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MOSAIC roadmap for mobile collaborative work related to health and wellbeing

Niilo Saranummi[1] and Val Jones[2]

[1]*VTT Information Technology, Human Interaction Technologies, P.O.Box 1206, FIN-33101, Tampere, FINLAN, ,Niilo.Saranummi@vtt.fi*

[2]*Centre for Telematics and Information Technology, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands, v.m.jones@utwente.nl*

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Niilo Saranummi[1] and Val Jones[2]

[1]*VTT Information Technology, Human Interaction Technologies, P.O.Box 1206, FIN-33101, Tampere, FINLAN, ,Niilo.Saranummi@vtt.fi*

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Abstract

The objective of the MOSAIC project is to accelerate innovation in Mobile Worker Support Environments. For that purpose MOSAIC develops visions and illustrative scenarios for future collaborative workspaces involving mobile and location-aware working. Analysis of the scenarios is input to the process of road mapping with the purpose of developing strategies for R&D leading to deployment of innovative mobile work technologies and applications across different domains. One of the application domains where MOSAIC is active is health and wellbeing. This paper builds on another paper submitted to this same conference, which presents and discusses health care and wellbeing specific scenarios. The aim is to present an early form of a roadmap for validation.

Keywords

ambient intelligence, collaborative working, mobile working, roadmap validation, health

Communities' Topics addressed

Well-being Services@Work: New collaboration approaches in health, healthcare and well-being

1 Introduction

The MOSAIC project [Mosaic] is a specific support action whose main objective is to accelerate innovation in Mobile Worker Support Environments by shaping future research and innovation activities in Europe. MOSAIC works closely with the New Working Environments Unit of the European Commission and with their Ambient Intelligence (AMI) @ Work initiative [AMI@Work] to shape future Framework Programmes and to establish communities in a number of vertical (application domains) and horizontal (technology) domains. This paper relates to one of these communities, namely Wellbeing Services @ Work.

The domain comprises two strands: Mobile working for health professionals, and health and wellbeing for mobile professionals.

This paper focuses on a roadmap for mobile work and mobile workplaces in the wellbeing and health care domain. The intent is to collect feedback to the ideas and propositions made in this paper from external experts.

2 Changing healthcare environment

Health systems in all countries have similar goals with regard to access, equity, quality and cost. The provision of health services is based on a varying mix of public, private and 3rd sector providers. Health systems are rather tightly regulated based on national legislation prescribing

e.g. patient rights, terms relating to production of health services, funding / payment / reimbursement mechanisms, rights to practicing medicine (and other health professions), data protection and privacy of data (partly covered by an EU directive), and safety and security of health technologies (in EU Medical Device Directives and in USA FDA requirements).

Today healthcare systems experience pressure for change from inside and outside. From the inside, the continuing innovation in medicine and healthcare technologies expands the methods and tools available in healthcare. Combined with citizen empowerment the demographic changes of an ageing European population stretch the limits of what countries can afford to offer as services of their national health systems. Governments are confronted by the need to find means to limit the rise in healthcare costs. Consequently, at national level health policies, incentives and guidelines for payers and providers of health services are being adjusted to meet the national targets relating to access, equity, quality and cost.

The changes in the framework conditions have lead the healthcare enterprises to look into new ways to organise and deliver health services. As organisations healthcare enterprises have been slow in embracing the possibilities offered by eWork and ICT to streamline their processes and services, and to create new "business" opportunities, such as selling excess capacity or buying-in services more cheaply than can be provided in-house. To some extent this is due to the fact that the incentives for healthcare organisations to step outside their established boundaries do not exist, rather the opposite. At the grass root level, however, eWork has gained acceptance. Healthcare professionals have in their domains of speciality adopted new technologies when these add value to their present work practises. For instance, in imaging services radiologists are routinely reporting imaging studies from their homes through secure web interfaces. These remote services are part of the Picture Archiving and Communication Systems that many vendors offer today. Telemedicine is a broader concept where eWork is strongly present today.

ICT's have 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. The "eHealth dot.com bubble" a few years back, however, taught us an important lesson. As a rule, citizens and patients are not willing to pay for eHealth services directly. Instead they expect these services to be made available by existing health service providers and to be paid as part of the regular, normal, service. Therefore new health-related "eServices" need be seen as an extension and sometimes a replacement of the services healthcare organisations are already providing. They must be integrated with normal existing business (healthcare) processes in order to add value to existing services and to leverage the infrastructure. A proof-of-concept implementation in real life conditions is needed in order to create the evidence of cost-effectiveness and to argue convincingly how the costs can be reimbursed.

3 Characteristics of the healthcare working environment

The healthcare working environment has a number of characteristics that distinguish it from other domains. First, the combination of knowledge, information and data is central in diagnosing, treating and monitoring of patients. Second, it is a collaboration intensive environment where care is delivered mostly by well-organised teams, and sometimes in acute cases by ad-hoc team arrangements. The collaboration environment is typically Peer-to-Peer communication along well-established procedures. Third, decision support by consulting colleagues and other experts for second opinions or by referring patients to other specialists or by accessing structured pieces of medical knowledge and clinical guidelines in textbooks, articles etc. are regular features of modern healthcare. Fourth, professionalism is a very strong feature in the practice of medicine and the master - apprentice relationship in on the job training is still highly important.

In addition to these profession centred features, the role of patients and their immediate family (interactive patient participation) has gained in importance with patient empowerment and a

deeper understanding of the role of the patient (and her immediate family) in solving and managing health problems, especially chronic, degenerative conditions (such as the management of diabetes, asthma or hypertension). In addition to the need to manage illnesses more emphasis is being given to wellness management in all its forms. This starts with public health promotional issues (such as quitting smoking, use of alcohol and other substances), life style guidance (such as exercise and diet) leading to health monitoring based on wearable sensors and ambient intelligence technologies.

In the health care domain management approaches are gaining ground and the old administration, resource-usage focused approach is being replaced by concepts such as citizen-centred care and continuity of care. Care processes are being streamlined production management concepts are being tried out. Although concepts such as workflow management and shared knowledge spaces (repositories) have been coined elsewhere healthcare has been among the first to make use of these. The distinction, though, is that most of this is taking place without explicit usage of ICT.

4 Use of ICT in Healthcare

ICT has been deployed in healthcare for more than 30 years. Since the early days the scope of ICT usage has widened (Figure 1). The original idea of supporting with ICT the health system and healthcare professionals in their tasks has widened to comprise the full continuum from genetics to health management to health policy setting and involves today as users also citizens and patients.

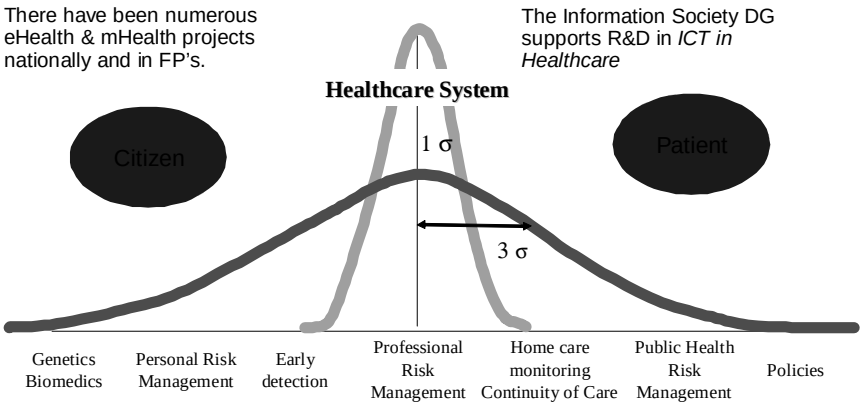

Figure 1: The scope of healthcare has widened.

In addition to national programs for ICT in healthcare the European Commission has been actively supporting R&D in this domain in its Framework Programs. Recently the various efforts at national and EU levels seem to be converging into a shared understanding that a health IT infrastructure is needed in order to create an interoperable electronic health record environment as illustrated by Figure 2.

The cumulative understanding of what is needed can be summarised as three "findings":

- An interoperable infrastructure is necessary for eHealth services to exist. This has to be based on global standards that all can accept, such as W3C web services combined with health specific standards such as Health Level Seven, DICOM and IHE (Integrated Healthcare Enterprise). Both enterprise level (EAI) and inter-enterprise integration (IEAI) issues have to be included.
- A structured semantic base has to be created to facilitate the exchange of medical data and knowledge in an understandable context. This means that global agreements on medical terms and vocabularies are needed in electronic health record and decision support systems.

- Finally, in order to provide citizen-centric care, current service structures and processes will have to be redesigned. This touches the roles and functions of existing health systems, organisations and professionals AND citizens (patients) and therefore calls for the systemic innovation approach as outlined earlier in this chapter.

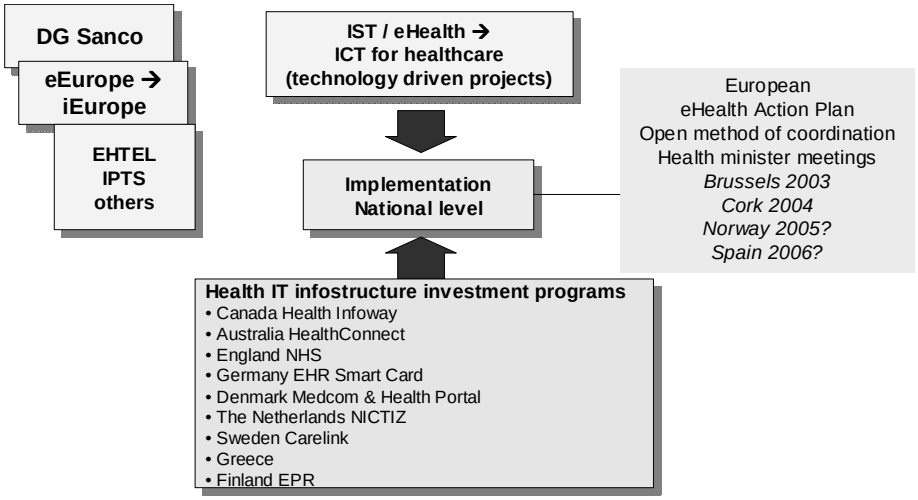

Figure 2: National and European Commission activities to create an interoperable health IT infrastructure.

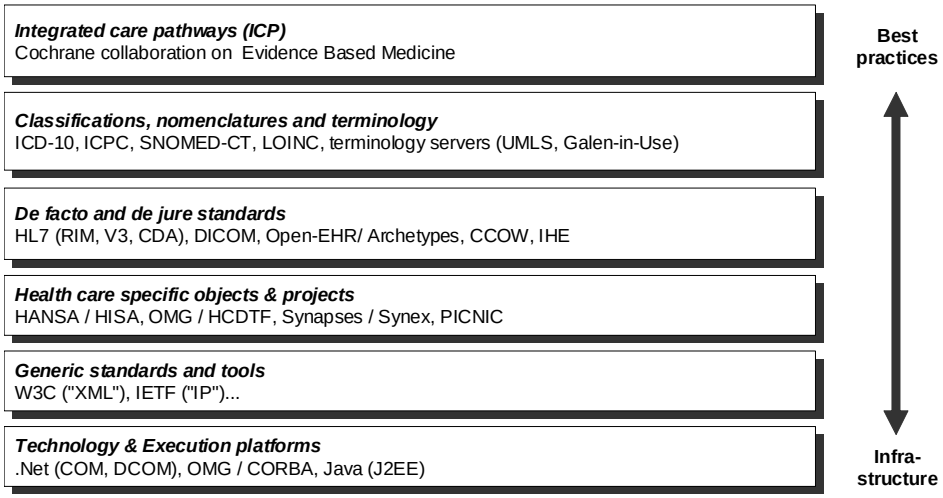

Figure 3: Stack of standards to create an interoperable environment for health data and knowledge.

Interoperability in the health domain can be represented by a stack of standards as shown in Figure 3. At the bottom are generic execution environments and communication networks to enable functional interoperability between organisations. On top of these healthcare specific objects can be deployed, such as the Personal Identifier Service (PIDS) specified by OMG or Document Exchange System (XDS) specified by IHE. Semantic interoperability requires adoption of common standards for exchange of patient data such as Health Level Seven and DICOM and adherence to a shared vocabulary between the collaborating organisations such as LOINC for laboratory examinations. The highest layer in interoperability relates to the care processes. Integrated Care Pathways are one example of how common practices can be created.

Consequently, several countries have launched large investment programs to set up an interoperable health IT infrastructure for the exchange of patient data (for instance as structured patient documents) and medical knowledge.

5 "Health Continuum" – Vision of Future Health Services

The change pressures and issues discussed above have lead to a redefinition of the content of healthcare, the "health continuum" defined as follows (Figure 4):

Being able to manage one's health, well-being and illnesses with support of information and expert services when needed independent of location.

The rationale behind this definition is that there is a widely shared understanding that well-being, health and illnesses form a continuum. They need to be handled as an integrated whole. However, healthcare systems have been created to treat illnesses. Turning them around to be citizen centric and proactive is a major challenge.

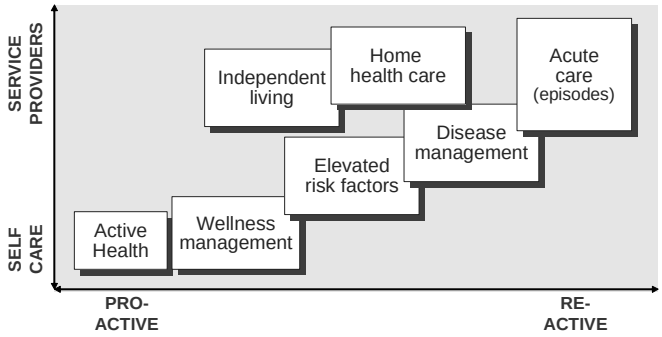

Figure 4: Coverage of healthcare, “health continuum”.

The health continuum is characterised by two axes. The other deals with how much health professionals are involved in the provision of the services and the other with whether the actions taken are proactively seeking to prevent illness episodes or reactively seeking to care for and cure illnesses. Acute illness episodes form the other end of the continuum, whereas wellness management and active sports form the other. In between these is the region where so called risk factors are elevated and some proactive and reactive measures are taken (like exercise, diet and medication) to prevent an illness to develop. The management of chronic degenerative diseases is also in the middle ground. Here the role of the patient is still central as (s)he has to follow a rather strict set of rules of behaviour (called compliance) in order to manage her / his chronic condition and to avoid illness episodes. The last segment of this future health continuum covers home care and independent living. The former refers to medical procedures (diagnostic, therapeutic and monitoring) that can be performed outside hospital walls in the homes and even location independently. Developments in medical devices and ICT allow a large number of procedures to be performed in this way while still being overseen by healthcare professionals. Independent living support stretches this concept even further by seeking to bring services to the homes of elderly and disabled individuals that allow them to lead independent lives and be integrated with the society.

Parallel to these changes in traditional healthcare services a more radical change is taking place. This emerging trend can be called “health continuum” where the citizen and patient also is expected to play an active role together with the healthcare team of specialised professionals. With the ageing population and current life styles chronic degenerative diseases are becoming more prevalent. The proper management of such conditions based on clinical evidence mandates active interventions to change life styles, diet and to increase exercise. Wellness management (Active Health) is seen as a highly important instrument to maintain an acceptable level of health. The role of the individual in carrying out these interventions is of course central for success. A further extension of health relates to facilitating the independent living of elderly in their natural surroundings by means of technology and technology based services.

The widened scope of health services calls for new means to finance and provide the services. Whereas in the past healthcare could be characterised as mostly a publicly funded service environment, in the future there will be larger mix of financing schemes and public and private providers.

6 Workshop: From scenarios to a road map

A workshop was organised to present and discuss scenarios and to draft an early version of a roadmap. This workshop took place at Telematica Instituut, in Enschede, April 15th 2005. In total 12 scenarios were analysed as input to the road mapping exercise (Table 1). The scenarios are discussed in a related paper submitted to this conference.

Table 1: Scenarios

1. Distributed healthcare-service provision
2. Welfare
3. Active Health
4. Major Incident (disaster response)
5. Management of resources in hospital
6. Diabetes Management
7. Mobile physical therapy workers
8. Domestic Wireless System (Smart Home for Special Needs???)
9. HealthSpace
10. Awareness Telemonitoring
11. Awareness Assistance to Disabled
12. FRUX illustrative scenario for elderly support in home environment

The road map (Appendix 1) was produced by the participants in teams each responsible for one of the scenarios. The exercise highlighted a number of issues that are discussed below in some more detail.

7 Shaping of the "market place"

Health care service providers are part of their respective national health systems. They have a role within the health care system based on legislation, health policies and the hierarchical structure of the health care system. The overall aim of the health policy of today is cost containment; the need to produce more high quality services without major increases in the share of public health care expenditure of GNP and without compromising national health care systems' overall objectives (access, equity and quality). Service providers must operate within these policies and structures.

However, there are external forces acting on them (Figure 5). The first of these relates to the continuous progress and innovation in science and technology that improves the medical knowledge and skills base and creates new means to diagnose and treat health problems. The diffusion of new innovations into health care can be characterized as a domino effect. Initially, the change is small and confined to a certain domain but with time as the innovation is used and its development is continued it may pervade a larger domain. Examples of the domino effect include Computed Tomography and Magnetic Resonance Imaging and minimally invasive surgery.

The second force relates to the changing needs and role of patients. The changes are due to the ageing of populations, the increasing prevalence of chronic degenerative diseases in all age groups and citizen empowerment.

The service provider must take these all into account and formulate a strategy that allows it to react and adapt to the other external forces. This is the most difficult activity as there are many stakeholders involved in the decision making process with different "vested interests". Change in most cases means that some stakeholders will benefit and some will loose. Consequently decisions often take a long time to make and are difficult to implement. With the ever changing

context of health care this means that health care is in an underdog position trying to react when in actual fact it should be proactive. To be proactive it should have a strategy and a capability to implement strategic objectives.

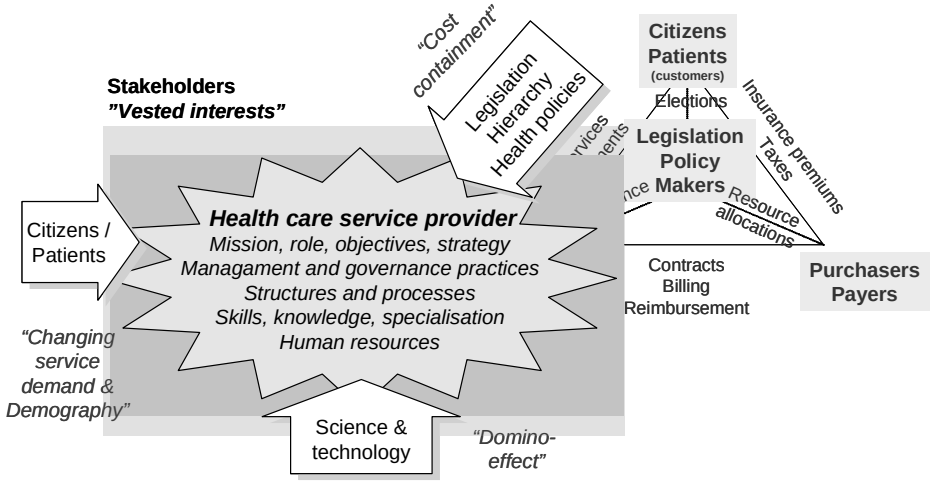

Figure 5: Forces acting on health care service providers.

Innovation in health care is characterized by the need to cross boundaries between scientific and professional disciplines and institutions. It must create and sustain a dialogue across numerous individuals with diverse perspectives to negotiate possible solutions. Building trust and developing negotiation skills are definitive challenges for collaboration. Solutions involve the whole organization and may require changes and adaptations in the integrated system of healthcare processes and services, institutional and organizational structures and products and technological systems.

Such systemic innovation calls for a combined effort of actors. The need for collaboration is confronted with several mechanisms that interactively tend to maintain the existing core capabilities. They relate to economics, politics of power and behaviour. Attacking core rigidities often means undermining the current economic foundations. Managers and powerful experts are understandably reluctant to give up their political power, and organizational routines are ingrained. Changes in organizational procedures often call for changes in skills. Skills frequently become closely entwined with people's identity so that the requirement to switch skill bases is experienced as an attack on their very being. Organizational change is always a demanding and slow process. An organization's core capabilities can become its core rigidities. A further barrier to cross is the fact that in most countries governments set up health policies and that a major part of health service delivery is within the public sector. Experience has shown that concepts and ideas that have proven to work in the business area (industry and services) cannot be translated directly into health care. Consideration must be given to adapting these to the value systems and "business environment" of health systems. It is not surprising that some consider health care to be the most change-averse "industry".

8 Need for systemic innovation

Developments in technologies, such as ICT and Ambient intelligence (AMI), and new organisational forms, such as mobile work and new working environments, are strongly intertwined (Figure 6). In medicine and healthcare innovation depends heavily on interactions between universities, particularly academic medical centres, and industrial firms. In other words, disciplinary and institutional boundaries need to be bridged for innovation to take place.

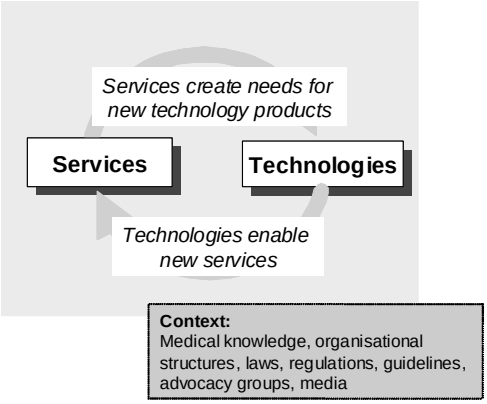

Figure 6: Development and innovation of services and enabling technologies is intertwined.

Collaboration between companies, public organisations and the third sector differs in nature from co-operation within organisations or between private companies. The former relationships are not mediated by hierarchy or market mechanisms but by negotiations between actors. Negotiations involve a wide range of issues, some of which are fundamental in nature, such as the roles to be played by different participants and the nature of the problem to be addressed. Building trust and developing negotiation skills are definitive challenges for collaboration.

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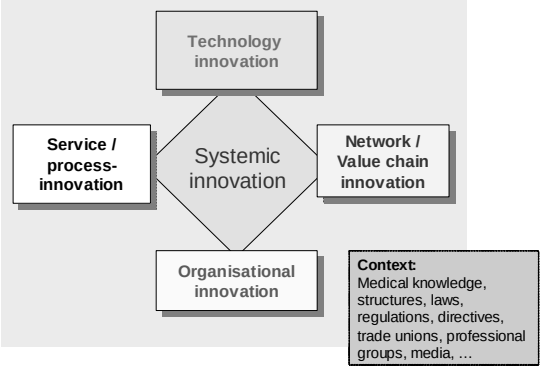

Figure 7: Systemic innovation comprises innovations in several areas of activity.

The traditional paradigm of technology catalysing change is not enough in the distributed healthcare environment as it does not address fully the interdependencies and interests of the various stakeholders. In healthcare, services and technologies are embedded deeply in wider social and technological systems. These create economic, technological, social, cognitive, cultural and political barriers for innovation. A more appropriate paradigm in this context is systemic innovation. It refers to changes and adaptations in the integrated system of healthcare processes and services, institutional and organisational structures and products and technological systems (Figure 7).

9 Conditions

Summarising, the key conditions for the health and wellbeing domain and the IST technologies uptake (esp. mobile and ambient intelligence technologies) are the following:

- Health (care) and wellbeing services are based on national level health policies, regulation, structure, financing. At the moment this sector is legislated mainly at the national level. The EU mandate only concerns public health.
- Health care today is "zero-sum game". This means that new ideas must be shown to work in real-life situations. This means among others that ideas must be benchmarked against existing work practices to show that they are cost-effective and efficient. At the same time medical knowledge is expanding rapidly enabling new and improved ways to diagnose and treat health problems.
- Innovation in this sector should be viewed as a co-evolution of the structures, organisations etc. with the advances in medicine, science and technology.
- A prerequisite for cost-effective ICT solutions in health and wellbeing applications is the creation of a health IT infrastructure that provides interoperability at the Electronic Health record level. This has been compared with highway & road networks. Several countries have embarked on this road and the infrastructure will be in place within a few years.
- Trust is an important factor in gaining user acceptance. This includes security and privacy of patient data. A simple statement in this aspect is "Applications must comply with the relevant legislation".
- Suitable business models for the different service segments (user needs) need to be demonstrated.

Acknowledgements

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Short biography

Niilo Saranummi (PhD 1976): Research professor, health technology Technical Research Centre of Finland (VTT). Chair of HL7 Finland. Editor-in-Chief of IEEE Transaction on Information Technology in Medicine. Elected leader of "Well-being Services @ Work" community. Served as Presidents of the International Federation for Medical and Biological Engineering, IFMBE (1991-1994, of the International Union for Physical and Engineering Sciences in Medicine, IUPESM (1994-1997) and of the European Alliance for Medical and Biological Engineering and Science EAMBES (2003-2004).

Dr Val Jones (received her PhD in Computational Sociolinguistics from the University of Newcastle upon Tyne in 1979. She has conducted research at the Universities of Newcastle, Stirling, Aberdeen and Twente, in the areas of Computational Linguistics, Computer Science and Health Services Research. She is currently a senior researcher at the University of Twente and was jointly responsible, together with Professor Dimitri Konstantas, for the scientific coordination of the MobiHealth project. Current research interests focus on ehealth and mhealth applications, the communications and software engineering challenges raised by these applications and future mhealth possibilities enabled by AmI (Ambient Intelligence) technologies.

Draft ROAD MAP (The numbers refer to the scenarios named in Table 1)					
	2yr (2005-6)	**3 yr (2006-8)**	**4yr (2009-12)**	**4yr (2012-15)**	**beyond**
Societal, organisational, legal, regulations, …	*12 (2005)* Country specific legislation, Co-operation of family and health sector Evaluation of mental status is quite a challenge Privacy issues *9 (2005-6)* Run the service based on national legislation, not against it AND make bi- / multilateral agreements between providers and purchasers Same for handling privacy and patient consent Same with contracts for reimbursement / fee for service	*4 (2006)* Allow to terminate on-going calls!! (in case of disaster) *4, 6 and 8 (2007)* Legal protection of sensitive and personal data (no tracking, exploitation, …) *4 and 6 (2007)* Shifting responsibility: Doctor → ??	*1, 10, 11 (2010)* mHealth service providers *12 (2012)* Harmonisation of procedures Increased social cohesion of community – neighbours to help	*1, 10, 11 (2016)* Privacy and trust delegation and organisation	*1, 10, 11* Acceptance of semantic health interoperability standards
Applications (group, networked, human, …)	*1 (2005)* Health & wellness buddy. *9 (2005-6)* Business plans for all clinical service cases (Business cases staggered at 6 month intervals of implementation)	*4 (2006)* Trust management between devices, applications and users including GUI aspects. *4 (2006)* BANs for: Trauma pt, Paramedics, Police and Fire fighter. *12 (2007)* Multimedia collection of memory: not trivial – configured to personal Recognise dynamic patterns Trigger memory - - daily use of devices Event detection with intelligence & distinguish normal and abnormal patterns. *9 (2008)*	*4 (2009)* Efficient way of connecting emergency services by members participating into the scenario. *10 (2010)* Telemonitoring *12 (2012)* Tuning to personal behaviour Cognitive and physical mapping Use whole system to detect degree of illness without being intrusive	*4, 6, 8 (2013)* Ambient intelligent centres *10 (2015)* Teletreatment	

		Virtual collaborative spaces – dynamic workflow management			
Interoperable EHR infrastructure: National level investment programs → Cross-border and EU / Europe					
Enabling technologies	*4 (2005)* Multi-technology ad-hoc networking End to end addressing (define the way of selecting it, globally unique as local / private. *9 (2005 -6)* Use of Dicom and HL7 v3 Link directory (OID codes as unique identifiers of objects) Web Services – web services orchestration	*4 (2006)* Interoperability, Wireless sensors + ad-hoc + wired + broadband. *4 & 6 (2006)* End to end security: Denial of service, user authorisation, confidentiality and integrity QoS. *4 (2007)* Ad-hoc auto configuration Ad-hoc QoS Ad-hoc security End to end resilience *1, 10, 11 (2008)* Privacy technology Context interpretation *9 (2007)* Health IT infrastructure to enable interoperability of EHR medical knowledge: Inside countries	*4 (2009)* Interoperability Wireless sensors + ad-hoc + wired + broadband End-to-end QoS End-to-end security *1, 10, 11 (2010)* Semantic interoperability for health *9 (2010)* Health IT infrastructure to enable interoperability of EHR medical knowledge: Inside countries: Inside EU & HealthCard *12 (2010)* Outdoor-indoor location detection Voice recognition Display devices Sensors for safety at home Integrated sensors *4 (2011)* Interoperability between technologies End-to-end semantics End-to-end QoS	*4 (2013)* Resilience *10 (2013)* Sensors: specific and small *1, 8, 10, 11 (2015)* Battery power	