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

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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
  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
  - 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!
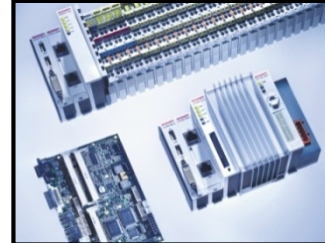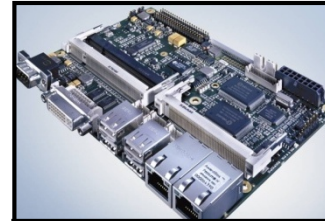
BECKHOFF: OPC Commitment

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
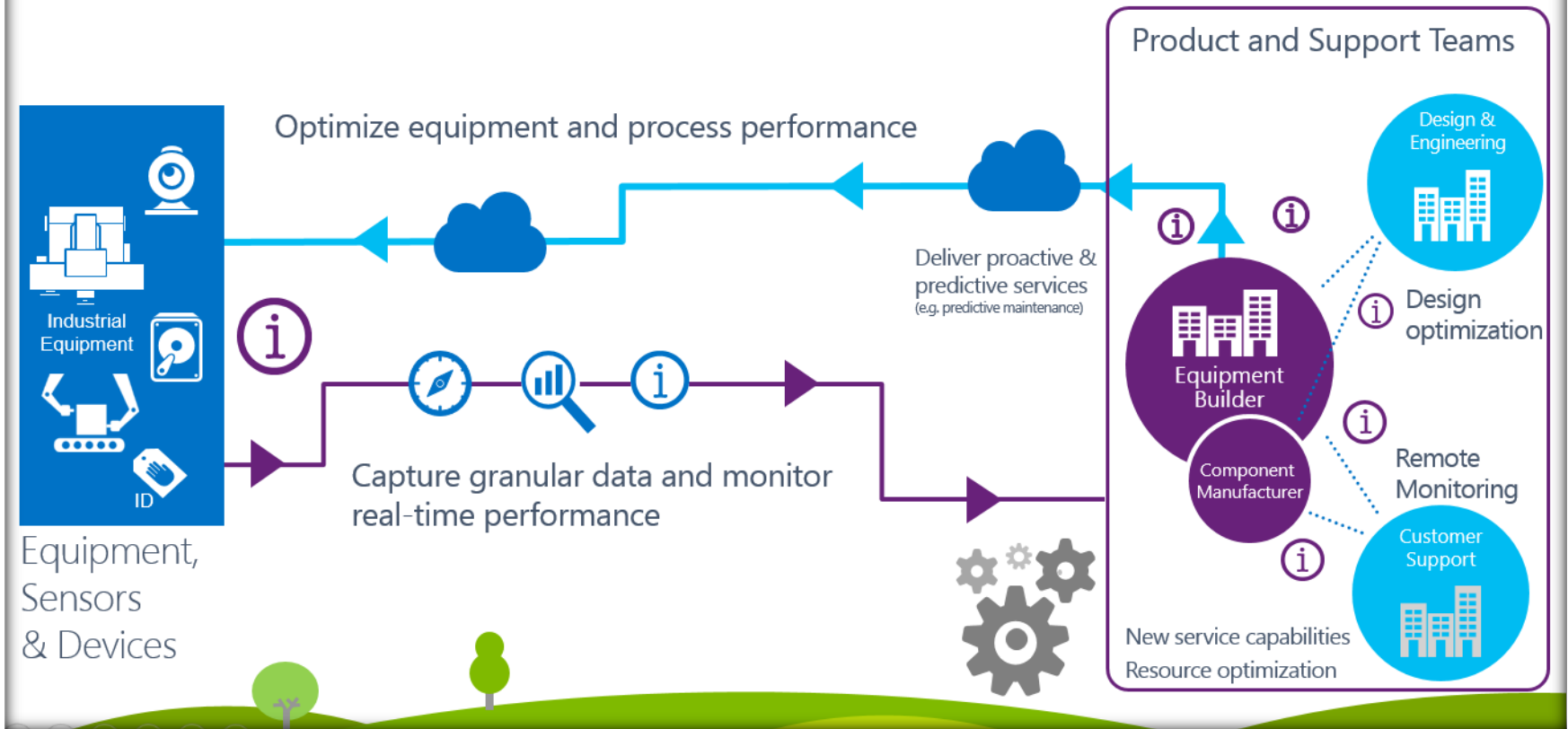
IoT - Definition

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. "
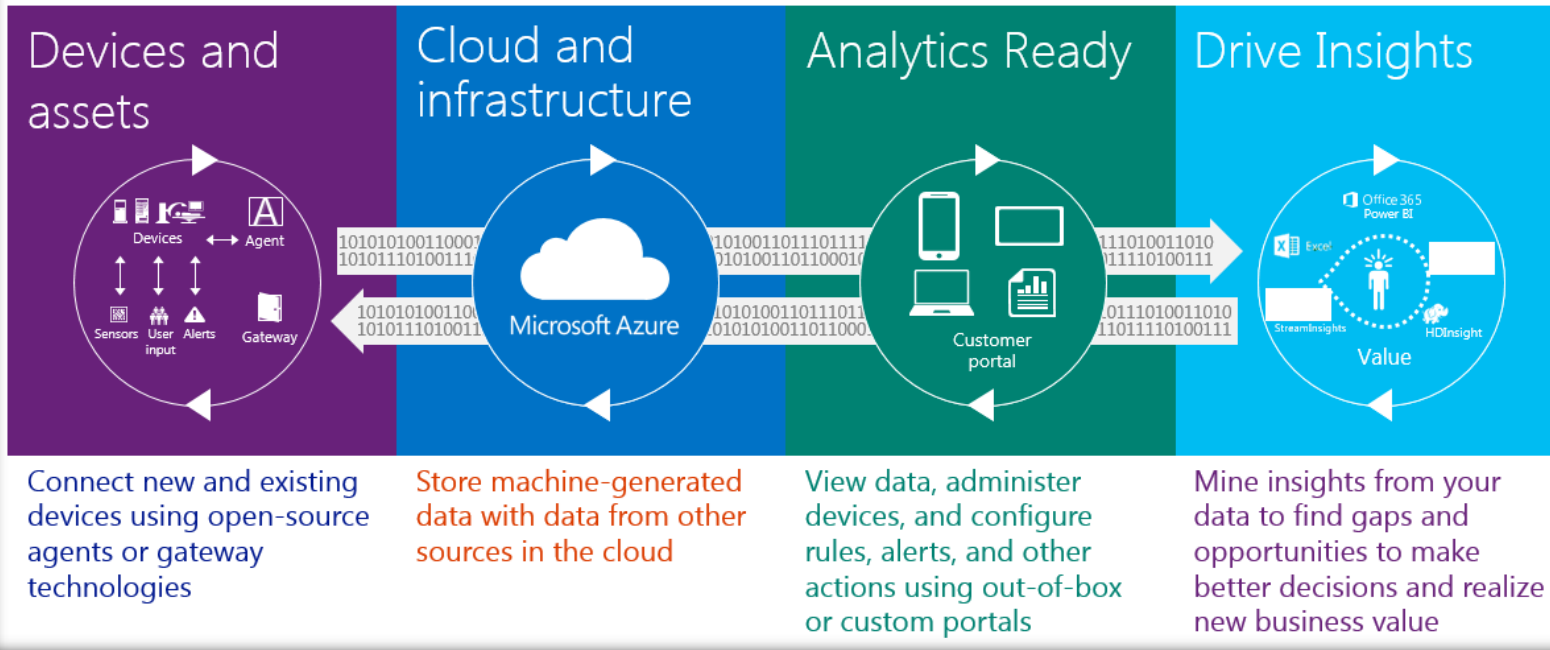
Source: Forrester

Things — **Connectivity**

01100
10010
00101

Data — **Analytics**
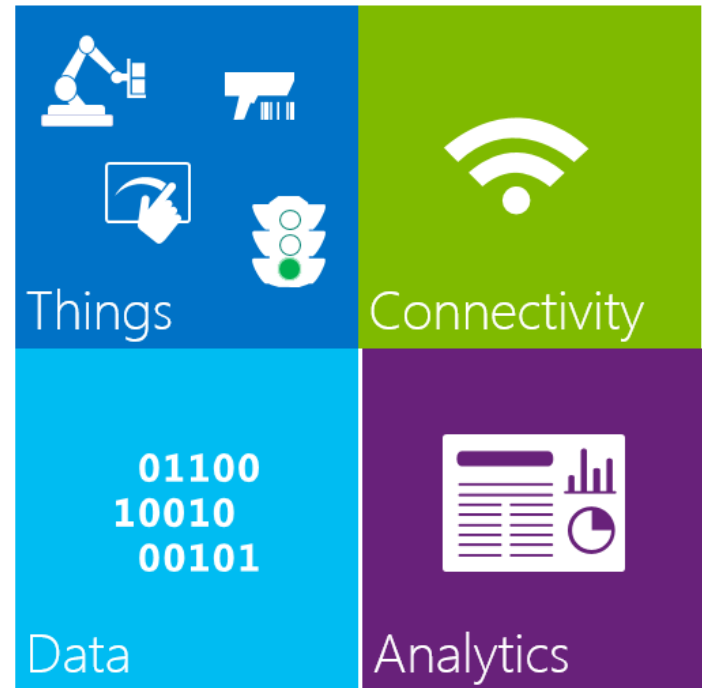
IoT - Definition

Information flow from connected devices...

IoT - Definition

Industrie 4.0 – Definition

Industrie 4.0

- everyone is talking about it: politicians, organisations…

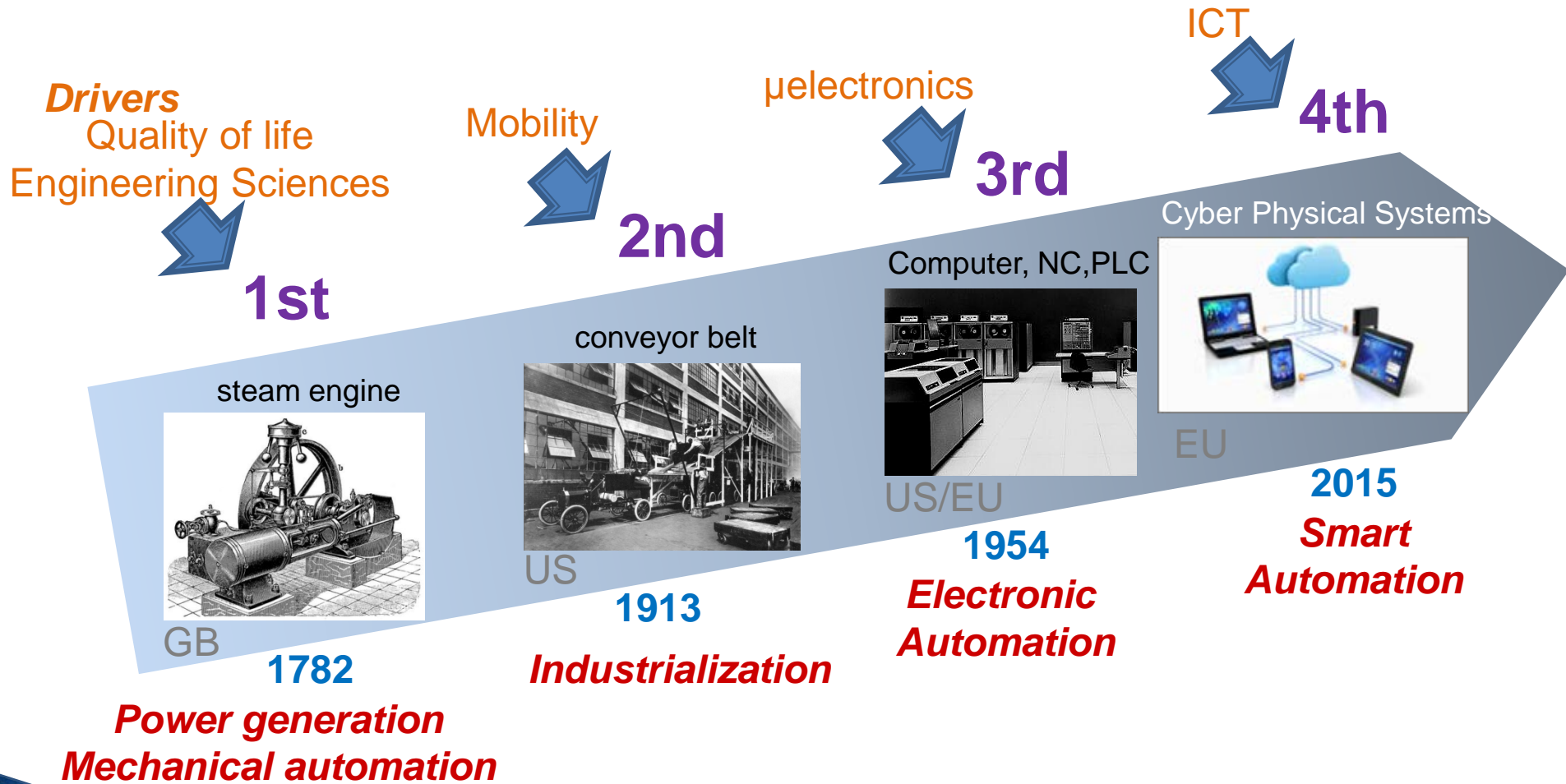- in all journals are innumerable articles

→ **Do you know what**

  Industrie 4.0 means?

Industrie 4.0:
4 stages of the Industrial Revolution

Drivers
Quality of life
Engineering Sciences

1st

steam engine

GB

1782

Power generation
Mechanical automation

Mobility

2nd

conveyor belt

US

1913

Industrialization

μelectronics

3rd

Computer, NC,PLC

US/EU

1954

Electronic
Automation

ICT

4th

Cyber Physical Systems

EU

2015

Smart
Automation

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

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Industrie 4.0: Acatech report

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

Forschungsunion

Wirtschaft und Wissenschaft
begleiten die Hightech-Strategie

acatech

NATIONAL ACADEMY OF
SCIENCE AND ENGINEERING

Securing the future of German manufacturing industry

Recommendations for implementing the strategic initiative INDUSTRIE 4.0

Final report of the Industrie 4.0 Working Group

Internet of Services

Smart Mobility   Smart Logistics

Smart Grids   Smart Factory   Smart Buildings

CPS

Smart Product

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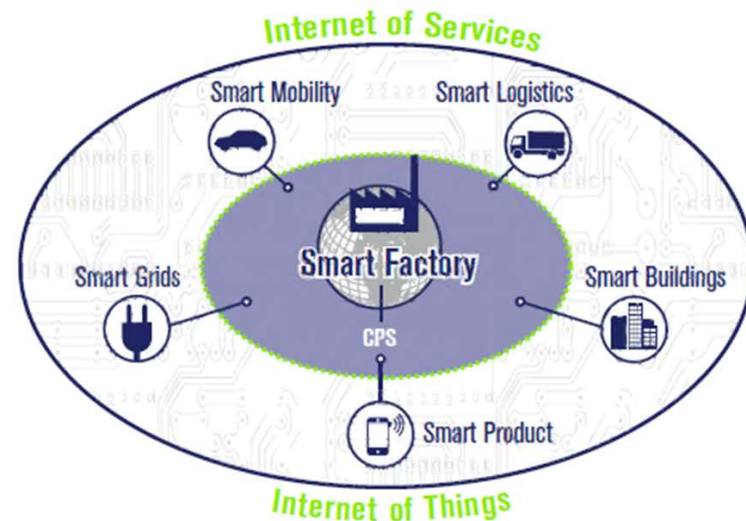
Source: Acatech, Final report of the Industrie 4.0 Working Group, April 2013

Extract „Acatech Recommendations for implementing INDUSTRIE 4.0"

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
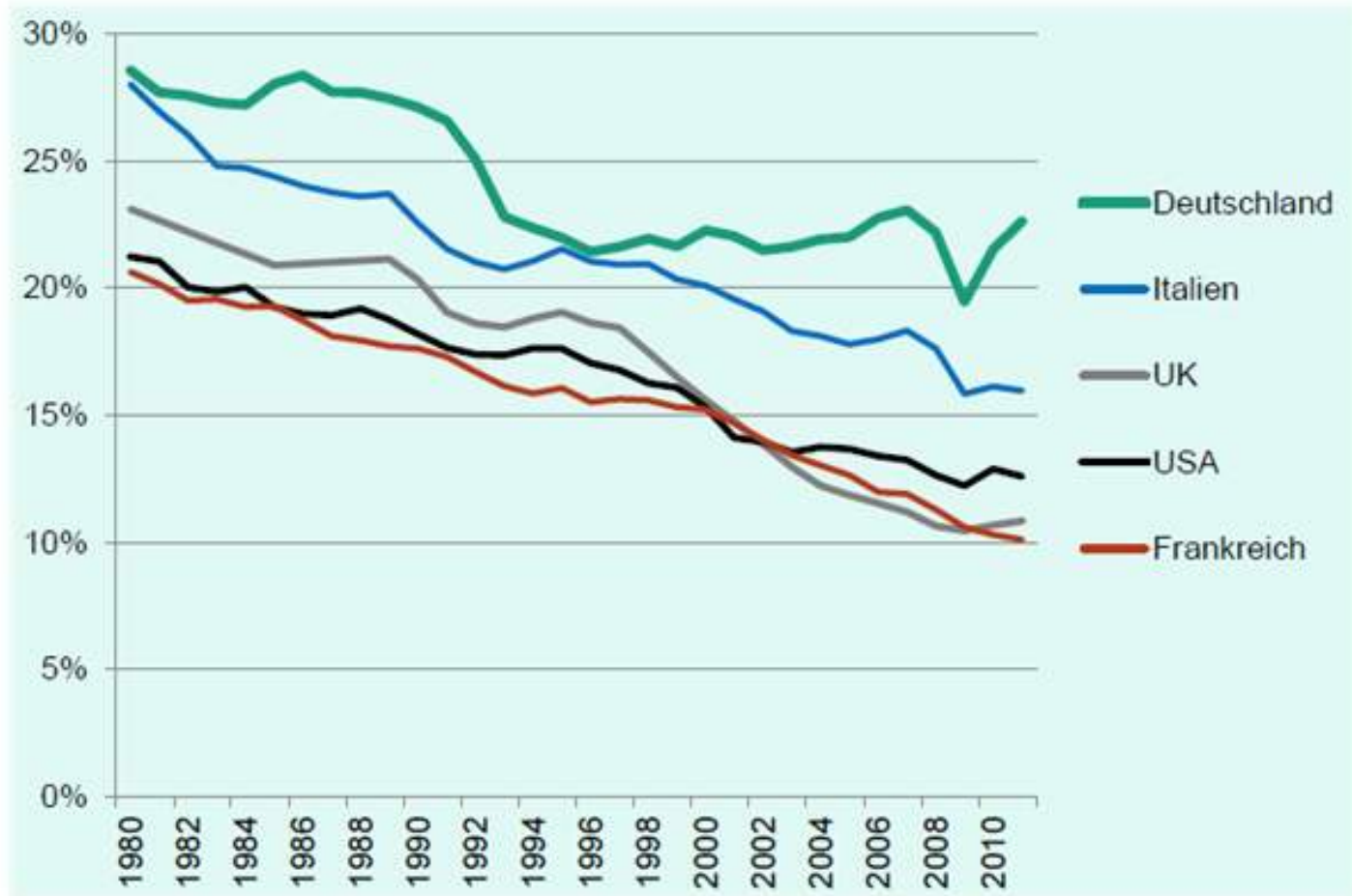
Quelle: UNData: Gross Value Added Manufacturing/Total Gross Value Added

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 ensurance
- self-optimizing manufacturing and production
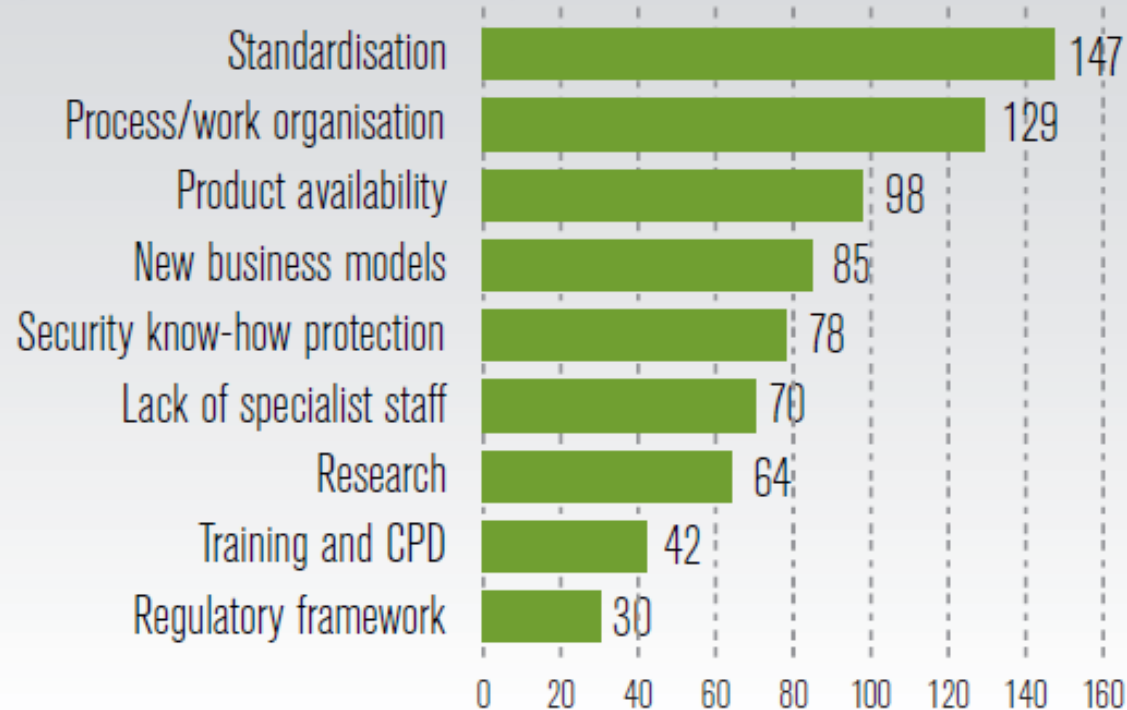- consistent engineering

Industrie 4.0: Intelligent control

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

What are the greatest challenges connected with implementing Industrie 4.0?
(you may select more than one answer)

Challenge	Value
Standardisation	147
Process/work organisation	129
Product availability	98
New business models	85
Security know-how protection	78
Lack of specialist staff	70
Research	64
Training and CPD	42
Regulatory framework	30

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
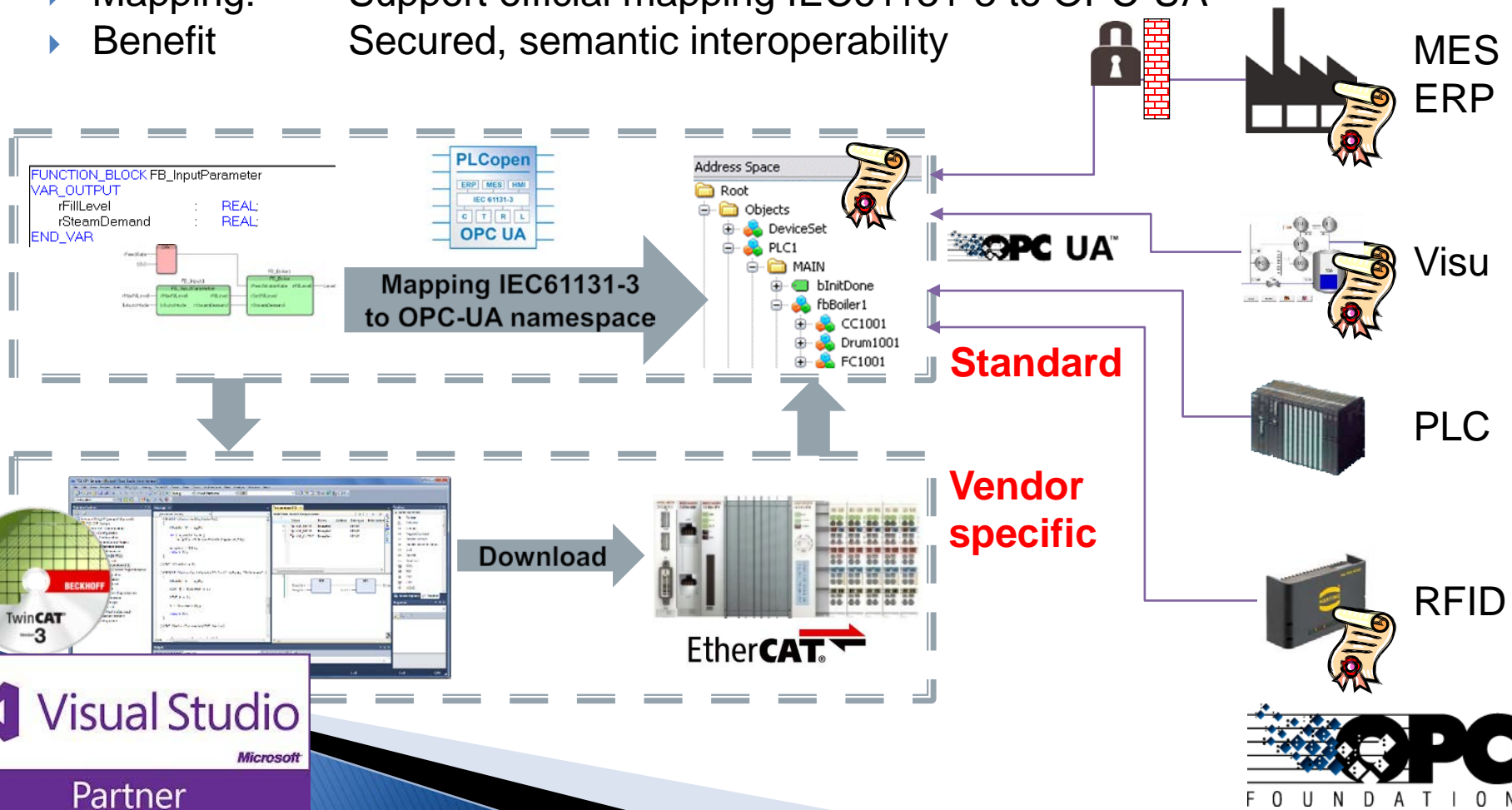 -> to service"

▸ Next: Service to service
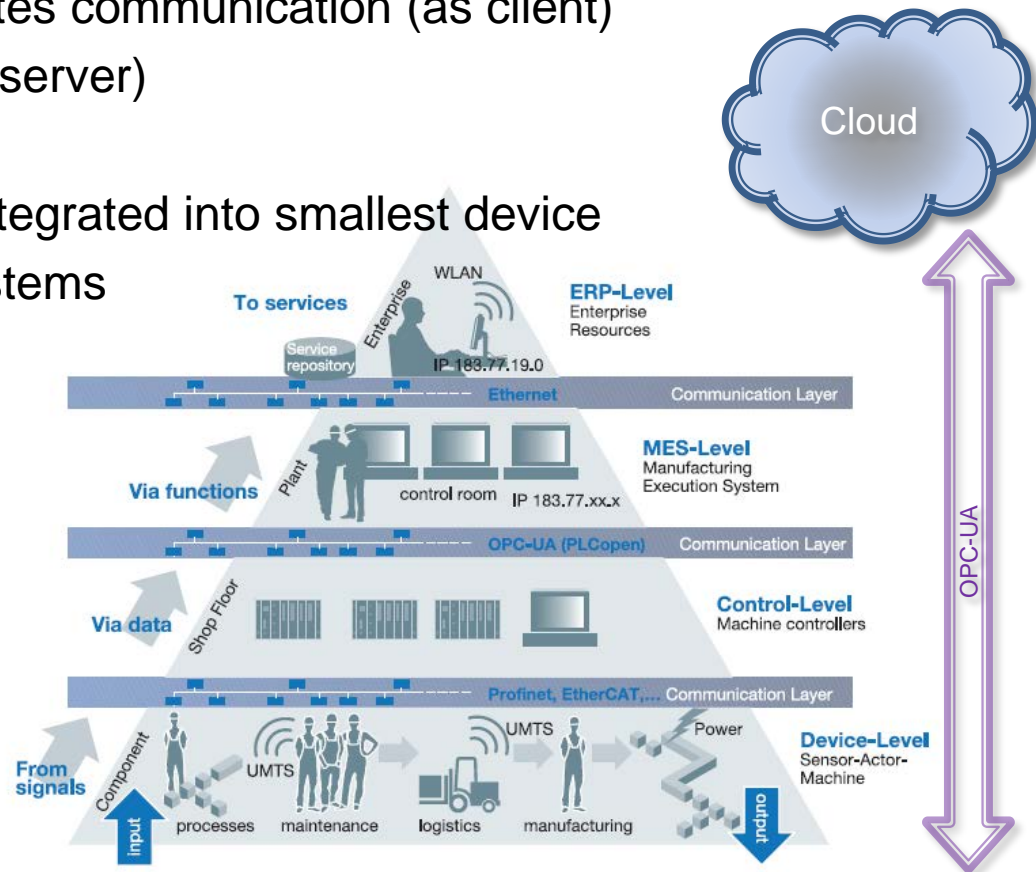
New: OPC-UA integrated into devices allow „From service to service"
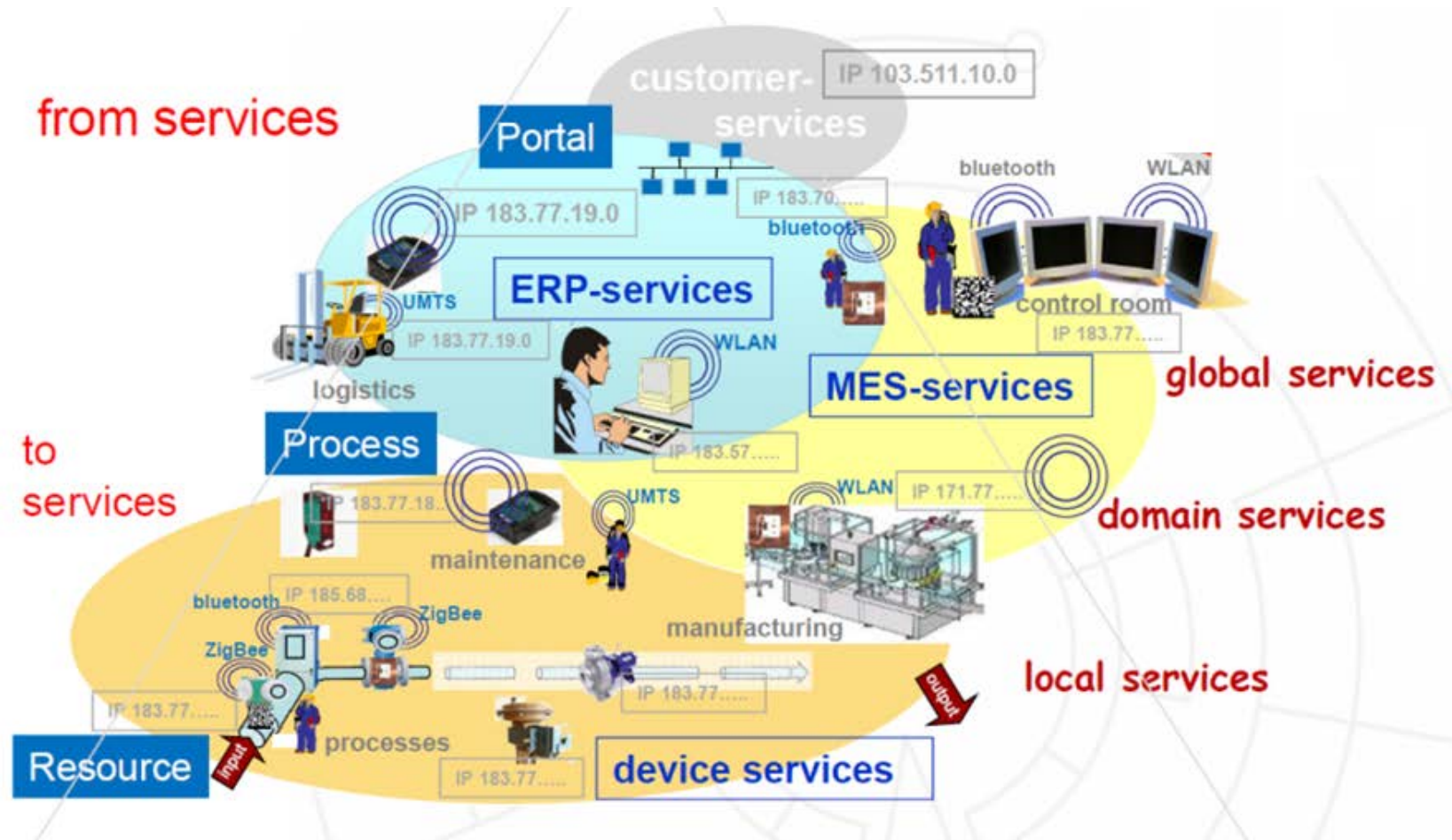
Source: Prof. Zühlke, DFKI

Into Controller: Informationmodell

▸ 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
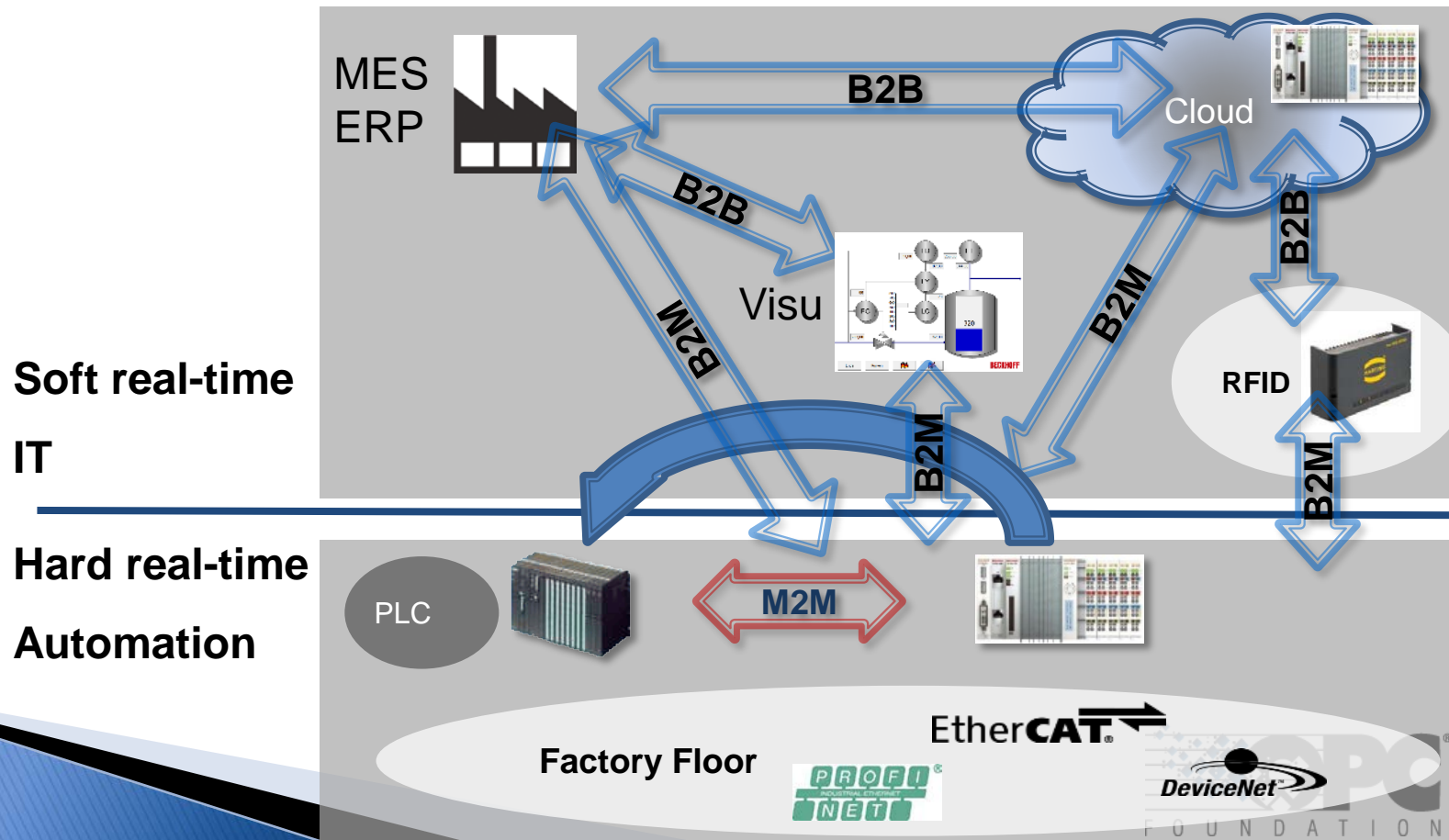
Metering
Gas, Water, Electricity
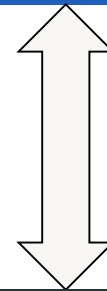
Different understanding of IT and IA3: Real-time Categories of communication

Services are running in IT or Automation teal 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)
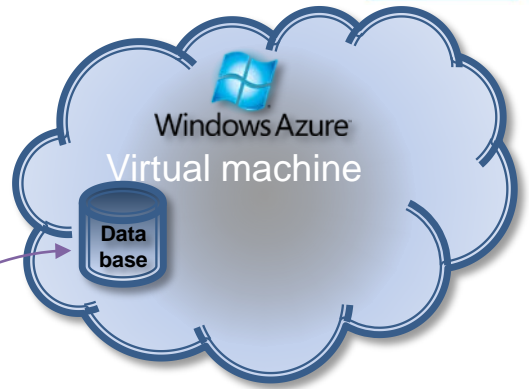M2M: machine to machine (µs to ms, e.g. robot to robot)
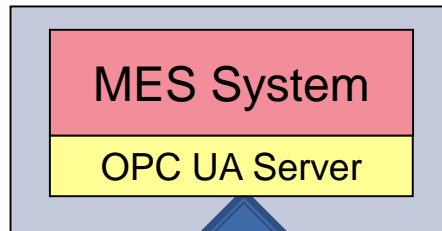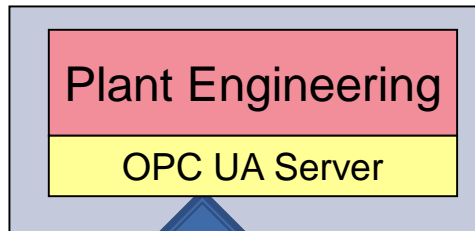
From Controller: PLCopen FB

Connection > **from the controller** <
Controller initiating communication

Released
April-2014

Windows Azure
Virtual machine

Data base

Plant Engineering	MES System
OPC UA Server	OPC UA Server

OPC-UA

OPC-UA

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

OPC-UA

OPC-UA

EtherCAT

PROFI®
INDUSTRIAL ETHERNET
NET

ODVA

		UA_MethodCall		
BOOL	Execute		Done	BOOL
DWORD	MethodHdl		Busy	BOOL
TIME	Timeout		Error	BOOL
			ErrorID	DWORD
ANY	InputArguments		InputArguments	ANY
ANY	OutputArguments		OutputArguments	ANY

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PLCopen
ERP MES HMI
IEC 61131-3
C T R L
OPC UA

Use Case | Machine to Machine

SCADA

Requests for process values and state changes

qualitiy problems in freshwater
① water works 1

pumping plant 1

② Requests for process values and state changes

closed user group

② please overtake filling of elevated reservoir

level ① reached

stop pumping ②

③ due to problems at group1 supplier of freshwater has changed to group 2

elevated reservoir

water works 2

pumping plant 2

Challenge:
500 devices
        pumps
        waterboilers
1400 km2

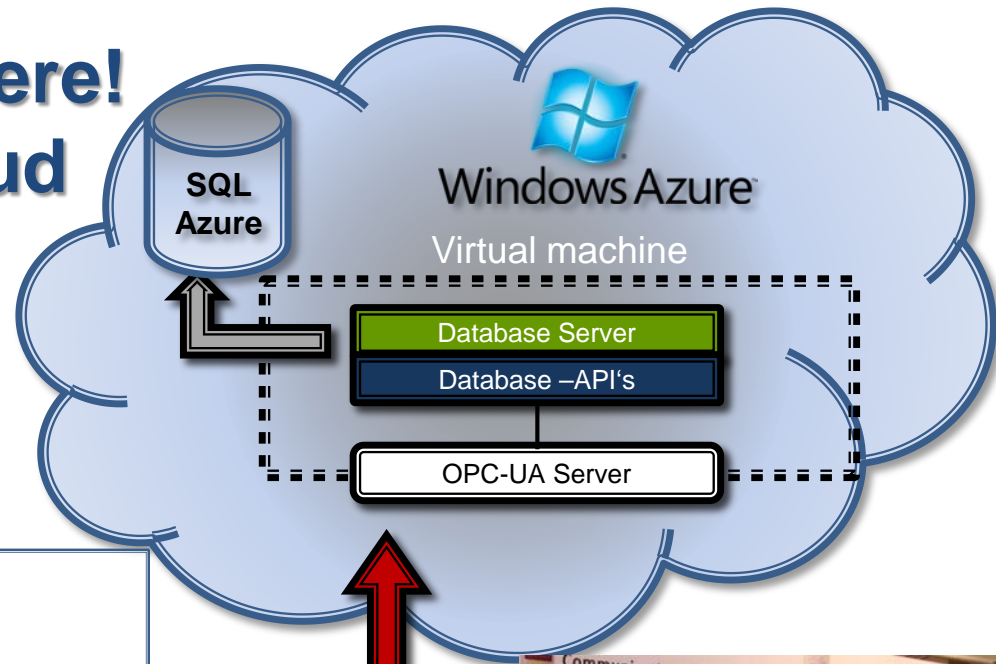# Use Case | Machine to Machine

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

- ▶ <u>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</u>

- ▶ 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

SQL Azure

Windows Azure

Virtual machine

Database Server

Database –API's

OPC-UA Server

Runtime: PLCopen Function Blocks for OPC-UA method call

```
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);
```

Communication from PLC to ERP
Data-Storage from I/O up to the Cloud

From Controller into the Cloud

Big Data & Analytics in the Cloud

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)

From Sensor to IT Enterprise
Big Data & Analytics in the cloud

Application: Smart Metering – Measurement of physical data

Decentral embedded controller

Access via OPC-UA or directly via SQL

Analytics App

Client

OPC-UA

OPC-UA-Server   SQL

OPC-UA   SQL

Cloud/VM

M-Bus
BACnet
IO-Link

Measure & Buffer | Transport | Analytics & Big Data | Consume & Control
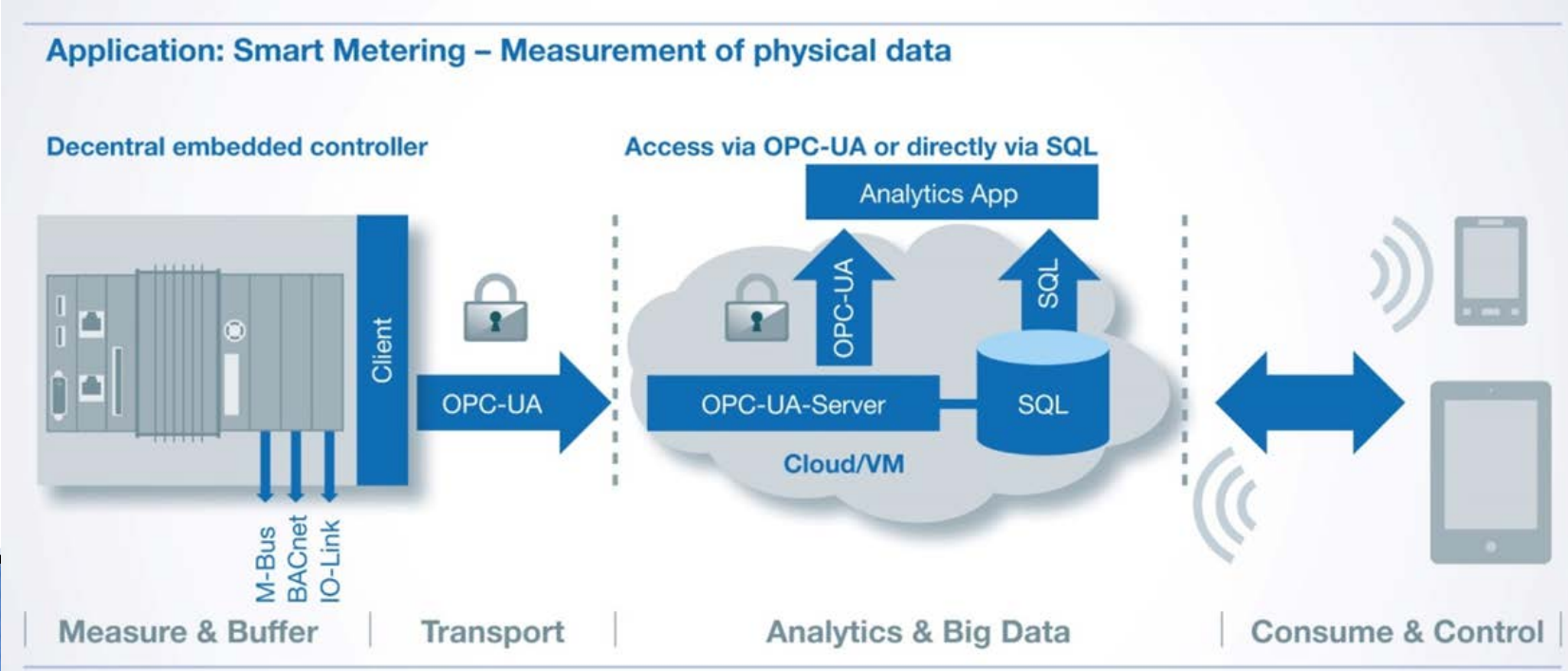
IoT vs Industrie 4.0

IoT: Simplified message:

- We provide an agent for all plattforms

- IoT starts with data are in cloud

- New business with analytics in the cloud

Required:

- (Just) data transport

- Security

Backbone

Agent

PC | MQTT/ AMQP/…

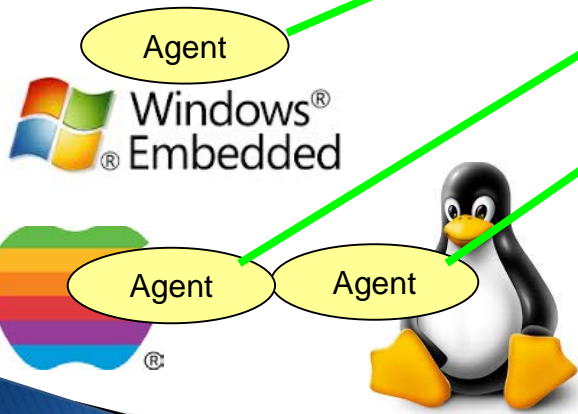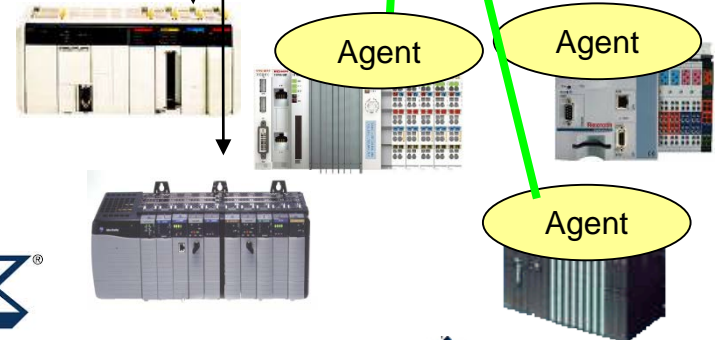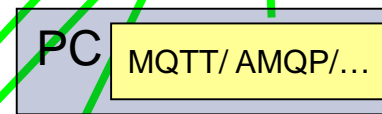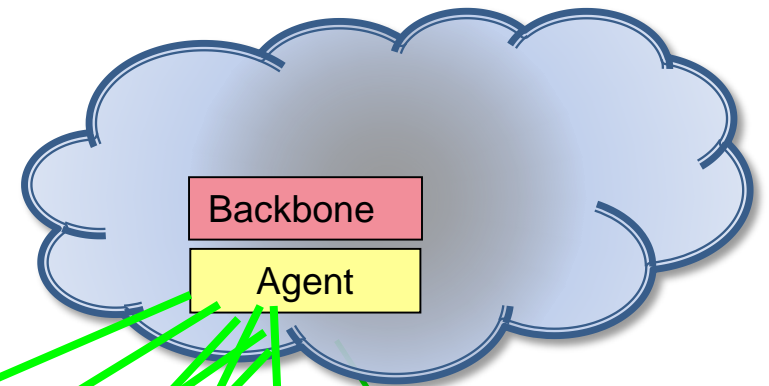Agent

Windows® Embedded

Agent

Agent Agent

Agent

VxWorks

Agent

Agent

QNX SOFTWARE SYSTEMS

Agent Agent

Agent

OPC FOUNDATION
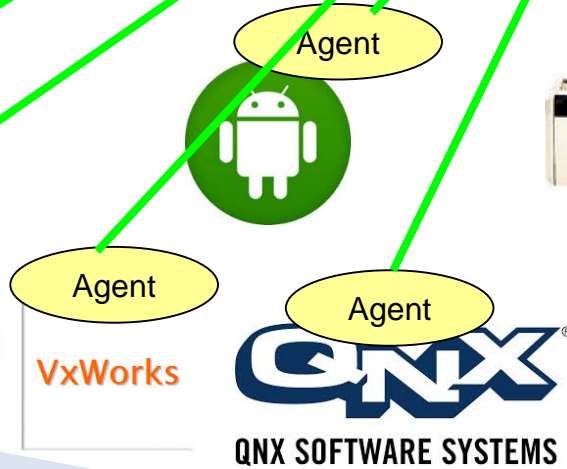
IoT vs Industrie 4.0

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

Backbone

OPC UA™ + Relay

PC AMQP-Agent

OPC UA™

PC OPC UA™

OPC UA™

OPC UA™

OPC UA™

Windows® Embedded

VxWorks

QNX SOFTWARE SYSTEMS

OPC FOUNDATION
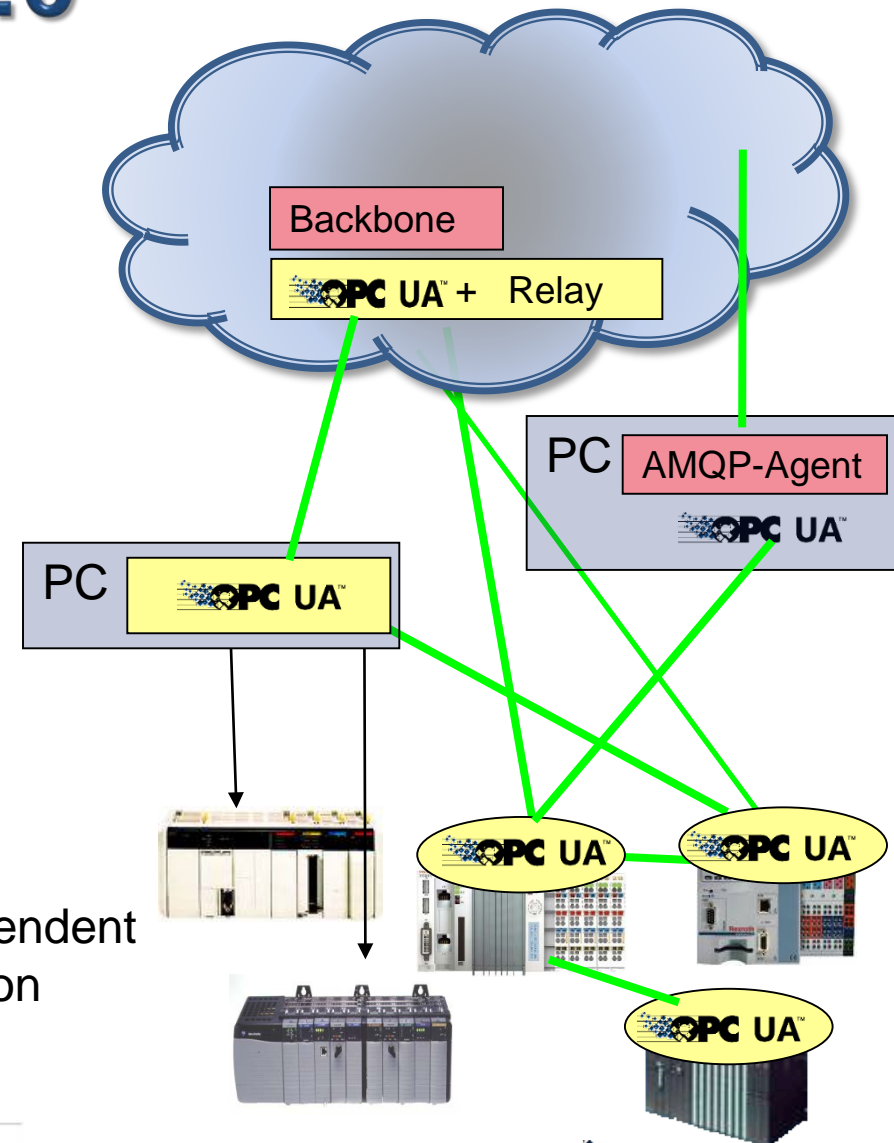
IoT or Industrie 4.0
OPC-UA is the enabler

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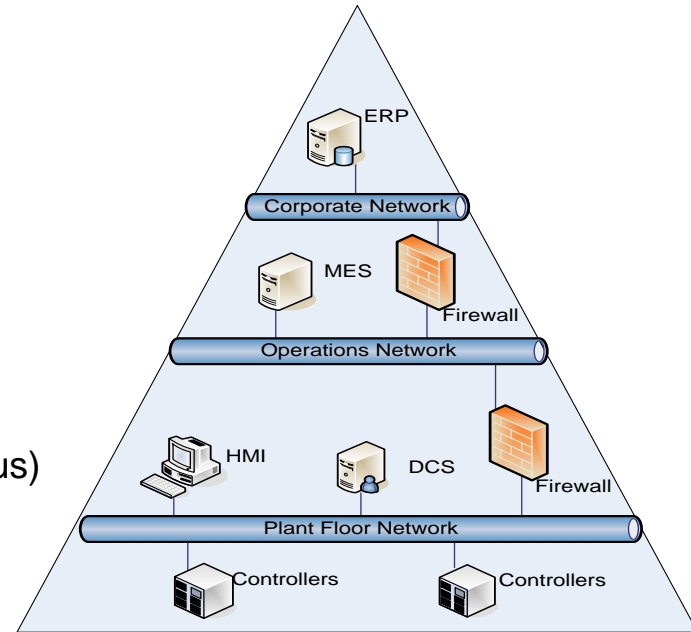 - Secure, interoperable, reliable, performant, scalable
  - Platform-independent (OS, language, vendor)
  - Technology:
    - Service-oriented
    - Provide technology independend from services
  - Small set of easy to use services
    - 37 operations
    - Grown up in Automation market - (e.g. time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

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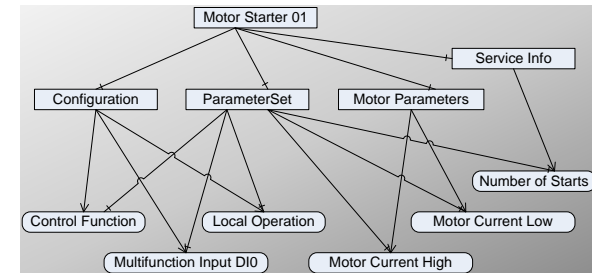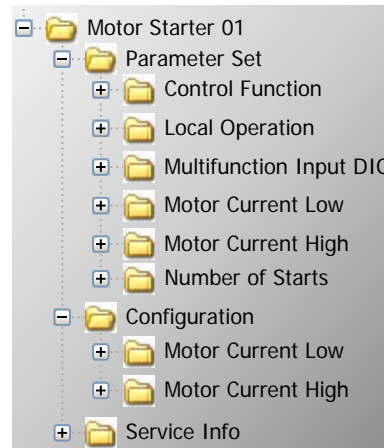
Trends: SoA-PLC: IEC61131-3 and OPC-UA RPC calls between IT and Automation

▸ "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
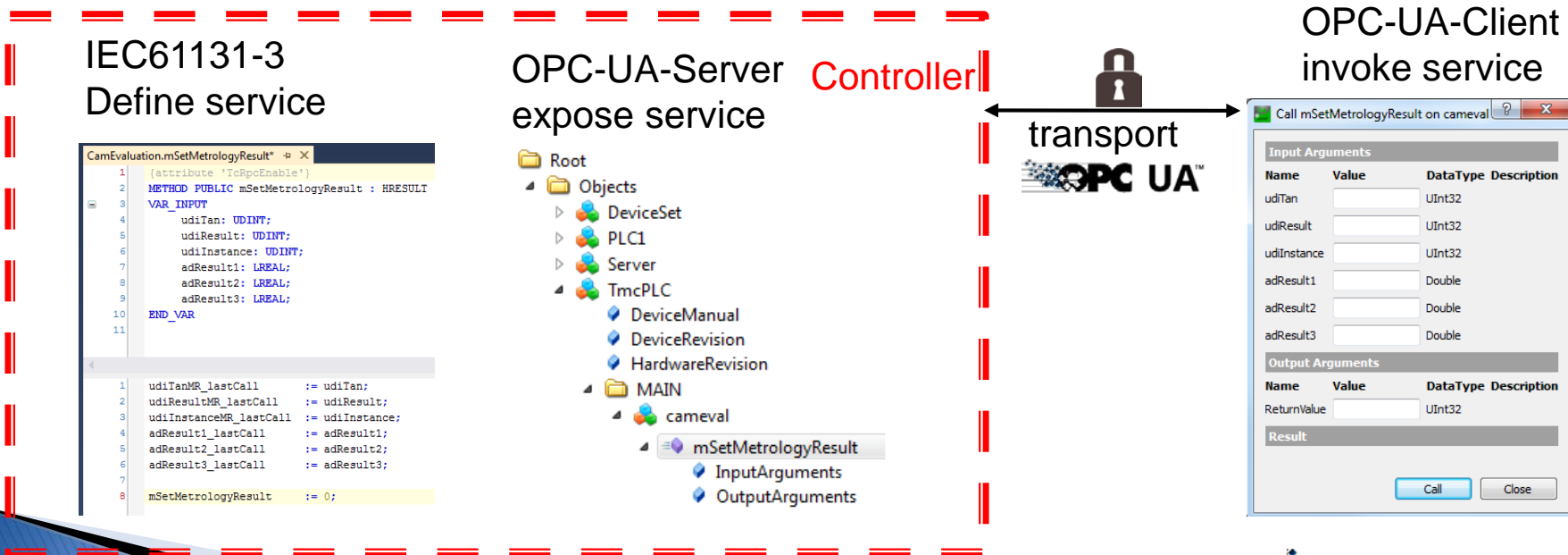
Trends: SoA-PLC: IEC61131-3 and OPC-UA → Increase efficency and data consistency

▸ 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"
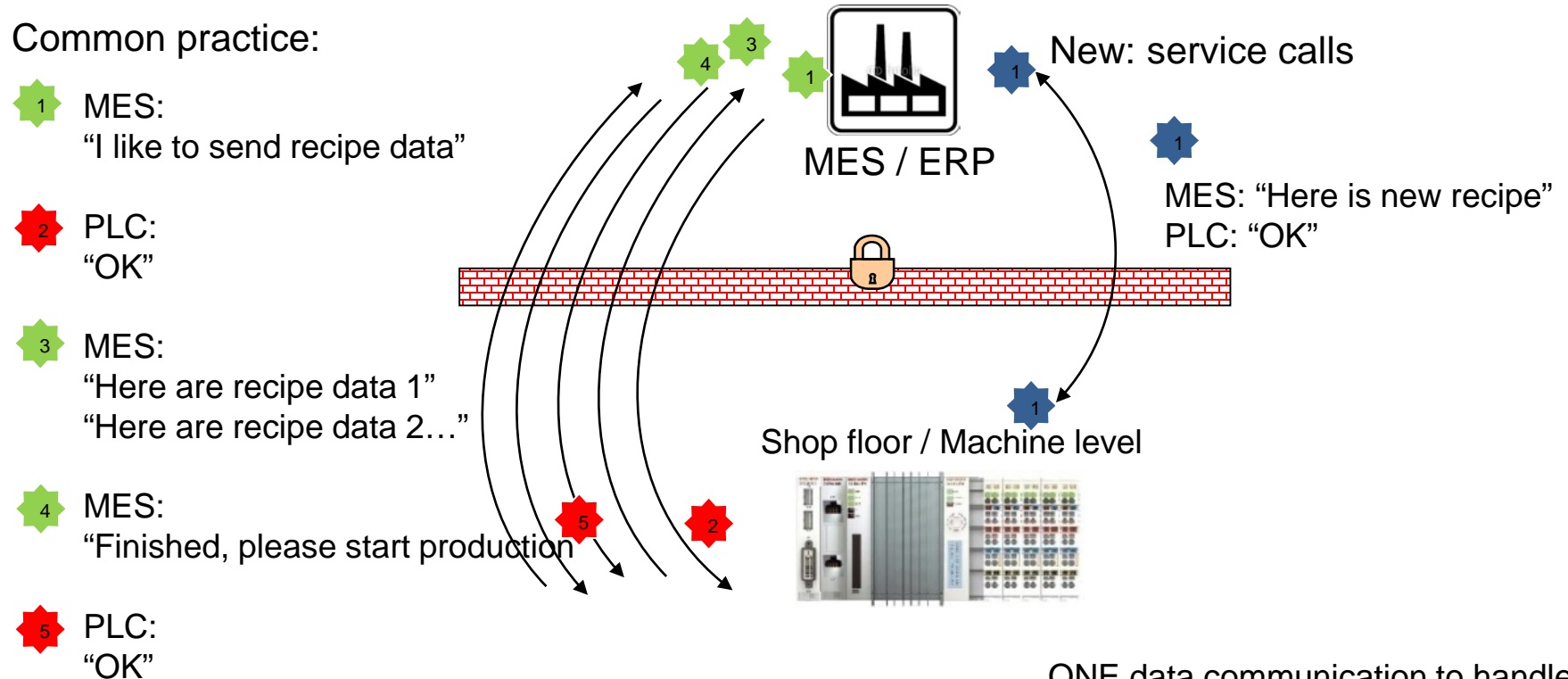
Time consuming handshake mechanism

MES / ERP

New: service calls

MES: "Here is new recipe"
PLC: "OK"

Shop floor / Machine level

Increase efficency

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

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Trends: Filetransfer & Modelling
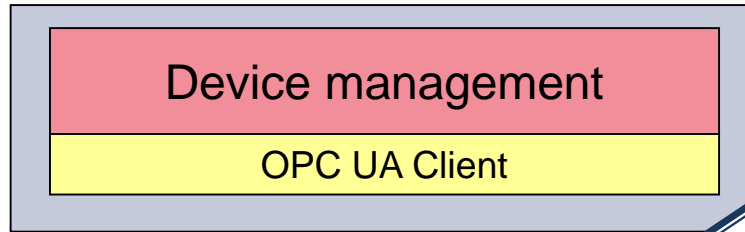
File transfer via OPC-UA

Device management

OPC UA Client

OPC-UA

I am a CNC machine

I am a energy sensor

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

FOUNDATION

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

▸ Brochure: "OPC UA – Pioneer of 4. industrial (R)Evolution"

▸ 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

OPC Unified Architecture
Pioneer of the 4th industrial (r)evolution
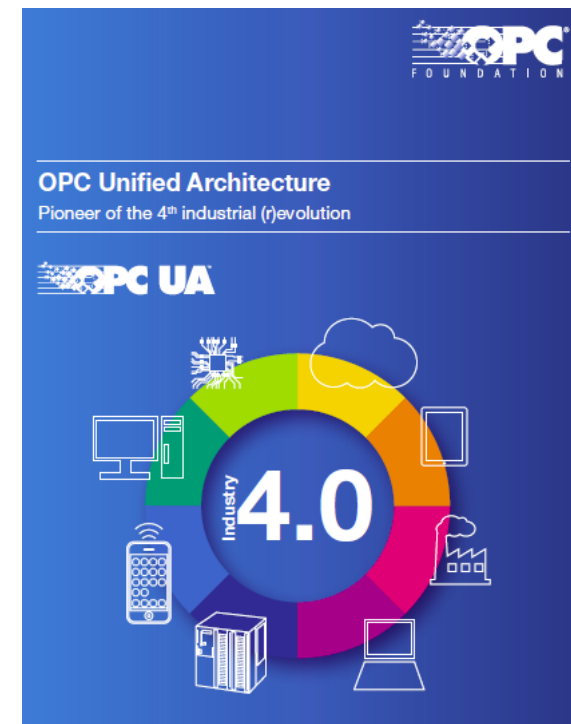
More Information

- OPC Foundation 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
  - Free download of introduction papers
  - See TC – Communication

- BECKHOFF Automation www.beckhoff.com

  - **Free downloads of trial versions**
  - **TwinCAT3: Automation integrated into Microsoft Visual Studio**

08.2014