palcorn

// making computing palpable

// Editorial comment

Ambient, pervasive and ubiquitous computing is quickly becoming a predominant trend within the IT industry and associated research work, both as a characteristic of ongoing developments within this area and as a powerful vision for longer term changes in our use of computing resources. The PalCom project shares both these views. On the one hand, the current development of new, small, specialised devices definitely points towards ambient computing being well on its way; on the other hand, we share the vision that, in the longer term, ambient computing may provide new opportunities for qualitative improvements to our lives.

In order to further the realization of this vision, however, it is not enough that devices become smaller, more powerful, less power consuming and less visible by being integrated into other artefacts, etc. It is of paramount importance that users of these new devices and systems understand them and their inter-relationships. It is further important that they are able to maintain control of such devices and their interaction with different systems, and that they have the possibility to deal with unforeseen situations and errors in adequate ways.

This is the overall objective of PalCom, namely to design a software architecture for this environment – an environment we have termed palpable computing.

The aim of this magazine is to provide the reader with an understanding of the vision of palpable computing, as well as to present a wide range of examples of the work presently being carried out with the overall objective of designing palpable systems, i.e. systems of devices that are capable of being noticed and comprehended.

The project is sponsored by Future and Emergent Technologies within the EU Information Society Technologies thematic area.

Read and enjoy!

Morten Kyng /professor, Dr. Scient/computer science/University of Aarhus and Preben Holst Mogensen/Associate professor/computer science/ University of Aarhus

// part_01 // the vision of PalCom

'Palpable computing' means pervasive and comprehensible IT solutions. The greater the influence IT has on our daily lives, the more apparent becomes our need for compatibility in the functioning of different technologies, whilst at the same time ensuring that such technology is easily understood by users. PalCom's researchers are developing design concepts and a range of software development tools, so that both technicians and general users have easy access to a reliable cross-section of different types of IT.

PalCom is short for 'Palpable Computing' and is a research project funded by the European Union (IST 002057). The project brings together around 100 researchers from all over Europe. The vision is to develop 'palpable computing', a new concept for computing that will make technologies a lot easier to understand, use and construct on-the-fly. The objectives of PalCom are, among others, for researchers to provide qualities as ad hoc networking and the opportunity for users themselves to inspect and remedy system failures. With technologies becoming more and more pervasive in our everyday lives, PalCom has made it its goal to deliver new development tools and a new approach to designing information systems that fit to the age of pervasive computing. When the project terminates by the end of 2007 the outcomes will be a conceptual framework for palpable computing, an open architecture, and a toolbox that researchers and professionals may use to develop new palpable devices and services.

PalCom is by nature multidisciplinary. In order to develop a new perspective on ambient and pervasive computing, insights from many different disciplines are needed. Therefore the project brings together a wide range of diverse competencies and professions. This section digs into the vision of the PalCom project and its approach to technology design.

PHOTO: MADS AARUP

> " Automation is fine so long as the intentions of the user are in agreement with the vision of the designer – but if you want to do something a bit different, then it is extremely annoying that the system is automated. In such case, there is a request for more user-control.

MORTEN KYNG, PROJECT LEADER, PALCOM

// The future belongs to palpable computing

Microchips in everything from the kitchen toaster to the firefighter's axe. In an era of ubiquitous IT, it is crucial that an increasing number of devices are able to function and communicate interactively and that users are able to understand how the systems surrounding them work. A hundred European researchers from the EU-sponsored project 'PalCom' have taken up the challenge.

BY RIKKE SKOVGAARD ANDERSEN

Since the late eighties, ubiquitous computing has been the design concept to attract many professional developers. For more than 20 years, concepts such as 'invisibility' and 'automation' have guided how IT-systems are designed. Since the project started in 2004, European researchers from the EU-sponsored research project 'PalCom' have challenged the traditional notion of ubiquitous computing with a more up-to-date concept for the design of Information Technology.

- Palpable computing is really about doing ubiquitous computing right. In its original sense, ubiquitous computing is centered round making technology invisible whilst using it. But if your tools do not fit the job

you are trying to do, or if there is a system breakdown, then you need to be able to see the tools, to experiment with them or even to repair them, explains Professor Morten Kyng from the University of Aarhus. He is the project leader and, together with over 100 other European researchers, he is developing the IT design concept of the future: palpable computing. According to the PalCom research team, we need new developmental tools and a new approach to designing information systems in order to meet the demands of a future with ubiquitous IT.

- With palpable computing, you create a spectrum of visibility. You can have a device that is visible in the sense that it is aesthetically pleasing and fun to use. At

the other end of the spectrum, you have recurring breakdowns and errors. Then you need to be able to see the system, to find out what has gone wrong and how to correct the error, says Morten Kyng, the person who came up with the term 'palpable computing' while waiting for his colleagues to join him at an early planning meeting. He was killing time browsing an online dictionary on the Internet when he came across the word 'palpable', which means 'tangible' or 'comprehensible'. Clearly the right name for the sort of IT he and his fellow researchers visualized and wanted to lay the foundations for.

Putting the user in control
The question of visibility is not the only area

in which the PalCom project is striving to improve ubiquitous computing. The team have a whole list of research issues that challenge the principles of traditional ubiquitous computing they wish to take a step further. Morten Kyng tells how PalCom also aims at supplementing system automation with more user-control:

- A lot of ubicomp systems have a high degree of automation; they take the burden of control away from the user by automating decisions. This is fine so long as the intentions of the user are in agreement with the vision of the designer – but if you want to do something a bit different, then it is extremely annoying that the system is automated. In such case, there is a request for more user-control, he explains and continues:

- In my view, one of the biggest problems that ubiquitous computing will face in the future is that people will not want to use the systems because they feel they have lost control – for example, people may become concerned about interacting with invisible systems where unknown companies or government agencies can snatch a lot of information about you from the system and use it to their own benefit. Today, we

are already beginning to see the first signs of such anxiety. The vision of palpable computing is to put comprehensibility and control over your own information on the agenda of system developers and into the hands of users.

From IT-chaos to ad hoc networks
PalCom researchers are concerned with a number of application areas, the majority of which are related to healthcare. Here they find inspiration and can test their ideas by building prototypes. The health sector is interesting because it is full of devices and technology and is rapidly approaching the vision of IT everywhere and in everything. A good example is PalCom's application area 'major incidents' involving, among others, emergency services. If a lorry is involved in an accident, or a fire breaks out, the police, the fire services and ambulances are just some of the services that can be called out. Each emergency service brings along its own communication system and technical equipment, so the scene of an accident quickly becomes a vast confusion of IT systems and communication between emergency services suffers.

The major incident scenarios highlight

a third important aspect of palpable computing: the more IT is built into our surroundings, the more important it is for different devices to be able to talk to one another. Getting different technologies to work together properly and to become parts of ad hoc networks is another task PalCom researchers are involved in.

From major incidents to pregnant women
Morten Kyng sees one more advantage in choosing healthcare as a test ground for palpable computing:

- The health sector also provides us with a diversity of settings we can use to test our design ideas and applications. A major incident is a hectic and dramatic situation, whereas another application area, IT-support for pregnant women, is a lot less stressful and has a slower pace – at least most of the time.

Besides major incidents and expectant mothers, researchers work with wireless monitoring of premature babies, rehabilitation of hand-surgery patients and training in water for children with Down's Syndrome. Outside the healthcare area, the focus is on supporting the work of landscape architects by developing

> " Palpable computing will make technology a much more integrated and dynamic part of our lives.
>
> MORTEN KYNG, PROJECT LEADER, PALCOM

// The firefighter as co-designer

systems for relating digital information (e.g. 3D models and other visualizations of construction projects) to the real world.

Across professional borders

The PalCom project spans a wide range of research competencies distributed all over Europe: Software engineers from Switzerland, software architects and industrial designers from Denmark, ethnographers from Britain, interaction designers from Italy and many more. In total 13 partners are involved in PalCom – not only European universities but also companies. Among them are the German IT-giant, Siemens, and the smaller, highly specialized Swiss undertaking, Whitestein Technologies.

- Our reason for starting PalCom was that we on the one hand had the technological competence to create new devices and platforms. And on the other hand, we had the organizational skills to cooperate closely with users and organizations outside research – that is to say, the professional users of the technology we are developing, says Morten Kyng and continues:

The universities benefit from working together with commercial developers because they know a lot about how to turn good ideas into products. On the

other hand, the companies profit from cooperation with high quality researchers from many different disciplines.

Designing together with users

In PalCom, end-users are deeply involved in the design. Pregnant women and hand-surgeons give advice and feedback in workshops, and host researchers as participant observers, e.g. in the drills of the local fire department or with the ambulance doctor when he is on duty. The method is part of a method called 'participatory design' and many of the universities taking part in PalCom are deeply rooted in this design tradition. Not least the University of Aarhus, where project leader Morten Kyng and his colleagues at the Department of Computer Science have worked with participatory design for more than 20 years.

- Participatory design and field studies are important starting points for PalCom. If we are to do pervasive computing the right way, by ensuring comprehensibility and user control, then we need to carry out our design work together with the people who are going to use the systems, says Morten Kyng.

A new way of thinking about IT

One of the most important achievements of

the PalCom researchers will be a toolbox with examples of palpable applications, software architecture and a set of design guidelines for professional developers. The goal is clear: these tools are intended to renew the way information technology systems are developed and used. Morten Kyng explains:

- Palpable computing will make technology a much more integrated and dynamic part of our lives. It has the potential to change technology from something rather static to something flexible that we can change and adjust on an everyday basis, just as we do with the contents of our pockets or the shelves in the kitchen.

The Danish Professor also stresses that palpable computing will make it much easier for companies to involve end-users in the development of new solutions. Recent research points to the fact that user-driven innovation is much more successful than internal company innovation. With palpable computing, the technological possibilities will be more tangible to non-professionals and it will be easier to give end-users a role in the innovation cycle.
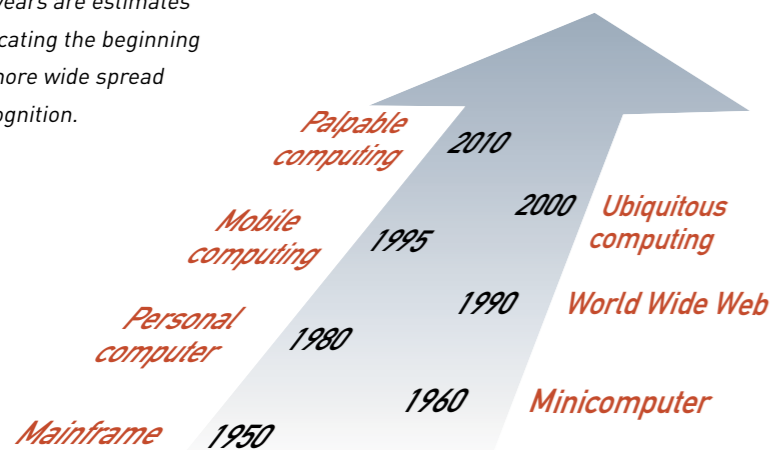
From research to products

The PalCom researchers are currently working on making their development tools available as open source. This is part of a strategy to make commercial developers and researchers outside the project aware of palpable computing and its possibilities. Soon, a group of PalCom researchers will also travel around Europe to visit IT companies that are interested in getting acquainted with the new design concept. A lot of time and energy is devoted to explaining and demonstrating the value of palpable computing and Morten Kyng is looking forward to seeing how the results of the project will be received by the IT industry:

- Since the beginning of the project, professional developers have reacted very positively towards our ideas and results and I am convinced that our key ideas will influence the general development taking place within the ubiquitous computing movement. So far the future looks bright for palpable computing, he concludes. ∎

Timeline of technologies.
All years are estimates
indicating the beginning
of more wide spread
recognition.

Palpable computing — 2010
Mobile computing — 1995
2000 — Ubiquitous computing
Personal computer — 1980
1990 — World Wide Web
1960 — Minicomputer
Mainframe — 1950

PHOTO: PALCOM

PalCom researchers believe that by developing technologies in close cooperation with end-users, they can enhance their usefulness as working tools. That is why both policemen and firemen join researchers at the drawing-board when new IT is being designed for major incidents.

BY RIKKE SKOVGAARD ANDERSEN

The end-user is of great importance to PalCom researchers, when they are developing their ideas. One of the project's application areas is Major Incidents, and the police and fire brigade from Denmark's second largest city, Aarhus, are given the opportunity to provide input on how palpable computing can make their jobs easier.

- For us, it is important that new technology is easy to handle. We firemen cannot stand in the rain on a dark night, fiddling with small buttons. As users, we help to bring the reality of real life situations to the development of new technologies, explains Jakob Andersen, the fire chief for

Aarhus fire brigade, who has been involved in PalCom since the project started in 2004.

This method is called "participatory design", a design-tradition with deep roots in Scandinavia. With four Scandinavian research institutes as partners in PalCom, it is not surprising that participatory design is a central element of the project's development strategy. An important design-tool are user-workshops, where researchers and end-users discuss their ideas, experiment with new technologies or test prototypes – depending on how far they have come in the design process.

Amrik Singh Chadha is the Deputy

Chief of Police in Aarhus and another of PalCom's users.

- I have never been told that something is impossible. My colleagues and I have come to appreciate that there are few limits for expanding technologies. As a part of the PalCom project, I have had to think in different ways than usual, he adds, and agrees with Fire Chief Jakob Andersen:

- Our dream is that these marvellous tools we are helping to develop together with PalCom's researchers result in actual products that we will be able to use in our daily work. Both the police and the fire brigade see great advantages to be gained from this. ∎

// 10 questions and answers about PalCom

// PalCom in numbers

1. What is PalCom?
The PalCom project is a European IST project. It commenced in January 2004 and ends in December 2007. The project consists of a consortium of European organisations collaborating to define software architecture and conceptual framework to support palpable computing in a variety of application domains.

2. What is the PalCom vision?
The PalCom vision is to produce the first version of a software architecture for palpable computing, i.e. an architecture that supports going beyond 'traditional' ambient computing. Where ambient computing sees invisibility of computing sources and automation of human tasks as ideals, we also insist on comprehensibility, user control and understanding.

3. How is PalCom organized?
PalCom is part of the Future and Emergent Technologies division of Information Systems Technologies within the 6th framework programme. It is run by its 13 partner organisations, and is coordinated by the University of Aarhus, which acts as the link between the partners and the commission as well as coordinates the activities of all partners.

4. Why collaboration across EU borders?
The competencies involved in PalCom are very diverse, including for example work analysts, interaction designers, industrial designers, architects, software developers and software architects. In order to find the best organisations within these domains, it is necessary to work on a European, not just a national, level.

5. Who pays for PalCom?
PalCom is primarily funded by the European Commission, but the Swiss Government also makes a significant contribution. In addition, all participating organisations also contribute, either by only being partly funded for the work (industry) or by contributing person months from permanent staff (universities).

6. Who is in charge at PalCom?
The day-to-day management is conducted by the University of Aarhus. More strategic and fundamental issues are handled by the Programme Management Committee and the Steering Committee with representatives from all partners.

7. Why the large numbers of universities?
PalCom is part of Future and Emergent Technologies and thus operates with a long-term research perspective. A natural consequence of this is a large proportion of University partners (and thus researchers).

8. What is palpable computing?
The term "Palpable Computing" was coined when writing the application in March 2003. Palpable Computing denotes that systems are capable of being noticed and comprehended. Palpable systems support people in understanding what is going on at the level they choose. And they support control and choice by people. Palpable Computing is the next step after ubiquitous and ambient computing.
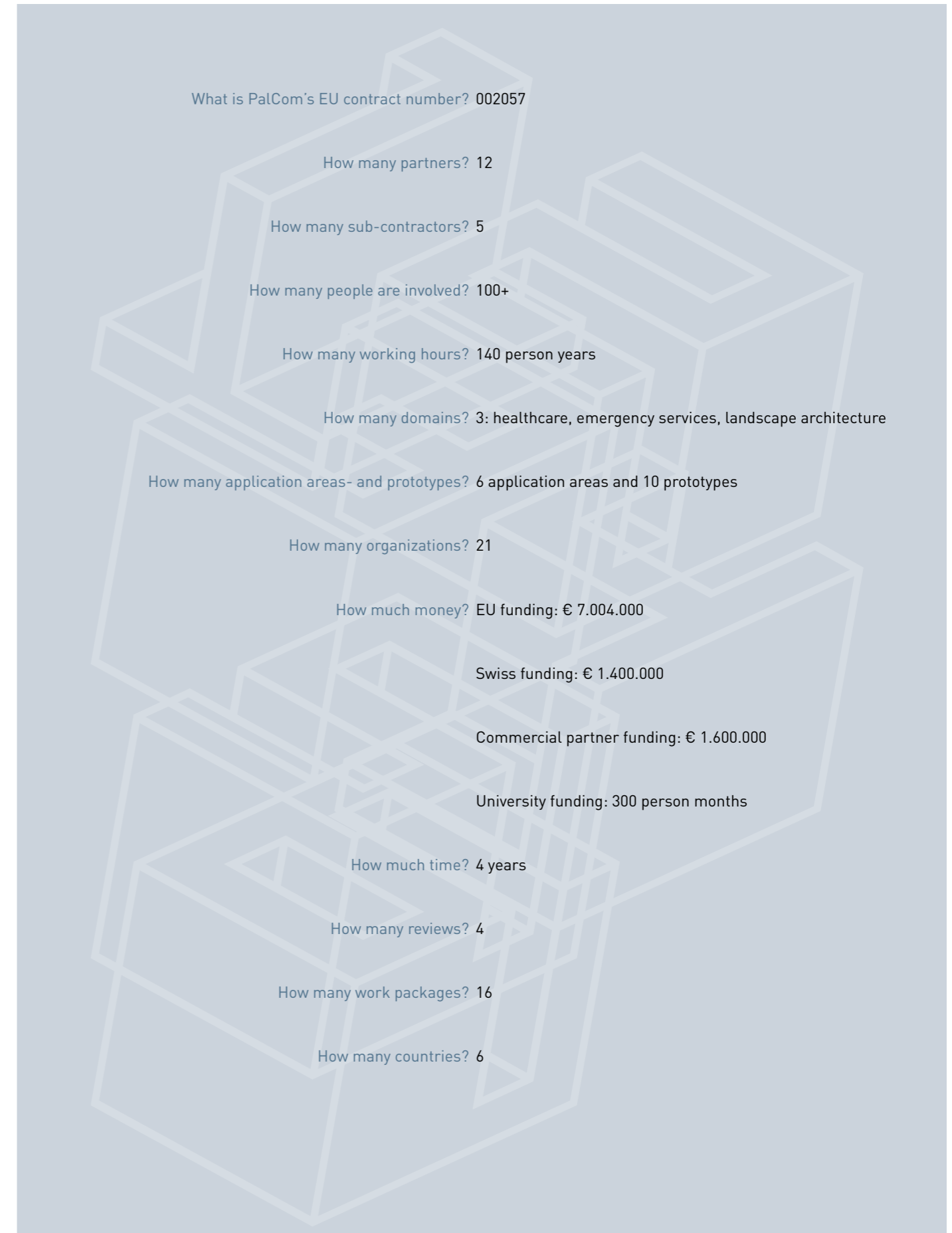
9. What are PalCom's results to date?
The results so far include a conceptual framework for palpable computing, a first version of the specifications of the architecture, a fundamental understanding of the application domains, a range of visions for future palpable usages, a toolbox for constructing palpable devices, and a range of prototypes to concretize and experiment with those usages in order to inform software architecture.

10. What will palpable computing look like in 10 years' time?
Ubiquitous and ambient computing technologies will have become palpable (under that name or another), otherwise people will neither understand nor trust them, and thus be unable to pick up on their usage.

What is PalCom's EU contract number? 002057

How many partners? 12

How many sub-contractors? 5

How many people are involved? 100+

How many working hours? 140 person years

How many domains? 3: healthcare, emergency services, landscape architecture

How many application areas- and prototypes? 6 application areas and 10 prototypes

How many organizations? 21

How much money? EU funding: € 7.004.000

Swiss funding: € 1.400.000

Commercial partner funding: € 1.600.000

University funding: 300 person months

How much time? 4 years

How many reviews? 4

How many work packages? 16

How many countries? 6

// PalCom partners

University of Aarhus
• Computer Science Department,
www.daimi.au.dk
The Computer Science Department at the University of Aarhus acts as coordinator; provides expertise with regard to object-oriented languages and architectures; as well as expertise on participatory design and user involvement. The department has a long track record of interdisciplinary work both in relation to other academic disciplines and in relation to industry. The group from the Computer Science Department participating in PalCom has extensive experience in organizing and coordinating large interdisciplinary projects on a national scale as well as on a European level.

University of Siena
• Communication Science Department,
www.unisi.it
The Communication Science Department at the University of Siena is engaged in research concerning information technologies for communication, learning and teaching. The Department's activities are oriented toward the development, analysis and evaluation of IT tools. The group comprises competencies in cultural psychology, computer science, network engineering, semiotics and anthropology, multimedia design.

Lund University
• Computer Science Department,
www.lucas.lth.se
• Department of Informatics,
www.ics.lu.se
The Computer Science Department at Lund University, has a long track record of software

research in relation to other academic disciplines and to industrial research. Much of the research has been in the general areas of object-orientation, real-time systems and software engineering, often with their application to embedded systems in mind. The Department of Informatics in Lund is multi-disciplinary in its approach and has a strong international focus in terms of research issues and general involvement.

Malmö University
• Arts and Communication,
www.mah.se/k3
The School of Arts and Communication, Malmö University, Sweden, was founded in 1997 with the aim of exploring digital design materials through the synthesis of creative and analytical work. The school is now holding a position among leading international actors in interaction design research and education, with particular strengths in fields such as embodied interaction and interactive media.

Lancaster University
• The Department of Sociology in Lancaster,
www.lancaster.ac.uk
One of the department's areas of research specialties is the ethnographic study of social practice to inform the design of information systems. They also specialise in participatory design and evaluation with end users, and in interdisciplinary theory for information system design. Related research in collaborative and ambient technologies is also carried out in the Computing Department.

Aarhus School of Architecture
• Department for Design,
www.aarch.dk
The Department of Design provides the expertise with regard to the design of physical objects and spaces and the design of information. The department has extensive knowledge in combining IT with design and architecture, both regarding the management of processes and incorporating IT in the final solutions. The specific interest of the department is the merger of the physical and digital world, and the investigation of what that will bring the end user.

Kings College London
• Department of Management,
http://www.kcl.ac.uk/schools/sspp/mgmt/
Work, Interaction and Technology (WIT) is an interdisciplinary research group based in the Management Centre at King's College London. It includes both computer and social scientists. It specialises in video-based field studies of organisations and operational practice, and uses those studies to inform the design, evaluation and deployment of advanced technologies.
Recent projects include studies in such areas as transport, medicine (surgery and primary health care), the construction industry, broadcast and on-line media, and museums and galleries.

École Polytechnique Fédérale de Lausanne (EPFL)
• Distributed Programming Laboratory,
www.epfl.ch
Research at the Distributed Programming Laboratory is centred round the DACE (Distributed Asynchronous Computing Environment) umbrella project. The LPD laboratory, under the supervision of Prof. Rachid Guerraoui, does research in the theory and practice of distributed computing, such as distributed algorithms and language abstractions for distributed programming.

Siemens AG
www.siemens.de
Siemens, headquartered in Berlin and Munich, is one of the world's largest electrical engineering and electronics companies. Siemens boasts an impressive international presence, focusing on the core business areas of information and communications, automation and control, power, transportation, medical equipment, and lighting. The company currently does business in over 190 countries around the world and operates more than 600 manufacturing and R&D facilities in over 50 countries. Innovation is a top priority at Siemens.

Whitestein Technologies AG
www.whitestein.ch
Based in Switzerland, Whitestein Technologies is a young SME (founded in January 1999) with a team of about 50 enthusiastic and highly skilled people distributed between various offices in Zurich (Switzerland), Bratislava (Slovakia) and Sophia Antipolis

(France). Whitestein Technologies strongly believe that agent-based technologies will be the foundation of a next generation of distributed information systems and network infrastructures; in particular, in combination with other leading-edge technologies such as web services, GRID approach and mobile wireless computing.

The Alexandra Institute
www.alexandra.dk
The Alexandra Institute is a limited non-profit organization owned by the IT Association Alexandra. The association is open to companies, organisations, associations, research institutions and authorities with an interest in information and communication technology.
Today, there are more than 40 member organisations. The mission of the Alexandra Institute is to strengthen research, development, knowledge sharing and education within the IT area.

43D ApS
www.43d.com
43D is a software and consultancy company delivering cutting edge-technology for working with visualizations in architectural and engineering contexts. They combine expertise in spatial computing, cooperative systems, participatory and interdisciplinary design to provide advanced technologies for dynamic visualisation. 43D originates from EU-funded research between landscape architects and University specialists in computing, interaction design and work analysis, collaborating to support the work of design professionals.
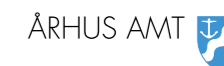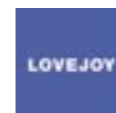
Subcontractors:

Aarhus Regional Authority,
www.aaa.dk/aaa

Edaw, Edinburgh,
www.edaw.com/

Lovejoy, Birmingham,
www.lovejoy.uk.com/

University Hospital MAS, Malmö,
www.mas.lu.se/

Azienda Ospedaliera Universitaria Senese,
www.ao-siena.toscana.it/

// A wider scope for ad-hoc networking

PHOTO: PALCOM

Application [PRE-Java]	Application [Smalltalk]	Application [BETA]	
System [Smalltalk/PRE-Java] Scheduler, Communications, Thread/Process management			Bytecode
VM [C++ subset] Primitives, Garbage Collection, Core component loading			Native code
OS [Optional]			

Flexibility and efficiency are keywords for palpable distributed system architecture, and visibility and construction are essential.

A proposed graphical interface for creating assemblies presented at the review in March 2006. The user connects devices with arrows to denote a connection between two PalCom objects: Digital compas and remote display.

Schematic representation of the virtual machine model. An operating system is optional, and parts of the system such as scheduler and thread management are written in PalVM bytecode.

BY DAVID TORDRUP

The architecture specification for palpable systems focuses on a few novel qualities that bring traditional concepts such as performance and availability a step further.

To allow a complex ad-hoc networking environment to arrange itself in a suitable way, the architecture must support such qualities as visibility and composability.

Klaus Marius Hansen, software architect at PalCom, explains:

- 'Visibility' means among other things being able to take a more in-depth look at the system and its components than previously, when information hiding was the order of the day in software architecture.

One way to achieve this is by placing information where it may be easily reached by users or other processes, as is the case with Hierarchical Maps or HMAPS.

- HMAPS form a kind of exoskeleton on processes that describe their properties, which processes are running on a particular device and their actual state, etcetera, says Klaus Marius Hansen.

A watchful eye
The idea behind the visibility quality is to promote understandability both on the user level and between computational services.

- If we are to understand these complex PalCom systems, we need to be able to inspect the infrastructure at runtime, and one of the prerequisites is that we support visibility even at the very lowest levels, adds Klaus Marius Hansen.

Visibility also simplifies recovery from errors. If there is exact information available on what went wrong, many systems might be able to recover automatically, or in the worst case give the user a detailed and comprehensive error message.

This quality is put to use in the Transient Locations RASCAL software, where the challenge is to keep up a working network connection, even in situations where connectivity is supplied by different providers and different technologies. RASCAL is an acronym for Resilience and Adaptivity Scenario for Connectivity over Ad-Hoc Links.

The way inside
Traditional qualities such as compactness are still an important issue at PalCom in the creation of an open architecture that is to be used in a wide variety of scenarios and support existing technologies.
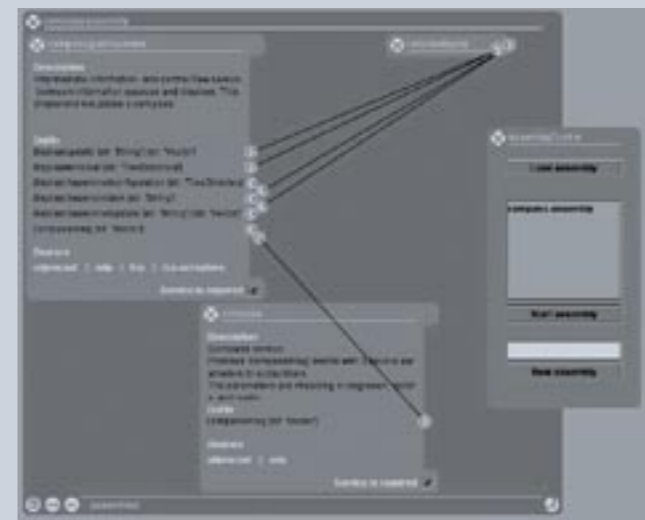
- The system should use minimal resources so it can run on pervasive computing devices, which is why we need to think about performance, says Klaus Marius Hansen. The virtual machine OSVM by Esmertec has been a source of inspiration and the goal for the PalCom virtual machine PalVM is to run on roughly the same requirements as OSVM, that is around a hundred kilobytes of RAM.

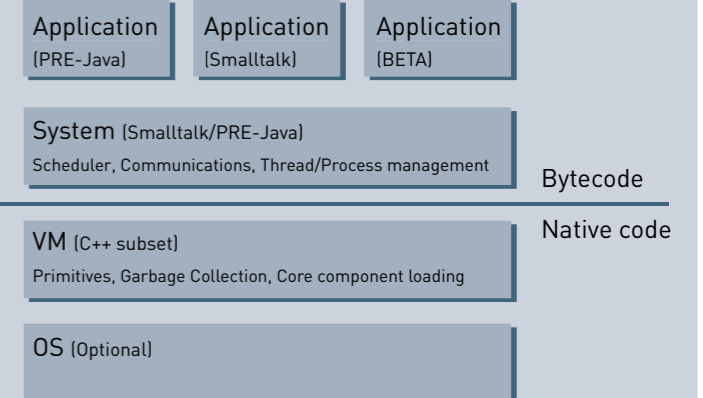As PalCom is not meant to replace all existing systems but rather support them, integrability is an important issue. If devices are able to communicate via the protocol defined by PalCom, they are amenable to composition and reuse through 'assemblies', dynamic collections of services that collectively provide new functionality.

One aspect of integrability is portability, where the PalVM in principle allows applications to be run on devices of different types. Another aspect is interoperating with devices that may not be able to or want to run the PalVM. Here PalCom defines a protocol that may be implemented by non-PalVM devices that still allows for communication with such devices.

How small is small?
Ideally, any type of device should be able to participate in a PalCom network, from laptop PCs to PDAs, to washing machines. For this reason, both a traditional operating system and the native PalVM should be able to execute PalCom codes. A small device running PalVM is however not the limit. Things can get smaller:

- You could also imagine using more basic types of sensors or actuators, says Klaus Marius Hansen, and continues:

- Actually we have a strategy for implementing services that can become part of a PalCom system even if there is very limited RAM available.

The solution involves stripped down software that implements only the wire communication protocol used in PalCom.

PalCom in use
A concrete example of the versatile nature of the PalCom architecture is found at Lund Hospital, where Boris Magnusson of PalCom is working on fusing the many varieties of digital information used into a coherent whole.

- Integration of digital information in the hospital is a complicated issue, says Boris Magnusson.

- The systems are supplied by many different producers and field standards are very complex and difficult to keep up to date with.

Basically, the individual information systems storing patient records, laboratory reports etc. may be enhanced with PalCom technology to allow all units to act as an assembly. Once all systems are speaking the same language, the task of integration is greatly simplified.

- We are working with large scale systems in this project, says Boris Magnusson.

- So from this perspective, what we are doing here is using the PalCom technology at the other end of the scale. In the future, we might also start to integrate smaller devices, but for now we are concentrating on integrating the services offered by the larger information systems. ■

> ❝ Europe should choose its own path and compete in the areas where European developers are strong. We should not copy, but be innovative and base our products on European values.
>
> BROR SALMELIN, THE EUROPEAN COMMISION

PHOTO: ANNE LEHMANN

// PalCom provides essential technologies

// The PalCom project

PalCom's research fits hand-in-glove with European research strategies. Bror Salmelin from the European Commission praises the project for delivering just the kind of technologies that are needed to support the lives of Europeans in the future.

BY RIKKE SKOVGAARD ANDERSEN

- Looking at collaborative tools, you can see that what is missing is the spontaneity of connectivity to user groups. We still lack the underlying layer of technologies that enable users to connect whenever and wherever they want. PalCom develops technologies that are essential to this, explains Bror Salmelin. He is head of the New Working Environments Unit under the aegis of the European Commission and envisions a future free from desktop computers and laptops. In his ideal world, people will bring only their virtual identities with them as they move around. The rest will be provided by sophisticated surroundings that change according to the communication needs of the individual. The key to realizing this vision is the development of technologies that are interactive and easy to modify.

The European way
According to Bror Salmelin, a project like that of PalCom fits perfectly into the European Union's research strategies. In its research programs, the EU strongly encourages initiatives in the field of pervasive computing and ambient intelligence. These objectives are carefully conceived with the aim of supporting the European developer community along the path to innovation.
- Europe should choose its own path and compete in the areas where European developers are strong. We should not copy, but be innovative and base our products on European values, explains the research expert and continues:
- The European IT-industry has its success stories in systems products with a high level of sophistication. A good example is mobile phones. You don't buy a mobile phone but a whole package of services. As a user, you customize your solution and transcend the boundaries between traditional consumer good, professional tool and personal device. That is a very typical European product. Projects like

PalCom help European developers move further in that direction.

Improving the quality of life
As well as lending European IT-developers a hand, palpable computing anticipates a second significant outcome: should the developer community embrace this new concept, it will improve the quality of life for European citizens.
- With pervasive technologies that are easy to grasp, we will be able to focus all our time and energy on our actual tasks and goals. We will no longer waste effort on the mere use of tools as we often do with ICT equipment today. ■

New Working Environments:
http://cordis.europa.eu/ist/ework

PalCom is a four-year research project that is funded by the European Union. At the start of the project in 2004, it was the only project accepted by the EU in the field of "The Disappearing Computer in Future and Emerging Technologies" and the total budget amounts to almost 13 million euros. Over 100 researchers and professional developers take part in PalCom. They come from universities and IT companies all over Europe. The initiative to form the PalCom consortium came from the University of Aarhus, Denmark, where Professor Morten Kyng is the project coordinator. The project develops software architecture and prototypes, where the latter is to a large extent focused on the health care sector.

PalCom partners

Universities
• The University of Aarhus, Denmark
• The Aarhus School of Architecture, Denmark
• Kings College, Great Britain
• Lancaster University, Great Britain
• The Polytechnic Institute of Lausanne, Switzerland
• Lund University, Sweden
• Malmö University, Sweden
• The University of Siena, Italy

Companies
• Siemens, Germany
• Whitestein Technologies, Switzerland
• The Alexandra Institute, Denmark
• 43D, Denmark

www
The PalCom project: www.ist-palcom.org
The Disappearing Computer in Future and Emerging Technologies: http://cordis.europa.eu/ist/fet/dc.htm

'Palpable computing' means pervasive and comprehensible IT solutions. The greater the influence IT has on our daily lives, the more apparent becomes our need for compatibility in the functioning of different technologies, whilst at the same time ensuring that such technology is easily understood by users. PalCom's researchers are developing design concepts and a range of software development tools, so that both technicians and general users have easy access to a reliable cross-section of different types of IT.

// part_02 // application areas

PalCom's researchers find inspiration for palpable technologies in a number of application areas. Such areas have been carefully selected and provide the researchers with a wide array of settings where palpability is a concern. All application areas are characterized by the use of a growing number of digital devices and a need for technologies that work better together and are easier to comprehend.

The need for technologies that are easy to assemble and use is particularly evident in the healthcare sector. Here, the success or failure of technologies can mean the difference between life and death. Therefore, many of PalCom's application areas are related to healthcare: major incidents, hand-surgery, pregnancies, prenatal care and rehabilitation of children. Also landscape architects face the challenge of ubiquitous IT in their daily work when assessing landscapes and the visual impact of proposed constructions. They need constantly to construct, deconstruct, and reconstruct how devices are arranged and assembled and are thus a valuable application area for PalCom's researchers. The last of PalCom's application areas, 'transient locations', is more generic. Here, developers, independent of a user domain, deal with the problem of getting many different technologies to work properly together.
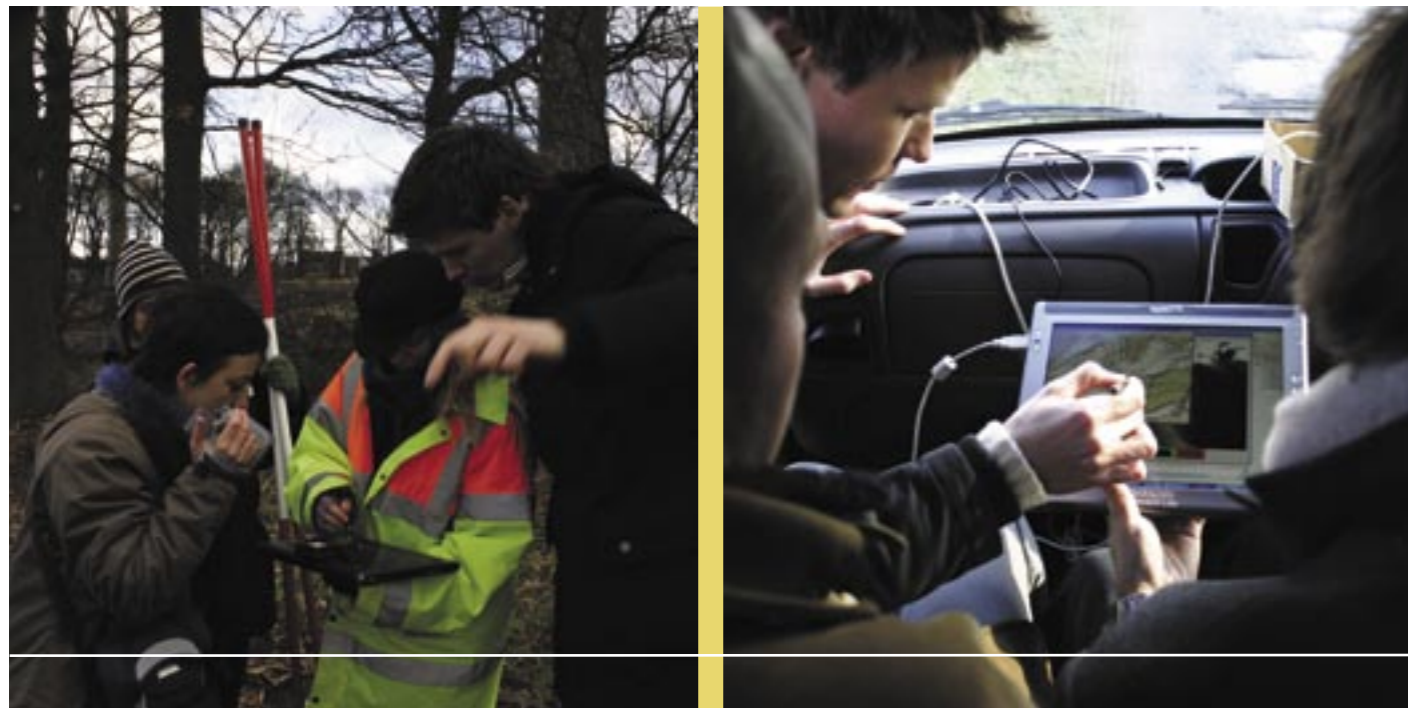
PalCom researchers observe landscape architects to learn about how they use new technologies.

> During physiotherapy meetings, the patient may be stressed, anxious and worried and might not be able to take in all the information presented.
>
> Jonas Löwgren, professor of interaction design at the School of Arts and Communication at Malmö University

Recording in progress during a physiotherapy session. Therapist's and patient's phones are placed in the recording station throughout the recording.

// Field work is one of PalCom's keys to success

Becoming familiar with the work routines that palpable systems will support in the future is one of PalCom's recipes for successful development. A team of researchers study how users from the project's application areas make use of current and emerging technologies.

BY RIKKE SKOVGAARD ANDERSEN

- I am interested in how people make sense of things, should it be social situations, material environments or technological devices. With PalCom, I can study these things in different settings, says ethnographer Monika Büscher from Lancaster University.

She is one of the driving forces in PalCom's fieldwork and collaborates closely with other ethnographers and interaction designers from research institutions involved in the project. Monika Büscher explains the motivation for including fieldwork and ethnographic studies in PalCom:

- Many of the universities involved in PalCom have done this kind of research for years. It is our experience that studying the work routines of end-users throughout the innovation process produces better technology and makes the appropriation of such technology much easier and much more fruitful.

Palpability emerges in use
Monika Büscher and her colleagues carry out participant observation: they shadow end-users such as firefighters, hand surgeons and landscape architects, interview them about their work and participate in their everyday working routines. One of the researchers' goals is to find out what it means for technologies to become palpable. Therefore, they also study the developers involved in the project to learn how they make computing palpable.

- What we found was that palpability is not a property of objects. You cannot design palpability into computers, because it is something that emerges in use. You

can, though, use design to support people in making computing palpable. A detailed understanding of people's perceptual and sense-making practices can provide basic information for such design. Doctors, for example, make things that are very hard to perceive – the processes of healthy, sick or injured bodies – palpable, for themselves and their patients. If we look at PalCom developers and how they work to make computing palpable, the practices of seeing and making sense of things are similar. Palpable computing supports such practices in innovative ways, concludes Monika Büscher.

Looking into the future
Another interesting perspective that the ethnographer from Lancaster sees in PalCom is the opportunity to study how people will interact with different technologies in the future. As Monika Büscher explains:

- When policemen and doctors use PalCom's application prototypes, we are able to see how people work with future technologies, inventing future work practices. We are able to empirically study emerging practices which is very interesting from an ethnographer's point of view, as well as very useful for the purposes of design that needs to fit such future practices. ◼
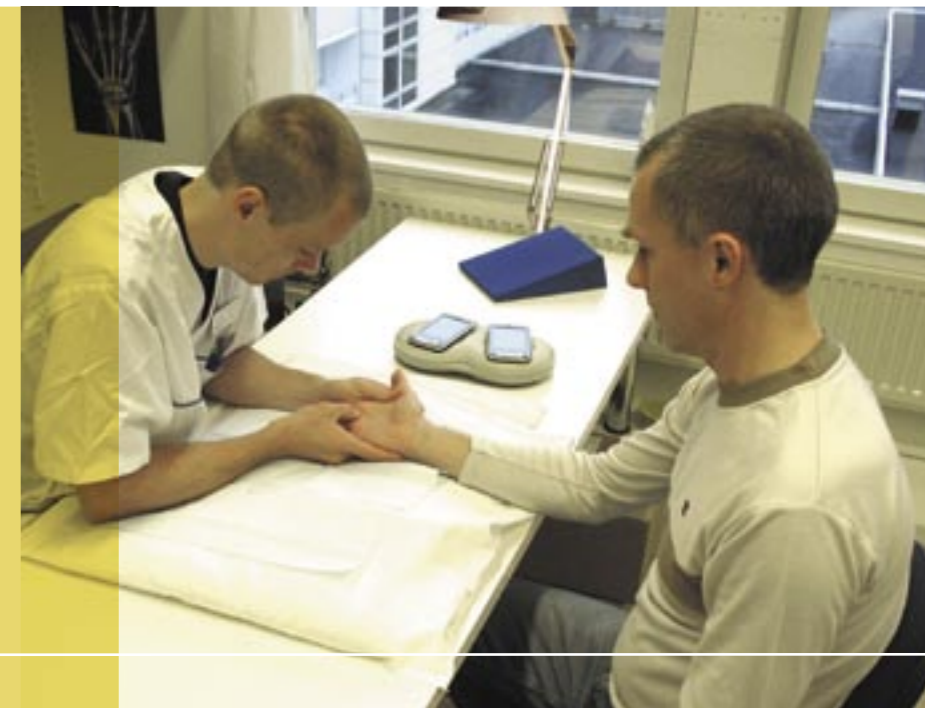
// Digital reminders for hand-surgery patients

In-situ media recording helps hand-surgery patients benefit from rehabilitational physiotherapy in several ways.

BY DAVID TORDRUP

CARE, for Collaborative Articulation in Rehabilitation, is a joint effort between Palcom researchers at Malmö University, Malmö University Hospital and other Palcom partners. The main focus of CARE is the rehabilitation process following hand-surgery and how it may be improved by digital media.

- During physiotherapy meetings, the patient may be stressed, anxious and worried and might not be able to take in all the information presented, says Jonas Löwgren, professor of interaction design at the School of Arts and Communication at Malmö University, which is why CARE is looking into ways of storing the interaction between therapist and patient for later retrieval.

The benefits of take-home instructional

media are twofold. Apart from reviewing exercise instructions and advice, patients can share information with friends and family, helping them to understand their situation and provide needed support.

A digital consultation
The typical scenario involving PalCom-enabled devices would proceeds as follows: The patient and therapist place their phones in the recording station when they agree to start a recording. Typically, this would be towards the end of the consultation when they go over the main points for the patient to keep in mind until next consultation. The displays on the phones show what the camera sees, and they start recording by pressing the Record button appearing on the phone. When they

are done, they press Stop or simply take the phones out of the recording station. The display on the patient's phone now shows a prominent handle to the new recording which can be viewed later on, perhaps on the Palcom-enabled TV set at the patient's home.

The prototype was evaluated with staff members and patients at the Hand Surgery clinic in the spring of 2006.

- Briefly, the results show that the interaction sequence of the new recording station is much more manageable and attractive than using a regular video camera plus DVD burner, says Jonas Löwgren.

- Further, we have indications that such video recording might enhance the patient's ability to share the burden of the rehabilitation process with social groups outside the hospital.

Palpable signals
The design of the recording station illustrates the "explicit interaction" design ideal, which is a way in which palpable computing can be understood from the users' point of view. Explicit refers to the self-evident nature of the interface design: place the phone in the recording station to form an assembly, as well as the social visibility of the assembly: when phones are in the recording station, recording is in progress, hence colleagues can avoid interrupting the consultation. ◼

// Major Incidents prototypes pump life into palpability

This is a story about unconventional collaboration and its results, the main theme is overview. The collaborators are: a team of professionals researching at PalCom, and a team of professionals acting in Major Incidents. Their procedure is based on designing and experimenting with prototypes. Their goal is to develop palpable tools that can support the participating professionals in their everyday work. For the researchers, this means materials in PalCom's line of operations (informing conceptual framework and software architecture); for the Major Incidents team, it means tools for use in the line of fire.

BY MARLENE NYBRO THOMSEN

Acute Medical Centre at hospital

Display 1 (doctor's cell phone)

Display 2 (at Strecher)

Biomonitor A

Basestation

Display 3 (in Ambulance)

Biomonitor B

Biomonitor X (on patient x)

The biomonitor prototype support medical response depending on the user's task and location.

PHOTOS: PALCOM

The collaborative team has already partly achieved its goal. At present, their prototypes support researchers' findings on Palpable Computing. Prototypes are basically technical and physical represen-tations of ideas. In time, they can be further developed into technologies to support the work of police, fire brigade and medical staff.

Major Incidents becoming minor
The tools are developed in collaboration with users in order to support both everyday and Major Incidents. They are: a wireless biomonitor and an overview application.

The wireless biomonitor is placed on the injured person.

- Today, they use a device called life-pack 12 containing a defibrillator and sensors for measuring ECG signal, blood pressure, oxygen saturation and pulse. The measured data is transferred via wired electrodes on the injured person's body. Therefore, you have to place a professional next to the patient to watch the data displayed on the box. If there are many patients, this is a problem, Margit Kristensen explains. She is one of the researchers on the Biomonitor prototypes from University of Aarhus.

The injured persons need hospital treatment fast. Nevertheless, they are often on site for a period of time, whilst waiting for transport. The biomonitor supports the medical response in several ways. First, by giving those who carry out medical response work on site access to measured data, independent of location. Secondly, by transferring the injured person's data to the emergency room at the hospital to prepare for treatment. Thirdly, by delivering information to the AMC (Acute Medical Coordination) so that they can coordinate the emergency response in relation to the hospital and watch the injured person's data in order to support doctors and ambulance staff on site.

Prototypes trigger palpable challenges
Another challenge is to get an overview of the incident. The overview prototype supports this:

- We are talking about collaborative technologies. The idea is to support the response managers on site or others in need of overview facilities. Depending on your role, you should be supported in relation to that role. Today, management leaders physically stay together to coordinate the incident response. They have different tasks and divisions of work in close collaborative situations. We are working on supporting them with e.g. electronic map information with different interactive overlays, advises Margit Kristensen.

The software developer Jacob Frølund, University of Aarhus, continues:

- We will give them tools to support, for example, their verbal exchanges of information, with the possibility of drawing on assistance from a kind of interactive whiteboard in order to see and discuss information on available resources.
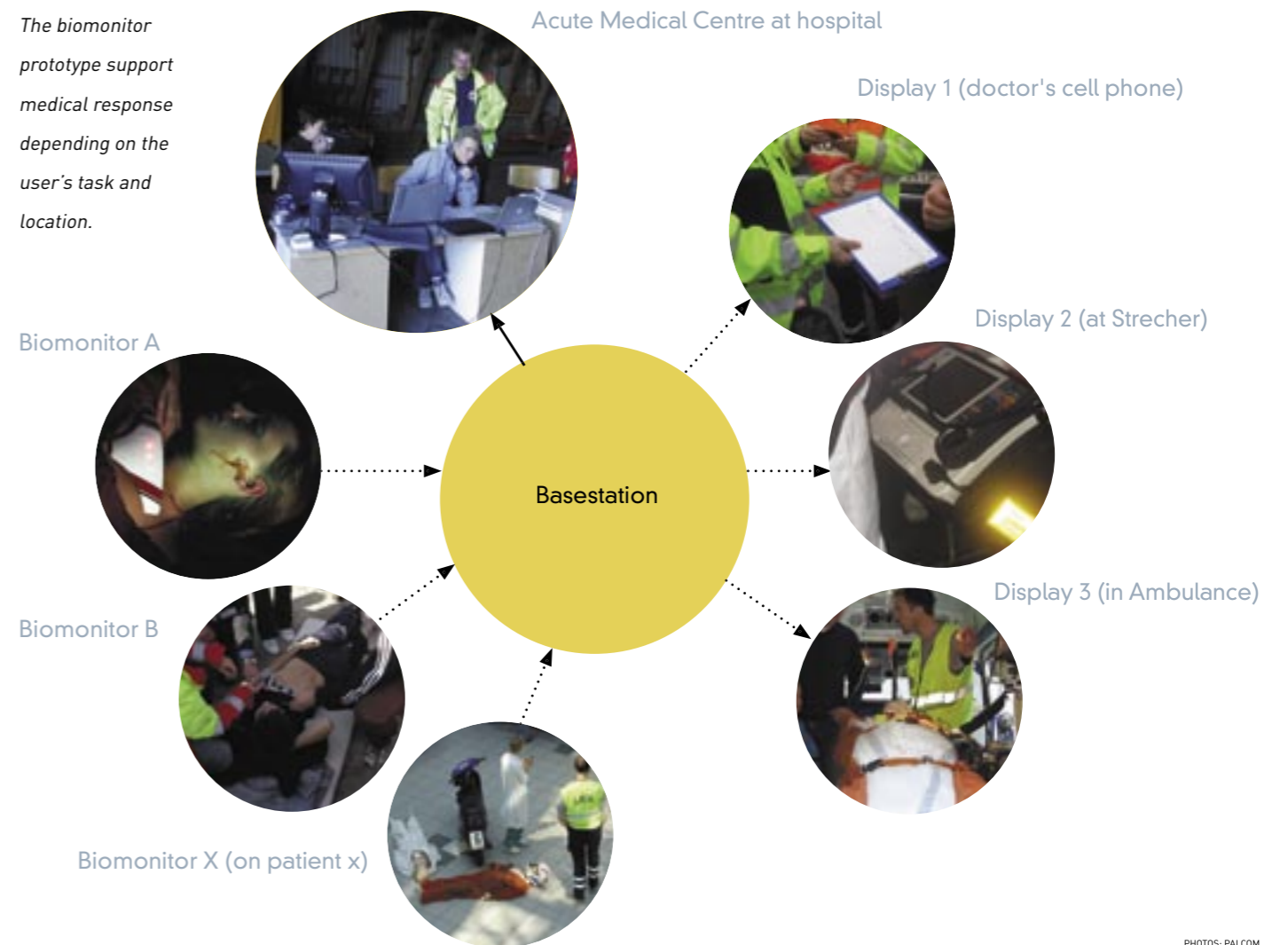
PalCom researchers work on defining palpability and palpable computing in relation to ambient computing. In Major Incidents, palpability is concerned with challenges like: comprehensibility, change and user control. In contrast, these challenges are concerned with: scalability, stability and automation in ambient computing. The objective is to find the balance between the ambient and palpable in order to produce usable tools.

The two prototypes are excellent tools for examining these challenges. By adding "Major" to incidents, the prototypes support the researchers' examination of "palpability" even more. They are developed to support professionals' work both on-site and off-site, e.g. at the hospital. They do not use wires. And they are in large numbers. These elements trigger PalCom challenges. In order to explore palpability and to develop usable tools, PalCom researchers continuously experiment with the users they work with.

Reality research
Over the past two years, the Major Incidents team has worked closely together to develop these tools of the future. The PalCom team has ventured into explosive exercises; they have joined emergency response courses, and participated in the users' everyday work. In short, the researchers have entered the field of work of the police, the fire brigade and medics, who in turn have joined workshops at the universities. Sometimes, on duty, they took off straight away with lights flashing. Many times, off duty, they came to the university offices in order to discuss a whole day's input and results. User centred collaboration has two intentions. Researchers build up a prototype to be used in reality, at the same time they examine the PalCom challenges.

Both aspects are essential for their research. Furthermore, it is of great importance to a EU financed project. They need to be sure that users will use the tools, and palpable challenges are investigated. The best way to find out is to make users participate. Joint ideas are discussed and developed over a long period. They are good ideas, but they are continuously enhanced.

- Experiments give us the input in order to make solutions that fit into the professionals' work situations. We experiment with receiving information in different ways depending on location, situation and task, advises Margit Kristensen. The researchers need this collaboration in order to develop tools that fit into working practice. Those professionals acting in Major Incidents gain new insight in future possibilities, and also contribute to what will eventually become part of their practice. Hopefully, in time, such innovative collaboration and Palpable Computing can help to "Minor" the Major Incidents. ◻

// Police chase down PalCom researchers

For the past two years, researchers at UAA and professionals acting in Major Incidents have collaborated in order to develop new tools to support professionals at work. Their efforts have resulted in two prototypes: biomonitors, which help keep track of the injured, and an "overview" application, which supports chaos assessment. Their collaboration has proven to be a great success. In fact, so great that police and other authorities are chasing PalCom researchers to get their ideas turned into reality.

BY MARLENE NYBRO THOMSEN

PHOTO: LARS BROSLET

PHOTO: PALCOM

Police and other authorities involved in Major Incidents scenarios are very interested in the prototypes developed to support their work.

- So when can we get these tools, an interested future user asks the PalCom team working on Major Incidents at University of Aarhus. He is ready to adopt the new application prototypes. The same applies to colleagues he teams up with at Major Incidents. Police, fire departments and medical staff are ready to turn prototypes into reality.

Wanted: PalCom prototypes
The two prototypes are in strong demand. They are in request, because they support the exact needs of those organisations in the line of fire.
- The users: medics, the Police and fire chiefs were involved from the beginning, Jacob Frølund explains. He is a developer at the Major Incidents scenario.
- They really liked the idea of the overview prototype that provides them with a 3D interactive world. It is a great tool to support collaboration and to share information because it is hard to share information by voice alone. They can actually point at a road with their finger and indicate, for example: I want the vehicles to approach here!

No doubt about it, the two prototypes are wanted. The next challenge is to bring the prototypes further along the road to development.

Tools of the future available soon
In spite of users' enthusiasm, the team plans to test the prototypes further at incident exercises.
- Both prototypes are important. The biomonitor is important because it enables us to experiment with patient monitoring in a way that no one has done before. The Overview prototype is important because it is rather mature. This is the one we have decided to advance to product development level. This decision is very important, because we have to reach the next level of development in order to find solutions which support the real product situation, indicates Margit Kristensen from University of Aarhus.

The final step will be to turn the prototypes into products. PalCom's partner company 43D ApS which has developed basic technologies in relation to 3D modelling and interaction as well as the basic support for collaboration, is a good candidate for further enhancing and developing their basic ideas.

In other words: the PalCom team is working intensively towards delivering palpable tools to support Major Incidents in the future.
- Hopefully, the move from prototype to product will get the police off our back, jokes Jacob Frølund. ■

// Pleasant pregnancies with palpable IT

For a group of PalCom researchers, one goal is to develop a palpable system that will make the nine months of pregnancy more relaxed and enjoyable for the expectant mother and her family. Another is to create a data storage concept that will fit into the PalCom vision of palpable computing.

BY RIKKE SKOVGAARD ANDERSEN

Maria is 12 weeks pregnant and has just had her first ultra sound scan a few days ago. Her parents are visiting and she wants to show them the pictures. From her purse, she takes a small device and brings it to the living room. The connection from the device to her TV is wireless and Maria says aloud: "Display pictures from my first ultra sound." On the screen appears a slide show with the very first pictures of her baby.

Enjoying maternity
A pregnancy gadget. In popular terms, that is exactly what the researchers from PalCom's application area 'pregnancy and maternity' are working on. They call their invention 'the stone'.
- The name is a bit peculiar, but the idea is that no one expects to get technology from a stone. That way we avoid associations like a 'pregnancy mobile phone' or a 'pregnancy PDA', because the device is much more than that, explains Konrad Tollmar from Lund University in Sweden.

The purpose of the device is two-fold. On the one hand, it aims to improve communication between healthcare professionals and to ensure more time for patient care. The researchers' fieldwork in Denmark has revealed that the midwife, the general practitioner and the obstetrician ask their patients many of the same questions. Therefore, the stone contains a pregnancy record with all the information they need.

Secondly, the stone helps to make the nine months of maternity more enjoyable for the expectant mother. If she adds functions such as a diary or a photo/video album, the stone also stores her personal memories of the pregnancy. And being a palpable system, it is of course easy to connect to a laptop, TV or mobile phone so that the expectant mother can share pictures and information with her family.

Palpable storage
The core of the work of this group of PalCom researchers is to develop a so-called storage component. With the pregnancy device as one example, they are working on a storage concept for palpable computing; a way to store and retrieve information that is easy to grasp. Aino Vonge Corry from the University of Aarhus is in charge of developing this concept:
- We think it will be easier for pregnant women and other users to understand how they can retrieve information if the database works the same way their brains work, namely by way of meanings and associations. For example, if a user asks, "Is my blood pressure normal?", then the device will find the last measurement in her medical journal, search a medical database for the figure that is normal for pregnant women and finally compare the two, she explains. ■

For a group of researchers at the University of Siena, their work is all about helping people get better with the assistance of palpable computing. On the one hand, they use palpability to improve conditions for rehabilitation. On the other hand, rehabilitation improves and challenges the testing of palpability concepts. The user site in Siena is the rehabilitation unit of Le Scotte hospital.

// Getting better with palpability

BY MARLENE NYBRO THOMSEN

The researchers from Siena focus on two scenarios: premature babies and the physical and cognitive rehabilitation of children with Down's syndrome. In their development of prototypes, they collaborate with users and also participate in cross-border collaboration with industrial designers from the Aarhus School of Architecture.

It is a vast challenge to work with the sensitive issues relating to difficult and painful topics. To do this, the Communication Science Department at the University of Siena has gathered together five people with different competencies ranging from computer science to psychology. They focus on technology, palpability, users and interaction design. The outcome of their work so far is two prototypes that examine palpable challenges and, most important, a new way of making rehabilitation less painful and more enjoyable. The two prototypes address the same PalCom challenges, but from the point of view of different actors.

- Users are always in control of the environment, and they can combine and de-combine different assemblies of different technologies in a specific situation, depending on their task and subject. These concepts are related to PalCom challenges to complement ambient computing with new features, states Patrizia Marti. She is one of the people working on the prototypes in Siena.

A secure space for different needs

The incubator prototype is concerned with the special care of newborn babies in the first phase of their lives. The incubator is a delicate but very interesting design space as it involves many users, all with extremely different needs.

- The main user, of course, is the tiny premature baby. Around the incubator stand the parents. They are vulnerable and would like to be in contact with the baby, but they are also nervous of all the wires and the vital life-protecting machinery. Next, there are the Neonathologists who need easy access in order to carry out operations. Finally, there are the nurses who support the baby's basic needs, for instance feeding, washing, etcetera. The incubator is where all these different needs come together, says Patrizia Marti.

To date, the research group has developed a physical prototype of the incubator with three components: the dome, the mattress and the wireless biosensors.

The dome is designed as a protective environment to filter the noise and the light to maintain good conditions inside. The mattress design is inspired by the Pin art game. Pins are going up and down all the time, massaging the tiny body. This is important in order to reproduce the same kind of movement the baby experiences in the uterus. The pins are also able to change the position of the baby who is not prepared for the gravity force outside the womb. The idea is to create a mattress you can manipulate without jerking the baby. Thirdly, we want to insert wireless biosensors in the mattress, so that doctors can detect variables in the baby's condition just by contact with the mattress, explains Patrizia Marti.

The funny side of rehabilitation

The basic concept of the active surfaces prototype is to combine the physical and the cognitive rehabilitation of disabled children in a swimming pool environment. Water is an interesting environment for people with disabilities as they can move freely around. Rehabilitation then seems more attractive to them.

- The active surface prototype is a collection of tile components. They constitute natural objects that can exchange data, they know their relative position in the space, and they can communicate. They display pictures that support the construction of many configurations of the different tiles outside the water. The therapists can combine the tiles with event games. They configure the tiles in specific patterns that the children have to reconstruct during the game in the water. The children have to discover the right sequence, for example how to put in sequence different images from the smallest to the biggest, says Patrizia Marti.

So far, the concept has proved success-ful. The children become very engaged in the water activities. Now, they can stay in the water for an hour without any problems, and they have fun.

Wrapping in palpability

The physical design of waterproof palpable devices for children with disabilities needs to be considered carefully. Mie Olsen is an industrial designer from the Aarhus School of Architecture working with the Siena researchers on the physical design of the tiles.

- The surface is a part of the game and the design must support the different features of the game. For the therapists, it has to be easy to configure different kinds of games. For the children, it has to be easy to understand the meaning of the game, says Mie Olsen. The design must enhance and secure the technology embedded in the tiles. At the same time, the design must support the overall purpose of the game; rehabilitation in terms of fun and games and other activities in the water.

- The physical shape must be without sharp edges and hard surfaces because the children hang onto the tiles and rub their tummies against them. Furthermore, they need to be safe and robust enough to be used and played with in water, Mie Olsen explains.

In the course of the Siena team's work with users and researchers, palpability and prototypes, they hope to expand their knowledge and soon have solutions for improving ways to wrap in palpability. ■

The incubator prototype is developed to provide a secure space for many different needs and sensitive issues.

The mattress design inspired from the Pin art game support the natural movement of the tiny body.
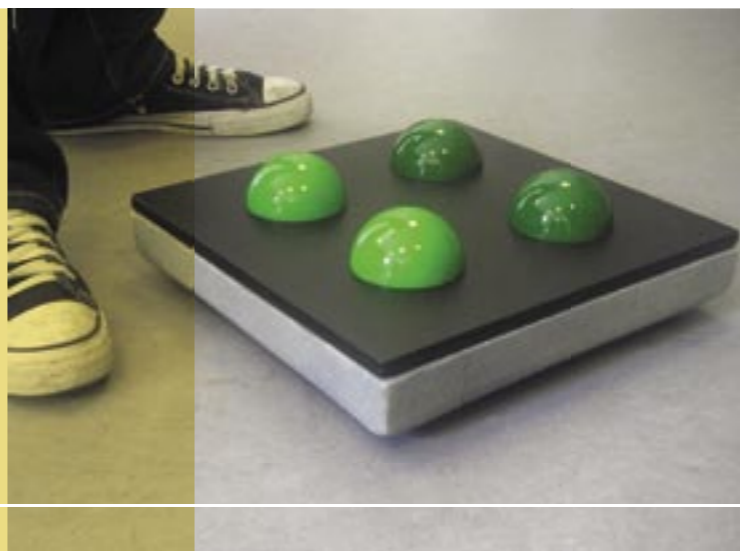
A GPS, a camera, a laptop, a digital map, a physical field, a digital setting, a physical map. Landscape architects work in a multifaceted world with mixed sources of information. Today, it is a difficult but necessary task to combine these data sources; sometimes all of them, and sometimes only some of them. How do you combine devices, software and physical reality when needed, and the next minute recombine them for another task? A group of PalCom researchers from the 'on-site' scenario collaborate with landscape architects in order to find the answers.

VIDEOCAMERA MOTOR DIGITAL COMPASS GPS DISPLAY

// Combining and recombining whilst on the move

BY MARLENE NYBRO THOMSEN

Together, they have collaborated side by side in PalCom for several years: Researchers from University of Aarhus, Lancaster University, and Aarhus School of Architecture as designers and observers in the field. Landscape architects from the UK as co-designers and subcontractors.

- It's refreshing for us to look up from our commercial business now and again, towards what might be happening some years down the line. We are helping the PalCom team to guide the development of scenarios. Also, we test the prototypes in a real world environment which obviously isn't available within a purely academic study, says Martin Stevens.

He is one of the project's main contacts and participants at the Edinburgh office of EDAW – a company of Landscape Architects primarily engaged in designing external spaces and public realm – from city planning and windfarm design to the detailed design of lighting and furniture.

The on-site prototype activities have two focus areas: one is to combine several devices depending on task and location.

The augmented version of physical poles "The SiteStick" prototype is tested in the field.

That is the SiteTracker. The other is to bridge physical reality and digital representations. That is the SiteStick.

The physical and the digital world stick together
The SiteStick supports the landscape architects' representations of ideas on site. It can be difficult to extend their digital drawings to the muddy countryside. For this reason, landscape architects often turn to physical representations of their ideas in order to assess how a building or new vegetation will affect the landscape. They mark the lines of their digital designs by placing physical poles around on the site. Still, hundreds of sticks all looking alike on a big field make it challenging to figure out

which poles correspond to the design of a new building.

The challenge is to combine the digital and the physical data, so to speak. With SiteSticks, the user can select a group of digital poles on his PDA or tablet PC, and the 'real world' sticks will light up. - The SiteStick prototype augments the poles. Each stick is fitted with an RFID tag. With the help of a GPS and a device with a map service, such as a PDA or a tablet PC, the landscape architect will be able to see the current and intended positions of the pole, Michael Christensen clarifies. He is one of the developers at the on-site scenario from University of Aarhus.

Tracking down a site
The SiteTracker assists landscape architects

on the move. The challenge is to combine and recombine the functionality of their devices in different site-visit constellations.

Examples of landscape architects' devices are: GPS, laptop, camera, compass, mobile phone, maps and digital wirelines of the site. The researcher's instrument is explicit formations, supporting the user's combination and re-combination of and communication between devices, depending on task and location. This is needed, for example, when landscape architects visit a huge site in order to find suitable viewpoints for the visual impact of a proposal. They need to locate exactly where they are and where the proposed project will be. Today, in order to do so, they use their car, several paper maps, wirelines, a GPS and a compass. Above all, they use a lot of time.

With the Sitetracker, the devices used correspond.

- A GPS provides constant information about locations, whilst a digital compass provides directional information about where a video camera is pointing. The footage from the camera is displayed on the landscape

A GPS provides constant information about locations, whilst a digital compass provides directional information about where a video camera is pointing.

MICHAEL CHRISTENSEN, UNIVERSITY OF AARHUS

architect's dashboard, with an overlay showing exactly where the object of interest would be positioned. Technology like the SiteTracker would save landscape architects a lot of time, says Michael Christensen.

Acting stably in a field of instability
The next minute, the landscape architects are outside the car; now with the camera on a tripod. In order to take suitable viewpoint pictures, they bring the GPS and several maps. Most likely, they discuss locations with colleagues at the office on their mobile phone while walking. Today, for each picture, they note position, number and comments on a piece of paper and combine the gathered information, when returning to the office some hours or a day later. The SiteTracker prototype provides the constellations wanted by the user when needed. This means that the combination of

several devices and their data could easily be handled on-site.

The PalCom project aims to research and develop palpable computing. Collaboration with landscape architects gives interesting input. Working in the field means working in an environment where resources such as power and networked bandwidth will be of a more fragile and unreliable nature than in the office context. Nevertheless, when returning to the office after site-visits, the same devices and services need to be able to communicate in the office context, with more network protocols, devices and services to be expected.

In relation to palpability, the devices must easily combine and recombine and each combination must function with stability whilst supporting the users' task at hand. Even in the unstable and ever-changing world of open fields. ■

// A smooth ride over bumpy terrain

BY DAVID TORDRUP

Say you had a laptop and say you really needed to access the internet, but network connections around you kept coming and going. RASCAL might be able to help you out.

Although current networking technology allows for a wide array of connection possibilities such as Bluetooth, WIFI, UMTS or good old LAN, keeping a live connection in dynamic surroundings can be a challenge; you might enter an area no longer covered by WIFI, your mobile phone might fail or you might exceed the limits of your LAN cable.

However annoying for everyday uses, in the context of emergencies and major incidents keeping a system online might not only be a matter of convenience but of life and death. Resilience and Adaptivity Scenario for Ad-hoc Links (RASCAL) helps to ensure the connection.

Keeping contact

At the scene of an emergency, you could imagine medical personnel needing to stay in touch with rescue personnel regardless of their locations and of the state of the equipment for, for example, reporting on wounded individuals or

calling for immediate assistance. A failed network connection in this case could be fatal, as could spending valuable seconds tweaking network settings.

The RASCAL prototype ensures both that the connection is not lost and that significant attempts are made to ensure that information reaches its target.

Keeping track of connections

The idea is that the user need not be concerned about which connections (ad-hoc or infrastructure) are available at any given time; he/she simply uses the application and RASCAL ensures that the most appropriate available connection is always used based on current network topology, connection quality, the priority of the information to send, etc.

RASCAL also applies policies which control such aspects as when to perform a vertical handover between communication technologies, how to adapt the form of content, or priorities defining how packets
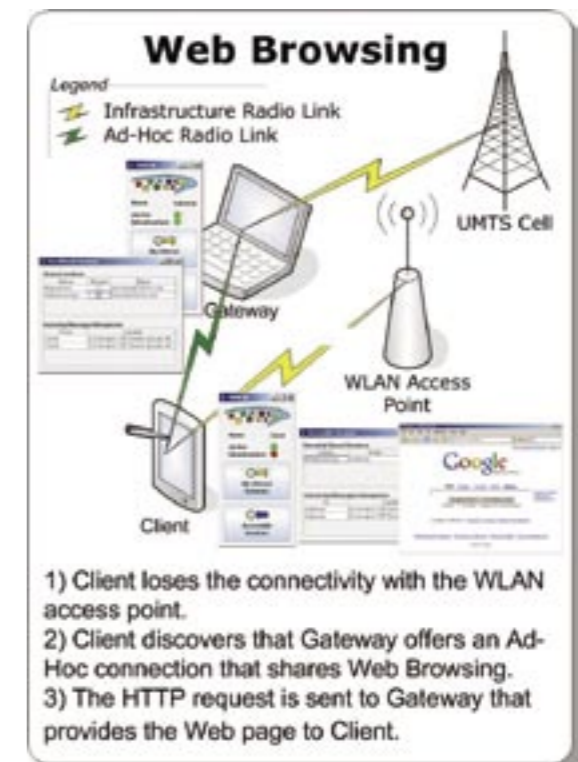
should be sent in order to ensure the information reaches the target.

An autonomous agent

The choice of connection is made by a software agent, a decision-making entity on the device that acts on behalf of the user. Software agents are one expertise of the Swiss IT company Whitestein Technologies, who are responsible for the Transient Locations workpackage.

- A PalCom device should be able to monitor its status, investigate failures, inform the user about them, and not least, either resolve the failure or propose alternative means of obtaining the service in question, says Roberto Ghizzioli of Whitestein.

- Palpable computing is based on the belief that it is necessary to put technology into the hands of the user. He/she shouldn't need to be constantly aware of technological issues in order to access and use the services required. ■

Web Browsing

Legend
- Infrastructure Radio Link
- Ad-Hoc Radio Link

UMTS Cell
Gateway
WLAN Access Point
Client

1) Client loses the connectivity with the WLAN access point.
2) Client discovers that Gateway offers an Ad-Hoc connection that shares Web Browsing.
3) The HTTP request is sent to Gateway that provides the Web page to Client.

// part_03 // towards use

One thing is to come up with a brilliant idea. Another is to turn your vision into reality and convince people to make use of your tools. The goal of PalCom's researchers is to succeed in both.

It is not easy to join 100 European researchers together in a common project. It is even harder to ensure innovative and groundbreaking results. But PalCom's strategy for innovation takes advantage of the diversity of its participants. A matrix organization comprised of workpackages concerned with prototypes and application areas on the one hand, and workpackages concerned with software architecture and conceptual framework-supporting technologies on the other, combined with frequent workshops, supports the sharing of knowledge and ensures cross-disciplinary collaboration towards common goals.

When the ends have been gathered together and results produced, another challenge is to ensure that the tools, concepts and ideas are disseminated to European developer communities. The project has taken several initiatives to this end. First of all, PalCom's industrial partners plan to exploit project results. Secondly, the researchers regularly update a 'toolbox' for palpable computing. It contains development tools, existing components, and tutorials for professionals who want to give palpable technologies a try. Lastly, the strategy is for developmental tools and source codes to become available as open source software before the project ends in 2007.

// Making ends meet

> It is palpably rewarding to get a product into your hands that actually works and makes it easy to relate to ideas put on the table.
>
> FIRE CHIEF JAKOB ANDERSEN, THE FIRE BRIGADE IN AARHUS

PalCom's development strategy integrates a broad range of disciplines and approaches.

In a big, multidisciplinary project like PalCom, researchers approach the development of new IT technology from many different perspectives. How do you gather the ends together in order to achieve ground-breaking results, when ethnographers, computer scientists, interaction designers and experts from many other disciplines are involved in the process?

BY RIKKE SKOVGAARD ANDERSEN

A big accident on a Danish highway. Police cars, ambulances and fire engines arrive and depart in a steady stream. Doctors and paramedics attend to the victims while firefighters struggle to put out a fire in a car wreck. Close by stand the fire chief and the police officer in command. They are in charge of coordinating the effort and they face a challenge: the area covered by the accident and vehicles stretches over almost three square kilometers and all their colleagues, literally, have their hands full. It seems practically impossible to get a full overview of the situation.

Planning for the unexpected
One of PalCom's testing grounds is major incidents in Denmark. Here the police and fire brigade need a system that can provide them with an overview of something that to the common man appears to be chaos. As with their other tasks, the researchers from PalCom tackle such developments with a wide range of means and facilities: some conduct user-workshops and build prototypes, others do ethnographic field studies and a third group develops core bits-and-pieces for the final software. All

these activities take place simultaneously – and do so right from the beginning of the project.
- The many parallel activities speed up the design process a lot. If we had started from just one perspective, it would be hard to reach our goals within the project's time limit. Secondly, having several research tracks and encouraging interaction between them is to provoke innovation. With this approach, we are, so to speak, planning for the unexpected, explains Preben Mogensen from the University of Aarhus in Denmark. He is vice-coordinator of PalCom and responsible for work on the application of a major incidents overview.

Several research tracks
Each of the main research tracks exists in its own right. Not least field study research, where Preben Mogensen, together with colleagues from Aarhus and ethnographers from the University of Lancaster, has spent countless hours observing the work routines of professionals involved in major incidents. Especially during the project's first year, fieldwork was intense.
- When we began field studies, we had

no idea that getting an overview of the scene is one of the biggest problems when a major incident occurs. Today it is one of our highest priorities to develop a system that provides the fire chief, the ambulance chief, and the police coordinator with the overview they need, explains Preben Mogensen.
In parallel with field work, other researchers host user-workshops. A workshop is a forum for researchers and users to discuss design ideas and try out prototypes. Early in the project, the prototypes were really simple, most of the time just state-of-the-art devices with commercial software. Today, they are more sophisticated with applications that are developed by PalCom's own software architects.
- It is palpably rewarding to get a product into your hands that actually works and makes it easy to relate to ideas put on the table. To be able to touch a screen and something or other happens – gives you something palpable and concrete that you can talk about afterwards, says Fire Chief Jakob Andersen from the fire brigade in Aarhus.
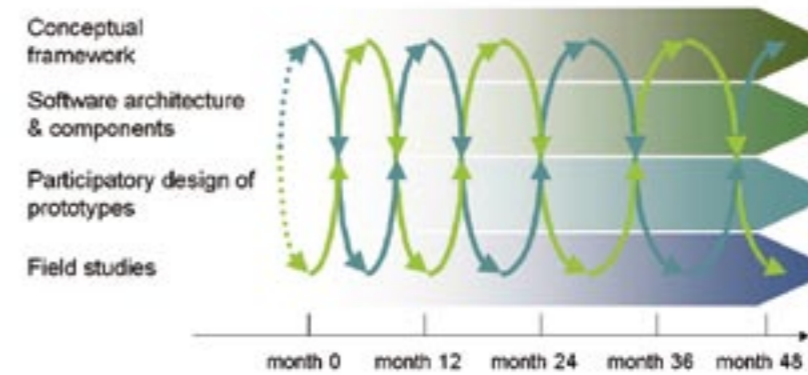
> The system is in fact a marvellous tool. My big dream is for someone to grab the idea and develop it further, in order that such a tool is available in future to support our leaders.
>
> FIRE CHIEF JAKOB ANDERSEN, THE FIRE BRIGADE IN AARHUS

The last main track is the work of PalCom's software architects. As with the other two, this track has been active since the first day of the project.
- Since day one we have had a vision of the technology we wanted to develop. Our ideas about palpability and palpable computing provided us with a research agenda and some basic requirements for the software architecture, explains vice coordinator Preben Mogensen.

Across any border
Without doubt, the research results of each track bring added value to the project – much more than each would be worth much on its own. If there is to be a solution to the problems that policemen and firefighters struggle with at the scene

of an accident, then all the researchers' experience and knowledge need to be put into one pool. All the ends have to meet. So how do you encourage interaction between three very different lines of work? The answer is: you make people meet and talk.
- We have a lot of cross-track activities. We have workshops and meetings where people from different tracks exchange knowledge and work together to develop their ideas, states Preben Mogensen. He further explains that the desire for multidisciplinary exchange is also reflected in the formal structure of PalCom as a whole. The project has a matrix organization that supports collaboration across application areas, institutions and national borders.

Multidisciplinary success
Years of intense interdisciplinary work have resulted in a clever solution. In future, a palpable system will provide the fire chief and police officer in charge with the overview they need. The idea is that a whiteboard with a two- or three-dimensional map of the accident area will help them locate their colleagues. In a similar fashion, biosensors will track injured people and display their location on the map. The two coordinators can also interact with the board; if they, for example, sketch the ambulance exit ways on the map, the information will be sent to the drivers.
- The system is in fact a marvellous tool. My big dream is for someone to grab the idea and develop it further, in order that such a tool is available in future to support our leaders. It will help us save lives, adds Fire Chief Jakob Andersen.
Judging from his enthusiasm, the meeting of PalCom's many ends is already a success. ■

Aino Vonge Corry from University of Aarhus is responsible for coordinating the work of PalCom's group of traveling software architects.

PHOTO: PALCOM

In a development project with 100 researchers situated in six European countries, it can be a challenge to ensure the high quality of software architecture. The 'Traveling Architects' technique is one way that PalCom deals with the complexity of an international division of work.

BY RIKKE SKOVGAARD ANDERSEN

// A new way of herding cats

From Sweden to Italy: PalCom's development teams are spread throughout Europe. Some of them design prototypes while others depend less on particular areas of application and, on a more general level, develop software architecture for palpable computing.

- After the project's first year, we needed a way to ensure that the great ideas emanating from the work on application prototypes would actually fit into the general software architecture. At the same time, we wanted the design teams to conform to the structural design that the software architects had started developing. Then we decided to let a small group of software architects travel around Europe and visit the development teams, explains Aino Vonge Corry from the University of Aarhus.

The role of the traveling architects is straightforward: They spread the word on evolving software architecture and collect input for its further development.

- The most important thing to come out of our first round of visits was mediation. We became familiar with the status of the application prototypes, explains Aino Vonge Corry.

With the overview and insight gained from the first meetings, she and her fellow traveling architects are able to dedicate the next to architectural design and review.

PalCom's nomads hope that their knowledge and experiences can be of benefit to others. Not least to developers who, much like themselves, face the challenge of an international division of work. According to Aino Vonge Corry:

- If you have a big project where the development of the software architecture takes place at several locations at the same time, then there is something to gain from our technique and experiences.

Five secrets to the success of the Traveling Architects:
• A group of two or three traveling architects is ideal for collaboration purposes
• Formulate your goals for the meeting and let the host team know your expectations
• If your project involves many different disciplines, be aware that each meeting may demand an individual strategy
• Early in a project it can be an advantage to choose a more ad-hoc, explanatory approach to meetings
• Use a common modeling language (e.g. UML) to share and discuss ideas, and use of white boards for informal discussions and CASE tools to agree on details.
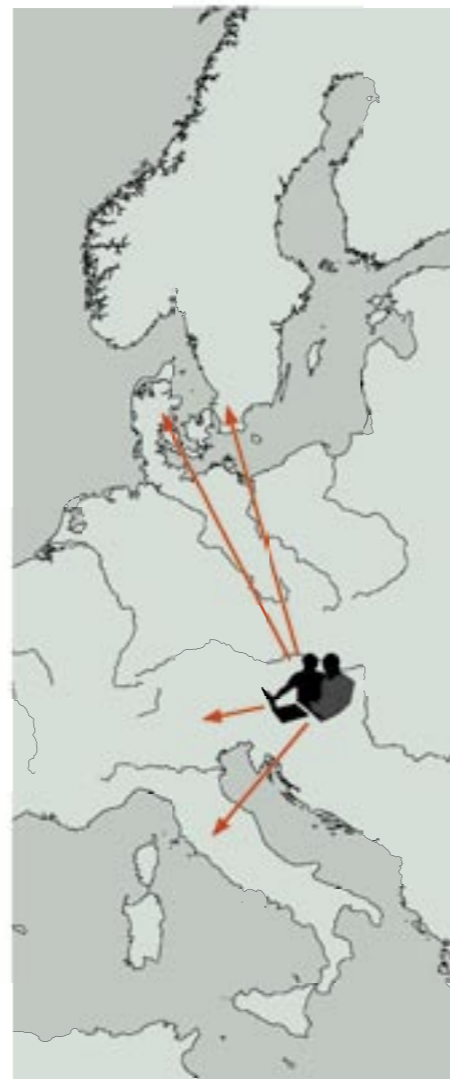
// PalCom moves towards open source

In disseminating the PalCom project, the overall aim is to share knowledge regarding palpability. PalCom partners continuously exchange and engage their knowledge and results: at public workshops, through cross-border collaboration and in collaboration with users. The final key to the puzzle will be to bring palpability out into the open. PalCom is now heading for an open source solution.

BY MARLENE NYBRO THOMSEN

By going "open source" with PalCom Software Architecture, the project expects it to be used by the public. Public use of PalCom's palpable software will hopefully provide important feedback from external users and perhaps even code contributions.
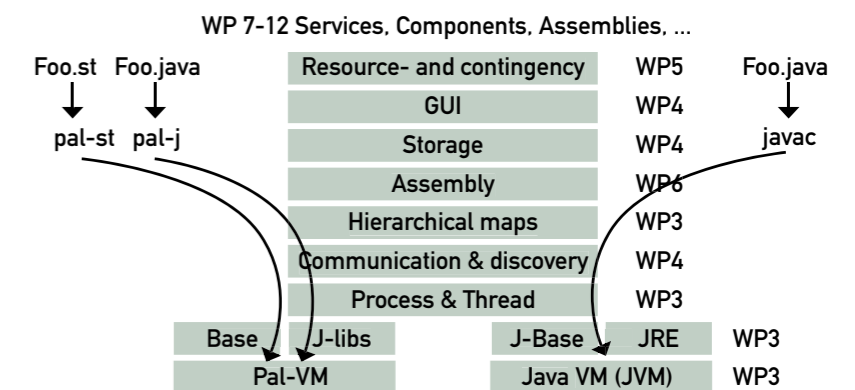
- There are a number of advantages for PalCom in going open source. In the short run, it gives us the opportunity to reach a wider audience and achieve more publicity about the project and our results. The potential long-term benefit is obvious; a dedicated developer community with volunteers that will provide us with ideas, updates and extensions for our code base, Peter Andersen explains. He is a developer at UAA and one of the people from the open source initiative group.

Which way to go?
To go open source is not just a matter of getting the software results out. Apart from outward appearances, there are many internal views and decisions to be taken into account. PalCom is a huge project with many partners. To go open source is a big next step. The first step is to make the ingredients suitable for both users and partners.

- The first part of the plan is to solve a number of legal issues. So far, responses from the partners in PalCom have been unanimously positive. Moreover, we have restructured the PalCom code base so that it will be accessible and easy to comprehend for outsiders. Although we are not yet finished, I think that we are well on the way. We presented a new structure at our Toolbox Exploratorium, but we still need to compile a lot of introductory material, such as tutorials and manuals, says Peter Andersen.

And where to go?
Then there is the decision on who is to host the precious "golden egg". Since PalCom is financed by the European Union, the team has decided to look for a European host. They have already found one candidate; an organization called ObjectWeb. It is based in Grenoble in France, and hosts about 125 projects, mostly related to middleware. Even if the PalCom code base is not traditional middleware, it does bear a certain amount of resemblance. Following a presentation at an ObjectWeb conference, ObjectWeb have expressed an interest in hosting PalCom.

So, well on their way with the open source initiative, PalCom partners add yet another option to their many ways of sharing and disseminating the project's results. ∎

THE TOOLBOX: WP 3-6

// PalCom's versatile version of a toolbox

" The toolbox is not just the outcome of our work. It is also a resource for assisting us in our work. We are in fact using the toolbox to create the toolbox. So, in a sense, we are taking our own medicine.

PREBEN MOGENSEN, THE VICE-COORDINATOR OF PALCOM

PHOTOS: PALCOM

One of the outcomes of the PalCom project will be a PalCom toolbox. In brief, the toolbox is a collection of 'building blocks' for constructing palpable components and devices. At present, the PalCom toolbox is composed of a collection of components gathered from prototypes, basic libraries, the first version of the Virtual Machine and the service browser. The PalCom toolbox acts as a tool in itself for testing both the ideas of palpability and the eventual contents of the toolbox.

BY MARLENE NYBRO THOMSEN

Currently, the tools are at the stage of experimentation and enhancement and the contents of the toolbox are in the process of being designed.

- At present, we put in whatever services and components are mature enough. Basically, everything that is mature enough for other developers to use. In the course of time, that will, of course, have to change. We are in the initial stages of constructing this toolbox. Time will show what it is people pick up and use, states Preben Mogensen, the vice-coordinator of PalCom and co-responsible for the dissemination activities work package.

For now, components that have been put into the toolbox and successfully used by someone else are good candidates for inclusion in the final toolbox.

" At present, we put in whatever services and components are mature enough. Basically, everything that is mature enough for other developers to use.

PREBEN MOGENSEN, THE VICE-COORDINATOR OF PALCOM

Tools as effective treatment
PalCom's specific vision is of a toolbox generally available via open source software to developers and eventually end-users of palpable systems and devices. For the time being, it is under development; and meanwhile the PalCom team uses the toolbox as a resource to create

prototypes and toolbox components. According to Preben Mogensen:

- The toolbox is not just the outcome of our work. It is also a resource for assisting us in our work. We are in fact using the toolbox to create the toolbox. So, in a sense, we are taking our own medicine.

Accordingly, the very first users of the

potential end-product are the PalCom team. Early in the developmental stages, they are therefore able to process relevant data and ideas based on their actual experience of which items in the toolbox other people will find useful. If the PalCom team cannot use it, the chances that others can are not that great.

Tools for dissemination and for the future
The toolbox is part of the dissemination strategy for PalCom's results.

- The idea behind PalCom is the ability to construct new devices and services on the spot. We provide a kind of toolbox for developers of potential PalCom devices and services. Ultimately, we also provide a toolbox for the ordinary end-user, so for example a Landscape Architect back at the office can construct new services out of existing ones and probably deconstruct them, Preben Mogensen explains.

Today, there are no native palpable devices or services, so developers need to wrap off-the-shelf devices in order to make them palpable. As they start to use the final toolbox, what they end up producing via the toolbox will be palpable devices:

- Hopefully, one day any new device, such as a camera for instance, will have software that enables it to function as a palpable device. This will mean that other

devices can identify it, see it, communicate with it, ask it and remotely inspect it. In principle, the PalCom toolbox will make that easier. As palpable devices start to emerge in the world, it will be necessary for end-users to start utilizing part of the toolbox as their tool for combining, for example, running services. The user may, for example, combine a camera with a GPS device and a remote display in order to combine the picture with where it was taken and pinpoint it on a map at the correct spot, adds Preben Mogensen, thus revealing his visionary hope for the future.

First of all, the toolbox provides its users with an overview of what it contains: components, services, devices, practical examples and tools. Secondly, users can get an overview of what these facilities might actually be able to do for them. Thirdly, they can examine how to construct new tools and facilities from existing ones.

Tools with a twist
The tools placed in the toolbox come on the one hand from a range of technical work packages relating to software architecture and supporting technologies. On the other hand, the tools and components may originate from the prototypes.

- The prototypes as such will probably

not go into the toolbox, as they are very specialized, but pieces of the prototypes could easily be included alongside practical examples for its use in order to explain why you might want to combine a GPS with a camera or with an RFID tag or something entirely different, states Preben Mogensen.

The PalCom team has, for example, developed prototypes for professionals acting in Major Incidents and Landscape and Visual Impact Assessment. Both prototypes make use of e.g. GPS services, video services, camera services and Bluetooth services. The implementation of the components is slightly different for the two scenarios, but the idea is to take the components relating to GPS, camera and so forth and reuse them. The point is; they have basic common functionalities. You can reuse them but with a twist. Currently, this twist is designed for programmers, as they would have to create a new specialized service by programming the twists. PalCom researchers are working on extending the ability to tweak components also to end-users. Tweaking is yet another tool to grab when you dig into the PalCom toolbox in order to make palpable devices of the future. ∎

→

TAKE A CLOSER LOOK AT THE PALCOM TOOLBOX

Potential candidates for the final toolbox

- Into the toolbox go pieces of code, examples of use, etcetera from both the prototypes and the more architecturally focused work packages. Think of it as a large repository containing many chunks of code, many chunks of examples of usage of such code and various tools for manipulating and combining them. Preben Mogensen , vice-coordinator of PalCom

• Components and services from prototypes: Components and services are constructed, on the one hand, with the aim of making specific prototypes work, and on the other hand, with the intention of being reused in other settings. A simple example: a generic GPS service that can talk to a physical GPS and make it act as a palpable service. The service was initially constructed for the purposes of tracking the positions of landscape architects in the field but is now reused for tracking patients involved in major incidents.

• Programming environment: PalCom has integrated their environment with Eclipse (open source integrated development environment). PalCom is writing plug-ins for this programming environment in order to make it easier for people to actually construct palpable components, devices and services.

• Service browser: Both a service in the toolbox as well as a tool making the toolbox usable. Example: a GPS, a camera and a display. The user wants a picture from a camera to be combined with the location from the GPS, and displayed on a display service. You start the service browser, and services on running devices will pop up. They expose an interface about what information they can receive or send out. You set up communication between them by dragging lines between them.

• A range of compilers and interpreters: The PalCom virtual machine – palVM – is a realization of the PalCom runtime environment. The code in palpable services or components is compiled to an intermediate "bytecode" level. The VM interprets that code and executes it on the device where it is running, whether it be a laptop, camera, GPS, etc. Highlevel programming language compilers for Smalltalk, (a subset of) Java and BETA are being developed. Furthermore, programming directly using the bytecodes is possible using a bytecode compiler and corresponding decompiler.

• Examples of use and tutorials: For users of the toolbox, the examples of use are an important element in understanding not only existing formations but also potential new combinations. If the toolbox only consists of a source code, it will be hard to get an overview of what is actually in there. And even more important, what it can potentially do for the user. Examples show how to utilize some of the individual components but also what the user can potentially achieve by combining them.

• Description of connections: between the software architecture, the toolbox components and examples of use. ∎

Example of combining use examples with software architecture.

One of the world's largest electrical engineering and electronics companies is an industrial partner in the PalCom project. The German electronics giant, Siemens, expects to gain great innovative advantages through taking part in the EU project.

BY MARIA GAARDMAND OESTER

Siemens is the largest industrial partner in the PalCom project. Innovation is a top priority at Siemens, and thus the company gain great advantages from being part of the project.

// Innovative advantages

- One of the main reasons why Siemens is participating in EU-projects in general is first of all to establish connections to the research community and other industrial companies; another aspect is to explore new trends and technologies in different areas, explains Reiner Schmid, project leader and software architect in a branch of Siemens' Corporate Technology Department, that specialises in software-architecture and engineering.

- With regard to the PalCom project, it is particularly in the area of ubiquitous computing that we are trying to gather information about important technologies we should be aware of and able to deal with.

Technological contribution

Reiner Schmid defines Siemens' contribution to the PalCom project:

- Within the PalCom project, we have an active stake in the research work mainly dealing with resource- and contingency management, because this is our main technological contribution to the project. He further explains:

- It all relates to how a really complicated system can be presented in a reliable and predictable way to a user. In a palpable computing environment, there are a lot of devices with a lot of interaction between them. In practice, this means that if an application depends on a lot of devices, there is a greater likelihood for errors to occur and for something that is needed for the application to actually be missing. What we are concentrating on in resource management is to see, what is available and if it can be used in a beneficial manner for the application.

In a traditional computer system, the application usually knows what is available because it is rather predictable, but Reiner Schmid further explains:

- In a palpable computing environment, it is different, because there is a lot of uncertainty. Accordingly, a system has to track whether the devices that are needed are available and if they really can be used in that particular case.

Resource management is therefore vital in order to make the application work efficiently.

Contingency management

Closely associated to resource management, contingency management concerns the balance between the computer's autonomous behaviour and user interaction requirements.

- Contingency management is about what happens if the computer system does not do what you want it to do. There may be different reasons for this. With regard to resource management, one reason may simply be that some necessary constituent is not available.

There may be an automatic resolution in the system, which means that the system itself figures out the best alternative for a device, that is capable of conducting the required task; but the case may arise when the system itself cannot solve the task properly and therefore needs interaction with the user in order to choose the best alternative of several options. The concern is therefore to find a balance between the computer's autonomous behaviour and user control.
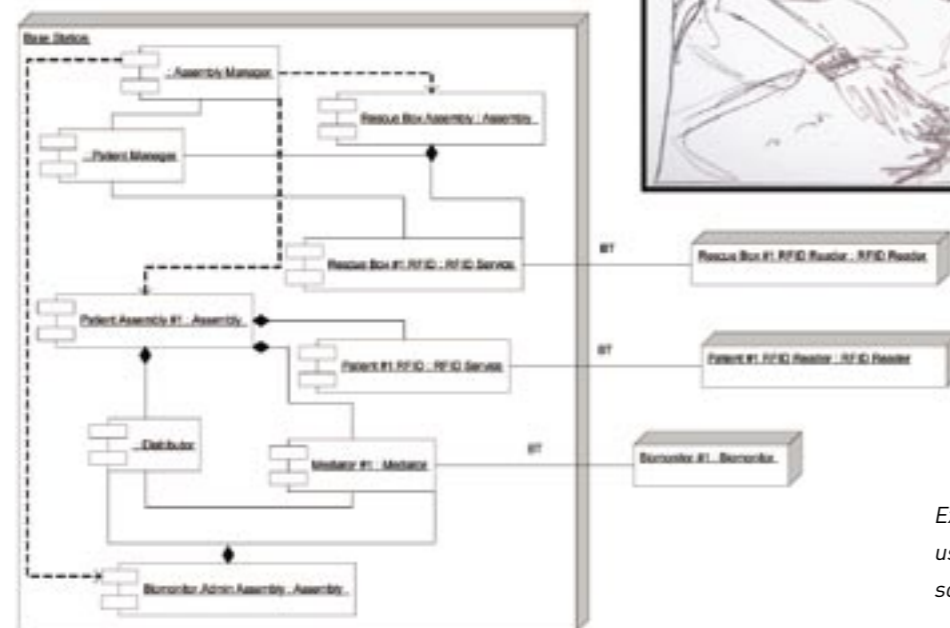
Gaining ideas and experience

For Siemens, end-products and technological devices are not the most vital outcomes of the project. Innovation is a top priority at Siemens, and the company therefore considers the PalCom project to be of great value for bringing new information and knowledge to the different Siemens' divisions:

- We do not develop end-products within European projects. What we do gain from a project like PalCom is ideas and experience. Subsequently, we try to transfer innovative concepts to the Siemens divisions. In this way, we are able to consult our divisions on what is possible from a technological point of view and what would be interesting ideas to pursue or follow in the future, concludes Reiner Schmid. ∎

> There is a huge challenge in developing applications compatible with the environment in people's homes which can adequately link the home to other arenas.
>
> MORTEN KYNG, PROJECT LEADER, PALCOM

// Getting ready for IT in every part of our lives

One of PalCom's industrial partners is the specialized Swiss organization, Whitestein Technologies. According to Whitestein, PalCom's results will play a vital part in preparing the company's core technology and products for a future with IT everywhere.

BY RIKKE SKOVGAARD ANDERSEN

- What ubiquitous computing has not yet addressed is thinking about the time when the whole world will be populated with ubiquitous devices. We will meet hundreds of them everywhere; at home, at work, on the train, in the street. What is missing is a means to comprehend and easily make use of this massive array of technologies. That is to me the central tenet of palpable computing, says software research engineer Dominic Greenwood from the Swiss company Whitestein Technologies. Whitestein is one of PalCom's industrial partners specializing in products based on software agent technology, and he is positive about the results of the project so far. Actually, the company finds the results so promising that Dominic Greenwood and his colleagues plan to use some aspects in the company's core technology:

- We plan to reuse some of the project's software tools in conjunction with our software agent middleware platform. This really amounts to taking the principles of PalCom and deploying them directly within our products, explains Dominic Greenwood.

Ad hoc telecom

Besides improving their middleware, there are many other areas in which Whitestein Technologies sees possibilities to exploit the results of the project. One is the company's telecommunications business line:

- Our primary telecom product is a single software system allowing a mobile user to access the internet using 2G, 3G, 3.5G or wireless LAN technologies. You can seamlessly connect to the internet wherever you are. With palpable technology, we would like to extend this product to also include support for ad hoc connections. This means, for example, you can easily connect your PDA, or someone else's, to your laptop and thus access the web using its connection, advises Dominic Greenwood and he further states that the knowledge gained from participating in PalCom is also inspiring innovation within the company's other areas of business: financial systems and transportation & logistics.

Part of an innovation strategy

Cooperation with researchers is an important part of Whitestein's strategy for innovation and the company actually considered several EU projects before joining PalCom. This project was particularly appealing because it not only deals with pervasive technologies but also with human comprehension and durability perspectives amongst others; issues which are closely related to aspects of software agent technology. Of course the opportunity to extend knowledge and contact networks is another of Whitestein's motivations for joining the project:

- The relationships to universities and companies we have built up during the course of the project are very good. These relationships will be a strong legacy of PalCom and will hopefully lead both to new projects and to new business in the future, concludes Dominic Greenwood. ■
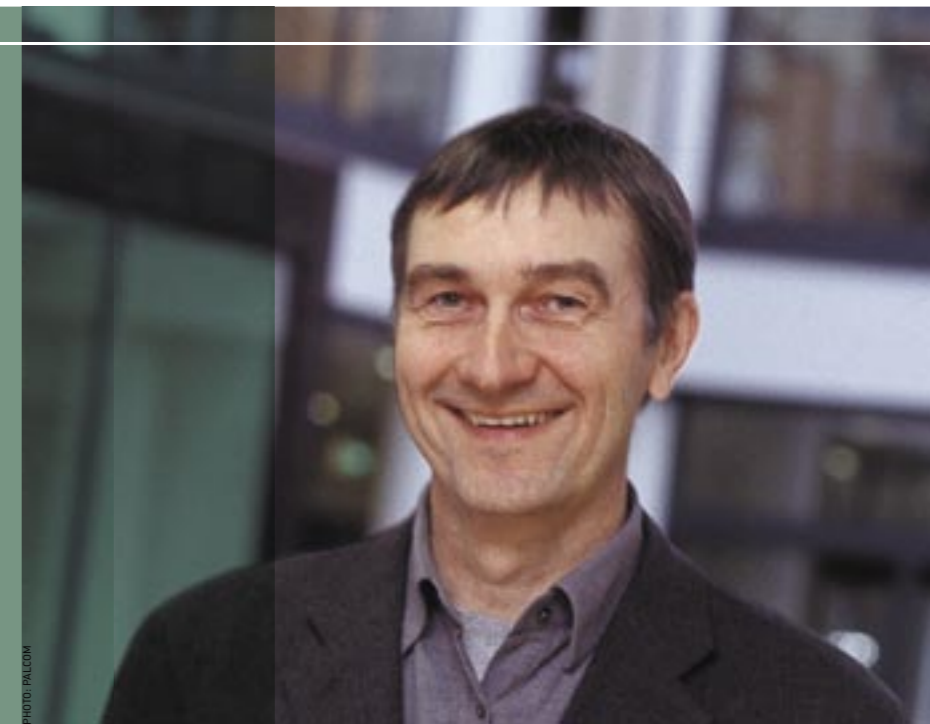
// PalCom gazes into the crystal ball

As old questions become answered new ones emerge. The knowledge from the PalCom project naturally leads to new areas of interest for European researchers. Project leader Morten Kyng presents here some of the main research areas of future interest that are to be taken up by him self and other European experts in pervasive computing.

BY MARIA GAARDMAND OESTER

- For palpable computing to become a success in the future, it is important that the everyday user can trust the systems, explains Professor Morten Kyng, project leader from the University of Aarhus.

To achieve this it is important to develop security and privacy mechanisms that are understandable and fit the natural behavior of the user. Otherwise, they will stop using the systems, or circumvent the security mechanisms.

- For instance, it is quite common that users at their workplace have a small post-it on their screen with their username and password. Their colleagues can then log in and continue their work, if necessary. This example illustrates that if a security mechanism does not fit the way that people work and cooperate, it will be circumvented and security disappears.

Security and privacy mechanisms are an aspect of the basic software architecture in the PalCom project, but developing them to better fit the ways people are working is, according to Morten Kyng, one of the areas that needs more attention in future research.

Large-scale – long-term

Another important area is long-term and large-scale experiments.

- So far, experiments have been limited to a few days; we have not had the chance to put our prototypes into use in e.g. multiple fire stations or hospitals for weeks or months, states Professor Morten Kyng.

Putting the equipment into everyday use over a longer period of time can offer the researchers important feedback on the software architecture and the prototype design with regard to palpable qualities, including robustness and scaleability.

From the public sphere to the private home

- There is a huge challenge in developing applications compatible with the environment in people's homes which can adequately link the home to other arenas, explains Morten Kyng.

- For instance, there are a lot of benefits to be gained by everybody, if you can integrate health care into people's home in such a way that it blends naturally with all the other activities going on – in the home and in the hospital departments, at the general practitioners etc.

By and large, the infrastructures that may support such co-existence between services and devices in the public sphere and in the home are a focal point in the PalCom project.

- What we need to develop are new ways of integrating and interrelating activities and it-support across the boundary of the home, the workplaces and public spaces, Professor Morten Kyng concludes. ■

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