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Siemens Corporate Technology | August 2014

Future of Manufacturing
View on enabling technologies
Thomas Hahn

Agenda

Innovations keep us strong –
Milestones across three centuries

Innovations for:
- Energy
- Industry
- Healthcare
- Infrastructure and Cities
- Information and Communications
- Home appliances

1965: Integrated circuit

1980: EWSD (digital switching technology)

1988: Megabit chip

2000: wind turbine rotor blades in one cast

2008: Corex steel production

2010: Biograph mMR

1939: Electron microscope

1881: Electric streetcar

1962: Thyristors for energy transmission

1974: Computer tomograph

2000: Piezo injection for diesel engines

1984: Hicom telephone system

360,000 employees worldwide in 2013*

revenue totaled €75,9 billion in 2013*
(€32 billion from green products and solutions)
1847-1914 in millions of marks,
1924-44 in millions of reichsmarks,
1949-2009 in millions of euros
(figures prior to 2000 converted from deutsch marks)

1881: Telephone switchboard

1924: Traffic light

1935: Coaxial cable

1958: Heart pacemaker

1953: High-purity silicon

1879: Electric train

1866: Dynamo

1905: Tantalum lamp

1959: Simatic (electronic automation)

2009: Most efficient gas turbine, 370 MW

1959: Fully transistorized universal computer

1994: High-temperature fuel cells

2000: *syngo* user interface

2010: First OLED panel for general lighting

2011: Smart Grid

1847: Telegraph

1847: Werner von Siemens founds the company

1906: Vacuum cleaner

1931: Electric hair dryer

1985: ICE train with top speed of 300 km/h

1998: Switch for one terabit per second

2004: 64-slice computer tomograph

2013: PLM Software

** from continuing operations

Electrification, Automation and Digitalization are the key drivers of our innovation agenda

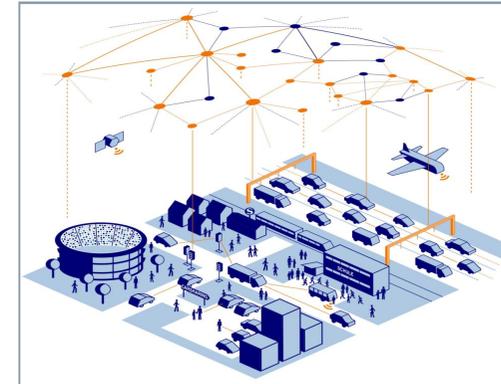Selected research topics

Electrification

- Smart Grid
- Storage technologies
- Power-to-value

Automation

- Autonomous systems
- Robotics
- Industrie 4.0

Digitalization

- Data analytics
- Cloud
- Mobile computing

Smart data to business example: Optimization of gas turbine operation

Results

- Reduced NOx Emissions
- Extension of service intervals

Energy system
- Market drivers
- Customer needs
- Product cycles

Gas turbines
- Mechanical Engineering
- Thermodynamics
- Combustion chemistry

Autonomous Learning
- Neural Networks
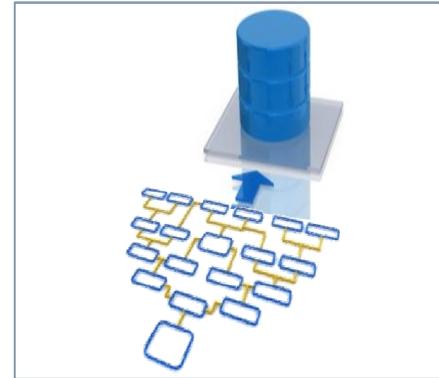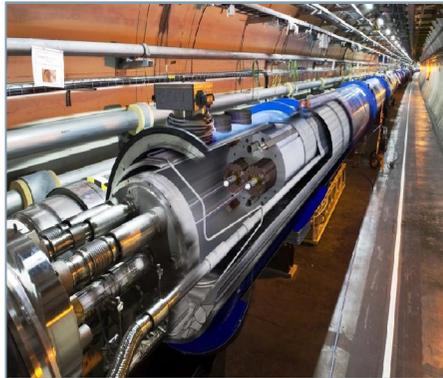- Smart Data Architecture processes data

| Domain know-how | + | Device know-how | + | Analytics know-how | = | Smart Data |

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Smart data to business example:
Health check for CERN's Large Hadron Collider

Results

- Early warnings to increase Operating Hours

Automation infrastruct.

- Market leader in industry automation
- Strong presence in all business areas

Autom. components

- Complex: hundreds of SCADA systems and SIMATIC control systems

Rule and pattern mining

- >1 terabyte of operational data generated per day
- Detect fault patterns

Domain know-how	**+**	Device know-how	**+**	Analytics know-how	**=**	Smart Data

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Smart data to business example:
Smart City Research Aspern, Vienna

Joint Investment City of Vienna/Siemens: Close to € 40 mil.

Objective

"My clear goal now is to become the greenest city in the world."

Michael Häupl, Mayor of Vienna

City infrastructure
- Market drivers
- Customer needs
- Power networks
- Building technology

Smart Grid/Smart building
- Electrical engineering
- Power storage
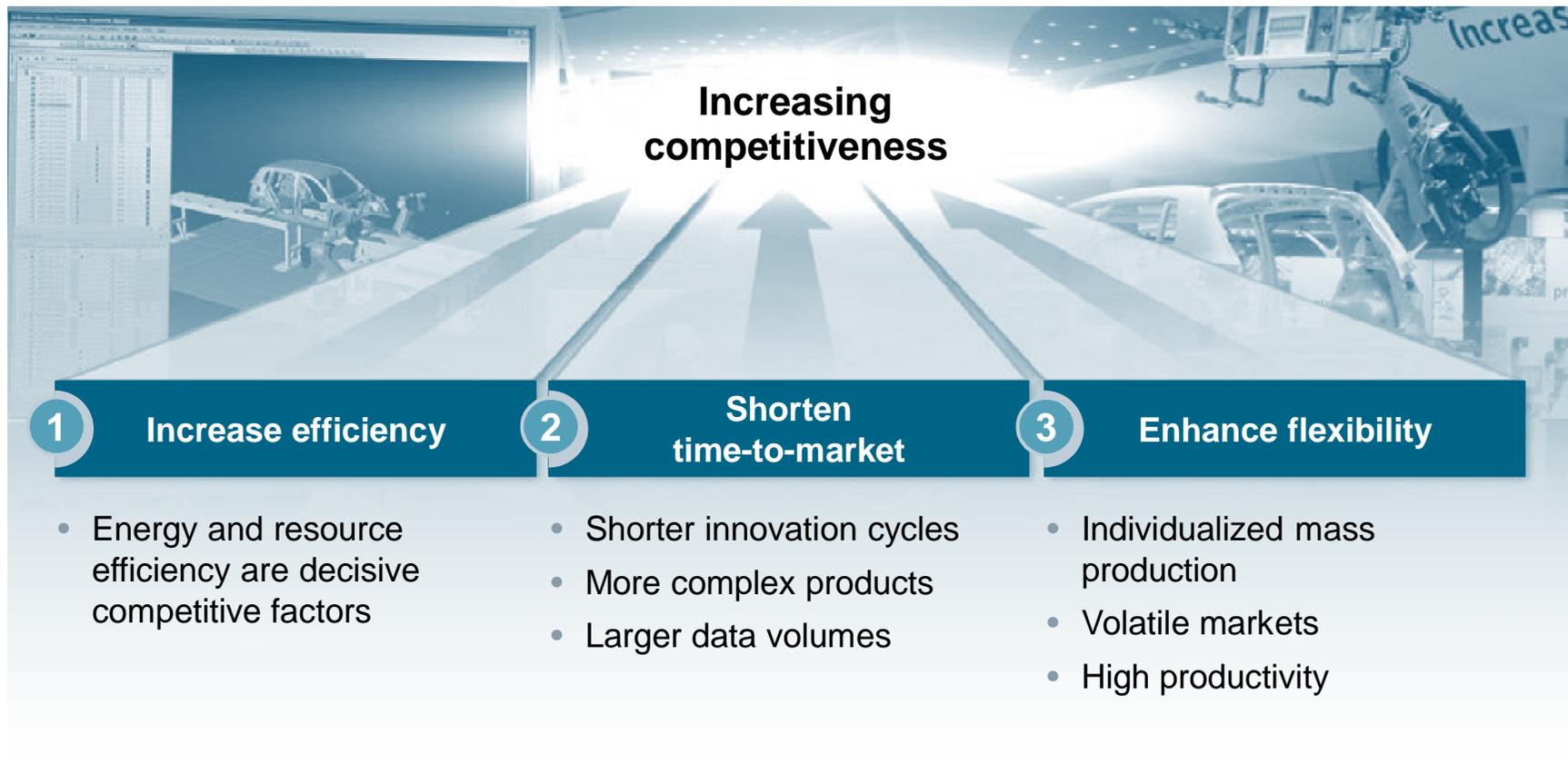- Smart meters

Smart City Cockpit
- Integration of smart grid, smart buildings, water and mobility
- Analytics dashboard

| Domain know-how | **+** | Device know-how | **+** | Analytics know-how | **=** | Smart Data |

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Agenda

1   **Siemens – Our innovation agenda**

2   **Manufacturing challenges and "Industrie 4.0"**

3   **Technical point of view on Cyber-Physical Systems**

4   **OPC UA and what's next**

Challenges:
Manufacturing is changing faster than ever before

Increasing competitiveness

1 **Increase efficiency**

2 **Shorten time-to-market**

3 **Enhance flexibility**

- Energy and resource efficiency are decisive competitive factors

- Shorter innovation cycles
- More complex products
- Larger data volumes

- Individualized mass production
- Volatile markets
- High productivity

Industrie 4.0 should help to solve manufacturing challenges

Recommendations for Industrie 4.0:
5 central research themes

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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

April 2013

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and Research

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

The research for realization of Industrie 4.0 covers 3 levels: Strategy, processes, system

Level strategy

Horizontal integration through value networks
- New business models
- Eco-systems

How can the **business strategy** of a company and new types of value networks are supported by CPS?

Level processes

End-to-end engineering across entire value chain
- Integration of product and production lifecycle: From design to production to service and loop-back

How can the **business processes** including engineering workflows are designed throughout with CPS?

Level system

Vertical integration and networked production systems
- Flexible production based on modular, autonomous production units

How can the **production system** using CPS be flexible reconfigurable and adaptable?

Defines goals

Implements

Services
Produktion
Produktionsengineering
Produktionsplanung
Produktdesign und -entwicklung

Set rules

Enables

Agenda

Vision Industrie 4.0:
Optimization by Cyber-Physical Systems (CPS)
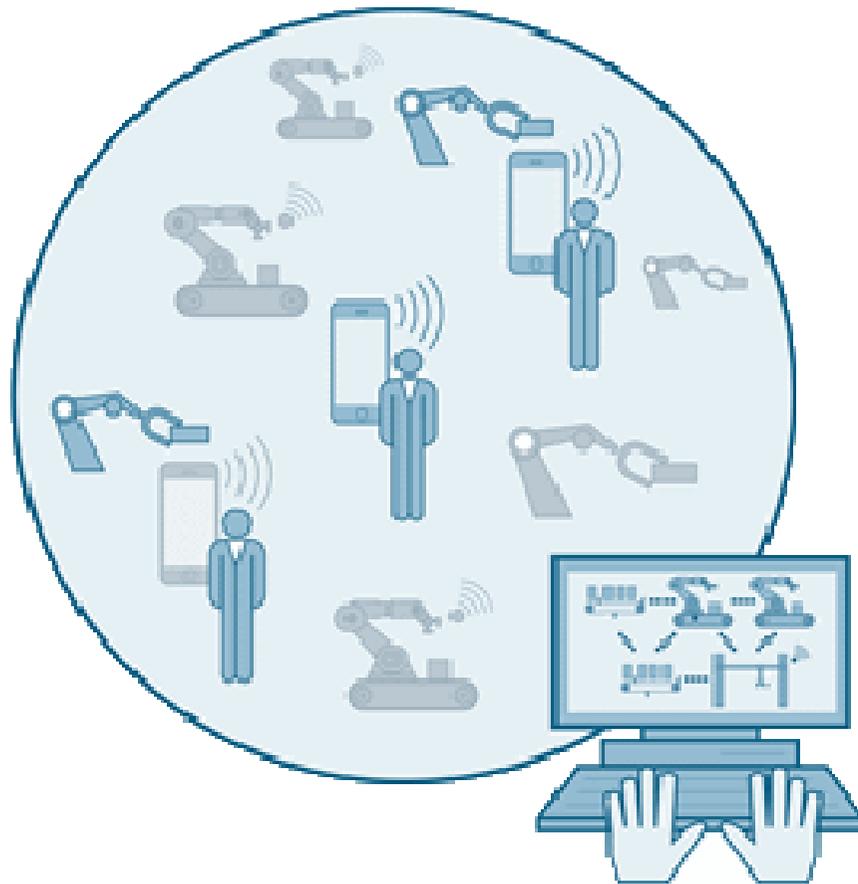
Vision for Industrie 4.0

- The **product** to be manufactured **contains all necessary information** on its production requirements

- **Self-organization of integrated production installations** considering the entire value chain

- **Flexible decision on production process** on the basis of the current situation

- **Human beings remain essential as creative planners, controllers and decision-makers**

Industrie 4.0
Production based on Cyber-Physical Systems

"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
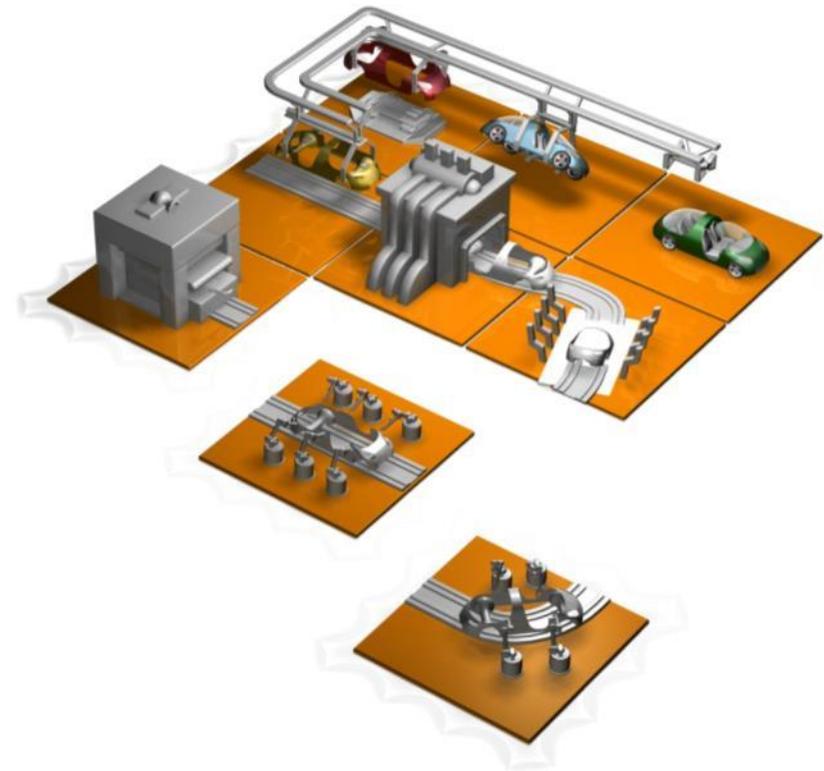
Reduction of complexity due to "smarter" structures

Cyber-Physical Systems
have all the information as a digital model

Cyber-Physical System (CPS)

Physical production facility **+** Digital model

Contains all the information on …

- Software / Informatics
- Mechanics
- Electrics, Electronics
- Automation, HMI
- Safety, security
- Maintenance

- Location, identity…
- Status
- SW version
- Interfaces
- …

The digital model is always up-to-date and is extended over the entire lifecycle
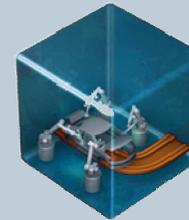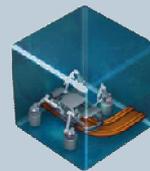
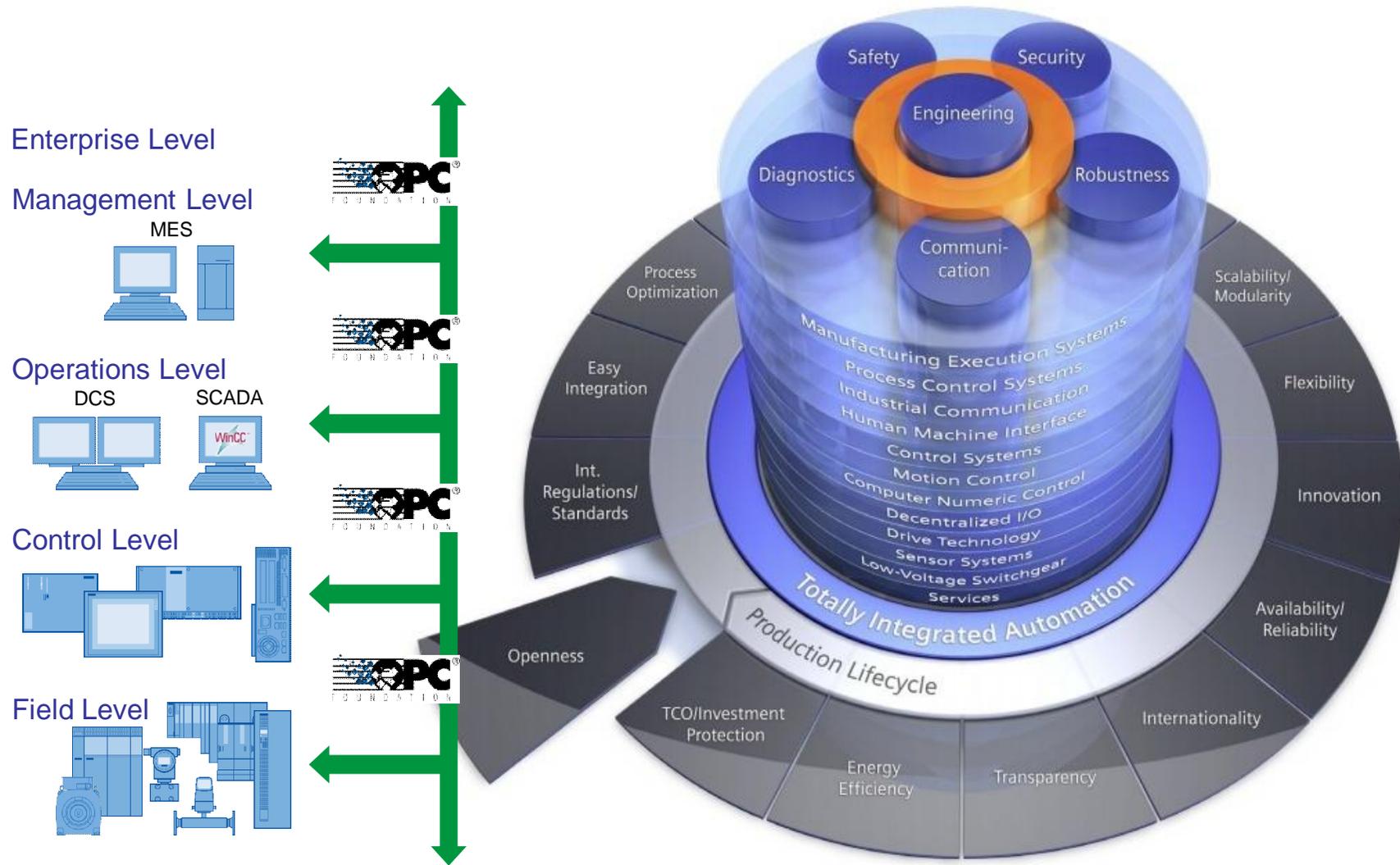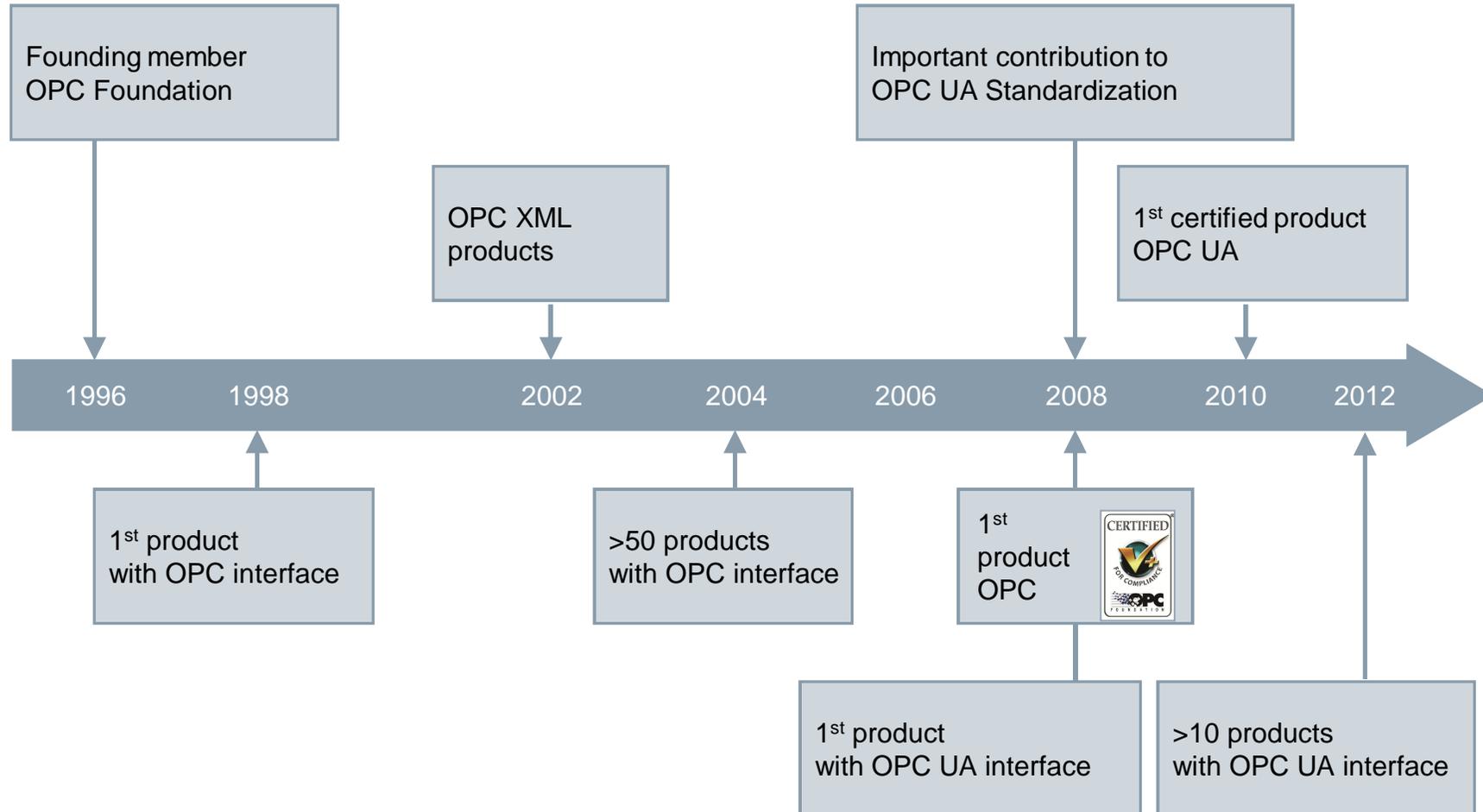| Product design | Production planning | Production engineering | Production execution | Services |

Agenda

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OPC on all automation levels

Enterprise Level

Management Level
MES

Operations Level
DCS   SCADA

Control Level

Field Level

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A long and successful history with OPC foundation

Founding member
OPC Foundation

Important contribution to
OPC UA Standardization

OPC XML
products

1st certified product
OPC UA

| 1996 | 1998 | 2002 | 2004 | 2006 | 2008 | 2010 | 2012 |

1st product
with OPC interface

>50 products
with OPC interface

1st
product
OPC

CERTIFIED
V+
OPC
FOUNDATION

1st product
with OPC UA interface

>10 products
with OPC UA interface

OPC UA and relation to Industrie 4.0
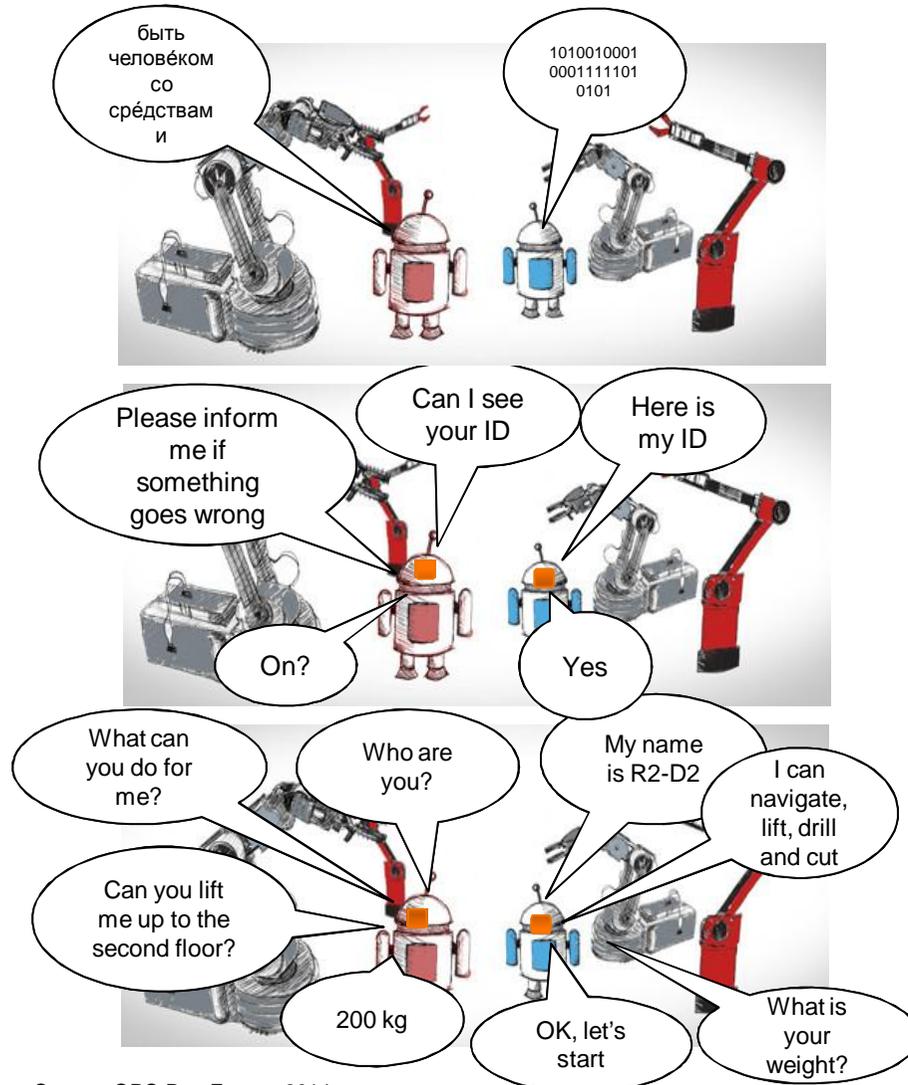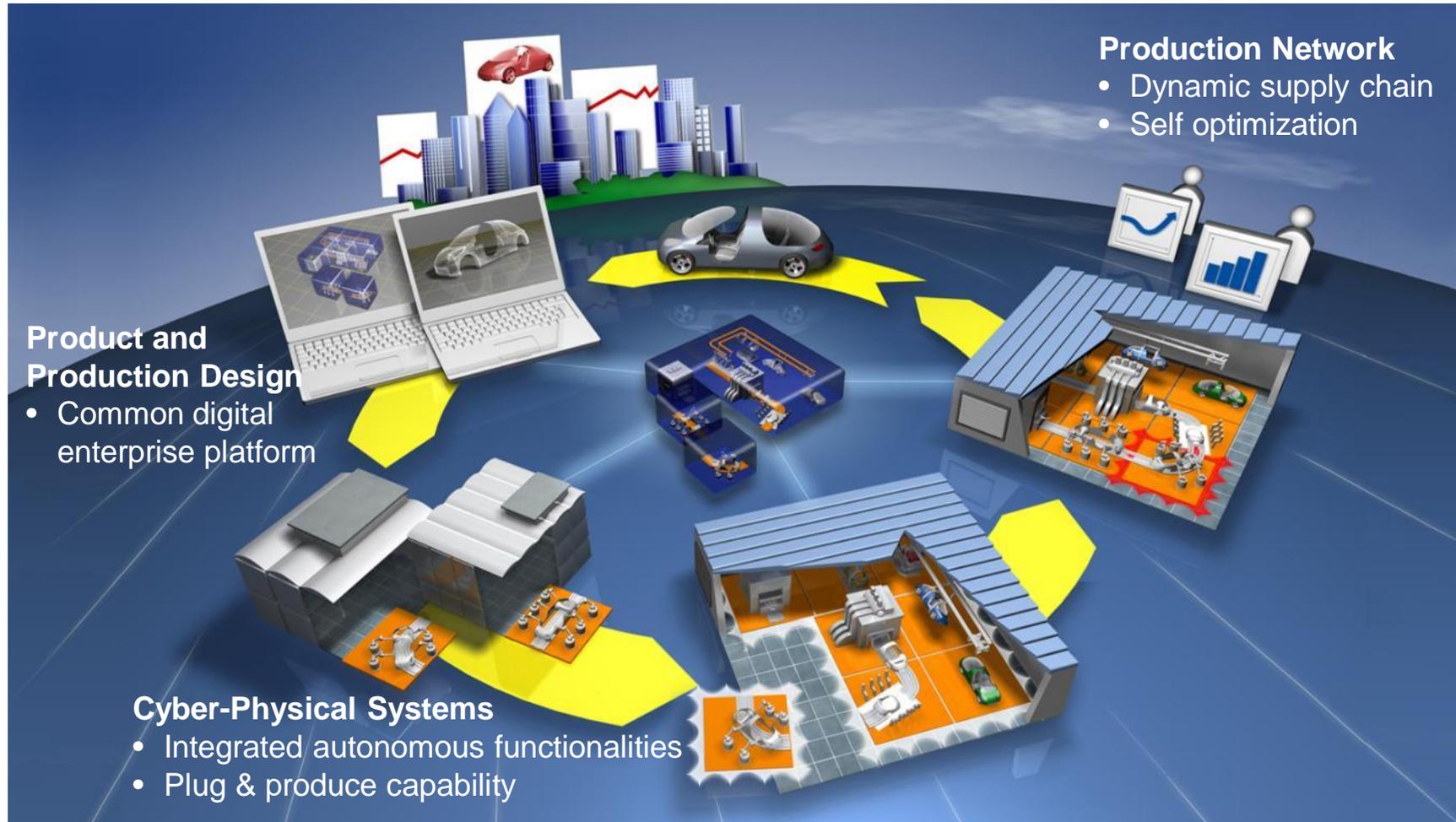

Before OPC UA

Features with OPC UA

- Multi Vendor Interoperability

- Secure, Cross Platform Protocols and Generic Services

- Semantic Interoperability – More than a protocol

- Enabler for Industrie 4.0 and Internet of Things

Call for actions

- Define information models for various industrial domains

- Synchronize with standardization committee

- Facilitate Industrie 4.0!

Source: OPC Day Europe 2014

Page 19   August 2014   Corporate Technology

Industrie 4.0: Faster time-to-market, increased flexibility and reduced complexity

Production Network
- Dynamic supply chain
- Self optimization

Product and Production Design
- Common digital enterprise platform

Cyber-Physical Systems
- Integrated autonomous functionalities
- Plug & produce capability

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Thank you for your attention.

Questions and remarks are welcome!