5G-Industry Campus Europe

**Let's innovate the future of the
manufacturing industry**

Motivation

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Shaping the future of innovative production with 5G. With the 5G-Industry Campus Europe, companies and research partners have access to an entirely new infrastructure. Various 5G applications in manufacturing and logistics can be tested and evaluated. We will completely redefine requirements for industries.«

Niels König
Coordinator 5G-Industry Campus Europe

5G for Industries

The 5G-Industry Campus Europe is the first site in Europe with a comprehensive 5G network to explore and test new applications for 5G in production environments under real-world conditions. With an outdoor network of around 1 km² and a shop floor size of 7000 m², the 5G network covers the area of the RWTH Aachen Campus Melaten and the machine halls of the participating institutes – the Fraunhofer Institute for Production Technology IPT, the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University, the Research Institute for Industrial Management (FIR) e. V. at RWTH Aachen University and the IT Center RWTH Aachen University. The 5G network supplier is Ericsson. The Fraunhofer IPT carries out the central coordination of the entire project.

To ensure the results are transferrable to the industry, the 5G network operates within the frequency band of 3.7 to 3.8 GHz. Also, it includes a 4G network.

- 5G outdoor network of 1 km² at the RWTH Aachen Campus
- 5G indoor network on different shop floors of 7000 m²
- 5G-NSA (non-standalone) and 5G-SA (stand-alone) running at 3,7-3,8 GHz
- Simultaneous 4G network at 2,3 GHz as anchor band

5G-Industry Campus Europe Objectives

The 5G-Industry Campus Europe offers a unique ecosystem for research, development and testing of 5G technology for industrial applications. The Fraunhofer IPT and its research partners in Aachen are testing the first industrial 5G applications at the 5G-Industry Campus Europe. In seven sub-projects, various application scenarios are being researched, from 5G sensor
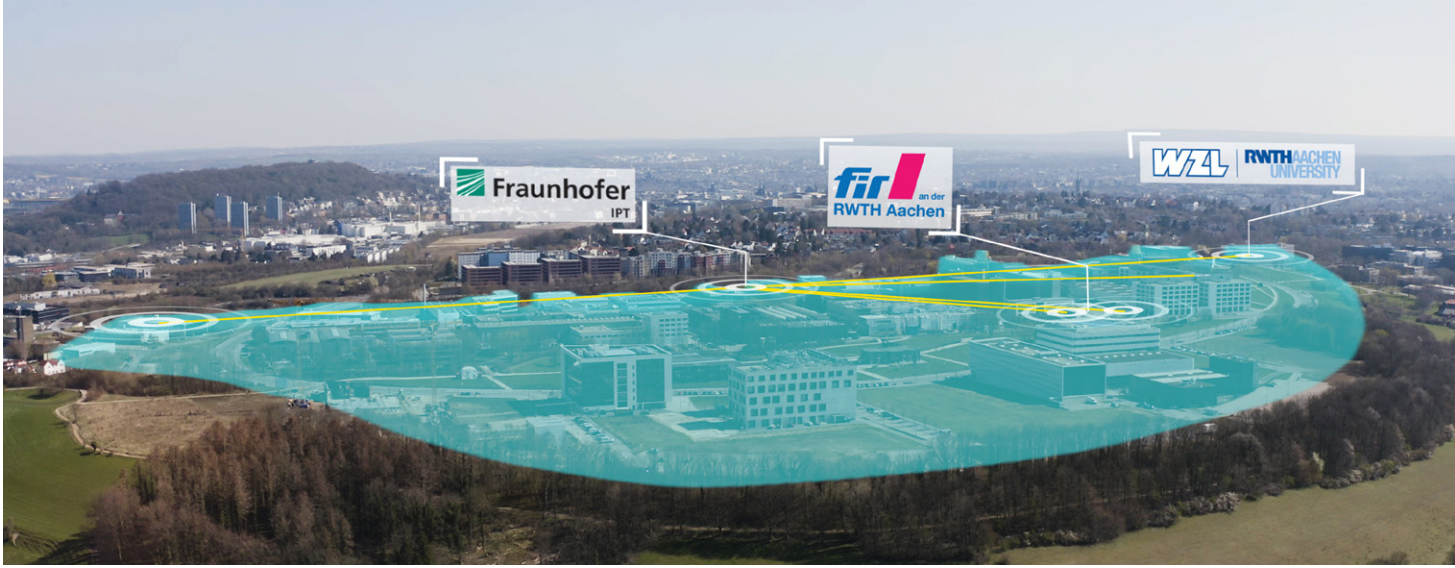
technology for monitoring and controlling complex manufacturing processes, mobile robots cooperating on an assembly task, or AGVs (automated guided vehicles) enabling flexible and logical supply chains – for all these applications, 5G offers the possibility of reliable real-time communication and thus the possibility of networked, adaptive production. Furthermore, the research partners are also testing the use of modern edge cloud systems for fast data processing in order to exploit the potential of 5G in networked, adaptive production.

Benefits of 5G

To realize the vision of a highly flexible and networked manufacturing system, individual processes and distributed systems must communicate reliably in real-time and without delay. This is the only way to ensure a high level of monitoring and control and to respond dynamically to the smallest changes in the production process.

Communication systems are the basis for the factory of the future. The latest mobile communications technology, 5G, offers the best conditions for this purpose: High data rates of up to 10 Gbit/s, high device density and ultra low-latencies of up to 1 ms are essential requirements for modern production systems. As a result, manufacturing processes can be made more mobile, flexible and adaptive than before. In addition, the quality of components can be improved, costs reduced and productivity thus increased. Networked, adaptive production systems, real-time process monitoring, image processing and autonomous robots are no longer just a vision, but could soon be part of everyday life in modern production.

- Data rates up to 10 Gbit/s
- Ultra low-latencies below 1ms
- Operate numerous devices simultaneously in tightly defined radio cells

5G-Application profiles

Depending on the area of application, 5G network can be optimized regarding various properties:

### eMBB (Enhanced Mobile Broadband Communication)
The Enhanced Mobile Broadband enables extremely high data rates of up to 10 Gb/s uplink and 20 Gb/s downlink and supports services with high broadband requirements.

uRLLC (Ultra-Reliable Low Latency Communication)
Ultra-reliable and low latency communications can be used optimally for time-critical applications. The requirements for availability with transmission reliability of 99.999% and short response times of less than 1 ms.

mMTC (Massive Machine Type Communication)
A high number of devices per unit area can be supported through massive machine-type communication, thus ensuring high energy efficiency.
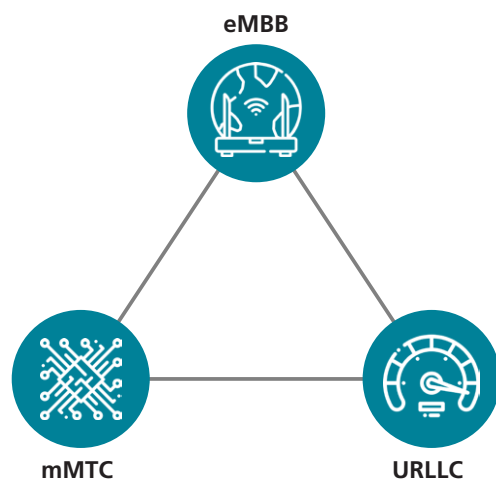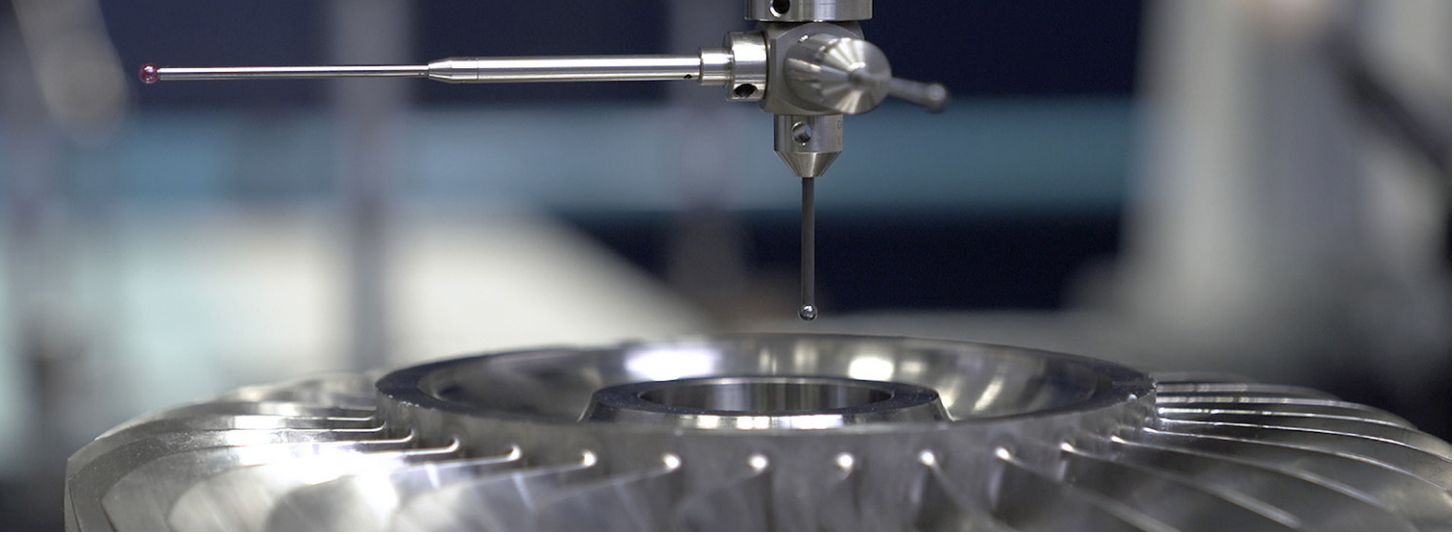
5G and Time Sensitive Networking (TSN)

For fast and reliable data exchange in the 5G production network, a number of standards are used, which are collectively referred to as Time Sensitive Networking (TSN): These enable data transmission with very low latencies and high availability and were developed by the Time-Sensitive Networking Task Group (TSN), a working group of the Institute of Electrical and Electronics Engineers (IEEE). These TSN standards are now to be combined with 5G to form an overall system with real-time capability, with the aim of enabling highly available, reliable and secure communication between all components and modules: From sensors and actuators in the field level via 5G and TSN-enabled networks to the Fraunhofer Edge Cloud (FEC).

5G Infrastructure

With the 5G-Industry Campus Europe, a complete 5G ecosystem was established on the RWTH Aachen Campus Melaten: On the one hand, this was realized with the indoor networks of the participating institutes in the machine halls, and on the other hand with the outdoor network, which covers the area between the individual institutes. The network consists of a 5G-SA part in the 3.7 to 3.8 GHz frequency range (band N77/N78) and 5G-NSA with a 4G anchor band at 2.3 GHz. On the IPT shopfloor, the network was additionally equipped with a modular test system from Ericsson. The test system operates in the millimeter wavelength range (mmWave), a new 5G spectrum with frequencies between 24 and 28 gigahertz. The new spectral range enables even higher data rates and lower latencies than previous systems. In particular, time-critical applications such as collision detection can also be implemented.

- Modular 5G test system in mmWave spectrum
- Fequencies between 24 and 28 gigahertz
- For time-critical applications

» The 5G infrastructure of the 5G-Industry Campus Europe with its one square kilometer outdoor and multiple indoor networks offers excellent conditions for testing and trialling time-critical use cases that require high reliability, availability and latency.«

Niels König
Coordinator 5G-Industry Campus Europe

Use cases

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The dividends sit on the cutting edge of the steel, but the speed of these cutting edges is a function of the machines that move them.«
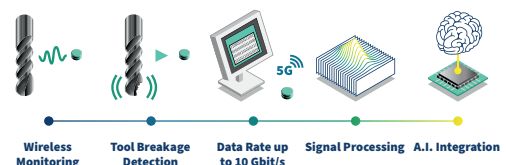
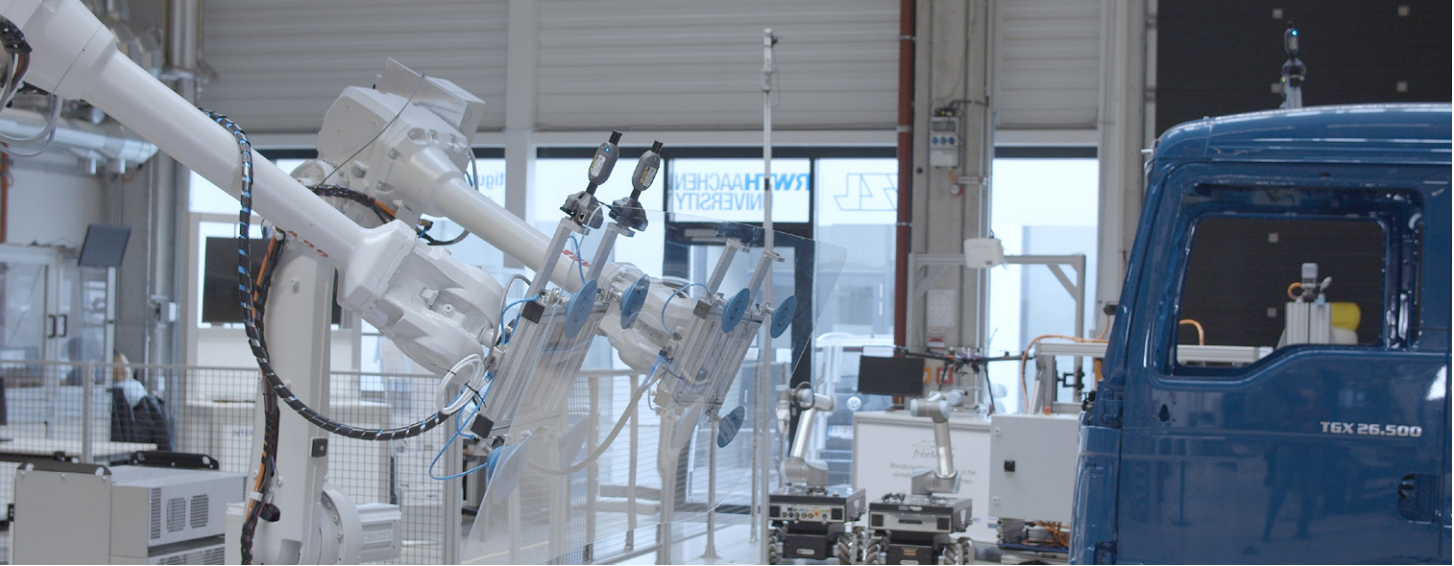**Georg Schlesinger,** 1911

5G-Multisensor

To reliably control highly complex processes, low latencies and component-related monitoring are required. However, current data transmission technologies, such as Bluetooth and WLAN, cannot meet industrial requirements due to low reliability. The 5G mobile radio standard allows large amounts of data to be transmitted at high speed, enabling ultra low-latencies between sensor, cloud, and mainframe systems. Furthermore, 5G sensors integrated on the workpiece close to the process capture physical data with much less interference. In the 5G-Multisensor project, a multisensor is being developed and tested on the production process of a BLISK.
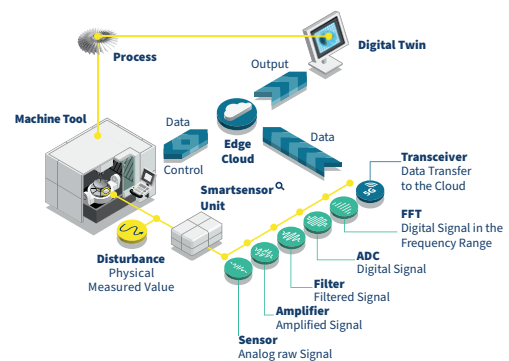
5G-AE Sensor

Cutting processes are the basis for many industrial value chains. The condition of the cutting tool is important for both the quality and the economical efficiency. Close monitoring of the tool condition using acoustic emission sensor systems can help to better understand tool wear and tool breakage.

Wireless Monitoring · Tool Breakage Detection · Data Rate up to 10 Gbit/s · Signal Processing · A.I. Integration
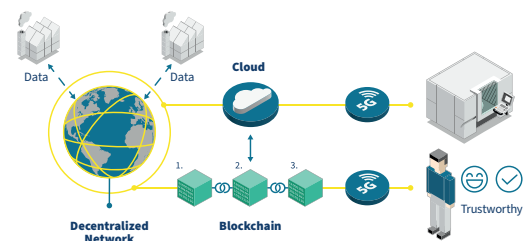
5G-Blockchain

Reliable, wireless network connectivity of many data sources is a central challenge in networked value chains.

The 5G-Blockchain project aims to test the limits of a completely wireless 5G network in a factory as part of a block-based data economy.


5G-Logistics

Adapting to customer requirements demands for flexible, transparent, and connected logistic supply chains. The increasing number of automated guided vehicle systems in workshops and logistics raises the barriers of current wireless communication solutions in terms of data usage for sensors and control. To demonstrate how 5G can coordinate autonomous systems in a supply chain, an autonomous logistics solution will be set up on the 5G-Industry Campus Europe.
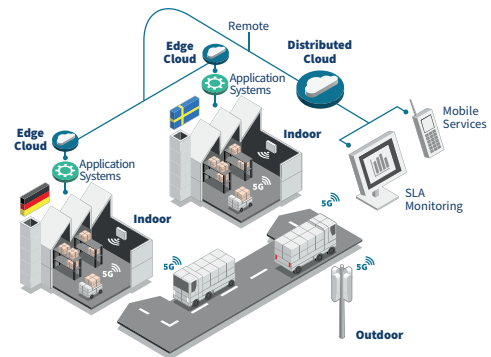

5G-Robotics

Flexible assembly in line-free, mobile assembly systems leads to complex, autonomous resources. The implementation of complex assembly tasks requires the synchronized processing of several robots. Therefore, a wireless connection with low latency is necessary to ensure resource mobility and connectivity to external measurement, sensor, and control systems. 5G-Robotics' objective is to create a control system for cooperating mobile robots connected by wireless communication.
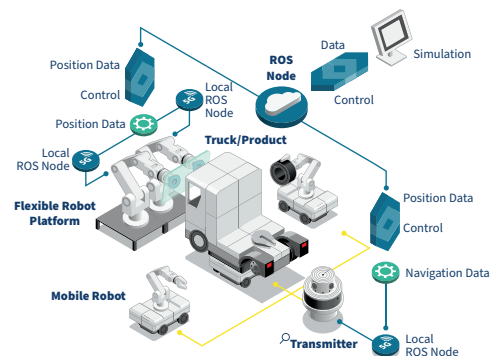
5G-Cockpit

Production processes today take place in many different places around the world. The same or similar production processes are often carried out at various locations, causing quality fluctuations between the individual productions. One solution is to reliably monitor various processes and make the production process transparent. The 5G production cockpit makes it possible to collect and compare data globally on one platform and to optimize the processes accordingly. Process monitoring and data acquisition in real-time via the Fraunhofer Cloud Solution leads to the same optimized process at all locations.
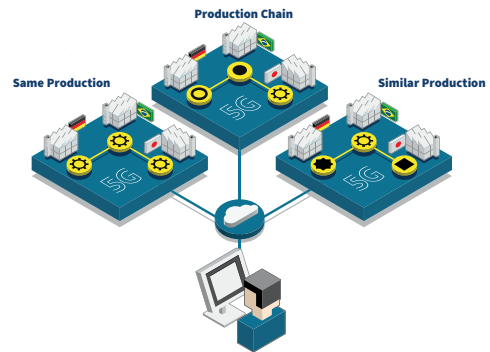

5G-Edge Cloud

The integration of the cloud into production enables new, more intelligent, and networked process chains, in the sense of Industry 4.0. The mobile communications standard 5G enables reliable and real-time capable communication in a factory cloud system. Complementary real-time capable computing platforms and applications must be designed and implemented for the industry. In the 5G-Edge Cloud project, a data analysis platform with low latency for closed-loop applications in manufacturing is being set up. The factory cloud system is directly connected to the 5G network.
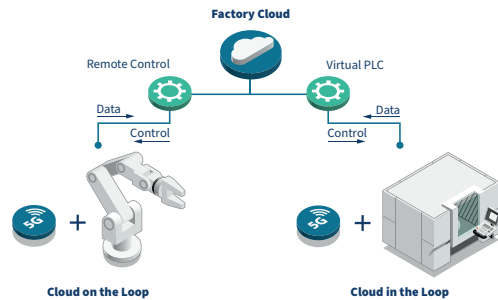
5G-3D Sensor

The 3D metrology of components has become very important in industry, particularly in the trending topic additive manufacturing. To accurately capture component geometries in three dimensions using a light section sensor, a tight synchronization of the handheld scanner and tracking system is necessary. In the project 5G-3D Sensor, a wireless light section sensor will be tested for 3D acquisition of components geometries.
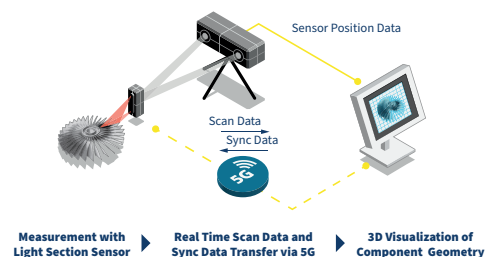
Service offering 5G-Industry Campus Europe

The research partners of the 5G-Industry Campus Europe are bringing their expertise and competencies to bear in order to offer service recommendations that are specifically tailored to the needs of industrial companies and make 5G interesting for their production. The offering ranges from customized hardware developments to IT and network solutions and strategic consulting. Our offering goes beyond what mobile network operators, suppliers and integrators from the mobile communications sector can offer, because we are testing 5G in an industry related context.

Hardware	IT	Strategy
▪ Development of Wireless Sensors ▪ Sensor Integration ▪ Process-Monitoring / Control ▪ Mobile Robotics ▪ Machine Connectivity	▪ 5G Public/Private Network configurations ▪ Edge Cloud Infrastructure ▪ Multi-Site Connectivity ▪ Remote Applications	▪ Business Case Analysis ▪ Technology Monitoring ▪ Roll-out Strategies ▪ 5G Industry Audit

It's a chicken-and-egg issue. You need a market pull with companies asking for a private network, equipment and services. From the research side, we can strengthen that pull by pioneering. By showing that it works and what it delivers. And by identifying the right applications.«

Niels König
Coordinator 5G-Industry Campus Europe

5G-Portfolio

What potential does 5G mobile technology offer? And how can it be successfully implemented in your production?

With the 5G portfolio, we have bundled our many years of knowledge and want to support you in using the potential of 5G for your own production. You have the option of choosing individually from three different modules to suit your situation. We will provide you with recommendations on how to integrate 5G into your own production and thus make your processes more efficient and adaptable in the long term. The three modules offer a unique opportunity to get to know 5G in an industry-oriented environment at the 5G-Industry Campus Europe, to have the potential of 5G integration tested in your halls and to develop further strategies for the integration of 5G in your production. The modules can be freely selected and combined to support you in the various phases of your own 5G production.

5G Start

You are interested in 5G and want to know how you can use the technology for yourself? But don't know exactly where to start? Then the modules in 5G start are just right for you: With the 5G-Experience Day we introduce you to the technology and show you hands-on examples of industrial use cases at our 5G-Industry Campus Europe. Furthermore, 5G start includes the identification of your own 5G use cases and an analysis of the economic potential.

5G Expert

You already had first contact with 5G and have decided to use a 5G network for your production? We develop individual 5G sensor technology, implement 5G blueprints and provide you with our mobile 5G test system for your use cases. Following the motto: "Test before Invest".

5G Professional

You want to build your own 5G network and want to know how your 5G network performs? Together with you, we develop your individual 5G roadmap for the successful roll-out of your own network. If you already have your own 5G network, we offer you an independent performance assessment with state-of-the-art measurement technology.

Partners

Fraunhofer
IPT

The Fraunhofer Institute for Production Technology IPT combines many years of knowledge and experience from all areas of production technology. In the fields of process technology, production machines, production quality and metrology as well as technology management, the Fraunhofer IPT offers its customers and project partners applied research and development for networked, adaptive production. The institute's range of services is geared to the individual tasks and challenges within specific industries, technologies and product areas, including automotive engineering and suppliers, energy, life sciences, aviation, mechanical and plant engineering, optics, precision and microtechnology, and tool and mold making.

fir an der
RWTH Aachen

The Institute for Industrial Management FIR is a non-profit, intersectoral research and educational institution at RWTH Aachen University concerned with business organization, information logistics and corporate IT with the aim to establish the organizational basis for the digitally integrated company of the future.

Through the development and transfer of innovative solutions, FIR contributes to enhancing the competitiveness of companies. This is undertaken within an infrastructure that is ideally suited for experimental organizational research – methodologically sound, scientifically rigorous, and conducted in close collaboration with experts from business and industry. The activities focus on the application of research to industry verticals: Future Logistics, Smart Services and Smart Maintenance, Smart Commercial Buildings, and Smart Mobility.

WZL | RWTH AACHEN UNIVERSITY

For more than 100 years, the Laboratory for Machine Tools and Production Engineering (WZL) of RWTH Aachen University has stood for successful and forward-thinking research and innovation in the area of production engineering. Under the direction of the four professors Christian Brecher, Thomas Bergs, Robert Schmitt and Günther Schuh, a wide range of production-related issues are dealt with in six areas – production engineering, machine tools, production systematics, gear technology, production measurement technology and quality management – together with industrial partners from various sectors.

The IT Center of RWTH Aachen University is responsible for the IT support of university-wide processes. It is responsible for the effective, efficient and secure operation of the IT infrastructure. For this purpose, the service catalogue offers high-quality IT solutions for study, research and teaching, adapted to current security standards. The structure and organization of the IT Center is based on the tasks and guidelines of the IT Center. As part of the restructuring of its service processes according to ITIL (IT Infrastructure Library) since 2008, the IT Center has introduced processes to ensure the quality and further development of the services. As part of RWTH Aachen University, the IT Center is not only a service provider but also a partner to its customers. The partnership is reflected in joint projects for the further development of services and joint research projects.

Ericsson enables communications service providers to capture the full value of connectivity. The company's portfolio spans Networks, Digital Services, Managed Services, and Emerging Business and is designed to help our customers go digital, increase efficiency and find new revenue streams. Ericsson's investments in innovation have delivered the benefits of telephony and mobile broadband to billions of people around the world. The Ericsson stock is listed on Nasdaq Stockholm and on Nasdaq New York.

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