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Web of Systems – Vision, Challenges, & Practices

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Outline

Vision

- What is WoS and why it's the future of industrial IoT

Challenges

- Challenges from legacy systems

Practices

- Our solution and examples from lab and real projects


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Vision

Vision vs. Reality

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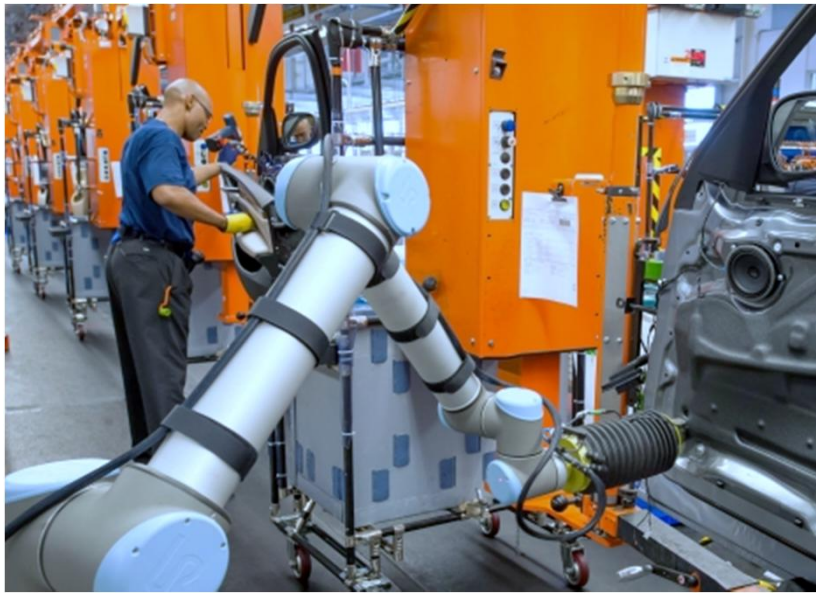
Machines and workers jointly work on assigned tasks



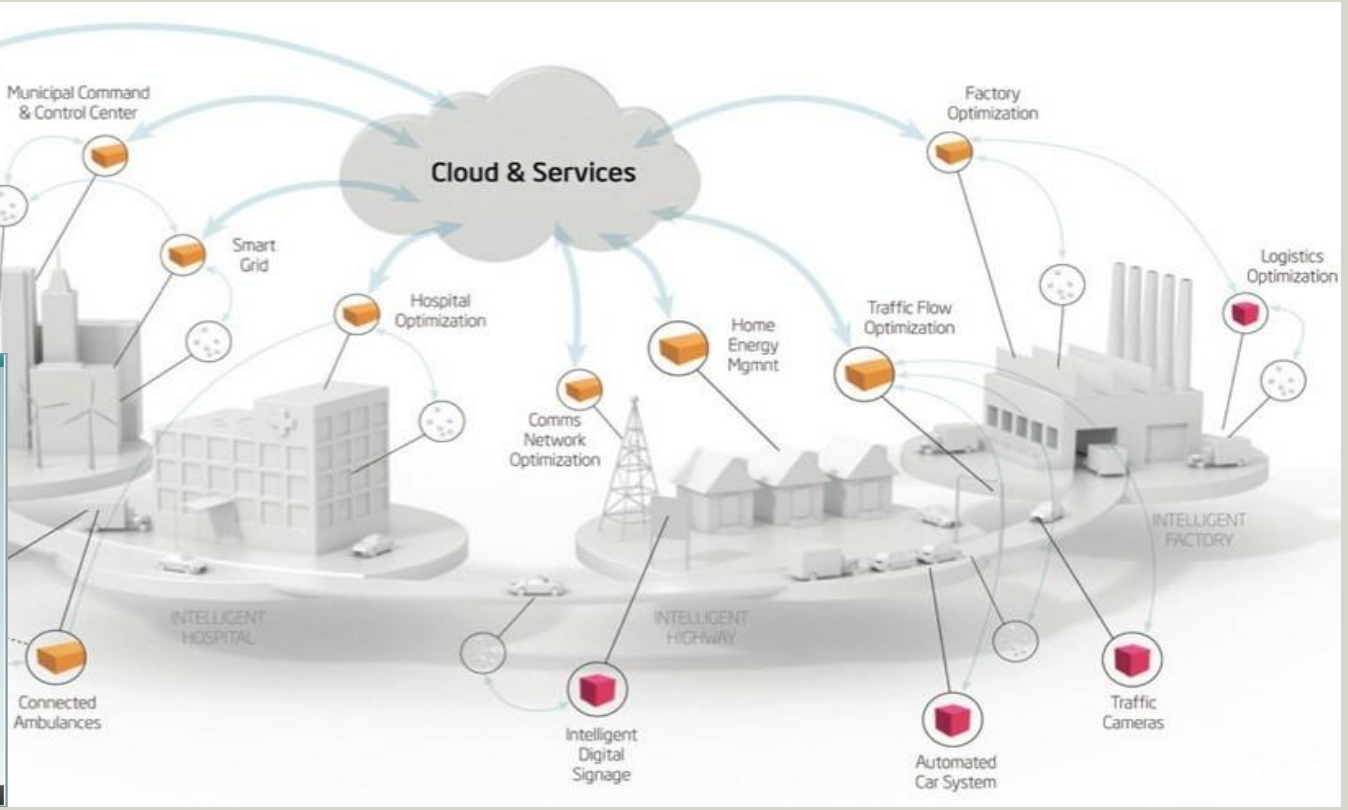
Vision

Prep-programmed machines confined in fenced area

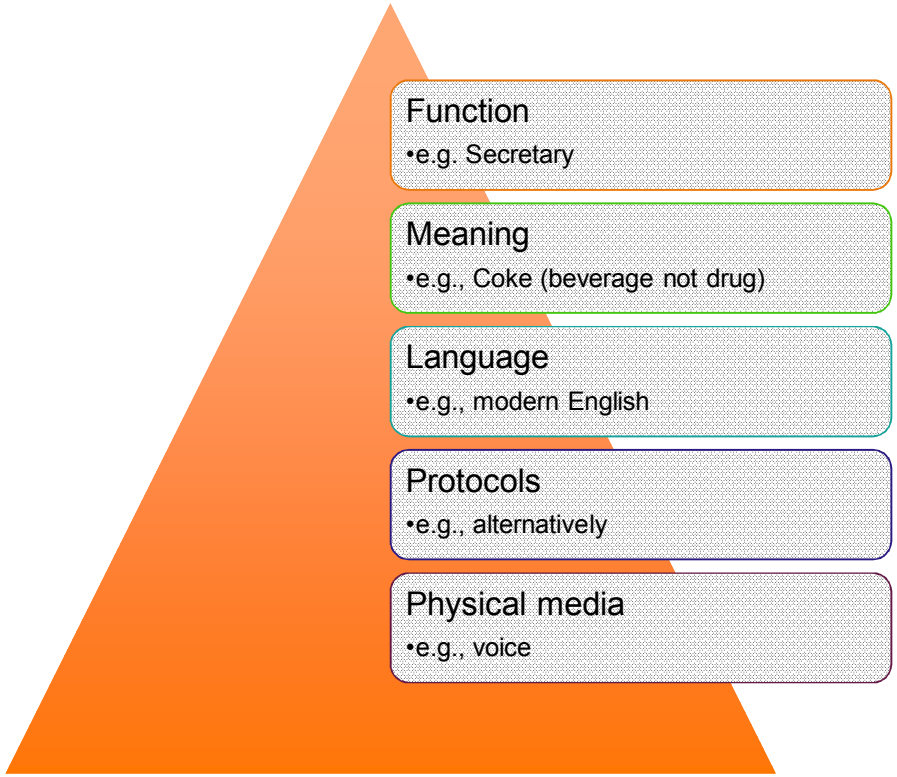
Reality

How to Solve the “Human NOT in the Loop” Problem?

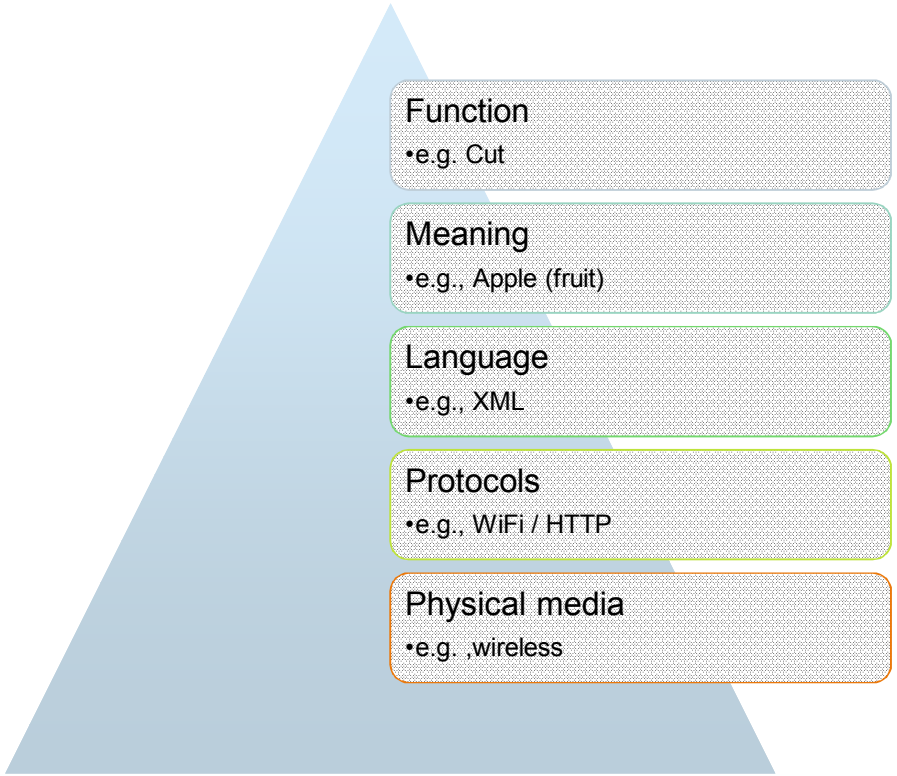
Human in the Loop
Cloud + IoT = Big Data



How Can Machines Collaborate Autonomously?

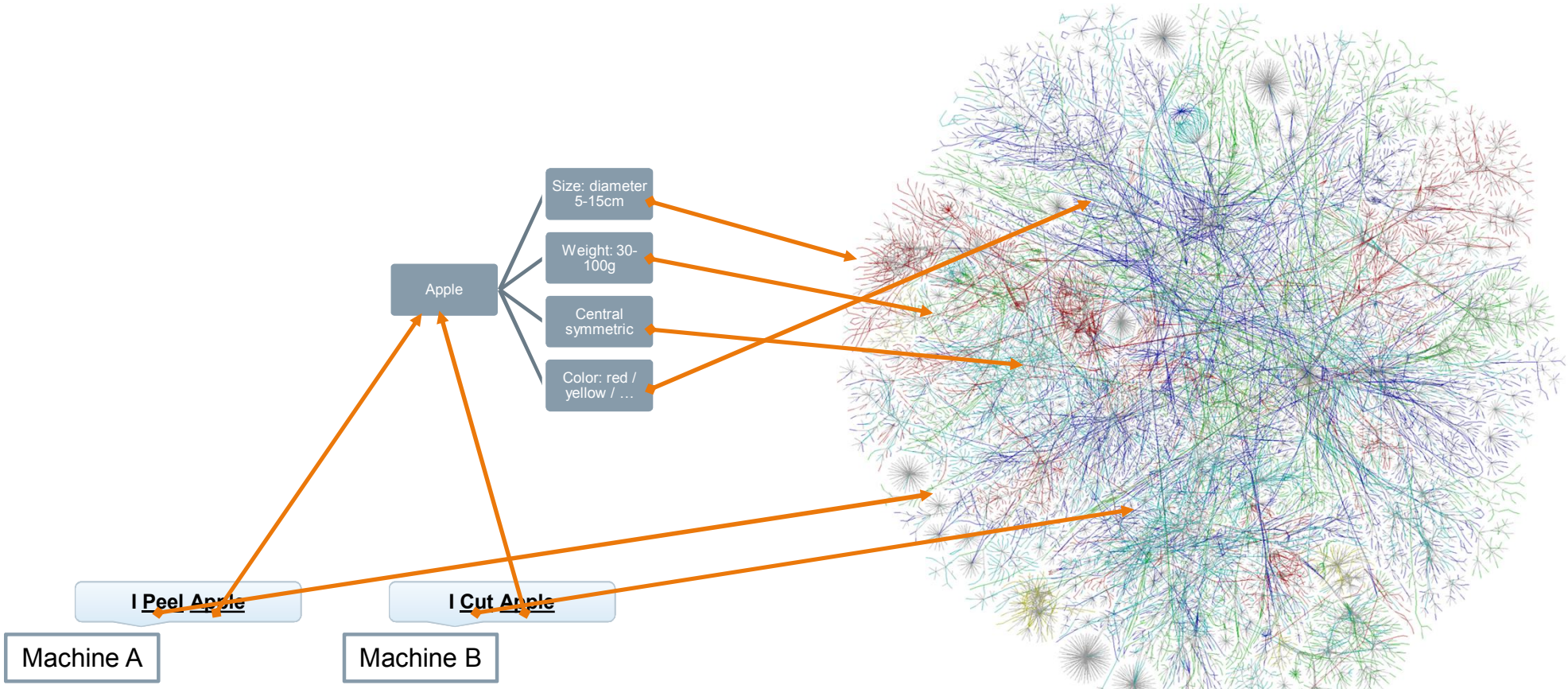


Man



Machine

Primer of Semantic Web



Context Driven Interaction

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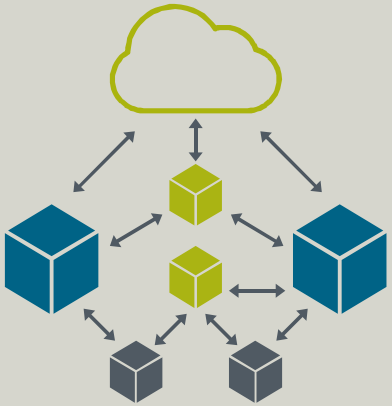
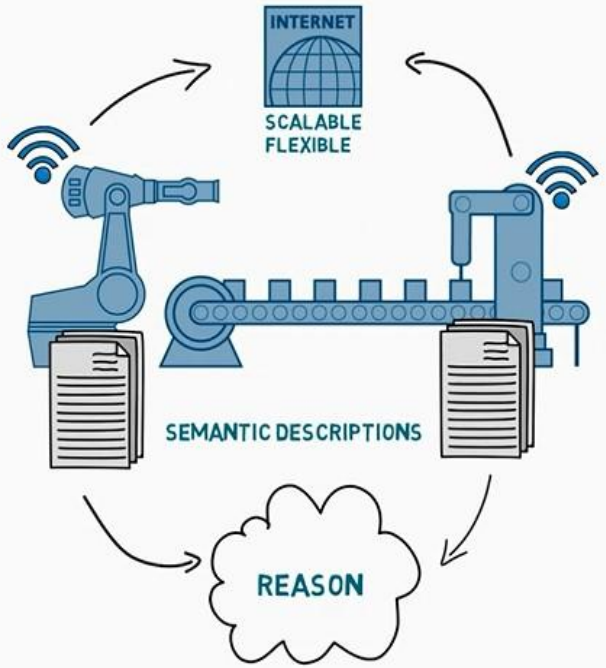
Semantic Interacting Devices



Interacting devices

Distributed **interacting autonomous devices** negotiate and coordinate processes

- Task driven system interaction is possible
- Semantic technologies are one cornerstone
- Functional Profiles are key enablers
- Industrial Standards are crucial



Additional Ingredients for Autonomous System

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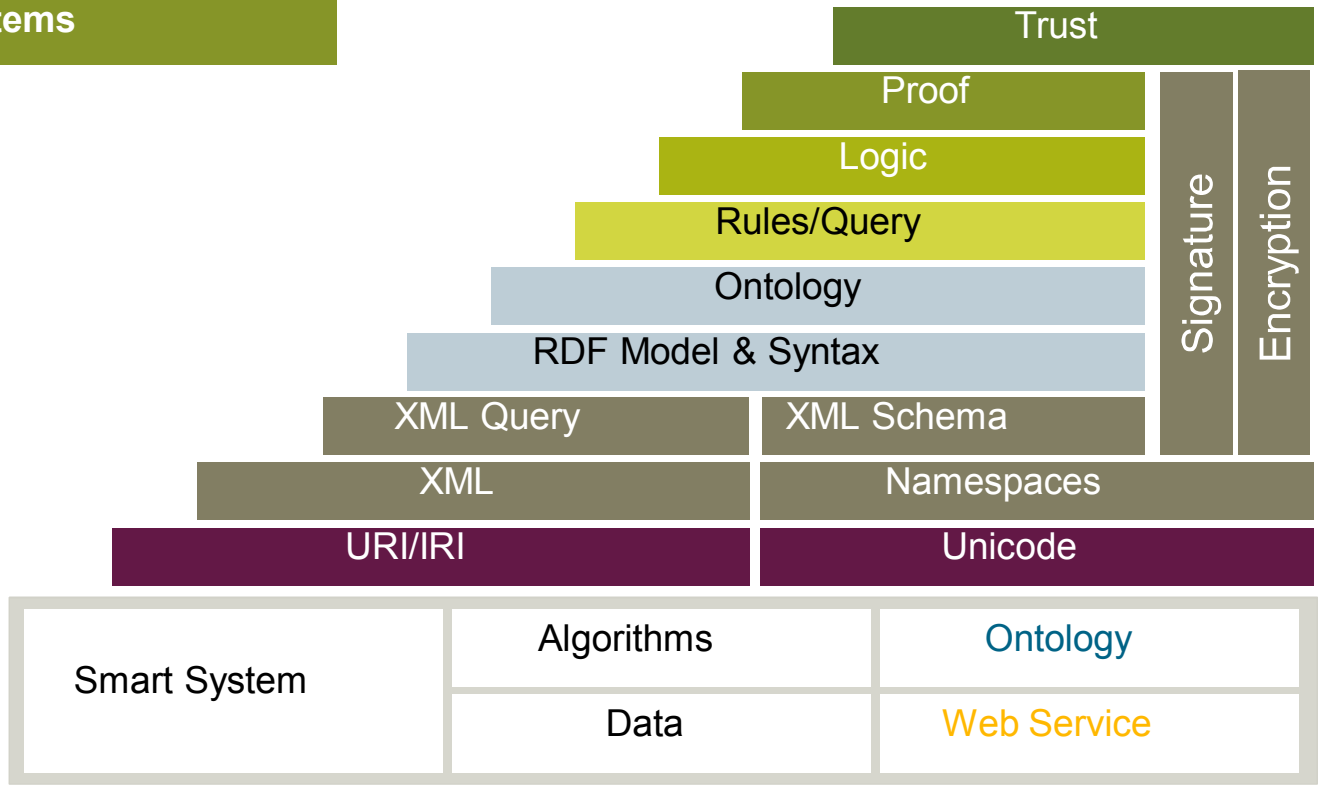
Autonomous System
Smart Systems + Web = Web of Systems



Web of Systems – Complete Formula

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Ubiquitous communication

- Internet
- Web/2.0 technologies

+

Smart networked devices

- Autonomous
- Interacting
- Local analytics
- App-enabled

+

Domain context

- Domain-specific requirements
- Cross-domain integration
- Semantics

=

Web of Systems

WoS combines web technologies with smart networked devices and domain context A device

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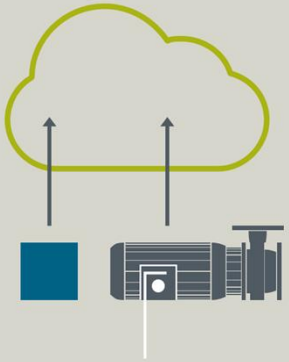
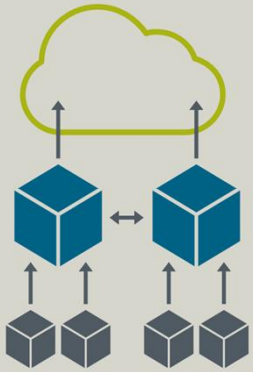
Connected devices



IP connected devices supply "**big data**" to cloud based **data analytics**

Improved **asset analytics** and **process optimization** by streaming data analysis

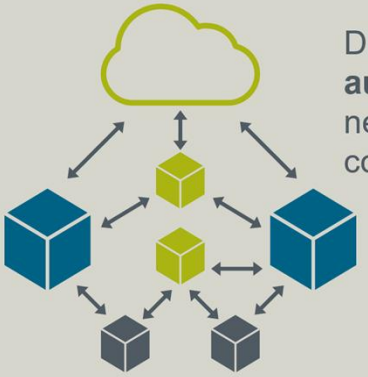
Smart devices



Web enabled smart devices provide local **automation, analytics** and other **services**

Local decision making at the point of influence for **operation fidelity**, **scalability** and **data ownership protection**

Interacting devices



Distributed **interacting autonomous devices** negotiate and coordinate processes

Maximum structural **flexibility** and **robustness** in complex, large-scale distributed **systems**

App-empowered

Highest functional flexibility and evolution over device and system lifetime

Challenges

Huge Installation Base of Legacy Systems to be Converted

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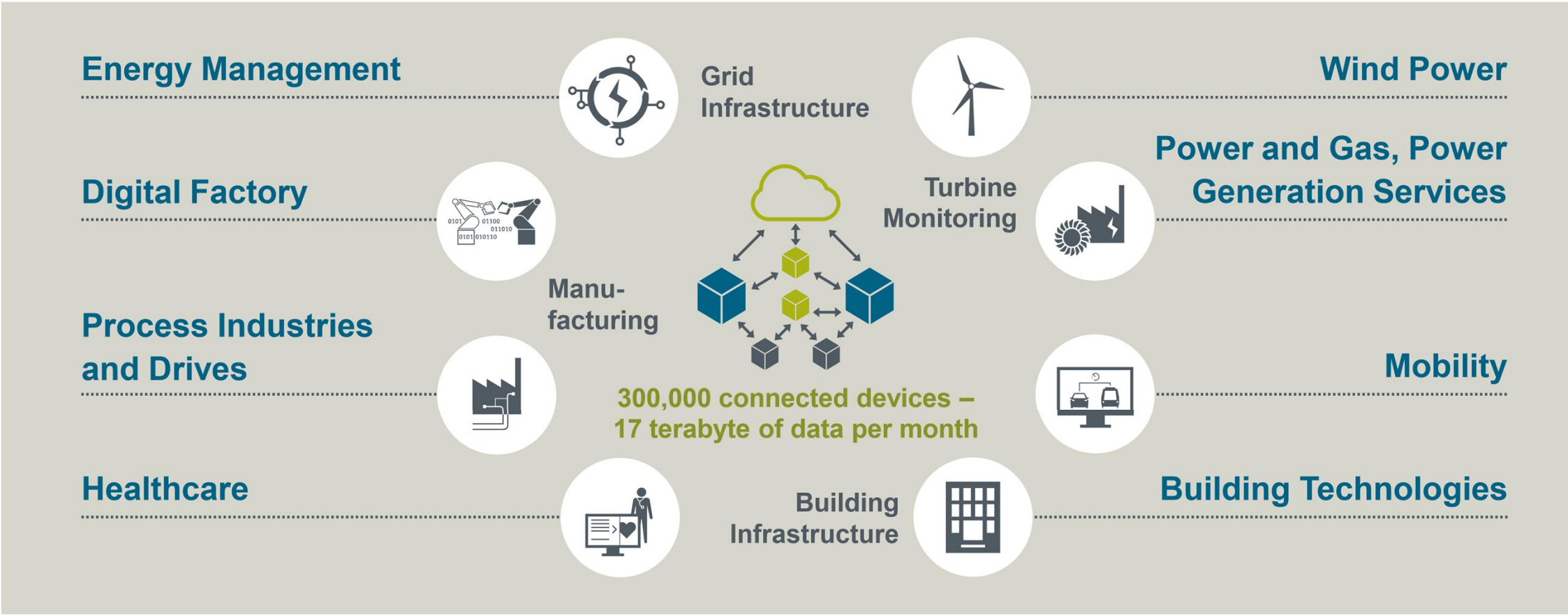
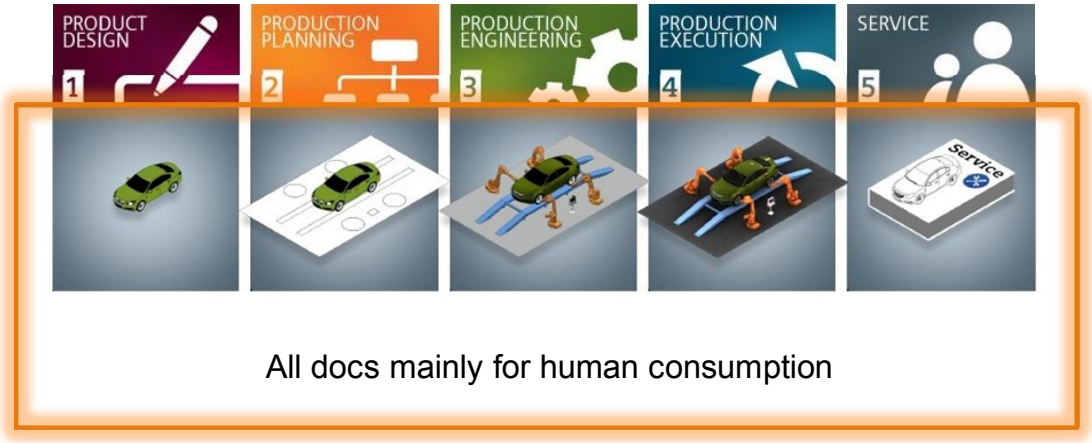
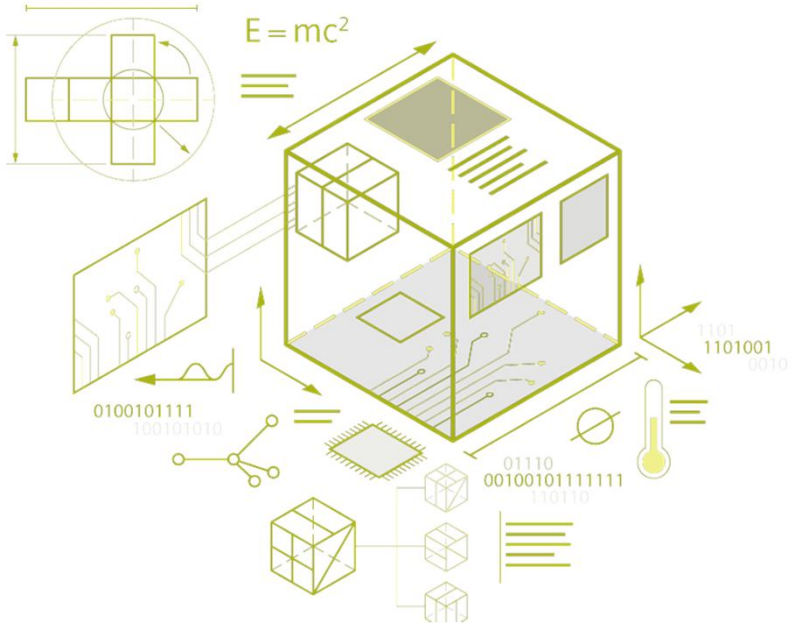


Challenge: From Recording to Manifesting



All docs mainly for human consumption



Challenge: Siloed Systems

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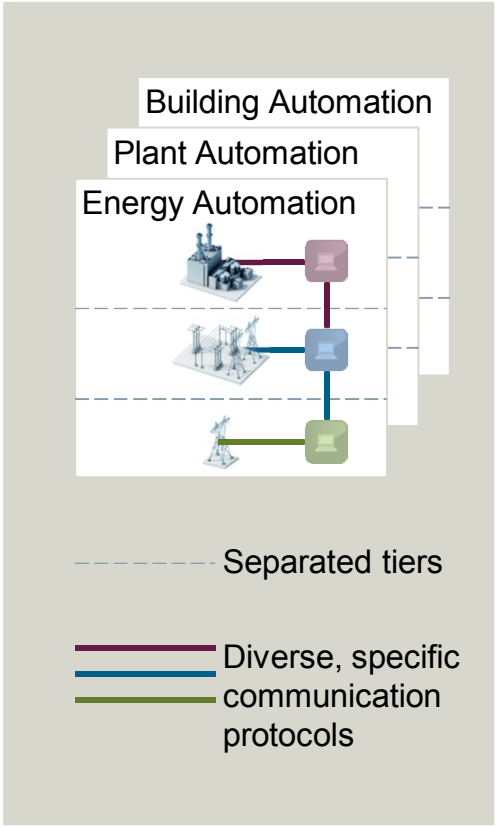
- Separated tiers in different systems
- Dedicated and domain specific communication
- Heterogeneous and
  low-level data representation
- Non-uniform access to devices and information
- Difficult cross domain integration



Challenge: Data Acquisition

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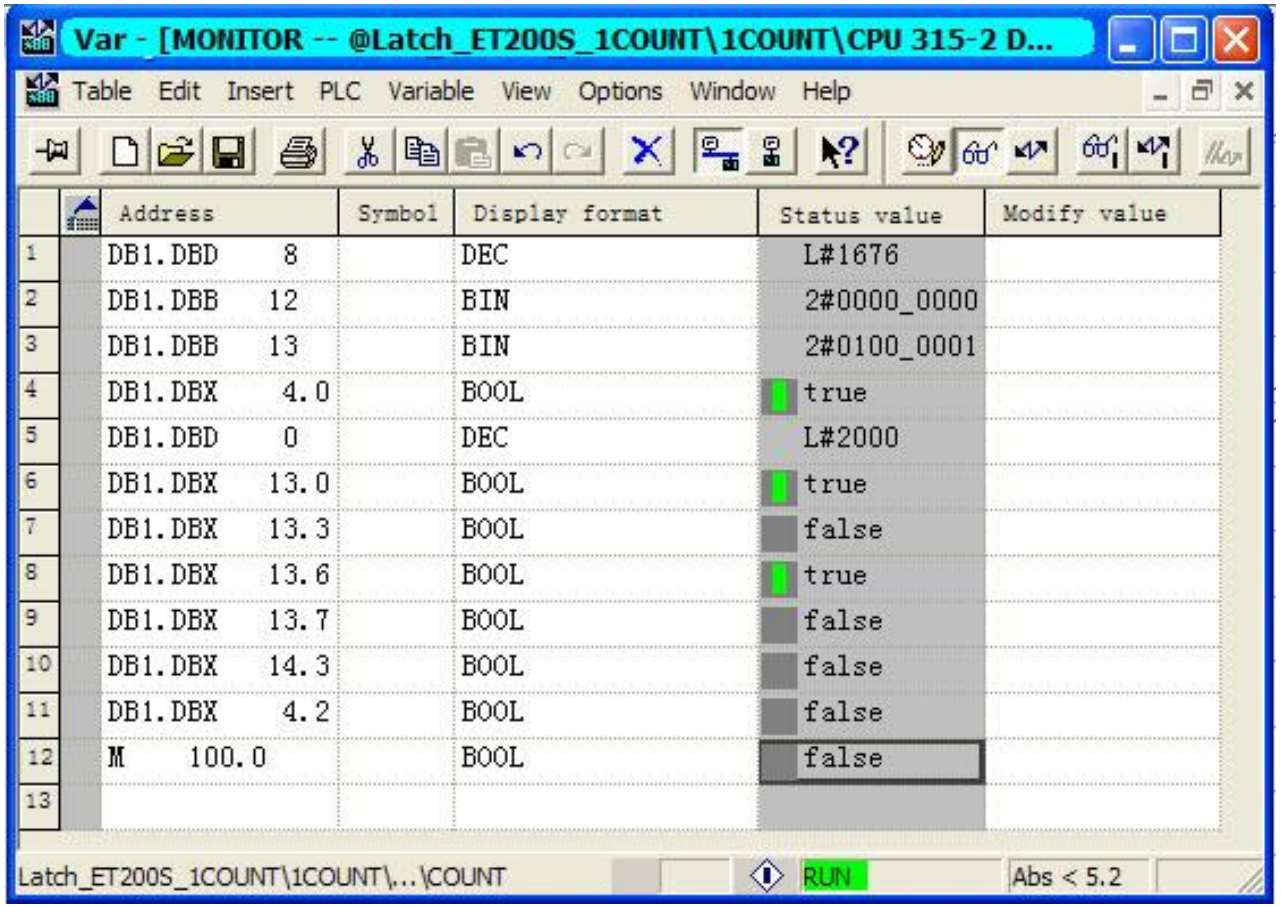
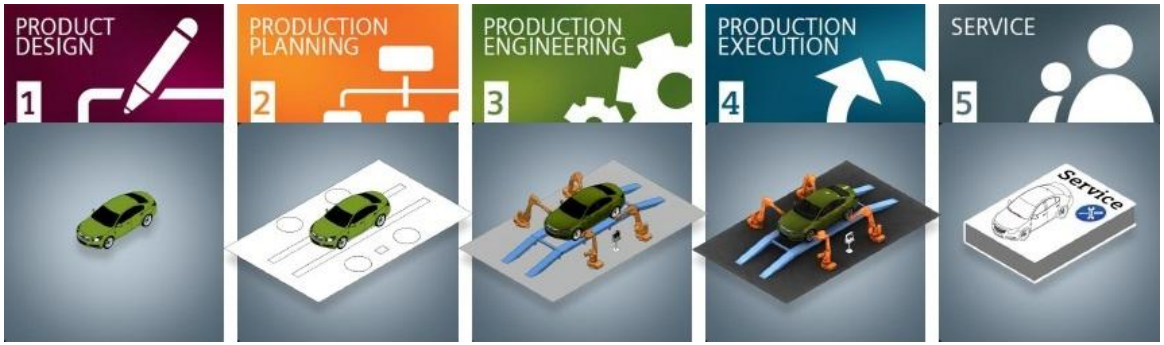
Legacy systems are not designed to share field data to external world

- Is the physical interface accessible?
- Does the field controller allow data to be uploaded?
- Is data encrypted?
- What is the communication protocol to share the data?
- …



Challenge: Meaning of Data



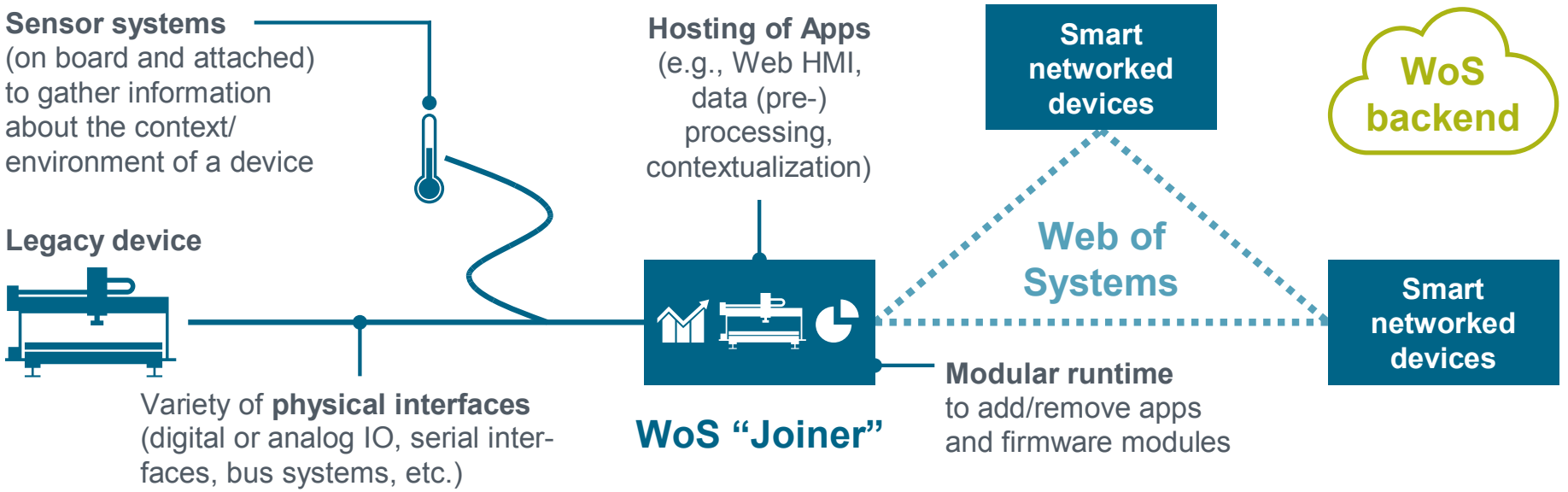
- Documentation may reside in different stakeholders
- Archive of some documents may be lost
- Source code may not be delivered to end user

- Unit of the data “Speed”?
- How are data sources related?
- How is the system configured?
- …

Datablock1

		Name	Data type	Start value	Retain	Visible in ...
1		Static				
2		Singlemotor	"Motordatatype"			
3		Statusword	Word	16#0		
4		Motorrelease	Bool	false		
5		Motor_turn	Bool	false		
6		Turn_right	Bool	false		
7		Turn_left	Bool	false		
8		Error_message	Bool	false		
9		Speed	Real	0.0		

Solution: Web of System Joiner Help Migrate Legacy Devices



And More Challenges … to Bridge Physical and Cyber Objects

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…	C-P mapping	Security	Data sovereign	Standardization	…

Examples

Examples

Web communication of busses and charging boxes as standardized in ISO/IEC 15118

Web access for all stakeholders to belonging parts of the system

- High performance charging interface for electrical busses uses CCS charging interface for EVs
- 12 installations are in pilot operation (Hamburg, Stockholm, Goteborg, Montreal, …)
  - Output power: 300 kW
  - Output current: 550A
  - Charging duration: 6 min/Bus

ICE Water

“ICeWater”: optimized water network operations

– **Smart devices:** Online monitoring of water infrastructure supported by smart sensors and smart metering

– **Interacting devices:** Enables energy optimization, leak detection/localization and asset/customer management

– **Interacting devices:** Decision support making use of contextualized smart data

– **App-powered devices:** Easy integration of new smart sensors and Apps

– **Cross domain integration:** “Smartification” of legacy sensors

Intelligent Secondary Substation

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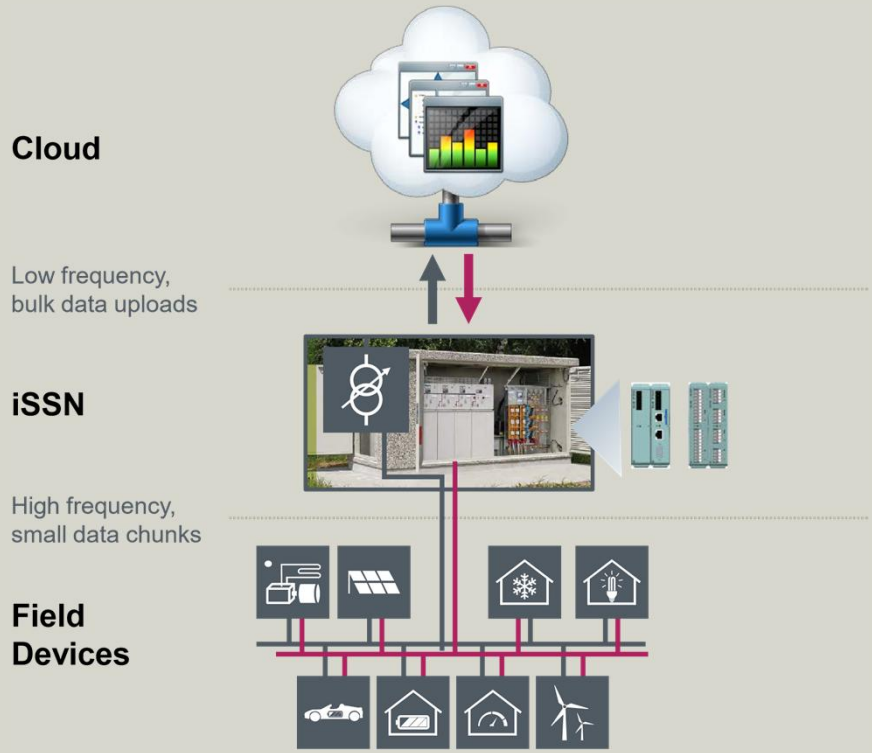

Web Technology in distributed monitoring and control

- –Cloud: Data center provides permanent bulk storage for planning-related use cases and hosts cloud applications
- –iSSN: Smart Devices work with downloadable applications. It controls transformer to keep voltage level in tolerable band
- –Field devices: Small sensor nodes provide limited storage for temporary connection loss buffering and local aggregation operations
- –Dashboard: Provides access to local data, monitoring of connected field devices, configuration of iSSN

Smart Freight Wagon

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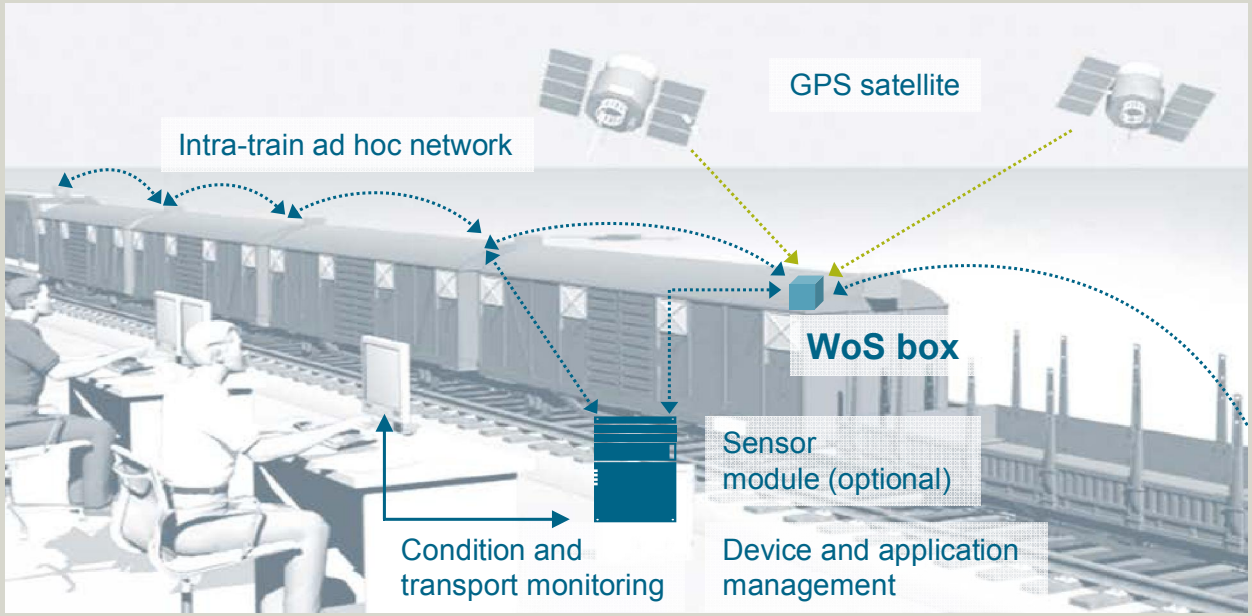


"Smart Freight Wagon"

– **Smart devices:** WoS box; Measures global position and collects/analyzes data from sensor modules, communicates to cloud, thereby making the wagon smarter

– **Interacting devices:** Intra-train ad hoc network [1]; e.g. capable of understanding and describing the whole train, including wagon sequence, thereby making the wagons interacting devices

– **App-powered devices:** WoS box to host applications such as freight document app, wagon service information app, rail track condition monitoring app, thereby making wagon an app powered-device

Example: Machine Tool Status Acquisition

Current (Ammeter)

Vibration (Accelerometer)

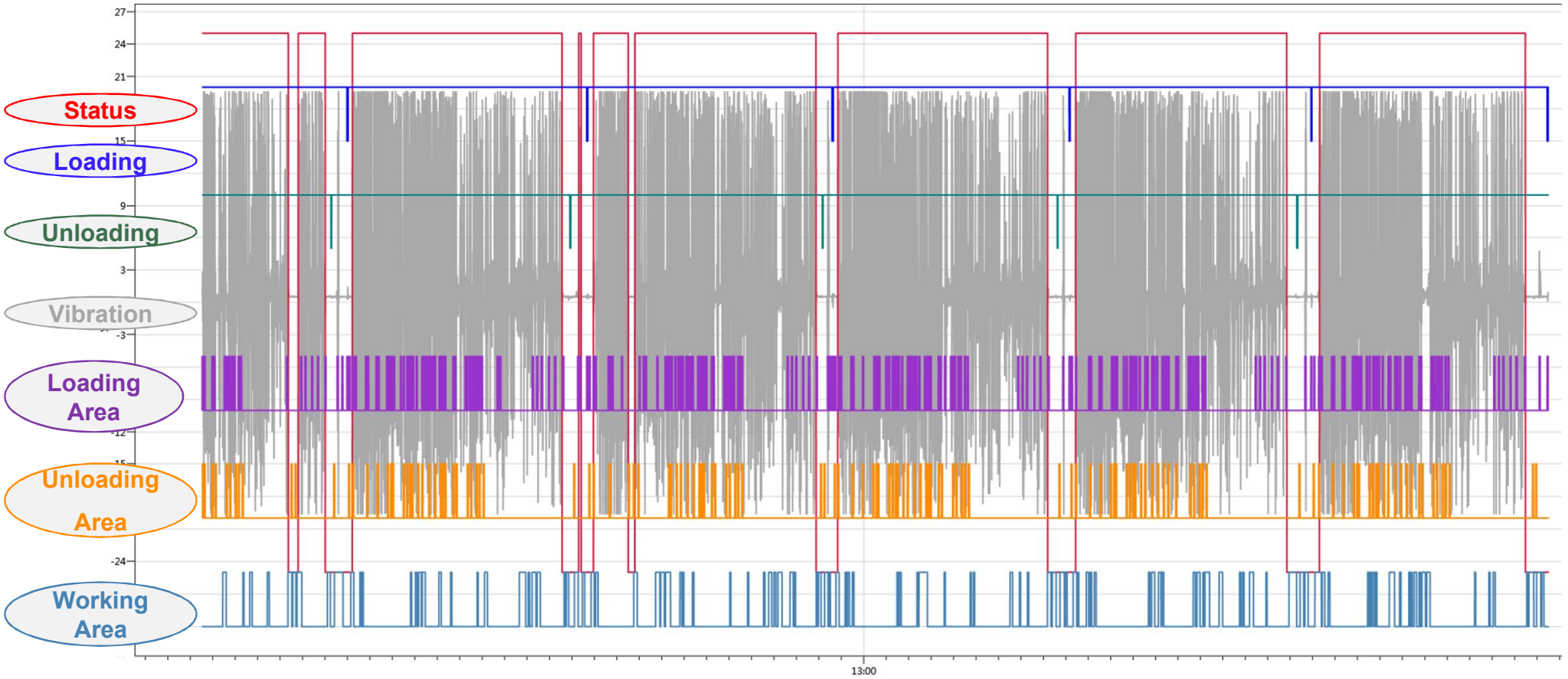
Loading / unloading (Photodetector)

Worker presence (IR sensor)

WoS Gateway

MES

Status Analysis



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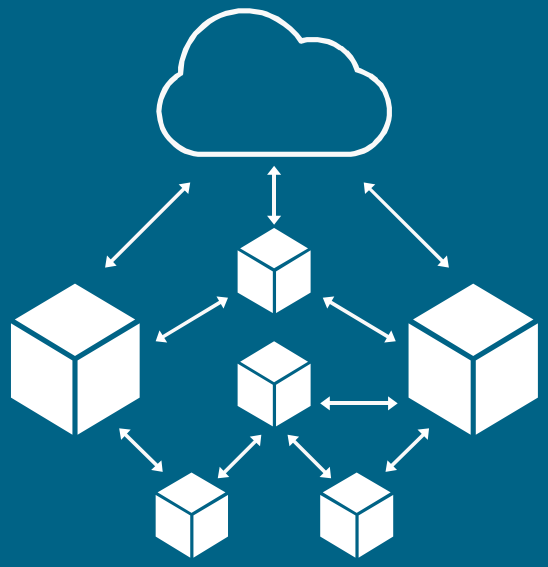
Web of Systems



Summary

- Web of Systems – Smart networked systems for industries and (critical) infrastructures
- Device centric and system aware approach supporting digitalization and automation
- Applying proven and widely used Web/2.0 technology and semantics within and across domains
- Sovereignty on value creation: The customer flexibly decides on data processing and automation as application anywhere
- Investment protection and migration of the installed base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Vision

Thanks

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