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# SOA PLC With standardized interfaces for cloud-enabled services





# Agenda



- 1. About Beckhoff
- 2. IoT vs Industry 4.0: What is different what is similar?
- 3. Communication requirements for intelligent devices
- 4. SoA-PLC: Definition and Realization
- 5. Success Story: Experiences from customers

# **About Beckhoff Automation**

Verl, Germany Verl, Germany > 452.000 sg ft 3,350 1,100 > 70 Countries 620 million € (+22 %)

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679 million € (+9.5 %)



**Headquarters: Production:** Headquarters premises in Verl: **Employees worldwide:** Number of engineers: International representation: Sales worldwide 2015 Sales worldwide 2016

# Verl

as of: 04/2017

# **About Beckhoff Automation**

- Solutions for Industrial Automation:
  - IPC, Motherboards, Display Panels, I/O
  - Various fieldbus solutions
    EtherCAT Technology
    <u>www.ethercat.org</u>
  - Scalable real-time extension for Windows
     DOS / NT / Win2K / XP / Win7 / Win8 / Win10 /
     Windows Embedded
     IEC 61131-3 PLC / C++ / Motion Control / HMI
- High level of expertise in Embedded Automation





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#### Member

 1998 May: Beckhoff becomes a Corporate Member of OPC Foundation

**Products**: Early adopter of technologies

- 1999 OPC-DA Server for IEC 61131-3-PLC
- 2006 OPC-DevCon: First OPC-UA Server embedded into PLC
- 2008 First UA product available: TwinCAT OPC-UA for Data Access
- 2011 Certified OPC-UA Server product
- 2012 First OPC UA Client embedded into PLC
- 2014 First OPC UA Server with SOA functionalities

# **OPC commitment**

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Vision: Actively pushing OPC-UA

- 2008: Chair of working group "PLCopen & OPC-Foundation"
- 2010: President OPC-Europe
- 2015: Vice President OPC Foundation | Member of OPC board

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# IoT Summary (with focus on communication)

#### Simplified message:

- IT companies provide agents for all OS platforms  $\rightarrow$  Push data into their cloud systems
- IoT starts with data in the cloud
- New business with analytics in the cloud

# **Required:**

- (Only) data transport
- Security?
- Interoperability?



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Backbone

Agent

# **I4.0 Summary (with focus on communication)**

#### Simplified message:

- Focus on factory & process automation
- Devices become more intelligent
- Communication "Service to Service"
- Cloud as one option (platform to host services)

#### **Requirements are higher:**

- Horizontal and vertical communication
- "Ad-hoc" discovery of services
- Modeling: Information Model
- Scalability: From sensor to the cloud
- Operating system and language independent
- Security: authentication, signing, encryption



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# **Today: Top down information flow**

# 1. Direction, "How" :

- Today: Top down information flow
  - upper level: always initiates communication (as client)
  - lower level: answers (as server)
- Next: Network of intelligent systems
  - Intelligent I/O sensor connected to intelligent camera

# 2. Content, "What" :

- Today: Multiple converters
  - "electrical signal" → via data
  - via functions → to service (mostly: data/property based)
- Next: Service to Service





Cloud

# **OPC UA at-a-glance**



• Summary: OPC Unified Architecture stands for...

| Data Modeling   | Communication  |
|---|--|
| Generic object-oriented modeling<br>Objects with variables, methods and events<br>Extensible type system<br>History for data and events<br>State machines, programs, alarms & condition<br>Complex data | Integrated security mechanisms<br>High speed UA TCP protocol<br>Web services for Internet<br>Platform independent<br>Built-in robustness and fault tolerance<br>Redundancy |
| Collaboration   | New Applications and Use Cases   |
| UA is IEC standard 62541<br>UA is base for other information models<br>EDDL and FDT<br>PLCopen, BACnet, MES, MDIS, ISA95  | Profiles for different use cases<br>Scalability<br>Integration into embedded systems<br>MES and ERP systems<br>Specialized versions for different industries               |

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# **SOA-PLC: Overview Architecture**



Service Oriented Architecture (SOA) PLC:

- Controller provides <u>Services</u>
- <u>Discovery</u> of Services
- <u>Standardized</u> Access
- Support of
  - Interoperability
  - <u>Security</u>: Rolls of access per user
  - Information-Modeling
    Type and Data consistency

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# **SOA-PLC: Overview Architecture**





#### **Standardized models**

- Standardized Models
- Beckhoff Model
- Customer Models

# **SOA-PLC: Standardized Models**



# Standardized Models – definition of semantic simplify engineering

- PLCopen
- MES / AutoID /
- FDI / Oil&Gas (MDIS) / ..
- CNC-HMI
- BACnet



Identification and Mobility



- Connection >to the controller <</p>
- Integrated: PLC and OPC-UA Server in embedded device
  - Mapping: Supports official mapping of IEC 61131-3 to OPC-UA

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All information about IEC61131-3 project:

- FBs
- POUs
- Structures
- Tasks/Resources



- Connection >from the controller <</p>
- Integrated: PLC and OPC-UA Client in embedded device
- Benefit: Secured, semantic interoperability



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# Status: PLC function blocks for data communication and method invocation

- UA\_Connect/Disconnect
- UA\_NamespaceGetIndex
- UA\_NodeGetHandle/GetHandleList
- UA\_NodeReleaseHandle/ReleaseHandleList
- UA\_Read/ReadList
- UA\_Write/WriteList
- UA\_MethodGetHandle/ReleaseHandle UA\_MethodCall



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# **SOA-PLC: Overview Architecture**





#### **Standardized models**

- Standardized Models
- Beckhoff Model
- Customer Models

Monitoring Industrial-PC / Embedded-PC:

**SOA-PLC: Beckhoff Models** 

- IPC-Device Manager:
  - Both: Monitoring (read) and Configuration (write)
  - Independent from OS and device
  - HW: CPU temperature & usage, Fan speed, RAID status...
  - SW: OS version, available RAM, IP, display, resolution, ...







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Windows 7

Windows CE

# **SOA-PLC: Beckhoff Models**

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#### File management of controller

- Scenario 1: Deploy new logic
  - "Stop" all devices in field
  - Download new files e.g. binary PLC project
  - "Start" all devices
- Scenario 2: Deploy OS update, receipes, ...
- Scenario 3: Upload measurement data, log files, ...

#### Administration

- Deploy binaries
- "Start" : Start execution
- "Stop": Stop execution
- "Reset"
- Device management e.g. file transfer



# **SOA-PLC: Overview Architecture**





#### **Standardized models**

- Standardized Models
- Beckhoff Model
- Customer Models

# SOA-PLC: Customer Models: Design own services **BECKHOFF**

- Customer to design own "my-SoA" services
  - Requirement: Easy, quick, reliable, secure, international standardized
  - Define service: IEC 61131-3 for easy implementation of services FUNCTIONBLOCK can be invoked from outside from any OPC-UA client
  - Invoke service: Remote-procedure-call (RPC)
    based on international standards: IEC61131-3 + OPC-UA



# SOA-PLC: Customer Models: Design own services **BECKHOFF**

- One-click engineering to enable service as SOA-service to IT world
- Design of SoA services available in



# **SOA-PLC: Increased efficiency**



Service calls vs. data/property exchange



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  - Joint Water and Wastewater Authority
  - Elster, Regio-IT and Grundfos

# M2M & IoT in decentralized, intelligent equipment BECKHOFF





Intelligent Water Management with OPC-UA Enabled Smart Devices



astewater plants. such as OPC-UR clents, while at the same time being that standardized EIPP) as OPC-UR servers. EIPI as OPC-UR servers. EIPI as OPC-UR servers. EIPI as OPC-UR servers.

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#### Testimonial: Licensing Costs Reduced by 90%

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#### Who?

Joint Water and Wastewater Authority

Vogtland, Germany

Silvio Merz, Divisional Manager, s.merz@zwav.de

#### What?

- Supply water to about 240,000 people and treating their wastewater as well
- Operate almost 600 Water and Wastewater treatment plants
  - Waterworks
  - Water pumps
  - Water reservoirs
- Distributed over about 1400 Km<sup>2</sup>



"The solution provided us with a saving on the initial licensing costs of more than 90 % per device."

# M2M & IoT in decentralized, intelligent equipment BECKHOFF

 Autonom M2M between devices – additional monitoring and control via SCADA



# Vertical: From shop floor to SAP top floor

# Who?

Elster

- 7,000 employees in 38 major locations
- 200 million installations in the last 10 years

# What?

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

# Benefit

- Quick: Connect machine within 30min
- Easy to use for PLC and MES team
- Standardized interface layer
- Fast connection, include security out of the box





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# Smart metering: From sensor to cloud – Case 1 BECKHOFF

#### Who?

Regio IT, Germany

#### What?

- Smart metering project in Germany
- Decentral measurement of energy data
- Optional local buffering of data
- Pushing data into central databases for analytics

|  | Mindows Az   |
|--|--|
| Searchine<br>The resourcement, collection of data and information in de-<br>central smallest enheaded devices has a common somethic. Data<br>is becoming currency when being able to controlly collect and<br>analysis the information – his helps collecting a process (e.g.<br>material janning) or save resources (e.g. energy manifolds)<br>and resolution deviction (e.g. energy manifolds) moleculars.                                     | A beshaft controller based on Wholews Embedded Ch<br>has been used as a de-central control unit. Beckhoff's as<br>tion arbitrary Twick& provides hard set (time, KCB133<br>programming or Microsoft's Visual Studio C+1 inspaces<br>datas explaintion and boffneing. This system uses CPC-<br>6224(4) with Integrated security methanisms as a data<br>port layer. The collected data gate pushed from control   |
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| Application: Smart Metering – Measurement of phy   | sical data   |
|  | Ct & r dwdrys 52.  |
|  | ability & Re Date  |

# Smart metering: From sensor to cloud – Case 1 **BECKHOFF**



SOA request "Save data"

# Smart metering: From sensor to cloud – Case 2BECKHOFF

#### Who?

- Grundfos Holding A/S
- 18.000 employees in more than 55 countries
- One of the worlds leading pump manufacturers
- Annual production of 16 million pump units

#### What?

- Smart metering project in Denmark
- Measurement of energy data in a student dormitrory
- Pushing energy data into Microsoft Azure cloud
- Goal: Scalable architecture with standardized communication



# Smart metering: From sensor to cloud – Case 2 **BECKHOFF**



# Smart metering: From sensor to cloud - Case 2 BECKHOFF

