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SOA PLC
With standardized interfaces for cloud-enabled services

Dr. Henning Mersch
Product Manager TwinCAT

Agenda

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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

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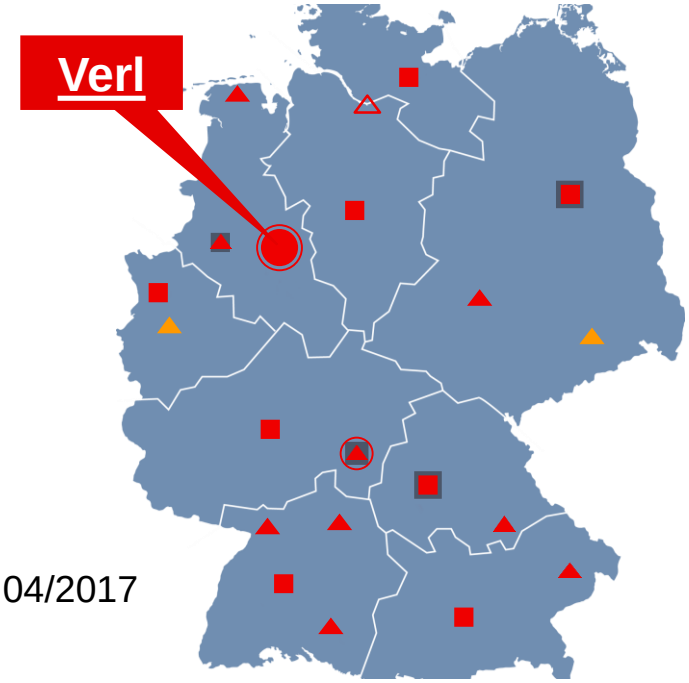
Headquarters:	Verl, Germany
Production:	Verl, Germany
Headquarters premises in Verl:	> 452.000 sg ft
Employees worldwide:	3,350
Number of engineers:	1,100
International representation:	> 70 Countries
Sales worldwide 2015	620 million € (+22 %)
Sales worldwide 2016	679 million € (+9.5 %)



as of: 04/2017

About Beckhoff Automation

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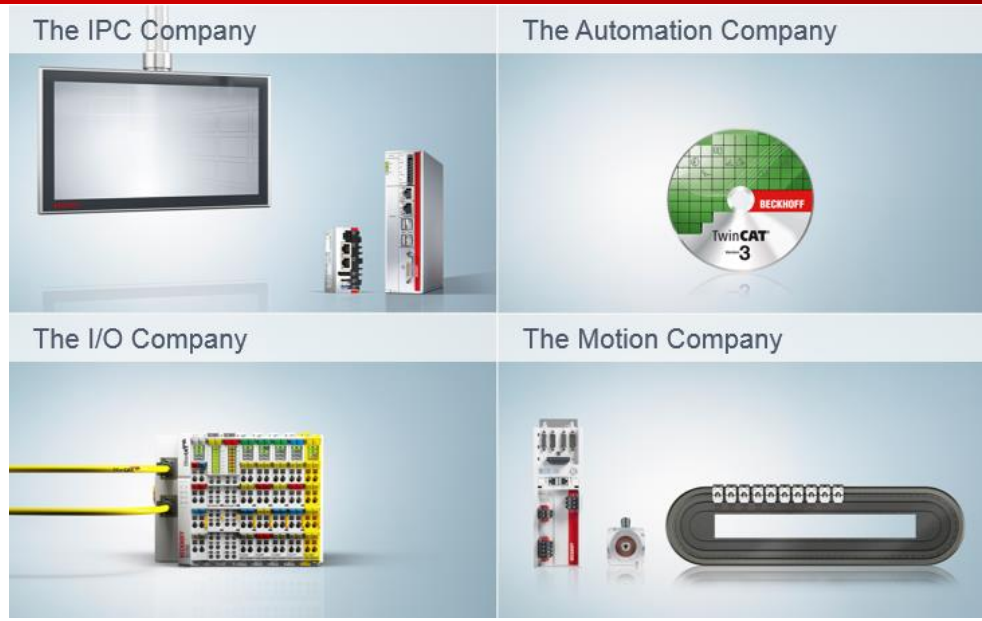
- Solutions for Industrial Automation:
  - IPC, Motherboards, Display Panels, I/O
  - Various fieldbus solutions EtherCAT Technology www.ethercat.org
  - Scalable real-time extension for Windows
    DOS / NT / Win2K / XP / Win7 / Win8 / Win10 /
    Windows Embedded
    IEC 61131-3 PLC / C++ /
    Motion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



OPC commitment

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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)

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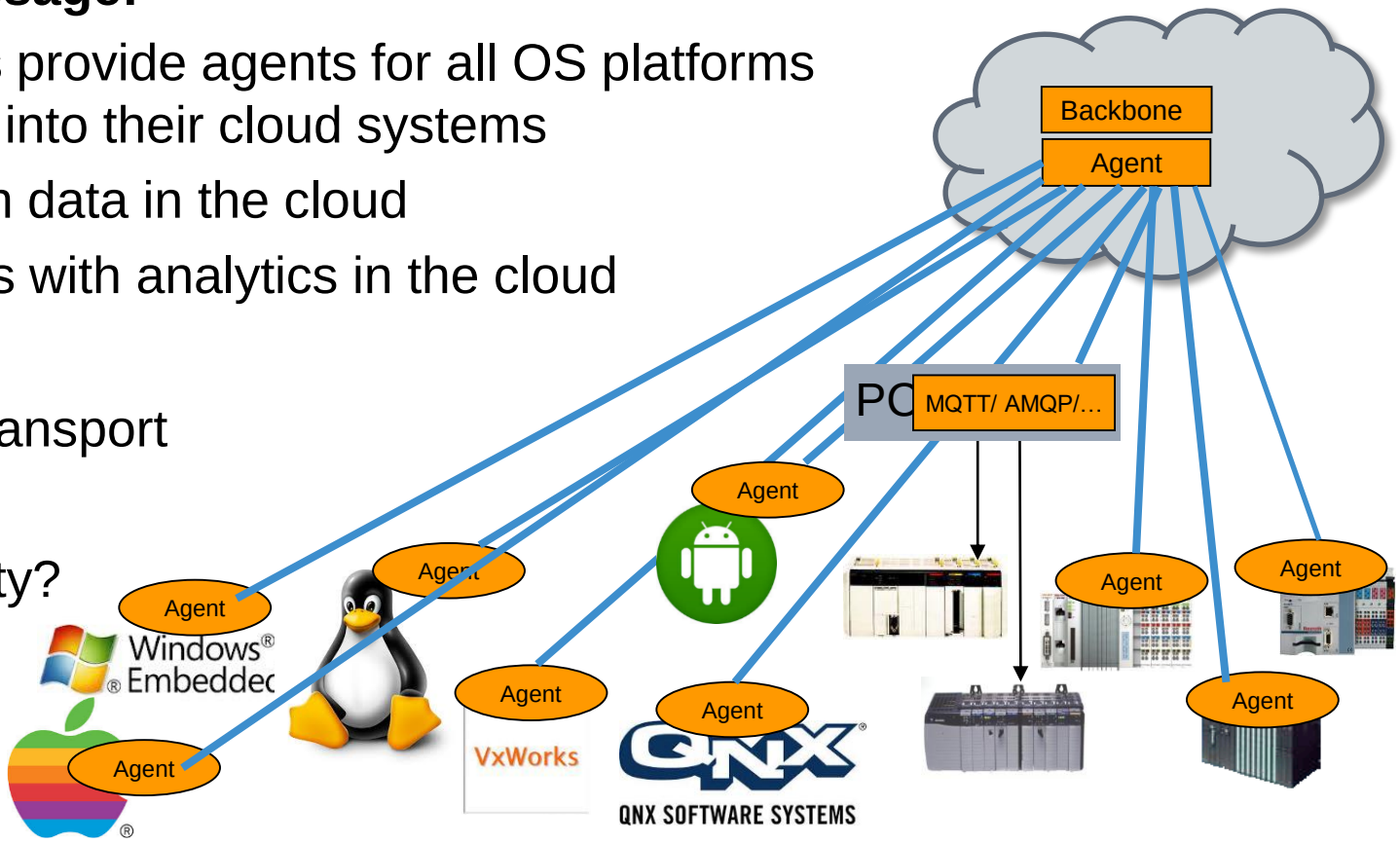
Simplified message:

- 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:

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



I4.0 Summary (with focus on communication)

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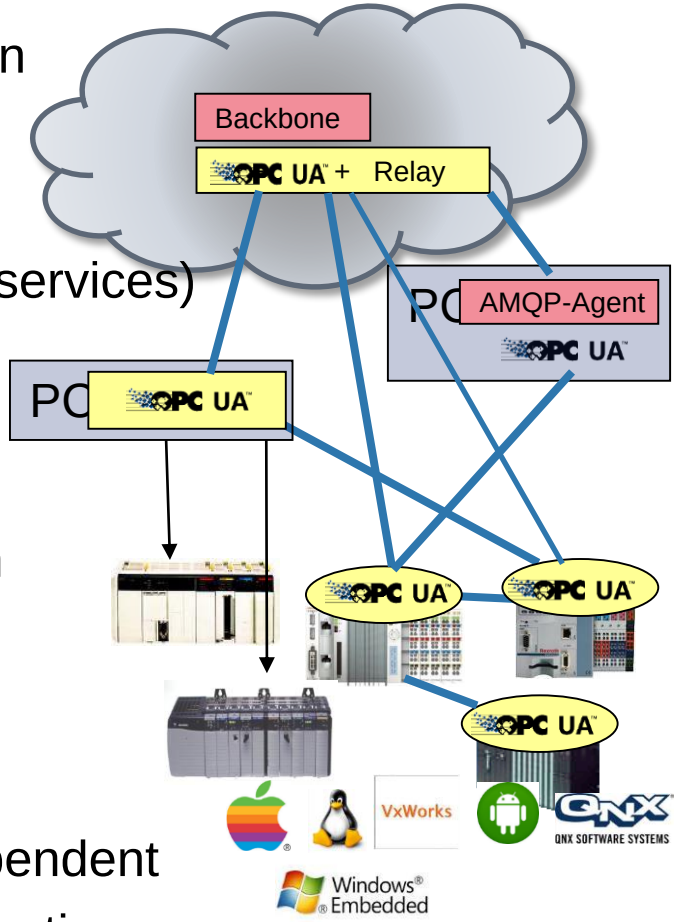
Simplified message:

- 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

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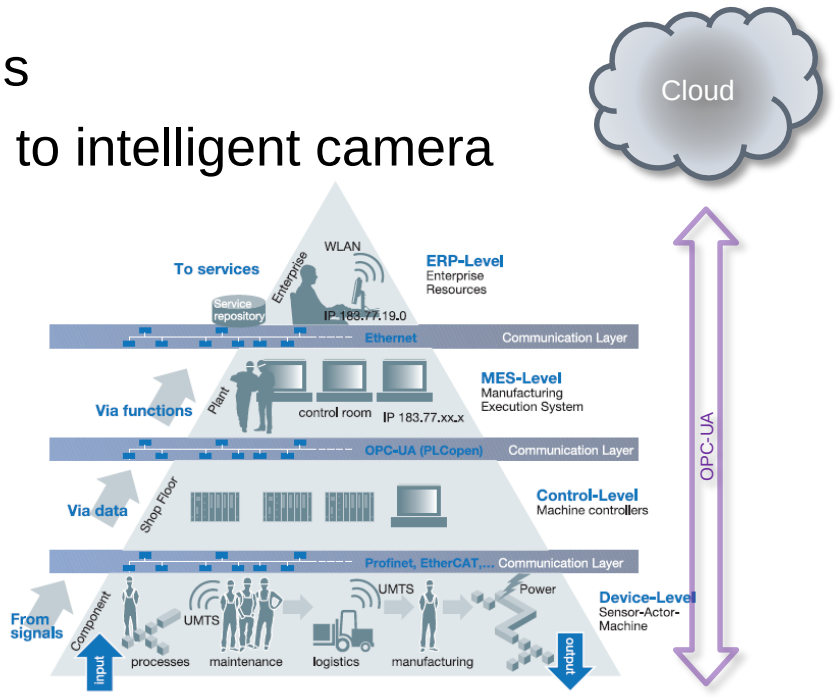
1. Direction, “How” :

- **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



OPC UA at-a-glance

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- **Summary:** OPC Unified Architecture stands for…

Data Modeling

Generic object-oriented modeling
Objects with variables, methods and events
Extensible type system
History for data and events
State machines, programs, alarms & condition
Complex data

Communication

Integrated security mechanisms
High speed UA TCP protocol
Web services for Internet
Platform independent
Built-in robustness and fault tolerance
Redundancy

Collaboration

UA is IEC standard 62541
UA is base for other information models
EDDL and FDT
PLCopen, BACnet, MES, MDIS, ISA95

New Applications and Use Cases

Profiles for different use cases
Scalability
Integration into embedded systems
MES and ERP systems
Specialized versions for different industries

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SOA-PLC: Overview Architecture

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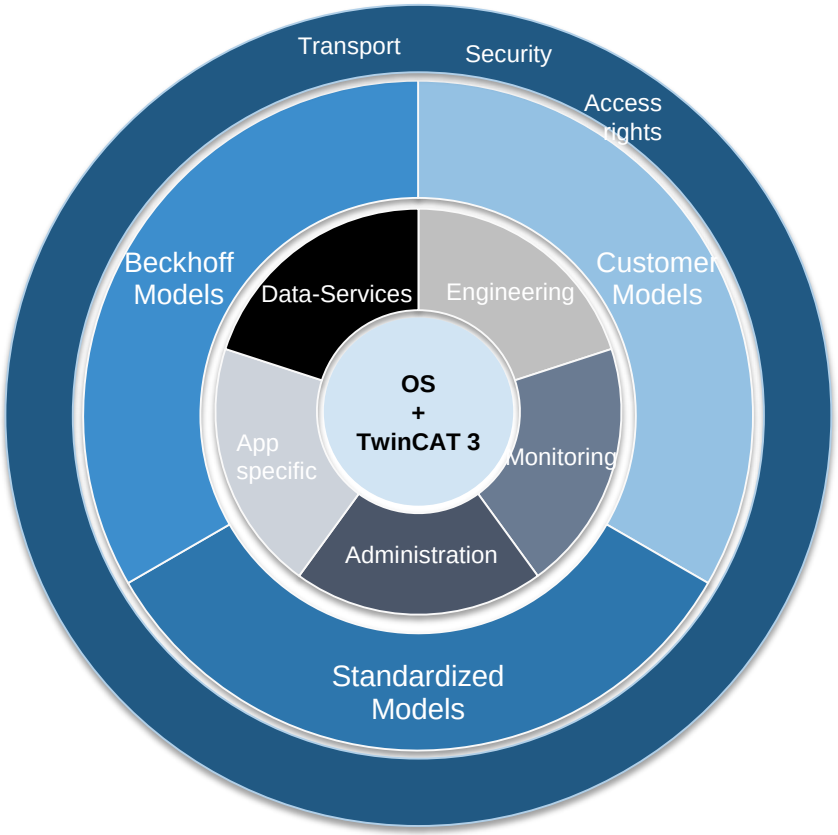

Service Oriented Architecture (SOA) PLC:

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

SOA-PLC: Overview Architecture

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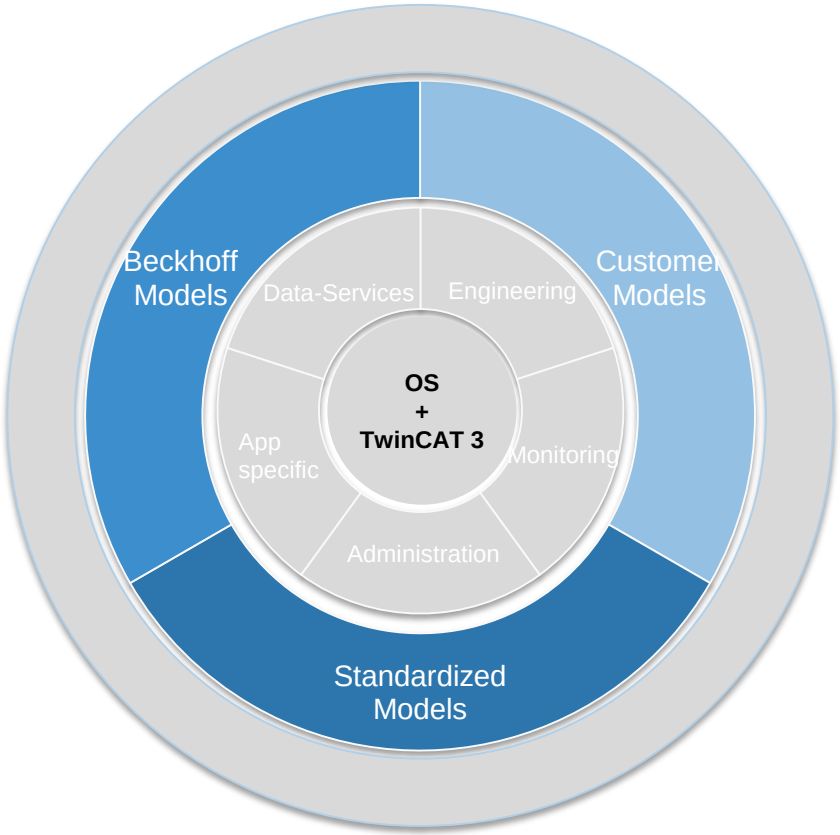

Standardized models

- Standardized Models
- Beckhoff Model
- Customer Models

SOA-PLC: Standardized Models

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Standardized Models – definition of semantic simplify engineering

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

Hi , I am a IEC61131-3 controller – but I also support MES profile

Hi , I am a Smart Meter

Hi , I am an RFID device

SOA-PLC: Standardized Model IEC61131-3

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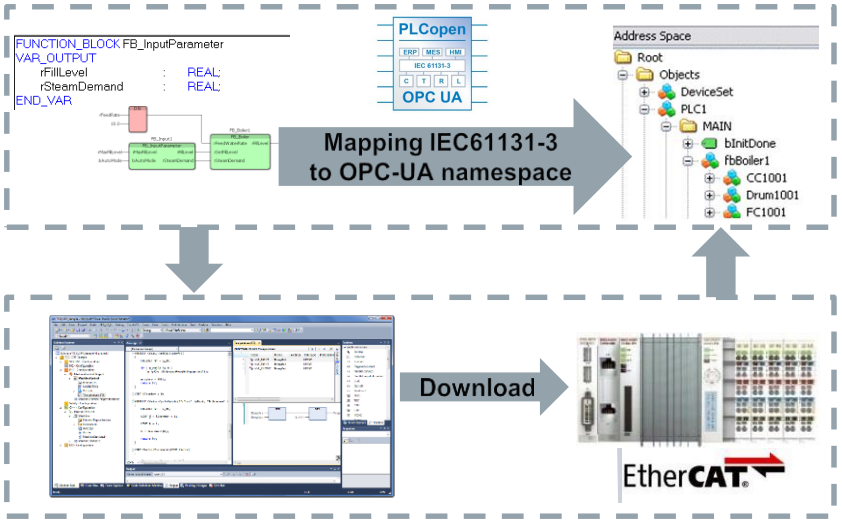
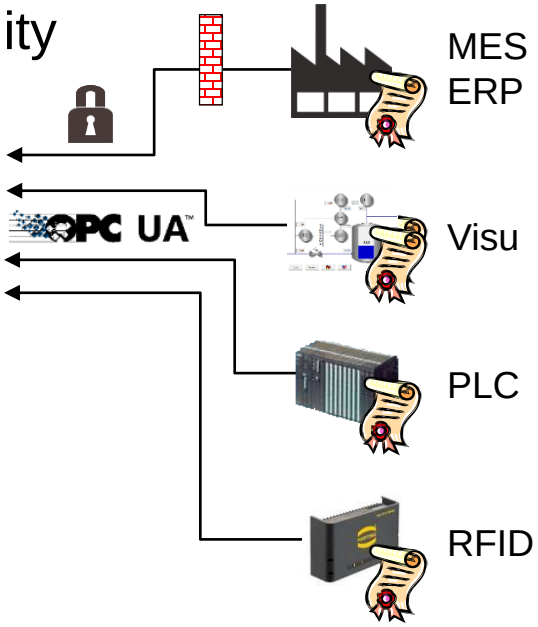
- Connection >**to the controller** <
- Integrated: PLC and OPC-UA **Server** in embedded device
- Mapping: Supports official mapping of IEC 61131-3 to OPC-UA
- Benefit: Secured, semantic interoperability





TwinCAT 3

Visual Studio Partner

SOA-PLC: Standardized Model IEC61131-3

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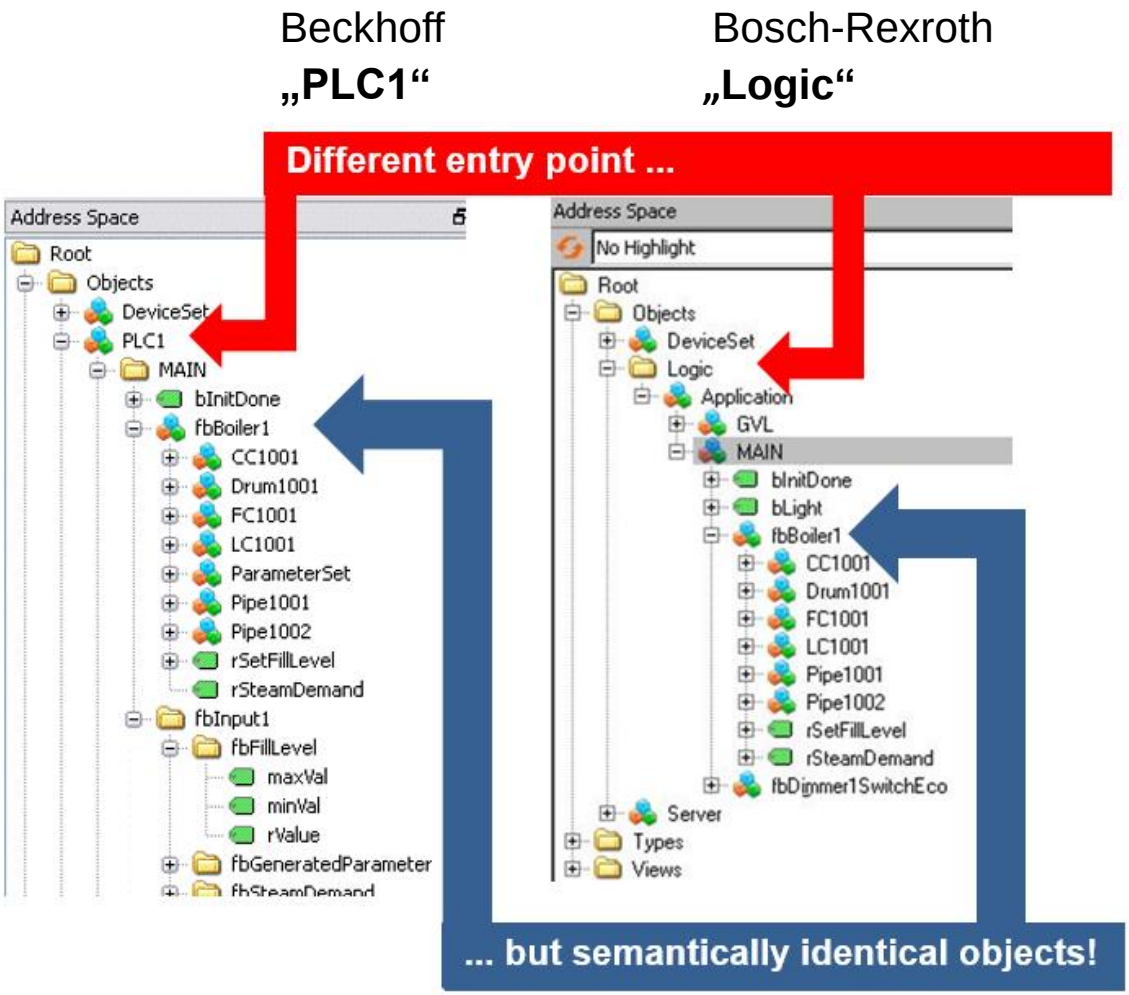
All information about IEC61131-3 project:

- FBs
- POUs
- Structures
- Tasks/Resources



SOA-PLC: Standardized Model IEC61131-3

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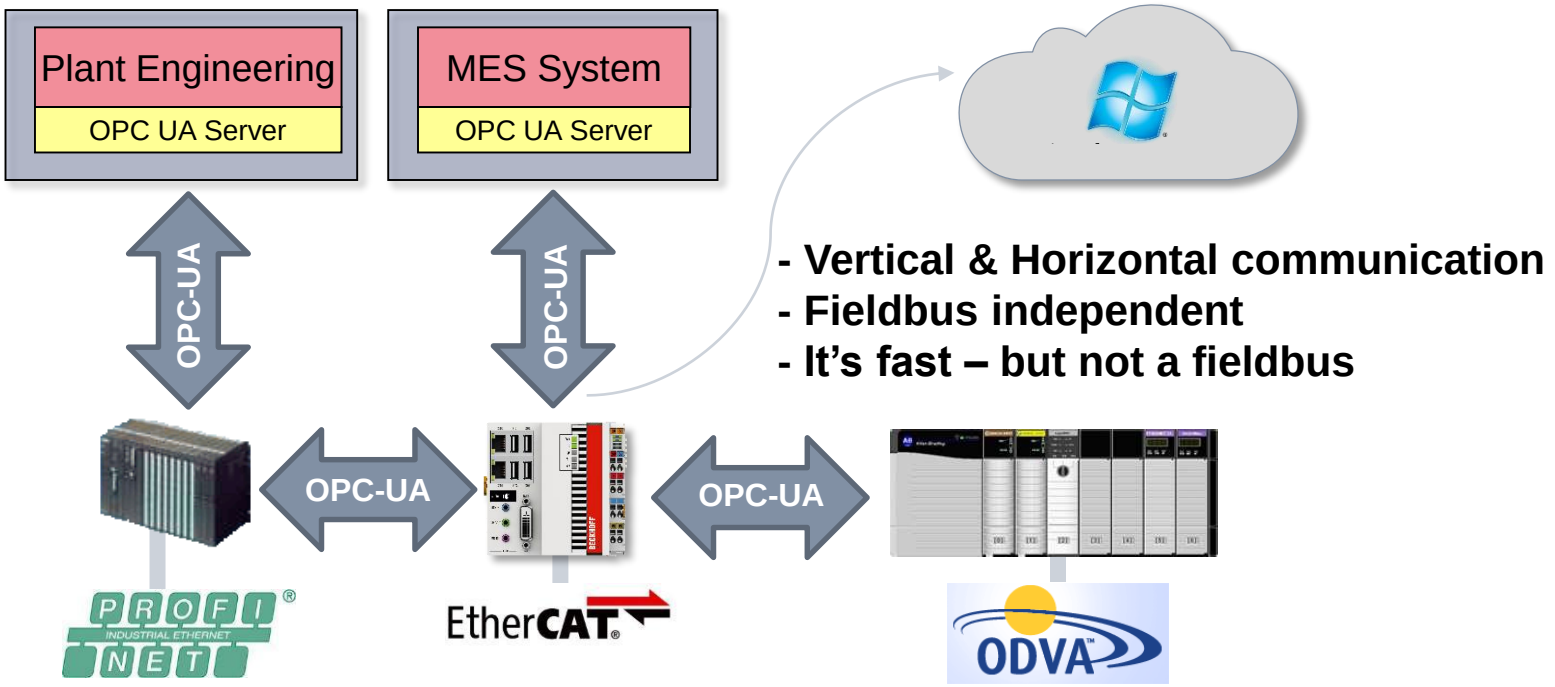
- Connection >**from the controller** <
- Integrated: PLC and OPC-UA **Client** in embedded device
- Benefit: Secured, semantic interoperability



SOA-PLC: Standardized Model IEC61131-3

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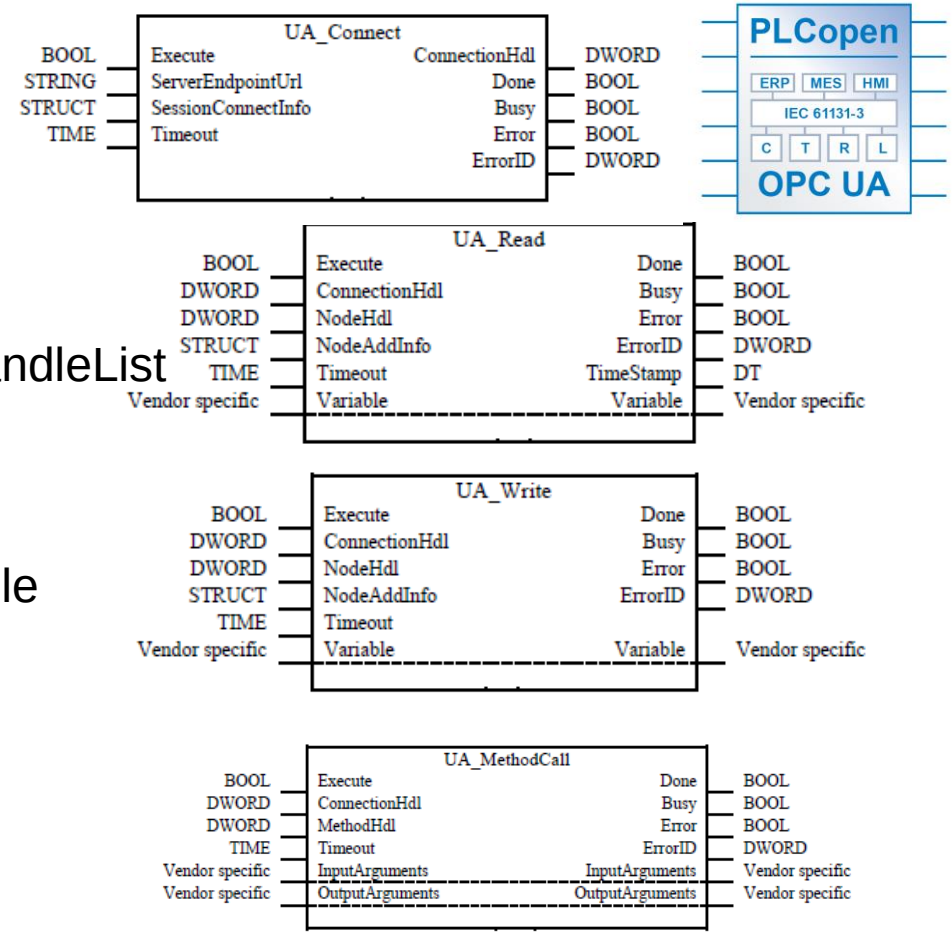
Status: PLC function blocks for data communication and method invocation

- UA_Connect/Disconnect
- UA_NamespaceGetIndex
- UA_NodeGetHandle/GetHandleList
- UA_NodeReleaseHandle/ReleaseHandleList
- UA_Read/ReadList
- UA_Write/WriteList
- UA_MethodGetHandle/ReleaseHandle
  UA_MethodCall



SOA-PLC: Overview Architecture

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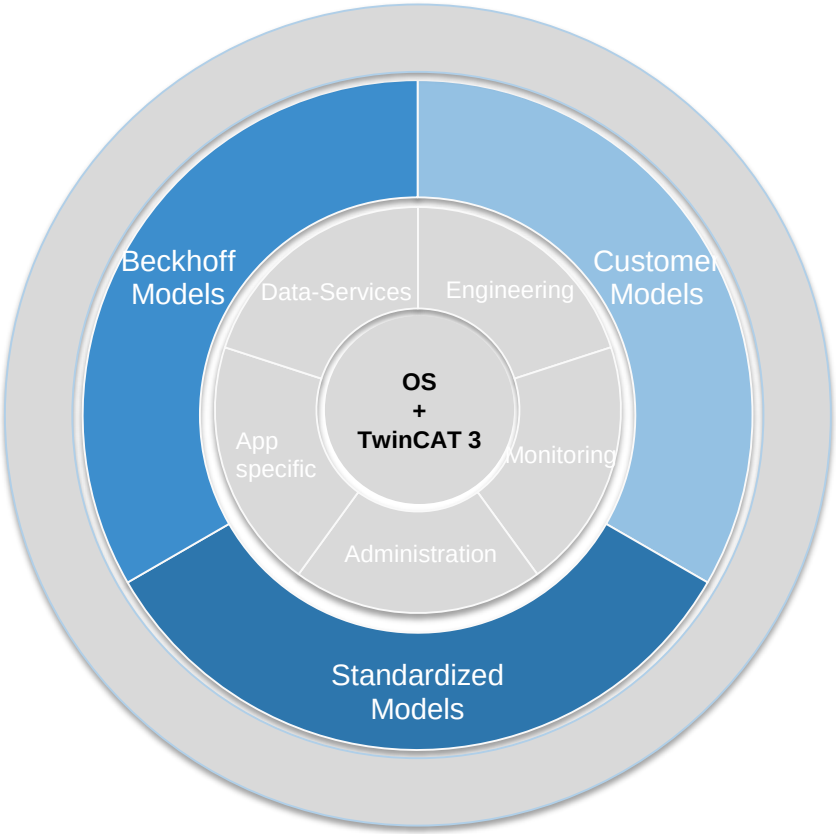

Standardized models

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SOA-PLC: Beckhoff Models

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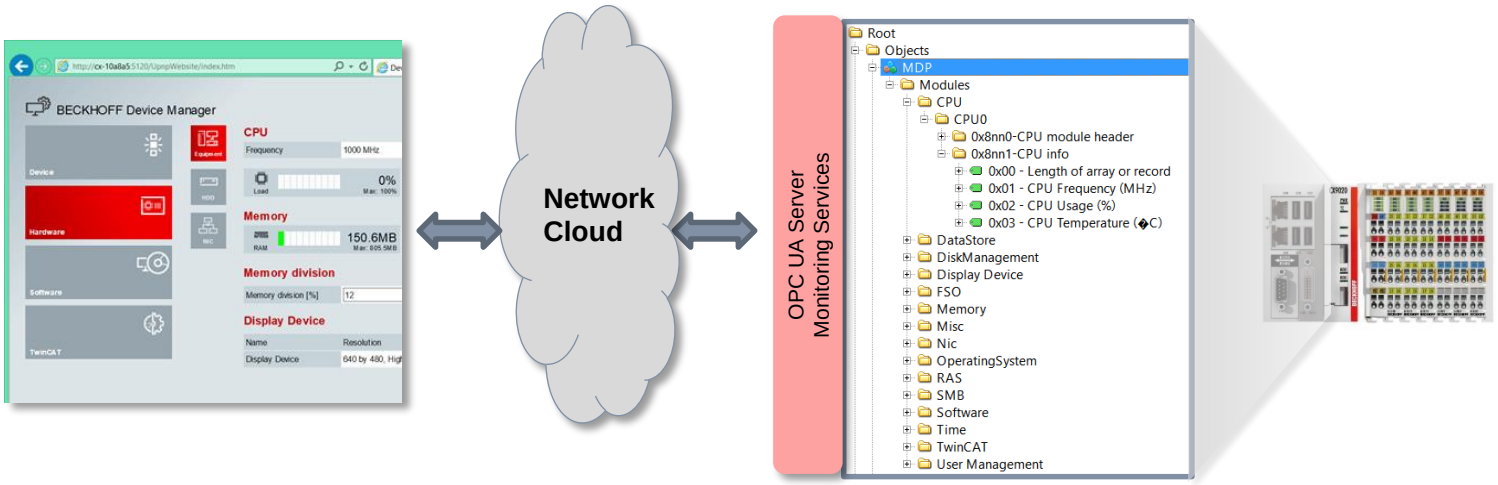
Monitoring Industrial-PC / Embedded-PC:

- 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, …


Windows CE


Windows 7


Windows 10



SOA-PLC: Beckhoff Models

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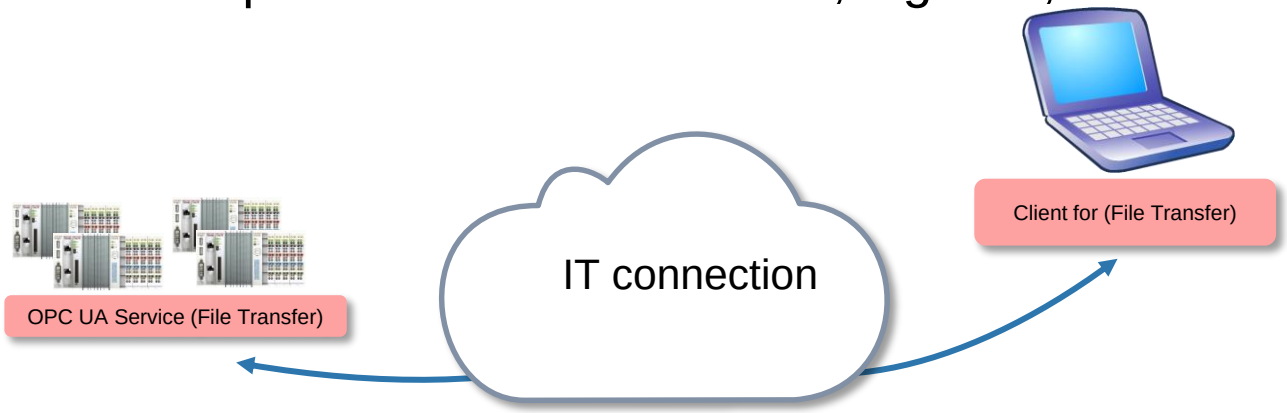
File management of controller

- 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, ...

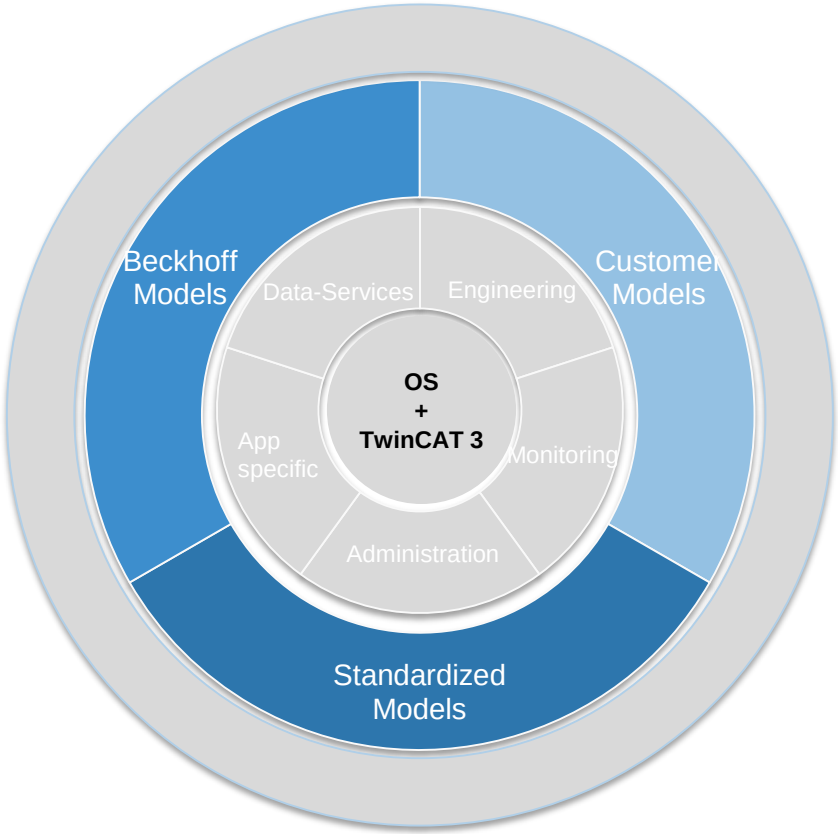
Administration
- Deploy binaries
- “Start” : Start execution
- “Stop”: Stop execution
- “Reset”

- **Device management e.g. file transfer**



SOA-PLC: Overview Architecture

BECKHOFF



Standardized models

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SOA-PLC: Customer Models: Design own services

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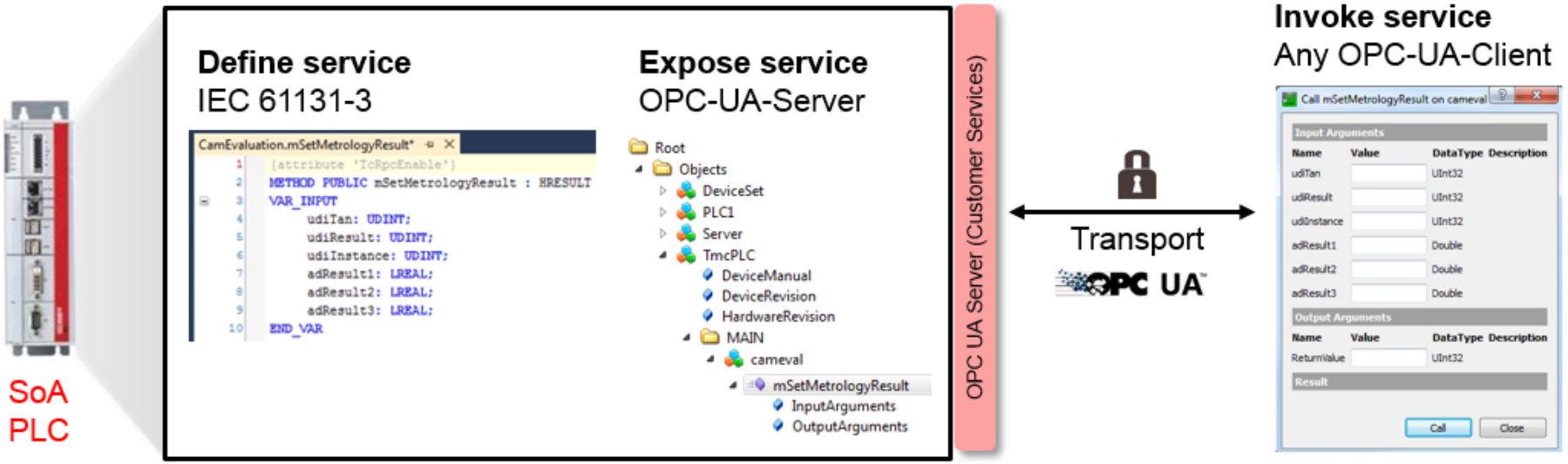
- Customer to design own “my-SoA” services
  - **Requirement:** Easy, quick, reliable, secure, international standardized
  - **Define service:** IEC 61131-3 for easy implementation of services FUNCTIONBLOCK can be invoked from outside from any OPC-UA client
  - **Invoke service:** Remote-procedure-call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



SOA-PLC: Customer Models: Design own services

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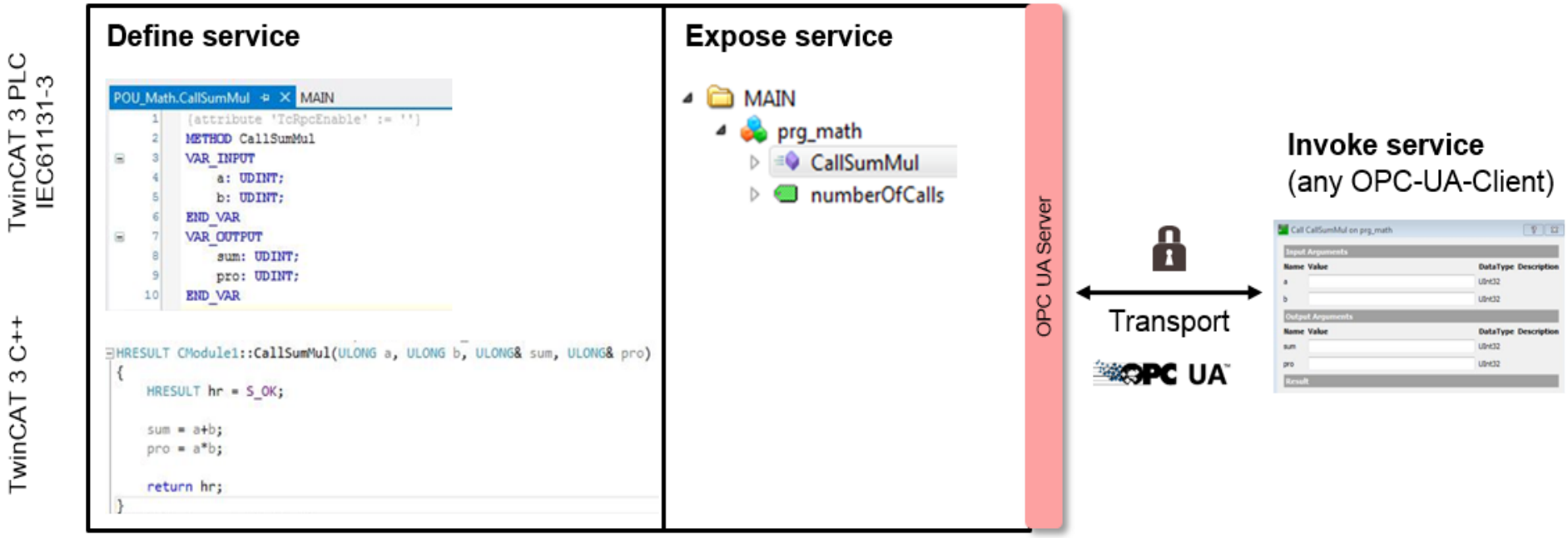
- One-click engineering to enable service as SOA-service to IT world
- Design of SoA services available in



SOA-PLC: Increased efficiency

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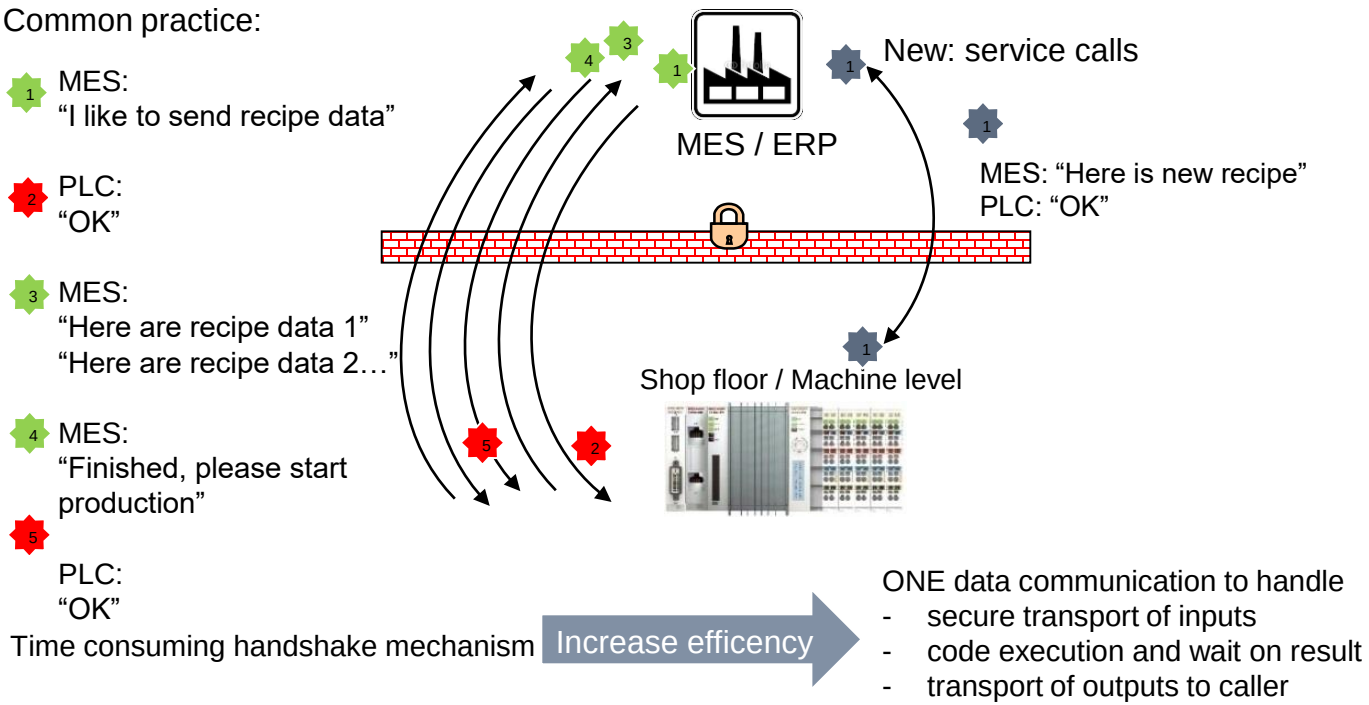
- Service calls vs. data/property exchange



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

M2M & IoT in decentralized, intelligent equipment

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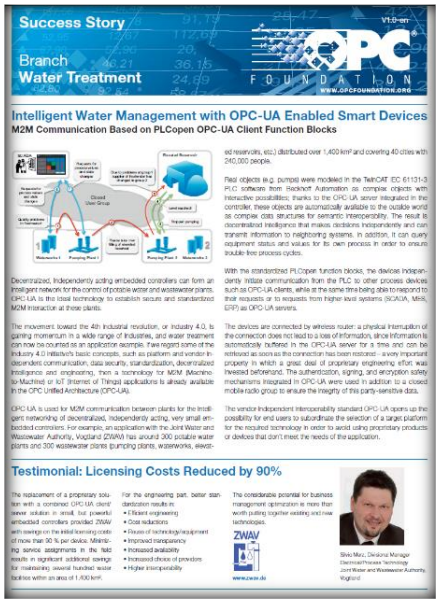

Success Story

Branch
Water Treatment

OPC FOUNDATION
WWW.OPCFOUNDATION.ORG

Intelligent Water Management with OPC-UA Enabled Smart Devices

M2M Communication Based on PLCopen OPC-UA Client Function Blocks

Testimonial: Licensing Costs Reduced by 90%

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 Km²

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

M2M & IoT in decentralized, intelligent equipment

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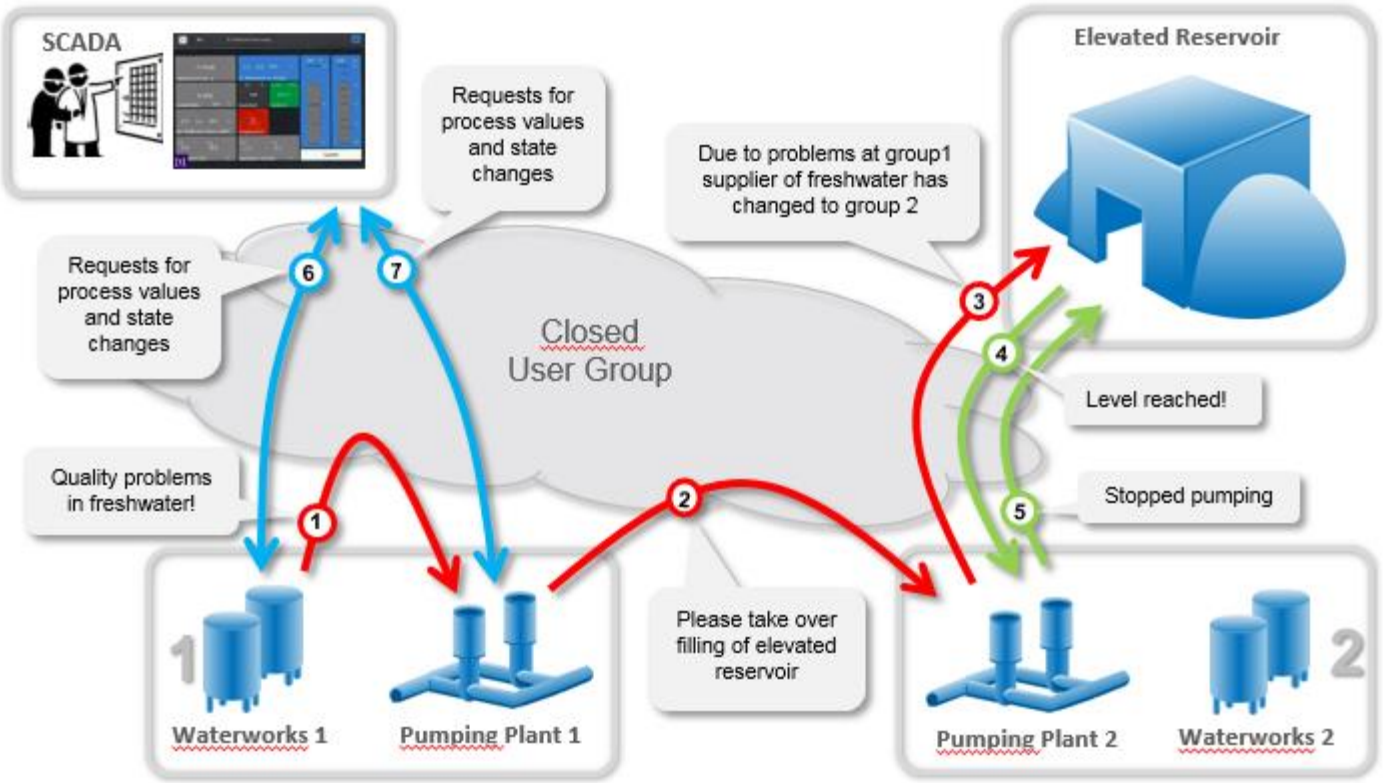
- Autonom M2M between devices – additional monitoring and control via SCADA



Vertical: From shop floor to SAP top floor

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Who?

Elster

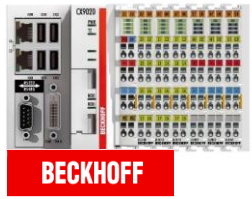
- 7,000 employees in 38 major locations
- 200 million installations in the last 10 years

Metering
Gas, Water, Electricity

elster
Vital Connections

SAP

OPC-UA



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

Smart metering: From sensor to cloud – Case 1

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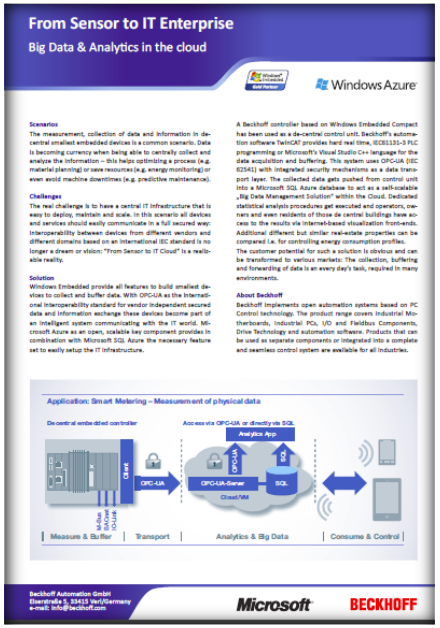
Who?

- 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



Smart metering: From sensor to cloud – Case 1

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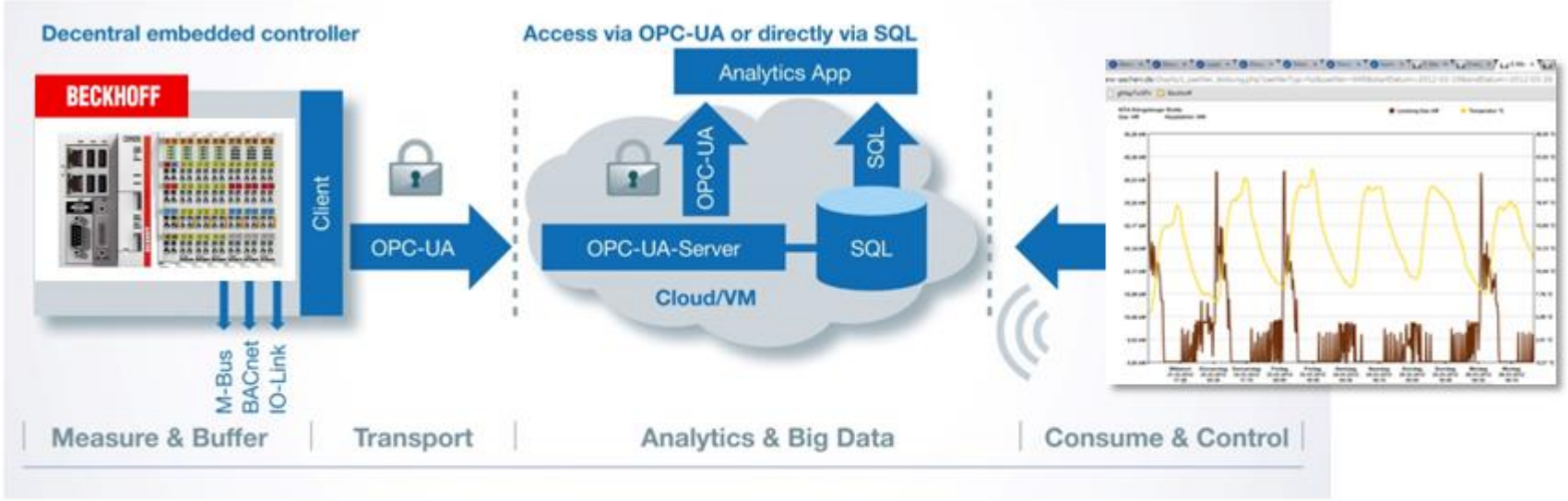

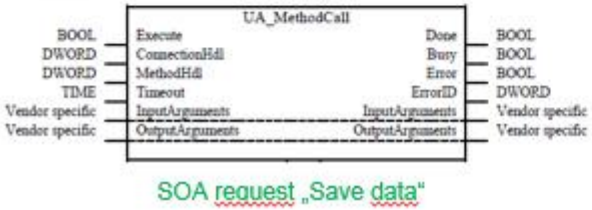

SOA request „Save data“

Smart metering: From sensor to cloud – Case 2

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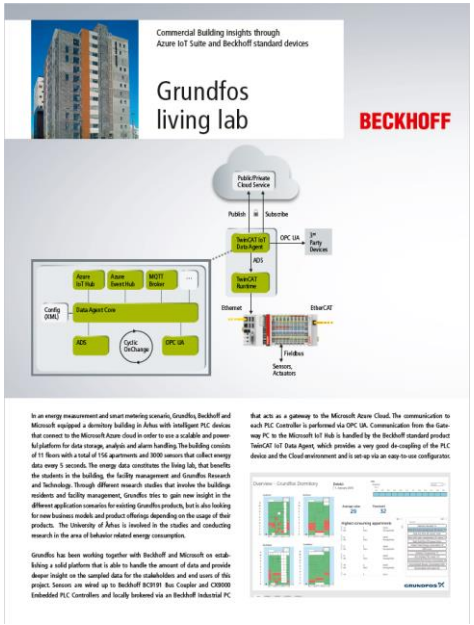
Who?

- 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

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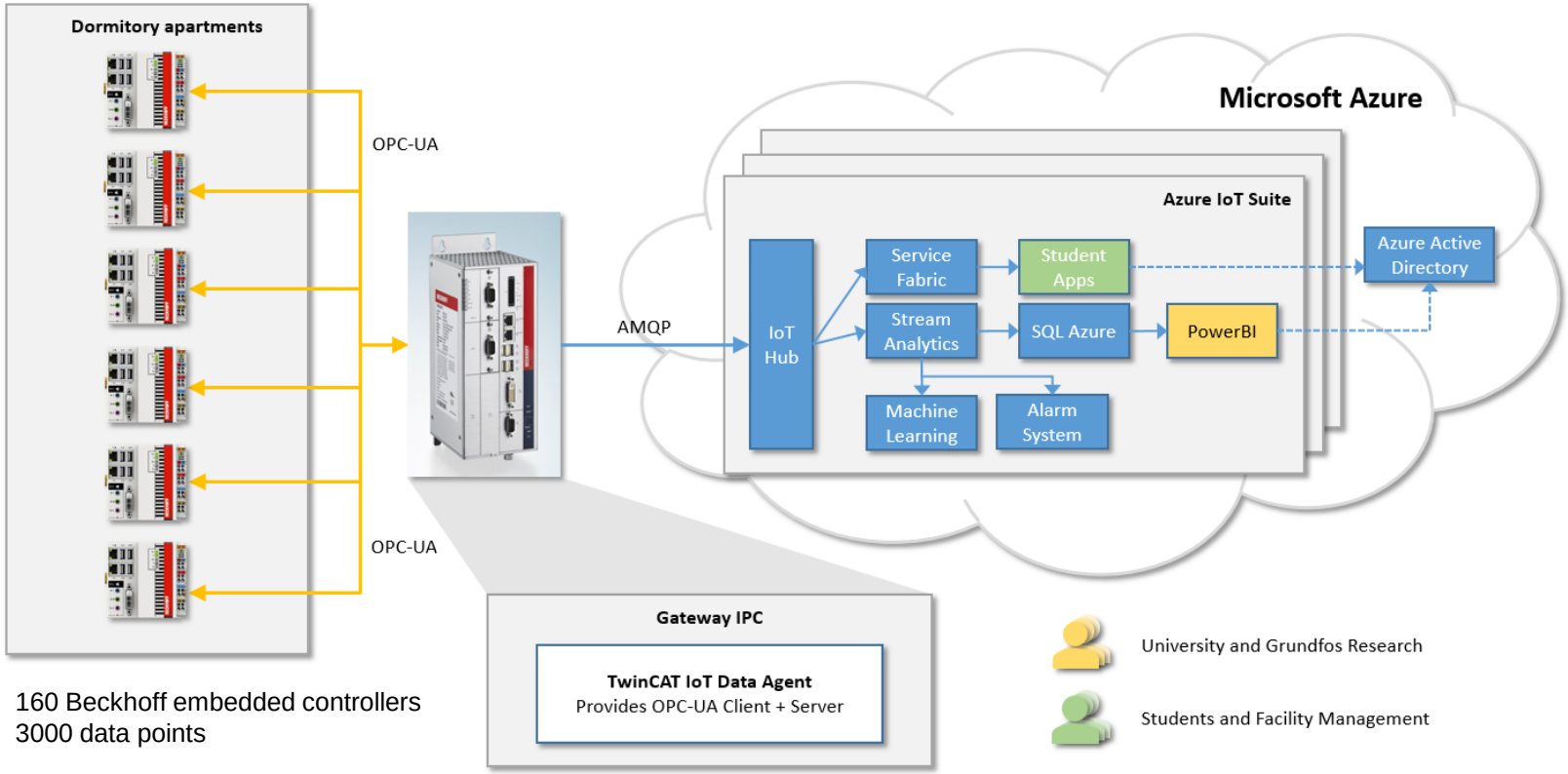

160 Beckhoff embedded controllers
3000 data points

Smart metering: From sensor to cloud - Case 2

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