



Federal Ministry
for Economic Affairs
and Energy

Development of digital technologies

Digitisation – the future of our economy



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All 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:

- **“Digital technology for the economy – PAiCE”** in which pioneering technology fields such as product engineering, agile logistics, service robotics, industrial 3D applications and industrial communication as well as their interconnectivity are addressed, which are particularly relevant for the digitalisation of the economy.
- **“Smart Data”**, to develop and test new technologies that enable big data to be used in both the private sector and by the public in a secure and legally compliant manner.
- **“ICT for Electric Mobility III”** focusing on the key areas of logistics, mobility and energy infrastructure.
- **“Smart Services World I and II”** to connect digital user areas using a targeted, secure combination of open service platforms, data management technologies, and Internet of Things.

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 must 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: Trusted Cloud – reliable cloud solutions for SMEs



With Cloud Computing, companies can make use of current software versions, computing power and storage space directly via the internet. This enables SMEs 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 programme: Trusted Cloud

Number of projects: 14

Period of duration: 2010–2015

Number of partners involved in the project: around 65

Total funding: €50m

Further information: <http://www.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, crafts, the health sector, and the public sector. During this process great attention was paid to the special requirements and needs of SMEs.

One outcome of this technology programme was the establishment of the association “Kompetenznetzwerk Trusted Cloud e.V.”, founded in mid-2015. The association has the task of developing and establishing a quality seal for trustworthy Cloud services.

Another outcome is the test standard for data protection certification which was developed in the Trusted Cloud technology programme: the Trusted Cloud Data Protection Profile for Cloud Services (TCDP). It is currently available in a 1.0 version, which was released in September 2016. The purpose of TCDP is to provide data protection certification in accordance with the Federal Data Protection Act. It illustrates the legal requirements on commissioned data processing in the form of a test standard and differs to that extent from data protection quality seals.

In a further activity, starting from 2017 the TCDP will be aligned with the General Data Protection Regulation of the European union, which will come into force from May 2018.

Smart Data – Innovation from data



Smart 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.

In 2016 the Smart Data Forum was founded to cross-link the research programme Smart Data nationally and internationally and to accelerate the transfer of knowledge and results. The aim of the Forum is to pool big data activities in Germany and in doing so to bring together all key stakeholders from business, science, politics and society that are part of the triangle research-innovation-education. The Smart Data Forum will promote innovative solutions and technologies from current research projects as well as products on offer by young and established German companies and will build a demonstration and experimental space for smart data solutions in Berlin.

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 Smart Data programme: Smart Data

Number of projects: 14

Period of duration: 2014–2017

Number of partners involved in the project: 69

Total funding: €32m

Further information: <http://www.smart-data-programm.de>

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 – however the results can also be applied in other sectors, for instance medical engineering, electronic energy, Ambient Assisted Living and Intelligent Mobility.

Smart Services World – ICT-based services for networked processes



The digital transformation is progressing at high speed world-wide. With this transformation more and more machines, products and equipment (“cyber-physical systems”) are being permanently interlinked via the internet. This produces more and more data that can be automatically analysed, processed and linked together. Combining this existing data presents a great opportunity to use this to develop intelligent services, so-called Smart Services.

The development of Smart Services opens up many new possibilities for entrepreneurs and citizens: Smart Services will not only lead in manufacturing companies to a new quality level in corporate and transnational production and value networks that make a high degree of automation possible as well as cost-effective, customised manufacturing (batch size 1). In our everyday lives

Smart Services can improve the mobility of people and goods using innovative concepts, make better medical supplies available to chronically ill patients, contribute to the optimisation of the local water and power supply or increase our security and home convenience in old age.

Digital platforms and the Smart Services running on these will fundamentally change the way that added value can be created. With the technology programmes Smart Service World I and II the aim is to set out clearly the opportunities and benefits for the economy and society using concrete examples, which improve the basic conditions of the digital transformation and strengthen competitiveness in the digital economy.

The “**Smart Service World Programme – Internet-based services for the economy**” includes 20 collaborative projects in the areas of

- Production (e.g. services for system optimisation, for agriculture or in the form of visualisation services),
- Mobility (e.g. app integration in vehicles, vehicle data collection),
- Quality of life (e.g. water management services, patient-doctor communication services),
- Cross-sectoral technologies (e.g. for interoperability, security and credibility of services).

The programme: Smart Services World I

Number of projects: 20

Period of duration: 2014–2019

Number of partners involved in the project: 115

Total funding: €57m

Further information: <http://smartservicewelt.de>

Smart Farming Project

In the Smart Farming World Project the technological foundation is laid to intelligently integrate agricultural processes with one another regardless of the manufacturer. Today agricultural machines already have a variety of sensors which collect mechanical and process-related information. All information collected will be combined with topology data, weather forecasts, data from the current harvesting process, etc., whereby, for example, optimum fertilisation and harvesting strategies as well as automation of processes are made possible. In addition, an app store is set up, which brings together smart business applications. The apps will run directly on agricultural machinery and profit from the existing sensor technology.

The programme “**Smart Services World II – new areas of application for digital services and platforms**” is designed to tap into application fields that are underrepresented in the programme Smart Services World I. Another aim is to promote applications for small towns and rural regions. The programme addresses services in the following areas of application:

- Employment (e.g. to secure employment or curb the shortage of skilled workers, etc.),
- Mobility (e.g. new logistics solutions, services for multi-modal public transport use, autonomous driving, etc.),
- Living (e.g. digital services for assistance in old age, to increase building safety and comfort, etc.),
- Basic Services (e.g. Smart Services for use in energy supply, supply of goods and services, primary health care, etc.).

The programme: Smart Services World II

Number of projects: currently in planning stages Period of duration: 2016–2021

Number of partners involved in the project: currently in the planning stages Total funding: €50m

For further information, please go to: <http://www.smartservicewelt2.de>

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 for Economic Affairs and Energy provides funding for research into the Internet of Things in strategically important areas of application, such as manufacturing, logistics and home automation.

Foundation: 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 opera-



tional conditions, and interacting with users. The programme primarily focused on applications in 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 formed 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 dealt with important issues across multiple sectors, including law, human-machine interaction, industrial service robotics, and reference architectures for autonomous systems. This also involved 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 partners involved in the project: 90

Total funding: €55m

Further information is available at <http://www.autonomik.de>

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 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 are now made available on the market.

Autonomics for Industry 4.0 – Production, products, services in the multi-dimensional internet of the future



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 programme addresses 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 explores important issues that cut across multiple sectors, including legal aspects and functional security requirements linked to the use of autonomous systems, and considers standardisation requirements.

The Autonomics 4.0 Programme

Number of projects: 16

Period of duration: 2013–2017

Number of partners involved in the project: 102

Total funding: €44m

Further information is available at <http://www.autonomik40.de/>

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

Our own homes are becoming more intelligent. More and more common household appliances are connected to the internet. With its many useful features, smart technology is there to assist us in coping with everyday life: the smart home optimises energy consumption, detects intrusion attempts in houses and flats, alarms residents and records action as it happens. The idea is to enable ill, frail or dependent people to continue being self-sufficient for longer by living in the smart home. Whilst the smart home of tomorrow can increase the security and comfort of people in their homes, in order to do so it forces the residents to accept a certain invasion of their privacy. When developing this technology further, a key goal must be to noticeably strengthen consumer trust and acceptance of this new technology. This is also what will be required to successfully tap into the market. Data protection and data security must be guaranteed, market transparency and investment security must be improved. Products must also offer clear added value and be easy to operate. One goal of the programme is to provide impetus for the development of a leading German market for Smart Home/Smart Living technologies with identifiable USPs such as certified quality and security.

The programme: Smart Home/Smart Living

Number of projects: 6

Period of duration: 2010–2016

Number of partners involved in the project: 43

Total funding: €13m

Further information: <http://www.connected-living.org>

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 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. (www.zertifizierungsprogramm-smarhome.de).

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.

PAiCE (Platforms, Additive Manufacturing, Imaging, Communication, Engineering).

In the technology programme PAiCE new solutions spanning several links of the value chain are developed and tested by interconnecting different technology fields. For instance, innovative technologies and methods are developed, which open up new possibilities for universal product engineering and for correlating this with production processes. Dynamic process optimisation also means the implementation of innovative logistics solutions in a highly agile manner so that these may be adapted fast to changing market requirements or unforeseeable events. 3D technologies offer new possibilities in the development and optimisation of products, in process monitoring and in quality assurance. Thus, there are projects that involve production-on-demand and production-on-site concepts in conjunction with additive manufacturing. Storage costs can be saved, transport routes and times can be shortened and customer-specific production is made possible at a viable cost. These far-reaching integration processes require appropriately designed communication networks that are specially designed for requirements in the industrial environment. These include high scalability, availability, real-time capability and high security in terms of credibility and integrity. Service robotics also plays a significant role in the automation of industrial production. The development of service robotics for wide low-cost industrial use, especially for SMEs, is a core objective of PAiCE.

The programme: PAiCE

Number of projects: 14

Period of duration: 2016–2021

Number of partners involved in the project: 95

Total funding: €46m

For more information please go to: <http://www.paice.de/>

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 contributing 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 for Economic Affairs and Energy and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety made a vital contribution to speeding up the German energy reforms.

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.

The E-Energy Programme

Number of projects: 6

Period of duration: 2008–2013

Number of partners involved in the project: 56

Total funding: €60m

For more information please go to: <http://www.e-energy.de>

ICT for Electric Mobility III – Integrating commercial e-vehicles in logistics, energy, and mobility infrastructure



Since 2009 the ICT for electric mobility programme has focused on the latest information and communication technology (ICT) as a crucial factor for the future success of electric mobility. Here electric mobility is regarded as the link between the generation of electricity by renewable energy sources and the traffic sector.

On the one hand the focus lies in 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. Research is also being conducted into 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. One focus of what is now the third stage of the programme is on integrating electric vehicles in modern transport infrastructures. Here the main goal is to integrate commercial electric vehicles in logistics and mobility infrastructures.

From 2009 to 2015 projects have been funded with a total of ca. €100m. For the current programme the BMWi is providing a further ca. €50m in research funds from the Energy and Climate fund (EKF), which mobilise additional funds of the same amount from the research partners.

ICT for Electric Mobility III: Integrating commercial e-vehicles in logistics, energy, and mobility infrastructure

With the technology programme “ICT for Electromobility III: Integrating commercial e-vehicles in logistics, energy, and mobility infrastructure”, the BMWi is continuing its research activities into the commercial use of the electric mobility. The aim is to set new impulses for the break-through of electric mobility in the commercial vehicle sector.

A study published in February 2015 that was commissioned by the accompanying research for the funding programme revealed that there is economic potential for up to 700,000 commercial electric vehicles by 2020.

At the centre of the research work are ICT-based innovations in the fields of automotive engineering, fleet and logistics concepts as well as loading, communication and platform technologies. Another focus of the research is the integration of electric vehicles in intelligent energy and transport networks. Suitable technologies and services for this purpose are to be developed and field tested.

The ICT for Electric Mobility III Programme

Number of projects: 13

Period of duration: 2015–2019

Number of partners involved in the project: 90

Total funding: €50m

For more information please go to: <http://www.ikt-em.de/>

Fields of application in the research projects include the use of electric lorries in factory transport and in cargo logistics, passenger car and commercial vehicle fleets in commercial transport and in outpatient care services, electric buses, new light electric vehicles in the taxi sector as well as electric mobility for agricultural purposes and in combination with buildings.

The eJIT Project

The idea behind the eJIT project led by the automotive network AMZ Saxony and its partners is to develop a just-in-time logistics system based on e-mobility. To this end two heavy-duty prototype vehicles are being constructed and tested in a field trial at two major automotive locations in Saxony. Testing of electrically-driven semi-trailers in supply traffic has shown that using these vehicles leads to a significant reduction in both emissions and noise pollution for local residents as part of the supply traffic passes through the town. Future e-mobility technologies will be integrated in the semi-trailers and new driver-assistance systems will be installed.

Strategic Individual Projects

Strategic individual 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 individual projects include:

- **3DinMed** – 3D technologies in industrial and medical applications – development of innovative key technologies for the collection, processing and transmission of stereoscopic data and the autostereoscopic visualisation of these data
- **CultLab3D** – aims to substantially speed up digital 3D scanning and recording of cultural goods.
- **BakeR** – Modular design system for cost-efficient, cleaning robots – for the simple development of new service robot applications and the “robotization” of mobile machines.
- **Fast Genomics** – development of a prototype service platform and an ecosystem service in the field of genome data analysis
- **STORE FACTORY** – Smart Services in the urban production business model – investigating the economic and technical feasibility of producing consumer goods in a city.
- **VIRTUOSE-DE** – cloud-based service platform for the analysis and processing of real-time Big Data.
- **Symphony** – A marketplace and management platform for telecommunication services.

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