



Federal Ministry  
of Education  
and Research

# Research for Civil Security

Protection systems for security and emergency services



HIGH-TECH STRATEGY

Igniting ideas!

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of Education  
and Research

# Research for Civil Security

**Protection systems for security and emergency services**

# Forewords

The success of our export-oriented industry would not be feasible without the free movement of information, persons and goods. Secure energy and transport networks, Internet and telecommunications, food and healthcare provision are vital nerves of our highly networked society. However, Germany's high population density and sophisticated technological infrastructure mean that it is facing increasing new threats. The security risks have changed. Despite robust technologies, our supply networks are vulnerable to even just small disruptions: Global mobility allows danger to spread more easily and makes it more difficult to combat. Natural disasters and technological accidents, but also terrorism, crime and sabotage can cause serious damage in a closer knit world.

The Federal Ministry of Education and Research (BMBF) will be investing approximately 123 million euros in security research in the period up to 2010 under its Research for Civil Security Programme, which is part of the High-Tech Strategy for Germany. The aim is to develop innovations which will provide more security without at the same time encroaching on Germany's culture of freedom. It is the task of stakeholders in the research projects to take up the best ideas from science and research and integrate them in innovative security solutions. It is decisive to involve the entire innovation chain from research to industry and end users in public authorities and private industry.

Innovation in this context does not only mean new technological processes, but also includes innovative organizational concepts and strategies. Interdisciplinary projects involving the humanities and the social sciences, the transfer of knowledge to the public, accompanying research on critical issues and transparency are important preconditions for the success of security research.



The individual projects in the programme will be presented within the framework of a series of publications. The present brochure provides an overview of research work in the development of protective systems for security and emergency services. This includes equipment and supporting organizational measures for use in the event of a disaster. The research results contained therein form the basis for improving security standards in our country for the benefit of our people.

A handwritten signature in blue ink, reading "Annette Schavan".

**Prof. Dr. Annette Schavan, MP**  
**Federal Minister of Education and Research**

Threats such as heat, poor visibility conditions or barely accessible locations are all too familiar to professional security and rescue forces. Without the necessary equipment, they cannot succeed in many of the situations they face, such as the localization and rescue of injured persons who are trapped or buried under rubble. Numerous factors of all kinds play a decisive role, but are also difficult to assess simultaneously and can therefore be life-threatening.

It is precisely for this reason that communication and coordination during operations of this type demand the support of reliable and user-friendly technologies and instruments. So-called 'smart clothes', for example – intelligent functional and protective clothing for emergency forces, which features embedded sensor and communication technology. Such clothing must be further optimised in order for it to provide even more reliable support during use. The further development of special localization and navigation systems or research into the operational applications of a drone system for reconnaissance can also optimise operational processes.

The Scientific Program Board welcomes, above all, the emphasis on user-friendliness and man-machine interface. These key topics cover a broad spectrum – which is a good thing, because personnel involved on-site and in the control and command centre cannot manage operations successfully in the event of a crisis without the interaction of all of the emergency forces. Aspects such as the degree to which emergency teams and the general population accept innovations or the operability and utility of the technological solutions developed in these projects play a decisive role – and not only on a national level.

This is because situations like the ones described in the projects – situations where the innovations will be put to use – are international in both scope and interest.



This is also reflected in the wide range of ideas and innovations presented here: The necessary end-user-oriented development of integrated protection systems and equipment can be combined with a clear view toward the development of new markets. This, in turn, will enable us to further strengthen and expand the position of Germany in the field of civil security research.

A handwritten signature in black ink that reads "K. Thoma". The signature is written in a cursive, slightly slanted style.

**Prof. Dr. Klaus Thoma,  
Fraunhofer-Gesellschaft / Head of Ernst-Mach-  
Institut, Chairman of the Scientific Programme  
Board Security Research**



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# Innovations for civil security: Protection systems for security and emergency services

In an emergency they are the first to arrive at the place of operation and are often exposed to unknown hazards: rescue and relief personnel have to deal with threats such as intense heat and smoke generation, a pollution-laden atmosphere, contaminated ground conditions, poor visibility or places of operation that are difficult to access. At the same time they have to act quickly and precisely in order to gain control over hazardous situations. Reliable, safe and user-friendly protection technologies as well as communication and coordination tools play a decisive role during such operations – under certain circumstances a life saving one – and are thus an indispensable part of the body of a modern rescue organization.

In order to meet these requirements in an optimal way, one important objective in civil security research is to promote the development of integrated technological approaches. This involves matching different systems to one another and embedding them in an overall solution: systems ranging from telecommunications systems to vital sign sensors, which, for example, can be integrated directly into the protective equipment of emergency forces.

## Significance of the research topic

In recent years technological progress has produced a steady stream of increasingly robust and lightweight materials and textiles while contributing to the miniaturisation of wireless information systems and sensors. These new technological developments can help provide optimal protection for rescue forces during their deployment – and make it possible to manage operations with greater safety and efficiency.

The protective equipment of any modern rescue force starts with heat and chemical-resistant clothing. Breathable clothing plays a decisive role in extending the length of time that rescue forces can be deployed. State-of-the-art communication and navigation aids also represent indispensable tools that permit rescue forces to get their bearings during an operation, for example in smoke-filled buildings. And the systems must operate reliably under extreme conditions, too. For this reason, new and refined safety engineering developments are needed, in which the latest communications

and material solutions are tailored to the specific requirements of rescue forces and ultimately integrated into improved protection systems.

The present brochure presents projects<sup>1</sup>, for which the funding totals about 23 million euros in all, together with the players involved. The Federal Ministry of Education and Research (BMBWF) provides this funding in order to promote the development of integrated protective systems and equipment as well as the preparation of supporting organizational measures for use in the event of a disaster.

## Protection systems for security and emergency services in the Research Programme for Civil Security

The Security Research Programme that the federal government adopted on 24 January 2007 as an element of the high-tech strategy for Germany focuses on improving the protection of citizens. The aim is to counteract threats to society posed by terrorism, organized crime, natural disasters or major technical accidents. The programme is characterized by



<sup>1</sup> The AIRSHIELD, I-LOV, Landmarke, LUMITEX, SAFE and SensProCloth projects are assigned to the funding priority “Integrated Protection Systems” of the “Research for Civil Security” programme; the “FeuerWhere” project is funded within the framework of the ICT 2020 research programme.

practical work extending the entire length of the innovation chain, from research and industry to end users. Partners involved as end users in the research area “Integrated Protection Systems” include infrastructure operators from private industry as well as state authorities and organizations with security-related tasks – such as fire brigades, police and the Federal Agency for Technical Relief, for example. This serves to ensure that the newly developed technologies fulfil the intended purpose in practice and are easy and safe to use at the same time.

However security cannot be achieved by the development and use of technologies alone. Especially within the context of developing and optimising robust protective systems and equipment, user-friendliness and the acceptance of security measures are of crucial importance for emergency forces in extreme situations. For this reason, as part of their scope, the projects evaluate the ergonomic properties of the protective systems developed and optimize human-machine interfaces through examination of psychological effects under operation conditions. The solutions to be developed are also evaluated in terms of ethical, legal and data protection aspects. Requirements for the education and training of rescue and security personnel are also analysed and the results are used to develop decision-making aids for authorities and emergency personnel.

The abovementioned challenges for science, business and end users are not principally national in character, but rather have to be viewed in a European and international context. Therefore the national research funding also aims, of course, to strengthen the collaboration of German partners at the European level as well as in international structures. Within the framework of the European Security Research Programme, the European Union is making further development at the European level a subject of discussion with a focus on the “First responder of the future”. In addition, the involvement of partners from abroad in existing or proposed international research alliances is designed to ensure that security solutions also keep the needs of the global markets in mind.

Such technologies hold considerable potential: according to a study commissioned by the Federal Ministry of Economics and Technology, the market



volume of products and services related to security technology in Germany was around 20 billion euros in 2008 alone. Annual growth rates are high – according to the OECD, they run at about seven percent per year. Along with integrating international know-how, the funding of innovations in the integrated protection systems research field thus provides German companies with an opportunity to increase their competitiveness and to participate in a growing market.

### Relevant research topics

Volunteer fire brigades and the Agency for Technical Relief (THW) are staffed by over a million helpers in Germany alone. In addition some 30,000 people are employed full-time in the fire brigades of the cities and municipalities, and a similar number serves in private fire brigades in companies and industrial works. They all need state-of-the-art equipment. The following summarises some of the key elements of the research:

#### Localisation systems for rescue forces

Particularly in major operations involving several hundred fire-fighters, coordination is extremely important. In complex or unknown buildings where

smoke renders orientation difficult, for example, it is essential to know the position of all emergency personnel operating on site throughout the course of the event. This obstacle is virtually impossible to overcome without technical aids. One possible approach is to integrate mobile tracking systems into clothing. In this way, the control and command centre is automatically and continuously informed of the location of all participants. This makes it possible to coordinate emergency forces efficiently, as the positional data can also be linked, for example, to other information on the type of equipment carried and its technical condition. The resulting flexibility ensures rapid and smooth coordination of all rescue forces involved, even when operation conditions change suddenly.

### Integrated sensors

Operations subject fire-fighters to high levels of physical stress. For this reason, it would be useful to determine vital signs such as pulse, respiration rate and blood pressure continuously, so exhaustion or a threat to the health of the emergency forces can be recognized early. Sensors that could detect poisonous gases such as carbon monoxide and warn of this hazard in time would be just as important. In order to avoid increasing the weight of the equipment unnecessarily and restricting the freedom of movement of the fire-fighter, however, such sensors can also be integrated into the clothing. Real-time transmission and evaluation of the vital signs and sensory data to the control and command centre requires a suitably adapted, high-performance communication infrastructure tailored to the needs of the emergency forces and to the demands of the operations.

### Semi-permeable protective clothing

Modern protective clothing is indispensable for all rescue forces: during an operation it must protect them from extreme hazards – in the case of fire, primarily from heat – as well as other hazardous situations such as poisonous gases or aerosols. The clothing must also be highly fire-resistant, heat-resistant, tear-resistant and impermeable to hazardous substances. Along with optimal protection, however, the clothing also has to be light and

flexible, so emergency forces can nonetheless move freely while wearing it. At the same time it should be breathable to prevent excessive temperature build-up inside the suit. This long list of material requirements necessitates the development of new high performance textiles especially tailored to the conditions of the operations: textiles that must prove their functionality and robustness in extensive practical trials.



### **Tracking systems for identifying the location of people trapped or buried under rubble**

One of the most difficult tasks that rescue and relief personnel face is the rescue of people trapped or buried under rubble in the wake of explosions, avalanches or natural catastrophes such as earthquakes. Particularly where the scene of an accident is spread over a large area and the number of victims is large, the position of those trapped or buried must be determined as rapidly and accurately as possible, so they can be rescued quickly. Today specially trained search dogs are the most commonly used means of locating trapped or buried victims. Especially in the case of larger disasters, however, this approach is too time-intensive. At the same time it is also hazardous for man and animal, due to rubble falling from damaged buildings, for example. For this reason, the development of innovative detection systems to locate trapped or buried persons is greatly needed here, but there is also a tremendous need for technical aids such as autonomous robotic systems to support and simplify the search and rescue of injured persons.

#### **Sources:**

Research for Civil Security - Programme of the Federal Government; Federal Ministry for Education and Research; Public Relations Division, 2007 (<http://www.bmbf.de/en/11773.php>)

Announcement of the Federal Ministry for Education and Research on guidelines governing the funding of the range of topics "Integrated protection systems for rescue and security personnel" within the framework of the Security Research Programme of the Federal Government (<http://www.bmbf.bund.de/foerderungen/10273.php>)

Federal Ministry of Economics and Technology: Study on market volumes in Germany for products and services related to security technology (<http://www.bmwi.de/English/Navigation/root.html>)

OECD (<http://www.oecd.org>)

Technisches Hilfswerk [Federal Agency for Technical Relief] (<http://www.thw.de>)

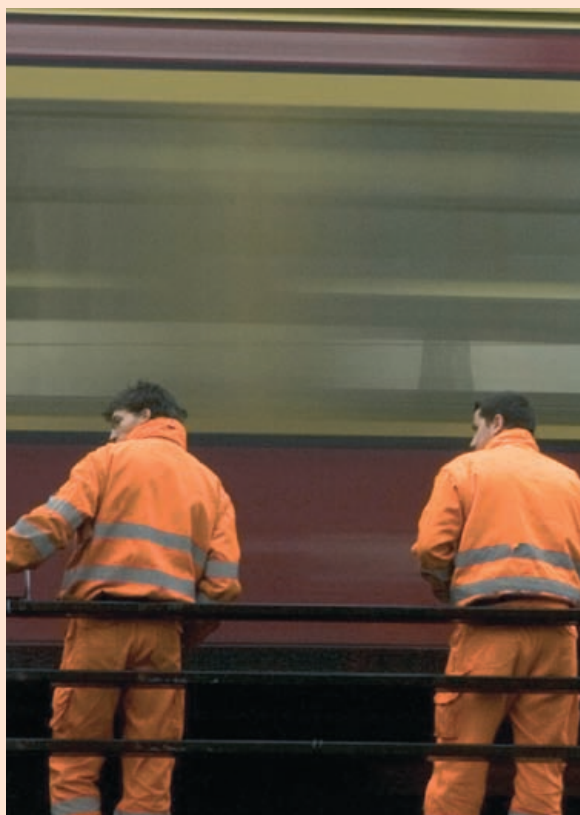
Deutscher Feuerwehrverband [German Fire-fighters Association] (<http://www.dfv.org>)



## Collaborative projects and players at a glance

The importance of using optimal equipment to face unknown hazards is growing and can ultimately save lives. This holds especially true for fire brigades and rescue forces, which are confronted by increasingly complex hazardous conditions during the course of operations. Therefore, the central focus of the collaborative projects presented here is to develop innovative safety solutions designed to significantly improve the performance and protection of emergency teams. This requires reliable, safe and compatible technologies and instruments for communication and coordination in an emergency, along with equipment and supplies to protect against chemical weapons or pollutants during an operation. In this context, the development of high-performance and robust protection systems - such as these - places particular emphasis on user-friendliness and man-machine interface issues. After all, the functional interaction of all of the emergency forces involved – using the technologies and new instruments developed in the collaborative projects, for example – can play a key role in helping fire brigades and rescue teams carry out operations under optimal conditions in the future.

On the following pages all players involved present short profiles describing their motivation, research priorities, goals and the potential for applications of the innovations developed under the collaborative projects.



# LUMITEX

## Development of textiles with electroluminescent properties for safety clothing and technical applications



Support for night-time operations: specially equipped high-visibility clothing and technical equipment (source: Getty)

### Motivation

In traffic system applications, conventional safety and high-visibility clothing relies on fluorescence and only works in the presence of light. In complete darkness, high-visibility clothing does not perform its function and additional information such as symbols, text or warning messages cannot be transmitted. Electroluminescing layers that emit light when subjected to an electrical voltage make it possible to produce innovative and intelligent high-visibility clothing that also functions reliably in complete darkness.

### Project description and goals

This project aims to develop and realize possibilities for the flexible manufacture of intelligently switchable light effects on textiles. To this end, low-ohm, electrically conductive pastes will be developed and made available for printing interdigital structures as electrodes designed to generate luminescence effects. The project will also provide especially bright luminescing pastes for the industrial printing of light-emitting textiles. In addition to this, luminescing filaments will be developed, which will be used to produce textiles with suitable luminescent surface characteristics.

### Innovations and applications

New textile-based optical component developments comprise the basic innovations of the project. The application potential ranges from safety clothing for road workers and police to active protective suits for fire brigades. Textiles for a large variety of other applications are also feasible, however, e.g.



Examples of electroluminescence (source: ITCF)



Textiles with glowing characteristics (source: ITCF)

interior lighting that does not cause blinding effects in automobiles (the roof lining, for example), escape route marking and emergency lighting in textile floor coverings, and switchable warning messages.

#### **Project title**

Development of textiles with electroluminescent properties for safety clothing and technical applications (LUMITEX)

#### **Duration**

1 January 2008 – 31 December 2010

#### **Project partners**

- Institut für Textilchemie- und Chemiefasern (ITCF) der Deutschen Institute für Textil- und Faserforschung Denkendorf (DITF), Denkendorf
- Lefatex Chemie GmbH, Brüggen-Bracht
- Reimotec Maschinen und Anlagenbau GmbH, Ober-Abtsteinach
- ITVP Produktservice GmbH, Denkendorf
- Mattes & Ammann KG, Meßstetten-Tieringen
- Color-Textil Veredlung GmbH, Frankenberg

#### **Collaboration coordinator**

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# SAFE

## Enhanced-performance, permeable protective clothing using new absorbents and vital sign sensors

### Motivation

In their work, rescue forces involved in fire protection and disaster management are exposed to unknown hazards due, for example, to heat, pollution-laden atmospheres or mechanical effects. For their own safety and to maximize their operational capacity, emergency teams must have optimal equipment designed to provide active and passive protection against the abovementioned hazards.

### Project description and goals

The aim of this project is to develop new protective clothing that combines the essential elements of optimal protective equipment for rescue teams: Based on an optimised adsorbent material capable of bonding a broad range of applicable pollutants, a comfortable protective suit will be designed with integrated sensors that will record the vital signs and position of rescue personnel and measure environmental parameters (e.g. temperature). Integration



Key factor in an operation: specially equipped protective clothing (source: State Fire Brigade School Hamburg)

of rescue forces in a communication network will enable the transmission of this sensory data to the command and control centre. This networking will permit rapid response to possibly life-threatening situations.

## Innovations and applications

The new protective suits with an integrated absorbent layer must be comfortable, breathable and washable, so the suits will provide significantly greater protection, utility and service life. The parameters recorded during operations will permit the targeted control, localization and monitoring of rescue forces, thereby enabling rapid action in critical situations and significantly reducing the hazards to which emergency teams are exposed.

### Project title

Semi-permeable suits for rescue forces (SAFE)

### Duration

1 May 2008 – 30 April 2011

### Project partners

- ATS Elektronik GmbH, Wunstorf
- Federal Office of Civil Protection and Disaster Assistance (BBK), Bonn
- Federal Institute for Occupational Safety and Health (BAuA), Dortmund
- Freudenberg Forschungsdienste KG, Weinheim
- Helmut Schmidt University / University of the Federal Armed Forces Hamburg
- Kärcher Futuretech GmbH, Winnenden
- State Fire Brigade School Hamburg
- Military Science Institute for Defence Technologies – NBC Protection (WIS), Munster

### Collaboration coordinator

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# SensProCloth

## Integrated sensory protective clothing system for fire brigades and disaster management

### Motivation

During disasters and large-scale emergencies, those who provide assistance, such as fire-fighters and disaster relief workers of the THW (German Federal Agency Technische Hilfswerk), perform physically demanding tasks and are exposed to other hazards, which are often initially unidentified or difficult to assess. Under the high stress of an operation, personal protective equipment can isolate the body from the environment, sometimes causing insufficient perception of normal corporeal sensations, environmental stimuli and hazard warnings. During large-scale emergencies, orientation is frequently difficult and locating forces in distress is often virtually impossible. Used for localisation and to measure environmental and corporeal variables, sensory technology embedded in the clothing is designed to reduce risk and improve emergency response capabilities.

### Project description and goals

The aim of the project is therefore to develop an integrated sensory clothing system for use in the workplace and as personal protective equipment. The systems to be integrated will comprise a recording and communications system with localisation to support operations and initiate aid and rescue measures for fire brigades and disaster management. In addition, these clothing systems will be equipped with specially adapted sensory technology, electronics and energy supply systems. This will enable them to automatically record and report environmental conditions, such as temperature, position or pollutant exposure. The physiological condition of the wearer will also be monitored in this way, including information on pulse (ECG), respiration rate and the generation of heat.



Special sensors for clothing to report environmental and physiological conditions (source: ITV Denkendorf)

## Innovations and applications

The biggest challenges involve the conceptual design of articles of clothing and the functional integration of technical modules, signal and data transmission lines and reliable energy supply system. The different functions form a networked structure and must first be combined into a working whole before they can provide significantly greater safety and protection for emergency personnel.

The clothing developed, however, must be robust, easy to use and insensitive to cleaning. The individual elements such as sensors, electronic bus systems and modules or radio transmission units must be adapted to the textile application and joined together in a functional system. To this end, developments and functional trials will be carried out for individual functional elements and circuits in textile structures and articles of clothing. Subsequently, a demonstration unit will be developed and tested.

### Project title

Integrated sensory protective clothing system for fire brigades and disaster management (SensProCloth)

### Duration

1 July 2008 – 30 June 2011

### Project partners

- Institut für Textil- und Verfahrenstechnik (ITV) der Deutschen Institute für Textil- und Faserforschung Denkendorf (DITF), Denkendorf
- Fraunhofer Institute for Integrated Circuits (IIS), Erlangen
- Hubert Schmitz GmbH & Co. KG, S-GARD® Berufs- und Schutzkleidung, Heinsberg
- JOSEF KANZ GmbH & Co. KG, Neufra
- getemed Medizin- und Informationstechnik AG, Teltow
- W. Zimmermann GmbH & Co. KG, Weiler-Simmerberg
- BIJO-DATA Informationssysteme GmbH, Holzkirchen / Ufr.
- Stuttgart Professional Fire Brigade
- Fire Brigade of the City of Nuremberg

### Collaboration coordinator

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# FeuerWhere

## New sensor network helps fire brigades during fire-fighting operations



In-door localisation: In case of an accident every second counts to send help to the right place (source: Feuerwehr Berlin)

### Motivation

During operations involving thick smoke, emergency forces are virtually blind when they have to explore buildings. Despite fire and smoke, they have to develop a clear overview of the situation: Where are the victims? Where are the other fire-fighters? Rescuing human life is a stressful undertaking and rescuers put their own lives at risk during fire fighting operations often enough. That is why it is important for each fire-fighter involved to have a clear understanding of the overall situation and to adapt to constantly changing conditions. To that end, the FeuerWhere project is developing a wireless sensor network as a tracking system for emergency forces.

### Project description and goals

For orientation purposes, usually only a rough layout is available. The command and control post obtains its information from layout sketches and via radiotelephony. The exact location and condition of emergency forces can be determined only roughly based on the often fragmentary information. Fire-fighting thus represents an extraordinarily stressful situation for everyone in the operation. Although they have professional protective clothing

and equipment, emergency forces are seriously endangered by conditions in the burning building. Here data on the location of emergency forces, their physical condition and current conditions in their immediate vicinity could help the command and control post fight the fire more efficiently while significantly improving the safety of the emergency forces at the same time.

The system to be developed must allow for rapid implementation as well as gradual expansion. It must also ensure a stable exchange of data – about the location of participants and their immediate vicinity, for example – under operation conditions. In parallel to this, an additional sensor network located near the body will record the necessary data on the physical condition of the emergency forces. All information must be available in bundled form in order to provide the fastest possible support to the command and control post when making decisions of vital importance.

## Innovations and applications

The rescue forces moving through the buildings wear sensor nodes, which enable their localisation and transmit relevant vital signs and environmental parameters. The sensor nodes are self-organising and forward data in a so-called multi-hop network. The emergency forces are located by means of the “chirp spread spectrum” radio process. This process cycles through a large electromagnetic frequency range in a short period of time, which significantly reduces problems with interference and reflection. Combining these innovative processes now makes it possible to locate emergency forces in buildings for the first time without the use of previously installed emitters and receivers.

### Further information:

[www.feuerwhere.de](http://www.feuerwhere.de)



Rescue forces enter buildings under harsh conditions (source: Feuerwehr Berlin)

### Project title

Tracking Fire-fighters - System to support emergency forces in the event of a fire (FeuerWhere)

Note: This project is funded within the framework of the ICT 2020 research programme.

### Duration

1 January 2008 – 30 June 2010

### Project partners

- Berlin Fire Brigade
- Freie Universität Berlin
- IHP – Innovations for High Performance Microelectronics, Frankfurt (Oder)
- MSA AUER GmbH, Berlin
- Nanotron Technologies GmbH, Berlin
- Associated partners:
  - MPA Technologies Ltd., Israel

### Project coordinator

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# I-LOV

## Intelligent safeguarding localization system for the rescuing of people trapped or buried under rubble

### Motivation

Images of events causing damage in which people have been trapped or buried under rubble serve as constant reminders of the vulnerability of the places where we live and work. To conduct rapid rescue operations, emergency forces all over the world need timely information on the exact position of people trapped or buried under rubble, information on the risk of collapse of debris and standardized intervention procedures as well as information on the state of the victims' health.

### Project description and goals

The project focuses on key aspects and challenges in terms of social conditions, emergency medicine, intervention psychology, law and technology required for the targeted and timely rescue of people who have been trapped or buried under rubble. It aims to ensure the safety of rescue forces and victims at all times during natural or man-made catastrophes. Above all, the emphasis is on innovative localization processes designed to improve the ability to locate buried and injured people.

Therefore, a portable information system is to be developed, which will constitute the core commu-

nications interface. This system will be used at the accident site together with especially developed modular and radio-based equipment systems, which will support rescue forces during rescue operations. These support functions will assist, among other things, in component securing / debris monitoring for the protection of rescue personnel and victims as well as in the localization of the people trapped or buried by rubble.

### Innovations and applications

At the conclusion of all research work, demonstrators will be developed that will be tested continuously in field trials under realistic intervention conditions during the course of the project. These field trials are intended to collect findings on suitability for use, localization precision and operational tactics, in order to optimize the suitability of the system for use in disaster areas. The technologies to be developed will help collect information at an accident site, optimize the communication and information flows, increase the efficiency of search and rescue measures and raise the overall safety level while at the same time lowering the cost of interventions.



Innovative search and detection processes will significantly enhance the ability of emergency forces to locate people and will facilitate the rescue of injured persons (source: German Federal Agency for Technical Relief (THW))



After an earthquake: The search for people buried under the rubble (source: Bundesanstalt Technisches Hilfswerk)

#### Further information:

[www.i-lov.org](http://www.i-lov.org)

#### Project title

Intelligent safeguarding localization system for the rescue of people trapped or buried under rubble (I-LOV)

#### Duration

1 June 2008 – 31 May 2011

#### Project partners

- Freiburg University
  - Institute for Public Law (IOR)
  - Institute for Microsystem Technology (IMTEK), Chair for Electrical Measurement and Test Methods
- BOS GmbH & Co KG, Berlin
- Bundesanstalt Technisches Hilfswerk, Bonn
- carat robotic innovation GmbH, Dortmund
- Dortmunder Initiative zur rechnerintegrierten Fertigung (RIF) e. V., Dortmund

- Cologne University of Technology, Institute for Plant and Process Engineering and Institute for Emergency Medicine, Cologne
- Erlangen-Nürnberg University, Chair for Technical Electronics, Erlangen
- Hövener & Trapp Evison GmbH, Dortmund
- JT-elektronik GmbH, Lindau am Bodensee
- Ruhr University Bochum, Chair for Machine Elements and Construction Studies, Bochum
- Symeo GmbH, Neubiberg
- Karlsruhe University, Institute for Technology and Management in Construction Operations, Karlsruhe
- Paderborn University, Computer Application and Speciality Area Integration in Construction and Planning (C.I.K.), Paderborn
- Associated partners:
  - Albert Ziegler GmbH & Co KG, Giengen
  - German Federal Criminal Police Office, Wiesbaden

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# Landmarke

## Navigation infrastructure for fire-fighters

### Motivation

During operations, fire-fighters have to be able to provide a reliable assessment of the situation on-site quickly, and in so doing explore the operation site reliably, also in unsafe environments and under poor visibility conditions. Despite proven aids, navigation under such conditions is difficult. Time and again, emergency teams are directly exposed to actual hazards as a result.

### Project description and goals

Navigation is an occupational competence, in which experience, sensory impressions and trained methods play an important role. The objective of the research project is to develop an orientation and navigation infrastructure based on ubiquitous computing technology. This infrastructure will effectively build on the capabilities of the emergency forces. The project applies a new research methodology, in which the developers also take part in fire brigade training exercises, in order to focus on the users and their expertise.

### Innovations and applications

In the application scenario, emergency forces mark important reference points with so-called interactive landmarks. These landmarks are small, distributable units that contain sensory and transmission technology. Their interactive clothing brings the distributed sensor units to the attention of the fire-fighters, permitting them to interact with the landmarks. The fire-fighters can refer to this reference system by radio or in status meetings and develop a common understanding of the situation on-site. The new system helps improve the reconnaissance effectiveness of emergency forces and increases their safety.

### Further information:

[www.landmarke-projekt.de](http://www.landmarke-projekt.de)



Emergency personnel during a reconnaissance operation (source: Fraunhofer FIT)

**Project title**

Navigation infrastructure for fire-fighters (Landmarke)

**Duration**

1 July 2008 – 30 June 2011

**Project partners**

- Siegen University, Institute for Business Computing and New Media, Siegen
- Karlsruhe University, Institute of Telematics, Telecooperation Office TECO, Karlsruhe
- Bremen Institute for Operations Technology and Applied Work Science (BIBA), Bremen
- Cologne Professional Fire Brigade
- Institute of the Fire Brigade of the German State of North Rhine-Westphalia, Münster
- Interactive Wear AG, Starnberg
- Waldemar Winckel GmbH & Co. KG, Bad Berleburg
- Associated partner:
  - Dräger Safety AG & Co. KGaA, Lübeck

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# AirShield

## Airborne Remote Sensing for Hazard Inspection by Network Enabled Lightweight Drones

### Motivation

When investigating, delimiting and combating large-scale hazards, the targeted, rapid and flexible inspection of a potentially contaminated environment represents a fundamental challenge. The project observes hazards that involve the uncontrolled escape of gaseous pollutants of all kinds as, for example, released during major fires.

### Project description and goals

The AirShield system is designed to deliver data and forecasts on the actual hazard to the emergency staff as efficiently as possible. It links a networked fleet of robotic aircraft equipped with lightweight gas sensory technology to a geo-information system via a high-reliability wireless communication network. The system edits the sensory data acquired according to operation plans and supplies forecasts on the hazardous situation, from which efficient protective measures can then be derived.

### Innovations and applications

Today, rescue measures include emergency staff equipped with the corresponding protective clothing being brought into the danger zone or specialists operating special equipment. The AirShield system will enable a reliable, largely self-organized situation analysis while at the same time providing guidelines for the protection of people and the environment. The system is designed to be employed by rescue organizations (fire brigades, disaster management) as well as private companies (e.g. works fire brigades).

### Further information:

[www.airshield.de](http://www.airshield.de)



Potential AirShield operation scenario: Information about hazards is gathered by aerial robots in order to enable ground personnel to define the corresponding protective measures to be taken (source: notfallinfo-bochum.de)



A drone supporting a fire brigade operation (source: TU Dortmund)

**Project title**

Airborne Remote Sensing for Hazard Inspection by Network Enabled Lightweight Drones (AirShield)

**Duration**

1 July 2008 – 30 June 2011

**Project partners**

- Dortmund Technical University, Chair for Communication Networks, Dortmund
- Microdrones GmbH, Kreuztal
- Dortmund Fire Brigade / Institute for Firefighting and Rescue Technology (IFR), Dortmund
- Siegen University, Institute for Real-Time Training Systems (EZLS), Siegen
- GIS Consult GmbH, Company for Applied Geo-Information Systems, Haltern am See
- Paderborn University, Computer Application and Integration in Construction and Planning (C.I.K. working group), Paderborn
- Gesellschaft für Gerätebau mbH (GfG), Dortmund
- Berlin Technical University, Chair for Innovation Economics (LIO), Berlin

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# Glossary

|                                |   |
|--------------------------------|---|
| <b>Adsorbents</b>              | Adsorbents are usually porous substances which are insoluble in water. Their large surface area enables them to bond with water and other molecules through physical forces. In other words, it makes them able to form a layer. This means that various substances are stored on the surface of solid bodies (Adsorbents). The best-known adsorbent is activated charcoal (activated charcoal filter).   |
| <b>Anthropogenic</b>           | Changes caused by humans are referred to as 'anthropogenic' – as in the case of the environment (greenhouse effect), for example – as opposed to natural changes.   |
| <b>Bus systems</b>             | In computer architecture, a bus is a subsystem that transfers data between computer components inside a computer or between computers. Each bus defines its set of connectors to physically plug devices, cards or cables together. The term is now used for any physical arrangement that provides the same logical functionality as a parallel electrical bus, but early computer buses were literally parallel electrical buses with multiple connections. Modern computer buses can use both parallel and bit-serial connections, and can be wired in either a multidrop (electrical parallel) or daisy chain topology, or connected by switched hubs, as in the case of USB. |
| <b>Chirp Spread Spectrum</b>   | Chirp Spread Spectrum (CSS) is a modulation process using the so-called chirp pulse. The latter is part of MDMA modulation (Multi Dimensional Multiple Access), which combines the benefits of classical modulation processes of amplitude modulation (AM), frequency modulation (FM) and phase modulation, is suitable for WLANs with medium and high transmission rates and features extremely low energy consumption. It is intended for industrial applications in the field of sensor/actuator networks, building automation, RFID and wireless multimedia technology.   |
| <b>(Electro) luminescence</b>  | The collective term for the emission of light from a substance or body, where the light emitted is not generated by means of high temperature, is 'luminescence'. Luminescence can be induced, for example, by means of irradiation with visible or ultraviolet light (photoluminescence), x-rays or gamma rays (x-ray luminescence). Electroluminescence is induced by applying an electrical voltage. When the luminescence occurs essentially only during excitation, it is known as fluorescence – otherwise it is called phosphorescence.  |
| <b>Filaments</b>               | Originally referring to strings or threads in the context of textiles, the term 'filament' is also used in both biology and astronomy. As applied to the example above, it relates to individual filaments used to produce the relevant surface structures.   |
| <b>Geo-information systems</b> | The term 'geo-information system', or GIS, refers to a computer-aided information system comprising hardware, software, data and applications. Such digital systems make it possible to collect and edit spatial data, store and reorganize them, model and analyze them, and display them alphanumerically and graphically. In this respect, GIS refers not only to a technology but also to products and processes for providing such data.   |

|                                       |   |
|---------------------------------------|---|
| <b>Interdigital structures</b>        | The term 'interdigital structure' refers to a type of construction in which the individual elements are entwined like interlaced fingers without actually touching each other. Interdigital structures are used as delay lines (interdigital lines), for example, or as electrodes of interdigital converters (interdigital transducers). In sensory technology, a converter of this type uses a component with an interdigital structure to convert measured values. In so doing, the incoming signals are converted into a measurable electrical signal.                                      |
| <b>Landmark</b>                       | The term 'landmark' originally derives from aeronautics and shipping. It refers to a conspicuous, often visible topographical object (such as a church, a tower, a mountain, etc) that is either specifically placed for this purpose (navigation marks) or already existent. Such landmarks have played, and continue to play, an important role in spatial orientation and navigation.  |
| <b>Low-impedance / high-impedance</b> | The term 'low-impedance' refers to lines of low electrical resistance; the opposite, 'high-impedance', refers to a high electrical resistance.  |
| <b>Self-reporting sensors</b>         | Autonomous, wireless, usually passive sensors, which are triggered automatically when an event occurs, whereby the signals detected are automatically passed on to a central computer/processing unit.  |
| <b>Ubiquitous computing</b>           | The term 'ubiquitous computing' (also known as 'pervasive computing' or 'ambient intelligence') refers to the vision of the omnipresence (ubiquity) of tiny, wirelessly networked computers, which are invisibly integrated in, or attached to, any number of everyday objects. According to this idea, 'intelligent' objects or devices are completely electronically networked and capable in some cases of automatically reacting to individual needs and movements. One example of this is the vision of a house in which room temperature adjusts to the needs of the individuals present. |



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