PalCom

Project full title: **Palpable Computing: A new perspective on Ambient Computing**
Web Site: **http://www.ist-palcom.org**

The PalCom project aims to research and develop a new perspective on ambient computing named palpable computing. *Palpable* denotes that systems are capable of being noticed and mentally apprehended. Palpable systems support people in understanding what is going on at the level they choose. Palpable systems support control and choice by people. Often the default mode for a palpable application is to suggest courses of action rather than acting automatically.

Palpable computing will go beyond state-of-the-art and complement the vision of ambient computing in six key areas:

ambient computing	complemented with	**palpable computing**
invisibility		visibility
scalability		understandability
construction		de-construction
heterogeneity		coherence
change		stability
sense-making and negotiation		user control and deference

Thus palpable computing complements the unobtrusive effectiveness of ambient computing with a focus on making the means of empowering people intelligible.

The two main objectives are to design:
- an open architecture for palpable computing
- a conceptual framework to understand the particulars of palpable technologies and their use.

Secondary objectives include:
- design and implementation of a toolbox for the construction of palpable applications.
- development of a range prototypes of palpable applications
- gaining a firm understanding of a range of practices into which palpable technologies may be introduced

The project will apply a participatory design process, where technical possibilities and scientific analysis are balanced with usefulness and the development is given direction through user needs. Through this work the project will contribute to the innovation of tools and techniques for user centred, participatory design of palpable applications.

As an important element in this process the project entails continuous involvement of a number of user sites.

The PalCom consortium consists of a number of universities and companies, including SME, with top-level competencies in the areas of ambient computing, software architecture, embedded systems, user interfaces, participatory design and management of R&D projects.

1 Project objectives

The project aims to research and develop a new approach to ambient computing denoted palpable computing. *Palpable* denotes that systems are capable of being noticed and mentally apprehended. Palpable systems support people in understanding what is going on at the level they choose. Palpable systems support control and choice. And users may require systems to suggest courses of action rather than acting automatically.

The main objectives are, therefore, to design

- an open architecture for palpable systems and
- a conceptual framework to understand the particulars of palpable technologies as well as the settings in which they may be utilized,

informed by and grounded in a range of real life settings.

The two main goals are addressed directly by two activity components/WPs: Open Architectures and Conceptual Framework respectively. A third activity component/WP, Languages, is intended to develop new programming language concepts based on the emerging conceptual framework and by drawing on the success of object-oriented programming. And in this way add to the usefulness of both architecture and framework.

In order to be able to explore and experiment with the open architectures and the conceptual framework three secondary objectives are set up:

- Design and implementation of a toolbox for the construction of palpable applications. A toolbox that illustrates the architectural ideas and contains specific examples of:
    - o software tools,
    - o software components,
    - o mixed-media devices and
    - o scenarios of use bridging between current practices and future possibilities involving palpable technologies.
- Development of a range of palpable application prototypes targeted at specific use settings in order to
    - o evaluate the feasibility of the underlying palpable computing approach and
    - o demonstrate the robustness and expressive power in the developed architecture, framework and toolbox.
- Gaining a firm understanding of a range of practices into which palpable technologies may be introduced through ethnographic analyses as well as more experimental approaches. The practices chosen are
    - o similar enough to allow for focus and in-depth understanding
    - o diverse enough to provide enough variation of challenges to avoid 'tunnel-vision'.

The first of the secondary objectives, construction of a toolbox, is addressed by the activity Specific design and development. The activity has four activity components/WPs corresponding to the four sub-objectives of the secondary objective: software tools, software components, mixed-media devices and scenarios of use.

The project's main objectives aim at the creation of palpable systems, systems that support people in competent interaction. In this way the project contributes to the development of a truly inclusive knowledge-based society for all that goes beyond the notion of easy-to-use interfaces.

By supporting visibility and understandability the project contributes to the development of more knowledge-based jobs where people are able to develop their skills and performance, through a better understanding of the tools they use in their work. In addition, through the support of both de-

construction and construction, the project supports people in participating in the refinement and even the further development of the applications and services they use.

The project will provide critical input to development of European competitiveness with respect to the next generation of generic products and services building on a large user industry and service providers. In particular the perspective of palpable computing will provide an advantage grounded in European values of self-determination, choice and control by individuals, companies, interest groups regions etc.

The project will strengthen competitiveness in important areas ranging from embedded systems to healthcare. In the latter case e.g. through the provision of architecture and tools for building ambient healthcare systems and services that will improve the quality of the care through better access to experts and at the same time support patients and families in taking increased responsibility for their own care.

Palpable Computing is an innovative development that draws upon longstanding expertise and skills from participants within the European Community within the context of recent initiatives in international research in computing, engineering and system design. Most notably, Palpable Computing seeks to develop technologies, and assemblies of technologies, that are coherent with participants' everyday tasks and interactions. To achieve this, the project needs to draw not only on skills in developing computer and communication frameworks and architectures, but also expertise in the design of artefacts and understanding individual and social behaviour. Indeed, it is critical for the development of these novel technologies that concepts, methods and approaches are developed that integrate and relate knowledge and skills from computer science, engineering with social sciences and design. Fortunately, within Europe there has been a longstanding tradition of developing and deploying technology that takes account of the inevitably diffuse concerns and interests of different participants and organisations. A Participatory Approach to design has been developed and utilised over the past fifty years that not only is concerned with the broader concerns that go alongside any implementation of a technology, but also avoids being restricted to particular kinds of technologies or with narrow conceptions of human conduct. With the emerging pervasive, ubiquitous and ambient technologies it is critical both for their successful exploitation and for effective deployment that their technological design and development is undertaken in the light of the practical skills, knowledge and experience of those who are meant to use them. The Palpable Computing initiative draws on this tradition of developing appropriate technologies that support and enhance the everyday lives and work of participants.

State-of-the-art and moving beyond

Ambient computing is an emerging field. The promise and the ambitions are high, and several contributions have been made to illustrate the potential. ISTAG has provided major input to creation of a vision for ambient intelligence and analysed what is required in order to realise the vision[1]. Several European companies have been actively engaged in the ISTAG work, including telecommunication companies, Ericsson, Nokia, Philips and DaimlerChrysler. At the same time some major companies have developed visions and technology illustrating their approach, e.g. HP Cooltown[2] and IBM autonomic computing[3].

Currently ambient computing draws on state-of-the-art in a number of related fields of information and communication technology. Some well established, like software architecture, distributed

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[1] ISTAG reports: Ambient Intelligence scenarios for 2010, and Strategic orientations and priorities for IST in FP6, www.cordis.lu/ist/istag-reports.htm.
[2] http://cooltown.hp.com/cooltownhome/index.asp
[3] www.research.ibm.com/autonomic

systems, virtual machines and usability, others more recent like augmented reality and design of new ICT-enabled artefacts (e.g. appliances, furniture and means of transportation).

In order to realise the vision of ambient computing, major enhancements on state-of-the-art is needed in many areas, and palpable computing will push several issues even further.

In the following we go through seven key research challenges. First we discuss six challenges, where ambient computing is pushing state-of-the-art forward and discuss how palpable computing, in particular the PalCom project will complement these efforts. Finally we discuss how to develop palpable applications.

Invisibility complemented with visibility

The vision of the disappearing computer, to see how information technology can be diffused into everyday objects and settings, is a very appealing one. There is no doubt that enabling everyday objects with computing resources opens up a host of new opportunities. This move towards invisibility of the computer resources, though, needs to be supplemented with notions of visibility, allowing people access information about the ambient systems. In many instances it is very desirable that ambient computing capabilities of devices and environments are invisible and just 'do the work', in others it is very important that devices and environments may, somehow, show their status and their affordances: i.e. make 'visible' what

- they *are* doing
- they potentially *may* do
- other devices they *might connect with*
- etc.

Construction complemented with de-construction

Besides the need to be able to construct collections with emergent behaviour from existing ambient components and devices, it is also desirable to be able to de-construct assemblies.

De-construction may take several forms:

- 'Logical' de-construction, in order, for example, to be able to understand the complexity or to find out where something has gone wrong.
- 'Functional' de-construction, where assemblies make their constituent components functionally available to other assemblies, for example a location device may utilize the display on a digital video camera in order to show location information where it makes most sense.
- 'Physical' de-construction, where one may take components out of one assembly in order to utilize them in another.

Heterogeneity complemented with coherence

The range of activities where computational support or augmentation is an attractive and desirable possibility is expanding fast. However, the heterogeneity of activities, possible locations, situations, new media, information appliances, and the systems they are embedded within, will become a paramount concern to designers of computation tools, services, appliances, and environments. Spontaneous interoperability, integration between the digital and the physical, and context awareness are just some of the challenges that arise from the tension between heterogeneity and coherence. Support for creating and maintaining coherence in this setting is a major research challenge.

Change complemented with stability

On the one hand, palpable components will have to be able to handle, sometimes radical, changes in their contexts (either by being moved or by other components entering or leaving the context). On the other hand, from a functional point of view and as seen from the user's perspective, it has to exhibit very stable behaviour. A location device, for example, may internally shift between using GPS, wireless networks, beacons, video-tags, etc. as the user moves around in and between particular environments, for example, in the open, under a tree, inside public spaces, or inside one's home or office building. To the user, though, the device ought to be able to show the location in a stable manner and with indication of available precision.

Scalability complemented with understandability

In order to support scalability, it is often necessary and desirable to build in mechanisms for components to be "self-healing" and able to act rather independent. This is a major challenge in itself. Furthermore, when logic is build into components their behaviour becomes, to some extent, independent. This makes the question of supporting understandability paramount.

Sense-making and negotiation complemented with user control and deference

As ambient devices or components are moved around or the environment changes (e.g. by other devices and components entering or leaving the 'vicinity'), there is a need for constant 'sense-making' and 'negotiation'. 'Sense-making' in order to grasp the environment and its capabilities and 'negotiation' in order to negotiate between several potential providers of the services needed (but in different formats and qualities) or to negotiate an optimal balance among the requirements to quality, reliability, speed, precision, etc. On the one hand, much of the 'sense-making' and 'negotiation' has to be provided by the ambient components and devices (otherwise the user will be overwhelmed with choices and decisions), on the other hand, it is very important for serious use of ambient devices that there exist intelligible mechanisms for deferring decisions to the user and that the user may maintain control of the components and devices and not vice versa.

Developing useful, usable and desirable applications

Today close cooperation between it-developers and users in the development of new applications is considered best-practice in most cases. When developing radically new applications this kind of cooperation is particularly important and difficult. Developing ambient and palpable applications calls for the improvement of interdisciplinary tools and techniques in the areas of iterative and incremental development, experimental prototyping, human-centred/participatory design, and ethnography based work analysis.

In addition to the challenges addressed above, PalCom will follow work in related projects to complement its own research with advances in relevant areas, e.g. safety, security and reliability.

2 Potential impact

2.1 Innovation

The innovation-related activities of the project are those that take up a new paradigm in information systems. This takes advantage of advances in miniaturisation and communication to 'explode' computing power out of its conventional locations and to embed it wherever it can be most effective, through providing an enabling architecture. This will generate a hybrid world in which the power and capacity of disparate systems and objects are able to flow over their physical, digital and communicative properties. This will often mean that people, in relating to each other through hybrid objects and systems, need no longer be aware of these explicitly as 'computing'. But they do need to be able to understand, in terms relevant to their own purposes, the capacities that are unleashed. Hence our emphasis on 'palpable' systems: making the means of empowering people intelligible.

2.2 Strategic impact

2.2.1 Competitiveness and effectiveness

In generating both an architecture and test-bed prototypes, Palpable Computing will provide the basis for major strategic impact in Europe and beyond. Part of this impact will be commercial, through the competitiveness and effectiveness of European industry. At one level, this relates to the European computing and information technology industries themselves. Through its willingness to coordinate its activities and provide open standards, Europe could take a leading role in a potentially vast emerging market for ambient computing infrastructures, components and applications, as it has already done with mobile communications. The resulting open markets would create opportunities across the spectrum of the European IT industry, from the largest firms to small and medium enterprises.

At another level, and potentially on an even larger scale, Palpable Computing would unleash strategic advances in competitiveness and effectiveness for its users. Through ambient and palpable computing, someone engaged in a work activity, wherever they are, will be able to take flexible advantage of appropriate combinations of both personal and encountered devices, services, and the telepresence of colleagues and materials. This could significantly reduce the costs involved in carrying out a set of activities, or significantly increase the effectiveness and client satisfaction of the work that is done, or both. This would be to the benefit of all stakeholders, whether through competitiveness in the private sector, or cost-effectiveness in public service delivery. Palpability in ambient systems will enhance their acceptability and accelerate their take up.

2.2.2 Quality of Life

A major aim of the project is the empowerment of people through placing palpable objects and systems in their hands, thus furthering the citizenship values and objectives of the European Union. This will arise in part through making powerful additional services available for information, participation, engagement, security, etc. For example, in health care, one of our areas of focus will be the medical care of long-term patients, such as people suffering from diabetes or recovering from surgery. We will work towards Patient Empowerment through new technology combining a solid empirical base and innovative design. This and comparable developments will provide real choice for citizens, companies and societal institutions, including support for "de-institutionalisation" and increased citizen involvement. However, such empowerment can only be realised from the

perspective of the general public if the basic services are simple, understandable, and easy to use – as envisaged in our emphasis on palpability. The objective is user control over appliances and information infrastructures in the environment and for high-penetration technology for everyday use, visibility and understandability are essential. Overall, palpable computing will facilitate the realisation of a 'network social morphology' in production, commerce, public administration and civil society.

2.2.3 Exploitation and dissemination

The exploitation and dissemination activities of the project can be categorised as focussed towards academic and related research communities, research and development in the information technology industries, user groups in industry, the professions and the public services, and the general public.

Dissemination to academic research communities and to high-level research oriented laboratories in the private sector will use the media of journal publications and conference and workshop presentations, including some fora initiated and promoted by the Palpable Computing project itself. We will take advantage of appropriate research networks such as Nordic Interactive (funded by the Nordic Ministerial Council), and the network of universities, companies and municipalities affiliated to the Danish Alexandra Institute. Since research activities come early in the development and adoption process, lead time here is important, and academic dissemination will take place through all stages of the project.

Dissemination and the encouragement of exploitation in the European information technology industries will use the mechanisms above, supplemented by articles in industry journals and promotions at industry exhibitions.

A.1 Participants and consortium description

The PalCom consortium is composed of a group of universities and companies, including SME, ideally suited to fulfil the objectives of the project. The participants have been selected in such a way that they represent top-level competencies in the area of ambient computing and related fields, in particular: software architecture and frameworks, distributed programming, embedded systems, user interfaces, work analysis, digital and physical design, participatory design and management of R&D projects.
As described in B.4 – outline implementation plan – the main objectives of the project are to design an open architecture and a conceptual framework for palpable computing that is informed and grounded in real life settings. To meet these goals, the RTD work in the project is organised into four activity areas:
- General design
- Specific design and development
- Application prototypes
- Sites

The selection of participants and their roles ensures that all four areas are covered with profound and leading-edge competencies.

University of Aarhus, Lund University, EPFL, OOVM, Whitestein, and Siemens together span most areas of software systems with respect to research as well as industrial experience in areas such as software architecture, application frameworks, design patterns, object-technology, distributed

systems, languages, conceptual framework, communication, embedded systems, mobile systems, software tools, and virtual machines.

The general design is primarily the responsibility of University of Aarhus, Lund University, and L'ecole Polytechnique Federale de Lausanne (EPFL).

The specific design and development is primarily the responsibility of Siemens, OOVM, University of Aarhus, Lund University, L'ecole Polytechnique Federale de Lausanne (EPFL), and Whitestein. Furthermore, as part of the specific design, we are developing mixed-media devices and scenarios. These are the primary responsibility of Malmö University, University of Siena, University of Aarhus, and Aarhus School of Architecture.

The Development of *Application prototypes* is primarily the responsibility of University of Aarhus, University of Siena, and Malmö University.

Understanding of work and evaluation of application prototypes on the *sites* is addressed both using ethnographical approaches (primarily Kings College London and Lancaster University) and more experimental approaches (primarily University of Aarhus, University of Siena, and Malmö University).

The plan is to subcontract 4 use-sites (3 healthcare institutions and 1 (landscape-) architectural company). Furthermore, Kings College has extensive contacts with local hospitals

A.1.1 Partners

Participant	Core Partner
Aarhus University	**Professor Morten Kyng**
The computer science department at University of Aarhus will act as coordinator; provider of expertise within 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. The coordination and management experience include - directing the Danish Centre for IT research (CIT) from 1996 to 2002 with a total budget exceeding €20 millions; - directing the Alexandra Institute that is a limited company constituted by a range of	Morten Kyng is professor of Pervasive Computing and director of the Centre for Pervasive Computing. He has a longstanding track record of research in participatory design and human-computer interaction. He received the ACM CHI academy award in 2001. From 1996 to 2002 he was the director of The Danish National Centre for IT Research, where he was responsible for a project portfolio with a budget of approximately 60 million. Most of his research has been done in cooperation with use-organizations and industry. He has participated in the development of several application prototypes in novel and emerging areas since the early 1980ies: computer supported cooperative work, hypermedia and pervasive computing. He is currently doing cross-disciplinary research on user-centred design of pervasive computing applications, primarily in the health care sector.

research institutions and private companies to further the collaboration between research and industry; • directing Centre for Pervasive Computing at University of Aarhus comprising more than 30 projects; and • coordinating the EU, FET, Disappearing Computer project Workspace (2001-2003). The *object-oriented software systems group* has more than 25 years of experience in, programming languages, programming, modelling, software architecture, language implementations and software development tools. The group has been at the forefront of research within object-technology for more than 25 years and has participated in a range of national and international projects. The *participatory design group* has a long experience in user-centred investigation based on tools and techniques developed within the Scandinavian tradition for cooperation with users in system evaluation and design. For more than 20 years, the group has been at the forefront of research within participatory design and CSCW and has participated in a range of national and international projects. **www.au.dk**	**Professor Ole Lehrmann Madsen** Ole Lehrmann Madsen is professor of Computer Science and director of the Alexandra Institute. He is president for the Association Internationale pour les Technologies Objets that promote the advancement of research in object-oriented technology.He has a longstanding track record of research in object-oriented software systems. He is one of the developers of the BETA programming language, and he has been a research manager for the Mjølner project where the first version of the BETA software was developed. He has been engaged in a large number of research projects using object-technology, including several projects with industry. He is co-founder and chairman of Mjølner Informatics A/S. He is currently working with object-technology in the context of pervasive computing and he is project manager of ISIS Katrinebjerg.
	Assoc. Professor Preben Holst Mogensen Preben Holst Mogensen is associate professor and Coordinator of the IST, FET, Disappearing Computer 1 project Workspace. He has a long track record within participatory design and CSCW, and he has been participating in a range of international and interdisciplinary projects. He is currently working with ambient and pervasive technologies in the area of spatial computing.
Communication Science Department University of Siena	**Ass. Professor Patrizia Marti**
The Communication Science Department at the University of Siena is engaged in research concerning information technologies (IT) for communication, learning and teaching. The Department's activity is 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. The Lab have been active in issues associated with psychology, communication processes, cognitive ergonomics, networking and human factors, mainly concerning, distributed cognition, interaction design, learning processes, human error. The Lab has been involved in several collaborative research projects with industrial and academic partners. **www.unisi.it**	Patrizia Marti is Assistant Professor in "Educational Technologies", Communication Sciences Department, University of Siena. She is involved in international projects in the areas of nomadic systems, educational technologies and air traffic control, in particular for the design of human activities in context (situated interaction), multi-sensorial and socio-cultural aspects of the interaction with artefacts. She joined the University of Siena in 1996 and since then she has been involved in several international research projects. **Professor Antonio Rizzo** Antonio Rizzo, professor of Multimedia Design. He got a degree in Experimental Psychology at the University "La Sapienza" in Rome. He has been involved in several EU projects He is currently involved in the following research

	projects:EU - Esprit I3. Narrative environment for learning (POGO); EU - Training and Mobility Program. Complexity in Social Science (COSI); EU – IST. Information Management and Interoperability of Content for Distributed System (i-Mass). He is member of the NATO working group on Human Reliability and Chair of the European Association of Cognitive Ergonomics.
LU	**Prof. Boris Magnusson**
The Computer Science department at Lund University, the largest university in the Scandinavian countries, has a long track record of software research with relations to other academic disciplines and industry. Much of the research has been in the general areas of Object-Orientation, Real-time systems and Software Engineering and has often been with an application in embedded systems in mind. Many of the industrial relations are with companies that do this kind of products. The research at the Department of Computer Science is coordinated with two neighboring departments, Automatic Control and Telecommunication Systems, through the Center LUCAS, www.lucas.lth.se	Professor in Computer Science at Lunds University since 1999. Director of the Lund Center Applied Software Research (LUCAS) at LU. Department head 1992-1995. Co-author of one book and several papers. He has a strong track record in the field of Object-oriented programming and software architecture where he has served in many capacities including conference and program chair any many times in program committees.

Malmö University	**Professor Jonas Löwgren**
The School of Arts and Communication, Malmö university, Sweden, was founded in 1997 with the aim of exploring the digital design materials through the synthesis of creative and analytical work. In this relatively short time, the school has reached an international position among the leading actors in digital design research and education. Fields of particular relevance for PalCom include interaction design, material and virtual design, and interaction technology. Malmö university is the eighth largest university in Sweden, employing 1.100 people and serving close to 20.000 students. It is located in the dynamic Öresund region and the strategic focus is interdisciplinarity and societal relevance. www.k3.mah.se	Jonas Löwgren, professor of interaction design is responsible at the School of Arts and Communication for the Mixed-media devices component and is specializing in mixed-media applications, interactive visualization and ICT design theory. His cv includes 30+ academic publications, 20+ interaction design pieces, 50+ pieces for students and the general public, creative and administrative direction of several multi-partner research projects, and 1.1 MECU of external research grants. http://www.k3.mah.se/k3jolo
Lancaster University	**Professor Dan Shapiro**
The Department of Sociology at Lancaster is one of only two UK sociology departments with the top '6-star' 'internationally excellent' official	Professor in Sociology since 1998. Director of the Centre for Research in Computer-Supported Cooperative Work at Lancaster University. Head

research quality assessment. One of the department's areas of research specialism 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. www.lancaster.ac.uk	of Department of Sociology in 1995-1998 and 2002. He is co-author of five books and many papers. Has a longstanding track record of research in the ethnographic study of social practice to inform the design of information systems, in participatory design and evaluation with end users, and in interdisciplinary theory for information system design and spatial computing. Coordinator and participant in several EU projects since 1992 http://www.comp.lancs.ac.uk/sociology/dshapiro.html
Aarhus School of Architecture (AAA)	**Professor Uffe Lentz**
The department of eDesign will act as provider of expertise on 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. The department has experience in participation and management of research projects funded by the Danish research council, and is currently a participant in the recently established Centre for Interactive Rooms and Buildings in Denmark.	Uffe Lentz, professor in "Industrial Design and Component Design" since 2001. He is responsible for Department of Communication Design and has a long track of interdisciplinary research and development in industrial manufacturing and building construction with special focus on ICT process integration in conceptual stages of the design process. Research includes projects funded by EU/comet, Danish government's investment promotion agency, Danish Design Center. He has published 30+ papers on National and International journals and Conference Proceedings and produced 10+ educational books and publications.
Kings College, London University	**Professor Christian Heath**
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. These projects have involved the design and development of for example; augmented paper technologies, multimedia mobiles, interactive broadcast systems, and advanced media spaces. Many projects include close collaboration with industrial, service sector and academic partners in the UK and abroad	Since 1998 Professor, The Management Centre, King's College London and Director of the Work, Interaction and Technology Research Group.. Research includes projects funded by the ESRC, EPSRC, EC RACE, ACTS, IST & TMR Programmes, and various industrial and service sector sources. Publications include seven books, various television and in-house programmes, and more than one hundred articles in academic journals and books. **Dr. Paul Luff** Senior Research Fellow at the Management Centre, King's College London. Publications include numerous journal articles and conference papers and three books in the fields of CSCW, HCI, Requirements Engineering,

Distributed Programming Laboratory, EPFL	Professor Rachid Guerraoui
Research at the Distributed Programming Laboratory is centred around DACE (Distributed Asynchronous Computing Environment) umbrella project.	Rachid Guerraoui is professor in computer science at the Swiss Federal Institute of Technology in Lausanne (EPFL) where he leads the Distributed Programming Laboratory. He has published more than 100 papers in the field of distributed computing and has been member of nearly all program committees of significant conferences in the area. He is also program chair of ACM Middleware, IEEE SRDS, IEEE ICDCS and ECOOP.
OOVM	**Lars Bak**
OOVM is a young startup company that designs and implements basic software infrastructure for embedded systems with the goal of improving reliability. They are working on virtual machines with the objectives of achieving: Embedded language runtimes No operating system Fast execution Minimal memory footprint	Since his M.Sc. degree in 1988, Lars Bak has designed and implemented object-oriented virtual machines. Prior to founding OOVM, Lars was the technical lead of the HotSpot Java Virtual Machine team at Sun Microsystems in Cupertino, California, USA. During the 10 years that Lars worked in Silicon Valley, he was a key contributor to the following systems: CLDC HotSpot (high-performance J2ME virtual machine for mobile devices), the Java Hotspot virtual machine (Sun's premiere Java virtual machine for J2SE/J2EE), StrongTalk, Self and the Mjølner Beta System.
Siemens	**Senior Principal Engineer Frank Buschmann**
Siemens, headquartered in Berlin and Munich, is one of the world's largest electrical engineering and electronics companies. Siemens have roughly 426,000 employees and posted sales of €84 billion in 2002. Siemens boasts an impressive international presence, focusing on the core business areas of Information and Communications, Automation and Control, Power, Transportation, Medical, 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. In 2002, the company invested €5.8 billion (7 percent of sales), in R&D. Siemens is the largest patent applicant at the German Patent and Trade Mark Office.	Frank Buschmann is senior principal engineer at Siemens Corporate Technology in Munich, Germany. Frank has more than 20 years of world-class experience in professional software development and core software technolgies. His research interests and technology experiences include Object Technology, Frameworks, Components, Patterns, Aspect-Oriented Programming, and Model-Driven Architecture -- both in general and with a specific focus regarding their use in distributed and networked systems. At Siemens Corporate Technology, Frank is leading the research activities on above technologies. He has been involved in many industrial software development projects, contributing as a developer, designer, chief architect, and mentor of the architecture team.

Approx. half of Siemens' 55,000 researchers and developers are working on software projects in various business areas, making the company one of the world's largest software houses. www.siemens.de	Frank is co-author of the award-winning books "Pattern-Oriented Software Architecture -- A System of Patterns" and "Pattern-Oriented Software Architecture -- Patterns for Concurrent and Networked Objects"

Whitestein Technologies AG	Dr. Monique Calisti
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). We 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 us web services, GRID approach and mobile wireless computing. One of our main interests is on the definition and deployment of flexible, smart and effective techniques for better coordination of software systems and components and thereby services offered in electronic complex environments such as communication networks, adaptive supply networks, hospitals, etc. This is in our strategy an essential element toward a concrete realization of palpable computing intended as the twofold capability of providing systems and offering services as smart support for human decision-making. We strongly believe our participation into the PALCOM project is essential to address important key issues for enabling the overall European vision of a future intelligent ambient placing the user at the centre of future development	Monique Calisti joined Whitestein Technologies AG in June 2002 as vice-president of the Research and Development group. She is currently responsible for several internal research activities; and for Whitestein's participation and technical contribution to two main current international - ITEA and IST- projects. She is actively involved in the worldwide standardisation body for software agents - FIPA- as member of the Board of Directors, and she has been working in several technical working groups since 1998. After her graduation (with distinction) from the Università degli Studi di Bologna (Italy) in Electrical Engineering in 1996, she obtained her first PhD in Telecom Engineering. She then attended the post-graduate School in Telecommunication Systems at the EPFL in Lausanne (Switzerland) before finally joining the Artificial Intelligence Laboratory of EPFL. Here she obtained in 2001 her second PhD in Computer Science (i.e., coordination of self-interested and constrained software agents). Direct participation in the European ACTS project KEOPS (1996-1997), active contribution to the Agentcities.RTD IST proposal and project (2001-2002), work package leader and contributor in the Agentcities.NET and AgenLink II IST projects.
The Alexandra Institute, Aarhus, Denmark The Alexandra Institute is a limited not- for profit company 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.	**Lise Bollhorn** Lise Bollhorn, Head of Unit for the Alexandra Institutes Copenhagen Office has a master degree in civil engineering. She has 10 years experience with management of complex international projects. She also has long experience with dissemination, network building and ICT from a

Today there are more than 40 members including companies such as LEGO, Bang & Olufsen, Cisco, Sun, Terma, TDC, Microsoft. A complete list of member may be found at www.alexandra.dk.

The mission of the Alexandra Institute is to strengthen research, development, knowledge sharing and education within the IT area. Furthermore it is the objective to bridge the gap between IT research and the business community for the benefit of both parties. The Alexandra Institute has an extensive experience with dissemination and exploration of research from organising large conference and exhibits to intensive workshops, symposia and research schools. Competences also include project management of complex international projects and communication strategies reaching across disciplines, countries and medias.   The Alexandra Institute is operator on several larger national and regional initiatives and is also operator of the Nordic Interactive Network sponsored by the Nordic Minister Council.
 www.alexandra.dk

political angle. Her past work experience includes working for IBM, The Danish Ministry for Trade and Industry and the Confederation of Danish Industry. She was Danish delegate in ACTS, Esprit and Telematics management committees in the EC 4 Framework Programme.