



**The MOSAIC Consortium**



Information Society  
Technologies

# **The Future Workspace**

Perspectives on Mobile and Collaborative Working

*Editors: Hans Schaffers, Torsten Brodt, Marc Pallot, Wolfgang Prinz*

Our working environment is in a process of transition. Due to the forces of globalisation and competition, location has diminished in importance. Mobility adds a new quality to the flexibility of knowledge workers, but could be constrained in the future due to concerns about sustainable development. New forms of collaboration are emerging, such as the community of professionals. Collaboration across organisational boundaries has become important, if not an imperative, and is enabled by user-friendly information and communication technologies and new ways of working. The word “place” embodies new meanings. Collaborative shared workspaces are increasingly complementing the physical workplaces we are used to.

This book presents key results of the MOSAIC project (FP6-2003-IST-2, March 2004 - October 2005). In addressing the future workspace and new ways of working, it investigates the current practice, future scenarios and challenges for research and innovation, resulting in a research agenda for the future. The agenda is based on an analysis of technological, organisational and social developments, as well as on case studies in three thematic domains: engineering, rural and regional working, and health and wellbeing. Besides, the book addresses the emerging societal challenges related to new and innovative ways of mobile working. The book concludes with recommendations for an innovative and socially sustainable workspace design of the future.



[www.mosaic-network.org](http://www.mosaic-network.org)

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# THE FUTURE WORKSPACE: MOBILE AND COLLABORATIVE WORKING PERSPECTIVES

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## **The Future Workspace. Mobile and Collaborative Working Perspectives**

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Our world of work evidently is in a process of transition. Location has diminished in importance. Mobility adds to the increasing flexibility of knowledge workers, but could be constrained in the future due to concerns about sustainable development. New forms of collaboration emerge, such as the community of professionals. Collaboration across organisational boundaries has become important, if not a matter of course, and is enabled by user-friendly information and communication technologies. The word “place” embodies new meanings. Virtual workspaces are complementing the physical workplaces we are used to.

This book presents the key results of the MOSAIC Specific Support Action (FP6-2003-IST-2), which has been running from March 2004 to October 2005. MOSAIC stands for “Mobile Worker Support Environments”. This book addresses the current state of the art and current practice, future scenarios of mobile workspaces, and challenges for research and innovation resulting in a roadmap and research agenda for the future. The roadmap is based on expected trends and developments as well as case studies in three thematic domains: engineering, rural and regional working, and health and wellbeing. Societal challenges related to new and innovative ways of mobile working are addressed as well.

Looking at the MOSAIC main outcomes, the value of the project is not only constituted by our project reports (which are available through our website [www.mosaic-network.org](http://www.mosaic-network.org)) or the about 20 events that we have organized. As a recent article in IST Results says, “The impact of the project will essentially be one of influence. It may impact the EU and the Commission in terms of policy and research priorities, and, potentially, research funding. What’s more the findings of the MOSAIC team will have a strong impact on European industry, as it considers MOSAIC’s vision”. This is of course what we should hope for. Our additionally hope is that the AMI@Work Family of Communities that we, in close collaboration with the European Commission New Working Environments unit, actively supported during the launching phase, will mature and play their role in the 7th Framework Programme and the European Research Area.

The MOSAIC Consortium wishes to acknowledge all those who have contributed to our results. The work has been co-funded by the European Commission through the MOSAIC Specific Support Action under the IST priority within the 6th Framework programme. We are grateful to the EU project officer Olavi Luotonen, from the New Work Environments Unit of the Information Society and Media Directorate-General, who has supported the project and has initiated the AMI@Work Family of Communities. Our thanks go also to the MOSAIC review committee chaired by Prof. Angela Sasse for fruitful discussions and exchanges, and to our colleagues from various AMI@Work communities who contributed to developing and validating the MOSAIC scenarios, roadmap and research agenda.

*Hans Schaffers, Telematica Instituut, MOSAIC Project Coordinator*





The key objective of the MOSAIC project ([www.mosaic-network.org](http://www.mosaic-network.org)) has been to accelerate innovation in the mobile and collaborative workplace, aiming to realize more productive and creative work environments. Through a process of vision development, scenario building and roadmap construction, and exploring the opportunities for innovation in different domains, MOSAIC has identified the challenges for research and innovation and has established a large community of practitioners and researchers preparing future innovation in new work environments in Europe.

### Preparing Europe

MOSAIC has explored business and societal innovation and has contributed to preparing Europe for deploying innovative mobile technology in a range of application domains, to support mobile workers in distributed and location-sensitive settings. MOSAIC focused on mobile and collaborative working in three key domains which are strategically important to Europe, namely (1) Healthcare and wellbeing, (2) Engineering sectors (building, construction, manufacturing) and (3) Working in rural and regional environments.

MOSAIC has worked closely with the New Working Environments unit of the Information Society and Media Directorate-General within the European Commission, to establish a family of communities in the area of Ambient Intelligent (AMI) technologies and user applications. The AMI@Work communities that have been launched in June 2004 now count more than 900 registered members, and currently cover work-related areas such as collaboration, mobility, knowledge and e-markets, as well as sectors and themes such as health and wellbeing, engineering and rural and regional working. Media and logistics were added to the initial communities, as well as special interest groups on Living Labs and leadership in work environments. More information is available on the AMI@Work website [www.ami-communities.net](http://www.ami-communities.net). Additionally, MOSAIC has strongly encouraged the participation of small and medium-sized enterprises and small research teams across Europe including the New Member States.

### MOSAIC Activities and Aims

MOSAIC has carried out a series of parallel activities such as to build an expert community network, identify good practices and critical success factors in current mobile working, identify themes for future R&D and develop domain-specific roadmaps to support the successful deployment of mobile working within the chosen three application domains. We also have developed a generic roadmap and research agenda for mobile working, promoted Europe wide collaboration for deploying mobile work environments, and we have run many working groups and dissemination activities. Through these multi-disciplinary activities, MOSAIC has aimed to influence policies and strategies of major stakeholders in business, government and research, at national and international levels, for research and innovation in the area of 21st century mobile and collaborative work environments. MOSAIC's publicly available reports are listed below (see also Appendix 3).

MOSAIC Reports, a selection (see [www.mosaic-network.org](http://www.mosaic-network.org))

- D1.1 Mobile Working State of the Art, Vision, Scenarios and Challenges (3 reports)
- D1.2 Mobile Working Roadmap
- D1.3 Mobile Working Research Agenda and Joint Projects
- D2.1 Mobile Working Best Practice Case Studies and Success Factors
- D2.2 Mobile Working in Health and Wellbeing: Scenarios and Deployment Challenges
- D2.3 Mobile Working in Engineering Sectors: Scenarios and Deployment Challenges
- D2.4 Mobile Working in Rural and Regional Areas: Scenarios and Deployment Challenges
- D4.1 Innovation and Systems Change: The Example of Mobile Collaborative Work
- D4.2 Mobile Working: Societal Change Aspects and Strategies

### **Towards Networked Workspaces**

Due to the steadily progress of technologies and processes for information sharing, communication and collaboration, and due to the forces of competition and globalisation, our work environment has changed considerably over the past 20 years. And it will continue to do so in the future, going into the direction of a more virtualized world. The network – the Internet, and the web of people – will become the workplace. People will be empowered for seamless dynamic and creative collaboration across teams, organisations and communities through a personalised and mobile collaborative working environment, enabling working from everywhere and at any time. Driving force for MOSAIC is the emergence of “networked workspaces” and the challenge for supporting efficient, intuitive, user-oriented and ‘human-centric’ work environments where technology is aligned to organisations and human behaviour, enabling people to work together irrespective of constraints in location and time. Without doubt, information and communication technologies (ICTs) supporting mobility, context- and location-awareness, networking and ambient interaction will play an important role in implementing this challenge.

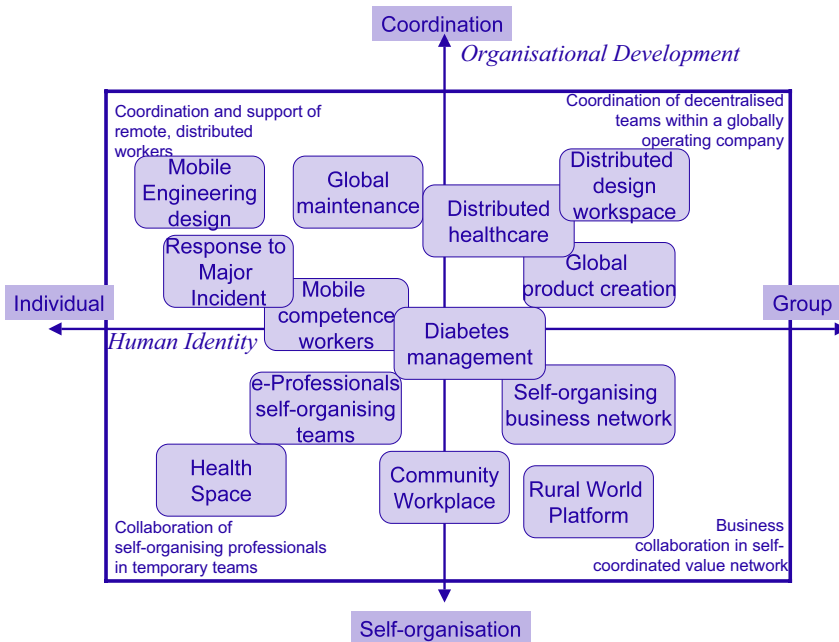
### **Innovation Breeding Ground**

Innovation in working environments is not a matter of technology alone. Among the key issues are: organisational aspects, new forms of cross-organisational cooperation, management and leadership, organisational structure and managing change, and incentive schemes. Although there haven’t been that many empirical studies in measuring the impact of workplace innovation, there is evidence that innovations in the workplace may further contribute to creating value, increasing productivity and improving the quality of work. However, the ICT impacts on the worker environment are not well understood, and this fact is hindering innovation. Therefore organisational and geographical aspects of workplace innovation, and coping with human and social issues in mobility, sustainability and quality of work should go hand in hand with ICT innovation.

MOSAIC therefore has pursued a holistic and multi-disciplinary view on innovation, bringing together different disciplines and communities, in particular those in the areas of mobile and wireless technologies and applications, workplace innovation, and spatial infrastructures for working and living. We believe that in order to exploit the potential of the area and set out a realistic research and innovation strategy and create an industry support base, boundaries between traditional disciplines and communities should be overcome. MOSAIC has aimed to create a “breeding ground” for such multi-disciplinary collaboration and innovation in the area of mobile work environments.

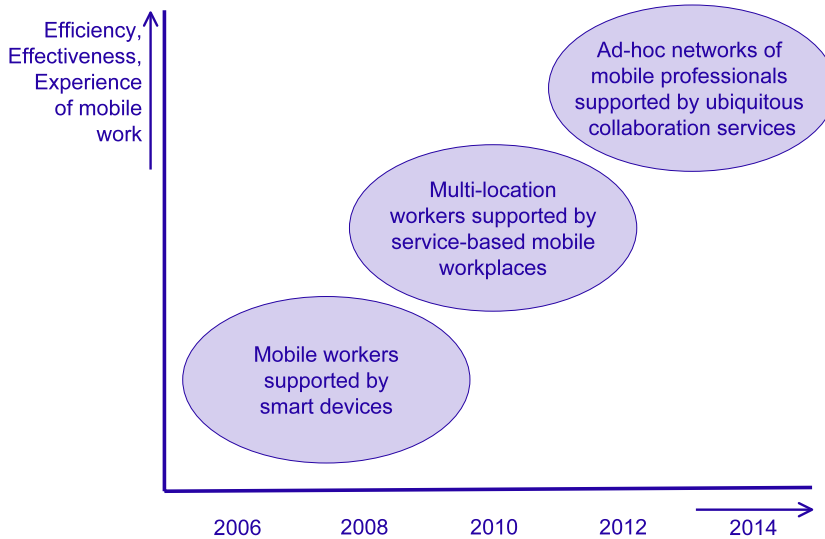
## Roadmap for Innovation

MOSAIC has realized this approach through a process of vision development, scenario building, roadmap construction, and preparing an agenda for innovation and change. The basis is an analysis of current working practice, which has resulted in a database of more than 20 cases of mobile working. The vision development process is supported by electronic polls inviting for opinions and priorities, thus providing an interactive setting and contributing to validation. The MOSAIC vision of networked and people-centric workspaces has also been supported by developing a set of scenarios for the future mobile and collaborative workplace and for future ways of working. These scenarios are visualized below.



The scenarios are designed to provide a context for identifying and discussing major underlying trends and uncertainties in shaping the new work environment. Through analyzing the critical requirements in these scenarios – covering technical, organisational and social aspects – the elements for a general strategic roadmap for research and innovation in collaborative and mobile workspaces have been identified in the form of milestones to be accomplished in order to realize the vision of networked people-centric working.

The MOSAIC general strategic roadmap presents three stages or ‘landing places’ for innovations. The first period of 2005 - 2007 is characterized by the fact that smart devices are supporting support mobile workers, whereas in 2008-2009 innovations will concentrate on multi-location work supported by service-based mobile workplaces. Finally, the period of 2010-2014 will be characterized by the ability to support ad-hoc collaborative and mobile teams of professionals by context-aware and service-based workspaces. Based on the strategic roadmap visualized by these envisaged landing places for innovation, the agenda for future research and innovation includes key themes for integrated projects.



### Strategic Research Agenda

The most important lessons conveyed by our scenarios, exploring various aspects of the vision of people-centric networked workspaces, are the following. Global division of work will be a major development, but work-life balance issues could hinder its full development and undermine current social models. Mobile workspaces can support the globalisation of supply chains and work environments, but require new forms of leadership, coordination and management. The vision of e-professionals collaborating in self-organising communities is among the promising models for the future but will require new business models, work regulations and IPR arrangements.

The key strategic challenge is to realise the potential inherent to the various innovations in the area of mobile and collaborative working, to the benefit of business, society and people. To that end a number of major directions that will drive innovation in mobile and collaborative working must be pursued. These directions include:

- The creation of better work regulations, IPR, policies, processes, business models and applications for flexible working anytime and anywhere.
- The development of standards and infrastructure allowing for interoperable and plug-and-play mobile and collaborative work environments.
- To develop a better ability for contextualisation of teamwork environments, and for mobile team workspaces, to make collaborative workspaces responsive to external changes.
- To apply the technologies to activities now clearly gaining in importance (e.g. multi-disciplinary and dispersed teams handling an emergency situation).
- To realize a paradigm shift from application oriented to activity oriented collaborative systems, supporting cooperation and interaction in terms of collaborative activities instead of technical functions and applications.

In order to implement the strategic agenda for innovation and to realize the potential that is inherent in the innovations addressed, the following actions are recommended.

- To enhance current key domains of innovative working environments. Exploit and transfer existing knowledge on technology acceptance and implementation from current innovation domains to so far untouched work settings.
- To stimulate the collaboration between various research groups and companies worldwide and communities such as AMI@Work operating across the 25 EU member states for the IST research programme dedicated to eWork, in order to cope with the new realities of global working.
- To set up a network of Living Labs in the area of innovative work environments, in order to explore and demonstrate the potential of the various mobile and collaborative working scenarios, to support the collaboration between users and developers, to create and disseminate good practices, and to understand the human and social impacts.
- To strengthen the focus on multi-disciplinarity in mobile and collaborative workspace innovation, bringing together technical, social, organisational, behavioural and business disciplines.
- To bring together the separated discourses related to working environments, hosted by different government departments and the different European Commission Directorates-General.



Due to the steadily introduction of new technologies and new processes for information sharing, communication and collaboration, and due to the forces of competition and globalisation at work in industrial value chains, our work environment and the way we are organising our work has changed considerably over the past 20 years and continues to do so in the future. Based on the current practice of mobile working and on the current state of the art in technologies and applications supporting the mobile workplace, the MOSAIC project presents a structured and detailed vision regarding the key characteristics of future ways of working and the key characteristics of future workspaces. In this vision, the needs of people at work, in particular with respect to collaboration and mobility, are on the forefront.

This book presents the insights we acquired during the course of the MOSAIC project (2004-2005) in trends and developments towards the new mobile and collaborative ways of working. We explore plausible future scenarios and deployment roadmaps in different sectors like healthcare and engineering. Our analysis of challenges and requirements results in a broad strategic roadmap for research and innovation. This roadmap presents a vision as how to implement innovative mobile and collaborative workspaces for the years to come in order to enhance European competitiveness. This roadmap is meant as a starting point for the development of innovative projects. Thus we hope that it will provide inspiration and guidance to European stakeholders in industry, research and policy, and that it will have its impact on national and international research programs.

### 1.1 THE RELEVANCE AND IMPACT OF NEW WAYS OF WORKING

The modernisation of the workplace has been a topic for research and innovation since long. Although – apart from a few companies – Europe has not a real strong industry sector developing technologies and solutions, there is a strong tradition in multi-disciplinary research in this area. Workplace innovation and in particular flexible working has also met considerable attention in European policy since the 1997 Green Paper on ‘Partnership for a New Organisation of Work’, the 2000 Lisbon summit focusing on creating a knowledge-based economy, and the 2002 Roskilde EU Presidency Conference on ‘New Forms of Work Organisation’. The main challenge is to realise real innovation and change in the workplace, and to cope with the many obstacles – human, organisational, societal, and technological - through learning and experimentation (Totterdill, Dhondt and Milsome 2002).

Workplace innovation is not just a matter of technology alone. Among the key issues are: workplace organisation, regulations, cross-organisational cooperation, management and leadership, organisational structure, business models, and incentive schemes. Introduction of new work practices and introducing new ICTs must go hand-in-hand. Although there haven't been that many empirical studies in measuring the impact of workplace innovation, there is evidence that innovations in collaborative workspaces may further contribute to creating value, increasing productivity and improving the quality of work. In one of the scarce empirical studies, measured over a period during the 1990s, it appears that ICT-related workspace innovations (including re-engineering, teamwork and worker involvement in decision-making) account for 30% of output growth in manufacturing, and 89% of multifactor productivity (Black and Lynch, 2004). Given the productivity gap between the US and Europe in exploiting ICTs, it definitely constitutes a real challenge for Europe to develop innovative collaborative workspace concepts that enhance productivity and human creativity.



The real impact of workplace innovation can only be understood at the level of sectors. In many sectors a number of key forces are at work providing innovative opportunities for mobile and collaborative workplaces. In manufacturing sectors like electronics, automotive, aerospace and building construction sectors we find that the trend of shortening product life cycles requires new capabilities, in order to deal with a situation of faster product development and rapid switching to new product families. Forces of global competition are increasing the pressure on equipment manufacturers and their suppliers to become more cost effective and flexible. Regional suppliers tend to become more collaborative and are eager to gain positions in global collaborative value networks.

Additionally, the complexity of products and production has enormously increased compared to a few years ago. Therefore, the organisation of the product development process must adapt as well. A holistic view of the product development process is necessary, and companies are experimenting with distributed forms of the design and engineering process and ad-hoc collaboration processes with corresponding workspaces. To a growing extent, industries like aerospace become organised as a distributed virtual organisation, requiring efficient collaborative tools and processes (Fernando, 2003).

Workspace innovation has also important implications for service-oriented sectors. For example, healthcare organisations experience pressure for change due to the continuing innovation in medicine and healthcare technologies, the pressure to limit healthcare costs and to manage complex organisational processes, the increasing citizen empowerment, and the demographic changes due to an ageing population. This has lead healthcare organisations to explore new ways to organise and deliver health services, and although there remain many bottlenecks to solve, eWork innovations have started to gain some acceptance (Saranummi, 2004).

Mobile and collaborative technologies can play a crucial role in order to increase communication among workers, organize work more efficiently and reduce process cost. Mobile technologies now already support many forms of individual working, and penetration of these technologies is considerable (Lilischkis and Meyer, 2003). But mobile technologies bear more promise than only supporting mobile individuals. For example, the building and construction industry is characterised by dispersed teams that jointly work on the development of a new site, sometimes not belonging to one and the same company, without being able to use fixed line infrastructure and having high mobility/travelling requirements on site and between sites. This provides substantial opportunity for mobile working. In order to realise this apparent potential, mobile and collaborative technologies alone can only address some elements of the problems faced by the sectors mentioned. A holistic concept of workspace innovation and ICT solutions is needed, giving due considerations to the different viewpoints and instruments: market pressures, people issues, and workplace organisation.

## 1.2 THE SCOPE AND VISION OF MOSAIC

Established thinking of mobile working is strongly confined to mobility of the individual worker. As Table 1-1 demonstrates, the challenge is now to relate worker mobility to new concepts such as the collaborative mobile team, the community of professionals and the networked workspace. Current examples of individual mobility support are mobile applications for sales support and customer relations management, maintenance support e.g. in manufacturing, aerospace and automotive industry and mobile access to information, knowledge and experts in design and construction activities. However, as there are increasing limitations to the mobility of workers due to both the emphasis on sustainable development and the quality of working life, a more

complete view of the mobile working environment is necessary. We propose to relate the concept of mobility not only to people, but also to the work, to work organisation, and to the networked workspace. Exploring this idea, the MOSAIC project has investigated the implications of this transformation of meaning of mobility, in the context of major issues related to globalisation, flexibility and work life balance. These issues are extremely important given the pan-European objectives of enlargement, integration and collaboration, and increasing competition from the emerging economies.

**Table 1-1: Mobility: traditional view and MOSAIC vision**

	Traditional view	MOSAIC vision
Mobility concept	Mobility of the individual, in different forms e.g. teleworking and working on the move	Mobility of individuals and collaborating teams, work and workspaces
Thrust	Supporting mobile working within existing process boundaries	Carry out work at place and time according to need
Values	Individualism, organisational efficiency and benefits	Work-life balance, sustainable development, societal benefits
Work environment	Individual work <b>place</b> , supporting people on the move or at different locations in carrying out their work	Collaborative virtual work <b>space</b> , adapting to context and enabling work to be carried out anytime and anywhere
Work	Mostly oriented to communication activities and access to information	Oriented to all primary and secondary aspects of work and to collaborative working

Thus, MOSAIC’s understanding of mobility is embedded in a vision of the “networked, virtual workspace”, supporting the worker and work independent of time, place and other constraints. Rather than on “worker mobility” MOSAIC focuses on “mobility of the work environment” according to the needs and demands of the worker and work.

In MOSAIC, vision development is not a starting point but it is itself the result of the process of scenario development, assessment of the current state (including existing work practice as well as the technological state of the art), identification and analysis of the gap between current state and future vision, and roadmap development to present foreseen solutions. The vision also recognizes the different stakeholder interests regarding new ways of working, e.g. employee and employer issues. The vision is not equal to the “expert expectation” of what the key trends will be, nor is it a futuristic phantasy. Rather, it represents the strategic objective at the European level: “where to go”.

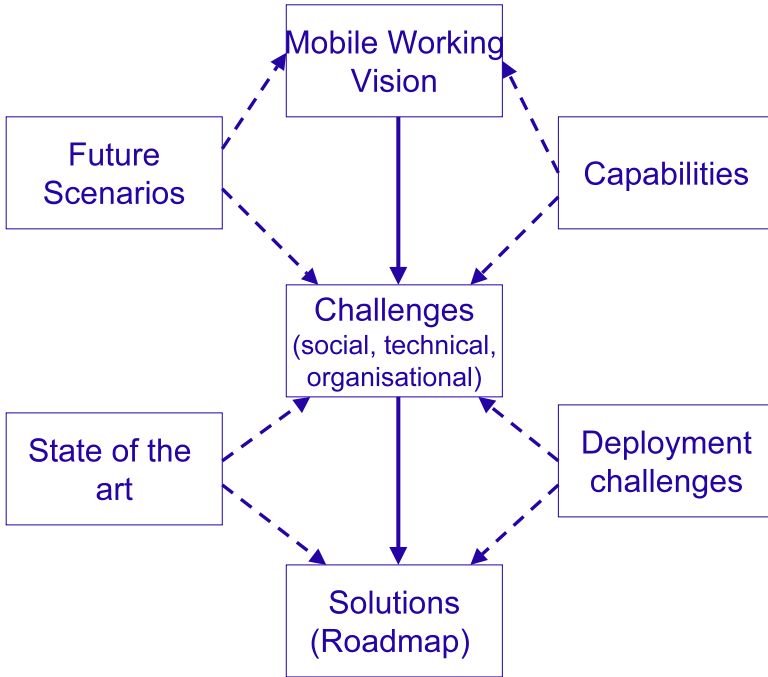
Table 1-2: MOSAIC Vision Summary, based on web-polls

	Vision
Social, legal, regulation and business aspects	<ul style="list-style-type: none"> <li>Europe can exploit mobile workspace innovation to increase competitiveness</li> <li>European integration and cultural diversity forms a sound basis for collaborative culture</li> <li>Mobile workplaces will support the agile, intelligent, smart organisation, will support smart product innovation, and will contribute to European competitiveness.</li> <li>Employment regulation will change towards more flexible work</li> </ul>
Mobility and (organisational) work settings	<ul style="list-style-type: none"> <li>Workspaces allow mobility of work and mobility of the workplace rather than mobility of people</li> <li>Workspaces allow work to be carried out collaboratively at anytime and anyplace</li> <li>Workspaces are context-aware, enabling the worker to switch easily between collaborative work context settings</li> <li>Increasing constraints for realizing full individual mobility will put attention more to multi-location work.</li> <li>Workplaces will have plug &amp; play capabilities</li> <li>Collaboration in shared workspaces will grow in importance</li> </ul>
Human interaction with mobile applications, and human aspects in mobile and collaborative working	<ul style="list-style-type: none"> <li>Workplaces become people- and network-centric instead of coordinating organisational processes</li> <li>The need for flexible work arrangements will increase considerably</li> <li>Social, learning and work aspects will integrate more and more</li> <li>Collaboration among distributed competencies will increase</li> <li>There will be growing emphasis on recruiting “on demand” independent experts</li> <li>Professional communities will be the way to develop careers</li> </ul>
ICT aspects (applications, services, service infrastructure, networks, devices)	<ul style="list-style-type: none"> <li>Ambient and context-aware, interoperable technologies are enabling human-centred collaborative practice</li> <li>Emergence of semantic-based applications</li> <li>Middleware for context awareness and semantic integration of services</li> <li>On-demand collaborative workspaces</li> <li>Standardised interaction between mobile devices and their environment</li> </ul>

MOSAIC has validated the proposed vision through web-based polls and through validation workshops, discussing the results with important stakeholders. A summary of the MOSAIC vision is presented in Table 1-2, and more information is given in Chapter 2. The four depicted dimensions of the vision are: Social, legal, regulation and business environment aspects; Mobility and collaborative work settings; Human aspects in mobile work, including human interaction and understanding; ICT aspects (applications, services, platforms, networks, devices). This vision on the one hand provides a normative view in terms of desirability and priority setting, whereas on the other hand the vision recognizes diversity in future work environments and diversity in stakeholder interests.

### 1.3 APPROACH OF MOSAIC

Key steps of the MOSAIC approach in developing the strategic roadmap are (Figure 1-1):



**Figure 1-1: MOSAIC Approach**

1. Development of a strategic vision regarding the future of mobile working to recognize the different viewpoints and interests and to provide a means to establish consensus among stakeholders;
2. Elaboration of the vision through the construction of future scenarios of mobile and collaborative working in order to scan future opportunities and learn about driving forces and human behaviour in coping with the scenarios. Scenarios are developed at the generic level as well as the sector level;
3. Assessment of current practice and state of the art of mobile working to find out where we are now, and what the currently experienced bottlenecks and needs are;
4. Evaluation of the technical, human, organisational and societal challenges in future scenarios, defined as RTD themes that must be addressed to cope with scenarios and realise the vision;
5. Identifying the potential solutions for the short and longer term and an RTD agenda for mobile and collaborative working, and representation of the solutions in a strategic roadmap; which is developed again at the generic as well as at sector level;
6. Assessment of the capabilities and deployment challenges, including the availability of critical factors like technology and knowledge, collaborative culture, and actors leading innovation and change, which is required for implementing the strategic roadmap;
7. Proposing joint collaborative projects, in which RTD challenges and deployment challenges are addressed.

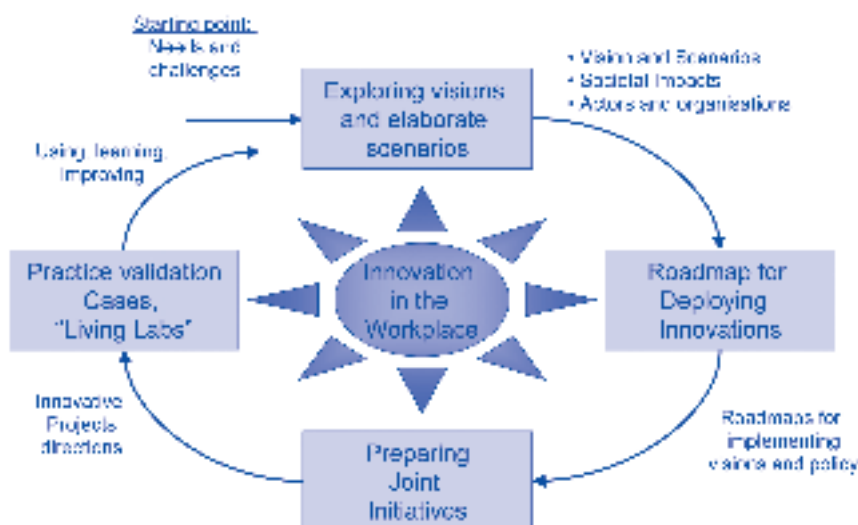
MOSAIC thereby has been working at different levels of analysis:

- The strategic roadmap level, addressing policy developers and key business and research stakeholders, presenting the broad lines of scenarios, challenges and solutions into a strategic roadmap
- The detailed roadmap level, looking at the more detailed technical, social, organisational, human challenges specified in RTD themes and foreseen solutions.
- The sector roadmap level, looking at the specific circumstances in sector domains and thematic issues (engineering, health, rural and regional working), including the domain-related deployment challenges

Several past roadmap projects dealing with new forms of organisation and collaboration such as the collaborative enterprise roadmap (CE-NET, 2004) and the virtual organisations roadmap (Camarinha-Matos and Afsarmanesh, 2003) have adopted an approach which is based on the steps of assessment of the current situation, development of a future vision, analysis of the gap between actual situation and future vision, and setting out the research needs and translating that into a roadmap of foreseen solutions. Other approaches like the ITEA roadmap on software-intensive systems (ITEA Office, 2004) start with developing scenarios describing the potential evolution of application domains, and then identify the technological challenges within these scenarios and technological requirements to implement the scenarios, finally clustering the results of the scenarios to outline the likely evolution of technologies and applications.

MOSAIC starting point was a vision about the importance of future ways of mobile and collaborative working for Europe, for the purpose of to stimulating awareness and consensus among business and societal stakeholders. We developed future scenarios about mobile working as a mechanism to learn about the underlying driving forces and uncertainties, which are shaping the future work environment. Our assumption also was that different workspace scenarios will co-exist and therefore we fully recognize the diversity of future work environments. Rather than to propose one direction, MOSAIC has used scenario construction to explore the space of a diversity of future workspace environments. We have done so to understand the strategies of human and organisational behaviours in these scenarios including the conflicts that might arise, and to learn about the driving forces and uncertainties. In thinking about the human, social, organisational and technological challenges and RTD needs as they form part of the scenarios, a more complete picture arises of the conditions that must be realized in order to implement the scenarios and thus a more complete overview of the elements of a strategic roadmap.

MOSAIC, through its linkage with AMI@Work communities, thereby intended to act as a breeding ground of new ideas, through the discussion of visions, scenarios, potential solutions and validation issues with business, societal and research stakeholders and in doing so through the preparation of new joint initiatives. Figure 1-2 visualises this.



**Figure 1-2: MOSAIC Breeding Ground**

Through discussing the strategic roadmap within the AMI@Work communities and with a large group of representatives from industry and academia it is aimed to create a realistic and broadly supported innovation agenda. This agenda aims to assist decision makers and technology providers throughout Europe in making strategic decisions for systemic innovation in mobile collaborative workspaces.

#### 1.4 STRUCTURE OF THE BOOK

Throughout the book, our analysis takes place at two levels: the generic level of societal trends and impacts of mobile working, and the level of specific domains, in particular those of engineering, healthcare and wellbeing, and rural and regional working.

In Chapter 2, we provide an overview of broad trends and developments shaping the future workplace. Besides generic developments taking place at the societal level we describe sector specific trends and their implications for business, with examples from manufacturing and healthcare. Additionally, a short overview of technological trends is presented.

In Chapter 3 it is described what the current practice in mobile working is, and an overview of the state of the art in mobile technologies and applications is given including an analysis of bottlenecks and opportunities for innovation. The chapter describes the emerging introduction of mobility and networking aspects in work environments. A selection of case studies of current practice in mobile working is discussed, and an assessment of these cases is provided. The chapter concludes with an evaluation of the short-term opportunities for wider adaptation of mobile and collaborative working.

We are taking a look to the future in Chapter 4, to explore the future vision of mobile working, and to present scenarios of mobile and collaborative working in various domains. It analyses the challenges inherent in these scenarios and paves the way for a broad roadmap for research and innovation challenges. MOSAIC has developed a diverse set of scenarios for future mobile and collaborative workspaces, and such scenarios serve as a stimulating framework for thinking about innovation and change and addressing human issues.

The strategic roadmap for mobile and collaborative working is presented in Chapter 5. This roadmap covers different areas of research and innovation, and proposes 'landing places' for innovative forms of future mobile workspaces for time periods 2006-2007, 2008-2009 and 2010-2013. Based on the roadmap, a detailed overview of technological, organisational and societal challenges for research and innovation is presented. Annex 1 presents some specific scenarios and deployment strategies that MOSAIC has been investigating for the domains of engineering, health and wellbeing, and rural and regional working.

Chapter 6 turns to the societal level to discuss the broader societal conditions for innovation and to propose strategies for change. In order to exploit the potential of workspace innovations we must better understand their systemic nature. The chapter describes how to build innovative arenas for dialogue between participants from different backgrounds and perspectives, and proposes strategies for change at societal and work organisation level.

Finally, in Chapter 7 conclusions and recommendations are given with regard to innovation opportunities, deployment challenges, an agenda for innovation, and the activities required in order to implement the agenda.



Pervasive forces such as increasing globalisation and competition, demographic changes such as an ageing population, the European enlargement, and the emergence of networked forms of organisation are affecting the nature of work and the adequacy of existing forms of work organisation. A diversity of work environments is developing, ranging from the creative environment of networked professionals using the Internet for a variety of activities to environments characterised by standardised work processes at physical places. Technologies such as the Internet and broadband networks, mobile and wireless services, collaborative and shared workspaces and software infrastructures allowing distributed working clearly play an important role in enabling creative and productive workplaces where people can work together efficiently and effectively while being more independent from time and place. However, the outcomes in terms of workplace innovations that will succeed or fail depend primarily on how we are able to cope with the human, organisational and social aspects of work. New problems are showing up in attempting to use the new technologies. Among them are distortions in work-life balance, difficulty to cope with different styles of working and organising, management and leadership issues in coordinating distant working, long working times and stress due to the blurring of boundaries between private and working life, poor capabilities of time management, the rise of work-related chronic diseases, and an apparent stagnation in skills development (Dublin Foundation, 2004). Additionally, the interrelations between employment, work environment and health imply an increased risk for workers who are not able to enforce healthy work environments.

Starting with a categorisation of mobile workplaces, this chapter highlights some of the trends shaping the future of work, sketches out their implications at the sector level, and reflects on the way systemic innovations could succeed. We also present the results of our survey into future mobile workspaces.

## 2.1 THE IMPACT OF MOBILITY ON COLLABORATIVE WORKING

Our initial focus is on the role of mobility in collaborative working and on the transition between traditional ways of working and mobile collaborative workplaces. Collaboration clearly is the key to most of current work practice. However, effective collaboration is difficult to achieve and depends on a number of interdependent factors. In case of mobile working, new factors come into play. Access to mobile technology is not enough on its own, and to be truly effective, organisational structure and support as well as effective collaborative behaviours are equally important. Figure 2-1 gives an idea of some of the factors that will need to be considered to have a good chance of success.

The new ways of working are within the context of virtual organisations. These organisations are often formed for the duration of projects and are then dismantled. Particular challenges for engineering are characterised by access to large databases such as product breakdown structures and geometries, product data management systems and workflow, analysis and modelling tools. This has driven the development of new collaborative and mobile technologies to allow work to be done in this way and to capitalise on the significant technological developments made in other domains, for example in mobile and wireless technology, GRID computing, and collaborative workspaces.



**Figure 2-1: Factors affecting collaboration in dispersed teams of mobile workers (Carver and Leggatt, 2002)**

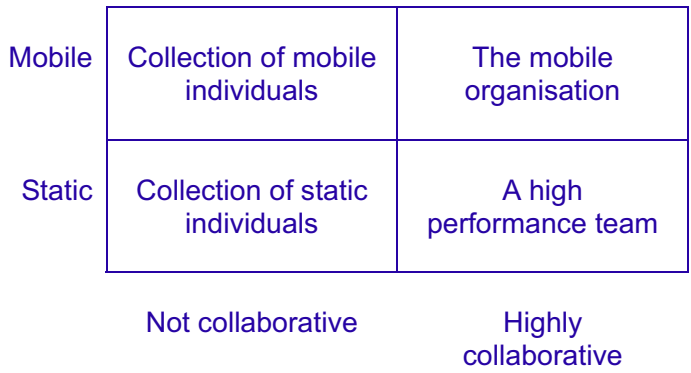
The transition between traditional ways of working to mobile and multi-location ways of working presents risks as well as opportunities to do things that could not be done before. It is necessary to understand the requirements for working in a more traditional environment to understand what the impact will be when elements of the working environment are changed. Even the challenges of collaborating when people are co-located are still not fully addressed, especially in a climate of competition. When teams become dispersed and mobile it is even more difficult. How can the technology replace the cues that are lost or how can new behaviours be trained if important elements are lost?

One way to cope with this challenge is to look at where the failure modes might be. For example there are many failure modes for e-mail, and e-mail is the most common form of communication for remote collaboration. Currently there are technologies supporting collaboration to varying degrees: for example voice and video links, e-mail access and use, shared working spaces, conferencing tools, document repositories, tools for presence and situation awareness, calendaring tools. However, a holistic and integrative approach to the impacts of mobile working is required in order to understand the risks and failure modes of the new ways of working, to and to understand the requirements for collaboration in the context of a changing environment and informal networks. There is a significant challenge in managing the transition between static and mobile ways of working and the various hybrid working scenarios that are particularly prevalent at the early phases of new technologies. In order to introduce mobile and collaborative working.

## 2.2 MOVING TOWARDS MOBILE AND COLLABORATIVE WORKING

What is mobile working, and what is a mobile organisation? What are the key issues in introducing new forms of mobile working? A mobile organisation could be described as an organisation "...where people, processes, technology and management support work (are) done anyplace/anytime" (Neal, 2004). This is a good description but does not indicate the variety of options that are possible particularly with respect to groups and teams of people who need to collaborate with each other and to access data, information and tools to support their activities.

The mobile organisation has to support not only individuals but also groups and teams who need to collaborate. In Figure 2-2, the true mobile organisation is described as highly collaborative, but acknowledges that co-located high performance teams are also important for success. A flexibility of approach is required that aims to support the collaboration process, to reduce unnecessary travel without creating further challenges for individuals, to enable people who are away from their 'home base' to carry on being effective and to allow individuals to make the best use of the time available to them to carry out both work and home commitments.



*Figure 2-2: Collaboration and mobility*

Ideally, the mobile organisation from an ICT perspective can be seen to have the following attributes:

- **No fixed working space.** Working in the office is just another place for the worker to work and access to the network is available wherever he or she happens to be. Moreover, instead of the architect being in charge of creating a collaborative environment, the applications architect is now responsible. However, since 'office' spaces are now 'shared' spaces, and may be used for many different activities, considerable care still needs to be taken in designing workspaces in buildings. If the home becomes a workplace too, equal attention should be paid to the design of that environment. There may also be running cost implications for workers working in places other than the traditional 'office', for example Internet connections, dial-in facilities or additional printers.
- **Internet-based processes.** Processes are designed to be useful and accessible by both mobile workers and co-located workers, and administrative forms and procedures are available in electronic form, with applications using the HTML-based browser.
- **Mobile technology.** Technology is used seamlessly to enable anyplace/anytime work. Different sorts of mobile devices can be used, and the choice of device is driven by user requirements rather than an organisation wide decision. Mobile devices are always on, are always connected, have rapid response rates and reliable connectivity, are light, small and non-intrusive, and most of all are not prohibitively expensive. Diversity of devices will incur costs, both in the hardware itself and in maintaining the skills and knowledge to support different systems and of course in the provision of 24hr support. The business plan needs to consider these elements and elaborate how the provision of technology will save costs and improve effectiveness. The positive aspects include more effective use of time, reduced down time, high levels of availability and employee satisfaction if they can be in better control of the way in which they achieve their goals. It is also important to consider some of the

potential negative aspects too – these might include time clock changes - for example the time taken to reach decisions or complete processes, there is additional pressure to ensure that contributions have been made and views considered, and not least the challenge of ensuring that there is understanding across the team, adequate situation awareness of the activities and requirements of the team, and no isolation of individuals.

- **Management of mobility and mobile working culture.** The organisation recognizes that mobile teams have different requirements and train their managers to motivate and manage mobile teams. Additionally, the organisation appreciates issues of privacy and accessibility and develops protocols to help workers maintain a work-life balance. One step further would be the acceptance of a mobility culture: mobility being the norm, not exception.

Many of the principles for a mobile organisation make sense for a more static or at least a mixed organisation too. But a mobile organisation is not just a collection of people with laptops, cell phones and pagers allowing people to take their office home after the “normal” working day. It is also not just a group of mobile workers bolted on to the standard organisation. However many organisations will not see a requirement to be entirely mobile and people may not work exclusively in one way all the time – this can be driven by individual preference, work life balance, or driven by project or task requirements. The role of the organisation and the type of work undertaken will also affect the type of choices of working environments open to an individual. The degree of choice is extremely variable across different industries, from engineering to telecommunications, and across domains from service industry e.g. health, consultancy, finance and insurance, to farming and other rural occupations.

Mobility leads to changes in working practices - as well as new terms and conditions. These might include expense account changes i.e. mobile phone charges, remote connection charges, teleconferencing costs, video conferencing costs, attribution of cost to project versus overhead, costs for IT support 24 hours per day, additional costs where IT devices are not all standardized, and potential health and safety considerations where employees are working outside the ‘normal’ working environment. In offering the flexibility to work at home or wherever is appropriate for the individual, the organisation also needs to address the risk of making team members feel isolated, unaware and not engaged in the process. Co-located team members may also exhibit virtual characteristics, for example, people using e-mail to talk to someone in the next room, or sending texts to someone in the same room.

One often cited business goal is to 'improve productivity by leveraging knowledge'. This is potentially even more difficult if the organisation is virtual and its employees mobile. However the challenge is realizing this and using the very mobility to create social networks and to build rich knowledge and information flows across the organisation. Leveraging knowledge across a dispersed organisation is often difficult if not impossible - not only because of the technical difficulties but also because of the politics and negative sharing ethos where knowledge still represents power rather than the other way round – i.e. sharing the knowledge creates the power.

The socialization of knowledge, that is, the direct exchange of ideas in conversations and other interactions, both planned and unplanned, speeds up the exchange of knowledge allowing organisations to get more value from it. However, this takes place most readily when people are located in the same physical environment. With more mobile communities, it is still important to consider this requirement in the physical design of work spaces and to acknowledge different spaces are required for different types of work (Duffy, 1997). Spontaneous interaction and ad-hoc

meetings decrease as distance between people increases but these spontaneous meetings have significant value. It is often only when we perceive a colleague that we think of issues that they can help us to solve, or even help us to frame the right questions to ask. Ambient intelligent systems bringing computing power everywhere, but in the “background”, may be one way of trying to support and facilitate these spontaneous interactions, but there may need to be cultural changes and training to enable individuals to succeed. Changes to the physical working environment and solutions linking the virtual world with the physical show promise but are as yet immature in their implementation. We need to think now about the impacts of these new environments and to consider how they might be integrated into new processes and organisational structures.

2.3 CATEGORISATION OF MOBILE WORKING

As there is a lot of innovation in work environments going on, any categorisation is limited. Are we describing current forms of mobile working based on worker mobility, or future ones based on the ability to work anywhere and anytime? Are we talking about (physical) workplaces, or about (virtual) workspaces? Current working environments and new technologies show that that we are on a transition point towards the future. In order to be able explore strategic research and innovation issues, we must confront current mobile working practice with the now apparent future trends in order to explore the diversity of aspects in mobile work and workplace mobility.

We distinguish between four types of working environments, using the dimensions of mobility (frequency of changes in location) and work location (Figure 2-2), and discuss shortly the impact of ICTs and the implications for collaboration and mobility.

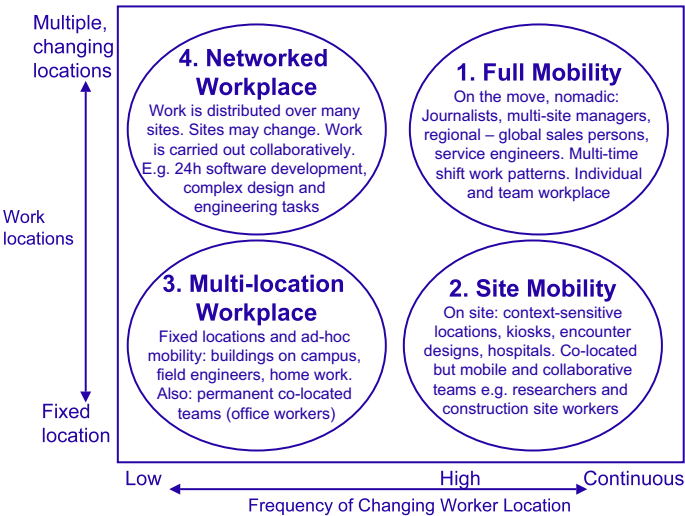


Figure 2-2: Mobile working environments categorisation (Schaffers, 2005)

1. The “full mobility workplace” describes a situation of mobility-intensive jobs, in terms of worker mobility and in terms of changes in work location, for activities such as maintenance, sales or consulting. Its widespread introduction may be more constrained in the future because of limits to physical infrastructure and also for work-life balance reasons. Collaboration is limited to bilateral communication-oriented tasks of short duration.

2. The site mobility or “micro-mobility” workplace denotes mobile workers in geographically restricted areas like hospitals, schools, offices and campuses where individual work locations. Collaboration is characterised by frequent face-to-face contacts in different settings (individuals, groups) in combination with bilateral electronic communication and group conferencing.
3. The multi-location workplace covers a situation where work is carried out at fixed locations, synchronous or asynchronous. The worker is travelling to such a location or a location is the home base of the worker. An example is distributed design review in aerospace engineering, supporting multi-functional teamwork and bringing in multiple competences in judgment and evaluation.
4. The networked workplace is characterised by limited physical mobility and at the same time the ability to work at many different locations. It might be a valid model for the future collaborative workspace and is not yet fully realised in practice. Current forms are diverse, covering working in hotspots and working distributed over many sites e.g. for collaborative R&D and software development.

This categorisation covers many of the current forms of mobile work, such as working away from a fixed location in temporary workplaces (e.g. the field worker), or teleworking as working in two different but fixed locations, or working at constantly changing places like hotels, train stations and airports (See Lilischkis, 2003).

## 2.4 TOWARDS FUTURE WORKSPACES: DRIVERS OF INNOVATION AND CHANGE

The realisation of more flexible, networked working environments termed “future workspaces” presents complex challenges in terms of new technologies, organisational arrangements, working behaviours, the nature and functioning of organisations, and societal structures and policies. Because of the many interlinked aspects involved, such innovations can be termed “systems innovations” and in order to succeed and to be absorbed in practice they require “systems changes”. Mobile working has not only to do with worker mobility, but also with mobility and/or flexibility of the work, the workplace and the organisation. Increasingly, it is the adaptive and networked organisational form, responding to a continuously changing business and societal environment, which becomes the future workspace that should provide the proper level of flexibility.

The EUFORIA Delphi (Popper, 2003) suggests that dominant trends in the knowledge society such as new forms of business organisation, the use of electronic networks for remote supervision, and increasing family stress and conflict affect negatively important aspects of working life resulting into loss of social cohesion, increasing social exclusion and deteriorating work-life balance. Workplace innovation requires us to face transition issues and uncertainties inherent in the development towards new working environments, such as the acceptance of particular styles of work, the quality and health aspects of work, and the networked forms of organisation and managing.

MOSAIC perceives three strands of drivers with critical influence on the future of work organisations. They relate to a set of interrelated developments: technological progress, economic and business trends, as well as behavioural and societal trends.

### Technology factors and decreasing cost of usage

Several technological trends are affecting the future of mobility and mobile working (see Brugnoli, Davide and Slagter, 2005). Moore's law, stating that the computing power available for a given price doubles every 18 months, is expected to hold at least for the next ten years. At the same time, battery life is expected to increase in a rapid pace. The telecommunication technologies that are expected to be dominant in the next ten years are mobile telephony (GPRS, UMTS) and various generations of WiFi. The existence of roaming contracts between many European mobile operators is an important enabler for mobile access to business services from anywhere in Europe. The various mobile access technologies will be available at competitive prices and offer the user an increasing amount of bandwidth and different Quality of Service levels. At the same time, the current heterogeneity of access technologies is likely to exist for the coming period of time as different access technologies have different advantages, such as high bandwidth or large coverage.

Another relevant trend is the migration towards all-IP networks: the current mix of IP (Internet Protocol) networks and circuit-switched networks, such as the current (fixed) telephone network, is likely to converge into multi-purpose all-IP networks. The availability of such networks facilitates the convergence of services, for instance allowing voice-over-IP calls to be placed to a mobile phone.

The next generation mobile technology will establish 'always-on connectivity' in combination with flat rates offered by operators. This will greatly stimulate the usage of new types of information applications like anytime-anyplace communication. Increasing mobile bandwidth and processing power are expected to support the development of more secure and user-centric work applications. Mobile applications will be coupled in a secure way according to the user's profiles, work context and availability to produce smart applications. Fuelled by the expected cost reduction in devices and network usage, presence awareness (ambient intelligence), instant messaging and audiovisual communication will be important drivers for convenience of real-time mobile groupware applications. Mobile Voice over IP (VoIP) applications will allow users to communicate with others using their handheld devices while sharing information. A current example is Skype going to launch specific new kind of mobile phones that will use VoIP.

A viable trend, which is also enabled by the increasing computing power, refers to the fact that devices like notebooks, cellular phones and Personal Digital Assistants (PDAs) together with position detection sensors converge to one integrated smart tool. Key actors in this area will be, first, the device manufacturers; second, the network operators installing hybrid networks including necessary gateways; and third, the operating system developers as mobile applications will become part of the operating system of mobile devices.

An open question is left how the end-to-end security with respect to mobile support applications will be enforced. Due to the limitations in current security solutions, organisations still are very reluctant to open their cooperation environments to others. Solutions will be based on secure access to information archives and databases, semantic-based knowledge repositories and other advanced functions in order to protect vulnerable infrastructures by sufficient trust and security. We expect a trend towards support for secure, ad-hoc collaborative mobile workspaces. The challenge here is to integrate trust and security into an architecture as well as into a middleware to facilitate trustworthy interactions between mobile workers and systems. Current R&D projects are working on improving security mechanisms based on more applicable algorithms and better functionalities, new approaches to meet computational demands



(e.g. Grid computing), more powerful hardware and software, delegation of tasks to dedicated servers, and trusted mobile platforms.

### **Increasingly sophisticated value adding networks**

Looking at the economic drivers affecting mobility, the future of mobile working seems to depend to a large extent on costs of transportation and travel. Although the steadily decrease of transportation costs has been a long-term trend, an increase in oil prices and costs associated with security measures and growing importance of sustainable development will probably result in an increase. There are many indications that in the long term scenarios (>5 years) fuel prices will increase due to oil price development, rapidly increasing demand from Asian countries and political instability of many of the world's largest oil producing areas. In other scenarios the cost of fuel could be increased by environmental concerns. In the specific case of air transport, the effects of increased fuel costs could be compounded by security costs (anti-terrorism), cancellation or reduction of the state subsidies, and taxation of transport organisations (e.g. carbon tax). In these scenarios, the increase in costs will be long term and is likely to provoke a major reduction both in long and medium range mobility (by air) and in short range mobility (by road). This is likely to lead to a reduction of business travel, leading to a potential increase in virtual collaboration and mobilisation of work.

Closely related to the technical advances mentioned earlier, we are witnessing the continuing sophistication of value adding networks. Value creation no longer happens in sequential chains but in multi-nodal and increasingly global value networks. As a consequence, network relations become tighter, the number and sizes of virtually collaborating teams increases and the mobilisation of work grows as well as the number of individual knowledge workers, often named eProfessionals. For individual knowledge workers this often means a more process oriented task structure, an increase of contact points and of roles to fulfil as they could be involved in different projects while being members of communities of professionals, communities of knowledge or communities of practices.

In the past, Enterprise Resource Planning (ERP) has focused on codifying processes such as sales, order processing and fulfilment, production and material planning, financial planning, logistics, and implementing them into ICT applications. Future ERP applications will increase flexibility to improve the integration of company spanning value chain activities and to extend the systems to mobile collaborative workspaces.

While the majority of interfaces today reach suppliers and customers, future structures will also involve public players as well as the wider stakeholder environment on e-enabled processes. The networked organisations will have to take into account local as well as global process requirements to become a seamlessly working “real-time enterprise” (Österle, 2000).

### **Behavioural and societal trends**

Unless the rise of teleworking and working on the move, most of the work today is still carried out in fixed locations, and during fixed time periods<sup>1</sup>. The more information-intensive, the better chances for work being carried out on a distance or mobile, and in collaboration with others. The decreasing cost of communication of remote information and increasing value of using remote information has stimulated the development towards decentralisation and networked

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<sup>1</sup> See the Collaboration@Work 2005 report, European Commission Directorate-General Information Society and Media (2005) for an overview of new working environments and practices in EU member states.

organisations to a considerable degree (Malone et al, 2003, and Malone, 2004). In increasing the opportunities for interaction, mobile and wireless technologies are providing a new generation of possibilities. But practical bottlenecks are many, and further innovation towards mobile workspaces requires new ways of working and time management, new ways of decentralised organising, new collaborative and information sharing behaviour of the worker, and also new styles of coordination, leadership, motivation and trust-building, and even new regulations at the societal level. As Table 2-1 shows, the actual work setting will be the result of a balance of forces operating at different levels: the work requirements, the worker needs, organisational factors, industry developments, societal policies, and technological opportunities and bottlenecks.

**Table 2-1: Forces affecting work settings at various levels**

Forces Levels of analysis	Forces promoting mobile workplaces	Forces hindering mobile workplaces
Nature of work	Task at hand requires more decentralization, e.g. distributed problem solving	Task requires more centralization of information and key experts
Human worker	Willingness for more flexibility, freedom, better work-life balance	Fear for more stress, more control, less human contact, trust issues
Team	Key experts are located at very different places	Key experts are located at same location
Organisation	Need for more flexibility and decentralization, complexity	Control and management procedures, leadership styles, culture
Industry	Globalisation of business activities due to worldwide operating competitive forces	Concentration of business activities to particular regions
Society	Offensive economic policies e.g. deregulation and liberalisation	Worker protection regarding working times, health and stress
Technology	Decreasing cost of communication, broadband networks, groupware, security	Problems in security and access management issues

Mobile collaborative work, enabling flexible working, could considerably increase productivity due to the fact that knowledge workers will have less need to travel every day to and from their office. This will allow to save many travelling hours that will be used for value added work, social networking, continuous learning and for private life as well. However, travelling to professional events will not disappear at once, especially because face-to-face meetings are often a prerequisite for ensuring a good level of relationships and trust among collaborative workers. Nevertheless, the potential reduction of daily travels to work office could have a positive impact on city environmental situation on both car traffic and air pollution. The other positive impact is that workers will not be any longer tired by spending hours in transportation systems, nor so much stressed by transportation period and depressed by transportation strikes.

The growing connectivity and information ubiquity in new work environments implies an increase of work complexity. The number of organisational interfaces, the globalisation of business relationships, and the digitalisation of information will increase the burden for knowledge workers. They will be required to accomplish additional roles and fulfil changing job profiles in a more process oriented business environment. This will increase complexity, besides the already existing information overload. Future ICT collaboration and business platforms will need to be designed in a more user friendly and automating way in order to reduce search and transaction cost. The improved usability design can evolve as another key driver for increasing adoption of new work technology (Gates, 2005).

On the one hand, complexity will undoubtedly increase whereas new technologies will considerably increase potential connections among people sharing common interests, especially when thinking about connecting people through the concepts they use and share. This will clearly lead, as shown by the actual trends, to an exponential increase of the development of on-line communities and social networks where everyone will need to spend part of his time, probably in replacement of the tiring transportation.

An additional phenomenon, that is not only relevant to less-developed countries but also to, for example, the new member states of the European Union and even to the relatively more prosperous Western society is the digital divide which also applies to emerging work environments. In many cases, digital divides equal social divides as well. In order to generate sustainable new work environments on a global scale, the requirements of elderly and handicapped as well as the ambitions and needs of new EU member states need to be considered.

## **2.5 IMPLICATIONS ON INDUSTRY SECTOR LEVEL**

It is instructive to look at different industry sectors to identify the critical factors in a sector affecting the mobility of the workplace and prospects for mobile working. MOSAIC has carried out analyses of the conditions and prospects for mobile working in several sectors, and circumstances are different. In particular we must take a look at the inherent mobility of production assets (in design, engineering, production, maintenance environments), knowledge assets (skills, experts), and the work it serves (including the subject of work, which could be people like in healthcare, or material goods).

### **Electronics and automotive industry**

In manufacturing sectors such as electronics and automotive, shorter product life cycle require new capabilities to deal with a situation of faster product development and rapid switching between product families. Forces of global competition are increasing the pressure on OEMs and their suppliers to become more cost effective and flexible. As a result suppliers become more cost effective and more collaborative and are eager to gain positions in global collaborative value networks. Overall, the complexity of the product and of its handling has enormously increased compared to a few years ago. To cope with this situation, the organisation of the product development process is changing. To be able to handle the holistic view of the product development process and the geographic dispersion of actors involved, companies are experimenting with distributed forms of the design and engineering process. The organisational implications are a trend towards ad-hoc collaboration processes, robust control and supervision system (with corresponding workspaces) and adequate inter-related workspaces for each type of engineering activity.

### **Aerospace industry**

The aerospace industry to a growing extent is organised as a distributed virtual organisation, which has complex characteristics compared to other sectors. Such characteristics include number of partners (i.e. Airbus network), complexity of the product (number of components and related disciplines), size of the organisation (OEM, risk-sharing partners, suppliers, sub-contractors, etc), long lead times, and huge capital sums for developing products. For example, Airbus has about 150 sites throughout the world with distributed manufacturing facilities in France, Germany, UK and Spain. As a result, this sector needs efficient collaborative tools and processes to work as a distributed virtual organisation. In the aerospace sector the situation is different from automotive as operation and maintenance is a crucial business

process and mobility its natural characteristic because of the inherent mobility of aerospace assets. Mobile applications for ground personnel involved in servicing and supporting aircrafts are not just communication oriented but are related to the primary processes of diagnosis and repair. As regards design and engineering the same situation as in automotive exists and mobile applications could enable networked teams to work on digital mock-ups.

### **Building and construction**

For the building and construction industry, mobile technologies can play a crucial role in order to increase communication among workers, organize work more efficiently and reduce process cost. This industry is characterised by dispersed teams that jointly work on the development of a new site, sometimes not belonging to one and the same company, without being able to use fixed line infrastructure and having high mobility/travelling requirements on site and between sites. This provides substantial opportunity for mobile communication. In the mobile data arena, mobile field applications are becoming crucial in this industry whereas the machine-to-machine applications are a further strand of development. Machines like elevators, heating systems and security systems will be equipped for ongoing communication with central surveillance systems, ensuring continuous controlling and monitoring and data availability for maintenance and security reasons. Although the industry has started in the mid nineties to centralise the development and standardisation of e- and m-technologies, the current state of the industry still needs to overcome structural challenges in order to allow stronger penetration with mobile technologies.

### **Health and wellbeing**

Finally in a service-oriented sector such as the healthcare sector there are pressures for change from the inside (continuing innovation expanding the available methods and tools, increasing organisational complexity) and from the outside (increasing demand for citizen empowerment, need for cost reduction, evolving implications of demographic changes like ageing). These changes in the framework conditions have led the healthcare organisations to look into new ways to organising and delivering health services. Information technology has a central role to play in the reorganisation of the healthcare service delivery environment by facilitating and enabling new trusted and secure ways of working, collaborating and sharing of knowledge. For example, IT-supported work processes enable virtual workspaces for health teams, provide healthcare professionals with access to relevant case data and knowledge in order to identify issues and therapies, and enable patients and healthcare professionals to discuss second opinion by making available patient multimedia data. The healthcare sector also provides a challenging validation environment for mobile applications.

From this overview it can be concluded that circumstances are quite different as regards the key factors determining success of mobile workplaces (Table 2-2). Mobility of production assets, of knowledge assets (workers), of the work it selves (and of the subject or subjects of work) are different across industry sectors. In aerospace the key assets, aeroplanes, which are also the subjects of work, are mobile thus requiring mobility in the knowledge assets (workers) in particular those related to maintenance and operations. In fact the work it selves is mobile by nature and the workplace (including knowledge assets) must follow the work. In healthcare, the subjects –patients – are to some extent mobile (while travelling) but more important they are highly distributed over different locations sometimes concentrated in areas (villages, cities) whereas the healthcare assets (hospitals, equipment) are fixed in buildings and whereas the healthcare workforce in particular in crowded areas is available near the patients. In building and construction, production assets are mobile and workers must be mobile at the workplace.

Construction work procedures are required to be replicated at very different locations but predominantly within a geographical area.

**Table 2-2: Mobility-related factors determining potential success of mobile workplaces**

Sectors	Mobility demands	Implications for mobile workplaces
Automotive	<ul style="list-style-type: none"> <li>Design and engineering skills are scarce and costly</li> <li>Production assets are concentrated, maintenance assets are distributed</li> <li>Cars are mobile and distributed</li> </ul>	<ul style="list-style-type: none"> <li>Mobile workplaces add value in maintenance processes (on travelling)</li> <li>Distributed workplaces add value in design and engineering process</li> </ul>
Aerospace	<ul style="list-style-type: none"> <li>Key business assets are also subject of work and are mobile in nature (the work is by nature mobile)</li> <li>Design and engineering skills are scarce and costly</li> </ul>	<ul style="list-style-type: none"> <li>Mobile and distributed workplaces for maintenance and operations are critical for business success</li> <li>Distributed workplaces add value in design and engineering process</li> </ul>
Building and construction	<ul style="list-style-type: none"> <li>Production assets are mobile</li> <li>Workers must be mobile at the workplace</li> <li>Skills are mobile and location-independently available</li> </ul>	<ul style="list-style-type: none"> <li>Mobile workplaces add value where the mobile worker is supported at the workplace location</li> <li>Distributed workplaces add value in design and engineering process</li> </ul>
Healthcare	<ul style="list-style-type: none"> <li>Subjects (patients) are mobile and distributed over many and changing locations</li> <li>Skills partly are available near patients, partly available at fixed locations. Experts are relatively mobile.</li> <li>Assets are fixed at particular locations</li> </ul>	<ul style="list-style-type: none"> <li>Mobile and distributed workplaces are critical as the subjects of healthcare are inherently mobile and distributed</li> <li>Distributed workplaces add value in those cases where assets (equipment, critical skills) are relatively scarce and bound to locations</li> </ul>

### 2.6 PROSPECTS FOR INNOVATION

#### From mobility support to networked and virtual workspaces

The introduction of new mobile collaborative work environments in practice attracted the attention of scientific researchers from various research disciplines, such as information systems research, management research as well as social theory and architecture and design. So far, research on mobile work is in its early stages and definitions and concepts of mobility are still emerging. Early work has focused on the geographical or spatial mobility of workers (Lilischkis 2003, and Perry 2001), which is criticised for being a too narrow focus (Sherry and Salvador, 2002). Andriessen and Vartiainen (2005) extended the concept of mobility to virtual mobility, which includes stationary actors moving "with the help of ICTs in a virtual working space". This is much related to the MOSAIC concept of networked, person-centric workspaces. Kakiyara and Sørensen (2004) postulate three interrelated aspects of worker mobility: location mobility concerned with the workers' extensive geographical movement, operational mobility in relation to flexible operation as an independent unit of business, and interaction mobility associated with their intense and fluid interaction with a wide range of people. As such, aspects of collaboration can also widely change due to new qualities of ICT.

Gartner and MIT (2001) support the multi-mobility notion, speaking of the "agile workplace". For them "agile workplaces" represent the next important step in workplace evolution. The basic finding is that a workplace that is distributed and connected and that facilitates work anytime

and anyplace in a face-to-face or a virtual environment is a prerequisite of organizational success and survival. Additionally, the workplace agility means constantly improving work and the underlying infrastructure, involving both infrastructure flexibility and a focus on the work characteristics itself. The virtual mobility of work will support work processes to be carried out whenever and wherever needed. This will accommodate the need for more controlled work time usage and reduced travelling due to increasing transportation cost.

Breaking down the observation of increasing numbers of networked organisations to the workplace level reveals the need for collaboration support for teams and individuals. A networked organisation can be studied from different perspectives. Whereas the top-down oriented business transactions perspective is focusing on business processes within and across its constituting organisations and their result in terms of transactions, the bottom-up perspective is that of the human worker who is a member of temporary teams and projects. Both perspectives are valuable and complementary, but result in different approaches for developing process and organisational improvements and IT support. MOSAIC approaches the networked organisation by emphasizing the people-centric “networked workplace” and the “we-centric” services that will form the core of modern workplace support.

From a workplace confined to particular locations and fixed working times mostly, we now are accustomed to more flexible forms of working, allowing more flexibility in choice of where and when to work. However, current collaboration and teamwork applications have changed the way we carry out tasks. This leads to a flexible workplace model enabling a diversity of new forms of people collaboration that are more independent from location and time. The flexible workplace model is enabled by information technologies, which - if combined with new organisational and management processes - affect the structuring of tasks and collaboration and their dependence on context parameters in a number of ways.

- *Context independence.* The balance between tasks that can be carried out independent or dependent of task context parameters (time, place) is changing. Tasks increasingly can be carried out independent of time and place. In the extreme, tasks are carried out “anywhere anytime”.
- *Context awareness.* Tasks can be carried out context-independent and context-aware. This contributes strongly to opportunities for optimizing task execution. An example is the use of location information and personal profiles for mobile salespersons, or the use of presence information for organising real-time collaboration meetings.
- *Context switching.* Collaboration is supported in more diverse context settings, ranging from “same time and same place” to “different time and different place” settings, and even including unpredictable places and times (Grudin, 1994).

Table 2-4 categorises different types of workplace support according to the dimensions of time and place. Working in networked organisations requires the possibility to switch between different contexts and different applications. It should be noted that applications intended for a certain context are often unexpectedly (mis-) used in other contexts. An example is the chat-like use of email for the frequent communication between local users.

**Table 2-4: Workplace support categorisation (adapted from Grudin, 1994)**

Place	Time	Same	Different, predictable	Different, Unpredictable	Aware of Time
Same		Electronic meeting and brainstorming support	Newsgroups, notice boards Electronic project room	Room infrastructure	Electronic project meeting
Distributed, predictable		Video/audio-conferencing; Co-authoring, Co-designing	Group scheduling E-mail Co-authoring	Shared workspace Virtual community	Co-authoring Shared workspace
Different, Unpredictable		Presence-based audio-conferencing Distributed work flow / task flow management	Distributed asynchronous collaboration (e.g. mobile E-mail)	Process coordination	Wearable computing /PAN
Aware of place		Mobile audio-Conferencing	Presence and instant messaging	Mobile document access	Context awareness services

As regards current work practice, still most work activities are being carried out at fixed locations and fixed working times, combined with traditional forms of teleworking and working on the move. Current mobile working applications are largely limited to supporting mobile individuals such as sales representatives and managers. The element of collaboration is still lacking as it is subsumed under the practice of mobile communication. Essentially these are solutions for mobile workers, supporting mobility by enabling new and mobile forms of communication in combination with presence and location awareness information.

Mobile work can be interpreted in an even more challenging way by applying the dimension of “mobility” to work and to the workplace. Following this view, a workplace could be envisaged allowing work to be carried out anywhere and anytime. Such a concept would include the use of context information beyond location and time, enabling new forms of cooperative interaction and workspace contextualization (Schaffers, Ribak and Tschammer, 2004). This concept also emphasizes emerging new structures of collaboration. The “virtual team” consists of a project team of geographically distributed members who temporarily cooperate to accomplish a common goal. Such global virtual teams provide an opportunity whose challenges require organisational skills and sophisticated ICT support. However, the “team” as the entity of work activity, as assumed by most CSCW (Computer Supported Cooperative Work) models, may decrease in importance giving rise to so-called “intensional networks” (Nardi, Whittaker and Schwarz, 2002). In such a way, mobile and location-aware technologies together with broadband networks and groupware applications and embedded in new collaborative structures and processes provide much scope for exploiting the potential of decreasing cost of communication in enabling new forms of decentralisation and networked organisations (Malone, 2004).

### **Systemic character of innovation in mobile working**

Many aspects in the way we are working, and in our workplace infrastructure, are changing rapidly and continuously. The pace of change in wireless and mobile technologies is enormous, and there is no single trajectory. The change is not simply about technology; it includes social change, changes in economic structure, and demographic changes. We are seeing a move from vertically structured organisations in a hierarchical steering society, with fixed workplaces, to horizontal communication between people participating in network organisations, with only a few layers of management. This means that conventional approaches to management and organisation, and their associated technologies and processes, are being replaced.



Change can go in a number of different directions. At the European level, commitment to a set of European policy objectives is shared, and principles such as participatory democracy and democratic dialogue are crucial for realising change. Our tasks are complicated by the multifaceted nature of social change. We must recognize that the pace of change brings attendant problems, in the form of cognitive dissonance and stress, with widespread implications for economy and society.

Even the set of European assumptions is increasingly challenged, for example through the current debate on a Single market in Service Industries, and Enlargement policies. New information technologies, including mobile and wireless, have a central strategic role because of their impact on business models, workplace regulation and employment.

We must be aware of the complexity of issues surrounding innovation, once the dimension of social change is considered. The challenge is to engage the technologically driven perspective with discourses in, for example, quality of work, work organisation, healthy work, regional development and lifelong learning. Each of these should be understood as reflexive characteristics of societal change.

Work environments and work practice comprise a complexity of interacting aspects that together form systems: technology, skills, learning, worker behaviour, organisational processes and structures, societal conditions of legal and regulatory nature. If we wish to understand and influence the patterns of workplace innovation, the success and failure factors and the strategies of designing successful innovations, we should capture all aspects in a holistic, systemic way and address the different interests and capabilities of actors. We also need to find out what the instruments are that are capable to create systemic innovation. Here we need to find out what can be left to the market mechanism, and what the type of policy interventions and coordinated forms of innovation and implementation are. In short, what are the environments in which systemic innovation may succeed? As regards innovations in information-technology based applications, one of the key instruments that arise is the large-scale validation environment where all actors and interests come together to establish networks for experimentation and learning.

## 2.7 SURVEY ON FUTURE MOBILE WORKPLACES

We conclude this chapter with the results of a survey of “Future Mobile Workplaces”. This survey<sup>2</sup> has been conducted in an innovative way of consulting the members of the MOSAIC project network and AMI@Work communities about their opinions concerning future mobile workplaces through the combination of complementary polls posted on the MOSAIC website (see [www.mosaic-network.org](http://www.mosaic-network.org)). Looking at the resulting figures of this survey and more particularly to the social perspective, it appears very clearly that most of the respondents, close to 90%, are already convinced about the implementation of flexible work arrangements before 2010. In fact, it has already started based often on the motivation of costs cutting and increases of productivity (less wasted time with for example no need to travel everyday to the office as the knowledge worker could decide to carry on his tasks from his home office, customers or suppliers’ premises) as a benefit for the organisation and on gaining more freedom for employees in becoming self-organised. Surprisingly, a majority, close to 70%, do believe that

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<sup>1</sup> More details about this survey are available within the MOSAIC newsletter issue n°4 article entitled “Vision Survey and Workplace Effectiveness”, which is also available on the Library articles section of the MOSAIC website.

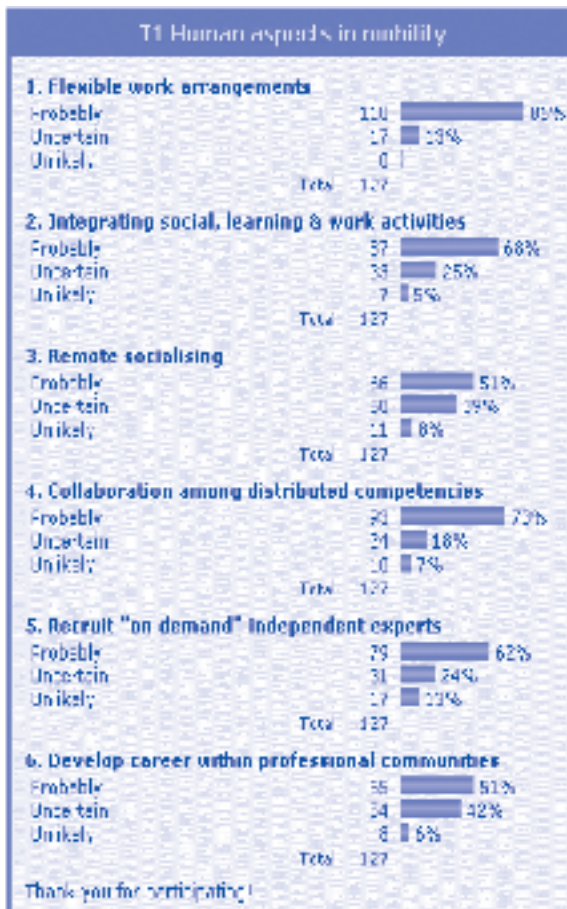
future mobile workspaces will better integrate social, learning and work activities. Especially because of the flexible working time, which allow the knowledge worker to decide to go, for social activities or learning breaks over the Internet whenever he needs it. Even more surprisingly, remote socialising is seen, by 51% of the respondents, as something that could happen before 2010. It seems there is a strong wish to get some kind of conviviality space, like the informal on-line discussion (coffee machine) area shared with his social networks colleagues, where they could have unplanned public or private discussions.

Collaboration among distributed competencies is also predicted, by 73%, as something that will happen while it is already becoming a reality. Recruit 'on demand' independent experts is gaining 62%, as part of the heavily required flexibility by organisations. This is something that could considerably reduce recruitment headache, as the contracted worker is not really recruited on basis of a fixed contract but rather for a short or medium duration depending on the needs.

Developing careers within professional communities has also reached the majority with 51% of respondents thinking it will happen before 2010 as means to increase employability. It is interesting to notice that only 6% do believe it will not happen at all. It means certainly that

people are seeing communities are a new motivating and stimulating form of organisation that is going to replace the traditional hierarchical management by control inherited from the army organisation. It is clear that communities' colleagues could be seen as an excellent support when searching for a job, especially because they know each other expertise and capabilities.

Nowadays, a traditional approach of workplace organisational models corresponding to different work styles is still appropriate. Nevertheless, there are new emerging practices introducing a new work style that could be named the "networked" work style, where knowledge workers are more or less permanently wireless connected with their peers and belong to several communities of practice or knowledge communities or even communities of professionals to serve either business or social purposes. They could be working from their home, from a customer or supplier's site, on the move in the plane, in the train, at their hotel, at the station, at the airport or anywhere else.



Actually, the foreseen main problem, beside organisational and social aspects, is to carry on various heavy equipments while network connection is not ensured anywhere. The Future

Mobile Workplaces survey did reflect perfectly these different points. About 90% of respondents are willing to get a new wearable computing device that integrates multimedia, telephony and computing in consumer's applications. More than 70% predict convergence of networks and IP connectivity anywhere at anytime as well as collaborative and context-aware applications, and "on-demand" collaborative workspaces. A large majority requires more interactions among multidisciplinary competencies and plug&play capabilities as well as mobile access to experts. More than 80% of respondents predict the implementation of flexible working and the integration of social, learning and work activities.

In terms of a workplace organisational model, the emerging signal is on "External Global Model" which means that individual workplaces are hosted by a service provider ensuring and guarantying permanent wireless connection to the network and shared applications anywhere at anytime. It is also quite clear that soon or later knowledge workers will be walking their hands in their pockets without to have to worry that much about their workplace and working environment as their workspace will follow them wherever they have to go and whenever they need it.

As a conclusion, a possible mobile workplace approach could be based on three main capacities: inclusiveness, innovation, and interconnection. Inclusiveness implies a flat and open structure of communities, allowing the inclusion of new comers at any time when needed. Innovation and creativity will be enhanced through stimulating multiple interactions among multidisciplinary competencies at the crossroads of experiences. Interconnectedness on basis of permanent wireless connections established anywhere at anytime will provide much more flexibility and adaptability to any situation.

Another concluding remark is that there is not any "universal" mobile workplace organisational model so far, due to the diversity of various legacy situations. Prediction is always a very difficult task because one needs to foresee the "weak" signals. But we can predict for sure, due to cost-to-use and time-to-market pressure, that soon or later "the network will become the collaborative workplace" for all knowledge workers.



This chapter highlights current examples of mobility and networking in emerging work environments and looks at points of change and transition. Our key messages are the following:

- First success stories of mobile and network work environments exist. They take advantage of technological advances and controllable cost of usage – and they generate business value.
- However, the examples are often disintegrated, they lack courageous process and organisation redesigns, and show ambivalent performance concerning implementation and change management.
- Ongoing technological improvements, most importantly bandwidth increases as well as functionality and security enhancements will provide the opportunity to broaden the new work concepts across organisational units and establish them in inter-organisational settings.
- A balanced change strategy should improve the flexibility of processes, organisations and regulation and address the determinants of ICT competencies among employees to adapt faster to technological opportunities.
- It is imperative to maintain social cohesion, identification and the “thinking” employee for critical tasks. Multiple-roles employees and dispersed organisations evolve from new working environments and must be managed accordingly.
- To increase technology progressiveness, ICT solutions should allow more flexible integration with adjacent systems and a less complicated deployment across divisions, functions, and countries.
- In the long run the development of new working environments yields a seamless e-integration along inter-company value chains.

### 3.1 MOBILITY AND NETWORKING ASPECTS IN EMERGING WORK ENVIRONMENTS

These are exciting times for many members of the European workforce as a growing number of companies are changing their traditional work environments. New work environments are characterized by knowledgeable, productive, and flexible employees, who contribute significantly to firm competitiveness through innovation (Kleinknecht and Mohnen, 2002). Such employees are supported by ICTs that support mobility, networking and interaction. So far, communication possibilities have improved high-quality collaboration between people across traditional boundaries. Businesses are no longer tied to a single time zone. The Internet as the almost universal medium for interaction across boundaries has created an infrastructure that enables many organisations to work across borders. Individuals may even work fully mobile as their link to their back offices, clients and partners is supported by high tech collaboration solutions, such as email, videoconferencing, electronic blackboards and sophisticated forms of groupware. There are hardly any technical obstacles for communication and collaboration across geographic boundaries as products and solutions are continuously improving. Mobile communication technology proves to be the most popular application with the most dynamic growth rates in the last decade. As mobility becomes a strategic force worldwide, the market researcher IDC expects the global mobile worker population to increase from more than 650 million in 2004 to more than 850 million in 2009, representing more than one-quarter of the worldwide workforce (IDC, 2005).

However, good quality communication and collaboration tools are not sufficient to establish productive work environments. Working across borders in a team or doing your job in a mobile fashion does not come without problems. For instance, what happens to job satisfaction, social cohesion, random encounters and other informal activities without the direct contact with

colleagues, when you work remotely? Also, how about managing a mobile virtual workforce? Managerial handbooks are still promoting models that are based on a traditional work models whereas most managers find themselves in complex distributed matrix structures where they manage processes and a growing number of distant employees.

There is a lack of systematic research on practices of mobile work. Our research addresses this gap and reports on the state of affairs in mobile work by analysing a set of case studies across different industries and application types. Our analysis focuses on the identification of enablers and barriers for successful implementation of mobile work in practice. We highlight aspects of location mobility and virtual collaboration and we analyse the changing work environment and the implications of change in terms of processes, organisation, technologies, implementation and performance.

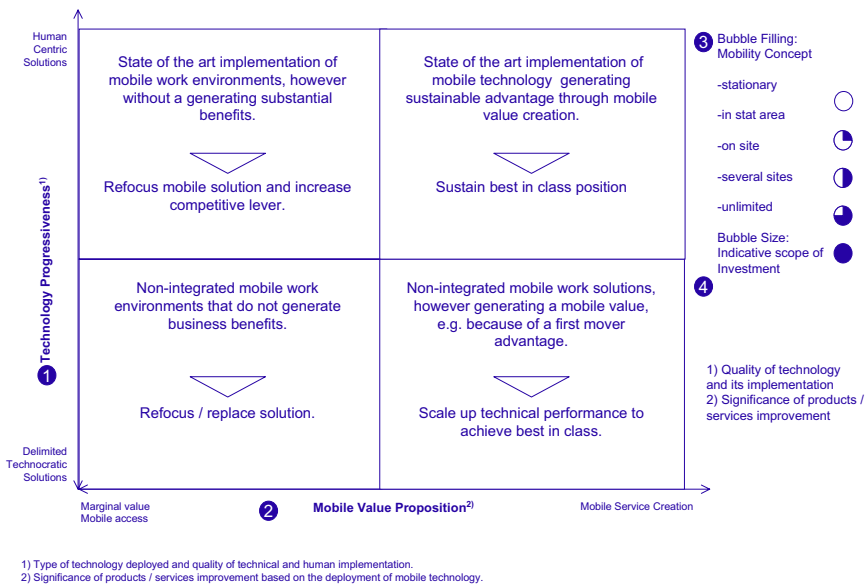
3.2 CURRENT PRACTICE AND PERFORMANCE OF MOBILE WORKING: CASE STUDIES

The MOSAIC research project allowed us to collect over a dozen case studies of emerging mobile and networked work environments (Brodts and Verburg, 2005). We have used this opportunity to identify the current state of new work environments in practise and cross check it against the major trends, discussed in the preceding chapter. A selection of three cases is portrayed in this book (see Table 3-1). The cases are based on personal interviews and have been analysed by the use of a specific assessment framework.

Table 3-1: Selection of Case Studies

Company background	Mobile application	Motivation focus	Specific benefits generated by mobile application
Hero AG (CH): international company for packaged food	Mobile sales force	Improve process efficiency and replace paper-based sales and order process	<ul style="list-style-type: none"> <li>Stabilised revenue</li> <li>Central marketing planning and controlling</li> <li>Advanced appearance in front of client</li> <li>Take over sales actions from other manufacturers</li> </ul>
Customs Agency (NL): national customs authority for control of goods, import and export	Mobile field force	Central planning to improve field force utilisation and decrease waiting and travelling times	<ul style="list-style-type: none"> <li>Improved control and more efficient work processes</li> <li>More flexible assignment of controls to distributed teams</li> <li>Reduced disturbance of client logistics</li> <li>Improved employee motivation</li> </ul>
Frimley Park hospital (UK): National Health Service Trust hospital, serving Surrey area	Mobile patient data	Comply with regulation for electronic patient data, reduce patient care costs	<ul style="list-style-type: none"> <li>Indirect benefits: improved bed usage, shortened patient release dates</li> <li>Process cost decrease and time savings</li> <li>Comply with stringent government requirements for reporting</li> <li>Motivated workforce</li> </ul>

The assessment framework consists of eight dimensions: 1) technology progressiveness, 2) mobile value proposition, 3) mobility concept, 4) size, 5) social impacts, 6) change effort in implementation process, 7) enablers / barriers, 8) near term developments. Dimensions 1 to 4 were used for the comparative analysis of the cases and for the case ranking in the technology-value matrix (Figure 3-1). The matrix features four sectors and a defined set of sector-specific characteristics and implications. Dimensions 5 to 8 helped the authors to identify issues related to the success of mobile work environments.



**Figure 3-1: Technology Value Matrix**

### Case 1: Mobile Sales Force at Hero Food Vendor

Hero focuses on branded retail business and selected business-to-business markets for packaged food. Its major products include fruit-marmalade, fruit-juices, fruit-bars and baby food. The company generates revenues of ~1 bn. g. In Switzerland the company employs 270 people. The mobile sales force (MSF) solution is based on SAP "mobile sales" and tablet PCs. It is a so-called "offline MSF solution", requiring wired synchronization via DSL. It has no permanent online connectivity. In total 27 sales representatives are supported in Switzerland. They serve restaurants, specialist retail sales points, totalling to 40.000 in Switzerland. Each sales representative covers between 600 and 1.200 customers in a dedicated region. The employee works from home, in a car and at the client site. A presence in the company's office is not required.

The company makes use of standard technologies that are combined into a working solution. However, certain shortcomings can be recognised; e.g. a lack of integration with company wide software environment, a dynamic upgrade of the electronic product catalogue according to customer profile and new marketing campaigns. The software solution is also not easily scalable to an international level, since it has been adapted to the specific Swiss sales organisation. Both facts limit the generation of scale effects.

The benefits of the solution include a more advanced appearance of the sales people in front of the client. The improved customer records allow for central marketing planning and controlling compare to the former situation where most of the customer knowledge used to be stored in the heads of the sales men. As a result, sales representatives can be better controlled and rewarded. The company does not realize more customer contacts per person because daily updates of customer base data compensate time gains from faster customer information access. However, the customer contacts can be planned better with improved targeted product and cross selling offering. The improved sales process allowed the company to acquire sales activities

from other companies in the same market. An integration of the external sales data was only possible due to the use of the digital sales and marketing database.

In summary this case shows a mobile work environment that enables the company to gain revenue by the acquisition of customers business. As such, and compared to the other cases, it is one example for a strategic benefit that resemble mere operational efficiency gains. Accordingly, the case scores high on the mobile value axis (see Fig. 3-2). The technology progressiveness however, yields below average scores since it not based on current soft- and hardware versions and lacks full system integration.

### **Case 2: Mobile Field Force at Customs Agency**

This case study concerns the external control of trade goods. In 2004 an experiment was performed with a few custom controllers in each of the four geographical sectors of the Customs Agency (CA) in the area of Rotterdam, The Netherlands. The controller's task is to perform customs related controls at premises of clients, on roadside trucks, at Rotterdam harbour or Schiphol Airport. At present, controllers come each day to the office where they get assignments on paper, which they execute that day. Completed forms are brought back to the office after the controls. In future, the allocation of assignments is delivered via GPRS to PDA's or laptops; during control digital forms are filled in and central databases may be consulted on-line, filled-in forms are returned electronically.

The purpose of the experiment was to develop a more automated and streamlined work processes and to test the use of certain devices (laptops, smart phones, tablet PCs) for the controllers. The work process implies that assignments are generated by planners and send to central control rooms. In the control rooms the assignments are allocated to the controllers. Their tasks are differentiated according to planned and ad hoc assignments, known and unknown clients. Controllers may be specialized in certain areas such as strategic goods, weapons, drugs or textiles. The Customs Agency relied on proven technology for the mobile work solution. Standard Internet connectivity and access gateways where used in the case. The organisation tested different end-devices as personal equipment for the controllers to be used in different physical environments.

Relying on proven technology resulted in limited technical problems and moderate need for employee up-skilling. However, the experiment identified some technical issues in the area of data transfer speed, battery duration, and certain ergonomic conditions, e.g. use of the tools in rough environments like freeze-cabins. The mobile work solution allows for better control of and more efficiency in work processes by immediate remote data exchange. The solution also allows for higher flexibility of task assignment and execution, and a higher probability of discovering frauds. As a result, goods can be cleared much faster for the client with fewer disturbances of client logistics.

In summary, the new work solution increased employee motivation and is expected to improve the outside image of the agency. Profit and loss implications have not been part of the experiment. We rate the overall value impact fairly high, since the set up of a running solution, and the reduction of the administrative work generates a well-perceived motivation- and image-impulse for the agency. The technology progressiveness can be characterised as below average since it is based on proven applications and has improvement potential regarding personalisation or localisation and systems integration.



### Case 3: Mobile Patient Data at Frimley Park Hospital

This case study was conducted at the National Health Service Trust hospital serving the Surrey area in southeast of the UK. The hospital treats 75,000 patients per year, manages 700-beds and employs a staff of around 2,500. The Frimley Park Hospital introduced a mobile online access to patient data for medical staff whilst working in the hospital premises. The solution is available for both doctors and nursing staff. In total some 60 devices located at nurses station are used as required by approximately 200 doctors and nurses. WLAN technology is used as access bearer. The system has been tested in a series of pilot trials carried out in August 2004. At present, the system is up and running and widely used in 12 wards.

The hospital is characterised as an early adopter of the mobile work solution in the health care industry. The main motivators lay in a need to increase quality and cost of the X-ray procedures and the need to comply with government regulations. Because the resolution of the digital image is now high enough to ensure quality of the X-ray diagnosis and cost effective it was decided to upgrade the X-ray procedure. Changing the process provided an opportunity to look at new technology to deliver a better IT service to both the medical staff and to the patients. The second driver for change was the upcoming requirement for web based NHS Care Records Service to be harmonised across the UK and accessible from anywhere.

This case identified key enablers in the area of technology management as well as in organisational and stakeholder management. As in other ICT-implementation projects in the health care industry (Mueller-Albrecht, 2000), the Frimley Park team found it critical to provide the project with a mixed implementation team of in-house and external personnel. The in-house team had access to the formal and informal process structure, whereas the external team provided specialised ICT and change management know how. In terms of organisational enablers, this case identified stakeholder management as a crucial aspect. An active stakeholder management should not be limited to single user-groups. The integration of different hierarchy levels (e.g. nurses and doctors) and different departments has repeatedly proven helpful. This does not only allow for capturing the various functional user requirements but sheds also light on the systems of power which might shift with the introduction of mobile working processes (Lapointe and Rivard, 2005). The early involvement of the mobile workers and the use of a pilot study were valuable to communicate changes and iron out problems. The hospital team described this as a "non-bureaucratic approach with an open and participative culture".

The mobile data access solution was well adopted by medical staff, resulting in a number of benefits:

- Indirect collateral benefits - better bed usage, patient release five hours earlier
- Time saved in accessing data and information per treatment
- Comply with the stringent government requirements for reporting
- Motivated workforce – seen that they are provided with top quality IT and that it works
- The mobile technology costs were offset by upgrade to digital X-ray process.

Due to the technological advance and the cost benefit generated by the case, we rank it clearly above average on both dimensions in Fig. 3-2.

### 3.3 CONSOLIDATED CASE STUDY ASSESSMENT

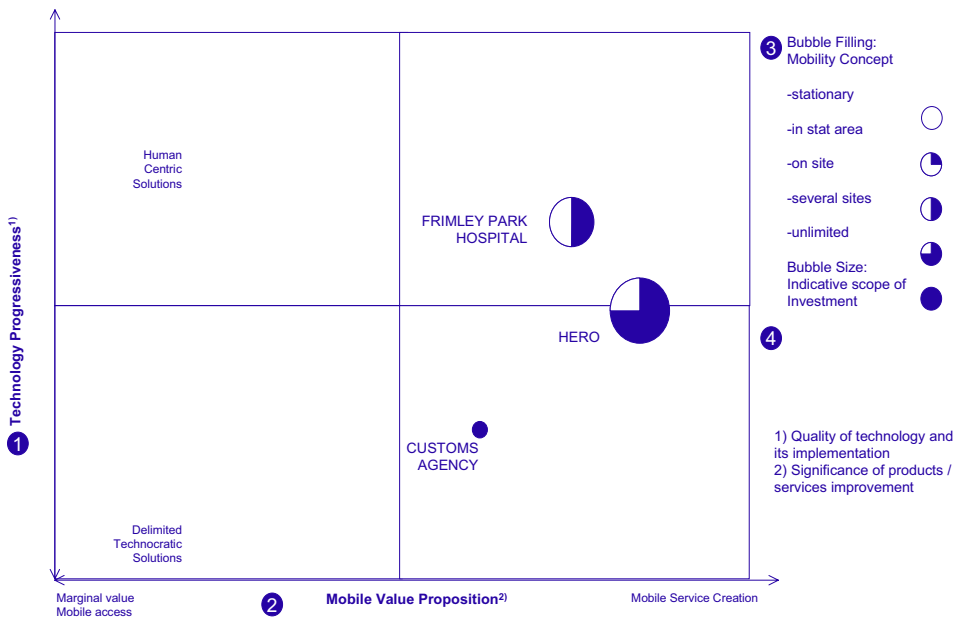
Figure 3-2 depicts the assessment of the cases along their technology progressiveness and their mobile value proposition. The Customs Agency case allows for global mobility of the work force, since it is based on GPRS connectivity. Hero salesmen need to synchronise their data by use of a

fix-net broadband access, which is in most cases done in their home offices and physicians in the Frimley Park Hospital are mobile within their building using WLAN network. The investments in the mobile work environment range from below 50.000 g in the pilot at the Customs Agency to over 500.000 g at Hero.

Regarding technology progressiveness, Frimley Park ranges higher then the other cases, since the soft- and hardware solution have been selected and customised to the hospital's specific requirements. The Customs Agency case copied a proven mobile field force system from another company and set it up as an island solution, i.e. without integration with existing back-office applications or database.

In terms of value generation, the Hero case ranges highest since the application enabled the company not only to introduce a sophisticated central marketing and sales planning, which helped them to stabilise revenues in a decreasing market but also to acquire additional sales activities from another company in the market.

Drawing upon our empirical research in the MOSAIC-project, we conclude that developments in mobile work are part of a steady move towards further automation, information and mobilisation of work. However, technology is far from being well implemented.



**Figure 3-2: Case Assessment in the Technology Value Matrix**

Most of the illustrated mobile work environments provide further potential for integration with adjacent systems. This is caused by a lack of holistic planning for business processes or by a lack of technical functionalities. The lack of technical functionalities appears in early adopter cases, where the compatibility to adjacent software systems could not be achieved as planned. This notion is confirmed by market research, where "integration complexity with linked ERP, email, legacy applications, (and challenges of) business process re-engineering" are ranked as second most important restraint for mobile sales force applications Frost & Sullivan, 2004).

In terms of human interface design none of cases utilised advanced hard- or software. Regarding connectivity, companies do use GPRS and to a certain extend UMTS connectivity. However, some of the organisations prefer to connect via faster and more cost efficient solutions, such as WLAN or fixed broadband connectivity. Finally, contextualisation, which is one of the long discussed mobile features (Dix et al. 2000), is rarely used in current practice of mobile work.

Corporate “mobilisation strategies” could not be observed in any of the cases. Initiatives are often driven by individuals or single teams (a notion confirmed by Carpenter, 2004). Top deciders seldom start the change process. As such, we observe, today's mobile work environments do create value. However, most value is created within selected functions or divisions – value chain integration and corporate alignment is not often found. Most of the mobile work environments support single employees or teams that have worked mobile in one or the other way before. Thus, the way of working was not subject to a radical change.

The investment in mobile work environments of the reported cases varies and shows different approaches of implementation management. Most of the interviewees, independent from that fact if they were early or late adopters, found it challenging to quickly make a mobile work solution beneficial to the organisation. However, as soon as a mobile work solution is up and running, the organisations report clearly positive effects on the motivation of employees and image of the company. An early user involvement and a strong top management support has repeatedly been stated an important factor for success. Profound performance controlling could not be identified in any case.

### 3.4 TRANSITION POINTS TOWARDS FUTURE DEVELOPMENTS

When we mirror the current state of affairs with the major trends shaping mobile and networked we can conclude that in near and mid term future, we will witness a growing adoption of mobile and networked working environments. As shown in our case analyses, today's work designs do create value, however, they are limited to single functions, show low degrees of systems integration and are half-heartedly implemented. I.e. they offer additional re-design and value creation potential. Drivers and restraints are listed in Figure 3-3.

Key factors supporting the wider adoption of new work environments stem from technological improvements and cost decreases, as well as growing experience with successful implementation and change management in the form of positive business cases from early adopters. These factors will lead to more awareness for mobile and networked working on decision-maker levels. Stronger top-management support will help to bring advanced work designs from individualist solutions to cross-functional and multi-national solutions.

On the other end, a number of restraints can be identified. Myopic re-organisation of work designs can lead to a fragmentation of organisations and to an “automation of humans”. This bears the danger of dissatisfaction and protest on employee level. Such design will minimize the benefits of new work environments and avoid further adaptation. A general barrier is seen the securing of corporate data and digital work. Mobile and hybrid networks as well as the growing number of participants will pose new security challenges.

In summary, we predict stronger and wider adaptation of mobile and networked working environments. We will witness stronger take up on the level of small and medium enterprises as well as in public organisations. The sophistication and improved usability of the solutions as well as decreasing cost of usage will bring these solutions to a greater range of organisational

functions. For employees, this development will imply higher degrees of working flexibility in terms of times and locations as well as concerning the organisational roles to play. For managers it becomes imperative to design implementation and change processes with highest professionalism in order to reach the envisioned improvements and avoid the pitfalls and restraints.

Rank	Drivers	Short to mid term <sup>1)</sup>	Mid to long term <sup>2)</sup>
1	▪ <b>Technology performance increase (bandwidth, processing, hybridisation and functionality)</b> enabling high quality communications & multimedia transfers	●	●
2	▪ <b>Increasing network organisation</b> and competition of value added networks - viable synergy due to value chains of different cooperating companies	●	●
3	▪ <b>Proper project and implementation management</b> (incl. communication and change management, training, process redesign and top mgt. commitment)	●	◐
4	▪ <b>Positive business cases from early adopters</b> fuelling more integrated and larger scale adoption of new work environments	◐	●
5	▪ <b>Security capabilities</b> allowing privacy/confidentiality, integrity and liability while using the air interface	◐	●
6	▪ <b>Cost reduction in devices and network usage</b> amplifying real-time mobile groupware in operating systems and applications	◐	●
7	▪ <b>ERP flexibility increases</b> by applications being capable of integrating value chain activities in the mobile work places	◐	●
8	▪ <b>ICT skills within the organisation</b> - even if it is not the core of the business (e.g. health)	◐	◐
9	▪ <b>Increasing travel and security cost</b> leading to stronger adoption of virtual collaboration in all process areas	○	◐
Rank	Restraints	Short to mid term <sup>1)</sup>	Mid to long term <sup>2)</sup>
1	▪ <b>Fragmentation of organisation</b> , loss of culture and shared values (social cohesion)	◐	●
2	▪ <b>"Automation of humans"</b> – limiting decision capabilities and self management, lack of employee autonomy	◐	●
3	▪ <b>Technical security issues</b> with regard to public key processing: grievance caused by shortened key lengths and reduced functionality	◐	◐
4	▪ <b>Increase of administrative activities</b> , which the mobile worker does not perceive important (e.g. data recording)	◐	○
5	▪ <b>Cost increase for outstanding research</b> regarding robust cryptography in firmware components or on trusted mobile platforms	◐	○
6	▪ <b>Issues of mobile hardware</b> and power supply - constraints due to limited computational power and short battery life	◐	○

1) within 1 to 3 years; 2) within 3 to 5 years      Impact: High ●      Medium ◐      Low ○

**Figure 3-3: Drivers and Restraints of emerging work environments**

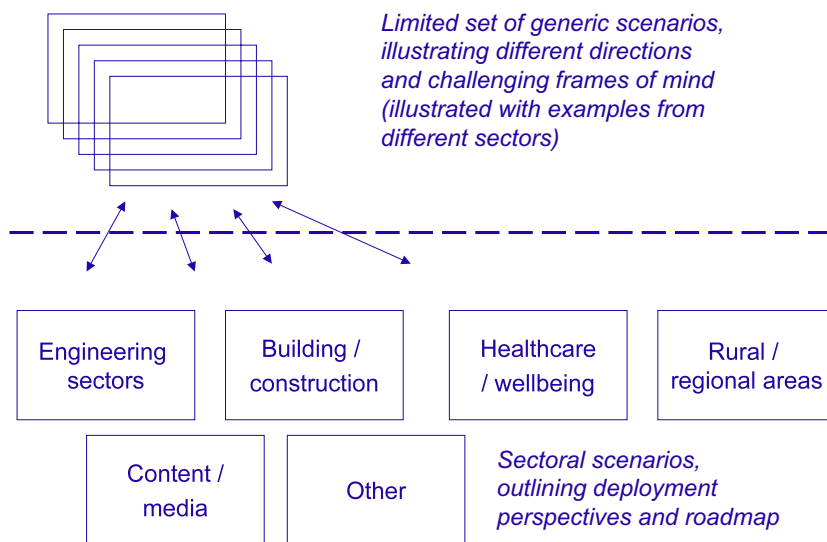
Informed by our assessment of current practices and ongoing trends, this chapter further elaborates the MOSAIC vision of future mobile and collaborative workspaces. It presents a collection of generic scenarios to explore the key driving forces underlying mobile workplace innovation, to investigate different directions of innovation in mobile workplaces and to prepare for developing a roadmap outlining potential solutions. The scenarios do not represent desirable futures per se. Rather, they represent strategies of coping with the future, in fact with very different but still plausible future situations. The driving forces underlying the scenarios, and their impacts, are uncertain in nature and comprise organisational, technological, societal, behavioural developments. The scenarios therefore are meant as a source of inspiration for innovators, users and policy makers. The objective of these scenarios is not to represent business opportunities, but to challenge existing frames of mind in envisaging different types of workplaces than those that are already existing, and to show plausible future directions and business cases and to identify enabling technologies and arrangements. Thus, the scenarios provide a framework for exploring strategic challenges concerning mobile and collaborative workplace innovations.

#### 4.1 APPROACH TO SCENARIO DEVELOPMENT

The scenarios are holistic and include human, societal, organisational and technological aspects. This is because in implementing the scenarios, not only technological aspects but also organisational changes and changes in business processes and working behaviours are required. The scenarios are not meant as to paint very futuristic situations, but aim to present plausible, realistic images of the near future, unfolding in different directions. They scenarios already could be fully realised within a few years, on the basis of the now existing or emerging technologies and organisational innovations (2005 – 2010).

We have made a distinction between generic scenarios and specific scenarios. The generic scenarios are meant to present the more general and fundamental, but still uncertain, directions in which mobile collaborative workspaces plausibly can evolve. To that end we explored the key driving factors as potential determinants of change. These factors and their impacts are uncertain in nature and comprise organisational, technological, societal, behavioural developments. In elaborating the scenarios, through drawing storylines strategies were designed to cope with uncertainty and to demonstrate the potential directions of innovation in mobile workspaces as sources of inspiration for innovators, users and policy makers.

The generic scenarios were informed by the specific scenarios, which were developed for the chosen application domains engineering, health and wellbeing, and rural and regional working. These scenarios were taking their departure in the driving forces operating at the specific sector or thematic level: the nature of competition, government policies, business networks, and technological innovation. These specific scenarios are more related to specific business opportunities and we used them as a point of departure in analyzing mobile working deployment strategies and drawing up the roadmap describing milestones for implementation. Through a process of workshops, the scenarios and deployment strategies were envisaged, elaborated and validated.



**Fig. 4-1: Scenario building at two levels**

In elaborating the sector specific scenarios, a much better insight has been developed in forces underlying innovation in the mobile workplace, and this has benefited the generic scenarios.

The scenarios for the manufacturing sectors have highlighted the particular characteristics of these sectors. Engineering sectors they are product-based, involve complex processes and products, distributed stakeholders, and require a multi-functional perspective. Manufacturing sectors experience the need to improve productivity, reduce time and cost, improve quality, and increase access to global competencies and information. The challenge from the perspective of mobile workplaces is to explore how mobile technology can be used to empower workers (individuals and teams) and build innovative workspaces to improve products and processes (design, construct/manufacture, maintain and disposal).

Our scenarios for the healthcare sector have highlighted the characteristics as being knowledge intensive, involving team work, publicly regulated, involve complex processes, distributed stakeholders. The healthcare sector experiences the need to improve productivity, reduce time and cost, improve quality of care, and guarantee continuity of care. Challenges from the point of view of workplaces are how mobile technology can support healthcare professionals, provide access to expert knowledge, establish collaboration between professionals, and support cost effectiveness.

### Factors driving towards future mobile working

In Chapter 2 it became already clear that pervasive forces are at work that could drive workplace innovations potentially in different directions, although there is uncertainty about the extent and direction. Even the kind of forces and their interrelations are at least partly uncertain. This is why we have developed our scenarios, to explore plausible future directions and to gain insight

in underlying driving forces, and thus to be in the position to draw up an informed roadmap for deploying innovations. We have assumed that the major forces will be technological transformation, globalisation and competition, human needs in work-life balance, demographic change, and European enlargement.

**Technological transformation.** It now becomes clear that the future workspace infrastructure will be supported by ICTs facilitating mobile and multi-location work and on-distance collaboration. Among the key technologies are: broadband access infrastructure; wireless Internet; software applications for mobile collaborative working; mobile communication and access to information and knowledge; ambient intelligence applications facilitating an increased level of location awareness; and security and access control. But innovations are likely to be multi-disciplinary and systemic: technological innovation must be embedded in organisational and social innovations resulting into new workplace models and working styles such as to be found in community-style workplaces and forms of self-organisation.



**Globalisation and competition.** Globalisation and outsourcing strongly affects the global distribution of work and the reconstruction of value networks around the globe. Companies are exploring new ways for organising their daily work as well as their supply chains. This brings forward the issue of balancing between the need for decentralisation and self-organization, and the requirement for minimum levels of planning and coordination. It can be assumed that in combining the power of both, more efficient, creative and productive organisational structures will arise (Malone, 2004). Several of the MOSAIC scenarios are exploring the potential of this vision.

**Human needs in work-life balance.** As the cited Euforia Delphi shows, trends in the knowledge society are blurring the traditional separation of private and working life, and threatening the work-life balance of workers. How will this balance evolve given the emergence of new mobile technologies? Will work become more dominant and pressured and will a 24-7 culture proliferate, or will we succeed in maintaining a balance between work and life? New work-



related problems currently arising are long working time, inadequate possibilities to manage time, stress and chronic diseases. As new processes and structures for collaboration in new types of social networks emerge – e.g. professional communities - the question arises what the impacts will be on human needs and considerations. A strong strongly relation exists with the longer-term evolution of human behaviour and identity, as well as the emerging new patterns of socialization.

**Demographic change.** With demographic change in Europe, particular attention is being given to older citizens, including ageing workers. There is pressure on them to continue working, and mobile and collaborative technologies can, potentially, have a part to play (Hilsen and Ennals, 2005). Indeed, it is now recognized that active ageing is central to enterprise development. One problem is that older users of technology often have difficulty in deriving benefits; they may have been accustomed with older systems, which have become outmoded, or failed to engage with technology at all. Given current problems with pension systems and pressure on workers to stay at work, there is a case for giving attention to job design and to usability of computer technology.

**European enlargement.** In a potentially more unified Europe of one common market of labour and competencies, national and cultural differences will no longer form obstacles for flexible and dynamic forms of work organisation. In contrast, there is a need for work environments to better exploit the cultural and national characteristics for the benefit of individual workers as well as well as regions. However, many new member states are not yet aligned with the traditional EU-15 and face tough social cohesion challenges, in areas like income distribution, labour market inclusion and educational opportunities, and there is a risk that major lags and gaps are there to stay (see Bogdanovich, 2005; also Popper, 2004).

Besides these major forces, others are at work, including the new spatial patterns of land-use, organisation and transport, the continuing emphasis on sustainable development, and the implications for housing and office buildings infrastructure. Through our domain studies in engineering, health and wellbeing, and rural and regional working, this broad framework of pervasive forces at the macro-level has been complemented with uncertainties that are specific at the domain level, to allow the development of detailed scenarios (Table 4-1).

*Table 4-1: Framework for scenario building*

	Major forces	Major uncertainties
Macro-level	<ul style="list-style-type: none"> <li>• Technological transformation</li> <li>• Globalisation and competition</li> <li>• Human needs in work-life balance</li> <li>• Demographic change</li> <li>• European enlargement</li> </ul>	<ul style="list-style-type: none"> <li>• How will organisations cope with these forces and what are viable organisational forms?</li> <li>• How will individuals cope with these forces and how will human identity and attitude develop?</li> </ul>
Domain-level	<ul style="list-style-type: none"> <li>• Need for faster innovation cycles and collaboration (engineering)</li> <li>• Pressure for cost efficiency and quality improvement (health)</li> </ul>	<ul style="list-style-type: none"> <li>• What is a viable balance between self-organisation and coordination?</li> <li>• How will technologies be integrated into the work organisation?</li> </ul>

#### 4.2 THE MOSAIC SCENARIOS

Following the framework for scenario building, the MOSAIC scenarios are structured along two driving forces, each having two extreme outcomes, 1. ‘human attitude’ (with extremes in individualism and community orientation) and 2. ‘Organisational development’ (extremes in



hierarchical control and self-organisation). Figure 4-1 presents the four quadrants and a selection of the scenarios that were elaborated and discussed in many workshops. Some of these scenarios are more generic in nature, others have been developed for different sector domains such as aerospace, automotive, health, building and construction, and rural and regional working. The scenarios must be seen as very different strategies for coping with different sources of uncertainty. Using this categorisation we analyse the future prospects and success conditions of particular new forms of mobile work, identifying the challenges and targets for innovation, and setting out a roadmap of innovative mobile work solutions and underlying technologies. We now present short summaries of a selection of the scenarios.

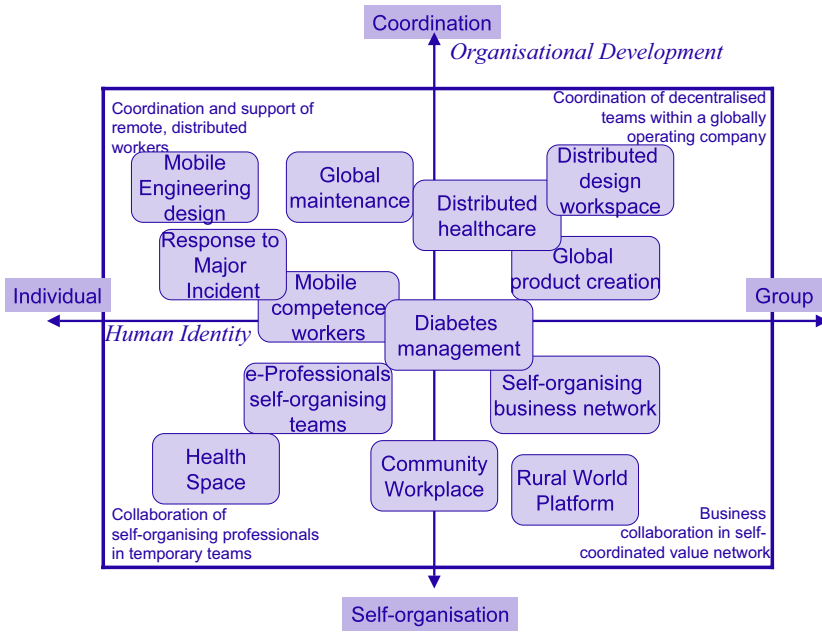


Figure 4-2: MOSAIC framework for mobile working scenarios

**Scenario 1: Global product creation in a networked company**

This scenario describes a situation of coordinating decentralized teams within a globally operating company. The company product creation environment is global, having operations in many sites in many countries and in many time zones as well. In exploiting a network of co-located sites, product creation processes can be shortened and the competencies of every site can be used in a more optimum way. Most of the product creation processes involve several partner, subcontractor and client sites in different countries. This requires effectively mobilizing both the work tasks and the worker, and has direct implications for work processes and the over-all work environment needed to increase productivity.

The rationale behind this scenario is the evolving global division of work and increasing speed of innovation and productivity requirements. At the same time the company experiences a shortage of talent in its home base and the company is forced to increase R&D presence in other countries rapidly. The global division of work helps the global company attract local knowledge and a global talent pool. The globally networked companies will build complex innovation and value creation networks and therefore more complex organisational and management arrangements.

Three different patterns of mobility can be identified: the Mobile worker, Campus-based worker, and Desk-based worker. The mobile worker typically works between many locations, has no dedicated workspace, needs remote access to most of their resources and may work from home for up to 2 days a week. The campus mobile worker typically works in one location but is highly mobile and away from their desk for considerable amounts of time. This requires solutions for managing storage and personal material. The Desk-based worker uses a dedicated team workspace in a company location. Their resources should be office-based but preferably, their desk should be cleared and made available to others when they are out. The technologies needed to support this scenario relate to hot-desking, W-LAN access, context sensitive locations, instant privacy technologies, 'follow-me' printing services, security, authentication, interoperability issues and multi-access wireless technologies (satellite, 4G, W-LAN, Bluetooth). The work task can be addressed by using multi-shift work patterns. This is also an area where exploitation of work mobility instead of worker mobility brings highest value and therefore different virtual workspace arrangements are common.



Individual challenges arise from the very matrix type of organisation, where many sites are integrated into the work process. This requires more standardised processes, work practices and tools. A second challenge at the individual level is the work-life balance when managers and engineers are working together over different time zones. Team-related challenges primarily are in the management of a highly talented workforce in a networked global organisation. Differences in work practices are also challenging: should teams be mixed with many nationalities and practices or should diversity be exploited through collaboration between diverse teams instead of diversity between individuals in a team? Additionally, the lesson of this scenario is that in order to realise the envisaged situation, mobilisation of the work (tasks and processes to be carried out in different places according to needs) and engineers is mandatory. This has direct implications for the work process and work environment (workplace design) needed for increasing productivity and creativity.

## Scenario 2: E-professionals in ad-hoc self-organising teams

This scenario describes the ad-hoc self-organisation of individual professional workers. It describes how a bank implements a software audit by using e-professionals in self-organising teams. The project actors consist of a project manager, a software development team and a field team that execute the audit. The software development and field teams are arranged as self-organising communities operating under the centralised control provided by the project manager. The development team is created by hiring individual e-professionals who are responsible for establishing their own support structure, such as communication needs, overheads, office space, design tools and work practices. The distributed and flexible nature of the team means that the e-professionals are mobile and can work from anywhere. The field teams are responsible for visiting different sites and are hence highly mobile. Their workplace is wherever they are scheduled to be. For these teams, support is needed to allow communication and coordination between the team members and the software development teams. They also require location-based services to find the sites, trust relationship technology to overcome security concerns and context aware services to manage their travel and expense accounts.

Essential to these activities is the collection and dissemination of data between the various mobile teams. The scenario looks at creating a centralised workspace/per team that meet the requirements of each team and providing this to each team member anytime/anywhere. As well as acting as a storage point for information, it also acts as a communication tool, giving quick access to each team member.

While the distribution of the team provides benefits in size, these may be complicated by factors such as security policies, contract negotiations, IPR agreements, inter-cultural and time zone differences. Additionally, people dedicated to core competencies in the technical field will be required to deal with legal issues, placing heavy burdens on their support and maintenance costs. The temporary nature of the self-organising teams has pitfalls in that it can increase job insecurity. For the employer, the difficulty may come when all of the most qualified workers are already busy and unavailable.

The scenario makes heavy use of lightweight Head Mounted Displays (HMDs) to provide the large displays necessary for the data used by the mobile workers. This is necessary as presenting significant amounts of data and small mobile devices with different display sizes limits usability. Co-located team members will operate short-range ad-hoc networks while remotely located teams will rely on wide area networks for communication. The scenario identified a number of other technologies such as e-payment systems and context aware services to update travel expenses. The scenario also identifies the use of biometric data for security, but also as a means for establishing trust relationships between members, especially those using ad-hoc networks.

The greatest social change inherent in this scenario affects the software development team. Team members are remotely located, highly specialised, work on temporary contracts and can work from home or wherever they choose. Therefore they are not part of a persistent social group and quite isolated from their fellow team members. As a result they are lacking the personal relationships developed through working together. This is made worse by involving workers located in different time zones. As for the mobile field team, there is even a different aspect in that they don't have a home base to work from. Besides social contact the challenge is to maintain job security. Additionally, this scenario indicates that some centrally organised structure and services are needed for temporary self-organising teams.

**Scenario 3: Coordinating distributed work of individual workers**

A very different scenario is dealing with the coordination of individual work tasks (Fig. 4-3). As an example we are describing new ways for mobile working in aerospace maintenance. Global collection of engine flight data is realised via Grid networks. Local area networks are supporting maintenance centres at airports. Maintenance engineers and other ground personnel involved in servicing and supportability of aircraft are supported by mobile communications infrastructure.



*Figure 4-3: Collaborative working in aerospace maintenance*

An engine non-conformance is noted on the BA 146 from Seattle - performance data is being continually gathered from this particular engine and sent to the diagnostics centre in London. Historic performance data from the same engine is accessed and compared with the current engine performance parameters. A mismatch is noted, analysed and a diagnosis given. Poorer performance or even failure is predicted within the next 3 days. A maintenance intervention is scheduled before the event becomes critical. A message is sent to the most convenient maintenance centre after negotiation with the airline operator, for the maintenance to be carried out. The aircrew may not have noticed the engine performance change but they are now informed of the requirement.

The required parts are identified, and specialist tool requirements and or skill requirements are relayed to the maintenance centre. The maintenance task appears on the task manifest at the maintenance centre and an engineering crew is allocated to the task. On landing the lead engineer contacts the aircrew via the maintenance centre local area network to get further information that may be available about the problem and the upcoming engine maintenance. In this case video is not necessary but some data relating to fuel consumption is felt to be useful and is sent to the operations base. The maintenance engineers leave the base to carry out their task with their wearable mobile computers and with communications gear built into their outer wear so that both hands are free to carry out the manipulative tasks required.

Looking to the factors that make this scenario plausible, one is to increase safety both by ensuring that aircraft are fully operational at all times and by reducing potential maintenance errors. Also, it is important to reduce aircraft down time, to offer a better service to customers, and to support operators in the field by achieving a predictive knowledge enabled capability in aircraft logistics. Additionally, to enable experts, expert knowledge, diagnostic tools as well as historic and operational task data and processes to be made available to the operator at the task site.

Enablers for this scenario are partly technological, partly organisational. Technological infrastructure, operating system, resources and services access must be in place, enabling the building and operation of a virtual organisation. But also partnerships must be built across national and organisational boundaries. Furthermore, secure data exchange is a necessity, brokering access to data, and sharing data for a common goal, thus creating benefits for all stakeholders. Also, there must be a capability to process the required data in real time and thus a step change in processing power is required. Coordination of business processes must take place at different levels (global data collection, local diagnostic centres and the individual maintenance engineer). There must be access to databases and maintenance manuals. As regards data input and document retrieval, the issue is how to achieve this in confined spaces, and how to manage access to enough information at the right time but not be overwhelmed by it.

#### Scenario 4: Community-based collaborative workspace

Again a different scenario is exploring the workspace and work environment of a community of professionals. Mobile work is enabled through community based collaborative mobile workspaces available anywhere at anytime, following the workers wherever they are. There is no more need to carry on documents or heavy equipment and to have to look for power sockets and network sockets.

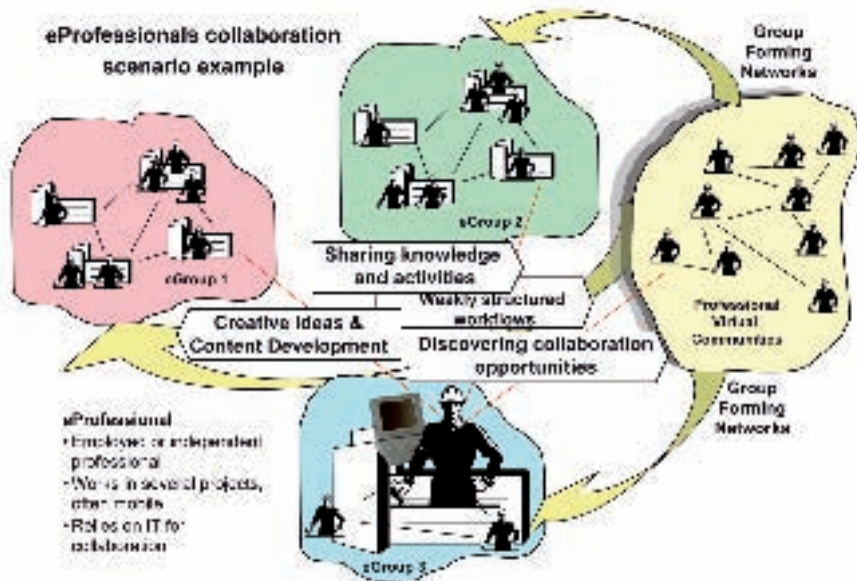


Fig. 4-4: Community-based collaborative workspace



This scenario is based on the use of small wireless computing devices fitting in the pocket of a jacket or on the wrist, enabling instant connection to other devices (i.e. flat screen in the train or plane and large screen in a meeting room) and to the Internet independent from place and time. This way, the network becomes the workplace, meaning individuals can be virtually and instantaneously collocated with your communities' peers and having access to whatever knowledge or expert you need to carry out their tasks.

The main actor in this story scenario is an independent expert member of a community of professionals and practices, operating through the Internet, specialised in the domain of collaboration engineering whose role is to facilitate the innovation collaborative process of a traditional furniture company with other complementary companies that could bring more value to their products within the near future. The developed scenario is telling the expert journey to identify opportunities of collaboration, travelling here and there and the way he is communicating, working and living as well as the role of technologies in his working and living environment. Business drivers in this vision scenario are clearly flexible and mobile working, improvements leading to higher productivity and creativity potential as well as providing much more innovation opportunities.

There are many social and organisational challenges and requirements, such as turning inside-out competencies, the evolution of work regulation and contractual employment, the move towards a collaborative attitude, catalysing the social role of flexible mobile workers through the involvement within communities of knowledge, communities of professionals, level of motivation and stimulation as well as engagement, virtual collocation of multidisciplinary experts, improve the level of trust and trustable knowledge.



Numbers of technological challenges and requirements appears in this vision scenario, mainly in terms of miniaturised wearable computing devices including wireless connection to IP access anywhere at anytime as well as miniaturised tracking device, a ring replaces the traditional mouse, projected or fold-out plastic keyboard and screen, large flat screens availability almost everywhere people are staying and travelling.

Communities of either professionals or practices, operating through the Internet, play an important role as knowledge and social catalyser through a quasi- permanent connection with members, which largely facilitate access to existing knowledge and appropriate competencies. Communities are also seen as a new form of organisation pushing a transition from management by control towards self-organised, self-managed by stimulation and motivation ensuring amuch

higher level of workers engagement in their activities and giving them more flexibility to balance work and life. Numbers of community services will have to be developed in the near future. One of the social activities presented in this vision scenario is the “conviviality space” providing a lot of opportunities to socialise with other members, based for example on common interests, in open discussion about various subjects that one can decide to join for few minutes in order to relax and better know other members. It is really something useful that contributes to build trust and confidence among people and stimulate creativity thinking as well.

### Scenario 5: Mobile workplaces in a collaborative business network

This scenario deals with collaborative working of individuals within the context of an evolving network of businesses. It represents a group of SMEs collaborating in a partner network in order to jointly pursue business opportunities. The network is characterised by same-level peer-to-peer relationships but there are specific responsibilities. The network expands internationally taking up new members and establishing local presence.

In manufacturing, forces of globalisation and outsourcing threaten the position of local suppliers. At the same time these forces provide new opportunities for suppliers to participate in global supply chains. Research, design and production are migrating throughout the world, following the attraction of local markets and to optimise logistic and supply chains. ICT and organisational innovations may help SME suppliers to anticipate and adapt to these forces enabling them to become part of international value systems. Collaborative workplaces and mobile working enable SMEs to participate in mobile and multi-site engineering teamwork. The scenario highlights different aspects of mobility and collaboration: SME management, network management, SME as part of value system, daily work collaboration

Our SME collaborates in a regional network of dozens of other SMEs. The SME network cooperates to jointly market products and share resources in design, accounting and marketing. Members are independent and contribute to managing the network. An electronic market passes requests for supplies. A collaboration platform is used to discuss project participation and sharing of resources. The network selects partners for collaboration with the contractor, using shared workspaces. New partners can be selected and negotiations supported. A design company in the network sets up design team and works with customer real-time and non-real time. The network gradually expands its international presence, allowing international partners to participate in the network. The network uses mobility support to enable communication and collaboration at varying places and times, access to documents and experts when needed.

Challenges to be met in order to realize the scenario are technological as well as organisational and social. Currently, adoption of collaborative SME networks has been relatively slow despite their large potential benefits, because of the lacking development of appropriate business models and network strategies. Business challenges include the development of business models for networked collaboration, the use of new processes and tools for project oriented collaboration, the balancing of coordination and self-organisation, competence profiling of partners, the integration of personal network presence and calendar functions into the network, and the collaboration between remote units and people. From technological point of view, challenges are in development of near-life remote meeting support, trust and security management, ad-hoc contextualised collaboration (finding people and knowledge), and workspaces for co-design, co-engineering, project preparation and management. Social and organisational challenges are in arriving at multi-dimensional work contexts such as working simultaneously for different companies, including their systems, processes, rules and cultures.

### Scenario 6: Mobile competence workers in global supply chains

This scenario reflects ongoing trends in individual working habits of competence workers and in organisational structures of globally operating companies: the trend to mobile teleworking and mixed forms of teleworking; to more autonomy in the individual organisation of working time and location; to blending in professional and private spheres; to more dynamic and flexible organisational structures and globalisation with semi-autonomous decentralized bodies of subsidiaries.

The scenario shows how mobile technology can both improve work in a globally operating supply chain and how it can make life easier for competence workers. This scenario describes the work of a lead buyer of a globally operated and distributed trading company. The company is hierarchically structured with (almost) autonomous subsidiary companies in many countries throughout the world and in many time zones and languages, down to the actual markets for end customers. Decentralized purchase companies handle purchasing, one for each country, sometimes even for regions. The lead buyer works in a central purchasing unit and is responsible for strategic purchasing between the regional purchasing companies. She works in the central headquarters, but frequently has to travel around to coordinate purchasing with regional purchase managers in various countries or to negotiate with suppliers. Her work is characterized by a dependency on in-house databases and information systems as well as a high degree of informal communication and document exchange with internal staff and external suppliers. The lead buyer frequently works at home or at other premises.

ICT in the company consists of standard in-house applications, which are networked (database systems, document management system, etc.). Security is an important issue, considering the amount of industrial espionage worldwide. The ICT system is quite regulated with a high degree of networking, but between subsidiaries, there is mainly informal communication and unstructured exchange of documents.

The scenario reflects a trend to more dynamic and flexible workplace organisational structures. Other trends focus on mixed forms of teleworking (as opposed to sedentary telework at home), more autonomy for the individual in the work organisation, excellent security for ubiquitous access to data and the blending of professional and private spheres. The scenario also identifies globally networked companies consisting of decentralized subsidiaries and support for an international multi-cultural workforce. Challenges identified in this scenario are: ubiquitous and secure access to the Internet and to local networks and to a wide range of devices, in addition to mobile devices being carried around; very small mobile devices with standardized interfaces to communication protocols and peripheral devices and with fold-out screens for PDAs; location-based services; multi-linguality and time-zones; ad-hoc contextualized collaboration; flexible access to shared workspaces; collaboration between remote units and people. Communication between mobile devices must be capable of supporting interoperability, scalability and adaptiveness of the data.

#### **4.3 REMARKS ON SCENARIO VALIDATION**

A scenario is not a business opportunity. Therefore a scenario must not be evaluated in terms of the value (benefits, costs and risks) of introducing an associated innovative mobile application. Indeed, business opportunities could be derived from scenario analysis and then such a value analysis and user validation is highly important.

During the process of constructing scenarios it is important to monitor their quality. Five quality characteristics can be identified. Scenarios have to be internally consistent in providing a coherent picture of the described future. They have to be plausible, such as being acceptable for the intended users. They have to be relevant in being connected to the ideas, concerns and issues the users are interested in. They have to be challenging in confronting the users conventional frame of thinking. Finally, they should be archetypical in describing different futures rather than describing outcomes of one and the same future. These quality criteria can be met through a process of participatory scenario development, involving the stakeholders including the users in the scenario process.



The potential of scenarios as an instrument to cope with uncertainty and to support policy processes is well known. The long-term oriented Royal Dutch / Shell scenarios (Shell International, 2002) provide excellent examples based on a long tradition. In the area of telecommunications, a recent and high-impact example of scenario development is the European Commission ISTAG Scenarios for Ambient Intelligence (2001). These scenarios have provided a very influential basis for discussing the 6th Framework Programme of the European Commission. Of a different nature and more directed to mobile technologies, infrastructures and markets are the UMTS scenarios developed by the UMTS Forum, and the IEEE/Cornell telecommunications scenarios (McAdams et al., 2000). The use of scenarios for the purpose of policy and strategy development seems mostly confined to the initial stages of uncertainty analysis and as a creativity exercise to identify and understand the underlying forces.

In discussing the function of scenarios in policy development and decision-making, it can be distinguished two roles, namely 1) To challenge decision-makers' mental models and frame of mind, and 2) Decision and strategy support: option development, evaluation and monitoring.

Scenarios can be used in policy exercises as agenda setting tools for decision-makers. This agenda setting is based on understanding the uncertainty and complexity involved and on understanding other players' positions and specifically mutual understanding of government and business. The value of agenda setting support can be found both in the conversation process and in the results of this process. One of the challenges in mobile workplaces decision-making is how to overcome the short time horizons of decision-makers. Because of short time horizons, discussions between stakeholders often start as negotiations instead as collaborative explorations. One of the ideas behind future oriented foresights is the notion that it is easier to communicate with each other about delicate subjects when one is talking about a future situation. Scenarios very well can be used as agenda setting tool in drawing attention to certain relevant topics (Schwarz, 1991).

Scenarios may also provide a sound framework for generating and analysing new options for decision-making and identifying and solving problems. Given a set of scenarios, options for decision can be identified and evaluated. Additionally, the robustness of options with respect to the over-all set of scenarios can be investigated and for each of the scenarios options can be tailored, refined and improved. This approach has been explored by Shell (Van der Heijden, 1996).

We consider the primary role of scenarios to extend conventional frames of thinking in discussing possible and plausible futures. In doing so we learn about the dynamics and volatilities of mobile workplace environments, recognising 'weak signals' and their underlying mechanisms. The role of scenarios therefore is not primarily to prepare planning or decisions. This has been recognised by Royal Dutch / Shell, whose experience was that a mechanistic link of scenario development to business unit planning processes as was done in the 1970s is not always feasible or effective. Rather, Shell is now using scenarios for a range of applications varying from global to specific business, providing a 'framework of ideas that influence strategy'. They are currently developing scenarios primarily as a means to challenge assumptions and widen perspectives, and using them to widen decision options.

Currently there is much attention for designing policy and strategy processes and agenda setting as to become more interactive and user or society driven. Scenarios provide an interesting means to implement these ideas on systemic innovation of the new working environment. Scenarios can be constructed in a communication process with companies,

employees, government and other stakeholders involved, at the same time analytical tools and instruments can be included to support the process of vision development and choice. This construction process initiates the dialog between these parties and encourages the sharing of knowledge and ideas regarding the topics of the scenarios. This creates a better understanding of the mutual interests and underlying forces.

Such interactive dialogue oriented processes can benefit from the concept of living laboratories, and in this way there is an interrelation between the scenario concept, and the user validation of alternative models for mobile working. The vehicle of living labs could enable very tight interaction between designers and users, visionaries and practitioners to make systemic innovation more successful.

Taking the point of departure in the mobile working vision outlining the concept of networked, people-centric workspaces, in the future scenarios and in the various challenges that must be addressed in coping with these scenarios, this chapter presents the MOSAIC roadmap for strategic research and technology development.

### 5.1 STRATEGIC CHALLENGES AS A BASIS FOR THE GENERAL ROADMAP

In Chapter 2 we identified the generic, pervasive trends that affect all scenarios as “certainties”. To a large part, economic factors affecting mobility such as cost of transportation and ICT affect also the future workspace. Technology factors such as the migration towards all-IP networks and the large-scale adoption of mobile technologies can also be considered as relatively certain trends. More interesting from the perspective of recognizing the diversity of future scenarios is the role of the uncertain factors that drive future ways of working. The scenarios are outcomes that we constructed on the basis of “what-if” questions: what if individualism will grow, and organisations will become more self-organising? What will be the problems and opportunities in that situation, and what are the instruments available? Such questions allow us to understand the success and failure factors and learn us to develop situation-dependent strategies.

The most important lessons conveyed by the scenarios can be summarized as follows.

- Global division of work will be a major development, but work-life balance issues could hinder its full development and undermine current social models.
- Mobile workplaces can support the globalisation of supply chains and work environments, but require new forms of leadership, coordination and management.
- E-professionals in a self-organising community are a promising model, but will require new business models and legal arrangements.

The mobile workplace scenarios represented plausible future work environments and explored various aspects of the vision of people-centric networked workplaces. Scenario analysis also proposed strategies to implement them. We now turn to the identification of the strategic challenges for research, technology development and innovation. In looking at the future vision and assessing current practice through the lense of our scenarios, we have identified gaps implying key strategic challenges as well as the corresponding requirements for technologies, applications and organisational issues. The challenges that we consider to be strategically important are summarized in Table 5-1. Summarizing the various issues illustrated there, several major directions that will drive innovation in mobile working can be identified.

- The creation of better work regulations as well as adequate policies and processes business models must support flexible work environments and enable a better management of time. Social, legal and business arrangements must support the implementation of such work environments.
- We need standards and infrastructure allowing for interoperable and plug-and-play mobile and collaborative work environments. There is a need for reference models, standards and ontologies enabling a seamless, ad hoc set-up of cooperation processes as well as a seamless transition of the mobile worker between different working context, domains and locations.

**Table 5-1: Strategic challenges and critical requirements in mobile working**

Strategic challenge	Technological innovations	Application innovations	Organisational innovations
Create better policies, processes, and applications for flexible working "anytime anyplace"; also including business models for a networked and mobile society	Service oriented architectures that support the on demand use of cooperation applications Reference models for cooperation applications. Standards for seamless switching between and the interworking of different cooperation technologies	Cross-organisational and cross community information sharing. User defined task-management and workflow.	New management and leadership procedures and styles Trust and privacy policies Time management policies Community-based workplaces, requiring flexible access to shared workspaces
Enable new scenarios for mobile collaborative work (people and network centric)	Wide area coverage of broadband access Augmented reality technologies for mobile cooperative engineering applications	Community-based mobile teamwork Distributed mobile teamworking. Shared and augmented access to engineering data.	Procedures and processes for collaborative work in shared and mobile workspaces Coordination tools and methods Trust and privacy issues for people centric applications: transparency and control
Develop standards and infrastructure to allow for interoperable and plug & play mobile and collaborative work environments	IP-connectivity Ontologies Semantic web technologies; semantic definition of services as basis for semantic infrastructure for collaborative services Concepts for the realization of policy based communication and cooperation applications	On-demand life-cycle supported workspace design methodology Semantic based workspace applications Integration of multimedia, telephony, computing in worker applications	Standardizing ubiquitous access to mobile workspaces and ambient intelligence environments: reference models for mobile workspaces and ambient environments
Develop better ability for contextualization of teamwork environments	User / team context modelling and interpretation Develop security policies for networked virtual and mobile team workspaces Personalisation and team awareness services Multi-sensor networks	Context-aware team workspaces Contextualization of sensor data Sharing of multi-dimensional work contexts and telepresence	Move from organisational to community oriented workplace design
Develop better ability for mobile team workplaces	Mobile access technologies Presence and awareness services Wearable computing services	Presence and awareness notifications and visualization. Business activity monitoring Applications that address the balance between the Self-organisation of mobile and local work as well as the integration into the organisational procedures.	Introduction of new management and leadership procedures and styles Trust and privacy policies Policies that open Adapting home and business environment Organisational processes for self-organisation
Create good practice of mobile and collaborative working	Connect different experimentation platforms Design experimental testing and validation tools e.g. experience sampling	Expertise and experience sharing.	Field test for integrating the next generation mobile devices into real business Development of concepts for organisational living labs

- A better ability for contextualisation of teamwork environments, and for mobile team workplaces, will allow collaborative workspaces to become more responsive to external changes.
- The development of adequate security policies for virtual and mobile team workspaces is a necessity to enable companies and other organisations to share collaboration environments and to make users accept the new collaboration tools.

- We must realize a paradigm shift from an application oriented to a service-based activity-oriented view on mobile collaboration support. Collaboration-aware work environments will support cooperation and interaction in terms of activities, not technical functionalities.

## 5.2 STAGES IN THE GENERIC ROADMAP

Together with the underlying trends and assumptions, the challenges form the basis for a general roadmap for mobile workplace innovation. This roadmap serves as a basis for a research agenda for strategic research and innovation. In Figure 5-2 we present the “stages” or “landing places” for mobile workplace evolution foreseen for the next decade.

**Table 5-2: Generic MOSAIC Roadmap**

These stages represent advances including technical, social, behavioural and policy-related factors as well as potential conflicts and new issues. These stages form the basis for a more detailed roadmap of technical and non-technical innovations. The following overview summarizes the result of discussions and workshops with a large number of practitioners. We consider the following assumptions as being most relevant for mobile work in the short term 2005 – 2007, the medium term 2008 – 2009 and the long term 2010 – 2014.

2005 – 2007: Mobile workers supported by smart devices	2008 – 2009: Multi-location workers supported by service-based mobile workplaces	2010 – 2014: Ad-hoc teams of mobile professionals supported by context-aware services
<p>Widespread use of combinations of PDA/mobile phone; mainly e-mail use; first mobile blogging approaches</p> <p>Emphasis on limited forms of micro-mobility: on-site mobile working at context sensitive locations, kiosks, encounter designs etc</p> <p>Standard groupware tools become more adapted to mobile settings</p> <p>Context-sensitivity covers mainly location and time parameters</p> <p>Emphasis on ad-hoc and occasional mobility: buildings on campus, travelling, sales jobs, field engineers, and home work.</p> <p>Connectivity and bandwidth allowing for document sharing and audio conferencing</p> <p>Research on “workspace authoring” enabling on-demand workspace support for ad-hoc mobile teams</p>	<p>Location-based personal services become dominant: where is my daughter?</p> <p>Mobile community and content services; end user content creation via mobile phones; community based organisation structures</p> <p>Complex forms of context sensitivity and better multi-user interfaces are realized, supporting mobile ad-hoc project teams</p> <p>Increase of well-supported forms of micro-mobility (on site) and multi-mobility (ad-hoc and occasional mobility); decrease of forms of total mobility (on the move)</p> <p>Increasing support of mobile teamwork in engineering, maintenance, services industries; including solutions for mobile workplace information and knowledge access/ sharing</p> <p>Pilots in on-demand mobile workplace support tools</p> <p>Resistance to changing workplace settings is developing; is addressed by paying more attention to policies for workplace health and safety</p>	<p>Mobile phone migrate into clothes and other devices, i.e. UMTS becomes a WLAN substitute</p> <p>Elementary forms of networked, “ambient” workplaces become reality with seamless transition between diversity of workplace styles (individual, team; on the move, located)</p> <p>Applications of mobile working in globally dispersed engineering and service teams and in collaborative learning</p> <p>New forms of networked organisation, enabling high level of interaction between central and decentralised levels and accommodating flexible forms of mobile working become reality and are becoming part of EU business infrastructure</p> <p>Negative impacts of workplace innovations on family conflict and work-life balance are not resolved, could create new divides</p>

### Stage 1 2005-2007: Mobile workers supported by smart devices

Mobile work short-term assumptions:

- The number of mobile workers will increase, while the types of mobile workers remain unchanged i.e. managers, sales, consultants, support technicians, scientists and academics.
- Low costs associated with mobility i.e. travel cost.
- Tele-maintenance, telemedicine, and all remote working activities call for wireless access by employees to report continuously on remote locations.
- Connectivity and bandwidth allows for audio communication and image / document sharing.

- Increasing globalisation and decentralization of business require new modes of communication and coordination.
- Mobile access takes place primarily through mobile phones and PDA's.
- The individual with his requirements for usability and usefulness is a main driving factor in the design of mobile work.

In the short term, it is expected an emerging demand for community services. Mobile workers will mainly use communication and presence services, and some special purpose mobile applications. Semantic-based information applications, to stimulate creating shared vision and understanding, are emerging. Basic life-cycle support of virtual teams is in rapid development. Web services allow mobile workers to access advanced functions and large databases whereas accessibility to mobile applications is improved.

### **Stage 2 2008-2009: multi-location working supported by service-based workspaces**

Mobile work medium-term assumptions:

- The societal cost associated with mobility gradually increases.
- Multi-cultural and multi-lingual support enables collaboration among foreign localized competencies.
- Connectivity and bandwidth allow for rich multimedia sharing.
- Smart, agile business networks start to emerge, based on smart collaboration workspaces.
- Mobile work is fully integrated into business processes.
- Mobile devices seamlessly integrate with desktop-based systems.
- In the design of mobile work, requirements of collaboration and coordination, as well as organisational requirements become more dominant.

For the medium term, ad-hoc mobile workspaces are developing, supporting secure access to information archives and advanced cooperation e.g. via multimedia communication. Formats and techniques to deliver content to various platforms become more powerful and less expensive. Applications are allowing for tele-assistance and mobile learning. Support services are developing to set-up and develop remote businesses and to internationalize businesses.

### **Stage 3 2010-2014: Ad-hoc teams of mobile professionals supported by context-aware and service-based workspaces**

Mobile work long-term assumptions:

- High cost mobility, leading to changes in the organisation of work: more mobile workers that mainly travel small distances.
- Using mobile information technology is becoming an established cultural practice.
- Independent experts form the flexible workforce any networked business organisation can recruit "on demand".
- Mobile workers have access to on-demand, service-based mobile cooperation support.
- Computers disappear: interaction via non-intrusive, attentive interfaces.
- There is a ubiquitous computing infrastructure, which is accessible anywhere, anytime.

For the long term, 2010 - 2014, work would become more mobile with less mobile workers. Mobile workplaces have plug and play capabilities for flexible integration into a networked business organisation. We see a high level of adaptability of systems empowering users to shape the technology to their specific situational needs. Mobile workers will have access to semantic-based knowledge repositories.

### 5.3 CONSTRUCTING THE DETAILED ROADMAP

The former section presented a general roadmap of mobile working research and innovation. This roadmap was based on the scenarios, which were describing plausible future applications of mobile working, and on the related challenges. The scenarios represent requirements and innovation challenges that must be dealt with over a time horizon. We now undertake the construction of a more detailed agenda for innovation and a corresponding roadmap. Such a roadmap helps policy makers and business stakeholders to clarify the challenges and milestones ahead. Taking the point of departure in the vision and challenges inherent in the scenarios, the key technical, human, organisational and social requirements have been identified for coping with these challenges. They were translated into a set of innovation and RTD milestones to be achieved in the future as well as an agenda for research and innovation. To develop a detailed roadmap for collaborative mobile workplaces RTD we have analyzed the emerging development pattern based on the following six layers of innovation: (1) Social and legal aspects; (2) Developments in mobility and work settings; (3) Implications for and developments in mobile applications; (4) Human interaction with mobile applications; (5) Mobile service design and service platforms; (6) Mobile access technology. Table 5-3 presents a roadmap for each of the six layers.





Table 5-3: Mobile Work Roadmap overview

	SHORT TERM 2005 – 2007	MEDIUM TERM 2008 - 2009	LONG TERM 2010 - 2014
<b>SOCIAL &amp; LEGAL ASPECTS</b> HUMAN AND SOCIAL ASPECTS, POLICY, REGULATION, EMPLOYMENT CONTRACTS	Migration issues (work and workers) influencing European and National policymaking. Consciousness about work/life balance issues. Individuals manage security and privacy in mobile contexts. Diversity of policy, regulation and employment contracts within the European Union results in complex ad-hoc mobile collaboration. However, the actual high demand of work flexibility by employees as well as organisations requires short-term solutions such as recruiting people or independent mobile workers for the duration of a specific project. As a consequence, mobility is not just referring to geographic location but also to switching between several organisations. Law unification (including work safety issues).	Mobile work becomes established. Work/life issues come to the forefront. Explicit needs for wide-scale technical support and self-management assistance. Professional communities merge with communities of practice / knowledge communities in order to host mobile workers and their employment contracts (as a business agent is doing for a sport man or a musician). Regarding direct employees of organisations, their employment contract will evolve, according to national employment policy and regulation, towards more flexibility in term of work arrangements and responsibilities. Duration of employment contracts is based on project duration.	Establishment of adapted trust frameworks. Issues of individual choice over mobility and work locality at the forefront. Wide-scale reliance on infrastructure for background technical support (invisible computer and wider deployment of ambient systems). Contractual frameworks (employment policy and regulation) emerge at the European Union level where mobile work be recognised as bringing more flexibility to employees and employers. Difficulty will remain on whether employees or employers will benefit most from increasing mobility in work.
<b>MOBILITY AND WORK SETTINGS</b> WORK PROCESSES, PROCEDURES, BUSINESS MODELS, ORGANISATIONAL ARRANGEMENTS	Demand for flexibility in the working organisation, yet most collaborative workspaces only allow for non-mobile access. Emergence of communities of knowledge and practice to support networked organisations and the mobile workplace. Emergence of the "mobile workplace everywhere at anytime" concept: the workplace belongs to each individual worker and links him with his organisation, his communities and the networked organisations where he has responsibilities and tasks to carry on. Mobile work applied in some processes that require ad hoc reachability combined with the provision of data and written instructions.	Demand for collaboration among competencies within the mobile workplace. Mobile (anytime, anywhere) access to shared workspaces. Support for secure, ad-hoc collaborative workspaces. Multi-site workers within the same organisation co-operate using shared workspaces. PDA's become fully accepted as standard devices in an organisational settings. Know-how is being gained on how to successfully deploy mobile IT in new application domains.	More mobile work, with less mobile workers. Mobile work performed by self-employed and self-managed experts, supported by communities of knowledge and practice, who are recruited by organisations "on demand". Their mobile workplaces have plug & play capabilities for flexible integration into a networked business organisation. Intelligent, adaptive collaborative mobile workspaces supported by trusted intelligent agents. Industrial-strength mobile IT is becoming normal support for professional work processes. Collaborative working between organisations, using mobile technology, becomes norm. Competent human activities are leveraged by well-integrated and adaptable mobile IT. More attention for physical and ergonomical aspects of mobile work.
<b>MOBILE APPLICATIONS</b> MOBILE COMMUNICATION, INFORMATION APPLICATIONS, MOBILE MULTIMEDIA	Demand for community based services. Mobile workers can mainly use communication and presence services, and some special purpose mobile applications. Emergence of semantic-based information applications to stimulate creating shared vision and understanding. Basic life-cycle support of virtual teams. Web-services allow mobile workers to access advanced functions and large databases. Improve accessibility to mobile applications.	Ad-hoc mobile workspaces supporting secure access to information resources, simulation services, ERP systems and advanced co-operation via multi-media communication. Formats and techniques to deliver content to various platforms become more powerful and less expensive. Applications allow for tele-assistance, m-learning and collaborative design. Support services to set-up and develop remote businesses and to internationalize businesses. Mobile services to develop local, ad-hoc communities.	High adaptability of systems empowers users to shape them to their specific situational needs. Mobile workspaces can be automatically reconfigured for a specific situation to support collaborative applications through context-aware environments. Mobile workers have access to semantic-based knowledge repositories. Industrial-strength mobile multi-media communication allows mobile workers to share and modify designs.



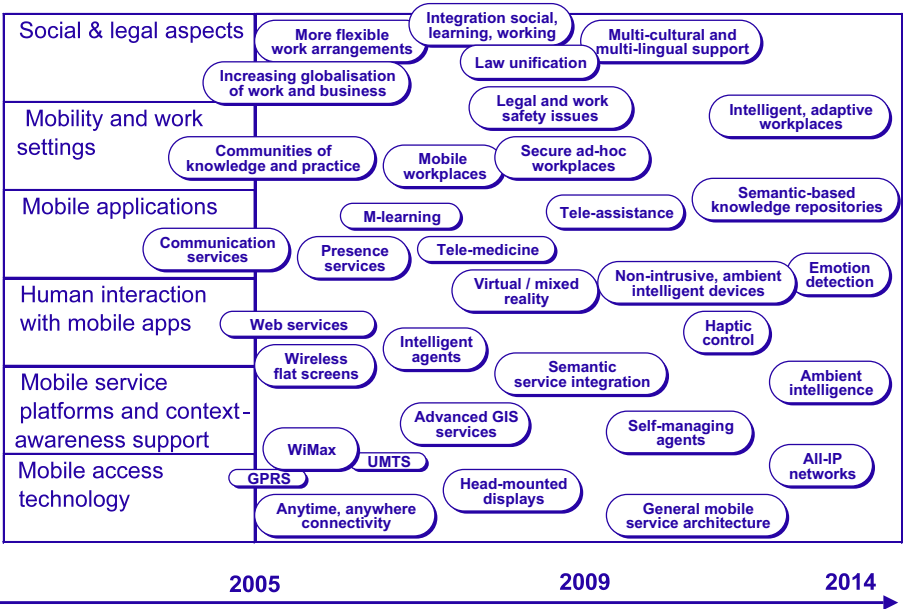
<b>HUMAN INTERACTION WITH MOBILE APPLICATIONS</b> MOBILE USE ENVIRONMENTS, MOBILE DEVICE INTERACTION, AMBIENT AWARENESS, UBIQUITOUS COMPUTING ...	Emergence of UI design based on (business) concepts rather than traditional computer science terms. UI mechanisms include keyboard, pen-based interfaces, some speech commands, and rudimentary sensory interfaces. First guidelines on interaction design for mobile applications.	Emergence of mobile devices that allow mobile workers to interact with a virtual / augmented reality world allowing for tele-maintenance, intelligent construction site planning and management, tele-medicine, and tele-training. Advanced context awareness and transparent access to resources. Multi-modal interfaces allow for intuitive interaction. Ubiquity as essential characteristic. Speech in- and output will become more sophisticated. Integration of many functions in a single device.	Advanced context awareness and ambient intelligence allow content to be embedded in its rich situational context. Multi-lingual interfaces. Virtual / augmented reality interfaces, based on emotion detection and biocentric control. Head-mounted displays and electronic paper used for interaction with mobile devices. Rudimentary possibilities for input by thoughts. Non-intrusive, ambient intelligent devices that react on the mobile worker's activities and together provide coherent support surround mobile workers.
<b>MOBILE SERVICE PLATFORMS AND CONTEXT-AWARENESS SUPPORT</b>	Emergence of wireless flat screens that are available in transportation systems, public areas and the home. Availability of different workplaces to support individual and collaborative work. Web services and agents allow for syntactic service integration and customized services. Rudimentary context-aware collaboration support. Services and applications available to mobile workers as applications for smart phones. Research and development is carried out on security middleware for context-awareness, semantic integration of web services. Use of e-tags (e.g. RFIDs) to monitor physical goods becomes norm. Exploration of the use of sensor networks to build intelligent monitoring systems for products and people.	Mobile workers can create "on demand" cooperative workspaces and share services. Workspaces generated based on business concepts and users' needs and requirements. Semantic service integration, followed by a transition from a semantic service web towards a semantic process web. Self-managing agents support adaptive, customized services. Standardised interaction between mobile devices and their environment for control and secure information exchange purposes. Functionality for consistently aggregating, interpreting and acting upon contextual information will become generally available. Location determination services widely available. Initial deployment of sensor networks to monitor the performance of products and services.	Community driven workspaces where mobile, independent experts collaborate through multiple wireless devices. Advanced context awareness and ambient intelligence allow for self-organising and self-configuring services that match the user's tasks and security needs. Free configuration and roaming of services in a network of interconnected resources creates the AML-environment. Intelligent sensor networks become norm supporting efficient logistics, performance monitoring and predictive maintenance.
<b>MOBILE ACCESS TECHNOLOGY</b>	Start of the transition towards IP connectivity everywhere anytime. First appearance of extra-small mobile computing devices enabling wearable computer with wireless connection to input/output devices, such as flat screens. UMTS will enable multimedia in pilot environments. Bluetooth enables short-range, secure, ad-hoc connection of devices. WLAN provides high-bandwidth mobile access to data. Combination of IP networks and circuit-switched networks leads to converged networks, enabling integration of (mobile) telephony and (mobile) computing.	Everywhere anytime IP connectivity. IP network integration starts with integration of multimedia, telephony, and computing in consumer applications. More demand for wearable computing and connectivity. UMTS publicly available for streaming video, applied to videoconferencing and co-design. Seamless transitions between access technologies possible. Galileo supports location determination. Mobile devices turn from PDA and phones into working artefacts. Mobile workers can use ad hoc P2P communication networks. Availability of light and durable power supplies and head-mounted displays.	Open, secure P2P systems and technologies. Wearable wireless computing reaches maturity. Connectivity via all-IP networks that enable integration of multimedia, telecommunication, and computing. Miniaturization of computing and connectivity will enable enhancing all sorts of objects with processing power and connectivity. Combined with a general service architecture, users will be able to gain a net advantage from these interconnected smart objects. Flexible displays and laser driven keyboards offering larger area for creating adaptive interfaces.

Table 5-4 identifies the critical innovations in these layers. In a next step milestones were identified for each of the layers of the roadmap. These milestones then were positioned on a time-scale.

**Table 5-4: Critical innovations in the six layers**

Layer	Main challenges
Social and legal aspects	Supporting flexible working, personal time management, IPR Issues.
Mobility and work settings	Organisational arrangements for mobile work, workplace mobility, mobile professionals who are employed on a per-project basis
Mobile applications	Interoperability, flexibility, standardisation, context awareness, shifting towards collaboration services instead of applications
Human interaction with mobile applications	Standardized user interfaces, multi-modal interfaces, augmented reality, natural interfaces, hand-free miniaturised devices that can be used in constrained settings. Scalable interface technologies, which can be used within small or large working areas.
Mobile service platforms and context-awareness support	Service-based collaboration, security, semantic context-awareness, supporting ad-hoc teams to set up tailored shared workplaces
Mobile access technology	Reconfigurable access technologies, combining multiple wireless technologies, peer-to-peer ad-hoc networks

An integrated high-level roadmap was constructed as presented in summary in Figure 5-1. This high-level roadmap shows the over-all key challenges and milestones for realising mobile and collaborative work innovations.



**Figure 5-1: MOSAIC Mobile Workspaces roadmap**

## 5.4 STRATEGIC RESEARCH AGENDA AND COLLABORATIVE PROJECTS

The next and final step is to propose a limited number of key themes for innovation that could be carried out in the form of multi-partner projects or programmes (see Schaffers, Prinz and Slagter, 2005). Here we address explicitly the level of systemic innovation. Systemic innovation requires a multidisciplinary approach to joint RTD in the area of mobile and collaborative working. Based on the MOSAIC scenarios and roadmap as explained in the earlier sections as well as on the scenarios of the Collaboration@Work Experts Group (CWEG, 2004) we have identified a number of issues for joint RTD as summarized in the following research clusters.

### 1. Business models for a networked, collaborative and mobile society

The new opportunities and demands of mobile work require the development of new business models that reflect the change from application to service driven solutions. Workers will no longer work and cooperate with or through an application, but they will use a mobile collaboration service. Thus people will not focus in the procurement of devices or software but on the on demand use and payment of context-based services.

Due to the complexity of the services to be delivered and to the number of organisations needed to deploy them to the end-user, the revenue flows and profits are expected to be generated through a complex value chain composed by a large number of loops and flows. To efficiently support the market growth of future mobile services business models will have to be flexible, adaptive as the services itself. A large number of producers will play a part in the value chain: equipment manufacturers, telecom operators, content providers, service management companies, software and platform providers, local services providers, education companies, and several others entities. All these entities will have specific aims and roles in the value chain that will be different and possibly be with conflicting goals. Also due to the important role of generic services (that are foreseen to play a crucial role providing added value to the “basic mobile service”), a strong presence of specialized companies within the value chain is expected. Due to the large number of different producers and having the risk of conflicting needs/objectives, these entities within the valued chain will necessarily have to find flexible way to collaborate reaching agreements to solve conflicts and to support and improve standards and interoperability aspects.

### 2. User-oriented design and tailoring methods for mobile workplaces

Local workplaces are often designed to support the organisational or group requirements and guidelines. However, mobile workplaces are more specific to the individual or to the cooperating community. Therefore methods are needed that address the balance between the self-organisation of mobile and local work as well as the integration into the organisational procedures. This will lead to the development of community based workplaces which will go beyond organisational workplaces, requiring flexible access to shared workspaces, with private and public access.

Language is one of the main barriers that globally networked companies must face. In a truly multi-cultural and multi-lingual working environment, it is vital that employees access information in a language that they understand. A number of companies adopt the strategy of a “working language”. For example, in a certain company with branches in several countries, all internal documents must be written in English, however, collaboration with local partners or clients must be made in the national language. Therefore a system should exist that can store documents in different languages, translate them, and provide them to the right person. In globally networked companies, multilingual search mechanisms should also be in place.

### 3. Paradigm shift from application to activity oriented system design

New working environments will be characterised by flexibility, mobility and ad hoc communication requirements. This raises additional demands on flexible collaboration support for intra- and inter-organisational communication and cooperation processes and a shift from application oriented developments towards the design of collaboration-aware work environments that support cooperation and interaction in terms of activities instead of technical functions.

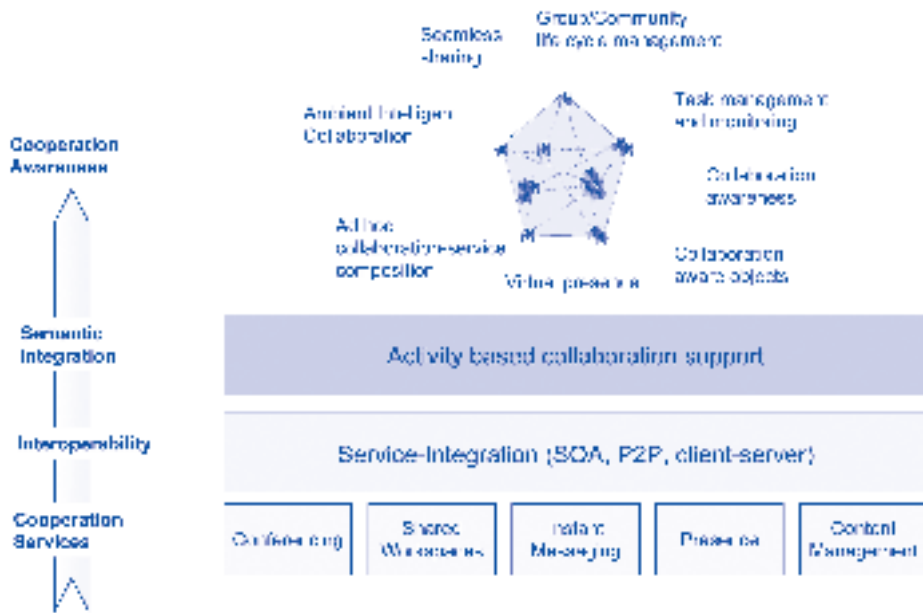
Currently most of our daily cooperation processes are supported using phones or email with an increased use of instant messaging. More advanced systems that support distributed task management, shared workspaces or workflows are still in their early adaptor phase compared to the use of email. This leads to the effect that complex and rich cooperation processes are narrowed through simple communication applications resulting in a cognitive overload of its users. Although the tools should support users in organising their work, people often complain about information and communication overload and the disturbance of work. Therefore research is needed to develop concepts for a semantic-rich cooperation support that reduces the workload and complexity of monitoring and organising the collaboration with different partners in multiple projects and processes.

Due to the increase in inter-organisational cooperation users form teams and communities across organisational boundaries. This raises the issue of standardisation and integration. Currently email is almost the only communication media that supports inter-organisational cooperation between different systems. Instant messaging, or shared workspace systems have not yet reached a status where systems of different vendors can easily be integrated or combined. Thus often the first decision an inter-organisational team or community has to make is the selection of the supporting collaboration environment. Since users are often involved in different teams they have to learn and use different collaboration applications for different teams and processes. Again this increases workload and complexity and it reduces the availability of time for creativity.

One approach to overcome these problems is a paradigm shift from application to activity oriented system design. This implies that we design collaboration applications based on an analysis of the collaboration activities of users in their working environment. When users want to provide a document to a colleague they should not think in terms of attaching a file to an email, but they should think in terms sharing this document by simply executing a sharing operation. The underlying cooperation environment should then select the appropriate communication application whether this is email, instant messaging or a shared workspace, based on the available technical infrastructure and user preferences. The following Figure 5-2 illustrates a possible approach towards such a collaboration environment.

The basis for such a cooperation environment is existing and new cooperation services such as email, shared workspaces or task and workflow management services. Among the new services presence and awareness services will play an important role. These services are needed for distributed cooperation to support users in their mutual understanding of the status and progress of work as well as the work rhythms of other organisations.

On top of these services an integration layer enables the integration of different services. It further supports the interoperability of similar services, e.g. two shared workspace systems, from different vendors, as well as the interoperation between different architecture paradigms



**Figure 5-2: Activity-based collaboration environment**

such as P2P or client-server. An important pre-requisite for the realisation of such a layer is the development of interoperability standards.

The activity and process support level abstracts from the cooperation application to provide an activity oriented collaboration environment. Within this environment users can organise their resources according to their processes, activities, teams and communities. I.e. the documents and messages exchanged within a project will no longer be scattered over the attachments of emails in email folders, the local disk and a shared file system or a shared workspace. Based on a semantic integration of the cooperation activities as well as the services users can organise the environment according to their project, team or community contexts. Within such a collaboration context the cooperation services are offered through so-called activity-functions such as share, inform, notify, send, but not as applications like an email client, or a shared files browser.

#### 4. Sharing multi-dimensional work contexts and telepresence

Community based and mobile workplace cooperation includes multi-dimensional work contexts such as working simultaneously for different companies, including their systems, processes, rules, cultures. This requires methods for easy switching between workspaces. This can be on a horizontal level: for co-design, co-engineering, project preparation and management; or on vertical levels: coordination of business processes at different levels (global data collection, local diagnostic centres, maintenance engineer). A particular demand derived from that is the need for awareness mechanisms that enable user to stay on top of their work processes and contexts.

#### 5. Trust and security management in a mobile world

Big challenges for flexible, mobile and local cooperation are security issues. Security threats make it more and more difficult to establish ad hoc cooperation spaces between arbitrary partners. Transparency is missing with respect to security measures. Organisations are very

reluctant to open their cooperation environment to others. Thus users are often forced to use third party services for inter-organisational cooperation. This leads to inconsistencies and problems in intra- and inter-organisational cooperation due to inhomogeneous applications and systems. To overcome this problem we need new approaches to an easy to use and end-user configurable security management for inter-organisational community based cooperation. Vulnerable infrastructures must be protected by sufficient trust and security.

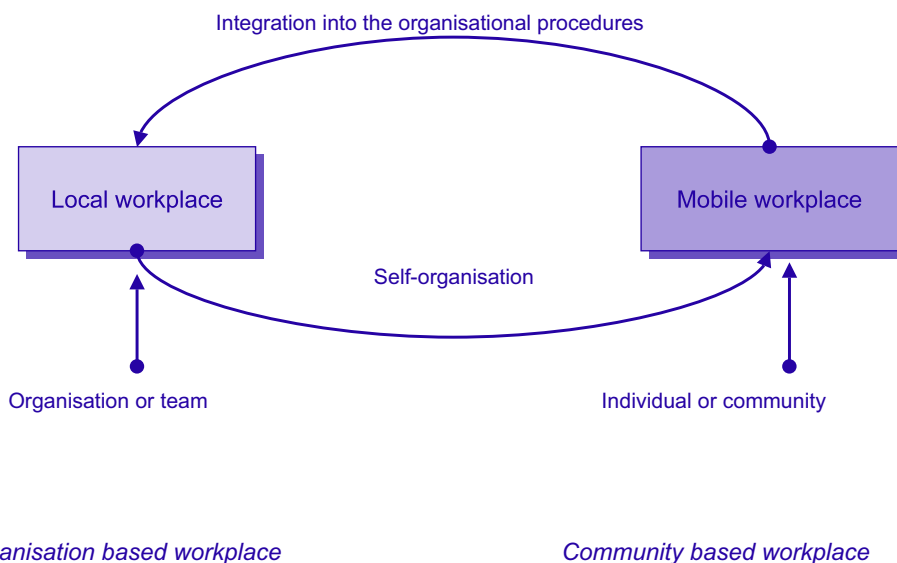
Future mobile and collaborative workspaces will be based on secure access to information archives and databases, semantic-based knowledge repositories and advanced functionalities. The challenge is to integrate trust and security into an architecture as well as into a middleware in order to facilitate trustworthy interactions between mobile workers and systems and maximize security for management of the different situational contexts. Only when the systems enforce full trustworthiness, the mobile users will accept the applications and will reap their benefits. This will require also new concepts for optimal security services of the platforms.

## **6. Tools and services enabling end-user configuration of community based workplaces in a mobile world**

Beyond current services for shared workspaces we need tools for end-user creation of ad-hoc workspaces including services for ad-hoc contextualised collaboration as well as for finding people and knowledge. Recent years have seen increased participation of the disabled and elderly in the work force. At the same time, there has been a rapid increase within the EU workforce in the number of people suffering from incapacitating or partially incapacitating neurological diseases (e.g. Alzheimer's and other dementia, stroke). A key goal of European policy is to empower the members of these groups, helping them to lead independent, full and rewarding lives as members of European society and to offer them the possibility of a full participation/continuance of their professional life. Mobile work tools and services already offer a partial answer increasing the degrees of freedom and enabling a number of people within these groups to go on with their working activities. A starting point for future research could focus on how to improve these technologies to compensate for sensory or cognitive deficits (for e.g. augmented videoconferencing tools), which might otherwise interfere with a person's ability to lead an autonomous life.

Another important aspect is the relation between the organisation of the local and mobile workplace. The following figure 5-3 illustrates the relationships: The design of the local workplace is determined by the constraints and regulations of the organisation and/or team. The mobile workplace is organised according to the needs of the individual or the various communities in which the user is involved. Thus the local workplace must allow the self-organisation of the mobile workplace while the mobile workplace must be integrated into the local workplace. Since both workplaces are often not disjoint this requirement raises new challenges for the design of the working tools with respect to interoperability and security.

Practical research will have to merge Ambient Intelligence, Augmented Reality, and advanced image processing technologies and (perhaps) brain-computer interfaces to build a new generation of devices (active in a "dedicated" Body Area Network), empowering people suffering from sensory, cognitive and physical impairments, to interact more effectively with their environment and with other people. These devices with augmented reality technology (e.g. intelligent eye-glasses or contact lenses) should provide their users with information suited to their specific needs (e.g. reminders of appointments, data and information specifically dedicated to their job-needs, location and navigation information, etc.), and (where appropriate) to detect



**Figure 5-3: Integration of local and mobile workplaces**

emergencies. This issue will become relevant as elderly will be a strong component of the EU workforce; the trend is already going on but will become critical from 2025-2030.

## 7. Standardizing ubiquitous access to mobile workplaces and ambient intelligence environments: reference models

Mobile work in different environments demands ubiquitous access to Internet and to devices such as touch sensitive screens, keyboards and pens. This can be achieved only if standards exist. A prerequisite for this is the development of reference models for mobile workplaces and ambient environments that reflect adaptiveness, scalability and interoperability.

## 8. Integrating the next generation mobile devices into real business

Special application domains must be identified to perform field tests or living labs in which the technologies as well as the impacts are investigated and understood. As far as very small mobile devices are concerned, it can be noticed that, due to the lack of a standardized information exchange protocol, in recent years PDAs have lost market. The future of mobile communication has been associated with Java 2ME. However Pocket PCs for example cannot support such technologies, and they represent 50% of the small devices available on the market. Therefore research in the area of standardisation of mobile communication protocols to support all small devices regardless of the operating system need to be explored. Moreover, the small size graphical displays of these devices impede their universal access and use. Thus a suitable method should be found that can adapt the interface to the user needs (e.g. vocal interface, zooming). Furthermore, the reduction of information displayed based on knowledge management techniques need to be investigated.

## 9. Social impact of distributed working relations

The impact of mobile and distributed working relations in knowledge communities is not yet fully understood. Further research must be performed to understand the risks and opportunities and to develop methods for adequate training or tools (for example, presence and awareness tools) that can support the transformation to these new work styles.



## 10. Adapting home and business environment

Mobile work involves working at different places including the home environment. This goes hand in hand with blurring the border between business and private life. As a consequence technologies are needed to adapt and to integrate the home and business environment as well as to find business and working models that support the integration of business and private life.

In Table 5-5, we have positioned these research themes on a time sheet, visualising when we expect the major breakthroughs to become available.

The concept of Living Labs, originating from MIT (Prof. William Mitchell), includes a holistic research methodology for sensing, prototyping, validating and refining complex solutions in a real-life social context. Partners include all stakeholders: users and their organisations, developers, service providers, equipment manufactures, cities and their relations are governed by some form of partnership model. In systematically creating conditions for learning through innovation and involving the users at an early stage, the concept seems particularly suited as an instrument for exploring complex “systemic innovations”. Current European examples of Living Labs include Testbed Botnia (real-life testing environment of mobility applications and services), Helsinki Virtual Village (Finland), Bremen Mobile City in Germany. In the Netherlands, the Freeband programme on 4<sup>th</sup> generation mobile technologies and applications potentially could evolve to such a Living lab.

**Table 5-5: Milestones in addressing the RTD themes**

Challenge	2005	2006	2007	2008	2009	2010	2011	2012
Business models for networked collaboration					◆			
Design / tailoring of mobile workp			◆					
Activity oriented system design				◆				
Sharing multi-dimensional work contexts					◆			
Trust and security management in mobility			◆					
Configuration of community based workplaces				◆				
Mobile workplace reference models					◆			
Field tests and living labs			◆					
Social impact of distributed work relations				◆				
Adapting home and business environments			◆					
Multi-cultural and multi-lingual support					◆			
Intelligent adaptive workplaces						◆		
Semantic-based knowledge repositories							◆	
Non intrusive, ambient intelligent devices						◆		
Emotion detection								◆
Haptic control							◆	
Self-managing agents						◆		
All-IP networks					◆			
General mobile service architecture							◆	

This final chapter discusses societal change and policy aspects of innovation towards mobile and collaborative workspaces, and current strategic challenges for stakeholders, including policy, business, societal organisations, and research. We discuss policies and strategies to be set in place, and present a few illustrative policy cases. This chapter also discusses concepts for understanding and exploiting “systemic innovations” in mobile and multi-location work. Examples of such concepts are ‘national innovation systems’, ‘transition management’, ‘adoption dynamics’ and ‘economics of organisations’. These frameworks enable us to better understand the success conditions and potential strategies that could create change and facilitate innovation in mobile workplaces. As the subject of innovation is systemic, there is a fundamental need for approaches that are also systemic. A few examples of such approaches are shortly discussed. The chapter is concluded with a summary of conclusions and recommendations.

### 6.1 THE SYSTEMIC CHARACTER OF MOBILE WORKSPACE INNOVATION

As we have been witnessing in earlier chapters, the “world of work” in Europe has been undergoing turbulent change. We discussed globalisation, transformations in technology, new forms of work organisation, and demographic change. These have all come at once, in different detailed combinations around Europe. Old certainties have gone. Ordinary members of the population are left confused. There are challenges for government departments and the European Commission, as the changes have impacts across normal disciplinary boundaries. Old paradigms have shifted, without the change always being noticed. Employment is no longer predominantly in large enterprises. Across Europe most workplaces are small. Large vertical management structures are becoming more rare. Increasingly it is essential to network, within and between organisations.

Mobile work environments and mobile technologies may be seen as adding to the complexity of those changes. In the MOSAIC project we have had the metaphor of a kaleidoscope, through which we see numerous simultaneous changes, rather than a static pattern. They also offer exciting prospects of innovative ways forward, both for individuals and for collective activities of enterprises, public sector organisations, and communities. There can be tensions, as mobile technologies tend to be marketed to empower the individual. The nomadic knowledge worker can escape the grasp of conventional organisations. The simplest impact of mobility is to transform our concept of the workplace. It no longer has to be regarded as geographically static. One worker can work in many places, or in many countries. As well as the national level, we have to consider both regions and the European level. This provides exciting opportunities for mobile knowledge workers, but may be worrying for those who lack control over their own work, and the opportunity to participate in decision making. For example, the spread of mobile working has accompanied the acceleration of outsourcing arrangements, including international outsourcing.

There are major challenges for governments, as legislation on employment has typically been based on the fixed workplace whereas mobile working introduces many new kinds of flexibility.

### 6.2 CONCEPTS OF SYSTEMIC INNOVATION

In evolving towards the introduction and use of future mobile and collaborative workspaces, we face transition issues presented earlier in our scenarios, such as:

- Acceptation of new work environments. Are we entering a 24-7 society, or can we establish a reasonable work-life balance?
- What kind of jobs and occupations will develop, given the move towards mobile working environments?
- Will organisations become more centralised and top down, or more self-organising and community oriented, or will hybrid forms of organisation emerge?
- How will legal frameworks develop, and will they constrain or facilitate new ways of working?

Several authors have developed concepts and frameworks that applied to the context of new working environments, shed light on particular aspects of workplace innovation and the role of mobility and collaboration. In particular we are interested in the use of these concepts and frameworks to understand the potential successful change strategies related to systemic innovation.

### **Mobile working strengthening the regional innovation system**

One way to understand the conditions for success of mobile working innovation is to analyse the factors shaping a national or regional innovation system. Michael Porter (1990) has developed this concept to understand why a nation becomes the home base for successful national competitors in an industry. His “diamond” model proposes five determinants that are mutually enforcing and shape the environment in which competitive advantage is created and local or regional systems of innovation thrive: (1) factor conditions, (2) demand condition, (3) related and supporting industries, (4) firms strategy, structure and rivalry, and (5) the role of the government.

Applying this model to mobile working, we are interested in the way innovations in new work environments may contribute to strengthening a national or regional system of innovation in creating better conditions for innovation and competitiveness, and in realising transitions towards modernised work practices and work environments. The five determinants must be in balance, in order to create the favourable conditions. Although the theory does not say how, the conceptual framework is relevant.

### **Mobile working enabling new forms of networked collaboration**

A second framework is provided by approaches based on the economics of organisations. The key issue is how organisational forms will develop in situations of uncertainty, complexity and information asymmetry given the cost of communication. Malone et al (2003) and Malone (2004) provide a theoretical framework based on evaluation of costs and benefits of communication and coordination in explaining the viability of particular organisational forms. For example in the current stage of ‘cyber cowboys’, communication costs have decreased to such a level that decentralised decision makers connected in networks are highly effective to combine local knowledge with the best information available elsewhere.

The value of this model, which is descriptive, is in taking into account explicitly the benefits and costs of using local information. It also points to the desirable level of making decisions: local or central, thus emphasising the importance of bringing decision power to where the most important information is. Applying this framework to mobile working, it can be concluded that mobile working further decreases the costs of communicating local information, and increases the way local information can be used to support even more decentralised ways of working. Mobile ways of working will also enable new ways to gather and use local information and interact with central units.

### Introducing and adopting the new forms of mobile working

The third framework we are highlighting is focusing on the dynamics of adoption and introduction. Approaches considering the adoption dynamics of particular technologies and products focus on markets, customers and on successful product introduction strategies in multiple stages of introduction, growth, maturity and decline. Often the innovation process is described as in terms of a family of technologies, each one succeeding the former with ever increasing performance characteristics. The general model for adoption dynamics is the well-known S-shape model. Shapiro and Varian (1999) add factors inherent to 'network markets' such as network externalities, lock-in, the exploitation of positive feedback, and the development of critical mass. They also discuss different strategies for innovators as in network markets there are important choices between revolutionary and evolutionary innovations (with implications for compatibility) and choices between openness and control with respect to technologies (with implications for market size). An additional element is from Moore (1999) addressing how to "cross the chasm" in developing and adopting innovations. This is based on an actor-oriented perspective to innovation, as in companies there are different viewpoints as regards innovation: technology enthusiasts and visionaries, but also pragmatists, conservatives and sceptics. In his view, innovation can only succeed if the different interests of stakeholders can be met.

Applying the adoption dynamics framework to mobile work innovation, the emphasis is on the role of positive feedback effects in network markets, and on the issue of diverging stakeholder interests. Mobile work innovation, in this view, requires attention to stakeholders in work organisations, and requires a strategy of introducing improvements step by step, through generating and exploiting learning effects.

### Mobile working and longer-term transformations

The fourth framework is the transition management approach as proposed by Kemp and Rotmans (2001) and Rotmans (2003), and focuses on the longer-term systemic changes in complex large-scale systems such as energy, water, healthcare and spatial development. The approach follows a multi-level description of innovation, distinguishing between 'niches' or protected experimentation spaces at the micro-level, 'regimes' at the intermediate level, and 'socio-technical landscapes' including aspects of infrastructure, culture and institutions at the macro-level. The approach assumes that innovation in complex systems requires transformation of 'regimes' of dominant technologies, practice and interest. It assumes a niche-based model of regime transformation starting in a protected environment. Also, the approach of transition management aims in what is called 'strategic niche management' to steer bottom-up niche-to-regime processes of transformation towards a pre-defined goal or vision. An example is the realisation of a low-carbon energy infrastructure at some point of time in the future.

This theory, using a "soft" systems approach, provides a useful general framework of thinking in terms of systemic change and strategic analysis, and could be helpful for general policy and strategy development. It provides a set of useful metaphors like "transition" and "transition management", "network steering" and "arena". The transition approach is descriptive; although at the general level normative conclusions can be proposed addressing the effectiveness of innovation systems and policy frameworks.

### Continuous learning, adaptation and innovation

A fifth and last framework focuses on learning networks. An example of this approach is the Hi-Res project (Totterdill a.o. 2002) promoting the concept of "arenas of organisational change", a process of continuous learning, experimentation, adaptation and innovation. The value is that it

brings together a collection of national models for workplace innovation and a comparative analysis. Hi-Res provides an analysis, a vision and an approach to workplace innovation based on case studies. The analysis results in a number of important challenges for policy makers and social partners. In some way this framework is highly complementary to the transition management framework, as the former could be considered very well as being an operationalisation of the latter.

### 6.3 CASES ILLUSTRATING STRATEGIES FOR CHANGE AND INNOVATION

The approach of MOSAIC in addressing societal change and policy issues related to introducing mobile working has been to raise discussion questions and to organise cross-disciplinary dialogue between stakeholders, in many workshops and action research type of activities. Examples of the questions, addressing themes such as regulation, regions, demographics, lifelong learning, health and infrastructure, are presented below.

- Mobile working takes workers, and their supporting technology, across borders. Who is most affected?
- Physical mobility has become less critical, with new technologies and virtual organisations. Does this offer solutions to problems of migration? What are the legal implications, for example in the delivery of services?
- Mobile working further complicates precarious employment relationships, as there is less day-to-day control over the worker. Do we have to re-conceptualize employment? What is the role of the social partners?
- The Social Dialogue is addressing trans-border teleworking. Why has it not become as large a phenomenon as had been envisaged?
- Mobile working complicates issues of working time. How do we determine when someone is working? What is the impact on work-life balance, and on issues of control and participation?
- There are issues of health and safety, and work-life balances. Who is responsible for the health and safety of the mobile worker?
- There are issues of security, privacy and data protection. How can the mobile worker handle them? Has technology rushed ahead too fast in comparison with regulatory policies?
- Companies generally seek to avoid the imposition of regulations, which impede business. In which cases do companies welcome regulation? How do companies seek to control the behaviour of their mobile employees?
- Rural areas and regions have different problems and approaches, compared with urban areas and regions. Can we generalise about mobile working across rural areas and regions in Europe?
- With the increase in activity at the regional level, does the national level become less significant? What are the political implications? Can regions link across borders, via mobile workers?
- Are all EU countries experiencing the same demographic challenges? What are the differences? What policies regarding working life have been developed so far? How can “Work Ability”, developed in Finland, be applied in other countries? Can jobs be redesigned? What contribution mobile working and mobile technologies can make?
- A more mobile workforce needs continuing professional development. What form will this take? How can mobile technologies help?

- Unless a workspace is a learning environment, it may not be sustainable. What are the implications for mobile work environments?
- Employers are responsible for healthy work in healthy workplaces. How is healthy working assured for mobile workers?
- Do mobile workers experience greater control of their own work? Alternatively, have they been obliged to assume many of the risks previously borne by employers?
- What are the demands to infrastructure policy and spatial development, and what are the requirements to office infrastructure when mobile working is developing further?
- As change agents, how can firms influence their own future by engaging in learning processes, long-term interaction and networking?

MOSAIC has highlighted new patterns of work organisation, which have taken advantage of mobile working and mobile technologies. As an example, we were involved in developing the “Healthy Working Centres” concept in the UK, which were intended to bring together employees of several organisations to share a common workplace. This raised issues of trust, confidentiality and new ways of working which need to be overcome if new social capital is to be created.

In another project, we have been involved in the issue of control and participation in new work environments. The strong technology focus underpinning much work on mobile work environments can reduce the attention given to the changes as they impact on those workers who lack control over their own work, and lack the opportunity to participate in decision making. For such workers, change can mean stress, and a variety of adverse consequences. This is exacerbated by corporate strategies such as restructuring and outsourcing, whereby particular functions are relocated. This can mean large-scale downsizing. There has been less discussion of the long-term impact on the enterprises, given that, in a knowledge-based economy, the knowledge of the workers is a key asset. Once it has become mobile, and departed, it may not be there when it is needed.

Also the issue of ageing is important in this context. During the course of MOSAIC there has been dramatic diffusion of mobile technologies, so that it is now commonplace to have Wi-Fi connectivity in the high street, and children have sophisticated low cost mobile phones. With discussions of free telephony via the Internet, the future of landlines is no longer secure. However, mobile technologies can also help maintain involvement of older workers, drawing on their experience and tacit knowledge to provide advice to colleagues.

A final example is the evolution towards “knowledge workplaces”. The dividing line between work and learning has become unclear. Organisations that had been established for one purpose can now take on another. A community school or college can also provide a local focus for enterprises, who now recognise that learning must be part of their ongoing business.

#### **6.4 ROLE OF STAKEHOLDERS AND CHALLENGES FOR THE FUTURE**

In the European Union we are accustomed to a central role for the Social Partners, who have seen it as in their shared interest to have stability and gentle change. The move to small and medium sized enterprises has reduced the power of the social partners, and mobile technologies have offered companies ways of circumventing local restrictions. We need new ways of communicating, new ways of achieving and sustaining consensus, amid rapid change.

There are tensions emerging in the European Union, with dimensions involving mobile technologies. The EU of 15 (with reservations from the UK) has developed a consistent social model, which balances security for workers with flexibility for employers. The new member countries in the EU of 25 have lacked the same policy and cultural infrastructure, and have been influenced by models from the United States and Japan. The UK has argued for deregulation, and for a single European market in services, which would make it easier for transnational companies to dominate new member countries.

Free trade and protectionism are alternative options, not just for textiles, but also for new technologies. The EU faces considerable competition, in particular from China. The EU is a major user of new technologies, including mobile technologies, but increasingly they are manufactured overseas. It is evident that the EU cannot compete with China and other emerging countries on the basis of cost. The challenge, set in Lisbon in 2000, was for Europe to become the world's leading knowledge-based economy by 2010. That target can only be achieved if new ways of working, and new technologies, are grasped as opportunities, not rejected as threats.



### 7.1 INNOVATION OPPORTUNITIES

Current innovations in the area of future workspaces demonstrate the potential to considerably change our way of working, affecting also our daily lives. ICTs have an important role to play in supporting mobility, collaboration, context- and location-awareness, networking and ambient interfaces to enable people to work together irrespective of constraints in location and time. A key challenge is to support efficient, intuitive, user-centric work environments where technology is aligned to the demands of people working in organisations and communities of individuals.

Mobile and collaborative technologies alone can only address some elements of workspace innovation. A holistic concept of workspace innovation and ICT solutions is needed, giving due considerations to the different viewpoints and instruments: market pressures, people issues and workspace organisation.

Traditional views on mobile working are confined to supporting the mobility of individual workers in order to increase individual productivity. This perspective should be broadened to include the mobility of the workplace and mobility of the work as well as in the view of improving collaboration among individual workers in order to increase inter-personal productivity and to stimulate creativity and innovation. The vision is that the workplace enables work to be carried out where and when it is found beneficial for the individual workers and for the collaborating groups or communities of workers, and to that end the workplace infrastructure must adapt to the demands of collaborating people.

Given the productivity gap between US and Europe in exploiting ICTs, and given the trends towards global working, it definitely constitutes a real challenge for Europe to develop innovative collaborative workplace concepts that enhance productivity and human creativity, and that integrate these concepts into smart organisations and environments such as on-line communities of eProfessionals.

### 7.2 DEPLOYMENT CHALLENGES

In mobile working, first success stories of supporting the mobile individual exist, in different sectors. However, the current examples are often disintegrated, lack courageous process and organisational redesigns, and are ambivalent regarding change management as they are looking mostly towards the workers performing non-collaborative activities.

A balanced change strategy should improve the flexibility of processes, organisations and regulations. The determinants of ICT competencies among employees must be addressed, to adapt faster to technological opportunities and to align opportunities and demands. ICT solutions should allow more flexible integration with adjacent systems. In the long run, the development of new working environments yields a seamless e-integration along inter-company value chains.

The transition between traditional ways of working to mobile and multi-location ways of working presents risks as well as opportunities to do things that could not be done before. It is necessary to understand the requirements for working in the new e.g. dispersed environments.

In engineering sectors, mobile and collaborative working enables companies to shorten product life cycles, to accelerate product development, select better solutions and to handle more complex design and engineering issues. A number of barriers need to be overcome in order to integrate mobile and collaborative technologies in engineering. Among the barriers are: organisational readiness for deploying mobile technologies; lack of adequate business models for guiding the collaboration between multiple partners; lack of integrated platforms, which should provide seamless access to information, tools and experts; lack of robust and reconfigurable devices to support various processes and communication.

In order to overcome the bottlenecks, the following activities must be part of a roadmap for innovation. In the short term we advocate so-called Living Labs research for concurrent user involvement, to experiment with different approaches, piloting current technologies and studying the human behaviour in simulated future scenarios. Mobile virtual reality and augmented reality environments may be studied in short term and human factor issues can be examined to develop adequate mobile devices. Mid term research would include standardisation issues among which the building blocks for a mobile and collaborative working reference architecture will be defined. In the longer term, completely interoperable and seamless services must become available along with context-aware interfaces.

In health and wellbeing, the key innovation is to establish a pan-European care service, provided by a citizen-centric network of professionals. This care service should be able to implement innovative health services scenarios, such as distributed healthcare provision, responding to major incidents, and we-centric services to the elderly. This vision can be realized by appropriate application of technologies within the larger context of managed change in the health and wellbeing sector: that is, systemic innovation. There are several preconditions to be met as part of a roadmap for innovation. These include an affordable infrastructure, trust management, including security and privacy of patient data, and suitable business models underpinning collaborative working in the sector. Large-scale trials (Living Labs) are important to accelerate the innovation cycle and to involve users at an early stage.

Regarding rural and regional areas, we expect a growing importance of implementing strategies for innovation and creation of high-quality working environments, resulting in electronic support of partnering, collaboration and doing business as well as education and learning. Regarding the current situation, there are many differences among the many geographical areas and types of rural areas in Europe. For example in the New Member States, Internet and mobile or wireless access infrastructure is a bottleneck for realisation of innovative regions. There are several challenges to be met in order to realise a roadmap of innovation. These challenges include the fostering of initiatives to support ICT education among rural workers, to set up pilots for promotion of ICT-enabled collaborative workplaces in particular to support the collaboration between SMEs, and to raise awareness of good practice regarding new forms of collaboration. Again, the setting-up of Living Labs will contribute to acceleration of innovations contributing to innovative regions.

### **7.3 STRATEGIC CHALLENGES AND AGENDA FOR INNOVATION**

The most important lessons conveyed by our scenarios, exploring various aspects of the vision of people-centric networked workplaces, are the following. Global division of work will be a major development, but work-life balance issues could hinder its full development and undermine current social models. Mobile workplaces can support the globalisation of supply chains and work environments, but require new forms of leadership, coordination and management.

The vision of e-professionals collaborating in self-organising communities is among the promising models for the future but will require new business models, work regulations and IPR arrangements.

The key strategic challenge is to realise the potential inherent to the various innovations in the area of mobile and collaborative working, to the benefit of business, society and people. To that end a number of major directions that will drive innovation in mobile and collaborative working must be pursued. These directions include:

1. The creation of better work regulations, IPR, policies, processes, business models and applications for flexible working anytime and anywhere. Social and legal arrangements as well as adequate business models must support the implementation of flexible work environments.
2. The development of standards and infrastructure allowing for interoperable and plug-and-play mobile and collaborative work environments. There is a need for reference models, standards and ontologies enabling a seamless, ad-hoc setup of cooperation processes as well as seamless transition of the mobile worker between different working contexts, domains and locations.
3. To develop a better ability for contextualisation of teamwork environments, and for mobile team workplaces, to make collaborative workspaces responsive to external changes. For example, the development of adequate security policies for virtual and mobile team workspaces is a necessity, as well as the development of team awareness services, and the sharing of multi-dimensional work contexts (such as working simultaneously for different companies).
4. To apply the technologies to activities now clearly gaining in importance. One of these activities is collaboration across multi-disciplinary teams in handling an emergency, including immediate rescue, arranging the logistics for support, provision of support for distributed healthcare teams, restoration of basic infrastructure and beyond.
5. To realize a paradigm shift from application oriented to activity oriented collaborative systems. New working environments will be characterized by flexibility, mobility and ad-hoc communication requirements. Collaboration-aware work environments will support cooperation and interaction in terms of activities instead of technical functions.

#### 7.4 IMPLEMENTING THE INNOVATION AGENDA

In order to implement the strategic agenda for innovation and to realise the potential that is inherent in the innovations addressed, the following actions are recommended.

1. To identify and elaborate the key domains for application of mobile and collaboration technologies and to focus on solving important business and societal problems. As an example we have mentioned the handling of emergency situations.
2. To stimulate the collaboration between various research groups and companies worldwide and communities such as Aml@Work operating across the 25 EU member states for the IST research programme dedicated to eWork, in order to cope with the new realities of global working;
3. To set up an international network of Living Labs in the area of innovative work environments, exploring and demonstrating the potential of the various mobile and collaborative working scenarios, to support the collaborationship between users and developers, to create and disseminate good practices; and to understand the human and social impacts;
4. To strengthen the focus on multi-disciplinarity in mobile and collaborative workplace innovation, bringing together technical, social, organisational, behavioural and business disciplines;

5. To bring together the separated discourses related to working environments, hosted by different government departments and the different European Commission Directorates-General.

MOSAIC has explored the future opportunities and deployment strategies for new ways of mobile working in three domains:

- Engineering. Emphasis was on automotive, aerospace, building and construction sectors.
- Health and wellbeing. Emphasis was on mobile working for health professionals. Additionally, emphasis was on health and wellbeing issues for mobile professionals.
- Rural and regional working. This is not a sectoral domain, but an important thematic area. The situation of the new member states has been covered as well.

The aim was to identify stakeholders and bring together key actors in each of the domains to specify requirements, future visions and scenarios for creating user-friendly and deployable mobile technologies to support mobile workers and mobile workspaces. Subsequently, the aim was to analyse the requirements, visions and scenarios, to identify the key challenges in order to define a roadmap for each domain to be more efficient and competitive in delivering services and to empower their workforce with information and skills through mobile working. To that end, each domain-specific roadmap has defined (a) where each sector would like to go with the mobile technology (vision of mobile worker and workspaces), (b) how they want to get there (prioritised key challenges over 2 year, 5 year and 10 year period) and (c) deployment challenges (skills, barriers etc). The work was carried out on the basis of a number of expert workshops.

The domain roadmaps resulted in indicative list of research projects. The domain work has informed the over-all roadmap and research agenda that has been produced by the MOSAIC project. Whereas the sections below present a summary, detailed results can be found in the MOSAIC Reports listed in Appendix 3.

## 1. MOBILE WORKING IN ENGINEERING SECTORS

The engineering roadmap for innovation presented here, considers the identified barriers and emerging drivers for the development and acceptance of mobile technologies. The series of actions leading to potential pathways for a wide and successful deployment are listed addressing different time scales. Finally some scenarios are drawn forming series of consecutive research and development activities aiming at achieving the desired impacts. The content is based on earlier studies and on the outcome of two MOSAIC expert workshops held in Summer 2005 in Germany and in the UK. The methodology takes advantage of recent FP5 IST Roadmap projects such as Future Workspaces and ROADCON, which were focusing on the aerospace, automotive and construction sectors.

Change and innovation in the area of new work environments for the engineering domain is imminent, especially in the wake of technologies that have now become habitual, e.g. the use of mobile phones and similar devices. While there are clear drivers for change, change itself or the speed of change is often hampered by a set of barriers.

### Barriers to change and drivers for innovation

Interestingly in the workshops it was stated that most of the barriers are not of technological nature, but rather related with human behaviour, man-machine interfaces and resistance to change. The organisational culture and readiness together with work processes preceded the interoperability and technology aspects in prioritisation. Lack of tools, cost, trust and security were also identified as important barrier to exploit mobile technologies. The issues of winning

competitive edge with these technologies, the fragmented nature of the collaborative work and the lack of powerful clients demanding innovation and change were other identified barriers.

The following barriers need to be overcome in order to achieve sustainable development with mobile technologies in engineering:

- Organisational readiness for deploying advanced technology including mobile workspaces.
- Lack of flexible work arrangements for workers to use mobile technology to work from anywhere, at any time and at any place.
- Lack of business models for supporting collaboration between stakeholders.
- Lack of understanding of models of collaboration.
- Lack of security and control for supporting seamless access to business information and tools.
- Lack of integrated platforms, which should provide seamless access to information, tools and people.
- Lack of standards for creating interoperable software platforms for supporting the entire product life cycle stages with adaptable interfaces.
- Lack of tools, which are to run on mobile devices to support various processes and communication.
- Lack of robust and reconfigurable mobile devices, which could be used to develop flexible mobile workspaces depending on the tasks in hand.
- Resistance to change.
- Lack of training to use advanced technologies by workers.
- High cost in developing and deploying appropriate mobile solutions.
- Lack of understanding of business benefits.

The market environment was identified as the major driver for mobile technologies in engineering. New phenomena, such as service-centric contracts were seen as important drivers together with high cost of (empty) office space. Technology was seen as a driver as well. Quality of life issues, demonstrated benefits and competitive advantage were also identified together with environmental and sustainability objectives.

The following drivers are seen to support and speed up the development and deployment of mobile technologies in different engineering domains:

- Need to improve business processes to compete in the global market.
- Increasing need for collaboration between workers in the same organisation and between stakeholders from different organisations.
- Company image for attracting potential clients and skilled workforce.
- Importance of service-centric products
- Environmental / sustainability objectives.
- Customer demand for smarter products
- High cost office spaces
- Need for offering stimulating new work environments for workers with improved quality of life.
- Affordable technology solutions.

### Research agenda

The engineering research agenda is presented in three time scales: short term (0 to 3 years), mid term (3 to 5 years) and long term (5 years and beyond). The time frame is indicative, because the technology maturity varies in different countries and regions. Some clients may be ready to exploit new technologies without delay, whereas in some other cases it may easily require some years of adaptation.

In the short term so called Living Lab research: experimenting different approaches, piloting current technologies and studying the human behaviour is seen to provide a platform for refining and simulating different future scenarios. Mobile Virtual Reality and Augmented Reality environments may be studied in short term and human factor issues can be examined to develop more safe and environmental friendly mobile devices. A common reference architecture model is needed for a unified communication infrastructure, integrated services and applications. New business models are needed to support mobile work. Powerless sensor networks are identified and potential new technologies. It is proposed to study the impacts of all these developments to quality of life.

Mid term research would include standardisation issues. The developed reference architecture could be implemented through demonstration projects. Assessment of mobile technologies and applications in real production processes is recommended and guidelines and recommendations would be needed for the systematic deployment and use. Adaptable natural (man-machine) interfaces could be studied and the organisational impact of new business models or new technologies should be researched as well as risk assessment with human impacts to project risks. Mobile environment fitting in time-critical multi-criteria decision analysis is also proposed in the mid term research agenda.

In the long term, year 2010 and beyond, the objectives are completely interoperable and seamless services. Content aware interfaces, completely new technologies and cognitive behaviour models are seen in research focus then, supported by emerging technologies.

### Roadmap for innovation

The results achieved in two workshops are presented in the form of scenarios. They present several logical development paths along with the timeframe of meeting the desired impacts. After that some building construction scenarios are discussed more in depth.

An example of a simple illustration of the previously described research agenda is shown in the following Figure A1-1. Here the desired impacts to be achieved using the mobile technologies in engineering are selected so as to increase the productivity in the value network and to improve the quality of life of the end users and other stakeholders.

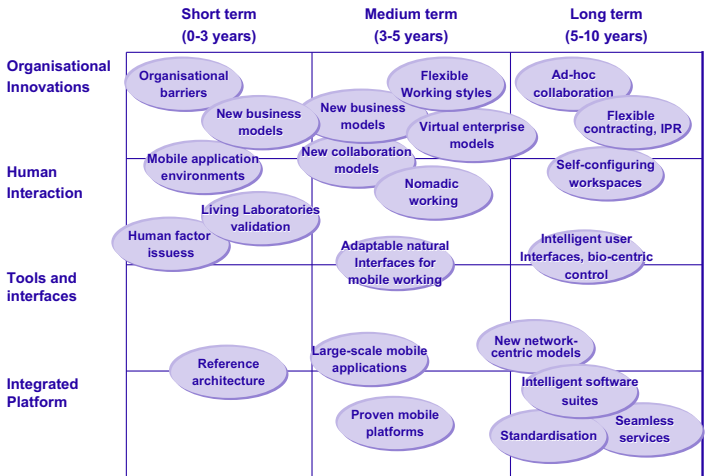


Figure A1-1: Mosaic mobile engineering roadmap



The illustration can be interpreted selecting first the topics that have been identified as current barriers, and then progressing through different steps positioned in different time scales.

### **Human barriers**

The Mosaic Workshops identified human barriers as biggest obstacles for the acceptance of mobile technologies in engineering. Therefore the human factor issues were selected as the basis for one scenario. In short term, the human acceptance, such as man-machine interface is brought as an important horizontal research topic. The human behaviour does not need to be studied apart; new applications may be developed, implemented and concurrently studied in Living Lab environments within the built environment. The common reference architecture providing interoperability to the use of mobile virtual reality or augmented reality environments gives the user a more natural interface to the work. In mid term, adaptable natural interfaces form the major technological challenge to meet the human requirements. Systematic risk assessment needs to be developed in parallel with other tasks in order to succeed in the development. In long term, context aware interfaces provide the opportunity for a breakthrough in order to meet the desired impacts from the use of advanced mobile technologies. The desired goal is to obtain seamless services, which is a considerable improvement from the state of the art in many domains. At the same time with other ongoing activities, new emerging technologies such be identified, studied and developed.

### **Interoperability**

Another main barrier for the extensive use of mobile technologies in engineering as recognized in MOSAIC workshops was the lack of interoperability. In short term, the reference architecture is seen as the key solution for the desired compatibility challenges. Use of new mobile applications and novel innovative services require integration of technologies where common reference architecture is the answer. A special concern should be given to human factors when developing interfaces to these applications and services. Virtual reality and augmented reality environments are also going mobile providing huge development potential. In mid term, standardisation is expected to give a solution to interoperability, not earlier. The standardisation work should lead to practical guidelines and recommendations. It should also relate to adaptable natural interfaces in order to successfully solve the human barriers and systematic risk assessment is required to be studied in parallel. In long term, seamless services are expected to follow the standardised mobile technology pathway for the new era of engineering. Systematic technology watch for emerging technologies is crucial to harness the sustainable opportunities for the coming generations.

### **Tools and methods**

The third clear barrier as observed was the lack of tools and methods for the exploitation of mobile technologies in engineering. The use of systematic methods and tools may lead into change in traditional working methods, the acceptance and spreading use of new tools based on mobile technologies speeds up the development towards mobile engineering services. In short term, the use of virtual reality and augmented reality technologies in mobile work environments is expected to provide the greatest opportunities. Together with this platform, the reference architecture should be developed in order to provide the needed interoperability. Sensor networks seem to provide, already in short term, means to spread the use of tools in real life and work in practice. Such promising platforms need to be studied in order to be able to deliver new innovative services for mobile work. In mid term, development and implementation guidelines and recommendations play an important role related with applications and practices that will have a strong support then from the standardisation work. New sustainable business models

need to be created to achieve progress. In long term, prospective studies on new technologies and research on new business models are proposed. Continuous study on emerging opportunities, systematic technology watch and updating the prevailing mega trends and new weak signals raise opportunities for innovative breakthroughs.

### **Work environment**

Mobile work, different lifestyles and work environments in the sustainable knowledge society create demand for services based on mobile technologies; the personal quality of life and well-being issues may also demand mobile services accepted by mobile knowledge workers. In short term, powerless sensor networks provide huge opportunities for developing intelligent work environments supporting individual user needs. Combining other technologies and understanding the outcome from human factor studies provide new avenues for new service platforms. In mid term, guidelines and recommendations are needed and the birth of new sustainable business models must be systematically supported. Based on the achievements at that stage and understanding the local user needs different kinds of new networked whole life service concepts may be developed. In long term, new technologies provide opportunities for innovative work environments and research on cognitive behaviour models provide an auspicious development path. Learning from other domains and technologies combined with the capability of integrating horizontal spearheads provide an opportunity for increased productivity and improved quality of life.

### **Conclusions**

The distributed and collaborative nature of work in addition to high ownership costs of work facilities are promoting mobile work in engineering sectors such as aerospace, automotive, and mainly construction. Availability of supporting technologies contributes towards increased productivity when used for mobile work.

We identified a set of limiting factors to mobile work within engineering sectors. These include: human barriers, interoperability issues, exciting tools and methods of work, and, existing work environments. A roadmap with supporting scenarios demonstrating short, medium and long-term actions was developed to show the different pathways to achieving context aware interfaces, seamless services, integration and use of new technologies, and cognitive behavioural models.

Technologies such as mobile phones that support mobile work have now become habitual technologies that form an integral part of a knowledge worker's attire like his/her watch. This is therefore an opportune time to leverage upon this as an enabler for change that will support improved productivity and improved quality of life through mobile technologies enabling mobile work.

## **2. MOBILE WORKING IN HEALTH AND WELLBEING SECTORS**

The MOSAIC vision for future Health and Wellbeing is to establish a sustainable pan-European (and ultimately global) citizen-centric care service, provided by citizen-centric Value Networks of Professionals. This vision will only be realized by appropriate application of technologies within the larger context of managed change in the health and wellbeing sector: that is, systemic innovation. In order to establish and introduce best e-Health solutions the overall context of the service must be taken into account, including the healthcare organisations, their working practices and the society served. The focus should be on points that promise better deployment of resources and hence cost savings for the service; and improved quality of care, quality of life and independence for the citizen/patient. The aims include bringing safe mobility to the patient,

overcoming distance in collaboration of medical teams and bringing mobility to health professionals.

The objective is to provide medical care and support of wellness and well being at high quality standards independent of the place and time of the players. There is a need to provide security and safety for patients with critical conditions by permanent monitoring of their health state in a way that allows the best medical specialists to collaborate and provide the best treatment based on best practice to patients independently of where they (patient and professionals) are located. This can be characterised as a commitment to ubiquitous healthcare mediated by the ambient intelligent workspace. The main goals are:

- To empower the patient and increase safe mobility and freedom for patients by means of tele-consultation, tele-monitoring and tele-treatment services;
- To facilitate collaborative working of medical teams at a distance;
- To enable mobility of medical professionals so that virtual medical teams can be constructed on an ad hoc basis irrespective of the location of the professionals.

The vision builds on a range of emerging and future technologies including broadband communications (wired and wireless access), multimedia EHR (Electronic Health Record), smart sensors, wearable computing, mobile devices, ad hoc networking and ambient intelligent environments to support innovative services for the mobile patient and for the mobile medical professional. Future e-Health systems should support collaboration between patients and health professionals within the new care model with the point of care able to shift seamlessly between healthcare centres, the home and the community at large, enabling global roaming for both professionals and patients without interruption of care. It should also include the patient (if able), and their family and informal network of careers, as part of the collaborating team.

Future provision should be characterised by consumer driven health, with appropriate incentives and disincentives for the health consumer, and a service environment which is created incrementally based on medical / clinical evidence. Future provision should also be characterised by provider systems where healthcare professionals and healthcare organisations work in accordance with predefined Integrated Care Pathways (ICPs), and learn and adjust and improve their processes based on documented data. Additionally, provider systems must include a semantically interoperable infrastructure providing access to patient data (EHR), process data (DW) and knowledge repositories, and allowing services to be provided anytime and anywhere.

There are several preconditions to be met before new ideas can become innovations in the context of Citizen-centric Value Networks of Professionals. These include:

- Affordable infrastructure that is in place (standards based and generic)
- Proof-of-principle: Ideas must be shown to work in real-life situations
- Ideas must be benchmarked against existing work practices to show that they are cost-effective and efficient
- Trust (including security and privacy of patient data): Applications must comply with the relevant legislation.
- Suitable business models underpinning collaborative work in the sector need to be demonstrated.

In the following section we list the scenarios illustrating some of the future possibilities arising from the MOSAIC vision of future care and collaboration in the health and wellbeing sectors.

## Scenarios and deployment strategies

We have developed 12 scenarios illustrating the vision of future mobile collaborative work in the domain of health and wellbeing Table A1-1. Each scenario is accompanied by an analysis of the actors involved and the challenges and requirements raised from three points of view: technological, societal and organisational. The scenarios cover both mobile working for collaborating teams of (health) professionals and support of the health and wellbeing of mobile workers. Applications range from use of mature existing technologies – but requiring systemic innovation in organisation and delivery of health care services – to very futuristic visions assuming existence of full Ambient Intelligent Environments. Chronic and acute care, including emergency medicine, are covered and a range of settings are represented, including hospital, homecare and the community, with mobile services allowing patients to roam freely, enabling ubiquitous care. Different categories of healthcare professionals (surgeons, physical therapists, anaesthetists, physicians, nurses) and multidisciplinary teamwork amongst different specialties are represented. Collaboration is seen as involving not only professionals but also the patient and their informal care network. Health and wellbeing support for workers in other domains is illustrated in relation to mobile services for disabled workers and for workers in hazardous environments. For example the Welfare scenario shows how mobile technology can support social services workers, and the Major Incident Scenario shows how inter-service collaboration and coordination between emergency services and safety of emergency personnel could be enhanced by use of advanced ambient intelligent environments and advanced networking concepts.

**Table A1-1: Health and Wellbeing scenarios**

Scenarios	Source
1. Distributed healthcare service provision	Niels Boye
2. Welfare	Paul Cheshire
3. Active Health	Active Health project (Michel Demeester)
4. Major Incident (disaster response)	Val Jones, Written for MOSAIC and <a href="#">AMI@Work</a>
5. Management of resources in hospital	Ilkka Korhonen
6. Diabetes Management	EU Domain project (Justin Meadows)
7. Mobile physiotherapists	PAINS project (Christopher Nester)
8. Domestic Wireless	Jorge Falcó, Armando Roy
9. HealthSpace	Niilo Saranummi
10. Telemonitoring	Freeband Awareness project
11. Assistance to Disabled	Freeband Awareness project
12. FRUX We-centric service for elderly	Freeband FRUX Project

These 12 scenarios for Health and Wellbeing cover a number of dimensions.

**Supporting collaboration amongst (virtual) teams of health professionals.** The scenarios cover chronic and acute care, including emergency medicine. The diabetes scenarios show how patients and their families can be better supported as members of the care network, which supports self-care and disease management for patients with chronic conditions. Detection of epileptic seizure in the Awareness Telemonitoring scenario shows how acute episodes may be detected and assistance sent to the patient. In the Major Incident Scenario the paramedics and the trauma team at the receiving hospital are able to collaborate together to give better quality of emergency care to the casualties.

**Different categories of healthcare professionals.** Different categories of healthcare professionals and clinical specialties (surgeons, physical therapists, anaesthetists, physicians, nurses...) and multidisciplinary teamwork amongst the different specialties are represented.

**Ubiquitous Point-of-Care.** Different settings are represented, including hospital, homecare and the community, with patients able to roam freely (potentially globally). Mobile devices plus wireless communications enable ubiquitous care, where the point of care moves seamlessly with the patient (e.g. the Awareness Telemonitoring and Teletreatment scenarios).

**Other Services for the citizen.** The Welfare scenario shows how social services workers can be supported by mobile technology. The Major Incident Scenario shows how inter-service collaboration and coordination between emergency services workers might be enhanced by use of advanced ambient intelligent environments and advanced networking concepts.

**Health and wellbeing support for workers in other domains.** The Awareness Assistance to Disabled scenario shows how a blind person can be helped to be independent and mobile in daily life activities including work-related activities. The Major Incident Scenario shows how workers in hazardous environments can have their health and wellbeing supported by wearables, which enable vital signs and environmental monitoring (firefighter, paramedic and police AMI-suits).

**Technological ambition.** The scenarios span a range of technological sophistication ranging from use of mature existing technologies (but requiring systemic innovation in delivery and organisation of health care services) (e.g. Active Health scenario using internet and web) – to very futuristic visions assuming the existence of full Ambient Intelligent Environments in buildings, vehicles, highways and wearables (such as the paramedic AMI-suits) in the Major Incident scenario.

During several workshops, various experts from relevant domains have validated scenarios.

### Health and wellbeing mobile working roadmap

Figure A1-2 (*next page*) summarizes the results of the expert evaluation workshop relating to predicted timescales for future developments. It shows a roadmap relating to the evolution in three key dimensions: societal, organisational, legal and regulatory developments; innovative mobile working applications, and enabling technologies.

### Conclusions

- Consultation with, and involvement of, the stakeholders in change planning and change process is a prerequisite to public and professional user acceptance of both technological and systemic innovation.
- The key technological challenges emerging from the validation workshop related to providing adequate mechanisms to support security and trust, protection of privacy of personal data, provision of adequate Quality of Service, and safety of applications, equipment, communications, and of information.
- From the non-technological perspective, the development of adequate business models is an essential prerequisite. Systemic innovation should begin from a thorough analysis of existing organisational and societal factors, sectoral work practices, workflow and business models, and proceed via a systematic concurrent evaluation process incorporating (but not restricted to) economic appraisal, and involving in vivo large-scale trials (Living Labs). Best practice for

evaluation at this stage is by means of large scale randomised controlled trials involving real end users, and applying trial design methods and analytical techniques from the disciplines of Health Services Research, Health Technology Assessment and Health Economics.

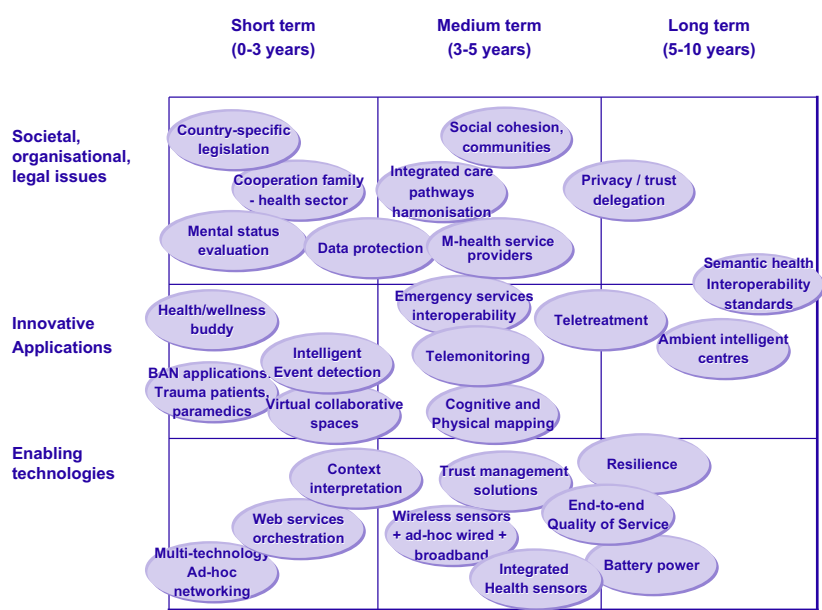


Figure A1-2 Roadmap for mobile working in the health and wellbeing domain

### 3. MOBILE WORKING IN RURAL AND REGIONAL AREAS

In exploring the role of mobile workplaces in rural and regional environments, we have focused on specific requirements resulting from the current situation, visions and scenarios for these environments, as well as on an analysis of case studies and on contributions from numerous experts, especially from the new member states that have participated to workshops. The scenarios were validated by groups of experts including practitioners, researchers, industry representatives, and policy makers during dedicated workshops.

#### Current situation

Today, most working practices in rural areas relate to traditional occupations and follow a traditional approach. Flexible forms of employment are rare exceptions. One of the basic reasons for this is a low level of ICT awareness and education among rural inhabitants and workers (even though rural ICT-based companies do possess adequate skills), and unwillingness of people who have lived and worked in these areas for their whole lives to change their traditional approach. On the other hand, due to different phenomena like migration, and increasing mechanisation of traditional activities, the quantity of these “base” traditional jobs and workplaces has been falling steadily.

These facts significantly and negatively impact the level of ICT demand, which in turn makes rural areas less attractive for commercial investments. Telecom service providers are thus unwilling to develop access infrastructures – also due to high costs of such developments and

inappropriateness of “urban” technologies to rural environments. Consequently, this unwillingness does not help to increase the demand, and thus a “magic circle” has been created.

On top of this, in some countries (especially in New Member States) national strategies of building the Information Society and introduction of new ICT-based working environments in rural areas have not been realised adequately. The obligation to provide basic infrastructure does exist but it has not been implemented properly. Tele-working is officially considered as important for development of the Information Society but few concrete steps towards its implementation have been taken. Additionally, insufficient interaction and collaboration among the key players (researchers, research institutions, industry and policy makers) at regional, national and European levels has been realised. What is more, the general representation and participation level of rural entities in decision-making organisations has been too low.

### **Vision**

Our long term vision of development of new working environments in rural areas assumes that these regions have become more important for policy makers and more visible in decision making bodies. This will result in certain legislative support e.g. by regulations concerning teleworking and in practical implementations of regional and national development strategies. When supported by changes in education and initiatives that stimulate awareness among rural workers and citizens, both the perception of IST benefits or usability and the demand for new communications and information technologies will significantly increase in rural areas.

By 2010 the currently existing digital gap should have been significantly decreased, thus allowing for new ways of working and living in rural areas. Due to certain developments (mainly in infrastructures) the migration will have stopped by then, and a younger generation of rural workers (including “traditional” professions, like farmers) will begin taking over.

Moreover, reverse migration will be noticeable – a part of companies and a certain number of people living in cities will decide to move to rural areas, due to better living conditions and lower costs attainable simultaneously with IST-based comfort of work and communications. Therefore, a number of new working practices and jobs in rural regions will significantly increase, while a large part of traditional activities will be done by means of ICT.

### **Scenarios**

We have developed two scenarios that draw a vision of future mobile collaborative working environments in the rural and regional domain. The first scenario is called “Rural World Platform” and focuses on a systematic approach to supporting rural industry. The scenario is composed of few simpler scenarios, derived on basis of case studies, which concerned only selected issues like e-learning or on-line rural trading platform. It does not focus on technological aspects but rather on organisation and “soft” skills that have to be provided to citizens, workers and organisations from rural regions. It describes a situation in which a rural area has access to a wired and/or wireless broadband connection. Farmers can use an on-line e-collaboration tool called Rural Advisory Platform – both for seeking assistance and for creating/maintaining their own business activities. Thus, after evolutionary change over several years, the rural sector may be seen as an economically viable and stable – similarly to today’s urban economies.

The Rural World Platform scenario highlights the importance of e-collaboration in rural areas (currently, many rural SMEs and/or individuals are not used to collaboration or partnering – this



is especially true in the New Member States). It shows how citizens see the rural sector as a working place for their life. However, in order to fully realise it, regulations related to different aspects of setting new working environments in rural areas have to be as uniform and transparent as possible. Appropriate representation of the rural sector in the public administrations is necessary, and changes in the distribution of rural funds have to be implemented so as to make them comparable to other – more “urban-centric” schemes.

The second scenario addresses collaboration among e-professionals and is called “EU Veterinarians – a working day”. This scenario, written by Mr. Mariano Navarro de la Cruz (Tragsatec) for the Collaborative Working Environments Expert Group in 2004, was analysed in MOSAIC in order to illustrate technological challenges of rural and regional working environments and to show what can be done in terms of defining innovative approaches to these problems. The scenario’s main actor, Victor, is a recently graduated veterinary, being on the first day of his job. While visiting a cattle-holding farm in Spanish Galicia, Victor is to carry out, together with his more experienced colleague, an identification inspection of the farm. They encounter a situation when an immediate organised action of the whole veterinary service in the region is required in order to prevent spreading of Food and Mouth disease. The introduction of ICT – relatively easy in densely populated urban areas – have proven to be very difficult in rural areas which are rather conservative in all countries, and complete adoption of these technologies arises many doubts at everyday work of professionals, like sanitary inspectors, CAP inspectors, natural resources preservation managers, etc. The scenario shows that extensive use of P2P networks, sensor networks, collaborative working environments, GIS management systems, along with strong wearable computers equipped with automatic configuration agents for any kind of mobile devices could bring up a complete solution that should entail a great opportunity for the adoption of those and other new technologies and for human resources / economic savings for the involved companies.

Both scenarios, although of a different character and scope, may be concluded with convergent conclusions. In each case, the necessary technologies are almost available; at least in a form which is sufficient to implement a demonstration system. Of course, moving from a demonstration to a working and sustainable solution would be a major step; a step that might be called systemic innovation. The key to change is likely to be the facilitation of the development of regional innovation systems in rural areas, providing a supporting infrastructure of relationships and networking among peers. Significant changes in the current approach to education must be additionally introduced in order to make it more appropriate to convey practical knowledge related to life and work that benefits from large-scale research programmes such as IST. And it is not enough to focus just on continuous learning. In order to establish a really effective system, a complete educational framework covering the whole learning period (from a primary school, to universities, to vocational courses) is necessary.

### Preparing the roadmap

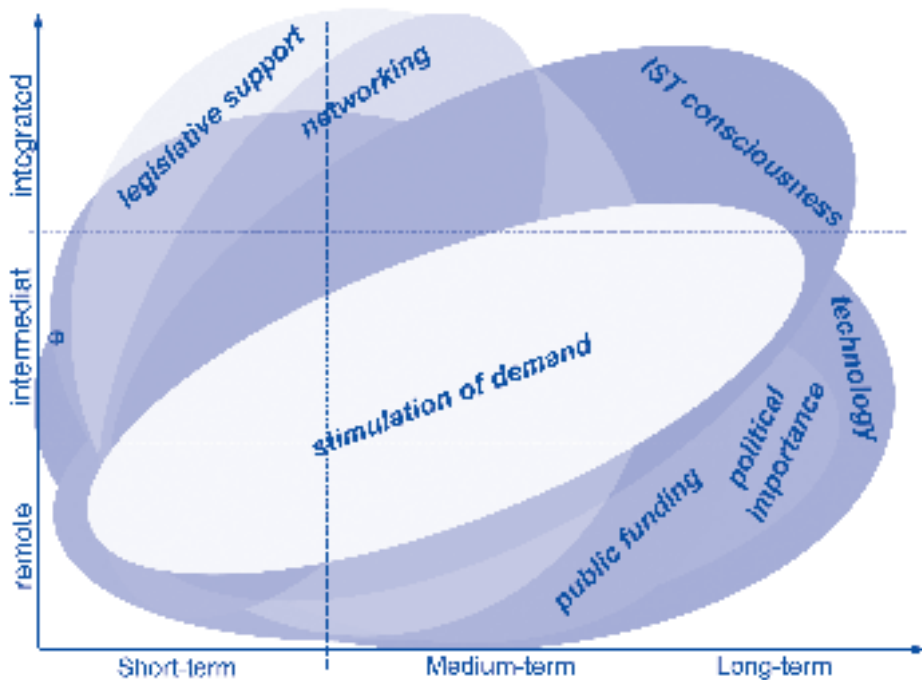
For the purpose of developing focused recommendations for future supporting actions dedicated to rural and regional mobile working, we have used a two-dimensional matrix of timescale / rural area type, as presented in the following figure. The periods for which we develop the recommendations include the short- (2005-2006), middle- (2007-2009) and long-term (2010 and later) perspective. The differentiation of rural area types was based on the classification proposed by the FP5 RuralWins project (IST-2001-39107):

- Integrated rural areas, being territories with a growing population, employed mainly in secondary and tertiary sectors, however with farming still being an important use of land.

The environmental, social and cultural heritage of some of these areas, relatively close to big cities, may be under pressure of "re-urbanisation". Similarly, the rural character of some of these territories is at risk of becoming predominantly dwelling suburban areas.

- Intermediate rural areas, which are relatively distant from urban centres, with a varying mix of primary and secondary sectors. In many countries larger scale farming operations are to be found in these areas.
- Remote rural areas, with rather low population densities, often also with the lowest incomes and ageing. They depend heavily on agricultural or fishing employment. Telecommunications services provided are typically inadequate, due to high costs and remoteness from transport networks and business centres.

The mapping allows exploring which categories of recommendations are important for which rural area types and for which implementation periods. For example, stimulation of demand for IST (in general) is essential for remote and intermediate areas – irrespective of the timescale, while raising IST consciousness should be the key priority for all area types at any time. On the other hand, legislative support – in all areas – seems to be especially important in a short- and medium-term perspective.



**Figure A1-3: Evolution in rural area types**

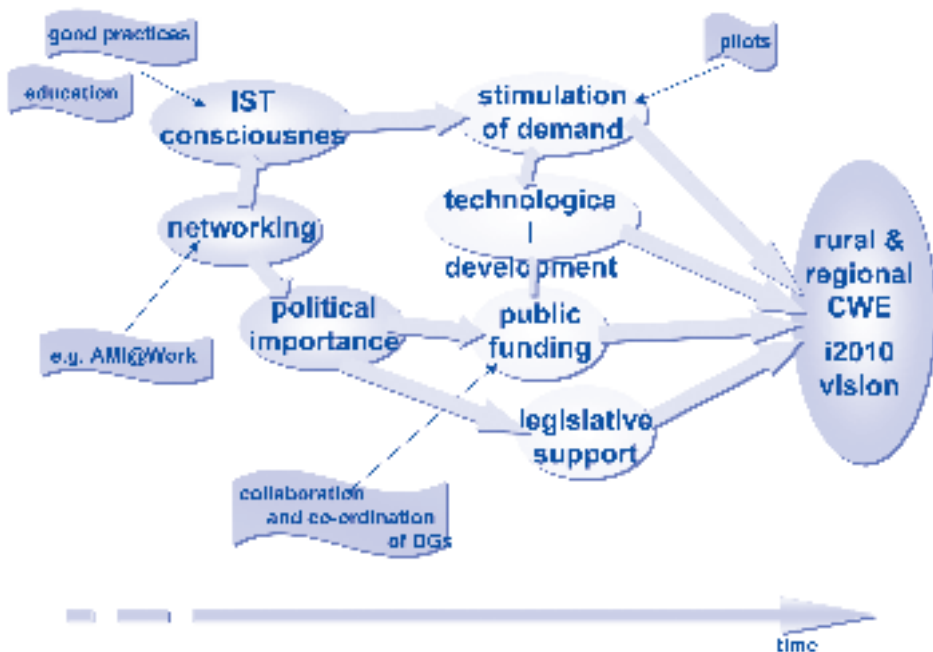
Based on the undertaken analysis of recommendation sets and of the scenarios, a number of key recommendations that form the framework of a rural & regional m-working roadmap have been provided. They encompass:

- Fostering of initiatives that support ICT education in rural areas and among rural workers, and that increase awareness of good practices (in order to build consciousness of the needs and challenges);

- Setting up pilots for further promotion of ICT (so as to stimulate demand);
- Promotion of networking through setting up initiatives for collaboration among key players of the rural market and for creation of rural business support and social infrastructure;
- Actions aiming at increasing the co-operation among European Commission's DGs (to facilitate distribution of public funding and to increase efficacy of its use);
- Inclusion of rural problems into national / regional strategies, to enable appropriate legislative support;
- Ensuring appropriate representation in key policy making bodies in regions/countries and in EU (and thus increasing political importance of rural working environments);
- Implementation of rural collaborative workspaces through technological research and aligning solutions to domain's specific needs.

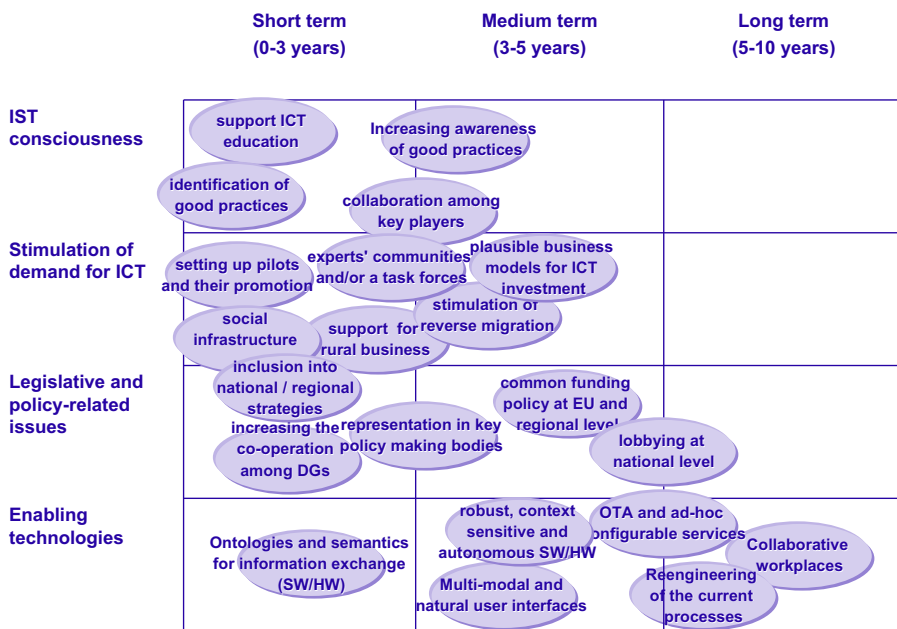
### Roadmap

It must be mentioned here that there are available specific roadmaps of rural and regional mobile working development, focussing on different types of rural areas (integrated, intermediate and remote). The following figure A1-3 presents a generic policy-oriented roadmap, showing the preferable path that must be followed in order to achieve the situation described by the MOSAIC vision. Through initiatives that build and strengthen the awareness of opportunities of information society technologies, stimulate networking and collaboration, and that increase political importance of rural issues, we will be able to initiate and sustain growth of ICT demand backed by tailored public funding, legislative support and relevant technological developments.



**Figure A1-4: Policy roadmap for rural and regional working**

The next picture shows a high-level roadmap setting out milestones for policy areas and technology, aiming to stimulate rural and regional working and create systems of innovation.



*Figure A1-5: Roadmap for rural and regional working*

### Conclusions and recommendations

Since many technological aspects of rural development have been discussed in previous studies, our key conclusions encompass mainly non-technological issues. We focused mainly on issues relating to the implementation of new working environments, e.g. on the need for detailed and multi-dimensional analysis of rural workers' and workplaces' needs and requirements for technologies, adaptation of hardware, applications and services to the specifics of rural environments. Our conclusions include:

- Education and good practice promotion: it is especially true in less-developed regions where traditional work and values prevail; many experts consider the 'learning by watching examples' - especially examples of your neighbours - as the most effective way of raising the awareness and increasing demand.
- Setting up pilots and "living labs": this is another practical method of spreading the news of benefits that information society technologies bring. A successful pilot may be easily extended in the implementation region or promoted elsewhere. However, it must be remembered that – especially in remote regions and specifically in the short- and medium-term – setting-up pilots will certainly require external (probably governmental) funding.
- Collaboration among key players and creation of rural business support: the key issue here is the extension towards co-operation in regional, national and – most importantly – EU level. For entities from New Member States, where partnering and clustering at least in the rural sector is still a rather rare phenomenon, is a priority. Such initiatives will lead to strengthening the position of rural economy, stimulation of demand and accelerating innovation and development. The most natural way of implementation of this is to continue and to intensify activities of the existing Rural@Work AMI Community.
- Better co-operation among different European Commission's Directorate-Generals. Without such collaboration, different DGs which are currently involved in selected rural-related activities (e.g. DG Information Society and Media, DG Agriculture, DG Research) will focus on

their own work agendas, even though the agendas should ultimately lead to achieving the same overall objectives based on the Lisbon Strategy and the i2010 Programme. In a medium-term perspective, joint planning, budgeting and spending rural policy from the involved DGs is necessary.



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Next MOSAIC reports are a selection and downloadable at: [www.mosaic-network.org](http://www.mosaic-network.org)

**Mobile Working State of the Art, Vision, Scenarios and Challenges. MOSAIC Report D1.1 (3 reports).**

Hans Schaffers (Ed.). Contributors: Maria Cristina Brugnoli, Seamus Hickey, Elke Hinrichs, David Martland, Manuel Mattheß, Veli-Pekka Niitamo, Marc Pallot, Wolfgang Prinz, Hans Schaffers, Robert Slagter, Stephan Vollmer.

**Mobile Working Roadmap. MOSAIC Report D1.2.** Robert Slagter and Hans Schaffers (Eds.).

Contributors: Maria Cristina Brugnoli, Terrence Fernando, Seamus Hickey, Irene Lorusso, Veli-Pekka Niitamo, Marc Pallot, Wolfgang Prinz, Petri Pulli, Hans Schaffers, Mikko Riissanen, Robert Slagter, Anna Tarchalska, Adam Turowiec, Stephan Vollmer. Edited by Robert Slagter and Hans Schaffers.

**Mobile Working Research Agenda and Joint Projects. MOSAIC Report D1.3.** Konrad Klöckner and Wolfgang Prinz (Eds.).

Contributors: Maria Cristina Brugnoli, Terrence Fernando, Seamus Hickey, Konrad Klöckner, Veli-Pekka Niitamo, Wolfgang Prinz, Hans Schaffers, Stephan Vollmer.

**Mobile Working Best Practice Case Studies and Success Factors. MOSAIC Report D2.1.** Torsten Brodt (Ed.).

Contributors: Erik Andriessen, Torsten Brodt, Liz Carver, Veli-Pekka Niitamo, Marc Pallot, Spiros Alexakis, Adam Turowiec, Olli Martikainen, Robert Verbarg.

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Contributors: Karel Charvat, Jose Franco, Javier Garcia Perez, Begoña Gonzalez Ruiz, Peter Gruhala, Elissaveta Gourova, Witold Holubowicz, Patrycja Mlynarek, Wendy Moreno, Ignacio Muro Benayas, Kazimierz Szopa, Anna Tarchalska, Adam Turowiec, Piotr Wiench.

**Societal Change Aspects of Mobile Working: Developing Strategies. MOSAIC Report D4.2** Richard Ennals and Chris Reade (Eds.).

Contributors: Richard Ennals, Campbell Ford, David Hopson, David Martland, Anne-Marie McEwan, Per Malmberg, Veli-Pekka Niitamo, Thomas Odamtten, Hiten Patel, Chris Reade, Hans Schaffers, Les Stratton, Jarmo Suominen, Peter Totterdill.





Key objective of the MOSAIC Specific Support Action (FP6-2003-IST-2) has been to accelerate innovation in the mobile and collaborative workplace, aiming to realise more productive and creative work environments. MOSAIC has established a community network preparing future innovation in Europe through a process of vision development, scenario building and roadmap construction.

The MOSAIC Specific Support Action has explored business and societal innovation and prepares Europe for deploying innovative mobile technology in a range of application domains, to support mobile collaborative workers in distributed and location-sensitive settings. It focused on mobile and collaborative working in three key domains: (1) Healthcare and Wellbeing, (2) Engineering sectors (building, construction, manufacturing) and (3) Rural and regional work environments. MOSAIC has worked closely with the New Working Environment unit of DG Information Society and Media to establish communities in the area of Ambient Intelligence (AMI) technologies. The AMI@Work communities that have been launched in June 2004, now counting more than 700 members, currently cover strategic areas such as collaboration, mobility, knowledge and markets, as well as sectors and themes such as health and wellbeing, engineering, and rural and regional working whereas recently Logistics and Media have been added. MOSAIC has encouraged the participation of small and medium-sized enterprises and small research teams across Europe including the New Member States.

MOSAIC has carried out a series of parallel activities such as to build a community expert network, identify good practices and critical success factors in current mobile working, identify future R&D and develop domain-specific roadmaps to support the successful deployment of mobile working within the chosen three application sectors, develop a generic roadmap and research agenda for mobile working, promote Europe wide collaboration for deploying mobile work environments, and run working groups and dissemination activities. Through these multi-disciplinary work activities, MOSAIC aimed to influence policies and strategies of major stakeholders in business, government and research, at national and international levels, for research and innovation in the area of 21st Century mobile and collaborative work environments.

The MOSAIC Network has been linking with all the AMI@Work communities, projects and other initiatives for joint activities. MOSAIC Working Groups offered membership to individuals either users, researchers, providers, consultants, policy makers and decision makers interested in contributing to shape the vision of the future mobile workplace, and to commonly develop scenarios and roadmaps for application domains in mobile working. Through registration on our MOSAIC website and participating in Working Groups and Workshop series anyone could contribute. MOSAIC workshops have been partly organised jointly with Ambient Intelligence@Work family of communities' events as initiated by the New Working Environments unit of the European Commission.



This Appendix provides a short overview of related projects in the area of New Working Environments. A more detailed overview is contained in the Collaboration@Work 2005 publication of the European Commission (2005). Application domains include health, family and working life, creativity, manufacturing, logistics, and emergency handling. Several of the projects are relevant for major emergency or disaster support. Advanced ICT is supporting collaboration across multi-disciplinary teams, which is relevant in several aspects of handling a emergency: immediate rescue; logistics for support; provision of support for healthcare teams etc; restoration of basic infrastructure; and beyond.

#### **Mobile user and worker infrastructure**

MuliMob (FP6-2003-IST-2-511483): Awareness enhancement for multilingual and multicultural mobility issues. Targeting the mobile value chain actors.

MobileIN (FP6-2003-IST-2-004498): Open framework for service creation and execution in multi-domain heterogeneous network environments.

#### **Health**

BEANISH (FP6-2004-IST-3-015838): Building Europe-Africa collaborative network for applying IST in the healthcare sector.

CASCOM (FP6-2003-IST-2-511632): Intelligent platform for mobile, context-aware applications and services. Validation in pervasive healthcare.

EU-DOMAIN (FP6-2003-IST-2-004420): Mobile distance working platform. Targeting a.o. healthcare trust.

#### **Manufacturing**

INTUITION (FP6-2003-IST-NMP-1-507248): Network of excellence on virtual reality and virtual environments applications for future workspaces.

SNOW (FP6-2003-IST-2-511587): Authoring and exploitation of multimodal mobile documentation for nomadic workers. Targeting industrial maintenance, repair, overhaul worker.

ULTRA (FP6-2003-IST-2-004734): Portable augmented reality for industrial maintenance. Targeting the industrial maintenance worker.

#### **Family Life**

MobilLife (FP6-2003-IST-2-511607): Context-aware mobile services in 3G and beyond. Targeting families and family-work interface.

#### **Creativity**

BrainBridges (FP6-2004-IST-3-015982): Collaborative technologies and environments enhancing the seamless creativity process, leveraging the full European potential.

CREATE (FP6-2002-IST-NMP-1-507947): Creativity processes for enterprise innovation. Validation in household appliance, motorbike industry.

### **Rescue**

SHARE (FP6-2003-IST-2-004218): Mobile support for rescue forces, integrating mobile modes of operation - develops advanced mobile services to support rescue forces during their operation (includes audio, video, text & graphics as well as location information).

WearIT@Work (FP6-2003-IST-2-004216): Support of mobile work in industrial and emergency settings, by wearable computing - develops new wearable mobile computing that supports working on complex tasks.

LIAISON (FP6-2003-IST-2-511766): Location based services (LBS) for the enhancement of working environments - preparation of European market in LBS for launch of Galileo.

AMIRA (FP6-2003-IST-2-511740): Advanced multi-modal intelligence for remote assistance - improves access and resources available to support urgent and critical diagnostics and decision making by mobile field workers in safety critical events.

### **Logistics and support**

POMPEI (FP6-2003-IST-2-511556): Peer to peer location and presence mobile services for managing crisis and disaster situations - integrates P2P, workflow, location, presence and mobile collaborative work services for innovative support of mobile teams in crisis management.

RIMSAT (IST-2000-28655): 'Remote intelligent management support & training' - integrated innovative knowledge engineering techniques and validated in a safety-critical environment.

X-MOB (IST-2001-37789): Extreme mobility - developed a Pan-European ASP-Oriented Open Mobile Platform, validated in scenarios including emergency healthcare application and access to emergency command & control.

eLOGMAR-M (FP6-2003-IST-2-511285): Web-based and mobile solutions for collaborative work environments with logistics and maritime applications. Mobile actors include: traders, reellers, railway carriers, shippers, insurers and others.

### **Policy and support**

COMIST (FP6-2004-IST-3-015809): Aml@Work communities stimulating the participation of NMS and ACC organisations in eWork and eBusiness related IST activities.