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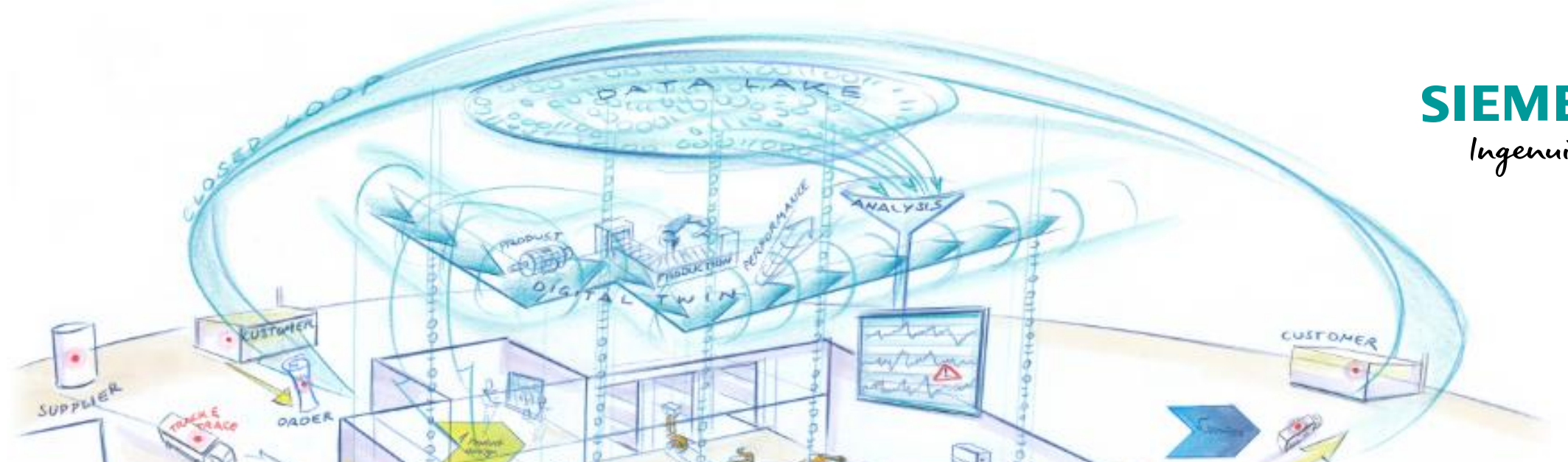

LDF
Lean Digital Factory

Lean Digital Roadmap of DI

Frank Bleisteiner – Senior Director Production Engineering
Digital Industries Factory Automation

Excellence in manufacturing – For our customers

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Our Mission

”

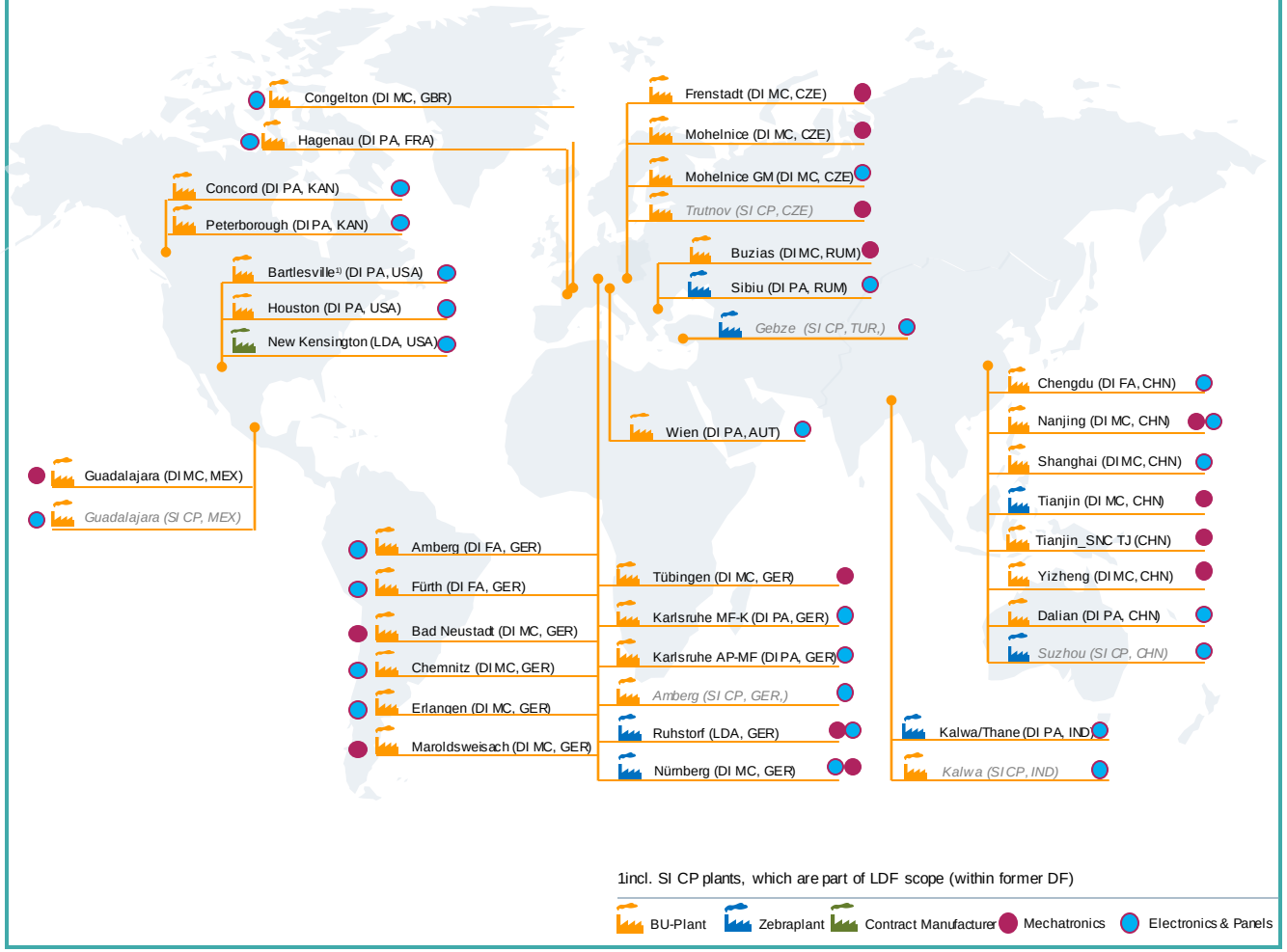
Be the Role Model for Excellence in Production and Logistics to provide proven Value Add for our Customers and Business Units, based on the methods of Digital Enterprise and Lean Industrial Engineering

Shape the Digital Future. Together.”

Dr. Gunter Beitinger, Vice President Manufacturing

Our Framework

Our Footprint[1)]



Our factories are known as Digital Lighthouse Factories

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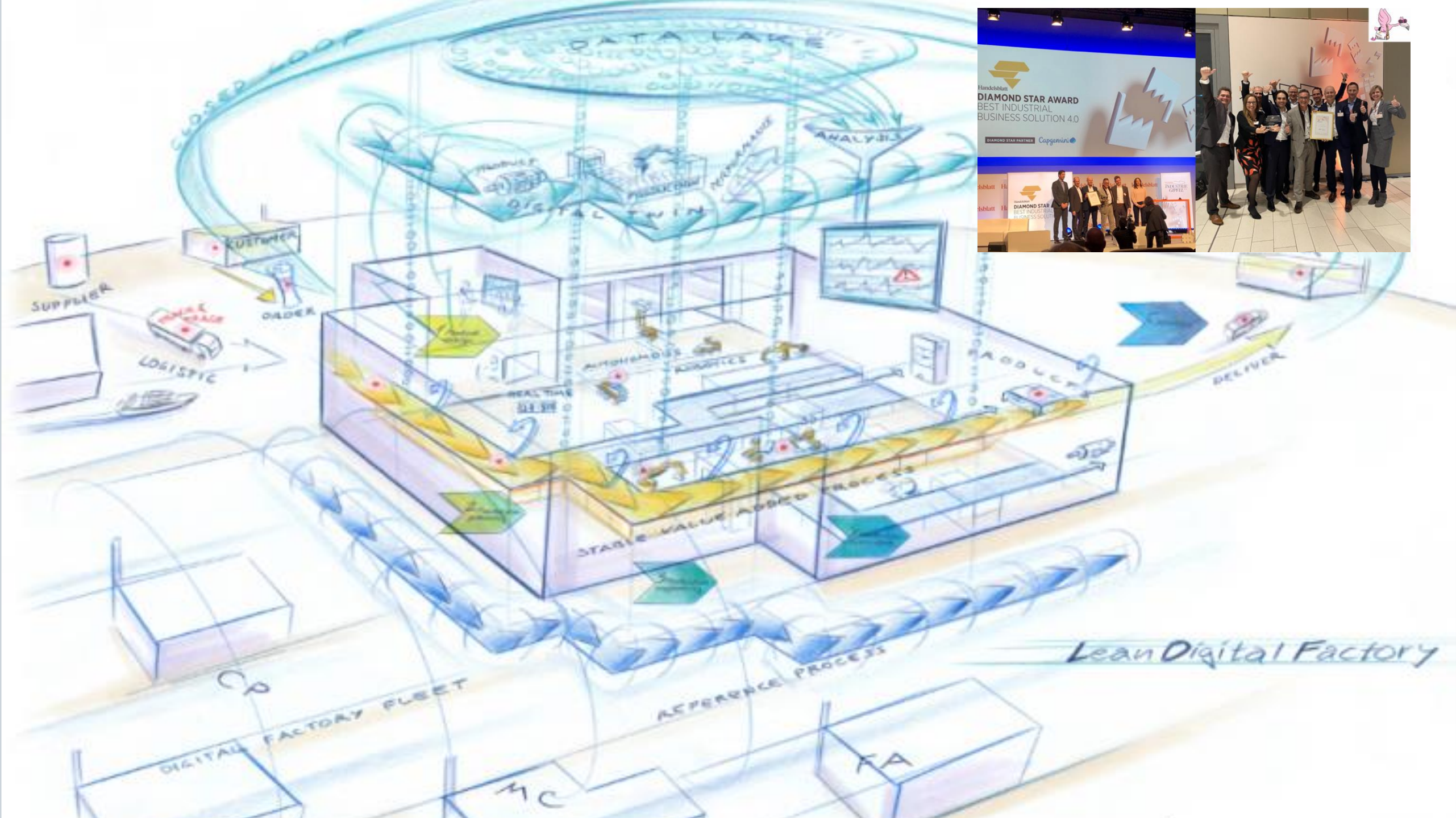
- 60,000 Customers
- 1 Product per second
- Highest Quality Standard
- Horizontal & Vertical Data Integration


DATA LAKE
DIGITAL TWIN
ANALYSIS
CUSTOMER
SUPPLIER
ORDER
LOGISTIC
AUTONOMOUS
ROBOTICS
REAL TIME
PRODUCT
DELIVER
STABLE VALUE ADDED PROCESS
DIGITAL FACTORY FLEET
MC
FA
Lean Digital Factory

Handelsblatt
DIAMOND STAR AWARD
BEST INDUSTRIAL
BUSINESS SOLUTION 4.0
DIAMOND STAR PARTNER
Capgemini

Siemens DI factories strengthen the focus on automation & digitalization hand in hand with lean productivity

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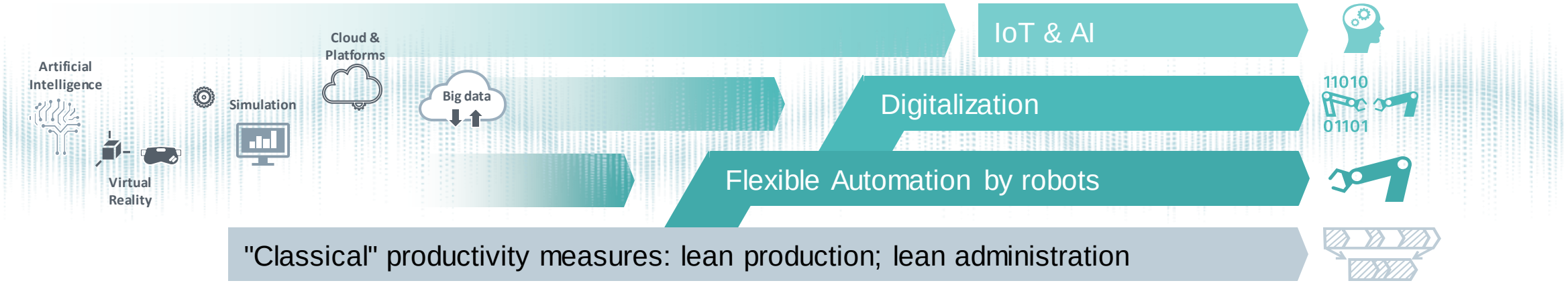

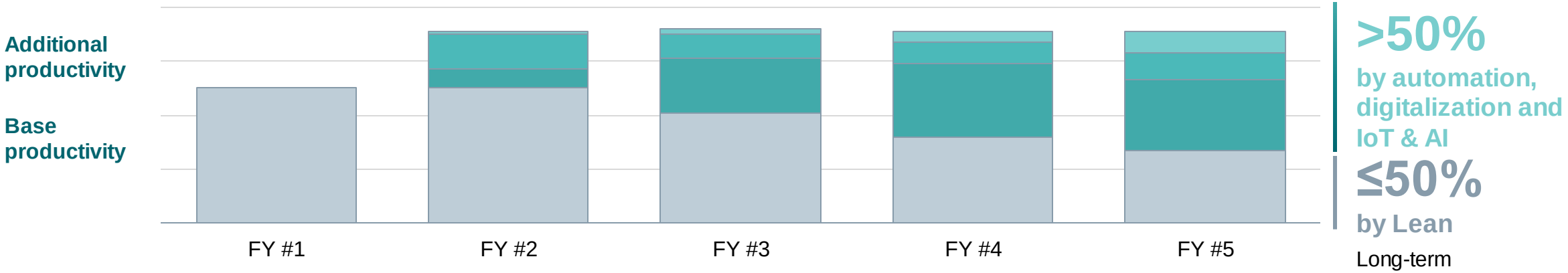

LDF guides the way to Digital Transformation

Lean Digital Factory: Digitalization Approach for over 30 plants

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Ideation

Organizational setup

Technology workshops

Reference processes

Reference process design

Technology radar

Mapping software platforms

Digitalization roadmaps

Streamline PLM

End-to-End

IoT operating system

Disruptive technology

People and methods

Reference IT architecture

IT Roadmap/Functions

PL Tool Definition

MOM Definition

With strong team commitment to the self-defined target state and roadmaps, project members drive implementation in their plants

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Roles in PMO

Expert core team

Consists of manufacturing network heads, plant managers and key experts bringing together strategic overview and technological expertise

Project lead (technical/commercial)

- Overall guidance
- Target setting

Plant coordinators (technical, commercial & IT)

- Coordinate project in own BU, consolidate financial/technical KPIs and support on critical topics
- Monitor and support progress of implementation with plant mangers

Workstream Coach

- Thought leader and scout in technology
- Directional support in roadmap development
- Align & identify cross workstreams potentials

Workstream leads (technical & IT): Selected key experts

- Drive definition of standards and ensure knowledge exchange cross plant and BU
- Strategic allocation of PoCs/pilots to best-fit factory and provide coaching support
- Identify transfer-ready solution and drive fast scale-ups to leverage synergies

Pool of experts (technical and IT)

- Execute proof of concepts
- Support specific topics

PMO

- Provide directional guidance to project lead and core team
- Align and coordinate between HQ and factories to ensure that high-impact solutions are implemented effectively

Source: Siemens Consulting

Roadmap to ensure holistic view on Digitalization per function & support stringent implementation

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Due to high dynamic of Digitalization the Roadmap is a working document !

Idea and approach for Digitalization Roadmap

Idea

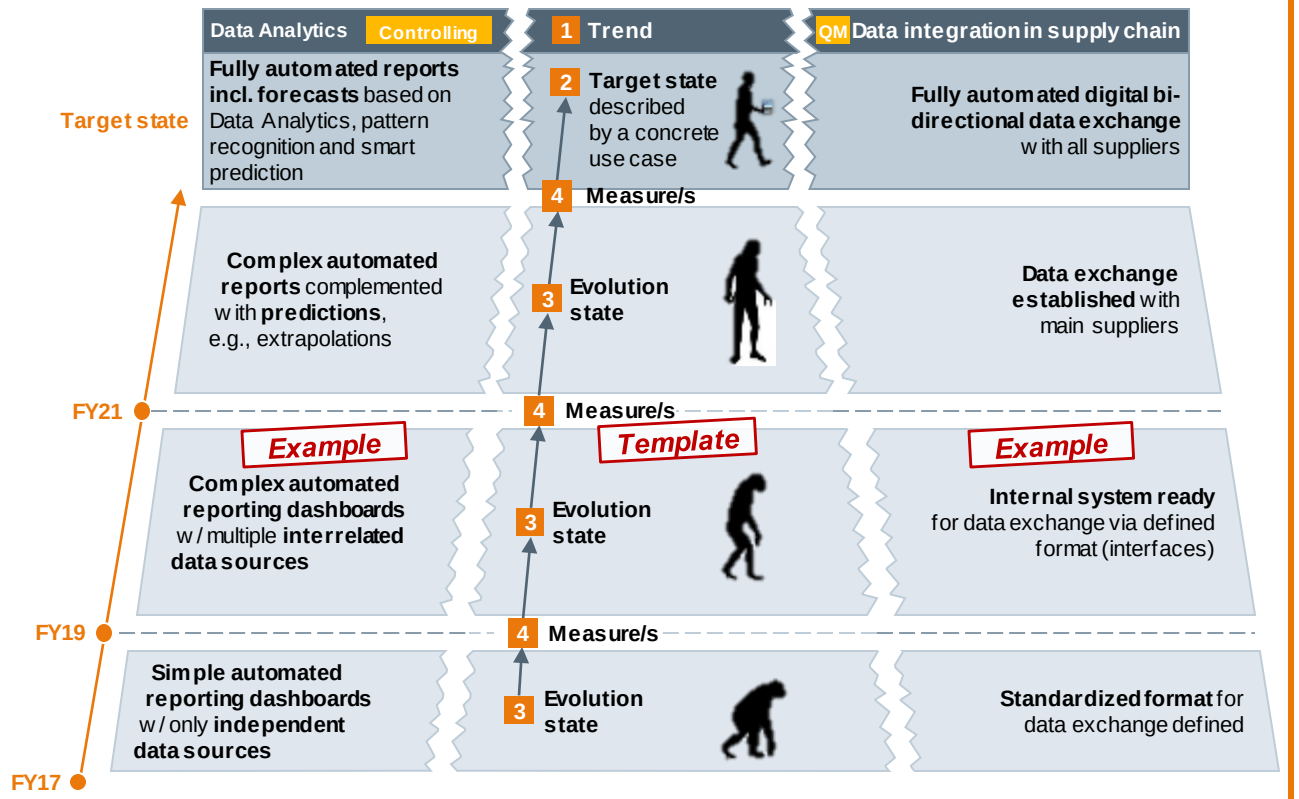
Sub-projects **develop first draft of Digitalization Roadmap** to …

- … **find new Digitalization measures** beyond classical ideas
- … **understand interdependencies** between defined measures
- … **enable mgmt. to trace progress** of Digitalization

Approach

1. **Identify** relevant **Digitalization trends**
2. **Concretize trend** through target state for specific function
3. **Define evolution states** & detail way to target state
4. **Elaborate & prioritize measures** to realize target states

Example/template



Cross-company scalability is enabled by detailed digitalization roadmaps and in-depth understanding of technologies

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Challenges in the continuation of LDF

Change working mode from evaluation of digitalization potentials to sustainable implementation

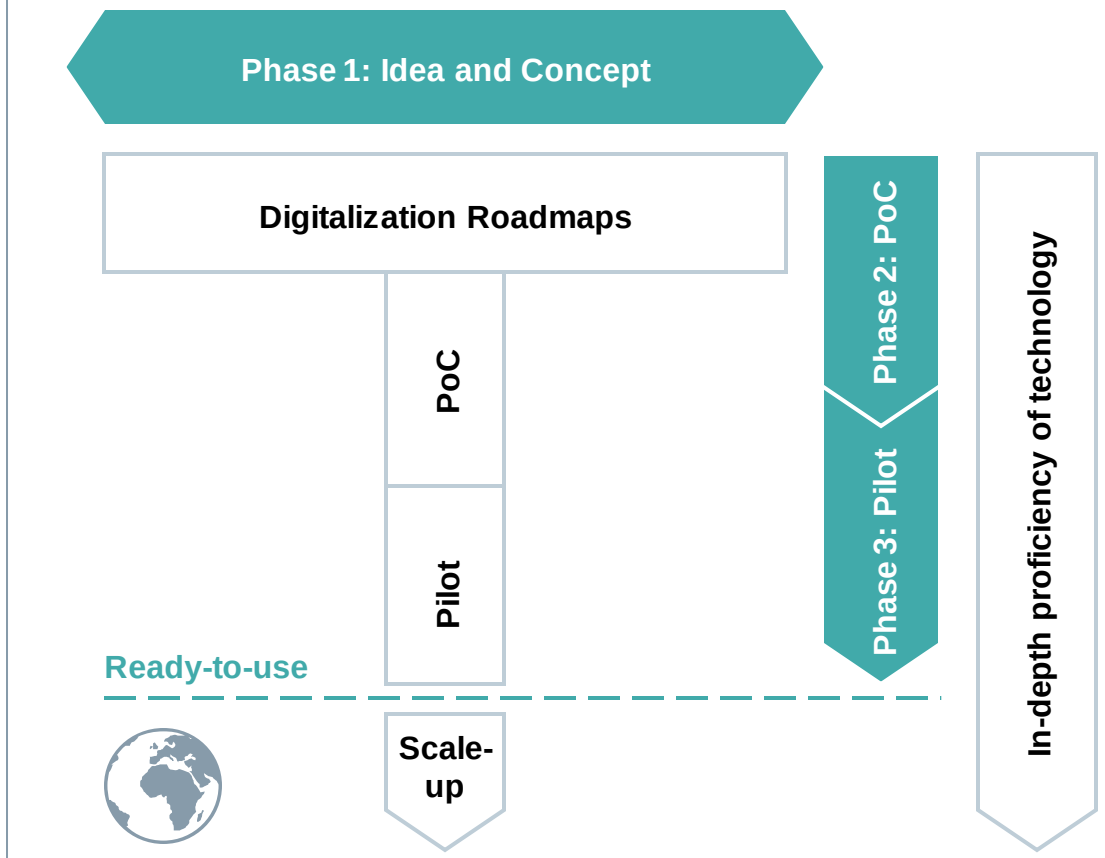
- Built up of in-depth knowledge to develop "ready-to-use" solutions transferable to other factories
- Consideration of fit to holistic roadmap
- Set standards and define platforms
- Continuous knowledge exchange

Maintain speed in implementation phase by

- Systematic transfer of proven solutions
- Technical coaching in case of road blockers
- Tracking of implementation progress in factories

Scouting for new technologies and periodic review of digitalization roadmap and potential

- Ongoing scouting for promising technologies
- Periodical review of roadmaps and adjustment of potential (in-between focus on implementation of defined concept)



Pilots should be fresh topics using new technology, which are scalable and measurable

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Digitalization pilot criteria, working principles

What? Digitalization pilot criteria

New Technology

Introduce / leverages a **new interesting technology** / solution

"Make things easy"

Makes a process / job **more convenient** for employees

Clear benefits

Value-add clear and easy to understand

Competences

Implementable with **available resources** / know how

Fresh topic

No **negative connotation** from previous experiences

Scalability

Scalable to **larger parts of organization** after small scale pilot

Timely

Creates **impact within 3-6 months** (1st wave pilots)

How? Principles of set-up

Dedicated Teams

Lean dedicated teams **working** on the project

Design thinking

Agile, building up ideas, user-centric, learn & iterate

Source: Siemens Consulting

„In addition to the financial & processual potentials, cross BU collaboration within LDF formed a solid network enabling sharing of ideas & innovation even beyond the project scope ."

Streamline PLM

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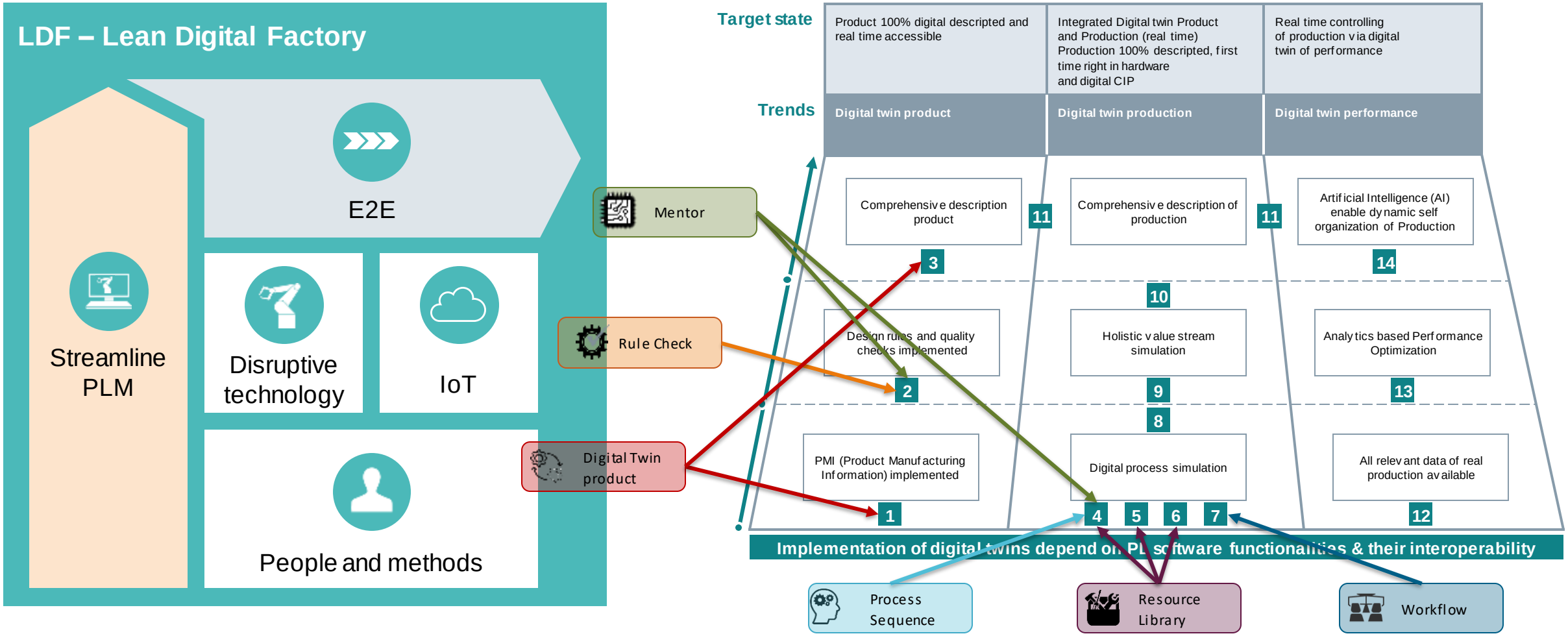
Lean Digital Factory (LDF) modules



SPLM Mapping of PoCs to Digital Twin Approach

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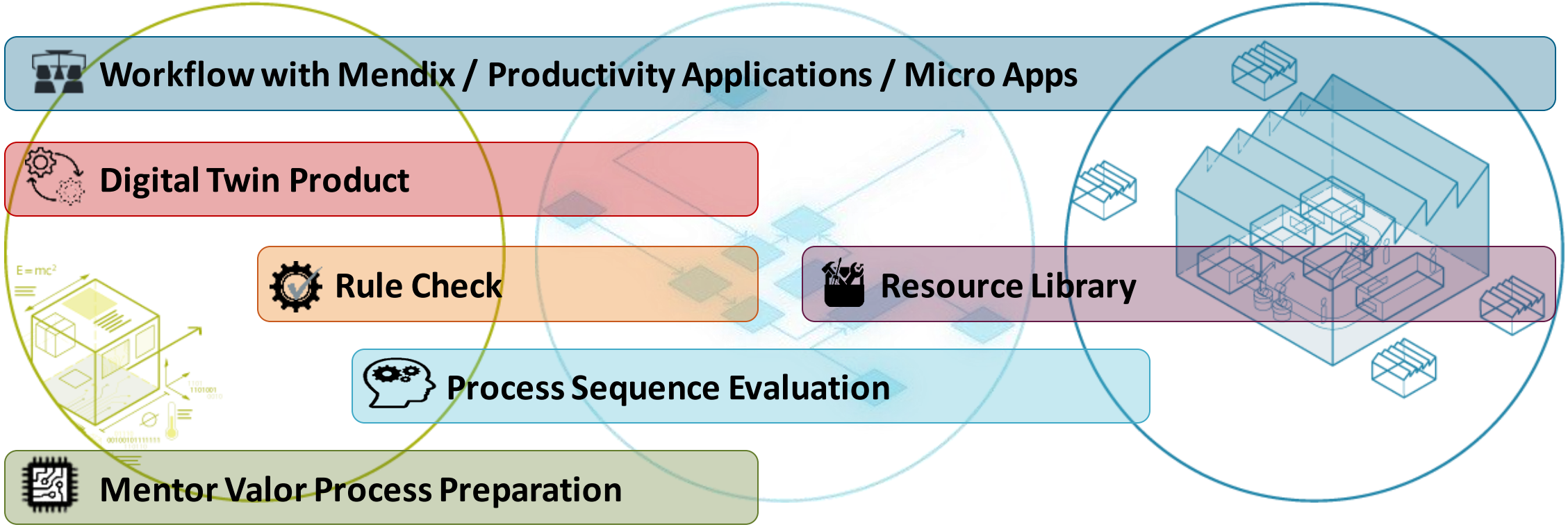
Digital Twin Product | Digital Twin Production | Digital Twin Performance



Closed Loop Production Introduction based on digital twins of product and production

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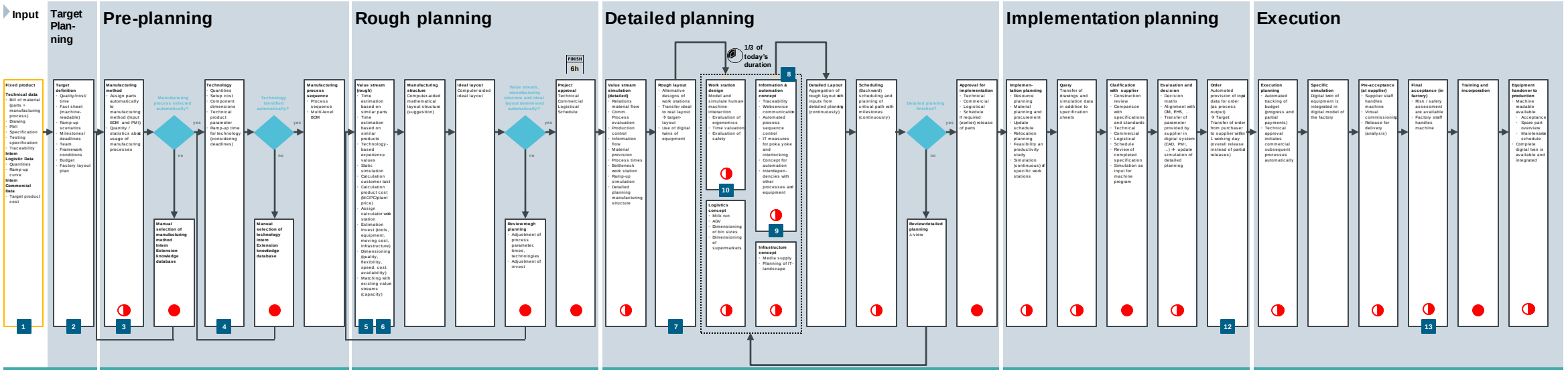
Reference process production system planning – Overview



◑ Partly automated process ● Manual process # Reference to requirement

PoC Workflow Engine

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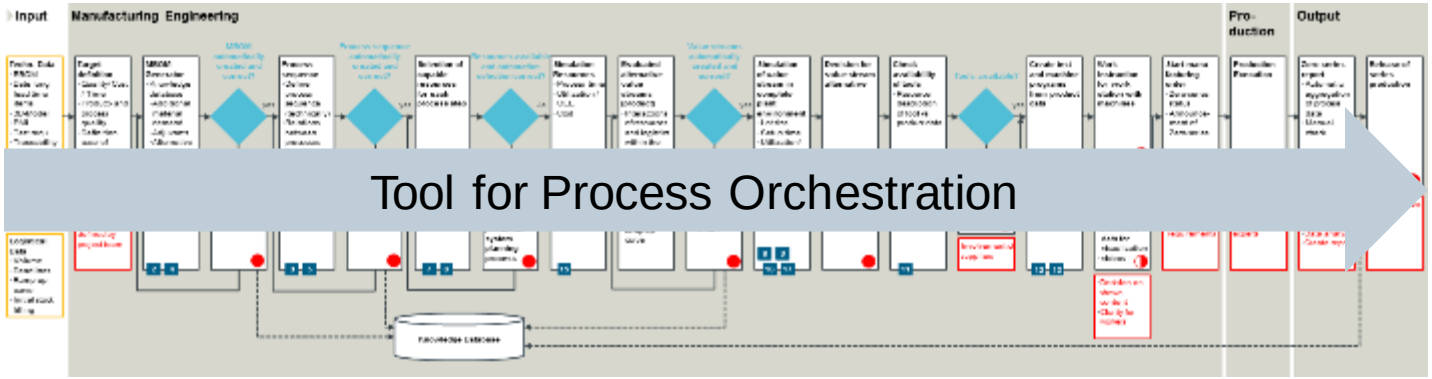
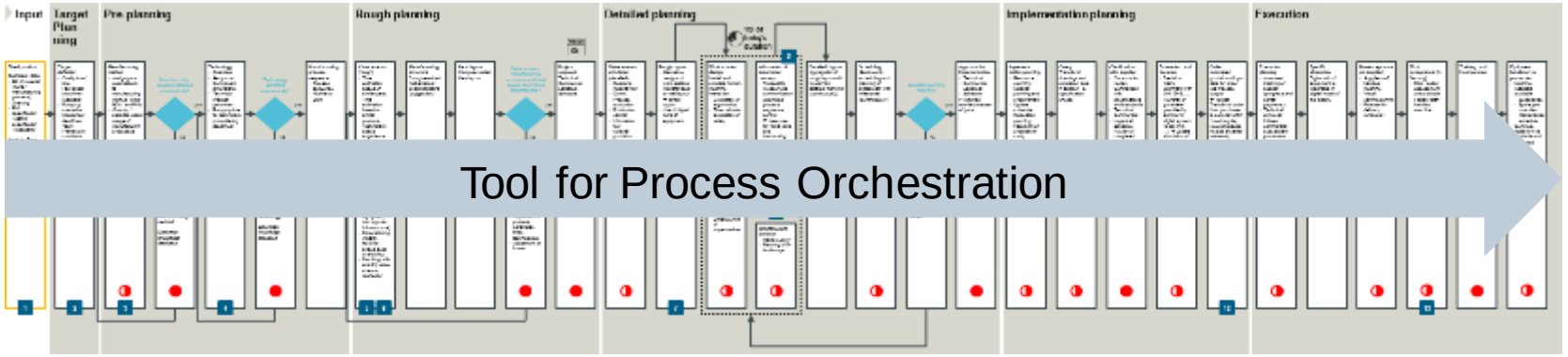
Workflow with Mendix / Productivity Applications / Micro Apps

Ref Process: NPI = New Product Introduction



Ref Process: NMI = New Machine Introduction



Workflow PoC supports the NPI[1)]/NMI[2)] reference processes (NPI: 2000/year @ EWA; 600/month @ WKC)

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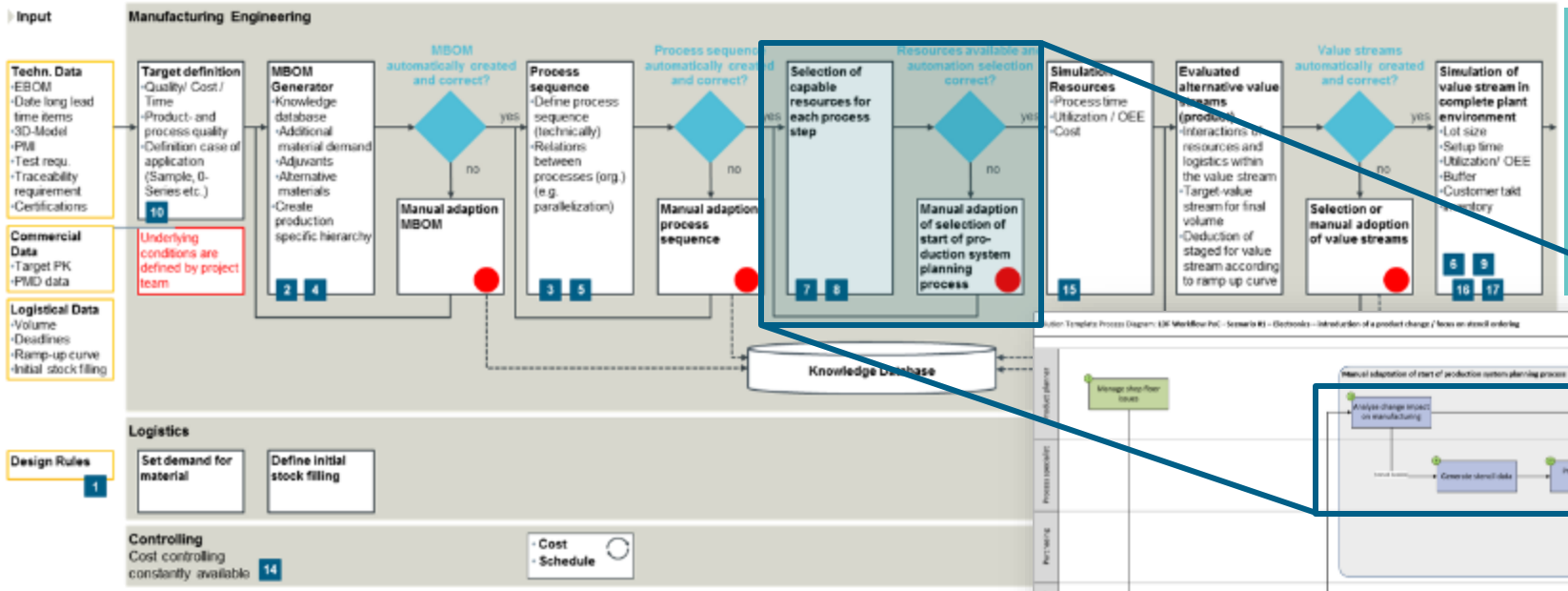
Workflow with Mendix / Productivity Applications / Micro Apps

Evaluation of a workflow engine	
PoC completed	PoC extension requested

Detail view: Reference process product introduction – Part 1/2



Stencil ordering is chosen for PoC

The example is just one out of 30+ sub-processes!

Flexible Microservice Apps
powered by Mendix

The PoCs digital twin product and DI-wide resource library resulted in a standard definition and thus reusability for DI

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Resource Library

Workflow (How to)

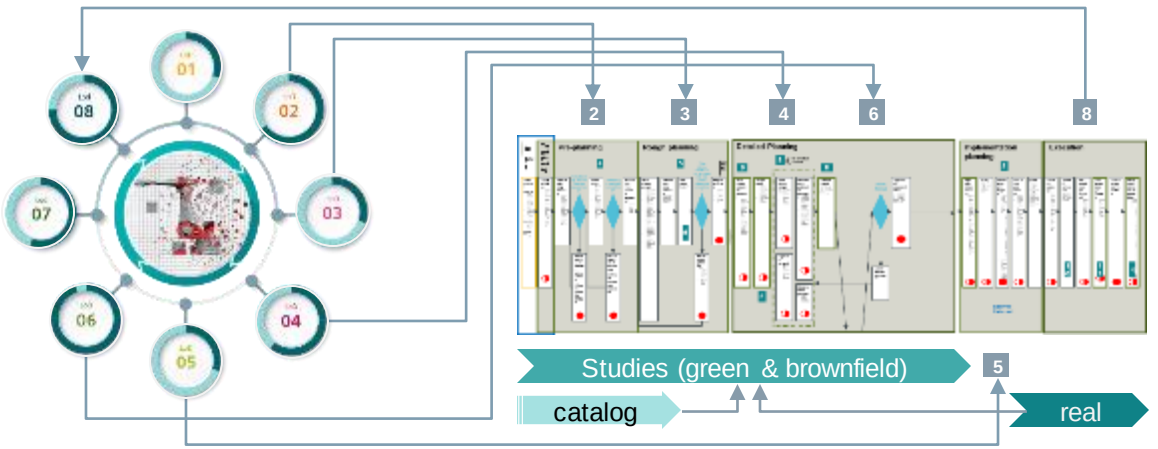
Levels of detail fulfilled by digital twin

Basic Info Name and type of an asset classified according to potential use cases (e.g., production, assembly, logistic, ...)	LoD 01
Supporting Pre-Planning phase as well as implementation and executing of SPLM Descr. of essential asset capabilities (PMI), all relevant data for factory planning & execution process	LoD 02
Basis for 2D-Layout planning and material flow analytics Factory planning, sensible 2D layout incl. all functional areas and relevant operation pages (operating page, material delivery/flow, maintenance access, ...)	LoD 03
Enabling for realistic rough layout planning Simplified 3D model (boundary view) with enveloping contours and provision in typ. exchange and planning file formats (e.g., JT)	LoD 04
Supporting workstation or work-cell design and detail layout of the factory 3D model based on NX incl. kinematic axes (if relevant for subsequent use in corresponding planning tools); NX assembly of complex parts (single resources) for integr. into combined plant project planning	LoD 05
Implementation planning and physical simulation evaluation (if needed) Native 3D design model incl. all material types and surface properties for simulation of physical, electrical and so on properties (e.g., FEM, thermo, …)	LoD 06
Execution phase based on specific simulation and virtual commissioning Mechatronic System/Cyber-physical model including all electrical capabilities for virtual commissioning, programming and simulation	LoD 07
Closed loop with life cycle data from operating phase Aggregated process and event data from MindSphere applications and microservices for reuse in next planning phase or scenario validation/simulation	LoD 08

eCl@ss

Linked to standard

Linked to the reference process

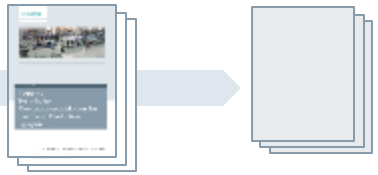


Level of Detail (LoD)

Frame Specification for Supplier

IN0692 – SITEMA

Purchase order



PI0674 – Introduction of systems

Linked to supplier

Digital twin of product		DF wide production resource library	
PoC completed	PoC: Evaluate defined concept	PoC completed	Pilot: Pre-filling of library

End 2 End

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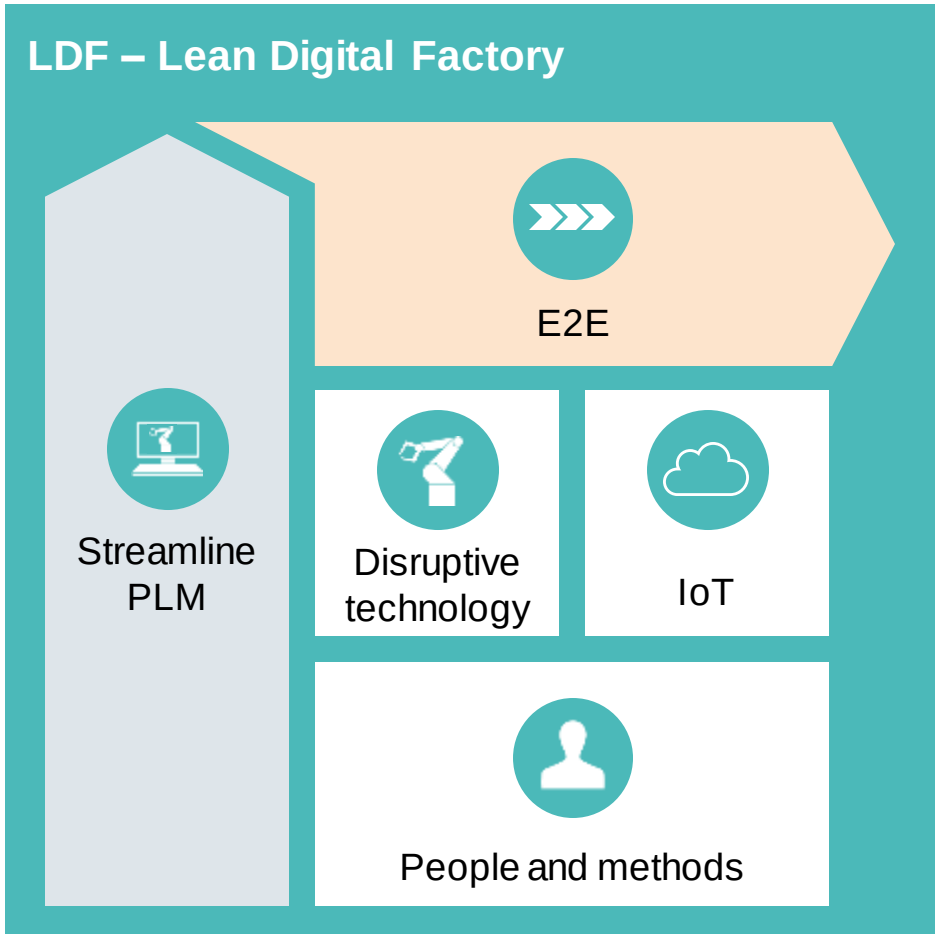
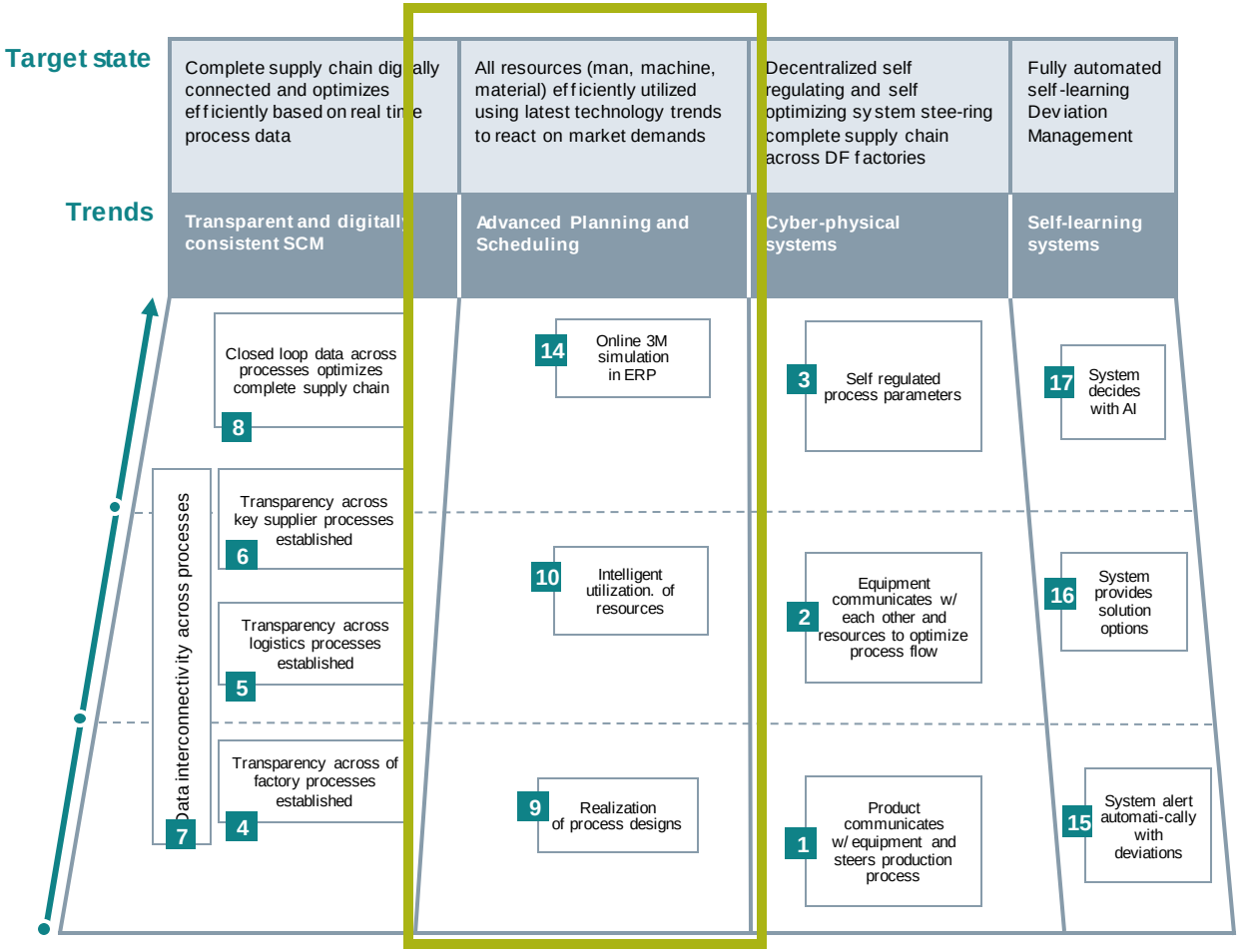
Lean Digital Factory (LDF) modules





Synchronized planning of all production resources and activities in the SCM for short lead times and maximum utilization

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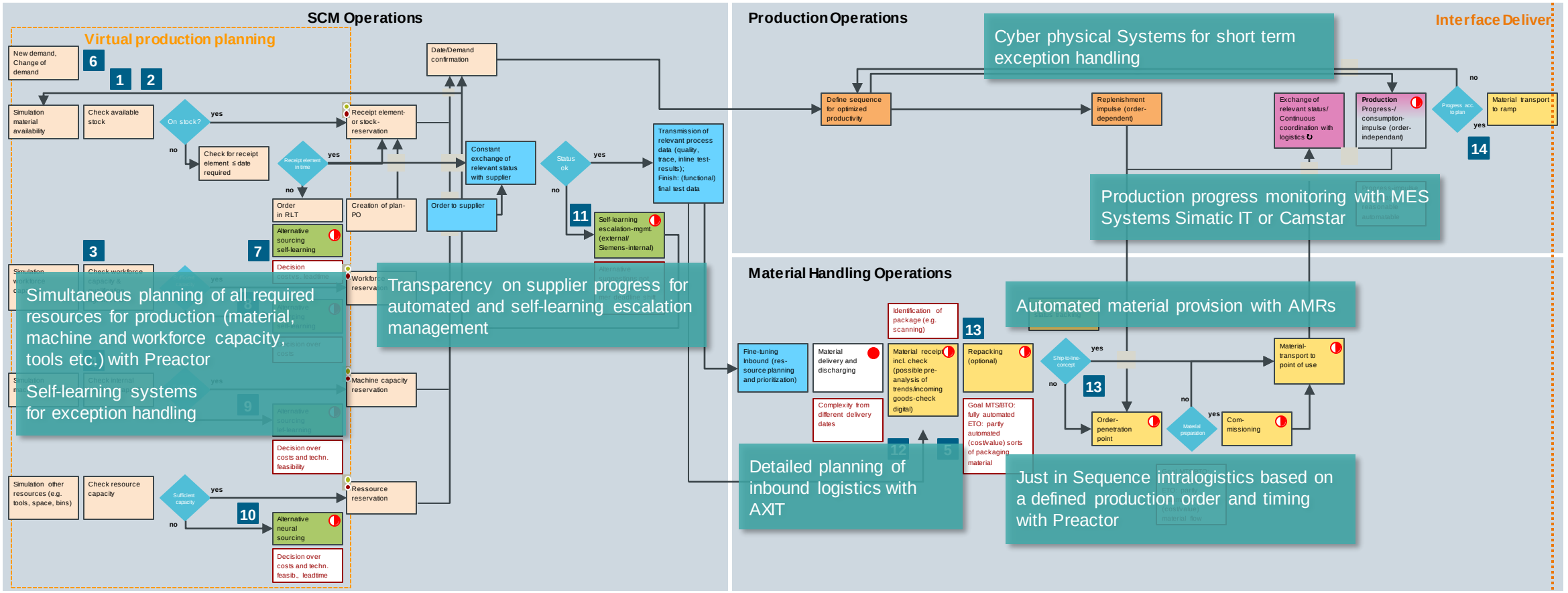
Reference process Inbound- and Intralogistics



Partly automated process | Manual process | # Reference to requirement | Synchronizing point for resource reservation

In the PoC "Synchronized scheduling and material flow" Preactor AS is applied to the APS reference process

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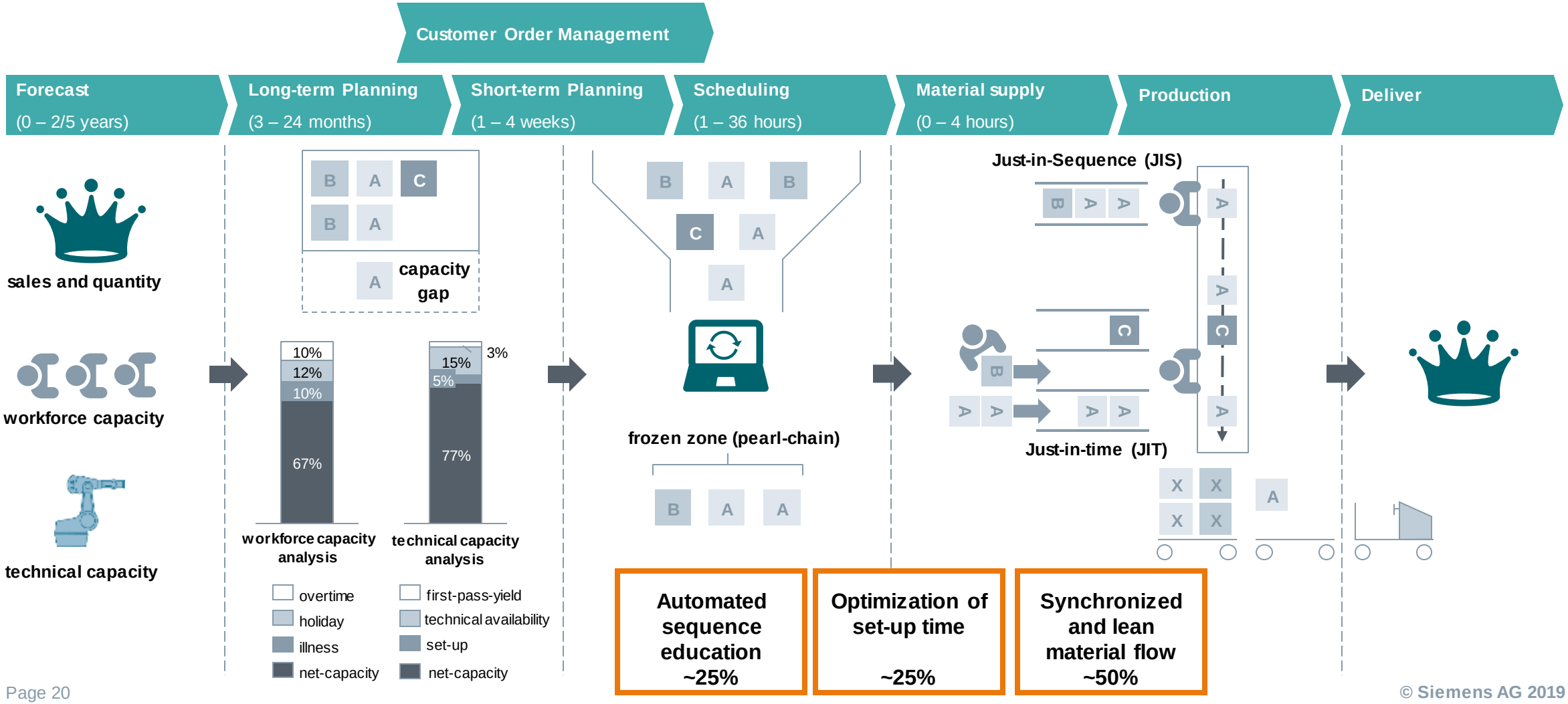
Reference process level 2 for Advanced Planning & Scheduling (APS)



Disruptive technology

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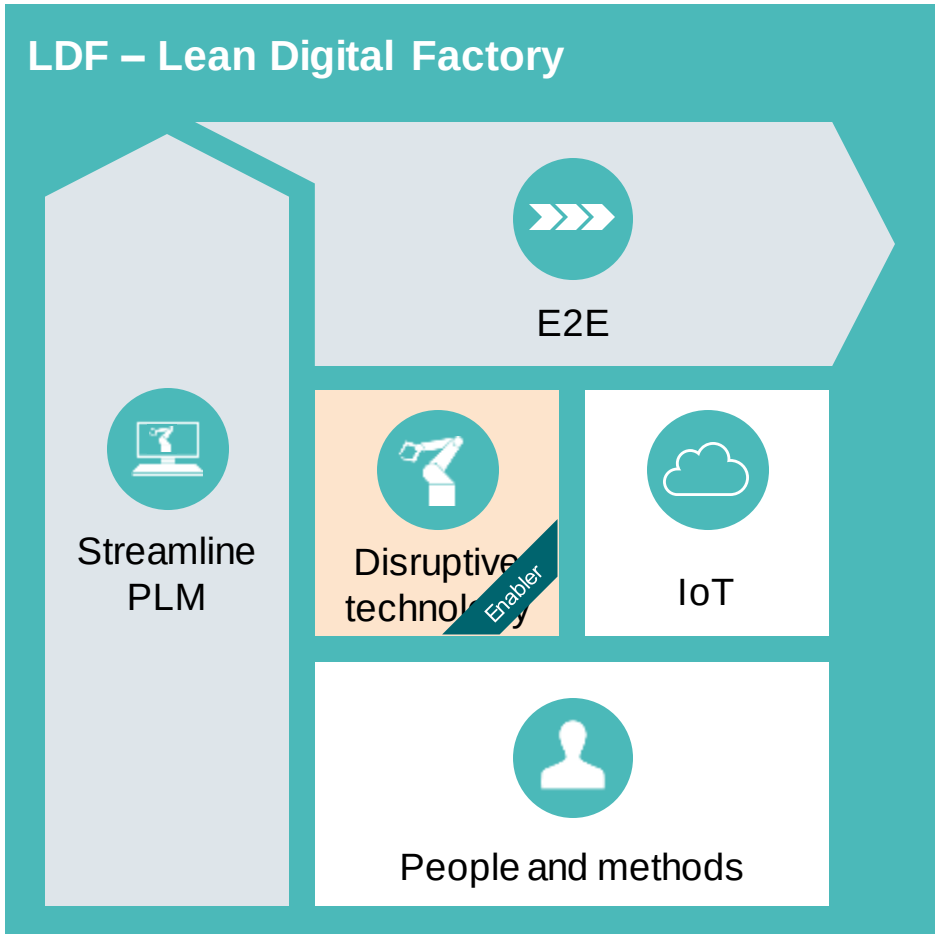
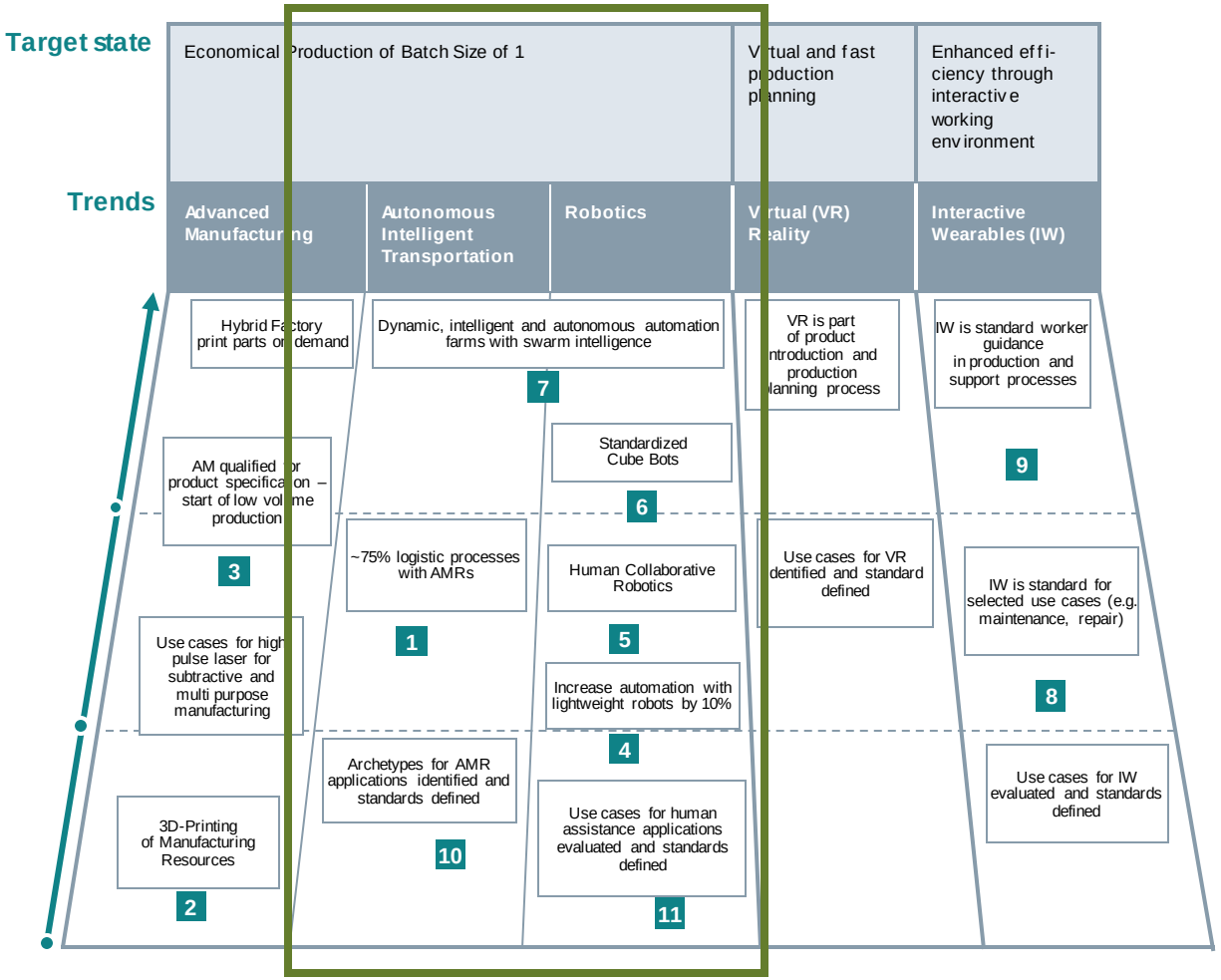
Lean Digital Factory (LDF) modules





Work Based Interaction with Robotics

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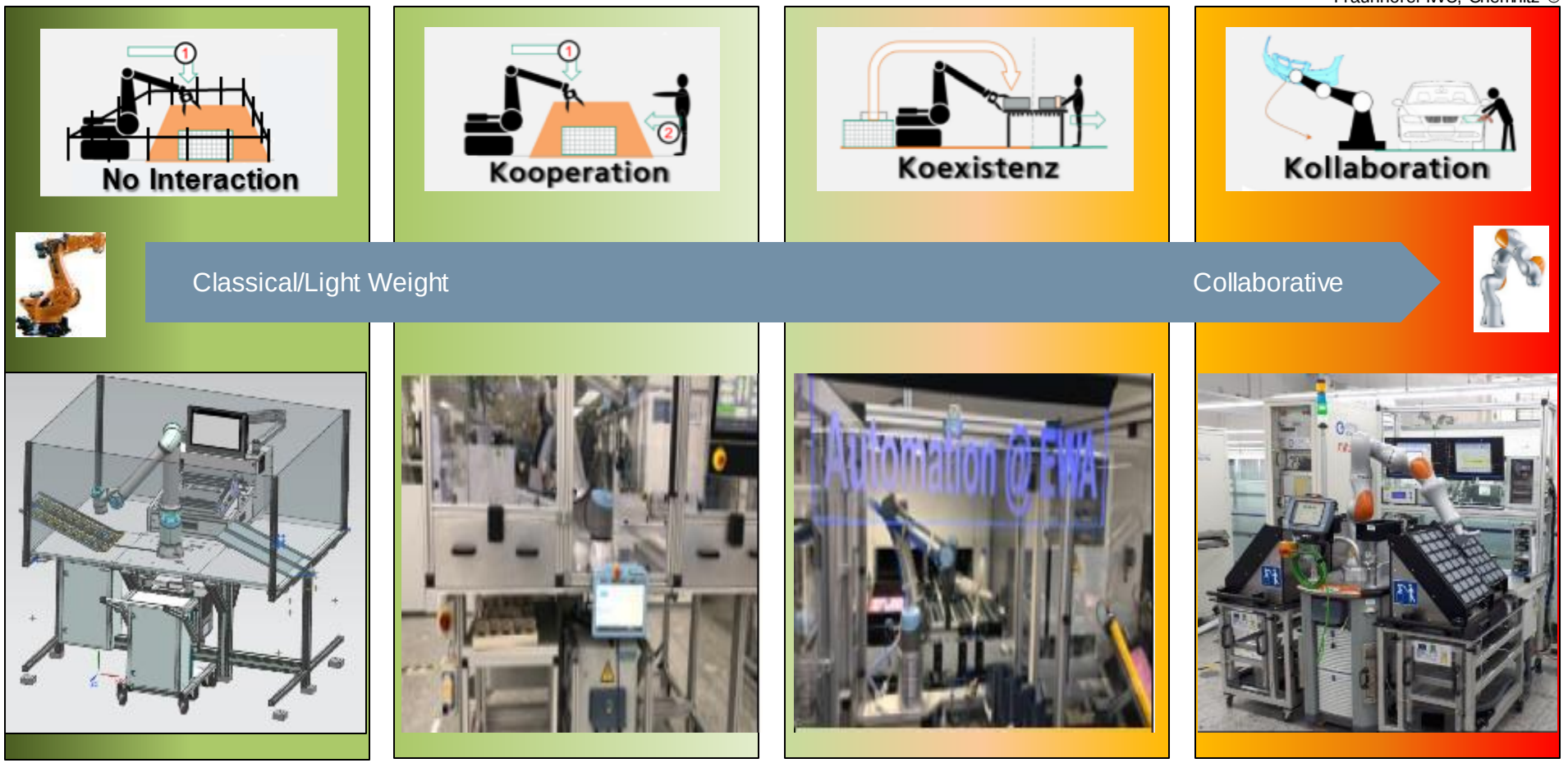
Classical/ LWR versus Collaborative

- Standard robot carrier system
- Increase efficiency
- Improve ergonomic
- High flexible
- High tact time
- ROI < 2a

Fraunhofer IWU, Chemnitz ©



SIMOVE is evaluated as Master Controller for Autonomous Mobile Robots (AMR) and forklifts

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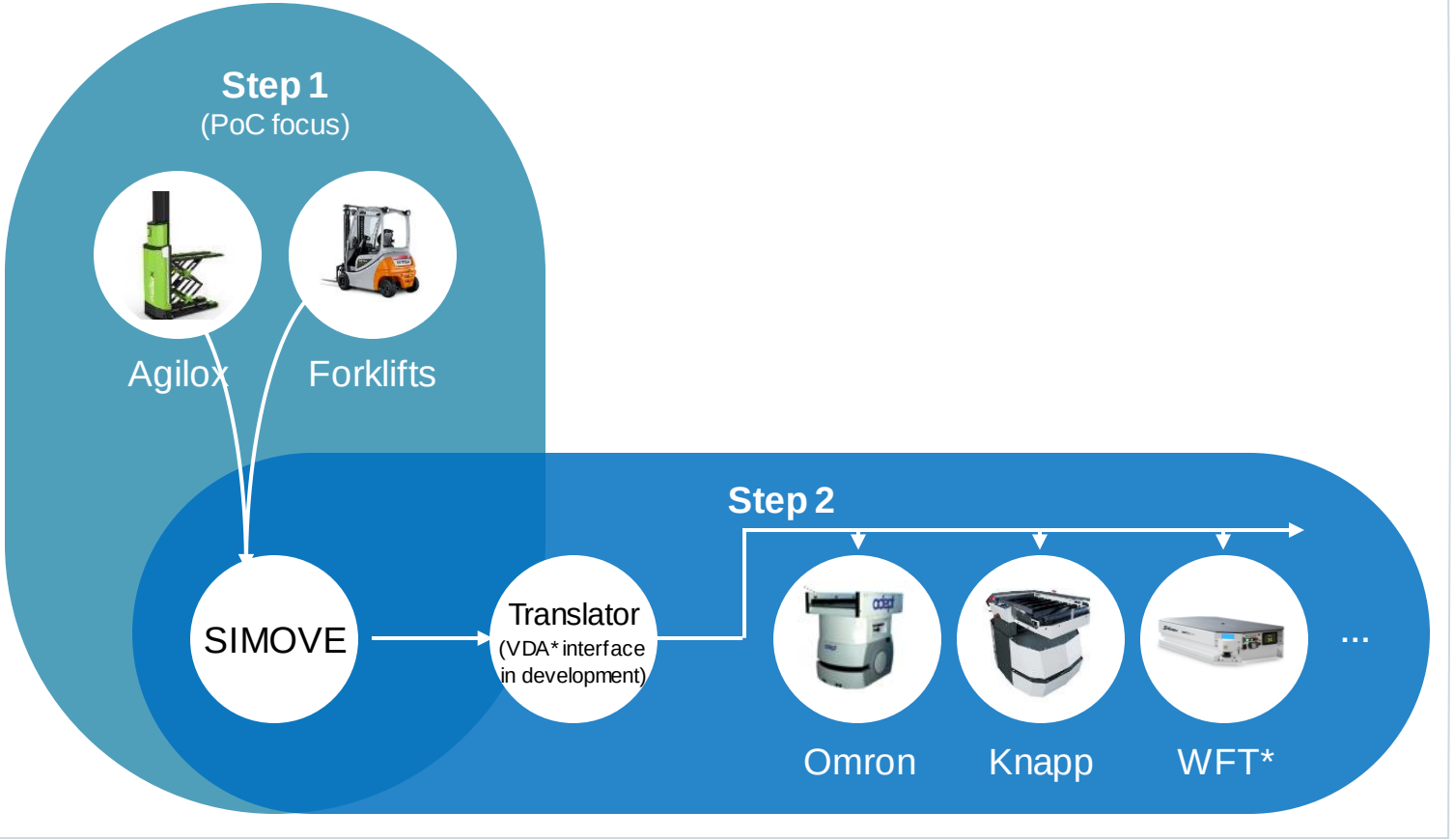
A unified control system for transport order assignment is needed

From separated control systems to one Master controller

Step 1 (PoC Focus):
Control forklifts & Agilox with one system

- Transfer forklift control system functionalities to SIMOVE
- Realize interface to Agilox

Step 2 :
Control forklifts & different AMR types with one system



* Verband der Automobilindustrie | ** STÄUBLI WFT GmbH

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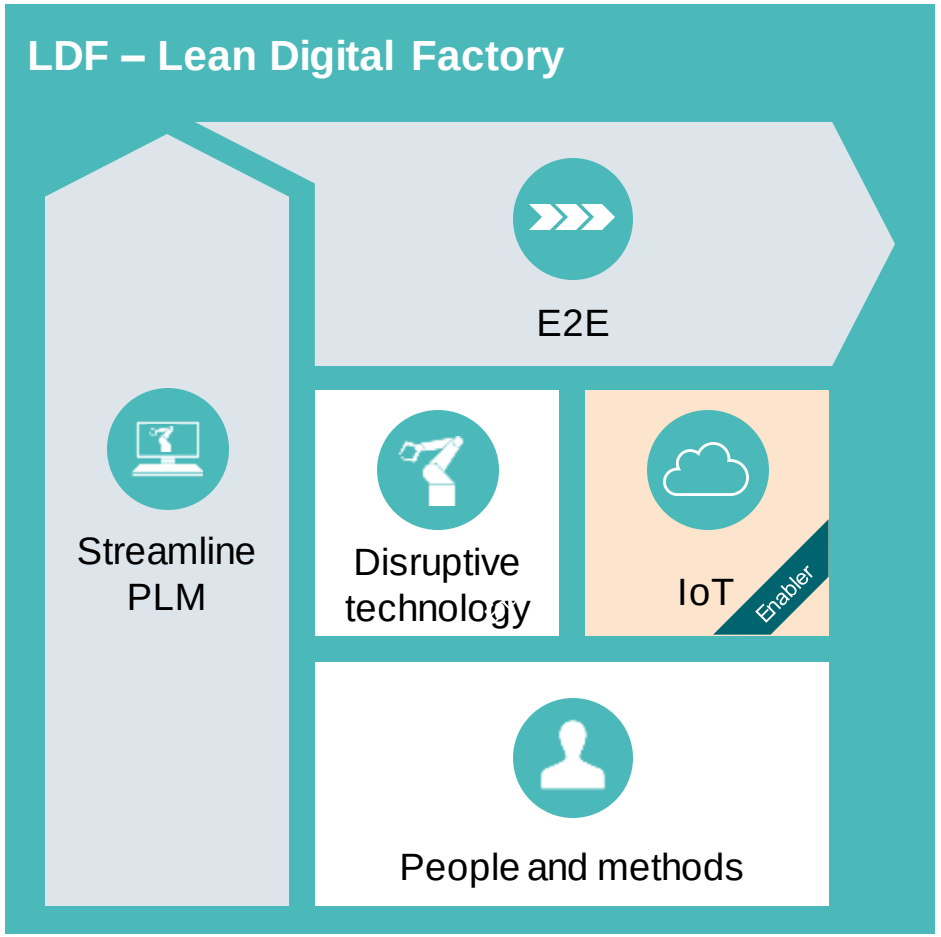
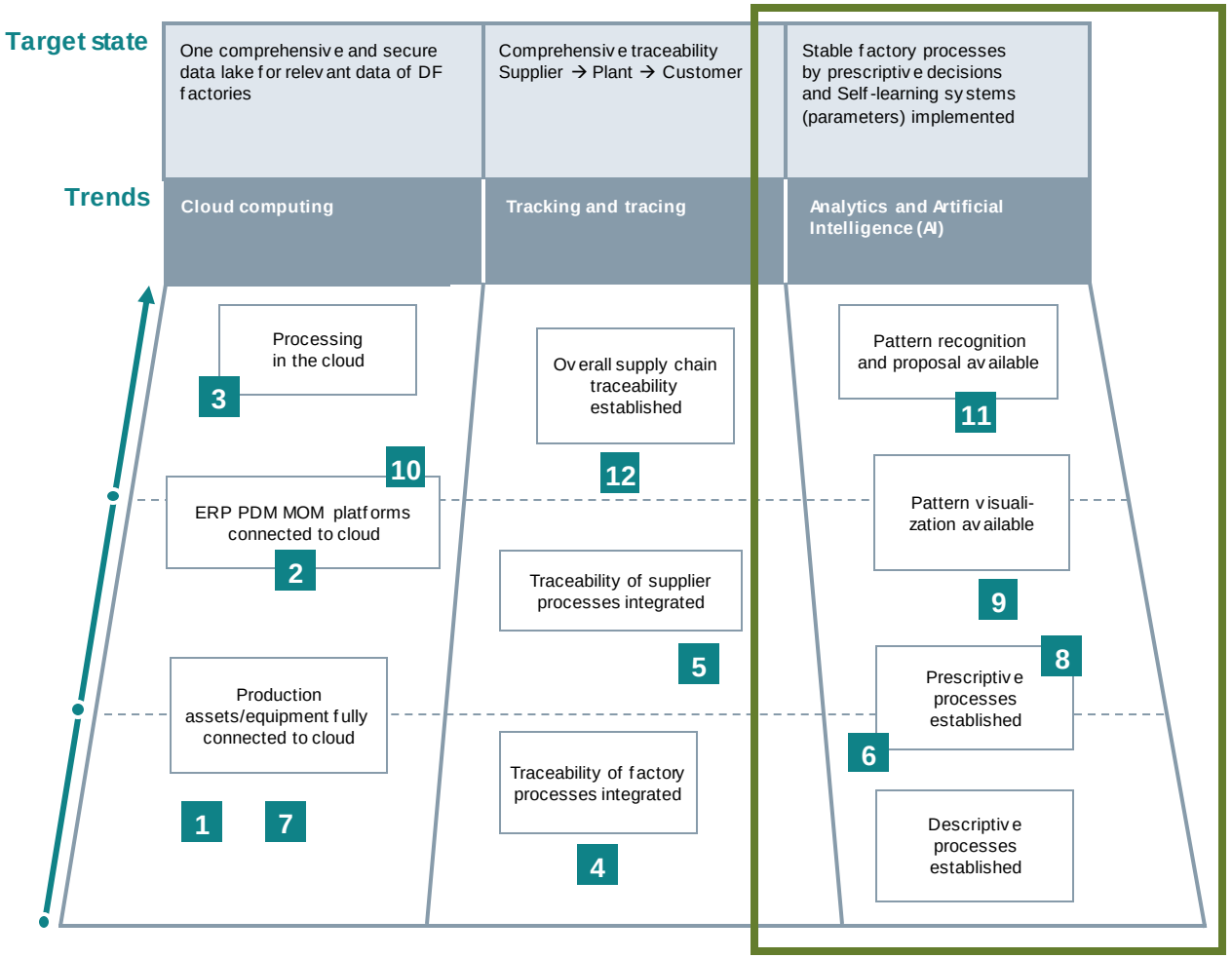
Lean Digital Factory (LDF) modules





Siemens Industrial Edge for automation and MDP on MindSphere Concept Overview

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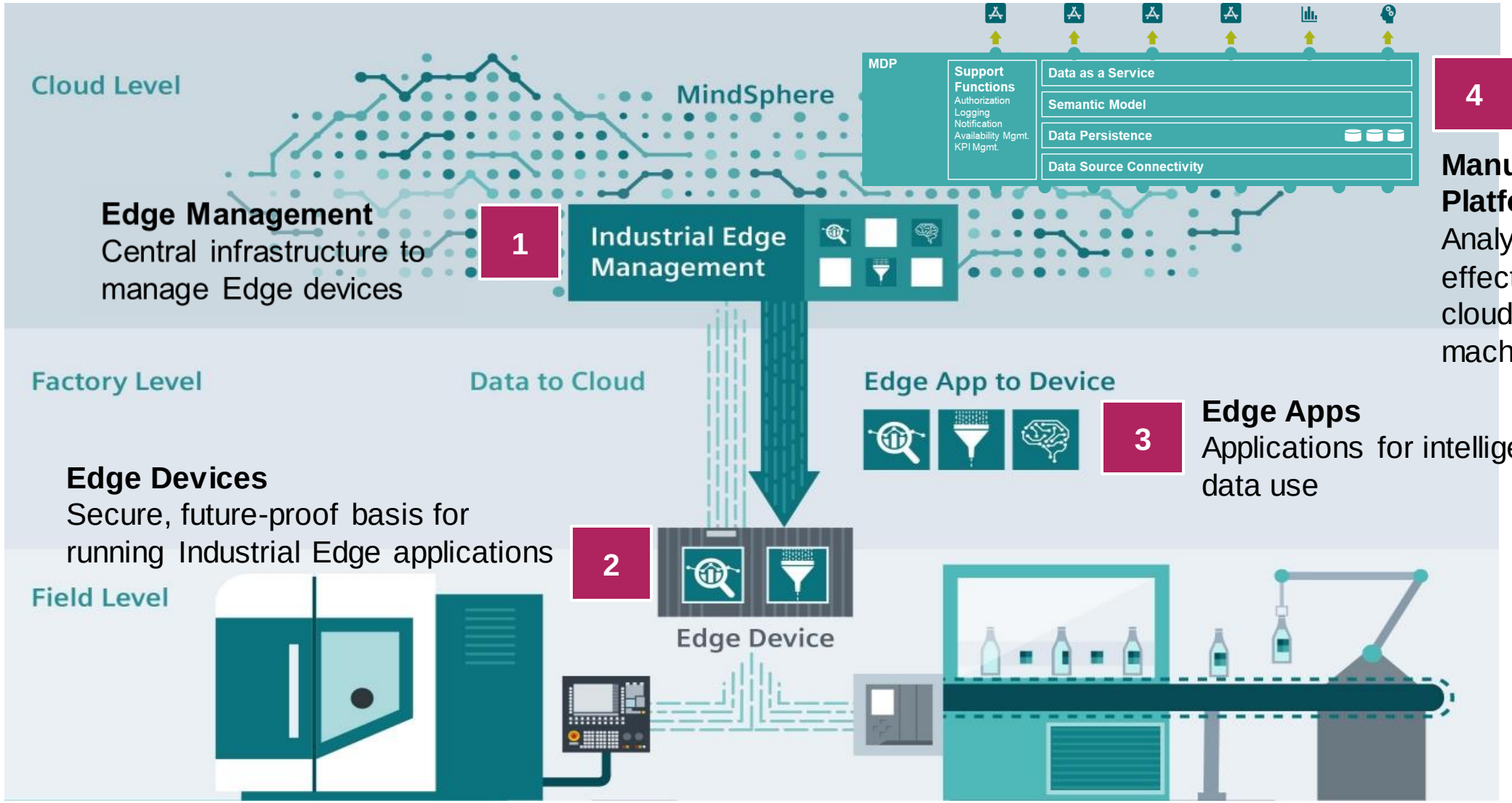

Manufacturing Data Platform
Analytics Factory for effective and scalable cloud computing and machine learning

Edge Apps
Applications for intelligent data use

Use Case Vacuum Gripper

Stabilization of packing machine by online monitoring of vacuum grippers

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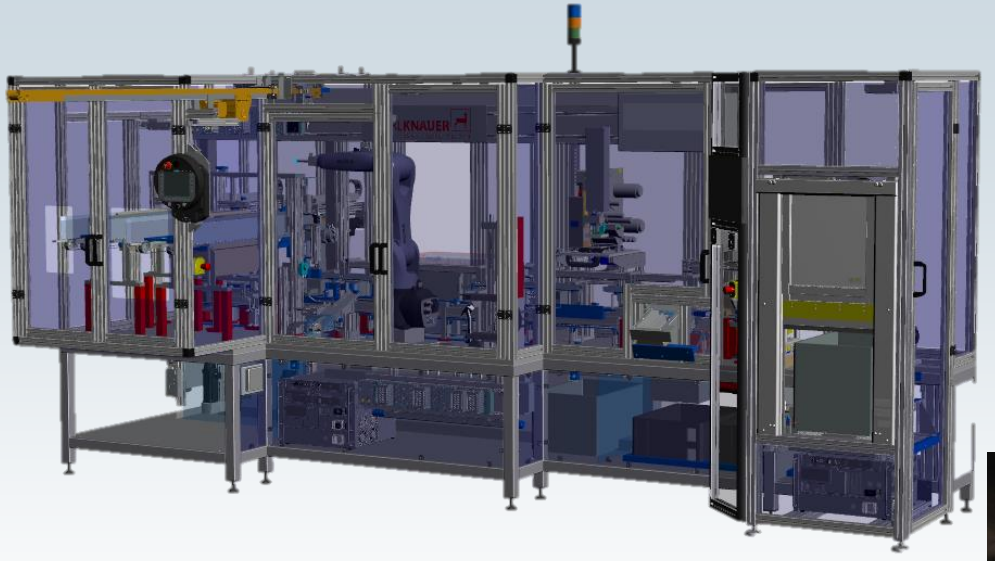
Challenge

Regular contamination of vacuum system due to heavy dust

Aggregation of process data without re-programming the PLC or intervention in the running process



In cooperation with

SCHMALZ

Splitting real time data for PLC and maintenance information for IT

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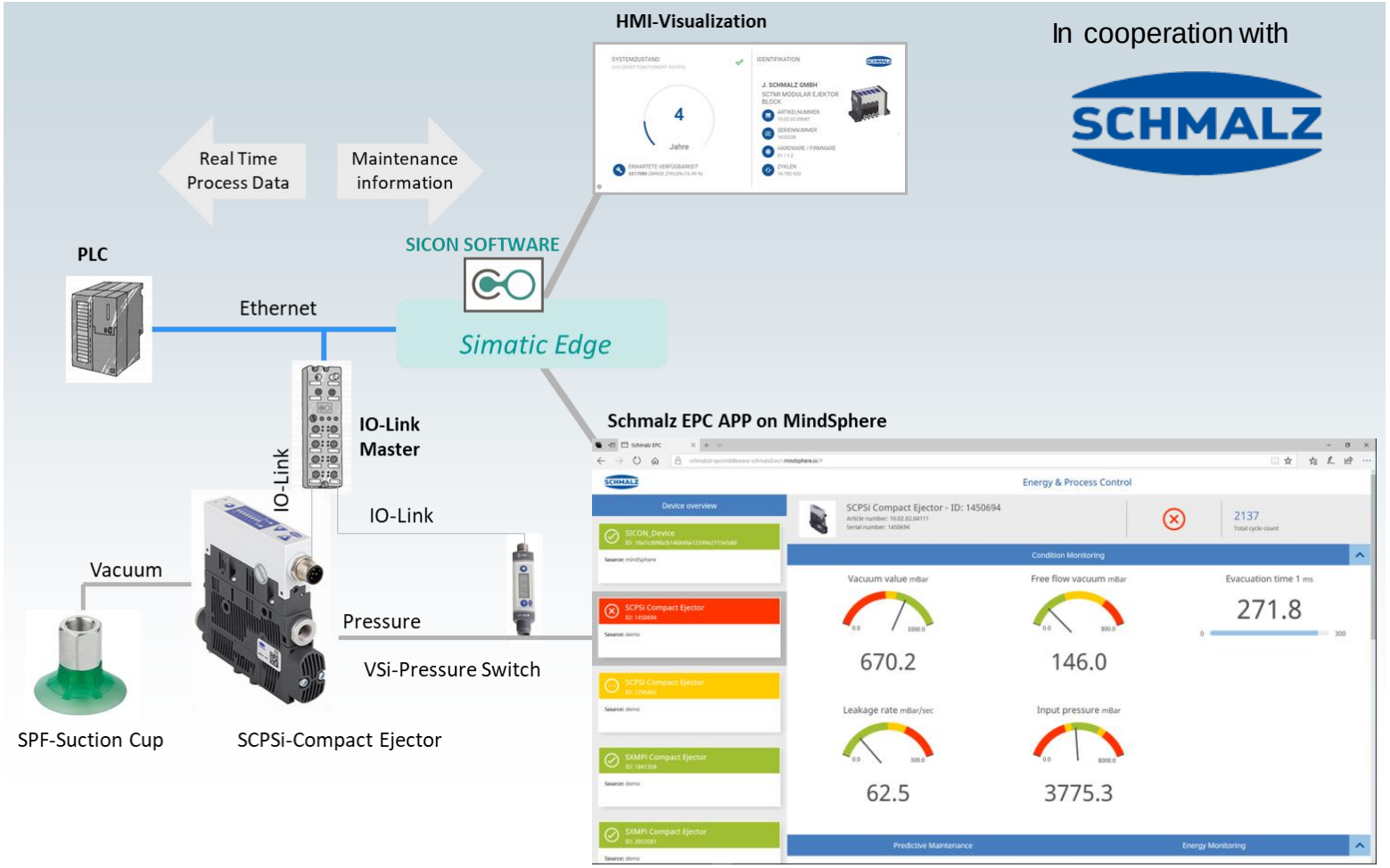
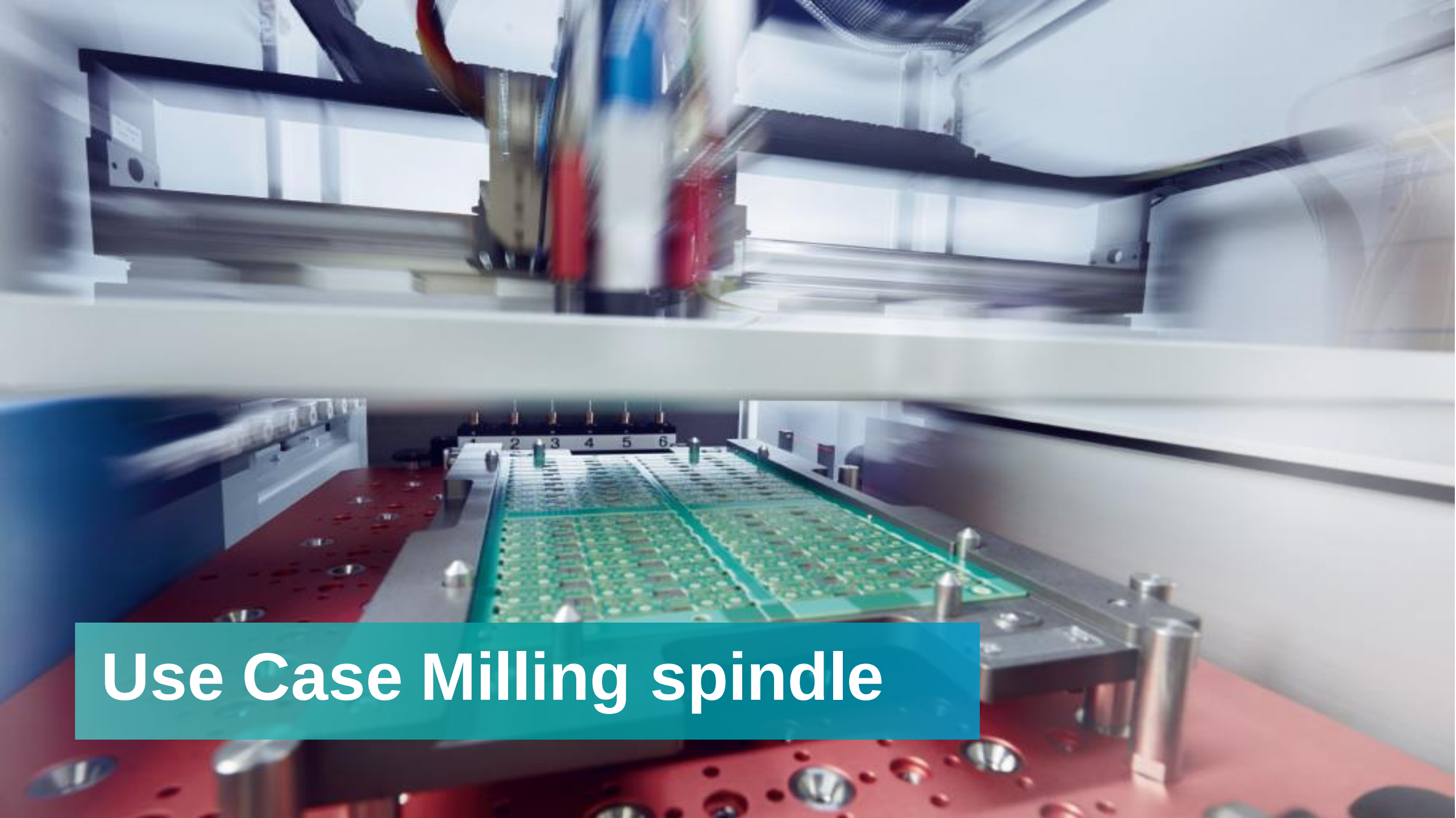
Solution

Easy integration of a Schmalz-specific condition monitoring in machine HMI and notification when to clean the filter

Utilization of the Schmalz EPC App with additional services

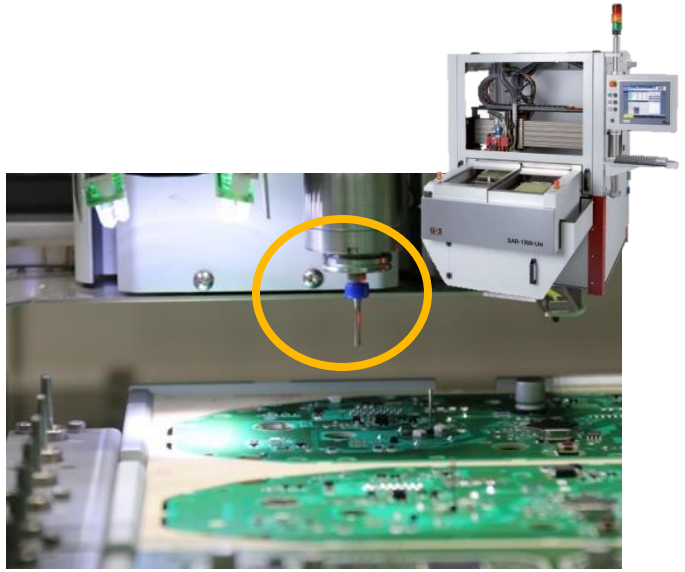
Scalable Plug&Play Connectivity

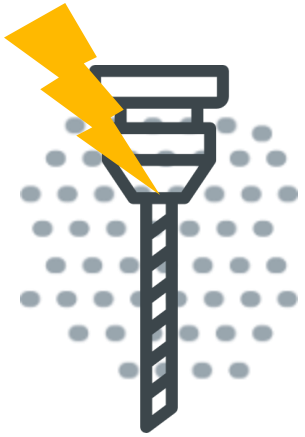


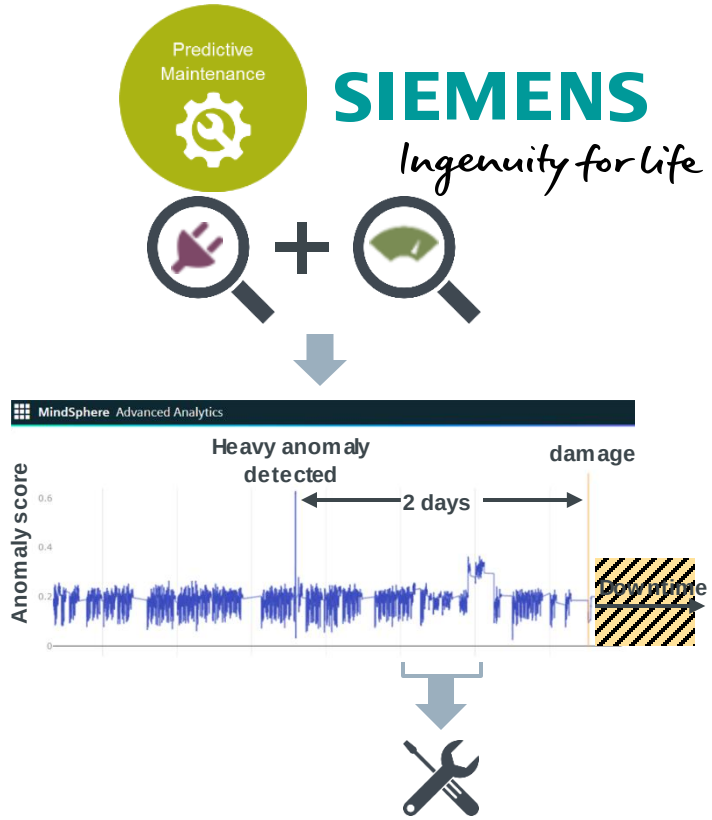


Use Case Milling spindle

Predictive Maintenance for depaneling machines







Objective:
Milling spindle in a printed circuit board depaneling machine

Problem:
Aggressive milling dust causes stiffness, which leads to machine failure

Target and approach:
Detect critical condition via current- and rpm analysis

- ✓ Edge app predicts downtime
- ✓ Cloud for alert & dashboard

Best results by combining different analytic methods

Predictive Maintenance

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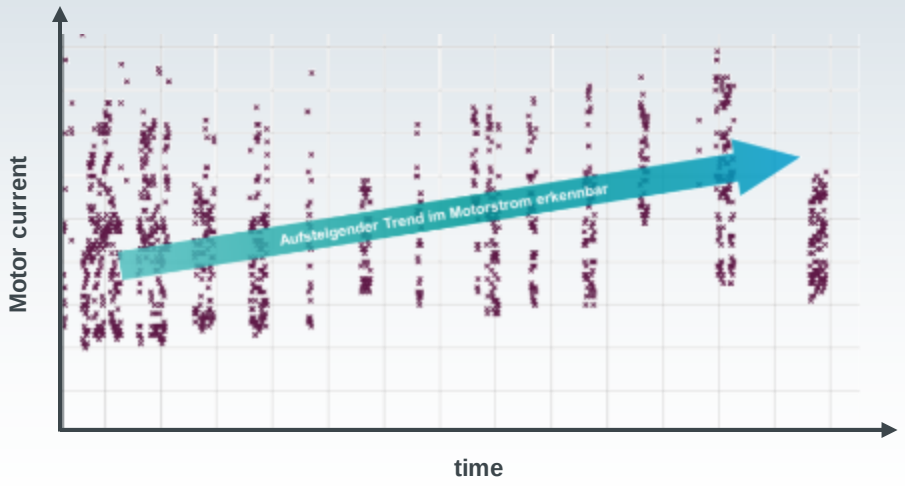
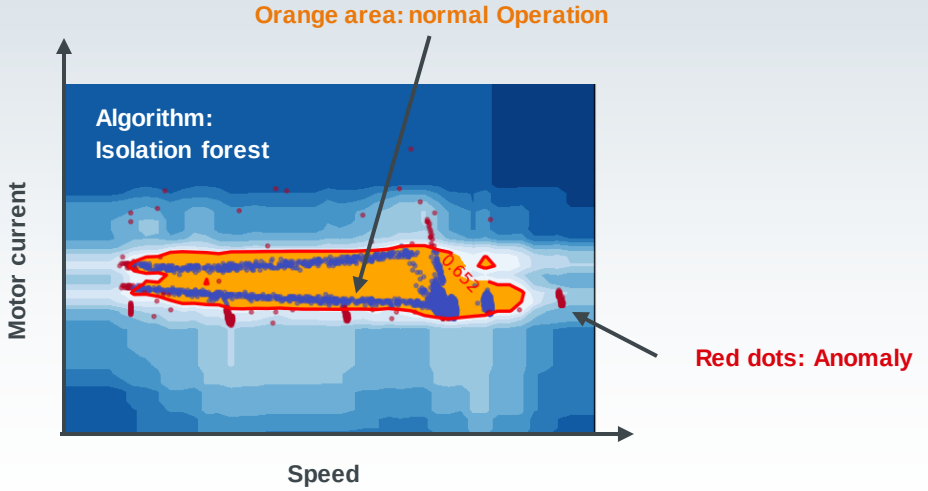
Trend analysis

Target: Locate downtime period

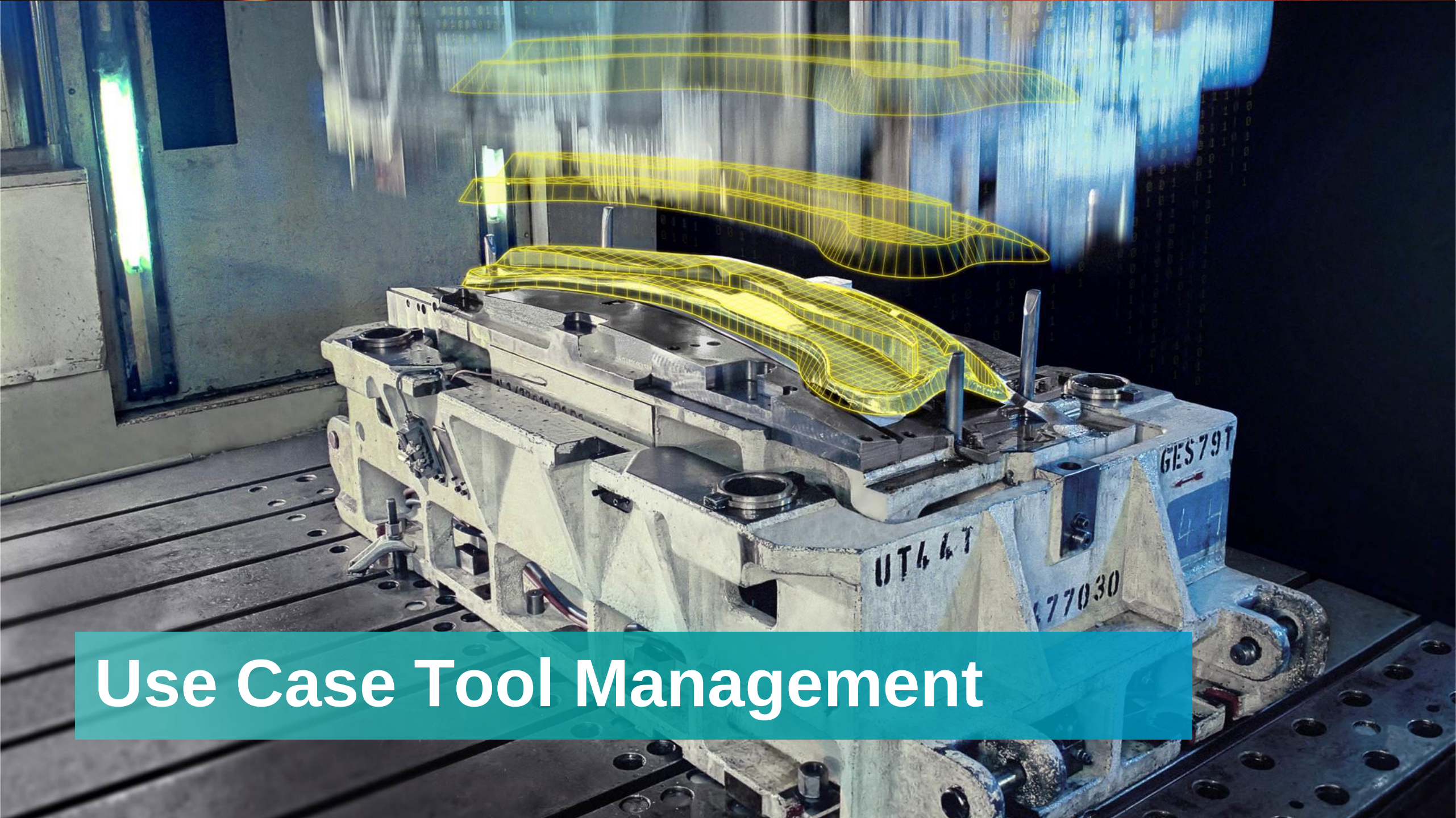


Anomaly detection

Target: Set trigger for service routine

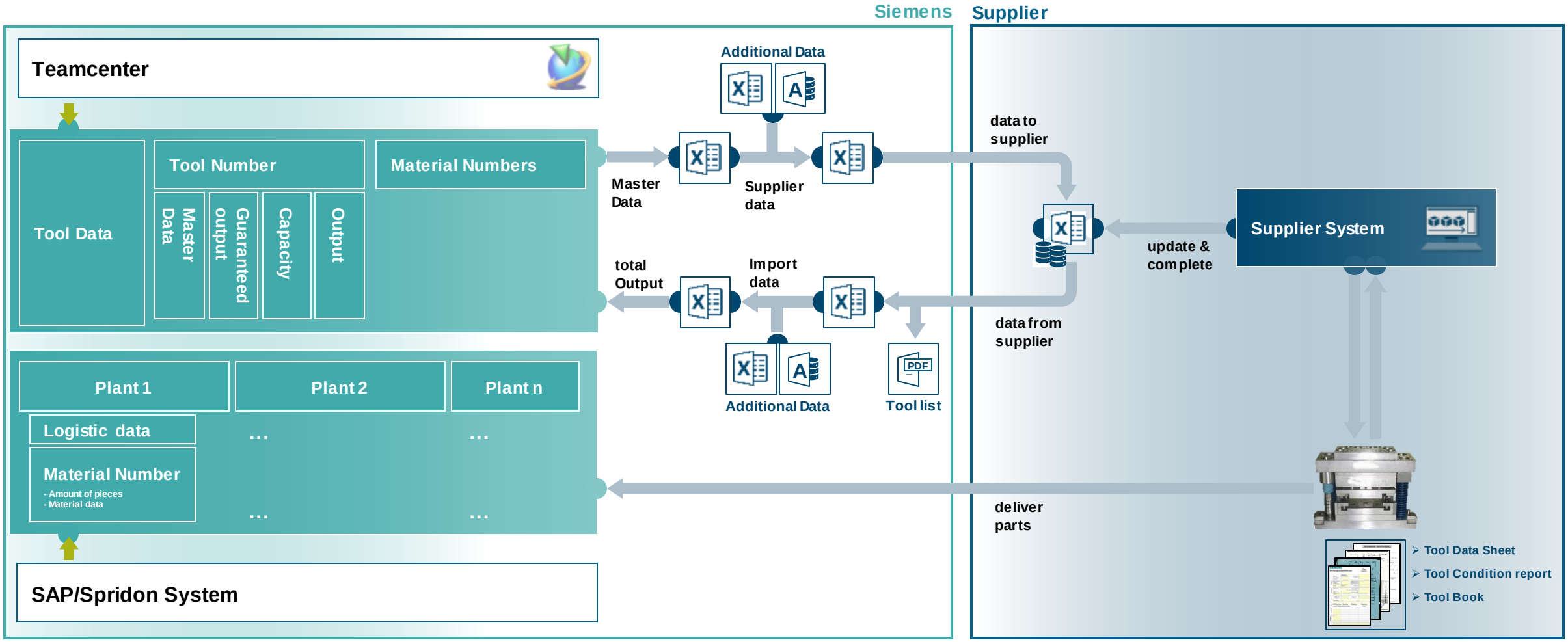


The algorithm detects downtimes up to 2 days in advance!



Use Case Tool Management

From the past… - where complex workflows were managed by tools between suppliers and Siemens



…to the future - where cloud technology as a data platform enables an easy tool monitoring and management

Supplier collaboration

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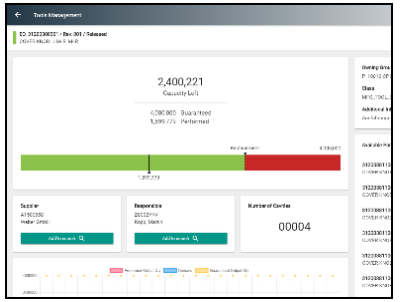
MindSphere

SIEMENS

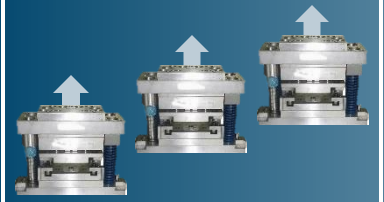
Tool Management



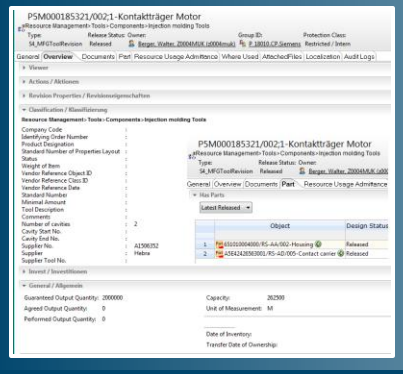
SUPPLIER

Dynamic Tool Data

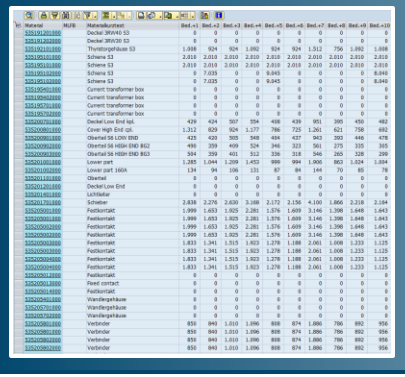
Production of parts

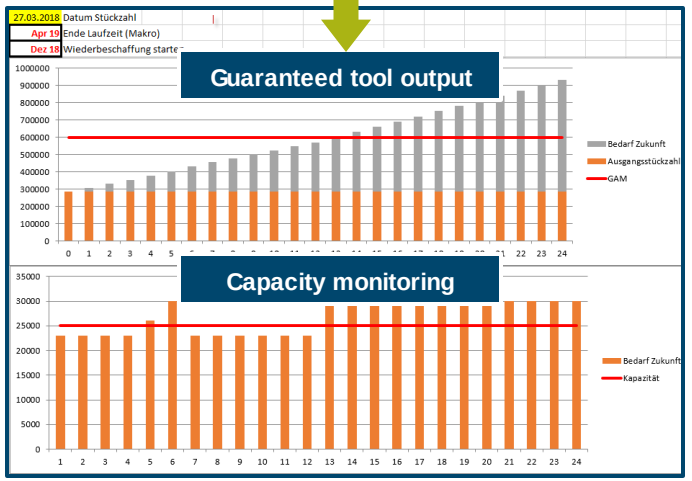


Tool Meta Data



Demand Data





People and methods

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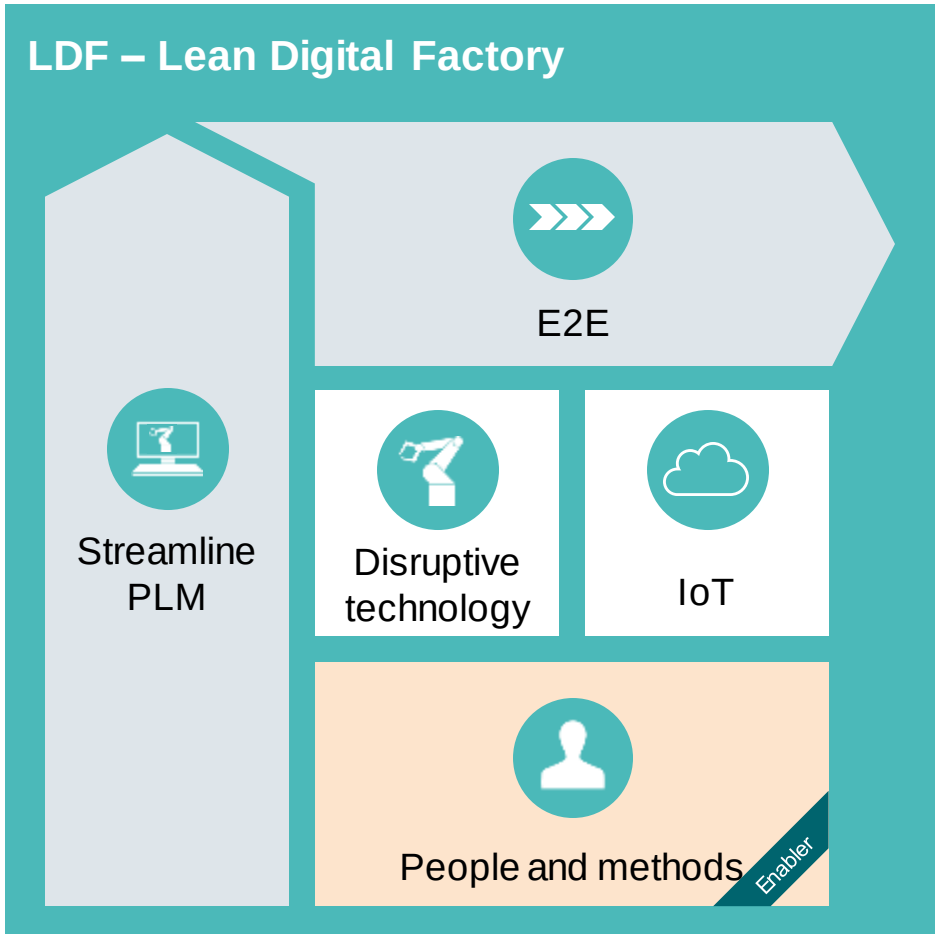
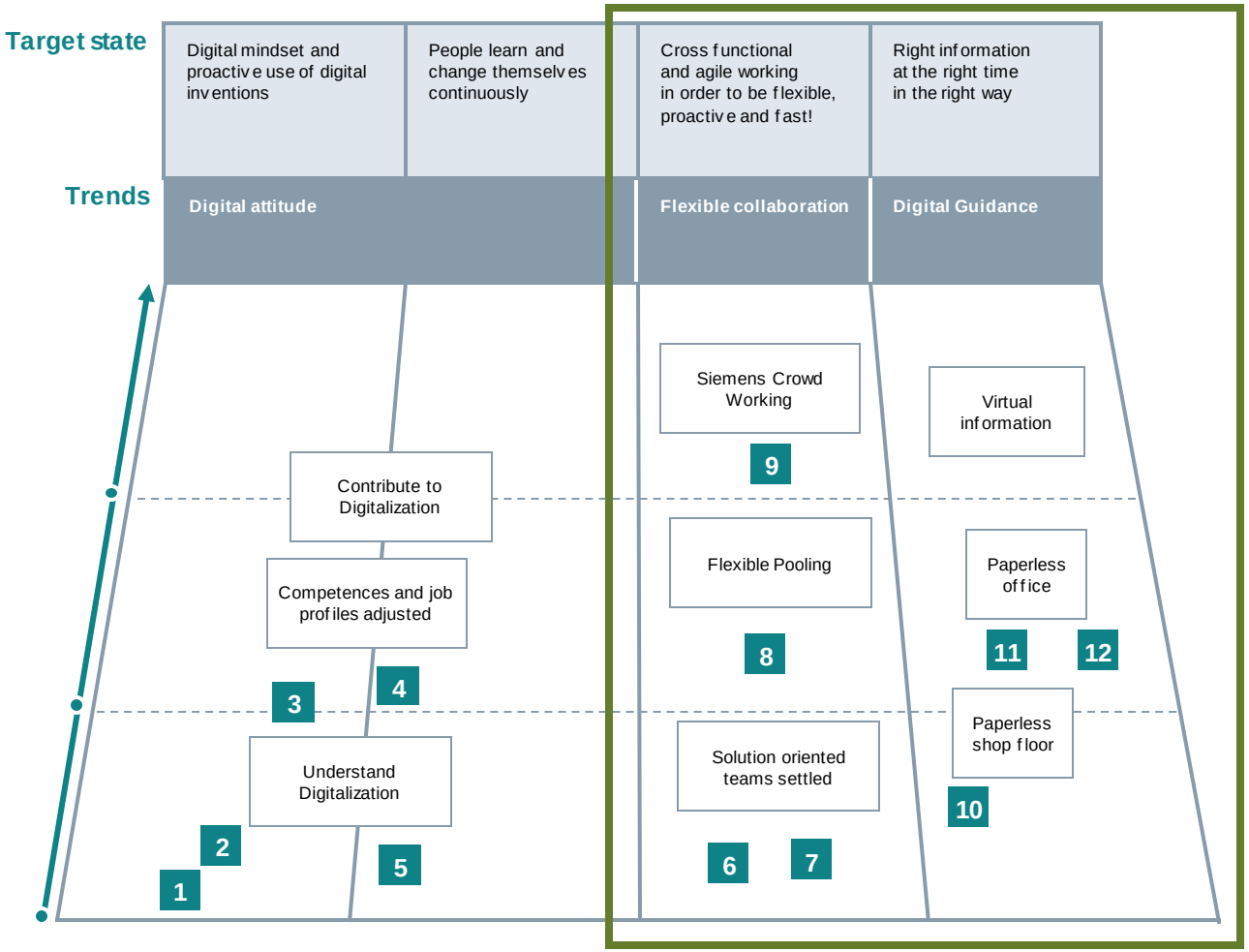
Lean Digital Factory (LDF) modules





Digital Time Management at a glance

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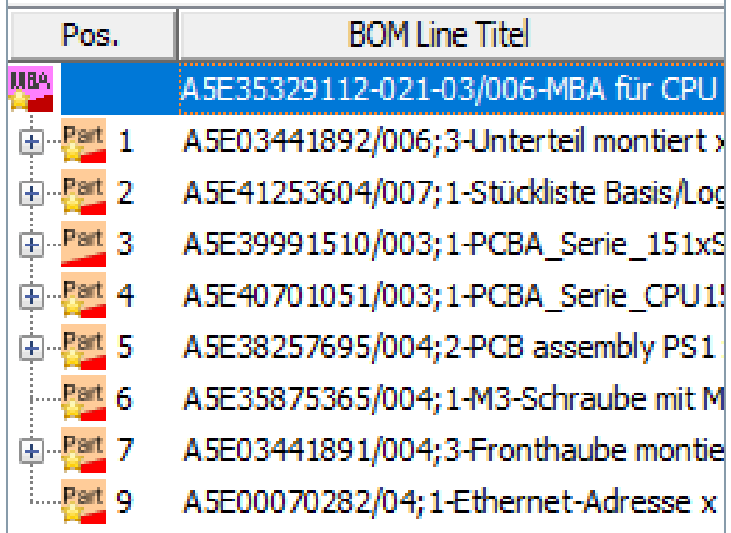
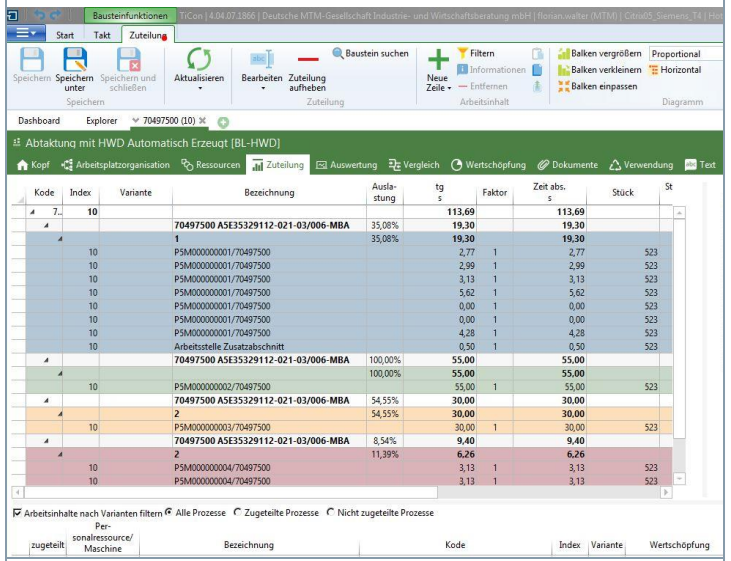
From TEAMCENTER Bill of Material



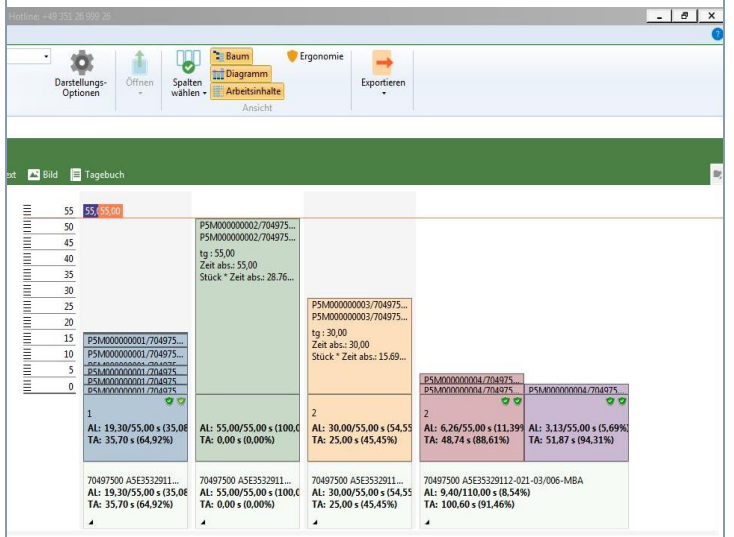
TEAMCENTER

… to bill of material with additional working time frames from MTM



TiCon Current LDF PoC Result

… to takt times for process optimization



Target state of the Digital Time & Ergonomic Management (DTM) full integration to Teamcenter

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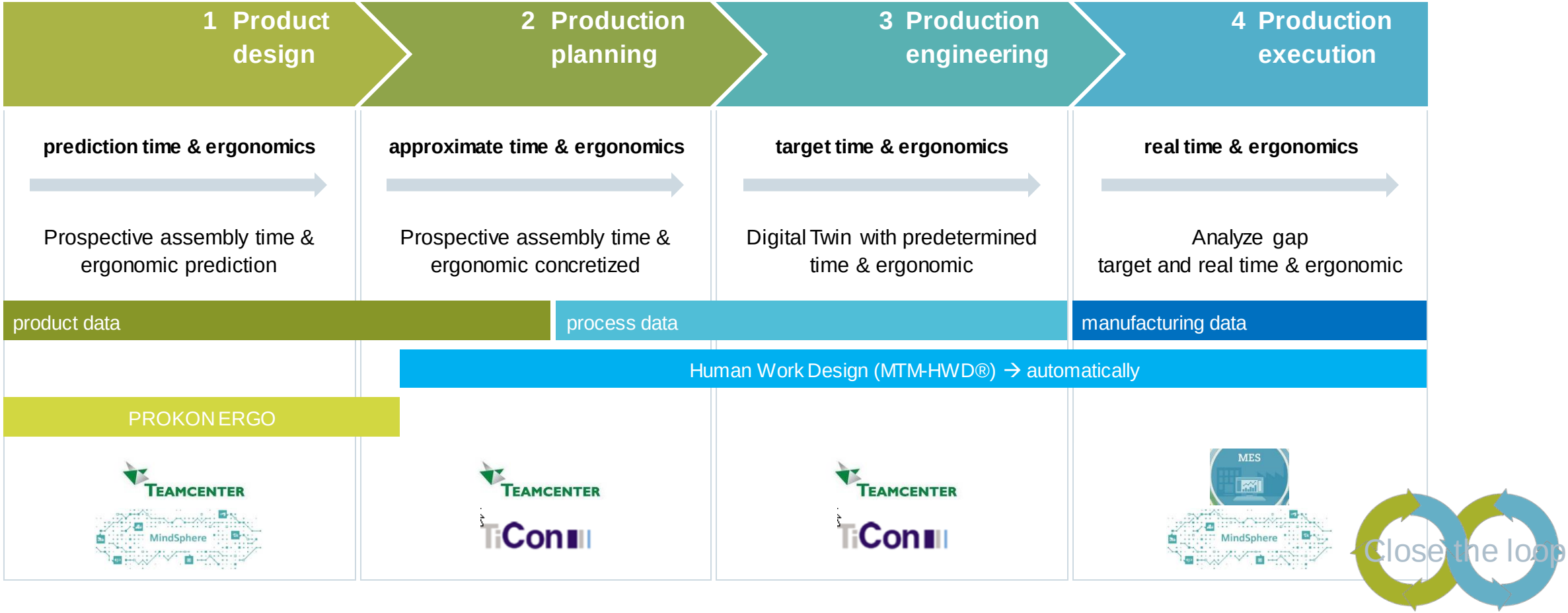
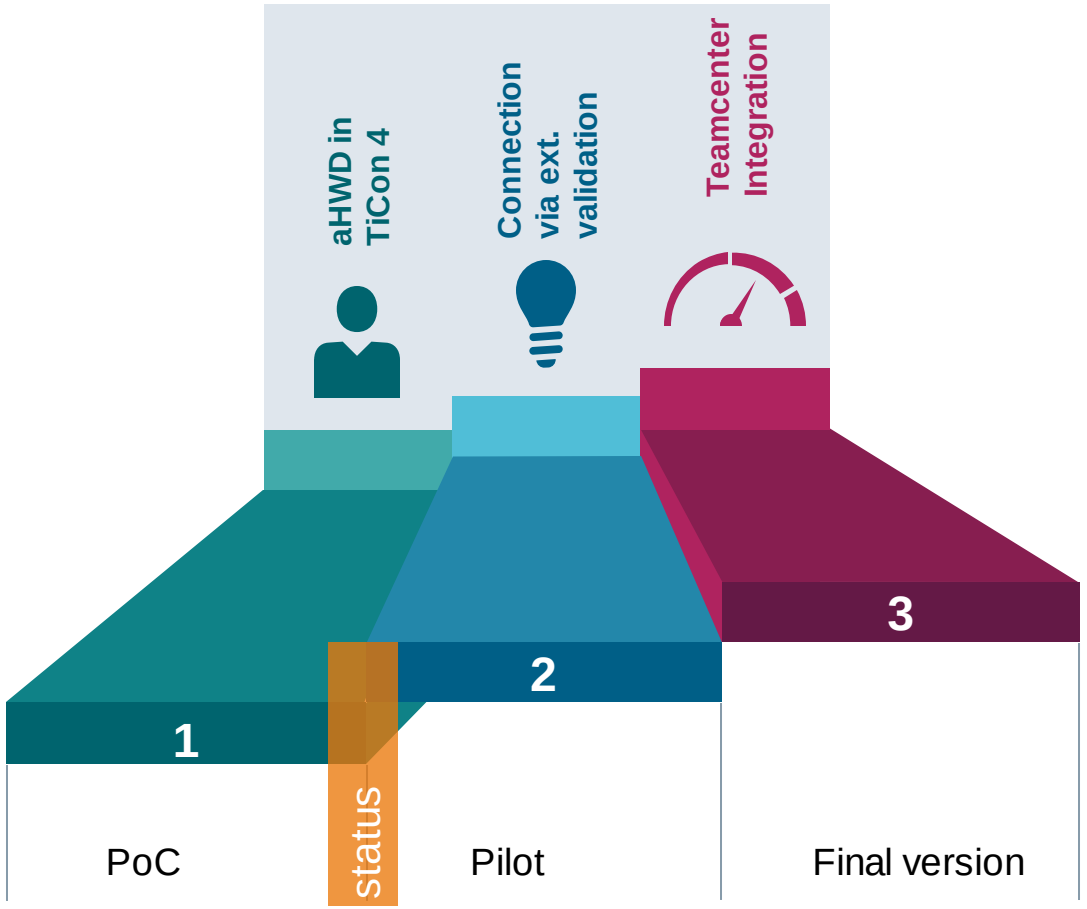


Stepwise concept of Digital Time Management integration into Teamcenter



1 aHWD Calculation at TiCon4

- Standalone development at TiCon4
- Manual Trigger
- Validation of Algorithm

2 aHWD Calculation with ext. Validation

- automatic Trigger
- Connection to Teamcenter
- manual transfer of the time values

3 Full integration to Teamcenter

- TiCon4Teamcenter
- Automatic HWD* calculation while generating new work plans or during changes

* Human Work Design

“New Ways of working” is the ability of our organization to react in a fast changing world supported by the digital inventions

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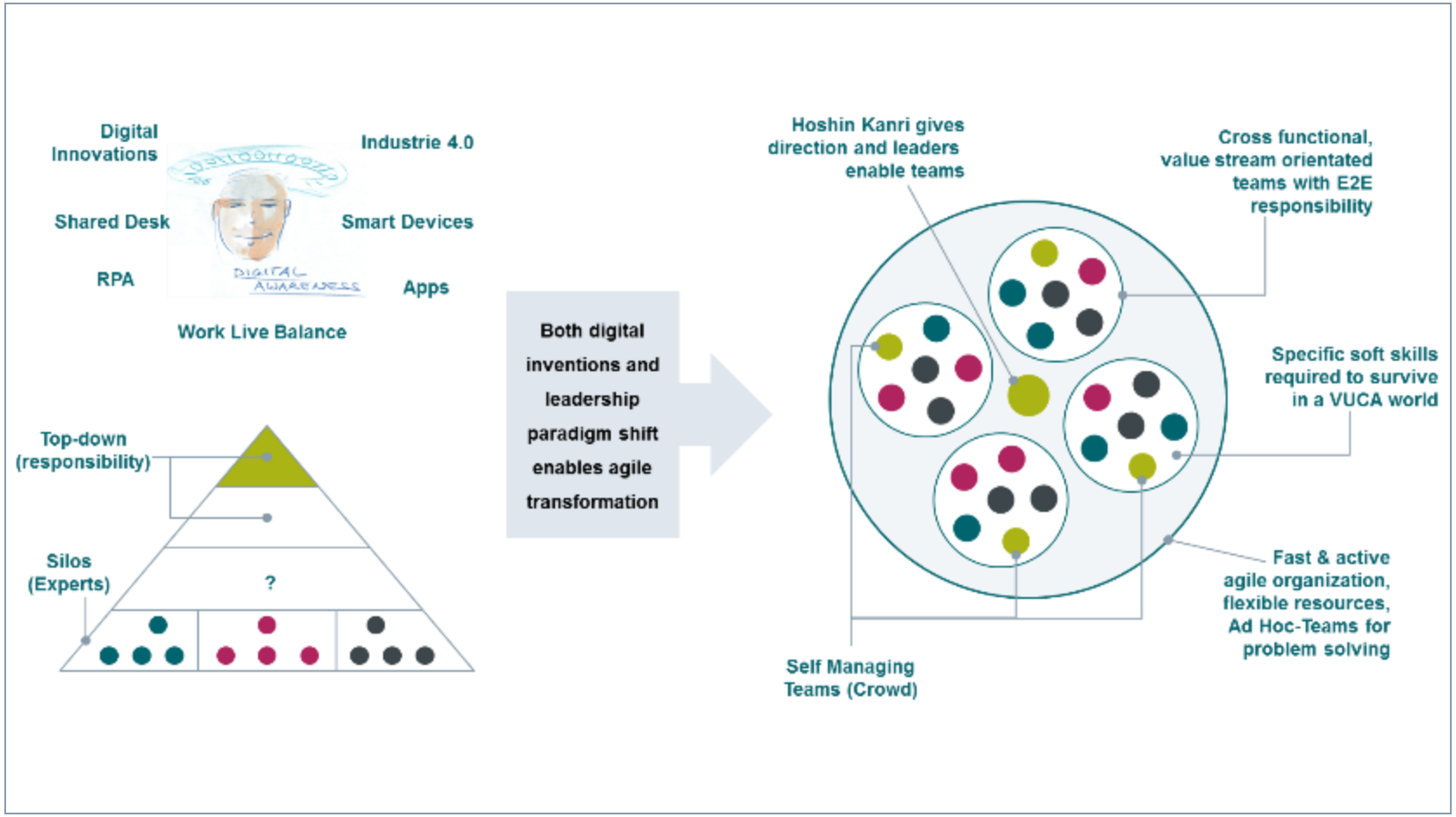
Example (LDF module: People and Methods)

Benefits

- Production is regarded as a modern employer
- Working in working groups is attractive and appreciated
- Collaboration is digital and intuitive
- Efficiency is strongly increased by working done by best fit and high automation degree
- Evolving a co-creation culture which acts accordingly to the needs of the system



Lean Digital Factory –
We are successfully together on the digital journey

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Optimization via Deep Learning

Future of Automation with Industrial Edge

Digital Twin

One voice

"Ready for Scale-Up"

New Ways of Working

Connection of 34 Factories to MindSphere Data Lake

Collaboration with MindSphere Partners

Together

Implementation of Smart Algorithms & AI

One for all with PoCs and pilots

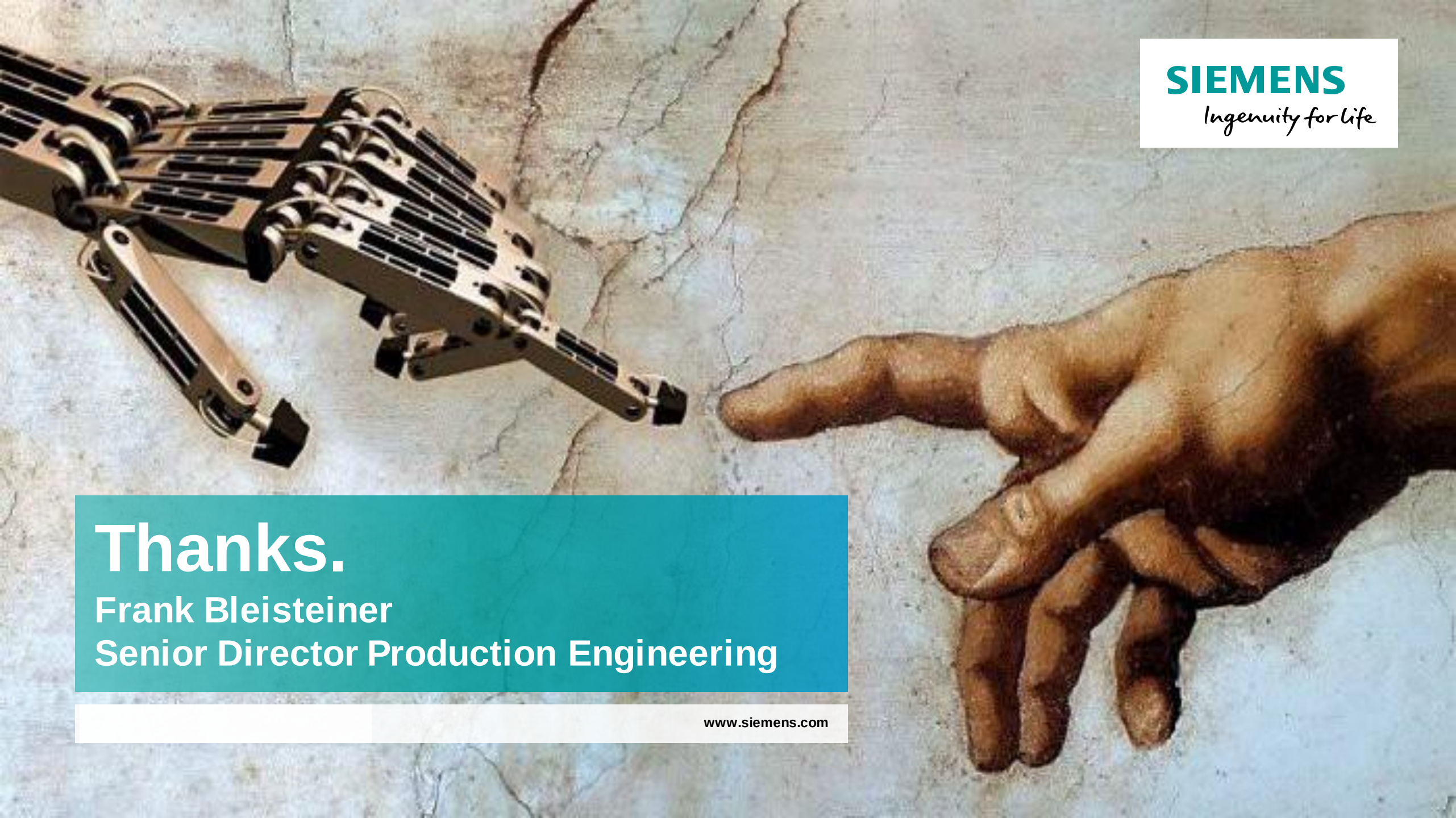
PoCs with Siemens portfolio

MES on MicroServices

Scale-up of Lightweight Robots and AGVs

Orchestrate AGVs with Master-Controller SIMOVE

Development of Digital Competencies



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Thanks.

Frank Bleisteiner
Senior Director Production Engineering

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