The intelligent connector as "enabler" of the Production Level 4 in the SmartFactory Kaiserslautern

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Agenda

- Production Level 4

  The smart Factory

- Production Level 4

  The intelligent connector

Production Level 4

Technologie-Initiative SmartFactory-KL e.V.
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Technische Universität Kaiserslautern

smartFactory KL®

DFKI IFS Innovative Fabriksysteme

WS KL Werkzeugmaschinen und Steuerungen TU KAISERSLAUTERN

The smartFactory KL®

2002 — Scientific Background

2005 / 2006 — Foundation 7 Members

2011 — Industrie 4.0 defined

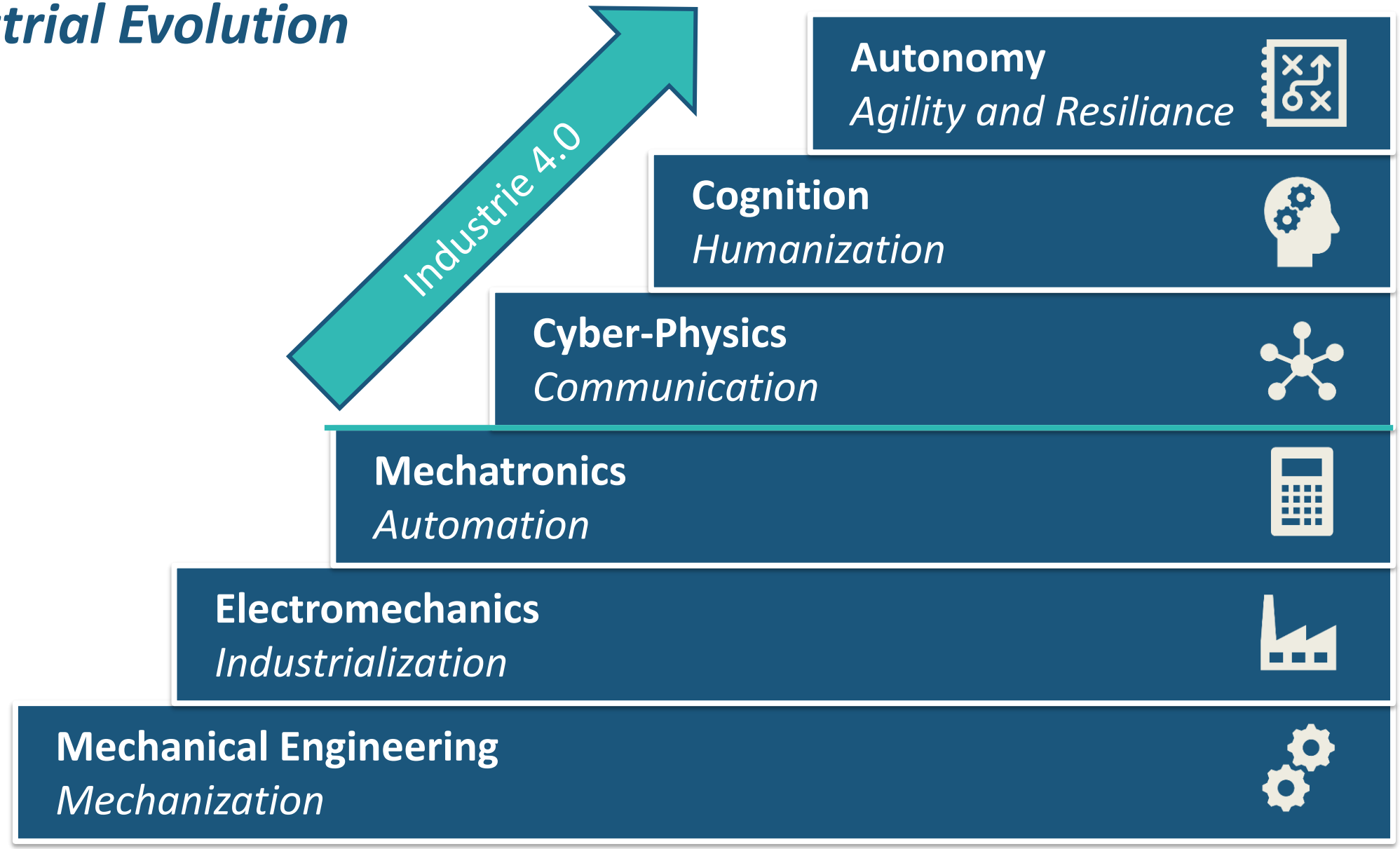
2014 / 2016 — SME Center of Excellence

2018 — 50 members

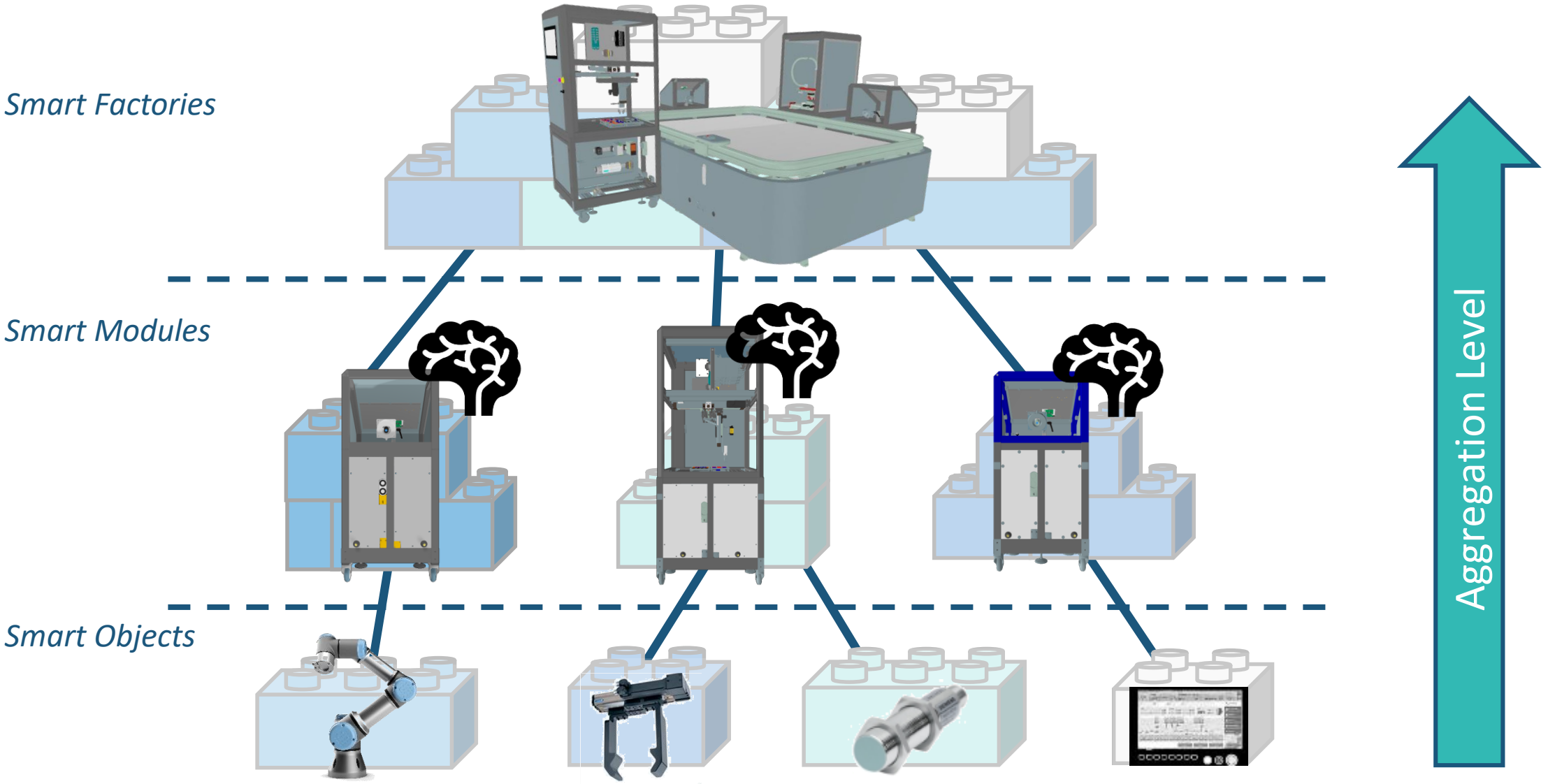
2019 — Vision 2025

2020 / 2021 — gaia-x, smart MA-X

Industrial Evolution

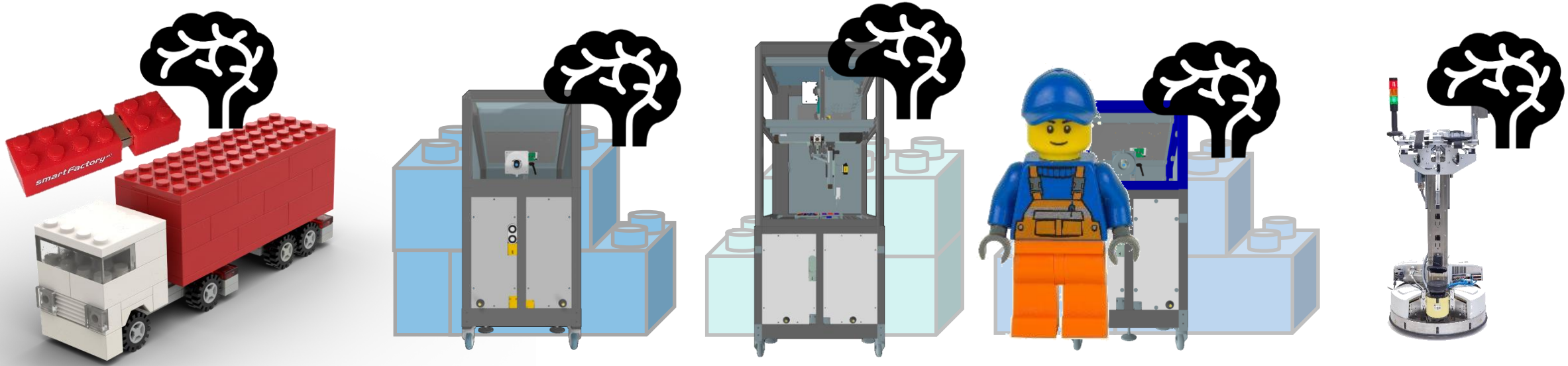


SmartFactory Architecture



Autonomous Production

Orchestration
(Flow Control)



SmartFactory KL and Production Level 4

- **Industry 4.0** generally describes the 4th industrial revolution.
- **Production Level 4** concretises Industry 4.0 in the form of a new architecture of the Smart Factory, the highly flexible and therefore modular production system of the Smart Factory KL.
- **Production level 4** refers to the autonomy levels and sees level 4, i.e. the partially autonomous production plant with the leading participation of humans, as the relevant level of future modular production plants.
- Modules of the modular production systems provide a production service that can be easily integrated into the overall system through assistance systems and is highly available through extensive autonomy.

Production Level 4
The intelligent connector

smartFactory KL®

IFS Innovative Fabriksysteme

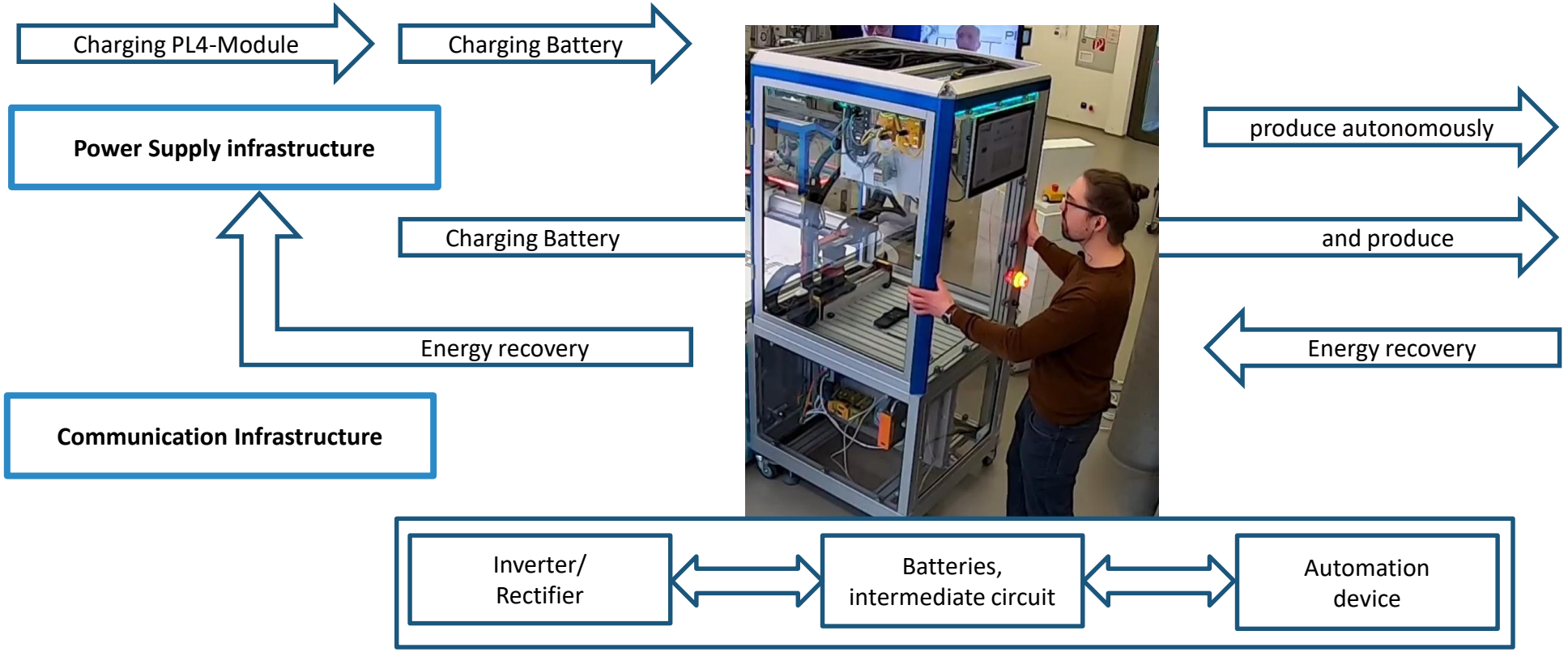
WS KL Werkzeugmaschinen und Steuerungen TU KAISERSLAUTERN

The role of the connector for Production Level 4

- Production Level 4 establishes autonomous functions in the modules in which the connector plays a key role as the user interface and as a connection to the infrastructure of all lifelines.
- The module as an entity must autonomously ensure that it is and remains coupled to the appropriate lifelines and can also be decoupled in the correct state (e.g. load-free) at the request of the user.
- Functions of the smart connector **(Smart Electrical Connector, SmEC)**:
  1. Connection with power (AC 400Volt / DC) and communication (Ethernet)
  2. Identification of the plugged connector and checking for compatibility
  3. Secure locking of the socket when the module is in operation
  4. Unlocking if required by socket / module, depending on the status

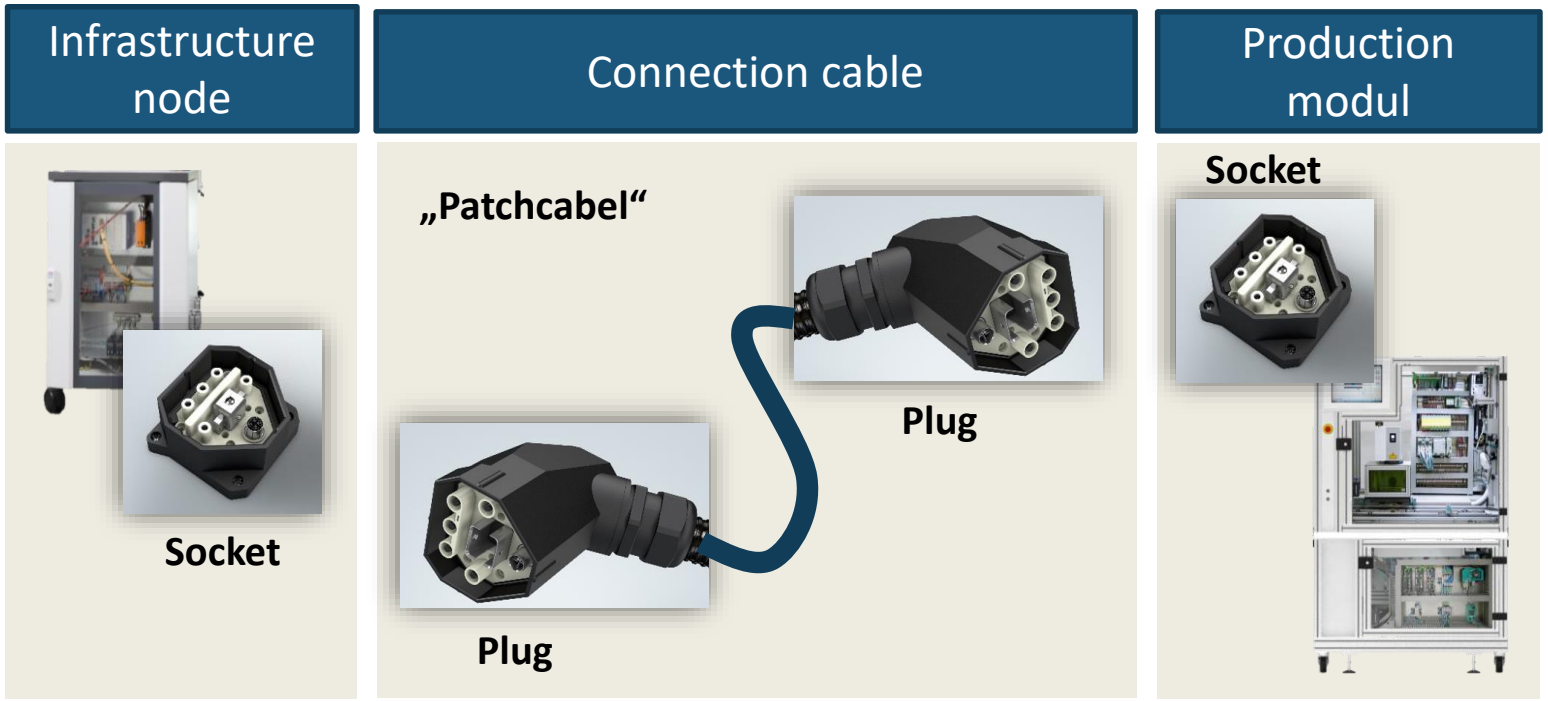
The future of Production Level 4 in the Smart Factory KL

Autonomy also requires a permanent supply: future PL 4 modules are "always-on" thanks to a battery



The character of the infrastructure is changing from a permanent supply infrastructure to a temporary charging infrastructure. This has implications for the connector.

The architecture of the smart connector in the Smart Factory KL



Actuators:

- **Locking**
- **de-blocking**

Sensors:

- **Mated state**
- **Measuring functions (e.g. temperature, current)**

- Plugs are simple electromechanical components with no additional function

  Additional smart functions are only implemented in the socket
- Sockets for infrastructure nodes and production modules are identical, so that they are connected using a symmetrical "patch cable"

It must be possible to address sensors and actuators from the Infrastructure Execution System

The smart connector in the context of Industry 4.0

Standardized
Industry 4.0 communication

Services interface

AAS

AAS

Asset
Administration Shell
(„Digital Twin“)

Integration over
active communication
of the socket

Integration based on
assignment and changes
by user / system

Socket

Plug

Communication

Data exchange with the
I4.0 component

Business

Business processes

Functional

Functions of the I4.0 component

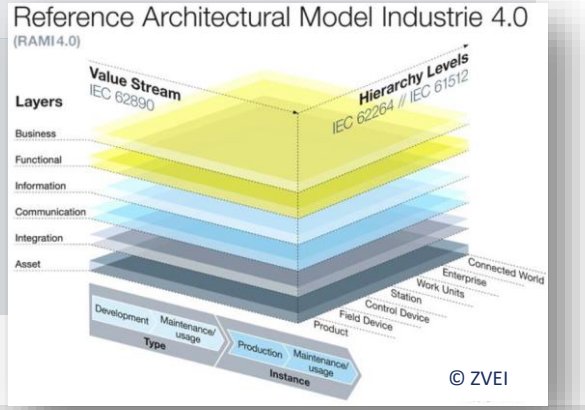
Information

Data of the I4.0 component

Integration

Expansion of the asset
to I4.0 component
(cyber-physical system)

Asset



Status of standardization and implementation

standardization

- DKE / AK 651.0.3 develops a draft for the initiation of an international standards project (IEC)
- Standard includes use cases
- The modular structure of the standard allows different mating faces to be accommodated
- Planned appendix for electromechanical sockets without additional functions

implementation

- The SmartFactory KL has various prototypes
- The SmartFactory KL is evaluating and improving the software implementation

Smart Electrical Connector as a class of connectors

differnt mating faces

Summary and Outlook

summary

- SmartFactory KL provides input and evaluation for a standardization project for an intelligent (Industry 4.0) connector with additional functions (Smart Electrical Connector, SmEC)
    - The data model and service interfaces of the SmEC are defined by considering different use cases and implemented using asset administration shells (AAS)
    - Actuators integrated in the SmEC socket are addressed via the I4.0 communication layer

outlook

- The international standard project for a generic SmEC will be finalized
- Other mating faces for different use-cases will be added, e.g. for DC

The smartFactory KL® Network

As of: Jan 1st 2021

Sequence diagram for the application “mating”