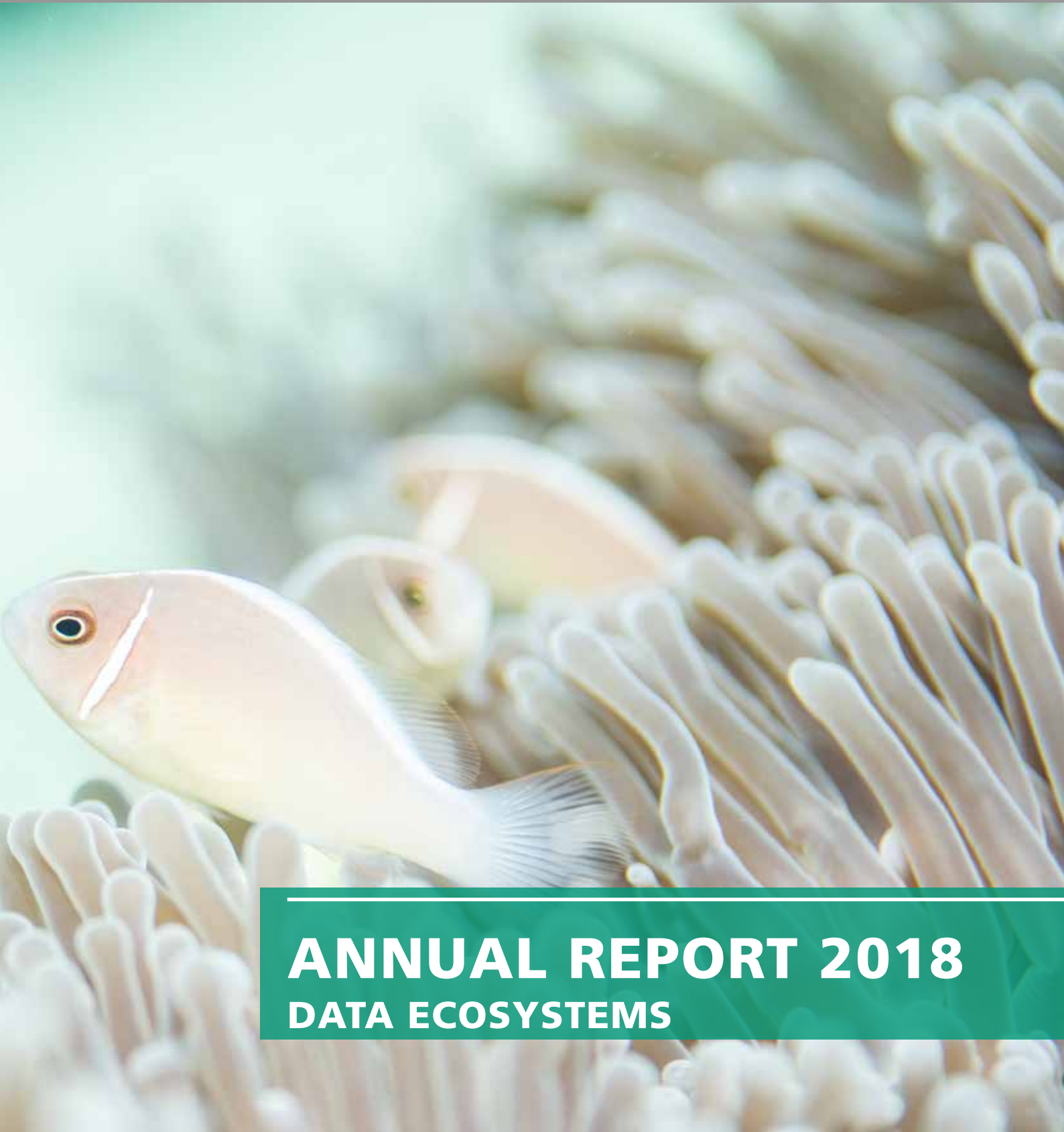




Fraunhofer
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FRAUNHOFER INSTITUTE FOR SOFTWARE AND SYSTEMS ENGINEERING ISST



ANNUAL REPORT 2018
DATA ECOSYSTEMS



ANNUAL REPORT 2018

DATA ECOSYSTEMS

PREFACE

WHAT DIGITIZERS CAN (AND SHOULD) LEARN FROM NATURE





Dear Readers,

Many trees standing close together, along with animals and other plants, forming an ecosystem that withstands periods of heat and cold. Trees create a communication network with their roots, extending over several hectares and benefiting every single tree but also the forest as a whole.

A natural wonder – and a paragon for highly modern value chains in the economy. Why? Because a characteristic of ecosystems is that no single member of the system can optimize their wellbeing alone. Instead the entire system has to join forces. In other words: Every single member has to participate in the ecosystem in order to benefit from it. Ecosystems establish a balance, an equilibrium between the mutual benefits of all members.

But what do ecosystems have to do with the digital economy?

Business models characterized by increasingly large data volumes are gaining momentum due to the growth of digital technologies and AI solutions. Viewed from this perspective, a Data Ecosystem is one in which data constitute the strategic resource for the success of the overall system.

While traditional business models are based on concrete, tangible goods, data are not only a valuable raw material for information and knowledge, but also for innovative services and customer experiences.

Aside from the transformation from material to smart products and from control of the physical supply chain to the orchestrated data value chain, there is another fundamental transformation in and through the digitized economy: Innovation is increasingly taking place in ecosystems consisting of multiple partners and parameters, for example companies, research organizations, and agents such as electronic marketplaces,

public authorities, and customers. In this new digital world, competitors work together to provide value-added offerings.

Thus, what we can learn from the trees is that we accomplish more by working together. This is also and in particular the case in the digitized economy. We, at the Fraunhofer Institute for Software and Systems Engineering ISST, have been working for years on setting up Data Ecosystems such as the “International Data Space” initiative. Crucial strategic advantages for the international competitiveness of our domestic industry are developed in networks.

We look forward to integrating your business into a successful and lasting data forest as well. This annual report provides you with a first impression of our services and expertise. Please contact us if you discover touch points for your Data Ecosystem. Let’s follow nature’s model together!

Yours truly,
Prof.-Dr.-Ing. Boris Otto

Executive Director
Fraunhofer Institute for Software and Systems Engineering ISST

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MISSION STATEMENT

DATA AS A STRATEGIC RESOURCE FOR DATA ECOSYSTEMS

Wherever artificial intelligence and distributed value chains significantly influence the success of companies, immense volumes of data need to be managed productively and tactically. This is because data are no longer a byproduct of service provision as such for the industry, but increasingly constitute the core business. Which is why, today more than ever, data are the strategic resource for digitizing the economy. Using this valuable raw material to best advantage has to be the goal of business ecosystems.

The Fraunhofer Institute for Software and Systems Engineering ISST sets standards for the (controlled) sharing of data. It researches the value and the competent handling of data. Along with numerous partners in politics and industry, the institute with the "International Data Space" establishes the macroeconomic framework for the use of data, but also develops individual solutions for specific companies. Here the institute focuses on four fields of application: logistics, the data economy, automotive, and healthcare.



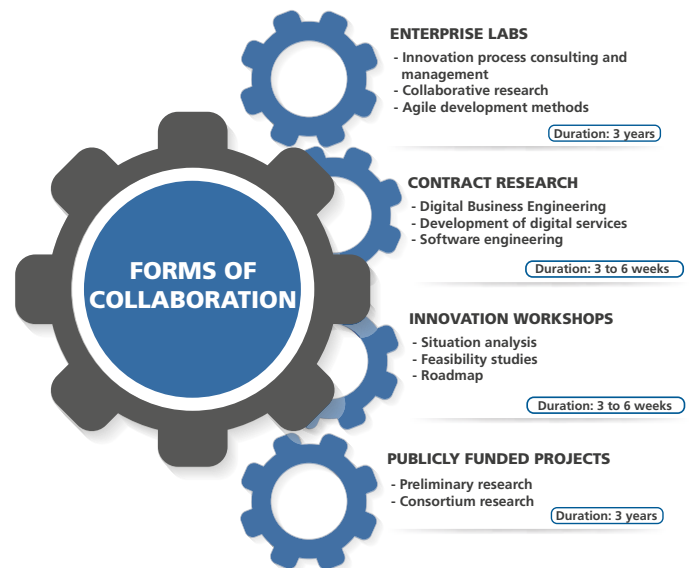
Jellyfish are masters of adaptation. While global warming is detrimental to most sea dwellers, jellyfish take advantage of the change in temperature to speed up their reproduction cycles. Thus they have survived over 670 million years of evolution. Jellyfish are a model of adaptability. Which is also demanded of us due to the rapid development of the digital economy. We want to master the digital transformation.

Source: www.planet-wissen.de/natur/tiere_im_wasser/quallen/index.html

THE INSTITUTE

The Fraunhofer Institute for Software and Systems Engineering ISST is an industrial research institute encompassing scientific research in its business units Logistics, Data Economy, Automotive, and Healthcare. From the institute site in Dortmund, it assists its customers and partners with everything related to digitization. Using data as a strategic resource in Data Ecosystems takes center stage. The institute with currently around 80 employees is part of the *Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.*, the largest organization for applied research in Europe.

It operates as a manufacturer-neutral partner working directly for industry, but also in publicly subsidized projects at the EU, federal, and state levels. Business activities encompass software engineering for new digital solutions, training, feasibility and market studies, and situation and potential analyses.



Organization and qualification



Prof. Dr.-Ing. Boris Otto

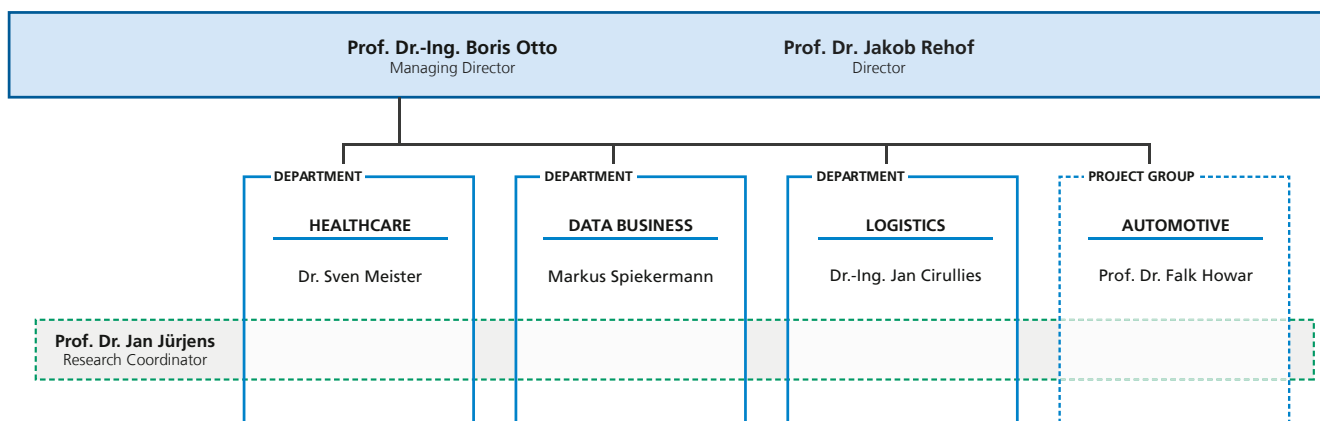


Prof. Dr. Jakob Rehof

The executive director is Prof. Dr.-Ing. Boris Otto, assisted by Prof. Dr. Jakob Rehof as the second director. They each have a professorship at Technical University Dortmund (TU Dortmund), which is closely connected scientifically with Fraunhofer ISST. The institute also maintains university cooperation with hsg Bochum and the University of Koblenz-Landau.

Research fellows qualify themselves with university and college degrees, mainly in computer sciences, business and medical informatics, engineering, and related disciplines.

Organizational chart



The institute is a member of various networks, including the Fraunhofer ICT Group, several Fraunhofer alliances for certain research topics, BITKOM, Wissenschaftsforum Ruhr e.V., windo e.V., and MedEcon Ruhr e.V.

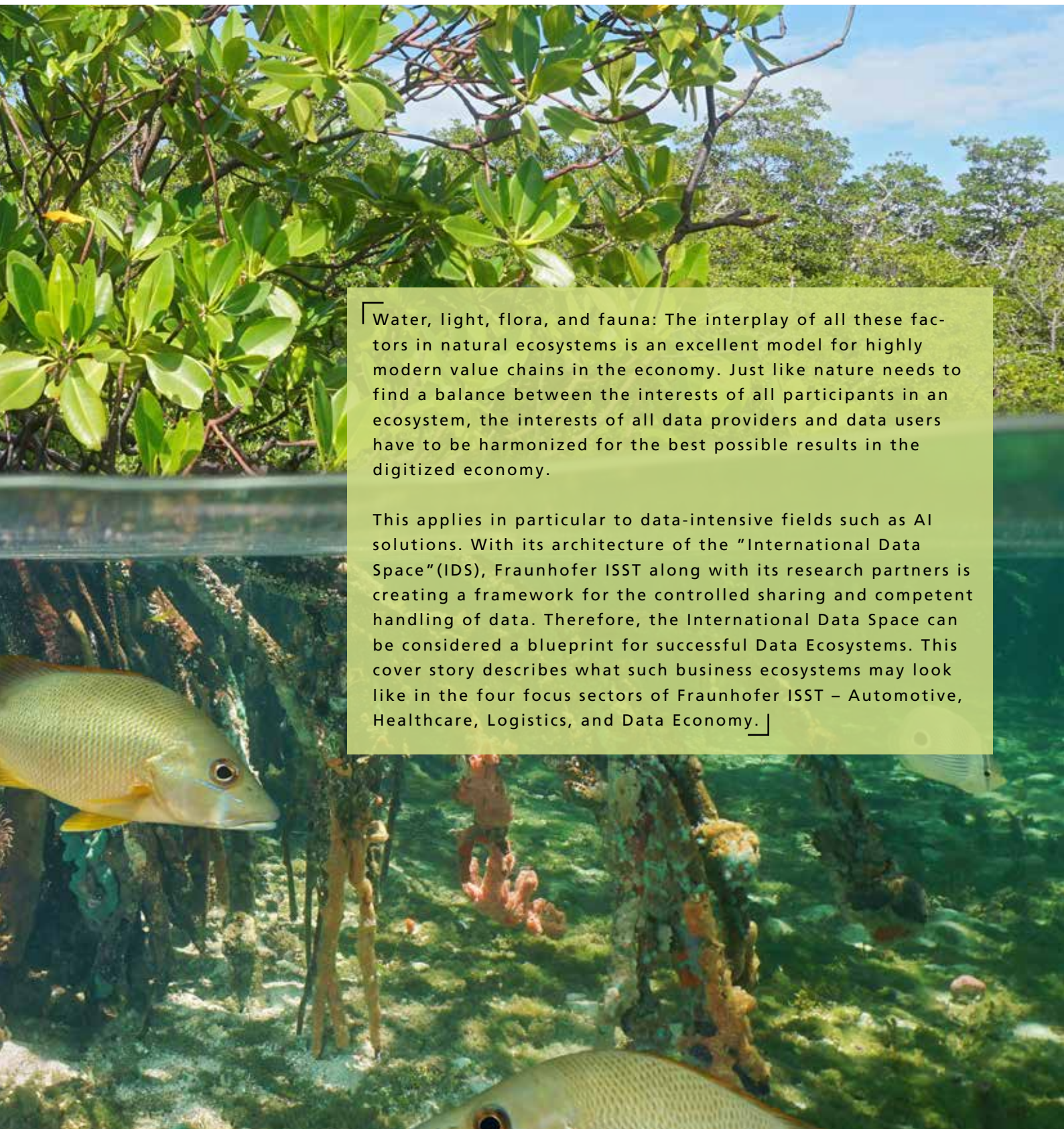
Key figures for the institute

	2018
Costs [in € million]	4,726
Personnel costs [%]	71
Industry and public sector revenues [in € million]	3,347
Institute subsidies [in € million]	1,380
Investment [in €]	294.400



COVER STORY

DATA ECOSYSTEMS



Water, light, flora, and fauna: The interplay of all these factors in natural ecosystems is an excellent model for highly modern value chains in the economy. Just like nature needs to find a balance between the interests of all participants in an ecosystem, the interests of all data providers and data users have to be harmonized for the best possible results in the digitized economy.

This applies in particular to data-intensive fields such as AI solutions. With its architecture of the "International Data Space" (IDS), Fraunhofer ISST along with its research partners is creating a framework for the controlled sharing and competent handling of data. Therefore, the International Data Space can be considered a blueprint for successful Data Ecosystems. This cover story describes what such business ecosystems may look like in the four focus sectors of Fraunhofer ISST – Automotive, Healthcare, Logistics, and Data Economy.

DATA ECOSYSTEMS – USING DATA AS A BALANCING AND GROWTH FACTOR FOR THE ECONOMY

The spread of digital technologies and artificial intelligence has been growing steadily for years, and is necessitating an overhaul of conventional business models. Here, data play a central role. While traditional business models are based on tangible assets, data as a raw material are not only valuable because they contain information and knowledge, but also because they can be used to influence and shape innovative services and customer experiences.

Thus, it is not only important to enable a shift from tangible, material products to “intelligent” products, or to link control of the physical value chain to the orchestration of the data value chain. Rather, data also have to be managed in the company as an important resource – according to the familiar parameters of time, costs, and quality.

Since innovations are increasingly being realized in economic ecosystems, in which various members such as companies, research organizations, intermediaries (such as electronic marketplaces), government agencies, customers, and competitors band together to jointly attain innovative value propositions, this transformation also has to take place at the data level: The ecosystem as a complex, interactive system encompassing various organisms and their organic environment is transferred to the business world and characterized by the need of the ecosystem to operate as a whole, with no member being able to produce innovations on its own. Each member has to make a contribution in order for all to benefit. Ecosystems can only function and persist when a state of equilibrium is achieved for all members.

We, at Fraunhofer ISST, help our customers and partners establish functioning and long-lived Data Ecosystems and integrate them into existing processes, among other things by establishing generally accepted rules and architectures that maintain balance in the Data Ecosystem. The fundamental modes of action are the same in all business units.

Healthcare: data as a valuable resource in the treatment process

Sensors, electronic patient files, and intelligent sensor networks play a very important role in healthcare. One trend in the healthcare sector is the spread and strengthening of cyber-physical systems (CPS). They combine and integrate sensor systems, data capture techniques, data processing methods, and real processes. Simultaneously, the mobile health trend, meaning the use of health-specific apps for documenting health-related data, is leading to the continuously increasing availability of citizen and patient data. Failing to make these data usable would prevent innovations to facilitate the treatment of various illnesses (P4 medicine) and to unburden service providers in the process, for example through documentation support.

Integrating and analyzing these data, harbors tremendous potential for creating better medications, better therapies, and better healthcare services, which can have a direct impact on our personal health. All these positive characteristics notwithstanding however, people still have to come first. It is essential to keep individual interests and the benefit for society in mind, and to protect the personal interests of the individual. The resulting Data Ecosystem – consisting of patients, medical device suppliers, healthcare service providers, insurers, and pharmaceutical companies – thus has to guarantee the data sovereignty of the patient and must protect the individual interests of the industry. Since healthcare is governed by several regulatory frameworks, combining medical and business interests is far from simple. Only with jointly agreed rules will the ecosystem be viewed as a whole, guaranteeing benefits for all members.

Data economy: data marketplaces connect participants via digital platforms

Digitization and "Industry 4.0" are spreading and establishing themselves in German companies. By now, the German economy would be inconceivable without them. Companies that are able to use, analyze, and interpret internal and external data and integrate them into existing process chains have inherent growth leverage. Considerable competitive advantages can be realized, costs reduced, processes optimized, and new, innovative business areas developed. But since concrete solutions for the holistic integration of data while simultaneously maintaining data sovereignty are lacking, the practical implementation still constitutes a problem for many companies.

As a result the number of data delivery platforms has grown tremendously in recent years. Trading in raw and processed data as well as offering data-related services are the primary goals of these platforms. The value of these marketplaces has also been discovered in science and practice. Here platforms offer an infrastructure for the exchange of data by serving as digital brokers,

connecting data providers with data buyers. In general it can therefore be noted that data marketplaces are platforms for trading data as a strategic resource.

Within the Data Ecosystem, data marketplaces constitute a digital platform that facilitates the exchange of data beyond the limits of an organization and connects the various participants within the Data Ecosystem. With the technological further development of web services and service-oriented architectures, data marketplaces are gaining importance alongside traditional data providers. Awareness of the demand for data marketplaces is continuously growing, forcing organizations in politics and industry to examine the design and development of data marketplaces. Fraunhofer ISST is responding to this demand and, in various projects, working on developing data marketplaces, integrating them into processes, and simultaneously maintaining balance in the Data Ecosystem.

Logistics: digital real-time presentation as a competitive advantage in distributed production processes

Today's products are often tremendously complex. Consequently the complexity of the supply chain is increasing as well. Just-in-sequence assembly scenarios require the delivery of components and parts to the assembly line in the correct sequence for the individual production orders. To meet the demand for individualized products and simultaneously control production costs, visibility along the supply chain – or more precisely within the supply network – is the key to success. Often the causes for capacity bottlenecks, which can lead to delivery bottlenecks, are not the fault of the primary supplier and manufacturer but found upstream. The necessary visibility requires data.

But since these data are produced by various organizations, which subsequently own the information as well, the overriding goal of supply chain transparency can only be reached if a mutual agreement is in place between the various partners regarding the joint use of the data. The resulting Data Ecosystem is then able to generate a continuous digital representation of the entire supply network, virtually in real time. Not only does this favor the competitive advantage of individual companies in the supply chain, the entire supply network can also benefit from these uniform rules.

Automotive: no artificial intelligence or machine learning without data

Artificial intelligence (AI) and machine learning (ML) embody trends that are still in their infancy and still pose challenges for many sectors. The fundamental concept is desirable: Laying the foundations for applications and systems with never-before-seen abilities (such as entirely autonomous driving). Changes like these not only affect the systems themselves, but also their own development, their own structure, and the subsequent state of these. Today the software that defines the behavior of these

systems is encoded by programs in the system itself. Ultimately the accumulated knowledge and entire intelligence incorporated in the code are reflected here.

But systems that work on the basis of machine learning are not programmed, they are trained. The required knowledge for the field of application does not have to be explicitly encoded by a developer, but can exist implicitly in the form of identified training data. The accuracy and usefulness of trained functions depends on the quality of the data used for training. Training data and data that can be analyzed using trained functions have already become a crucial factor for business success, making data a strategic resource for success here as well.

Currently Data Ecosystems are increasingly emerging in highly regulated or safety-critical areas (such as autonomous vehicles) where machine learning is also expected to have major effects. Here too we are researching common rules that guarantee equal rights for participants in the Data Ecosystem as well as economic success, while simultaneously taking the individual need for security into account.

Creating Data Ecosystems: the position of Fraunhofer ISST

These examples show that Data Ecosystems need to be created in all sectors, as different as they are, allowing all ecosystem participants to survive and succeed in and with their environment. With architectures such as the International Data Space, which is being specified by numerous Fraunhofer Institutes under the auspices of Fraunhofer ISST and is already supported by around one hundred international companies (from start-ups to renowned big corporations) as well as politics, such Data Ecosystems can succeed because they establish a framework for the joint action of the ecosystem participants.

The position paper
“Data Ecosystems
– Conceptual Founda-
tions, Constituents,
Case Studies and
Recommendations for
Action” from Fraunhofer
ISST will soon be available
for download at www.isst.fraunhofer.de/en/data-ecosystems.





F R A U N H O F E R I S S T

HIGHLIGHTS 2018

- Data Spaces research center
- DEMAND: Data management as a success factor
- STARS: How risky are autonomous systems in the automobile sector?
- RIOTANA®: How productive are my industrial trucks?
- Launch of project for "CLINOTEL" – investigating the digital maturity of hospitals
- Optimizing clinical care and research with SMITH
- AMable: integration of International Data Space and blockchain to support additive manufacturing



DATA SPACES RESEARCH CENTER: INTERNATIONAL DATA SPACE ARCHITECTURE AS THE BASIS FOR THE COGNITIVE INTERNET

The Fraunhofer “Cluster of Excellence Cognitive Internet Technologies” (CCIT) researches cognitive technologies for the industrial Internet. Researchers in various disciplines are developing key technologies along the value chain, from sensors to intelligent learning methods in data processing to the cloud. CCIT helps companies with the future-proof design of their business by opening up market access with cognitive solution offerings and products. These highly intelligent solutions and products are intended to maintain the competitiveness of German companies, boost their innovativeness and ensure their digital sovereignty. CCIT, through domain-specific expert knowledge of each phase in the transformation process, offers tailor-made cognitive solutions and provides assistance with the management of complexity. Support ranges from analysis, to planning a future-proof business strategy, to agile technology development, as well as testing in the CCIT’s numerous innovation and application centers.

Concepts and technologies for the sovereign industrial exchange of data

The cluster bundles the expertise of thirteen Fraunhofer Institutes and consists of three centers: IoT Comms, Machine Learning, and Data Spaces. The Data Spaces research center, which is managed by Fraunhofer ISST, focuses on establishing trusted data

spaces for the controlled exchange of data between companies. Thanks to extensive, successful legwork by twelve Fraunhofer Institutes in the context of the International Data Space initiative, making Fraunhofer one of the leading international research institutions for the topics of data sovereignty and data economy, the Data Spaces research center focuses on developing a comprehensive, industrially usable implementation of the International Data Space reference architecture model. This model calls for company data to remain decentralized with the respective company, only being exchanged with other companies as needed within the framework of jointly agreed conditions.

Within the Fraunhofer Cluster of Excellence Cognitive Internet Technologies (CCIT), the Data Spaces research center is responsible for the data infrastructure level and therefore constitutes the link between physical communication (IOT-COMMS center) and the application level (Machine Learning center). Here the work focuses on the topics of data sovereignty and data economy to form the basis for data-driven value chains, which are to be enabled by the CCIT.

On September 12, 2018 the "International Data Spaces Association" (IDSA) and "Industrial Internet Consortium" (IIC) signed a **memorandum of understanding** in Chicago. The IIC aims to establish a trusted industrial Internet of Things that securely interconnects systems and devices. Harmonizing both architectures, cooperation in standardization, and the development of joint use cases with companies are among other things planned in the memorandum of understanding. Information is to be exchanged to this end in the future along with holding consultations and joint seminars.

Richard Mark Soley, PhD (Executive Director of the Industrial Internet Consortium IIC) and Prof. Dr.-Ing. Boris Otto (in his function as deputy chairman of the board for the International Data Spaces Association) signing a memorandum of understanding at IMTS in Chicago in September 2018.





DEMAND: SUCCESS FACTOR DATA MANAGEMENT

The digital transformation describes a process of change and renewal, in which established companies are forced to adapt their business model to new technical possibilities while new market participants alter entire sectors and create new markets. Companies face novel challenges in the development of digital business processes, and practical solutions, which suitable information systems are currently lacking. Handling the steadily growing, diverse data resources is the key challenge. In order for digital business processes to operate efficiently and to monetize data assets, data need to be managed strategically and responsibilities have to be clearly defined.

This problem is being examined in the joint project DEMAND – Data Economics and Management of Data-Driven Business subsidized by the Federal Ministry for Economic Affairs and Energy (BMWi). The project aims to close the currently existing gaps for successful data management and to develop process models, usable architectures, catalogs of requirements, and support tools

for data management. Enabling the economic valuation of data and their treatment as an asset is a core aspect here. Based on the International Data Space reference architecture and in cooperation with companies in concrete use cases such as

- the development of data-driven services (predictive maintenance for instance),
- the development of a data marketplace,
- the optimization of inbound logistics, and
- trading in traffic and environmental data,

blueprints are being prepared for the required data governance and information architecture that are adapted to the novel challenges of modern data management.

The project is taking an inventory of data management in more than one thousand German companies in order to establish the status quo and identify potential spheres of activity. Based on this inventory and the use cases that are examined, needs for action are identified in order to realize the potential in business model development. The project is deriving a maturity model that facilitates classification and benchmarking between companies. Tool-assisted guidelines subsequently help companies to determine the individual need for expertise in order to advance the development of data-driven business models. Thus the project establishes an action framework for various digitization projects of German companies, thereby enhancing their competitiveness in the international comparison.

Project consortium: German Economic Institute, thyssenkrupp AG, Breuer Nachrichtentechnik GmbH, Advaneo GmbH, Fraunhofer Institute for Software and Systems Engineering ISST

Project start: April 2018

Term: 18 months

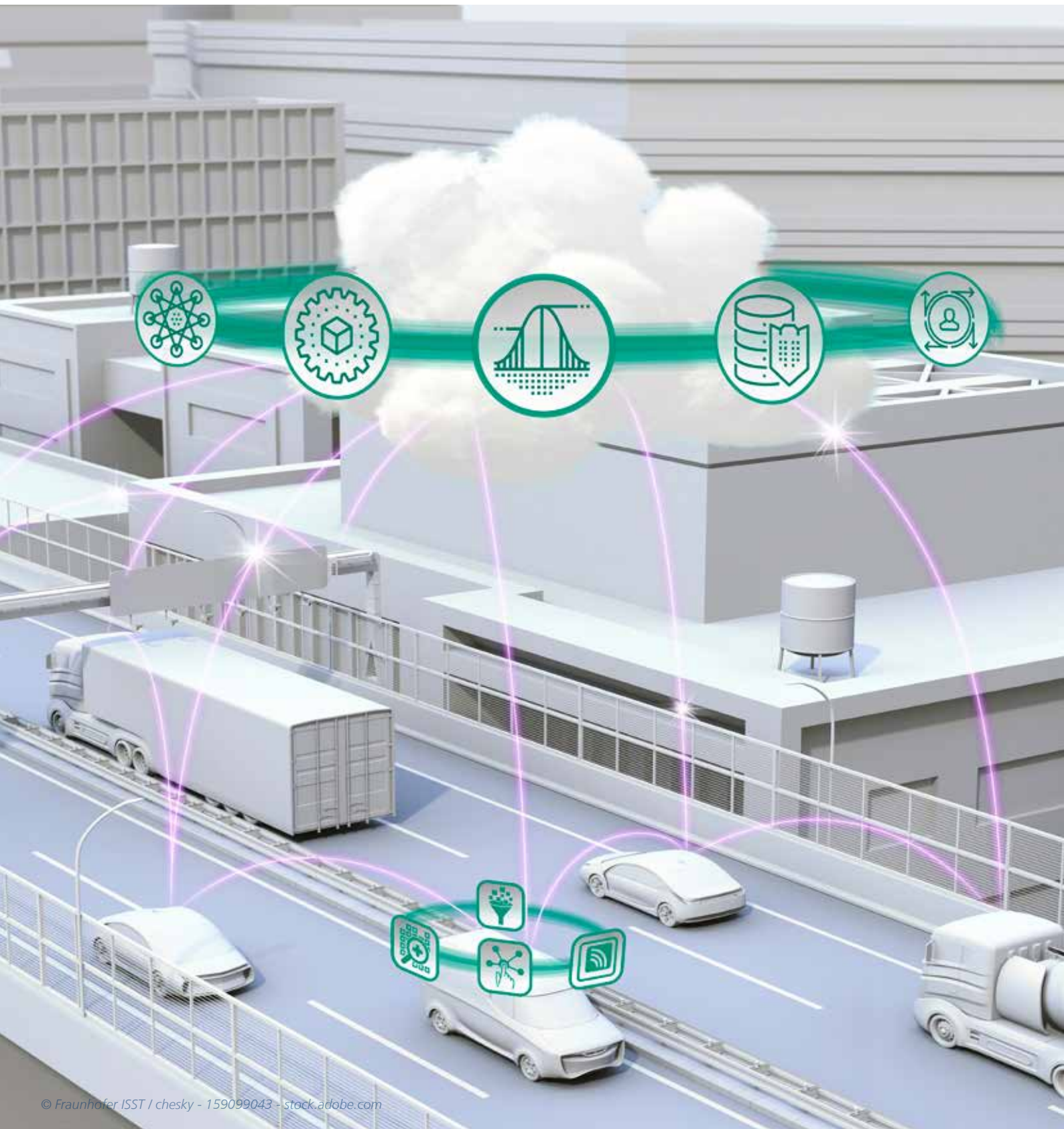
Subsidization: Subsidized by the Federal Ministry for Economic Affairs and Energy (BMWi) (Project number: FKZ01MT18002A).



Current whitepaper "Data economy – status quo of the German economy and spheres of activity in the data economy" and further information about the project available at www.demand-projekt.de.

HIGHLIGHTS 2018

FRAUNHOFER ISST



STARS: HOW RISKY ARE AUTONOMOUS SYSTEMS IN THE AUTOMOBILE SECTOR?

The use of autonomous robot systems for industrial applications began years ago. They assist people in many ways and today's workplaces would be unthinkable without them. The STARS project of the Automotive business unit at Fraunhofer ISST stands for "Scenario-based Testing for Autonomous Robotic Systems". Its objective is to simulate test scenarios for autonomous robot systems. Based on observations and real-life data, risk analyses are conducted in simulations in order to evaluate the probability of error and the safety level of a system.

Autonomous robot systems have to meet especially strict requirements because they are intended for use in environments that are not strictly separated from people. Here the potential danger of errors in the system is particularly great. The system must behave as expected in every situation and errors have to be excluded.

Automotive researchers at Fraunhofer ISST are developing a special domain-specific language intended to ensure that the requirements for the behavior of autonomous systems can be specified so they can also be subsequently validated. Expressing the requirements as specifically as possible is a special challenge.

The project focuses primarily on autonomous vehicles with the development of a method that establishes a connection between real-life street conditions and the simulations. Monitors are used for calculating, verifying, and recording street situations to derive new test cases and system simulations. This is intended to create realistic simulations on the one hand and, on the other hand, to determine whether autonomous robot systems act correctly in complex street situations. The dynamics between the vehicle environment and the requirements that need to be met for the vehicle to be approved are being analyzed. Data supplied by internal and external sensors, for example regarding the position, rotation, and speed, are collected for this purpose and an exact environment model is created using what is known as Lidar. The vehicle assistance systems (such as driver assistance systems or autopilot) use these data to analyze their environment and identify obstacles in a timely manner.

Aside from the autonomous vehicle application, transferring the method to other autonomous robot systems is possible as well. The STARS project has been part of the Fraunhofer-Gesellschaft's ATTRACT subsidy program since January 2018, and is being subsidized with approximately 2.5 million euros until 2023. ATTRACT supports researchers and assists with the application-oriented further development of their ideas at Fraunhofer. The project manager is Prof. Dr. Falk Howar, who has been with Fraunhofer ISST since early 2018 and is currently developing the Automotive business unit at the institute.



RIOTANA®: HOW PRODUCTIVE ARE MY INDUSTRIAL TRUCKS?

Industry 4.0 and the accompanying digital transformation of objects are giving rise to entirely new optimization possibilities, not only for production but for entire operational process chains, in particular for logistics.

A straightforward industry 4.0 entry solution is offered by RIOTANA® (“**R**ealtime **I**nternet **o**f Things **A**nalitics”). As a sensor-based IT solution for generating key performance indicators (KPIs) for logistics objects such as industrial trucks, RIOTANA® helps to make ongoing logistics processes visible in real time and display them graphically. The logistics objects in question are equipped with low-cost sensors for this purpose. Subsequently, the recorded sensor data such as speed, acceleration, and temperature are transferred to a big data infrastructure in the cloud. Various analysis methods and machine learning technologies are used to analyze the transferred data in real time. Digital twins are created to generate and process the data. These digital twins are digital images of the respective logistics object. They describe an object with the data that are relevant from the application perspective. These may be master data but also business management or operational data. Typical examples for elements of an industrial truck’s digital twin would be the contents of a type datasheet established in VDI directive 2198 or operating costs according to VDI directive 2695, but also measured capacity utilization. Data defined in the directives include the drive type and information about the industrial truck’s conditions of use, among others.

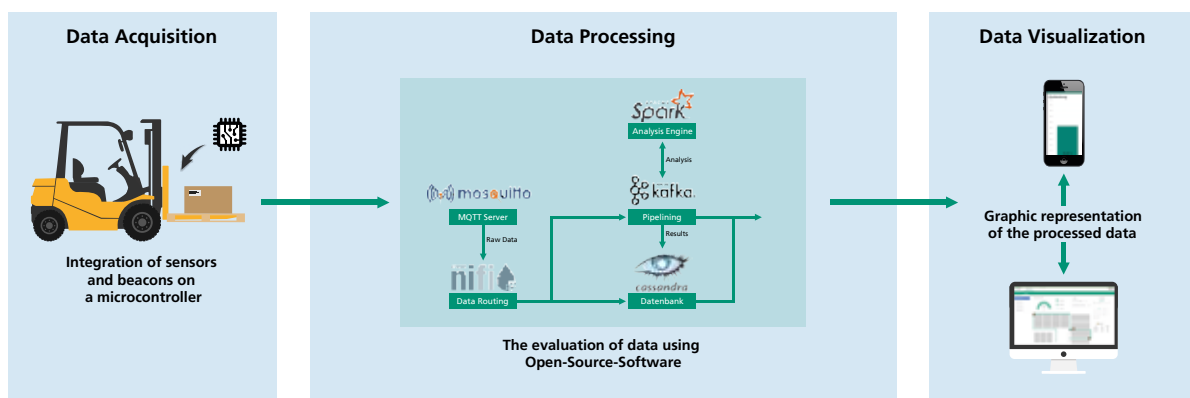
This form of real-time data processing supports entirely new possibilities for understanding relationships between events, uncovering weaknesses in the process, and predicting events.

Using RIOTANA® for forklifts or entire forklift fleets is only one of many possible use cases. In this context, RIOTANA® enables the analysis of usage phases to provide an overview of forklift utilization and allow conclusions to be drawn regarding the intensity of use. The intensity of use can, for example, serve to determine the optimal scheduling of maintenance in terms of predictive maintenance. Recording the usage phases also establishes a key basis for optimizing the use of individual forklifts so that unnecessary downtime can be avoided. RIOTANA® is compatible with forklifts from all major manufacturers, so it can also be used for a fleet comprised of vehicles from different manufacturers. Identifying impacts that may have damaged the forklift and the goods to be conveyed is another possible application scenario.

However, the possible applications of RIOTANA® go far beyond the optimization of forklift fleets. RIOTANA® can be used for virtually all logistics objects and is adaptable to a wide variety of scenarios. These include for example the handling of hazardous substances and the optimization of warehouse structures.

Using the resources of logistics objects in a company can be optimized with the help of RIOTANA®. This is based on analyzing criteria such as throughput times, holding times, frequented locations, shocks, and temperature. These data are transferred via the "International Data Space" (IDS) architecture as a secure communication link to a big data infrastructure in the cloud, where they are analyzed in real time. This does not put any additional strain on an existing IT department. By working with the International Data Space, the intended use of the data can also be restricted, thereby ensuring control of the data even in complex supply chains.

A clear advantage of RIOTANA® is the easy integration of cost-effective, mobile sensors with existing processes and infrastructures. Additional advantages are the ease of installation and configurability according to the use case. Here a crucial aspect is that no integration into existing IT is necessary. RIOTANA® therefore delivers an ideal basis for the digitization of logistics processes.



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LAUNCH OF PROJECT FOR “CLINOTEL” – INVESTIGATING THE DIGITAL MATURITY OF HOSPITALS

Scientists at Fraunhofer ISST have been advising the CLINOTEL hospital group since the summer of 2018. CLINOTEL is a shared community of interests, in which the members are able to derive benefits through joint action and to learn from each other, while each entity remains legally and organizationally self-sufficient. Since the membership structure is highly heterogeneous, the action strategies deviate considerably from each other.

But what is the connecting element?

In the course of advancing digitization, CLINOTEL has recognized that the need for action is great in order to ensure efficient patient care in the future and relieve service providers. The members intend to build up a shared store of knowledge, identify and utilize synergies, and mutually benefit from experiences. In order to reach these goals, the degree of digitization of individual members is being determined in the current project.

The group turned to Fraunhofer ISST to clarify this issue: Based on the researchers' experience in the course of international hospital projects, among others in Denmark but also with hospital groups in Germany, such as the BBT Group, a tool to determine digital maturity in the hospital was developed and adapted to the specific needs of the CLINOTEL group. To guarantee a quick win for the group and capture digitization as both an entrepreneurial and a technical issue, the survey is organized in two parts. An interdisciplinary workshop on site and structured questionnaires that take the technical level of digitization into account are intended to record the hospital's strategic paths, work out problems, and identify topics where digital solutions can contribute to eliminate drawbacks.

Here the human factor is taken into account along with the specific ambient conditions of each clinic, since the relevance of specific areas with digitization potential in the respective organization plays a central role in evaluating the quality of digital maturity. Fraunhofer ISST worked closely with its cooperation partner hsg Bochum (University of Health Sciences) in this context. hsg Bochum explicitly examines this issue in the course of educating nursing staff. This ensures that human-to-human interaction is, and remains, the focus of action in digital process support.

Following the workshop, each organization that was visited receives an evaluation report including a results matrix (Figure 1) that determines the state of digitization. Then the next steps for individual organizations can be derived based on the individual status quo and specific central challenges. By taking the individuality of each hospital into account, the members obtain a tailor-made, individual solution to advance digitization in their organization.

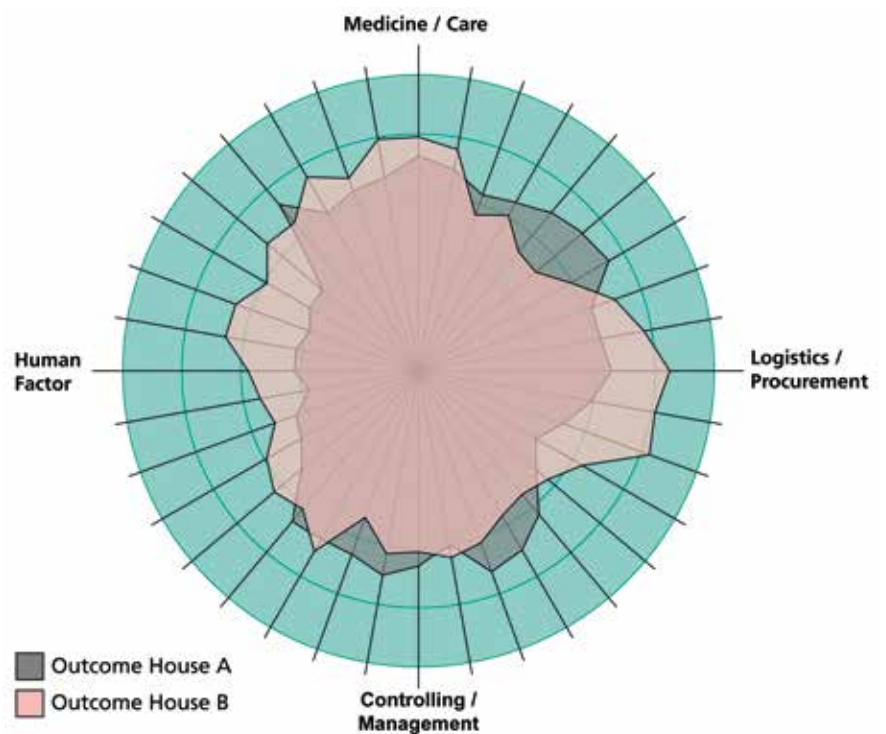


Figure 1: Radar chart showing the results for each organization and a comparison between them.



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OPTIMIZING CLINICAL CARE AND RESEARCH WITH SMITH

The SMITH (Smart Medical Information Technology for Healthcare) consortium, a group of research institutes and select industry representatives, has set the goal to create and establish a software architecture to optimize and strengthen the integration of clinical care and clinical research. To obtain the greatest possible benefit, data integration centers operating in close cooperation across sites are to be established in the current project. As one of seven consortiums subsidized under the federal medical informatics subsidy concept (Federal Ministry of Education and Research (BMBF)), it aims to

- enable the integration of care and clinical research,
- improve individual patient care through innovative medical engineering solutions and establish new data processing options on the basis of standards,
- enable data sharing for research purposes under consideration of all data protection and security requirements,
- enable active patient participation in care and research, and
- adapt existing curricula to the new challenges.

The work of the SMITH consortium has been in the setup and networking phase since January 2018. In the consortium, Fraunhofer ISST is responsible for conceptualizing and implementing the SMITH marketplace jointly with Healthcare IT Solutions GmbH and the Aachen University Hospital. As a representative of the standardization organizations "Integrating the Healthcare Enterprise" (IHE) and "Health Level 7" (HL7), the institute supports the use and advancement of standards to ensure that Information and Communication Technology (ICT) system architectures are manufacturer-neutral.

Thanks to Fraunhofer ISST's many years of experience with digitization processes in healthcare and industry, the scientists draw on a large store of knowledge that they contribute to the initiative: Among others, the SMITH consortium takes aspects of previous and ongoing projects into account, such as the "International Data Space" (IDS) and general IHE profiles that are used in numerous telematics projects, such as I/E-Health.

That Fraunhofer ISST is among the pioneers in the development of hospital IT is proven again by its involvement within the SMITH Consortium. Research activities such as these will prepare the hospitals for the future in patient care and medical research.

Nine university hospitals and nine additional research and industry partners joined forces in the SMITH consortium. SMITH is being subsidized by the Federal Ministry of Education and Research (BMBF) with total subsidies of 44.97 million euros from 2018 to 2021.

Consortium manager: Leipzig University

Partners: RWTH Aachen, Uniklinik RWTH Aachen AÖR, ID Information und Dokumentation im Gesundheitswesen GmbH & Co. KGaA, Universitätsklinikum Bonn, Fraunhofer Institute for Software and Systems Engineering ISST, Düsseldorf University Hospital, Essen University Hospital, März Internetwork Services AG, Averbis GmbH, Halle (Saale) University Hospital, Hamburg-Eppendorf University Hospital, University of Jena, Jena University Hospital, Forschungszentrum Jülich, Leipzig University, Universitätsklinikum Leipzig AÖR, Bayer AG, Rostock University Hospital.

Term: January 2018 to December 2020

Subsidization: Subsidized by the Federal Ministry of Education and Research (BMBF) (Project number: 01ZZ1803J).



Further information: www.smith.care
www.fallakte.de
www.medizininformatik-initiative.de/de/konsortien/smith



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AMable: INTEGRATION OF INTERNATIONAL DATA SPACE AND BLOCKCHAIN TO SUPPORT ADDITIVE MANUFACTURING

The main objective of the AMable project is to enable the use of additive manufacturing (AM) technologies by SMEs/mid-caps, leading to the development of innovative business and service models as well as novel value chains. AMable is creating an additive manufacturing ecosystem to reduce the hurdles faced by EU SMEs/mid-caps on entry. This ecosystem consists of a marketplace for services that drive the development of an additive manufacturing product through the manufacturing phase from the concept to design, printing, and processing. Members of the AMable ecosystem include providers of additive manufacturing services, users of these services (mainly SMEs), and AMable infrastructure providers.

In order to achieve its goals, AMable offers a digital marketplace for booking AM services and a secure infrastructure for the exchange of information between AM service providers and AM service users. The exchange of information uses the "International Data Space" (IDS) as its basis.

Expanded by blockchain technology, the following components are used in the AMable infrastructure:

- International Data Space connectors for secure data processing in distributed manufacturing environments
- A blockchain app integrated into the International Data Space as the client for the blockchain infrastructure
- A blockchain instance for the verifiable recording of transactions

Thus the AMable ecosystem utilizes a combined International Data Space/blockchain approach for continuous, end-to-end, encrypted documentation of the product development process along the entire value chain, from IP-relevant ideas to production process events that are relevant for quality.

Fraunhofer ISST as a member of the AMable consortium is responsible for the delivery of technology and consulting to make the International Data Space technology usable for AMable stakeholders as well as supporting the integration of the International Data Space with Hyperledger Fabric as the open-source implementation basis for community blockchain solutions. In addition to adapting an International Data Space base connector to AMable, Fraunhofer ISST set up a test environment for the AMable exchange of information using a combined International Data Space/Hyperledger Fabric infrastructure. The International Data Space connectors enable the linking of data artefacts (such as a CAD file or simulation result) with contracts, data transfers between two connectors by means of International Data Space messages, and calling Hyperledger Fabric chaincodes (also called smart contracts) to record transfer transactions.

Several project partners are already using the IDS connectors provided by Fraunhofer ISST in order to respectively try out a local test environment for connecting their AM services to the AMable ecosystem. Work on a Europe-wide test of transferring AM artefacts is currently ongoing.

Project consortium: International Data Space Association, Keen Bull, strategy&, Zabala Innovation Consulting, Fraunhofer ILT, Fraunhofer ISST, AIMEN Technology Center, Danish Technological Institute, European Federation for Welding, Joining and Cutting (EWF), Frederick Research Center, inspire, LMS Laboratory for Manufacturing Systems and Automation, IK4-Lortek, mtc Manufacturing Technology Center, Politecnico di Torino, sirris, Scuola universitaria professionale della Svizzera italiana (SUPSI), TNO, TWI, VTT, Politechnika Wroclawska

Subsidization: European Union within the Horizon 2020 framework (Project number: 768775).



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Further information: www.able.eu



「A flock has unique dynamics. Each member exerts a non-linear influence on the other members of the flock. Road traffic works in a similar way. Each driver influences other vehicles, thereby complying with the implicit rules of road traffic. Explicitly implementing these rules in software, for example for autonomous driving, is a challenge faced by the Automotive business unit.」



B U S I N E S S U N I T

AUTOMOTIVE

HOW RISKY ARE DRIVERLESS SYSTEMS?

Autonomous driving and networked automobile systems are important future topics for the automobile industry. Digitization makes new, intermodal mobility services and applications possible, linking data from a wide variety of sources. In the Automotive business unit, the Fraunhofer Institute for Software and Systems Engineering ISST contributes to designing digital ecosystems related to autonomous driving.

To allow autonomous vehicles to participate in road traffic, their guaranteed safety plays a crucial role. Ensuring that the vehicle behaves as expected, even without the driver as a controlling instance, is the challenge. This is particularly true in cases where the vehicle can or will not be tested over countless kilometers. That is why the team of the Automotive business unit at Fraunhofer ISST, in the “Scenario-based Testing for Autonomous Robotic Systems” (STARS) research project, is working on developing a scenario-based methodology for the validation of autonomous robotic systems (see pages 22-23).

Does the robot always meet my expectations?

So far, driver assistance systems have been designed for people to take control in critical situations. The driver is therefore responsible for safety. This however will change with increasing automation, since autonomous vehicle systems and especially fully autonomous vehicles have to guarantee safety themselves. Thus the programmed software has to execute the expected actions and operate independently in all conceivable situations. When people and robots are expected to share an environment, it is essential to assess the safety of the systems correctly and efficiently as errors harbor an elevated hazard potential. Therefore the technical requirements for autonomous robotic systems are far stricter in comparison to previous systems, which are permanently monitored and controlled by people.

Verification and validation of autonomous robot systems at runtime

The complexity of the real world however prevents the complete testing and analysis of autonomous systems. Guaranteeing safety for every conceivable case is therefore not possible, especially since the hazard potential of a self-driving vehicle is extremely high.

Researchers in the Automotive business unit at Fraunhofer ISST are therefore working on a methodology to support the verification and validation of autonomous robotic systems at runtime.

In the future, autonomous robotic systems could deliver goods from autonomous logistics systems to any location around the world, without the need of people or their working time for transportation.

Data already constitute a significant element of autonomous driving today, and their importance will continue to increase steadily in the coming years. In order for these data to be transmitted securely and protected against attacks, data security is another component that needs to be considered. It is a prerequisite for privacy in the vehicle and encompasses secure communication between the vehicle and cloud as well as protection against attacks. Creating a secure cloud infrastructure that ensures safe networking in the vehicle and with the environment is an important basis for this.

The employees in the Automotive business unit are outstanding partners for companies that are involved with security, autonomous driving, and connectivity in the automobile industry.

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The dry savanna is home to animal species that have adapted to this habitat's vegetation, and other animals that kill the adapted species as prey or consume them as carrion. Animals also influence the competitive structure between grasses and trees: Elephants break tree branches to reach the leaves, peel the bark, and trample or push down trees for other reasons. Killing trees makes the forest less dense, which improves the growing conditions for grasses that are grazed by buffalo, zebras, and gazelles. Fraunhofer ISST is striving for this type of mutually beneficial balance for the data-driven industry in the Data Economy business unit.

The use of data must be fair for individual citizens and companies, and has to contribute to the lasting prosperity of economy and society.



A herd of elephants is walking across a savanna landscape. The elephants are in the foreground, and the background features rolling hills and a bright blue sky with scattered white clouds. The overall scene is bright and clear.

BUSINESS UNIT

DATA ECONOMY

DIGITAL VALUE CHAINS FOR DATA-DRIVEN BUSINESS MODELS ACROSS COMPANIES

OPPORTUNITIES OF DIGITIZATION FOR THE DATA-DRIVEN INDUSTRY

While the share of the gross domestic product contributed by production and the building sector is falling, data-driven business models are on the rise. Growth is most rapid among business service providers, in financing, leasing, and the information sector. All of these are knowledge-intensive services where data constitute a strategic raw material. Here the data available in a single company are often no longer sufficient to develop innovations and implement new products and services. Digital value chains are increasingly forming across company boundaries, realizing the economic use of existing data, whether internal to a company or across companies. These consortiums can be called Data Ecosystems.

The term data economy covers all aspects of economic utilization, such as data analysis. In concrete terms, the influence of data on the economic result and the ways that data change the business models of companies are examined. Due to the growing number of companies with purely data-driven business models, the data economy is increasingly positioning itself as a separate industry that supports other sectors and makes new products and services possible. Here the potential of personal data and non-personal data is similarly considered.

Data economy value chains encompass data generation, collection, storage, processing, and analysis up to final utilization or erasure. Digital technologies, methods, and algorithms are used along the value chain to realize added value from the data and enable new business models, production possibilities, process optimizations, or improved customer loyalty. Here the commercialization and monetization of data are in full swing. The term data monetization goes back to the classic trading of data. Due to the digital transformation in terms of industry 4.0, the quantity and availability of data are increasing exponentially. This applies for all digital ecosystems forming in the various industrial sectors, for example in the manufacturing trade, agriculture, and especially in the information and telecommunication sector. Order data, machine data, process data, and a wealth of transaction data are for example available to companies, waiting to be monetized.

In this context, the character of data as a key resource can be viewed as the beginning of a fundamental new economic era. Just like we transformed our society's capital from the agricultural to the industrialized society, data will effectively turn all lives in the data society upside down with the only difference being that these changes will be even more profound, from both an economic and a social perspective.

Companies that are able to utilize, analyze, and interpret internal and external data and integrate them into existing value chains have intrinsic leverage for growth. Considerable competitive advantages will be realized, costs reduced, processes optimized, and new, innovative business areas developed. This is accompanied, in particular, by supplementing and altering existing business models through service components. However, numerous companies are still facing the issue of meaningful implementation since concrete solutions for holistic data integration, while maintaining data sovereignty, are lacking.

So how can these Data Ecosystems be realized from an organizational and technical perspective? How can the required data in them be administered and used efficiently? These questions are answered by Fraunhofer ISST in the Data Economy business unit.

When the topic of data is examined from the perspective of materials and inventory management, the discrepancy between the assets of the “old economy” and data becomes clear. Principles of classic materials management (meaning the administration as well as the planning and control of material movements within a company, and between a company and its environment) also have to be applied to the data resource in the course of digitization. The management of data is accompanied by new challenges for companies:

- Definition of a company-wide data strategy
- Data governance to regulate objectives and responsibilities for the management and use of data
- Management of the data resource as an economic good (inventory, valuation, administration, controlling)
- Design and implementation of a data architecture and data integration in line with the business result
- Development of new data-driven business models

When the actual situation in companies is examined today, this is often just wishful thinking. Management of the existing data is characterized by a lack of housekeeping, organizational and functional data silos, intransparent control and governance structures, barriers to the collaborative exchange of information, uncoordinated maintenance processes throughout the data lifecycle from procurement to archiving, and also inadequate controlling. Currently there is no data management.

No innovation without data

Regardless of whether we are talking about purely digital services or supplementary services that complement the classic product range: Data form the basis of innovations today.

Effective data handling is essential in order to meet new market demands and offer data-centered services or supplement physical products with effective services. In the Data Economy business unit, Fraunhofer ISST therefore views data as an

economic good and overcomes the challenges of the service sector with an engineering approach to data. The smart data engineering method that is used not only makes organizational processes transparent, but also transfers the insights directly to the company's logical and technological data architecture. By examining the business processes, the required service structures, internal and external data access, the keeping of data, and data integration are worked out and transferred from a current state to a future-oriented data architecture that meets the demands of digitization, where the data can be managed operationally.

Focus on future-oriented data management

We developed a tool-assisted approach for the integration, inventory, analysis, and valuation of data sources. Our approach supports the integrated management of internal company data and the specification of an organizational framework. Through innovative data analysis methods, this enables automated metadata management and monitoring of the data properties (such as data quality, frequency of use, data provenance).

The recording and exchange of data, including purchasing, costs companies money. Not only the apparent costs for access to external data or the costs incurred for recording internal company data have to be considered here. Internally incurred consequential costs also play a significant role for the effective and economic management of the data resource. Costs are incurred for storage, regular maintenance, and verification to ensure a corresponding data quality and the delivery of data. Current studies show that more than 50 percent of all data resources in companies today are considered "dark data". This means that no business value can be determined for these data, and that the effects on the success or failure of the business cannot be estimated. Here the DIVA tool (Data Inventory and Valuation Assistant) developed by Fraunhofer ISST contributes to the recording, valuation, and maintenance of data in companies. Based on the general assumption of a 40 percent proportion of data sources that have not been accessed for at least three years, a structured inventory using DIVA clearly harbors even more potential savings.

Not only unused data are of interest here, but also the identification of redundant data sources within the company. The average figure of approximately 30 percent redundant data determined here results in tremendous consolidation and savings potential for companies.

Realizing the economic potential of data

Aside from the management of company data, economic utilization also plays a central role. That is why the Data Economy business unit examines all services from the business model to the technical architecture. Naturally this means our solutions also support interfaces to other organizations and external data sources in order to transparently and effectively organize all data required for an innovative service and the surrounding Data Ecosystem of providers, users, servers, and applications.

The institute's offering includes, among others:

- Integrated support for digitization projects: We help you manage your data from the strategic perspective to the process view down to the technical level of implementing data-driven services.
- Data management for value chains: We assist with the valuation of data sources and develop concepts and processes tailored to the respective context for collecting, storing, processing, and maintaining data banks.
- Customer process improvement and redesign: We assist with improving and redesigning customer processes, uncover new service potential and provide valuable impulses for the development of new offers.
- Conceptual design and feasibility studies for new services: On behalf of customers, we research whether and how a new service can be technically realized. For this purpose, we devise and develop the required data structures and algorithms needed to offer a service. We then test these along with the underlying, data-driven business models in the course of feasibility studies and analyses.
- Individual software development: We develop the designed solutions in concrete software for our customers and partners. Here the spectrum of services ranges from small tools to mobile apps to scalable cloud solutions, including data integration and interfaces.

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┌ Trees are an important element of the forest community. Yet a collection of trees does not make a forest ecosystem, nor a forest in the narrower sense. Only when trees are numerous and close enough together for a typical forest climate to develop (the temperatures fluctuate less, air movements and the light intensity are reduced, the relative humidity is increased) does one speak of a forest. So a park landscape is not a forest.*

Transferred to the Healthcare business unit, this means that we are not examining individual players acting side by side, but the establishment of cross-platform communication solutions for the healthcare sector, leading to better balance and therefore the improved wellbeing of all participants by making valuable health data available in the right places faster, more securely, and efficiently.└

Source: www.sdw.de/waldwissen/loekosystem-wald/was-ist-wald/index.html



B U S I N E S S U N I T

HEALTHCARE

DATA SOVEREIGNTY FOR THE “DIGITAL HEALTH SELF”

CONTROL AND TRANSPARENCY IN DATA ECOSYSTEMS IN HEALTHCARE

Virtually no information is so sensitive for people as data about their own health. This very personal concern must be considered when digitization projects are planned in the healthcare sector. The electronic health file of my insurance provider – that is me. The data collected about me in the hospital – that is me. And the data about me recorded by my smart home system – that is me. Maintaining control over this flood of individual and highly personal data is the central research objective of the Fraunhofer Institute for Software and Systems Engineering ISST in the Healthcare business unit. The premise is that the individual has sovereignty over their data. In order for this to succeed, an integrated Data Ecosystem is needed, returning control of their own data to the individual across all platforms.

Focus on the individual: Give control back to the data owner

In the Healthcare business unit, Fraunhofer ISST has set the goal of focusing on the individual as the sovereign of their data: Give control back to the data owner. In order to accomplish this, the scientists are applying data sovereignty concepts developed in the “International Data Space” (IDS) initiative to medical issues. Currently this is happening in several projects: In the DaWID project subsidized by the Federal Ministry of Education and Research (BMBF), citizens are to attain greater transparency regarding data usage and data access rights, also across platform boundaries, with the help of International Data Space concepts. Overcoming platform limits is a key requirement for an integrated Data Ecosystem in healthcare.

It can after all be assumed that numerous platforms with their own data endpoints will be maintained and created in the future due to functional or business-driven interests. Thus Fraunhofer ISST within the framework of the SMITH project subsidized by the Federal Ministry of Education and Research (BMBF) as part of the medical informatics initiative is supporting the development of a data marketplace for patient data that are relevant for research (see pages 28-29). A service integration platform is also being established as part of the Smart Services Worlds II initiative of the DACE project subsidized by the Federal Ministry for Economic Affairs and Energy (BMWi). Not least Fraunhofer ISST is also committed to the EU-wide exchange of patient data: The interoperEHRate project subsidized by the EU in 2019 will permit the exchange of patient-related data from the national infrastructures via smartphone.

Overcoming platform limits

The steadily increasing availability of data also poses challenges for companies in the healthcare sector far removed from subsidized projects: Increasingly data are becoming a distinct asset, making a significant contribution to a company's value. Yet a strategic approach to handling company data is often still lacking: What data are available to me and where? What is the value of my data? How can data be converted and organized? That is where Fraunhofer ISST comes in with its Data Ecosystems approach that goes beyond platform limits. This approach enables healthcare facilities and organizations to make data accessible and develop digital services and business models. Ensuring data sovereignty is crucial, especially in healthcare. Citizens in their various roles (patient, insured person, etc.) have rights to their data, especially also under the GDPR. Nevertheless they frequently do not possess these data – they are for example stored by hospitals or other secondary service providers. Fraunhofer ISST's Data Ecosystem approach helps with the technical implementation of the legally specified framework.

What is my hospital's digital maturity?

The healthcare researchers at Fraunhofer ISST were for example able to establish cooperation with CLINOTEL, which represents more than 60 hospitals across Germany. The mission is to determine the digital maturity of all facilities with the help of the Digital Health Maturity model of Fraunhofer ISST (see pages 26-27). One component of this model is the human factor as a key player within healthcare processes. Enabling these players is also a concern in the HealthReality project launched in 2018 (subsidized with EU EFRE NRW funds) in cooperation with hsg Bochum: Going forward, it will make new technologies in healthcare tangible in a joint experimental and living lab.

All of these projects offer numerous starting points for setting up digital ecosystems for healthcare facilities and organizations, paving the way for the sovereign exchange of data for both patients and facilities, and enabling greater transparency and security in the handling of data.

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Ants ensure that sparse landscapes can be populated by plants. They transport the seeds of around 150 plant species and loosen up the soil with their passageways. What's more, they promote the formation of fertile topsoil.

Ants are the ecosystem's logistics objects. They transport and prepare. Ants form the foundation for fertile soil and natural diversity, like logistics forms the foundation for efficient processes.

Source: www.planet-wissen.de/natur/insekten_und_spinnentiere/ameisen

A close-up photograph of several red ants on a dark, textured gravel surface. The ants are carrying small, bright green fragments of leaves. The background is a solid grey color.

BUSINESS UNIT

LOGISTICS

“DATA” AS A RESOURCE – A VALUE FOR AN INDUSTRY WHERE EVERYTHING DEPENDS ON INFORMATION TECHNOLOGY

HOW LOGISTICS LINKS GOODS AND DATA IN DATA ECOSYSTEMS

Logistics, with a turnover of more than 200 billion euros per year, is Germany’s third-largest economic sector after the automobile industry and mechanical engineering. Internationally it assumes a leading position (2016: 1st place according to the World Bank’s International Logistics Performance Index). For trade and industry, logistics is both a cost and a competitive factor. That is why it has long since developed beyond the classic disciplines of transportation, trans-shipment, and storage, into a growing market of complex and interlinked services.

Today logistics no longer just networks the world physically through the flow of goods, but also digitally by providing the right information to the right player at the right time. The mega-trend of digitization not only influences established logistics processes but affects the entire logistics company, including its ecosystem. The surrounding ecosystem determines the company’s freedom of action and is essential for the present business model. Increasingly, the business ecosystem in which companies operate is affected by the development of new technologies and digital services. This results in changing processes due to new business models, new partners, and products. These developments lead to a rising flood of data. In view of the increasing importance of data, complexity is assuming new dimensions that bring up numerous questions for companies:

- What data are generated and processed in which production and logistics processes, when, and why?
- What data can be used to generate information and therefore knowledge for optimizing these and also other processes in customer order processing?
- What is the value of production and logistics data, and are they suitable for a new business model?
- Can data generation and management areas be developed from cost centers to profit centers?

To master this complexity, companies have to adapt to a new ecosystem – the Data Ecosystem. This results in data transparency throughout the ecosystem. For example, the generation of new data becomes visible and the efficient use of existing datasets is enabled.

To utilize the value of data in a future Data Ecosystem, companies have to adequately position their IT and data architecture: Data formats need to be flexible and manageable, the intelligent networking of data has to be possible, dataset-specific quality requirements have to be controlled – also for external data – and the heterogeneity of data relevant for a company in regards to quantity, frequency, form of description, quality, or significance for business processes requires greater consideration. Fraunhofer ISST is therefore researching innovative concepts, technologies, and architectures for the digitization of logistics and production. Many years of experience with the conceptual design of innovative services, the modeling of business processes, and the setup, migration, and consolidation of long-lived, complex IT systems make the institute a competent partner for the logistics sector in order to improve the efficiency of logistics solutions and therefore the competitiveness of logistics companies overall.

Our offering

In the Logistics business unit, Fraunhofer ISST assists logistics and production companies with meeting the challenges of and enabling the participation with in the Data Ecosystem. We establish the prerequisites for your company through the development of industrial data management in conjunction with smart processes and tools.

Digital shop floor transformation

What is the potential of digitization for your company? How can your production, logistics, and support processes be optimized through digitization? How much industry 4.0 is in your company already? What new data-based products and services can expand the offering for your customers? What data need to be captured for this? What technologies are suitable for this? How are the recorded data used in the process?

On basis of our always current technical expertise and our experience in the industrial and service sector, we will work on these as well as similar questions with you for your company. For this, we use proven methods such as Digital Business Engineering for the development of data-driven business models or the "Acatech Industry 4.0 Maturity Index" that determines the maturity of companies regarding "Industry 4.0". We will gladly offer our facilities for a creative environment outside of the day-to-day business – for instance in the Digital Hub Logistics – or visit you on site for a process inspection.

The special requirements and restrictions of companies and their environment have to be taken into account in the digital transformation of business processes. Blanket solutions for process digitization are therefore not suitable. An individually coordinated concept is required. We develop this with you in creative workshops with the help of "Lego Serious Play®".

Based on our current technology overview and our project experience, we develop concepts for you to capture data and deliver information in the process. On request we also implement a prototype. In doing so, we examine the suitability of using smart devices such as tablets or wearables and localization technologies such as beacons (Bluetooth signal emitters).

Customer order process and supply chain optimization

Every company faces the challenge of making the processing of its orders from receipt to delivery of the finished product fast, efficient, and adaptable in order to survive in the market. Organization in silos, media breaks, and insufficient IT support however result in uncoordinated planning processes, duplicate work, and long planning cycles, the results of which often disregard numerous factors such as internal and external capacities (for instance those of suppliers). This leads to hectic and usually costly reactive action – firefighting – in operating processes.

The automobile industry is very advanced in the design of customer order processing due to its high product and production complexity. Fraunhofer ISST assists various European passenger and commercial vehicle manufacturers with optimizing customer order processing and individual sub-processes, the conceptual design of the required IT architectures, and the setup of a digital twin.

Our approach to the data-driven optimization of customer order processing initially calls for an analysis of the current process state, in particular identifying challenges that span organization units. This is followed by the development of a process vision for customer order processing and its sub-processes as well as embedding in the supply chain ecosystem. The vision is based on the existing production system and utilizes current and foreseeable information technology possibilities. This leads to requirements for the third phase, the development of an IT landscape and guidelines for its further development.

Industrial data management

What data are available in your company? In what business processes are they used? What data constitute a strategic advantage? What data are suitable as an added source of income? What is the benefit of networking data? Who is responsible for data availability and quality? Do your data have the required protection? How will your employees interact with data in the future?

Industrial data management forms the methodology foundation for answering these and similar questions. The approach develops use-case-driven supply chain and company-wide data architectures that enable the digital transformation in your company and meet the prerequisites for participating in the Data Ecosystem. Such a data architecture describes an organizational and technical concept for data recording, keeping, and maintenance, taking into account the use case-specific criteria regarding data validity (local vs. supply chain or company-wide), data sovereignty (is the responsibility for delivery centralized or decentralized?), quality assurance, unique identifiability, desired redundancy, and the logical and physical keeping of data. In reality, such data architectures only exist to a limited extent. This is because data, in many companies, exist in the individual specialist departments, and often only there. Consequences of this silo-thinking include poorly coordinated processes within the business ecosystem and the redundant keeping of data. In particular however, it prevents comprehensive data analysis that could for example be used to identify imminent peaks in demand, the pending realization of risks, or also uneconomical product segments.

The economic potential of a Data Ecosystem with networked data, clear responsibilities for their delivery, and quality assurance as well as straightforward access for the specialist user is therefore considerable.

In a project coordinated individually with you, we make more from your data and answer the questions asked at the outset. To this end we devise a specific information architecture for your company. Based on concrete, future-oriented use cases, we analyze the data sources that are currently available and needed in the future, along with their networking requirements, for example with the help of a semantic information layer. Here the possible networking with third parties while maintaining data sovereignty – for example based on the “International Data Space” (IDS) – plays an important role. To ensure data availability and the definition of responsibilities related to data, we develop a governance concept that fits your company’s existing organizational structure.

Technical concept and development

For a company to become part of the Data Ecosystem, digital process innovations require targeted and reliable implementation in addition to a reasoned and future-proof concept. IT developments in particular offer the possibility of an agile approach with the initial creation of minimal viable products, meaning software and systems encompassing the minimum functionality. The development of a tailor-made management system for example first maps the core functionality, such as a user dialog. Scaling, user management, additional reports, and so forth follow later.

The team of researchers in the Logistics business unit at Fraunhofer ISST has the IT and logistics expertise required to develop technical solutions quickly in close proximity to the customer, as a rule in a business area. We will gladly develop your prototype quickly and effectively with competitively priced microcontrollers and back end solutions hosted by Fraunhofer on a test basis.

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FRAUNHOFER ISST

NETWORKS

FRAUNHOFER NETWORKS AND ALLIANCES

The Fraunhofer-Gesellschaft

Practical research is the Fraunhofer-Gesellschaft's central task. The research organization founded in 1949 conducts application-oriented research for use by industry and for the benefit of society.

The contractual partners and customers are industrial and service enterprises as well as the public sector.

Currently the Fraunhofer-Gesellschaft operates 72 institutes and research facilities in Germany. More than 26,600 employees, most of them with a natural or engineering sciences education, conduct the annual research volume of 2.6 billion euros. 2.2 billion euros of this amount is for contract research. Around 70 percent of that is generated by the Fraunhofer-Gesellschaft with orders from industry and with publicly financed research projects. The federal and state governments contribute about 30 percent as core funding so the institutes can develop solutions for problems that will only become current for the economy or society in five to ten years.

International cooperation with excellent research partners and innovative companies worldwide ensures direct access to the leading current and future scientific and economic areas.

With its clear mission of applied research and its focus on key technologies that are relevant for the future, the Fraunhofer-Gesellschaft plays a central role in Germany's and Europe's innovation process. The effects of applied research go beyond the direct benefits for customers: With their research and development efforts, the Fraunhofer Institutes contribute to the competitiveness of the region, Germany, and Europe. They promote innovations, strengthen technological capabilities, improve the acceptance of modern technology, and provide training and continuing education for the urgently needed new scientific and technical talent.



The Fraunhofer-Gesellschaft offers technical and personal development opportunities to its employees for demanding positions at its institutes, universities, in industry, and in society. Thanks to their practical education and experience at the Fraunhofer Institutes, students have access to outstanding entry and development opportunities with companies.

The namesake of the *Fraunhofer-Gesellschaft*, recognized as a nonprofit, is the Munich scholar Joseph von Fraunhofer (1787–1826). He was equally successful as a researcher, inventor, and entrepreneur.

Figures dated: January 2019

[\[www.fraunhofer.de\]](http://www.fraunhofer.de)

Fraunhofer ICT Group

Fraunhofer ISST is a member of the Fraunhofer ICT Group. This group of all Fraunhofer Institutes in the field of information and communication technologies is Europe's largest IT research organization. From the smartphone to intelligent power networks, from the operating theater to the decision support system in the vehicle: Modern life and day-to-day work would be inconceivable without information and communication technology.

Fast-moving developments and short innovation cycles are typical for IT. Therefore, fast reaction and efficiency are even more crucial for competitiveness than in most other fields. Software systems are also becoming increasingly complex – from embedded systems in everyday objects to process optimization for public authorities, from IT integration in medical processes to the latest technologies in the media sector and manufacturing trade, to process optimization in finance. Expert knowledge is short-lived and always being updated.

The Fraunhofer ICT Group serves as a direct point of contact for companies and users in all of these cases. We know the markets and offer know-how, experts, and the latest technologies to help companies overcome their challenges. [\[www.iuk.fraunhofer.de\]](http://www.iuk.fraunhofer.de)

Fraunhofer Big Data and Artificial Intelligence Alliance

Big Data and Artificial Intelligence (AI) are disruptive, strategic, and technology drivers for the digital transformation of the economy and the innovativeness of companies. More and more decision-makers want to utilize this advantage to effectively optimize products and services as well as internal company processes. But how to integrate big data and AI technologies into ongoing operations or conceive them in the first place is often unclear. On numerous occasions the know-how is lacking, consultancy comes at a high price, and the exchange of experiences with other companies does not take place for competitive reasons. Through the Fraunhofer "Big Data Alliance", companies gain direct access to technical and industry expertise. They can obtain relevant know-how and network in various ways.



As a research group of over 30 Fraunhofer Institutes, the Fraunhofer Big Data and Artificial Intelligence Alliance is a leader in the fields of big data and AI, networked in the economy across industries. The alliance considers itself the central point of contact and exclusive networking platform for companies and start-ups. Its mission is to promote the transfer of technologies and knowledge, and to support cooperation between science and industry and advance it in the long term – including subject-specific exchange, concrete projects, and joint research projects. [www.bigdata.fraunhofer.de]

Fraunhofer Ambient Assisted Living Alliance AAL

In the Fraunhofer "Ambient Assisted Living Alliance" (AAL), 11 Fraunhofer Institutes work together on AAL and personal health solutions. An integrated approach is pursued, encompassing various technologies, applications, and user groups, along with related activities in the area of research coordination, business model development, and standardization, as well as enabling modular systems consisting of interoperable components.

AAL represents intelligent environments that adapt independently and proactively to the needs and goals of the user according to the specific situation in order to support the user in daily life. Intelligent environments are in particular intended to permit people who are older, with disabilities, or in need of nursing care to live a self-determined life in a private setting. [www.aal.fraunhofer.de]

Fraunhofer Cloud Computing Alliance

Cloud computing, virtualization and Software-as-a-Service (SaaS) top the rankings of the major researchers as leading topics. Meanwhile numerous use cases and corresponding business models prove that these topics are more than just hype.

Whether and when the deployment of cloud technologies or the use and delivery of applications and IT resources as a service is worthwhile does however need to be examined in detail on a case-by-case basis.

With the application-oriented research mandate of the Fraunhofer-Gesellschaft, eight institutes with complementary topics cooperate within the Fraunhofer Cloud Computing Alliance in the fields of cloud IT and software-as-a-service.

The partners work together in both industrial and scientific research cooperation depending on the application requirements. Interdisciplinary solutions from one source are therefore possible. [www.cloud.fraunhofer.de]

Fraunhofer-inHaus-Center

The Fraunhofer-inHaus-Center works with manufacturers, service providers, users, and Fraunhofer Institutes to create novel system solutions for the business areas of work, construction, energy, hotels, resources, and living. As a creative think tank, the Fraunhofer-inHaus-Center bundles the potential of science and industry with the goal of developing novel room concepts, innovative building materials, intelligent building services engineering, and electronic assistance, thereby accessing new markets.

Currently the focus is on the areas of energy efficiency, room and building systems, the (further) development of measurement and energy systems, as well as the development of groundbreaking products and services for healthcare and nursing. [www.inhaus.fraunhofer.de]



THE FRAUNHOFER ISST ADVISORY BOARD MEMBERS

The advisory board is made up of science, industry, and public sector representatives, and advises the management of Fraunhofer ISST.

Paul Schwefer

Chair of the advisory board
Consultant, Fair Sourcing, Hanover

Dr. Reinhold Achatz

Chief Technology Officer and Head of Corporate Function
Technology, Innovation & Sustainability der thyssenkrupp AG,
Essen

Guido Baranowski

CEO of TechnologieZentrum Dortmund

Prof. Fritz Henglein

Department of Computer Science (DIKU), Copenhagen
University, Denmark

Katrin Hinne-Mohrmann

Vice President Practice Transport and Logistics, Deutsche Bahn
AG

Prof. Dieter Kempf

President of Bundesverband der Deutschen Industrie e. V.,
Berlin

Fabian von Kuenheim

Managing Director of Kuenheim Familiaris GmbH, Stuttgart

Volker Lowitsch

Head of the IT business area and chair of the Verein elektronische
FallAkte e. V., Aachen University Hospital, Aachen

Prof. Christine Legner

Head of the Information Systems Department
Université de Lausanne, Lausanne

Dietmar Pawlik

Commercial Manager of Städtisches Klinikum München GmbH,
Munich

Michael Schmelmer

CFO at Boehringer Ingelheim International GmbH,
Ingelheim am Rhein

Eva Schultze

Head of Global Master Data Management, Transport und
Warehouse Management, Drägerwerk AG & Co. KGaA

Björn Stammer

Head of Logistics (ND-L), Nestlé Deutschland AG

Dr. Frank Wille

Managing Partner of HYBETA GmbH, Münster

TECHNICAL UNIVERSITY (TU) DORTMUND

Chair for Industrial Information Management

At the Faculty of Mechanical Engineering, the Chair for Industrial Information Management researches innovative concepts, methods, architectures, and solutions for business and logistics networks. The work is defined by interdisciplinary access to the research object at the interface of engineering sciences, business administration, and computer sciences.

Located on the LogistikCampus, the chair participates in the education of logisticians, mechanical engineers, and industrial engineers in the courses of the Faculty of Mechanical Engineering. Cooperation with numerous national and international science and industry partners defines the research and teaching activities.



Chair for Software Engineering

At the Chair for Software Engineering at TU Dortmund, fundamental research is linked with applied contract research in cooperation with Fraunhofer ISST. Current research topics are in the fields of software architecture, business processes, and the formal and logical fundamentals of software engineering.

The focus in the software architecture field is on modern and abstract architectures. In particular the specification, communication, design, and automatic synthesis of (industry-specific) business and software architectures are investigated here. Modeling new business processes and the reconstruction of business processes from reports (logs) are researched in a second area. Another focal point is the analysis of process patterns and ad-hoc changes. The behavior and other dynamic characteristics of distributed systems are investigated in the third research area "Formal Methods of Software Engineering".



hsg Bochum

Prof. Dr. Wolfgang Deiters holds a professorship for Health Technologies in the Department of Community Health at hsg Bochum. His core topic is technical decision support systems for healthcare. Research focal points include the areas of digitization strategies in healthcare, user-oriented digital health services for prevention, therapy, and care, mobile health services, socio-technical and resource-oriented everyday support systems for a long and healthy life, digitally assisted supply structures, and the development and strengthening of digital health expertise.

Prior to his work at hsg Bochum, Prof. Wolfgang Deiters was part of the Fraunhofer ISST's management team for many years. Today he assists the Healthcare department in particular as a senior scientist and consultant. This cooperation results in numerous joint project activities.



Prof. Dr. Wolfgang Deiters

University of Koblenz-Landau

Prof. Dr. Jan Jürjens (Director Research Projects at Fraunhofer ISST) heads the Institute for Software Technology IST at the Koblenz campus of the University of Koblenz-Landau as Professor for Software Engineering. Strategic cooperation with Fraunhofer ISST has been ongoing since 2017.

Prof. Jürjens is researching the topic of software engineering for secure systems and their application in distributed architectures for intelligent data analysis, found for example in the International Data Space. At Fraunhofer ISST, Prof. Jan Jürjens coordinates public subsidy projects and scientific publications, and is a member of the Program Management Board for the International Data Space initiative.

The first joint cooperation projects have already been initiated between Fraunhofer ISST and the Institute for Software Technology, such as the EU project "Visual Privacy Management in User Centric Open Environments" (VisiOn) successfully completed in 2017 and the EU project "Digital Reality in Zero Defect Manufacturing" (QU4LITY) launched in 2019.



Prof. Dr. Jan Jürjens

Scientific publications (selection)

- Ahmadian, Amir Shayan; Jürjens, Jan; Strüber, Daniel: **Extending model-based privacy analysis for the industrial data space by exploiting privacy level agreements.**
In: Haddad, H.M.: SAC 18, 33rd ACM/SIGAPP Symposium On Applied Computing. Proceedings: Pau, France – April 09 - 13, 2018 New York: ACM, 2018, pages 1142-1149 (DOI: <http://dx.doi.org/10.1145/3167132.3167256>)
- Ahmadian, Amir Shayan; Strüber, Daniel; Riediger, Volker; Jürjens, Jan: **Supporting privacy impact assessment by model-based privacy analysis.**
In: Haddad, H.M.: SAC 18, 33rd ACM/SIGAPP Symposium On Applied Computing. Proceedings: Pau, France – April 09 - 13, 2018 New York: ACM, 2018, pages 1467-1474 (DOI: <http://dx.doi.org/10.1145/3167132.3167288>)
- Böhmer, Martin; Dabrowski, Agatha; Otto, Boris: **Conceptualizing the knowledge to manage and utilize data assets in the context of digitization: Case studies of multinational industrial enterprises.**
Dortmund: Fraunhofer IML, 2018, 22 S. (URL: <http://publica.fraunhofer.de/documents/N-506696.html>. Creation date: August 22, 2018. Access date: March 4, 2019)
- Bürger, Jens; Strüber, Daniel; Gärtner, Stefan; Ruhroth, Thomas; Jürjens, Jan; Schneider, Kurt: **A framework for semi-automated co-evolution of security knowledge and system models.**
In: The Journal of systems and software 139 (2018), pages 142-160 (DOI: <http://dx.doi.org/10.1016/j.jss.2018.02.003>)
- Cassel, Sofia; Howar, Falk; Jons-son, Bengt; Steffen, Bernhard: **Extending automata learning to extended finite state machines.**
In: Bennaceur, A.: Machine learning for dynamic software analysis: Potentials and limits: International Dagstuhl Seminar 16172, Dagstuhl Castle, Germany, April 24-27, 2016; Revised papers. Cham: Springer International Publishing, 2018, pages 149-177 (Lecture Notes in Computer Science 11026) (DOI: http://dx.doi.org/10.1007/978-3-319-96562-8_6)
- Cui, Shaolong; Wang, Dacheng; Holtkamp, Bernhard; Yao, Xiaojing; Fang, Jinyun: **A multi-frequency acquisition algorithm for a GNSS software receiver.**
In: Institute of Electrical and Electronics Engineers -IEEE-; IEEE Geoscience and Remote Sensing Society: IGARSS 2018, IEEE International Geoscience and Remote Sensing Symposium. Proceedings: Observing, understanding and forecasting the dynamics of our planet, July 22-27, 2018, Valencia, Spain Piscataway, NJ: IEEE, 2018, S.1082-1085 (DOI: <http://dx.doi.org/10.1109/IGARSS.2018.8517898>)
- Deiters, Wolfgang; Burmann, Anja; Meister, Sven: **Digitalisierungsstrategien für das Krankenhaus der Zukunft.**
In: Der Urologe 57 (2018), no. 9, pages 1031-1039 (DOI: <http://dx.doi.org/10.1007/s00120-018-0731-2>)
- Dimjasevic, Marko; Howar, Falk; Luckow, Kapser; Rakamaric, Zvonimir: **Study of integrating random and symbolic testing for object-oriented software.**
In: Furia, Carlo A.: Integrated formal methods. 14th International Conference, IFM 2018: Maynooth, Ireland, September 5-7, 2018; Proceedings. Cham: Springer International Publishing, 2018, pages 89-109 (Lecture Notes in Computer Science 11023) (DOI: http://dx.doi.org/10.1007/978-3-319-98938-9_6)
- Grambau, Jens; Hitzges, Arno; Otto, Boris: **Predictive maintenance in the context of service – a state-of-the-art analysis of predictive models and the role of social media data in this context.**
In: Hammoudi, S.; Institute for Systems and Technologies of Information, Control and Communication -INSTICC-, Setubal: 20th International Conference on Enterprise Information Systems, ICEIS 2018. Vol.2. Proceedings: March 21-24, 2018, in Funchal, Madeira, Portugal SciTePress, 2018, pages 223-230

(DOI: <http://dx.doi.org/10.5220/0006669902230230>)
Halmheuer, Rainer; Otto, Boris; Hegel, Johann: **Layout optimization of a system for successive laser scanner detection and control of mobile robots.**
In: *Robotics and autonomous systems 101* (2018), pages 103-113

(DOI: <http://dx.doi.org/10.1016/j.robot.2017.12.007>)

Hessenkämper, Axel; Howar, Falk; Rausch, Andreas: **Digital Transformation Trends: Industry 4.0, Automation, and AI: Industrial Track at ISoLA 2018.**
In: Margaria-Steffen, T.: *Leveraging applications of formal methods, verification and validation. 8th International Symposium, ISoLA 2018. Pt.4: Industrial practice: Limassol, Cyprus, November 5-9, 2018; Proceedings.* Cham: Springer International Publishing, 2018, pages 469-471 (Lecture Notes in Computer Science 11247)
(DOI: http://dx.doi.org/10.1007/978-3-030-03427-6_34)

Holtkamp, Bernhard; Cirullies, Jan; Dahlmann, Tim; Steinbuß, Sebastian: **A lightweight industrial**

data space sensor connector: Concept, implementation and first experiences.
Dortmund: Fraunhofer ISST, 2018, 32 S. (ISST Report)
(URL: <http://publica.fraunhofer.de/documents/N-525723.html>).
Creation date: January 10, 2019.
Access date: March 4, 2019)

Howar, Falk (publisher); Barnat, Jiri (publisher): **Formal Methods for Industrial Critical Systems.**
23rd International Conference, FMICS 2018: Maynooth, Ireland, September 3-4, 2018, Proceedings.
Cham: Springer International Publishing, 2018, XVI, 290 S S. (Lecture Notes in Computer Science, 11119) (ISBN 978-3-030-00243-5; ISBN 978-3-030-00244-2; ISBN 978-3-030-00245-9)

Howar, Falk; Giannakopoulou, Dimitra; Mues, Malte; Navas, Jorge: **Generating component interfaces by integrating static and symbolic analysis, learning, and runtime monitoring.**
In: Margaria-Steffen, T.: *Leveraging applications of formal methods, verification and validation. 8th International Symposium, ISoLA 2018. Pt.2: Verification: Limassol, Cyprus, November 5-9, 2018;*

Proceedings. Cham: Springer International Publishing, 2018, pages 120-136 (Lecture Notes in Computer Science 11245)
(DOI: http://dx.doi.org/10.1007/978-3-030-03421-4_9)

Jürjens, Jan; Fernandez, Eduardo B.: **Secure Database Development.**
In: *Encyclopedia of Database Systems*, Springer, 2018. Invited chapter.

Jürjens, Jan: **Security by Design for Web Applications.** In: *MCT Summit 2018*, October 21-26, 2018.

Jürjens, Jan: **Advanced Smart Data Analytics.**
In: *MCT Summit 2018*, October 21-26, 2018.

Jürjens, Jan: **AMable – IDS and Blockchain for Additive Manufacturing.**
In: *1st Industrial Data Space Association Summit*, Frankfurt, March 22-23, 2018.

Michalik, Alexander; Möller, Frederik; Henke, Michael; Otto, Boris: **Towards utilizing customer data for business**

model innovation: The case of a German manufacturer.
In: *Procedia CIRP 73* (2018), pages 310-316
(DOI: <http://dx.doi.org/10.1016/j.procir.2018.04.006>)
Möller, Frederik; Oprel, Sebastian; Hermann, Mario; Otto, Boris: **Digital business engineering: Findings from the install4schecker case.**

In: Drews, P.; Leuphana Univ. Lüneburg: *Multikonferenz Wirtschaftsinformatik 2018. Volume 2: Data driven X - Turning Data into Value*; Leuphana Universität Lüneburg, March 6-9, 2018
Lüneburg: Leuphana Universität, 2018, pages 538-549

Moetz, A.; Meinschmidt, J.; Otto, B.: **Schedule Instability in Production Networks: An empirical Study on Drivers and Mechanisms within the Automotive Industry.**
In: *IFAC-PapersOnLine 51* (2018), no. 11, pages 1071-1076
(DOI: <http://dx.doi.org/10.1016/j.ifacol.2018.08.463>)

Otto, Boris; Lohmann, Steffen; Steinbuss, Sebastian; Teuscher, Andreas; Auer, Soeren; Boehmer, Martin; Bohn, Juergen; Brost, Gerd; Cirullies, Jan; Ciureanu,

- Constantin; Corsi, Eva; Daniels, Soeren; Eitel, Andreas; Ernst, Thilo; Geisler, Sandra; Gelhaar, Joshua; Gude, Roland; Haas, Christian; Heiles, Juergen; Hierro, Juanjo; Hoernle, Joachim; Huber, Manuel; Jung, Christian; Juerjens, Jan; Kasprzik, Anna; Ketterl, Markus; Koetzsch, Judith; Koehler, Jacob; Lange, Christoph; Langer, Dorothea; Langkau, Joerg; Lis, Dominik; Loeffler, Sven; Loewen, Ulrich; Mader, Christian; Menz, Nadja; Mueller, Andreas; Mueller, Bernhard; Nagel, Lars; Nagel, Ralf; Nieminen, Harri; Reitelbach, Thomas; Resetko, Aleksei; Pakkala, Daniel; Patzer, Florian; Pettenpohl, Heinrich; Pietzsch, Rene; Pullmann, Jaroslav; Punter, Matthijs; Quix, Christoph; Rohrmus, Dominik; Romer, Lena; Sandloehken, Joerg; Schoewe, Patrick; Schulz, Daniel; Schuette, Julian; Schweichhart, Karsten: **IDS Reference Architecture Model. Industrial Data Space. Version 2.0.** Berlin: International Data Spaces Association, 2018, 91 S. (URL: <http://publica.fraunhofer.de/documents/N-525030.html>). Creation date: December 19, 2018. Access date: March 4, 2019)
- Otto, Boris; Cirullies, Jan; Schwede, Christian: **Innovation durch Kooperation in Supply Chains. Geschäftsökosysteme und die Rolle der Daten.** In: Wimmer, Thomas; Bundesvereinigung Logistik e.V. -BVL-, Bremen: Digitales trifft Reales: 35. Deutscher Logistik-Kongress, Berlin, October 17-19, 2018, Kongressband Hamburg: DVV Media Group, 2018, pages 45-62
- Peldszus, Sven; Strüber, Daniel; Jürjens, J.: **Model-based Security Analysis of Feature-oriented Software Product Lines.** In: 17th International Conference on Generative Programming: Concepts & Experience (GPCE 2018), Springer, LNCS, 2018.
- Ramadan, Qusai; Strüber, Daniel; Salnitri, Mattia; Riediger, Volker; Jürjens, Jan: **Detecting conflicts between data-minimization and security requirements in business process models.** In: Pierantonio, A.: Modelling foundations and applications. 14th European conference, ECMFA 2018: Held as part of STAF 2018, Toulouse, France, June 26-28, 2018; Proceedings Cham: Springer International Publishing, 2018, pages 179-198
- (Lecture Notes in Computer Science 10890) (DOI: http://dx.doi.org/10.1007/978-3-319-92997-2_12)
- Schäfer, Tristan; Möller, Frederik; Burmann, Anja; Pikus, Yevgen; Weißenberg, Norbert; Hintze, Marcus; Rehof, Jakob: **A methodology for combinatory process synthesis: Process variability in clinical pathways.** In: Margaria-Steffen, T.: Leveraging applications of formal methods, verification and validation. 8th International Symposium, ISO LA 2018. Pt. 4: Industrial practice: Limassol, Cyprus, November 5-9, 2018; Proceedings. Cham: Springer International Publishing, 2018, pages 472-486 (Lecture Notes in Computer Science 11247) (DOI: http://dx.doi.org/10.1007/978-3-030-03427-6_35)
- Schütte, Julian; Fridgen, Gilbert; Prinz, Wolfgang; Rose, Thomas; Urbach, Nils; Hoeren, Thomas; Guggenberger, Nikolas; Welzel, Christian; Holly, Steffen; Schulte, Axel; Sprenger, Philipp; Schwede, Christian; Weimert, Birgit; Otto, Boris; Dalheimer, Mathias; Wenzel, Markus; Kreutzer,
- Michael; Fritz, Michael; Leiner, Ulrich; Nouak, Alexander; Prinz, Wolfgang (Ed.); Schulte, Axel T. (Ed.): **Blockchain and smart contracts: Technologies, research issues and applications.** Munich: Fraunhofer-Gesellschaft, 2018, 48 S. (URL: <http://publica.fraunhofer.de/documents/N-497216.html>). Creation date: June 21, 2018. Access date: March 4, 2019)
- Spiekermann, Markus; Wenzel, Sven; Otto, Boris: **A conceptual model of benchmarking data and its implications for data mapping in the data economy.** In: Drews, P.; Leuphana Univ. Lüneburg: Multikonferenz Wirtschaftsinformatik 2018. Volume 1: Data driven X - Turning Data into Value; Leuphana Universität Lüneburg, March 6-9, 2018 Lüneburg: Leuphana Universität, 2018, pages 314-325
- Spiekermann, Markus; Tebernum, Daniel; Wenzel, Sven; Otto, Boris: **A metadata model for data goods.** In: Drews, P.; Leuphana Univ. Lüneburg: Multikonferenz Wirtschaftsinformatik 2018. Volume 1: Data driven X - Turning Data into

Value; Leuphana Universität Lüneburg, March 6-9, 2018
Lüneburg: Leuphana University, 2018, pages 326-337

Stewart, Harrison; Jürjens, Jan: **Data security and consumer trust in FinTech innovation in Germany.**

In: *Information & computer security* 26 (2018), no. 1, pages 109-128
(DOI: <http://dx.doi.org/10.1108/ICS-06-2017-0039>)

Strüber, Daniel; Peldzus, Sven; Jürjens, Jan: **Taming multi-variability of software product line transformations.**

In: Russo, A.: *Fundamental approaches to software engineering. 21th international conference, FASE 2018: Held as part of the European Joint Conferences on Theory and Practice of Software, ETAPS 2018, Thessaloniki, Greece, April 14-20, 2018 April; proceedings.* Cham: Springer International Publishing, 2018, pages 337-355 (Lecture Notes in Computer Science 10802)
(DOI: http://dx.doi.org/10.1007/978-3-319-89363-1_19)

Toennemann, Jan; Rausch, Andreas; Howar, Falk; Cool, Benjamin: **Checking consistency of real-time requirements on distributed automotive control software early in the development process using UPPAAL.**

In: Howar, Falk; Barnat, Jiri: *Formal Methods for Industrial Critical Systems. 23rd International Conference, FMICS 2018: Maynooth, Ireland, September 3-4, 2018, Proceedings* Cham: Springer International Publishing, 2018, pages 67-82 (Lecture Notes in Computer Science 11119)
(DOI: http://dx.doi.org/10.1007/978-3-030-00244-2_5)

Walther, Sebastian; Sedera, Darshana; Urbach, Nils; Eymann, Torsten; Otto, Boris; Sarker, Sanoone: **Should we stay or should we go? Analyzing continuance of cloud enterprise systems.**

In: *Journal of information technology theory and application* 19 (2018), no. 2, pages 57-88
(URL: <http://library.aisnet.org/Default.aspx?url=https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1731&context=jitta>.
Zugriffsdatum: 4.3.2019)

Winkels, Jan; Graefenstein, Julian; Schäfer, Tristan; Scholz, David; Rehof, Jakob; Henke, Michael: **Automatic composition of rough solution possibilities in the target planning of factory planning projects by means of combinatorial logic.**

In: Margaria-Steffen, T.: *Leveraging applications of formal methods, verification and validation. 8th International Symposium, ISO LA 2018. Pt. 4: Industrial practice: Limassol, Cyprus, November 5-9, 2018; Proceedings.* Cham: Springer International Publishing, 2018, pages 487-503 (Lecture Notes in Computer Science 11247)
(DOI: http://dx.doi.org/10.1007/978-3-030-03427-6_36)

Winter, Alfred; Stäubert, Sebastian; Ammon, Danny; Aiche, Stephan; Beyan, Oya; Bischoff, Verena; Daumke, Philipp; Decker, Stefan; Funkat, Gert; Gewehr, Jan E.; Greiff, Armin de; Haferkamp, Silke; Hahn, Udo; Henkel, Andreas; Kirsten, Toralf; Klöss, Thomas; Lippert, Jörg; Löbe, Matthias; Lowitsch, Volker; Maassen, Oliver; Maschmann, Jens; Meister, Sven; Mikolajczyk, Rafael; Nüchter, Matthias; Pletz,

Mathias W.; Rahm, Erhard; Riedel, Morris; Saleh, Kutaiba; Schuppert, Andreas; Smers, Stefan; Stollenwerk, André; Uhlig, Stefan; Wendt, Thomas; Zenker, Sven; Fleig, Wolfgang; Marx, Gernot; Scherag, André; Löffler, Markus:

Smart Medical Information Technology for Healthcare (SMITH): Data integration based on interoperability standards.
In: *Methods of Information in Medicine* 57 (2018), no. 5 01, S.e92-e105
(DOI: <http://dx.doi.org/10.3414/ME18-02-0004>)

EVENTS 2018 (SELECTION)

Fraunhofer ISST places great emphasis on providing its customers and the public with information. In 2018 the institute's solutions and services were once again presented at numerous events and trade fairs.

Some of the highlights:

ConhIT (April 17-19, 2018, Berlin)

Fraunhofer ISST presented solutions for data-driven medicine in April 2018 at the "ConhIT – Connecting Healthcare IT" trade fair in Berlin (today: DMEA: Digital Medical Expertise & Applications). This trade fair is the central platform for digital healthcare. The exhibits focused on the electronic case file as the IT standard for quality assured doctor-to-doctor communication, the maturity model for the "digital hospital", and the SMITH consortium – Smart Medical Information Technology for Healthcare.



Hannover Messe (April 23-27, 2018, Hanover)

The "International Data Space" thematic area, under the auspices of Fraunhofer ISST, attracted numerous visitors to the joint Fraunhofer exhibition booth at Hannover Messe 2018 – among them Anja Karliczek, Federal Minister of Education and Research and Dorothee Bär, State Secretary for Transport and Digital Infrastructure. Five exhibits for the International Data Space were on display. The IDS thematic area centered on the "IDS City", a city model that vividly illustrated all elements of the International Data Space architecture using buildings and connections. For this model conceived under the leadership of ISST scientist Heinrich Pettenpohl, Fraunhofer ISST received the Think Tank Award of the Fraunhofer-Gesellschaft for the best strategic and target group-oriented sales pitch at the trade fair.



ChanceMint.NRW: Young female scientists get a taste of research (June 27, 2018, Dortmund)

The “ChanceMint.NRW” program supports female students in the engineering and computer sciences at the University of Duisburg-Essen and Ruhr West University of Applied Sciences. It gives participants the chance to explore numerous occupations related to their field of study. They come into contact with potential future employers and are encouraged to engage in active career planning.

In the practical phase the students get to know individual partner companies. Excursions grant them insights into day-to-day work and they have the opportunity to talk to practitioners on site. Within this framework the participants visited Fraunhofer ISST on June 27, 2018.



Fraunhofer Day of Cognitive Internet Technologies (November 22, 2018, Berlin)

How can companies overcome digitization hurdles? How can the industrial Internet be designed to meet the requirements of the digital future? On November 22, 2018 these questions were discussed by experts from industry, science, and politics at the Fraunhofer-Forum Berlin during the Fraunhofer Day of Cognitive Internet Technologies. The event was organized by the Fraunhofer Cluster of Excellence Cognitive Internet Technologies, in which Fraunhofer ISST heads one of three research centers, the Data Spaces center (see pages 18-19).





FRAUNHOFER ISST

**INSTITUTE CULTURE
AND TEAM**



「Together, we are strong: Just like ants pursue a common goal, we work together to shape the future (a little bit better) through our research. As members of Europe's largest institution for applied research, we support each other, complementing our interdisciplinary expertise in research projects and bundling our strengths in teams.」

WHAT WE STAND FOR. THE GUIDING PRINCIPLES OF FRAUNHOFER ISST

At the Fraunhofer ISST institute site in Dortmund, around 80 employees in four specialist departments and administration work day after day on the best possible shaping of digitization in the interest of people and industry. We are computer scientists and industrial engineers, medical information scientists, and mathematicians of any gender, some young and some older, some experienced and some curious, always creative and solution-oriented.

The values that drive us in our work are:

Responsibility.

Freedom is only possible with sense of responsibility. This is second nature for us from outset on.

Lateral thinking.

Only those who "mad" today will really change the digital world of tomorrow.

Enthusiasm.

We believe in what we do.
Won't work?
We say, "Yes, it will".

Passion.

Shaping the future by working at Fraunhofer ISST is more than a job.

It is conviction.

Team.

No one can do everything. We are innovative only together. Everyone contributes to the effort. Diversity means strength.

Freedom.

Research mandates high degrees of freedom. We design our work environment ourselves to a great extent.



MEET US: RECRUITING DAY FOR COMPUTER SCIENCE STUDENTS

On July 12, 2018 students in the disciplines of computer science, medical information science, industrial engineering, and related fields got their first taste of research at Fraunhofer ISST. Institute employees at various stations presented digitization projects currently being pursued in logistics, healthcare, the service sector, and the automobile industry, as well as the possibilities they offer for participation. Brain input came from Fraunhofer ISST – stomach input from the Grill Instructor. It was an outstanding afternoon with many interesting discussions!



MINDS WITH THE SPIRIT OF RESEARCH: GET TO KNOW OUR TEAM!

Who is behind Fraunhofer ISST? Who are the creative minds that conceive the digitization strategies of tomorrow for logistics, healthcare, and industry?

Get to know us! Through the social media channels of Fraunhofer ISST, we are presenting the "Meet us" series that puts faces to our topics in a loose sequence.

Two of our team players are also being introduced here: Anja Burmann and Patrick Poeten.

What do you like best about Fraunhofer ISST?

#thatswhatllike #DigitizationinHealthCare #creating the #DigitizationMadelnGermany #Zukunftsforscher #ISSTdreamjob

Anja Burmann: I especially like the open working atmosphere, flat hierarchies, and the young, dynamic environment. Everyone can and is expected to contribute their own ideas in order to advance topics personally within the day-to-day work. Naturally,

this freedom motivates both me and my colleagues. I experience a feeling of appreciation, personal responsibility, and trust here, with the opportunity to test myself personally and professionally, pursuing my further development.

Why would you choose Fraunhofer ISST as your employer again?

#WhyIApplied #Digitizationin... #creating the #DigitizationMadelnGermany #Zukunftsforscher #ISSTdreamjob

Anja Burmann: Fraunhofer ISST offers me the opportunity to pursue personal goals to a much greater extent than I have ever experienced in commercial enterprises. The freedom to position your own topics and take responsibility for them is a comfortable situation that provides plenty of leeway for shaping my professional career, allowing me to influence the current social development, in my case through digitization in healthcare. I would not want to give up this autonomy.



Anja Burmann, 28, research fellow in the Healthcare department and Equal Opportunity Officer at Fraunhofer ISST



Why did you choose @FraunhoferISST?

#WhyIApplied #Digitizationin... #creating the #DigitizationMadelnGermany #Zukunftsforscher #ISSTdreamjob

Patrick Poeten: My move to Fraunhofer ISST in 2018 was a conscious choice. The opportunity to actively help research and shape the structure of Data Ecosystems in particular served as an incentive for me. The research topics are in tune with our time: I am convinced that the sovereign and value-added handling of data in companies and business networks will be one of the key challenges in the coming years. The possibility of obtaining a doctorate while working is also of interest to me, since the results of the innovative projects can be directly incorporated into a dissertation.

What makes up your day-to-day work?

#dayinthelifeof #Digitizationin... #creating #DigitizationMadeln-Germany #Zukunftsforscher #ISSTdreamjob






Patrick Poeten: My function as a research fellow, in which I play various roles in industry-related, application-specific research projects, continuously harbors new challenges and variety. Cooperations with numerous industry partners and other Fraunhofer Institutes across Germany give me the opportunity to steadily expand my own network and gather new professional experience.



Patrick Poeten, 30, research associate in the Data Economy department

Judith Dittmar of the PR team at Fraunhofer ISST was recognized with 3rd place in the Fraunhofer communication prize in November 2018 for this social media employee campaign.

You would like to learn more about Fraunhofer ISST? Then follow us!

-  Twitter: @FraunhoferISST
-  Facebook: @FraunhoferISST
-  LinkedIn: Fraunhofer Institute for Software and Systems Engineering ISST
-  YouTube: Fraunhofer ISST
-  XING: Fraunhofer Institute for Software and Systems Engineering ISST

JOIN US

FRAUNHOFER ISST

JOIN US!

- Do you want to help shape the digitization of companies at the leading edge?
- Are you interested in IT research and science?
- Are you looking for a part-time job or a project-related topic for a bachelor or master thesis?
- Do you not want to choose between science and industry right away after your studies, and / or do you want to earn your doctorate while working?

If so, we should get to know each other!

At the Fraunhofer Institute for Software and Systems Engineering ISST in Dortmund, computer scientists (and related disciplines) find numerous opportunities to gather practical experience early on, even while studying, and – as graduates – to assume responsible tasks in customer and research projects in the Automotive, Data Economy, Healthcare, and Logistics business units.

All current job postings are found online at

www.isst.fraunhofer.de/jobs

Please submit unsolicited applications and questions to this e-mail address:

bewerbung@isst.fraunhofer.de

We are looking forward to new creative minds!



Photo: © Fraunhofer ISSI

HOW TO REACH US

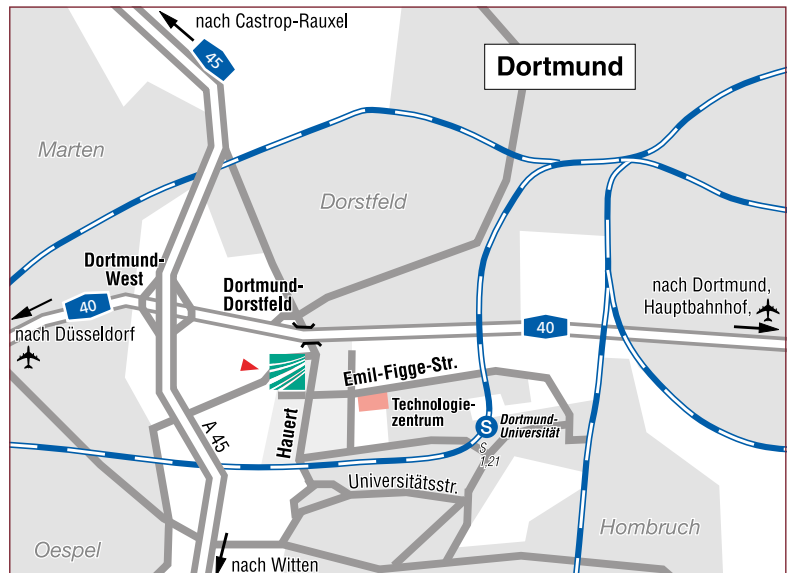
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By car

Freeway A40/highway B1, exit Dortmund-Dorstfeld, Universität.

Heading towards Dortmund: At the first set of lights turn left into the street "Hauert" (towards Technologie-Zentrum), at the next set of lights turn right into Emil-Figge-Straße (dead end).

Coming from Dortmund: At the first set of lights turn right into the street "Hauert" (towards Technologie-Zentrum), go under the bridge, at the second set of lights turn right into Emil-Figge-Straße (dead end).

By train

From the Dortmund central station, take the urban railway line 1 towards Düsseldorf to Dortmund-Universität, from there 15 minutes on foot or take the Sky Train to the Technologiepark/Technologiezentrum stop.

By air

From Dortmund-Wickede airport, take the bus to Dortmund central station, *from there: see "By train"*; or go by taxi from the airport in about 25 minutes.

From Düsseldorf airport, take the urban railway line 1 towards Dortmund to the Dortmund-Universität stop; or go by taxi from the airport in about 60 minutes.

Legal notice

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