AUTONOMOUS LOGISTIC SYSTEMS FOR SMART FACTORIES
Robotics for Logistics and Transport - ERF 2016 Workshop

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Fraunhofer IML - Institute for Material Flow and Logistics

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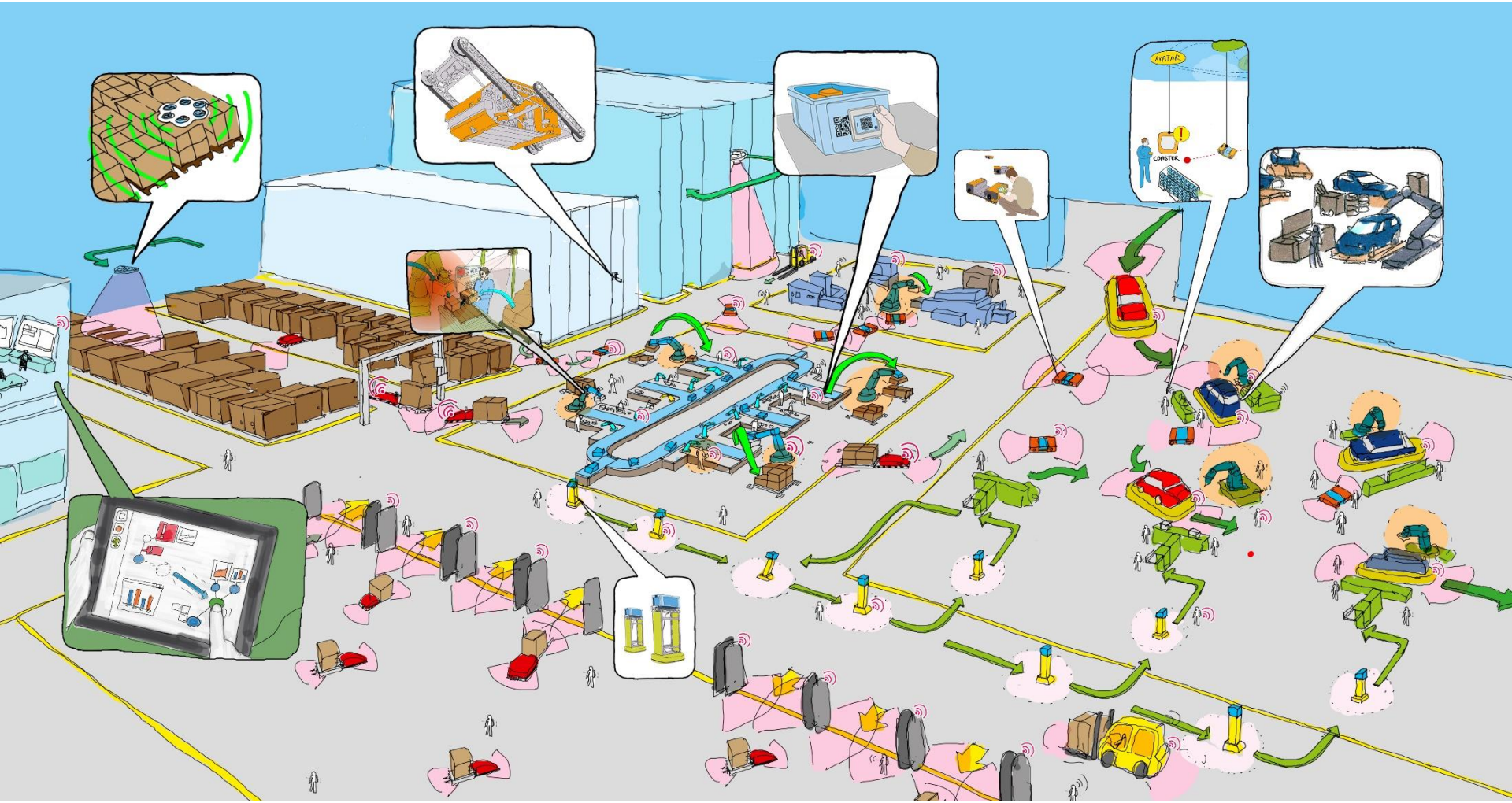
PICTURE OF THE FUTURE · CYBER PHYSICAL SYSTEMS
Enabler for Smart Factories with Smart Logistics



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REALITY CHECK · INDUSTRIE 4.0
Everything is (already) autonomous!

EMPLOYEES
plan, control, orchestrate

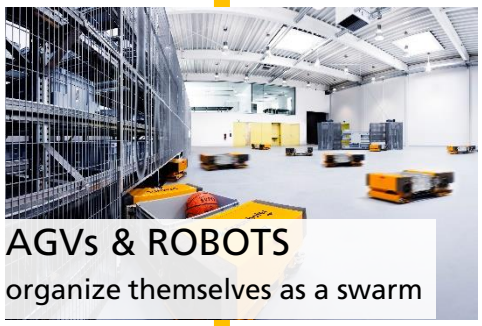
TRUCKS
deliver goods autonomously

DRONES
act as mobile sensor hubs

CLOUD

SHELFS
place replenishment orders

BINS
route themselves



AGVs & ROBOTS
organize themselves as a swarm

Image Sources: Fraunhofer IML, Jettainer, Daimler

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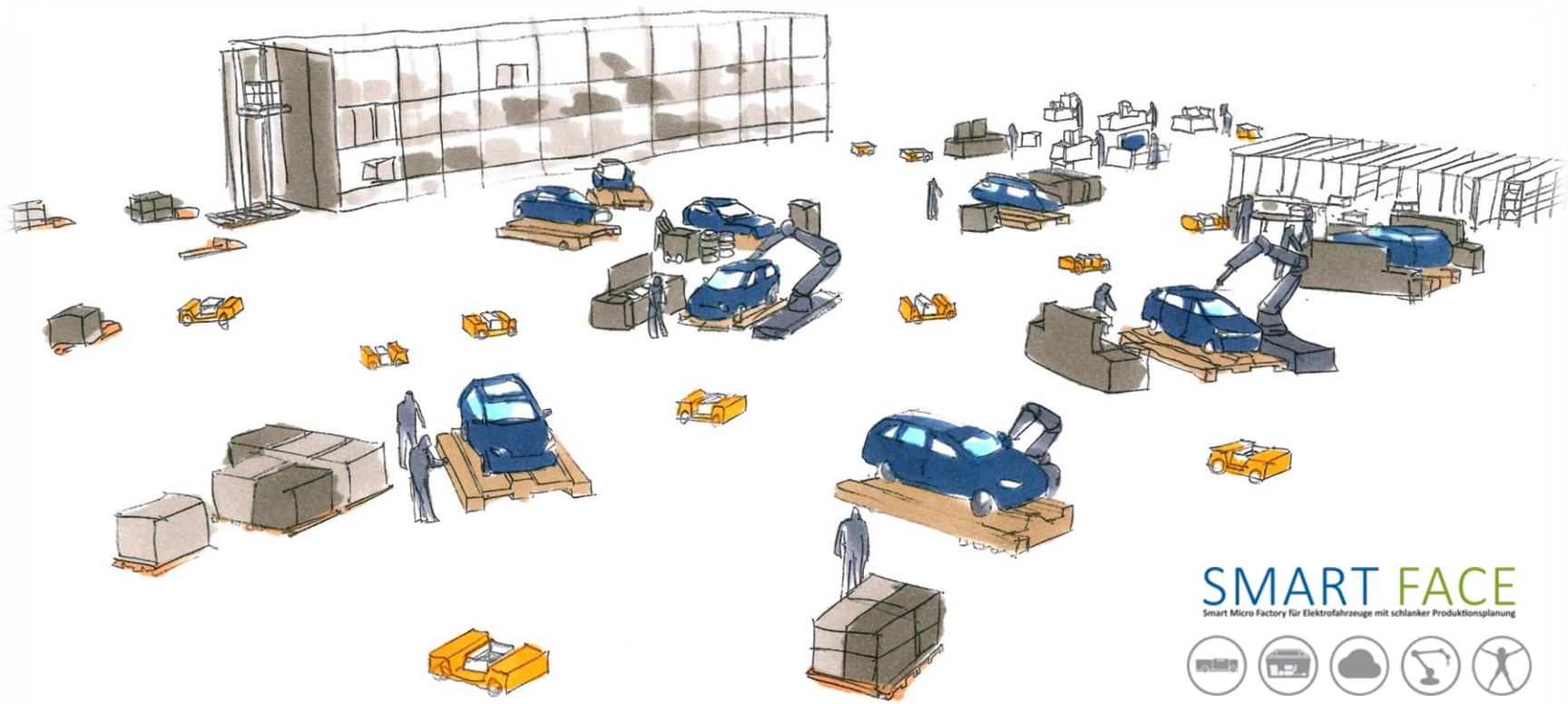
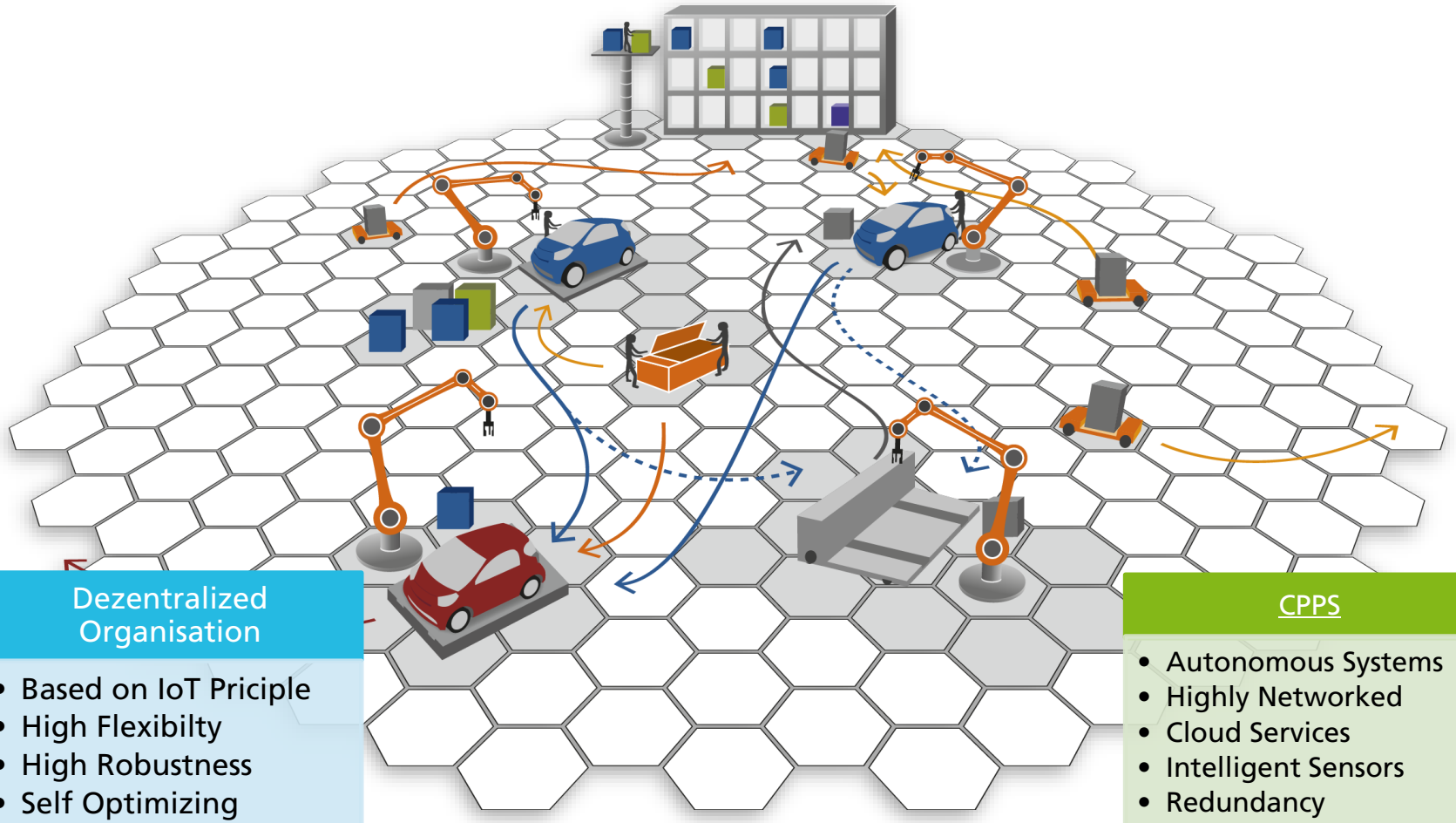
NEXT PRACTICE IN SMART FACTORY
Automated Decentralized Manufactory



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

VOLKSWAGEN AKTIENGESELLSCHAFT
Fraunhofer IML
SICK Sensor Intelligence.
PSI FLS Fuzzy Logik Systeme GmbH
Fraunhofer IML
Continental
technische universität dortmund
LANFER AUTOMATION
LinogistiX

SOLUTION · Shop Floor becomes a Cyber Physical Production System (CPPS)



Dezentralized Organisation

- Based on IoT Priciple
- High Flexibilty
- High Robustness
- Self Optimizing

CPPS

- Autonomous Systems
- Highly Networked
- Cloud Services
- Intelligent Sensors
- Redundancy

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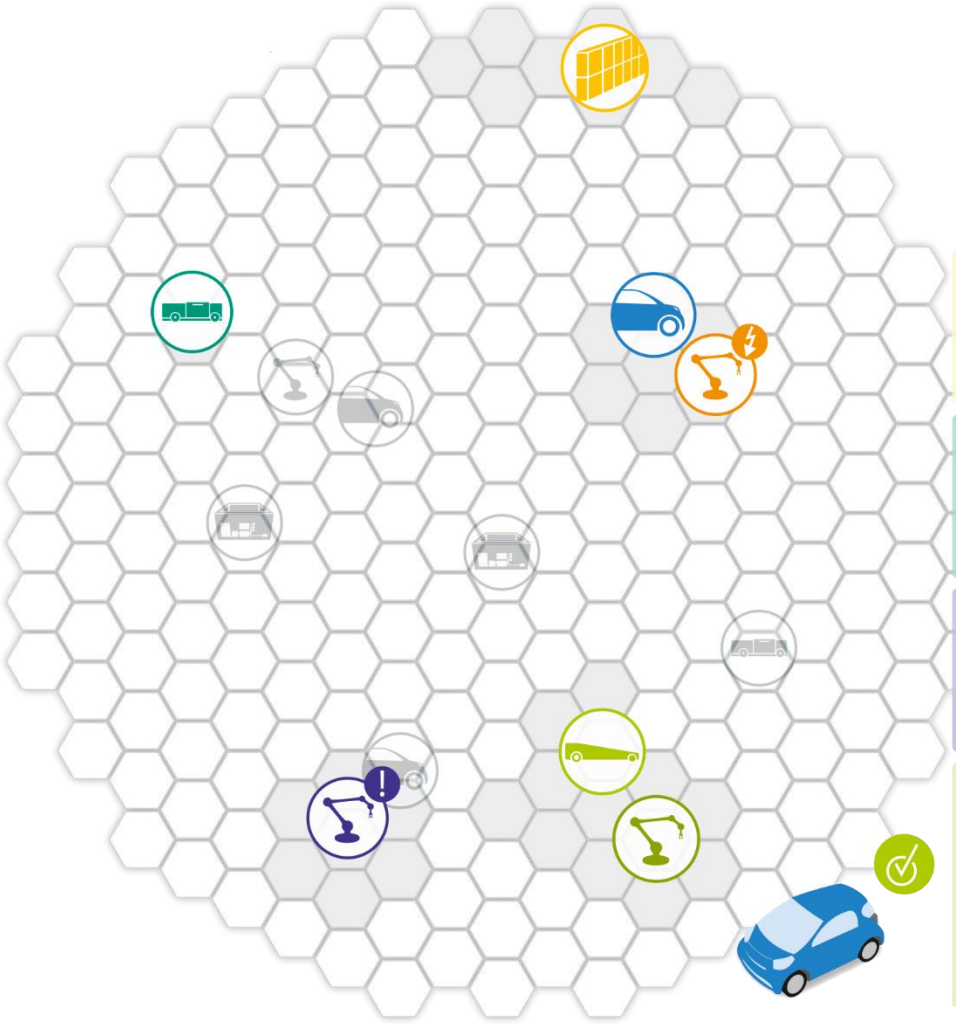
REDUCTION OF PROBLEM COMPLEXITY
Multi-Agent based Control System

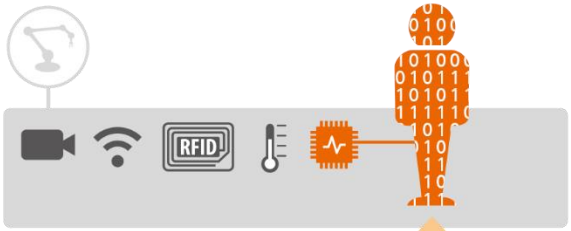


Parts available
AGV requested

Order accepted
Parts loaded
Delivery started

Station busy
Send: busy

Station available
Recieve: requirment
Process possible
Send: stand-by
Negotiation …
Send: delivery OK



Vehicle arrived
Stock of installation parts low
    # Send purchase requisition
    # Warehouse reports order OK
    # AGV reports: order accepted
    # AGV reports: supply in transit
Assembly starts...

Overheating noticed
Order aborted
Repair requested

Send: compensatory station sought

Receive: station in use

Send: compensatory station sought

Receive: station available and suitable
Negotiation: order transfer...
Successfully transferred

Waiting for repair

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AUTONOMOUS TRANSPORT SYSTEMS
CPS Swarm for Smart Factories

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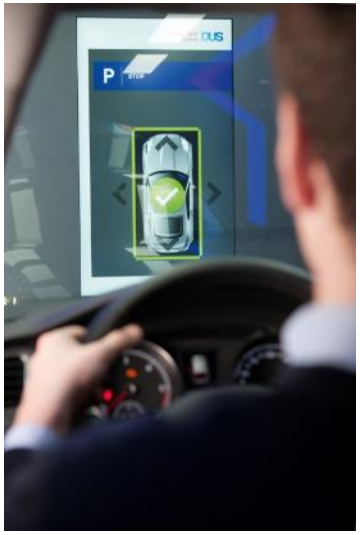
AUTONOMOUS TRANSPORT SYSTEMS
Car Transport Prototype developed by Fraunhofer IML



Eine Entwicklung für:

serva transport systems

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AUTONOMOUS IDENTIFICATION
Drone as mobile sensor hub for warehouse inspection

InventAIRY wir gefördert vom BMWi · Quelle: www.digitale-agenda.de

Die Bundesregierung

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AUTONOMOUS TRANSPORT
3D printed drone for transportation

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AUTONOMOUS TRANSPORT
BinGo - Novel Transportation Concept

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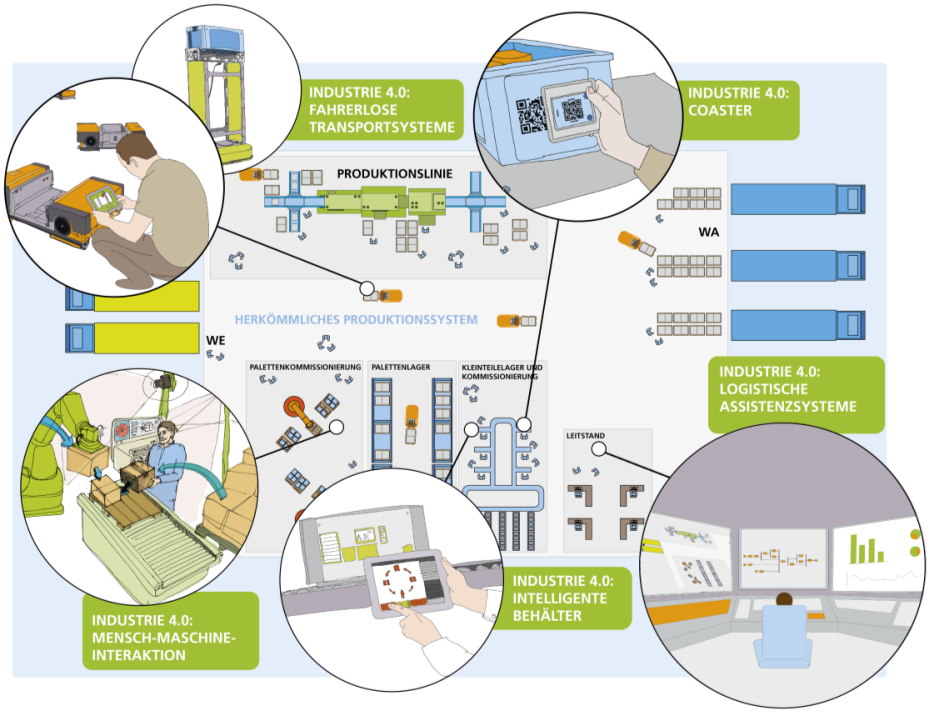
Thank you for your attention!



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