OPC UA as enabler for Internet of Things and Industry 4.0:

Status and roadmap

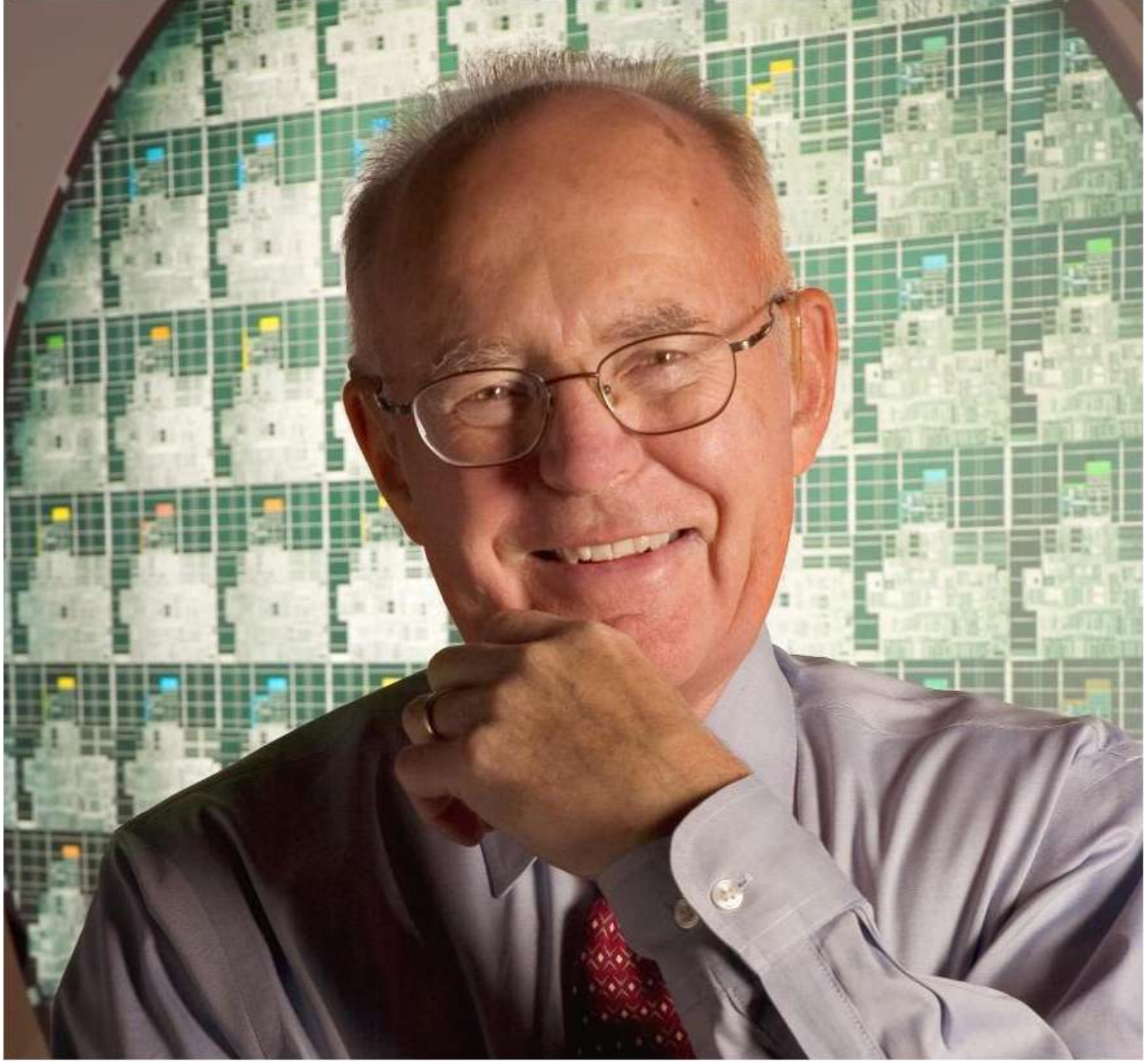
Peter Seeberg
Softing Industrial Automation GmbH
OPC-Europe Advisory Board

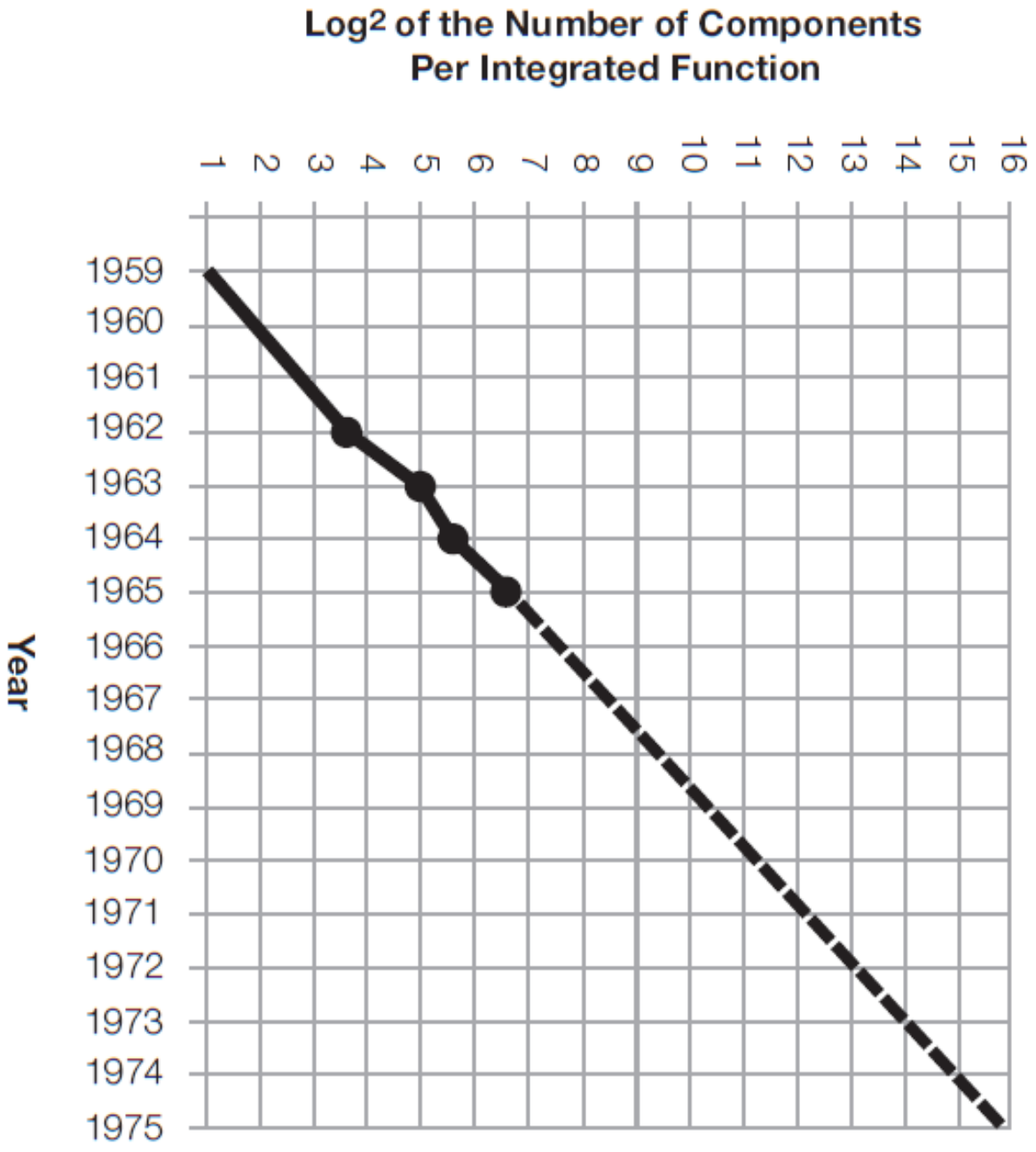
peter.seeberg@softing.com

Agenda

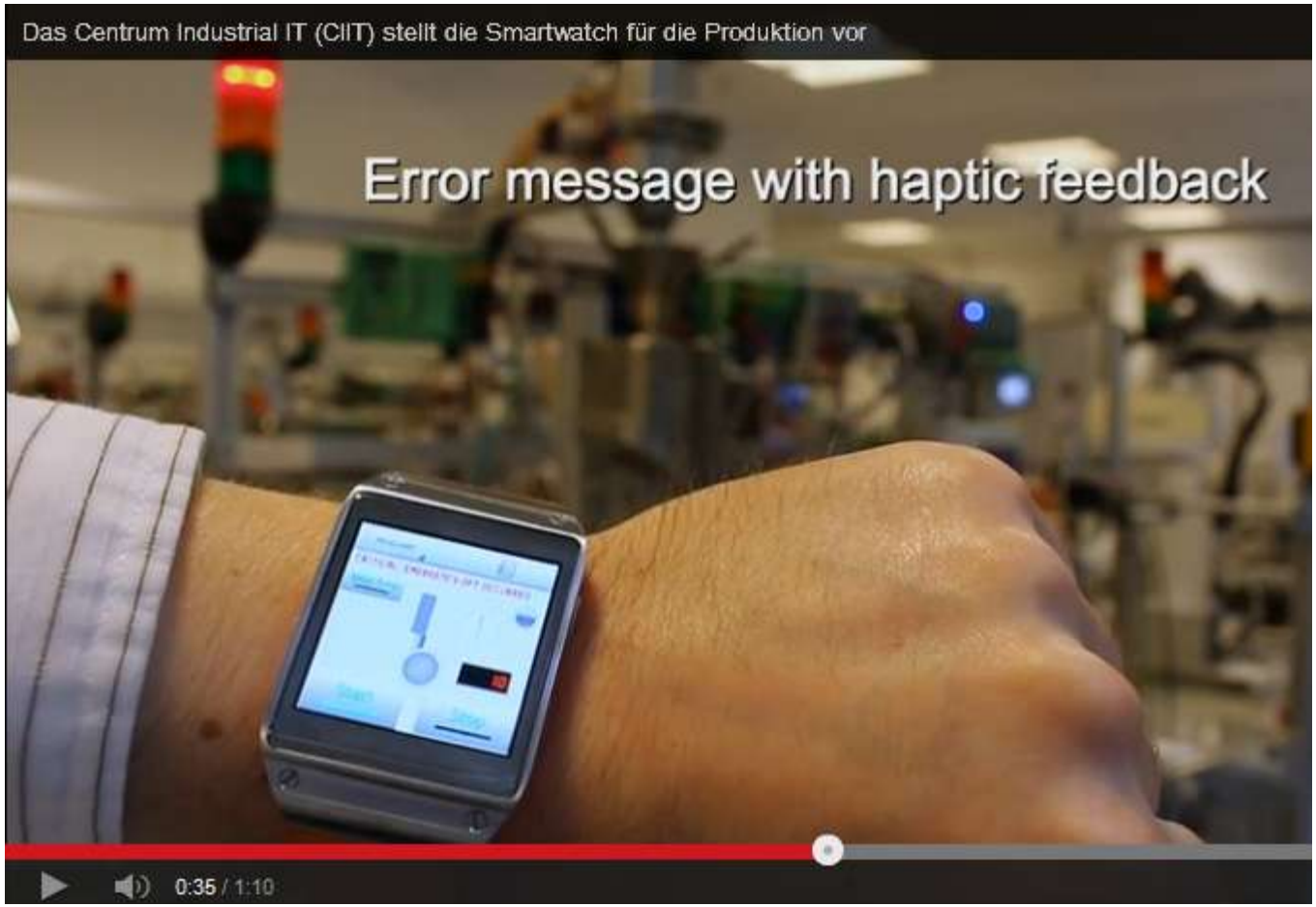
- A little History of IT
- Industrie 4.0
- Internet of Things
- Ten Facts about OPC UA
- OPC Foundation

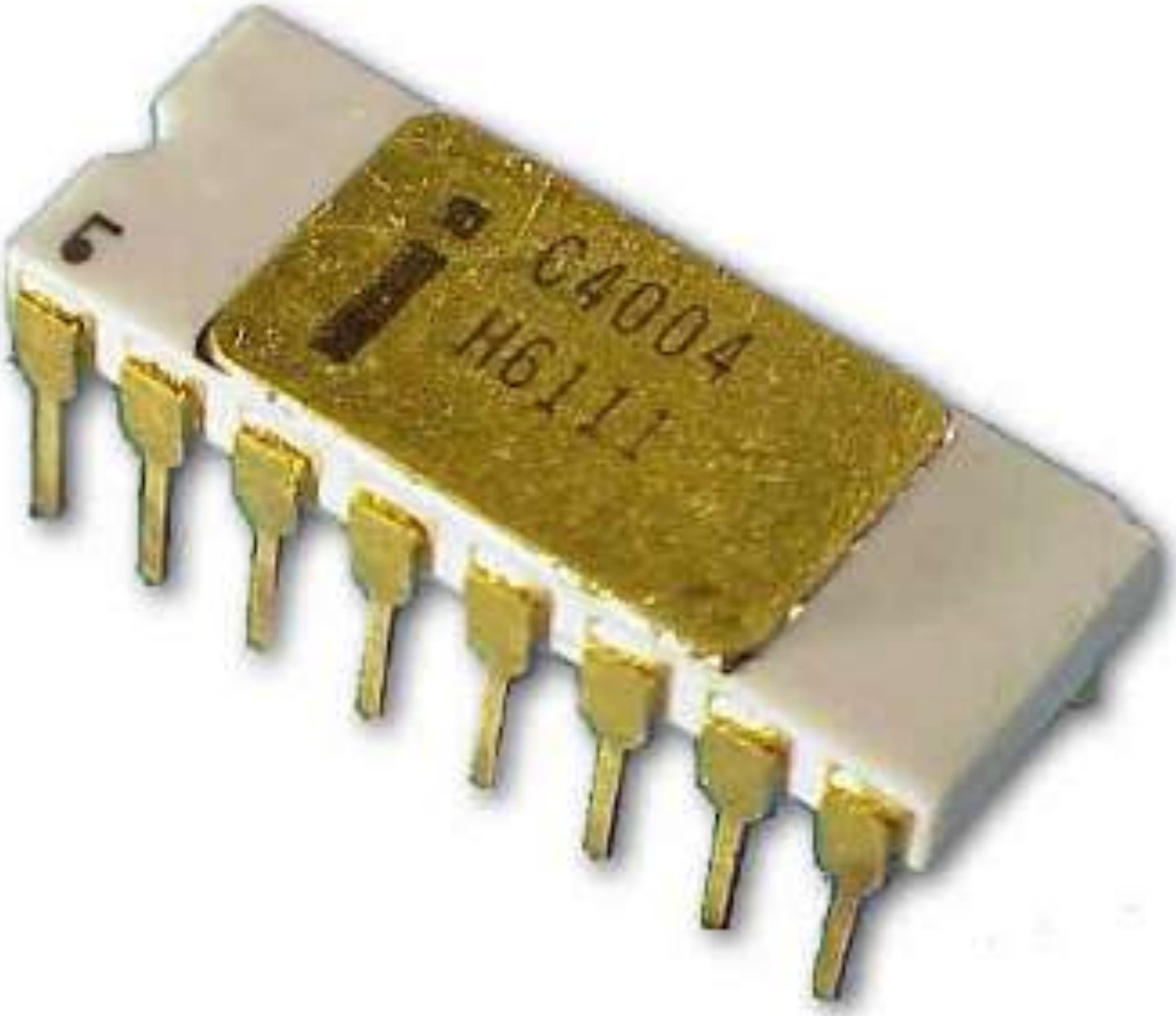
OPC FOUNDATION





Smart Watch Machine Control – embedded OPC UA

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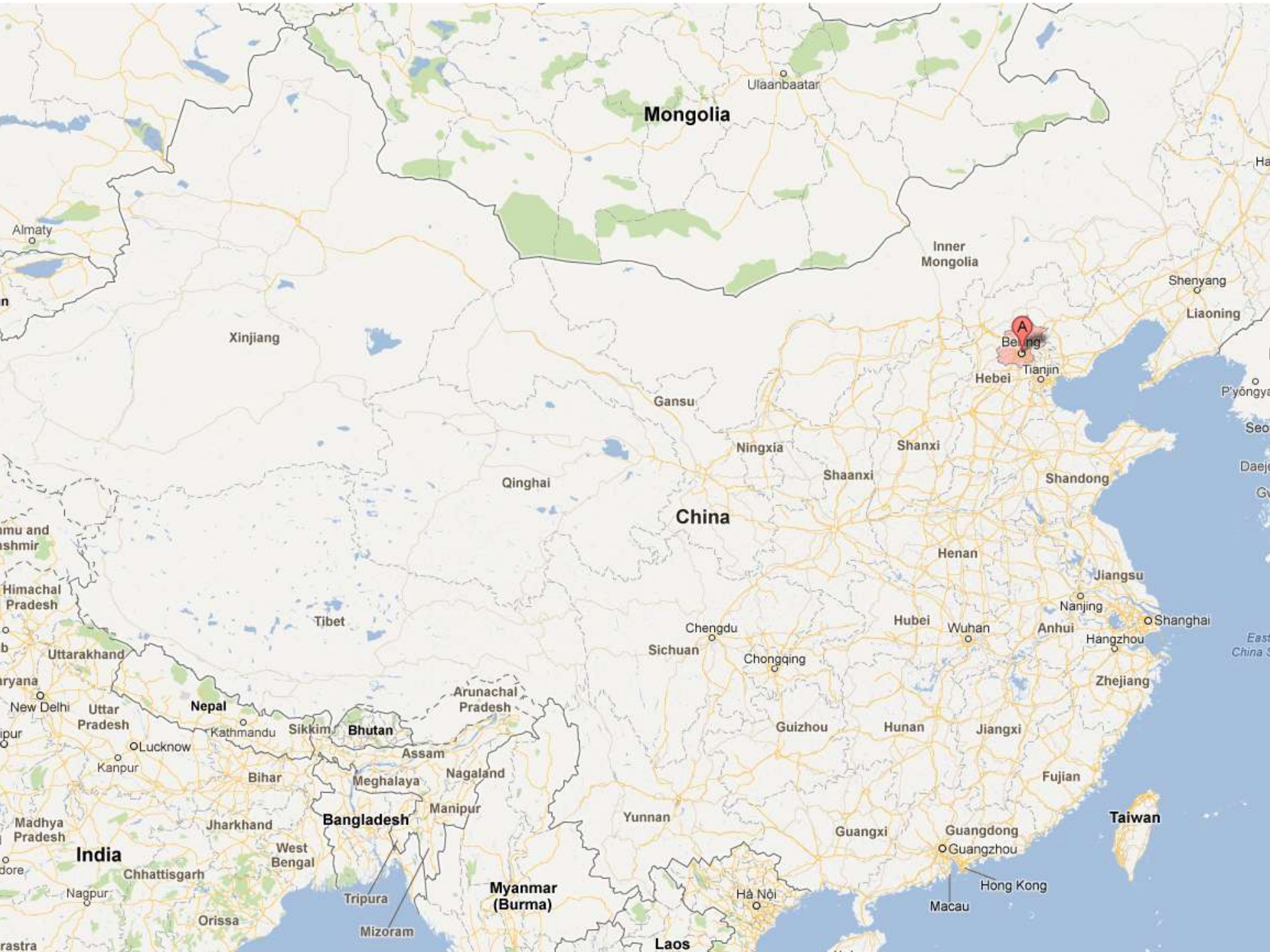

Ulaanbaatar
Mongolia
Almaty
Inner Mongolia
Shenyang
Liaoning
Xinjiang
A
Tianjin
Hebei
Gansu
Ningxia
Shanxi
Shaanxi
Shandong
Qinghai
China
Henan
Jiangsu
Himachal Pradesh
Tibet
Nanjing
Shanghai
Hubei
Wuhan
Anhui
Hangzhou
Chengdu
Sichuan
Chongqing
Uttarakhand
Zhejiang
New Delhi
Uttar Pradesh
Nepal
Arunachal Pradesh
Kathmandu
Sikkim
Bhutan
Guizhou
Hunan
Jiangxi
Lucknow
Assam
Kanpur
Nagaland
Bihar
Meghalaya
Fujian
Manipur
Madhya Pradesh
Jharkhand
Bangladesh
Yunnan
Taiwan
Guangxi
Guangdong
India
West Bengal
Guangzhou
Chhattisgarh
Hong Kong
Nagpur
Tripura
Myanmar (Burma)
Hà Nội
Macau
Orissa
Mizoram
Laos

2007

iPhone 3G S

2009

iPhone 4

2010

iPhone 3G

2008

iPhone 5

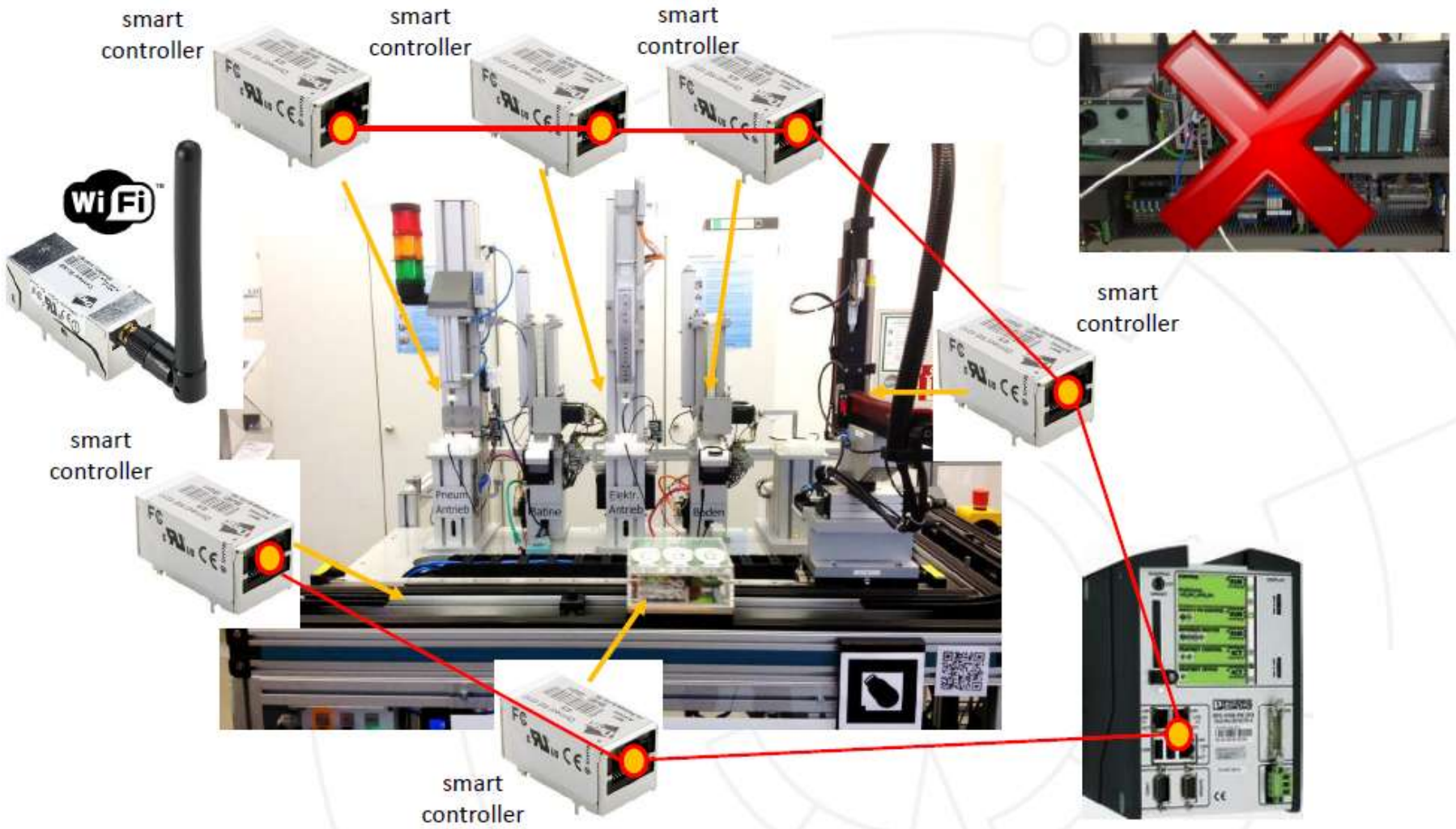
2012

2014

iPhone 6


IBM

Smart Machine Module




dustrial IT

Forschungsunion

Wirtschaft und Wissenschaft
begleiten die Hightech-Strategie

acatech

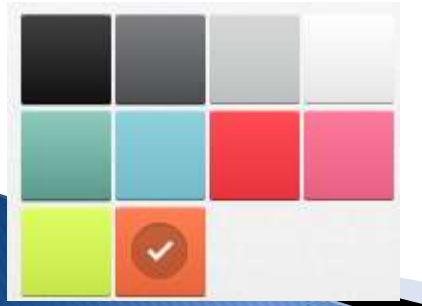
DEUTSCHE AKADEMIE DER
TECHNIKWISSENSCHAFTEN

Recommendations for implementing the strategic initiative INDUSTRIE 4.0

Final report of the Industrie 4.0 Working Group

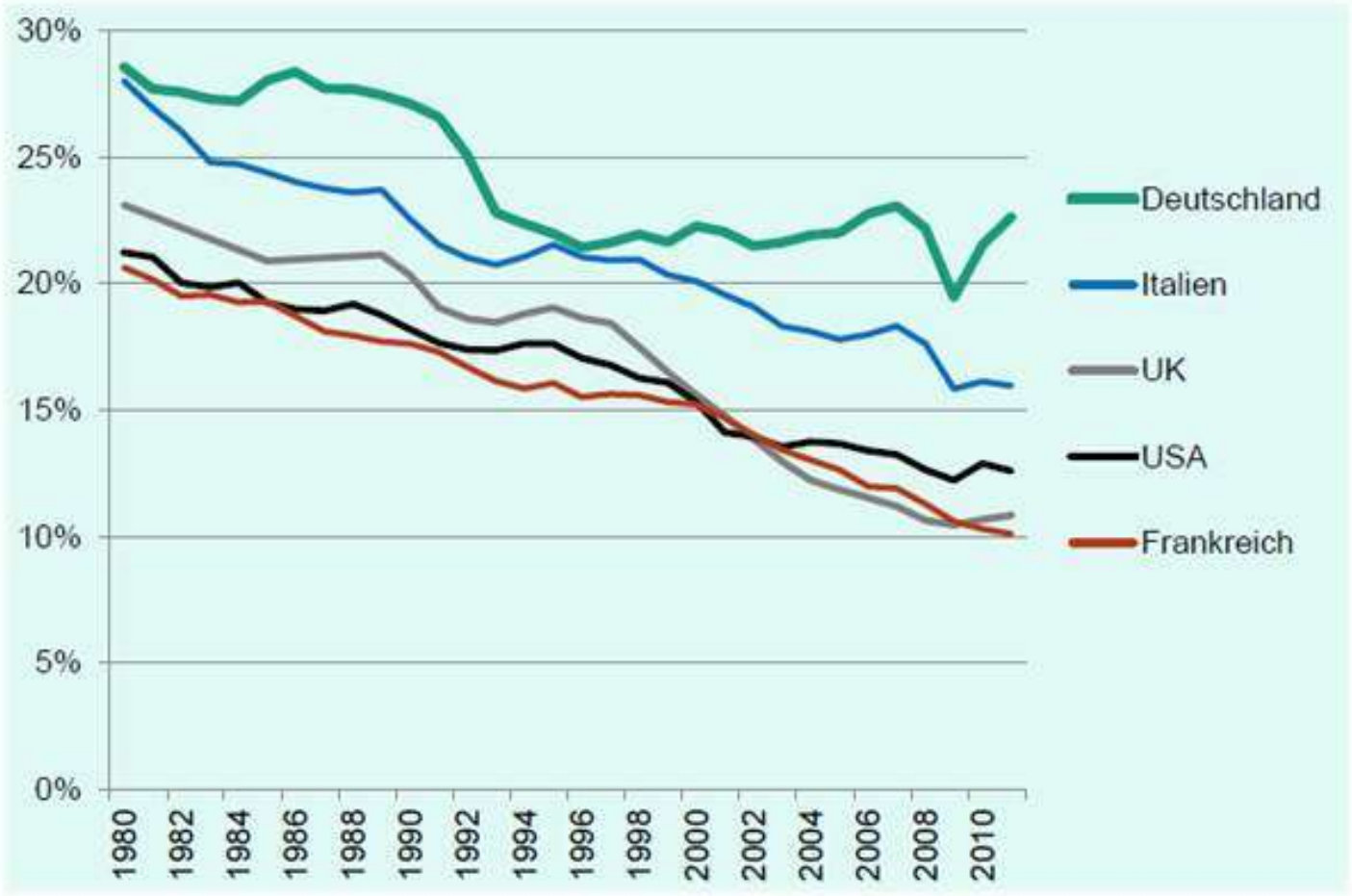

Lot
Size
One

Flexible Production



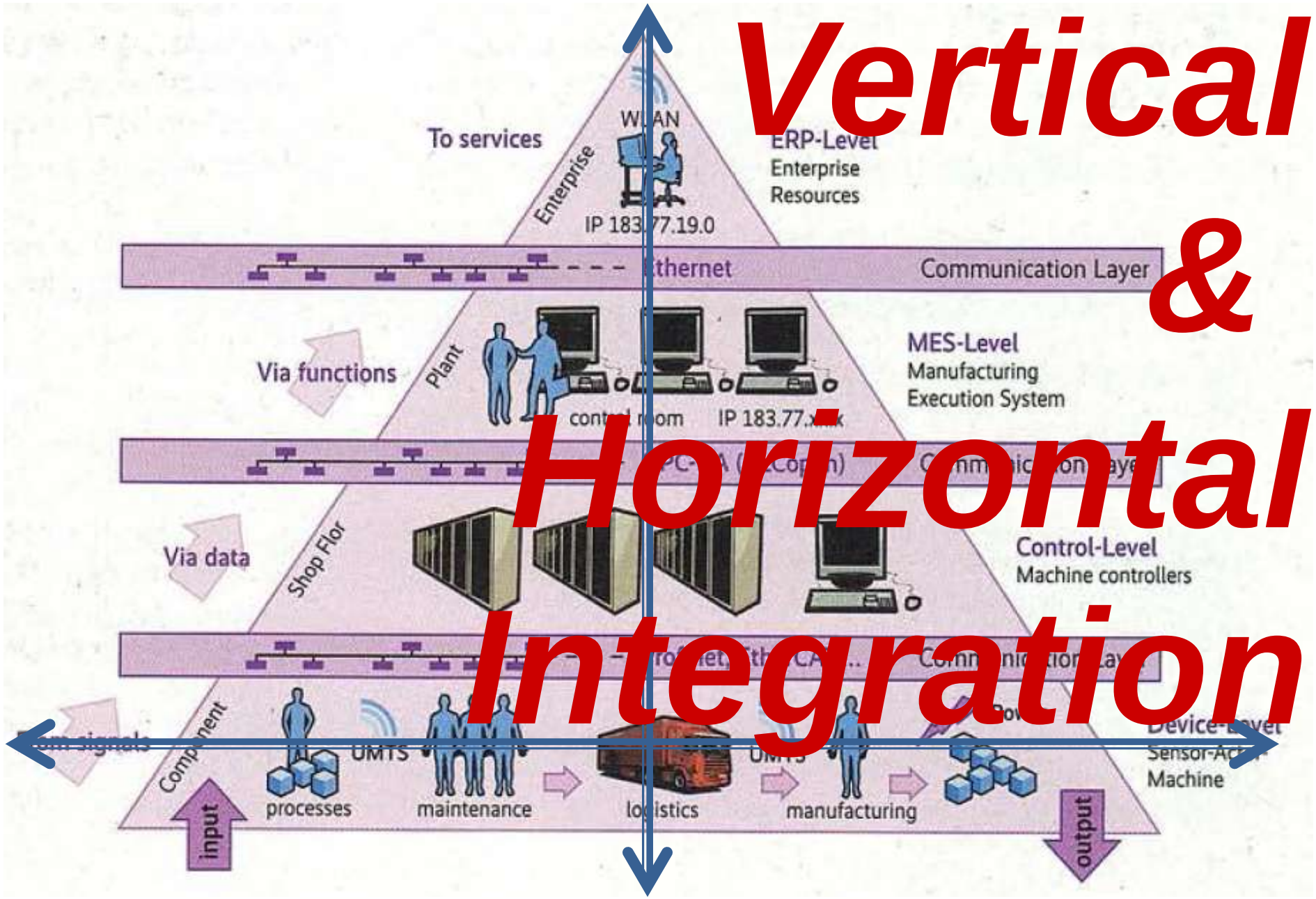
OPC FOUNDATION

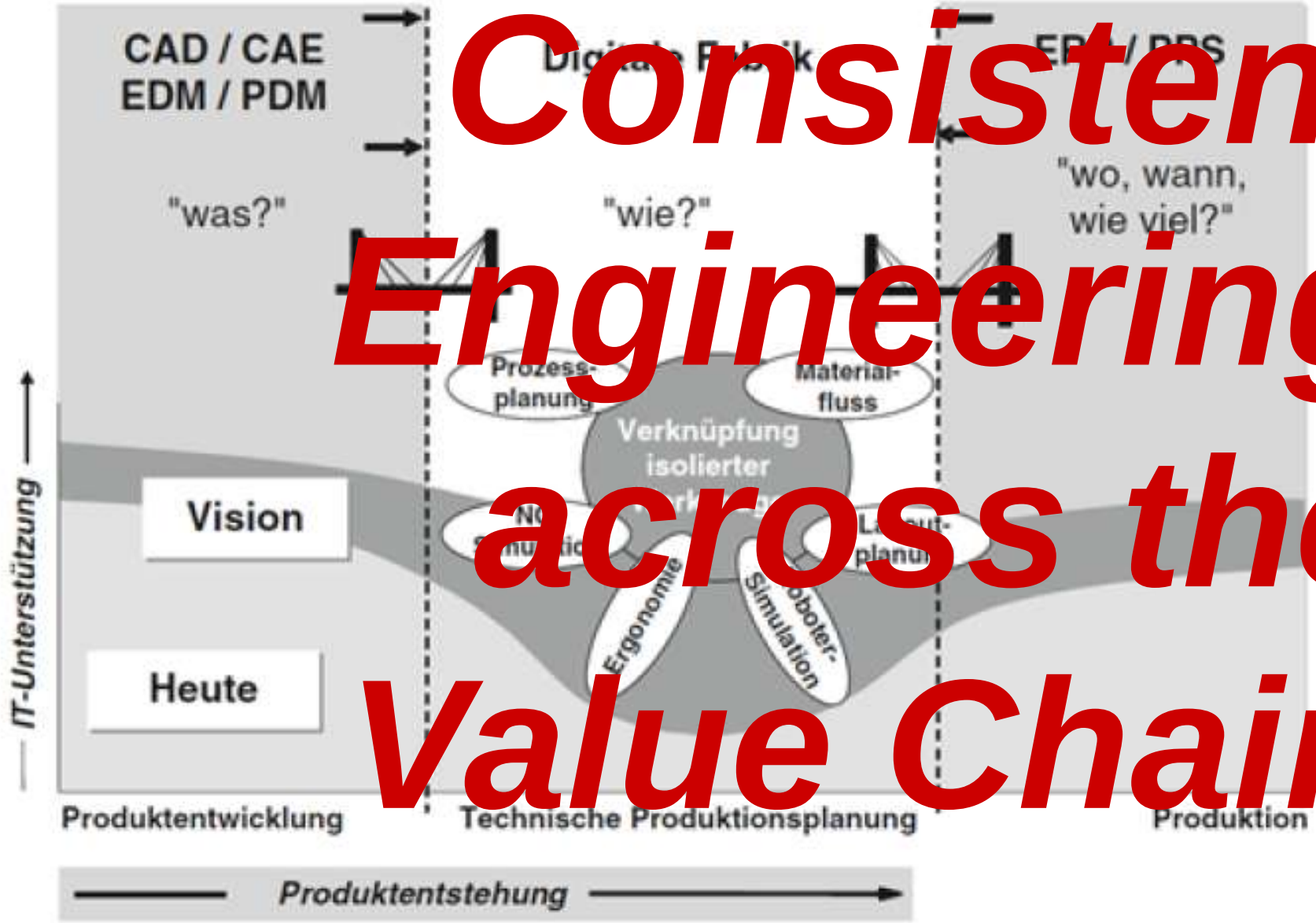
Manufacturing Revival (Re-Increase % GDP)



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

OPC FOUNDATION


Vertical
&
Horizontal
Integration
To services
WLAN
Enterprise
ERP-Level
Enterprise
Resources
IP 183.77.19.0
Ethernet
Communication Layer
Via functions
Plant
MES-Level
Manufacturing
Execution System
IP 183.77.x.x
Via data
Shop Flor
Control-Level
Machine controllers
Component
UMTS
UMTS
Device-Level
Sensor-Actor
Machine
input
processes
maintenance
logistics
manufacturing
output



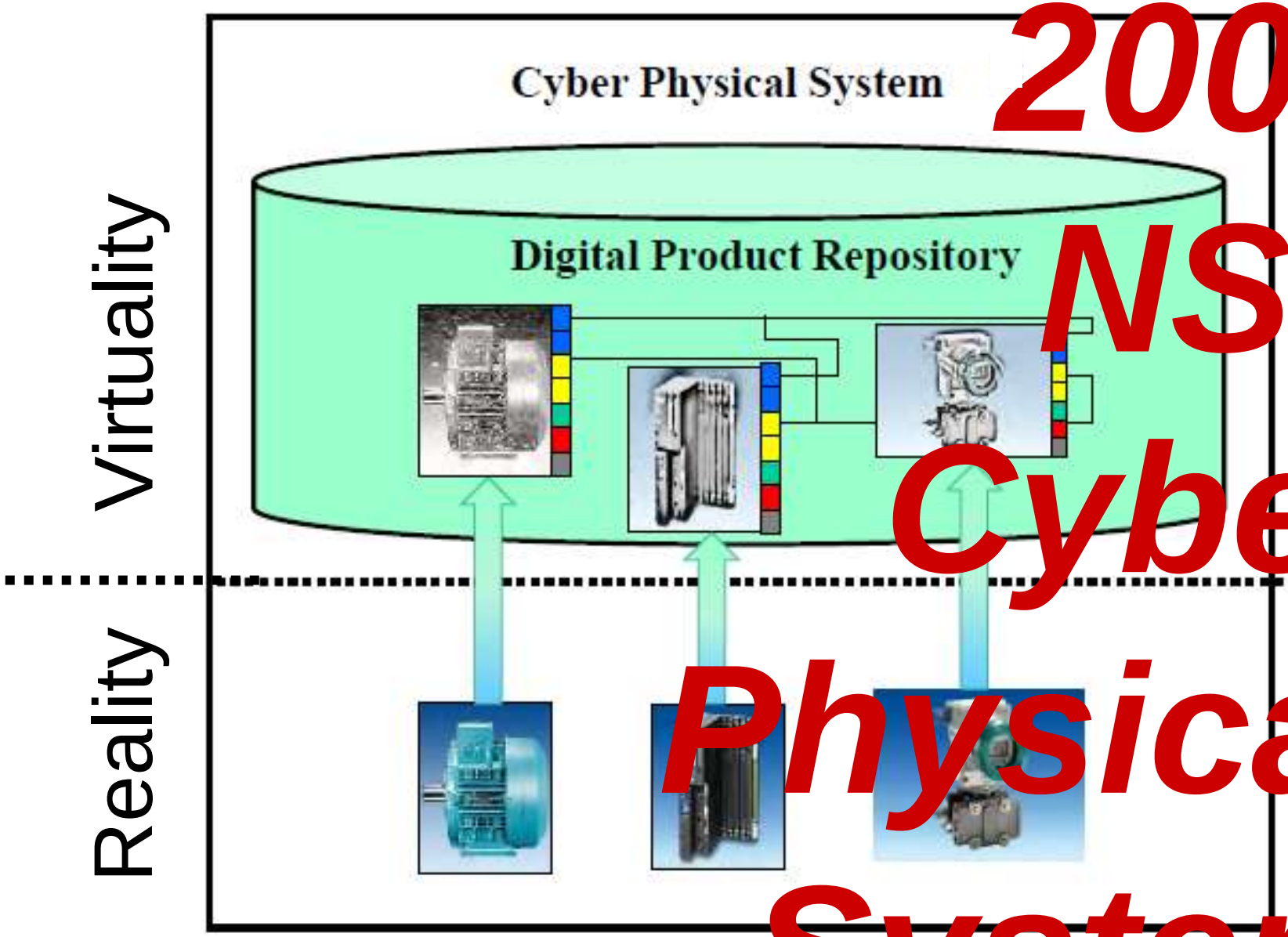
Consistent Engineering across the Value Chain

Bridging IT and Automation


1606
Jerónimo
de Ayanz
y Beaumont
1781
James
Watt
Abdampfl.ins Freie


1913
Henry
Ford

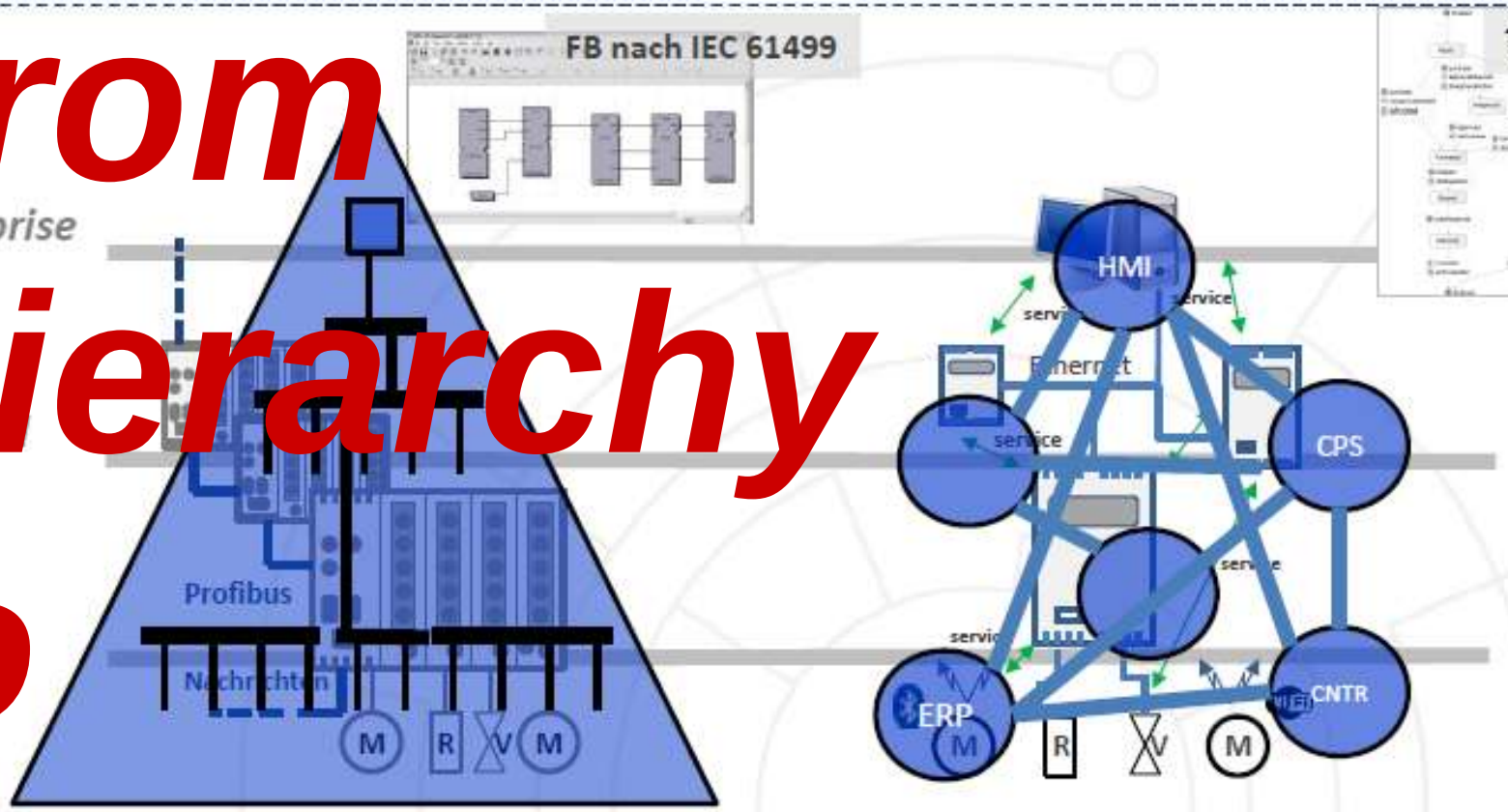
1968 Richard Morley (Modicon)



2006 NSF Cyber Physical System

Changing control architecture

From Hierarchy to Network of CPS



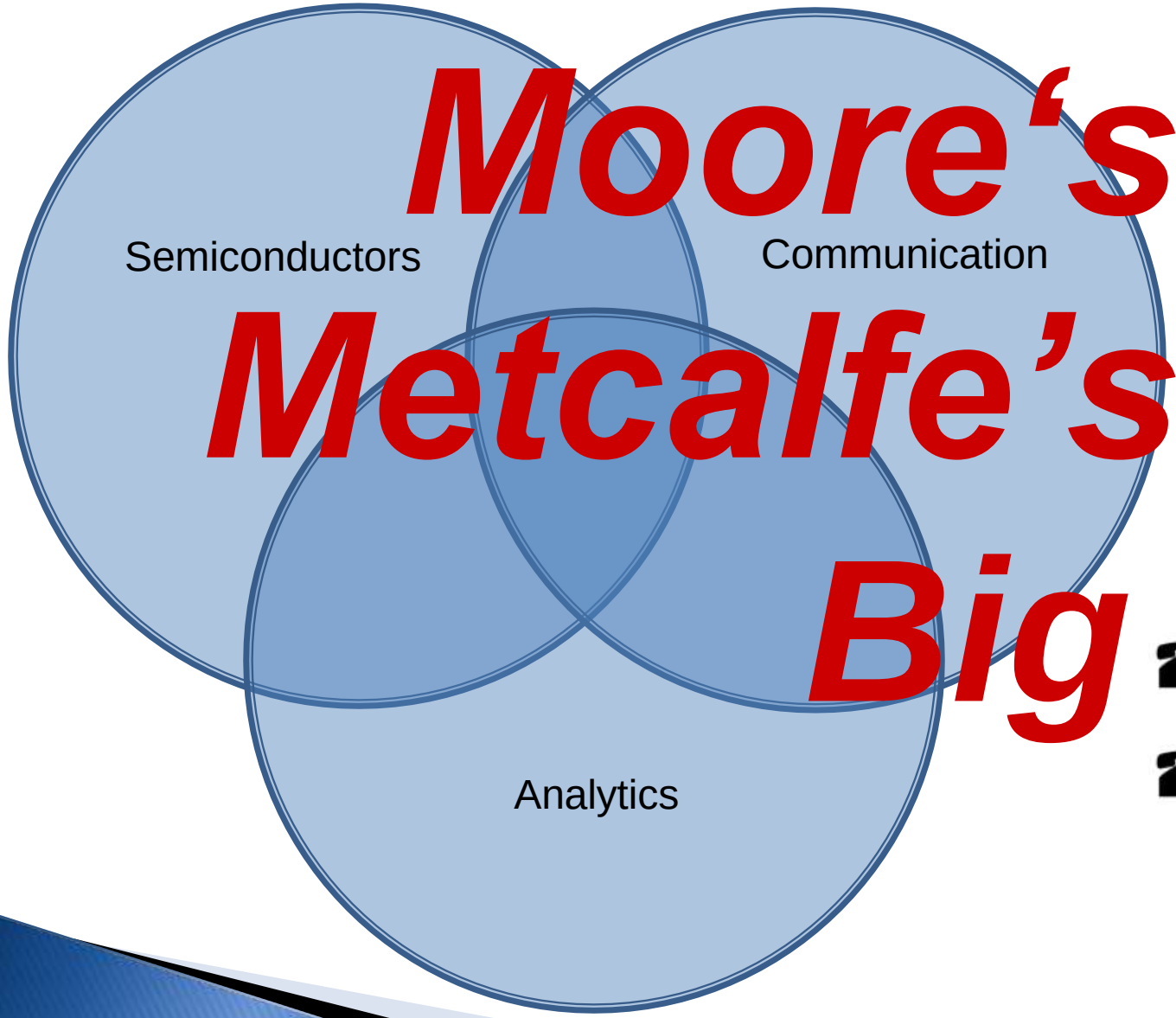
Today

hierarchical automation pyramid

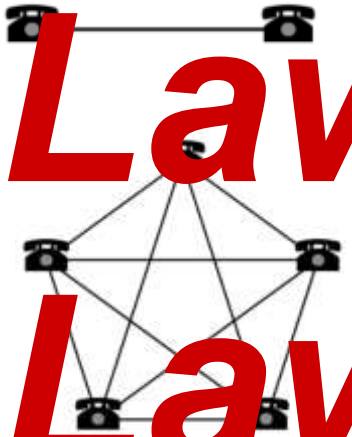
Tomorrow

smart CPS network

The Internet of Things



Moore's Law

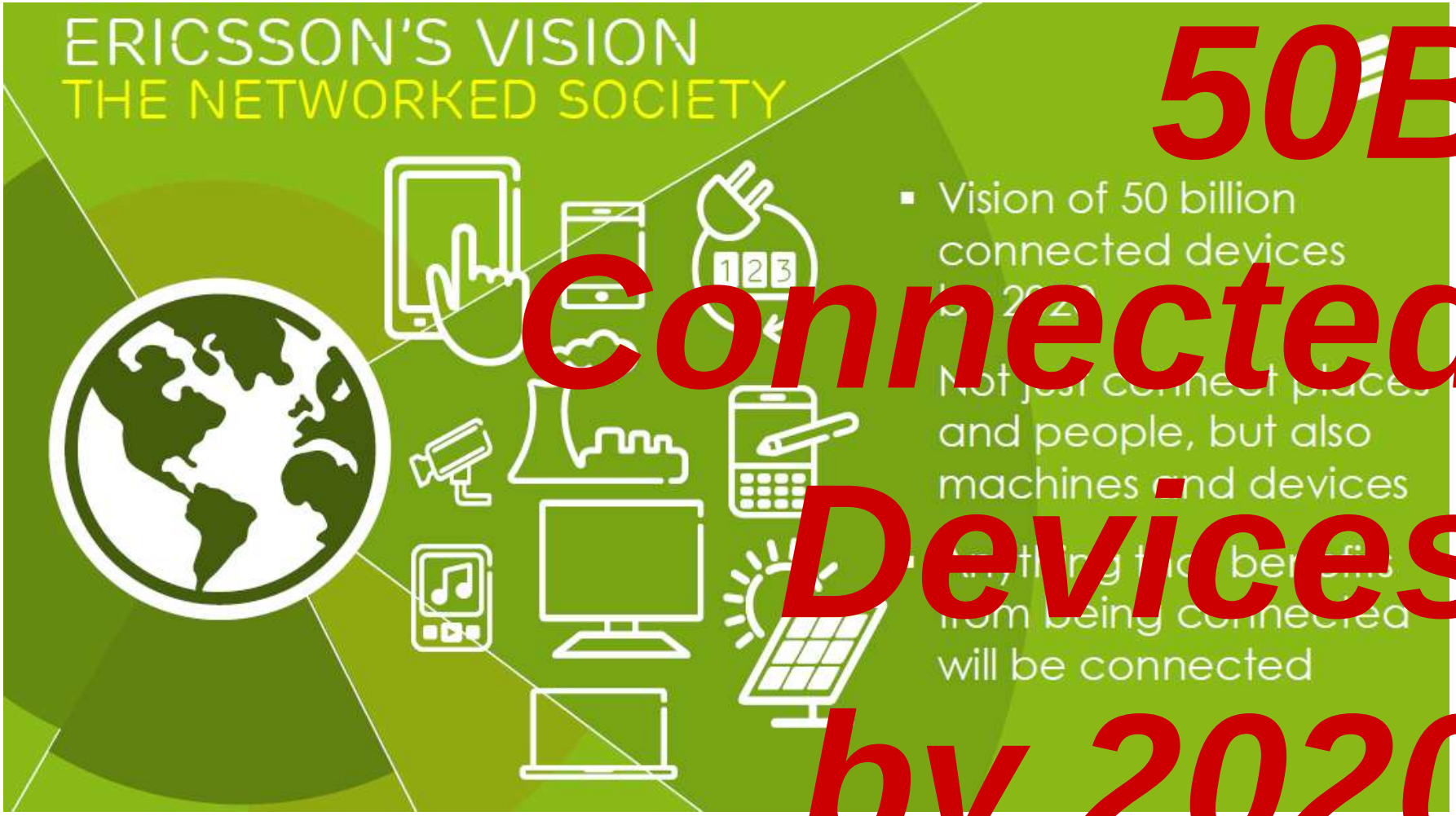


Metcalfe's Law

Big Data

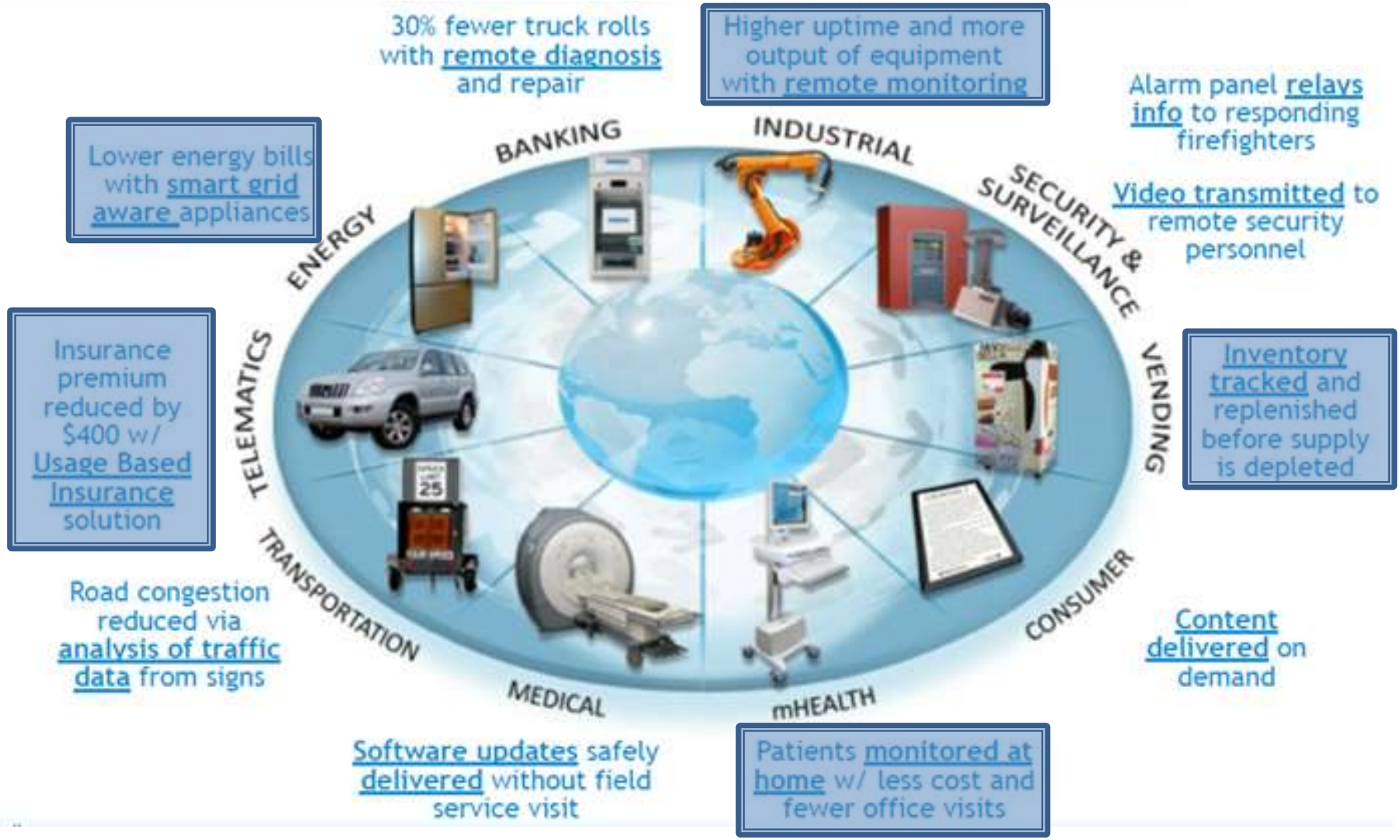
OPC FOUNDATION

Connecting Places, People, Machines, Devices



OPC FOUNDATION

Changing value propositions



From selling HVACs to helping customers manage buildings

OPC FOUNDATION

From selling equipment to helping farmers optimise the harvesting process

ICT ENABLERS

Source: CLAAS

From selling turbines to helping customers reduce fuel (MH370)

Intelligent Platforms

2014 User Summit

Making the Industrial Internet Real

October 27-30th, 2014 • Orlando, Florida

Discover how our high-performance technology solutions – enabled by the Industrial Internet – help companies drive new levels of efficiency and results like never before.

Keynote

Jeff Immelt

GE Chairman and CEO

Agenda

Top 10

Reasons to Attend

Register Now !!

OPC FOUNDATION

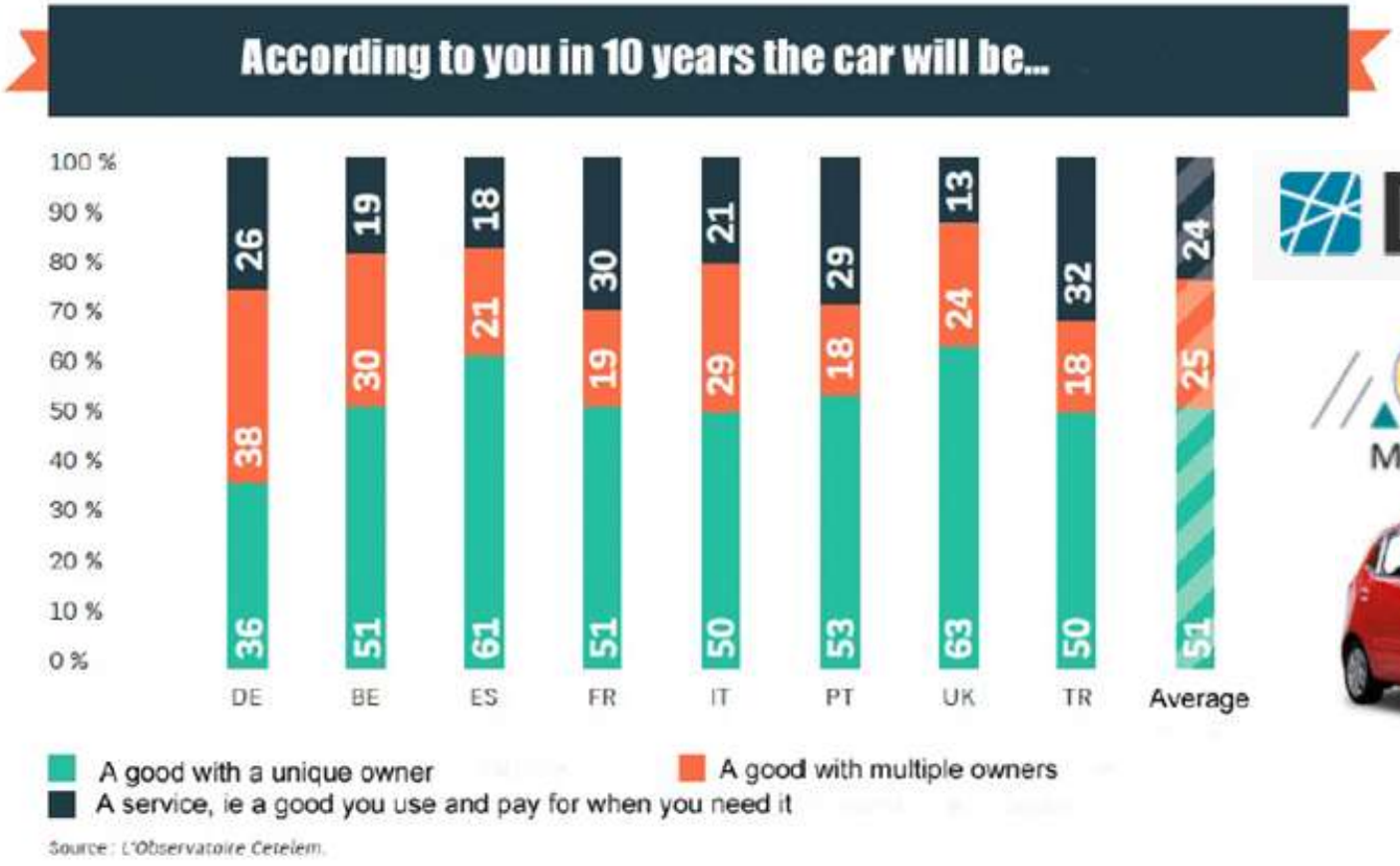
Gepinnter Tweet

GE IP @GE_IP · 28. Okt.

"If you went to bed an #industrial company, you're going to wake up a #softwareanalytics company" #GEMakesItReal

OPC FOUNDATION

From selling cars to helping customers move from A to B

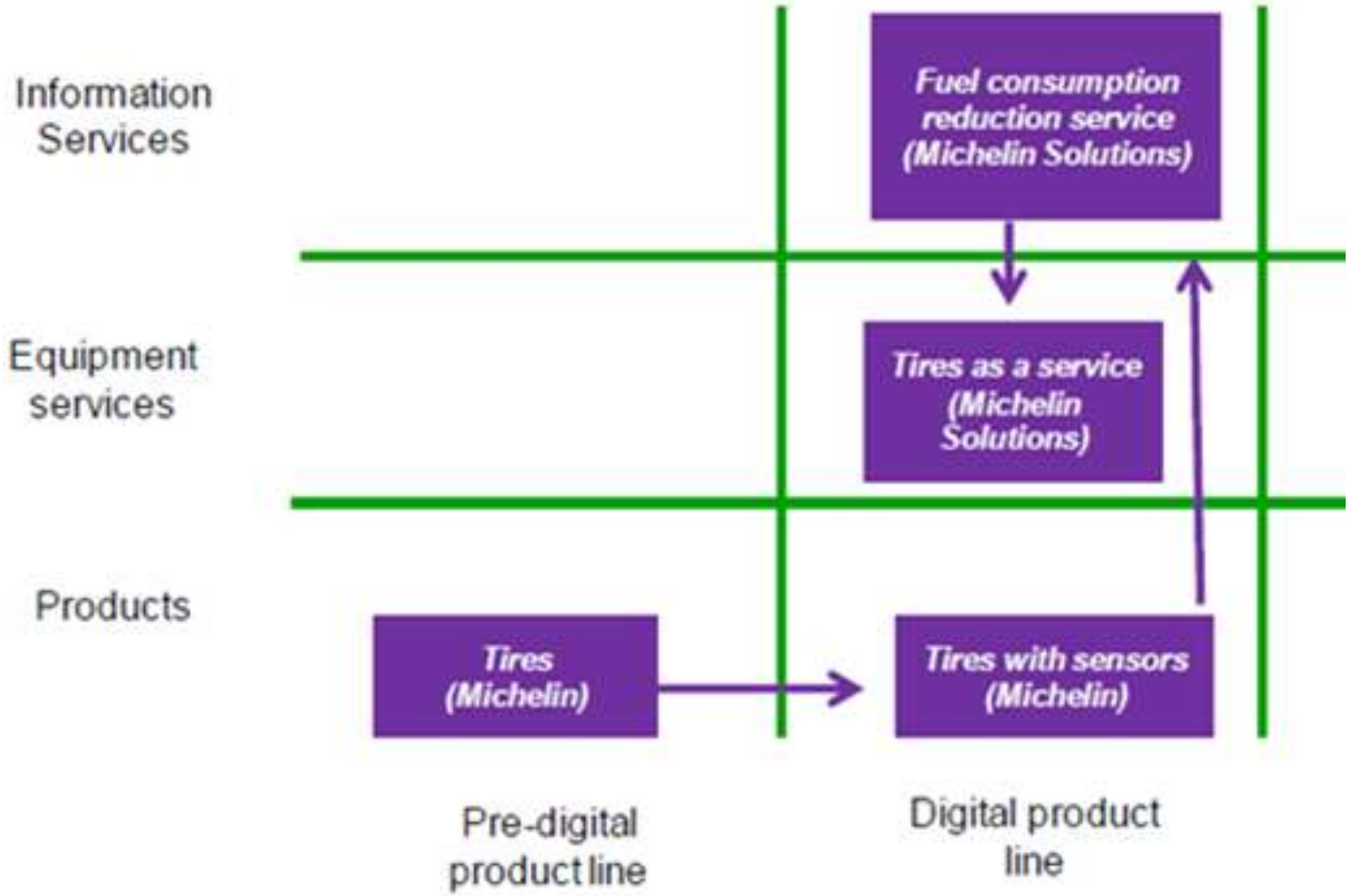


DriveNow

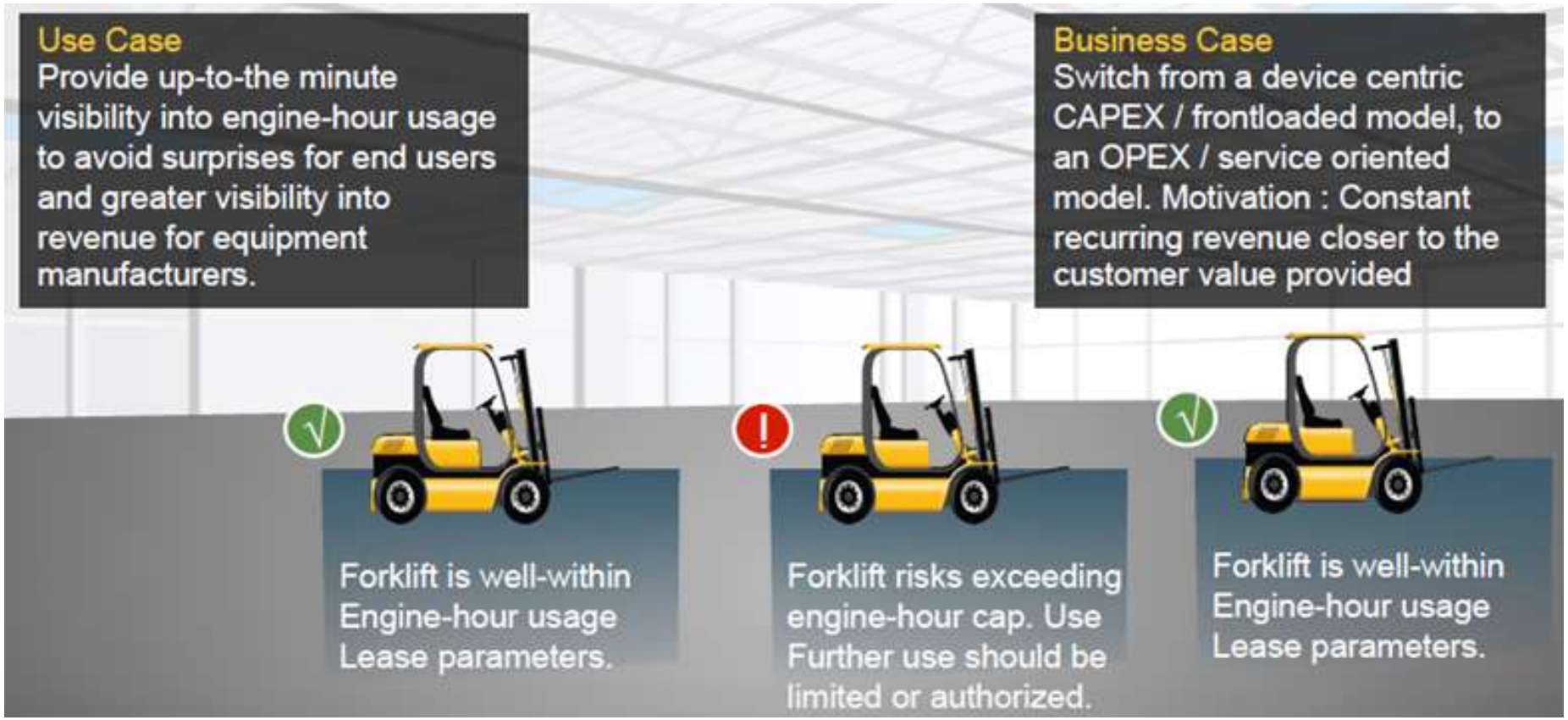
STATT AUTO
München·CarSharing

OPC FOUNDATION

From selling tires to helping truck fleet managers reduce fuel consumption



From selling forklifts to helping customers optimise usage



Quantified Self: From selling gear to helping consumers improve their workout

Smart Watch Machine Control – embedded OPC UA

Die Smartwatch als Steuerung einer hochkomplexen Industrieanlage. (Heymann/CIIT)

OPC FOUNDATION

Smart Watch Machine Control – embedded OPC UA

OPC FOUNDATION

TeslaSCADA Android App

© http://teslascada.com

From selling wind turbines to helping customers improve operations

OPC FOUNDATION

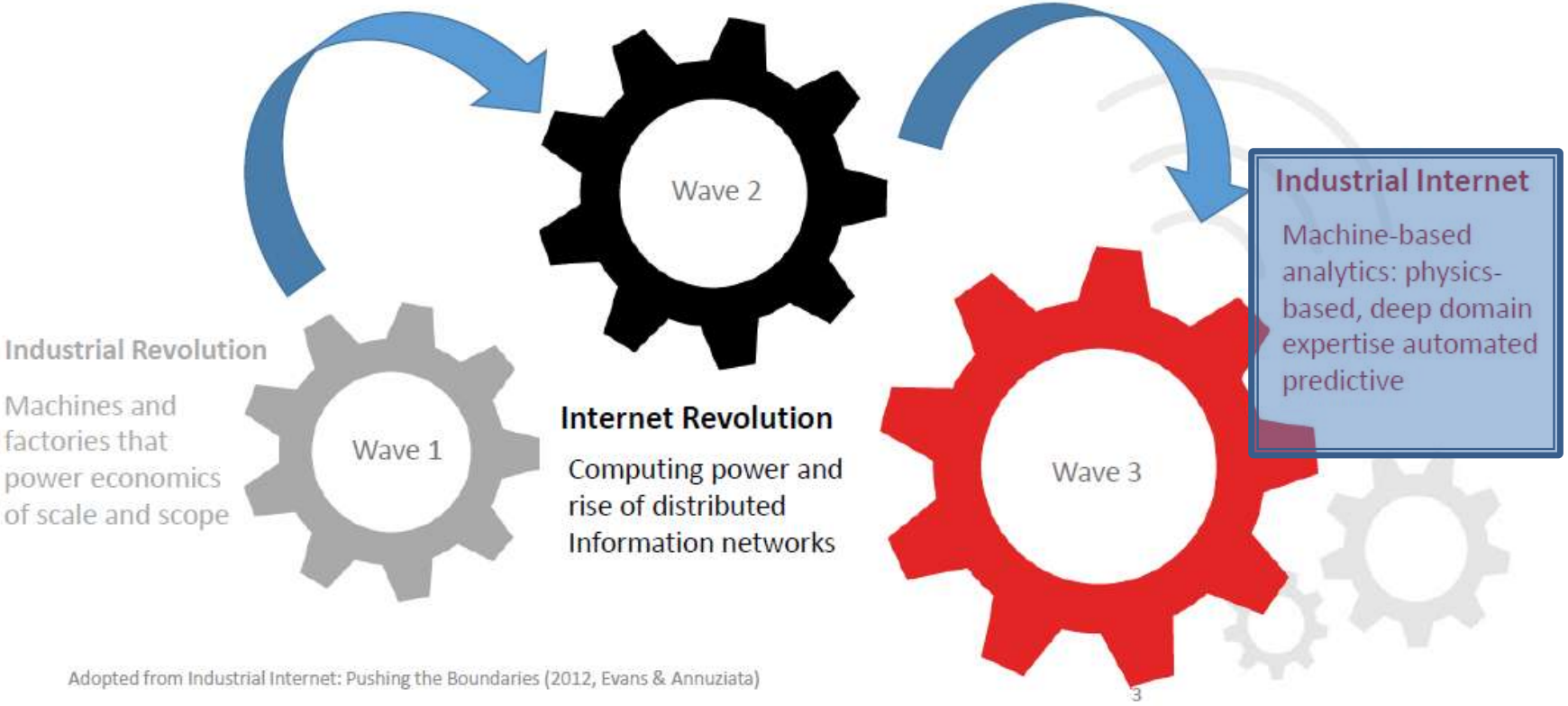
Wind Turbine Monitoring Service

Industrial Internet Consortium

at&t cisco intel IBM

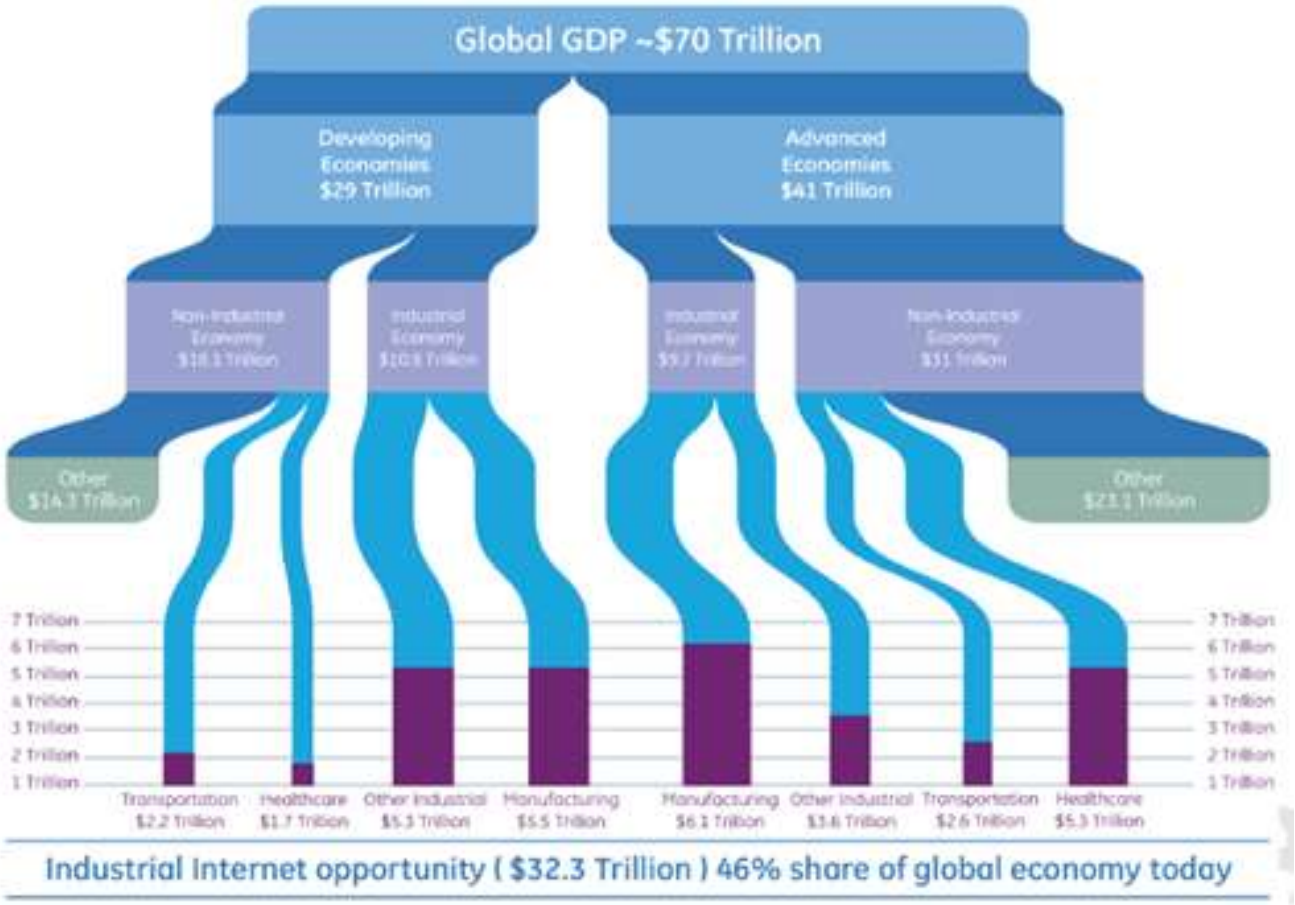
IIC: Third Industrial Revolution

The next revolution: An opportunity for a new wave of Innovation



Adopted from Industrial Internet: Pushing the Boundaries (2012, Evans & Annuziata)

Industrial Internet impacting 46% of the world's GDP



From: Industrial Internet: Pushing the Boundaries (2012, Evans & Annuziata)

ICC: 90+ Members in 6 months

As of 9-12-2014

OPC FOUNDATION

ICC: Not a standards organization

IIC Overview

- Our mission is to **accelerate growth** of the Industrial Internet by **coordinating ecosystem** initiatives to **connect and integrate** objects with people, processes and data using common architectures, interoperability and open standards that lead to **transformational business outcomes**
- Founded by AT&T, Cisco, GE, IBM and Intel in March 2014
  - Open membership, global, nonprofit
  - 82 members to date
    - 9 percent of our members are headquartered in Europe
  - Governed by the 10-person IIC Steering Committee
- Not a standards organization
  - The IIC evaluates and organizes existing standards and will influence the global standards development process for Internet and industrial systems

OPC FOUNDATION

1% savings from IoT solutions could save … operational costs

From selling compressors to helping customers increase uptime

„GE's Intelligent Platforms business … equipment Insight, a new … industrial Internet solution from GE Predictivity … new services program called Flocos™ InSite Support*.

"…better support GE's Roots blowers, compressors and controls customers… combines GE hardware and software to deliver insights that customers need to maximize the performance of local site equipment in the form of an after-market service offering."

"…provide actionable information, responsive troubleshooting and problem-solving support to help keep … valuable … waste water assets running smoothly to avoid unnecessary downtime and associated costs. ."

"…a team of GE controls and rotating equipment experts can provide early detection of equipment problems to avoid extended outages and seamless visibility to critical data for improved decision support."

Serviceability

Sensors

CPS

Big Data

OPC FOUNDATION

Siemens CEO: „Growing Importance of Data-based Services“

Für Dr. Peter Weckesser werden der Mehrwert und das Potenzial neuer Technologien schnell sichtbar. Bild: Siemens

„Not just technologies… but business models are changing“

„From selling or buying air pressure machines to selling or buying air pressure.“

„Through sensors machines are connected back home and deliver volume, status, energy and predictive maintenance data.“

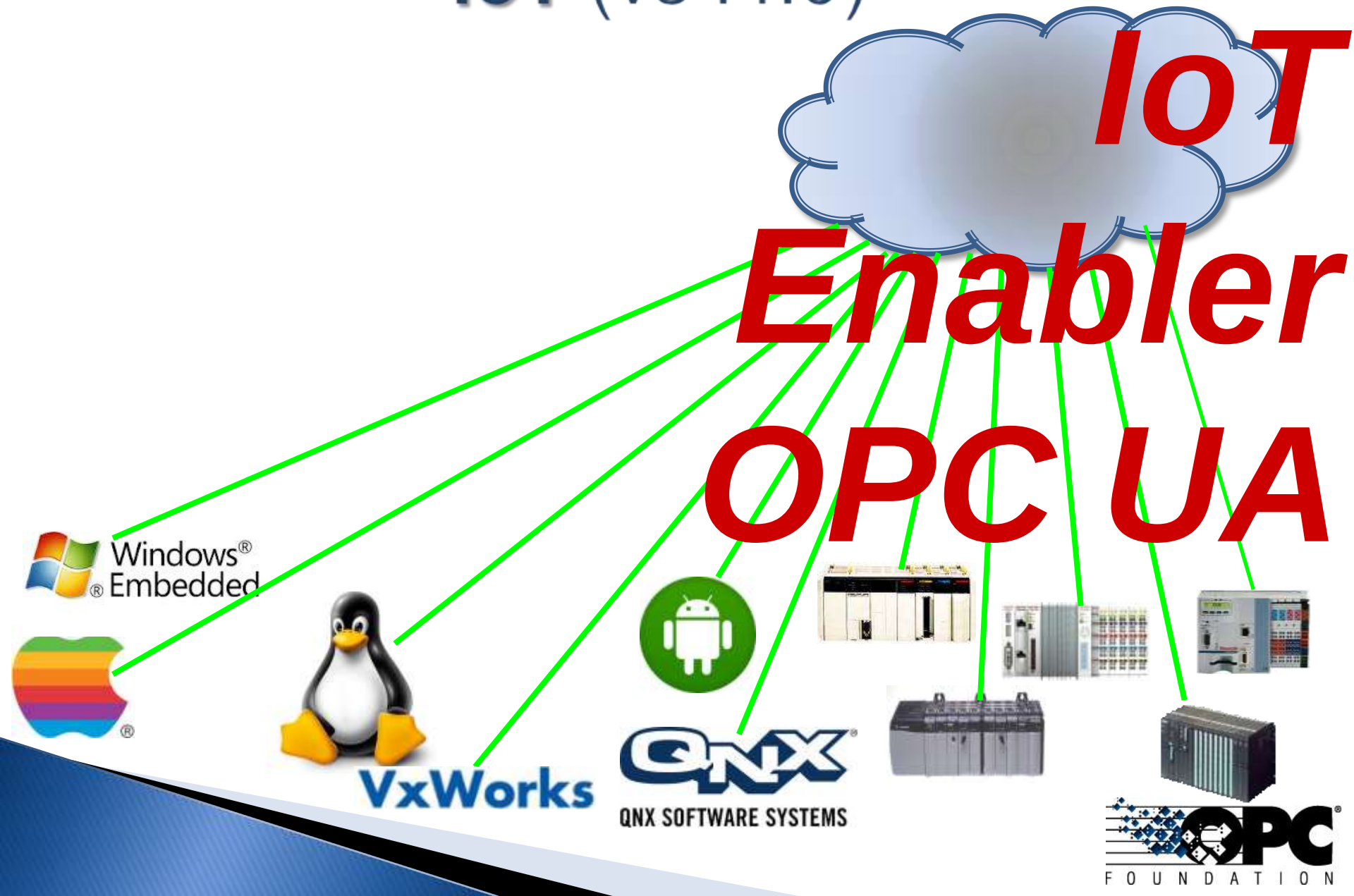
„Condition Monitoring predicts potential machine problems and reduces bottom line maintenance cost.“

„Siemens provides Plant Data Services dealing with sensible production data in the cloud. All 3 services – from Plant Analytics Services via Plant Cloud Services through Plant Security Services – are already implented although in an early phase.“

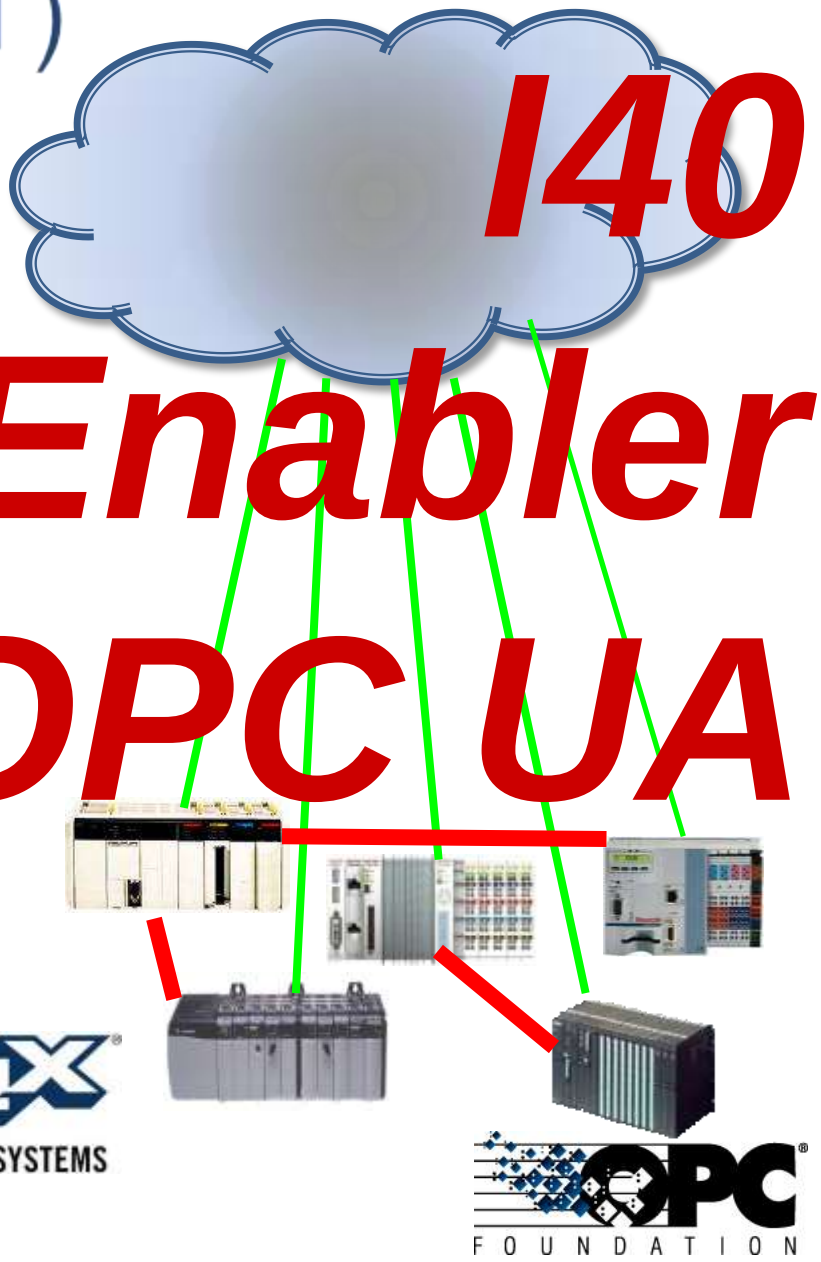
SIEMENS

OPC FOUNDATION

IoT (vs I4.0)


IoT
Enabler
OPC UA
Windows® Embedded
VxWorks
QNX
QNX SOFTWARE SYSTEMS
OPC
FOUNDATION

I4.0 (v IoT)



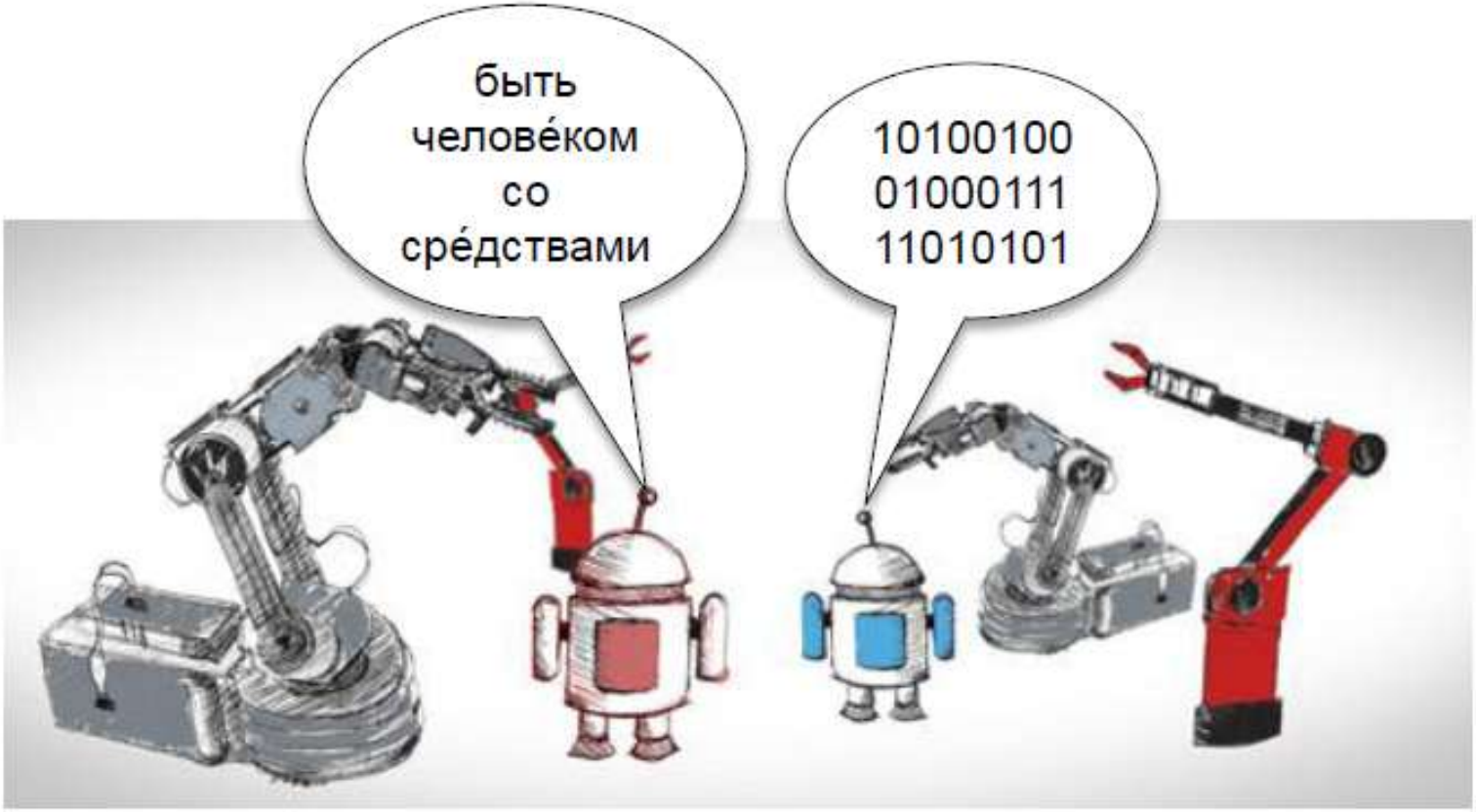
Windows® Embedded

VxWorks

QNX SOFTWARE SYSTEMS

OPC FOUNDATION

Before OPC



OPC FOUNDATION

History

1990‘s:

1990s	Microsoft operating systems dominate the industrial automation landscape. Automation vendors begin using Microsoft’s COM and DCOM in their product offerings.
1995	Automation vendors Fisher-Rosemount, Intellution, Opto 22 and Honeywell Software form a task force to develop a standard for data access based on COM and DCOM, and call it OPC, an abbreviation for OLE (Microsoft Object Linking & Embedding) for Process Control.
1996	The task force, established a year earlier, releases version 1.0 of a simplified OPC specification for Data Access (DA) in August.Within the first year, several other software and hardware vendors began using OPC as their mechanism for interoperability.It soon becomes clear that a more formalized organization of compliance, interoperability, certification and validation is
1998	The OPC Foundation begins converting its existing specification to web services.

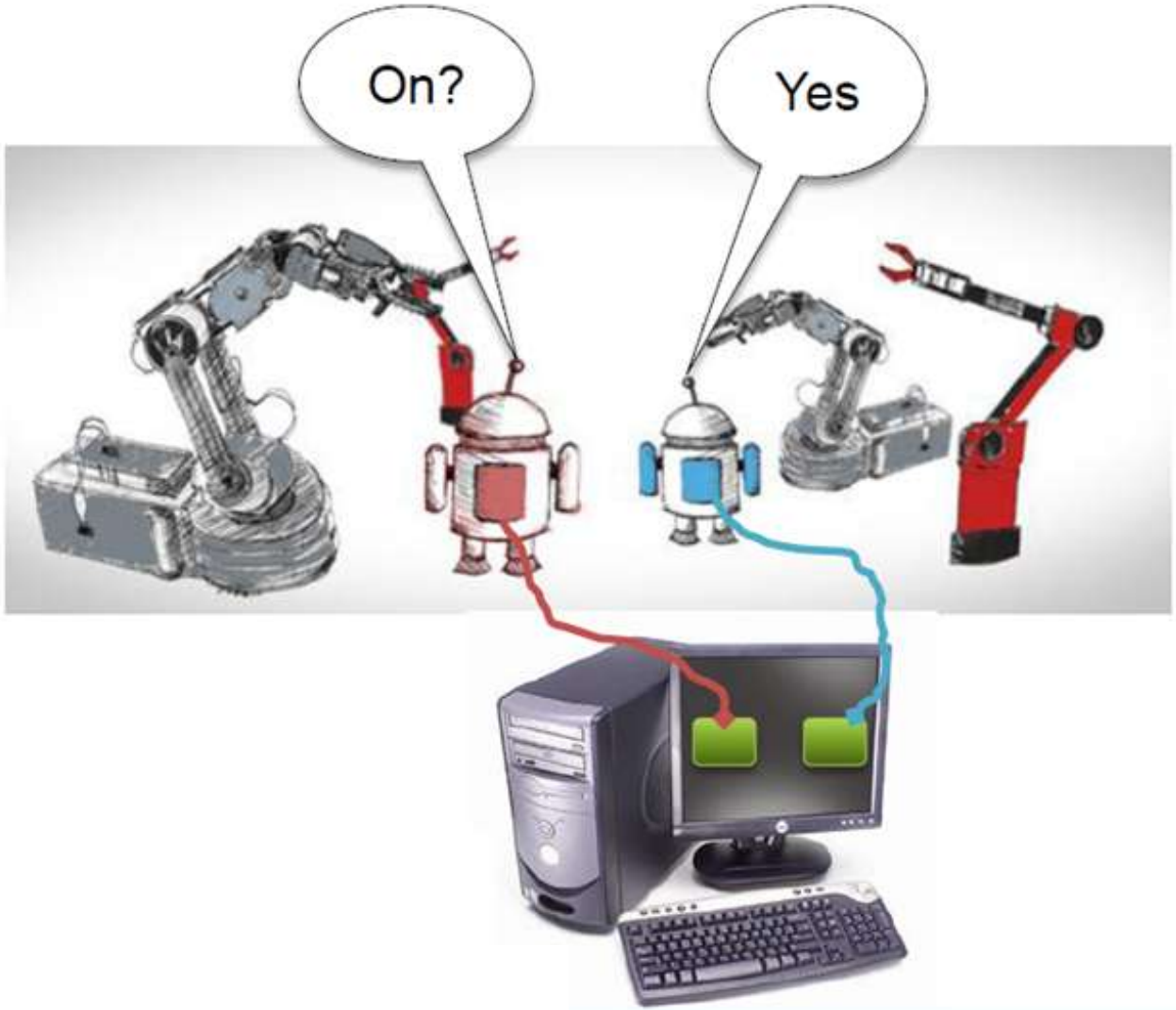
DCOM

2000‘s:

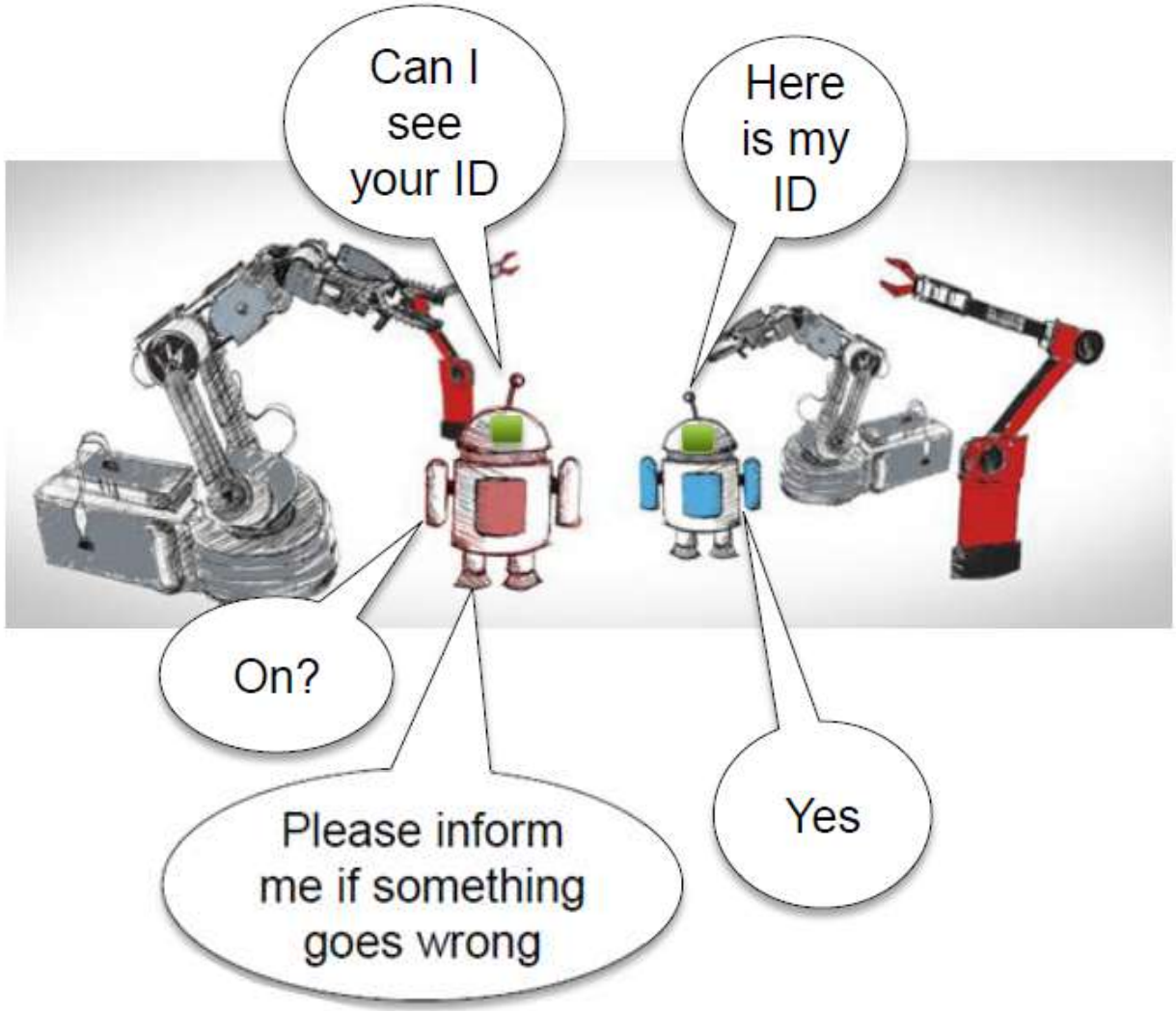
Web Services

OPC FOUNDATION

With Classic OPC

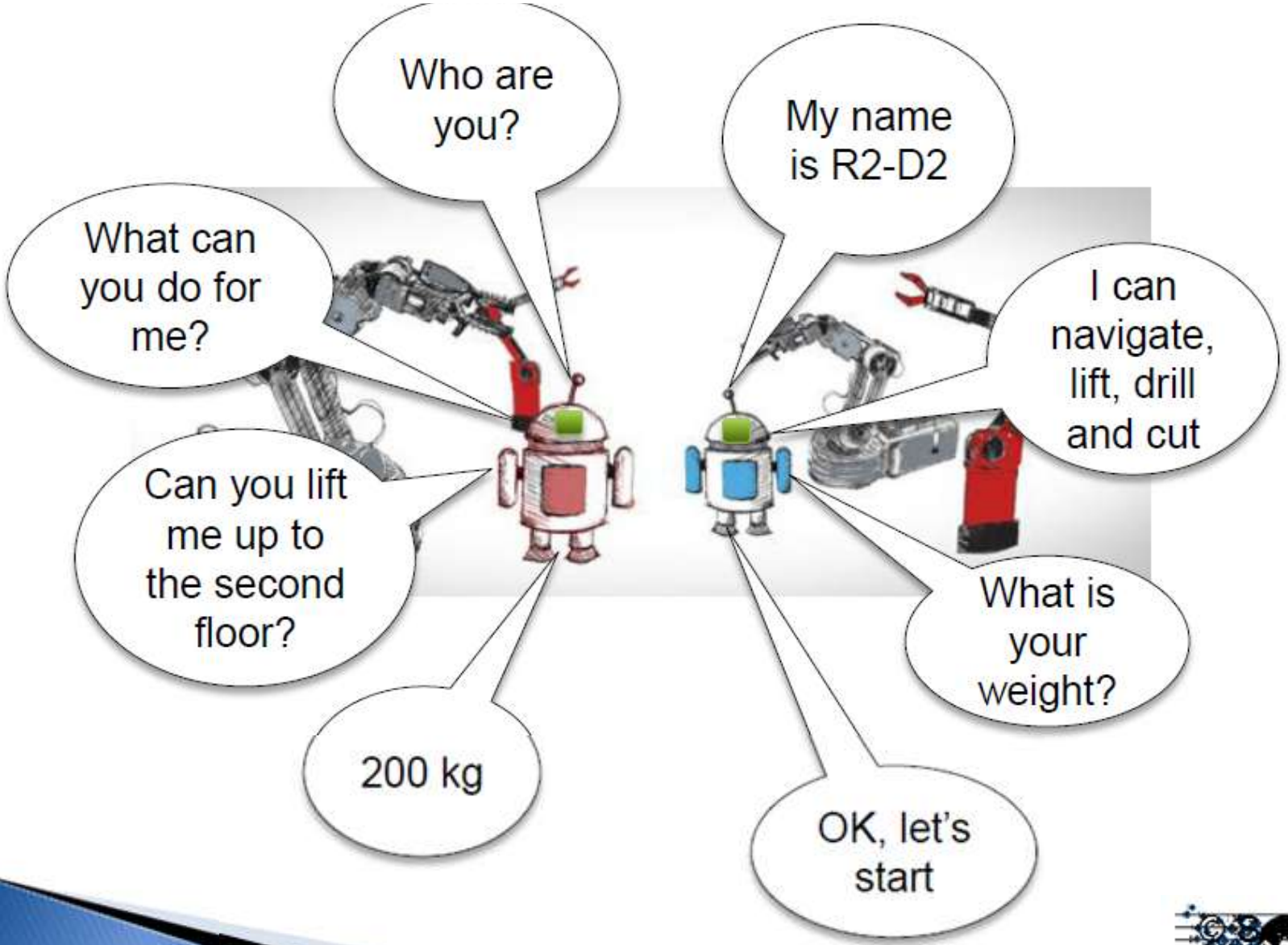


With OPC Unified Architecture

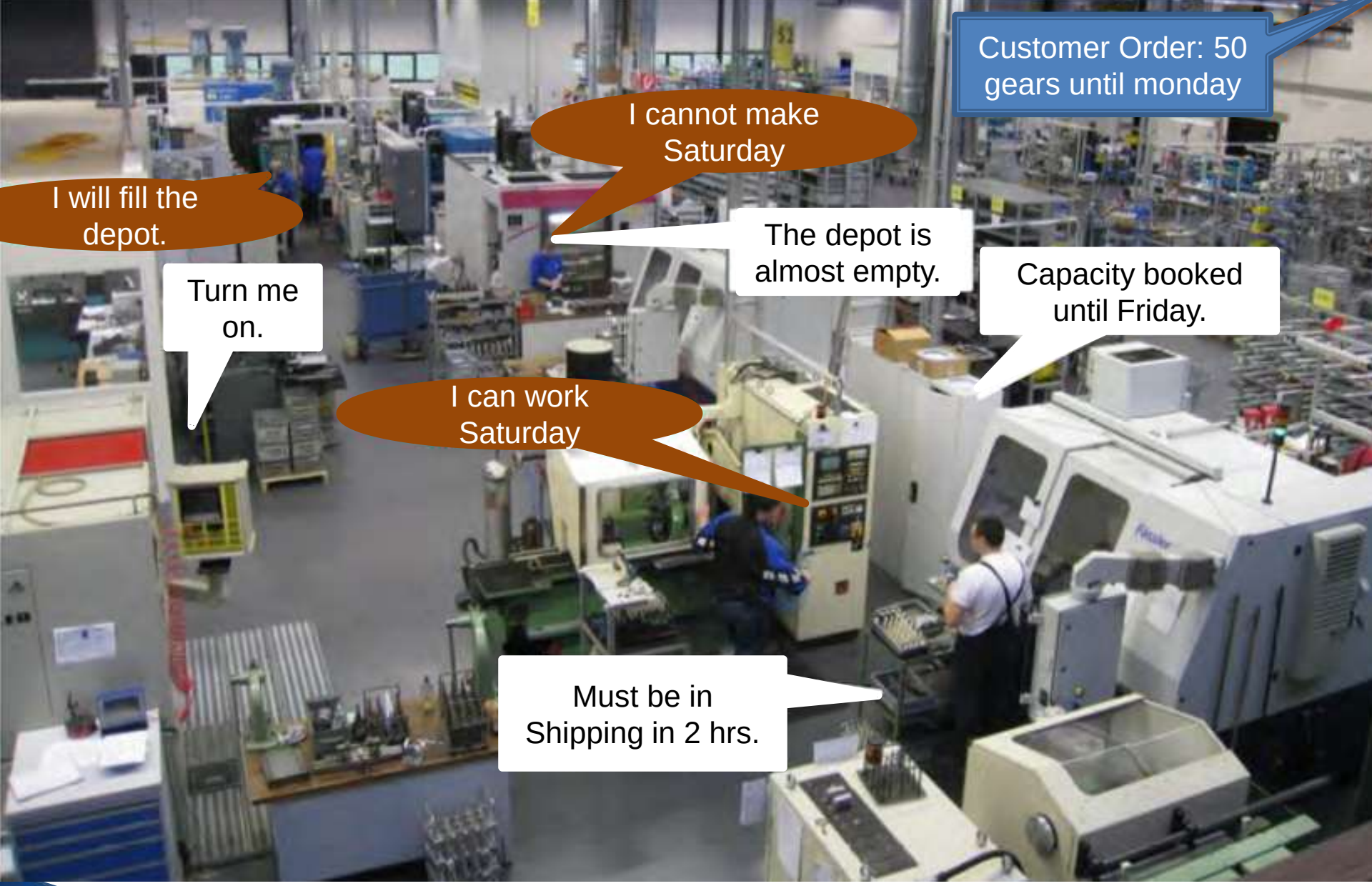


OPC FOUNDATION

With OPC UA Information Models



OPC FOUNDATION



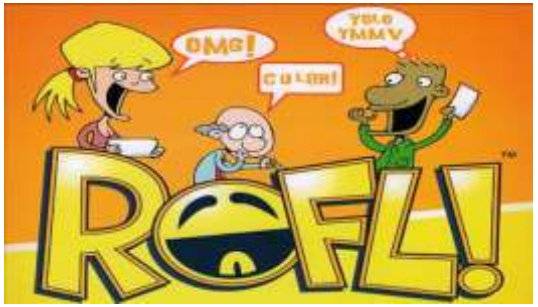
OPC FOUNDATION

q

"The soul that sees beauty may sometimes walk alone."

"I can navigate, lift, drill and cur."

"00011010 111001011 011111011."



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CHALLENGES FOR THE IMPLEMENTATION OF INDUSTRY 4.0

(several answers are possible)

Source: "Recommendations for implementing the strategic initiative Industry 4.0", Forschungsunion, acatech 2013

DKE NORMUNGS-ROADMAP

Service oriented Architecture

IEC 62541 OPC UA

DIE DEUTSCHE NORMUNGS-ROADMAP INDUSTRIE 4.0

OPC Unified Architecture

Pioneer of the 4th industrial (r)evolution

OPC UA

IEC 62541

OPC is… a Standard

February 2010

Part 1 – Overview
Part 2 – Security Model

July 2012

Part 7 – Profiles
Part 9 – Alarms & Conditions
Part 10 – Programs

December 2014

Edition 2.
Part 1 – 1
New – Edition 1.0
Part 11 – Historical Access
Part 13 – Aggregates

Edition 1.0/OPC UA 1.01

2010 | 2011 | 2012 | 2013 | 2014 | 2015

OPC UA 1.02

October 2011

Part 3 – Address Space Model
Part 4 – Services
Part 5 – Information Model
Part 6 – Mappings
Part 8 – Data Access

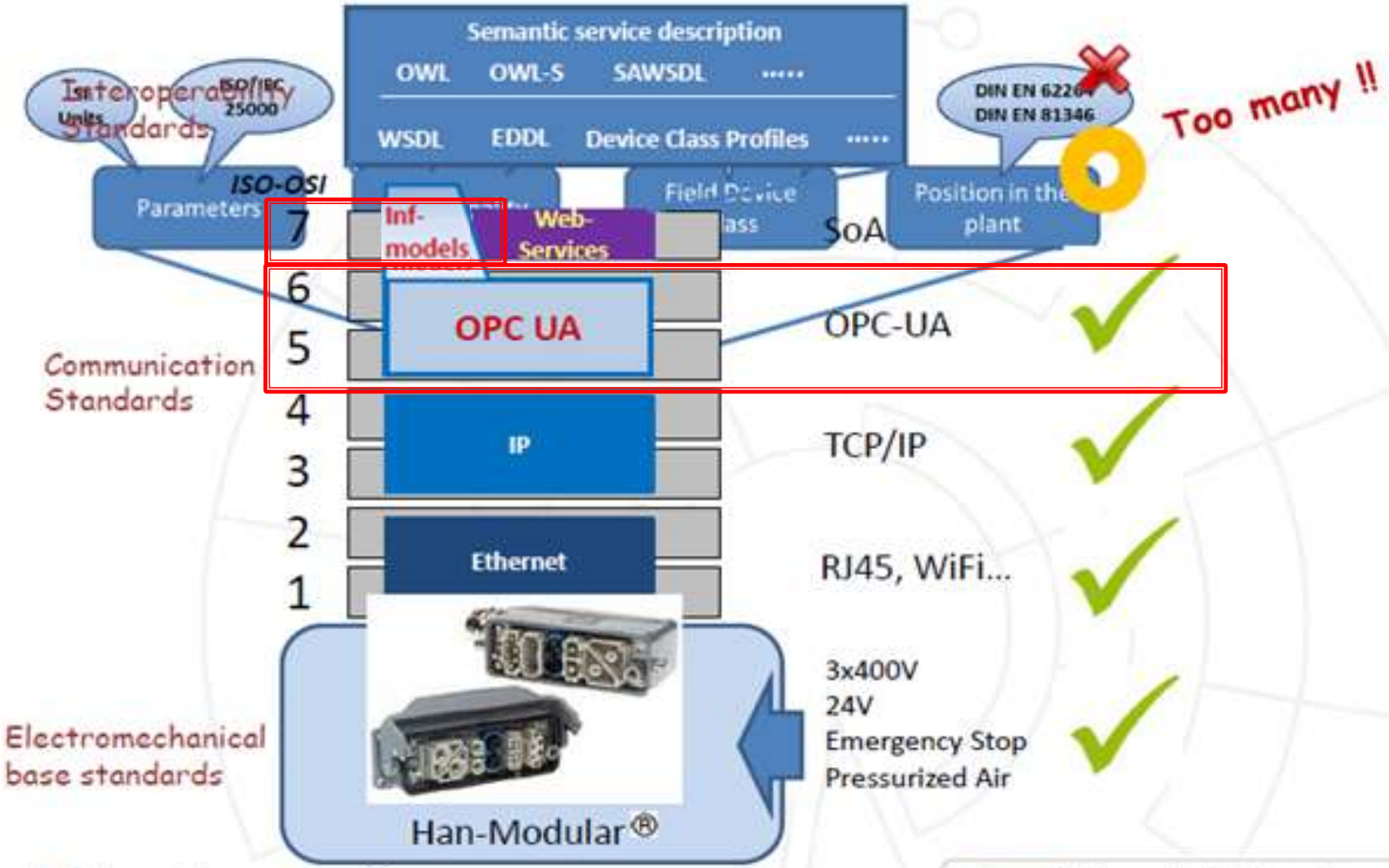
Companion

Part 100 – Devices

August 2015

Part 12 – Discovery

Standards are available



smartFactory KL ®

IFS Innovative Factory Systems

OPC FOUNDATION

Implicitly Secure

Authentication of Clients and Servers

- Achieved by using X.509 certificates ("application instance certificates")

Authentication of users

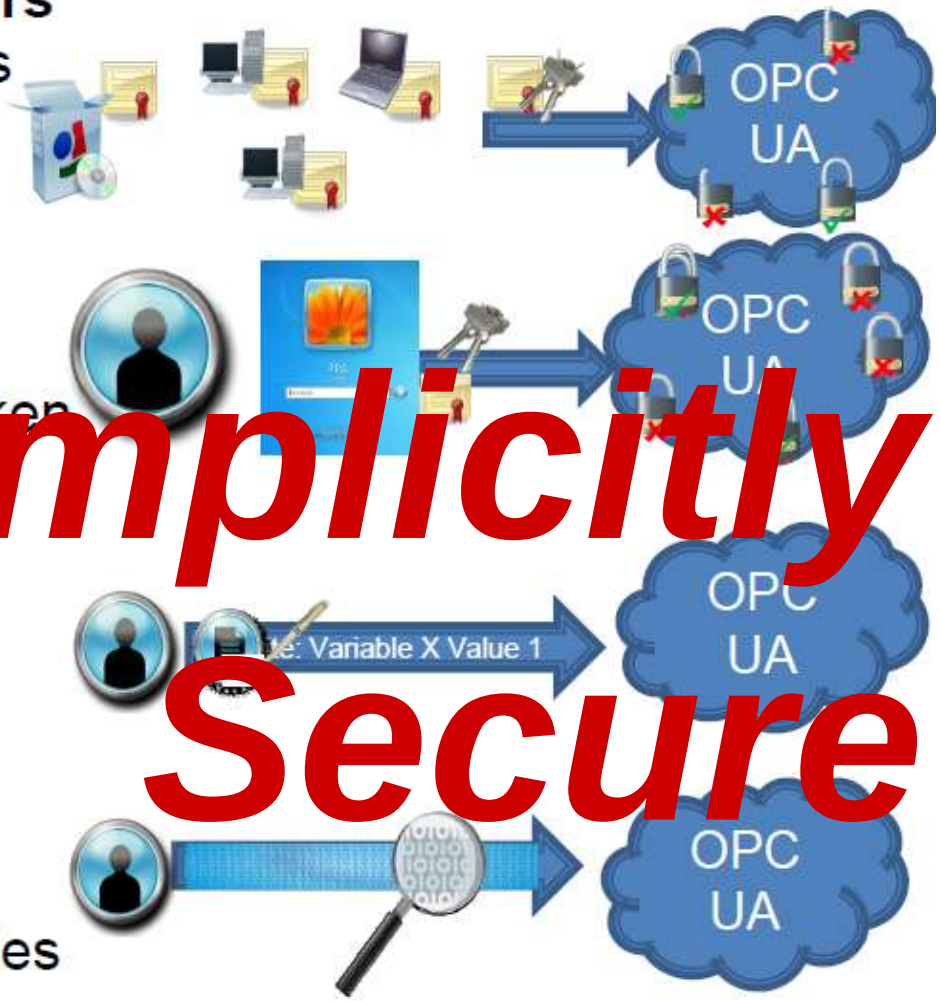
- Achieved by using username/password, X.509 certificate, or WS-SecurityToken

Integrity of their communications

- Digital signatures based on X.509 certificates

Confidentiality of their communications

- Encryption based on symmetric cryptography, key negotiation includes authentication based on X.509



ICS TOP 10 Threats and OPC UA Countermeasures

		OPC-UA
1.	Infection with malicious software via Internet and Intranet	++
2.	Transfer of malicious software via removable media or external Hardware	O
3.	Social Engineering	-
4.	Human Error and Sabotage	- +
5.	Intrusion via Remote Service Access	++
6.	Internet-connected control components	++
7.	Technical Malfunctions and Force Majeure	O
8.	Compromising Smartphones used in Production environment	+
9.	Compromising Extranet and Cloud-Components	++
10.	(D)DoS Attacks	++

„OPC UA key role for industrie 4.0“

„OPC UA culture of security“

Bundesamt für Sicherheit in der Informationstechnik

OPC FOUNDATION

Platform Independence

Scalability

Platform Independent, Scalable

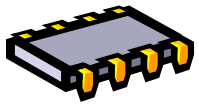
Cloud

Server Cluster

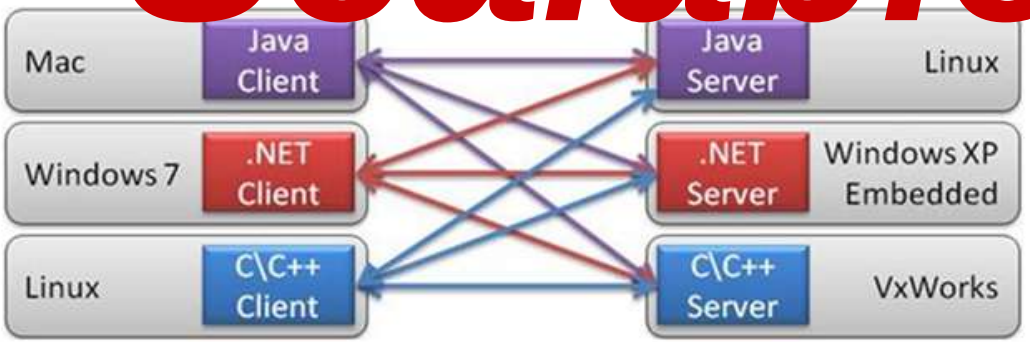
Desktop PC

Portables

Controllers



Embedded Systems



OPC FOUNDATION

Embedded OPC UA

OPC UA Server

OPC UA Server

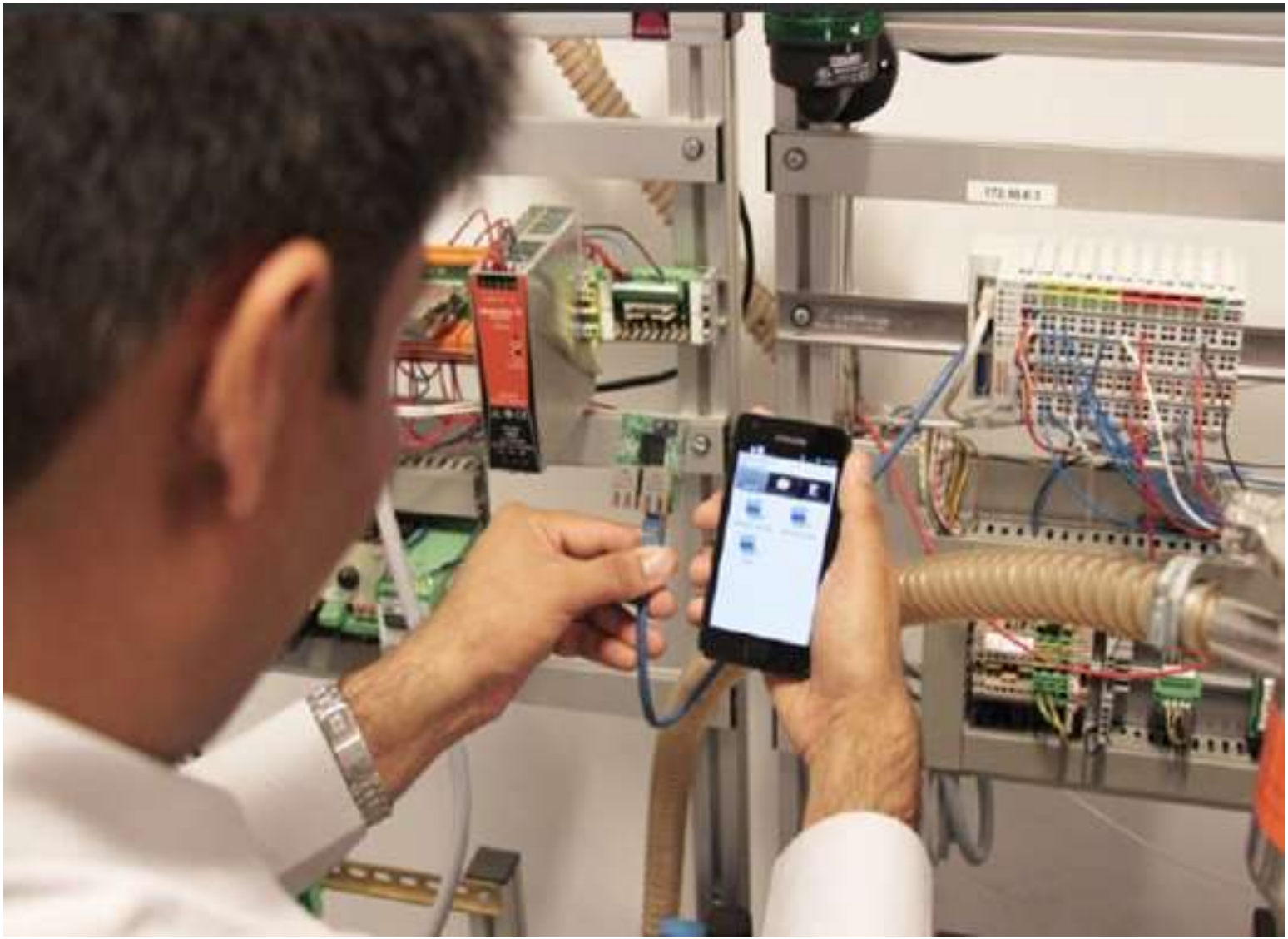
MES

OPC UA Client

Wind River VxWorks

OPC UA Server

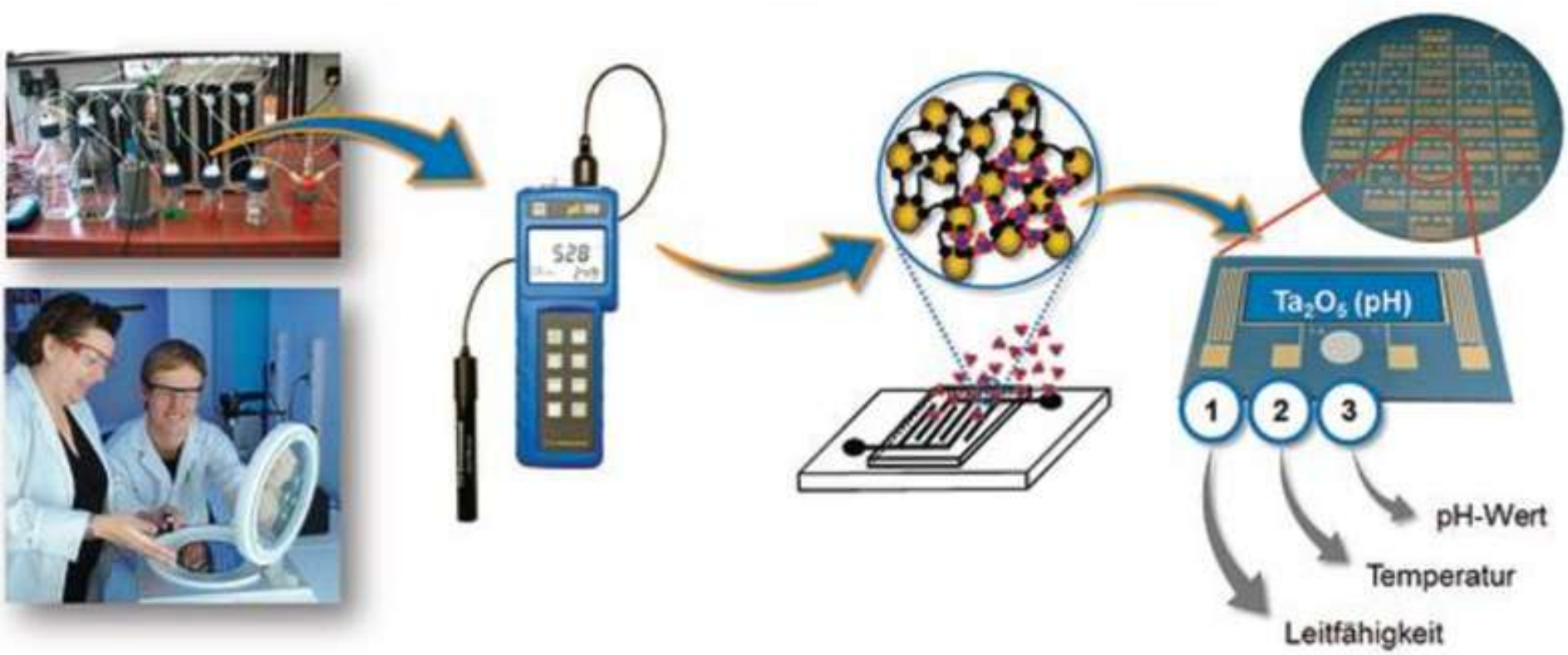
Embedded OPC UA



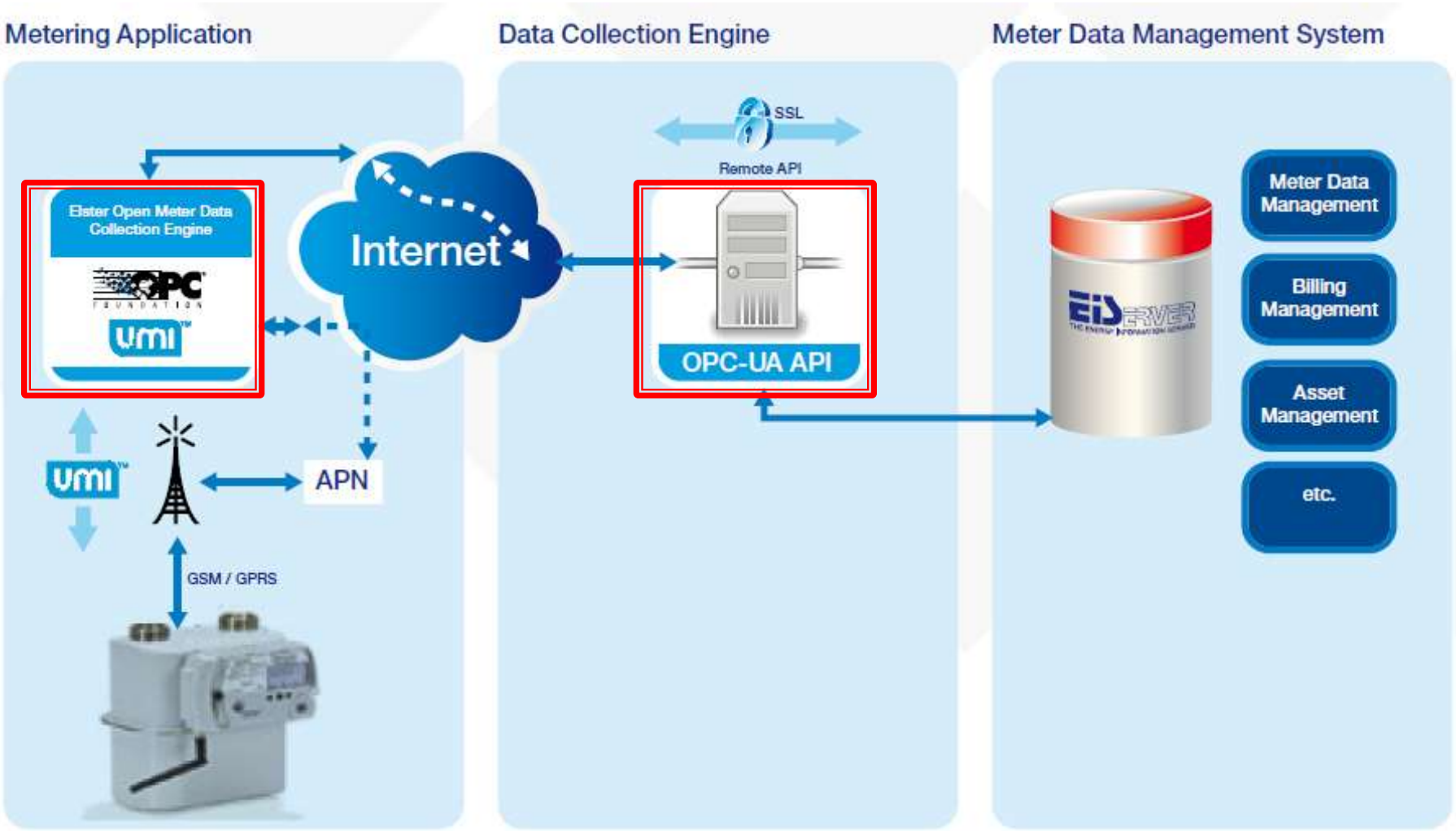
OPC FOUNDATION

Embedded OPC UA

Lab on a Chip



Smart Meter Data Collection



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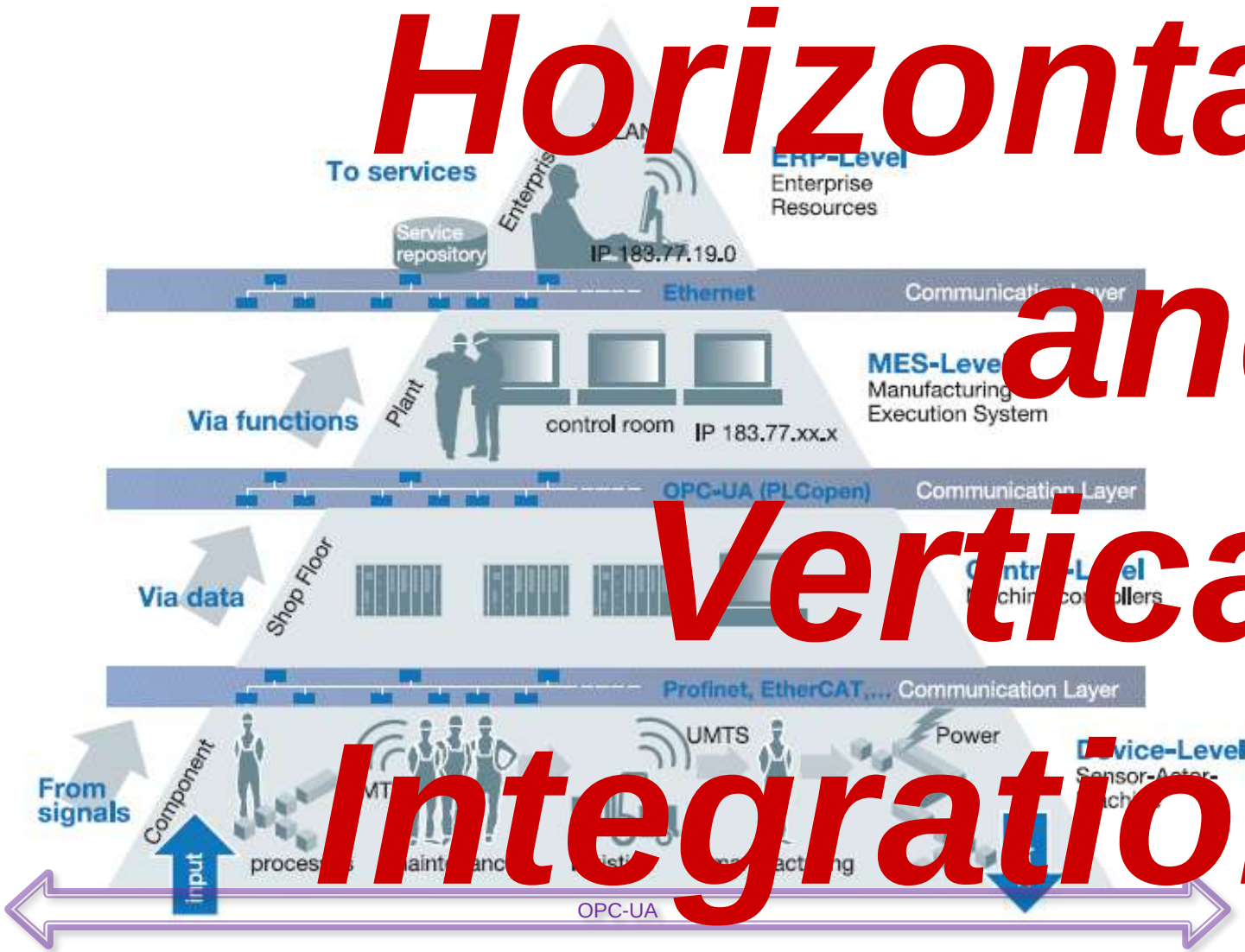
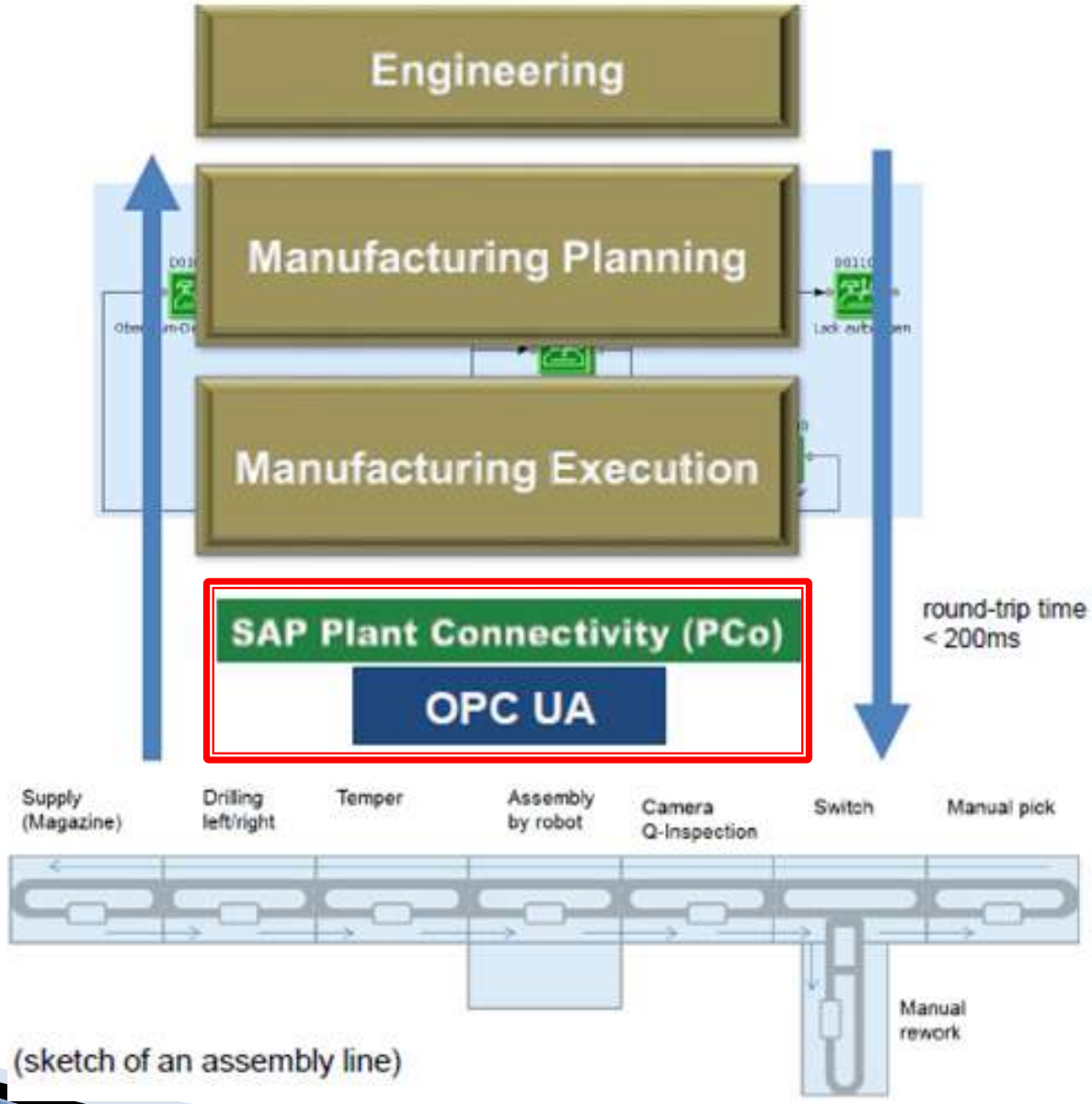
OPC FOUNDATION

Horizontal & Vertical Integration



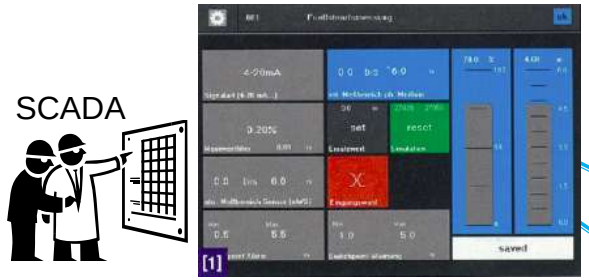
FOUNDATION

Manufacturing Process Control



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 reached ①

stop pumping ②

water works 2

pumping plant 2

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

elevated reservoir

<u>Challenge:</u>
500 devices
- pumps
- waterboilers
1400 km2

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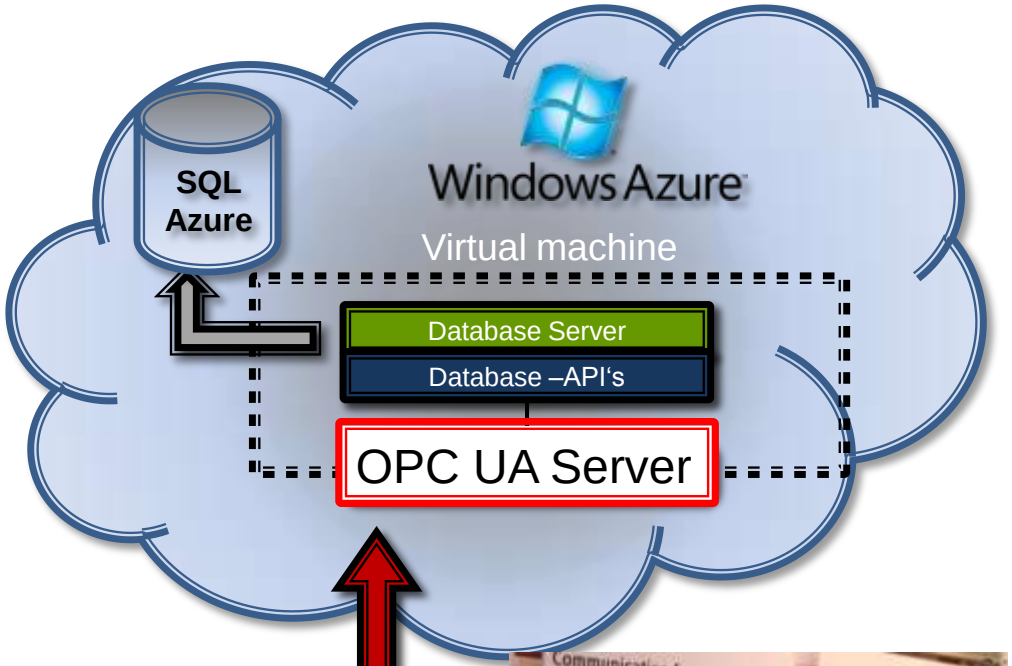
PLC to Cloud



OPC UA Client

Transport Protocol Bindings

- OPC UA has been architected for speed and network performance

XML Web Services

Optimized OPC UA Binary

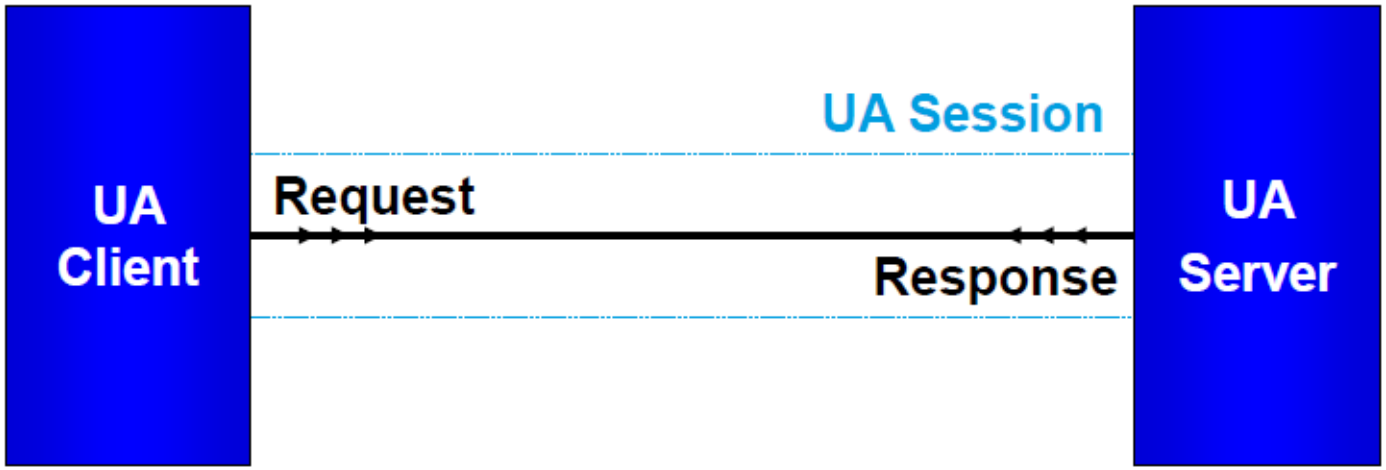
UA XML	UA Binary
WS Secure Conversation	UA Secure Conversation
SOAP 1.2	UA TCP
HTTP	TCP/IP

Transport Protocol Bindings

Communication Reliability

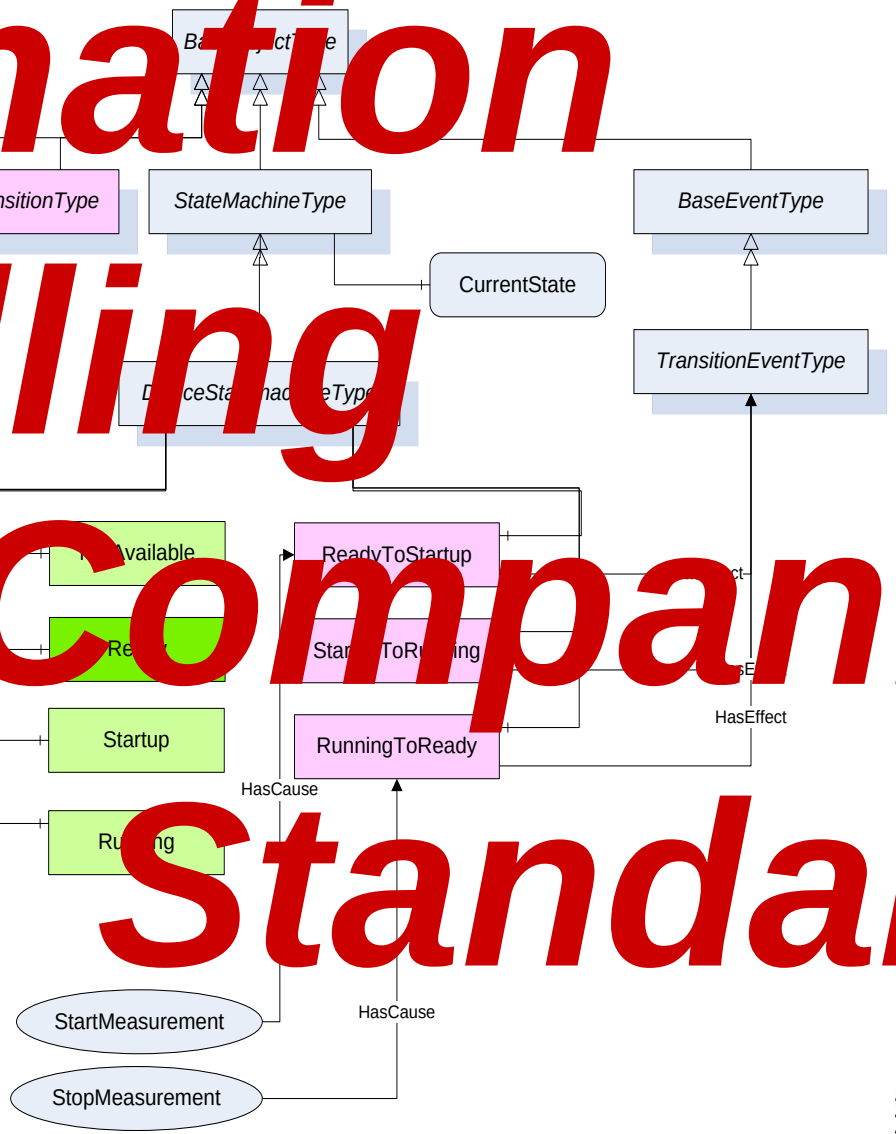
- OPC UA recovers from communication loss
- OPC UA ensures robust and reliable communication
  - Keep-alive monitoring
  - Buffering of data and acknowledgements
  - Fast recovery in case of communication errors
  - Redundancy concepts

Data Buffering



Information Modelling

Information Modelling Companion Standards



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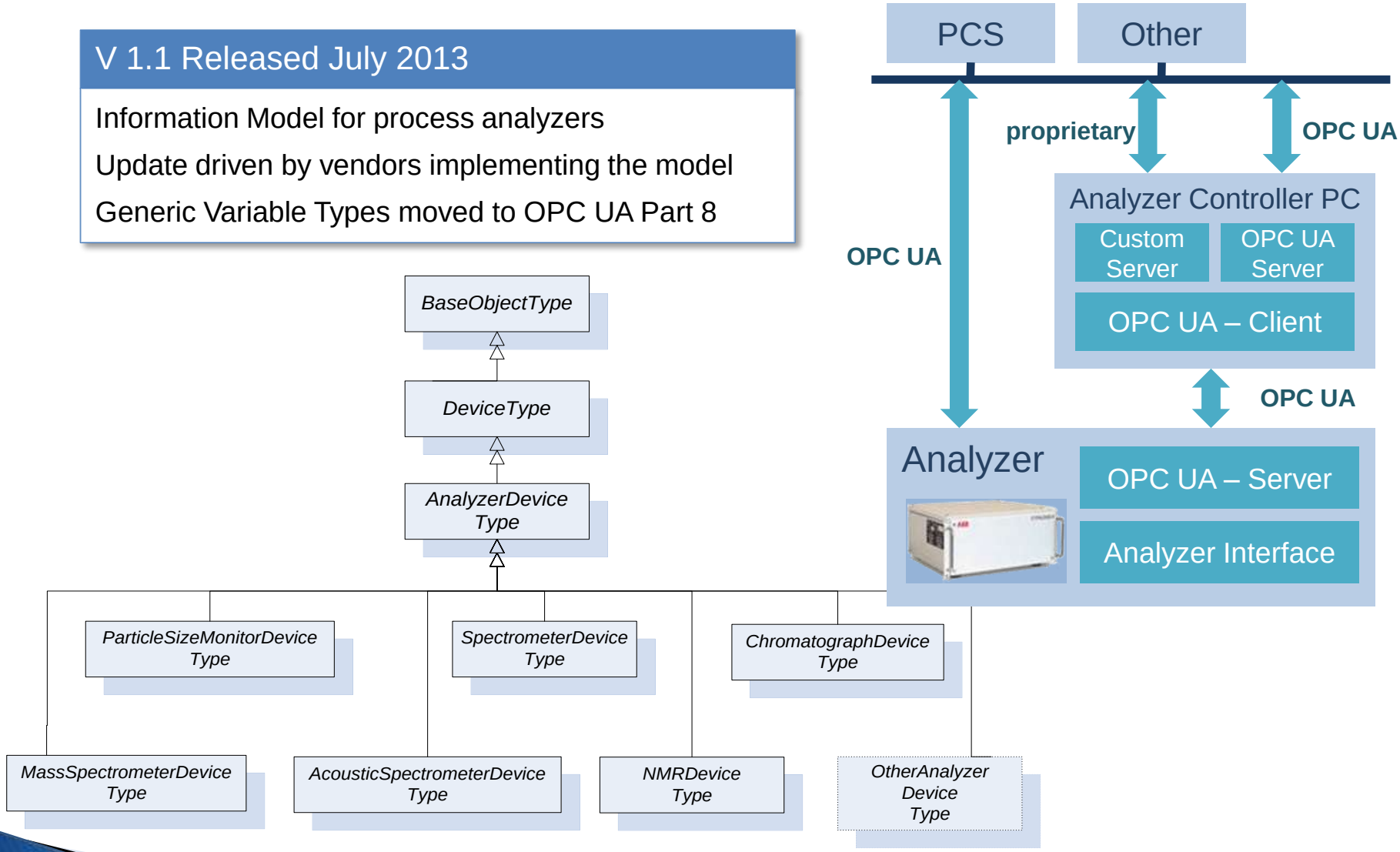
OPC UA for Analyzer Device Integration (ADI)

V 1.1 Released July 2013

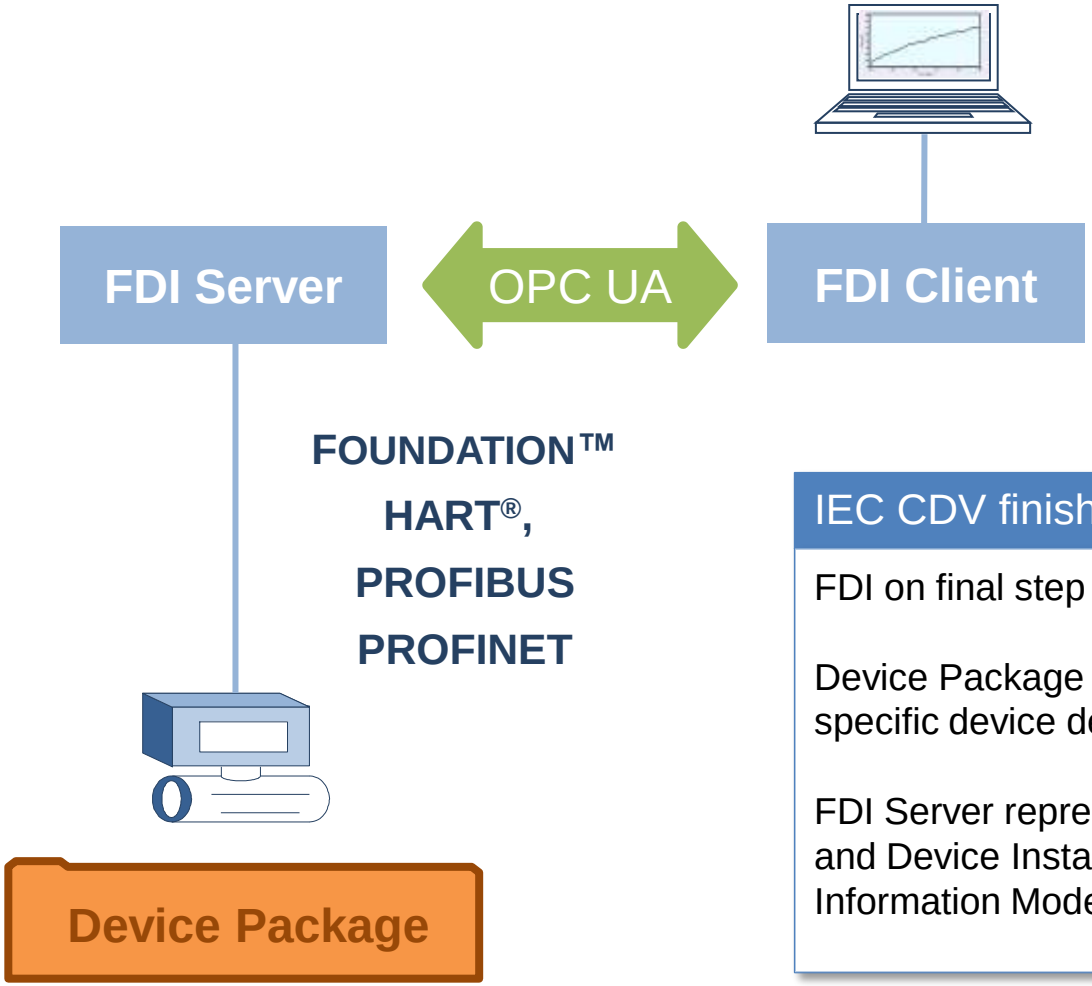
Information Model for process analyzers

Update driven by vendors implementing the model

Generic Variable Types moved to OPC UA Part 8



OPC UA for Field Device Integration (FDI)



IEC CDV finished

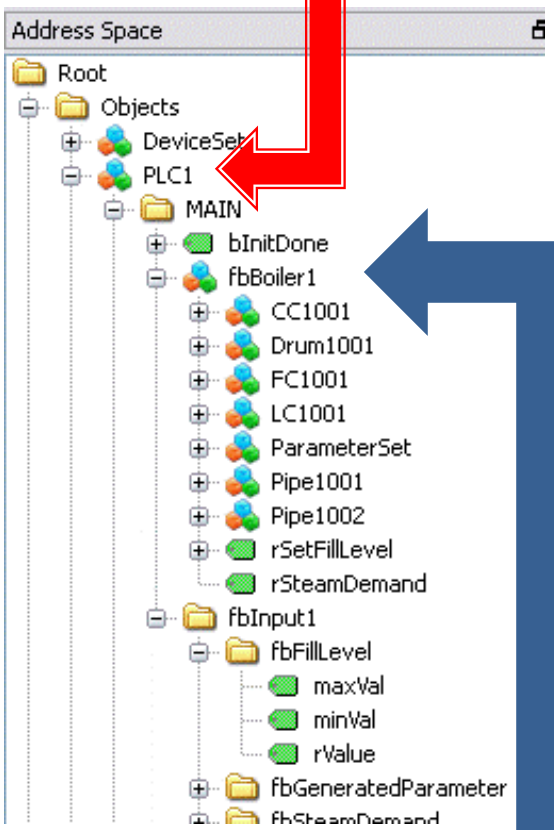
FDI on final step to IEC Standard

Device Package contains vendor specific device description

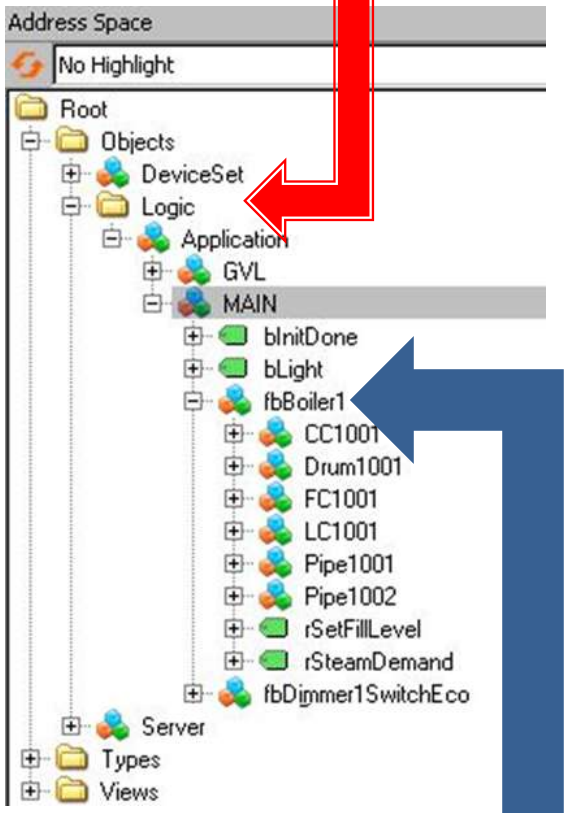
FDI Server represents Device Types and Device Instances as OPC UA Information Model

OPC UA for PLCopen IEC61131-3

Different entry point



Beckhoff „PLC1“



Bosch-Rexroth „Logic“

... but semantic identical objects!

BACnet – Building Automation

Release Candidate Specification

BACnet OPC UA Mapping

- BACnet objects to OPC UA objects
- BACnet events to OPC UA alarms
- BACnet logging to OPC UA HA
- BACnet structure to OPC UA structures
- BACnet units to OPC UA units

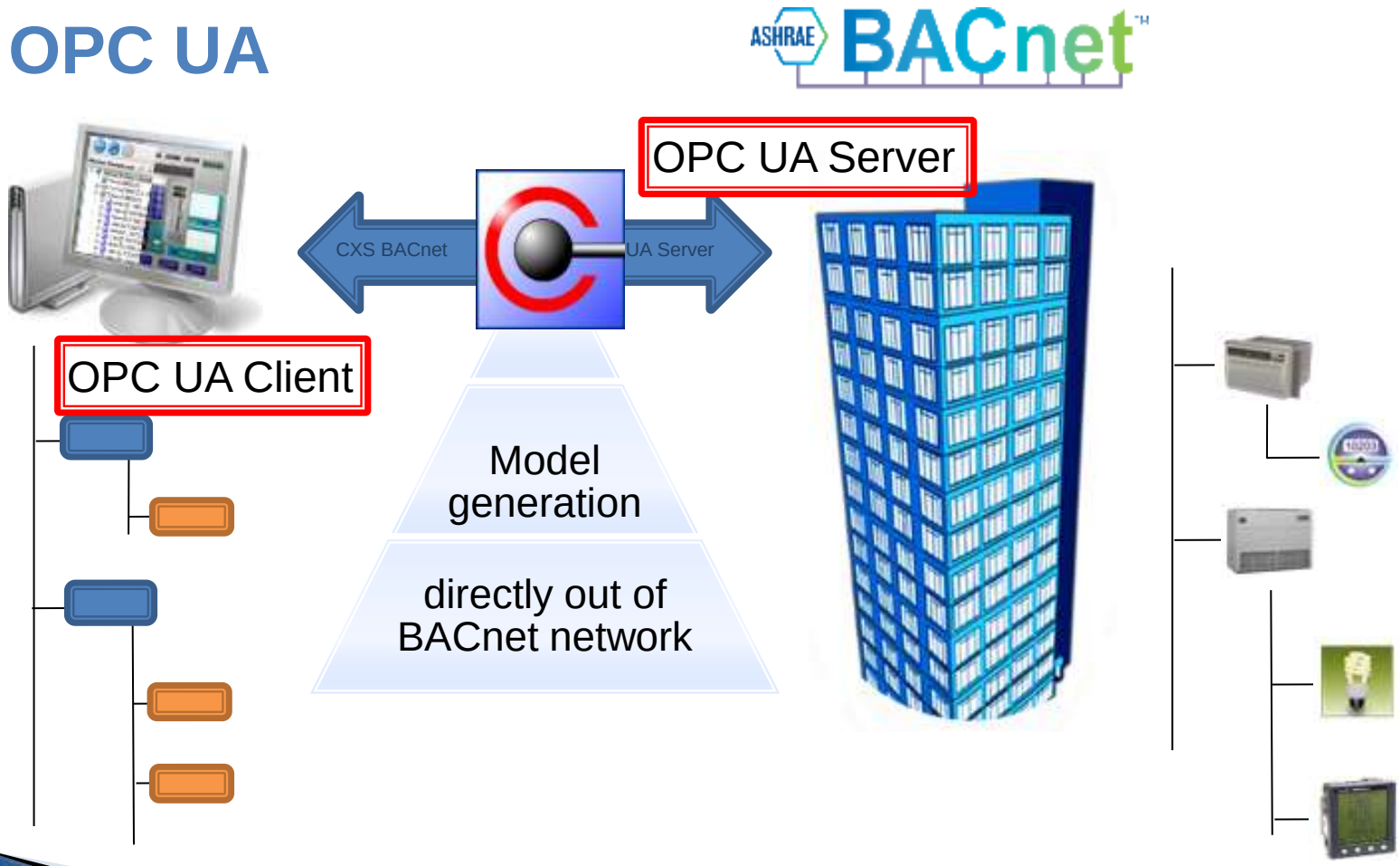
OPC UA for BACnet

“Energy data is semantically defined through BACnet and can conveniently and interoperably be made available to enterprise systems via OPC UA:

An ideal standardization from sensor right up to IT billing systems.«

Frank Schubert
Member of the Advisory Board
of the BACnet Interest Group Europe

Facility Management



CONNEX SOFT

OPC FOUNDATION

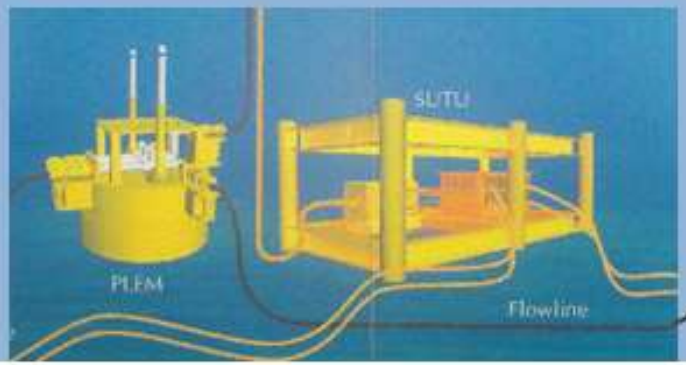
MDIS – Oil & Gas Industry

Working Group since 2012

MCS – DSC Interface Standard

Working Group consists of

- All major Oil companies (operators)
- All major DCS vendors
- All major Subsea vendors



OPC UA for communication between Subsea Production and DCS Systems

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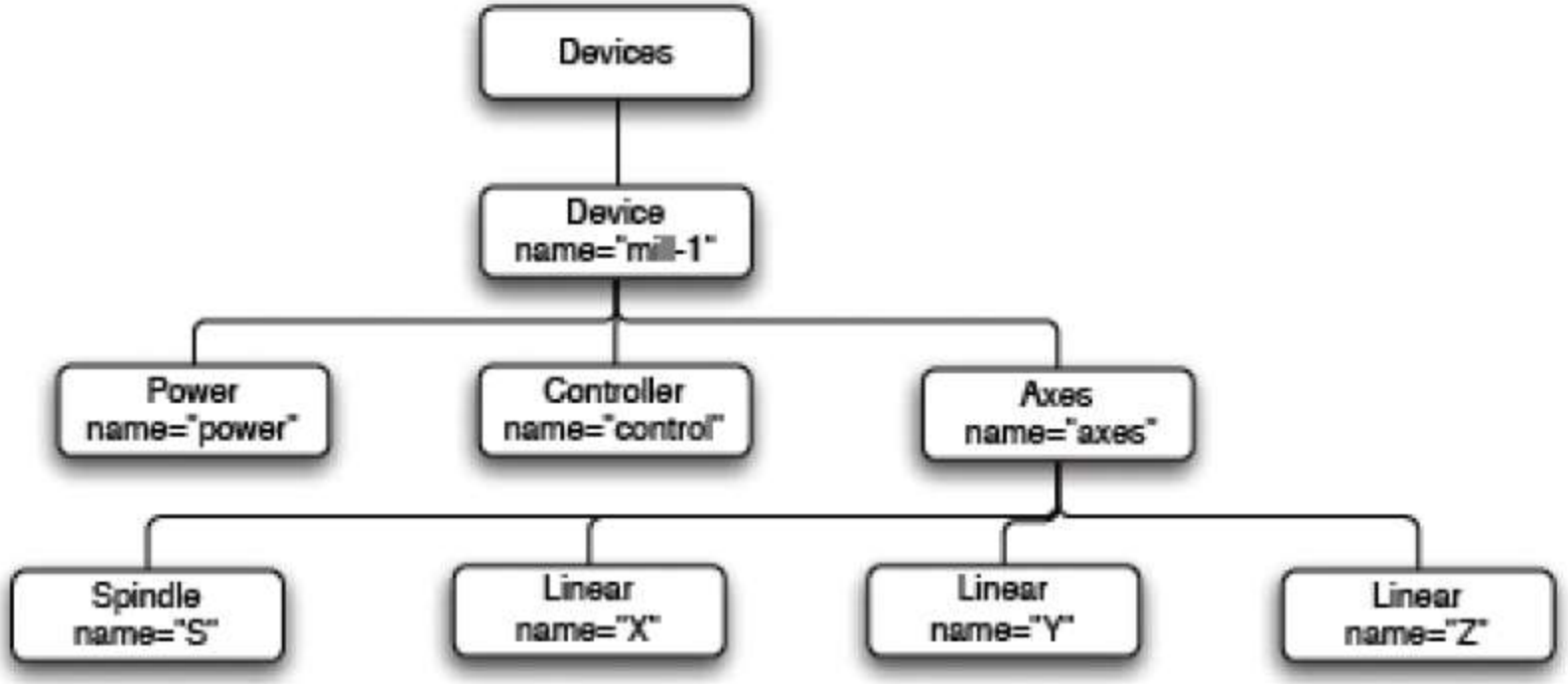
OPC UA for MTConnect (shopfloor data)

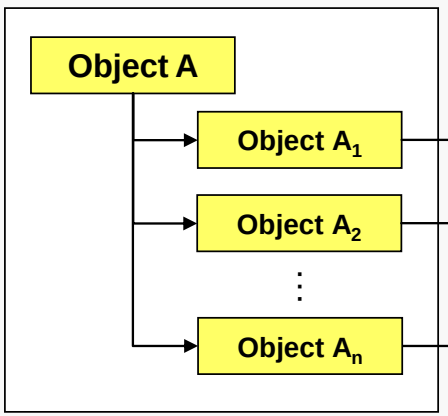


OPC UA for AutomationML

AutomationML
Engineering data

CAEX IEC 62424
Top level format

Plant topology information
- Plants
- Cells
- Components
- Attributes
- Interfaces
- Relations
- References

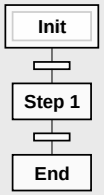


COLLADA

Geometry
Kinematics

PLCopen XML

Behaviour
Sequencing



Further XML Standard format

Further aspects of engineering information

DAIMLER
KUKA
SIEMENS
ABB
zühlke
empowering ideas
Fraunhofer IOSB
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
Universität Karlsruhe (TH)
Forschungsuniversität · gegründet 1825
NETALLIED SYSTEMS

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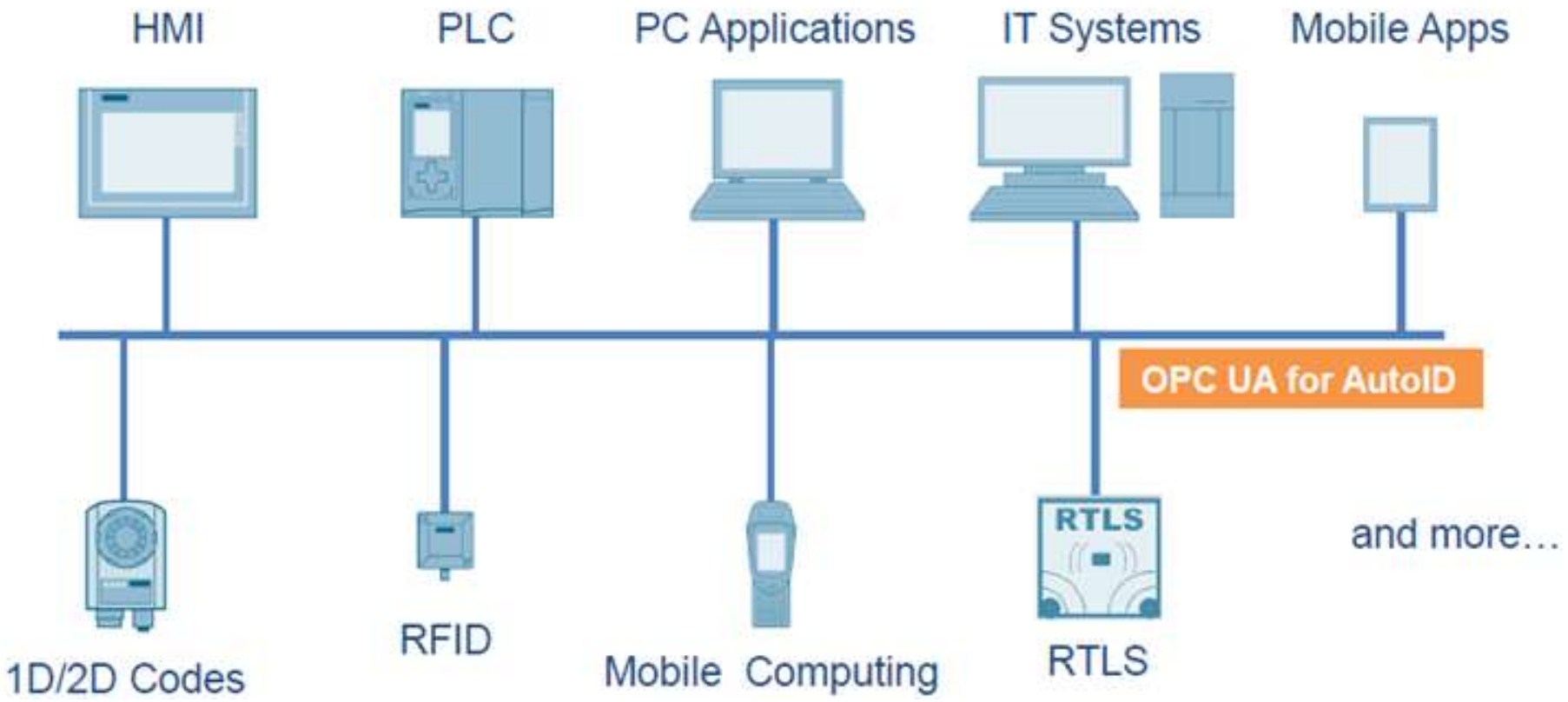
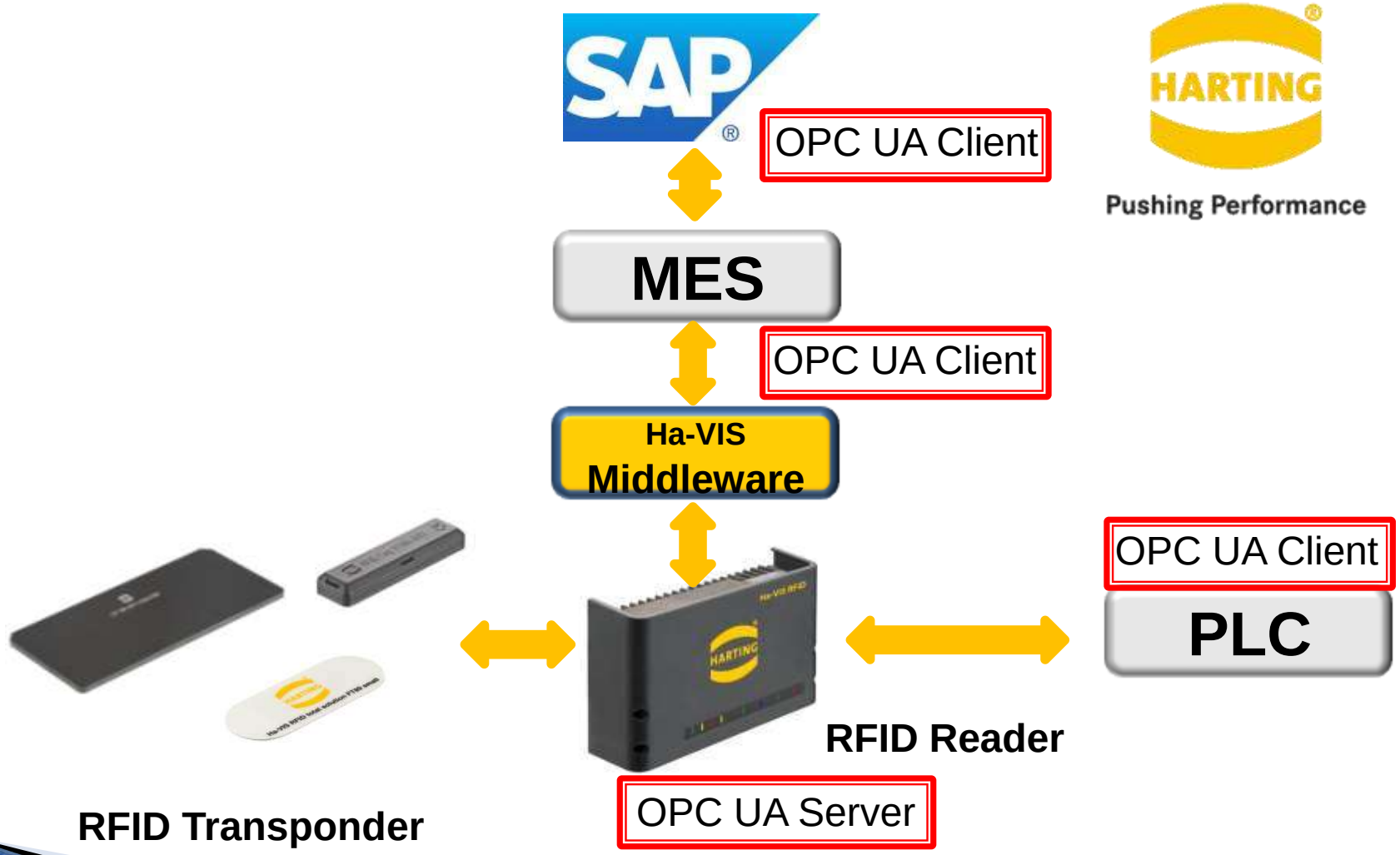
AIM – OPC UA for AutoID



Embedded OPC UA – RFID Reader



Compliance

Compliance

OPC FOUNDATION

What is Certification?

The OPC Foundation's Certification and Compliance program exists to help members develop and provide high quality products that meet minimum operability requirements. OPC Certified products are:

- **Compliant** with the OPC specifications
- **Interoperable** with other OPC products from other vendors
- **Robust**, reliable and able to recover from lost communications, etc.
- **Usable**, by following universally accepted best-practices
- **Efficient** in managing resources (CPU, memory, disk space etc.)

The Certification program is under the jurisdiction of the Compliance Working Group that is responsible for:

- The rules of the certification program
- Criteria and test-procedures that determine compliance
- Guidelines for the OPC Test Labs
- Continued development and refinement of test-cases and test-tools

Compliant
Robust
Interoperable
Efficient
Usable

OPC FOUNDATION

Find Certified Products

The OPC Foundation's Certification Program ensures that products meet OPC Foundation requirements for interoperability, reliability and minimum performance. End-users can reduce their system integration costs when deploying OPC-based systems by purchasing OPC Certified products such as those listed here.

Search

	Member	Products	Certified Profiles
+	Apriso Corporation	(1)	
+	Azbil Corporation	(3)	
+	Baker Hughes Incorporated	(1)	
+	Beckhoff Automation GmbH	(1)	

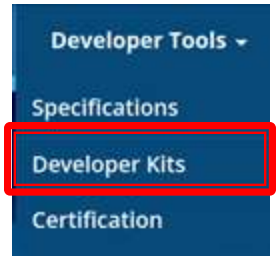
Choosing Certified Products

OPC FOUNDATION

Search: sdk

Name	Member	Description
Free OPC UA Demo Servers	Unified Automation GmbH	Unified Automation's OPC UA Demo Servers provide simulated data ...
Java Based OPC UA Client SDK/Toolkit	Unified Automation GmbH	OPC UA Java SDK Client implements the necessary client side infrastruc...
Java Based OPC UA Server SDK/Toolkit	Unified Automation GmbH	The OPC UA Java SDK allows efficient development of OPC UA clients and...
MatrikonOPC UA Device Server HDK	MatrikonOPC	The OPC UA Device Server Hardware Development Kit is the easiest way t...
MatrikonOPC UA Embedded Server SDK	MatrikonOPC	The OPC UA Embedded Server SDK from MatrikonOPC is a software developm...
OPC Classic DA Client Development Toolkit for Windows	Softing Industrial Automation GmbH	OPC Classic DA Client Development Toolkit for Windows Data Access &...
OPC Classic DA Server Development Toolkit for Windows	Softing Industrial Automation GmbH	Data Access – OPC Connectivity Integration Made Easy ...
OPC Classic Test and Demo Server	Softing Industrial Automation GmbH	The Softing OPC Classic Demo Server is an easy to use OPC Server, crea...
OPC Classic XML-DA Server Development Toolkit for Linux	Softing Industrial Automation GmbH	OPC Classic XML-DA – OPC Connectivity Integration Made Easy ...
OPC Classic XML-DA Server Development Toolkit for Windows	Softing Industrial Automation GmbH	OPC Classic XML-DA – OPC Connectivity Integration Made Easy ...

SDK Toolkit Time to Market



OPC FOUNDATION

Mission Statement

OPC Foundation: The Interoperability Standard for Industrial Automation™

The mission of the OPC Foundation is to manage a global organization in which users, vendors and consortia collaborate to create data transfer standards for multi-vendor, multi-platform, secure and reliable interoperability in industrial automation.

To support this mission, the OPC Foundation:

- Creates and maintains specifications
- Ensures compliance to OPC specifications through certification testing
- Collaborates with industry-leading standards organizations

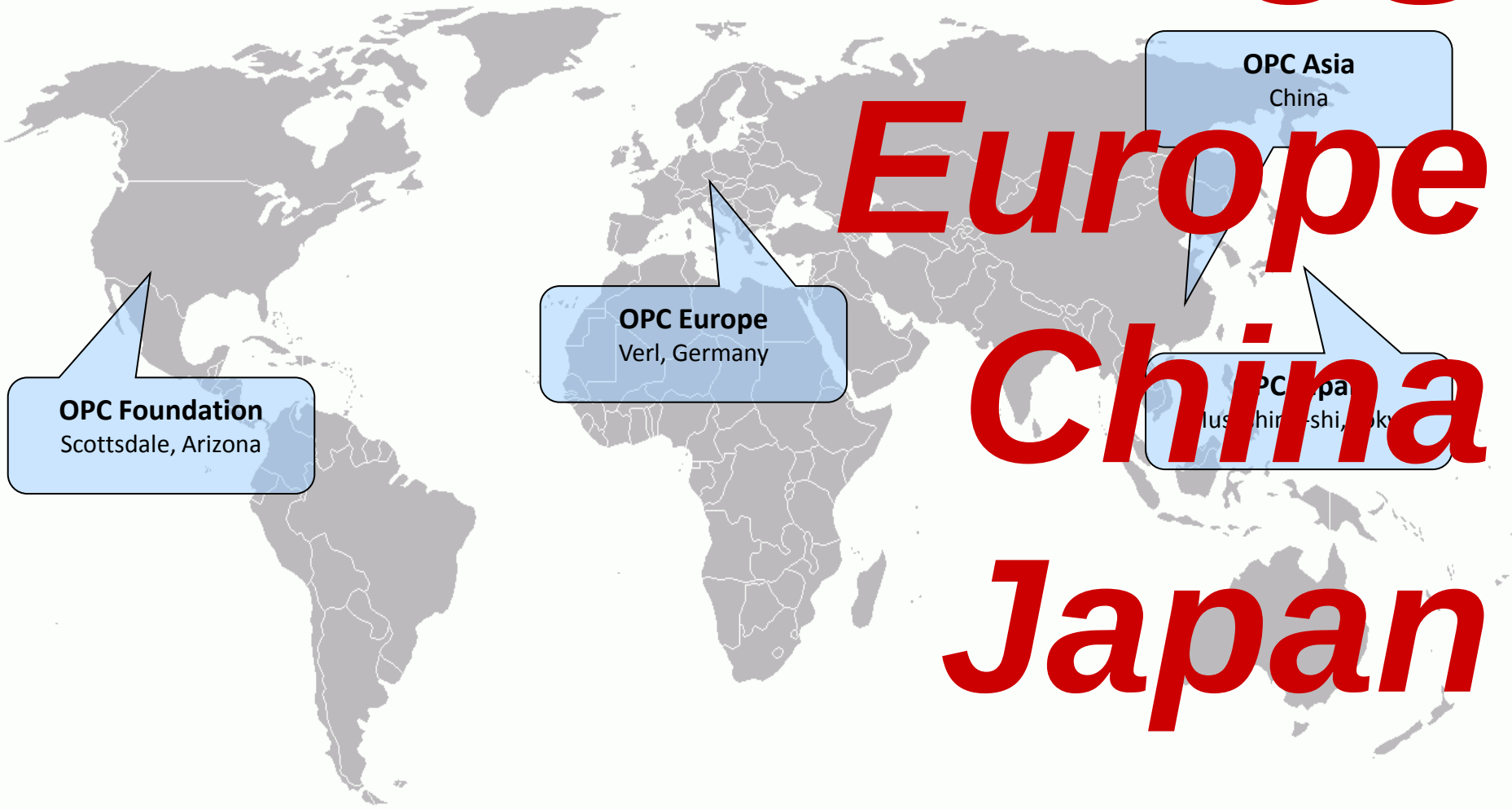
Specifications

Compliance

Collaboration

OPC FOUNDATION

Global Organisation



US

Europe

China

Japan

FOUNDATION


OPC
FOUNDATION

OPC Foundation Working Groups

The OPC Foundation working groups are essential for the development of industry-leading specifications, technologies, certification and processes. The focus of these working groups is to produce the deliverables that are adopted by the OPC community in real-world products and services. Meetings are generally conducted online and occasionally in person.

Members have the opportunity to participate in Working Groups to ensure that their unique technology needs are considered by the industry-at-large. This approach allows the OPC Foundation, through the participation of its members as marketing and engineering resources, to move the standard forward to meet the technology challenges of tomorrow.

Compliance

PLCopen

TAC

UA

- Compliance Working Group (CWG)
- ISA-95 Working Group
- PLCopen Working Group
- Technical Advisory Council (TAC)
- Unified Architecture Working Group

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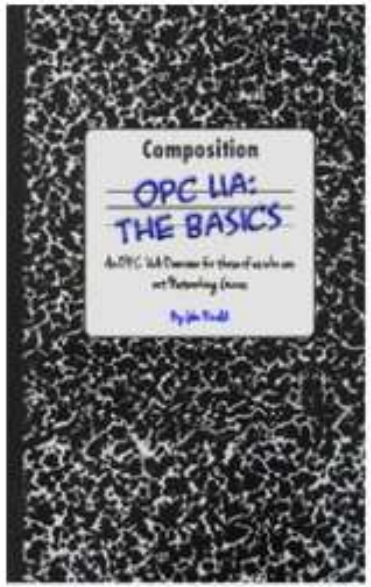

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Plug & Play

The new smartfactory demonstrator and its partners

Plug & Play

smartFactory KL ®

DFKI German Research Center for Artificial Intelligence

IFS Innovative Factory Systems

OPC FOUNDATION


AUTOMATION
& IT TOUR


Rexroth
FESTO


Rexroth
Bosch Group
FESTO


Rexroth
Bosch Group
FESTO


FESTO


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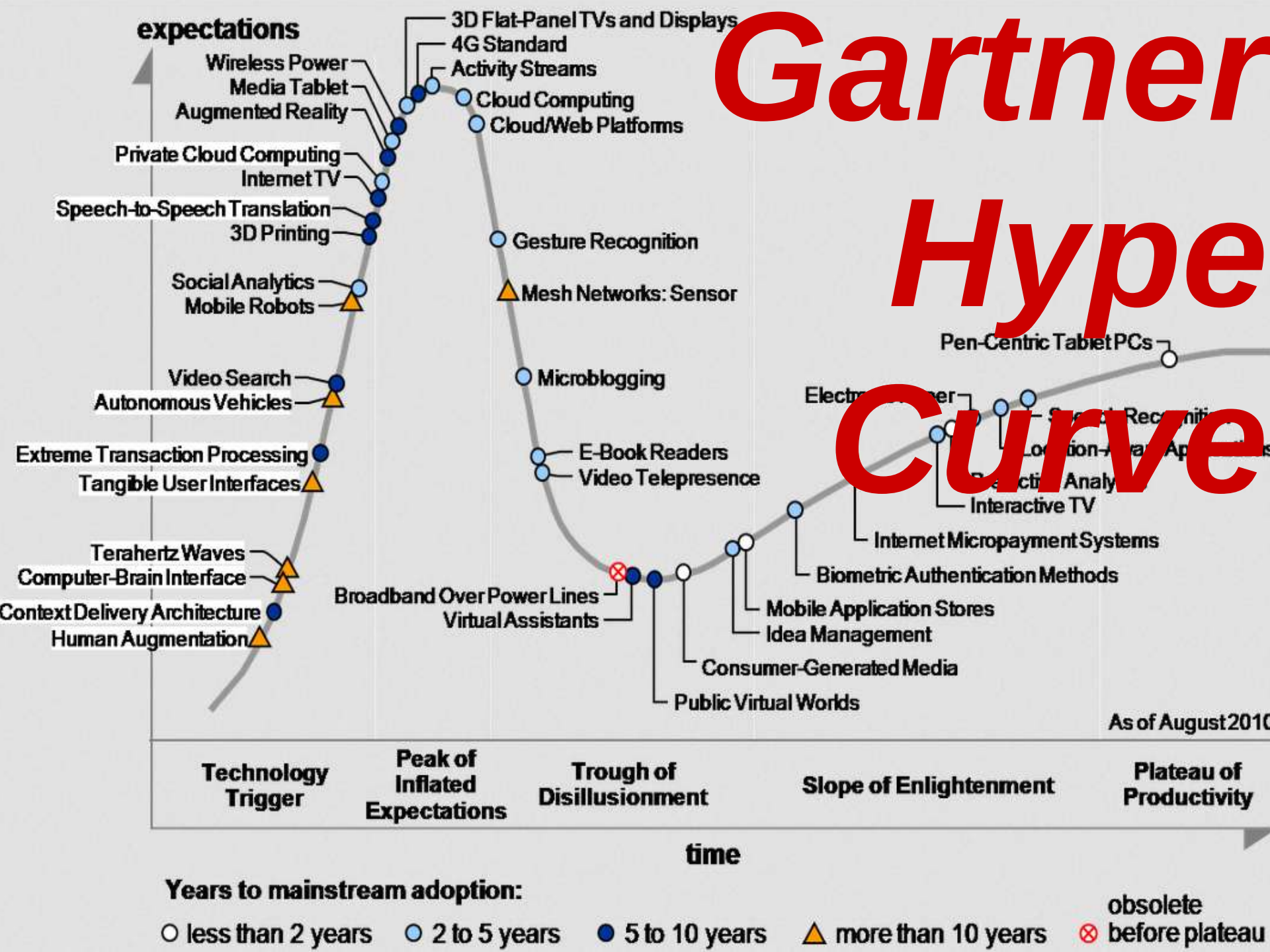
Rexroth

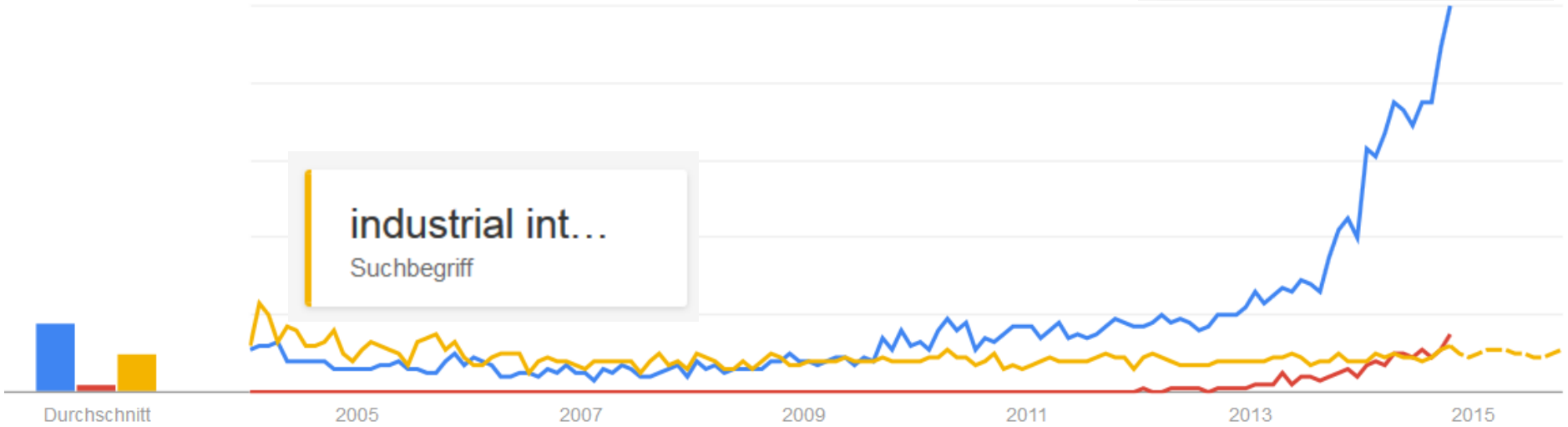

FESTO
Rexroth
FESTO


Gartner Hype Curve
expectations
3D Flat-Panel TVs and Displays
4G Standard
Activity Streams
Wireless Power
Media Tablet
Augmented Reality
Cloud Computing
Cloud/Web Platforms
Private Cloud Computing
Internet TV
Speech-to-Speech Translation
3D Printing
Gesture Recognition
Social Analytics
Mobile Robots
Mesh Networks: Sensor
Pen-Centric Tablet PCs
Video Search
Autonomous Vehicles
Microblogging
Extreme Transaction Processing
Tangible User Interfaces
E-Book Readers
Video Telepresence
Interactive TV
Internet Micropayment Systems
Terahertz Waves
Computer-Brain Interface
Biometric Authentication Methods
Broadband Over Power Lines
Virtual Assistants
Mobile Application Stores
Idea Management
Context Delivery Architecture
Human Augmentation
Consumer-Generated Media
Public Virtual Worlds
As of August 2010
Technology Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity
time
Years to mainstream adoption:
less than 2 years
2 to 5 years
5 to 10 years
more than 10 years
obsolete before plateau


Google
Trends
Industrie 4.0
Suchbegriff
A
B
C
D
E
F
G
2011
2013

Google

Trends



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Peter Seeberg
Market Segment Manager,
Factory Automation

www.opcfoundation.org

Softing Industrial Automation GmbH
http://industrial.softing.com