

# TOMORROW TODAY

Dorothea Heiss, Senior Engineer  
at the AIT Safety & Security Department

Developing the technologies, methods and tools of tomorrow



## → SAFETY & SECURITY

### CRISIS AND DISASTER MANAGEMENT

6

Natural disasters or attacks on critical infrastructures cannot be ruled out. Therefore, well-prepared crisis management is of utmost importance. The research staff at AIT provide the required technologies to decision-makers that allow quick action.

## PHOTONS TO COMBAT CYBERPIRACY

10

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## → HEALTH & ENVIRONMENT

### MOLECULAR TOOLS FOR PERSONALIZED MEDICINE

14

Aging-related diseases such as diabetes, cancer and types of fibrosis are heavily increasing in industrialized nations. Researchers at AIT are working on new biomarkers and molecular probes for early diagnosis and, consequently, effective therapy.

## → ENERGY

### HEATING AND COOLING WITH NATURAL ENERGY

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Securing energy availability in a sustainable manner is one of the major challenges for our society. One giant step towards this goal is being taken by AIT scientists now by paving the way for renewable energy sources for heating and cooling.

## → MOBILITY

### SMART LOGISTICS FOR SHORTER TRAVEL TIMES

22

The efficient and environmentally compatible transportation of people and goods is at the top of the traffic agenda throughout Europe. Experts at AIT are developing path-breaking logistics solutions that are deployed in both goods transportation and health care.

## → FORESIGHT & POLICY DEVELOPMENT

### SIGNPOSTS IN COMPLEX SYSTEMS

26

Especially when it comes to the new major societal challenges facing us, such as demographic change and resource scarcity, conventional government policy-making instruments often prove inadequate. AIT researchers are analyzing a broad variety of governance requirements to make new decision processes possible.



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OF TECHNOLOGY**

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# KEEPING UP MOMENTUM, STAYING ON THE BALL

/// The AIT Austrian Institute of Technology has established itself since its realignment two years ago as an indispensable research partner for industry and public sector organizations. In conversation with Tomorrow Today the two Managing Directors Anton Plimon and Wolfgang Knoll explain how this turnaround was achieved and how this positive dynamic can be maintained in the coming years with AIT's Strategy Version 1.2. ///



Wolfgang Knoll

Anton Plimon

**TWO YEARS AGO MARKED THE BEGINNING OF THE BIGGEST CHANGE PROCESS IN THE HISTORY OF THE RESEARCH ORGANIZATION. DO YOU FEEL YOU HAVE KEPT IT ALL ON THE RIGHT TRACK SINCE THEN?**

**Anton Plimon:** AIT stands on a very firm foundation today. The basis for this of course is the strategic realignment that took place two years ago. AIT has concen-

trated on precisely those research areas that are among the greatest challenges facing our society today. This has enabled us to become one of the key know-how partners for industry and the public sector. We have achieved this partly through our clear strategic goals, but primarily through the introduction of a governance system, which ensures equally clear decision-making structures and responsibili-

ties and so rules out ad-hoc decisions. That's how we managed to shed our old ways step by step and clear the way ahead. Today we are in a position where we can concentrate wholly on our strengths.

**HOW DOES THIS CLEAR FOCUS IMPACT ON YOUR INTERNATIONAL COMPETITIVENESS? A NUMBER OF RESEARCH FIELDS IN WHICH YOU WERE SUCCESSFUL IN THE PAST HAVE NOW BEEN DROPPED FROM THE PORTFOLIO.**

**Wolfgang Knoll:** The core element in the strategic realignment was the focus on clearly defined research topics. If AIT was really going to be successful it had to stop being a jack-of-all-trades and achieve a critical mass in specific research fields. As a small country Austria has to utilize its resources very carefully. Today AIT has a clear focus, working on eleven research areas altogether with the accordingly competitive critical mass in five Departments.

**SO HOW DID YOU GO ABOUT CHOOSING THE TOPICS FOR YOUR DEPARTMENTS?**

**Knoll:** Our main focus of course is on the infrastructure topics confronting us globally associated with what is often referred to as the grand challenges for our society. This is where AIT can build up interdisciplinary systems competence over an extended period and foster the development of

ground-breaking technologies - whether with new methods, tools, prototypes, simulations or other means. This understanding of system interactions is of help to our partners and customers in industry for example, in making their particular products and services marketable. Our main field of activity on the whole is applied research but in some areas it is inevitable that we get involved in basic research.

**Plimon:** Whatever happens of course, our future-oriented research has to earn us money, so it has to be competitive and market-based. Sustainability and the ability to plan are important stability factors because, as already indicated, AIT operates in the field of pre-competition research. We have to assume here a timeline of about five years until industry takes up a new research finding and markets a specific product based on it. AIT does not get involved in production and product marketing. AIT has the "systems competence" for specific areas of research where we aim to become thematic leaders both locally and, increasingly, with an international dimension. That this strategy is proving valid is clear not just from the growing number of major strategic projects among the contracts we get, but from the latest business figures.

#### SO DESPITE THE ECONOMIC CRISIS YOU HAVE BEEN ABLE TO GROW PROFITS?

**Plimon:** Yes, despite the tougher economic conditions AIT has made profits on ordinary activities for the third year in succession. This amounted in 2010 to EUR 3.53 million. In the current year 2011 EUR 1.5 million will be taken from profits and go into strategic research projects. In addition, our earnings forecast for the current fiscal year is for profits on ordinary activities of EUR 2 to 2.5 million.

AIT operates in a dynamic global competitive arena.

#### HOW DO YOU MAKE SURE THE BUSINESS MODEL REMAINS FLEXIBLE, SO AS TO STAY ON THE BALL - TO USE A SPORTING METAPHOR?

**Plimon:** The dynamic changes I referred to

affect us all of course - research areas, local and international markets, and employees. And a system that doesn't adapt gets lazy and loses momentum. So you have to keep tweaking it, looking carefully at the processes, tightening the portfolio of topics covered and developing career models for employees for instance, if they are going to produce the performance expected by the market. These adjustments can't of course be haphazard. The decisive factors are the strategy drawn up, the road map to be followed and the right corporate culture that facilitates verifiable implementation.

**Knoll:** There is a growing trend towards interlinking research areas - and this is where AIT hopes to take a lead. When we talk about mobility today, for example, we are also talking about security. Questions of energy provision play a vital role, it's about making helpful mobile technologies available to an aging society and much more



besides. If you make a point of focusing your efforts in a specific area as we do, you have to act accordingly and the focus must be adapted from time to time.

#### ARE YOU IN THE PROCESS OF THIS KIND OF STRATEGY UPDATE RIGHT NOW?

**Knoll:** At the moment we are primarily concerned with adjusting the portfolio. We have also made adjustments to the site structure which had developed over time. The choice of sites helps to position AIT and its applied research clearly between university and industry. This is clearly evi-

dent from the new AIT site in Muthgasse in the 19th district of Vienna near the BOKU, the University of Natural Resources and Life Sciences. The latest development here is the University and Research Centre at Tulln (UFT), which is a joint project with the AIT Austrian Institute of Technology, the BOKU, the city of Tulln and the province of Lower Austria. But at the same time we are also working on a more comprehensive update - the "Vision 2020". As part of these deliberations the main pillars of AIT - our five Departments - may be more closely linked for example, which means we would be enhancing our systems competence to an entirely new level, at least by European standards.

**Plimon:** But at the moment we are just making fine adjustments to the strategy. Version 1.0 was needed to build a solid foundation in the first year, and Version 1.1 marked the inauguration of AIT, as it were, when it was entered in the Austrian Companies Register in 2009. Then 2010 - when the strategy took hold on the market - was an important year for us when we learned lessons from our experience so far. These lessons have now been fed into our "Strategy Update 1.2" and are helping us make the current adjustments.

#### ONE ELEMENT IN YOUR STRATEGY VERSION 1.0 WAS TO EXPAND INTERNATIONALIZATION. HOW ARE YOU GOING ABOUT THAT?

**Plimon:** There's no doubt internationalization is important for us, it offers so many opportunities for networking. But it mustn't happen at any price. We have to know what we want to achieve and select the right partners accordingly. Because the relationship must be carefully balanced. AIT concentrates on research areas with a medium to long term time horizon. This enables us to acquire our own expertise over an extended period of time, which is then of genuine interest internationally. Whenever we offer our skills, the offer is taken up.

#### CAN YOU GIVE US SOME EXAMPLES?

**Knoll:** The 2010 World Expo in Shanghai for example generated satisfactory waves

of interest for AIT and resulted in a project funded by China. We are now working with Nanchang, a city of five million inhabitants in China, on the development of a low-carbon city. China also offers a great opportunity for AIT to give talented young people the chance of establishing themselves as research scientists and engineers. Another docking point in Asia is Singapore where we are collaborating with Nanyang Technological University (NTU). In the USA there is a tremendous scientific density and we are working there in association with three renowned research institutes including MIT. In Europe, for example, we are a member of the European Energy Research Alliance (EERA) as one of 14 top institutes. EERA's main interest lies in the strategic and targeted development of next-generation energy technologies. Thanks to the international links, we make sure AIT always gets a share of the action. And let's not forget, it means AIT also opens the doors for other Austrian businesses.

#### HOW DOES AIT MANAGE TO ATTRACT THE BEST MINDS?

**Knoll:** If you want to play in the Champions League, you need a tip-top team. But there is of course stiff international competition for the best minds. So our aim is to stake out specific goals so the years at AIT represent a peak in the scientific career of our research staff.

#### YOU REFERRED EARLIER TO AIT'S CORPORATE CULTURE. TO WHAT EXTENT IS IT AN ADVANTAGE IN COMPETING FOR HIGHLY QUALIFIED STAFF?

**Plimon:** It's a huge advantage. We give our researchers the right working environment for their project and so enable them to put their research into practice. AIT's corporate culture creates important added value because it provides stable and clearly defined working conditions. This enables us to create a superstructure which doesn't constrain the various departmental cultures and provides a general model for the attainment of our goals.

#### CAN YOU DESCRIBE THAT IN A LITTLE MORE DETAIL?

**Plimon:** There are three major interconnecting aspects here: the formulation of a strategy, the various career models and associated career paths, and the daily productive engagement with each other, for which we have developed a code of conduct. This means the working environment is clearly defined and decisions are causally verifiable. If for example we are considering starting a project, corporate culture is valuable and helps us argue the case objectively and avoid making arbitrary decisions.



Anton  
Plimon

#### WHAT ARE THE ADVANTAGES OF THE CAREER MODELS AND CAREER PATHS YOU MENTIONED?

**Plimon:** Well, the main goal is to give our staff the opportunity to create exciting careers. Let's take young gifted university graduates, for example. They often cannot see where the possible openings are to their future career path. AIT career paths, which include a lot of professional development options, are very flexibly designed. Researchers can develop a professional profile in-house, then after a few years embark on an academic career or switch to industry.

#### HOW LONG ARE STAFF EMPLOYED AT AIT ON AVERAGE?

**Knoll:** That's varies widely and there's no useful average because it depends heavily on the respective Department and the type of work they are doing. Staff continuity is an important factor in long-term customer relationships, for example, but is generally regarded in relation to the work

achieved. AIT career paths are designed in such a way that we also invest heavily in the training and professional development of our employees. So we can assume that a good two years is the minimum time spent with us. If you put the window needed for a research project at about five years, that gives you a fair idea. All in all the collaboration has to be useful for both sides and the results must be mutually satisfactory.

#### WOULD YOU WELCOME IT IF THE STAKEHOLDERS EXTENDED THE CURRENT BUDGETARY PLANNING HORIZON OF FOUR YEARS?

**Plimon:** The degree of planning certainty must always fit the type of business. I believe that, given our business model, a longer term could tempt the system to become a bit easygoing. Four years in my view are just right.

MANY THANKS FOR TALKING TO US! ///



# CRISIS AND DISASTER MANAGEMENT

/// When there are threats of avalanches, technical accidents at atomic power plants or, not least, attacks on critical infrastructures, it is essential to have a well prepared crisis and disaster management plan in place. AIT is now stepping up its activities in this area by improving the links between existing systems for example, or capturing environmentally critical data for disaster prevention using human sensors. ///

## ● IN A NUTSHELL

If crisis and disaster management (CDM) is going to work well, good preparation is the chief priority. A key element in this is to link all existing systems and collect environmentally critical data for disaster prevention. It is precisely in these areas such as the systematic collection and processing of environmental data like air pollutants and water quality that AIT has years of experience. For example, the emissions registry developed by AIT assists in crisis prevention. Policy-makers can have freely definable scenarios produced to prepare preventive measures. The complete system developed in the UWEDAT project allows the recording, evaluation and archiving of environmental parameters like air, water or meteorology. But regional climate models are also produced for flood protection, and systems are developed in which humans act as mobile sensors to report critical natural events or accidents.

**CRISES OR DISASTERS** tend in the natural course of events to hit a region or an entire country without warning. In the worst-case scenario one thing above all is needed: well prepared crisis plans and a carefully planned disaster response management. "Most crises in Austria are natural ones caused by hydrological events like floods, mudslides, avalanches or blockages," explains Georg Neubauer, scientist and expert in Crisis and Disaster Management in AIT's Safety & Security Department. Common to all disasters, whether of natural or technical origin or caused by human error or even deliberately, is a certain cycle of activity in responding to it.

**GEORG NEUBAUER ///  
Scientist, expert for crisis  
and disaster management**

..Apart from reporting avalanches with automatic location identification, mobile sensors might in future also identify threats posed by pollutants after accidents or attacks.“



If, for example, a river overflows its banks flooding large populated areas, the first thing is the direct response to the disaster with all the search and rescue and safety measures. But each disaster produces new intelligence and it can be utilized to avoid such events in future by putting specific action plans in place. “Disaster response comprises the immediate rescue services and the reinstatement of damaged infrastructure. In disaster protection we then devise concepts for both prevention and preparation so as to be better equipped for future events,” says Neubauer. These phases can chart the course of crises and disasters. AIT has decades of experience here, especially at the level of prevention, through the systematic gathering, recording and processing of environmental data on air pollutants, water quality and electromagnetic exposure for example.

#### **IMPORTANT TOOLS FOR GOOD DECISIONS**

“These data are important in that they provide policy-makers with the tools for decision-making,” explains Neubauer. So for instance, negative health impacts on the population caused by sudden severe environmental shocks can be avoided by taking rapid action. A typical response might be selective road traffic closures if a region is too heavily contaminated by traffic and other emissions in adverse weather conditions. This can then be followed up by other projects on general emission reduction such as improved air purification systems for production plants and heating systems or perhaps the fostering of low-emission inner city transport systems. These may be based on the emissions registry for example, developed by AIT in the EMIKAT project. EMIKAT is a complete system for emission data management used in various places including Upper Austria and Vienna. It is important to know which polluters contribute to the emissions and how so as to be able to take exactly the right action. The system allows to record even the many small emission sources such as cars or heaters, which are ex-

trapolated accordingly in the emissions inventory. To process the innumerable data in the end requires powerful and transparent data management. A particularly useful instrument for political decision-makers is the EMIKAT function which can produce freely definable scenarios. The evaluation tools also allow annual comparisons to be made so we can track the action taken and trends.

#### **SENSOR NETWORK USED INTERNATIONALLY**

Other AIT projects have been concerned for some time with the subject of environmental data acquisition. The main AIT project in this field is UWEDAT, a complete system for the collection, evaluation and archiving of environmentally related parameters such as air, water or weather conditions. The system allows us to develop sensor networks to monitor factors like air quality or drinking water, to enable rapid action to be taken in the event of a threat to health. This requires continuous environmental monitoring. The Umweltbundesamt (Environment

The emissions registry developed by AIT is one feature that assists in crisis prevention. Policy-makers can have freely definable scenarios produced to prepare preventive measures.

Agency Austria, a state-owned organization established under Austrian law specializing in environmental themes) is an important partner for AIT experts here. The AIT technologies used by the Umweltbundesamt to collect and evaluate air quality data have already been exported to Bulgaria and Indonesia, for example, where they have contributed to making decisive improvements in air quality management.



Accurate topographical data is indispensable especially in the case of forest fires or landslides.

A key focus of the research projects of the AIT Safety & Security Department is the development of tools for preventive action. The InnoSens project (innovative environmental and traffic monitoring) combined environmental monitoring and traffic data for example, while the SUDPLAN project (Sustainable Urban Development Planner for Climate Change Adaptation) developed climate models for specific areas with a much higher resolution. This means scenarios can be run at regional level such as: "What effect does climate change have on the high water situation in the town of Linz?"

The data obtained from SUDPLAN are an important decision-making aid for policy-makers in planning preventive measures such as the correct dimensioning of sewage and drainage systems.

## HUMANS AS DANGER ALERTS

In the latest projects the Crisis and Disaster Management research team of the AIT Safety & Security Department has been concentrating specifically on crisis and disaster management. One problem is that cell phone networks are not available in all regions to quickly call assistance when accidents happen or when there are warning signs of natural disasters such as avalanches or landslides.

"But even well established cell phone networks can crash as we saw with the earthquake and tsunami disaster in Japan," says Neubauer. ENVIROFI, a project arising from the EU Call for the Future Internet Private Public Partnership, aims to develop systems for using people as mobile data suppliers and is now to be further developed for applications in crisis and disaster management.

Apart from reporting avalanches and landslides with automatic location identification, mobile sensors might in future also identify threats posed by pollutants after accidents or attacks. The use of mobile interlinked sensors is an important issue for the future, according to AIT expert Georg Neubauer. They allow information and images on risky situations along with the spatial coordinates to be passed to the appropriate bodies without delay.

## IMPROVED INTERLINKING OF RESCUE SERVICES

Crisis and disaster management nowadays involves a whole range of response systems, but they only deal with isolated aspects - such as sending an alert to warn of increased radioactivity. But crises and disasters often trigger whole cascades of events, as demonstrated recently by the earthquake in Japan with the subsequent tsunami and nuclear disaster. So effective networking between the various rescue teams and their systems is extremely important. In the CRISMA project AIT is developing high-level systems jointly with international partners that will allow smooth collaboration between different systems for complex crisis scenarios. ///

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## RESEARCH SERVICES

### Crisis and Disaster Management (CDM)

Crises and disasters normally take a region or a country unawares. That is why in the actual crisis situation one thing is required above all - an extensive functioning disaster management process based on ready prepared, carefully thought out crisis plans.

But nowadays crisis and disaster management does not only comprise immediate aid action to deal with the events such as efficient and coordinated response services or the reinstatement of damaged infrastructure, but comprehensive precautionary disaster protection activities. Ongoing risk analyses and systematic collection of relevant data for different disaster scenarios is used to devise reliable plans and guidelines to avoid or prepare for imminent or early-stage crises, which facilitate sound decision-making at command level and the interaction of response organizations.

With the increasing use of data acquisition intelligence in the form of sensors or cameras at disaster-prone locations - such as slopes at risk of landslide or the banks of torrential watercourses - today enormous quantities of data are permanently recorded and electronically stored. What is often lacking, however, is firstly having this data in a structured form and therefore easier to interpret, and secondly access by different crisis stakeholders across domains.

AIT has decades of experience in the systematic acquisition and processing of environmental data such as air pollutants and water quality and is therefore the obvious technology partner for organizations involved in crisis and disaster management, when it comes to finding technical solutions to the problems described above. In this context AIT is concerned primarily with solutions for disaster prevention and interoperable metasystems, enabling improved linking among response services, and across national borders too.

In developing these systems, AIT relies on standard-based but semantically enriched architectures, and provides services for information access to large-scale sensor networks and cutting-edge visualization technologies for the optimum assessment of crisis scenarios. It means the relevant information such as sensor data from various web-based resources can be easily located, and the data can be enriched with additional intelligence, e.g. from the immediate on-site situation assessment.

Thanks to the systems developed by AIT, policy-makers have access to a technological toolkit for efficient crisis and disaster management. ///



**SIEGFRIED JACKS**, HEAD OF NATIONAL CRISIS AND DISASTER PROTECTION MANAGEMENT AND CIVIL DEFENSE IN THE AUSTRIAN FEDERAL MINISTRY OF THE INTERIOR, ON THE IMPORTANCE OF PUBLIC AWARENESS AND LONG-TERM PREPARATION FOR CRISIS EVENTS.

*Mr. Jachs, to be well prepared for crises and disasters, ongoing preparations are needed. AIT has established a network for collecting critical environmental data. What is the significance of these developments - especially as regards prevention?*

Integrating data from monitoring networks is very important in many areas including specifically disaster management. Sensor networks deliver the information needed to produce computer models. Often it is a question of exactly how the data is obtained, distributed and analyzed. Research findings from environmental monitoring can also be useful for disaster management and for research projects with that particular focus.

**How important is research in crisis and disaster management?**

Research has been given greater emphasis in our ten-year strategy plan. That's not only true for our Department, the view is shared by other stakeholders like the Austrian federal provinces or response organizations. Where technology-related research is concerned the main thing is the IT systems. This is where research findings can be converted into valuable intelligent applications for crisis and disaster management so that both preventive and operational action can be taken to minimize damage. An important point here is that research is linked as closely as possible to practice. So we are keen to pursue further activities in this area jointly with AIT and other stakeholders.

**How can public awareness of crisis and disaster prevention be improved?**

You have to make a point of concentrating on plausible scenarios. In Austria that means mainly natural dangers such as avalanches or floods. Provided information is supplied in practicable and clearly presented form properly tailored to target groups, you can increase the motivation for people to take precautions for themselves. When we are targeting the important youth element of the population, the Internet plays a vital role. But the mass of digital information has to be prepared in a way that can be easily grasped. In fact we have already had discussions with AIT about a specific project idea.

**What role do AIT's experts play here?**

AIT has offered us its services as an information broker, to allow a systematic dialog between potential users, stakeholders and research institutions. This is an extremely valuable initiative, which we share and support. It will give rise to projects that are important for us, such as making data real-time available in crisis events from public information sources.

**How do you rate AIT's innovative abilities?**

AIT is not just an important partner for us in the context of specific projects, it is particularly useful as an information hub in the field of research. We meet regularly to discuss research issues and ideas. Good networking among potential stakeholders and the research community is vital here. ///

# PHOTONS TO COMBAT CYBERPIRACY

/// In quantum cryptography, data is encoded using principles of physics to offer the highest known standard of security. Working jointly with the research team led by the renowned Austrian scientist Anton Zeilinger at the University of Vienna, researchers at AIT have taken several giant steps in advancing this field. AIT is in the meantime offering a wide variety of components and systems to promote commercial use of the method. ///



## ● IN A NUTSHELL

Quantum cryptography, a new discipline, is currently regarded as the only absolute secure method of encryption in existence. Initially AIT achieved several breakthroughs with experiments, such as in 2004 with the first bank transfer secured by quantum key and in 2008 with the launching of the largest quantum cryptography network at the time; since then the aim has been to make the transition from the world of academia to the industrial world. AIT has in the meantime developed a large array of components and systems in this field. This includes a unique software system for use in quantum cryptography environments and networks, fast detectors for measuring single photons, high-precision time tagging modules as well as various types of complete systems for practical use in research labs. With the aim of facilitating rapid dissemination of quantum cryptography, an Industry Specification Group was established at the European Telecommunications Standards Institute two years ago.

**QUANTUM RESEARCHERS AT AIT** have already attained a number of achievements in the fledgling science of quantum technology. Examples include, in 2004, the first electronic bank transfer to be secured by quantum key and the largest quantum cryptography network to date, which went live in Vienna in 2008. The quantum technology experts at AIT are currently developing complete quantum key distribution (QKD) systems, based on research findings published by Anton Zeilinger, which are already being used in other countries.

A tremendous advance in terms of practical implementation of this technology was the network installed in Vienna three years ago as part of the EU-wide SECOQC (Secure Communication based on Quantum Cryptography) project, in which a total of six stations are linked by using communication channels that are absolutely eavesdropping-proof. In a way similar to telephony in the past, the researchers were able to advance beyond the original point-to-point architecture implemented in the first QKD systems. As many as 41 partners in twelve countries became involved in the project, which was observed with keen interest the world over, so that the basis was established for demonstrating the economic feasibility of an absolutely secure network which encrypts data using the principles of quantum physics.

What makes the system absolutely eavesdropping-proof are the peculiar phenomena of quantum physics that are utilized in key distribution. Specifically, through the use of entangled photon pairs, quantum

mechanical states occur simultaneously at the sending and receiving ends, allowing a common and unique random number to be generated which remains unknown to everyone else. Any attempt to tap the data flow is recognized immediately, since such interference automatically alters the quantum information transmitted.

### USE OF EXISTING NETWORKS

The existing optical networks can be used for quantum cryptography. In key distribution, light quanta are transmitted, which are then used to generate the cryptographic keys. In a way similar to bits in electronic data processing, qubits (or quantum bits, representing a combination of varying quantum states) serve as information carriers. The challenge lies in making existing networks compatible with the extremely weak signals used in quantum cryptography. With the devices required for quantum cryptography, and especially the detectors, still being very costly, experiments are currently being performed involving asymmetrical architectures, in which only one base station containing the expensive detectors is used together with several cheaper partner stations. The Local Quantum Network (LQuNET) project, headed by AIT expert Michael Hentschel, is focused on methods for creating secure local area networks of the kind found in airports, power plants or health insurance institutions.

"The first commercial applications are already available," explains Andreas Poppe, Senior Scientist with a focus on research in experimental quantum optics at AIT's Optical Quantum Technology Research Service. Examples include a research laboratory which AIT has equipped with single photon detectors and complete quantum cryptography systems for research purposes which have been supplied to Thailand and Poland. Hybrid systems employing two security layers, one based on quantum cryptography and the other on classical cryptography, are still used for the most part in commercial applications.

### SPREADING AWARENESS OF QUANTUM TECHNOLOGY

One obstacle that continues to hamper widespread commercial use of quantum cryptography is a lack of information to a certain extent among security experts and decision-makers as to the potential uses of

the new technology. An additional barrier is the fact that no standardized security certification for quantum cryptography systems has yet been established. "It is now important to advance efforts towards standardization," says Thomas Länger, Scientist responsible for areas including security proof at AIT's Optical Quantum Technology Research Service. "Certification would be a great help in spreading the use of quantum cryptography." For this purpose an Industry Specification Group was initiated two years ago at the European Telecommunications Standards Institute (ETSI), and currently 20 research and industry organizations have become involved in joint efforts to hammer out specific standards. In order to clearly demonstrate to the industry the ways in which the new technology can best and most effectively be applied at individual companies, the ETSI Industry Specification Group for QKD has also prepared specific application scenarios.

**ANDREAS POPPE //**  
**Senior Scientist at Safety & Security Department**

*..Hybrid systems employing two security layers, one based on quantum cryptography and the other on classical cryptography, are still used for the most part in commercial applications."*



The experts at AIT enjoy a tremendous advantage in this endeavor. "AIT is already heavily involved in this area," Poppe notes. The range of expertise ranges from the engineering of individual components such as single photon detectors to the software system - in high demand worldwide - used to generate cryptographic keys from detector measurements and complete system architectures that include all optical and electronic components. In addition, AIT has specialized know-how in the use of quantum cryptography within existing optical fiber networks, as well as in the development of security proof based on information theory.

"Currently we can truly cover every area, from the most fundamental quantum phenomena up to network security," Senior Scientist Momtchil Peev points out, whose areas of responsibility at AIT's Optical Quantum Technology research group include algorithm development. Yet times are changing, as this field of research continues to expand more broadly

**THOMAS LÄNGER ///**  
**Scientist at Safety &**  
**Security Department**

„It is important to advance efforts towards standardization. Certification would be a great help in spreading the use of quantum cryptography“



and subsequently requires greater specialization. It is thus becoming more crucial to establish collaborations with partner institutions. To this end AIT has already built up global contacts on a broad basis.

### NEW DETECTORS

Because the information in quantum cryptography systems is encoded in light quanta, such systems require individual photons to be transmitted from the sender to the receiver. This means, however, that a light quantum must be reliably routed through the optical networks as far as the receiver's detector. The detector needs to be both highly sensitive, in order to detect individual photons upon reception, and very fast, so that large data volumes can be transmitted. Processing rates have increased tremendously in recent years – by a factor of five to ten each year. “With the help of the recent developments, we want to achieve processing rates of several hundred megabits per second,” says Christoph Pacher, scientist and project manager of the HiPANQ project, which is dedicated to developing new high-rate algorithms (see also the interview with Renato Renner of ETH Zurich). Until very recently the rate was a few kilobits per second, which allowed only small amounts of data, such as occur in phone conversations, to be encrypted. Now it is possible to encrypt and decrypt large amounts of data as well, for example images used in medicine. In line with all processes in quantum cryptography, extremely fast measurement methods are also required. A time-tagging module recently developed at AIT can now measure the time it takes for light to travel 2 centimeters. Not bad, considering that light moves at a speed of 300,000 kilometers per second.

### WORLD CLASS QUANTUM CRYPTOGRAPHY SOFTWARE

The Optical Quantum Technology research team is especially proud of the software it has developed, a system that is used by research institutions and part-

ners worldwide and includes all features required for signal processing and key encryption and decryption. The software was developed as part of an open source project to ensure rapid distribution worldwide within this still novel research area. The software is highly complex, and it supports the processing of data at an extremely high rate with the aid of massively parallel computer systems (such as are found in high-performance graphic cards). Consequently, any further development of quantum cryptography software requires the assistance of the experts at AIT.

Martin Stierle, Head of the Optical Quantum Technology Business Unit, envisions many different potential applications for quantum cryptography as add-ons of the kind used for instance in mobile networks. Air transmission of mobile phone calls and data within such networks is usually possible only within a range up to a few hundred meters. The mobile network radio signals are then passed on to optical fiber lines. Very little security is available within this segment, so that the entire information stream could be tapped and stored. Quantum cryptography could enable absolutely secure encryption to be achieved in such intermediate optical fiber networks. This would also protect the infrastructure from routing attacks. Quantum encryption could also be used in cloud computing, the current subject of much IT hype, as a means of transmitting data to cloud computers in a truly secure manner.

The development of quantum computers will in any case pose a very serious threat to the cryptographic methods based on mathematics that are currently in use. The experts at AIT predict that, once such computers are available, quantum cryptography will become the first choice, for example in Internet banking, because the method is based on the laws of physics and thus can be proved to be secure, even when faced with decryption attempts using quantum computers. ///

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## RESEARCH SERVICES

### Optical Quantum Technology

In the Optical Quantum Technology Research Service, technology is developed to enable secure electronic communication between two partners. Building on the basic research in this area by Anton Zeilinger at the University of Vienna, a technology is being developed which allows the absolutely eavesdropping-proof exchange of a digital key between partners; the key can then be used to encrypt any type of electronic communication. Within this research area, AIT plans to develop, on up through the industrial prototype stage, equipment that supports this method of key exchange as well as to create the basic infrastructure for securing communications networks using quantum cryptography.

Contract research and innovations are offered in the following fields of expertise:

- Generation of entangled photon pairs
- High-precision time tagging
- Polarization control

### Generation of entangled photon pairs

We are developing equipment used to generate pairs of entangled photons. This dynamic system, in which different parameters such as photon number, wavelength, and coherence length can be adapted to the client's needs, was developed for use in university education, but also for research facilities requiring entanglement as the basis for scientific experiments. The device generates up to 1,000,000 photon pairs per second.

### High-precision time tagging

We are developing measurement equipment for high-precision time resolution of events. Such devices, which are suitable for laboratory use, permit either the measurement of 8 channels at a time resolution of 82 ps, or 2 channels at a time resolution as fine as 10 ps. The TMM-8 time tagging module can be used for the runtime measurement of optical signals and thus for length measurement (e.g. OTDR) as well as for spectroscopy.

### Polarization control

We are developing equipment for the simultaneous monitoring and control of all polarization states in long optical fibers. Our patented process permits the active adjustment of polarization drift during ongoing operation. These devices can be used in any situation where the polarization of light plays a role in the transmission of information. In optical networks, for example, the encoding of information by polarization permits an increase in bandwidth. //




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**PROF. RENATO RENNER,**  
OF THE INSTITUTE FOR  
THEORETICAL PHYSICS AT  
ETH ZURICH, ON POTEN-  
TIAL METHODS FOR  
SECURE DATA TRANSMIS-  
SION.

*Prof. Renner, you are conducting research at ETH Zurich into phenomena of quantum physics that are still largely unknown. An example is the collaboration with AIT and the University of South Australia for the purpose of developing algorithms that allow quantum information to be more efficiently processed for use as keys. How does the collaboration work?*

The project itself is highly interdisciplinary. My responsibility is physics, while AIT has focused on software development and the Australian team on encoding theory. This clear division of responsibilities allows each to do what they do best. We then meet regularly to coordinate activities. At the meetings, people come together from a wide variety of disciplines that are normally separate. That is a very interesting situation full of learning opportunities.

***What findings do you expect this research project to identify?***

Until recently, quantum cryptography used to be an ivory tower notion. When it was invented in the 1980s, it was considered something of a thought experiment. The goal now is to take the step from the academic world to the industrial sector and to manufacture commercial products. Previous research in the university sphere turned a blind eye to the practical problems involved. It was enough, for instance, to transmit a tiny amount of data in order to demonstrate the proof of concept. However, the slow data rate turned out to be a major obstacle to widespread industrial application.

The new algorithms are now accelerating the process, allowing large volumes of data to be transmitted. The technology is being used today in a very small number of applications. Yet, useful solutions for widespread industrial application should become available in five years.

***What benefits and applications do the new cryptographic technologies from the field of quantum physics provide?***

The encryption systems in common use today offer only what is termed as "computational security". This type of security cannot be proved, rather, it rests on the mere assumption that any potential opponent will be unable within a reasonable time period to identify an algorithm capable of decrypting the encrypted messages. E-banking systems are an obvious example. Because the security implemented is based on unproved assumptions, we are never quite certain whether the system just might not be hacked. And history has shown this to be the case time and again. Quantum cryptography offers a fundamental advantage here: it can be proved secure.

***What part do the research findings and the developments by the AIT experts play in this project?***

The work done by AIT is vitally important because it bridges the gap between the academic world and industry. Especially for this project we need people who both understand the principles of quantum mechanics and at the same time know how to program. AIT fills an important need in this context. //



# MOLECULAR TOOLS FOR PERSONALIZED MEDICINE

/// Researchers at AIT are working on new biomarkers and molecular probes for medical applications. They are thus laying the groundwork for early diagnosis and targeted treatment of a wide range of diseases. ///

## ● IN A NUTSHELL

Age-related diseases such as diabetes, cancer and types of fibrosis are seeing a heavy increase in industrialized nations. This fact faces science with the challenge of identifying effective methods for early diagnosis and targeted treatment of such diseases. Researchers at AIT's Health & Environment Department are using imaging techniques, pharmacokinetic modeling and methods from molecular biology at DNA and protein level to develop preclinical and clinical tools. Their key aim is to understand the mechanisms of action of pharmaceutical agents and to ensure early diagnosis and individual, personalized medical treatment.

**BIOMARKERS ARE SUBSTANCES**, generated by the body itself, which are characteristic of certain diseases, thus allowing early recognition and targeted treatment. Such substances are consequently regarded as an important component in the personalized medicine of tomorrow, which pursues the goal of ensuring customized treatment for each individual patient. The experts at AIT are responding to the issues involved by developing biomarkers ba-

sed on nucleic acids and proteins, and by employing radioactively labeled substances along with imaging techniques.

The latter are used mainly to clarify whether a sufficient concentration of a specific drug does in fact reach the intended target area. "This plays a central role in cancer therapy and similar treatments," AIT molecular imaging expert Claudia Kuntner explains. "Recent years have seen the increased use of antibodies to treat such diseases. In the quest for new drug candidates, we often encounter the fundamental issue of whether such protein molecules, which are relatively large, will be able to pass physical obstacles within the body such as the blood-tumor barrier." Furthermore, due to increasing consumption of medication, it is frequently becoming necessary to examine potential interactions between different drugs.

#### A MOLECULAR VIEW INSIDE THE HUMAN BODY

The substance under examination is labeled with a radioactive nuclide and administered to the patient. The tracers emit photons as they move through the body, which can be made visible with the aid of positron emission tomography (PET). The PET scan provides a precise image of how and where the substance is distributed throughout the body over time. "This technique offers the tremendous advantage of allowing the progress of both the disease and treatment to be traced non-invasively," Kuntner points out. Pharmacokinetic modeling, meanwhile, provides an even more detailed molecular-level view inside the body. Using detailed tracer and blood data, experts are able to calculate the quantities of the particular substance stored within the organ and thus predict the therapeutic effect.

#### NEUTRON RADIOTHERAPY IN THE FIGHT AGAINST LIVER CANCER

As part of a WWTF (Vienna Science and Technology Fund) project currently being undertaken in cooperation with the JGU University of Mainz, the vast knowledge acquired by the experts is being applied in the treatment of liver metastases. The specific therapy, referred to as boron neutron capture therapy (BNCT), utilizes the property of boron-10 to disintegrate into an alpha particle and a lithium nucleus, which subsequently destroy any cells within a radius of a few thousandths of a millimeter. Following injection with a boron solution, the patient's

**CLAUDIA KUNTNER ///**  
**Senior Scientist at the**  
**AIT Health & Environment**  
**Department**

..Radioactively labeled substances are used, for instance, in cancer therapy to clarify whether a sufficient concentration of a specific drug does in fact reach the intended target area."



liver is surgically removed, exposed to neutron radiation in a reactor and subsequently reimplanted. "In order for the procedure to work, it is necessary to ensure that the boron administered accumulates selectively in the liver metastases," Kuntner notes. "And we are able to determine this very precisely using PET analyses." To achieve the best possible treatment results, the AIT experts also calculate the required dose and the point in time for administering the boron as well as the length and intensity of neutron radiation.

#### DETECTING TRACES IN BLOOD

With about 300,000 new cases of indications per year, breast, colon, prostate and lung cancer are the most prevalent varieties of cancer in Europe. In the face of demographic trends, such forms of cancer and other age-related diseases are expected to become even more widespread in the future and are thus a focus of biomarker development activities at AIT. In the quest for suitable biomarkers, attention is primarily concentrated on nucleic acids such as DNA and RNA and on proteins. "We have specialized expertise in DNA methylation," molecular biologist Andreas Weinhäusel explains. "This type of chemical modification of the DNA provides a number of advantages for developing biomarkers. For one, methylation profiles are tissue-specific and become modified at a very early stage in tumor development." Another advantage is that tumor DNA can be found circulating freely in the bloodstream.

**ANDREAS WEINHÄUSEL ///**  
**Senior Scientist at the AIT**  
**Health & Environment**  
**Department**

..We have specialized expertise in DNA methylation. This type of chemical modification of the DNA provides a number of advantages for developing biomarkers."





Loading of the high throughput microfluidic PCR chip for 9,216 parallel qPCR reactions.

Consequently, any change in the pattern of DNA methylation that is identified in blood serum serves as an early indicator of a tumor in specific tissue, rendering this technique especially suitable for minimally invasive testing.

#### TUMOR DETECTIVES IN ACTION

In biomarker development, AIT works jointly with clinical partners, defining tumor-marker candidates on screening sets consisting of tissue samples from diseased and healthy individuals. "From the samples, we isolate the DNA and RNA and perform genome-wide screening, including covering some 21,000 human genes," Weinhäusel explains. "The multitude of methylation patterns found are then subjected to complex bioinformatic analyses to identify the specific candidate markers most suited to distinguishing healthy tissue from diseased tissue." The next step is biomarker validation, which involves the use of high throughput methods to validate the candidates for a large group of patients and narrow down the list of potential biomarkers. In the search for suitable markers, the Department's many years of expertise and advanced infrastructure for performing high throughput analyses as well as the interdisciplinary approach to research in ge-

neral are obviously great advantages. "In particular, the close collaboration with the bioinformatics researchers and software engineers at our Department allows us to tackle issues which remain a closed book to other research groups," the molecular biologist observes. The technology developed at the Department has already enabled the successful identification of biomarkers for improved early recognition of breast, lung and colon cancer. In addition, other biomarker sets have been identified that support therapy decisions in breast cancer patients by clarifying possible risks of metastization, or that allow an unequivocal diagnosis of thyroid carcinoma. The ability to reliably distinguish non-malignant nodules from malignant ones in such cases saves many patients from unnecessary removal of the thyroid, surgery that might otherwise be performed in response to identifying "clinically suspicious" nodules.

#### ANTIBODIES ACTING AS BIOMARKERS

Besides nucleic acids, proteins can also serve as biomarkers. The immune system responds to tumors by generating specific autoantibodies, so that antibody profiles in the blood are particularly suited for use in minimally invasive and early testing. As part of a WWTF project carried out in cooperation with the Medical University of Vienna and the Vienna University of Natural Resources and Life Sciences, researchers at AIT intend using such altered antibody profiles to develop a test for the early detection of breast cancer. A protein chip has already been successfully tested at AIT that allows healthy women to be distinguished from women with mammary nodules on the basis of antibodies in serum. The current objective is to identify additional protein markers that further allow benign and malignant nodules to be distinguished. "At the end of the project, we aim to make available a simple blood test that allows reliable diagnosis from a single drop of serum after one or two hours," Weinhäusel says. The test would be a valuable supplement to mammography as early detection of breast cancer substantially improves the chances of successful treatment as well as survival rates. ///

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## RESEARCH SERVICES

### Development of biomarkers

Researchers at the Health & Environment Department are developing biomarkers for early diagnosis and targeted treatment of complex diseases. The main focus is on markers based on nucleic acids and proteins, with services ranging from genome-wide screening and biomarker validation to the development of customized diagnostic tests.

#### ■ Biomarker screening:

- Efficient identification of biomarkers by applying high throughput technologies (e.g. DNA/protein microarrays, next generation sequencing) based on RNA, DNA (methylation) and autoantibodies

#### ■ Validation of biomarkers and development of diagnostic assays:

- Design, establishment and application of assays specific to biomarkers identified in genome-wide screens
- Validation of the biomarkers for large groups of patients while devoting special attention to implementing cost-effective technologies suited to the clinical setting (e.g. nanoliter real-time PCR, bead-based protein assays)

#### ■ Bioinformatics and software solutions:

- Specialized software solutions for automated, seamlessly traceable high throughput analysis
- Customized workflows for assay design, data analysis and decision support

### Imaging techniques for targeted drug development

The Department provides a wide scope of services to the pharmaceutical industry to support the development of new substances. With the aid of imaging techniques applied at the molecular level, new medications can be brought to market sooner, while therapeutic strategies developed in the laboratory can be put into clinical practice more quickly.

#### ■ Radioactive labeling of drug candidates

- Labeling of small molecules and biologicals for specific molecular targets using various radionuclides, including C-11, F-18 and I-124

#### ■ PET studies

- Preclinical pharmacokinetic (PK) and pharmacodynamic (PD) PET studies
- Metabolite analysis
- Tumor therapy monitoring
- Pharmacokinetic modeling for calculating distribution volumes and transfer constants

#### ■ Computer modeling for nuclear medicine

- Software algorithms and modules for treatment planning in targeted radionuclide therapy (TRT)
- Simulation of radiation transport in nuclear medicine and boron neutron capture therapy (BNCT)
- Dosage calculations, biokinetic modeling, digital image processing algorithms, segmentation and preparation of digital phantoms of the human body. ///



**MARKUS MÜLLER**, HEAD OF CLINICAL PHARMACOLOGY AT THE VIENNA UNIVERSITY CLINIC, TALKS ABOUT DEVELOPING BIOMARKERS FOR FAST AND RELIABLE DISEASE IDENTIFICATION.

*Mr. Müller, the life sciences sector in Austria has made impressive progress in recent years.*

***What new challenges does this growth pose and what part could AIT play in meeting those challenges?***

Life sciences in Austria, at the universities as well as within the biotechnology industry, have truly made tremendous progress during the past 20 years. This has been frequently highlighted in international analyses and in the media. The sector will, in my opinion, be one of the most prominent drivers of future growth, and everything should be done to develop it further. AIT is already playing a key role in interactions among life science disciplines in Austria. For AIT it will be vitally important to also become better established as an institutional point of contact for stakeholders in industry-related high technology at international level.

***What timeframe do you envisage for implementing personalized medicine and what contribution can biomarkers make to this development?***

One could argue that personalization in medicine has in fact always existed. Yet the flood of new data, particularly as a result of the Human Genome Project (which lasted about 15 years and cost about three billion US dollars), has added a whole new dimension to personalization. Within the next five years, sequencing costs can be expected to drop even further, so that we will move from the current price of 1,000 dollars for a genome to a situation where complete genome data, in other words 30,000 individual genes or biomarkers, will become available to practically everyone. In combination with direct-to-consumer testing, as is currently offered by companies such as 23andme and Navigenics, this will fundamentally change the medical landscape. The outlines of 4P medicine (i.e. personalized, participatory, predictive and preventive), a new catchword, can already be seen, and 4P medicine will become fully established in the next five to ten years.

***In which areas of medicine do patients especially benefit from diagnostic imaging? What direction will future research in this field take?***

In addition to genomics, which I already mentioned, imaging techniques will advance to become key medical technologies of the future. Molecular imaging is directly related to 4P medicine. Methods such as PET or MRI will make it possible to visualize virtually any molecular mechanism as a biomarker by depicting it in pixels.

These technologies have already become indispensable, for instance in the development of CNS drugs and medications used in oncology. This trend will become even more pronounced, and it will become possible to characterize disease processes individually *in vivo*. This will provide the opportunity to "custom-tailor" treatment specifically to one particular molecular process. ///

# HEATING AND COOLING WITH NATURAL ENERGY

/// Researchers at AIT are working on innovative solutions to open up renewable energy sources for heating and cooling - the applications range from air-conditioning systems in buildings to supplying process heat for industry. ///

**IN EUROPE**, the provision of heating and cooling for buildings and industry accounts for about half of total end-user energy consumption. Michael Monsberger, Head of Business Unit "Sustainable Thermal Energy Systems" at AIT is convinced that, "Given this situation, innovative heating and cooling technologies based on renewable energy sources such as solar energy and ambient heat can make an important contribution to solving our climate problems."

Researchers working in the AIT Energy Department use proven scientific methods and a high quality laboratory infrastructure to develop these technologies - the main focus being on compression heat pumps, absorption heat pumps and chillers, and solar thermal components and systems. "The goal is to foster product innovations in the dynamic renewable heating and cooling market through scientific development support and research projects," says Monsberger. AIT is also taking an active role internationally in the development of research strategies for the energy system of tomorrow, for instance as part of the

**MICHAEL MONSBERGER //**  
Head of Business Unit  
"Sustainable Thermal  
Energy Systems"

„The goal is to foster innovations in the dynamic renewable heating and cooling market through scientific development support and research projects.“



European Technology Platform on Renewable Heating & Cooling (RHC), the International Energy Agency (IEA) and the European Energy Research Alliance (EERA).

## INNOVATIVE TECHNOLOGIES

One of the key research topics at AIT is absorption heat pumps, which can "pump" heat from a low to a higher temperature level using a thermally driven process. The process to achieve the required rise in temperature needs no electrical energy but driving heat - for example from renewable sources such as solar energy, waste heat or district heating. The advantage is that, depending on the direction of the absorption cycle, such systems can be used for both heating and cooling, making the technology highly versatile.

## ● IN A NUTSHELL

In times of climate change, volatile energy prices and dependency on fossil fuels, new types of technology for renewable heating and cooling are increasingly important, both from an economic and ecological point of view. AIT's Energy Department provides the industry with sound scientific expertise and a high quality laboratory infrastructure for developing innovative thermal components and systems, with the research emphasis on heat pumps and solar thermal technology. The whole aim of its research, development and quality assurance is to help achieve a lasting breakthrough for these environmentally friendly technologies to pave the way for a more sustainable energy system.

## NEW METHODS WITH AN INTEGRATED APPROACH ...

Despite their advantages, absorption heat pumps and chillers have only gained acceptance in niche applications in the high-power range because of



their high system complexity and investment costs. Researchers at AIT are therefore working on several projects with the aim of developing low-power machines which may create new markets in the future.

"One reason for the high overall costs is that these machines are usually manufactured from separate individual components in labor-intensive processes," says Thomas Fleckl, expert at AIT Renewable Heating & Cooling. "In the MiniPAC research project we are currently working on a highly integrated system approach for devices in the under 10 kilowatt range. This would then enable single-family houses for example to be cooled with solar or district heating energy."

Based on a novel heat exchanger concept it should be possible to produce systems of extremely compact design in future. This approach also allows a very high level of production automation and is expected to result in a marked reduction in investment costs.

#### **... AND NEW MATERIALS**

"Another weakness in today's absorption heat pumps and chillers is that the working pairs used are usually lithium bromide/water and water/ammonia," says Fleckl, suggesting a potential for further improvement. "They lead to problems such as corrosion, formation of inert gas and crystallization, which restrict the deployment possibilities of the machines and require the use of expensive materials and additional components." That is why the AbsoFLUID project sets out to develop novel alternative working pairs in collaboration with an industry partner. AIT's researchers are investigating the new fluids for their heat and mass transfer properties and developing concepts for customized heat exchangers.

#### **HEAT FOR THE INDUSTRY**

Solar thermal energy is still used mainly for domestic hot water preparation and space heating in the

**THOMAS FLECKL ///**  
**Engineer, AIT Energy Department**

„The AbsoFLUID project focuses on investigating novel working pairs for absorption heat pumps and chillers.“



residential sector. In the MasterCPC project researchers are now trying to expand the range of applications for solar thermal energy to include the provision of industrial process heat. "This medium-temperature range extends from 100 to 250°C and requires highly efficient collectors such as CPC collectors, which concentrate sunlight using mirrors," explains project leader Christoph Zauner. So far, the efficiency of these collectors has been enhanced on a trial and error basis, but AIT is now keen to use a combination of experimental and theoretical methods - the spectrum ranges from thermophysics, particle imaging velocimetry and FTIR spectrometry through to computational fluid dynamics and ray tracing.

#### VIRTUAL COLLECTOR

"Our aim," says Zauner, "is to model a virtual collector on the computer so we can already estimate at the planning stage how changes in the design, the selection of materials or the components impact on the thermal losses and therefore the efficiency."

Innovative heating and cooling technologies based on renewable energy sources such as solar energy and heat pumps can make an important contribution to solving our climate problems

At the end of the project in 2012 the experts plan to have both an optimized prototype and an extensive methods portfolio at their disposal, allowing them to assist manufacturers in developing high-performance collectors. Since the new generation of collectors also places new demands on the laboratory infrastructure, AIT's Solar Lab has been expanded accordingly.

"With a temperature range of up to 230°C and flow rates from 20 to 2,000 l/h, we can cover a huge range of applications and are a European leader in the field of medium-temperature collectors," says AIT

solar thermal technology expert Franz Helminger. There is certainly a lot of interest from the European solar energy sector: numerous collector manufacturers have already inquired about using the know-how and the new opportunities offered by the Solar Lab for further development and optimization of their products.

#### QUALITY AT THE HIGHEST LEVEL

To increase customer confidence in the new technologies AIT experts are preparing common quality standards for sustainable heating and cooling systems in a number of major international projects. The AIT Energy Department is a lead partner in the QAiST project working on the development of standards and test methods for solar thermal components and systems. By taking account of new developments on the market such as the combination of solar thermal technology and heat pumps, it aims to give an even greater boost to innovations in future. The SEPEMO monitoring project in turn aims to

**CHRISTOPH ZAUNER /// Scientist, AIT Energy Department**

„In the Master CPC project we are now expanding the range of applications for solar thermal energy to include the provision of industrial process heat.“



establish a common European method for determining the seasonal performance factor of heat pumps. Reliable data on the efficiency of devices under real conditions will lay the groundwork for efficient operation in residential buildings. High standards must apply not only to the components and systems themselves but also to the training of the specialist engineers installing them. The QualiCERT project is developing common quality criteria to establish a uniform certification scheme for installers of renewable energy systems - because it is only through systematic quality assurance and specialist workmanship that sustainable energy systems will gain wide acceptance in the future. ///

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## RESEARCH SERVICES

### Heat pump technologies

The AIT Energy Department supports industrial partners in developing innovative heat pump technologies. Along with research services, quality assurance plays a significant role.

- Technological development of compression heat pumps at component and system level
- Long-term analysis of heat pump systems in combination with other building services components in existing installations
- Performance and functional tests to the relevant standards and for the EHPA quality label
- Development of new technological methods in the field of absorption heat pumps
- Experimental and theoretical process optimization using various simulation models (e.g. CFD) and experimental environments

### Solar thermal technology

A balanced mix of experimental and theoretical methods is provided to support collector manufacturers and solar systems providers.

- Optical materials properties using FTIR spectroscopy
- Thermal analysis and thermophysical properties
- 3D modeling using CFD and ray tracing
- Heat loss and collector hydraulics analysis (e.g. with PIV, CTA and thermography)
- Performance and reliability tests to EN 12975 and ISO 9806
- Certification and monitoring of quality labels such as Solar Keymark and SRCC
- Simulation and analysis of (novel) solar thermal energy systems
- Monitoring of solar installations

### Comfort ventilation

The AIT Energy Department offers the following services with wide-ranging expertise and a laboratory infrastructure unique in Europe:

- Conformity tests to EN 13141-7
- Support in product development
- Optimization of comfort ventilation systems

### Training & education

The Energy Department offers the following tailored training and education programs in collaboration with partner companies:

- Certified Solar Heating Installer and Planner and Solar Heating Practitioner
- Certified Photovoltaic Installer and Planner
- Certified Heat Pump Installer
- Certified Comfort Ventilation Engineer

### Laboratory infrastructure

- Thermophysical laboratory: calorimetry, dilatometry, laser flash, thermogravimetry including FTIR and mass spectrometry; materials data and models
- Fluid dynamics analysis: PIV, CTA
- FTIR spectroscopy (250nm – 25µm) for analysis of optical properties
- Laboratory for compression and absorption heat pumps and chillers
- Laboratory for solar thermal collectors (indoor solar simulator, outdoor test facility, medium-temperature collector test facility) ///



### MATTHIAS SEILER,

EVONIK INDUSTRIES AG,  
ON INNOVATIVE RENEWABLE COOLING TECHNOLOGIES.

*Mr. Seiler, in 2010 alone Evonik applied for patents for 250 new inventions. How do you manage to integrate new research findings into your company?*

Innovations at Evonik are driven by customer and market needs. We

don't engage in innovation for its own sake but to satisfy a market need or customer requirement. The key to success in integrating new research findings into our company is early collaboration between the experts in marketing & sales, research & development, applications engineering, process technology & engineering, production and controlling in cross-disciplinary teams. The earlier such networking between the necessary specialists takes place and the earlier a common understanding is reached on how the research result can add value, the sooner we achieve rapid transfer and implementation. So the success of an innovation as a practical invention and making it a marketable proposition depends crucially on a smooth functioning internal network and close collaboration between the specialists in all the relevant organizational units.

*Evonik is one of the world's leading industrial enterprises in the field of specialty chemicals and the development of new working pairs for absorption heat pumps. What steps are you taking to maintain and consolidate your leading position in this field?*

Evonik earned about 80% of its chemicals revenues in 2010 from leading market positions. Essential components in the successful development of new system solutions are the combination of market-oriented research and development that includes customers in the process at an early stage together with integrated technology platforms. The development of new working pairs is an excellent example of this: you really have to know your customers' needs if you are going to be able to offer them a customized system solution giving them real competitive advantages. In this case we were able to eliminate the disadvantages of conventional working pairs such as crystallization, corrosion and toxicity by coming up with a system solution consisting of a customized Evonik absorbent and specific Evonik performance additives.

*If you are to remain globally competitive in the long term, you have to have innovative products and applications. To what extent can AIT help you do that?*

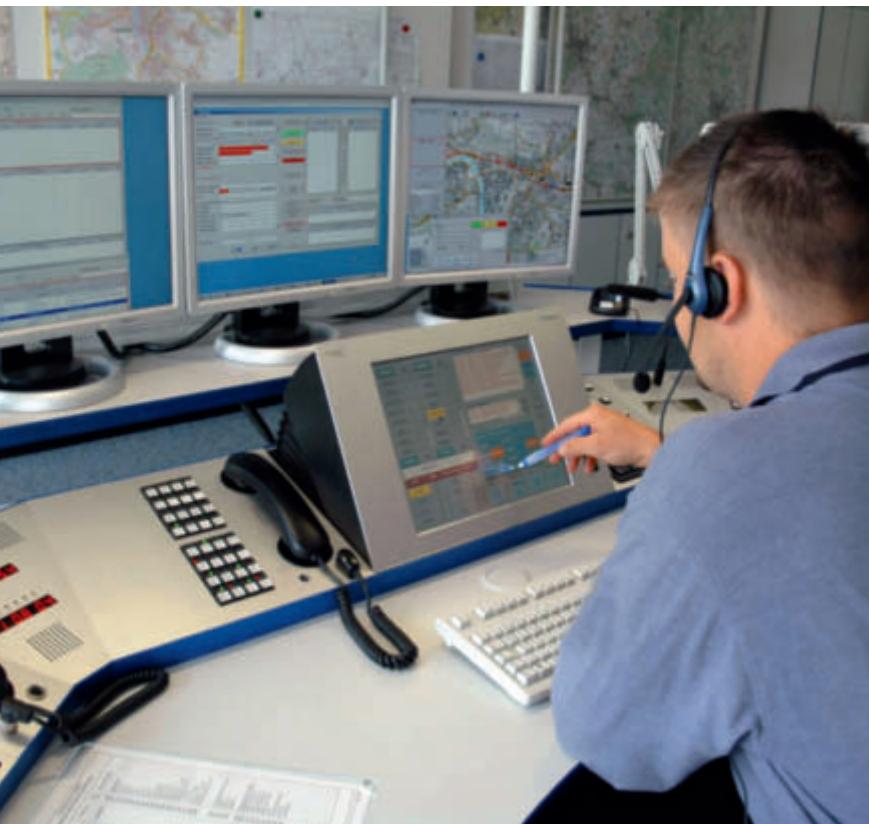
As far as collaboration with AIT is concerned, it is not so much the system solutions referred to earlier but rather the working pairs of the day after tomorrow. In the joint Absofluid project we hope to develop a genuinely game-changing technology, where AIT's skills in installation testing, wetting, and heat and mass transfer are extremely valuable for the project team.

*What do you particularly appreciate about your collaboration with the AIT experts?*

Their dynamic, innovation-driven attitude at a technically excellent level. These aspects combined with professional project management, an extensive network and very nice people impress my colleagues and me time and again. ///

# SMART LOGISTICS FOR SHORTER TRAVEL TIMES

/// Efficient and green transportation of people and goods is at the top of the European transport agenda. Experts at AIT develop cutting edge logistics solutions which are deployed in diverse areas such as transportation of goods and health care. ///



## ● IN A NUTSHELL

It is the EU's ambitious aim to reduce transport-related CO<sub>2</sub> emissions by 60% below 1990 levels by 2050. The greatest potential for achieving this target apart from energy-efficient vehicles lies in intelligent transportation management systems, which aim at using infrastructure more efficiently and optimising multimodal logistic chains on road, rail and water. In order to tackle the associated challenges, AIT uses a sophisticated mix of techniques including data acquisition, data analysis, modelling and optimisation. Efficient tour planning creates a win-win situation reducing environmental impacts and saving time and cost.

**IN MARCH THIS YEAR** the European Commission published the White Paper on Transport 2011 which is a roadmap towards a competitive and resource efficient transport system. One of the main problems identified is congestion of the transportation infrastructure. The daily traffic jams on Europe's roads do not just cause economic damage but send CO<sub>2</sub> emissions soaring. "Hence it is going to be increasingly important in the future to use the infrastructure more efficiently with intelligent transportation management and co-modal approaches, meaning a combination of different modes of transport," explains Norbert Brändle, Deputy Head of the Dynamic Transportation Systems Business Unit in AIT's Mobility Department. "The great challenge is to balance the optimal solution for each individual with the overall optimum for the traffic system. Scientific methods in logistics and fleet management can make an important contribution."

## LINKING AT EVERY LEVEL

One focus of AIT's work in this context is the planning of transportation networks and how to best utilise them to bring goods as rapidly as possible from A to B with minimum environmental impact - the EU target after all is to shift half of road freight transport over 300 km to rail and ship. "In addition to this, route and tour planning must increasingly be combined with other logistics areas such as inventory management and work time planning or linked with real-time traffic data to ensure efficient fleet management," says AIT logistics expert Jakob Puchinger, summing up further challenges.

**NORBERT BRÄNDLE ///**  
**Deputy Head of Dynamic Transportation Systems**

"The great challenge of smart traffic management is to balance the optimal solution for each individual with the overall optimum for the traffic system."



for this task is a cargo handling system developed in Austria, which enables containers to be reloaded from trains to HGV outside a container terminal.

"There are basically three planning levels to be optimised in the construction sector," explains project leader Matthias Prandstetter. "First of all, strategic investment planning for locations and means of transportation for the next 20 to 30 years, then medium-term planning of the intermodal transportation network, and finally operational planning of the specific routes for individual transports by HGV, rail and, alternatively, also by ship."

So AIT is currently developing a novel model that for the first time is looking at all three levels in an intermodal approach. This model can provide decision support for all logistics problems. This means, for example, that for any potential transportation problem the optimal solution can be computed based on the given fuel prices and personnel costs. "Alternatively, we can also review proposed corporate plans with respect to cost efficiency," says Prandstetter, highlighting the versatility of the system, which is set to go into operation in the middle of next year.

**MATTHIAS PRANDTSTETER /// Junior Scientist, Mobility Department**

"AIT is developing a model that for the first time is looking at all three levels in an intermodal approach, which can therefore be drawn on as a decision-making aid for all logistics requirements."



**MORE EFFICIENCY FOR HEALTH CARE LOGISTICS**

Some 200 ambulances run by the Wiener Samariterbund, the Vienna branch of an Austrian-wide NGO operating in the health care sector, carry out approximately 200,000 patient transports annually covering more than four million kilometers. About two-thirds of the transports are already scheduled the previous day - but in the course of the day new calls keep coming in, vehicles already assigned are withdrawn for emergency trips or planned trips are delayed due to traffic congestion.

"The aim of our HealthLog project is to achieve big reductions in patient waiting times by efficient tour planning and utilize resources, that is the ambulances, more efficiently," explains Ulrike Ritzinger, who is currently working on the new dispatching system

**MODELING THE FUTURE**

To plan logistics processes as efficiently as possible the very first thing needed is a realistic picture of the future. The researchers rely on stochastic models to enable them to predict in advance transport demand and travel times. In the subsequent search for optimised solutions they use a hybrid approach combining exact mathematical techniques and so-called heuristic processes which efficiently find good approximative solutions. "Complex logistics problems require a systemic approach says Puchinger. "Our interdisciplinary team comprises computer scientists, mathematicians and transport telematics scientists and is definitely one of our biggest assets." Collaboration in this area extends not just across disciplinary boundaries but also across national borders – apart from the University of Vienna and Vienna University of Technology the Department works together with experts from the Massachusetts Institute of Technology.

**CEMENT – CHANGE HERE PLEASE**

Transportation of building materials accounts for about one tenth of freight transport in the EU. Cement and other bulk goods are often transported over long distances by HGV because a mode shift from road to rail is usually too complicated and expensive. In the "i2Bau" project AIT experts optimise bulk logistics for the Austrian construction company Strabag, in order to make the modal shift both ecologically and economically attractive. The basis



for her doctoral thesis. To enable the system to react rapidly to unplanned incidents and include them in the tour planning, the call probabilities for different districts and times of day and the anticipated journey times of patient transports are estimated on the basis of historical data and current traffic information.

**ULRIKE RITZINGER ///**  
**PhD Student, Mobility Department**

"The aim of our HealthLog project is to achieve big reductions in patient waiting times by efficient route planning and utilize ambulance cars more efficiently."



"To make the predictions more reliable, we also plan to include how much time the collection and delivery of patients takes," says Ritzinger. The system should be ready to be deployed next year. The virtual tour planner will then advise the scheduler

**JAKOB PUCHINGER ///**  
**Scientist, Mobility Department**

"To solve these complex problems of tour planning, we rely primarily on methods of statistical data analysis, mathematical modeling and optimization."



in the dispatch center on the best vehicles to use for each new call to handle the transport to the destination in the given situation. The Samariterbund hopes that this will result in higher customer satisfaction and greater cost efficiency; small wonder that other aid organizations have already shown interest in the innovative tour planning tool.

**ELECTRIC LINK IN THE TRANSPORTATION CHAIN**

"A really exciting issue just around the corner will be the integration of electromobility into logistics," adds Puchinger, looking ahead to the not so distant future. Given the fact that more and more cities are considering introducing restrictions on HGV traffic because of increasing particle pollution, the expert sees the micro distribution of goods in inner-city areas as one of the most promising applications. Mixed fleets especially, made up of conventional, electric and hybrid vehicles, will bring new challenges for fleet management with their different refueling and loading times and distances between refueling - in other words the challenges of tomorrow which the logistics team at AIT are already getting to grips with now. ///

**i2Bau:** Austrian Research Promotion Agency (FFG) project funded through the "i2V" program of the Austrian Federal Ministry of Transport, Innovation and Technology (BMVIT).

**HealthLog:** FFG project funded through the "ModSim" program of the BMVIT.



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## RESEARCH SERVICES

### Transport logistics and fleet management

The AIT Mobility Department applies a broad mix of methods from statistical data analysis and numerical modeling to develop efficient, cost-effective and green solutions for transport logistics and fleet management. Its special interdisciplinary expertise is the planning and optimization of intermodal transport networks and the combination of route and tour planning with projected traffic information and real-time traffic data. The optimum tour planning achieved through this systemic approach saves time and costs while simultaneously reducing CO<sub>2</sub> emissions.

### Performance analysis and cost evaluation

The two key challenges in transport logistics are to reduce freight charges and produce reliable estimates of arrival times. With many years of experience in analyzing transport problems in relation to the current traffic situation, the Mobility Department offers comprehensive support in the evaluation of current route and tour planning and the identification and implementation of cost-cutting measures.

- Analysis of current transport plans (tours, routes) including GPS tracking
- Evaluation of transport plans based on different performance indicators (e.g. time, costs or emissions) in conjunction with the traffic situation
- Identification and calculation of potential savings
- Assistance in selecting optimization techniques geared towards more efficient transport logistics

### Optimisation of vehicle fleet operation

Mastering complex route planning tasks requires the use of various mathematical and statistic methods. The interdisciplinary team of the Mobility Department develops innovative optimization algorithms to ensure efficient and reliable transport planning while taking account of the current and projected traffic situation. The broad spectrum of techniques used means optimum solutions can be developed to meet the widely varying needs - from patient transport to the planning of intermodal logistics chains for specific goods.

- Analysis of customer-specific requirements
- Solutions to integrated problems through deviation management
- Intermodal route planning
- Stochastic and dynamic optimization for cost-efficient problem solving. ///




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**OLIVER LÖHLEIN,**  
DIRECTOR OF THE SAMARITERBUND, ON THE LOGISTIC CHALLENGES FOR PATIENT TRANSPORT IN URBAN AREAS.

*Mr. Löhlein, the Samariterbund in Vienna is engaged mainly in ambulance and patient transport as well as home-based care. What sort of logistics questions are you facing here?*

The first priority in emergency transport of course is to get to the accident site as fast as possible, where we have to estimate the severity of the emergency and the traffic situations. What is needed in patient transport is the optimum allocation of transport that ensures both the shortest possible waiting times for patients, reduces unnecessary stand-by times for our personnel and achieves a steady utilization of vehicles. Where home care is concerned, on the one hand individual client wishes have to be considered, which impacts on personal care times and trusted care staff. On the other hand, we need to keep journey times between individual appointments as short as possible for our personnel. These processes get even more complex if client visits are missed because of hospital stays or new patients are referred to us at short notice.

### *In what areas can research make a contribution here and where do you see the major challenges for the future, including electromobility?*

On the whole there is a lot to be said and done for promoting electromobility, both from the environmental point of view and due to the rising cost of fuel and fuel taxes. However, our emergency and patient transport vehicles respond to up to 800 calls a day and are on the go virtually round the clock. They need exceptionally long ranges and short refueling times - But I'm following the advances being made both in research and industry with great interest and hope there will soon be new and attractive possibilities available to the ambulance organizations in this respect.

### *AIT is currently developing a new dispatching system for patient transports for the Samariterbund. What's your opinion of the collaboration with AIT and what advantages do you expect from the new system?*

We give AIT our call data – excluding patient data of course – such as routes and trip times. They develop a model from this which enables the dispatch center to assign for patient transport not always the nearest vehicle but the most effective, with the decision based on transports requested, historical transport data, the location of all vehicles and their respective status, and the current traffic situation. Later in the project we are planning to test the system with some of our vehicles and compare the proposals with the behavior of our vehicle dispatch staff and drivers. The collaboration with AIT is going very well. It's a friendly, relaxed and very cooperative relationship. The experts involved are eager to get a precise idea of our actual situation and I believe both sides benefit from an extremely productive exchange of information. ///

# SIGNPOSTS IN COMPLEX SYSTEMS

/// The attempts to introduce climate change regulation imposed by the Kyoto Protocol show how difficult it is to reach a consensus in complex social systems. Especially when it comes to the new major social challenges facing us, such as climate change, demographic change and resource scarcity, conventional government policy-making instruments often prove inadequate. ///



## ● IN A NUTSHEL

The major societal problems like climate and demographic change and resource scarcity, and the social transition processes in mobility and social provision systems demand new approaches on the part of policy-makers, such as transdisciplinary collaboration. AIT experts are addressing these new governance requirements for complex systems. They are demonstrated in a project such as AIT's "Ex Kyoto" excellence project at all its different spatial and administrative levels, and combining the interests of the different stakeholders. Legitimization of state interventions and the new transition processes are important issues at AIT, for which it is developing new ways of providing support for policy-makers.

## ADDITIONALLY, SOCIAL TRANSITION PROCESSES

are taking place in many areas, which make collaboration between and across political fields essential. By analyzing these complex systems AIT governance specialists provide policy-makers with the tools and arguments they need, especially in RTI policy. There has been a significant change in the last few decades in what is understood by the terms government and policy-making. Our understanding

today of how social consensus is reached can best be described by the broad concept of governance. The term governance is roughly described by asking the question "Who makes what decisions and who influences these processes?", and it can be applied to companies, organizations, government or societal processes in general. What are the specific structures and processes that eventually result in specific decisions?

"In the past we tended to use the term control, but that is too mechanistic," explains Matthias Weber, Head of AIT's Research, Technology & Innovation Policy Research Area in the Foresight & Policy Development Department. So nowadays governance is understood as a process which involves all sorts of different players.

The challenges in the field of governance are particularly evident when it comes to innovation policy. For innovation processes in particular are characterized by a high level of uncertainty and the interaction of a large number of stakeholders all of whom have different goals.

### **GOVERNANCE IN THE COMPLEX SYSTEM OF THE KYOTO PROTOCOL**

A good example of all today's governance requirements is the AIT excellence project "Ex Kyoto", which demonstrates with exceptional clarity the necessity of getting multi-level perspectives as a basis for attempted interventions in a complex system. The project has to consider governance processes at different spatial and administrative levels (local, national, EU and UN) combined with the rationalities and interests of different groups of stakeholders (government, economy, science, civil society and others) in the decision-making processes.

"The Kyoto Protocol is actually a big experiment," explains project leader Eva Buchinger. In this global process the failure to attain the agreed goals has distinctly painful consequences for the state and for those businesses involved in trading with emission certificates. It costs a lot of money (through the purchasing of the certificates needed). So far, however, this experiment has not brought the hoped-for success. Although it can be regarded at the moment as a global success in that a considerable number of states (including the EU) have agreed CO<sub>2</sub> reduction targets and flexible mechanisms such as emissions trading, these targets are far from being achieved. Which

**MATTHIAS WEBER ///**  
**Head of RTI-Policy Business**  
**Unit in the Foresight & Policy**  
**Development Department**

"Innovation processes in particular are characterized by a high level of uncertainty and the interaction of a large number of stakeholders all of whom have different goals."



means the "successes" of multi-level coordination between the UN, the EU and national governments in formulating the targets are offset by the "failures" in achieving them. With emissions trading, policy-makers have attempted to apply a market-based instrument, but market forces have failed to steer developments in the right direction or to do so adequately. This prompts some to call for more legislation and regulation again. Such major processes as the Kyoto Protocol are fraught with a huge number of uncertainties. It is not sufficient simply to turn a wheel to achieve a target. The need for coordination and consultation is immense. "We are talking about different classes of uncertainty and a wide variety of stakeholders with different interests," says Buchinger.

### **MASTERING THE GRAND CHALLENGES**

These new grand societal challenges we are seeing with climate change, for example, require new methods of governance that go beyond the conventional instruments of regulation and financial incentives.

*There has been a significant change in the last few decades in what is understood by the terms government and policy-making. Our understanding today of how social consensus is reached can best be described by the broad concept of governance.*

That's why we are putting increasing emphasis on other equally important mechanisms, which aim to find a common direction for all the stakeholders involved in the decision-making processes. Foresight processes are also applied in many cases to arrive at common values, a common understanding of the problems and common visions, and to develop new networks.



The grand challenges can no longer be addressed in conventional and segmented policy areas. The key question is how the political and administrative system can be organized.

### LEGITIMIZATION FOR POLITICAL INTERVENTIONS

Whether you are in favor of a political intervention or not should be able to be measured by the question of whether there is a scientific basis for it or not. In other words, it is a question of deciding whether the need for political interventions can be formulated on the basis of a heuristic process that suggests solutions. This involves another important issue, namely that there must be solid legitimizing arguments if the state is going to take action. To what extent can scientifically based arguments be found for whether the state should take action at all and if so in what form? "There is a growing trend today," according to Matthias Weber, "to assume that where there is a deficit in whatever area or form the state should automatically step in."

**EVA BUCHINGER ///**  
Scientist at the AIT  
Foresight & Policy  
Development Department

"With the Kyoto Protocol we are talking about different classes of uncertainty and a wide variety of stakeholders with different interests."



**KLAUS KUBECZKO ///**  
Scientist at the AIT  
Foresight & Policy  
Development Department

"We are working on the application of legitimization arguments for the development of policies."



Arguments of market or system failure based on a neoclassical or evolutionary economic theory are today often used as rationalizations justifying political interventions. Whether and how the new societal challenges should be addressed by state intervention can no longer be automatically legitimized by these heuristics. AIT governance researchers are grappling with the search for more adequate heuristics for this legitimization.

"We are working firstly on the application of legitimization arguments for the development of policies, and then using them to devise new policy instruments, in the same way as happened with the competence center programs a few years ago," explains RTI expert Klaus Kubeczko. But a particularly pressing issue today is the grand societal challenges, which go beyond anything that was needed in the past decades. They involve more than simply promoting innovation. It is a question of safeguarding economic growth and the attractiveness of the business location.

To keep our finger on the pulse of the scientific discourse and bring the relevant governance issues into the scientific process, the Department is involved in organizing, for instance, the conference of the European Association for Evolutionary Political Economy, which is discussing "Schumpeter's Heritage – The Evolution of the Theory of Evolution" at Tech Gate Vienna at the end of October.

### NEW UNDERSTANDING OF CROSS-POLICY ISSUES

The grand challenges can no longer be addressed in conventional and segmented policy areas. The key question is how the political and administrative system can be organized. Both in the EU Commission and at national level sectoral policies like traffic, agricultural or energy policy have been largely segregated, particularly from research and innovation policy, so new interfaces, coordinating entities and organizational forms have to be created and the existing responsibilities redefined in some cases. "We are just confronting this issue now for the first time, and it is a major new task for policy-makers," says Weber firmly.

The grand challenges involve transition processes too, in the mobility system and the energy supply system for instance, or - prompted by demographic change - in the social services systems.

For these reasons, addressing transition processes like this has an important role at AIT. Foresight processes are applied here in order to create a similar perception of the problems and possible solutions to them in the different policy areas and at different policy levels. ///

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**JOSEF OSTERMAYER,**  
STATE SECRETARY FOR  
MEDIA AND COORDINA-  
TION, ON THE POSSIBILI-  
TIES OF IDENTIFYING THE  
CONDITIONS FOR  
GREATER ACCEPTANCE OF  
POLITICAL INTERVENTI-  
ONS.

*Mr. Ostermayer, creating the conditions conducive to the positive development of our society is one of the most important tasks of government. What problems have you already encountered in this area?*

It seems to me that encouraging public participation is one of the chief challenges facing government in creating the right conditions. "What is not accepted won't work," so it is clear that changing conditions will only be successful where the public are given a sense of direction and the possibility of participation. This means of course that we have to think hard about our education system, from the pre-school age up to graduation from university.

*Coordination is an important instrument for steering complex systems. Could you give us some examples of the systematic difficulties in this context and tell us about some of your successes?*

As I see it, some parts of complex systems tend to get into deadlock situations, to reach stalemate, and the complex policy-making system is no exception to this. Coordination, in this case in fact institutionalized coordination by Federal Minister Maria Fekter and me, assists week by week in resolving these stalemates. The best example I can give here from personal experience is how we solved the Carinthian signposting controversy. After 56 years of stalling, this summer we were able to present a solution that met broad acceptance.

*What contribution can applied research make to the steering of complex systems by government?*

I am a committed supporter of fact-based policy-making, because research findings can and should make significant contributions to it. So in today's political debates I am always on the lookout for the latest research findings or international comparisons that can guide us in making our decisions.

*The AIT Foresight & Policy Development Department has been providing support for Austrian RTI policy for years now. Do you think there are any other issues where the Department should make a positive contribution to Austrian policy-making?*

The network analysis deployed by the Foresight & Policy Development Department can certainly make valuable contributions to our understanding of other policy areas apart from RTI policy, because stakeholders and typical interactions are brought out and therefore made more intelligible. So I would be very pleased to see more of the analytical aspects of the research findings of the Department's network analysis feeding in to my work. ///

## RESEARCH SERVICES

**Systemic research, technology and innovation policy**  
Research, technology and innovation policy plays a central role in advancing innovation systems, strengthening economic performance and the ability to tackle societal challenges. This requires designing, analyzing and evaluating effective and well-coordinated organizational structures, governance processes and policy instruments. Foresight is an especially valuable tool for achieving this.

### Regional and infrastructure policy

To ensure a sustainable regional development, it is important to provide ecologically and socially viable infrastructures. So knowledge of spatial structures, spatial references, interactions and processes, and their spatial analysis and modeling is an essential expertise, which has been consolidated in the Department in recent years.

### Management of complexity

The increasing differentiation of organizations and the advanced complexity of the corporate environment means that organizations can no longer be managed with simple control mechanisms. Methods of complexity management, transdisciplinary research and system integration are essential if we are to create systems and instruments for the sustained development of organizations. ///

# CAREER PATHS AT AIT

/// Tomorrow Today asked AIT Senior Engineer Dorothea Heiss about her main reasons for choosing a research career at the AIT Austrian Institute of Technology. ///



Dorothea Heiss  
Senior Engineer at  
the AIT Safety &  
Security Department

*Ms. Heiss, what was your "moment of awakening", in other words the key experience that led you to choose a career as researcher?*

**Dorothea Heiss:** Every summer during my university studies in information science I worked at a different software company. And during a summer job at a research center belonging to a multinational IT corporation it became clear: research – that's for me. I find it fascinating to work on something completely new, something that no one else on the planet has ever done just that way. Research includes by definition the possibility of failure: no one knows whether the chosen goal can even be achieved at all. But that is just what makes the matter so exciting.

*At AIT you are an expert for high-performance image processing, a technical research field in which the proportion of women is still relatively small – even viewed internationally. What reasons do you see for this?*

**Heiss:** A wealth of research exists in the meantime that proves the direct impact of prejudice and discouragement on achievement and test results,

which in turn leads to further discouragement and reinforces the prejudices. In other parts of the world, such as Asia and the former Soviet Union, there is much less prejudice against women in technical fields, and the proportion of women in technical professions is much higher in those places than here.

I personally have never encountered any prejudice at AIT, on the contrary, people have always received me with a positive attitude. Part-time employment models that facilitate the reconciliation of work and family life are at AIT an option that people actually choose – even some of my male colleagues, who are recognizing more and more the importance of their role in the family and in child-rearing.

*Engineers, women or men, are highly sought after worldwide. Why are you involved in research particularly at AIT?*

**Heiss:** If research were entirely theoretical, I would start wondering about the sense of it. Fortunately at AIT, research in line with international standards goes hand in hand with direct applicability. I am proud of the fact that the technology we are developing in high performance image processing is being very successfully applied by a global market leader. That is proof of both the excellence and the relevance of our research. The ideal motivation for me is to produce outstanding research that benefits business. A further aspect is the long-term perspective that AIT offers. While previously working for small start-ups and spin-offs it was frustrating to be completely dependent on individual grant approvals. The base funding at AIT ensures the option of being able to work on research topics for several years and in this way produce highly meaningful findings.

The extraordinary team spirit prevailing within the High-Performance Image Processing Business Unit is also an important factor. I appreciate the supportive atmosphere and the collective responsibility for results – for me very important prerequisites for enjoying my work. ///

## AIT CAREER MODEL SENIOR ENGINEER

Senior Engineers support the Business Unit management in the strategic development and positioning of the Business Unit. Responsibilities include the development and management of large, complex projects of strategic importance, as well as publishing articles and registering patents, developing concepts for applying and exploiting the findings and instructing Junior Engineers and Junior Expert Advisors. Success in this role depends in particular on a system-oriented appreciation of the available technological options as well as of customer needs and the market situation. Specialized training corresponding to the particular professional and strategic orientation is available. Individuals demonstrating superior leadership competence have the option of assuming additional management responsibilities as a Thematic Coordinator.

### Requirements

- Completed Master level degree or equivalent
- Several years of professional experience in research and development
- Profound scientific or technical knowledge in the respective field coupled with a superior appreciation of systems
- Exceptional knowledge of the market and of customer needs
- Ability to successfully network both within the organization and beyond as well as to implement plans
- Ability to think and act strategically and in a business-minded manner

# INNOVATION CALENDAR

## OCTOBER 1-19: 4TH ANNUAL MIDDLE EAST HEALTHCARE EXPANSION SUMMIT 2011

The Middle East Healthcare Expansion Summit, with a focus on e-Health, is being organized with the support of health care facilities and hospitals in the region. The conference is intended for stakeholders from the industry and for members of senior management in the IT sector from the GCC region (Gulf Cooperation Council). Peter Kastner, e-Health expert at the AIT Safety & Security Department, has been invited to the Middle East Healthcare Expansion Summit to give a presentation on the topic "With AIT technologies toward closed loop health care". Venue: Qatar

**Information:** [www.flemingulf.com](http://www.flemingulf.com) (under Conferences)

## OCTOBER 17 – 28: DIMETIC SESSION “MODELLING, GEOGRAPHY OF INNOVATION AND GROWTH, POLICY”

Within the framework of the DIME project (Dynamics of Institutions and Markets in Europe), young researchers will have the opportunity in Maastricht on October 17-28 to receive specialized training in new developments in the dynamics of institutions and markets in Europe, as well as to meet experienced researchers to discuss their current research focuses.

**Information:** <http://dimetic.dime-eu.org>

## OCTOBER 19: AIT HEALTH & ENVIRONMENT SEMINAR SERIES 2011

As part of professional development activities for its staff, AIT is inviting distinguished individuals from the international scientific community to hold workshops on a variety of topics related to areas of research under study at the AIT Health & Environment Department. Each of the scientists will additionally hold a lecture at the Tech Gate in Vienna, open to the general public. Upcoming lecture: Application of photoremediation technologies in Canada. Jim Germida, University of Saskatchewan, Canada

**Information:** <http://www.ait.ac.at/departments/health-environment/?L=1>

## October 19 – 20: 3rd Buildings under Control Symposium

Symposium for planers, system integrators, engineers and sales and marketing experts from all over the world in the field of building automation. Keynote speech by Peter Palensky/AIT Energy Department: "Predictive controls for sustainable buildings" (October 19, 9:15 am); venue: Vienna, TECHgate

**Information:** [www.loytec.com](http://www.loytec.com)

## October 19 – 21: ANSYS CONFERENCE & 29. CADFEM USERS' MEETING

The ANSYS CONFERENCE is one of Europe's largest annual user conferences in the area of numerical simulation for product development. Matthias Hartmann of Light Metals Technologies Ranshofen (LKR) will present the topic of: "Numerical investigation of a hybrid space frame structure for class L7e electric vehicles". Venue: ICS International Congress Center Stuttgart, Germany

**Information:** <http://www.usersmeeting.com/en.html>

## October 20 – 21: New concepts for electrical power – innovations for prosperity”

49. Professional Meeting of the Austrian Society for Power Engineering in the Austrian Electrotechnical Association (OVE); keynote address by Brigitte Bach/AIT Energy Department: "Smart cities – current trends in European research" (October 21, 10:00 am). Venue: Innsbruck, Congress Innsbruck

**Information:** [www.vde.com/de/technik/e-energy/veranstaltungen](http://www.vde.com/de/technik/e-energy/veranstaltungen)

## October 27 – 30: Vienna 2011 Conference on Schumpeter's Heritage – The Evolution of the Theory of Evolution

On the occasion of the 100th anniversary of Joseph Schumpeter's work "The Theory of Economic Development", the AIT Foresight & Policy Development Department and the Institute of Mathematical Methods in Economics of Vienna University of Technology are holding a conference dealing with the main topics of Schumpeter's research.

**Information:** <http://schumpeter2011.econ.tuwien.ac.at>

## November 15 – 16: First Annual Forum on Smart Cities 2011

Successful models for smart cities – smart technologies for the city of the future. The Smart Cities Forum presents concepts, ICT applications, factors in success as well as practical experience gained in Austria and abroad.

Keynote speech by Brigitte Bach/AIT Energy Department: „Smart cities – a European concept for ultra-low carbon cities“ (November 16, 9:05 am)

Venue: Vienna, Hotel Hilton Stadtpark

**Information:** [www.ait.ac.at/news-events/events/?L=1](http://www.ait.ac.at/news-events/events/?L=1)

## November 15 – 17: CARTES & IDentification

Cartes is an international trade fair for digital security, smart technologies and for regular and contactless payments. It is one of the world's leading events for plastic and magnetic cards. Around 20,000 visitors and some 1,300 delegates will attend as about 450 companies on hand at the event present new developments on the international market in the fields of smart technologies and identification. The IDentification forum, taking place simultaneously, provides an opportunity to become familiar with the most recent solution innovations in biometrics and authentication as well as the major potential applications. The introduction of electronic identification cards in a number of European countries and the fight against cybercrime are currently providing strong impetus for advancing identification technologies. As a certified and accredited expert for radio-frequency identification (RFID), the AIT Austrian Institute of Technology Mobility Department will be on hand at this professional event with its own booth. Venue: Nord Villepinte exhibition center, Paris, France

**Information:** [www.cartes.com](http://www.cartes.com)

## December 7 – 9: 17th Annual International Wood Construction Conference (IHF 2011)

The IHF is one of the major platforms for international players in wood construction, with more than 1,300 attendees from many nations. Topics include: wood construction with a focus on energy, ecology and sustainability principles in project planning, execution, construction engineering and architecture. Presentation by Susanne Gosztonyi/AIT Energy Department within the thematic block "Future of construction: intelligent facades and building service concepts": "BioSkin bionic facades – the potential of bionics for adaptive energy-efficient facades of the future" (December 9, 9:30 am). Venue: Garmisch Partenkirchen, Germany

**Information:** [www.forum-holzbau.com/ihf/garmisch\\_index.html](http://www.forum-holzbau.com/ihf/garmisch_index.html)

## 19 – 21 December: 9th International Conference on Frontiers of Information Technology (FIT 2011)

Keynote speech by Peter Palensky/AIT Energy Department: "Smart cities – a large scale cyber-physical energy system and a complex optimization problem" (December 19). Venue: Islamabad, Pakistan

**Information:** <http://fit.edu.pk>



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