PRODUCTION LEVEL 4

Resilient, Sustainable, and Flexible
Shared production implemented in Kaiserslautern

smartFactory KL®

PREFACE

"We need to completely rethink production, that's the goal of Production Level 4."

Dear Reader,

Last year, we presented some parts of our shared production at the Hannover Messe (Industry Fair). The response was overwhelmingly positive. We had numerous conversations at the stand and made many new contacts that may serve as new start points for future work projects.

A lot has happened since then. The Federal Ministry for Economic Affairs and Climate Action (BMWK) endorsed our vision for ***Production Level 4*** and launched the Manufacturing-X initiative, which we support to our utmost ability.

Production Level 4 also provides a foundation for implementing new regulations concerning the CO_2 footprint. At our production station KUBA, we demonstrate how the CO_2 values from production activities are captured live and stored in the administrative shell. In addition, we store energy consumption data and information about the materials used. In this way, recycling rates improve and, looking to the future, the circular economy comes within reach.

In developing the production of the future, we pay particular attention to the issue of safety. An intelligent safety concept is necessary from the start to ensure that flexible manufacturing architectures can be used on the shop floor. We concentrate development on dynamic and AI-controlled technologies that focus on productivity as well as on the more conventional methods. In this way, we hope to increase value creation.

I hope you enjoy reading these pages. Perhaps, you will find some new ideas among them that will support your work.

With this in mind,
Sincerely,
Martin Ruskowski

Prof. Dr.-Ing. Martin Ruskowski
Chairman of the Executive Board of
der *SmartFactory*^{KL}

CONTENT

PRODUCTION LEVEL 4 — Page 04

SHARED PRODUCTION — Page 05

THE PRODUCTION STATIONS — Page 07

SMARTMA-X: GAIA-X AND THE INDUSTRIE 4.0 DATA SPACE — Page 12

TECHNOLOGIES — Page 15

SCIENCE AND INDUSTRY — Page 18

DEMONSTRATOR PARTNERS 2023 — Page 20

SELECTED RESEARCH PROJECTS — Page 32

CO-EXHIBITORS AT HM 2023 — Page 37

THE ASSOCIATION AND ITS MEMBERS — Page 38

MEMBERS — Page 39

PRODUCTION LEVEL 4

Production Level 4 (PL4) is the dynamic upgrade of the Industrie 4.0 (I40) concept and was formulated in 2019 by the ***SmartFactory***^{KL} network.

The original idea of I40 from the year 2011 has been greatly enhanced with new technologies like artificial intelligence, cloud architectures, and high performance computers. In addition, PL4 emphasizes the central role of humans in production, who, unlike machines or software, have unique capabilities such as error analysis, system optimization, and creativity. PL4 adheres to the concept of subsidiarity in manufacturing, aiming for automation level 4 where humans are still able to intervene in the final decision. Transparency of production is paramount.

We have established the initial implementation as a skill-based shared production ecosystem in Kaiserslautern. We plan to continuously develop the operation over the next few years.

SHARED PRODUCTION

Shared production is based on configuration service systems (CSS model). All registered services in a secure data space can be accessed. These can include AI operations as well as machine capabilities like drilling or mounting, transport capacity, and quality controls.

Every asset is identifiable and accessible via its administrative shell. Dynamic supply chains for a product can be created from these technical offerings. In our vision of ***Production Level 4***, the product to be manufactured is entered into a data space. Software agents then independently prepare a kind of blueprint as to how the product can be manufactured and what services, capabilities, and skills are needed. Someday soon production bots and software agents will be able to coordinate and monitor the production.

In the future, it will be possible to account for variables like the CO_2 footprint and the energy consumption in addition to the physical description of the product. On the basis of these requirements, preference will be given to the supply chains (e.g., the machines) that best satisfy the needs, i.e., the lowest CO_2 footprint or the most energy saving manner. You see how sustainability becomes a competitive advantage.

In our PL4 system, we start with the product to be manufactured. Our focus is on the output. Often, different manufacturing methods can be used that deliver identical results. For example, a pocket in a plastic block can be drilled or milled. Potential providers/companies in the shared production data space can be identified and the alternative production routes can be quickly compared. The important thing is that the customer receives the desired product at the specified conditions and parameters. The different providers become compatible by the use of Gaia-X in the data space.

WHAT PART DOES THE ADMINISTRATIVE SHELL PLAY?

The key element in shared production is the asset administration shell (AAS). In the future, each asset will be described by its asset administration shell (AAS). The shell may contain (dynamic) data such as material composition, production history, CO_2 footprint, manufacturing instructions, etc. It can also be expanded with the addition of sub-modules. The AAS enables communication between all services in the data center.

SHARED PRODUCTION KAISERSLAUTERN

Different services are implemented at three locations in Kaiserslautern, where four modular production stations perform the work: transport system, AI operations, a manual work station, assembly, 3D printing, quality control, etc.

The communication is Gaia-X compliant and operates skill-based as shared production via AAS. The four production stations are named _JAVA, _CAPRI, _KUBA, and _MILOS.

Shared Production in Kaiserslautern - How does it work?

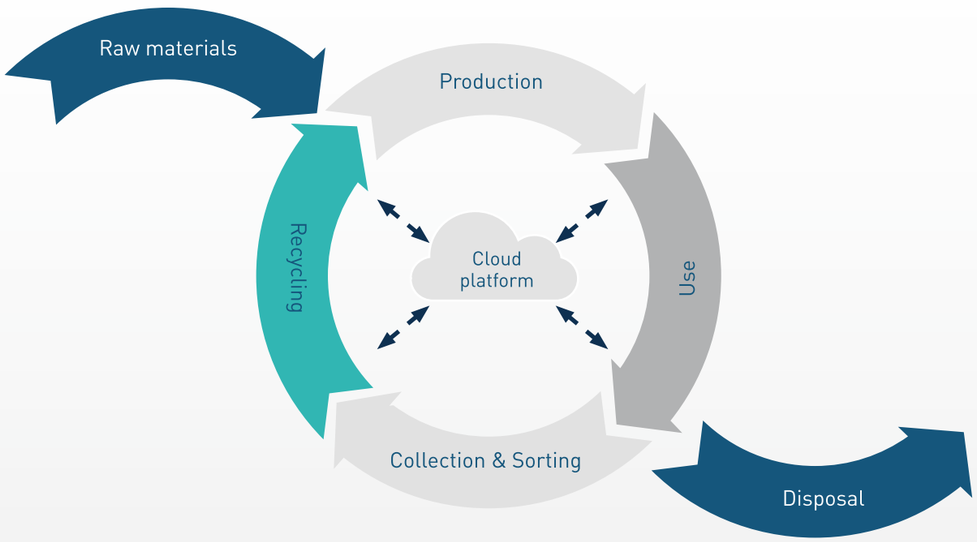
As an example, in the ***Production Level 4*** demonstrator ecosystem, we manufacture a model truck as the product. The customer can individually configure the truck to be manufactured and each production station takes over certain tasks in the production process of the end product. The configuration determines which modules and production stations are involved in manufacturing the necessary parts. The services (capabilities) are offered, selected, and individual work steps coordinated via the administrative shell: for example, milling, quality controls, transport, assembly, etc.

Currently, the production sequence is created by a product configurator. The customer configures the desired truck. Via a Gaia-X data space, a matching platform queries the services and assigns the tasks. The connected services begin their respective tasks after coordinating the production steps. At the end, the customer awaits the output of the desired truck.

The product-specific CO_2 footprint in shared production

Currently, it is possible to calculate and transparently display the CO_2 footprint of each model truck. In addition, the software generates a Product Carbon Footprint (PCF) certificate. In the future, it will be possible to enter many other properties of a product, such as the recyclability of its materials, or optimization potential in production processes.

The Digital Lifecycle File



THE PRODUCTION STATIONS

Our ***Production Level 4*** ecosystem consists of individual production stations, representing different companies. They produce individual components of the model truck, have their own data spaces, and initiate delivery processes via standard interfaces. These production stations are networked via the Eclipse Dataspace Connector (EDC), which meets European requirements and is also an important part of the Catena-X ecosystem.

PRODUCTION STATION_JAVA

_JAVA was the world's first ***Production Level 4*** demonstrator. It was introduced in 2020, when it was used to produce a configurable USB stick that can be loaded with individual data.

Today, _JAVA is part of our shared production and in the future, it will be expanded to allow parts of the truck to be produced and pre-assembled in addition to the USB stick.

Our circular transport system will also be expanded to accommodate this. The production modules integrated in the transport system will receive additional functions (services), and further modules are being built. There are plans to give the ‚Assembly' module the capability to assemble, in addition to USB sticks, a trailer for the truck body as well as all to stock all the necessary components.

The ‚Quality Control 1' module will check the USB sticks and the trailer superstructures.

The ‚Data Entry' module will additionally handle the pre-assembly of the „semi-tractor truck."

A docking station for feeding and ejecting parts and assemblies will be implemented as a new module.

PRODUCTION STATION_KUBA

The core task at the production station_KUBA is to assemble the model truck and prepare the handoff to the customer. The key element of _KUBA is the transport system ACOPOStrak and the various modules arranged around it.

A docking station is used to deliver components such as trailer bodies or driver's cabs. In the future, it will be available to all prefabricated assemblies.

A modular 3D printer station makes the individual trailer superstructures. Future plans call for the module to also recycle 3D printed material.

A manual work station is part of this module for pre-assembly of the semi-tractor and trailer assemblies. A robot arm is integrated to take over the tasks of infeed and removal of the parts and assemblies. The chassis for pre-assembly are temporarily stored directly at the manual work station.

The 'Quality Control' module inspects all parts and assemblies delivered and assembled at _KUBA. Object and anomaly detection methods from the world of Artificial Intelligence are used by the QC module.

In the future, _KUBA will be expanded to include a module for final assembly. This requires an additional robot arm to accept the supply of "semi-tractors" and "trailers," assemble them into the finished truck, and eject them for handover to the customer.

PRODUCTION STATION_MILOS

The production station_MILOS is located in the department of Machine Tools and Control Systems (WSKL) on the RPTU campus in Kaiserslautern.

Job orders for drilling or milling trailer superstructures are executed at _MILOS.

An Automated Guided Vehicle (AGV) offers the skill "transport" and either brings the workpiece to the robot unit or picks up the finished products. The robot performs the manufacturing step according to the requested product specifications. It offers the skills 'Milling' and 'Drilling' and decides for itself just how to implement the skills on the product.

PRODUCTION STATION_CAPRI

The production station_CAPRI performs the first step in the production process for the model truck in our shared production ecosystem. Components are produced here for further assembly and forwarded to the other production stations.

The Print4PAUL module is equipped with several 3D printers and produces the cabs for the model trucks. Depending on the desired product specifications and the occupancy of the printers, the module independently selects the most suitable printer and initiates the production process.

The quality control is managed by the QS4PAUL module. The cabs are checked here for production and material defects using AI-based methods...

Production Level 4
5G
AI
PRODUKTIONSINSEL_KUKA
PRODUKTIONSINSEL_MILOS
smart factory
Smart MA-X
gaia-x
PRODUKTIONSINSEL_JAVA
PRODUKTIONSINSEL_CAPS

SMARTMA-X: GAIA-X AND THE INDUSTRIE 4.0 DATA SPACE

The smartMA-X project is deeply involved in realizing the vision of Shared Production and the establishment of the *Production Level 4* ecosystem. The project goal is to develop a secure, federated data platform for production - the Gaia-X Industrie 4.0 Data Space.

GAIA-X AND THE DATA SPACE

Gaia-X is a European Initiative that aims to create a common understanding of sovereign data exchange and an ecosystem of services, where participants are able to manage and transfer data autonomously and safely. The priority of effort is on the definition of common rules, requirements, and principles through the Gaia-X AISBL, the umbrella organization of the initiative. The principles are designed to represent European standards in a digital infrastructure. In contrast to existing infrastructures, Gaia-X places great emphasis on the digital sovereignty of shared data.

OUR USE CASE

The Shared Production use case describes a supply chain in a federated network of trusted partners that dynamically provide manufacturing services and is reconfigurable during runtime. The ***Production Level 4*** ecosystem built in Kaiserslautern over the last two years demonstrates this use case. The foundation for this demonstrator is the model truck presented on the previous pages as the sample product and the manufacturing production stations. Each production station represents an individual company. To network these sovereign companies, the project develops its own Gaia-X Ecosystem (Minimal Viable Gaia-X), which represents a potential data space for Industrie 4.0.

To effectively link the production stations in a Gaia-X data space with each other requires:

- a manufacturer-independent, standard data model for the exchange machine readable and interpretable data,
- a standard interface for automated negotiations and data exchange, and
- a federated and secure data infrastructure.

Our implementation relies on a combination of concepts including the administrative shell (AAS), Industrie 4.0 language, and the Eclipse Dataspace Connector (EDC). The figure below shows how our production stations are linked with each other. Starting with the machine and its skills and on to the service modules at the production station, the interfaces are described by the asset administrative shells. Ultimately, the service is offered in the data space via the connector.

THE CONNECTOR

The Eclipse Dataspace Connector provides the technical implementation for the management and handling of data and the transfer to participants in an ecosystem that meets the requirements derived from the Gaia-X initiative. The EDC can be used as a compliant tool for communication between entities within a data space. Furthermore, the EDC can be modified with extensions to enable the design of functionalities in encapsulated modules as well as improved user friendliness, interoperability, and expandability.

THE FEDERATED SERVICE CATALOG

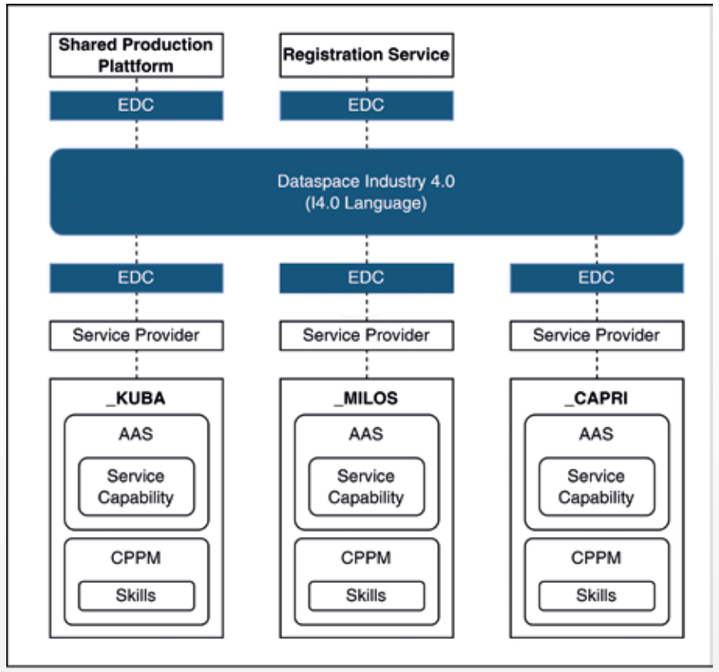
The services offered in our data space are collected and listed in a federated catalog. The production stations function as a service provider offering various services. The available services are described in a factory administrative shell (factory AAS). All services in the data space are aggregated in the catalog, which makes them available via a standard interface.

THE SHARED PRODUCTION PLATFORM

Similarly, companies can also act as intermediaries in the network. One example of an intermediary is the shared production platform. The platform can generate supply chains for a product inquiry and identify available services within the network. Requesters submit an inquiry to the platform for the required service.

We currently offer additive Manufacturing-as-a-Service, Assembly-as-a-Service, Machining-as-a-Service and various AI-as-a-Services in our catalog.

Please, contact us if you have a service that you would like to offer in our catalog.



TECHNOLOGIES

SmartFactory^KL establishes research projects and working groups that include member companies to develop and test pioneering production technologies for the future. In addition, we maintain relations with scientific institutions and networks to collaborate on useful findings that we can put into practical applications.
The ***Production Level 4*** ecosystem built in Kaiserslautern serves as a testbed for, among other things, the Gaia-X data space and AI applications like Knowledge Graphs.

Selected current core topics are described below: This section includes several use-cases that we plan to present at Hannover Messe 2023.

USE CASE: OPERATIONAL SAFETY INTELLIGENCE

At ***SmartFactory***^{KL} the "Connect & Control" Working Group (WG) is developing a dynamic safety architecture: Operational Safety Intelligence.

It can counteract severe productivity losses caused by conventional safety measures in industry.

Specifically, digital tools such as knowledge graphs and multi-agent systems are used to create and perform dynamic situational safety assessments as well as implement the appropriate recommended actions. The basis for this is additional sensor technology such as a radar sensor from Pilz, which expands functional safety components. The sensor not only detects the position of objects, but also their direction of movement and speed. This data allows anticipated, future movements to be included in the safety assessment.

Example: If a person is slowly approaching a unit, the unit will reduce its operating speed accordingly: when the person moves away, the unit returns to increased productivity.

USE-CASE: PRODUCT CARBON FOOTPRINT (PCF)

Every product generates CO_2 emissions during its production, including the ***SmartFactory***^{KL} model truck. Parts of it are manufactured on the production station_KUBA that we are setting up at the Hannover Messe. At our stand, we will demonstrate how we calculate the CO_2 emissions of the model truck during production.

In addition, the system shows how much of each material is consumed to facilitate recycling later on. Furthermore, the exact energy consumption data are also determined and stored.

The data is collected in the administrative shell and will be available in the Digital Product Passport (as a sub-module of the AAS) in the future.

ARTIFICIAL INTELLIGENCE

The ***Production Level 4*** ecosystem at ***SmartFactory***^{KL} employs artificial Intelligence (AI) methods for various production tasks. We use AI to assist humans as they go about their activities. Especially, for repetitive work associated with large databases, AI is often more powerful and more accurate. However, it is limited when it comes to optimizing workflows, developing new processes, or detecting structural faults. We are working to make the best use of both - AI methods and human capabilities.

THE ASSET ADMINISTRATION SHELL (AAS)

The Asset Administration Shell (AAS) manages assets, which could be either documents, drawings, hardware or software. The AAS enables detailed descriptions of the asset and the communication with other AAS. Seen in this way, it is a specific digital twin, an Industrie 4.0 component that enables interoperability.

INDUSTRIAL EDGE CLOUD

To enable subsidiarity in production, the acquisition, processing, and evaluation of data is of critical importance. The development and application of edge and cloud technologies and the necessary infrastructure poses a major challenge for the production environment.

The term Industrial Edge Cloud refers to a private cloud with direct or indirect access to the field level. The Industrial Edge Cloud provides scalable and resilient distributed computing power, which is made available by one or more edge nodes to perform edge computations. The communication in the Industrial Edge Cloud can be real-time or non-real-time. The failure of individual edge nodes can sometimes be compensated. An Internet connection is not required for the functionalities of the Industrial Edge Cloud. The

reference architecture in ***SmartFactory***^{KL} is a major enabler of ***Production Level 4*** in that it ensures highly flexible, efficient, and resilient communications. It is also possible to define where certain data can be exchanged, for example, to ensure absolutely secure data.

DATA ECOSYSTEM / GAIA-X

Data ecosystems are of critical importance for the production of tomorrow. The Federal Ministry for Economic Affairs and Climate Action (BMWK) supports the Gaia-X Initiative to develop the next generation of infrastructure for European data ecosystems. The aim is to build a secure and networked data infrastructure that meets the highest standards of digital sovereignty and promotes innovation. In the network, data and services are collated and shared in a dynamic supply chain architecture based on the values of openness, transparency, and trust. ***SmartFactory***^{KL} is participant in the Gaia-X effort with its own sponsored project called smartMA-X. We put the focus on the industry's need for a secure and agile data infrastructure. For example, our production stations are networked via the Eclipse Dataspace Connector, which meets European specifications. The PL4 ecosystem at ***SmartFactory***^{KL} is the testbed and central reference for data ecosystems in industrial applications.

MANUFACTURING-X

Manufacturing-X (M-X) is a government initiative, in particular, by the BMWK, to push the digital transformation of industrial supply chains. It is a logical part of the series of Gaia-X data ecosystems currently under development. In Manufacturing-X, business, politics, and science are equally involved. ***SmartFactory***^{KL} participates in the "Plattform Industrie 4.0" network, which has set for itself the goal: to implement the data space for Industrie 4.0, shaping the digital transformation and networking of industry across the entire spectrum. Companies will be able to share data across the entire manufacturing and supply chain. This makes digital innovation possible for more resilience, sustainability, and competitiveness. This initiative is to be developed on a European and global level – similar to how value networks are organized.

5G

A high data rate combined with low latency has made 5G the new standard in communication – not only for cell phones, but also for industry. This is because 5G, for the first time, enables wireless "critical communication" in real time. Applications that absolutely must function reliably and securely can now be realized wirelessly.

At ***SmartFactory***^{KL}, we are researching these new, industrial application fields, for example, in the 5G IDEAS research project where we have built a module for the _KUBA production station that is fully connected via 5G.

SCIENCE AND INDUSTRY

Our working groups have researchers and representatives of our member companies working together to develop new concepts and systems. Results feed into our ecosystem, where they are tested and improved.

Currently, three working groups are addressing current practical issues in manufacturing, while focusing on the following characteristics of subsidiarity:

- A self-explanatory capability
- Fault tolerance and resilience
- Resource adaption
- A cooperative ability
- A decision making ability.

WG 1

CYBER-PHYSICAL PRODUCTION MODULES

Vision
To design and control cyber-physical production stations and the production infrastructure for sustainable factory floors in the future.

Goals
- Develop innovative PL4 modules and hardware.
- Prepare the design and definition of production infrastructure.
- Develop new power supply infrastructure based on overall concept, topology & power media (DC, AC, Ethernet, etc.).
- Integrate an industrial edge architecture (edge devices, edge nodes, etc.).

WG 2

CONNECT & CONTROL

Vision
To build a manufacturer-independent system for autonomous control of the production process

Goals
- Build a manufacturer-independent and robust information infrastructure and middleware.
- Implement data and capability models in the administrative shell.
- Develop a matching approach for autonomous and flexible process control in production.
- Design negotiation strategies for optimal and sustainable resource use.
- Perform advance development of operational safety intelligence.
- Enable visualization of module states and production decision processes.

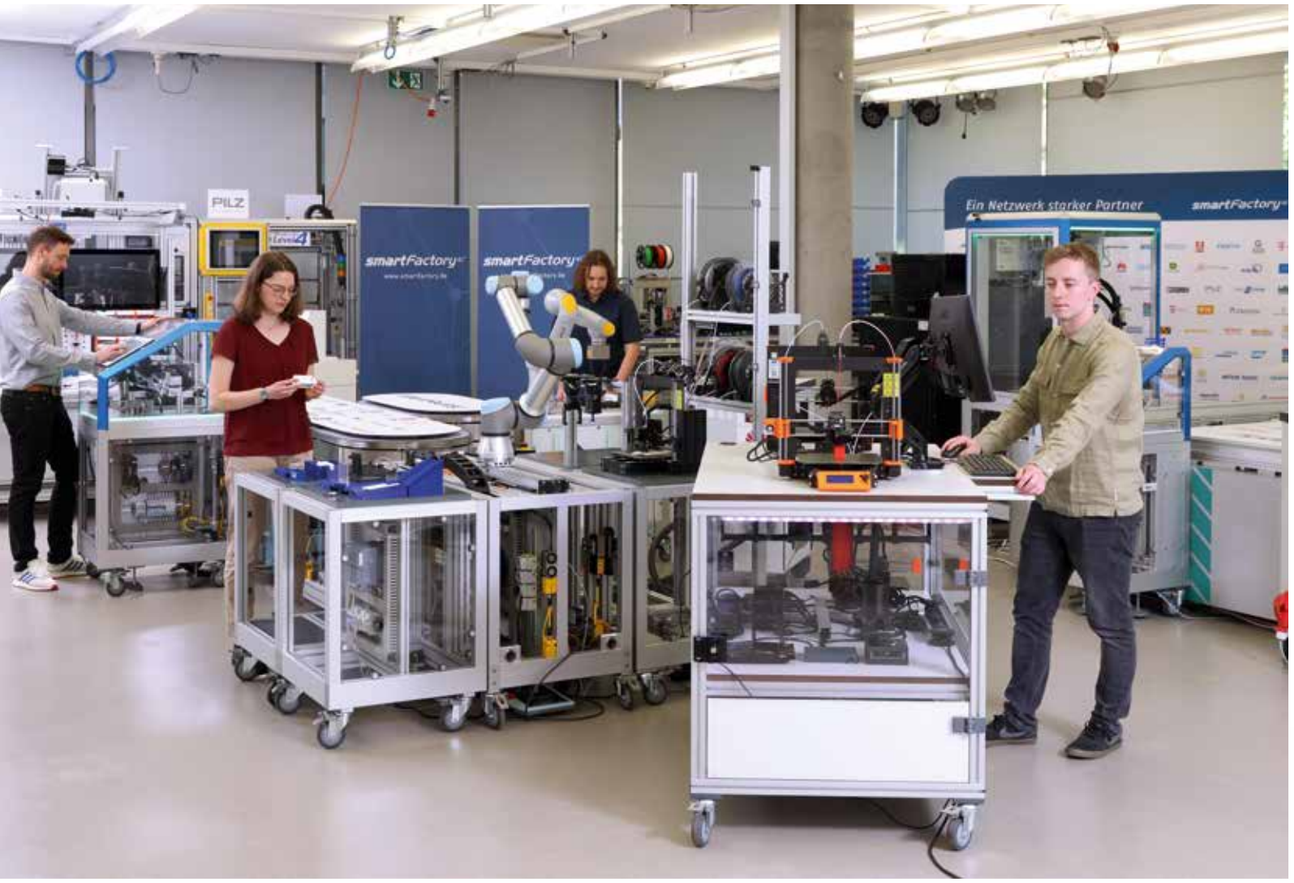
WG 3

THE COGNITIVE FACTORY

Vision
To set up a cognitive factory able to actively make decisions to improve production.

Goals
- Assist users through automated data processing and the resulting recommendations for action.
- Optimize and control production workflows using agent systems.
- Enable early detection of faults and malfunctions through modern sensor technology.
- Minimize and optimize retooling through automated parameterization.
- Integrate IT and OT: Link shop floor and cloud on the basis of machine learning methods.
- Link all stations with the dashboard (digital twin).

DEMONSTRATOR PARTNERS 2023



B&R

Brief description

B&R Industrial Automation manufactures industrial automation systems and ABB's global center for machine and plant automation.

B&R was established Erwin Bernecker and Josef Rainer in 1979 with headquarters in Eggelsberg, Austria. Today, B&R is a leading automation solution provider for automating machines and factories and is responsible for ABB's robotics and production automation division. Steady innovation and strong partnerships have been the hallmarks of B&R's success for over 40 years.

Demonstrator contribution

ACOPOStrak from B&R is the name of a highly flexible transport system at the heart of the production station_Kuba. The integrated "high-speed-switches" in ACOPOStrak enable separating and merging of product flows at full speed production. Individual products can take individual routes through the production system. The modular architecture of the ACOPOStrak system means it can grow with production requirements and adapt to changes in the production process at any time during operation. Setup times are for the most part eliminated! Thanks to its flexibility and modularity, ACOPOStrak is perfectly adapted to the requirements of shared production and the production of very small batch sizes.

The ***SmartFactory***^{KL} demonstrator landscape also includes B&R industrial PCs and control panels, as edge devices and HMI systems, in addition to our functional safety technology and vision technology, which are in use as part of the further development of ***SmartFactory***^{KL}'s modular safety concepts, up to and including "operational safety intelligence."

More information at

www.br-automation.com

BOSCH REXROTH

Brief description

Economical, precise, secure, and energy efficient: Drive and control systems from Bosch Rexroth moves machines and plant systems of all sizes. The company combines worldwide experience in the market segments of mobile applications, plant engineering and construction, and factory automation in its development of innovative components, customized system solutions, and services. Bosch Rexroth is the single source for customers seeking hydraulics, electric drives and controls, gear technology as well as linear and assembly systems. In 2021, with more than 31,000 associates in 80 countries, the company generated sales of around 6.2 billion euros.

Demonstrator contribution

Implementation of the ctrlX AUTOMATION system at production island station_Kuba. The ctrlX CORE serves as a communication interface and takes over the control and description of each module. Control of the retrofitting milling at _MILOS, with the aim of automated production of milled parts in batch size 1, which are sent in the shared production network via CAD. Active member of WG 1 (Cyber-physical production modules) & WG 2 (Connect & Control). Collaboration on various edge and edge-cloud concepts (Gaia-X), together with IBM, German Edge Cloud, B&R, Siemens, Perinet, DFKI, TÜV SÜD, Pfalzkom, Telekom, Huawei, and Weidmüller.

More information at

www.boschrexroth.de

DFKI

Brief description

The German Research Center for Artificial Intelligence (DFKI) GmbH with headquarters in Kaiserslautern, Saarbrücken, Bremen and a project office in Berlin, is the leading business-oriented research institution in Germany in the field of innovative software technologies. In the international scientific community, DFKI is one of the world's most important "Centers of Excellence", which succeeds in the rapid transfer of cutting-edge research into practical applications. Founded in 1988 by well-known German information technology companies and two research institutions as a non-profit limited liability company, DFKI has gained a national and international reputation as a competent and reliable partner for innovative companies through its proactive and demand-oriented project work.

Demonstrator contribution

In the context of applied research, DFKI is actively involved in the construction and integration of demonstration modules for shared production. The current research focus topics are resilient production with AI-based, predictive fault detection in Project RACKET and skill-based, modular work stations in Project DIMOFAC.

More information at

www.dfki.de

EMPOLIS

Brief description

Empolis helps its customers to make the right choices. At approximately 500 Empolis installations worldwide, around 700,000 professional users are using our solutions to serve around 40 million end customers. We bundle artificial intelligence technologies for CRM and service management applications in cloud platforms. These enable a completely new quality of service, customer approach, and digital "as a service" and platform business models - from signal to action. Together with the Internet of Things, AI holds great promise in production, service and maintenance for manufacturing companies. Real-time analysis of machine, product, and service related data and the use of the latest human-machine interfaces (for example, voice interface, image recognition, and Augmented Reality), leads to fast development and distribution of innovative service products. Future service technicians will have personal service assistants to guide them through the repair, maintenance, and diagnostic tasks using voice controls. AI continuously processes data and information automatically and provides it to the worker, if requested. AI technologies and digital assistants represent the next logical step in the fourth industrial revolution; Human and artificial Intelligence working hand in hand in the future.

Demonstrator contribution

Empolis support is based on the use of Artificial Intelligence. Several workgroups use Empolis' AI for anomaly detection, error analysis and understanding, guided worker assistance as well as in the areas of safety and security in worker activities. This facilitates the implementation of shared production concepts and resilient production. Knowledge graphs, natural language processing, semantic search, decision trees and also machine learning methods for the analysis of machine data are used, which, in the context of ***Production Level 4***, revolutionizes Human-Machine Interaction.

More information at

www.empolis.com, www.service.express

EPLAN

Brief description

EPLAN develops CAx, configuration, and mechatronic solutions and provides consulting services to companies as they optimize their engineering processes. Customers benefit from improved efficiency in the product development process with standard models, automated processes, and integrated workflows. EPLAN delivers customized concepts for system introduction, setup, and precise integration into the IT and PLM system landscape – based on standard engineering solutions. The service portfolio includes customizing, consulting, and training. The development of customized and standard interfaces enable bi-directional data exchange with ERP, PLM, and PDM systems in product development, order processing, and manufacture. Consistent customer orientation, global support and innovative development and interface competence are success factors in engineering. EPLAN was founded in 1984 and the company is part of the Friedhelm Loh Group.

Demonstrator contribution

The new ***SmartFactory***^KL demonstrator is planned 100% with EPLAN. Several EPLAN products are used: EPLAN Electric P8 (ECAD), EPLAN Fluid (Fluid-Engineering), EPLAN Pro Panel (controller and switchboard design). The entire plant is designed with EPLAN and stored after completion in the cloud via EPLAN eVIEW. Project data is then shared and exchanged with value-adding partners.

More information at

www.eplan.de

FUJITSU

Brief description

Fujitsu is the leading Japanese supplier of Information and Communication Technologies (ITC), offering a broad range of technology products, services, and solutions and has approximately 124,000 employees supporting business customers in more than 100 countries. Together with its customers, Fujitsu is using its ITC expertise to shape the future of society. In the fiscal year 2021 (ended March 31, 2022), Fujitsu Limited (TSE:6702) headquartered in Tokyo, Japan, reported consolidated annual revenues of 3.6 trillion Yen (32 billion USD).

Demonstrator contribution

The need for more sustainable production in the future is closely linked to the issue of resilience and a potential solution is shared production. Three fields of action are prerequisite for innovative and sustainable shared production environments: self-determined data sharing by means of data spaces, integrated use of comprehensive energy data, and IT/OT security. Using the IoT Operations Cockpit and SaaS solutions for Catena-X, Fujitsu is recording live PCF data and, together with Radiflow, doing continuous risk analysis with regard to OT security and the systematic mapping of production modules.

More information at

www.fujitsu.com

GERMAN EDGE CLOUD

Brief description

German Edge Cloud (GEC) is part of the Friedhelm Loh Group and specializes in innovative edge and cloud solutions for manufacturing companies that enable optimal networking of shop floor infrastructures, ensure rapid and secure data access, as well as make perfect process optimization in manufacturing possible. As a founding member of Catena-X, the company places a special emphasis on data sovereignty and scalability from the edge to the cloud.

The ONCITE Digital Production System (DPS) product is a combination of industrial software applications, coordinated and based on a cloud or edge infrastructure. GEC digitalizes manufacturing processes and creates a manufacturing digital twin using ONCITE DPS. The system is precisely designed to meet the challenges and new goals of intelligent production environments. ONCITE DPS is being used at the smart factory plant of Rittal, the sister company in Haiger, and is a blueprint and a visual model of "Edge/Cloud-based, real time capable, and data sovereign Industrie 4.0 application scenarios."

Demonstrator contribution

ONCITE DPS is a central component of the industrial edge cloud for the ***SmartFactory***^{KL} Demonstrator ecosystem. As in productive use in customer environments, it represents the digital twin of the various ***SmartFactory***^{KL} production stations. It ensures secure data transmission throughout the entire ecosystem value chain and low latency times, which favor fast data processing on the shop floor. The normed ONCITE DPS data model creates the basis for the easy reuse of data for visualization, analytics, and AI scenarios. In addition, the system enables the standardization and consolidation of the shop floor infrastructure.

More information at

www.gec.io

HARTING

Brief description

HARTING Technology Group is a leading global supplier of industrial connection systems for the three vital resources data, signal, and power. Harting has 14 production facilities and subsidiaries in 44 countries. The company also manufactures checkout zones for the retail trade, electromagnetic actuators for automotive and serial manufacturing industries, charging equipment for electric vehicles, and hardware and software applications for customers in automation sector, mechanical and plant engineering, robotics, and transportation, etc. Around 6,500 employees generated revenues of 1,059 million euros in euros in funding between 2021 and 2025.

Demonstrator contribution

Anchored in the company vision is the desire to shape the future using technologies for people and, clearly, ***Production Level 4*** aligns this vision on production. This agreement is why it is easy for us to fully support the demonstrator. Together with ***SmartFactory***^{KL}, HARTING developed one module of the demonstrator. The main aspect for HARTING is connectivity. There is a new role for connectivity in highly flexible and adaptable production systems, where connectors that are simple and safe to plug and unplug become the key to flexibility. This activity should be implemented on a state-dependent basis. Plug connectors with smart optional features can perform this task. HARTING implements connectivity concepts and tests them for their utility in the ***Production Level 4*** ecosystem.

More information at

www.harting.de

HUAWEI

Brief description

Huawei Technologies is one of the world's leading suppliers of information systems and telecommunications platforms. More than a third of the world's population and more than half of Germany's population use Huawei technology. Headquartered in Shenzhen, China, the company has over 197,000 employees worldwide and operates in 170 countries through its three business units: Carrier Network, Enterprise Business, and Consumer Business. Huawei has 107,000 employees in the area of research and development and operates 16 R&D clusters worldwide as well as 28 innovation centers together with partners. Huawei has been operating in Germany since 2001 and employs over 2,000 people at 18 locations. The headquarters of Huawei's European Research Center is located in Munich, Germany.

Demonstrator contribution

We use the aspect of quality assurance in a shared production environment networked with our production cell in Munich as an example of federated AI, a kind of data-sovereign machine learning method. A mobile camera sends data via 5G to a local edge device that monitors manufacturing quality. The common AI model built in the cloud receives from all manufacturing partners, where it is stored maintaining data sovereignty and optimized for local use at the partners. In the "smartMA-X" project, we are partnered with Gaia-X and demonstrate how our production equipment and services are integrated on a customer-specific basis into a virtual ***SmartFactory***^{KL}.

More information at

www.huawei.com

IBM

Brief description

IBM supports companies in the transformation to Industry 4.0 - from the idea to continuous value creation. Our customers' success is based on vertical and horizontal integration, data-based optimization of manufacturing, services, and products as well as more efficient business processes in all areas of operation. IBM offers consulting, design, and implementation as well as the necessary system modules. Analysts attest to IBM's leading position in the provision of complete IoT software platforms with integrated functionalities such as cognitive applications, augmented reality, blockchain, natural language processing or edge computing. The scalability and open interfaces of IBM solutions make Industrie 4.0 a realistically exploitable opportunity for every company.

Demonstrator contribution

The "IBM App Connect for Manufacturing" serves as the basis of the ***SmartFactory***^{KL} demonstrator. It demonstrates IBM's approach to the future of Industrie 4.0 by bridging the OT/IT gap in a scalable, actionable, and secure way and paving the way to a hybrid cloud. We demonstrate a managed, semantic representation of all OT data in the IBM IoT platform using IBM App Connect. Paired with the latest version of the ***SmartFactory***^{KL} Dashboard, we deliver a complete representation of the entire factory floor live and in real time. This accelerates our anomaly detection development at the infrastructure nodes, which supports the demonstrator as a whole and opens up more opportunities for innovation in the cloud. In addition, we demonstrate the first steps in implementing a shared production scenario across multiple factories based on Gaia-X. Mettler Toledo's quality inspection module is physically located in the Watson Center Munich, where we demonstrate vibration and acoustic analysis at both edge and cloud levels.

More information at

www.ibm.com

KIST EUROPE

Brief description

The Korea Institute of Science and Technology (KIST) Europe is the Korean government's R&D institute in Europe, which was founded in Saarbrücken in 1996. KIST Europe houses specific know-how in innovation-oriented research and industry support as an open R&D platform between Korea and Europe.

Our staff performs research to share science and technology innovation in the fields of environment and energy, integrative bio-nano engineering, and smart convergence worldwide. Likewise, we provide information on technologies, support for technology transfer and collaborative projects, and we link Korean and European partners for the purpose of scientific and technical cooperation.

More information at

www.kist-europe.de

MAKINO

Brief description

Makino Milling Machine Co., Ltd. is one of the leading technology a service provider in machine tool industry. The company is listed on the Tokyo Stock Exchange and employs more than 4,400 people in America, Europe, and Asia. Sales for the fiscal year ended March 31, 2022 were nearly 1.5 billion USD. MAKINO's wide range of world-class production solutions includes machining centers for parts manufacturing and tool and die making, with a variety of applications for aerospace, automotive, construction and agricultural machinery, industrial components, and micro technology. MAKINO Europe employs around 200 people in technology centers and offices in Germany, Italy, France, Spain, Slovakia, Poland, and Russia, with a focus on marketing, sales, application engineering and service. www.makino.eu

More information at

www.makino.eu

MINITEC

Brief description

MiniTec – from modular systems to custom, fully automated integrated systems. The MiniTec system is a modular design – consisting of profile as well as linear systems. Our designers and engineers passionately follow the principles that characterize all MiniTec products: maximum simplicity, no machining, unlimited range of applications with few components and universal compatibility. We always aim to avoid senseless product diversity. The shortest assembly time and avoidance of machining have top priority – true to our slogan "The Art of Simplicity."

More information at

www.minitec.de

PERINET

Brief description

Perinet develops innovative electronic, electromechanical, and software components to enable a seamless connection, of sensors and actuators to IT systems via a hybrid single-pair ethernet. Direct, fully encrypted communication with every sensor and actuator in the field enables operational access to relevant process data in a wide range of IoT, Industrial IoT, and Industrie 4.0 use cases. Our components can be implemented in new and – through retrofitting – in existing plants, enabling fast, efficient and economical digitalization. The modular design of our requirements-based edge computer completes our product portfolio in the vertical. In addition, we advise customers on digitalization and Sensor2Cloud.

Demonstrator contribution

Perinet provides intelligent sensor and actuator technology, so called smart peripherals, for the implementation of ***Production Level 4*** within the framework of Industry 4.0. These smart peripherals are networked via future-proof hybrid single pair Ethernet (SPE). Perinat's products are easy to integrate (Self-X) and communicate via established Internet Technology (IT). In contrast to conventional PLC solutions, our IPv6-based Sensor-2-IT approach offers real end-to-end communication by implementing established security technology.

More information at

www.perinet.io

PFALZKOM

Brief description
Digital – but secure! PFALZKOM is a reliable ICT partner that makes your IT infrastructure efficient and affordable. We provide highly reliable data centers, high performance fiber optic network, and managed services.

Use colocation and operate your IT hardware in our regional data centers. Improve your energy efficiency, benefit from high reliability and save costs in the process. Unburden your IT team by outsourcing recurring, standardized IT services - managed services - to us. You too will benefit from fast transfer rates and excellent availability when you connect through our own fiber optic network.

Demonstrator contribution
PFALZKOM provides the Industrial Edge Cloud for the demonstrator environment. Specifically, the Regional Edge Cloud is provided in the regional PFALZKOM data centers. Building and operating data platforms such as Gaia-X requires secure private cloud architectures with dedicated access. These foundations make autonomous production possible and enable the advantages of federated services.

More information at
www.pfalzkom.de

PILZ

Brief description
The Pilz Group is a global supplier of products, systems, and services for industrial automation systems. This family business has 42 subsidiaries and branches worldwide working to ensure the safety of people, machines and the environment. The technology offers integrated automation solutions comprising sensors, control and drive technology - including systems for industrial communication, diagnostics, and visualization.

Demonstrator contribution
The safety solutions from Pilz protect both physical and digital access to machines and processes. Our machine safety components (safety gate system, emergency stop) combine with selectable operating mode and access authorization systems, plus a firewall to create a consistent access concept that satisfies both machine and industrial plant safety requirements.

More information at
www.pilz.com

PROALPHA

Brief description
proALPHA, with 1,700 employees at 49 locations around the globe, has been the digital sparring partner for small and medium-sized businesses for about the past three decades. The powerful ERP core and add-on solutions from proALPHA and its partners form the digital backbone of the entire value chain for more than 7,700 customers – from the manufacturing industry, wholesale, and other sectors. proALPHA software ensures intelligent interconnection and efficient control of all business-critical systems and core processes. In increasingly competitive markets, a crucial factor is an optimal integration of up and downstream processes. The various software solutions from the proALPHA Group and its 181 partners support every customer in precisely the areas that are of major relevance to their business.

Demonstrator contribution
proALPHA provides the interface between the business processes and the manufacturing levels: Using the integrated product configurator, it is easy to design the model truck – it is even browser based with an interactive 3D previewer. The communications interface, which is based on technologies such as REST and MQTT, ensures the secure synchronization of order data and feedback to and from the ERP system.

More information at
www.proalpha.com

RADIFLOW

Brief description
Radiflow develops OT-specific security solutions that enable critical infrastructure and ICS organizations to assess and monitor all ICS traffic for attack attempts, provide full network visibility, and minimize cyber risk - all with the aim of ensuring operational resiliency and optimizing OT security expenditures.

Radiflow operates a global network of certified local channel partners and maintains a world-class technology partner ecosystem that enables it to complement existing platforms with Radiflow's threat detection, asset management and risk assessment data. All of Radiflow's solutions are developed for local or centralized deployment in the enterprise SOC or an MSSP.

Founded in 2009, Radiflow protects more than 7,000 locations worldwide in many different sectors.

More information at
www.radiflow.com

RAUSCH UND PAUSCH

Brief description
The medium-sized RAPA Group is an internationally recognized development and technology partner and a system supplier of application-specific valves and fluid-mechatronic system solutions for the automobile industry, medical technology, and manufacturing industries – and has been for more than 100 years! The operational business is organized in the subsidiaries RAPA Automotive, RAPA Healthcare, and RAPA Industry. Dr. Roman Pausch heads the family business with co-CEO Karin Wolf. In addition to its headquarters in Selb, Bavaria, RAPA is represented by subsidiaries in North America and China. RAPA currently employs around 1,000 people worldwide.

More information at
www.rapa.com

RPTU

Brief description
The University of Technology Kaiserslautern-Landau (RPTU) has a student enrollment of more than 20,000 students, more than 300 professors, and employs a staff of more than 3,000 people. It is the only technical university in the state of Rhineland Palatinate and offers 160 degree programs.

RPTU emerged from the merger of two state universities - Kaiserslautern and Landau on January 1, 2023. It combines expertise in engineering and the natural sciences with a focus on the social sciences and also has many years of expertise in teacher training for all types of schools. The RPTU acknowledges its responsibility to make scientific contributions to the social and economic transformation processes, especially, in the areas of sustainability, digitalization, and education. It is also characterized by a high level of third-party funding and a variety of coordinated research projects.

Demonstrator contribution
The University of Technology Kaiserslautern-Landau (RPTU) maintains a close cooperation with the ***SmartFactory*** ^{KL} and contributes hardware and software to the demonstrator ecosystem. The university is represented in project Kokobot, funded by the MWVLW RLP, at the ***SmartFactory***^{KL} stand. The stand exhibits manufacturing with robots that autonomously perform task planning in dynamic environments and demonstrates the potential of flexibility at the field level. Furthermore, the project shows new collaborative approaches between humans and robots that enable a more intuitive cooperation. The production station_MILOS, located at the department of Machine Tools and Control Systems, will have a live hook-up to show the implementation of skill-based manufacturing using industrial robots, machine tools, and an automated guided vehicle system.

More information at
www.rptu.de

SIEMENS

Brief description
Siemens (Berlin and Munich) is a technology company with a focus on industry, infrastructure, mobility, and healthcare. Resource-efficient factories, resilient supply chains, and smarter buildings and power grids, cleaner and more comfortable rail transportation as well as advanced healthcare – we create technology with a purpose, adding real value for customers. By combining the real and the digital worlds, Siemens empowers its customers to transform their industries and markets, helping them to improve the everyday lives of billions of people. Siemens is the majority owner of the publicly listed company Siemens Healthineers - a global leader in medical technology that is shaping the future of healthcare. Siemens also holds a minority stake in the publicly listed Siemens Energy, one of the world's leading companies in power transmission and generation. In fiscal year 2022, which ended on September 30, 2022, the Siemens Group generated revenue of 72.0 billion euros and net income of 4.4 billion euros. As of September 30, 2022, the company had around 311,000 employees worldwide.

More information at
www.siemens.de

TE CONNECTIVITY

Brief description
TE Connectivity is a global technology leader working to ensure a safer, sustainable, productive, and connected future. Our broad range of connectivity and sensor products has proven itself in demanding environments while enabling advances in transportation, industrial applications, medical technology, energy technology, data communications, and in home use. With more than 85,000 employees, including more than 8,000 engineers, we work with customers in nearly 140 countries. Our commitment is reflected in our motto: EVERY CONNECTION COUNTS. Learn more about our company at www.te.com and on LinkedIn, Facebook, WeChat, and Twitter.

More information at
www.te.com und auf LinkedIn, Facebook, WeChat und Twitter.

TIKI

Brief description

The Technical Institute for Applied Artificial Intelligence (TI.KI) was founded in 2017 with headquarters in Weiden in der Oberpfalz. TI.KI develops and operates AI systems for the 3 shareholders in the fields of electrical engineering, plant engineering, and service, as well as for other customers. The focus is on standardized integration of AI in everyday business activities. On its own developed AI ecosystem (more than 50 man-years and an investment of 20 million euros), it is possible for the company to promise its customers "from an idea to useful AI in 90 days." TIKI is also a Gold Partner of Dremio and supports consulting and implementation of data lakehouse platforms. This new architecture enables engines to access data between different data sources as one data product.

In collaboration with ***SmartFactory***^{KL} we are striving to develop processes to deliver on the new promise "From the completed AI model to useful AI in 90 days."

More information at

www.tiki-institut.com

T-SYSTEMS

Brief description

T-Systems is one of the leading service providers for information technology and digitalization. With operations in 20 countries and about 28,000 employees (2022), the company reported annual revenues of 4 billion euros. T-Systems supports corporate customers from all industries in their drive to digital transformation. Focus industries are automotive, public sector, healthcare, and transportation. Long-standing customer relationships exist with Daimler, DPDHL, Eon, and Shell. T-Systems' digitalization services are part of the integrated B2B portfolio of Deutsche Telekom. The company supports the digital transformation of its customers along the core themes of consulting, cloud services, digital solutions, security and connectivity.

More information at

www.telekom.de

TÜV

Brief description

TÜV SÜD: More Value. More Trust.
Around 25,000 employees at more than 1,000 locations worldwide ensure the optimization of engineering, systems, and know-how. They are responsible for a significant contribution toward making technical innovation safe and reliable - such as those in Industry 4.0, smart safety and security, autonomous driving, and renewable energies. TÜV SÜD is a partner with industrial experience and internationally recognized expertise that is addressing the complex requirements of a "factory of the future" and related topics such as digitalization and automation.

Demonstrator contribution

To achieve the greater flexibility required in modern production systems, not only are manufacturing concepts like modular production essential, but also I4.0-compatible assessment concepts for machine and plant safety are needed. The use of knowledge graphs as a central component of an I4.0 safety architecture enables the linkage of multimodal interactions for reality-mapping. The implementation of an agent-based, distributed approach requires a safety ontology and safety semantics oriented to the demonstrator ecosystem. TÜV SÜD experts are significantly involved in this development.

More information at

www.tuvsud.com/de

WEIDMÜLLER

Brief description

Be it automobile manufacturing, electricity production or water management – hardly any of today's industries can do without electronics and electrical connectivity. In this globalized, technologically changing world, the complexity of requirements is rapidly increasing with the emergence of new markets. New and more varied challenges have to be overcome. Connectivity is the key, whether it involves theory and practice, or power, signals, and data, or demands and solutions. Industrial connectivity needs connectors and Weidmüller's 6,000 employees worldwide are providing them!

Demonstrator contribution

For more than 10 years, Weidmüller has played a key role in shaping the infrastructure concept of ***SmartFactory***^{KL}. The increasing automation of the infrastructure is possible because we bring the energy measuring equipment, provide consumption data for different media in an interoperable way, and, finally, we install the intelligent connectors. Industrial controls at the infrastructure nodes and the use of intelligent connectors serve to support the flexibility and modularity of the ***Production Level 4*** demonstrator by enabling automatic commissioning and decommissioning of the various production modules. Plugging and unplugging of the connector is only possible when there is no voltage flow, regardless of whether an AC or DC power supply is used, which means our smart plug connector provides increased safety.

More information at

www.weidmueller.de

SELECTED RESEARCH PROJECTS

TWIN4TRUCKS

The "Intelligent Networks" research department was launched on September 1, 2022. It represents a unique combination of scientific research and industrial implementation. The project consortium consists of six partners:

Daimler Truck AG (DTAG) is the project leader. It is the largest commercial vehicle manufacturer in the world and T4T is helping to optimize its production through the use of new technologies such as digital twins or an Industrial Edge Cloud.

Technologie-Initiative ***SmartFactory***^{KL} (SF-KL) and the German Research Center for Artificial Intelligence (DFKI), as pioneers of ***Production Level 4,*** are setting the development direction.

IT-service provider Atos is responsible for data exchange via Gaia-X, quality assurance using AI, and an implementation concept for DFL.

Infosys is responsible for the network architecture, 5G network, and integration services. Pfalzkom is building a regional edge cloud, as well as a data center in addition to the Gaia-X implementation and network operating concepts.

This is a BMWK funded project. Project manager is VDI TZ.

KOKOBOT

Design and develop technology-oriented competence fields for a "Collaborative and Cooperative roBot platform."

KoKobot has three sub-modules that can be used as closed stations. Specifically, there are two modules with collaborative universal robots and a manual workstation module.

Each module serves as an agent in the system. Two robot modules cooperate by taking on different tasks to solve a requirement while executing optimal and collision-free trajectories to arrive at their destination. Tracking of worker movements at the manual workstation module will be enabled so that humans and robots can perform tasks collision-free in a workspace.

MITTELSTAND-DIGITAL ZENTRUM KAISERSLAUTERN

The SME Digital Center Kaiserslautern provides free support to small and medium-sized enterprises in Rhineland-Palatinate and beyond in the form of information and suggestions that assist in the implementation of their projects.

The SME Digital Center Kaiserslautern is a part of the Mittelstand-Digital Network. The Mittelstand-Digital Network is a program of the German Federal Ministry of Economics and Climate Protection to support digital transformation in small and medium companies and commercial trades.

TRANSFER4PRODUCTION

Transfer4Production (T4P) is a transfer project at ***SmartFactory***^{KL} and a link between the scientific development of complex Industrie 4.0 systems and their implementation by small and medium sized companies. T4P aims to employ integrated transfer services to close the gap that currently exists at this point.

Transfer means making useful in applications out of scientific developments, while at all times aligning scientific activities with the needs of business and industry. Transfer4Production fulfills these tasks by establishing personal contacts and networking, organizing workshops with companies, and building networks between companies, associations, and research institutions.

The topics always in focus are those that raise a broad application potential for the economy: from production architecture, manufacturing infrastructure, artificial intelligence in a production environment, digital twins, secure data spaces, to 5G applications in a production environment.

PHYSICS

The function as a service acronym PHYSICS stands for "oPtimized HYbrid Space-tIme Continuum in faaS." It focuses on a software platform that enables users to run their applications as encapsulated functions via cloud and edge services. What is new about this is how the application software works or is accessed. The user can use the functions one time per day or hundreds of times per second. Depending on the requirements, the platform adapts dynamically to the resource usage. There is no additional cost to the user. In addition, users pay only for the services actually used.

MAS4AI

The aim of the MAS4AI project is to develop a distributed and interoperable AI architecture based on multi-agent technologies. This gives European factories a hyper-agility through modular and flexible production, while keeping humans in control of the AI technology. The multi-agent system integrates recognized Industrie 4.0 approaches like the administrative shell and OPC-UA, which facilitates the spread of AI algorithms in industry and manufacturing.

- Multi-agent systems for the distribution of AI components in various levels of a hierarchy.
- AI agents that use knowledge-based representations with semantic web technologies.
- AI agents for the hierarchical planning of production processes.
- ML agents - using model-based machine learning systems
- Humans as agents - to interact with the technical system at the level of the action

The solutions are tested and validated on a modular, pilot line testbed and five industrially relevant, large-scale trial runs.

CO-EXHIBITORS AT HM 2023

B&R
A member of the ABB Group

FUJITSU

HARTING
Pushing Performance
Since 1945

HUAWEI

PFALZKOM
Pfalzwerke Gruppe

PILZ
THE SPIRIT OF SAFETY

Radiflow

RPTU Rheinland-Pfälzische Technische Universität Kaiserslautern Landau

TIKI Technologisches Institut für angewandte Künstliche Intelligenz

TÜV SÜD

Weidmüller

THE ASSOCIATION AND ITS MEMBERS

*SMARTFACTORY*KL

SmartFactoryKL (SF-KL) is the name of a research and industry network with three pillars of support: the non-profit association Technology Initiative ***SmartFactory***KL and two scientific research organizations (the Innovative Factory Systems department at the German Research Center for Artificial Intelligence (DFKI), and the department of Machine Tools and Control Systems (WSKL) at the RPTU Kaiserslautern campus. Prof. Dr. Dr. has been responsible for organization and content since 2019. He serves as chair of the association's management board as well as the faculty chair and head of the DFKI research department. ***SmartFactory***KL brings stakeholders from industry and research together in a unique Industrie 4.0 network to facilitate collaboration in the joint development and implementation of future production concepts for the factories of the future. A manufacturer-independent demonstration and research platform enables industry representatives and researchers to jointly test innovative production technologies in a realistic factory environment. Since 2020, the association has participated in the European Gaia-X network with its smartMA-X research project. As a testbed, the demonstrator plays a major role in the European effort.

In 2019, the partner network revisited the concept of Industrie 4.0 and that resulted in the upgrade now known as ***Production Level 4*** (PL4).

In 2021, SF-KL presented the concept of Shared Production, implemented for the first time as a skill-based PL4 manufacturing ecosystem in Kaiserslautern. This has revolutionized production, enabling dynamic supply chains that are individually configurable via digital platforms. The PL4 ecosystem is based on three production stations, one of which - _KUBA - was exhibited for the first time at the 2022 Hannover Messe. Many key enabling technologies such as AI operations, digital twins, operational safety intelligence, asset administrative shells, 5G, and Industrial Edge Cloud applications have been implemented to date. SF-KL and DFKI are technology leaders in the TWIN4TRUCKS projects launched on the first of September 2022. Daimler Truck is lead manager for that project. The aim is to optimize value creation in commercial vehicle production on the shop floor.

In 2016, the German Federal Ministry for Economic Affairs and Energy (BMWi) appointed SF-KL lead manager of the Mittelstand 4.0 Competence Center (SME4.0) Kaiserslautern, which supported the digitalization efforts of SMEs until 2021. Since 2021, that work continues as the Mittelstand-Digital Zentrum Kaiserslautern.

MEMBERS

AREND PROZESSAUTOMATION
B&R A member of the ABB Group
Continental
DAIMLER TRUCK
Doosan Machine Tools
DFKI
EMPOLIS
EPLAN
FUJITSU
GERMAN EDGE CLOUD
Industrial Automation HANNOVER MESSE
HARTING Pushing Performance Since 1945
HIRSCHMANN A BELDEN BRAND
HUAWEI
IBM
KIST Europe
KSB
MAKINO
MiniTec THE ART OF SIMPLICITY
Perinet Seamless IoT Connectivity
PFALZKOM Pfalzwerke Gruppe
PHOENIX CONTACT
PILZ THE SPIRIT OF SAFETY
PROALPHA
RAPA
Radiflow
rexroth A Bosch Company
RPTU Rheinland-Pfälzische Technische Universität Kaiserslautern Landau
RITTAL
SAMA PARTNERS
SIEMENS
TE connectivity
TIKI Technologisches Institut für angewandte Künstliche Intelligenz
TÜV SÜD
UNIVERSITATEA LUCIAN BLAGA DIN SIBIU
Weidmüller
WIBU SYSTEMS

www.smartfactory.de

Technologie-Initiative SmartFactory KL e.V.
Trippstadter Straße 122
67663 Kaiserslautern

P +49 (0) 631 / 20575-3401
F +49 (0) 631 / 20575-3402
M info@smartfactory.de

The Technologie-Initiative SmartFactory KL e.V. (***SmartFactory***^{KL}) is a non-profit association registered in the register of associati-onsfor Kaiserslautern.

Association registration number: VR 2458 Kai
Sales tax identification number: DE249965612

Executive Board
Prof. Dr. Martin Ruskowski (Chairman of the Board)
Andreas Huhmann, HARTING AG & Co. KG
Klaus Stark, Pilz GmbH & Co. KG
Eric Brabänder, Empolis Information Management GmbH

Management
Rüdiger Dabelow, DFKI GmbH

Source for images
Christopher Arnoldi, A. Sell, DFKI/Juergen Mai

smartFactory^{KL}®