Development of digital technologies

Digitisation – the future of our economy

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Content

Development of digital technologies

Our tasks in the Division responsible for the "Development of digital technologies" revolve around the promotion of research and development at the precompetitive stage. The aim of our work is to pick up on key trends at an early stage and to accelerate the process of transferring scientific findings into the development of marketable high-tech technologies with high-level potential for practical applications.

All of the research programmes that receive funding involve model users who pilot the developments in order to establish their technical and economic viability. The results are then used as a starting point for the creation of market-ready products, solutions, and business models, particularly for SMEs.

The research covers a broad spectrum of different projects, from the development and testing of a smart, ICT-based energy system fit-for-the-future, which integrates electric mobility (the Internet of Energy), web-based knowledge infrastructures that pave the way for new electronic services (the Internet of Services), to the networking of "smart objects" for industrial and home applications (the Internet of Things).

Currently, most of the funding is devoted to the following programmes:

- **Trusted Cloud** – to develop and test innovative, secure and legally compliant cloud-computing solutions

- **ICT for Electric Mobility II** – Smart Cars, Smart Grids, and Smart Traffic

- **Autonomics for Industry 4.0** – to identify forward-looking approaches for smart production technologies and smart products

- **Smart Data** – to develop and test new technologies that enable big data to be used in both the private sector and by the general public in a secure and legally compliant manner

- **ICT for Electric Mobility III** – focusing on the key areas of logistics, mobility and energy infrastructure (from 2015)

- **Smart Services World** (from 2016), to connect digital user areas using a targeted, secure combination of cyber-physical systems, data management technologies, and open service platforms

New technologies for the Internet of Services

The internet has become one of the most important infrastructures in modern business and society. It opens up new possibilities for knowledge-intensive services that involve a high level of automation and which range from specific tasks undertaken (e.g. use in x-ray diagnostics) up to complete end-to-end service chains (e.g. in logistics). Today, any company that wants to compete successfully in the domestic and global markets has to ensure that electronic services are integrated well into its business processes. However, the increasingly complex administration and storage of "big data", and the scalability of services pose new challenges, particularly for SMEs. When it comes to cloud computing, much is expected in terms of the economic viability and efficiency of ICT services. There are also challenges concerning the uptake and security of these technologies, as well as their conformity with the law. The availability of ever greater pools of information as part of "Big Data" opens up brand new opportunities for knowledge acquisition. Other challenges include ensuring interoperability between sensor and data infrastructures cutting across companies and processes. These infrastructures serve to support the continued development of our digital economy.

Foundation: THESEUS lighthouse project – tapping the potential of the information available on the internet

The aim of the THESEUS programme was to generate prototype solutions for accessing information via the internet and to develop automated means of processing services and data available on the web. The individual THESEUS projects explore a range of new services and service platforms for various fields of application both for home and private-sector use.

The THESEUS programme	
Number of projects: 28	Period of duration: 2007-2012
Number of partners involved in the project: around 60	Total funding: around €100m
Further information is available at http://theseus.pt-dlr.de/en/index.php	

The technological focus of the project was to develop automated means of processing multimedia content (text, audio, and video formats), generate semantic knowledge models (ontology management), create context-sensitive user-interfaces, visualise complex information, and develop computerised processes of capturing and interpreting data (machine-learning systems). The technologies developed were tested in six application scenarios and 12 SME projects. Over 1,200 individual results were gathered during the course of the THESEUS research project.

Trusted Cloud – reliable cloud solutions for SME

With Cloud Computing, companies can make use of current software versions, computing power and storage space directly via the internet. This enables SME to take advantage of technologies that so far were mostly used just by large companies. With the Cloud Computing Action Programme the Federal Ministry, in cooperation with private enterprises and science organisations, addresses relevant challenges in the field of cloud computing. The technology programme "Trusted Cloud – Innovative, Secure and Legally Compliant Cloud Computing" is the main BMWi contribution to the Action Programme.

The Trusted Cloud programme	
Number of projects: 14	Period of duration: 2010-2015
Number of partners involved in the project: around 65	Total funding: €50m
Further information is available at http://trusted-cloud.de	

In the context of the Trusted Cloud technology programme, the advantages of cloud computing are developed and demonstrated along with concrete pilot applications. The evolving reference examples are suitable for being used in various branches – in industry, the crafts , the health sector, and the public sector. Concurrently, these solutions are supposed to be transferable to other usage areas.

The Cloud4Health project

Cloud4health offers legally compliant solutions which enable personal, medical data to be processed securely. It uses scalable cloud-technologies which allow large volumes of data to be processed in a flexible and affordable way.

Smart Data – Innovation from data

The realms of information available on the internet pose new challenges in terms of data-management and data-processing. However, they also open up far greater possibilities when it comes to data analysis and information gathering (big data). Combining everyday infrastructures and objects with information and communication technologies leads to exponential growth in the volume of data being processed and, at the same time, creates brand new application and usage scenarios, and opportunities for a whole host of new services, especially for business.

The Smart Data programme	
Number of projects: 13	Period of duration: 2014-2017
Number of partners involved in the project: 65	Total funding: around €30m
Further information is available at http://www.smart-data-programm.de	

The Smart Data programme aims to identify practicable, secure, and legally compliant solutions that allow mass data to be processed and will test these ideas using different prototypes across specific usage scenarios.

The PRO-OPT project

Industrial production processes, such as those used in the automotive industry, are characterised by a high degree of division of labour which extends beyond the individual company. The PRO-OPT project has been set up to improve the handling of data that is needed in the context of processes that take place between different companies. The project will develop a smart data platform for decentralised data analysis and its visualisation which particularly takes into account local data sovereignty and different data qualities. In this way, PRO-OPT enables companies which increasingly interact in networked structures to use internal and external data flows more effectively. The project partners are hoping that this will reduce errors in production and make supplier chains used in car-making more efficient.

Smart Services World – ICT-based services for networked processes

The introduction of technologies that are summed up as the "internet of things" (cyber-physical systems) is taking digitisation in industry to a whole new level. This is particularly true as far as the digitisation of manufacturing ("Industry 4.0") is concerned, but also extends to other infrastructure that businesses and society as a whole depend on. The networked metering and control components are controlled by software and produce mass data, which is then processed in cloud computing centres in a highly automated way. This mass data provides the basis for brand new smart products and ICT-based services, which are also

known as smart services. Most of the systems that are currently available, however, are run in an isolated manner or are incompatible with others. This prevents data collected by different systems from being brought together and creates gaps in the value chain that in turn result in major potential being lost for the industry and society at large.

Programme: Smart Services World	
Number of projects: currently in the planning stages	Funding period: 2014–2017
Number of partners involved in the project: currently in the planning stages	Total funding: currently in the planning
For further information, please go to: http://www.smartservicewelt.de	

The new clusters which are being funded under the new Smart Services World programme have been tasked with developing and testing prototypes that make targeted use of cyber-physical systems in manufacturing (Industry 4.0), in various industries, and in private and public-sector infrastructures. These systems are to be used to aggregate and mine data, create value-added from it and make it available and accessible to industry via online platforms.

Technologies for the Internet of Things

The Internet of Things makes objects and everyday appliances "smart" through the use of programming, memory capacities, sensors, and technology for communication. These items can independently exchange information with one another, initiate various actions, and exert reciprocal control over each other. The opportunities created by this development are used in the general interest of society and to boost economic growth. The Internet of Things was declared a lighthouse project at the National IT Summit. The Federal Ministry of Economics and Technology provides funding for research into the Internet of Things in strategically important areas of application, such as manufacturing, logistics and home automation.

Foundation: Next Generation Media – Networking our working and living environments

The Next General Media technology programme provided funding for 11 collaborative projects which explored new opportunities linked to electronic networking, and focused on ubiquitous computing and its use in specific fields of application.

The Next Generation Media programme	
Number of projects: 11	Period of duration: 2005-2011
Number of project partners: 70	Total funding: €37m
Further information is available at http://www.nextgenerationmedia.de/en/index.php	

Through its Next Generation Media programme, the Federal Ministry of Economics and Technology has made a major contribution to cutting-edge innovations in production and logistics, consumer electronics, and health care. Examples of new developments include complete traceability for parts in the automotive and textile industries using RFID tags, the use of self-powered sensor networks to wirelessly assess the condition of a machine, the world's first approval-related study on remote health monitoring based on a new care model, the concept of a digital butler for the comprehensive management of home networks, and the first comprehensive model for machine lifecycle management.

Autonomics – autonomous and simulation-based systems for SMEs

The Autonomics programme was about forward-looking approaches to the development of a new generation of smart tools and systems that are capable of autonomous action – i.e. of networking with each other independently via the internet, maintaining situational awareness, adapting to changing operational conditions, and interacting with users. The programme primarily focuses on applications iin the logistics and transport sector as well as in service robotics.

The AUTONOMICS programme provided funding for R&D projects in the fields of manufacturing, logistics, and assembly. The outcomes and findings of these projects form an important basis for the programme entitled "autonomics for Industry 4.0 – manufacturing, products, services and the multidimensional internet of the future" launched by the Federal Ministry for Economic Affairs and Energy in 2013.

In addition to focussing on technological developments, Autonomics also deals with important issues across multiple sectors, including human-machine interaction, industrial service robotics, and reference architectures for autonomous systems. This also involves consulting with experts from industry and business in interdisciplinary forums. Six sets of guidelines have been published based on the outcomes of the projects. These provide a basic overview of current issues in the development and use of autonomous technologies and thus enable the outcomes of the Autonomics projects to be used for the intended purposes, as well as in other fields of application.

The Autonomics programme	
Number of projects: 14	Period of duration: 2009-2014
Number of project partners: 100	Total funding: €55m
Further information is available at http://www.autonomik.de/en/index.php	

The Marion Project

The Marion (mobile autonomous cooperative robots in complex value chains) project centred on introducing robots into work flows involving autonomous vehicles. The brief here was to do accomplish this across the entire value chain and to ensure that all the machines involved should cooperate with one another. The project succeeded in developing autonomous mobile machines for the two fields of application (indoor and outdoor logistics). These machines are smart enough to be able to autonomously respond to changes in their surroundings. The technology behind these machines includes sensors that capture their surroundings and an over-arching route-planning system, which calculates the situation at a given time by dynamically working with the information captured by the sensors. The result of this planning is then transmitted wirelessly to the network linking the mobile machines, which can then go on to independently carry out the harvesting process or unload the lorry in the warehouse, for instance. The project has resulted in the creation of autonomous harvesting and transport systems which are fully integrated into the value chain and can thus further improve resource efficiency. Some key elements of the vehicle control systems are being developed for large-scale production and will be available on the market as of 2016.

Autonomics for Industry 4.0 – Production, products, services in the multidimensional internet of the future (starting 2013/2014)

Autonomics for Industry 4.0. uses state-of-the-art ICT to reduce the amount of energy required in manufacturing processes, whilst also aiming to make these processes more environmentally friendly and efficient in terms of material wear. Another aim of the programme is to foster the development of a highly flexible production infrastructure that is able to respond to customer demands for highly individualised products (batch size 1). In turn, this is to stimulate the development of innovative premium-level products (e.g. service robots) that offer particular benefits, added value, and are thus highly attractive for users from the various industry sectors and for consumers alike. The idea is to allow for the manufacturing of high-performance products like these at marketable prices by relying on state-of-the-art, ICT-based manufacturing processes, by using modular models, and by making use of economies of scale.

The new programme is to address a range of technologically important issues, including innovative methods of human-machine interaction, the use of 3D technologies in industrial applications, as well as cognitive features that enable systems to act independently. Furthermore, it will explore important issues that cut across multiple sectors, including legal aspects and functional security requirements linked to the use of autonomous systems, and will also consider standardisation requirements.

The Autonomics 4.0 programme	
Number of projects: 102	Period of duration: 2013-2017
Number of project partners: 102	Total funding: around €42m
Further information is available at http://www.autonomik40.de/	

Networking the home from out-and-about – integrated smart-home solutions of the future

A growing share of household appliances and components are capable of being integrated into networks. They are smart objects that allow for complex systems to interact with one another. If equipped with the right software and sensors and actuators, they can independently solve tasks, perform functions, and communicate with other smart objects via the internet. This makes the smart home a perfect a perfect illustration of the many challenges posed by Industry 4.0 and addressed by the AUTONOMICS technology programme.

The Connected Living programme	
Number of projects: 6	Period of duration: 2010-2016
Number of project partners: 43	Total funding: around €13m
Further information is available at http://www.connected-living.org/en/	

Over the coming years, home and building networking technologies have the potential to provide major market opportunities. In order to make use of this potential, different industries – such as ICT, household appliances, consumer electronics, heating and cooling, the energy industry – will have to join forces to create accepted and over-arching solutions and standards. Therefore, a primary funding aim in the area of smart homes is to bring together important partners from different sectors in order to develop new and forward-looking solutions for using smart networking in the home, as well as sustainable business models.

Smart Home & Building Certification project
The Smart Home & Building Certification project focuses on making the market for home networking solutions more transparent, and on boosting market growth in this area. The aim is to instil greater consumer trust in the solutions available and also obtain investment security. The project is to develop and pilot a certification scheme that enables smart home appliances and systems to be tested for interoperability, information security, and functional security.

A quality mark or label will indicate to customers that the product meets compatibility requirements. The industries affected by these developments have been closely involved in this project from the outset.

The Universal Home Control Interface (UHCI) project
Concepts for easy-to-use and state-of-the-art interaction technologies for the smart home.

The ProShape Project
Hard- and software solutions for flexible energy supply at the lowest possible cost.

Technologies for the Internet of Energy

Our energy landscape is undergoing fundamental changes. We are deriving more and more of our electricity from renewable sources. This means that the energy industry has major challenges to face: It is difficult to predict the hours of sunshine and the force of the wind, and it lies in the nature of renewables that they are highly volatile energy sources. In the interest of grid stability, it is vital to balance the amount of electricity fed into the grid at a given time with the amount that is taken off the grid.

Foundation: E-Energy – decentralised energy marketplaces of tomorrow

The E-Energy programme served to develop new solutions for the Internet of Energy and to test these new approaches in real-life scenarios. This led to the development of new ICT products, processes and services which can help improve energy efficiency and security of supply, whilst also making a contribution to mitigating climate change. The "E-Energy" programme also demonstrated that there is potential for new markets and professions in an emerging field at the crossroads between the energy and ICT industries.

The E-Energy programme, which was a joint initiative of the Federal Ministry of Economics and Technology and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety made a vital contribution to speeding up the German energy reforms.

The E-Energy programme	
Number of projects: 6	Period of duration: 2008-2013
Number of project partners: 56	Total funding: €60m
Further information is available at http://www.e-energy.de/en/	

The new E-Energy systems that were developed as part of the individual projects funded under this programme were thoroughly tested in real-life scenarios across 6 selected pilot regions. This led to the development of concepts for

integrated ICT systems designed to improve every aspect of the overall power supply system and thus deliver the best possible solutions for generating, transporting, distribution and consumption of electricity.

IT2Green: energy efficient ICT systems

The IT2Green technology programme was launched to provide funding for innovative pilot projects which aim to develop comprehensive solutions that make the use of ICT in data processing centres, telecommunications networks, and office and home appliances more energy-efficient. IT2Green is made up of three clusters in three regions, each focusing on a different area of research: telecommunications networks, data processing centres and cloud computing, and monitoring and management.

The IT2Green programme	
Number of projects: 10	Period of duration: 2008-2013
Number of project partners: 49	Total funding: €60m
Further information is available at http://www.it2green.de/en/index.php	

The telecommunications networks cluster seeks to improve the way activities and loads are managed in wireless networks and landlines in order to achieve the best-possible standards of energy-efficiency. The work that is being conducted in the area of data processing centres and cloud computing focuses on data management and a smart distribution of information load – again to achieve better energy-efficiency. The solutions are to be partly based on cloud-computing technologies.The monitoring and management cluster focuses on developing and testing new measurement and control procedures that will help to make information and communications technologies more energy-efficient.

The ComGreen project

The ultimate goal of this research is to provide every user of telecommunications networks anywhere in the country with the transmission capacities they actually need – unlike now where maximum capacity is used. In order to achieve this, the project involves the development of an architecture that allows the network parameters to self-organise. The system is flexible and capable of adjusting to the context in which the network is being used. It thereby ensures that quality services are provided in as energy-efficient a mannerng any hardware that is not needed to be switched off.

ICT for electric mobility II: Smart Car – Smart Grid – Smart Traffic

The ICT for electric mobility II programme focuses on the latest information and communication technology (ICT) as a crucial factor for the future success of electric mobility.

This programme combines three different areas of research: The focus of the research into smart cars is on developing and testing new ICT architectures for electric cars. These will help reduce the weight and cost of future generations of electric cars and lay the basis for more convenience and new entertainment and safety features. The aim is to rely on software rather than hardware, wherever possible, and to replace the many control devices and cable connections found in vehicles today with a small number of main computer units. This concept could make a major contribution to reducing complexity in automotive engineering.

The research that is being conducted into smart grids focuses on finding smart solutions for integrating electric vehicles into the overall energy supply system. These solutions are to allow vehicles to be charged in a way that does not put undue strain on the grids, whilst also tapping the potential of renewable energies. It is to this end that ideas for controlled charging, feeding back electricity from

batteries of electric cars, and standardised access to charging infrastructure are being developed and tested. Another issue that has to be addressed in this context is how payments for electricity used to recharge the batteries of electric cars can be settled in a way that is both economical and simple.

The third area of research that is covered by this programme is smart traffic. Here the focus is on integrating electric vehicles in modern transport infrastructures. More specifically, the research work in this area involves developing standardised interfaces in order to reduce traffic congestion, maximising the range of electric vehicles, and finding ICT solutions for the management and route planning of entire electric vehicle fleets.

The total investment of €140m across the 16 projects currently funded by this programme is being used to develop comprehensive concepts for electric mobility and to thoroughly test them in the field. This also includes concepts for using electric mobility in areas where little use has been made of it to date: in trade, in closed logistics systems (Hamburg container port), in agriculture, in taxis, and in fleets that are shared by several companies.

ICT for Electric Mobility II is part of both the Federal Government's Electric Mobility Programme and its Digital Germany 2015 strategy. It builds upon the results of the ICT for Electric Mobility I programme designed by the Division for the Development of Convergent ICT. The focus of this earlier programme (2009-2011) had been on the development and testing of open, ICT-based system solutions for the best-possible integration of electric vehicles in transport systems and energy grids. Most of the research was dedicated to ICT-based charging, control, and settlement infrastructures and to their implications for new business models, services and standards. Projects tested across seven pilot regions received funding under the programme. The over-arching aim of ICT for Electric Mobility was to pave the way for the everyday use of electric vehicles and fleets of electric vehicles.

The ICT for electric mobility II programme	
Number of projects: 18	Period of duration: 2012-2016
Number of project partners: 124	Total funding: around €77m
Further information is available at http://www.ikt-em.de/	

Integrating commercial e-vehicles in logistics, energy, and mobility infrastructure

The commercial vehicles market segment is highly diverse and offers tremendous potential for electric mobility – potential that has remained largely untapped. Initial findings of the ongoing research programme entitled "ICT for electric mobility II" suggest that there can be not only an environmental, but also an economic case for using electric drivelines in commercially used cars, light duty commercial vehicles, busses, tractors, and heavy duty vehicles which are part of a closed-loop logistics system.

Programme: ICT for electric mobility III	
Number of projects: currently in the planning stages	Period of duration: 2015-2019
Number of project partners: currently in the planning stages	Amount of funding: approx. €30m
Further information is available at http://www.ikt-em.de/	

The idea behind the technology competition is to identify profitable applications of electric mobility for the commercial vehicles segment and help them to achieve a breakthrough. To this end, various fields of application for commercial mobility (including on-site and city logistics, agriculture, the construction sector, public transport and taxis, fleets) are being tested to see if electric drivelines could be of use in these areas. This includes pilot projects in these fields of application. The focus here is not on the development of electric vehicles and drivelines as such, but on the way they can be integrated in over-arching ICT-based logistics, energy management, and mobility concepts.

The RACE project
In their RACE project, Siemens and its partners are working on a uniform and open ICT architecture for electric vehicles and are creating prototypes. The project was set up to address the fact that the ICT architectures used in vehicles have become increasingly complex over the years. The idea behind RACE is to ensure that new infotainment and driving and assistance features can be added on by simply installing software on existing hardware, so as to eliminate the need for specific hardware or additional control devices.

Strategic technology projects

Strategic technology projects serve to advance selected cutting-edge, forward-looking technology solutions, which the Economics Ministry sees as potential game-changers within the ICT sector. Some of the wide variety of projects are designed to lay the groundwork for future larger-scale projects. Current strategic technology projects include:

- **Automated Stereo Production ASP** – development of a prototype for a robust and cost-effective 3D camera system
- **CultLab3D** – aims to substantially speed up digital 3D scanning and recording of cultural goods.
- **Smarter Privacy** – to ensure that smart grid technology complies with existing data privacy regulations
- **motionEAP** – a system based on motion sensing and projection, which is designed to assist with and improve the efficiency of corporate manufacturing processes
- **Symphony:** A marketplace and management platform for telecommunication services
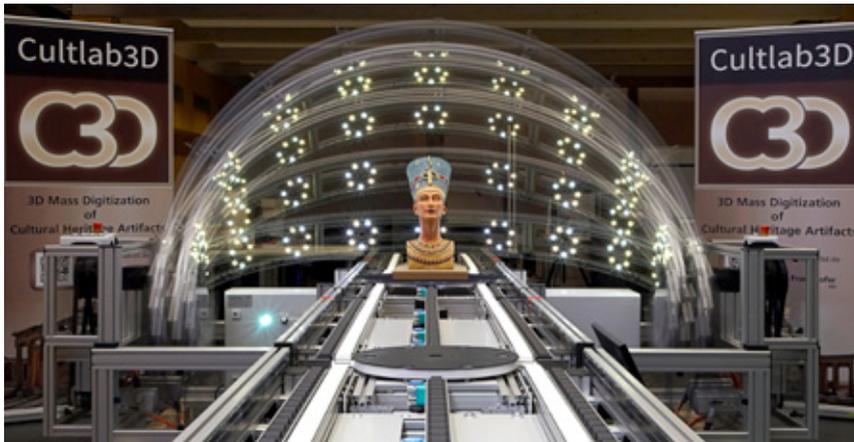
Contact

Federal Ministry for Economic Affairs and Energy
Head of Division VIB3; Development of convergent ICT
Dr. Alexander Tettenborn, LL.M (USA)
Scharnhorststrasse 34 – 37
D-10115 Berlin, Germany
www.bmwi.de

Tel.: +49 30-186156330
Fax: +49 30-18 615-5496
Email: Buero-VIB3@bmwi.bund.de

German Aerospace Centre – Project Management Agency (PT-DLR),
on behalf of the Federal Ministry of Economics and Technology
– Technical innovation in business –
Dr Christian Schmidt
Linder Höhe
D-51147 Köln, Germany
www.pt-ikt.de

Tel: +49 2203 601-4090
Fax: +49 2203 601-3017
Email: c.schmidt@dlr.de