increase efficiency
IoT / Industry 4.0 in Industrial Automation

Agenda

1. The Smart Factory and Automation
   - Internet of Things
   - Industry 4.0
   - IoT vs Industry 4.0: What is different – what is similar?

2. Need for Standards
   - OPC UA

3. Application Examples

4. Industry 4.0 Technology Demo
IoT / Industry 4.0 in Industrial Automation

Nobila and Beckhoff: Industry 4.0 in practice since 1990!

Nobilia-Werke J. Stickling GmbH & Co. KG, Verl

- Oracle Database
- 540 Beckhoff PC clients
- “Lot size 1” manufacturing
- >1 million transactions/day
- Average 100ms response times
- Part identification by barcode and RFID
- No intelligence or data storage in manufactured parts!
- centralized data ware housing
- “Manufacturing by wire”
- Low-cost manufacturing in high cost Westfalia, Germany!

- Europe’s leading manufacturer of complete kitchens
- 2450 employees, € 900 million sales (2012)
- Manufacturing 2,500 kitchens/day, 500,000 kitchens/year!
Global cumulative smart meter deployment increased by 500% between 2008 and 2012, from 46 million to 285 million meters installed, with a further increase to almost one billion installations projected before the end of 2018. (Source)
IoT / Industry 4.0 in Industrial Automation

Agenda

1. The Smart Factory and Automation
   - Internet of Things
   - Industry 4.0
   - IoT vs Industry 4.0: What is different – what is similar?

2. Need for Standards
   - OPC UA

3. Application Examples

4. Industry 4.0 Technology Demo

Image Source: http://www.electronicproducts.com
IoT / Industry 4.0 in Industrial Automation

Industry 4.0: Intelligent Control

- Standardized communication > from the controller <

MES System
- OPC UA Server

Plant Engineering
- OPC UA Server

Virtual Machine
- Windows Azure
- Amazon Web Services
- Database
Wearable systems for industrial automation

www.beckhoff.com/wearable
IoT / Industry 4.0 in Industrial Automation

Thank you

BECKHOFF Automation:

www.beckhoff.com/industry40
www.beckhoff.com/wearable

This is Industry 4.0 and IoT, and it’s happening NOW.

- Daymon Thompson
  BECKHOFF Automation
  d.thompson@beckhoff.com