DEVELOPMENTS IN MATERIAL HANDLING AND AUTOMATION

Rotterdam, May20th, 2015

Detlef Spee

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AGENDA
DEVELOPMENTS IN MATERIAL HANDLING AND AUTOMATION

- Introduction to the „4th Industrial Revolution“
  - Megatrends of the future
  - What is the 4th Industrial Revolution – “Industry 4.0”?
- Examples for upcoming Industry 4.0 products/solutions
  - Industry 4.0 technologies
  - Industry 4.0 for software products

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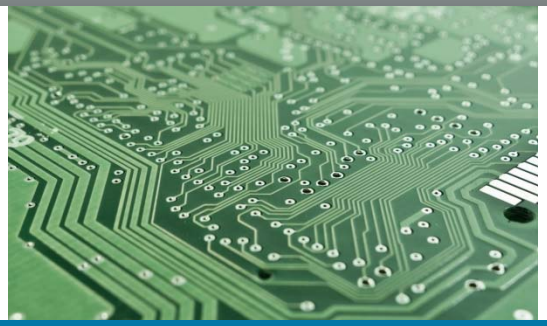
Wandel und Entwicklung - die Geschwindigkeit nimmt zu

Gesellschaftlicher Wandel



Globalization, Individualization, Social Media, Demographic Change, Urbanization & Climate Change …

Technological Advancements


Automatization, Mikrosystemtechnik, Web 2.0, Smartphones, Sensor-tecnology, 3D-Printing, Internet of things, Big Data, 4. industrielle Revolution

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Megatrends of the future
Theses

1

The business environment is becoming faster and more turbulent

2

The amplitude and frequency of the influencing factors are increasing

3

Systems are growing in complexity and the processes in business and production environments are speeding up

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Megatrends of the future
Theses

4

Complex systems have to be made manageable for people

5

Integrated and intelligent logistics and IT systems guarantee economic success: Data and information flows through industry and trade without direct human interaction

6

New services and products are possible because of more advanced technologies

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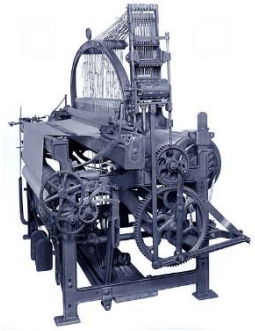
The „4th Industrial Revolution“



First mechnical weaving loom by Edmund Cartwright
(Source: Deutsches Museum)

Insertion of machines into the production processes

end of the 18th Century

Workers at band-conveyor at Ford in Michigan
(Source: Hulton Archive / Getty Images)

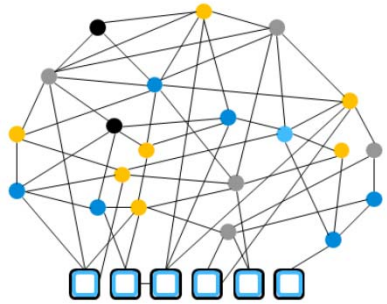
Insertion of work-sharing mass production(taylorism and fordism) via electricity

start of the 20th Century

First PLC: Modicon 084
(Source: openautomation)

Insertion of electronics and IT for further automation of mass production

start of the 70ies (20th Century)



Cyber-Physica-Systems „CPS“-based automation
(Source: VDI)

Insertion of cyber-physical systems for decentralised decision-making

today

Source: DFKI (2011)

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The „4th Industrial Revolution“ (Industry 4.0) causes for far-reaching changes




characteristics	Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0
trend of society	basic supply	mobility, energy	consumption, economy	individuality
product	one of a kind	standard products	mass products	individualised products
organisation of work	workshop	factory organisation, flow production	robot controlled production	autonomic, decentral production
the machine‘s part	strengthener of humans	pulse generator	doer	decision maker
the human‘s part	craftsman, „artist“	specialist	machine controller	administrator, decision maker
idea of system design	reproducibility	mass, standard, scaling	quality, efficiency	autonomy, flexibility, cooperation
locating of knowledge	human	human, process	production system, human	network, human
unlearned things	manual manufacturing	function of the whole	manufacturing technology	?

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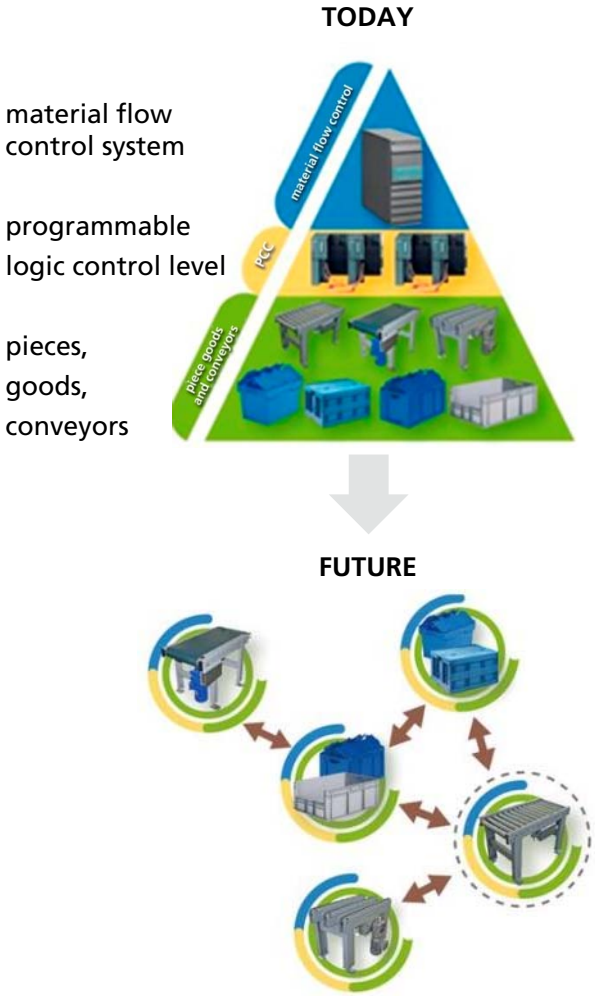
Definition of Industry 4.0
Solution Components: Networks



- Adaptable, needs-based, and decentralized networks
- Cyber-physical Systems (CPS)
  - Development of (data) standards and guidelines
  - CPS for material flow, production, and transportation
- Multiagent Systems (MAS)
  - Self-controlling multiagent systems consist of programs (software) that are virtual representatives of containers, vehicles, machines, and so on
  - Agents negotiate decisions based on defined rules

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Definition of Industry 4.0
Solution Components: IT Tools

- Powerful and manageable IT tools for people (assistance systems)
- Full real-time transparency through the use of sensors throughout the entire network
- Modular software
  - Apps
  - Business Objects (for example, LogisticsMall)
- Knowledge-based systems and Big Data (Decision Support Systems)
- Virtual experimental opportunities and automated planning environments (for example, through the use of online simulation)

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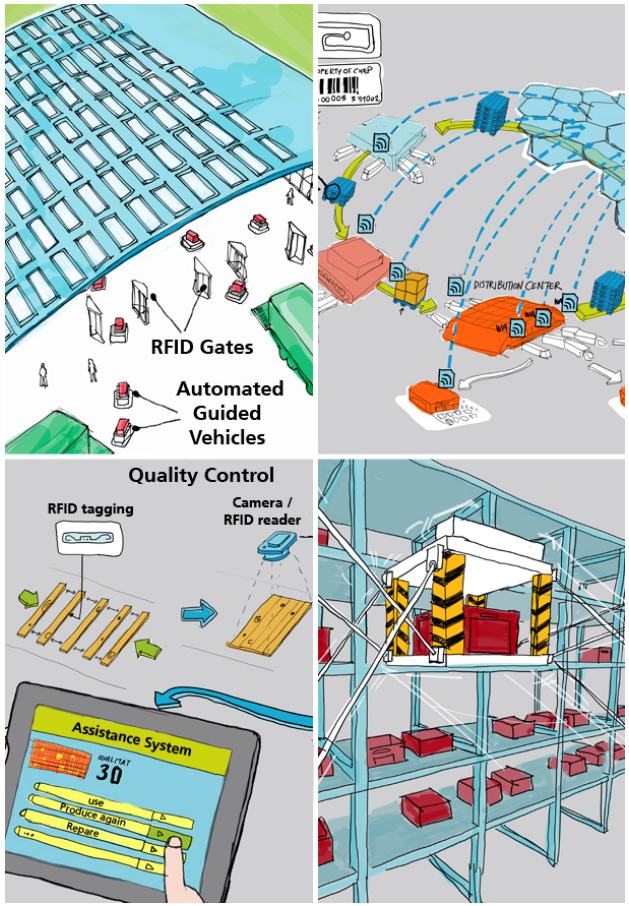
Definition of Industry 4.0
Solution Components: Technological Innovations



- Technological innovations that are flexible in location, performance, and functionality
- Modularity and interface standards at all levels
- Mobile factories and logistics locations
  - Inner and outer flexibility of the infrastructure
  - Temporary relocation and/or reconfiguration of processes, resources, and buildings
- Highly flexible zero investment locations
  - Client-neutral factories and logistics parks
  - Infrastructure with defined interfaces
  - Multimodal connections
- Cooperative technological components (physical and Human Machine Interfaces)

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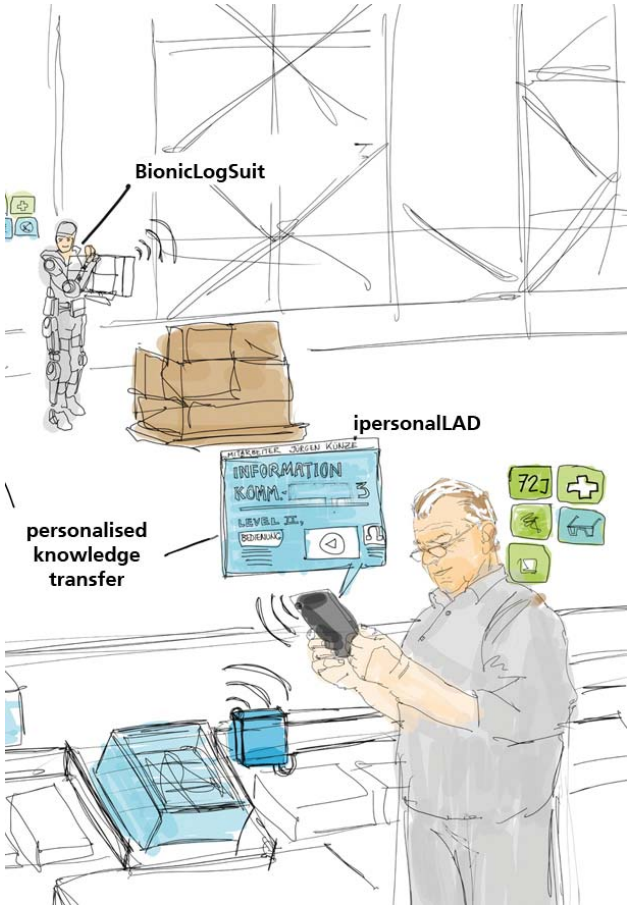
Definition of Industry 4.0
Solution Components: People



- Productive employees in the value added chain
- Ergonomic design of workstations – adapted to suit the needs of the individual
- Individualized Human Machine Interfaces, processes and procedures, and training programs
- Customizable assistance systems (expands what the person is able to do)
- Work systems tailored to the available technology and the regional skill level
- Adaptability of the company through the use of adaptable personnel structures
- Companies with fixed pools of employees / Reduction in part-time and temporary workers
- Automated workforce planning for the entire company based on the characteristics and skills of the employees

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Definition of Industry 4.0
Conclusion: Flexibility for the loss of determinism

- Current situation: Orchestration (centralized control e.g. traffic lights)
  - Needs predictable future
  - Quick reaction on new requirements is hardly possible

- Control and behavior of Industry 4.0 systems is no more deterministic nor predictable

- Future situation: Choreography (decentralized control e.g. roundabout)
  - Cooperation of autonomous entities
  - Swarm behavior

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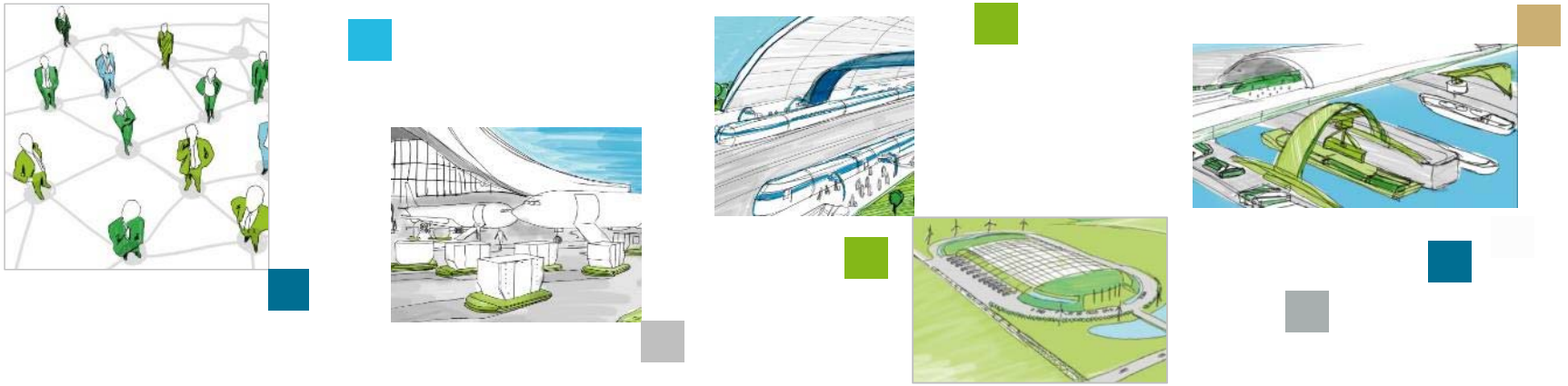
Definition of Industry 4.0
Conclusion: Individualization

- In the future, there will be less firmly and permanently installed infrastructures
- That will facilitate application–specific adjustments of intralogistic systems as they are necessary under the banner of eCommerce and one piece flow



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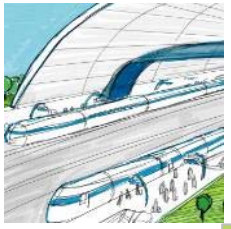
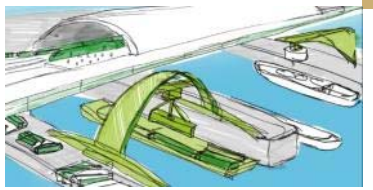
Definition of Industry 4.0
Conclusion: Decentralization · Self-Control · Self-Organization

- The degree of decentralization and self-organization increases with the complexity of the systems!
- New hardware and sensor technology facilitate new, less expensive and autonomous Cyber-physical Systems (CPS). An intelligent design of CPS leads to their seamless migration into existing logistic environments







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LOGISTIK UND IT ZUSAMMENDENKEN!

The connection between information technology (IT) and logistics has the greatest potential for the sustainability of the industrial and logistics location of Europe.

It is therefore the central strategic demands of logistics to take a clocking leadership in computer science and in the development of information technologies.

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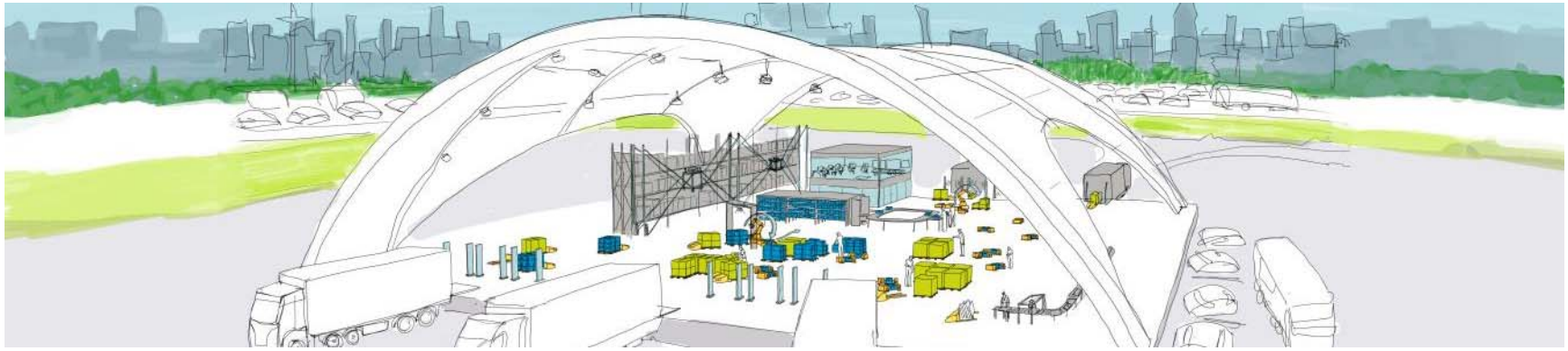
Definition of Industry 4.0
Vision «Factory of the future»



The factory of the future

- Connects the virtual world of data with the physical world of goods
- Is highly connected with customers, suppliers, and the entire factory network
- Adapts online, quickly, and optimally to the fluctuations in global demand that arise from a wealth of product ranges and risks
- Uses open structures and configurations for its space, technology, and personnel

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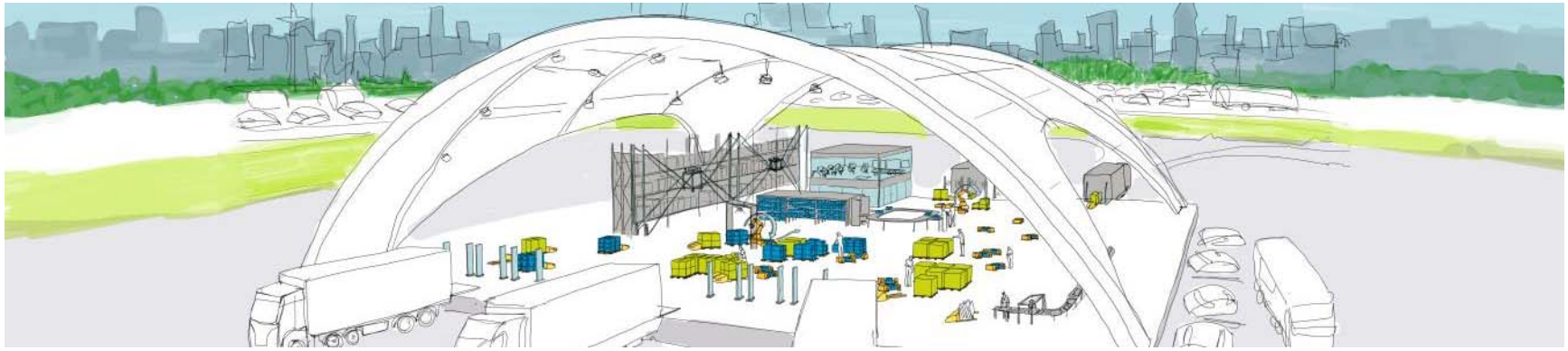
Definition of Industry 4.0
Vision «Factory of the future»



The factory of the future

- Connects individual solution components (plug & play components) to autonomous, adaptable structures
- Reduces management complexities in all areas (connecting autonomous components, automating decisions, assistance systems)
- Acts largely autonomously and independently when performing detailed planning of manufacturing programs

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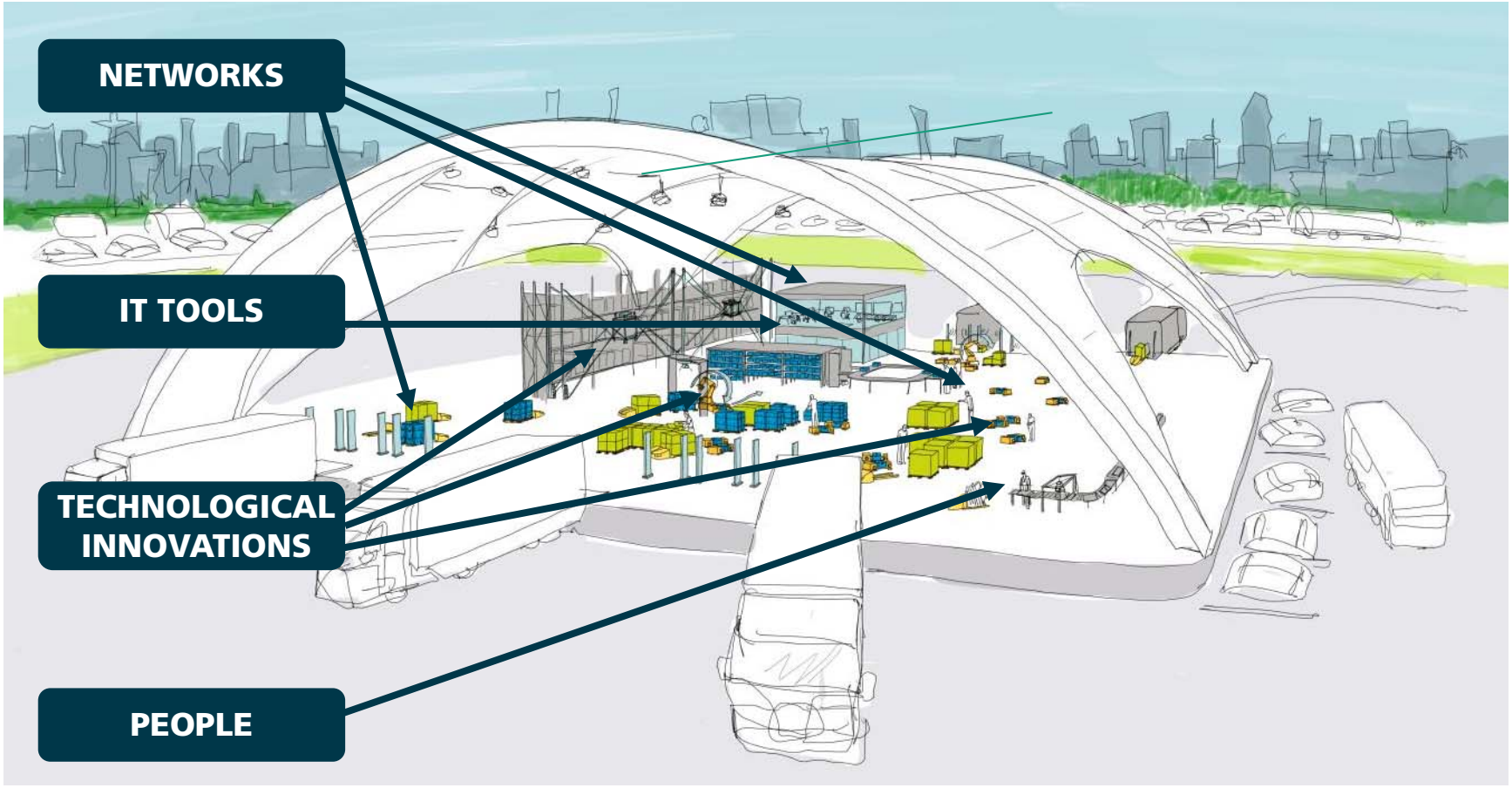
Definition of Industry 4.0
Solution Components «Factory of the future»



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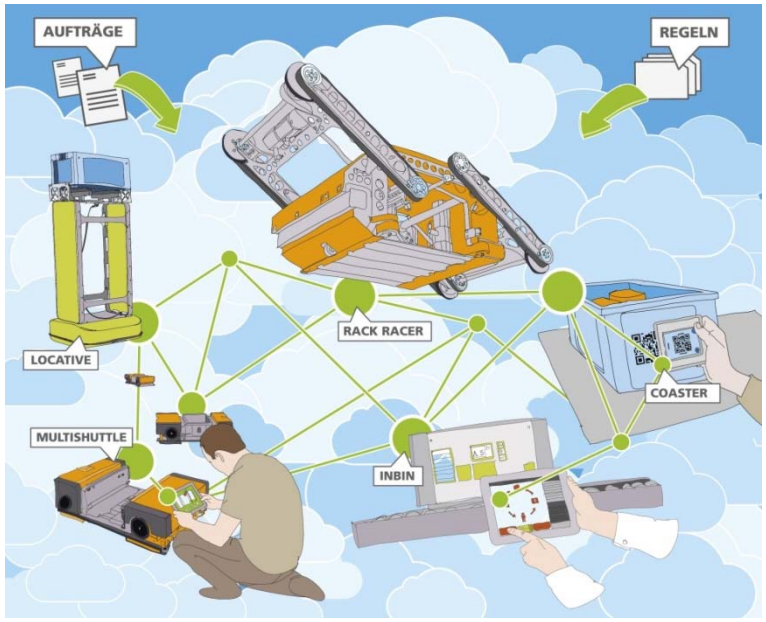
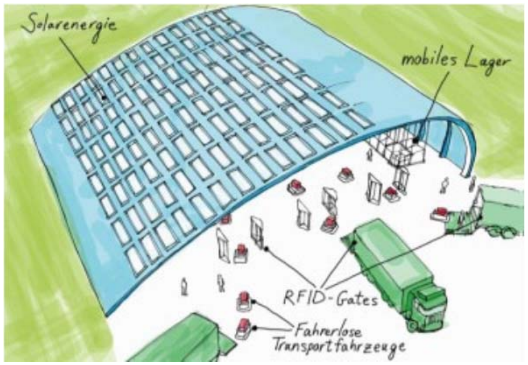
Material Handling will change
Vision for a Hub2Move

The vision of Hub2Move is the realization of material flow systems for the physical distribution of goods that may be in a location easily adapted to changing requirements and which can become easily implemented at another location, to fulfil the changed functional performance





Thus, arrangement and configuration of Material flow systems will become elements of the short- and Medium logistics planning and optimization In the future

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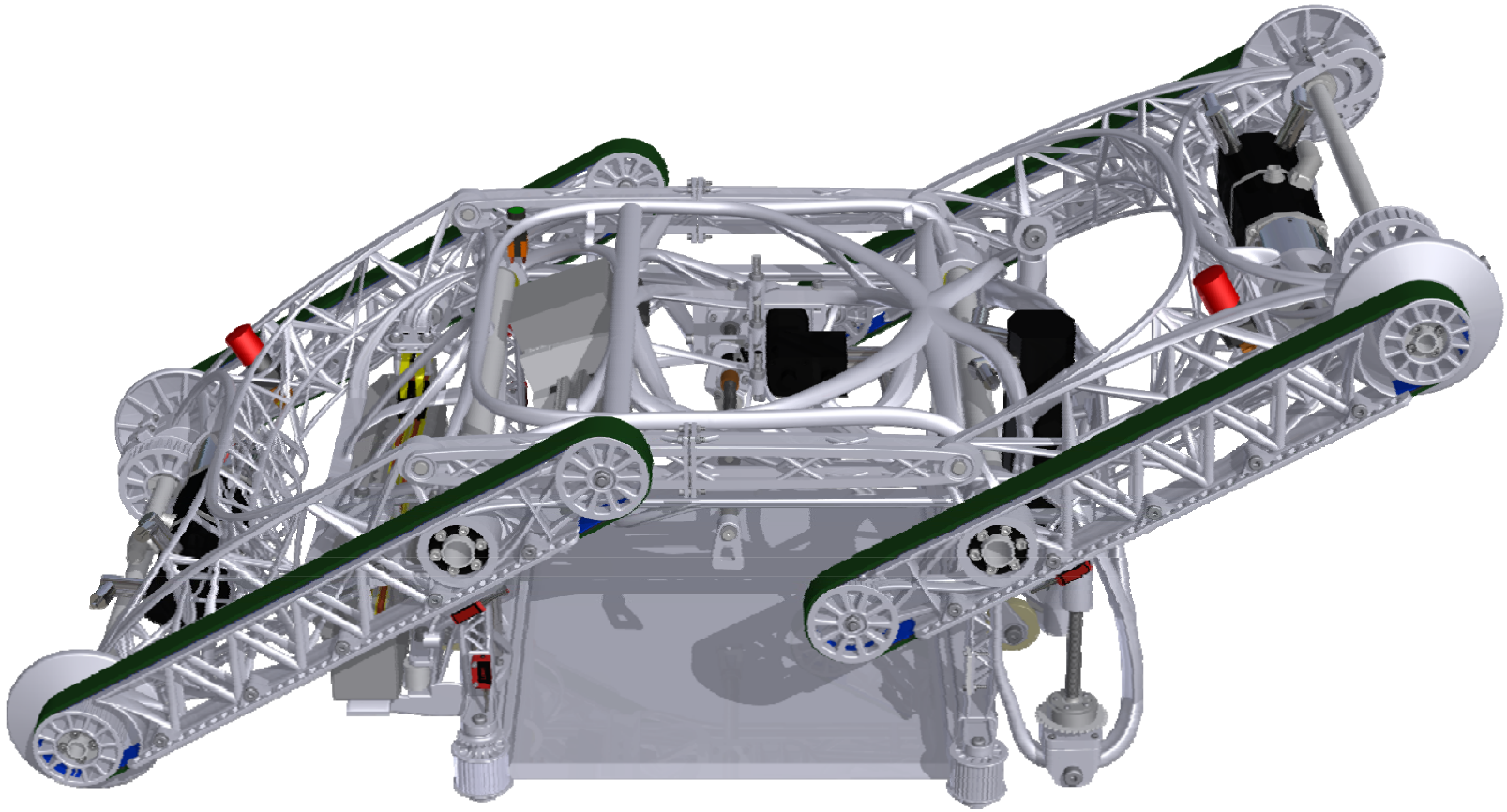
Rack Racer · autonomous climbing in the rack
Diagonal moving · bionic funcional design · 3D-Printing



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Examples for Industry 4.0 technologies
Serva: Automatic driving/parking system at Duesseldorf Airport

Ray im Einsatz am Düsseldorfer Flughafen

Eine Entwicklung für:

serva transport systems

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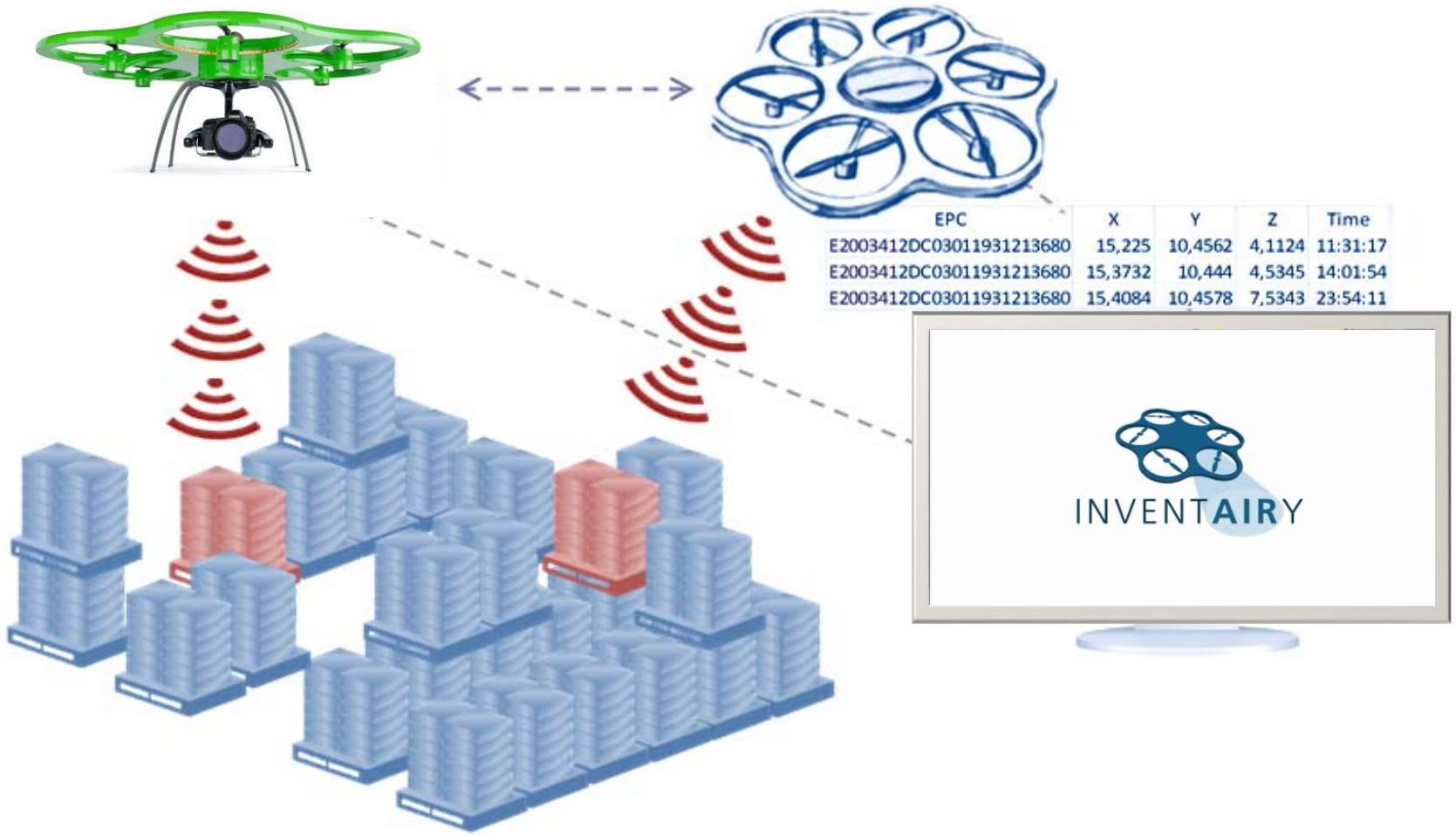
Examples for Industry 4.0 technologies
INVENTAIRY · autonomous flight to check the inventory



Gefördert durch:
Bundesministerium für Wirtschaft und Technologie

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Research Consortium

Manufacturer

AIBOTIX

Research & Development

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universitätbonn ais

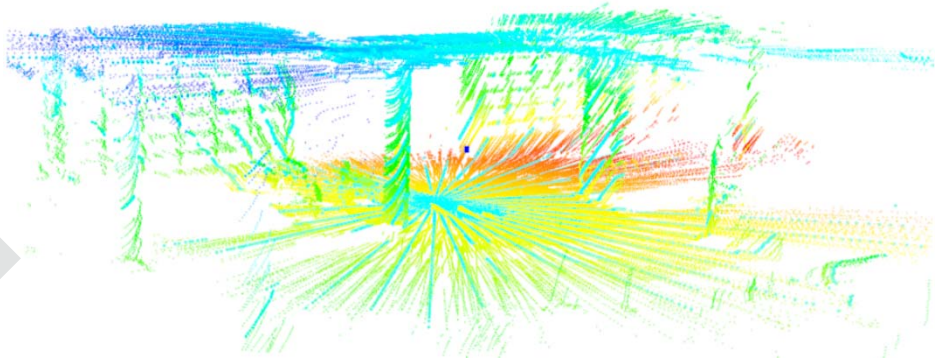
Users

Wiedmann

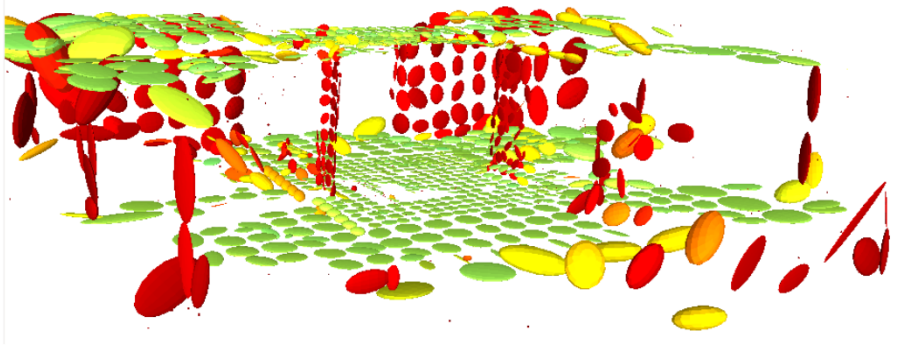
Panopa

Mapping and detection of the enviroment

INVENTAIRY



universitätbonn ais



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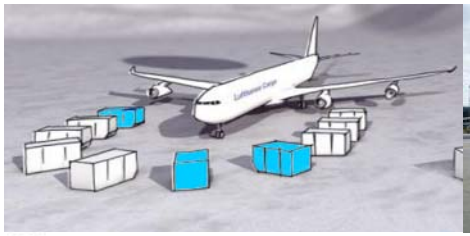
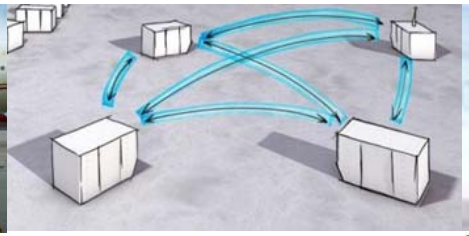
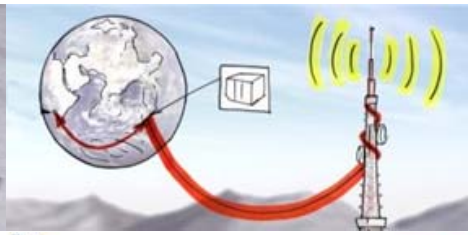
Examples for Industry 4.0 technologies
DyCoNet · smartULD - Container becomes «intelligent»

- Integration in existing airport IT systems
- Recognizes flight mode
- Multi agent system for the global autonomous network control, use of Ad-hoc networks for container-to-container-communication
- Energy self-sufficient function by energy harvesting
- Environment data will be gathered by sensors, alarms will be set off and transferred to the control panel (Telematics)



Lufthansa Cargo
Networking the world.

jettainer
WORLD CLASS ULD MANAGEMENT

PalNet
AIR CARGO PRODUCTS

enocean

INNOTEC.

Bundesministerium
für Bildung
und Forschung

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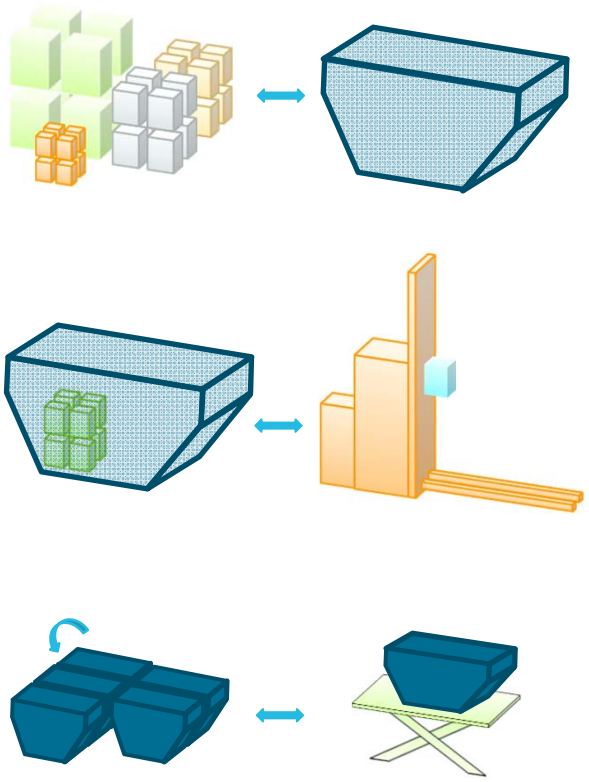
Examples for Industry 4.0 technologies
DyCoNet communication concept



- communication with the **comprehensive IT network**
  - GSM
- communication of the **goods** and the ULDs
  - RFID (UHF EPC Gen2)
- communication of the ULDs with conveying devices and infrastructure
  - Short range wireless
- communication among each other and with the loading means

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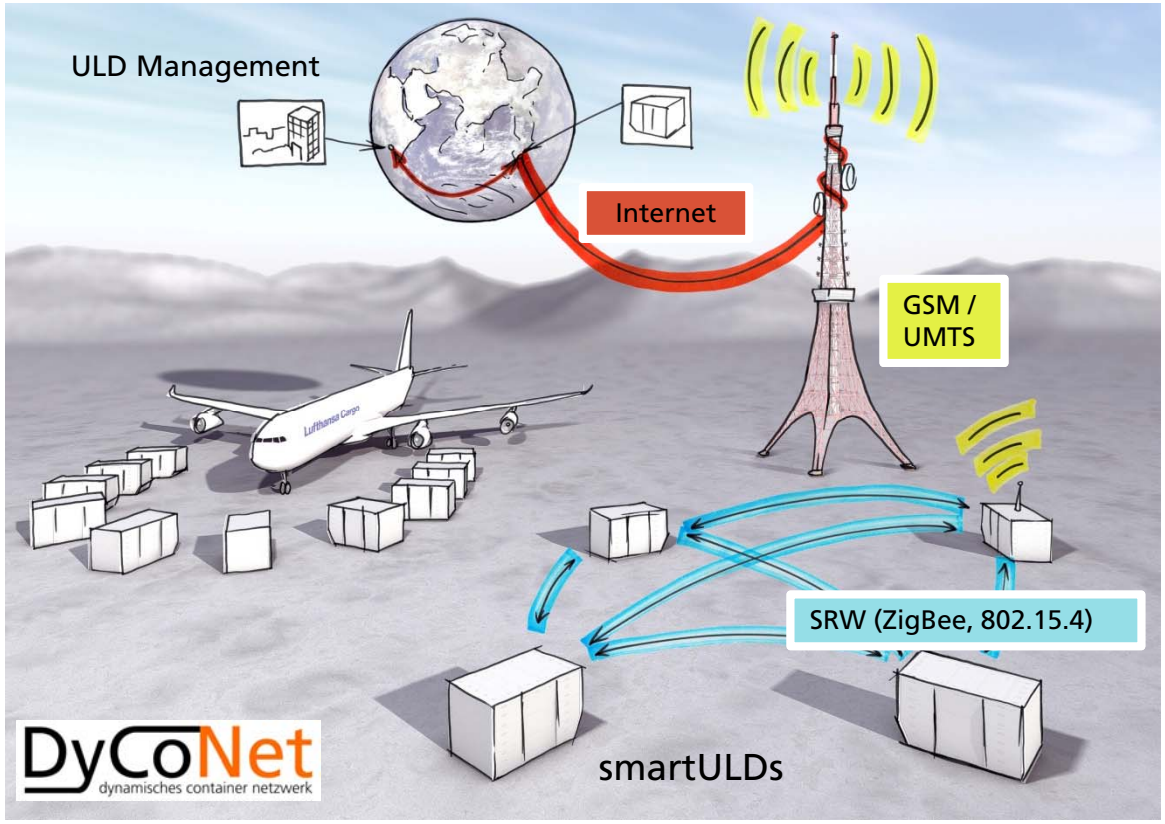
Examples for Industry 4.0 technologies
Smart air freight containers (smartULD)



DyCoNet smartULDs…

- collect environmental data with sensors, trigger alarms autonomously
- interact with IT-networks (e.g. ULD management)
- build **local networks** of charge carriers via short range wireless (SRW)
- order transports to a destination (loading devices, aircrafts)
- use energy harvesting

Gefördert durch:
Bundesministerium für Wirtschaft und Technologie
aufgrund eines Beschlusses des Deutschen Bundestages

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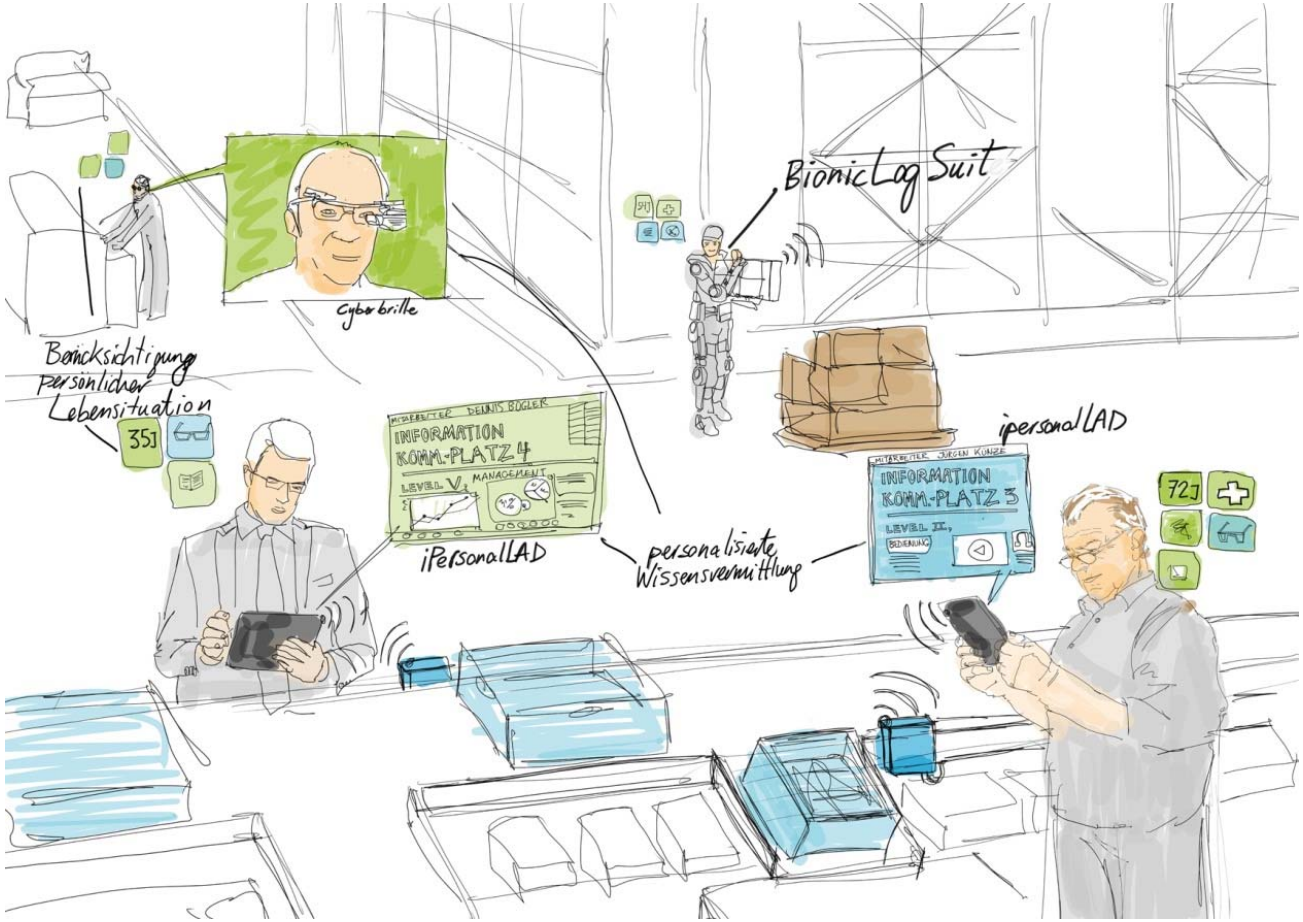
Examples for Industry 4.0 technologies
Human-Machine Interfaces - «People on focus»



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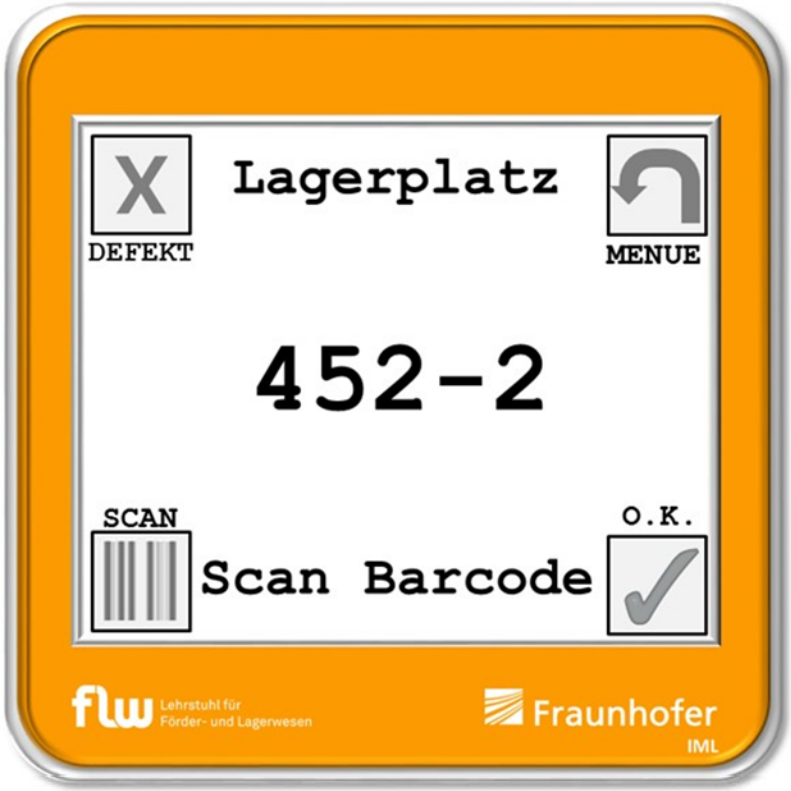
Examples for Industry 4.0 technologies
Human-Machine Interfaces - COASTER

The really important things in life
fit on a beer mat!



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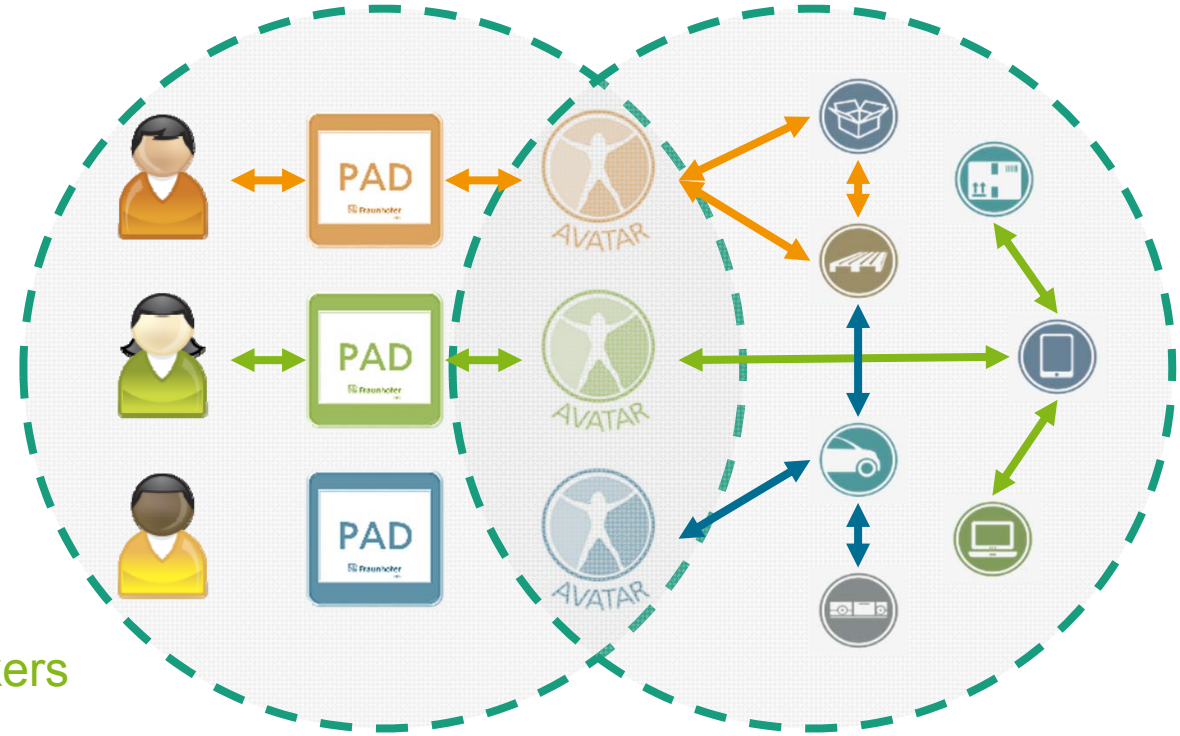
Examples for Industry 4.0 technologies
Humans and machines in joint Social Networks



Human workers

CPS

Interact, check, control

Real-time capable control

«SOCIAL MEDIA»

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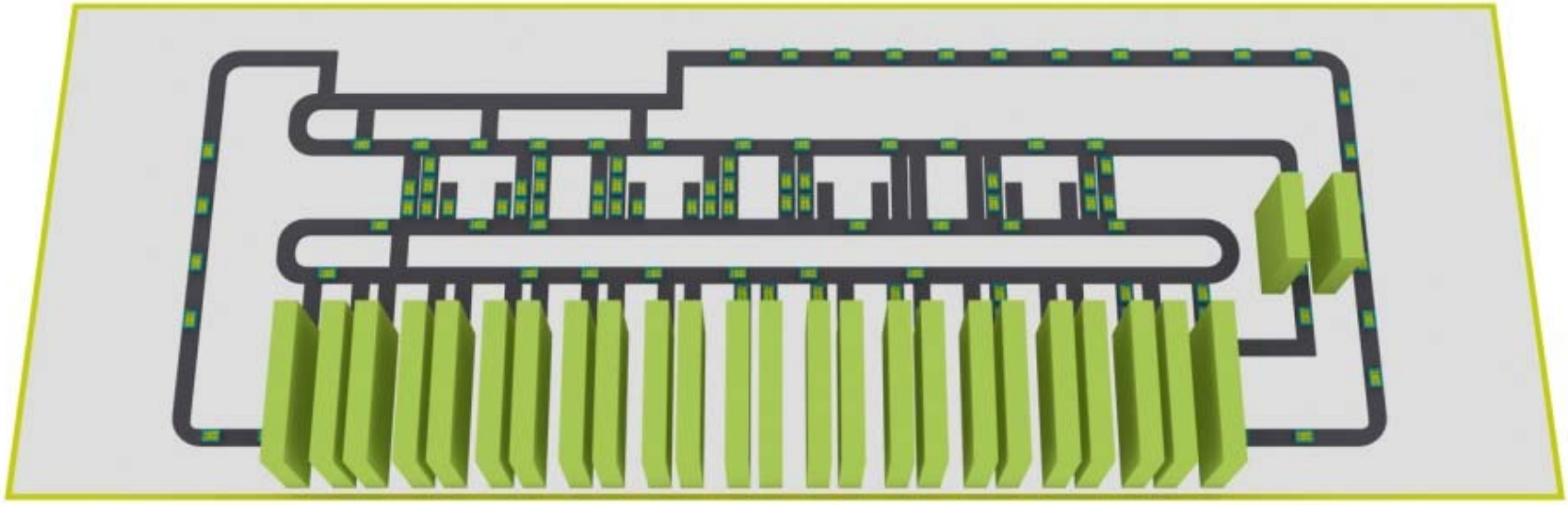
Examples for Industry 4.0 technologies
Cellular Transport Systems

Today´s distribution center



limited

unflexible

expensive

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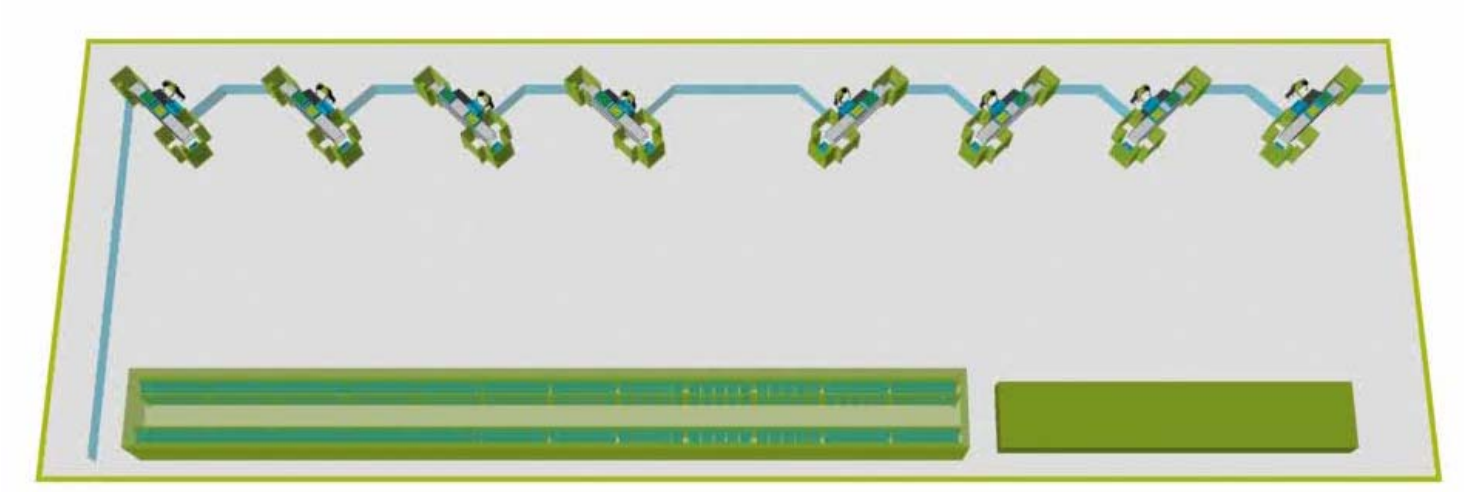
Examples for Industry 4.0 technologies
Cellular Transport Systems



1) Removing static conveyer systems (e.g. roller conveyors)

2) Replacing those conveyer systems by a set of autonomous, mobile robots with transport capabilities (e.g to transport bins)

Examples for Industry 4.0 technologies
Cellular Transport Systems

A Cellular Transport System is based on a swarm of autonomous transport-vehicles.

Swarm Intelligence enables the creation of a collective that interacts and cooperates amongst each other in order to solve complex tasks.

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Examples for Industry 4.0 technologies
Cellular Transport Systems

- Autonomous behaviour
- Multimodal chassis
- Decentralized control architecture
- Hybrid sensor concept
  - Wireless positioning system and
  - Safety laser range finders
- Swarm intelligence
  - Distributed transport management (Negotiation)
  - Cooperative positioning and mapping
  - Intelligent and coordinated path planning

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Industry 4.0 for software products
First questions

- What is the relevance of Industry 4.0 for software?
- Are there any impacts?
- If yes, what are the requirements to the software
- If yes, what are the main challenges?

Industry 4.0 for software products
Relevance

- Industry 4.0 simply doesn‘t work without software !!
- The whole concept requires new / different software structures
- Real time control of linked processes and equipment is getting more important
- A decentralized concept requires decentralized software
- Therefore the **relevance of software for Industry 4.0** is immense!

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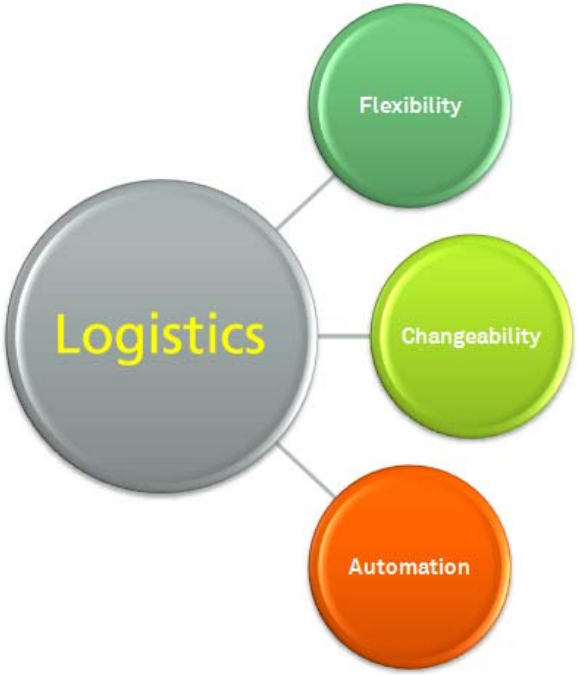
Industry 4.0 for software products
Impact



We have to create systems meeting future demands!

- It is necessary to create flexible systems
  … Others will not survive.
  - → The end of rigid, hierarchical systems
  - → The end of deterministic systems
- It is necessary to create adaptive systems
  … Others will not survive.
  - → Self-organizing, agent-based control systems
- It is necessary to create learning systems
  … Others will not survive.
  - → Learning requires awareness of the environment.

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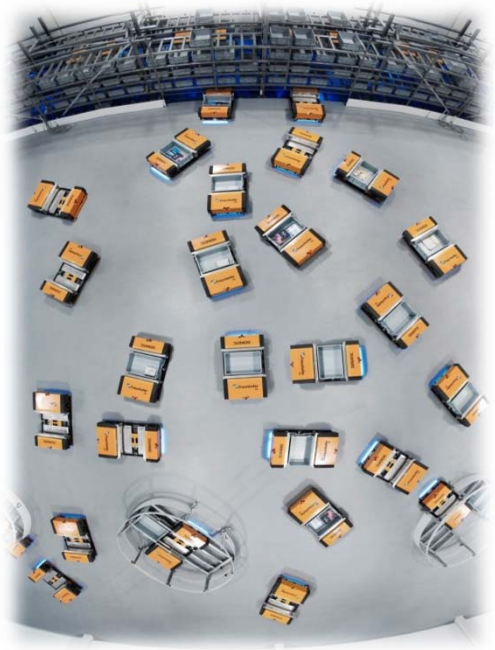
Industry 4.0 for software products
Impact



- Processes are getting more complex
- Processes are getting more flexible
- Objects have to communicate with each other
- Decisions have to be made decentralized and in real-time
- Man-Machine-Interface is getting more important
- Data structures and data interchange
- I 4.0 requires decentralization of the software, instead of monolithic systems
- Industry 4.0 produces „Big Data“

Industry 4.0 for software products
Requirements

- Change from monolithic systems to smaller services, modules (App-ization of the software)
- Much more flexible software
- Transparency of systems and data
- Work flow must allow an easy set up
- New algorithms must be developed e.g. ant-algorithms, multi agent algorithms, autonomous decision systems

Industry 4.0 for software products
Challenges

- Standardization of
  - Data & data structures (Reference model)
  - Interfaces
  - Communication mechanism
- Open Standards for Reference Architecture (100% software)
- Sufficient band width for communication
- Safety & Security

Industry 4.0 for software products
Challenges

- In Production and warehouses
  - Instead of passive and preplanned processes, there will be active, autonomous and self-organizing units
  - The intelligent systems are actively supporting the processes
- Production and warehouses will
  - be highly flexible
  - be high productive
  - be ressource-friendly
  - follow the human work flow and speed
- The software has to follow and to support!

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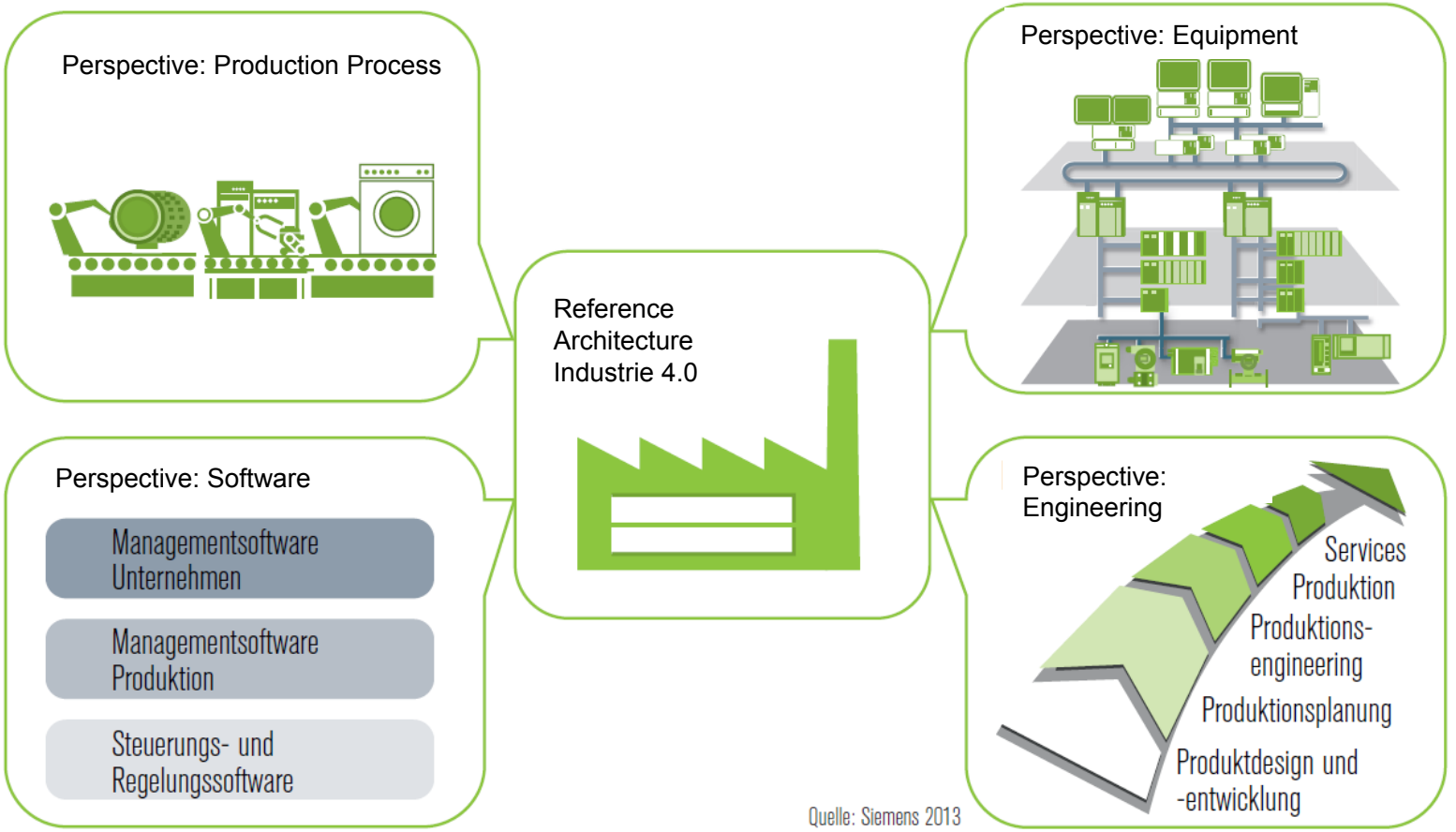
Industry 4.0 for software products
Challenges

Example for different perspectives on the I 4.0 reference structure



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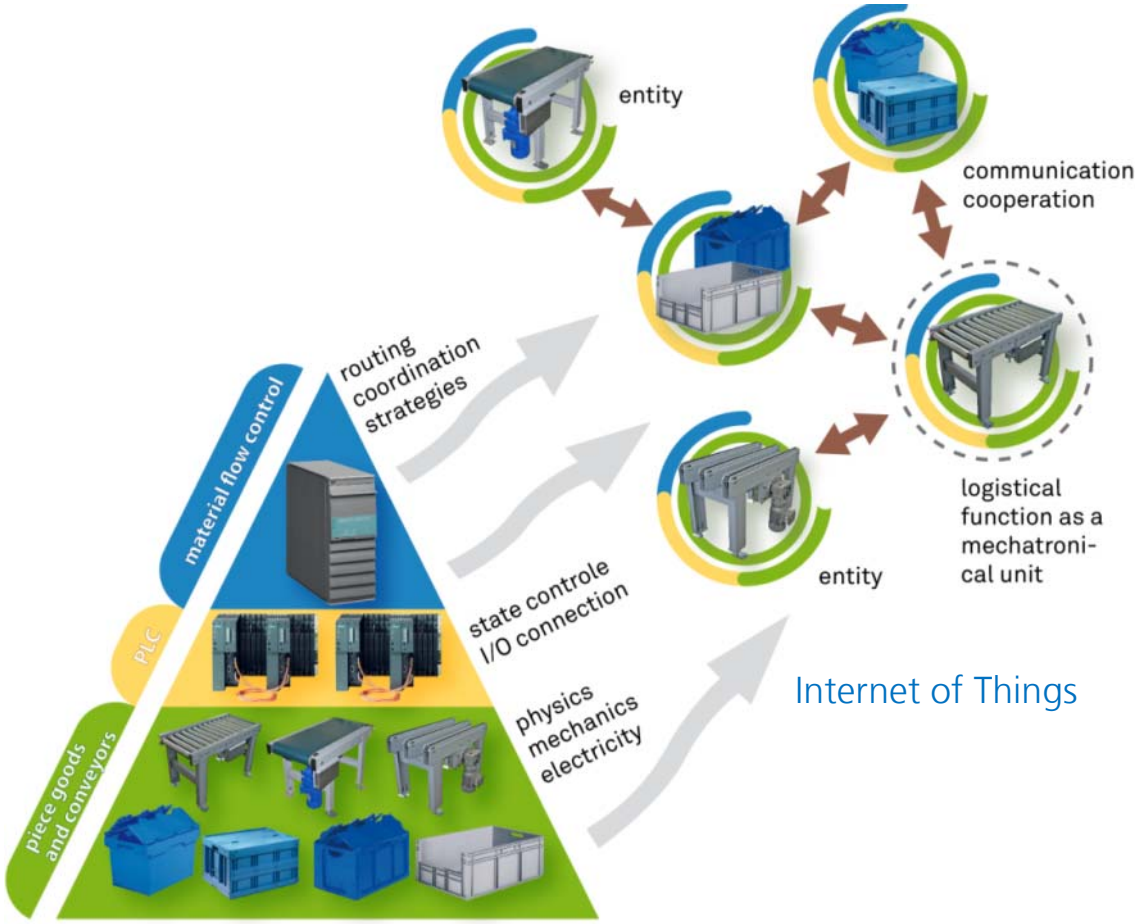
Industry 4.0 for software products
Internet of Things in Logistics



Classical material flow control

Internet of Things

- The trend is going from centralized to mesh-like structures
- Modularization of mechanical components
- Distribution of control functions over the system
- Every logistics object is represented by an autonomous entity (e.g. software agents)

- This leads to:
  - decentralization
  - internet of things in logistics

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