



DFKI at CeBIT and HANNOVER MESSE  
W3C and Internet of Things  
Smart Data, Deep Learning, Wearable AI

# HANNOVER MESSE 2016

April 25-29



**„Get new  
technology first“**

DFKI presents the modular designed  
INDUSTRIE 4.0 demonstrator of *SmartFactory<sup>KL</sup>*,  
an innovative IT infrastructure for smart  
factories, cognitive augmented reality  
handbooks for manufacturing, cyber-physical  
IT systems for multi-adaptive factories,  
and model-based software development  
for robots.

**DFKI-SmartFactory<sup>KL</sup> Hall 8, Stand D20**

**SmartF-IT – Cyber-physical IT Systems for Multi-adaptive Factories Hall 2, Stand B46**

**CoCoS – IT Infrastructure for Smart Factories Hall 2, Stand C28**

**IOXP – Cognitive Augmented Reality Handbooks Hall 2, Stand B40**

**D-Rock – Reconfigurable Autonomous Systems Hall 2, Stand B01**



## Artificial Intelligence for New Business Areas

► Artificial Intelligence is gaining prominence in the public arena. This is not because of the Hollywood blockbusters, where machines find ever new plots to threaten the continued existence of humans, but rather in terms of real social impact and economics. The year 2016 also marks the 60th anniversary of the Dartmouth Conference held in Hanover, New Hampshire, where the term “Artificial Intelligence” was coined.

Since that time, the exponential growth in hardware capacity, the price decline for sensor technology, the bridging of the media chasm caused by digitization, the successful application of machine learning methods, and the broad network coverage, have all, in combination, enabled systems today that approach the original intent of AI – the simulation of human know-how: speech recognition, language and image processing systems, machine translation, and robotic assistants that operate in toxic environments, on the sea floor, or in space; mixed teams of humans and robots in manufacturing as well as cooperative healthcare situations. System prototypes already exist in all these areas that require continued intensive development, but are sure to reach the stage for mass production in the coming years.

DFKI is the leading business-oriented research center in Germany and the world’s largest AI research facility in the field of innovative software technologies based on the methods of Artificial Intelligence. However, innovation is abstract and if not experienced, it can easily fall victim to the legend makers. To ensure factual discussion of the latest developments, illustrations are required. The answer is the establishment of the DFKI Living Labs. These futuristic labs are set up by topic and address the areas of robotics, retail, automotive, INDUSTRIE 4.0, urban lifestyles, and assisted living.



The living labs present technologies and integrated systems in a way that allows the visitor to reflect on the technological opportunities and their own personal dreams and expectations for the future.

Robert Thielicke, Chief editor of *Technology Review* and Prof. Wolfgang Wahlster, CEO of DFKI will discuss the significance and the opportunities at the CeBIT future talk: “Artificial Intelligence – Overhyped or underestimated?” The focus is on: self-driven cars, highly networked mobility from Car2X communication, Deep Learning approaches for safe autonomous driving, and 5G – the next generation of wireless communications – for automobiles and medical applications in the “tactile Internet,” which will enable zero latency services. Of course, it is also about the smart services that open up entirely new business segments, allow predictive maintenance and the consequent contribution to resource efficiency, but also about INDUSTRIE 4.0, the future of manufacturing and related topics that, since 2011, always end with the suffix “4.0” – representing the impact of the 4th Industrial Revolution. ◀

### CeBIT future talk

March 14, 4:15 - 5:00 p.m

Hall 6, B54

[www.cebit.de/event/artificial-intelligence-overhyped-or-underestimated/EXP/68338](http://www.cebit.de/event/artificial-intelligence-overhyped-or-underestimated/EXP/68338)







**CLIMBTRACK – ASSISTANCE TECHNOLOGIES FOR CLIMBERS – AMONG THE WINNERS OF CEBIT INNOVATION AWARD 2016**

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## Climbtrack – The “Third Hand” on the Climbing Wall

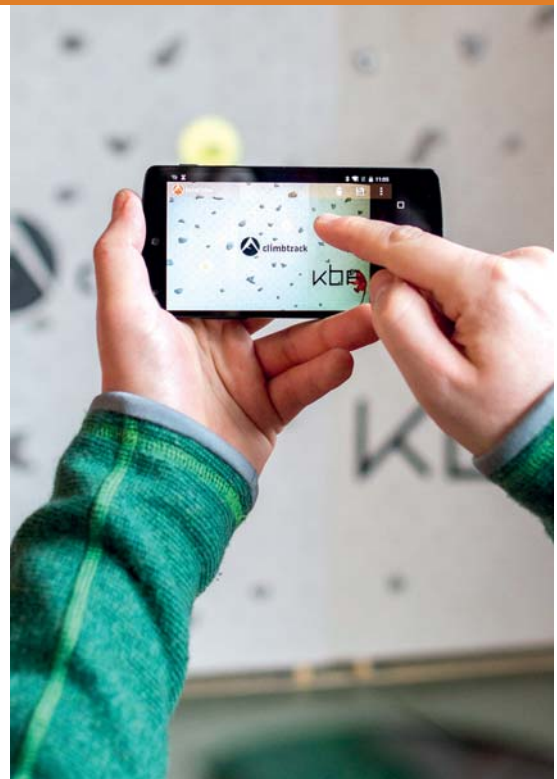
DFKI Spin-off Among the Winners of  
CeBIT Innovation Award 2016

► A new concept called climbtrack makes the fascinating field of Human-computer interaction (HCI) interesting to the sport of climbing. As passionate climbers, two DFKI researchers Felix Kosmalla and Frederik Wiehr founded a company that develops assistance systems for climbers that identify, explain, and solve climbing problems in a fun way.

At the core of this innovative application is the betaCube, an integrated system consisting of a 3D camera and a projector. At the push of a button, the betaCube detects a climbing wall and projects a life size image of the climber, stored routes, and previously recorded actions onto the wall, and provides a detailed video analysis. In this way, the climber intuitively and easily learns new climbing techniques. “The routes climbed are recorded and stored in the system in the individual fitness history for later analysis. By tracking the routes climbed, the user can see what progress is being made and can make individual adjustments to improve,” said Felix Kosmalla, co-founder of climbtrack.

The most interesting thing about the betaCube for operators of climbing wall facilities is the idea of giving their customers the opportunity to improve their skills with the aid of state of the art technology. The system works at the touch of a button and can be installed practically anywhere, as the integrated 3D camera recognizes any climbing wall within a few seconds and eliminates the need for expensive built-in installations.

The climbtrack Augmented Reality App also provides for the interactive planning of new routes via a smart phone or tablet. These climbs can be stored and later projected onto the display wall. This feature expands the functional range of the existing climbing walls. If the system is linked to the climber's personal wearable, the sensor data may be used and supporting moves can be projected onto the wall, for example, to show how to apply strength efficiently at a certain hand hold. The climbtrack system offers climbing enthusiasts and facility operators a tool

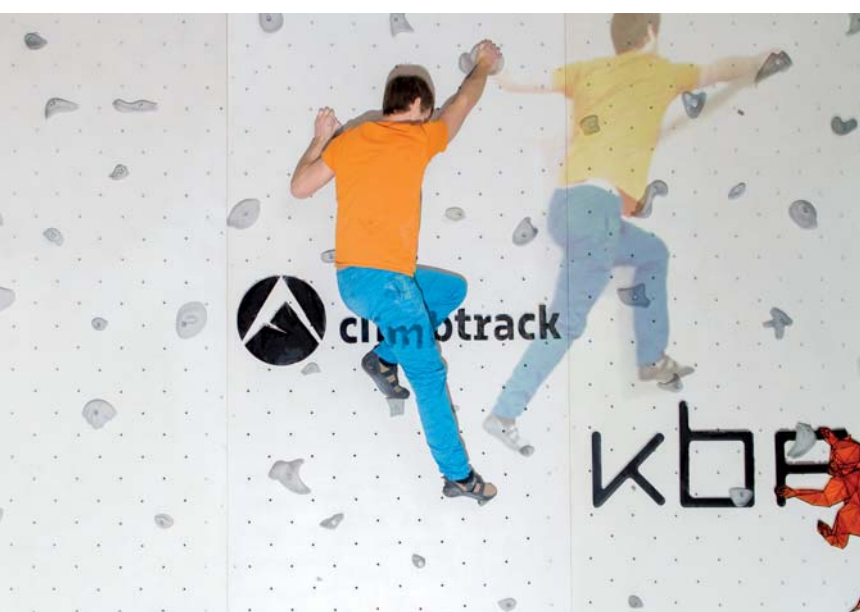


Planning new climbing routes with the smart phone

that supports the individual's progress while climbing, without changing the culture of the sport.

The most recent DFKI spin-off is one of the three winning projects in the CeBIT Innovation Award 2016 competition. The fourth time this coveted prize for innovation will be awarded is on March 14, 2016. The user friendly climbtrack technology is being presented at CeBIT 2016 at the joint exhibit stand of the Federal Ministry of Education and Research (BMBF). ◀

**More information**  
<http://climbtrack.com>



Climber and projection of the saved route

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and Research



**climbtrack**

**CeBIT** Hall 6, Stand A34

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## Model-based Production – Business Process Management Meets INDUSTRIE 4.0

A showcase of LEGO® blocks illustrates the planning, control, and analysis of flexible manufacturing processes while taking into account the total value added by cyber-physical systems

► In the context of the German government's high-tech strategy, the futuristic INDUSTRIE 4.0 project describes the thinking production machines of the future and a truly exciting vision: the real world merging more and more with the virtual world in the form of modular units participating in the production and even the products themselves. Cyber-physical systems in smart factories are changing the production processes in ways never before imaginable. They are extremely flexible and primarily support the automated manufacture of smaller lot sizes with the same great diversity of options.

This flexibility presents the managers of smart factories with entirely new demands overall and, in particular, for production planning and control. An integrated planning and modeling process with sufficient degrees of freedom for products and production processes is essential. In addition, decisions about what information needs are required to be communicated and how to communicate them among all the production units and information systems that are generating the added value. The future challenges for the INDUSTRIE 4.0 vision will include not merely the intelligent production alone, but also the intelligent design of the entire value-added chain, from the supply chain to the warehousing and distribution management.

This is the context illustrated by the LEGO® showcase demonstrator, an innovative scenario that applies the business process management approach to INDUSTRIE 4.0. The scenario uses a flexible manufacturing process for the production of tractors with various options and is initially based on a descriptive production and product model in terms of a process model. This is then related to a specific product and embedded in an integrated model for value creation in the Smart LEGO Factory. Next comes the fully automated control and monitoring of real value added by a cyber-physical system that begins with the parts supply and covers the actual production and quality control to the "end-of-the-line" and also warehousing.

True to reality, the human actors are also included, for example, their roles in parts supply and assembly. Using the RefMod-Miner, a prototype built at DFKI to analyze business processes (models) and to develop reference models, the complete value creation chain can be visualized and analyzed in real time using the model while taking into account all human and machine work operations. Looking forward in this way, errors can be prevented and a proactive response taken to any possible problems. ◀

### More information

[www.dfki.de/web/research/iwi](http://www.dfki.de/web/research/iwi)  
<http://refmod-miner.dfki.de>



Production line based on process models for the manufacturing of LEGO®tractors

**CeBIT** Hall 6, Stand B48

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## 3Digify – DIY Construction of a 3D Scanner

► 3D scanners perform a valuable service, for example, for the measurement and replication of components or, for the documentation and digital preservation of cultural artifacts. However, such systems have a very high purchase price and are prohibitively expensive, above all, for private users.

Now, for the first time, this technology is affordable to all – thanks to the 3Digify software jointly developed at TU Kaiserslautern and DFKI. The selection of the device is up to the user who can draw up a flexible and cost efficient plan for a 3D scanner. With the help of the software, anyone can construct a high quality 3D scanner at no great expense using commercially available cameras and video projectors. 3Digify controls the interface and processes the generated data.

Reconstructions created with 3Digify are compact, but extremely detailed and can be directly published to the Internet, integrated into websites, replicated in a 3D printer, or further processed in other programs.

3Digify entered the spin-off phase in January 2016. ◀

**More information**  
[www.3digify.com](http://www.3digify.com)

**3Digify**



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**CeBIT** Hall 6, Stand C17

## Multimedia Opinion Mining – Automated Analysis of Opinions on Global Affairs



► Companies have a keen interest in knowing the collective mood in the social networks concerning their products and services. Hidden between millions of irrelevant and unstructured data in the internet, opinions are being exchanged. On micro-blogging platforms like Twitter or video platforms like Youtube, users express their views about companies and institutions as well as about current events in a multimedia image or as a text. Multimedia Opinion Mining System (MOM) responds to the challenge of extracting opinions from online multimedia content, to find out what people are thinking about some topic and what motivates them at a given time. Of all the various formats on the web, the social media networks are the most direct source.

The processes and methods used in Multimedia Opinion Mining enable the so called trend scout to first identify trends as such and then to track their development by watching the opinions expressed in the various multimedia data channels as text, images, and video data.

In a second step, the mood of the image or text is determined (a sentiment analysis) for the purpose of classifying the opinions. Subsequently, a social media analysis identifies the various stakeholders, i.e., the major source or distributor of the opinion. In a final step, the results are analyzed and linked to a life cycle analysis to form a final prediction about the expected course the trend will follow. ◀

**More information**  
<http://madm.dfki.de>

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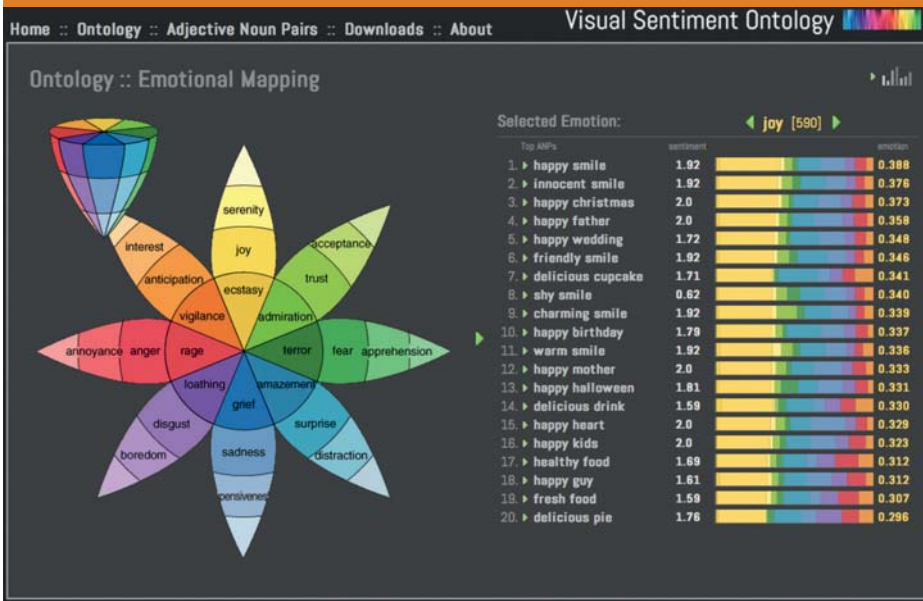
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Assignment of adjective-noun pairs to emotions in Robert Plutchik's Wheel of Emotions

## SentiBank – Deep Learning for the Visual Sentiment Analysis of 100 Million Images

► Deep Learning is currently one of the most exciting topics in machine learning. It represents the most successful approach in the area of visual recognition of concepts and objects. A most recent aspect in this field is the recognition of emotions and moods from photos. Visual content not only represents objects, people, or places, but also influences our perceptions and feelings. It produces so called mood pictures. These are very useful in the semantic understanding of the content of videos and photos and significantly improve the benefits of large digital data sets for the users.

The researchers in the SentiBank project take a new approach to sentiment analysis, one based on the semantic understanding of visual content. They are generating a data-driven ontology of semantic concepts that have emotional ties, trigger a strong feeling, or appear frequently in Internet platforms like Flickr and YouTube. The ontology currently contains more than 30,000 concepts, represented as adjective-noun pairs, for example, “blue sky” or “sad eyes.”

The visual sentiment analysis in SentiBank is based on Deep Convolutional Neural Networks (DCNN). Thanks to the training (supervised machine learning) on one of the largest data sets in computer vision and multimedia research, the Yahoo Flickr Creative Commons 100 Million (YFCC100m), we can see the

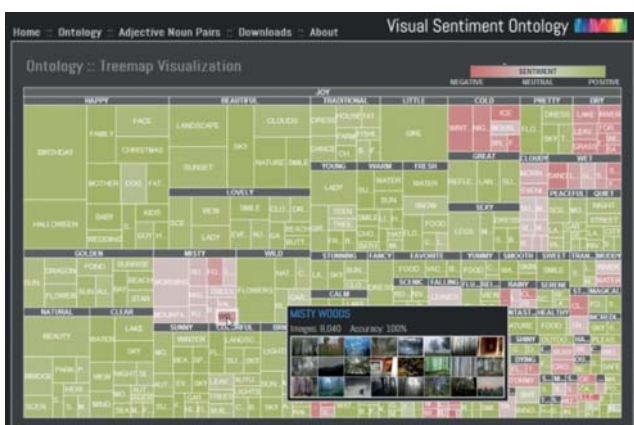
“beautiful” part of a “nice landscape” or the “frightening” part of a “scary dog.” Assigning a picture to an emotion is possible on the basis of the emotion theory by Robert Plutchik, which differentiates 24 emotional states. SentiBank finds photos or videos for each of the 24 emotions in open access sources like Flickr and YouTube.

Various scenarios can be implemented with SentiBank, for example, concept detectors that perform a sentiment analysis from photos in Twitter or improve the specific placement of advertisements for videos on YouTube.

The early experiments with 2,000 real photo tweets from Twitter show that this method improves forecast accuracy by 13% compared to text-only methods. SentiBank provides its concept ontology, the recognition library, and the benchmark for visual sentiment analysis online as open source.

The DFKI Competence Center of Excellence for Multimedia Analysis and Data Mining (MADM) has a partner in the SentiBank project, namely, the Department of Electrical Engineering at Columbia University, New York. ◀

More information  
[www.sentibank.org](http://www.sentibank.org)

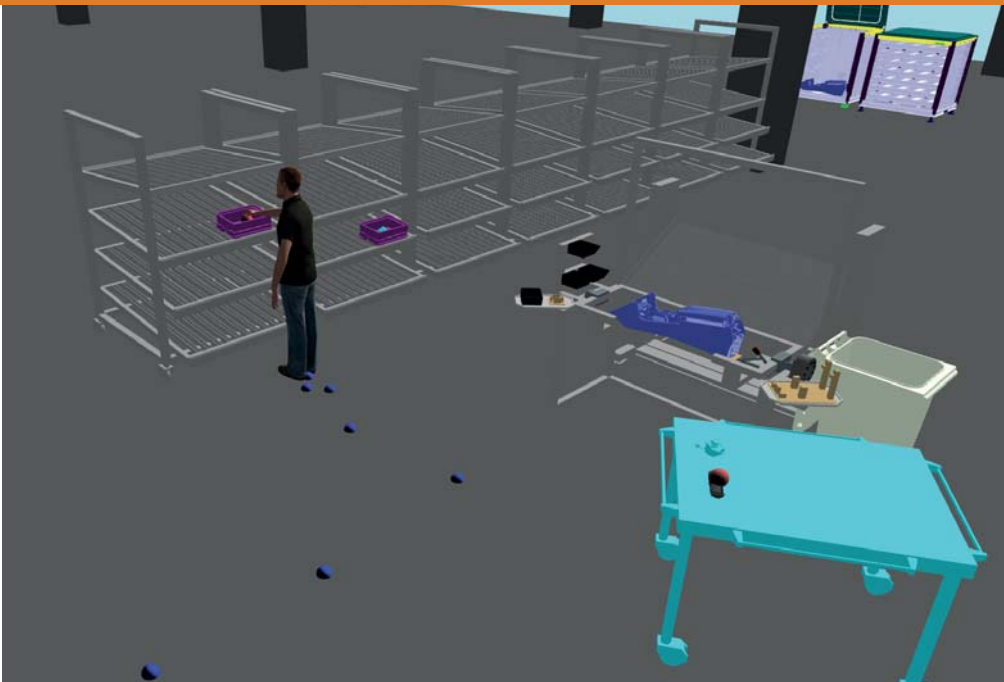


A TreeMap of Visual Sentiment Ontology



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## EU Project INTERACT – From Written Assembly Instructions to Digital Simulations

► The workers in an industrial manufacturing plant know how the individual steps of an assembly process can best be performed, how they may be combined, and where the job sequence could be improved. If assembly processes for new product variants have to be adjusted or completely redefined, these people are the ones to ask. In the past, a process was first described, then programmed as a virtual assembly process, and finally, implemented in the production.

The aim of the INTERACT project (Interactive Manual Assembly Operations for the Human-Centered Workplaces of the Future) is to directly apply the know-how of the production staff regarding the manual performance of assembly tasks and incorporate this knowledge into the digital tools that support the design, verification, validation, modification, and the continuous improvement of human-centered assembly work stations.

To achieve this, the activities and movements of the workers are captured using low cost, non-contact sensors and tracking technologies like Kinect sensor cameras or data gloves and

merged with data of a previously modeled visualization. The result is a precise visualization of the required assembly processes.

For the analysis of voice instructions, planning of activities, and synthesis of natural looking movements, two AI technology departments are involved: 1) Agents and Simulated Reality and 2) Language Technologies. Researchers are cooperating on the development of an integrated software architecture, which first converts a natural language description of an assembly job to formal language and then to a visualization. This facilitates faster start-up phases and the design of correct assembly processes right from the start, regardless of production line and location.

The assembly planner is guided by a computer through the preparation of natural language instructions, enabling the generally underspecified inputs to ultimately be automatically completed. This includes, for example, the clarification of linguistic terminology by assigning defined names to individual



### Project partners

- Daimler Germany (coordination)
- German Research Center for Artificial Intelligence (DFKI)
- Electrolux Professional, Italy
- Emphasis Telematics, Greece
- Hadatap, Poland
- IMK Automotive, Germany
- Intrasoft International, Luxembourg
- University of Patras, Greece
- Universität Ulm, Germany

components, tools, and expendable supplies; adding of additional activities to be visualized, as required – such as the procurement of parts and tools.

In particular, we study movement synthesis in the planning, visualizing, and analyzing of motion sequences to achieve realistic, animated virtual characters. The interactions between findings at the AI level and the underlying visualization components are also of major interest.

The project results are tested and evaluated on the vehicle assembly lines at Daimler and in the production of kitchen appliances at Electrolux.

The project framework includes the development of tablet and smartphone apps, to facilitate and improve the sustainable support for human-centered assembly tasks. ◀

INTERACT is funded for a period of three years under the 7th EU Framework Program for Research.

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**More information**  
[www.interact-fp7.eu](http://www.interact-fp7.eu)

## Software for Companies of the Future – OSMOSE and BEinCPPS Striving for Comprehensive Networking

▶ The increasing industry demand for flexible and cost efficient production processes is forcing companies to take an interest in fast and reliable solutions. The department of Agents and Simulated Reality (ASR), headed by Prof. Dr. Philipp Slusallek, is answering this challenge in two EU projects that are having a major influence on the development of prototype applications for the factory of the future.

In the collaborative project OSMOSE (*OSMOsis applications for the Sensing Enterprise*), experts are developing the next generation of intelligent communication systems in a consortium of partners from industry and research. The aim of the project is to create a reference architecture to 1) map an enterprise in the real, digital, and virtual worlds, 2) seamlessly open the gates to all three worlds and, 3) in this way, link them to one another. Real users will be able to browse in this “universe,” entering, controlling, exchanging experience and knowledge with the “residents.” The range of specific applications is appropriate, for example, in the aerospace or the automotive sectors.

The industrial production of the future relies more and more on networked, cyber-physical systems (CPS). The BEinCPPS project (*Business Experiments in Cyber Physical Production Systems*) ties in at precisely this point. The team around Prof. Slusallek, together with researchers from the Innovative Factory Systems (IFS) department is developing new methods for the integration and testing of a CPS-oriented, future-internet based, cloud service platform for machining and manufacturing plants. The innovative measure mainly facilitates the adaptation of CPS-based production applications throughout Europe.

The ASR research department anchors the thought of networked smart objects in innovative project work and provides industry with solutions that successfully adapt to meet the requirements of future applications. ◀

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**More information**  
[www.osmose-project.eu](http://www.osmose-project.eu)

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At CeBIT, SPECiflC demonstrates an airport access security system.

## SPECiflC – Quality Driven, Flexible Design Process for Embedded and Cyber-physical Systems

► In order to respond to the increasingly stringent requirements for quality and security in modern systems, DFKI researchers from the department of Cyber-Physical Systems (CPS), headed by Prof. Dr. Rolf Drechsler, have developed an innovative design process. The SPECiflC project aims to facilitate the formal modeling of systems right from the start whereby design errors are detected early in the process. This capability is especially interesting for chip manufacturers as it saves time and money in chip development.

The project is demonstrating a simplified airport access control system at CeBIT 2016: The visitors can interactively explore the design of the access control system and judge for themselves whether it is correct.

The design process developed by the researchers in the SPECiflC project consists of methods for determining the correctness of the design on multiple levels. At the first level, system requirements are formulated in natural language. In the context of the airport access system these include, for example, the access controls through which passengers or employees must pass. In this way, all of the concerned parties – programmers, project leaders, customers, etc. – can reach a common understanding of the product to be developed. Between the natural language requirements and their implementation on a chip or in a program, however, there is a large gap in terms of the strength of expression and accuracy. This poses the danger that ultimately, the implementation of the desired specification will not be met. That is why the CPS researchers have de-

veloped a method that breaks down this error prone step – from the specification of requirements to the implementation – into manageable intermediate steps. The method is based on the idea of a formal specification level, which combines the useful features of natural language and implementation by means of introducing a model-based requirements specification. The formal specification level permits an abstract description of the system, which is still sufficiently formalized and accurate enough to allow early examination of the attributes of the model and the identification and, if needed, correction of any design errors. To avoid having to recalculate the entire design with every corrective change to the specification or model, the researchers have also created a functional change management system that evaluates and limits the impact of each change. The design process has now become much more flexible without adding risk to the guarantee of correctness. ◀

**More information**  
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**CeBIT** Hall 6, Stand B48

## Work Overalls that Prevent Posture Problems

► How a sensor suit can protect the wearer from physical strain on the job is demonstrated at CeBIT 2016 by the DFKI research lab Cyber-Physical Systems (CPS) by means of overalls equipped with special sensors. Visitors to the DFKI exhibit stand can gain a better understanding of the suit, which was developed in the SIRKA project (Sensor Suit for Individual Feedback of Physical Activity).

To all outside appearances, the suit looks no different than normal work clothing. However, on the inside are huge differences: 20 miniaturized computers, 19 of them on tiny circuit boards approximately 4cm<sup>2</sup> in size are distributed throughout the entire suit. The inertial sensors placed on the circuit boards measure the magnetic fields, speed of rotation, and acceleration. The boards are so positioned that at least one inertial sensor captures – at least as an approximation – the motion of one body part. The computer units assigned to the sensors process the recorded data and send them to the central unit by means of the integrated network also sewn into the suit. All the measurements are combined to create a momentary estimate of the body posture. The resulting posture film is used in two ways: first, it is stored on an SD-card in the central unit where it serves as the basis for a physician or therapist to identify potentially dangerous practices as health risks. Second, it produces an immediate warning to the wearer when a posture is assumed that is classified as risky.

From a technical and scientific perspective, a special feature of this sensor suit is the unique method developed by DFKI researchers Felix Wenk and Udo Frese that allows an estimate of the body's position even without the magnetic field data. This method uses the skeletal structure of the wearer to compensate for information lost through the lack of magnetic field measurements by using the relative orientations of the body parts. This enables the use of the sensor suits in environments where the magnetic field is constantly changing which hinders reliable posture estimates, for example, in shipbuilding.

SIRKA has been funded by the Federal Ministry of Education and Research (BMBF) since May 2014 with a total of 1.1 million euros. Seven partners are working closely together on the project: Besides DFKI, these include: lead manager Budelmann Elektronik, Rofa Bekleidungswerk, MEYER WERFT, St. John's Ambulance (*Johanniter-Unfall-Hilfe*), OFFIS Institute for Information Technology, and Osnabrück University of Applied Sciences. ◀

**More information**  
[www.dfki.de/cps](http://www.dfki.de/cps)

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**CeBIT** Hall 6, Stand B48

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Photo: Meyer Werft

The sensor suit helps to prevent problematic motion sequences.



Detailed view of the suit

## Next Generation Robots – Autonomous, Reliable, and Cooperative

► Robotics is a key technology that is already supporting people in many areas and promises huge potential for the future – whether in manufacturing, rehabilitation systems, or the deepest oceans. Scientists at the Robotics Innovation Center (RIC) are developing the next generation of robotic systems to cooperate with people and independently perform complex tasks.

Industrial robots are still often separated from their human colleagues by protective cages. The future will look different: humans and machines are no longer working in parallel but rather, to an increasing extent, cooperating with one another in overlapping workspaces. New, intelligent, sensor-based safety mechanisms and inherently reliable systems will take the place of cages and enable direct cooperation in a common working environment. RIC focuses on the integration of robotic systems into the existing and future structures found in industrial manufacturing. The research priorities are on manipulation, mobility, and interaction as well as the required system capabilities like situational awareness, information processing, and collision avoidance. This so-called HRC (Human-Robot-Collaboration) capability requires systems capable of direct interaction with humans, the ability to recognize and interpret human gestures and situations. Consequently, the prerequisite is the highest possible level of autonomy so the robot can react appropriately to unforeseen events.



Human and robot safely working as a team

Equipped with sophisticated sensors, intelligent control systems, and powerful software, the systems created at RIC are not only for use in manufacturing, but more generally, for areas of application where humans and machines directly interact with one another. In the field of rehabilitative robotics, RIC is working on robotic exoskeletons that can process bio-signals to assist people with neuro-motoric disabilities (for example, stroke survivors). In addition, intelligent robots can be used in environments that are dangerous or difficult to access for humans such as in outer space or deep under the sea. Operating independently without remote controls or the aid of human operators, the systems can reach a designated target on the basis of well-prepared action plans – all while under constantly changing conditions. The autonomous underwater vehicles (AUVs) developed at RIC will someday perform fully autonomous inspections and even manipulative tasks over long periods, for example, on pipelines or offshore industrial parks. ◀

**More information**  
[www.dfki.de/robotics](http://www.dfki.de/robotics)



Autonomous underwater vehicles (AUVs) at DFKI Maritime Exploration Hall in Bremen

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## Wearable Technologies from the Competence Center Wearable AI

► The new Wearable AI Competence Center, a joint facility of DFKI's Embedded Intelligence Department and the Design Research Lab at Berlin University of the Arts, presents the latest developments and the upcoming trends in the area of wearable technologies at CeBIT 2016. This relatively new field combines the unique functioning of innovative sensors with important application domains to improve people's lives both at work and at home.

### Smart Watch Life Saver

More than 95% of the people who experience a heart attack outside of a hospital will die from it. A feedback app for smart watches supports medical non-professionals in reanimation techniques while administering heart massage by telling them by means of vibrations, the correct pressure interval and number of repetitions. It also checks the depth of compression and, in case of deviations, gives the appropriate corrective feedback by means of colors, as in a traffic signal.

### CTS Therapy Cuff

The cuff is an interactive tool for measuring the strain on the inner and outer sides of the wrist. This area is susceptible to pain, particularly, for patients with carpal tunnel syndrome (CTS), with symptoms ranging from a burning sensation to the loss of strength in the fingers, and even circulatory problems in the hand. Built-in sensors in the textile of the cuff detect if the hand is flexed and measure the pressure on the joint.



### Smart Sportband

Muscle strength is a key factor of performance in sports. Equipped with a textile sensor, the smart sportband records muscle activity in the arms, legs, or chest muscles and enables an analysis of the muscle performance.

### Smart Wristband

The armband has capacitive textile sensors that detect gestures, enabling a non-contact human-computer interaction.

This is very practical, for example, when using a tablet with wet or dirty hands. It can also be used to measure vital data like pulse and respiratory rate.

### Smart Shirt

The smart shirt is designed for long term nutrition monitoring with unobtrusive sensor technology. Another main use is to



check the healing process of patients with difficulty swallowing, for example, after surviving a stroke. Textile sensors detect the swallowing process with no direct contact to the skin.

### Smart Helmet

Many of the documentation tasks at major construction sites or building projects or for shipbuilding require precise location information. A helmet with integrated sensors that can be worn at construction sites or in factory production halls enables the estimation of a position to accuracies within 20 cm.

### Fully Flexible Display

In the area of wearables, the small size of rigid displays severely limits the interaction between humans and computer. A fully flexible thin display that can be scaled to 50 x 50 pixels allows bigger displays for wearables and facilitates interaction with the devices. ◀

### More information

[www.dfki.de/web/competence/wearable-ai](http://www.dfki.de/web/competence/wearable-ai)

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CeBIT Hall 6, Stand B48



Use of Wearable Computing Technology for experimental learning in the field of acoustics

## Wearables in the Classroom – Physics with a Google Glass

► The higher the water level in a glass filled with water, the lower the tone when striking the glass. The physical principle behind this phenomenon is often covered in the classrooms, although the relationships in the water glass experiment are so complex that even using this everyday example, teaching in a way that it can be understood is rarely possible. Scientists at DFKI and TU Kaiserslautern have developed an app that helps students determine relationships between the water level in the glass and the sound of the tone. gPhysics analyzes the water volume, measures the tone frequency, and displays the results in a diagram. The app can be used simply by head gestures and no manual interaction is required.

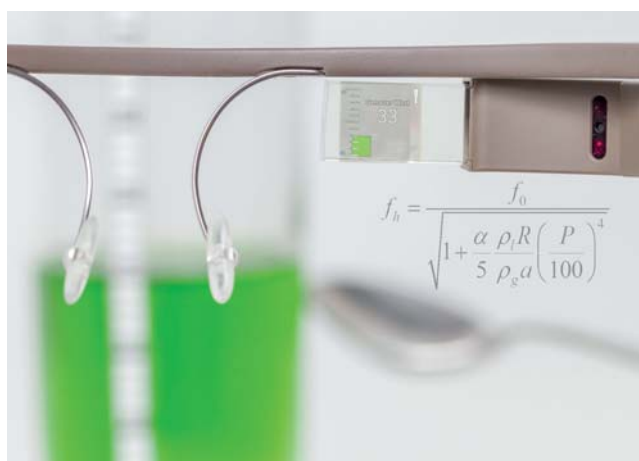
In traditional classroom teaching, the student must first measure the water volume then, using a suitable instrument to strike the glass, try to determine the tone frequency and finally, enter this value in a diagram. In gPhysics, the amount of water is captured by a camera and the value it determines may be corrected by head gesture or voice command, if necessary. A microphone built-in to the Google Glass measures the tone frequency. This information is then entered in a diagram and is continuously updated on the Google Glass display. The pupils can follow how the frequency curve moves in relation to the water volume while they are filling the glass. Because the curve is generated fairly quickly, students have the opportunity to test various hypotheses directly during the interactive process by varying diverse parameters of the experiment. For example, what is the effect when the glass has a different shape or is made of a different material, or a different liquid is used? Through additional, qualitative observations and explanations of the phenomenon and by representing this physical phenom-

enon in various media – diagram, photo, image, graphic – pupils can gain a deeper understanding of these theoretically complex relationships.

The gPhysics app is an exemplary development from the field of Wearable Computing Technology. Through the “fusion” of the real and digital worlds, students in the university level MINT programs can interactively experiment in real time, gaining an appreciation of the relationship between practice and theory. The term “practice” as used here refers to both classroom instruction and the experiments conducted at universities as well as the experiences and observations from everyday life. The overall aims are to make learning more tangible through the development and use of new technologies, to discover new forms of interaction for individual and group experiments, and to study and develop didactic methods, tools, and learning systems matched to the learning objectives. ◀

### More information

<http://www.dfki.de/web/competence/wearable-ai>  
[www.physik.uni-kl.de](http://www.physik.uni-kl.de)



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## Panorama View Versus Tunnel Vision – Effective Search and Compare with “Parallel Exploration”



The faceted search with “Parallel Exploration” provides users a way to view the results of several related queries at the same time: The interim results can be compared, different types of objects can be found, and the results can be saved or shared with others.

In addition to tourism, this technology is suitable for use in a diverse range of other domains such as product catalogs, logistics, media libraries, or trade fair programs.

The prototype demonstrated at CeBIT 2016, is developed as part of three year collaborative project 3cixty, financed by the European Institute of Innovation & Technology (EIT Digital), and comprises 10 partners and 5 small companies from 6 countries working as a consortium led by DFKI. ◀

**More information**  
[www.3cixty.com](http://www.3cixty.com)

► Numerous websites and apps allow customers to search for flight connections, hotels, or products with keywords and filters. However, their perspectives are limited because at any one time only a single set of results is displayed. The advanced DFKI technology “Parallel Exploration” lets you see – and compare – a clear presentation of interim results at each step in the search process for example, among several travel destinations in terms of attractions, events, and leisure activities.

Using an innovative application, the search technology demonstrated at CeBIT 2016 will allow visitors to search European cities. If looking for concerts, festivals, or art exhibits, for example, in Milan on a certain weekend, you will get parallel listings that show activities in all three categories. In case the category “Festivals” is no longer of interest, the user can restrict the results to concerts and art exhibits, by selecting two from the maximum of three columns that are displayed next to one another. Next, you can enter the new category restaurants and cafés in the vicinity of each event to compare concerts with the best gastronomical options nearby and then designate a favorite on your wish list.

Friends or other family members can help to decide which leisure activity wins by means of a linking function. Via e-mail, you can share the search results with other people; on the basis of the data in the app, they can search further or make another comparison.



**CeBIT** Hall 6, Stand B48

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## Selected Lectures, Presentations and Discussions at CeBIT 2016

### IT-Planning Board

Tuesday, 3/15/2016  
10:30-11:00 a.m.

Panel Discussion  
**Bridging the Language Gap – Public Service Totally Multilingual**  
Moderation: *Prof. Dr. Josef van Genabith*,  
Scientific Director Multilingual Technologies, DFKI

CeBIT Global Event for Digital Business

CeBIT Hall 7, Stand B42

### future talk CeBIT 2016 – The Innovative Conference Forum

Monday, 3/14/2016

Opening / Welcome  
10:00 - 10:05 a.m. **Official Opening of future talk CeBIT 2016**  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

CeBIT Innovation Award 2016  
11:30 - 12:00 a.m. **Innovation at the Interface Between People and IT**  
The CeBIT Innovation Award 2016 winners present their innovative ideas:  
**Amelie Künzler**, **Sandro Engel**; ActiWait / **Felix Kosmalla**, **Frederik Wiehr**; climbtrack / **Tobias Hagemann**, **Sebastian Stenzel**; Cryptomator  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

2:00 - 3:00 p.m. **Smart City – IT Opportunities for SMEs**  
*Prof. Dr. Lutz Heuser*, Founder and CTO, [ui!] – the urban institute

Panel Discussion  
3:00 - 3:45 p.m. **Smart Services / Smart Data / Smart Everything?**  
Ministerialrat *Dr. Alexander Tettenborn*, Head of Departement VIB4, BMWi / *Prof. Dr.-Ing. Peter Liggesmeyer*, President of Gesellschaft für Informatik e.V. (G.I.) / *Prof. Dr. Jörn Müller-Quade*, Professor at KIT, Director at FZI, KIT / *Prof. Dr. Beatrix Weber*, Head of Research Group Law in Sustainability, Compliance and IT, Hochschule Hof / *Prof. Dr. Hans Uszkoreit*, Scientific Director, DFKI  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

Fireside Talk  
4:15 - 5:00 p.m. **Artificial Intelligence – Overhyped or Underestimated?**  
*Robert Thielicke*, Chief Editor 'Technology Review' / *Prof. Dr. Wolfgang Wahlster*, CEO, DFKI

Tuesday, 3/15/2016

9:30 - 10:30 a.m. **CeBIT Innovation Award 2016 – Award Presentations and Announcement of Winners**  
*Prof. Johanna Wanka*, Federal Minister of Education and Research / *Prof. Gesche Joost*, Juri president / *Oliver Frese*, CeBIT Managing Board

The CeBIT Innovation Award 2016 winners:  
**Amelie Künzler**, **Sandro Engel**; ActiWait / **Felix Kosmalla**, **Frederik Wiehr**; climbtrack / **Tobias Hagemann**, **Sebastian Stenzel**; Cryptomator  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

3:45 - 4:00 p.m. **Informatikland Saarland – IT-Summit 2016**  
*Annegret Kramp-Karrenbauer*, Minister-President of Saarland  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

Wednesday, 3/16/2016

12:00 - 12:30 a.m. **Multimodal Language-centered Control and Response Systems for INDUSTRIE 4.0**  
*Jochen Steigner*, Chief Sales Officer, SemVox

12:30 a.m. - 1:00 p.m. **More than a Measuring System: Future Trends in 3D Scanning**  
*Dr.-Ing. Johannes Köhler*, Managing Director, 3Digify

3:00 - 4:00 p.m. **What Can IT Do to Help Alleviate the Refugee Crisis? Disruptive Challenges Create Modernization Opportunities in Administration**  
*Prof. Dr. André Göbel*, Professor and Head of Laboratory, Hochschule Harz / *Marc Reinhardt*, Senior Vice President / Head of Public Sector, Capgemini / *Franz-Reinhard Habel*, Spokesperson and Delegate, DStGB / *Ingo Engelhardt*, Head of Coordination and Steering, Federal Labor Office  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

Friday, 3/18/2016

11:00 a.m. - 2:00 p.m. **Priority: Digital Diplomacy and Nation Branding**  
*Ariane Derks*, Managing Director, Initiative 'Germany – Land of Ideas' / *Vito Cecere*, CIO, Federal Foreign Office  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI

future talk Final

3:30 - 4:30 p.m. **The Future Looks Good! – Back to the Future!**  
Moderation: *Reinhard Karger*, Corporate Spokesperson, DFKI / *Frank Sonder*, foresee GmbH

More information:  
[www.cebit.de/event/future-talk-das-innovative-konferenzforum/FOR/68016](http://www.cebit.de/event/future-talk-das-innovative-konferenzforum/FOR/68016)

CeBIT Hall 6, Stand B54



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 Federal Ministry  
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Gaze control and attention analysis for Human-Robot-Collaboration in a mixed-reality-environment

## EyeBots – Of Humans and Robots

► DFKI researchers present EyeBots, a new form of Human-Robot-Collaboration (HRC) that incorporates the latest advances in the areas of wearable technologies, virtual environments, augmented reality (AR), robotics, and visual sensor systems. The EyeBots system consists of various individual solutions from each of the fields mentioned above which, in combination, form the basis for the execution of complex tasks in demanding industrial environments.

The EyeBots demonstrator shows how humans and robots can work together as a hybrid team. In the scenario introduced here, two people, together with a customizable and trainable robot complete a task, while observers in another room track the ongoing work via a virtual reality (VR) system and can even take corrective actions, if required. The VR system enables the manipulation of objects in a three dimensional, virtual representation of the collaboration scenario in real time. This allows the user to interact with the robot simply by pointing at the target object by hand or just by looking at it.

The human gaze is an important indicator of the focus of visual attention. It is a source of information in a double sense: when we look in a certain direction, we first gain information about a specific area of our surroundings. On the other hand, we also signal to others, who may be in our vicinity, our interest in that specific area. EyeBots can process information both from a virtual and a real environment and can provide this data along with the exact position and orientation of the objects and people. This aggregated information can be used, for example, for remote maintenance or for advanced training purposes.

The EyeBot demonstrator addresses core aspects of the HySociaTea (Hybrid Social Teams for Long Term Collaboration in Cyber-Physical Environments) project, which is sponsored for a period of two years by the Federal Ministry of Education and Research (BMBF). The HySociaTea project uses a packaging scenario

with collaborative work by a hybrid team consisting of two people, three robots (two mobile and one stationary) and a virtual character. Besides Human-Robot-Collaboration via diverse modalities as demonstrated here, the priority research topics in HySociaTea are team coordination and the autonomy of the robots.

In summary, EyeBots research prototypes are demonstrating new forms of collaborative factory work that allow employees at different locations to respond in a mixed-reality-environment and, fully in the spirit of INDUSTRIE 4.0, to flexibly solve tasks together with robots. ◀

**More information**  
<http://hysociatea.dfki.de>

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**CeBIT** Hall 6, Stand B48

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## Research for Data-driven Innovation at CeBIT 2016 – DFKI Projects in the BMWi Smart Data Program



The German Federal Ministry for Economic Affairs and Energy (BMWi) selected 13 projects for funding in 2014 at the start of its Smart Data Technologies Program. DFKI Kaiserslautern, Saarbrücken, and the Project Office in Berlin are involved in five of these projects.

### Smart Data for Mobility (SD4M) and Smart Data Web (SDW) – Data Analysis for Mobility Providers and Supply Chain Management

► Researchers in SD4M are developing a cross-sector service platform that integrates data from various mobility providers and social media and then processes it for publication. The Big Data Analytics Platform provides a foundation for intelligent data management, the basis for diverse, multimodal, smart mobility services. For example, the platform offers logistics and travel service providers a nationwide mobility summary and assists them in improving their forecasting, planning, and utilization.

The aim of the Smart Data Web is to build a bridge between the two previously separated data ecosystems: the public access Internet and the internal information environment of major corporations. A new kind of knowledge network enables this link and simplifies the selection and analysis of relevant data. The information acquired in this way supports supply chain management and helps manufacturing companies to optimize their planning and decision making processes.

The multi-project demonstrator shows how the deep analysis of heterogeneous data creates added value for supply chain management and mobility monitoring. The semantic analysis

uses a combination of publically accessible information with company-specific data. The results are visualized on a large, interactive map of Germany that shows the relevant road traffic conditions and tracks the current movements of people and freight, and the industrial landscape in real time. ◀

Supported by:



**More information**  
<http://sd4m.net>  
<http://smartdataweb.de>

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**CeBIT Hall 6, Stand C38**

## SmartRegio – Trend Analysis Based on Heterogeneous Big Data



► SmartRegio studies the feasibility of identifying local trends on the basis of Big Data. Small and medium sized enterprises, public institutions, and infrastructure providers are often deeply rooted in their respective regions, which is the reason they need to be aware of local trends and the impact on their business processes. To analyze these trends,

SmartRegio uses locally available Big Data. A modular platform flexibly evaluates the data in time, space, and content; detects any relevant changes, and prepares it for distribution to various addressees.

SmartRegio supports companies with regional operations with their decision making, in particular, SMEs. This is clearly illustrated by the example of regional energy suppliers and grid operators: network development, planning, management, and new services are dependent on demographic and regional economic developments or trends, which are outside the usual field of vision – for example, the increasing e-mobility with its

associated demands for the expansion of the regional power grids.

The SmartRegio project partners are YellowMap and Disy, SMEs that provide geo information and decision support services. Also contributing are the data integration and platform specialist USU Software, Goethe University Frankfurt, and DFKI. DFKI's Knowledge Management research department develops suitable data mining methods and links trend spotting to selected regional social media content. It is responsible for the ongoing system integration and the inclusion of selected regional distribution grid operators. ◀

**More information**  
[www.smartregio.org](http://www.smartregio.org)

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**CeBIT Hall 6, Stand C38**



## PRO-OPT Big Data – Production Optimization in Smart Ecosystems

► This project designs a smart data platform that enables intelligent, integrated analysis and visualization of large volumes of distributed data in the production processes while respecting the local data sovereignty. This provides the different businesses in a value adding chain with the means to avoid errors and significantly improve their processes.

PRO-OPT consortium partners AUDI, Fraunhofer Institute for Experimental Software Engineering (IESE), camLine, and DFKI are developing effective and intelligent solutions for the analysis of big data in decentral, cooperative structures under the lead management of DSA (Data and Systems Engineering).

Along the entire production chain in the industrial automobile manufacturing sector – from vehicle construction to maintenance and services – digitization and automation are causing ever increasing data volumes. Data sources are distributed among different, economically unrelated participants in this ecosystem. Frequently, components from different producers are used. Access authorizations and data privacy rules make the comprehensive analysis of this data very complex.

The Big Data strategies developed by DFKI scientists are designed to allow more efficient analysis.

In this shared project, DFKI research departments Knowledge Management and Innovative Factory Systems are developing methods and tools for data modeling, data analysis in distributed integrated scenarios, and solutions for the integration of heterogeneous data sources. ◀

**More information**  
[www.pro-opt.org](http://www.pro-opt.org)



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**CeBIT Hall 6, Stand C38**

**Smart Data Forum** combines the Big Data activities in Germany, networks the national and international research on Smart Data, and accelerates knowledge and experience transfer. The forum supports the exchange with other initiatives, promotes the transfer of technological innovation to the SMEs, and raises international visibility abroad through the distribution of research results. The forum is a place of inspiration for experts and for information for the broader public. It provides insights into the world of data and data analysis. Installations show how innovative Smart Data solutions are changing research, business, and everyday life. Through events, workshops and conferences, the Smart Data Forum promotes exchange and knowledge transfer between smart data research projects and initiatives and the stakeholders from business, government, and science. The overall aim of the forum is to create, by means of focusing support for critical Big Data know-how, an innovation-friendly environment, which gives visibility, in particular, to the new and already established German mid-sized enterprises.

**Smart Data**

## Clinical Data Intelligence – Links Patient Data, Optimizes Treatment

► Patient data are generated at different sources and have different formats, for example, text, audio, and image data, or even individual genome data or diagnostic data from an ECG, MRT, or CT. Add to this are the details about the patient, the history of the disease, the medication, and therapy to date. If new digital tools like fitness and health apps or wearables are used, then even more data are generated. In most cases, these data are not networked and the attending physicians have, at best, limited access to the various data sets.

The aim of the CDI project (Clinical Data Intelligence) is to automate and drastically simplify the evaluation of this comprehensive and complex patient data. All available patient data from the various sources is brought together in a patient data model. Integrating the data in this way creates the basis for further innovative patient care services and medical research. An important result is integrated clinical decision support based on the assessment of all data sources.

At CeBIT, visitors will see a faceted search of patient data being used for integrated decision support. By means of a tablet, the attending physicians can not only call up this data, but also annotate by input pen. Results are presented and discussed using novel projection systems or the virtual reality data glasses, Oculus Rift. ◀

**More information**  
[www.klinische-datenintelligenz.de](http://www.klinische-datenintelligenz.de)



Annotation of patient data on the tablet

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**CeBIT Hall 6, Stand C38**



Mary-Lynne Nielsen (IEEE), Wolfgang Dorst (BITKOM), Dr. Dave Raggett (W3C), Thomas Hahn (Siemens), and Jeremy Geelan (moderator)



INDUSTRY  
OF THINGS  
WORLD



Dr. Georg Rehm and Dr. Dave Raggett at the W3C stand of the parallel trade fairs

## World Wide Web Consortium at Industry of Things World

► The German-Austrian Office of the World Wide Web Consortium (W3C) hosted at DFKI Berlin, participated in several aspects of the Industry of Things World Conference 2015. About 750 people attended the event which took place on September 21-22, 2015 at the Berlin Congress Center located on Alexanderplatz.

At the W3C stand of the industry trade fair, which was organized in parallel as part of the conference, participants were provided more information about the new “Web of Things” Initiative of the World Wide Web Consortium. This relatively new standard is still under development and represents a way to manage a very lightweight approach to interoperability among the various architectures for the Internet of Things. This is achieved with the “Thing Description Language” and associated communication protocols that facilitate the semantic description of attributes and methods in generic “Web Things.” These are the focus of activity in the Web of Things Working Group sponsored by Siemens and supervised by Dr. Dave Raggett (W3C). Both Dave Raggett and his colleague Bernard Gidon (W3C) travelled to Berlin to introduce this new approach. Dave Raggett also contributed to a panel discussion on the topic of standards for the industrial Internet.

The W3C German-Austrian Office is one of three DFKI groups (Intelligent User Interfaces and Innovative Factory Systems) participating in the project coordinated by the National Academy of Science and Engineering (Deutsche Akademie für Technikwissenschaften, Acatech). Dr. Christiane Plociennik (Innovative Factory Systems) used the two-day conference together with three colleagues from the project to conduct comprehensive expert interviews with 20 of the conference participants. The interviewees were selected in advance through the close cooperation with the conference organizers under the auspices of the “INDUSTRIE 4.0 in a Global Context – Cooperative Strategies with Global Partners” project. These interviews will be incorporated into a recommendations catalog on the topic of INDUSTRIE 4.0 for the German Federal Ministry for Economic Affairs and Energy (BMWi).

The Industry of Things World 2015 was the first event in a new conference series that continued with the Industry of Things World USA 2016 on February 25-26, in San Diego, California. The keynote speaker was Dr. Jeff Jaffe, CEO

of W3C. The next conference is scheduled from 19-20 September 2016 in Berlin, when Prof. Dr. Wolfgang Wahlster, CEO of DFKI, will provide the keynote address. Prof. Dr. Detlef Zühlke, who presented the activities of the DFKI department Innovative Factory Systems at Industry of Things World 2015 and Dr. Georg Rehm were given invitations to participate on the Advisory Board of this event. ◀

### More information

[www.w3.org](http://www.w3.org)  
[www.w3.org/WoT](http://www.w3.org/WoT)  
[www.w3c.de](http://www.w3c.de)  
<http://industryofthingsworld.com>  
[www.acatech.de/?id=2627](http://www.acatech.de/?id=2627)



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## DFKI, World Wide Web Consortium, and German Automobile Industry Discuss Cars of the Future

► The first W3C/DFKI Automotive Workshop was held on November 17, 2015 in Berlin. The event was organized by the German-Austrian Office of the World Wide Web Consortium (W3C), which has its offices at DFKI-Berlin, with the support of Dr. Christian Müller (DFKI, Automotive Intelligent User Interfaces) and Stefan Nürnberger (DFKI, Embedded and Automotive Security). Organizations in attendance included: ADAC, ATS, Bosch, Deutsche Telekom, HERE Deutschland, Secunet, and Volkswagen. Approximately 20 workshop participants focused on the role of modern information technologies and standards for the automobile industry, with special emphasis on networked vehicles.

Dr. Georg Rehm (DFKI, W3C) kicked off the workshop with an overview of the World Wide Web Consortium and its automobile-related activities. Specifically, this involves the W3C Automotive Business Group and the W3C Automotive Working Group, which are currently developing two specific standards: 1) Vehicle Data API, and 2) Vehicle Information API. The participants from industry were particularly interested in these two standards. DFKI's automotive experts reported on the subjects "Networked and autonomous vehicles require new safety architectures" (Stefan Nürnberger) and "Human Factors in Automated Driving – The Role of the Human-Machine-Interface" (Dr. Christian Müller). The workshop participants presented a series of brief, and informative, contributions to round out the workshop. The focus topics were safety, stability, driver modeling, predictive maintenance, OEM clouds, and standard access to data in addition to "over the air updates" from on-board software systems.

In a post-event survey, all participants reported a high level of satisfaction concerning the topics, the moderated discussions, and the collected ideas. Next steps were also agreed at the workshop: After a teleconference in the spring of 2016, a follow-on event will be organized for the summer 2016. ◀



### More information

[www.w3.org](http://www.w3.org)  
[www.w3c.de](http://www.w3c.de)  
<http://automotive.dfki.de>  
[www.automotive-security.net](http://www.automotive-security.net)  
[www.slideshare.net/georgrehm/w3cdfki-automotive-workshop](http://www.slideshare.net/georgrehm/w3cdfki-automotive-workshop)

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## Collaborative Project City2.e 2.0 Demonstrates Intelligent Parking Area Management at Press Event in Berlin

► At a press event on September 24, 2015 the project partners in the collaborative research project City2.e 2.0 demonstrated, on the Bundesallee in Berlin, how drivers of the future will be able to find a parking spot faster and avoid all the unnecessary traffic looking for free spaces. Project partners are: Siemens, Berlin Senate Administration for Urban and Environmental Planning (SenStadt-Um), VMZ Berlin, Institute for Climate Protection, Energy, and Mobility (IKEM), and DFKI's Robotics Innovation Center.

The aim of the project is to develop a radar sensor system for detecting available parking in public or semi-public places. For test and demonstration purposes, project partners placed radar sensors on street lights along a 250 meter long section of the road in the Berlin district of Friedenau. The sensors continuously monitor the city parking spaces and report all free spaces as well as those parking spaces configured with electric charging stations to a parking management software. In this way, motorists of the future will be informed at all times per app as to where a space is free. Based on the recorded sensor data, the Robotics Innovation Center created a forecasting module that generates predictions about the future parking possibilities in the area. ◀



New app informs drivers about free parking spaces.

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<http://robotik.dfki-bremen.de/en/research/projects/city2e-20-1.html>  
[www.siemens.com/presse/smart-parking](http://www.siemens.com/presse/smart-parking)





## DFKI *SmartFactory*<sup>KL</sup> at Hannover Messe 2016

► The joint venture *SmartFactory*<sup>KL</sup>, being developed by DFKI and partners is once again the major exhibit for production solutions in the area of INDUSTRIE 4.0 at this year's trade fair. The world's first multi-vendor demonstrator platform for INDUSTRIE 4.0 is on display in Hall 8 at Stand D20 – across from the INDUSTRIE 4.0 Forum.

Since 2005, DFKI and its industry partners in the *SmartFactory*<sup>KL</sup> Technology Initiative have been developing and implementing the vision of INDUSTRIE 4.0. From the initial concept through the first demonstrator to a market ready solution, the ground breaking work of the platform and the recently created INDUSTRIE 4.0 Competence Center have been crucial. The consortium completed another step in the implementation this year. Predictive maintenance, accident free repair and maintenance tasks, and scalable automation have all been successfully demonstrated by the expanded consortium to be practical solutions in the modular design production facilities of the future.

Special focus is devoted to supporting the people in the production process, whether in assembly, or operator, or maintenance tasks. Mobile and stationary assistance systems help workers perform varied and complex tasks in a zero-error production environment. The industry consortium under the lead management of *SmartFactory*<sup>KL</sup> introduced the world's first multi-vendor INDUSTRIE 4.0 demonstrator for the first time at Hannover Messe 2014. Every year since that time, trade fair visitors have been further impressed with what they see. The fully modular design of the unit facilitates the flexible and efficient production of batch size 1 as

standard interfaces ensure the compatibility of equipment and systems provided by various suppliers. At the same time, the detailed integration of the IT systems is enabled through timely and continuous data flows.

INDUSTRIE 4.0 has arrived! Already today, some market-ready partner products, open standards, and the simple implementation of the vision allow users to take the first steps into "Production 4.0". ◀

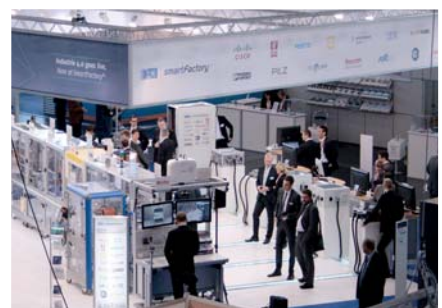
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Hannover Messe  
Hall 8, Stand D20

## Successful Exhibit at SPS IPC Drives

► *SmartFactory*<sup>KL</sup> and DFKI were at the center of a collaboration of 15 industry partners in the "INDUSTRIE 4.0 Area" of Hall 3A at SPS IPC Drives, one of the most important trade shows for automation engineering. The INDUSTRIE 4.0 plant they have developed serves as a realistic illustration of all the research topics related to INDUSTRIE 4.0. Market-driven products, uniform standards, and multivendor compatibility underscore the unique nature of this simulator and demonstrate the steps required along the path to realizing the 4<sup>th</sup> Industrial Revolution. At the joint exhibit and in the lectures held in the "Automation meets IT" Forum over the course of the trade fair, experts and visitors from industry, government, and the press obtained insights into the subjects and innovative work of *SmartFactory*<sup>KL</sup> and its partners in the area of INDUSTRIE 4.0. ◀



## SmartF-IT Brings INDUSTRIE 4.0 to the Shop Floor

Assistance systems manage high frequency refitting, adaption, and optimization tasks and even the operations of INDUSTRIE 4.0 production systems

Highly integrated, adaptive assistance systems support digitization and decision processes in semi-mobile production environment

► Semi-automated production lines already have a variety of assistance functionalities at individual stations, but the majority of these are only loosely linked. The SmartF-IT research project is developing the semantic factory memory that integrates current information about the plant, products, processes, services and employees in a knowledge base and prepares it for use in the production process. This information base uses adaptive assistance systems for diverse processes used to assist the individual worker, support effective team leadership, and manage collaborative fault and repair. The result is an integrated, homogeneous and highly flexible system for stationary as well as mobile production support. The prototype production plant on display at the Hannover Messe shows a lightweight digitization of this scalable approach for mainly manual assembly processes in a realistic shop floor scenario.

**Situation-specific, human-centered, anytime-optimization of production systems – using dynamic line balancing for multi-variant lines to batch size 1 as an example**

In the conventional mono-line production, employees are typically divided in advance into so called job-loops. In this case, the separate work steps are completed sequentially from station to station and the product being produced is passed to a colleague at fixed transfer points. In the case of dynamic multi-variant manufacturing with small lot sizes, dead time or improper loading often occurs in the process because of the earlier completed production planning. To achieve optimal line utilization, employees must be assigned job changes while production is running. A solution to this problem demands fine tuning at the operational level with dynamically changing environmental conditions, for example, a failure at one of the stations. This is a highly relevant issue economically and scientifically, as the use of conventional production planning algorithms is very difficult to achieve because of the dynamic, real time requirements and the correlation between various optimization factors or different optimization parameters. The latest human-centered, anytime optimization system under development in DFKI's



Photos: Miele

SmartF-IT project can solve the problem of dynamic line balancing. This system relies on distinct domain knowledge from the semantic factory memory of production and operator to master the complexity of the diverse optimization problems. In addition, it uses modern parallel computing architectures to guarantee efficient, real time calculations. ◀

**More information**  
[www.smartf-it-projekt.de](http://www.smartf-it-projekt.de)



Photos: Miele



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## D-Rock – Reconfigurable Autonomous Systems

► Recognize and perceive changes in an environment, adjust the actions required to perform the task: autonomous systems must be able to adapt quickly to unanticipated situations and act accordingly. This requires them to coordinate their behavior models with the hardware and software and, in effect, dynamically reconfigure themselves.

DFKI researchers in project D-Rock (FKZ 01IW15001, funded by the Federal Ministry of Education and Research – BMBF) are working on the standardization of the development sequence at all levels of autonomous systems: from hardware and electronics design, to the software and behavior modeling. This approach, which represents a new and improved standard for operating systems like ROS, is designed for use with highly complex robotic systems of the next generation, autonomous systems in unfamiliar and unstructured environments that are far superior to today's systems.

The D-Rock approach is demonstrated using the MANTIS, a multi-legged walking robot [dimensions (LxWxH): 2.5 m x 2.5 m x 1.85 m], as the mobile manipulator developed in Project LIMES (FKZ 50RA1218 & 50RA1219, funded by the Federal Ministry for Economic Affairs and Energy – BMWi) and sponsored by the German Aerospace Center (DLR).

Its flexible and adaptive movement apparatus enables a high degree of mobility on uneven and unstructured surfaces. The two front extremities can be employed as manipulators or for walking. Gripping tools equipped with multimodal sensors enable tactile perception and assist in object handling. MANTIS is capable of autonomous actions in diverse areas of employment: It can move objects and assist, for example, in disaster area relief in difficult access terrain in the rescue of survivors (something that will be demonstrated at the end of the D-Rock project in a similar scenario for the DARPA Robotics Challenge:



A biomimetic walking robot that resembles a praying mantis

a door blocked by debris must be autonomously cleared and entered).

D-Rock is presented at BMBF's High-Tech Forum Autonomous Systems at the Hannover Messe 2016. ◀

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Federal Ministry  
of Education  
and Research

**More information**  
[www.dfki.de/robotics](http://www.dfki.de/robotics)



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## IT Infrastructure for Intelligent Factories – Optimized and Networked Production Plants

► Cyber-Physical Production Systems (CPPS) will soon make industrial manufacturing much more flexible and efficient than ever before. These systems consist of intelligent machines, warehousing systems, and operating resources that exchange information, trigger operations, and interactively control one another. CPPS, however, is still lacking one important basic: an integrated information and communication infrastructure, that would network the entire system and link multiple CPPS together – even across company boundaries. The aim of the CoCoS project (Context-Aware Connectivity and Service Infrastructure for Cyber-Physical Production Systems) is to create such an infrastructure.

CPPS requires a cooperative network architecture (rather than a hierarchical one), that connects the entire CPPS, networking all sensors and actuators, linking other CPPS, and integrating island solutions. Companies will be able to uniformly control the complete production process, for everything from management to logistics across various locations.

The researchers are developing a so called multilayer-approach. The CPPS environment consists of a networked platform that allows the manufacturing components and the embedded sensors and actuators to communicate, plus a service platform that controls the entire modular system. Various CPPS can be integrated and coupled via cloud computing.

CoCos is making an important contribution as pertains to the implementation of CPPS in the technology program "Autonomik" for INDUSTRIE 4.0, which forms the core of the intelligent factory. Based on a resolution of the German parliament, BMWi has funded the project with approximately 2.4 million euros. ◀

**Partners:** Robert Bosch (project manager); German Research Center for Artificial Intelligence, DFKI; DMG Electronics; TU Berlin; IT-Solutions; XETICS

**More information**  
[www.cocos-project.de](http://www.cocos-project.de)

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and Energy

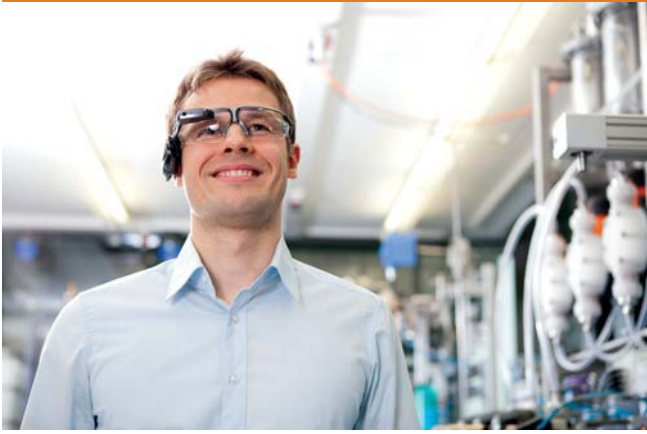


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The Head Mounted Display shows assembly, repair, or maintenance instructions.

## Learn from watching – Cognitive Augmented Reality Handbooks

► Digital handbooks, presented directly in the user's field of vision as step-by-step instructions in a head-mounted display (HMD) can facilitate and accelerate the maintenance, repair, or installation of production units. They explain each individual step at the station precisely and clearly, can be called up at any time, reduce the safety risk to the employee, and contribute to perfect results.

Until now, the preparation of user instructions, so called authoring, was performed manually and with the associated high costs. Modern systems often require manually prepared action scripts; furthermore, expert knowledge of the tracking system and the didactic preparation of the content may be necessary.

At the DFKI exhibit stand, the research spin-off ioxp is introducing the Augmented Reality (AR) Handbook System, a light-weight system developed to produce automatic documentation and assistance for operating procedures.

To create new AR content with the system, all that is needed is a single recording of the sequence of actions with a head-mounted camera. The authoring tool independently divides the sequence by means of hand tracking and machine learning methods into distinct, singular activities and then combines the individual segments with a stochastic transitional model. The job sequences lend themselves to quick and easy recording and are made available to the user directly after completion. If required, each single work step can be assigned a symbol or indicator to emphasize certain behaviors. The technology significantly reduces the time required to create an AR Handbook and because it is far less complex, it can be used in a wide variety of applications.

The users of such handbooks are shown superimposed videos of the assembly, repair, or maintenance instructions in the HMD. The handbook facilitates the correct orientation of each step relative to the component located directly in front of the user. By means of an integrated camera in the HMD, the system recognizes the manually performed actions and automatically jumps to the next work step. No special markers, other aids, or systemic know-how are required in the process.

In addition, the user is by no means merely the consumer in the system. For example, if the users find that, over time, a component has changed and different steps are required or useful to solve the task, they can enter the information directly in the system from the job station. This simplified authoring method can be used in other areas of application, e.g., quality management and can be performed by the domain experts trained in the subject job sequence. Technicians at an assembly station can record "reference procedures" to ensure that all future assembly activities follow the same procedural pattern. ◀

**More information**  
[www.ioxp.de](http://www.ioxp.de)

**ioxp**  
cognitive AR

CeBIT Hall 6, Stand B48

Hall 2, Stand B40

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## Online Voting with Certified Security



**Prüfstelle  
für IT-Sicherheit**

► The IT Security Evaluation Facility at DFKI completed the independent testing and evaluation of POLYAS CORE (Version 2.2.3) in December 2015 and has issued a positive evaluation result. POLYAS CORE is a flexible web application for the implementation of online voting. The independent evaluation followed the internationally recognized standards of the Common Criteria (CC) for IT Security Evaluations. The CC certification is awarded by the Federal Office for Information Security (BSI).

POLYAS CORE is the first online voting product in the world with a security certification. The certificate confirms compliance with the generally accepted security objectives for online elections and the suitability of POLYAS CORE for the secure conduct of various types of election, particularly, for clubs, committees, and similar non-political elections.

The IT Security Evaluation Facility performs evaluations of IT products in its capacity as an independent expert testing laboratory recognized by BSI since 2000. All evaluations are impartial, independent, and conscientious, free from any undue pressures and performed on a purely technical basis.

The assessment of POLYAS CORE marks the successful evaluation of a pure web application in accordance with the require-

ments of the Common Criteria (CC). The IT Security Evaluation Facility is now applying this experience towards the evaluation of other web applications, for example, Display as a Service, a technology developed at DFKI for the dynamic linking of screens without a dedicated cable connection. ◀

### More information

[www.dfki.de/web/research/asr/services](http://www.dfki.de/web/research/asr/services)



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## DFKI, TU Kaiserslautern, and Rhineland-Palatinate Sign Strategic Development Agreement



► The State Ministry of Rhineland-Palatinate for Education, Science, Continuing Education, and Culture has awarded, via TU Kaiserslautern, the amount of 500,000 euros per year with continuing effect to DFKI that can be used as complementary funding for research projects.

Science Minister Vera Reiß said, "DFKI is a flagship for research excellence in the

state. It creates high-tech jobs and its research work provides the foundation for the establishment of new enterprises based in the region. The agreement promotes the sustained strength of DFKI-Kaiserslautern and its role as a knowledge transfer center and driving force in the state of Rhineland-Palatinate."

As a non-profit organization, DFKI receives no core funding from public sources. Complementary funding is an important means in addition to industry projects for supporting the implementation of projects that may not be fully funded. The speedy establishment of this package in the state budget will provide DFKI Kaiserslautern the necessary planning security required to apply at national and European sponsors for proportionate public funding.

This agreement is accompanied by a roadmap for the further expansion of the DFKI facilities. Besides further development of the Living Labs, proposals have been made for new research activities in the contemporary topics of the future. It should also allow expansion of the important role played in extra-regional leading edge clusters and joint ventures. Moreover, the parties agree to pursue the goal of spinning-off one company per year on average from the resident working groups and having them based in Rhineland-Palatinate. ◀



(l. to r.) Prof. Andreas Dengel, Site Director DFKI Kaiserslautern; Prof. Wolfgang Wahlster, CEO DFKI; Science Minister Vera Reiß; Dr. Walter Olthoff, CFO DFKI and Prof. Arnd Poetzsch-Heffter, Vice President Technical University Kaiserslautern signing the agreement



Assistance system for troubleshooting



DigiLernPro enables the recording of work processes

## Assistance and Knowledge Services for “Smart Production”

### Research from the DFKI Educational Technology Lab – Projects APPsist and DigiLernPro

► The transformation from industrial production to INDUSTRIE 4.0 comprises increasingly complex unit operations and maintenance in addition to a greater diversity of production processes and procedures to control. The professional expertise of the operators, programmers, and production controllers and the information and knowledge requirements are growing rapidly both in scope and the need for agility.

At CeBIT 2016, DFKI's Educational Technology Lab (EdTec) is presenting innovative solutions to these challenges designed to create learning and working environments that expand the area and scope of employee activities and enable independent work and learning.

Created in cooperation with Festo Didaktik SE, a robot cell is used to demonstrate how intelligent services can support troubleshooting as well as the structuring and recording of acquired knowledge. At the DFKI exhibit stand, live testing of the robot cell is performed for fault clearance. The exhibits feature the actual results from the collaborative projects APPsist and DigiLernPro.

The APPsist project (Intelligent-adaptive assistance and knowledge services for INDUSTRIE 4.0) develops a software architecture that enables the recording of work processes and work related practices to be made available to the employees as a video documentation in support of the workflow and knowledge acquisition. APPsist is funded for a period of three years under the “Autonomik” initiative for INDUSTRIE 4.0 by the Federal Ministry for Economic Affairs and Energy (BMWi). In addition to the lead manager Ruhr University Bochum (RUB), the APPsist project includes the Festo Learning Centre and the Educational Technology Lab, as well as the Institute for Information Systems at DFKI, and the DFKI Innovative Retail Laboratory. EdTec develops the AI-based services that form the foundation for the adaptive assistance and knowledge transfer.

In the DigiLernPro collaborative project (Digital Learning scenarios for workplace-integrated knowledge and activity support for Production) sponsored by the Federal Ministry of Education and Research (BMBF), the focus is on the simple in-

tegration of occupational training processes, in particular, the build-up of knowledge and experience from the operational processes. A content management tool allows the employees to record work processes themselves. The tool includes an intelligent-adaptive media based support function that ensures the recorded content contains all the relevant information needed for learning. Various work processes can be recorded via multimedia systems and played back for the visitors at the exhibit stand. ◀

**More information**  
[www.appsist.de](http://www.appsist.de)  
[www.digilernpro.de](http://www.digilernpro.de)



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## ► DFKI Interview – Dr. Carsten Ullrich

Dr. Carsten Ullrich is deputy director and department head of the Educational Technology Lab (EdTec) at DFKI Project Office, Berlin

### **What do you see as potential applications for your research?**

Sustainable, technology-aided learning systems, the so called educational technologies, can only be studied when in use, that is, when the user is learning and acquiring knowledge. This complicates the research effort required, but opens up a positive sense of the future for this technology. During my six-year posting at Shanghai Jiao Tong University, I worked on a research program that provided access to the best Chinese universities for 40,000 students (some from Tibet and Western China) via Internet technology.

### **When did your interest in Artificial Intelligence begin and how have AI processes changed since that time?**

My first and formative encounter with Artificial Intelligence was in 1996, as an ERASMUS student in Paris. Jacques Ferber's lecture about multi-agent systems introduced me to a field of unimagined potential. Once at DFKI, I started to work on the ActiveMath Online Learning system, which set new standards in the use of AI technologies in modeling educational knowledge. The World Wide Web now provides a mass of structured semantic data that further creates new possibilities for learning algorithms. In my opinion, the most impressive practical example of this is the self-driving car in highway traffic.

### **What are the greatest challenges and opportunities for AI systems?**

The major challenge and, simultaneously, the greatest opportunity in our field is to ensure AI systems create or expand the freedom of action for people. Socially responsible AI must serve the interests of helping people without limiting or even undermining their freedoms. In the field of learning systems, this means for example, a learning system that does not define how an employee is to quickly return a machine to operations, but rather, one that presents the problem as an opportunity for long term development of knowledge.

### **What do you enjoy doing when you are not working as research scientist?**

In China, I started to practice Tai Chi, a martial art that is, regrettably, generally misunderstood in Europe. Eventually, I earned the third Dan and won a bronze medal at the international Tai Chi competition in Jiaozuo. I am presently learning Tai Chi-Sword and helping my wife to establish her Tai Chi Training Center in Berlin.



### **Do you see any parallels to your professional work?**

As in all martial arts, Tai Chi is not merely a sport; rather, it is about principles learned in training and practice that are applicable in all aspects of life. It is peculiar, especially in Tai Chi, how the most powerful dynamic may arise out of a stable footing. Also, how applying the proper technique with minimum force can produce a stronger effect than a greater force with the incorrect form.

### **What are your current projects?**

The most interesting projects that I am now working on are the INDUSTRIE 4.0 projects APPsist and DigiLernPro (see page 29). The participating companies in both projects have already expressed great interest in applying the project findings to their ongoing operations.

## ► Professor Frank Kirchner Inducted into the Berlin-Brandenburg Academy of Sciences

Prof. Dr. Frank Kirchner, professor of robotics at the University of Bremen and Head of DFKI's Robotics Innovation Center, was nominated, elected, and accepted on November 27, 2015 as a full member of the Technological Sciences class of the Berlin-Brandenburg Academy of Sciences (BBAW). The BBAW is a multi-disciplinary association of scientists that enjoys an excellent reputation at home and abroad. Acceptance into the academy honors Professor Kirchner's outstanding contributions to the field of robotics.



Vice President of the Berlin-Brandenburg Academy of Science, Prof. Annette Grüters-Kieslich praising Prof. Frank Kirchner

## ► Prof. Wahlster Appointed to Advisory Council of TU Darmstadt

On January 22, 2016, Boris Rhein, Hesse's Minister of Science and the Arts, appointed Prof. Dr. Wolfgang Wahlster to the Advisory Council of TU Darmstadt for the period of office 2016 – 2020. The Advisory Board exercises a control function and has the right of initiative in fundamental issues, especially, in matters of university development.

## ► ITH Conference 2016 for “Innovative Technologies for Commerce”

This year's conference on research and development trends in commerce is planned for June 9-10, 2016 in St. Wendel, Saarland under the sponsorship of Jürgen Barke, State Secretary in the Ministry of Economics, Labor, Energy, and Transportation. In addition to the lectures, presentations, and panel discussions with representatives from industry, retail, and research, the sponsors and organizers are planning the “marketplace for innovation.” As a key part of the conference, this area features selected exhibits that introduce the latest developments in their sectors.

The ITH 2016 is organized by the Innovative Retail Laboratory (IRL). Established in 2007 and restructured in 2015, the IRL evaluates potential areas of use in realistic scenarios in close cooperation with project partner GLOBUS Warehouse Holding.

More information and registration at:  
[www.innovative-retail.de](http://www.innovative-retail.de)

## ► VDI Honors for Pioneer of INDUSTRIE 4.0 – Detlef Zühlke

As part of the 4th VDI Conference on INDUSTRIE 4.0, Prof. Dr.-Ing. Detlef Zühlke, head of DFKI's Innovative Factory Systems and chairperson of the *SmartFactory<sup>KL</sup>* technology initiative, received the second highest VDI decoration for his achievements in the area of innovative factory systems. In presenting the distinguished award, VDI President Prof. Udo Ungeheuer praised the contributions of Detlef Zühlke in the promotion and implementation of INDUSTRIE 4.0. Since 1931, VDI has awarded this recognition to deserving engineers for their special contributions in a technical field or for outstanding service to the professional community.



Photo: KONZENTRAT Düsseldorf

## ► Prof. Zühlke: “Knowledge Transfer Ambassador” of Rhineland-Palatinate

The Minister President of the State of Rhineland-Palatinate Malu Dreyer has named Prof. Zühlke as one of three “Transfer Ambassadors” for the state. He will represent the high potential area of production systems and automation with a primary focus on INDUSTRIE 4.0 technologies. The ambassador program was proposed by state ministers Vera Reiß, Science Minister and Eveline Lemke, Economics Minister in association with the Knowledge Transfer Network of Rhineland-Palatinate, which is intended to promote and strengthen high potential areas of innovation within the state through increased cooperation between universities and companies. Rhineland-Palatinate currently has three special knowledge transfer ambassadors.

## ▶ Austrian Government Appoints Prof. Zühlke to Advisory Board of Technology Initiative

In December 2015, Prof. Zühlke was named to the advisory board of the FTI Initiative “Production in the Future.” The FTI (Research, Technology and Innovation) Initiative is dedicated to the central issues of the goods manufacturing industry and increasing the productivity of the Austrian economy through innovative projects. The Austrian Federal Ministry of Transportation, Innovation, and Technology (bmvit) established the advisory board of the FTI Initiative “Production in the Future” in 2012 with the purpose of directing the program strategy and content and evaluating the call proposals of bmvit and the national “Manufuture” platform. The responsibilities also include making recommendations concerning the calls as well as addressing other measures in the area of production.

## ▶ Common Goals Agreement for Competence Center Power4Production

The DFKI, the Centre for Mechatronics and Automation Systems (ZeMA) and the Saarland State Ministry for Economics, Labor, Energy, and Transportation have signed an agreement on objectives for Power4Production (P4P) – Center for Innovative Production Technologies. The agreement specifies the working objectives of P4P, which include the design of Workplace 4.0 and the development of a business network. P4P is also tasked to develop counseling and support services for businesses. The intention is to assist especially midsize companies to better participate in the digital economy.



## ▶ Professor Rolf Drechsler Elected to Review Board of DFG (German Research Foundation)

Prof. Dr. Rolf Drechsler, Head of the Cyber-Physical Systems department and member of the faculty for computer architecture at the University of Bremen, was elected in 2015 to the DFG “Computer Science” review board, special subject area “Computer Architecture and Embedded Systems.” The four-year period of office begins in Spring 2016. The Review Boards are the most important advisory bodies for the award of research funding for DFG, Europe's largest research funding organization. Research scientists from all over Germany are elected every four years to serve on the foundation's boards.

## ▶ Stronger Networking of University of Bremen and DFKI – Prof. Dr. Tim Güneysu Appointed as Chair

In the context of its Excellence Initiative, the University of Bremen recently established a new interdisciplinary professorship that also strengthens the Cyber-Physical Systems research department. Prof. Dr. Tim Güneysu was appointed as the Chair for “Technical Information Systems.” The primary focus of Professor Güneysu is IT Security, in particular, secure embedded systems.



The interdisciplinary chair is intended to forge new connections between disciplines within the University of Bremen and, most of all, between the university and non-university research institutes to allow the joint pursuit of new research topics.

## ▶ Farewell Event for Dr. Werner Stephan

A fitting retirement colloquium was held for PD Dr. habil. Werner Stephan – DFKI Research Fellow since 1999 – in recognition of his retirement on November 20, 2015. Prof. Wahlster opened the event with praise for Dr. Stephan's academic career in the fields of formal methods, deduction and verification of software systems, in addition to his great success in projects like FairPay (payment security), Verisoft (continuous formal development), and the verification of the protocol for passports and ID cards. Additional speakers included: Prof. Jörg Siekmann, Prof. Philipp Slusallek, Prof. Maritta Heisel (KIV project), Prof. Markus Ullmann, Prof. Dieter Hutter, and Roland Vogt.





## DFKI Service Offering

As an internationally renowned Center of Excellence for innovative software systems based on Artificial Intelligence (AI) methods, DFKI is offering the following services with more than 25 years of experience in basic and applied R&D

- ▶ Technology transfer of the award-winning research results of DFKI
- ▶ Innovation coaching and start-up consulting in the public-private partnership sector
- ▶ Individual design, development and implementation of innovative application solutions
- ▶ Market studies, expert surveys, feasibility analysis and empirical user studies
- ▶ Component development with AI-functionality, enhancing the performance of complex software systems
- ▶ Scientific advice on the selection and implementation of complex software solutions
- ▶ Customization, implementation, deployment and maintenance of DFKI AI-solutions
- ▶ Scientific evaluation and benchmarking of software solutions
- ▶ Application-oriented basic research
- ▶ Independent assessment of IT-security and privacy
- ▶ Technology workshops, training and practice
- ▶ Scientific monitoring of data collections and their evaluation
- ▶ Business engineering: Process analysis and development
- ▶ Innovation coaching and turnaround management
- ▶ Strategic and technical due diligence consulting for companies in the ICT sector
- ▶ Technical and organizational support for the standardization in the IT sector (Including W3C, ISO)
- ▶ Design, construction and operation of Living Labs



Kaiserslautern Site



Saarbrücken Site



Bremen Site



Project Office Berlin

## German Research Center for Artificial Intelligence Company Profile

- ▶ **Established**  
1988
- ▶ **Legal Form**  
Non-profit organization  
(public-private partnership)
- ▶ **Executive Board**
  - ▷ Prof. Dr. Dr. h.c. mult. Wolfgang Wahlster, CEO
  - ▷ Dr. Walter Olthoff, CFO
- ▶ **Supervisory Board**
  - ▷ Prof. Dr. h.c. Hans-Albert Aukes, Chair
  - ▷ Dr. Susanne Reichrath, Representative of Saarland's Minister President for Higher Education, Science and Technology, Vice Chair
- ▶ **Locations**  
Kaiserslautern (registered office), Saarbrücken, Bremen, Berlin (project office). Further operating sites in Osnabrück and St. Wendel
- ▶ **Shareholders**  
Airbus Group, BMW Group Forschung und Technik GmbH, CLAAS KGaA mbH, Deutsche Messe AG, Deutsche Post AG, Deutsche Telekom AG, Empolis Information Management GmbH, Fraunhofer Gesellschaft e.V., Google Inc., Harting KGaA, Intel Corporation, John Deere GmbH & Co. KG, KIBG GmbH, Microsoft Deutschland GmbH, Nuance Communications Deutschland GmbH, RICOH Company, Ltd., SAP SE, Software AG, University of Kaiserslautern, Bremen University, Saarland University, Volkswagen AG, VSE AG
- ▶ **Equity Holding**  
GraphicsMedia.net GmbH, Kaiserslautern - Ground Truth Robotics GmbH, Bremen - SemVox GmbH, Saarbrücken - Yocoy Technologies GmbH, Berlin

### Intelligent Solutions for the Knowledge Society

▶ The German Research Center for Artificial Intelligence (DFKI) was founded in 1988 as a non-profit public-private partnership. It has research facilities in Kaiserslautern, Saarbrücken and Bremen, a project office in Berlin, and branch offices in Osnabrück and St. Wendel. In the field of innovative commercial software technology using Artificial Intelligence, DFKI is the leading research center in Germany.

Based on application oriented basic research, DFKI develops product functions, prototypes and patentable solutions in the field of information and communication technology. Research and development projects are conducted in fifteen research departments and research groups, nine competence centers and seven living labs. Funding is received from government agencies like the European Union, the Federal Ministry of Education and Research (BMBF), the Federal Ministry for Economic Affairs and Energy (BMWV), the German Federal States and the German Research Foundation (DFG), as well as from cooperation with industrial partners. Twice a year, a committee of internationally renowned experts (Scientific Advisory Board) audits the progress and results of state-funded projects. In addition, BMBF evaluates DFKI regularly. The most recent assessment was again very successfully concluded in 2010.

Apart from the state governments of Rhineland-Palatinate, Saarland and Bremen, numerous renowned German and international high-tech companies from a wide range of industrial sectors are represented on the DFKI supervisory board. The DFKI model of a non-profit public-private partnership (ppp) is nationally and internationally considered a blueprint for corporate structure in the field of top-level research.

DFKI is actively involved in numerous organizations representing and continuously advancing Germany as an excellent location for cutting-edge research and technology. Far beyond the country's borders DFKI enjoys an excellent reputation for its academic training of young scientists. At present, 479 highly qualified researchers, administrators and 353 graduate students from more than 60 countries are contributing to more than 180 DFKI research projects. DFKI serves as a stepping stone to leading positions in industry and successful careers as founders of spin-off companies. Over the years, 98 staff members have been appointed professors at universities in Germany and abroad. ◀

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## Research & Development

### ▶ Research Departments and Research Groups

#### Kaiserslautern Site

- ▶ Prof. Dr. Prof. h.c. Andreas Dengel:  
Knowledge Management
- ▶ Prof. Dr. Paul Lukowicz:  
Embedded Intelligence
- ▶ Prof. Dr.-Ing. Hans Schotten:  
Intelligent Networks
- ▶ Prof. Dr. Didier Stricker:  
Augmented Vision
- ▶ Prof. Dr.-Ing. Dr. h.c. Detlef Zühlke:  
Innovative Factory Systems

#### Saarbrücken Site

- ▶ Prof. Dr. Josef van Genabith:  
Multilingual Technologies
- ▶ Prof. Dr. Antonio Krüger:  
Innovative Retail Laboratory, St. Wendel
- ▶ Prof. Dr. Peter Loos:  
Institute for Information Systems
- ▶ Prof. Dr. Philipp Slusallek:  
Agents and Simulated Reality
- ▶ Prof. Dr. Dr. h.c. mult. Wolfgang Wahlster:  
Intelligent User Interfaces

#### Bremen Site

- ▶ Prof. Dr. Rolf Drechsler:  
Cyber-Physical Systems
- ▶ Prof. Dr. Frank Kirchner:  
Robotics Innovation Center (RIC)
- ▶ Prof. Dr. Joachim Hertzberg:  
Plan-Based Robot Control, RIC Branch Office Osnabrück

#### Project Office Berlin

- ▶ Prof. Dr. Volker Markl:  
Intelligent Analytics for Massive Data
- ▶ Prof. Dr. Hans Uszkoreit:  
Language Technology

### ▶ Living Labs

Testing, evaluation, and demonstration of innovative technologies in comprehensive application scenarios: Advanced Driver Assistance Systems Living Lab, Bremen Ambient Assisted Living Lab, Innovative Retail Lab, Robotics Exploration Lab, Smart City Living Lab, Smart Factory, Smart Office Space

### ▶ Competence Centers

Coordination of research activities in particular areas: Ambient Assisted Living, Case-Based Reasoning, Deep Learning, Multimedia Analysis & Data Mining, Language Technology, Semantic Web, Safe and Secure Systems, Virtual Office of the Future, Wearable AI

## Key Figures

- ▶ **Annual Budget 2014**  
€ 38.4 million
- ▶ **Total Assets 2014**  
€ 108 million
- ▶ **Employees**  
479 professional staff, 353 graduate student staff

## Scientific Excellence and Transfer

### ▶ International Scientific Advisory Board

Bi-annual evaluation of publically funded projects:  
▶ Prof. Dr. Markus Gross, Eidgenössische Technische Hochschule Zürich (ETH), Switzerland, Chairman

### ▶ Leading-Edge Research

DFKI is the only German institute for computer science to participate in each of the three leading-edge research clusters:

- ▶ Cluster of Excellence “Multimodal Computing and Interaction” funded by the German Research Foundation (DFG)
- ▶ Leading-Edge Cluster “Software Innovations for the Digital Enterprise” funded by BMBF
- ▶ European Institute of Innovation and Technology (EIT Digital)

### ▶ Networks of Excellence

At present, DFKI is a coordinator or core partner in four European Networks of Excellence

### ▶ Promoting Young Talent

DFKI is a founding member and core partner of the Academy Cube and the Software Campus to promote managerial talent in the IT industry

### ▶ Academic Chairs

98 former staff members have been appointed professors at universities in Germany and abroad

### ▶ Spin-offs

70 spin-off companies have created more than 1,700 highly skilled jobs

## Committees and Academies

DFKI is represented by its scientific directors on numerous committees and academies:

### ▶ Scientific and Government Committees

Advisory Board of the Future Internet Public-Private Partnership Programme of the European Union (FI-PPP), Big Data Value Association, Brazilian Institute of Robotics (BIR), Center of Innovation Program of the Japanese Ministry of Education (COI), Feldafinger Kreis, Management Board of the International Computer Science Institute in Berkeley, Münchner Kreis, National Institute of Informatics (NII, Tokio), Program Committee of the National Aeronautics and Space Research Centre DLR, Research Alliance of the German Federal Government, Steering Committee of the German Informatics Society (GI), and others

### ▶ Business Committees

Deep Sea Mining Alliance (DSMA), Governance Board of the Intel Visual Computing Institute, and others

### ▶ Scientific Academies

Academy of Sciences and Literature, Berlin-Brandenburg Academy of Sciences, European Academy of Sciences, German National Academy of Sciences Leopoldina, National Academy of Science and Engineering, Royal Swedish Academy of Sciences, and others



# Intelligent Solutions for the Knowledge Society

- ▶ INDUSTRIE 4.0 and Innovative Factory Systems
- ▶ Smart Data – Intelligent Analytics for Massive Data
- ▶ Wearable Computing and Interactive Textiles
- ▶ Knowledge Management and Document Analysis
- ▶ Virtual Worlds and 3D Internet
- ▶ Educational Technologies
- ▶ Development of Provably Correct Software
- ▶ Smart City Technologies and Intelligent Networks
- ▶ Information Extraction and Intelligent Web Retrieval
- ▶ Deep Learning
- ▶ Multiagent Systems and Agent Technology
- ▶ Multimodal User Interfaces and Language Understanding
- ▶ Visual Computing and Augmented Vision
- ▶ Mobile Robotic Systems
- ▶ Shopping Assistance and Intelligent Logistics
- ▶ Semantic Product Memories
- ▶ Safe and Secure Cognitive Systems and Intelligent Security Solutions
- ▶ Ambient Intelligence und Assisted Living
- ▶ Driver Assistance Systems and Car2X Communications
- ▶ Cyber-physical Systems
- ▶ Multilingual Technologies



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