Fraunhofer
IVI

FRAUNHOFER INSTITUTE FOR TRANSPORTATION AND INFRASTRUCTURE SYSTEMS IVI

INSTITUTE REPORT
2015

FRAUNHOFER INSTITUTE FOR TRANSPORTATION AND INFRASTRUCTURE SYSTEMS IVI

INSTITUTE REPORT 2015

TIMES OF CHANGE

PREFACE

A distinctive scent, a rare splash of color, an old photo, a well-known melody, toys from childhood days – seemingly banal sensations sometimes have the power to transport us back to times nearly forgotten. In moments such as these, the passing of time is clearly palpable for me – both in the changes that take place over the years and in the things that remain unchanged and provide us with support in times of rapid social, demographic, intercultural, industrial and environmental transformation processes that are so often used as political arguments.

While preparing my course on systems theory, I was forcefully reminded of the immense speed at which cutting-edge technologies are evolving today. In the same context, the institute's IT manager and I had the opportunity to operate a well-preserved Telefunken analog computer from the 1960s. It was extremely fascinating for both of us to experience the clicking relays, the humming oscillators, the flickering oscilloscope and the ampere-laden scent of this machine, diligently grinding away at its work. This wondrous piece of technology, which used to be the cornerstone of the first German institute for control engineering located here in Dresden in our institute's building, still works perfectly and can be used to demonstrate to students how complex differential equations can be solved using simple, analog electronic circuits. Although the degree and dimension of their differential equations was severely restricted by the limited number of available integrators and high-precision potentiometers, analog computers provided the computational basis for rocket development up until the Apollo missions. Fifty years later, we are now able to solve nonlinear differential equations of nearly unlimited dimensions in the fields of complex computer-based vehicle construction, dynamic simulations and strength analyses, model-based statistical studies and Big Data applications even at our comparatively small institute, thanks to our own multi-core cluster, our high-performance software tools and our access to the TU Dresden High Performance Computing Center.

It is fundamentally important for the economic success of a Fraunhofer Institute to detect the dynamics and market relevance of emerging technologies at an early stage, and to adapt the scientific profile of individual research groups to these at the right time. This institute report looks back at 2015 as the most successful year in the Fraunhofer IVI's history so far, but many of our technological developments that are in world-wide demand today are actually based on visionary ideas and research activities that were initiated years ago and have undergone a consistent development process until reaching an industry-ready standard. It certainly seems as if we have detected the right trends over the past years and pursued them with the right amount of persistence. For this reason, the presentation to our Advisory Board was given the title »There is a time for everything« after the well-known Bible passage that also contains the words »a time to plant, and a time to pluck up that which is planted«. With our excellent annual result, we have brought in a very good harvest, but we have also laid the seeds for a promising future in close to one hundred ongoing projects in 2015. For this, I would like to express my sincere gratitude to all my colleagues, as well as to our research partners from universities and industry.

Today, the term »change« is most often associated with spontaneous transformation. The German word for change, »Wandel«, and its corresponding verb »wandeln«, however, still carry traces of another meaning that is often forgotten today: they describe the ceremonial walking of clergymen in their cloister for the purpose of meditation and contemplation. The present institute report contains a little of both aspects – accounts of rapid scientific progress as well as lively and sometimes idyllic scenes from our everyday life and work here at the Fraunhofer IVI.

CONTENTS

FRAUNHOFER IN DRESDEN

The Fraunhofer-Gesellschaft maintains five institutes and five other research establishments in Dresden. Combined, they have a staff of over 1,300 and annual revenues of over 130 million euros.

INSTITUTES

- Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP
- Fraunhofer Institute for Ceramic Technologies and Systems IKTS
- Fraunhofer Institute for Photonic Microsystems IPMS
- Fraunhofer Institute for Transportation and Infrastructure Systems IVI
- Fraunhofer Institute for Material and Beam Technology IWS

FRAUNHOFER BRANCHES AND ESTABLISHMENTS

- Fraunhofer IVV, Dresden Branch Lab for Process Engineering and Packaging
- Dresden branch of the Fraunhofer IFAM Bremen
- Dresden branch of the Fraunhofer IIS Erlangen
- Dresden branch of the Fraunhofer IWU Chemnitz
- Project Group ASSID (All Silicon System Integration Dresden) of the Fraunhofer IZM

FRAUNHOFER-GESELLSCHAFT

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the organization for applied research drives economic development and serves the greater societal good. Its services are solicited by customers and contract partners in the industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 67 institutes and research units. The majority of the nearly 24,000 staff are qualified scientists and engineers who work with an annual research budget of more than 2.1 billion euros. Of this sum, more than 1.8 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society for another five or ten years.

International collaboration with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region and throughout Germany and Europe as a whole. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in the industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787-1826), the illustrious Munich researcher, inventor and entrepreneur.

THE FRAUNHOFER IVI

IN THE ICT GROUP

As a part of the Fraunhofer-Gesellschaft, the Fraunhofer ICT Group is Europe's largest IT research organization.

The group has about 5,000 members who work together to provide customized, industry-specific and holistic IT solutions from a single source. They offer research and development work as well as competent technology consulting for the following business units:

- Digital media,
- E-business,
- E-government,
- Information and communication technology,
- Energy and sustainability,
- Manufacturing,
- Medicine,
- Safety and security,
- Financial services,
- Automotive

Virtually all fields of information technology are addressed.

Chairman of the Group
Prof. Dr. Dieter W. Fellner
Fraunhofer Institute for Computer Graphics Research IGD
Phone +49 6151 155-100
dieter.fellner@igd.fraunhofer.de

Managing Director
Alexander Nouak
Fraunhofer ICT Group
Phone +49 30 7261566-0
alexander.nouak@iuk.fraunhofer.de

www.iuk.fraunhofer.de

The group's 19 current members are the Fraunhofer Institutes for

- Algorithms and Scientific Computing SCAI,
- Applied Information Technology FIT,
- Applied and Integrated Security AISEC,
- Communication, Information Processing and Ergonomics FKIE,
- Computer Graphics Research IGD,
- Digital Media Technology IDMT,
- Embedded Systems and Communication Technologies ESK,
- Experimental Software Engineering IESE,
- Industrial Engineering IAO,
- Industrial Mathematics ITWM,
- Integrated Circuits IIS (Guest),
- Intelligent Analysis and Information Systems IAIS,
- Medical Image Computing MEVIS,
- Open Communication Systems FOKUS,
- Optronics, System Technologies and Image Exploitation IOSB,
- Secure Information Technology SIT,
- Software and Systems Engineering ISST,
- Telecommunication, Heinrich Hertz Institute HHI (Guest),
- Transportation and Infrastructure Systems IVI

Contact
Prof. Dr. Matthias Klingner
Phone +49 351 4640-800
matthias.klingner@ivi.fraunhofer.de

IN ALLIANCES

FRAUNHOFER BIG DATA ALLIANCE

Within the newly established Big Data Alliance, 25 institutes offer support and solutions for the efficient exploitation of large and heterogeneous sets of data.

Spokesperson
Prof. Dr. Stefan Wrobel

Fraunhofer IVI contact
Dr. Sunna Torge
Phone +49 351 4640-663
sunna.torge@ivi.fraunhofer.de

www.bigdata.fraunhofer.de/en

FRAUNHOFER BATTERY ALLIANCE

Researchers from 19 Fraunhofer Institutes pool their expertise in the Fraunhofer Battery Alliance. Their aim is to design and implement technologically and economically feasible solutions for electric storage systems. Their services include topics such as materials, systems, simulation and testing. One of the alliance's current projects is the development of cyclically stable and intrinsically safe storage cells on a lithium-sulfur basis with energy densities of up to 400 Wh/kg. This research is conducted within an internal research project (MAVO) with the participation of the Fraunhofer IVI.

Spokesperson
Dr. Jens Tübke

Fraunhofer IVI contact
Dr. Ulrich Potthoff
Phone +49 351 4640-638
ulrich.potthoff@ivi.fraunhofer.de

www.batterien.fraunhofer.de/en

FRAUNHOFER TRAFFIC AND TRANSPORTATION ALLIANCE

At present, 15 Fraunhofer Institutes combine their specific know-how and long-standing experience in the area of transport-related research within the alliance. Their aim is to offer complete systems solutions to public and industrial customers on an interdisciplinary technological and conceptual level.

Spokesperson
Prof. Dr. Uwe Clausen

Fraunhofer IVI contact
Dr. Torsten Gründel
Phone +49 351 4640-664
torsten.gruendel@ivi.fraunhofer.de

www.verkehr.fraunhofer.de/en

FRAUNHOFER ENERGY ALLIANCE

The Fraunhofer Energy Alliance is one of the largest energy research organizations in Europe. Its 19 member institutes provide their respective expertise in the fields of renewable energies, energy efficiency technologies, intelligent power grids, energy storage systems, as well as buildings and components.

Spokesperson
Prof. Dr. Eicke R. Weber

Fraunhofer IVI contact
Claudius Jehle
Phone +49 351 4640-698
claudius.jehle@ivi.fraunhofer.de

www.energie.fraunhofer.de/en

PROFILE OF THE INSTITUTE

Building on and incorporating the scientific competencies of the former Dresden Branch Lab for Process Control of the Fraunhofer IITB (now IOSB) in Karlsruhe, the Fraunhofer IVI was founded in 1999. Today, over 100 employees and about 60 students work in the institute's four departments. The connection to basic university research and qualified junior scientists is maintained by two shared working groups with the TU Dresden and the TU Bergakademie Freiberg.

As a member of the Fraunhofer ICT Group, the institute contributes its expertise in diverse areas such as the recording, locating, control and optimization of complex traffic flows and transportation processes, traffic information services, electronic ticketing, as well as computer-based disposition and hazard prevention in crisis situations.

The institute's profile is characterized by developments in the field of vehicle engineering for public transport. For the testing and presentation of its developments, the institute maintains its own test track. Worldwide attention was raised especially by the AutoTram® Extra Grand and the fast charging battery bus.

Thanks to this international reputation, the institute has been able to achieve stable industrial revenues of over to 30 percent for the fifth year in a row. The acquisition of projects from the European Framework Programme HORIZON 2020 has been especially successful. Currently, the institute's researchers are working on 20 ongoing EU-funded projects, gaining roughly the same revenue from them as in the previous year. 32 percent of the total revenue of 8.1 million euros was earned through projects funded by the German Federal Government and the German States.

We are especially proud of the fact that by rising from 8.8 million euros in 2014 to 10.7 million euros (including construction investments) in 2015, our total annual budget has exceeded the ten million mark for the first time.

In addition to this well-balanced mix of funds and both the number and variety of new funding measures and industry projects, we are particularly grateful for the great commitment all of our employees bring to their work. We feel that the Fraunhofer IVI is well-positioned to meet the challenges and opportunities that lie ahead.

COMPETENCIES

- Autonomous utilities systems
- Business processes
- Electromobility
- Identification of traffic situations
- Logistics
- Mobility and travel assistance
- Multi-axle steering and guidance systems
- Operational planning and command
- Propulsion technologies
- Sensor and actuator systems
- Stationary energy storage systems
- System modeling and process control
- Ticketing and fares
- Transport planning
- Transportation ecology
- Transportation systems
- Vehicle and road safety
- Vehicle technologies

DIRECTOR

Prof. Dr. Matthias Klingner
Phone +49 351 4640-800
matthias.klingner@ivi.fraunhofer.de

DEPARTMENTS

Transportation, Energy and Environment

Dr. Ulrich Potthoff
Phone +49 351 4640-638
ulrich.potthoff@ivi.fraunhofer.de

Storage Systems and Converters
Claudius Jehle

Mechatronic Systems
Richard Kratzing

Vehicle and Transport System Engineering

Dr. Thoralf Knote
Phone +49 351 4640-628
thoralf.knote@ivi.fraunhofer.de

Vehicle and Propulsion Technologies
Dr. Frank Steinert

Transportation Systems/Human Machine Interaction
Dr. Thoralf Knote

Vehicle Control and Sensor Systems
Dr. Sebastian Wagner

UNIVERSITY RESEARCH GROUPS

Locating, Information and Communication

Prof. Dr. Oliver Michler
Phone +49 351 4640-629
oliver.michler@ivi.fraunhofer.de

TECHNISCHE UNIVERSITÄT DRESDEN

ADMINISTRATION

Head of Administration

Kornelia Brüggert
Phone +49 351 4640-670
kornelia.brueggert@ivi.fraunhofer.de

Communication and Design

Elke Sähn
Phone +49 351 4640-612
elke.saehn@ivi.fraunhofer.de

ORGANIZATION CHART

Intelligent Transport Systems

Dr. Torsten Gründel
Phone +49 351 4640-664
torsten.gruendel@ivi.fraunhofer.de

Mobility and Travel Assistance
Sebastian Pretzsch

Traffic System Data
Dr. Sunna Torge

Ticketing and Fares
Dr. Torsten Gründel

Strategy and Optimization

Dr. Kamen Danowski
Phone +49 351 4640-660
kamen.danowski@ivi.fraunhofer.de

Disposition
Dr. Kamen Danowski

Business Processes
André Rauschert

Logistics
Axel Simroth

Energy System Engineering

Prof. Dr. Jana Kertzscher
Phone +49 3731 39-2926
jana.kertzscher@ivi.fraunhofer.de

International Business

Mandy Koritz
Phone +49 351 4640-637
mandy.koritz@ivi.fraunhofer.de

European Business

Daniela Larsen
Phone +49 351 4640-817
daniela.larsen@ivi.fraunhofer.de

FRAUNHOFER IVI ADVISORY BOARD

Chairman of the Advisory Board

Prof. Dr.-Ing. Christian Lippold,
Managing Director,
Institute of Transport Planning and Road Traffic,
Chair of Road Planning and Road Design,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
TU Dresden

Members of the Advisory Board
(as of March 2015)

Dr. Annerose Beck,
Head of Division, Saxon State Ministry for Higher Education, Research and the Arts (SMWK)

Burkhard Ehlen,
CEO, Verkehrsverbund Oberelbe (VVO)

Prof. Dr.-Ing. Viktor Grinewitschus,
Institute for Energy Systems and Energy Business, Hochschule Ruhr West

Prof. Dr.-Ing. habil. Prof. E.h. Dr. h.c. Werner Hufenbach,
Director, Institute of Lightweight Engineering and Polymer Technology (ILK), Faculty of Mechanical Science and Engineering, TU Dresden

Prof. Dr. techn. Klaus Janschek,
Managing Director, Institute of Automation, Chair of Automation Engineering, Faculty of Electrical and Computer Engineering, TU Dresden

Dr. Siegfried Meuresch,
Head of Division,
Federal Ministry of Economic Affairs and Energy (BMWi)

Prof. Dr. Dirk C. Meyer,
Prorector, Structural Development, TU Bergakademie Freiberg

Peter G. Nothnagel,
CEO, Saxony Economic Development Corporation GmbH

Dirk Schillings,
Senior Director Engineering, Bombardier Transportation GmbH

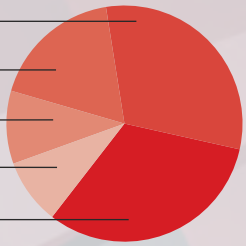
Bernhard Schmidt,
Manager of Operations, Sileo GmbH

Reiner Zieschank,
CFO and Dean of Technology, Dresdner Verkehrsbetriebe AG

ECONOMIC DEVELOPMENT

OPERATING BUDGET

Industrial revenues	31 %
EU	18 %
Basic financing	10 %
Miscellaneous	9 %
Public sector	32 %

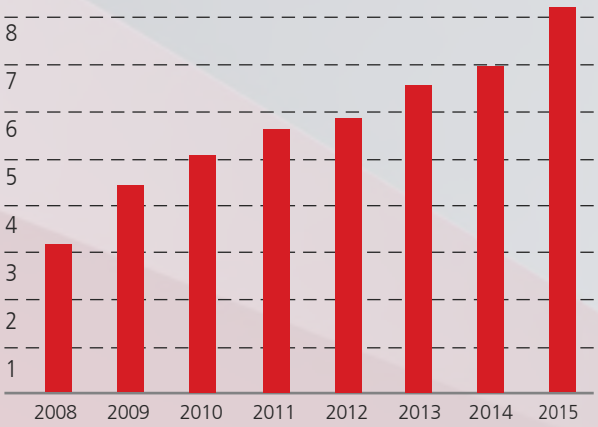


EMPLOYEES 2015

Research fellows	91
Research assistants	66
Trainees	4
Administrative and technical staff	14
Total	175

FINANCIAL DEVELOPMENT

in € million



PARTNERS

International Business Relations

In the past years, the Fraunhofer IVI has increasingly expanded its activities beyond Germany's borders. Cooperation with European partners in EU-funded projects is one of the important factors of this development. The institute has successfully raised the approval rate of its proposals and is currently working on 20 EU projects from both the 7th Framework Programme and HORIZON 2020 with partners from all over Europe.

Nine of these projects were kicked off in 2015, spanning topics from the protection of critical infrastructure (EU-CIRCLE) to aspects of the modal shift to rail (IT2Rail, In2Rail) and serious gaming for training purposes (TARGET). INFRALERT (Linear Infrastructure Efficiency Improvement by Automated Learning and Optimised Predictive Maintenance Techniques), a three-year project that started in the beginning of May, is coordinated by the Fraunhofer IVI. Its main objective is to develop an expert-based information system to support and automate linear asset infrastructure management for infrastructures such as rail or road networks.

Regarding industry projects, the sometimes lengthy negotiations and acquisition activities undertaken in the past are finally beginning to bear fruit. Important contacts have been established and stabilized in the past years, most prominent among them relations with China and South America.

The institute is very proud to count renowned companies and institutions from all regions of the world among its partners.

Industry and Economy

- ACEA European Automobile Manufacturers' Association
- Alois Pöttinger Maschinenfabrik GmbH
- Amadeus IT Group S.A.
- Baiyun Power Group
- Carrosserie Hess AG
- CEMOSA S.A.
- CSR Zhuzhou Institute Co., Ltd.
- CWA Constructions SA/Corp
- DAF Trucks N. V.
- DERAP AG
- Indra Sistemas S.A.
- IRIZAR
- Iveco France
- Lotus Engineering
- Maxwell Technologies SA
- NXP Semiconductors
- OLTIS Group a.s.
- OPTIMAL Ltd.
- Scania AB
- Škoda
- Southwall Europe GmbH
- Strukton Rail
- Swissphone Systems GmbH
- T-Systems International GmbH
- T-Systems Multimedia Solutions GmbH
- TECNALIA
- Thales Communications & Security
- TLP spol. s.r.o.
- TME Toyota Motor Europe
- Van Eck B. V.
- VectorCommand Ltd.
- Volvo Bus Corporation
- Volvo Lastvagnar AB
- Volvo Technology

Research Organizations and Universities

- Akademie o.p.s. Brno
- CERTH-HIT Centre for Research and Technology Hellas – Hellenic Institute of Transport
- FEHRL Forum of European National Highway Research Laboratories
- Flanders Drive
- IFSTTAR French Institute of Science and Technology for Transport, Development and Networks
- Politecnico di Milano
- POLITO Politecnico di Torino
- TNO Netherlands Organisation for Applied Scientific Research
- TOI Institute of Transport Economics, Norway
- UITP International Association of Public Transport
- Universidad de Sevilla
- UPM Universidad Politécnica de Madrid
- VTI Swedish National Road and Transport Research Institute
- VTT Technical Research Centre of Finland

Public Institutions

- Government of the Grand Duchy of Luxembourg, Ministry of Interior Security
- Liberec region
- Ústí nad Labem region

Transport Associations and Providers

- Bernmobil – Städtische Verkehrsbetriebe Bern
- Network Rail Infrastructure Ltd.
- Trenitalia S.p.A.

A list of German partners can be found in the German section of the institute report on page 16.

FACILITIES AND LARGE EQUIPMENT

TEST VEHICLES

- AutoTram® for the evaluation of alternative propulsion systems, lane guidance and automatic steering control
- AutoTram® Extra Grand
- Fast charging battery buses (12 and 18 meter)
- Mobile command vehicle equipped with management and planning system for decision support in emergency and crisis situations
- Platform »ELENA« for the evaluation of steering strategies
- Test vehicles for driver assistance, driver information and automated driving

LABORATORY FACILITIES

- Battery lab
- Communication and radio technology lab
- Demo lab for transport telematics
- Electronics lab
- Mobikat lab

SOFTWARE

- ANSYS (Finite Elements Simulation)
- Apache Hadoop, Map/Reduce, HDFS, HBase, Hive, Mahout
- ArcGIS 10.3 (geographic information system)
- CATIA V5 (design)
- COMSOL (Multiphysics Simulation)
- Dewesoft (data logging and analysis)
- DSpace Rapid Prototyping Control
- Dymola (interdisciplinary simulation of physical systems)
- Halcon (image processing)
- Help & Manual 7
- LabView (environment for the development of measurement, monitoring and control systems)
- Matlab/Simulink (complex systems calculation/simulation)
- SIMPACK (simulation of multibody systems)

TECHNICAL EQUIPMENT

- Calibrated infrared measurement technology
- Development control unit for mobile applications (AutoBox)
- Driving simulator for road vehicles
- Environment for the development and testing of embedded microcontroller systems of different classes
- External evaluation and data acquisition facilities for traffic applications
- Functional models and environment for the development of DC/DC converter control
- Google Glass
- HiMoNN – Highly Mobile Network Node
- Mobile camera for situational monitoring in crisis situations
- Mobile hydrogen production (HyTra) and filling station
- Mobile measurement data acquisition system (DEWETRON)
- National Instruments CompactRIO control and surveillance system with multiple IO modules
- National Instruments USRP-2920 for Software Defined Radio (50 MHz-2.2 GHz)
- Octocopter HORUS for photography and videography, 3D and infrared images
- PTZ camera
- Satellite-based inertial measurement unit (ADMA)
- Smartwatches (Android, iOS)
- Steering and accelerator robots
- Test stand and data acquisition systems for battery and capacitor storage units on cellular and system level
- Toolkit for EMC testing (electromagnetic compatibility)
- Universal Receiver Tester (URT): dual-channel, 250 kHz-2.7 GHz, bandwidth 20 MHz on each channel
- Universal Receiver Tester (URT): three channels, 85 MHz-2.7 GHz, bandwidth 50 MHz on each channel

TECHNICAL CENTER

LARGE-SCALE TEST STANDS

- Engine test stand for combustion engines and electrical machines
- High-performance battery simulators
- Serial hybrid powertrain and engine test field
- Test stands for
  - → auxiliary components
  - → battery cells
  - → battery modules
  - → high current contacts
  - → traction energy storage systems

MOBILE MEASUREMENT EQUIPMENT

- DGPS measurement system Leica VIVA G15
- Long-term data acquisition in vehicles
- Measurement equipment for
  - → the analysis of traction power electronics
  - → the determination of fuel consumption
  - → vehicle dynamics
- Power and energy balances of vehicles

HIGH FREQUENCY MEASUREMENT TECHNOLOGY

- Environment for the testing of navigation applications (GPS and INS simulation)
- Environment for the testing of radio sensor networks (ZigBee, UWB, Bluetooth LE)
- EMC shielding tent
- HF signal generation
- Interference analyses
- Interference resistance and emission
- R&S realtime spectrum analyzer FSVR 7 (10 Hz-7 GHz)
- Wideband radio channel simulator PROPSim C2

The expansion of the institute building by a modern technical center with adjacent test track rounds off the institute's range of services, especially in the fields of vehicle and propulsion technologies:

▶ **Vehicle Hall**
- Working platform for buses and electric vehicles
- Crane system

▶ **Workshop**

▶ **Test Track**
- Test Drives
- Testing of new propulsion technologies
- Testing of sensor systems and locating methods
- Public presentations

In addition, the Fraunhofer IVI collaborates with the Institute of Electrical Engineering at the TU Bergakademie Freiberg within the high-performance center for electromobility, offering all development steps starting with

- analytical design of electrical machines, over
- numerical optimization, up to
- experimental support of test vehicles,

both as partial solutions or as a complete package.

TRANSPORTATION, ENERGY AND ENVIRONMENT

RANGE OF SERVICES

- Control-based multidomain modeling, simulation and implementation
- Consulting about the selection of storage unit types
- Measurement series on thermo-electrical test stand
- Automated data transfer and monitoring of distributed process variables
- Robust state estimation of operation-relevant parameters such as state of charge and state of health for single cells, battery modules and battery systems
- Impedance spectroscopy testing
- Experimental characterization of the individual components such as batteries, charging devices, DC/DC converters, inverters and electrical machines, as well as integrated system testing
- Technical design, 3D visualization and 3D rapid prototyping
- Studies and expert assessments

Dr. Ulrich Potthoff
Phone +49 351 4640-638
ulrich.potthoff@ivi.fraunhofer.de

Our motivation in offering research and development services in a diverse spectrum ranging from mobile, traffic-related applications to stationary solutions stems primarily from the necessity to use energy resources responsibly.

The key component of many of our technological system solutions is the capacity to store large amounts of energy and release it in a needs-based way.

Will we succeed in restructuring our changing energy system so as to be both practicable and economically feasible? This question opens up a broad field of applied research options for the department's researchers and engineers.

Our scientific and economic approach to the energy storage topic comprises the following areas:

- Planning and characterization,
- Modeling and simulation,
- Implementation and optimization.

In dialog with our clients, we will find the best possible mix of energy supply, storage capacity and performance for a given energy system, whether it be a traction energy storage unit with new battery chemistry or a stationary storage unit for the autonomous supply of domestic heat and power.

»autartec®« – INTEGRATED ENERGY STORAGE UNITS AND STRUCTURAL COMPONENTS

Richard Kratzing
Phone +49 351 4640-639
richard.kratzing@ivi.fraunhofer.de

The autartec® Innovative Regional Growth Core is a project that develops function-bearing structural components for buildings and larger settlements in the region Südbrandenburg/ Ostsachsen with a largely autonomous supply of electric energy, heat and water.

A Construction Kit for Autonomous Utilities Supply

The aim of the consortium consisting of small and medium-sized industrial enterprises, engineering companies, scientific institutions and future end-users is to improve existing technologies for solar-powered electricity and heating, decentralized storage, micro-filtration and disinfection so that they can be integrated into a building's wall structure. As a result, the living space of buildings equipped with this kind of technology is kept clear of complicated supply technologies and synergies can be achieved in terms of building physics.

The autartec® partners share the entrepreneurial vision of developing and marketing the structurally integrated autartec® technologies as a construction kit for largely autonomous buildings, responding to the rapidly increasing demand for buildings functionalized in terms of energy and room climate. Due to global changes in energy supply systems, broad markets in all fields of the construction, renovation and outfitting sectors are to be expected.

Main Research Topics

The autartec® Growth Core comprises three sub-projects:

- Functionally integrated textile-reinforced concrete building components,
- Structurally integratable utilities systems, and
- Technology platform: foundations of the construction and production of function-bearing structures in buildings.

A variety of high-quality systems that supply modern buildings with self-generated electricity and heat can already be found on the global environmental technologies market. In contrast, technologies for the self-supply with drinking and household water that are also able to solve the problem of treating wastewater directly on site are still in the pilot testing stage. Closing regenerative water cycles efficiently and establishing largely autonomous electricity supply in urban settlements are two global development goals that are also addressed by the autartec® Growth Core.

To this end, different function-bearing structural elements are being developed: from conventional construction components and larger support structures with integrated novel lightweight elements up to super-thin textile-reinforced concrete elements.

Practical Testing

Settlements close to the shore and »floating architecture« offer especially favorable conditions both for exceptional architectural design and for autonomous or at least semi-autonomous energy and water supply. Using the example of the autartec® building, the integration of the individual autartec® components will be tested and demonstrated to the general public.

- ine verlängerte Lebensdauer (> 10 Jahre).

WACHSTUMSKERNE
UNTERNEHMEN REGION

SPONSORED BY THE
Federal Ministry of Education and Research

VEHICLE AND TRANSPORT SYSTEM ENGINEERING

RANGE OF SERVICES

- Conception and design of electric powertrains for commercial and special-purpose vehicles
- Energy demand detection and analysis; Energy demand simulation for conventional, hybrid and fully electric vehicles
- Introduction concepts for electric buses
- Vehicle concepts for special purposes
- Testing and setup of powertrain components
- Fast charging concepts for electric commercial vehicles
- Innovative steering systems for extra-long road vehicles with multi-axle steering
- Functional safety analysis, design and implementation of vehicles and vehicle components
- Image processing
- Accident analyses and methods for the assessment of vehicle safety systems

Dr. Thoralf Knote
Phone +49 351 4640-628
thoralf.knote@ivi.fraunhofer.de

The transport sector is faced with the immense challenge of having to provide cost-efficient transportation and shipping services while increasingly utilizing renewable, climate-friendly energy sources with low or no emissions and maintaining a high degree of traffic safety at the same time.

In response to these challenges, the research areas of the Department »Vehicle and Transport System Engineering« include, among others, hybrid and fully electric propulsion systems, management of auxiliaries and storage systems for electric energy, power transmission between charging infrastructure and vehicle storage units, innovative steering systems for long road vehicles, as well as analyses and concepts for functional safety. The main focus lies on commercial and special-purpose vehicles, especially in the field of public transport.

Due to their electric energy storage systems, battery buses are still limited in range. The department develops implementation concepts for battery buses and other types of electric buses that objectively and independently demonstrate the potential of these vehicles and suggest a schedule for the implementation of this new propulsion technology. Current developments in battery technology are taken into account, as well as new concepts for charging infrastructure and energy transmission.

New approaches in the field of accident research for increased road safety complete the department's spectrum. Methods for the reconstruction of road traffic accidents and for the assessment of active and passive safety systems are most prominent in this sector.

IMPLEMENTATION CONCEPTS FOR ELECTRIC BUS NETWORKS IN METROPOLITAN AREAS

Matthias Breitkopf
Phone +49 351 4640-642
matthias.breitkopf@ivi.fraunhofer.de

Electromobility is regarded as the key to the transportation sector's climate-friendly transformation and as an integral part of a turnaround in energy policy. At the current development stage, many different concepts and approaches are being pursued, each comprising specific types of electric buses in combination with the appropriate charging infrastructure and operational planning. Public transport providers are challenged with the task of making landmark decisions for their future development that will influence not only their budget planning for the purchase of new technologies. In addition, these decisions will have a great impact on the respective transport providers' existing processes and structures.

Complex Tool-Based Analysis

In order to minimize the technological and financial risk, it is most sensible to adopt a strategy that favors a step-wise transition from diesel-propelled to electric city buses. Within this kind of strategy, it is important to take into account aspects of technology and design such as route network analysis, vehicle schedules and technical features of both electric buses and charging infrastructure.

Every city and every public transport provider has unique and typical characteristics that call for individual analysis. With the help of IVI*net*, a tool developed at the Fraunhofer IVI, the route schedules of entire cities can be recorded and assessed regarding the operation of vehicles with fully electric propulsion and an energy storage unit.

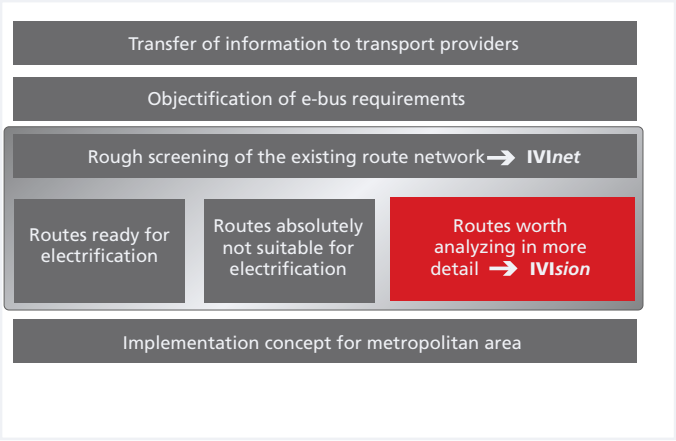
The tool records the energy consumed for traction, auxiliary components, heating and cooling during every single trip and visualizes the data for the users. Thanks to specific algorithms, charging locations that are optimal in terms of energy supply can be determined even in the extremely large route networks of metropolitan areas.

Cities whose route networks are closely interlinked and branch out widely are often not able to electrify all routes and all cycles at the same time. On the basis of the data provided by the tool IVI*net*, it is possible to generate an implementation concept with different network conversion stages.

It is often necessary to analyze certain routes and cycles in more detail due to their complexity. In these cases, the simulation tool IVI*sion*, which was also developed at the institute, can be used to conduct a more comprehensive analysis of the vehicles' energy consumption under real operating conditions.

Decision Support for Cities and Communities

On the basis of the route schedules calculated by IVI*net*, the detailed evaluations provided by IVI*sion* and with the cooperation of local transport providers, advice on the feasibility of implementing fully electric transport services can be given without a lengthy waiting period.



1 *Schematic of the implementation process for electric bus networks.*

INTELLIGENT TRANSPORT SYSTEMS

RANGE OF SERVICES

- Design and testing of system solutions for connected and automated driving
- Methods and algorithms for traffic detection, information and management
- Information and navigation applications
- Analysis, evaluation, integration and quality control of traffic and sensor data
- Processing of large data sets (Big Data)
- Software solutions for mobile applications, both frontend and backend
- Utilization of semantic technologies for data processing and service integration
- Fare-based solutions for conventional, electronic and mobile ticketing
- Modeling and simulation of fares
- Trend and technology studies

Dr. Torsten Gründel
Phone +49 351 4640-664
torsten.gruendel@ivi.fraunhofer.de

The level of interconnection and digitalization in complex transport systems is increasing rapidly. With the help of information and communication technologies, it is possible to organize traffic more efficiently, establish new mobility services and integrate traffic participants more actively. Key factors of this process are smartphones and wearable devices, as well as connected vehicles and automated driving.

The Department »Intelligent Transport Systems« responds to these developments and makes use of their potential. The focus is on public and private transportation – starting with a holistic view of these transport systems and ending with specialization on relevant research topics, among them information and navigation, traffic automation and management, as well as ticketing and fares. Interdisciplinary topics such as electromobility are also taken into account.

The processing of large data sets is an important aspect of all these topics. For this reason, the Fraunhofer IVI operates its own traffic and mobility data center. The institute is an associated partner of the national Big Data competence center ScaDS at the TU Dresden and contributes its expertise in the transportation sector.

The basis for the department's successful work is in-depth knowledge in the fields of information technology, mathematics, software engineering, automation technology and transport sciences, as well as experience and know-how gained in practical project work.

MOBIVERDE – MOBILE VIDEO-BASED RECORDING OF TRAFFIC DATA

Jan Grimm
Phone +49 351 4640-620
jan.grimm@ivi.fraunhofer.de

The recording of traffic data is an important method used for the demands-based dimensioning of road intersections and the optimization of a »green wave«. Recording systems available today are designed only for use with pre-defined intersection profiles. For complex intersection layouts that require the separate analysis of driving and turning maneuvers, the automated evaluation of video footage is not yet practicable. Due to the lack of technological solutions, small and medium-sized enterprises that offer temporary traffic surveys as a service are forced to resort to time-consuming manual evaluation techniques.

Fusion of Video Data

Identifying a multitude of different driving relations is a challenge that especially affects video detection at traffic junctions. The vehicles need to be recorded, followed and classified from a variety of angles. In contrast to many other use cases in image processing, objects have to be detected even under unfavorable conditions and attributed to the correct vehicle class and driving/turning relation. The odds of vehicles not being detected because they are too close or obscure each other, and of several vehicles falsely being merged into one object are especially high at busy junctions. In order to better exploit the information potential, the video signals of several cameras filming from different perspectives are evaluated. This fusion is based on methods for automated calibration comprising the following steps:

- Temporal synchronization of the video signals,
- Spatial registration of the detection areas,
- Transformation of the image coordinates into world coordinates.

For purposes of practical testing, the approach is subjected to fixed framework conditions. In this context, it is necessary to consider junctions of varying complexity and with different lighting scenarios so that recordings can be made over several days independently of both weather and time of day.

Automated Quality Assessment

In order to assess the reliability of the recorded data and to avoid manual video analysis, it is highly important to constantly and systematically evaluate the detection quality. This quality assessment process is based on a dual approach:

- A priori: evaluation of image quality and information content,
- A posteriori: rule-based plausibility assessment of the linked vehicle objects and calculated traffic data.

The work described is conducted in collaboration with traffic information and management GmbH within the MOBIVERDE research project, which is part of the »KMU-innovativ« funding initiative of the Federal Ministry of Education and Research BMBF. By the end of the project in March 2017, the partners will have developed an automated traffic data recording system using simple, mobile, scalable tools suited especially for complex junctions. In addition to adapting and expanding the technological foundations, a further prerequisite for creating a market-ready service in the field of road traffic surveys is to minimize the costs for procurement, set-up and removal, as well as operation and maintenance of the technical system components.

SPONSORED BY THE
Federal Ministry of Education and Research

STRATEGY AND OPTIMIZATION

RANGE OF SERVICES

- Command systems for fire fighters, emergency service providers, disaster management and police
- Analyses and risk assessment in hazard prevention: planning of fire safety requirements and rescue service zones, optimization of site concepts
- Web-based systems for data acquisition and analysis: master data and on-call duty, positioning of forces, camera surveillance, web GIS, etc.
- Robust distributed systems with analysis tools from Data Mining, Machine Learning and Natural Language Processing on the basis of Big/Smart Data
- Process restructuring on the basis of the digital transformation of SMEs, data visualization based on the Fraunhofer IVI data exploration tool AcubeS
- Decision support for operative logistics optimization: dynamic route planning, components for integrated cargo space and production planning
- Asset Management Systems for transport infrastructures: strategic, tactical and operative maintenance planning, risk assessment and predictive analysis

Dr. Kamen Danowski
Phone +49 351 4640-660
kamen.danowski@ivi.fraunhofer.de

In collaboration with its partners, the Department »Strategy and Optimization« develops solutions for the effective planning and control of resources. The solutions are applied in a wide range of fields:

- Security and risk prevention: firefighting and emergency services, disaster management and police
- Business processes: operators of digital platforms and infrastructures, OEMs, software service providers, as well as
- Logistics and infrastructure: transport service providers, infrastructure operators and contractors

The department's key competencies are the development of new scientific models and optimization methods, as well as the conception, design and implementation of complex systems.

Within numerous research and development projects, application-oriented solutions are developed and immediately put into practice. The software systems and modules developed by the department are independently configurable and therefore flexibly operable. There are separate modules for algorithmic planning and optimization of processes, resource management, trend and scenario analysis, evaluation of uncertainty factors, infrastructure, geographical and object data integration and visualization.

Thanks to close cooperation with the end users, the systems have a high acceptance level with the main customers, who can be found among federal and state ministries, districts, communities, public offices and authorities, industry and the European Union.

SYNCHRO-NET – DE-STRESSING SYNCHRO-MODAL SUPPLY CHAINS

Axel Simroth
Phone +49 351 4640-665
axel.simroth@ivi.fraunhofer.de

Synchro-Modality and Stressed Supply Chains

Synchro-modality is a novel paradigm in logistics management which focuses on highly flexible transport operations: In a synchro-modal scenario, the shipper agrees with the logistics service provider (LSP) on the delivery of products at specified costs, quality and sustainability, but leaves the decision on how to deliver according to these specifications to the LSP. With this freedom, the LSP can use different modes of transportation flexibly. The decision to switch to a different mode of transportation may depend on actual circumstances such as traffic information or availability of resources.

This flexibility comes at a price: Real-time planning and control of synchro-modal supply chains is highly complex – indeed too complex to be adequately modeled by current tools on the market. This means that logistics and supply chain managers can at best undertake a localized or oversimplified approach, often resorting to »gut feel« decisions. This inevitably leads to unnecessary stress and waste in the supply chain: ships going full speed only to arrive at the port and wait 24 hours to be docked because no berth is available; goods being transported by the fastest (and highest-emission) option only to be stored in a warehouse for two weeks occupying valuable space; trucks queuing through overloaded pinch-points while unused rail capacity lies just a few meters away; etc.

Holistic Approach

These inefficiencies are no-one's »fault« as such – they are simply a consequence of key decision makers at all levels and points in the supply chain not having adequate support for a very challenging task. The key concept, therefore, is to provide powerful tools that first enable the right de-stressing strategies to be identified and then enable them to be implemented in a synchro-modal supply chain.

SYNCHRO-NET will demonstrate how a powerful and innovative synchro-modal supply chain eco-net can catalyze the uptake of both the slow steaming concept and synchro-modality, guaranteeing cost-effective robust solutions that de-stress the supply chain, reducing emissions and costs for logistics operations while simultaneously increasing reliability and service levels for logistics users.

SYNCHRO-NET will not be restricted to ICT aspects: it will follow a holistic approach covering all relevant aspects and guaranteeing new forms of collaboration, and it will allow the introduction of SYNCHRO-NET innovative collaborative business models across Europe. Only this will guarantee a high level of user acceptance across all the stakeholders, convincing the sceptics, captivating industry-driven entities and empowering authorities to open European networks to a new form of collaboration.

Objectives

The most important result of SYNCHRO-NET will be the demonstration of the eco-net's benefits to stakeholders in three large-scale, real-world use cases:

- 20 to 25 percent reduction in fuel costs and emissions for ships (over and above existing slow steaming savings)
- 25 to 30 percent increase in modal shift to rail, with resulting 12 to 15 percent reduction in truck kms
- 5 to 10 percent reduction in finished goods inventory holdings for importers and manufacturers
- 12 to 20 percent reduction in hinterland transport costs
- Increased resilience, security and flexibility along the entire supply chain
- Increased safety and quality of life for employees in the synchro-modal logistics chain
- A profound and lasting benefit in terms of global supply chain sustainability

LOCATING, INFORMATION AND COMMUNICATION

TECHNISCHE UNIVERSITÄT DRESDEN

RANGE OF SERVICES

- Design and testing of hybrid locating methods
- Development of solutions for precise track-selective locating
- Integration of wireless sensor networks
- Tests for the verification and validation of locating and communication components
- Evaluation of locating sensor systems
- Assessment of digital traffic data services
- Signal simulation using Software Defined Radio
- Interference analyses
- Propagation and performance analyses
- Evaluation of electromagnetic compatibility (EMC)

Prof. Dr. Oliver Michler
Phone +49 351 4640-629
oliver.michler@ivi.fraunhofer.de

The acquisition of positioning information is the basis for processes of tracking and route planning executed in the field of transportating goods and persons in traffic networks. In these situations, absolute coordinates usually do not play a predominant role. Instead, the relative distances to specific points (e. g., terminals, bus stops), curves (e. g., driving lanes or tracks) or other moving objects (e. g., nearby vehicles) are much more important. Depending on the respective application, the required precision and integrity can be very high for these locating tasks. Innovative hybrid approaches and technologies crossing all transport modes are needed to achieve the necessary standard.

In order to meet these demands, the Research Group »Locating, Information and Communication« of the Fraunhofer IVI works in close cooperation with the Chair of Transport System Information Technology, »Friedrich List« Faculty of Transportation and Traffic Sciences at the TU Dresden.

The group is specialized in the testing and analysis of components for Intelligent Transport Systems during their development, with a focus on locating and communication applications for public transport, rail freight transport and urban road traffic. Interference analysis and standards-compliant simulation of locating and communication signals on radio frequency level are some of the various methods applied in this context. Different signal generators and analyzers allow complex experiments in the laboratory, in vehicles and in the field.

INTELLIGENT FREIGHT WAGONS

Ina Partzsch
Phone +49 351 4640-631
ina.partzsch@ivi.fraunhofer.de

Digitalization of Economy

Seemingly ubiquitous key words such as Internet of Things, industry 4.0 and cyber-physical systems describe aspects of the steadily increasing level of digitalization of ordering, production and delivery processes. As these topics always contain a transportation component, they cannot be discussed separate from current developments in the field of Intelligent Transport Systems (ITS). Although the rapid technological progress in road traffic regarding connected and automated driving seems much more present in the media than innovations in rail transport, similar efforts are being undertaken in the rail transport sector as well.

One important area of development is concerned with the so-called intelligent freight wagon. Among others, networked telematics components in intelligent freight wagons allow:

- Observation and tracking of transport routes,
- Recording of mileage,
- Significantly improved disposition, and
- Monitoring of the freight including detection of load conditions and overload.

In addition, these solutions can support operational processes such as the identification of train formation and train integrity, early notification of derailments and automated execution of braking tests.

Finally, the uninterrupted monitoring and documentation of the flow of goods is economically promising due to the large number of involved agents and transition points, both in production and along the supply chains.

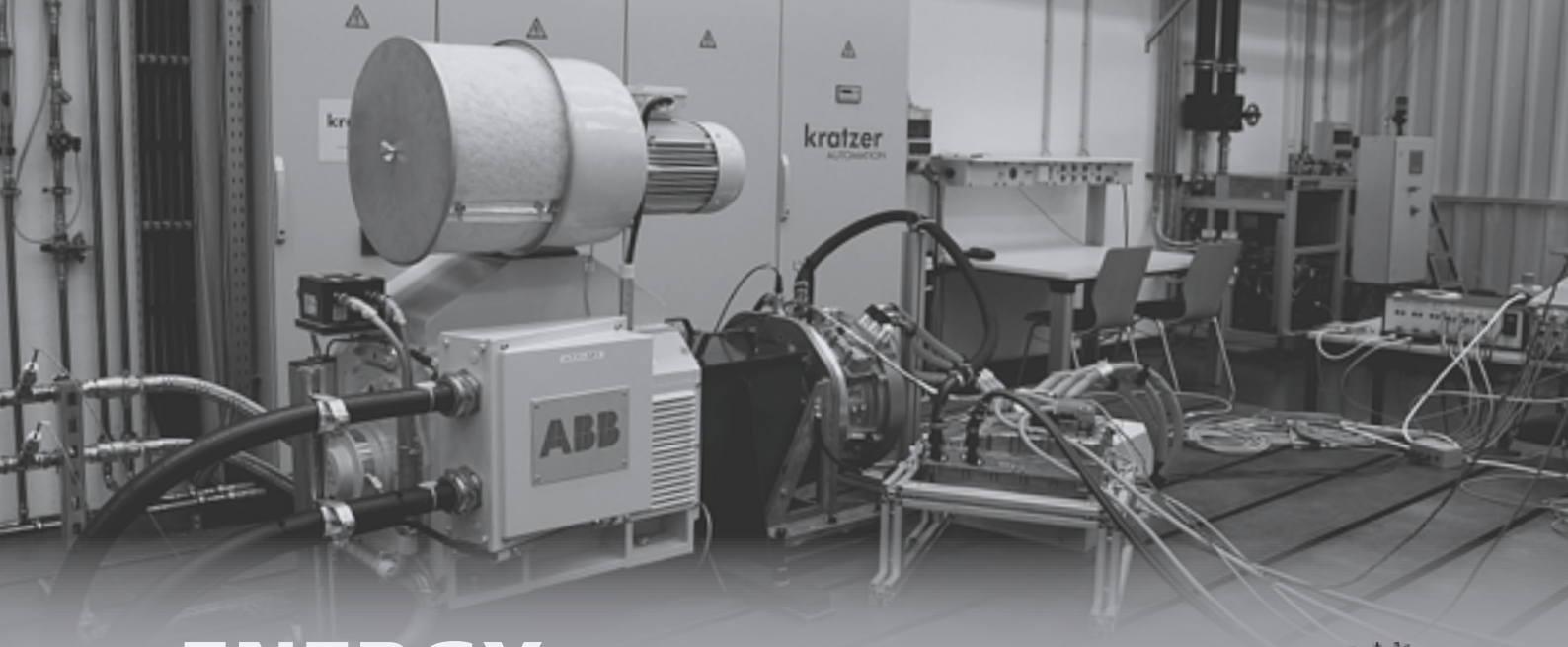
Technological Barriers

At present, important steps have yet to be taken on the way to standardized data communication and energy supply for wagon-independent radio and sensor networks. Both of these issues are significant barriers for the broad introduction of intelligent freight wagons. Regarding freight wagon locating applications that demand a level of precision extending to specific tracks, unfavorable propagation conditions in railroad environments are a great challenge for conventional satellite locating. Dominant shadowing and multipath effects that occur due to small distances between wagons on neighboring tracks and high percentages of metal in the vehicle construction have especially grave effects.

Track-Selective Locating

As one of their activities in the past year, the group worked on questions of track-selective locating of freight wagons in holding depots. Together with different industry partners, the Fraunhofer IVI carried out a cooperative evaluation of raw data from a pair of GPS receivers attached to one freight wagon's longitudinal side. The partners were able to show that, in contrast to the conventional single-device use, improving effects for track-selective locating can be achieved by taking into account geometric environment data such as wagon geometry and distance between tracks. The work was part of the VERSATO project (Connecting Satellite Data for the Improvement of Locating Precision), which was funded by the Federal Ministry of Education and Research BMBF within the scope of the initiative »KMU-innovativ«.

SPONSORED BY THE
Federal Ministry of Education and Research



ENERGY SYSTEM ENGINEERING

RANGE OF SERVICES

- Analytical design of standard electrical machines and special designs with the help of our own tool chains
- Numerical calculation and optimization of electrical machines (ASM, SM, TFM)
- Thermal modeling and development of temperature sensors for spatially resolved temperature prognosis
- Control and optimization of electric traction drive systems
- Development of novel types of electrical machines (HTS motor)
- Experimental analysis of single components
- Testing of electric propulsion systems, both as individual systems and in vehicles
- Studies and expert assessments

Prof. Dr. Jana Kertzscher
Phone +49 3731 39-2926
jana.kertzscher@ivi.fraunhofer.de

Since fall 2013, the Fraunhofer IVI and the Institute of Electrical Engineering at the TU Bergakademie Freiberg have been cooperating closely within a shared research group. The cooperation's aim is to exploit synergies and establish further research and development topics within the group.

The scientific expertise of the Institute of Electrical Engineering centers on the design, calculation and thermal modeling of electric propulsion systems.

During its start-up period, the research group's scientific profile will be primarily founded on the following key topics:

- Electronic drive control,
- Design of infrastructure systems with heavily fluctuating input, and
- Energy flux control in buildings and settlements with autonomous utilities supply.

The group's long-term goal is to establish an independent research portfolio that seamlessly fits the Fraunhofer IVI's own scientific topics and that supports both teaching and research at the Institute of Electrical Engineering.

The expertise of both institutions also served as the foundation for the establishment of the shared high-performance center ELEKTROMOBILITÄT with the goal of developing electric propulsion systems that are specifically tailored to their respective applications.

E-FFEKT – EFFICIENT FLUX MANAGEMENT FOR A CAGE ROTOR DRIVETRAIN

Prof. Dr. Jana Kertzscher
Phone +49 3731 39-2926
jana.kertzscher@ivi.fraunhofer.de

Most powertrain concepts for current electric vehicles are based on permanently excited synchronous machines (PSM) with field-oriented control. This is due to their higher power density and the fact that their efficiency in partial-load range is superior to that of the more economical, robust asynchronous machines. Some of their disadvantages, on the other hand, are expensive magnetic raw materials and highly complex production processes.

Within the »ATEM – Antriebstechnologien für die Elektromobilität« funding initiative of the Federal Ministry of Economic Affairs and Energy BMWi (ATEM – propulsion technologies for electromobility), the E-FFEKT project aims at establishing asynchronous machines as energy and cost efficient alternatives to PSMs by developing a new efficiency-optimized Rotor Flux Control (RFC) under consideration of all secondary effects. The new RFC will be implemented in a demonstrator and validated to ensure that the method, in addition to being functional, is also ready for series production for ordinary vehicles. The research project is supported by an industry advisory board that is open to interested participants.

Efficient Flux Management

The approach is based on the so-called cosφ-control, which is often employed as an »energy saving option«. However, when employed for load-based rotor flux management, the cosφ-control can only use some of its potential because the following important aspects are not taken into account:

- Iron and friction losses,
- Temperature dependencies,
- Saturation effects,
- Stator frequency variation and
- Additional losses.

Due to these aspects, the efficiency of a drivetrain can decrease substantially, for example, when the stator frequency increases.

Series Production Readiness through Parameter Identification

The method's key problem is the immense effort necessary for the exact identification and tracking of parameters for each electrical machine. Measuring all electrical machines for all possible operating points is not an appropriate solution in terms of cost-efficient series production. Therefore, the integrated, automated detection of highly precise parameters is paramount.

The motor's parameterization during operation will be achieved with the help of a method for parameter identification during standstill. This method yields very precise results, but owing to its general principles it does not record any parameters during operation. Online-identification of parameters during operation, on the other hand, can be applied both in stationary and in dynamic cases. This method is not quite as precise as parameter identification during standstill, but it yields situation-specific results.

On this basis, parameter identification during operation is being further improved and integrated into the efficiency-optimized control for asynchronous machines. The methods described were developed and validated by the Institute of Electrical Engineering at the TU Bergakademie Freiberg.

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

JUNIOR RESEARCH

THERMAL STRESS OF POWER SEMICONDUCTORS IN PUBLIC TRANSPORT

Motivation and Tasks

The addition of energy storage units to electric propulsion systems increases the complexity of powertrains and requires controllable converters for the coupling of propulsion components with different input/output behaviors. Power electronics components in public transportation vehicles are especially exposed to alternating thermal stress. The power densities of traction current converters used in contemporary trams and trolley buses are relatively low. Against the backdrop of increasing traction needs and demands for complete low-floor construction, the integration of these components is becoming more and more difficult. Expansion of the system by energy storage units further aggravates the situation. Therefore, future applications call for DC/DC converters that provide higher power densities without a decrease in operating reliability and life span.

The primary aim of the dissertation was to develop a simulation model for the junction temperature progression in the semiconductor components of DC/DC converters used in vehicle energy storage units under realistic stress conditions. Furthermore, different methods for reducing the alternating thermal stress on the semiconductor components were to be analyzed. For this, it was necessary to study the effects of changes to the hardware configuration within the power elements of DC/DC converters. Finally, a control strategy was developed that allows the energy storage unit to take in braking energy and release it to the traction motors. This task also included the assessment of possible effects on the thermal stress on DC/DC converters.

Next to a significant improvement of energy efficiency, further demands of modern traffic systems can be met by integrating mobile storage units in vehicles. Public transport providers and decision makers of public authorities express growing interest in these systems. Due to reasons of city and infrastructure planning, the demand for electric vehicles without the need for continuous energy supply is steadily increasing.

The dissertation's second aim was to develop an online monitoring method for the junction temperature of DC/DC converters. In order to temporarily allow stress above the maximum long-term stress levels of the respective power semiconductors, a preset target current was connected to this information. It was assumed that this novel method was suited to exploit reserves both in terms of current load and in the fast-charging processes of energy storage units.

Simulation Results

Until now, a closed model of alternating thermal stress had been missing. This gap was filled by the simulation model developed. Detailed knowledge about the storage unit's current state of charge and the operating requirements of the upcoming route sections is the control strategy's basis. Under these known conditions, it is possible to control the energy storage unit's participation in the traction task so that the state of charge is kept at a sufficiently high level. At the end of each braking process that occurs immediately before the next regular operating stop, the storage unit will have returned to its maximum operating voltage. It was demonstrated that the newly developed control strategy is able to:

- Significantly reduce the alternating thermal stress on all power semiconductors involved in energy transmission and
- Greatly improve the vehicle's energy efficiency.

The increased utilization of braking energy results from reduced thermal losses in the power transmitting components of both DC/DC converter and energy storage unit.

By studying optional hardware changes, employing power semiconductors with a higher current carrying capacity and connecting semiconductor modules in parallel, it is in principle possible to prolong the semiconductor components' life span.

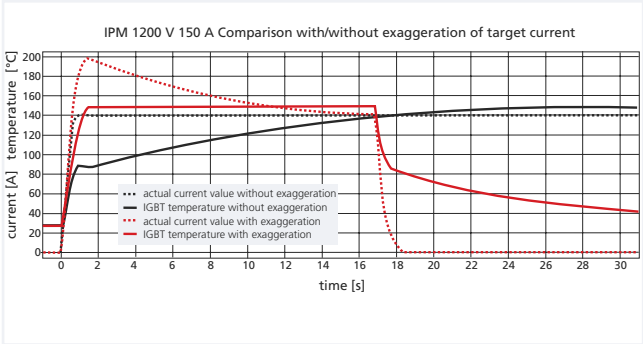
Dr. Sven Klausner
Phone +49 351 4640-812
sven.klausner@ivi.fraunhofer.de

However, it should be noted critically that the aforementioned measures reduce utilization of the available braking energy due to increased losses within the DC/DC converter.

Target Current Presetting by Junction Temperature Estimation

Integrating an energy storage system into a vehicle leads to an overall improvement of its energy efficiency. In addition, there is no longer a need to maintain a continuous energy supply locally or even in entire route networks. A concept for the operation of electrically driven public transport vehicles developed by the Fraunhofer IVI can be used to compensate for the very restricted energy density of current storage units through recharging during passenger interchange. Because the amount of energy to be recharged is very large, and because the time for passenger interchange is invariable, energy transmission processes are needed that may lie far above the vehicles' traction performance. The nominal current carrying capacity of the power semiconductors involved in the energy transmission proves to be the charging limit.

The dissertation introduces a method for controlling the stress on power semiconductors on the basis of knowledge about their junction temperature, which can be determined with the help of estimation algorithms. Thus, higher amounts of energy can be transmitted without causing the catastrophic failure of the power semiconductors due to thermal stress. The described method was developed analytically and verified experimentally using a specifically configured power electronics module (see figure).



1 *Test run of the developed algorithm (measurement curves).*

Outlook

The newly developed algorithm promises to be an option for accelerating the en-route fast charging of energy storage units in public transport vehicles during regular operating stops. The respective acceleration potential of each use case depends on the respective power electronics employed in the DC/DC converter.

In addition to the described aim of shortening the time needed for fast charging processes, the algorithm can be applied in all use cases that call for precise information about the momentary junction temperature of power semiconductors under operating conditions.

The results of this work were submitted as a dissertation to the Faculty of Mechanical Science and Engineering of the TU Dresden. With special thanks to my supervisor, Prof. Dr.-Ing. habil. Jörg Huhn, and the reviewers, Prof. Dr.-Ing. Arnd Stephan and Prof. Dr.-Ing. Achim Trogisch.

FLEXIBLE JOB MANAGEMENT FOR AUTOMATED NAVIGABILITY ANALYSES

Intention

Freight traffic in Germany has been growing steadily, and so have requirements of transport capacity and efficiency. Increasingly long truck-trailer combinations (> 70 m) are operated especially in the field of heavy and large cargo transport. The existing infrastructure, however, is often not dimensioned for these large vehicles. In order to reduce unusually high stress, § 29 III of the StVO (road traffic regulations) mandates that an approval must be obtained for each shipment. The application has to contain a route protocol including proof of navigability and planned measures such as removal of obstacles or expansion of the driving surface by laying panels. These navigability analyses are currently executed manually based on personal experience and cannot usually make guaranteed claims. Thus, accidents involving shipping vehicles often occur despite a favorable navigability analysis, infrastructure being damaged in the process. The consequences are longer shipping periods and additional costs for repairs and salvage missions. To prevent this, an algorithm was developed that executes automated navigability analyses and yields reliable information.

Embedded Algorithm in a Comprehensive System

The vehicle and its features are recorded by the user in a web-based computation request. Afterwards, the vehicle is positioned and its destination marked on a bottleneck map. All details are then sent to a database server and stored there. The best navigation path is calculated using the embedded algorithm and a locally stored parameter set. When the calculation is completed, the path found is also stored in the database and then visualized for the users on a website. The path planning algorithm relies on a complex graph search method, whose computation time and quality of results depend fundamentally on the parameter set used. Therefore, it seems reasonable to calculate identical requests with different parameter sets.

System Improvement

The parameter sets stored in the database can be automatically combined with the requests to form so-called jobs. This improvement to the former system allows simultaneous processing of a request via the jobs by different entities on different hosts. In order to obtain a standardized quality criterion, the result of each computation is later evaluated with regard to quality and computation time. The previously determined success rate of the parameter set used is then trained using a learning method. The success rate can be used for claims about whether the parameter set is potentially suitable for a given calculation. The following features remain unchanged or are added:

- The computation entities are independent from each other.
- The number of computation entities can be scaled freely.
- The computation entities are able to process a request simultaneously with different parameter sets.
- Potentially efficient calculations are given priority based on their success rate.

Relational Database Model

Due to an irregular number of parameters, there is a multitude of possible combinations consisting of variable parameter sets controling the algorithm (see figure). A specifically developed switch-ID relation enables the visualization of the database's parameter sets in a table. Thanks to two fields reserved for this purpose, one containing the table name to be referred – the so-called switch field – and the other containing the respective entry's primary key – the ID field –, it is possible to refer to any number of tables as often as is required.

Eric Gleitsmann
Phone +49 351 4640-625
eric.gleitsmann@ivi.fraunhofer.de

Self-Management of the Calculation Software

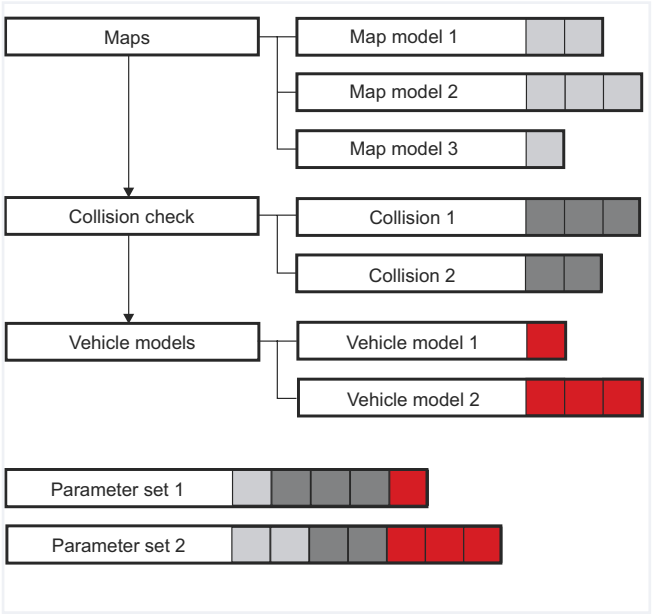
In the case of one entity already having yielded a result, the software automatically triggers the abort of the other calculations. For this, flags were placed in the semantically connected tables that allow the different entities to communicate in a simple way and make decisions about their own behavior without creating interdependencies.

Conclusion

By combining a calculation request with different parameter sets, evaluating the parameter sets and processing them simultaneously, the likelihood of a request being calculated with a potentially efficient parameter set was increased. Using this approach, the computation time can be reduced by up to 58 percent.

The automated evaluation of both the calculation result and the parameter set offers new analysis options that can be used, for example, in a parameter study that aims at enhancing parameter sets, reducing computation time and improving the quality of results.

The underlying system can be easily transferred to other applications as it is designed for tasks that require a high level of computing power, such as the processing of large amounts of data. In addition, it is scalable without any additional configuration adjustments. Thus, the job management system supports any number of decentralized computation entities, provided they all have access to the centralized database.



1 *Example of a parameter set structure.*

With special thanks to my supervisors,
Prof. Dr.-Ing. Arnold Beck, HTW Dresden, and
Dipl.-Ing. Susann Beyersdorfer, Fraunhofer IVI, as well as to
Dr.-Ing. Sebastian Wagner and Prof. Dr.-Ing. Matthias Klingner,
Fraunhofer IVI.

HIGHLIGHTS

Visit from State Secretary Hartmut Mangold

Under the heading »Synchronized Mobility 2023«, a test environment for intelligent transport systems in urban regions will be constructed in Saxony. Special focus will be put on the development of highly automated driving functionalities for a better utilization of traffic infrastructures. During a meeting at the institute on March 11, Dr. Hartmut Mangold, State Secretary with the Saxon State Ministry of Economy and Traffic (SMWA), informed the Fraunhofer IVI researchers about the Saxon Government's cabinet decision to create the necessary framework conditions for the project.

Director of Infrastructure, Transport and Logistics of Australian Research Organization NICTA at the Institute

On March 18, the Fraunhofer IVI welcomed Rob Fitzpatrick, Director of Infrastructure, Transport and Logistics of NICTA – an Australian research center for information and communication technology with a focus on machine learning, optimization and mobile systems. After the introduction of both institutions' profiles, the schedule moved on to an exchange of experience gained in areas such as crisis management, Big Data and logistics. Options for future collaboration were explored during a spirited discussion about challenges in the development of computer-based real-time decision support for evacuation, re-routing systems and fleet management under consideration of social media information.

EDDA-Bus at the German Association of Cities and Towns Assembly in Dresden

The general assembly of the German Association of Cities and Towns met from June 9 to 11 at the MESSE DRESDEN. Over 1,000 delegates and their guests attended the event.

The evening before the event held the opportunity for the association's presiding committee to experience the advantages of the Fraunhofer IVI's fast charging battery bus. Head of Department Dr. Thoralf Knote related essential facts about the bus' development. On the following days, the vehicle was available to all delegates as a shuttle bus.

TUgether e. V. Freiberg at the Fraunhofer IVI

On June 12, the TUgether e. V. – a student cultural society in Freiberg – held a meeting at the Fraunhofer IVI. The students were open and very interested in the institute's area of work. After a number of presentations and time for discussion, they had the opportunity to get behind the wheel of the institute's electric BMW i3 cars on the test track. As for most other visitors to the institute, the highlight of the meeting was a ride in the AutoTram® Extra Grand.

Kick-off Meeting INFRALERT

The Fraunhofer IVI is coordinator of the INFRALERT project, which started in May and will be funded over a three-year period. INFRALERT stands for »Linear Infrastructure Efficiency Improvement by Automated Learning and Optimised Predictive Maintenance Techniques« and aims at supporting and automating the management of large transportation infrastructures such as rail and road networks with the help of an expert-based information system.

The kick-off meeting was held on May 15 at the Fraunhofer IVI. During their stay in Dresden, the 15 delegates from 7 project partners also visited the famous Blaues Wunder (Blue Wonder Bridge) and the Pillnitz Castle gardens.

Kick-off Meeting Ecochamps

The Fraunhofer IVI is a partner in the EU-funded Ecochamps project, which aims at significantly reducing the costs of hybrid propulsion systems in passenger cars and commercial vehicles while increasing their efficiency at the same time. In order to achieve this goal, new powertrain components and auxiliary units are being developed for different vehicle classes. The Fraunhofer IVI leads work package 1 »Target Settings, Tracking and Evaluation« and is a key partner in work package 2 »Components Standardization, Modularization and Development«. The opening event for all project partners was held on June 15 and 16 in Eindhoven, Netherlands.

Kick-off Meeting of an EBSF_2 Sub-Project

In May 2015, a large-scale European project looking at the future of public transport from different relevant angles was continued under the title »European Bus System of the Future 2 – EBSF_2«. The Fraunhofer IVI contributes to two larger research topics dealing with city buses. The first of these topics aims at increasing the efficiency of electric buses via an intelligent management system for the auxiliaries, while the second one is concerned with the needs-based adaption of the length of city buses during regular operation. It proposes to split an 18 meter-long articulated bus so that the 6 meter trailer can be detached at the articulation joint and the remaining 12 meter segment can be used independently as a fully functional city bus.

The kick-off meeting for this fascinating research task was held on June 18 together with Hübner GmbH – world leader in the manufacture of articulation systems for city buses – at the Fraunhofer IVI. The final demonstration of the results using the example of the AutoTram® Extra Grand is scheduled for 2017 and will also take place at the institute.

Anniversary Night of Science and Economy in Freiberg

On June 20, the Institute of Electrical Engineering at the TU Bergakademie Freiberg and the Fraunhofer IVI presented themselves together at the Anniversary Night of Science and Economy. They chose the shared motto »Electromobility moves all of us – from current research to application«.

The institute's fast charging battery bus and the e-bike VeloCité were not the only attractions that night: two fully electric BMW i3 were also able to capture the attention of the interested visitors. The large-scale event was held on occasion of the TU Bergakademie Freiberg's 250 year anniversary.

Visit of a High-Profile Delegation from Nevada

Within the scope of State Governor Brian Sandoval's tour of Germany, a high-profile delegation representing Nevada's science and economy sectors stopped at the Fraunhofer IVI on July 28. In addition to cooperation opportunities, the guests were especially interested in cutting-edge technologies in the fields of electromobility and intelligent transport systems. By riding the EDDA-Bus and the AutoTram® Extra Grand and watching a flight demonstration of the octocopter HORUS, they were able to gain a first-hand impression of these technologies. As a first outcome of the trip, negotiations about possible cooperative projects on the topic »synchronized mobility« have been taken up.

Exploratory Talks with Company CIDETEC

In a meeting with CIDETEC from San Sebastián (Spain) on July 9, there was an active exchange between Dr. Oscar Miguel Crespo and Dr. Ulrich Potthoff about their experience in energy storage systems. The heads of their respective departments also talked about possible collaboration within the European funding program HORIZON 2020.

Disposition During Large-scale Events

In 2015, the Department »Strategy and Optimization« again gave active support to fire departments, rescue services, crisis management staff and event protection services. Both well-tried and newly developed systems and modules were applied on a broad basis in day-to-day operations and in large-scale events such as the Dresden City Festival (August 14 – 18), the Day of the Saxons (September 4-6) and the Dresden Marathon (September 18).

In addition to providing support in operational preparation and command, a variety of further tasks in the fields of risk analysis, planning of fire safety requirements and planning of rescue service zones were successfully taken on and executed in collaboration with the end users.

Virtual Topping-out Ceremony autartec®

The first public presentation of the autartec® project took place on September 16 on Fraunhofer IVI premises in the form of a »virtual topping-out ceremony«. The current state of developments was illustrated within a number of specialist lectures. The highlight of the event was the traditional topping-out ceremony, which was carried out using a model of the floating building in the scale of 1:10.

At the subsequent in-house exhibition, the interested guests had the opportunity to gain a first-hand impression of the autartec® technologies in their current state.

The autartec® FreiLichtHaus design was submitted to the Brandenburg Design Awards and pre-selected as a nominee. The project is set up for three years and funded by the Federal Ministry of Education and Research (BMBF) within an Innovative Regional Growth Core.

German-Swedish Workshop »Autonomous Driving«

Automated and connected driving are gaining increasing importance. The Fraunhofer IVI has already presented multiple innovative solutions in this field, such as lane and object detection with the help of camera systems, guideway detection using laser sensors, as well as steering and path planning algorithms for commercial vehicles.

Following an initiative of the Corporate Strategy and International Affairs Department of the Fraunhofer-Gesellschaft, the Fraunhofer IVI acted as host for a German-Swedish workshop on October 8-9, 2015. Representatives from a variety of Fraunhofer Institutes, the SP Technical Research Institute of Sweden and the Swedish operator of a test site for automated driving functions attended the workshop. During the two-day meeting, collaboration opportunities on a European level were explored and key tasks were defined according to the scope of several current EU calls.

Stakeholder Advisory Group (SAG) Meeting of the European IMPRESS Project

On October 12-16, the Fraunhofer IVI and several peer groups (panel of experts, steering committee, technical working groups) worked on the strategic advancement of the IMPRESS project. Thanks to the feedback given by members of the SAG, which consists of doctors and medical researchers, end user scenarios were discussed and prepared for implementation. With the help of effective algorithms and multidimensional response mechanisms, IMPRESS wants to improve decision support in medical crisis situations of the kind that may occur all across Europe due to large-scale events.

On October 13, the partners had the chance to visit the Dresden Technical Collections and enjoyed the exhibits from different eras of technology.

TRADE FAIRS

Visit from a Korean Delegation

Looking to establish global connections and hoping for collaboration opportunities with the Fraunhofer IVI, a delegation of the Korean Research Center for Overseas Construction (KRC) traveled to Dresden in the beginning of November.

Accompanied by Deputy Manager Kim Seung Wong and Team Manager Jung Jong Hyun, Director Kang Sin Young visited the institute and expressed great interest in collaborating in several of the institute's major research areas.

»Energy in Future« Conference

At the conference held on November 10-11 at the Dresden International Congress Center, the Fraunhofer IVI headed its own session dealing with the topic »mobility« and illustrated problems and solutions of the field in lively talks. In addition to the institute's fast charging battery bus, a futuristic pedelec was presented as an innovative example of micromobility.

3rd Dresden Conference – Innovation Electric Bus

The specialist conference, which took place on December 10 and 11, held the opportunity to demonstrate the institute's long-standing experience in the field of fast charging electric buses. The DockingPrinciple, a fast charging system developed at the Fraunhofer IVI, was introduced in a presentation. It has lately been brought to series readiness and demonstrated in a six-month practical testing period.

At the adjoining exhibition, the institute presented its fast charging battery bus, a battery monitoring system and a tool for giving recommendations regarding the step-wise implementation of electric bus routes.

- **Interschutz in Hannover**
  June 10, 2015
  Presentation of results gained in the ***PrimAIR*** research project (Air Rescue as an Innovative Concept for Primary Rescue in Structurally Weak Regions), funded by the Federal Ministry of Education and Research (BMBF).

- **BauenKaufenWohnen in Dresden**
  September 12-13, 2015
  Presentation of the ***FreiLichtHaus***, a design developed under aspects of autonomous utilities supply, funded by the BMBF within the autartec® Growth Core.

- **IAA Automotive in Frankfurt**
  September 15-18, 2015
  Exhibition of the ***HY²PE²R*** prototype (Hydraulic Hybrid for Extended Electrical Range) for commercial vehicles, result of the Fraunhofer System Research for Electromobility II

- **1st RF and Wireless Technology Day in Tönisvorst**
  June 24, 2015
  Presentation of a measurement system for the synchronized recording of GNSS, video and high frequency signals in vehicles.

- **Conference for IT Users in Logistics in Berlin**
  November 11-12, 2015
  Presentation of the IVI*on* telemetry system for diagnosing the parameters of batteries in commercial electric vehicles.

PUBLIC BODY MEMBERSHIP AND PATENTS

PUBLIC BODY MEMBERSHIP

Danowski, Kamen
- Section »Civil Protection«, Euroregion Elbe/Labe

Engelbrecht, Julia Maria
- IEEE Region 8: Europe, Middle East and Africa
- IEEE Vehicular Technology Society
- IEEE Intelligent Transportation Systems Society
- VDE Dresden District Association e. V.

Grimm, Jan
- BASt Federal Highway Research Institute Supervisor Group »Impact of Errors on Traffic Management Systems«
- COST Action TU1305 Social Networks and Travel Behaviour
- FGSV German Road and Transportation Research Association, Working Group AG 3.2.9 »Video Detection in Traffic Management Systems«

Gründel, Torsten
- kontiki – Contactless smart card systems for electronic ticketing
- CNA Center for Transportation & Logistics Neuer Adler e. V.
- ECTRI European Conference of Transport Research Institutes
- Fraunhofer Traffic and Transportation Alliance
- Network »SatNav Saxony«
- Silicon Saxony e. V., Applications Division
- UITP International Association of Public Transport

Jehle, Claudius
- Fraunhofer Energy Alliance

Kertzscher, Jana
- VDE Association for Electrical, Electronic & Information Technologies e. V.

Klingner, Matthias
- Dresden-concept e. V.
- Development association HYPOS – Hydrogen Power Storage & Solutions East Germany e. V.
- Fraunhofer ICT Group
- International Monorail Association
- Network »Dresden – Stadt der Wissenschaften«
- Forum on Electromobility

Knote, Thoralf
- Working Group AG 3.10 of the FGSV (German Road and Transportation Research Association) »Theoretical Basics of Road Traffic«

Michler, Oliver
- Cool Silicon e. V.
- DGON German Institute of Navigation e. V.

Potthoff, Ulrich
- Fraunhofer Battery Alliance

Städel, Christian
- DIN German Institute for Standardization e. V., committee »Thermal Storage Systems for Commercial Applications«

Torge, Sunna
- Fraunhofer Big Data Alliance
- COST Action TU1305 Social Networks and Travel Behaviour

PATENTS

- Klausner, S.; Gamsizlar, Ö.: **Elektrische Kontaktanordnung.**
  Patent no.: DE 10 2009 023 072 B4, 2012

- Klingner, M.: **Leistungssteuereinrichtung und Verfahren zum Lastausgleich eines Netzes.**
  Application no.: DE 10 2011 114 344 A1,
  Publication: March 21, 2013
  European Application: September 20, 2012

- Wagner, S.; Zipser, S.: **Verfahren zur automatischen oder teilautomatischen spurtreuen Mehrachslenkung eines Straßenfahrzeugs und Vorrichtung zur Durchführung des Verfahrens.**
  Patent no.: DE 10 2006 037 588 B4, 2011

- Zipser, S.; Wiel, M.; Möhler, N.; John, D.: **Bilderfassungssystem für Kraft- und Schienenfahrzeuge sowie Verfahren zur elektronischen Bilderfassung.**
  Patent no.: DE 102 00 601 4504 B3, 2007

TRADEMARKS

- **AutoTram®** DE 304 17 949, 2004

- **autartec®** DE 30 2012 021 316, 2012

- **Feldschwarm®** DE 30 2013 013 880, 2013

- **HORUS®** DE 30 2013 006 673.1, 2014

- **TruckTrix®** DE 30 2014 003 169.8, 2014

PUBLICATIONS

ARTICLES AND PRESENTATIONS

Baldi, M. M.; Heinicke, F.; Simroth, A.; Tadei, R.: **The Generalized Bin Packing Problem: a Link between Logistics and Maintenance Optimization.** 45th Annual Conference of the Italian Operations Research Society AIRO, Pisa, Italy, September 7-10, 2015, presentation: M. Baldi

Brunsch, R.; Holfeld, D.; Simroth, A.: **Job Shop Production Planning under Uncertainty: A Monte Carlo Rollout Approach.** 10th International Scientific Practical Conference »Environment. Technology. Resources«, Rezekne, Latvia, June 18-20, 2015, presentation: R. Brunsch

Büchner, S.; Klausner, S.: **Full-Electric Bus Operation According to the DockingPrinciple in Regular Service.** *In: eb International, Munich, Deutscher Industrieverlag, 2015, vol. 113, issue 1, pp. 38-43, ISSN 0013-5437*

Büchner, S.; Klausner, S.; Engel, M.: **Conception and Realisation of a Charging Station for Electric Buses in Public Transportation.** 15th International Stuttgart Symposium »Automobil und Motorentechnik«, Stuttgart, March 17-18, 2015, presentation: S. Büchner
Published in: Proceedings. Bargende, M.; Reuss, H.-C.; Wiedemann, J. (eds.), Wiesbaden, Springer Vieweg, 2015, pp. 585-594, ISBN 978-3-658-08843-9

Chaari, R.; Dieudonné, M.; Toth, A.; Kratzing, R.: **Aqueous Supercapacitors Solutions for HEV Applications.** 5th European Symposium on Super Capacitors & Hybrid Solutions ESSCAP 2015, Brasov, Romania, April 24, 2015, presentation: R. Chaari

Erbsmehl, C.; Schebdat, H.: **Statistical Driver Model for Accident Simulation.** 6th Expert Symposium on Accident Research ESAR, Hannover, June 20-21, 2014. *Published in: Proceedings. Fachverlag NW, Bremen, 2015, 11 pp., ISBN 978-3-95606-154-7*

Fichtl, H: **Battery Electric Trolley Buses – a Solution for Electric Transport?** Moscow Trolley Workshop, Moscow, Russia, February 2, 2015

Heinicke, F.; Simroth, A.; Scheithauer, G.; Fischer, A.: **A Railway Maintenance Scheduling Problem with Customer Costs.** *In: EURO Journal on Transportation and Logistics, Heidelberg, Springer, 2015, vol. 4, issue 1, pp. 113-137, ISSN 2192-4376*

Holfeld, D.; Simroth, A.: **Monte Carlo Rollout Method for Optimization under Uncertainty.** 15th International Conference on Civil, Structural and Environmental Engineering Computing, Prague, Czech Republic, September 1-4, 2015. *In: Proceedings. Civil-Comp Press, 2015, ISSN 1759-3433*

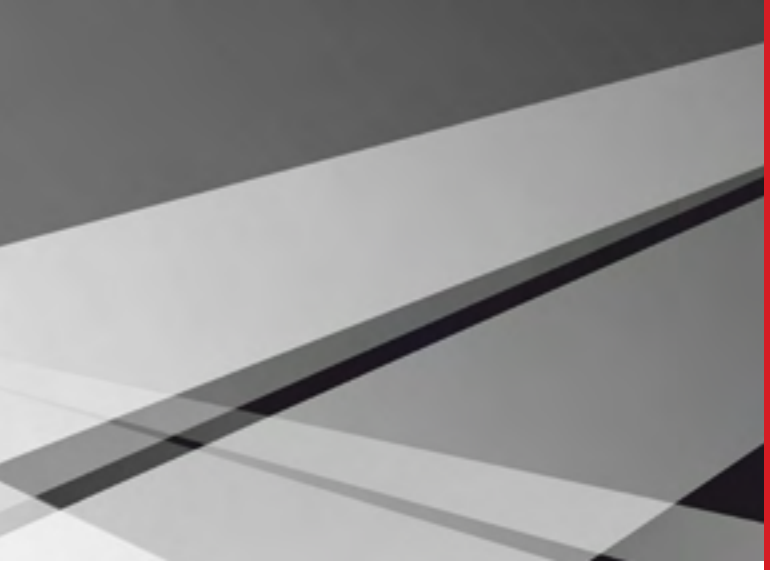
Johannsen, H.; Otte, D.; Urban, M.: **Pre-Crash Analysis of Accidents Involving Turning Trucks and Bicyclists.** IRCOBI Conference 2015, Lyon, France, September 9-11, 2015. *Online: http://www.ircobi.org/downloads/irc15/pdf_files/87.pdf*

Klausner, S.: **Fast Charging Technology for Public Transportation Systems.** MONORAILEX 2015, Las Vegas, USA, November 13, 2015

Knote, T.: **Battery-powered Bus Employs Fast Charging for Regular Operation.** *In: power electronics (online), URL: http://powerelectronics.com/power-management/battery-powered-bus-employs-fast-charging-regular-operation, June 19, 2015*

Kratzing, R.: **Dual Mode Energy Storage Using Multicore Technology.** 4th Generation Cluster Electric Vehicle Workshop, Graz, Austria, May 27, 2015

Liapis, A.; Seynaeve, G.; Olunczek, A. et al.: **A Position Paper on Improving Preparedness and Response of Health Services in Major Crises.** Second International Conference on Information Systems for Crisis Response And Management – Mediterranean Countries ISCRAM-med 2015, Tunis, Tunisia, October 28-30, 2015, presentation: G. Seynaeve



DAK

DRESDNER AUTOMATISIERUNGS-TECHNISCHE KOLLOQUIEN

Published in: Proceedings. Bellamine Ben Saoud, N.; Adam, C.; Hanachi, C. (eds.), Cham, Springer International Publishing, 2015, pp. 205-216, ISBN 978-3-319-24398-6

Michler, O.: **Energy Efficient Communication and Localization in Urban Traffic Environments Using WSN-based Devices.** SEMICON® Europa 2015, Dresden, October 6-8, 2015

Michler O.; Weber, R.; Förster G.: **Model-Based and Empirical Performance Analyses for Passenger Positioning Algorithms in a Specific Bus Cabin Environment.** Models and Technologies for Intelligent Transportation Systems Conference MT-ITS, Budapest, Hungary, June 3-5, 2015. *Published in: Online proceedings, IEEE, pp. 200-208, DOI: 10.1109/MTITS.2015.7223257*

Nitzsche, G.; Röbenack, K.; Wagner, S.; Zipser, S.: **Exact Input-Output Linearization for a Trailer Steering Controller.** 18th IEEE International Conference on Intelligent Transportation Systems ITSC 2015, Las Palmas de Gran Canaria, Spain, September 15-18, 2015, presentation: G. Nitzsche. *Published in: Proceedings. IEEE, 2015, pp. 962-967, ISBN 978-1-4673-6595-6*

Pietschmann, D.; Kratzing, R.; Potthoff, U.: **Voltage- and State-of-Charge-Managed Storage Integration for Grid Stabilization.** Energy, Science and Technology Conference EST 2015, Karlsruhe, May 20-22, 2015, poster presentation

Steinert, F.: **Challenges of Pure Electric Driving in the Field of Public Transport – Energy Efficiency as Necessity for Usability.** 4th International Conference on Energy Efficient Vehicles: Visions, Trends and Solutions for Energy Efficient Vehicle Systems ICEEV 2015, Dresden, June 16-17, 2015. *Published in: Proceedings. Bäker, B.; Morawietz, L. (eds.), Dresden, TUDpress, 2015, pp. 177-184, ISBN 978-3-95908-008-8*

- **Pushing the Boundaries of Small Spacecraft Technologies.**

  Prof. Yang Gao
  University of Surrey, Surrey Space Centre, United Kingdom, May 11, 2015

- **Modellierung und Zustandsschätzung für Lithium-Ionen-Batterien – eine praktische Sicht.**

  Dr.-Ing. Ralf Bartholomäus
  Fraunhofer Institute for Transportation and Infrastructure Systems IVI, July 6, 2015

- **Linearisierungen – Wege, um die lineare Theorie zu retten.**

  Priv.-Doz. Dr.-Ing. Lutz Gröll
  Karlsruhe Institute of Technology KIT, Institute for Applied Computer Science IAI, October 19, 2015

- **Modellprädiktive Regelung von Smart Grids.**

  Jun.-Prof. Dr. Karl Worthmann
  Technische Universität Ilmenau, Institute of Mathematics, November 16, 2015

The DAK is a cooperation between the Fraunhofer IVI and the Institute of Automation at the TU Dresden. The talks are held at the Fraunhofer IVI.

The full list of publications can be found in the German section on page 44.

TEACHING ENGAGEMENTS

Bartholomäus, Ralf

Optimale Steuerung kontinuierlicher Prozesse.
TU Dresden,
Faculty of Electrical and Computer Engineering,
Laboratory of Control Theory, SS 2015

Robuste Regelung.
TU Dresden,
Faculty of Electrical and Computer Engineering,
Laboratory of Control Theory, SS 2015

Kertzscher, Jana

Berechnung elektrischer Maschinen.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, SS 2015

Einführung in die Elektrotechnik.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, SS 2015,
WS 2015/16

Elektrische Energiewandler.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, SS 2015

Elektrische Maschinen und Antriebe.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Energiespeicher.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Energietechnik. (Lecture series)
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Grundlagen der Elektrotechnik.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, SS 2015

Hybrid- und Elektroantriebe.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Regelung elektrischer Antriebe I.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, SS 2015

Regelung elektrischer Antriebe II.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2015/16

Theorie elektrischer Maschinen.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Knote, Thoralf

Straßenverkehrstechnik.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Transport Planning and Road Traffic,
WS 2014/15, SS 2015, WS 2015/16

Klingner, Matthias
Elektroenergiesysteme.
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, SS 2015

Systemtheorie in der Anwendung. (Compact seminar)
TU Bergakademie Freiberg,
Faculty of Mechanical, Process and Energy Engineering,
Institute of Electrical Engineering, WS 2014/15, WS 2015/16

Michler, Oliver
Elektrotechnische, informations- und kommunikations-technische Grundlagen. (Teil II: Grundlagen der Informations- und Kommunikationstechnik)
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics, SS 2015

Fahrzeugkommunikation und Ortung.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics,
WS 2014/15, SS 2015, WS 2015/16

Satellitenkommunikation und positionsbezogene Kommunikationssysteme.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics,
WS 2014/15, SS 2015, WS 2015/16

Technik und Verfahren digitaler, adaptiver und intelligenter Systeme.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics,
WS 2014/15, SS 2015, WS 2015/16

Theorie und Technik der Informationssysteme.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics,
WS 2014/15, SS 2015, WS 2015/16

Verkehrssensorik.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics, SS 2015

Potthoff, Ulrich
Modellierung und Simulation in der Verkehrstelematik.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics, WS 2014/15, WS 2015/16

Modellierung und Simulation 2.
TU Dresden,
»Friedrich List« Faculty of Transportation and Traffic Sciences,
Institute of Traffic Telematics, SS 2015

Rauschert, André
Ideen-, Innovations- u. Change Management.
Gründungsmanagement.
Hochschule Mittweida (FH),
Faculty of Economic Sciences, Faculty of Media Sciences
WS 2014/15, SS 2015, WS 2015/16

The Fraunhofer IVI employees supervise many final papers, including PhD and Master's theses, each year.
A full list of 2015 theses can be found in the German section of the institute report on pages 49 and 51.

LIFE AT WORK AND BEYOND

Ensuring job satisfaction and career flexibility is an important internal goal of the Fraunhofer-Gesellschaft. The Fraunhofer IVI supports the reconciliation of professional and private life through a variety of offers for the employees.

Special attention is given to preventive health care at the institute. In addition to using the in-house gym and participating in annual sports events such as the Rewe Team Challenge and the dragon boat race, employees have the opportunity to get therapeutic back massages at the institute on a regular basis.

At this year's Health Day, information was given about preventive measures in health care and new developments in traffic law. Later in the day, the employees were invited to visit several info booths and have different health aspects checked that are relevant to their working capacity.

For the social well-being of the employees, the institute offers coaching in times of crisis and day care for children. In addition, a KidsOffice was established in 2013 providing several work stations for parents and enough room to play in for their children.

In order to balance research and free time even after working hours and at the weekends, the employees are free to use the institute's two electric BMW i3 vehicles for logged private trips.

Special events such as the company excursion to the Schloss Proschwitz vineyard and the Christmas party in Dresden-Pillnitz topped off the harmonious work atmosphere and were some of 2015's highlights for the staff.

HOW TO REACH US

DIRECTIONS

By **public transport** from Dresden Hauptbahnhof/ Main Station, take bus 66 in the direction Technische Universität, ride three stops to »Mommsenstrasse«, 5-minute walk from there (or take a taxi from Dresden Hauptbahnhof/Main Station, ca. 2 km)

From all directions coming from **motorway junction** »Dresden-West«, change to Autobahn A17 in the direction Pirna/Prag. Take exit »Dresden-Südvorstadt«. After ca. 3 km on the B170 (Bergstrasse) in the direction Dresden, turn right into Zeunerstrasse. Information about parking facilities will be given at the reception desk

From **Dresden Airport**, take a taxi (15 km) or the S-Bahn train via Dresden-Neustadt to Hauptbahnhof/Main Station (approx. 22 minutes)

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

Zeunerstrasse 38
01069 Dresden
Phone +49 351 4640-800
Fax +49 351 4640-803

EDITORIAL NOTES

DIRECTOR

Prof. Dr. Matthias Klingner
Phone +49 351 4640-800
matthias.klingner@ivi.fraunhofer.de

ADMINISTRATION

Kornelia Brüggert
Phone +49 351 4640-670
kornelia.brueggert@ivi.fraunhofer.de

COMMUNICATION AND DESIGN

Elke Sähn
Phone +49 351 4640-612
presse@ivi.fraunhofer.de

INTERNATIONAL BUSINESS

Mandy Koritz
Phone +49 351 4640-637
mandy.koritz@ivi.fraunhofer.de

EUROPEAN BUSINESS

Daniela Larsen
Phone +49 351 4640-817
daniela.larsen@ivi.fraunhofer.de

www.ivi.fraunhofer.de

CONCEPT AND EDITING

Elke Sähn
Kathy Lindt

SETTING AND LAYOUT

Gitta Neumann
Manuela Stahr

TRANSLATION

Kathy Lindt
Bettina Adler

PHOTO ACKNOWLEDGEMENTS

Elke Sähn
Manuela Stahr

Fraunhofer IVI	p. 20, 24, 28, 50-51
DHL Supply Chain	p. 26

PRINTED BY

SDV
Die Medien AG.

Tharandter Strasse 23-35
01159 Dresden
Phone +49 351 4203-1305
www.sdv.de