Towards an inclusive future

Impact and wider potential of information and communication technologies

Edited by Patrick R.W. Roe

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COST219ter

Accessibility for All to Services and Terminals for Next Generation Networks

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Foreword

Technological innovation has brought immense benefits to our society and economy. Information and communication technologies (ICT) now play a key role in all our daily lives, in our work, education, use of public services and in our homes. New possibilities emerge of products and services that are flexible, quick, adaptable to our preferences, reliable and robust.

Yet these same technological advances can present significant barriers to some of the very people able to benefit most from these services and, without the right support, can even add to the exclusion many people suffer. Key decisions made when designing and developing technological products and services will dictate whether some groups, like people with disabilities, will be able to use them or not.

About 15% of Europeans report difficulties performing daily life activities due to some form of disability. With the demographic change towards an ageing population, this figure will significantly increase in the coming years. Older people are often confronted with multiple minor disabilities which can prevent them from enjoying the benefits that technology offers. As a result, people with disabilities are one of the largest groups at risk of exclusion within the Information Society in Europe.

It is estimated that only 10% of persons over 65 years of age use internet compared with 65% of people aged between 16-24. This restricts their possibilities of buying cheaper products, booking trips on line or having access to relevant information, including social and health services. Furthermore, accessibility barriers in products and devices prevents older people and people with disabilities from fully enjoying digital TV, using mobile phones and accessing remote services having a direct impact in the quality of their daily lives.

Moreover, the employment rate of people with disabilities is 20% lower than the average population. Accessible technologies can play a key role in improving this situation, making the difference for individuals with disabilities between being unemployed and enjoying full employment between being a tax payer or recipient of social benefits.

The recent United Nations convention on the rights of people with disabilities clearly states that accessibility is a matter of human rights. In the 21st century, it will be increasingly difficult to conceive of achieving rights of access to education, employment health care and equal opportunities without ensuring accessible technology.

Technology penetrates ever more in our daily lives. It is crucial that we create solutions that are usable and accessible for everyone, regardless of their abilities. This is not just about meeting the needs of a small part of the population. In fact, evidence suggests that facilitating access to the information society for people with disabilities benefits many more people in the general population, for example as it drives innovation towards easier to use products and websites.

Last year, all Member States agreed on a declaration in Riga committing themselves to take concrete steps to build an Inclusive Information Society and setting clear targets for the coming years. To achieve these objectives, it is important to make everyone aware that eAccessibility is a positive factor for the competitiveness of our industries. Technology is pointless unless it ultimately meets the needs of society. This must be fully reflected in the European policies for building the Information Society. eAccessibility is thus essential to achieving an inclusive society and key for the success of the i2010 initiative, A European Information Society for Growth and Employment.

European funding on research and development for accessible technologies and services is not the only precondition to building an information society for all. To ensure that everyone has the opportunity to benefit from these impressive technological advances, it is also essential to create a legal and economic environment in which these European socio-economic objectives can be achieved. The various factors that can contribute to the risk of exclusion are indeed often interrelated, like poverty, low level of education, unemployment, disability and old age. These need to be addressed in a consistent and coherent policy framework.

A truly inclusive Information Society must be socially and economically sustainable. For many years, accessibility efforts have been concentrated on removing existing barriers. But this is not enough. COST 219 activities have been pioneers in preventing eAccessibility problems by promoting a Design for All approach for telecommunication products and services.

This book addresses the accessibility of next generation ICT networks and services running on them. Some of the specific issues in this context are: how to ensure accessibility to new IP based communication solutions? What features do we need to build in next generation networks to ensure real time multimodal conversations? How to ensure the accessibility of emergency numbers? Next generation networks offer immense opportunities for having, besides voice, good quality real time video communication using sign language and text, including for example display in real time virtual Braille. This would open up new communication opportunities in particular for deaf-blind persons.

The time is ripe for addressing these issues, asking questions such as the ones above. This book will certainly contribute to the debate and stimulate the implementation of accessible solutions in next generation networks. I welcome this important contribution to the telecommunications field and to the construction of an Inclusive Information Society in Europe.

Viviane Reding

Member of the European Commission
for Information Society and Media

Contents

Contents

1. Introduction

Patrick Roe

There is no question that over the last twenty years, since the inception of the original COST 219 Action, a considerable shift in attitude and awareness has occurred towards including people with disabilities and older people in all aspects of society.

From a situation of ignorance and overall lack of awareness, there is now a general acceptance at a political, societal and even to a certain extent at an industrial level that it is no longer acceptable to develop products and services that will exclude a substantial proportion of the population, including people with disabilities and older people.

This is not to say that all issues have been resolved, far from it. For example, one of the aspects that still needs to be conveyed to all stakeholders is that embracing the Design for All principle is not a one off effort but an ongoing and permanent commitment over the longer term. However at least there is now a state of recognition that these issues have to be addressed and a realisation that if these complex issues are suitably handled with appropriate strategies and policies, there are exciting potential rewards to be gained. Indeed, with the well-publicised ageing of the population the issue of technology at the service of older people is seen as an opportunity and an integral part of future strategies in tackling the problem of how to keep people in their homes for as long as possible (chapter 3).

A crucial and recurring theme throughout the book is that it is vital to design products and services right from the beginning that can be used by the broadest possible section of the population (Design for All approach discussed in chapters 3, 4, 5, 6, and 7, for example).

The purpose of this book is to give the reader an overall picture of the current situation with the latest trends in products and services that can be used by as many people as possible including people with disabilities and older people (chapter 2). One example from section 2.3.2 will show how remote sign language interpretation using 3G telephony had a high take up when priced affordably. Other examples presented in chapter 2 include showing how new technologies can help with safe navigation (section 2.2.1) and how the potential of broadband can be fulfilled in providing useful new services (section 2.3.1). Some of the latest issues concerning relay services and text telephony are discussed in sections 2.3.3 and 2.4

There is also a presentation of the latest possibilities of using speech processing (section 2.2.2). This technology has been promising much for many years, and the reader will be able to assess the degree of maturity it has now reached whilst being able to appreciate the potential for using it in applications for people with disabilities.

Another very important emerging technology/area is that of Ambient Intelligence (AmI). The potential implications for all citizens are immense. In chapter 4, the reader will get an insight into the exciting new possibilities that AmI could offer people with disabilities and older people. The approach used has been to take the ISTAG (IST Advisory Group) scenarios (with some adaptations) and to analyse what would happen if people with disabilities were introduced into the scenarios. In this way, it has been possible to carry out a detailed analysis of some of the implications and possibilities of AmI for people with disabilities. This should help all potential users answer the question, "The Future is here, can I live with it?" Ethical issues related to AmI, which are of course of particular relevance to all disadvantaged groups, are discussed in section 4.3.

An important component in this gathering groundswell of awareness is the willingness of governments, both at national and EU level, to introduce new laws and/or regulation, backed up by standardisation, so as to ensure equal rights of all citizens in relation to access and use of technology.

A comprehensive review of the current situation is given in chapter 5, where the reader will be able to gather a clear idea of the available choices within the review of Framework Directives and the potential impact these decisions will have on people with disabilities. The EU is clearly at an important regulatory crossroads with the next few years being crucial in determining which is to be the future direction of regulation. This chapter indicates how the interest of disadvantaged users can be protected within this Framework Directives review without hampering innovation and investment.

An additional key issue raised in chapter 5 is that of certification, be it self-declaration certification, certification/accreditation of suppliers or third-party certification schemes. The various options and their implications are discussed leading on quite naturally to chapter 6 where an overview can be found of current trends in accessibility evaluation and what types of evaluation and usability assessment are currently being carried out by test houses. The reader will be able to gather information about a mobile phone evaluation toolkit developed within the framework of COST 219ter (section 6.3) which is a simple methodology for assessing the accessibility of a mobile phone. The best time to use this toolkit would be while testing/checking other protocols and design issues. A case study from Portugal of how evaluation may change the design is also given in section 6.4.

Despite the growing awareness and increasing technological possibilities, offered for example by broadband, there is still widespread frustration that more truly accessible and usable products are not appearing on the market. To try and understand the reasons for this lack of products and services COST 219ter resolved to employ the Interactive Management (IM) methodology with the triggering question "Considering the availability of powerful broadband technologies and the development of relevant scenarios, what are the obstacles that prevent us from producing more practical applications?". The intriguing results and ensuing roadmap from of these two (IM) workshops are described in detail in chapter 7. Without revealing too much, it is possible to say that the process yielded some unexpected results. For example, the roadmap on page 293 shows that some very fundamental issues, such the difficulty in turning a statement of user needs into design requirements, still needs to be resolved in order for there to be more practical applications and products on the market.

This roadmap also highlights some of the challenges that still lie ahead on the road to inclusion. The momentum is surging ahead pushing all components of our society including, users, disability organisations, regulatory authorities, legislators, standardisation bodies, civil servants, governments and industry towards having to grapple with new issues and break new ground. There is no turning back now and by the end of this book, the reader should have a better appreciation of the point we have reached on this road towards a truly inclusive future.

Note from the Editor

Although the Members of COST 219ter are well aware of the WHO "International Classification of Disability, Functioning and Health (ICF)", the terminology used through out the book is not wholly consistent. This is partly for reasons of style but also partly reflects the various opinions and preferences of the authors, amongst whom no consensus was reached (and probably never will be) on what were the most acceptable terms to be used. The Editor decided to respect this variety of usage and hopes that no offence is taken by anyone.

Acknowledgements

I would personally like to like to thank all the authors for their most valuable contributions written in most cases in busy circumstances under heavy workloads. This effort is much appreciated. I would particularly like to thank the lead authors of each chapter, without whom this book would never have been finished on time and a special thanks to John Gill for his advice and support throughout the whole process.

Patrick R.W. Roe

Editor

2. Current examples of existing products and services for people with disabilities

2.1 Introduction

Julio Abascal and Patrick Roe

This chapter brings together a number of examples of good practice that have been chosen with the objective of providing some insight on the possible evolution from current telecommunication technologies to future "intelligent environment" services. The main aim is to give a snapshot of current trends in services that are accessible to people with disabilities and to discuss the possible impact on people with physical, sensory or cognitive restrictions (that may be due to a disability, ageing or to the special conditions or equipment they use). The emphasis is on presenting current services and how they are likely to evolve in the future to show what the potential impact could be on people with disabilities and elderly users. This will also serve as a baseline of what is the current situation in comparison to the possible future scenarios discussed in chapter 4.

The chapter is structured into four main sections (apart from this introduction): 2.2. New technologies to help people with disabilities and elderly people; 2.3. New remote services; 2.4. Evolution of text telephony; and 2.5. User participation in technology. A summary of the contents is given below.

Section 2.2 New technologies to help people with disabilities and elderly people

Technological advancement in the field of robotics has provided devices and techniques for sensoring, positioning, mapping, navigating, etc. These techniques have made it possible to develop devices to help people with physical, sensorial or cognitive restrictions to navigate both outdoors and indoors. The section "Safe navigation with modern technology" makes a detailed description of current technology to support human navigation and discusses the possibilities for the near future.

It is known that speech is the main means of communication between people. Nevertheless a number of users with disabilities experience restrictions in their speech capacity that limit their communication skills. Current speech technology is able to translate text-to-voice and voice-to-text (the latter still without enough quality and reliability), enabling the design of diverse mediation devices and services. These include, for instance, reading texts aloud for people with sight restrictions, and controlling devices in a more natural way through the voice. The section entitled "Speech processing for people with disabilities" reviews current and more particularly, future applications of speech technologies that can enhance the communication of elderly people and people with disabilities.

Section 2.3 New remote services

Broadband communication technologies are already available. They can sustain advanced services to support people with disabilities and elderly people. Relay services, virtual communities, enhanced communication, etc., are being successfully tested in a number of countries. The section entitled "Novel broadband-based services: new opportunities for people with disabilities" describes seven trials of advanced broadband-based support services, conducted by the National Post and Telecom Agency in Sweden (Post- och telestyrelsen, PTS), to test the validity of current and future broadband telecommunications services in providing remote support that is tuned to the needs of specific groups of people with disabilities.

Relay services usually act as communication mediators between users, one of whom at least has a disability that prevents them from using standard communication devices or services. These services are able to translate from signs-to-voice (and vice versa), from text-to-voice (and vice versa), etc. They can also provide other services such as the description of a received image to a blind person. Some pre-existent relay services may be enhanced, universalised and made less expensive by means of the currently available advanced telecommunication technologies. The section entitled "Access to video relay services through the pocket Interpreter (3G) and Internet (IP)" presents two experiences developed by the Swedish National Post and Telecom Agency: The IP access project, a video telephony relay service based on IP and the pocket interpreter for mobile video communication, both for signing deaf people.

Efficient use of relay services requires that a number of steps be closely followed in order to speed up the service. The section entitled "Convenient invocation of relay services" describes the best way to invoke various relay services currently existing in Sweden. These experiences may be taken as examples of good practice that help optimise the design of the access to future relay services.

The rise of Short Message Services (SMS) tied to the expansion of mobile telephony, is frequently associated in our minds to young people. Short messages are cheaper than voice calls and don't require that both interlocutors are simultaneously engaged. Nevertheless, SMS can be also useful for other groups of the population. A remarkable application of SMS is shown in section "Ways of using mobile telephones by people with dementia", revealing that elderly people with cognitive restrictions can take advantage of this technology for verbal, text or symbol communication and support.

SMS technology is also used in the "Implementation of an SMS-based emergency service in Finland" to allow not only deaf people, but any other user, to contact the universal 112 emergency service sending emergency text messages. After making contact the user receives an acknowledgement message and can be located for assistance.

Section 2.4 Evolution of text telephony

Text telephony is currently the basic means of communication for many people with disabilities, such as deaf people. The technology supporting mobile telephony does not allow the extension of traditional text telephony. For this reason, many users substitute mobile text telephony by the use of SMS messages, but they do not allow full interactive communication, hence the need to develop novel mobile text telephony services.

Since the next generation of text telephony in Europe is under development, it is necessary to establish basic design guidelines that guarantee the quality of the service. "The recommendations of the Nordic countries regarding functionality for text telephony" section compiles criteria that include mobility, interoperability, continuity, accessibility from the internet, and availability of relay services.

Diverse experiences have been developed to provide mobile text telephony through the access to internet servers. The section entitled "Mobile & IP-based text telephony" shows the deployment of such a service in Sweden, while "Mobile text telephony based on GPRS communications" explains the results obtained by a Spanish project.

Section 2.5 User participation in technology

With the attraction of a growing market, there is a greater likelihood that more and more companies will be marketing devices in the near future that can be accessed by elderly people and/or people with disabilities. Since these concepts can be interpreted in diverse ways, consumers may find that devices advertised as fully accessible, straightforward and easy to use, do not really fulfil their needs. It is within this context that the availability of functional specifications of terminals becomes essential, so that products can be checked and certified in order to give to the customer a guarantee of the appropriateness of a given product or service in relation to his or her needs. The section entitled "Functional specification for terminal procurement" presents an example of good practice from Sweden in what will become an important area for the future.

2.2 New technologies to help people with disabilities and elderly people

2.2.1 Safe navigation with wireless technology

Jan-Ingvar Lindström

Background

How can I be sure to find my way? Can I walk safely here? What happens if I get lost? Do I dare to try a new route? What if I suddenly fall ill and need help? The lack of good answers to these and similar questions have prevented a number of vulnerable people to move around in outdoor as well as indoor environments which they are not familiar with.

And who is not vulnerable? Basically, all of us sometimes are in need for help because we have lost our way or feel unsafe or have made a mistake in our way-finding effort. Among us, however, are people who feel more at risk than others, not least people with various kinds of disabilities. And among these, people with visual disabilities and those who suffer from cognitive impairments have expressed strong interest in finding solutions to overcome their problems.

Historically, blindness and partial sight have inspired engineers and psychologists to find solutions to way-finding problems for these groups, both in terms of personal navigation aids and landmarks in the environment. Early on, the long cane became a well known attribute to blind pedestrian's navigation, and later efforts have been made to improve the cane by adding remote sensors. Examples are laser emitting diodes end sensors, magnetic field probes and – most recently – RFID[1] detecting devices. Other ideas have been to simulate bat's navigation technique, i.e. the development of various kinds of ultra sonic devices to scan the environment and get some idea of what it looks like.

The common denominator for all these examples has been the individual characteristics of the solutions. Also, they only provide information about the very near environment.

Given these historical facts, over the last few decades, navigation problems of other groups have been acknowledged. An example is the large group of people with cognitive impairments, including e.g. those with dyslexia, mental disabilities, dementia and stroke, but also people with mobility problems, including wheel chair

[1] Radio Frequency Identification

users. The problems here are wide ranging from being able to read and understand a map or remember information to learning in advance about obstacles, on-going road works and similar matters. Even people who are deaf or hard-of-hearing have experienced great problems in moving from their home to e.g. a school or working site by public transport as so much information is given about changes in time tables and alternative means of transport, etc., has been given orally. Slow improvements have come about in society as much information has successively been given both as voice information and presented on visual displays. These solutions, however, have been generic, and not been of much help to people who suffer from dementia, mental disabilities and other cognitive disorders.

A break through came about with the installation of the American Global Positioning System – GPS, that has been used since the late 1980s for positioning purpose, mainly as a tool for finding the way for car drivers and boat and aircraft navigation. As it will be discussed later, the GPS system per se does of course not solve the problems displayed above, but it forms a basis for further development that can lead to powerful tools for all groups with significant navigation problems.

Positioning, orientation, navigation, communication and localization

Mobility outdoors

Knowing one's position is important, but not enough for safe moving around in an unknown environment. A system should also make it possible for users to orientate themselves, i.e. to know in which direction they are standing in relation to, for example, the points of the compass, to navigate independently, i.e. be able to move from one given position to another, and also if necessary, raise an alarm or communicate with an information or alarm centre for personal support and assistance. It should also be possible, for those who so wish, to be found without having to consciously trigger a localization function themselves.

Positioning

Satellite systems

The most widely used and available system – the GPS system – is based on the use of radio signals transmitted from satellites orbiting the Earth and with whose assistance it is possible, with the use of special receivers, to get a position on the

Earth's surface in the form of coordinates. This kind of reference can be transformed into, for example, an indication on an electronic map on a GPS receiver. This can be linked to a mobile telephone, handheld computer or the like.

At present there are two existing systems in use: the American GPS (Global Positioning System) and the Russian GLONASS (Global Navigation System). The latter does not have any marketing in Europe and is currently being extensively updated. For many years, a system has been planned in Europe known by the working name Galileo. This system is designed to be well-adapted for European environments in particular. However, it is still presently at the development phase and will not be fully accessible until 2008 at the earliest.

GPS is designed to provide the best possible coverage some hundred miles north and south of the equator. This means that the further north and south one goes, the worse coverage one gets with GPS owing to the satellites all appearing to lie rather close to the horizon.

In it simplest form, GPS provides a positioning accuracy of some tens of meters. However, there is an extensive system of terrestrial stations that can take care of and process signals before they are received in the individual GPS receiver. This is known as Differential GPS or DGPS. With such support, it is possible to get down to an accuracy of just a few meters. In principle, it is possible to achieve even greater accuracy in this way (to within centimetres) but, for various reasons, it is not practically feasible for the navigation application in question. One reason is that access is not available everywhere to the terrestrial stations required for processing the signal. Another reason is that it may take up an unacceptably long time to process the signal – sometimes several seconds, which is too long in a real orientation situation.

Another possibility is Assisted GPS – AGPS – which can be used in situations where the signals from the satellites are too weak. This may be appropriate indoors, but also outdoors under less favourable circumstances. Examples of such circumstances are when only a small number of satellites can be reached or when moving around on narrow streets surrounded by high buildings or other similar environments – the so called canyon-effect.

It should be pointed out in this context that GPS receivers with much greater sensitivity than before – iGPS – are now starting to come onto the market, which may allow navigation with sufficiently good precision even in environments that are currently problematic from a radio perspective[2].

[2] www.gpsworld.com and www.esa.int/esa websites can be consulted for more information about GPS, DGPS and AGPS.

Mobile telephone cells

A less precise, but not uninteresting method is what's called 'Cell Global Identity', CGI. This is based on the possibility to register and identify the communication between a telephone and its activated base stations. There is consequently a technical possibility to determine the approximate position of a particular mobile telephone at any given moment. However, the technology is far too imprecise and is not yet adequately established to be of interest in the present context.

The utilization of GPS and CGI results in some form of coordinate references. These are only meaningful if they can be related to reality in the form of an appropriate map reference. Accordingly, access to maps and an appropriate user interface is necessary. This must be available in several alternative designs in order to adapt to the user's special capacities, for example people with visual impairments, people with reading and writing difficulties, people with cognitive problems and people with intellectual disabilities.

Landmarks

A landmark means here some kind of identifiable point in the surroundings that one can relate to in order to determine ones position. Such points are virtually everywhere for people who have sight and full control of their surroundings – it may be a familiar sign, a church tower or a distinctive large tree.

For people with visual impairments, different kinds of acoustic landmarks (sound beacons) have been tested for position determination. Examples are the ticking devices at pedestrian crossings that both confirm a position and to some extent guide the user to the post. Among the more exotic ones are recorded bird's songs used in Japan!

Today, there are various technical possibilities to provide this kind of guidance:

- *One is based on Bluetooth technology. This means that small radio transmitters are positioned at strategic points in the environment. When one approaches such a transmitter carrying an appropriate receiver, pre-recorded information will be read out, which could include anything from advertising to the identification of, for example, a bus stop. Bluetooth transmitters need an energy supply in the form of, for example, an integral battery*

- *Another technology is based on what is called RFID – Radio Frequency Identification. This is based on a passive or active radio circuit that transmits information when approached by a special combination of transmitter and receiver. As the fixed transmitter normally is passive, it does not need to have its own energy supply*

- *A third possibility is WLAN – Wireless Local Area Network – which are local, radio-based networks that send information to, for example, a mobile telephone or PDA about what is located in the vicinity.*

All these systems have pros and cons for the user.

- *The WLAN concept provides a rather inaccurate position determination if not calibrated at the spot where it is intended to offer positioning capabilities. It is most appropriate for information about, for example, what a shopping centre offers in the form of shops and connections for adjacent public transport. It is consequently more of an information system than a positioning system*

- *Bluetooth technology is significantly more precise from a positioning perspective, but it still allows quite a number of meters of deviation without 'losing' the receiver. To bear in mind is that Bluetooth technology does not support information concerning direction or relative distance between the user and the Bluetooth unit, but merely if a user is within range*

- *The RFID circuit is the most accurate, often functioning at very short distances – in the region of a few decimetres.*

WLAN and Bluetooth technology are already commercially available and have been implemented in various contexts, while the most common usage of RFID applications is in logistics. All have the advantage of functioning both indoors and outdoors. The disadvantage is that they require varying degrees of attention and maintenance.

Where there is a risk of radio black spot, the possibility of using landmarks like RFID, Bluetooth and WLAN for secure navigation indoors and outdoors should be considered.

Orientation

Some kind of compass is required for orientation. A traditional type of magnetic compass, i.e. a needle compass, can of course be used, but this is not particularly practical, especially for people with visual impairments. In this context, it would probably be more practical to have a magnetic field sensor and presentation in a visual or acoustic form. However, all magnetic compasses are affected by fields of magnetic disturbance – a strong deviation may be directly misleading and thereby be dangerous for the user. A more secure way is to make use of 'inertial navigation' in some form, but accessible systems are voluminous, expensive and require a lot of power. A further possibility is to utilize the compass function offered by the GPS system. The principle for this is that the system registers two consecutive points and calculates the angle between the points on the basis of these measurements, which in general is the same as the angle of travel. However the disadvantage is that this only functions when one is moving. It is consequently not possible to start from a given point and at that point determine which direction one is facing.

At present, the GPS system offers the best opportunities available for direction orientation while moving and an integral digital compass function in a handheld unit when stationary.

Navigation

The GPS system constitutes the basis for navigation, i.e. support to move from point A to point B. The simplest form of navigation means that one receives almost continuous backup support – visually or acoustically – in the form of appropriate road descriptions. However, this can also mean information about what is available on the route during the journey, in the form of ancillary information, for example the shops that are available in the vicinity and the range of products that they offer. These facilities will probably use local transmitters based on, for example, Bluetooth technology, RFID or WLAN.

How the system is used can vary according to need. In general one knows where one is and wants to go, but needs feed back during the route. It should also be possible to tell the system where one wants to go and let the system find the best route. An extreme case is when one has got lost and just wants to get back to the starting point – the 'back to base function'.

Maps

Maps are of great importance for navigation for most people. This applies not least for people with different disabilities. For people using wheelchairs, for example, it is important to have an overview of the route to be taken and, if possible, to assess any slopes, the nature of the route, etc. For people with visual impairments, this is perhaps even more important. Here, it is necessary to assimilate a mental map of the route to take. This can basically be done in two ways:

- *For those with partial sight, maps with good contrast, preferably with different scales for overall and detailed information respectively are necessary. This is relatively simple to do now that maps are digitally stored. It is also possible to show them in colour and at the desired size on a computer screen and get a print out on a colour printer*

- *For people who are blind, the visual information must be translated into tactile information in the form of raised-line maps. There is no special simple technique to achieve this. It requires preparation in good time and access to special technical equipment.*

There are digitally-stored maps for satellite-based systems that can be entered into the navigator. One of the many advantages of these is that they can be kept up-to-date and, in certain systems, are almost continuously fed into the navigator.

Both digital and analogue maps are required. It should be possible to download digital maps onto the user's handheld unit and onto a computer at a service centre. Analogue maps in visual and tactile form – raised-line maps – are provided primarily when planning a travel route.

Most digital land-maps of today are intended for car drivers. They are of very limited use for pedestrians, especially those who are visually impaired. Therefore, maps must be developed that show safe ways for pedestrians, i.e. sidewalks, pathways, stairs etc.

Another method for people with visual impairments is a verbal description where the route is explained in sequence of the type: "Go along Main Street towards Main Square. Go past two street crossings. Take a right at the third. Walk for approximately 100 meters. You are then close to a pedestrian crossing with a ticking acoustic signal. Cross at this pedestrian crossing." This kind of information can, for example, be recorded on a pocket memory and be retrieved subsequently as the user is moving along, which however requires that someone assumes the role of recording the information. One disadvantage is that there is no help if something goes wrong on the way – there is nothing to put the user back 'on track'. Nor is there, of course, anything that gives a warning of impediments in the form of road works and the like.

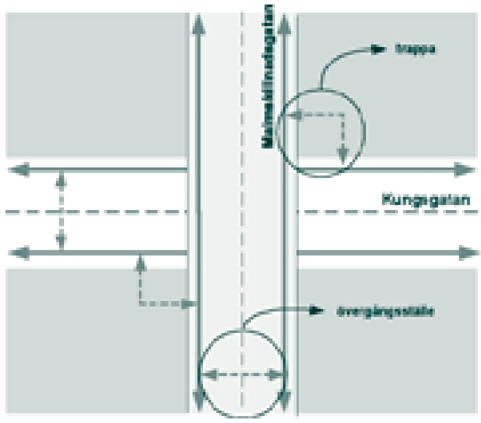

Figure 2.1 Digital map showing the importance of including sidewalks and stairs for pedestrian safety.

Communication

For communication – everything from a call to an alarm – it is necessary to have a manned centre with which users can communicate. In its simplest form, this comprises a person who can answer the telephone and by talking to the user can assist with orientation. In a more advanced system, a 3G telephone can be used, where users can send pictures or video clips from their surroundings to a support person, who can then assist them more easily. In its more advanced form, the support person has access to an electronic map on a screen, where the user's position is automatically entered as a point of reference.

Localization

The function 'localization' aims at being found if lost and not able to call for help. In principle, there are two ways of achieving this.

One is to use a combination of GPS and mobile communication in such a way that the user's own mobile telephone automatically transmits information to a service or an alarm centre, where the position is shown on a map on a screen terminal.

Figure 2.2 Position determination on a digital screen map, for example at a service centre.

The other way is radio direction finding, which means that a transmitter position is located with the help of one or more antennae for radio direction finding. In this case, the user has to wear a special transmitter designed much like a wrist watch. These transmitters can be activated via Minicall[3], after which the transmitted radio signals can be picked up by a special radio direction finding receiver.

Users have stressed the importance of it being possible to locate them when they have lost the capacity to orientate themselves during a journey. Methods for position determination on a map on a computer screen through, for example, a service centre have been developed and implemented by, among others, the Swedish police.

Indoor navigation issues

One condition for the use of a GPS receiver is that it can be reached by signals from at least three satellites. Basically, a clear line of sight to the satellites is required from the receiver as the signal strength is very weak. This means that reception indoors cannot be deemed reliable. AGPS can to some extent be used for indoor orientation. More reliable, however, is an inertial navigation system – gyrocompass and accelerometer in combination with a system for 'dead reckoning' – to keep track of where someone is located. However, the situation may rapidly change. Technology is developing towards increasingly sensitive receivers and, as mentioned earlier, the European Galileo system will allow reception where the current GPS system is too weak. However, it is wise for the moment to rely in practice on other methods for indoor navigation.

The most obvious is to rely on transmissions of radio signals from locally placed transmitters, for example, in shopping centres and arcades. – The disadvantage of

[3] Minicall is an RF-based technology, used for distribution, e.g. of text messages on 169,800 MHz

this method is that it requires the placement of transmitters at many sites. This requires a great deal of organization, standardization, maintenance, etc., something which has not been established completely today.

Many of the technologies and assistive devices that have been described in the Landmarks section are of course also applicable for indoor environments. This applies not least to maps, which can be essential to enable users to find their way around shopping centres and arcades.

The user's device

User devices utilizing the GPS system have been on the market for several years, and today stationary as well as hand held navigators are available for private use in boats and cars. Most of them are dedicated for the purpose, integrated in a device with a screen in full colour. There are also some separate units to be connected to PDAs (Personal Digital Assistants) or Mobile telephones.

Figure 2.3 An example of a hand held GPS navigator.

There are ergonomic advantages with the integrated solutions. The drawback is that it might be difficult to find an optimal position for the GPS receiver at the same time as the device should be manipulated or the screen read. An interesting compromise has been developed in the Canadian Trekker, where the GPS receiver is mounted on a belt to be hung on the shoulder and the processing device – in this case a PDA – is positioned at hand level. The output device – in this case a loudspeaker – is also mounted on the belt close to the ear of the user.

Figure 2.4 Victor Trekker, designed and manufactured by Canada-based company VisuAid, was launched in March 2003.

The Trekker solution allows for independent navigation but does not supply any service or alarm function. For this a separate mobile phone has to be used.

Swedish activities

In Sweden, a study aiming at initiating a few trials was made in 2005. In the study, possible technologies were investigated and planned and on-going activities as well as available technical equipment identified. Also, representatives from Swedish handicap organizations were interviewed and given the possibility to put forward demands and desires on equipment and system.

Among other things it became clear that the functionality, reliability and easy-to-handle matters were priority tasks. Also, all interviewed persons wanted a kind of "life-line", i.e. the possibility to get help if the track was lost, some unexpected obstacles appeared or an emergency situation came about. Therefore, there was a demand for a kind of service centre which could be reached via a mobile telephone, preferably with video transmission facilities.

The persons interviewed also pointed out that they did not want another technical gadget to take care of, but preferably a mobile telephone with built in facilities for GPS-navigation and access to RFID- and Bluetooth based information[4].

[4] A report, "Navigation, alarming and positioning – A preliminary study conducted in Sweden by the Royal Institute of Technology (KTH), Department of Speech, Music and Hearing in the assignment of the National Post and Telecom Agency (PTS) 2005" is available at http://www.pts.se/Dokument/dokument.asp?Sectionid=&Itemid=5678&Languageid=EN

Swedish trials

The study revealed three on-going and planned pre-studies. These are localized in the three biggest cities of Sweden – Stockholm, Gothenburg and Malmoe.

In Stockholm, the focus is upon people with visual disabilities. A digital pedestrian map has been developed for an area in the city by name Sodermalm. The intention is to start a study towards the end of 2006 with a small group of people with visual impairments. The technology that will be used in the first phase of the study includes server based map and obstacle data, route planning functionality, a mobile phone and positioning technologies. Later on additional functionality such as individualization of required information, alarm functions and points of interest is intended to be added.

In Gothenburg the primary target group is people with cognitive impairments. Even here the study is intended to start late 2006, and embrace a small group of people to start with. The project will be linked to intentions by the local public transport authorities to facilitate the use of public transport by elderly and people with disabilities.

The study in Malmoe will aim at people with visual impairments as well as those with physical disabilities.

A service centre that can handle alarms and be contacted via the user's mobile telephone facility will also be included.

A schematic overview of the functions is shown in figure 2.5.

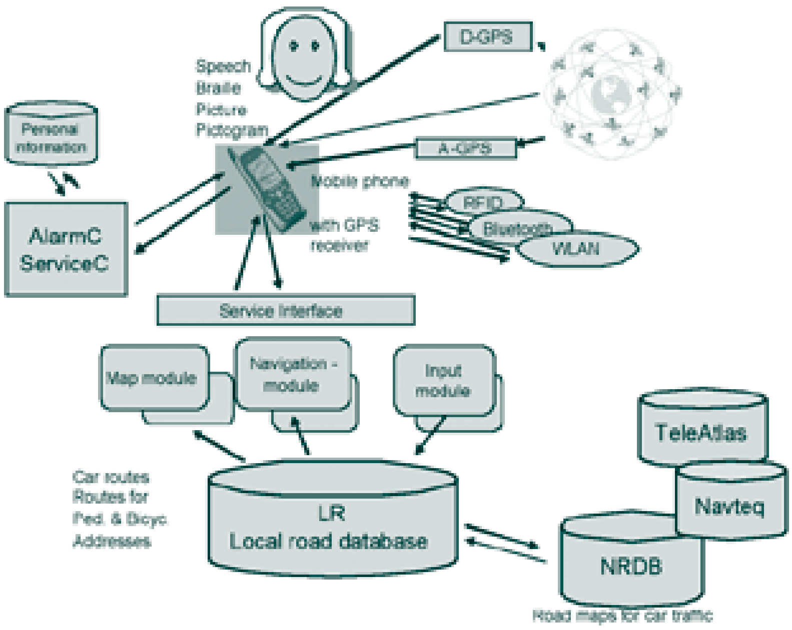

Figure 2.5 A schematic overview of the planned navigation systems in Sweden.

The user – the focal point of the system – is assumed to have impaired vision, hearing, motor or cognitive functions. Software for implementing speech synthesis, speech control and Braille presentation (on a separate display) and the possibility of an individual design and adaptation of the visual presentation on the screen (for example, zooming in and pictograms) are required.

It is assumed that the user has a mobile telephone or handheld computer with mobile communications facilities with the above-mentioned adaptations. There are many different mobile telephones available on the market, appropriate for this purpose, for example Nokia Serial 60 phones, e.g.6630, N70 etc. but also Sony Ericsson UIQ phones or stronger Java phones.

A handheld computer (PDA) is interesting from many perspectives, but must be supplied with a telephony attachment. Only a few have integral telephone functionality. Regardless of what one chooses, a terminal with a digital compass, camera and Bluetooth function is recommended.

The telephones must have open operating systems. Symbian and Windows Mobile can both be used. The latter is more powerful and quicker, but requires more power. Symbian is considered to be preferable, not least because there are many telephone models to choose from with this system.

The telephone is linked to a GPS receiver. This can either be integral or separate. The latter is preferable, first because reception is generally better if the GPS receiver can be placed independently of the handheld communication unit and second for power supply reasons (the batteries last longer).

There is a large variety of software to choose from for navigation, for example various Garmin products, GPS Pilot Tracker, Mapmate, Navicore, Route 66, TomTom, Trekker and Wayfinder.

All systems have their pros and cons. Trekker is specially developed for people with visual impairments. Wayfinder is a system that can offer streamed downloading of route information, if this is required.

There are several digital road databases available in many countries, e.g. Navteq and TeleAtlas. They have limited wealth of details and actuality and are basically intended for vehicular traffic.

In Sweden an effort is made to collect and store more qualified data in a National Road Data Base – NVDB. Currently it’s limited to road information for car drivers. At the beginning of 2007 road information for cyclists will be possible to store in the NVDB.

The local municipalities are building up Local Road Data Bases, LV:s. They have capacity for more sophisticated information, like accurate pedestrian routes, and the information can be frequently up-dated. This work has started in Stockholm with the development of a Digital Pedestrian Foot-path Network (DG).

It’s important to point out, that the system is designed with open border lines so that other implementations can hook on.

Besides resources for autonomous navigation, it is expected that the user will need to communicate with a manned alarm or service centre via a mobile telephone. The centre should be able to take care of both 'soft' calls (including calls from camera mobiles) with oral and visual support information, and 'sharp' calls with a requirement for, for example, the support of rescue units. The alarm/service centre can be one and the same unit or they can be stationed at different locations. It is expected that the alarm centre will have rapid access to the rescue services. The service centre can be anything from a county alarm centre to a relative's home. In any event, it should be possible for all personal details to be extracted from, for instance, a database. It is also important that the alarm/service centre can locate the user.

Owing to the wide range of both hardware and software, a final decision on the choice of products must represent a balance between the various pros and cons. The most important thing, besides satisfying the needs of the user as far as possible and comprehensively, is to stick to non-proprietary solutions and, where this is not possible, to conclude contracts with those suppliers who will provide the greatest possible freedom for different component choices.

A system like this is generic and is the basis for all three trials in Sweden. It will be possible to use in any place in Sweden. It will be designed so as to be easily adaptable to local transport information systems.

Conclusion

Many groups of people with disabilities experience problems when moving around in an unknown environment. It has been anticipated that modern satellite navigation systems could form a basis for overcoming most of the problems.

A study has been made in Sweden on this issue. It concludes that there are significant possibilities to improve the situation for the groups in question with the aid of GPS-based navigation, combined with the use of mobile telephony and databases for storing maps, personal information etc. The study also suggests the National Post and Telecom Agency to support three pilot studies in Sweden to explore the pros and cons for a few groups of people with disabilities in the three largest cities in Sweden.

2.2.2 Speech processing

Klaus Fellbaum and Diamantino Freitas

2.2.2.1 Introduction and state of the art

Communication is an essential part of human life. If communication is disturbed or impossible, the consequences are loneliness and isolation.

It is well known that speech plays a key role in communication and it explains why humans also want to have speech as a means of communication/interaction with computers. Although human-like speech dialogue with computers is still far off, even with current state-of-the-art technology, the benefits and potential of speech processing are obvious. As will be seen in the next sections, this is especially true in applications for persons with disabilities. Well-known examples are reading machines for blind people, voice control for wheel chairs or speech-based dictation systems for physically impaired computer users.

This chapter presents some new applications for speech-based systems that are (partly) still at the research or prototype stage. Since some of our readers may not be familiar with the principles of electronic speech processing and the state of the art, our presentation will start with some relevant basic definitions.

Speech recognition or equivalently voice recognition is the automatic recognition of spoken words or sentences by a machine. In many cases the result of the recognition is a displayed text and then the terms voice-to-text or dictation system are used. Other important areas for speech recognition are systems for the recognition of spoken commands and the control of basic functions of a personal computer.

There are three main modes for speech recognition.

a) Isolated word recognition up to a vocabulary in the order of 50 000 words and more is on the market. Most of the systems have to be trained before they reach a good level of reliability (up to 98 to 99% correct recognition in controlled environments) or they are speaker-adaptive, that means, at the beginning the recognition accuracy is very moderate, but after intensive use it continues to improve and the accuracy can also reach up to 98...99%.

b) Word spotting or key word recognition is another form of recognition with the aim of recognizing key words in continuous speech. Let us consider, for example, a flight information dialogue system where a user wants to know when is the next flight to Brussels, he might ask in a different way like: 'next flight to Brussels' or 'when will be the next flight to Brussels?' or 'please give me the next flight to Brussels'. In all of theses cases the key words are obviously 'next' and 'Brussels' and the rest of the words are not relevant. The advantage of word spotting is that the flight destination can be formulated as desired which makes the dialogue much more user friendly.

c) Continuous speech recognition has also reached market maturity but the recognition accuracy still leaves to be desired as regards robustness. The main applications for continuous speech recognition are dictation systems which can recognize more than 1 Million word forms. The term 'word forms' is not equivalent to words. It has to be noted that most words may appear in different forms (basic form, flexions, different tenses etc.) and each word form has to be considered as another word (pattern). That's why such a high number of word forms is needed for ordinary office vocabulary.

A serious problem of all speech recognizers is their sensitivity to noise. However, for certain applications in noisy environments (factory floor, aeroplane cockpit, cars in heavy traffic) very robust recognizers have been developed, but the vocabulary is of moderate size (in the order of some hundred words, isolated mode). This is, on the other hand, not very restricting because the vocabulary being used in such situations is rather limited anyway.

Speaker recognition tries to identify and/or verify the identity of the speaking person and is applied in many security-sensitive situations such as access control to secured areas or bank transactions. State of the art systems have an accuracy (correct recognition) of up to 98%.

Speech replay is the speech reproduction by a technical system (computer etc.). The speech being used was spoken in advance by a person and then stored in a fixed memory or disk. Typical applications are announcement systems (e.g. in public transportation) or system messages. A significant characteristic of a replay system is its limited vocabulary. The speech quality is usually good, in principle it can be increased to a high-quality level, this is only a question of the amount invested in the recording equipment and the storage capacity. It is important to mention that the adequate quality level strongly depends on the application [Jekosch, 2005]. For example, a user accepts a lower quality in a telephone conversation than in a radio announcement.

Speech synthesis has, in contrast to speech replay, an unlimited vocabulary. The speech is concatenated artificially from more or less short speech elements like phonemes or diphones or even longer segments. Although speech synthesis has reached an advanced level of maturity, it still suffers from an audible 'machine accent' but since the intelligibility (not necessarily the naturalness!) of synthesized speech is comparable to natural speech, this kind of speech is usable in many practical applications. As a well-known example the screen readers for blind people can be mentioned.

A very important parameter which strongly influences overall speech quality (in both speech replay as well as speech synthesis) is intonation or, more generally, prosody. It is composed of several speech features such as intonation, speed and rhythm, pauses, intensity and is connected to other features such as voice quality (breathy, modal, creaky, etc). All these features, together as a whole multidimensional set, carry so-called supra-segmental information to the utterance that enriches the meaning and can make speech human-like and intelligent. Prosody is the underlying speech layer that conveys pragmatic information. It can also provide para-linguistic and non-linguistic information like intentional and emotional information, respectively [Botinis, 1997].

For more details about the principles of electronic speech processing, the interested reader is referred to the literature; recommended are for example [Furui, 2001], [Gardner-Bonneau, 1999], [Vary, 2006] and, for an extended description of the mathematic principles of speech processing, [Deller, 2000].

2.2.2.2 Speech-based applications for persons with disabilities

Advances in synthetic speech

Multilingual speech synthesis

We are living in a multilingual world. Especially in Europe, different languages are closely related and usually we are trained from school to speak different languages. The same situation exists with written documents or websites. It is thus obvious that most speech synthesis applications (for example enquiry systems or reading machines for blind persons) have to be multilingual.

There are several multilingual systems on the market. One of these was produced by the Bell Laboratories (AT&T, Murray Hill, New Jersey). It functions as a synthesizer for English, French, Spanish, Italian, German, Russian, Romanian, Chinese and Japanese. Interestingly, the underlying software for both linguistic analysis and speech generation is identical for all languages, with the exception of English. However, it is clear that the acoustic elements, used for the concatenation into continuous synthetic speech, must be spoken from a native speaker and thus this part of synthesis is language-dependent. The same holds for the base data of linguistic analysis. However, these components are stored externally in tables and parameter files and they can be loaded when needed in real-time. A detailed description of the AT&T Synthesis can be found in the book of Sproat [Sproat, 1998]; the synthesis of different languages is demonstrated on [Sythesis testsite AT&T].

Another system which became very popular in the speech synthesis society is the MBROLA system. *"The aim of the MBROLA project, initiated by the TCTS Lab of the Faculté Polytechnique de Mons (Belgium), is to obtain a set of speech synthesizers for as many languages as possible, and provide them free for non-commercial applications. The ultimate goal is to boost academic research on speech synthesis, and particularly on prosody generation, known as one of the biggest challenges taken up by Text-To-Speech synthesizers for the years to come."* More details and demos are presented on the home page of MBROLA [MBROLA].

Emotional speech

Emotional speech can remarkably extend the content and expression of spoken information. Moreover, sometimes the way how items are expressed is more important than what is expressed. The key parameter which determines the emotional content is the prosody as discussed before.

A great deal of work has been done in the recognition and production of emotional speech; among others, there was the EU FP6-IST project HUMAINE (Human-Machine Interaction Network on Emotion). For more information visit the home page which is under [HUMAINE].

In a man-machine communication, let's consider a speech-based dialogue system, emotional speech can be used in two directions:

a) The user speaks with emotions and the system has to recognize these emotions in addition to the 'pure' speech recognition. As an example, a situation might occur where the system does not sufficiently recognize the user and reacts in an unsatisfying manner. This is very often annoying and leads to an angry voice. If this angriness is recognized by the system, then it might be wise for it to react with excuses and/or an explanation why the recognition failed [Lee, 2002].

b) If the system produces speech (be it stored or synthetic speech), it can in principle be used to express emotions. Everyone has a need to transmit emotions. But if we think of deaf persons or those with severe speech disorders or people suffering from muscular dystrophies and cerebral diseases that often have also aphasia along with body paralysis, these persons are unable to express their emotions through speech although they have a strong desire to do so.

Several research groups have investigated emotional speech. Concerning the speech quality and, above all, the naturalness of the recognizability of the emotions, the results are encouraging; see for example [Burghardt, 2006].

Iida, Campbell and Yasumura [Lida, 1998] describe an application concept of an affective communication system for people with disabilities who cannot by themselves express their emotions. They get help from some buttons for the selection of emotions. These 'emoticons' are very helpful and they can be easily added to an ordinary text-to-speech synthesis (figure 2.6).

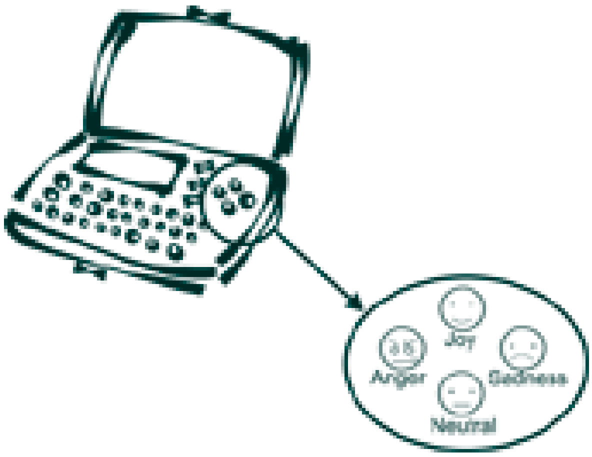

Figure 2.6 EMOTICONS (Emotion keys).

In many cases, a user (who cannot speak as well as a normal speaking person) needs a synthesizer to produce a specific voice from a selected person or with specific features. The underlying concept which fulfills this requirement is called voice personalisation. This facility is very interesting when there is the need to transmit synthetic speech from a text given by a specific person. Voice personalisation is nowadays available at a constantly decreasing cost with the advent of statistical speech-model-based speech synthesizers [Barros, 2005].

Support of a speech conversation for hard of hearing or deaf persons

In this application two persons have, for example, a telephone conversation. One person has normal hearing, the other has a severe hearing impairments. The idea is now to support the hard of hearing person with additional visual information, either in the form of an animated face or as text or in both forms which are presented on a screen (figure 2.7).

The technical implementation works as follows. The speech of the normal hearing person is automatically recognized by a high-level speech recognition system. The result is a text which can be displayed. In the next processing step the text is converted into control parameters for a talking head. At least the person with hearing problems can receive the message in three versions: as original speech, as text and as an animated face. It is assumed here that the hard of hearing person speaks normally, which is quite common.

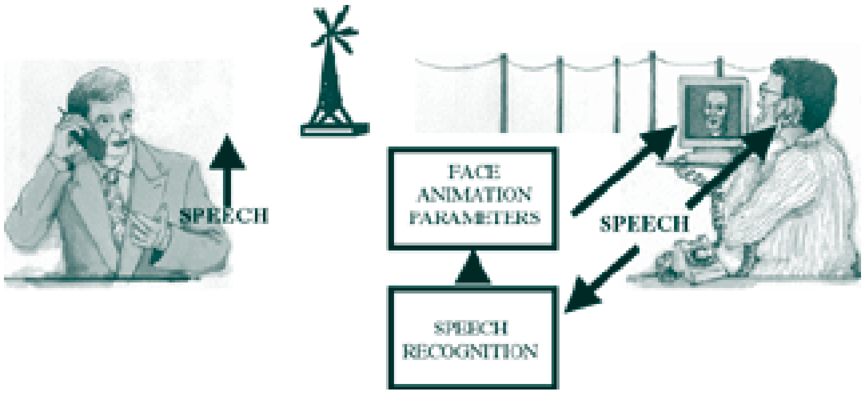

Figure 2.7 Telephone conversation, the partner on the right is hard of hearing.

If the person is deaf, he or she will not have serious problems to understand the message by reading the text and watching the animated face. But problems arise when the deaf person wants to respond to the normal hearing person. This problem will be discussed in the next section.

There are several research projects dealing with speech to text or speech to animated faces. One of it is SYNFACE which was developed at the KTH in Stockholm until 2004 [SYNFACE, 2005]. In the meantime it has become a commercial product. The speech recognition is based on phoneme recognition and a speech synthesizer activates the talking head, mainly the lips. The movements of the talking head are synchronized with the telephone speech and thus the listener can directly complete the part of the information which he or she does not hear.

A similar system that is on the market is iCommunicator [icommunicator]. The system aims mainly at the group of deaf persons, but also at those who are hard of hearing. The kernel of the system is the Dragon Naturally Speaking Professional Engine [DRAGON, 2006], at the moment one of the best and most powerful speech-to-text systems on the market. iCommunicator runs on a higher end laptop computer. Among other features, iCommunicator converts in real-time, speech to text, speech to video sign language, speech to computer generated voice, text to computer-generated voice or to video sign language.

A third system, which can be mentioned here, was developed in a project called MUSSLAP at the University of West Bohemia in Pilsen, Czech Republic. One of the outcomes was a real-time recognizer which presents its results as text on the screen. As a very impressive example, an ice hockey match is shown on a tv screen and the system automatically recognizes the comments of the reporter and displays the result as text in real-time [MUSSLAP].

Speech processing for the communication of a deaf person

If deaf persons communicate over a distance (telecommunication), a very common method since a long time is text telephony or fax which also has the advantage that the communication between deaf and normal hearing persons is possible without any problem. For several years, SMS has also served as a cheap and widespread communication tool. Above all, the Internet with its many services (for example Web and email) has dramatically widened the communication in general and specially between deaf and normal hearing persons.

On the other hand, text communication has some drawbacks: text information is rather impersonal and the typing procedure is laborious and time consuming and not all deaf people have a sufficiently high level of understanding of written language to be able to access text.

For these reasons most deaf persons prefer sign language communication. This form of communication has remarkable advantages:

- *Sign language is fast and its speed is comparable to speech because sign language is produced 'multidimensional'. The 'speaker' can express several items at the same time, for example using in parallel both hands and face expressions. There are, however, some exceptions, which make sign language slower, among others, finger spelling or some complicated words can be mentioned, but these exceptions do not significantly affect the average speed*

- *Sign language is individual. Persons can (beside the 'pure' information) express their personal accentuations and emotions.*

The adequate tool for a sign language communication is obviously video telephony, mostly using a standard like H.320 which is also compatible to ISDN. With the advent of UMTS (3G) and WLAN, a mobile video communication became reality. In both cases usually relay services are applied to connect deaf users, but also, with the aid of a sign language interpreter, deaf and normal hearing subscribers can (indirectly) communicate.

Several projects exist which work on sign language transmission. One is the European IST project WISDOM (Wireless Information Services for Deaf people On the Move, lifetime from 2000 to 2004), in which several advanced wireless services for the Deaf were developed and evaluated [WISDOM].

The situation is different when a direct (face-to-face) situation between a normal hearing and a deaf person is considered. As a first observation it comes out that the communication is obviously much easier from the side of the deaf person because he or she has learned to understand a speaking person by lip reading and watching face expressions and gestures. Although this special form of 'human speech recognition' is never perfect (among other reasons because some sounds are invisibly produced inside the mouth), often fragmented utterances can be completed by the context. It is interesting to state that the recognition of emotions works rather well by watching the face movements and gestures.

For an additional support of the communication process for the deaf person, a speech to text and/or a speech to sign language transformation, as described in the previous section, might be useful. The result of such a transformation can be presented on a display or, more advanced; it could be beamed to little mirrors in the spectacles of the deaf person.

But looking at the other direction: what about the normal hearing person who does not understand sign language?

If we imagine this situation, we can state that - even without any knowledge of sign language – valuable information is transferred about the intention of the deaf person and his/her emotions when we watch gestures, mimic, body movements and other kinds of visual information. In this respect, the situation is similar to those of the other communication direction (from the speaking to the deaf person). The key problem is the recognition of the objective, content-carrying part of the message. For this we can come back to the relay service solution. The deaf person has a camera (maybe as a part of a mobilephone) which records the gestures to the interpreter who translates them into speech, which is then audible for the hearing person. This procedure works well as several projects (also the WISDOM project) have shown, but the problem here is the availability of the interpreter and the fact that a face-to-face situation often happens unforeseen.

Obviously a better solution would involve an automatic gesture recognition which transforms gestures into synthetic speech. In this case the normal hearing person receives the information of the deaf person twice: as gestures and as voice and both forms of information complete each other. There is no need for emotional synthetic speech because emotions are optimally expressed by gestures and the face, as mentioned before.

It is important to state that automatic gesture recognition or, more extended, automatic sign language recognition, is probably one of the most difficult research tasks in the area of communication aids. Difficulties are:

- *the detection and triggering of face and hands*
- *the ambiguity and individual variations of the movements, above all from the hand movements and*
- *the structure of the sign language itself which has no strict one-to-one relation to text or speech syntax.*

The first systems for sign laguage recognition were based on the data glove(s). These gloves are well-known tools, mostly used in the Artificial Intelligence research and in entertainment applications. The advantage of such a glove is the precision with which hand positions are recognized. But for many situations in the daily life, the use of gloves might be too uncomfortable.

A better (but much more complicated) alternative are video-based systems. The deaf person uses sign language, a video camera recognizes gestures and facial movements (above all lip movements) and as result of the video processing, the sign language is transformed into text which can be displayed somewhere and/or the text can be transformed into synthetic speech. A very detailed description of problems and solutions in that area are presented in a recently published book on human interaction with machines [Kraiss, 2006].

We will now briefly mention some research projects.

In the framework of the European IST research program ARTHUR, the Lab. of Computer Vision and Media Technology, Aalborg University Denmark investigated the automatic recognition of hand gestures used in wearable Human Computer

Interfaces [Moeslund, 2003]. Different gesture detection devices are described, among others the 'classical' data glove and reduced versions of it (index finger tracker with a wired or wireless connection to the receiver), a 'Gesture Wrist', a 'Gesture Pendant' and, of course, camera solutions.

A famous researcher, Christian Vogler, who is deaf himself, has made his PhD in automatic recognition of American Sign Language (ASL). He describes the problem of simultaneous events in sign language (for example, the handshape can change at the same time as the hand moves from one location to another, or hand(s) and face express signs simultaneously). Another important aspect is the segmentation of the continuous stream of movements into discrete signs and the breaking-down of signs into their constituent phonemes. If this works satisfactorily, the next steps, namely transformation of signs into text and then into synthetic speech, are relatively easy to manage. For more information see [Vogler, 2000].

Thad Starner and his group from Georgia University of Technology, Atlanta USA, are working on several projects in American Sign Language recognition. They use multiple sensors for the recognition, among others a hat-mounted video camera and accelerometers with three degrees of freedom mounted on the wrist and torso to increase the information of the video camera. For control reasons, the deaf user has a head-mounted display which shows what the camera captures [Brasher, 2003]. The aim of the activities is a flexible mobile system for the output of text or speech, depending on the application. Figure 2.8 shows the head-mounted camera and a recorded gesture.

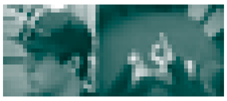

Figure 2.8 Base-cab-mounted camera and a recorded gesture (with kind permission of Thad Starner, Media Lab, MIT).

Visual and audio-visual speech recognition based on face or lip reading

A methodology which is quite similar to gesture recognition, mentioned before, is automatic facial reading or lip reading. The result is a text sequence which represents the content of the utterance. Figure 2.9 shows the region that is investigated for lip reading.

Figure 2.9 The region of interest of the video facial image.

The automatic recognition of facial images has been used for a number of years for the improvement of a (spoken) speech recognition under noisy conditions and it has been proved to be very successful [Kraiss, 2006], [Moura, 2006], although the accuracy, obtained with purely visual speech recognition, is not as high as in audio speech recognition. There are a number of reasons for this; one is that visual speech is partially phonetically ambiguous.

Nevertheless, for the communication between deaf and normal hearing persons, facial or lip reading is a very valuable help and, as previously mentioned, the human face can optimally express emotions and this information is dectectable for the visual recognizer.

Small-vocabulary preliminary trials have been reported [Moura, 2006] to obtain word recognition rates of about 65% for a one speaker lip-reading task with grammar correction. Interestingly, the performance of professional observer was in the range of 70%-80% for the same corpus. Figure 2.10 shows the situation under remarkable noise conditions and it demonstrates the advantage (in terms of recognized words error rate – WER) of a simple combination in a multi-stream recognition approach [Moura, 2006].

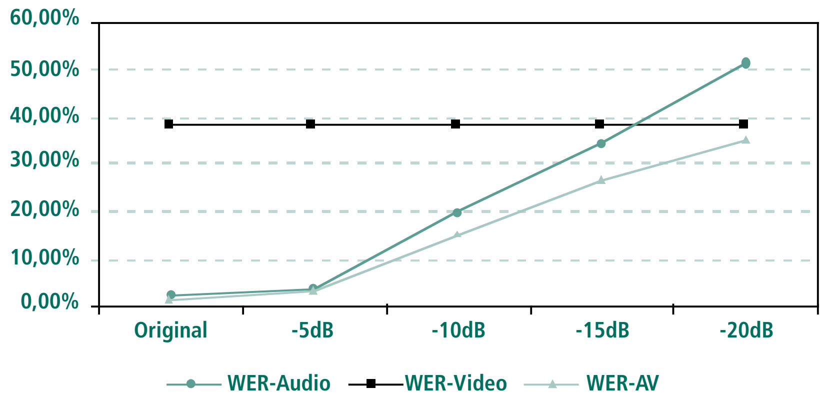

Figure 2.10 Variation of the total word error rate in function of the signal-to-noise ratio.

Correction of speech defects, unintelligible speech

If a person is unable to speak 'normally' resulting in unsatisfactory intelligibility, a speech recognition and synthesis system can be a valuable aid. The impaired speech is the input for the recognizer, which converts it into text and the text is then converted into clean synthetic speech.

It is very important to state that even totally unintelligible speech or any acoustic utterance can be recognized, the only prerequisite is the ability of the 'speaker' to reproduce utterances with sufficient similarities and to train the recognizer with this kind of 'vocabulary'. As a matter of fact, even emotions can be expressed, using emotional speech synthesis. Finally, visual speech recognition, as mentioned before, can significantly contribute to better speech recognition.

A system for speech therapy

It is well known that many deaf persons have fully functioning speech organs but the problem is that they cannot control articulation because they do not have acoustic feedback through the ears.

When the deafness occurred after the complete language/speech acquisition, the deaf person can maintain (with restrictions) his/her speaking ability with the help of a speech therapist. But there is the necessity of a permanent training with a therapist which is obviously not always possible.

Many attempts have been made to develop systems which perform a visual control of a spoken utterance. The time signal or the spectrum of the speech are not very suitable because the relation between the sound production and the resulting signal is rather complicated and abstract.

A better solution is obviously a face animation showing two speaking faces: the 'reference' face and the (deaf) speaker's face. Thus the deaf person can directly see deviations between the two faces and he or she can try to adapt. Since some sounds are produced invisibly inside the mouth, as mentioned earlier, a useful help is a transparent mouth region (figure 2.11).

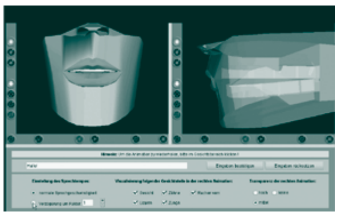

Figure 2.11 Face animation with a transparent area of the mouth region [Pritsch, 2005].

Screen readers for blind or partially sighted persons

The usual computer desktop metaphor practically leaves blind persons out because it is a Graphical User Interface (GUI), based on a more or less rich graphic display of icons, windows, pointers and text. Since blind persons require non-visual media, the alternative is, among tactile information (Braille), primarily an aural interface which can be called, analogous to GUI, Aural User Interface (AUI), based on the terminology supported by many authors including T.V.Raman [Raman, 1997].

Since the early 80's, after some trials with special versions of self-voicing software, capable of driving a speech synthesizer and so providing access for blind persons, a more general concept appeared and a family of applications, called screen-readers, was initiated with the purpose of creating a vocal rendering of the contents of the screen under user control through the keyboard, using a text-to-speech converter [Wikipedia]. In this way, properly installed screen reader software stays active in the operating system and operates in the background, analysing the actual contents of the screen. From the initial command-line interface (CLI) to the now existing ubiquitous graphical user interface (GUI) screen reader software has evolved much in 2,5 decades.

Screen readers can also analyse many visual constructs like menus and alert or dialogue boxes and transform them into speech to allow interaction with a blind user.

Navigation in the screen is possible as well, to allow a non-linear or even random exploration and acquisition of the depicted information. Control of the produced speech is normally given to the user so that quite fast navigation becomes possible when the user works with shortcuts. A simulation of a screen reader is available at the WebAIM website [WebAIM].

Although many screen reader applications exist, there are many limitations that current screen readers cannot overcome per se, for instance those related to images and structured text (tables etc.). Screen readers cannot describe images, they can only produce a readout of a textual description of these and the user has problems to realize how the page is organized.

The basic requirement in terms of speech processing for screen reader applications is a robust text-to-speech converter with the possibilities of spelling and reading random individual characters and all kinds of text elements that may appear like numeric expressions, abbreviations, acronyms and other coded elements. Punctuation is also spoken in general, besides being determinant in introducing some prosodic manipulation in the synthetic voice.

Following this idea, the World Wide Web Consortium (W3C) in 1998, with the issue of the Cascading Style Sheet 2 (CSS2) recommendation, has introduced the Aural Cascading Style Sheet (ACSS); a chapter respective to the acoustical rendering of a web page is presented in [WDAC].

Auditory icons, sometimes also called earcons, are made audible to the user by means of a loudspeaker or earphone system that should have advanced acoustic features (high quality, stereo etc.). The acoustic elements contain voice properties like speech-rate, voice-family, pitch, pitch-range, stress, and others that are used as command parameters to the speech synthesizer.

An extended investigation of spatial acoustic features as a component of a screen reader was performed in the GUIB (Graphical User Interfaces for the Blind) project in the framework of the European TIDE initiative [Crispien, 1995]. The idea was to generate an acoustic screen in front of the user on which windows, icons and other graphic elements are audible on different places, and the mouse position is also audible when the mouse is moving.

In a former project (AudioBrowser, 2003-2005, see [Repositorium]), developed for Portuguese, but applicable for most other languages, the structure or outline of a web page can be discovered and used as a table of contents, and it was implemented successfully. The user in this application can freely navigate inside the contents of each window or jump between windows from contents to tables of contents or vice-versa in order to scan or navigate through the page in a more structured and friendly way. The blind or low-vision user is constantly helped by the text-to-speech device that follows the navigation accurately.

The W3C consortium, through its Web Accessibility Initiative (WAI) has been issuing a relevant set of Web contents accessibility guidelines (WCAG), now in version 2. These guidelines are greatly helpful in orienting web page design for accessibility [WAI]. Authoring Tool Accessibility Guidelines (ATAG), nowadays in version 2.0, are also important for developers of authoring tools.

Reproduction of complex documents for blind persons

Complex documents like mathematical and other scientific, technical or even didactic documents are usually equipped with graphical representations. Above all, equations and other mathematical expressions have posed a substantial barrier to the access by visually impaired persons. Most representations and charts may also be included in this group.

Representation in special Braille codes of complex mathematical elements can almost totally solve the problem for blind persons. The LAMBDA project [LAMBDA, 2005] has produced a mathematical rendering package using such a system.

In the case of more lengthy mathematical objects, more refined solutions might be preferable using audio rendering of the mathematical expressions through synthetic speech. Using the codification of the expression in MathML, a browsable textual description of the expression can be automatically derived from the MathML code by means of a special lexicon and a grammar. Both must be specially designed for the purpose according to the mathematical conventions and concerns of non-ambiguity of the textual description. This work has been carried out in the AUDIOMATH project [Ferreira, 2005] carried out at the Faculdade de Engenharia da Universidade do Porto. A demonstration page is available at [Ferreira].

Acoustical cues, contributing to the clearness of the speech rendering, are also important. Previous authors have used, for instance, prosodic modifications such as raising or lowering the pitch of the synthetic voice to signal upper or lower parts of the expression, respectively. In the work of AUDIOMATH the influence of pitch movements as well as of pauses during description of expressions was studied and rules were extracted. An intra-formula navigation mechanism was designed in order to allow the user to explore the formula at her/his own will thereby not putting too much stress on audio memory in the case of longer formulas.

2.2.2.3 Conclusions and future developments

The aim of this chapter was to show how electronic speech processing works and how persons with disabilities can benefit from it.

Since speech is man's most important form of communication, all efforts must be done to make speech communication possible, and if the speech channel is disturbed, technical solutions have to be found to overcome the obstacles.

The accuracy and quality of modern speech recognition systems as well as synthesis systems has reached a state of maturity which allows the development of very poweful support systems for persons with disabilities and to bridge the gap between these persons and those without disabilities, as was shown, for example, between deaf persons and the rest of the world.

Looking into the future of speech technology, some important research areas can be identified as follows:

- *Improving the robustness of speech recognition systems. Although the robustness has been remarkably improved over the last years, the systems are still far behind human capabilities. Noise, especially non-stationary noise, background speakers or music can still reduce the recognition reliability well below an acceptable error rate. Improvement is expected (and partly proven, as has been seen) from a multimodal recognition which includes also visual information (above all, mimics, facial and hand gestures)*

- *A more extended use of semantic and pragmatic information. When the system (recognizer or synthesizer) 'knows' what the speaker wants to express, which covers both, the content and the emotion, then the recognizer can usefully complete a spoken message which has recognition errors. A synthesizer could automatically generate the right accentuations and emotional 'colouring' of the speech. For the sake of completeness it has to be mentioned here that the permanent improvement of the quality of synthetic speech also includes multilinguality as well as speaker-specific synthesis and will remain within the scope of research. Audio rendering of complex documents through synthetic speech is also a very important development area where document description strategies, their conversion into full text form and intra-document navigation or browsing are the crucial steps*

- *A challenge and wide field of research is sign language recognition. As mentioned earlier, there are several research activities but much more work has to be done. More needs to be known about structures of sign languages (and there are very many and all are different!) and their relations to spoken and written languages. Automatic translations should be possible in different directions (sign language into speech and vice versa, sign language into another sign language, speech into a foreign sign language and vice versa, for example German speech into American sign language). Also the technical part of the problem is challenging. Using the Ambient Intelligence (AmI) approach, we can expect micro cameras in the clothes or in a pendant as well as position sensors in finger rings etc., and the environment will have enough intelligence to take on most of the processing activities needed for recognition and translation*

- *For blind persons, screenreaders and the automatic recognition of graphics, pictures and the environment are a never ending research area. As a matter of fact, for blind persons a verbal (spoken) description of the recognition result is, in many cases, the best solution. As before, AmI will be of crucial importance here.*

It should be mentioned here that the enumeration given in this chapter from being complete. Further examples will be given in other chapters, showing that speech technology and speech applications will play a dominant role whenever communication is discussed.

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2.3 New remote services

2.3.1 Novel broadband-based services: new opportunities for people with disabilities

Broadband trials by the National Post and Telecom Agency (Post- och telestyrelsen PTS), in Sweden

Patrik Bystedt

PTS seven broadband trials

Broadband technology has become accessible for a steadily increasing proportion of the population in Sweden. With the aid of more rapid data transmission it has become possible to send and receive large quantities of information via computer networks. The opportunities for communication have broadened with e-mail, chat and video communications in real time. It has become easier to choose the means of communication that best suits each individual. For people whose opportunities for communication are limited owing to a disability, IT technology in general and broadband in particular can often make things much easier.

In December 2001, the National Post and Telecom Agency (Post- och telestyrelsen, PTS), in Sweden was commissioned by the Government to conduct a number of trial operations where broadband technology was utilised to create new services for people with a disability. One important issue was how the new technology could be used and target-group adapted for these groups. The following seven trials have been conducted:

- *Service centre for people who are deafblind*
- *Distance education for people with mild aphasia*
- *Digital distribution of talking books to university students*
- *Broadband for people with intellectual impairment*
- *Distance education in sign language*
- *Winning Communication – distance guidance*
- *Mobile video communications for people who are deaf.*

A common feature of these trials is that standardised technology has been used to the greatest extent possible. By using, whenever possible, existing aids and standard equipment, such as web cameras and ordinary personal computers, these solutions prove more cost effective for society and users.

A socioeconomic evaluation of these trial services has been undertaken with the assistance of the Center for Medical Technology Evaluation at Linköping University. The so-called 'ICF-model' (International Classification of Disability, Functioning and Health) has been used as an evaluation model.

Service centre for people who are deafblind

Being deafblind involves special problems that affect everyday life, for example, reading food packaging, trying to find something you have lost that is actually lying right under your nose, or quite simply checking whether you are neatly and properly dressed.

Communication with others is a common problem for people who are deafblind. This can sometimes be resolved with the help of a person with normal vision, a personal assistant, a relative or someone who can be around to help and who can communicate with a deafblind person.

The trial 'Service centre for people who are deafblind' aims to act as a supplement to this, by a person who is deafblind being able to make use of technology to get help in those cases where it suits them. Many situations can be solved rapidly and easily with the remote service. This means that people who are deafblind will not be so dependent upon help from people in their immediate surroundings.

In the trial conducted by the Association of the Swedish Deafblind (FSDB), a service was developed whereby a person who is deafblind can communicate with a manned service centre. With the aid of a computer-based terminal with cameras, the person who is deafblind can contact the service centre via broadband. The conversation is conducted through pictures, text and speech using the combination that is most suitable for the deafblind person.

The most common kind of conversation comprises the person who is deafblind using sign language to speak with the service centre, which responds with text. The user reads the text with the aid of a Braille display which is connected to the computer. If the user has residual vision or hearing, the service centre can also sign or speak. The controlling information can also be provided in another form, for example, by a vibrating device that the user can feel on their body.

Figure 2.12 Service centre for people who are deafblind.

With the aid of cameras, the user can be seen or display an object at home that the service centre can see. A moving, zoomable camera is used to show various parts of the room, for example, to find a particular object or in order to read the text on a jar.

During the trial period, a service centre was established and manned Monday to Friday, 08.00 to 17.00, by personnel with backgrounds as sign language interpreters. The trial has been received positively by the four deafblind persons who used the service. The assessment was made that this method of communication provides people who are deafblind with new opportunities to communicate with everybody and that the services provided by the service centre are important and valuable. It is also considered that people with visual impairment could benefit from a similar service centre.

Facts

Technology

Computer connected to broadband with software for total communication, screen reader program and speech synthesis. Braille display, a stationary analogue video camera for communication and a moving, zoomable and remotely controlled camera connected to a video server for presentations.

Target group

FSDB has 400 deafblind members, but there are also deafblind people who are not members. Another potential target group is people with visual impairment.

Number of users

4

Project period

February 2003 - March 2004

Distance education for people with mild aphasia

It is becoming increasingly difficult to justify why students should live away from home in order to participate in residential courses at folk high school. Distance courses allow students to continue living at home while they are studying, which is economical and often socially advantageous. If a prospective student has a disability, the need to be able to remain in the home environment increases while the need for contact with the outside world must also be met. People with aphasia are often affected by a combination of disabilities, primarily difficulties with communication, both spoken and written, together with some impaired motor functions.

The aim of the distance education trial was primarily to consider adapted forms for distance instruction using the best possible broadband technology available. The vision was to develop and expand the work within distance education so that people with mild aphasia would be given new opportunities for education and personal development. This provides participants with the opportunity to attain an enhanced quality of life and in some cases to return to working life.

Figure 2.13 Distance education for people with mild aphasia.

For the group 'people with mild aphasia', the possibility of combining speech and pictures is important to be able to communicate as effectively as possible. To share documents, make use of a 'whiteboard' and make presentations using a computer were common components for the training.

Karlskoga Folk High School, which was responsible for the implementation of the project, has long experience of teaching people with aphasia. As part of the trial, they have conducted distance education at scheduled times in, among other subjects, Swedish and presentation techniques. Eight participants from various parts of Sweden participated in the trial. Regular tuition was provided, three times a week, with positive results, and the participants also made use of the opportunity for sound and video contact for their own discussions with each other. The social aspects of being able to use video conferencing to communicate with other people with aphasia outside the teaching, has also been very much appreciated by participants in the trial project.

The trial enhances the availability of effective adult education and means that it is also easy to reuse the courses that have been prepared.

Facts

Technology
Computer connected to broadband with web camera and headset, video conference software (Click-to-Meet).

Target group
People with aphasia.

Number of users
8

Project period
July 2002 - December 2003

Digital distribution of talking books to university students

University students with a reading disability – people with visual impairment, dyslexia and restricted mobility – are now able to get their course literature as talking books. Students can order the talking books, which are then sent via post from the Swedish Library of Talking Books and Braille (TPB) in Stockholm. Besides the time that the dispatch actually takes, the borrower is dependent upon the book being in stock, that is to say that no-one else has borrowed it. However, as talking books are now digital produced in the international standard DAISY, it is possible to handle them in a different way.

The trial in question is a broadband service that provides access to talking books via digital distribution to students with a reading disability. A central digital talking book archive, which has approximately 13 000 titles, is being built up by TPB, where all recorded university literature is made available for downloading. The aim is to provide access to literature through broadband technology to students with a reading disability, on equal terms with other students.

The project has been conducted by TPB, which is the authority responsible for satisfying the needs of people with visual impairment and other people with reading disability for literature in the form of talking books, Braille books and electronic media.

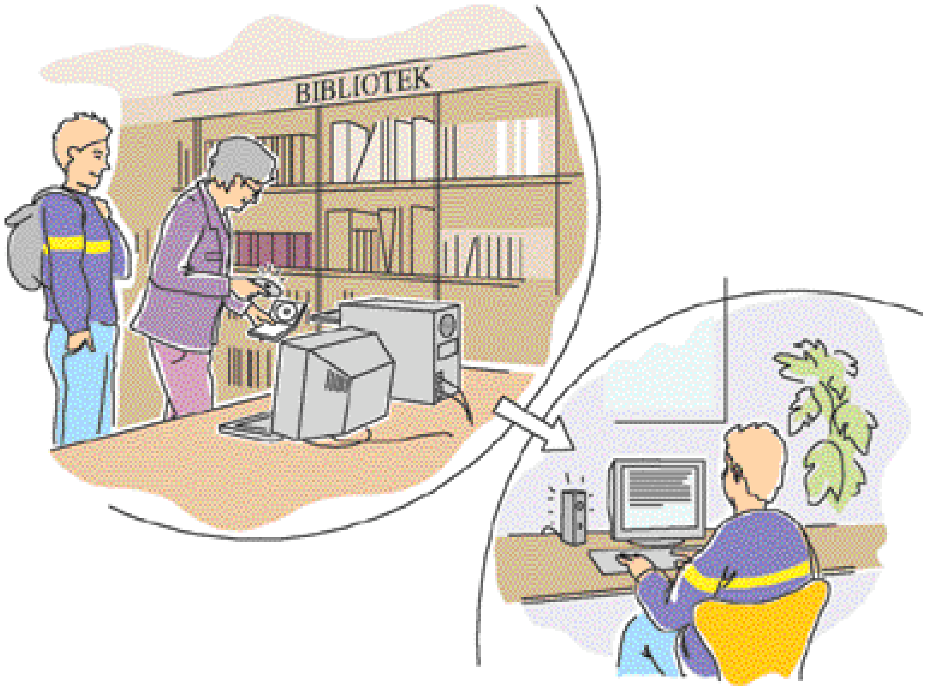

Figure 2.14 Digital distribution of talking books to university students.

Through SUNET, the university computer network, the four university libraries that have participated in the trial have access to broadband with high transmission capacity. The average talking book is 225 MB in size and university books are often twice as big, which imposes demands for rapid connections and an acceptable download time. Equipment for downloading and burning CD-ROMs has been set up within the library. When a student comes to the university library to borrow course literature, the librarian simply downloads the talking book from the talking-book archive and transfers it onto a CD-ROM for the student to borrow. The system is simple to use and the talking books in the archive are always available, which means that there is no waiting list.

The project also has two sub-projects where sub-deliveries and so-called 'streaming reading' are being tested. If the book is in the process of being recorded, it can be downloaded to the student bit by bit in pace with the progress of the recording. This can sometimes be decisive for keeping up with course studies. Streaming reading of talking books over the Internet means that students can themselves connect from home and read the relevant books, without needing to go to the local library to download the talking books.

The trial subjects who participated in the project have made frequent use of the opportunity to download talking books and university libraries have demonstrated great interest, even those who have not participated in the trial. In addition to the trial subjects and the university libraries that participated in the project, approximately 100 other students have made use of the service and 13 new university libraries have gained access to the archive. The broadband service has now been established as a regular service.

Facts

Technology

University library: Computers with a rapid broadband connection and CD burners. The reading program EaseReaderOnline was used for streaming reading.

Target group

People with reading disability (for example, people with visual impairment, dyslexia, impairment to mobility)

Number of users

49

Project period

June 2002 - May 2004

Broadband for people with intellectual impairment

Intellectual impairment involves, among other things, difficulties in dealing with abstract concepts and contexts, for example, time, quality, quantity, cause and spatial relations. One consequence of this is that people who are disabled are limited by their capacity to communicate with each other at a distance, for instance, by telephone. If two people can see each other, and in this way perceive body language, pronunciation and tone on the part of the person they are talking to, communication is made significantly easier.

Being in control of your everyday life, for example, by gathering and understanding public information, news, participating in leisure interests with others, shopping, attending to your finances, writing to authorities and friends, are important activities that allow full participation in society and are essential for an independent life. For many people with intellectual impairment, participation and the opportunity to live independently is severely restricted. A computer with a broadband connection provides opportunities for enhanced participation and independence.

For the trial 'Broadband for people with intellectual impairment', two-way video communications with high audio and picture quality are essential for communication at a distance to function. The trial was implemented in collaboration with the Municipality of Bollnäs, the Grunden Association in Gothenburg and Höghammar School in Bollnäs.

Figure 2.15 Broadband for people with intellectual impairment.

The objective of the trial was to determine the benefits of broadband for people with intellectual impairment. One important aim was to be able to communicate and cooperate individually or in groups with the aid of two-way video communications via the Internet. Another aim was to test the possibilities of people with intellectual impairment to use the services on the Internet, for example banking, e-commerce and other services. In addition to these activities, the aim was also to provide participants with an opportunity to discover their own uses and benefits from broadband.

Members of the Grunden Association in Gothenburg and pupils at Höghammar School in Bollnäs participated in the trial. For example, they tested various services on the Internet and pooled their experiences in order to learn more about the Internet as an everyday tool. Video communication was often conducted from several people to several people, that is to say, between groups. The working groups also collaborated on a joint web newspaper, publishing results and experiences from the trial.

Experiences from the trial have shown that users have rapidly assimilated this new method of communication and felt both the benefit and joy of using it. The Internet and video-supported communications can facilitate distance communication. This particularly applies to the opportunity to establish new contacts beyond the individual's circle comprising other people with disability. This is very important as many people with intellectual impairment encounter impediments that limit their opportunities to meet other people.

Facts

Technology

Studios (Gothenburg and Bollnäs): Computer connected to broadband, large screen, video-conference program (Click-to-Meet), web camera, digital video camera for better quality and documentation.

Home environment

Computer connected to broadband, video-conference program (Click-to-Meet), web camera, and headset.

Target group

People with intellectual impairment

Number of users

6 people at Grunden Media in Gothenburg and 5 pupils at Höghammar School in Bollnäs.

Project period

July 2002 – May 2004

Distance education in sign language

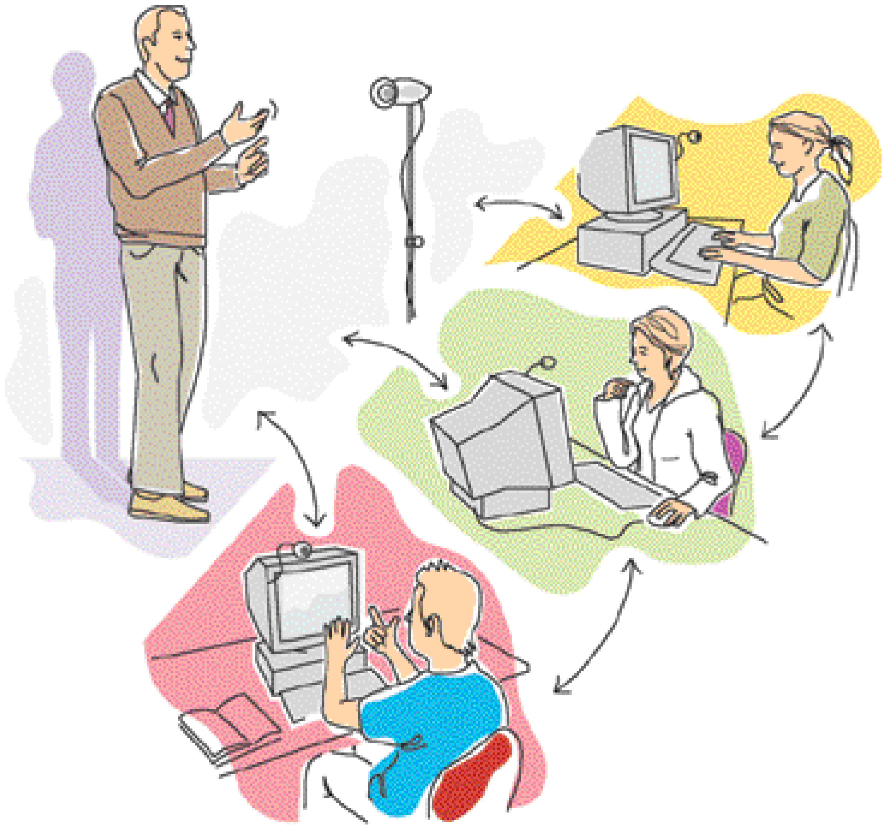

Figure 2.16 Distance education in sign language.

Sign language is the first language of deaf people and it is consequently important for people who are deaf to gain access to education in sign language. The adult education courses in sign language that are currently on offer today for people who are deaf are often arranged at boarding schools far from home. There is consequently a great need for and interest in distance education.

The aim of the project was to use the framework of a flexible course to create an opportunity for sign language interaction between course leaders and participants. Communication takes place by video over the Internet, either as direct communication or through the participants downloading video files or sending video messages. The project is being conducted by the Swedish National Association of the Deaf (SDR) in collaboration with Västanvik Folk High School in Leksand.

The project basically employs three methods of communication for interaction between the teacher and the participants:

- *Video files with course material and assignments in sign language that the participants access via the Internet*
- *Participants' feedback to the teacher in sign language via recorded video messages*
- *The teachers and participants meet for scheduled lessons in a virtual classroom on the Internet through videoconferencing.*

The course should be easily accessible, through a user-friendly interface, and at a reasonable cost for the individual user, without lowering educational standards. The communication of high quality video over the Internet imposes great demands on high bandwidth, but the equipment that participants require is a standard computer, web camera and software. The course methods may also benefit people who need lip-reading or signs to support their understanding.

Experience from the trial is that the technology functioned beyond all expectation and the pupils were very positive towards the opportunity of communicating in their first language at a distance. "Wonderful contact from 200 kilometres away!", according to one participant.

Facts

Technology
Computer connected to broadband, web camera, videoconferencing software (Click-to-Meet).

Target group
People who are deaf or people with hearing impairment with sign language as their first language.

Number of users
13

Project period
July 2002 – April 2004

Winning communication – distance guidance

Figure 2.17 Winning communication – distance guidance.

Considerable resources are required to provide people with disability with effective guidance, for example, about labour market issues. Limiting factors include access to specialists in labour market guidance for deaf people and sign language interpreters. Resources are also unevenly distributed across Sweden, which means that it can take a long time for people with disability to get to meet these guidance specialists.

The aim of the trial project known as 'Winning Communication' was to develop ways of using video communication in regular work at the employment offices. The primary goals for the group comprising jobseekers with disability were to facilitate more rapid contact with specialists at the employment offices and thereby enhance opportunities of finding work. At the same time, this would reduce both travel costs and travel time.

Guidance can be provided individually and for groups. When the counsellor, together with the applicant, identified the service need and decided on the most appropriate method, the applicant was offered the opportunity of meeting an expert at a distance. Together with his/her caseworker, the applicant met up with, for example, a psychologist, teacher of the deaf/hard of hearing, teacher of the deaf, vision consultant, occupational therapist or other expert via video communication. Communication is conducted using video, text and voice and the counsellor is able to display documents and websites. The technical equipment is installed at ten employment offices in the counties of Uppsala and Västmanland, which means that people with disability can visit their nearest employment office.

Experiences from the trials have been very positive. Ten employment offices took part and guidance was provided both individually and with groups of up to five people. During the trial period, distance guidance was integrated into the regular operations. Meetings were considered to be effective and there were few limitations for the scope of use of the concept.

The project also provides the preconditions for greater cooperation and a more efficient transfer of competence between the staff at the employment offices who work with people with disability.

This trial was based at the County Labour Board in the County of Uppsala and has been co-financed by the National Labour Market Board (AMS). Methods for providing distance guidance for deaf people have been applied in Uppsala for the past couple of years with very good results. As distance guidance is now being integrated into the regular operation, it will also continue in the future after the conclusion of the trial project.

Facts

Technology

Computer connected to broadband with video camera, microphone and video communication software.

Target group

People with impaired mobility, deaf people, people with hearing impairments, people with visual impairments, people with intellectual occupational disability, applicants suffering from asthma/allergies, people with dyslexia, people with heart and/or lung diseases and other somatic-related occupational disabilities.

Number of users

37

Project period

July 2002 – June 2004

Mobile video communications for people who are deaf

Video calls via mobile telephones brought about a revolution in the communication opportunities for people who are deaf. Text messages (SMS) soon became an important means of communication for deaf people, although it uses the second language of deaf people, Swedish. Video calls make it possible for deaf people to use their first language – sign language – for mobile communications.

The third generation mobile telephony, 3G, has high capacity and is capable of transmitting moving pictures, essential for allowing sign language use with a mobile. The trial project 'Mobile video communications for people who are deaf' aimed to investigate how deaf people can use 3G telephones in order to communicate with sign language. The project period was May 2004 to February 2005.

The trial group conducted video calls in real time, and also sent video messages to each other. The possibilities that 3G technology offers were investigated and evaluated by testing the various terminals and 3G networks. In the course of the trial period, video calls became increasingly common in Sweden among people who are deaf.

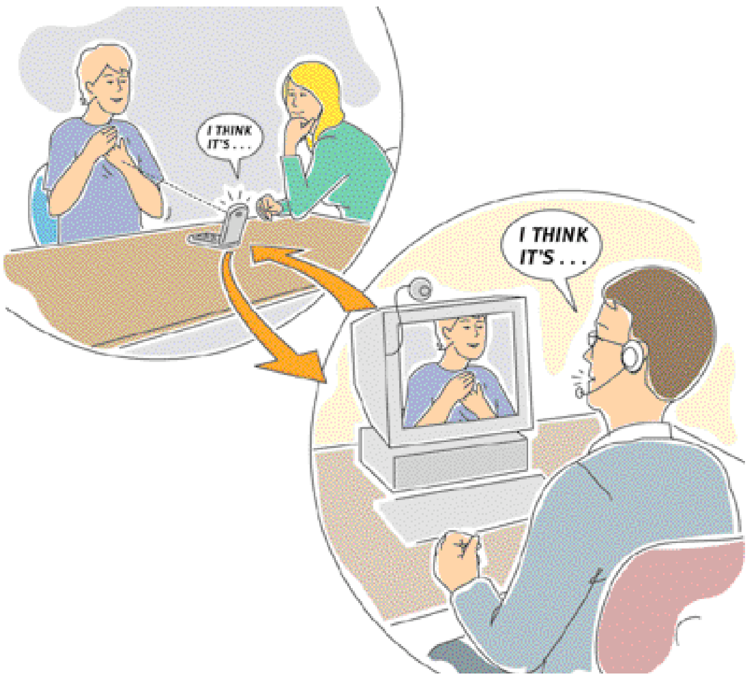

Figure 2.18 Mobile video communications for people who are deaf.

The positive experiences from the first trial resulted in a new development project being initiated during the spring of 2005. This was to test a communications and interpreter service for 3G calls. These services mean that a deaf person can contact a sign language interpreter who interprets between sign language and speech. In this way, a deaf person can communicate directly with a hearing person. This may, for instance, involve distance interpretation, for example, when visiting the bank or during a spontaneous meeting. It may also involve a communicated call, for example, when one deaf person wishes to make a call to a hearing person or vice versa. In this way the deaf person becomes less dependent upon physical access to interpreter resources and the need to book such services well in advance, which creates opportunities for more spontaneous communication.

The new project aimed to develop both technology and methodology for receiving and dealing with 3G calls at an interpreter centre. The project is now finalised and the functionality is since September 2006 integrated in the service provided by the Relay service for video telephony operated by Tolkcentralen in Örebro Läns Landsting (the Örebro County Council Interpreter Centre).

Facts

Technology
3G technology and telephones with video functionality.

Target group
People who are deaf and hearing-impaired persons who use sign language as their first language.

Number of users
Approximately 100

Project period
April 2005 – February 2006.

Conclusion

Broadband communications have demonstrated that they can play an important role in providing vital services to people with special needs for communication. The technology is mature enough to provide advanced services and it is reasonable to expect that such services will become more widely available as long as organizational and economical aspects can be solved.

References

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http://www.pts.se/Dokument/dokument.asp?Sectionid=&Itemid=3745&Languageid=EN.

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http://www.pts.se/Dokument/dokument.asp?Sectionid=&Itemid=4615&Languageid=EN.

2.3.2 Access to video relay services through the Pocket Interpreter (3G) and Internet (IP)

Patrik Bystedt

Background

The National Post and Telecom Agency (Post- och telestyrelsen, PTS) is the authority that monitors the electronic communications and postal sectors in Sweden. PTS has according to governmental regulations and decisions, an assignment to, through procurement, ensure that the special needs of people with disabilities are satisfied. The Government grants an allowance for this purpose every year to PTS.

PTS procures a number of electronic communications and postal services. Furthermore PTS continuously initiates projects with the aim to test new technologies and new functionality that could support different groups of disabled people.

The technological development and rapid growth of fixed and mobile broadband networks creates new possibilities for people with disabilities. There are two significant trends that PTS has recognized. The first is that more and more services are based on the IP protocol. The second is an increasing demand for services to be mobile. A recent survey in Sweden shows that practically everyone in Sweden has a mobile telephone, senior citizens is the only group where accessibility to mobile telephones is less than 90 %.

The relay service for video telephony has been available in Sweden since 1997. It is primarily used for relaying telephone calls between a deaf person using sign language and a talking person. During the first years, the service was only offered to sign language users via the ISDN network. Since the ISDN network is not widely spread and communication is quite expensive, the number of users was limited. ISDN is no longer a promoted service in Sweden and the number of subscriptions will decline. Today video calls via IP based video and 3G telephones are more used. There is therefore a need to develop the relay service for video telephony to meet the new communication need and trends. Since 2003 PTS has initiated two different development projects, the IP access project and the pocket interpreter.

The IP access project

PTS started the IP access project in 2003. The overall aim of the project was to develop the relay service for video telephony and build a new IP platform that could handle calls to and from different types of video telephones. The IP access project was concluded in August 2006.

Before the incoming calls to the service were handled in different studios at the interpreter centre depending on the video telephone. If the user called from an ISDN telephone the interpreter would go to the ISDN studio and if the user called from an IP based video telephone the interpreter would go instead to the IP studio. This was not an ideal situation and certainly not a scalable solution.

In February 2006 the new IP platform was put into use. Today all incoming calls are handled on the same platform, with the same service quality measures. The studios connected to the service are no longer dedicated to a certain type of video telephone. Another aim of the project was to allow access to the service through a web client. A user with a computer, web camera and a broadband connection can download software for video telephony. This means that the user becomes less dependant on the specific video telephone.

With the new IP platform, a call centre solution has been initiated. Collaborating interpreter centres or companies can now connect their studios to the service and supply interpreter services. The incoming calls are distributed through an automatic call distribution (ACD) mechanism. This gives the relay service flexibility and ability to grow. The dependency on certain interpreter centres and geography is also minimized.

Figure 2.19 describes how the service looks like today with more accessibility for the user (left hand side) and a more flexible and scalable solution with collaborating suppliers of interpreter services (right hand side).

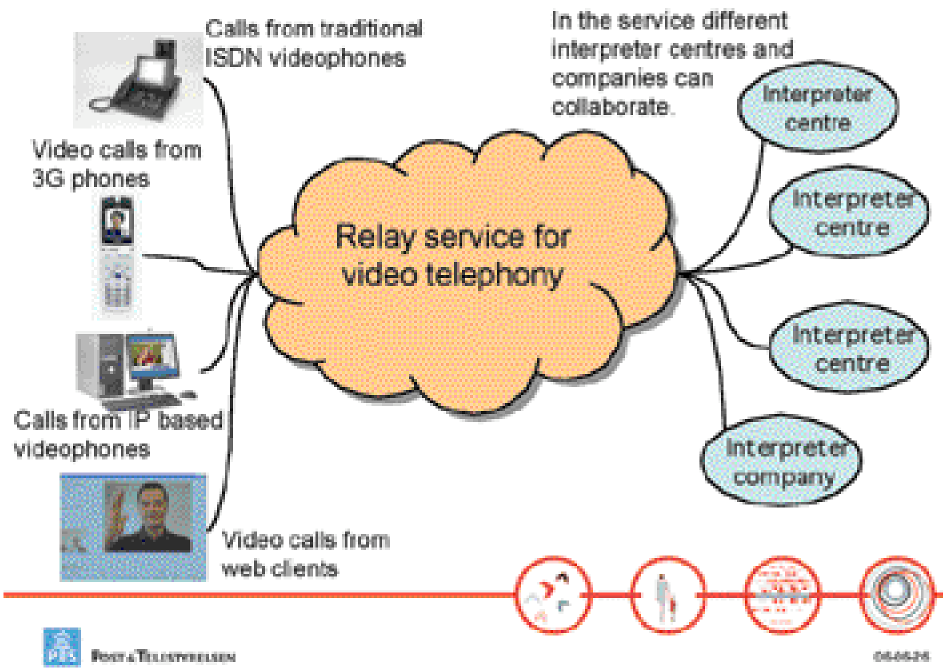

Figure 2.19 Overview of the Relay service for video telephony in Sweden.

The pocket interpreter

In 2004 PTS initiated a trial project called Mobile video communication for people who are deaf. One of the services tested in the trial was distance interpretation and relay of mobile video calls. This mobile application of interpretation services has, among users, been referred to as "the pocket interpreter". The use of 3G is rather extensive among people who are deaf. According to Sveriges Dövas Riksförbund (the Swedish National Association for the deaf) an estimated 4 000 to 6 000 people who are deaf use a 3G telephone, which would represent approximately half of the number of people who are born deaf in Sweden. The conclusion of this trial project was that there is a great demand for this service and there are many potential users of the service.

In order to meet this demand PTS started the development project, the Pocket interpreter, in April 2005. The main objective of the project was to develop methodology and technology for distance interpreting and mediation of mobile video calls (3G) to the new IP platform.

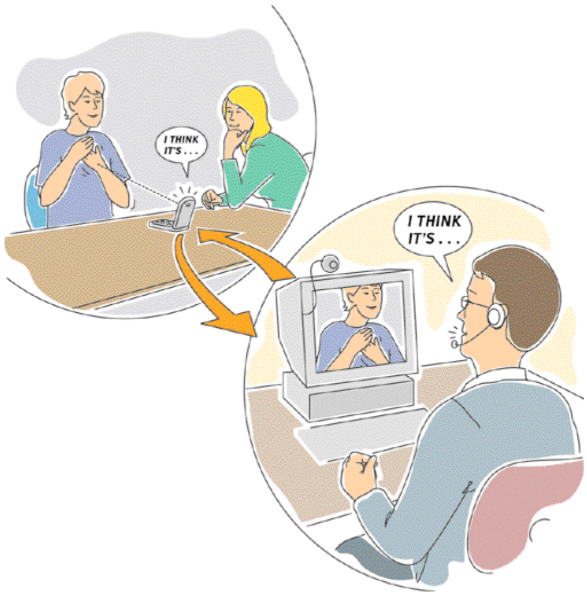

Figure 2.20 The pocket interpreter, distance interpretation via a 3G telephone.

One of the major efforts in the project was to improve the interpreter situation. When the project started the interpreter used the same equipment as in the trial Mobile video communication for people who are deaf. This was an ordinary 3G telephone and the interpreter sat in a specific 3G studio at the interpreter centre. Since February 2006, when the new IP platform was put into operation, mobile video calls were handled in the same platform and in the same manner as any other call to the service. The specific solution and studio is not used anymore.

Figure 2.21 The interpreter studio – from a modified 3G telephone to a multifunctional IP platform.

The number of 3G users in the project was initially limited to 100. In May 2006 new functionality was implemented in the platform so that incoming 3G calls could be distributed through the ACD. This means that more studios can handle incoming 3G calls and that the number of 3G users can increase.

There has been a lot of interest shown in the project and the Pocket interpreter has been demonstrated frequently, for example at the World Summit on Information Society (WSIS) in Tunis in November 2005. The project has also competed in the Stockholm Challenge Award.

The project was concluded in August 2006, but the Pocket interpreter, the mobile access to the relay service for video telephony, lives on.

Conclusion

The development project was finished by the end of August 2006. As a result of these projects, users can now call the video relay service using their 3G telephone, IP based video telephone or web client as well as their traditional ISDN video telephone. The future of the video relay service is that both the service and the user will be less dependant on the specific video telephone. The service will become much more flexible. The number of video calls from mobile telephones and computers connected to Internet is expected to grow rapidly and will create demand on the service resources. The new service platform allows interpreter companies to collaborate as sub contractors which means that more interpreters can handle incoming calls, regardless of geographic location. The future will probably see more of these joint ventures to create national services.

2.3.3 Convenient invocation of relay services

Robert Hecht

Introduction

The term relay service refers here to a service that allows people with a disability to use the telephone, when normally they could not, through the use of an operator. Today these three types of relay service are in common use in Sweden and other countries:

- *Video telephone relay services: telecommunications services that enable deaf video telephone signers and voice telephone users to interact*
- *Text telephone relay services: telecommunications services that enable text telephone users and voice telephone users to interact by providing conversion between the two modes of communication in substantially real time*
- *Speech-to-speech relay services: telecommunications services that enable speech impaired telephone users and other users to interact by providing skilled assistance between them.*

These relay services are very good and important for translation between various means of communication. They thereby contribute towards ensuring equal opportunities for telecommunications for people with disabilities. Further variations of relay services can be created through new combinations of media and language in the calls.

To call through a relay service is currently a two-step process. First a person calls the service and explains who they really want to call. The relay service then connects and performs the relaying action.

The methods for invoking the relay service for a call can be improved so that the relay service can contribute more effectively to equal opportunities for communication. There are methods to arrange the convenient invocation of relay services that are listed below.

Needs and functional description of connection cases

In the illustrations, a picture of a text telephone that has a call through the Relay Service for Text Telephony is usually used, but the cases also apply to video telephony through the Relay Service for Video Telephony and voice telephony through the speech-to-speech relay service (Teletal in Sweden).

The descriptions provide reasons for why the connection cases would simplify the relay services for the user.

Direct dialling to relay service users

Of all calls to the relay services, 85% are initiated by relay service users. Voice phone users rarely call to relay service users. One reason for this is that it is too complicated for a voice telephone user to call to a relay service user. It is also too complicated to describe how to do it.

One solution is to be able to use a voice telephone number to the relay service user that automatically connects the call from the voice telephone user through the relay service to the relay service user.

This leads to equal opportunities for communication and reduces unequal treatment of people with disabilities. An illustration is shown below of how such a call between a voice telephone and a text telephone could be performed.

Figure 2.22. The voice telephone user rings a direct number to a relay service user with a text telephone. The relay service for text telephony is automatically invoked.

Direct dialling to voice telephone users

Today the relay service user first calls the relay service and requests that they arrange for the call to be connected to the destination. This is sometimes perceived to be an inconvenient and time-consuming process. It also makes it more difficult to benefit from electronic telephone directories.

In order to simplify management of dialled calls to voice phone users, a function is needed that allows the relay service user to dial the destination's number, and allow the call to invoke the relay service and connect the destination.

An illustration is shown below of how such a call between a text telephone and a voice phone could be performed.

Figure 2.23. The relay service user's call from a textphone to a voice phone goes automatically through the Relay Service for Text Telephony.

Forwarding voice calls so that they are connected via the relay service

For relay service users, it may be very frustrating to be alone in premises where there is a voice telephone. When someone calls to the voice telephone, the relay service user must be able to get the call connected via the relay service.

When the relay service user realises that no one can receive a voice call for a period, then the relay service user should, by a simple action, be able to request call forwarding via the relay service of incoming voice calls. This may mean that the call, after having been connected through the relay service, also goes to another terminal that can deal with the media that the user wishes to use.

Today it is usual for a voice telephone and a text telephone to be on the same number and telephone connection. For users who wish to retain this form of connection, it is desirable to have a call forwarding that has the effect that only incoming voice calls go through the relay service, while text calls are dealt with directly.

An illustration is shown below of how a connection from a voice telephone to a text telephone via the Swedish Relay Service for Text Telephony is performed, when the voice telephone is forwarded to the relay service user via the relay service.

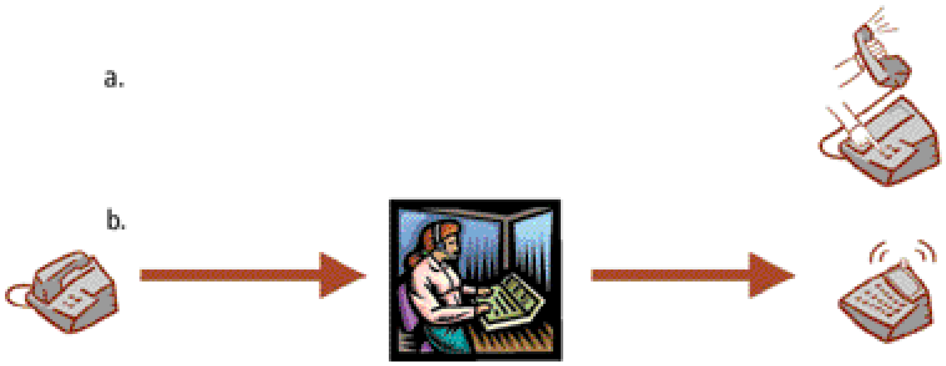

Figure 2.24.

a. The relay service user by a simple action requests connection on the voice phone of an incoming call via the Relay Service for Text Telephony.

b. An incoming call is connected to the relay service user's text telephone via the Relay Service for Text Telephony.

Transferring an incoming voice call so that it is connected via the relay service

It is very frustrating for relay service users when a voice phone rings when at that particular time there is no hearing person in the vicinity who can answer.

It is desirable to have a function that by a simple action allows the relay service user to request that the incoming call to be transferred to him/her via the relay service.

Today it is usual for a voice telephone and a text telephone to be on the same number and telephone connection. For users who wish to retain this form of connection, it is desirable that the transfer can be made selectively so that only incoming voice calls go through the relay service, while text calls are dealt with directly. It is also desirable that calls, after connection through the relay service, can revert to text calls on the same number.

An illustration is shown below of how a transfer of an incoming voice call via the Relay Service for Text Telephony to a text telephone could be performed.

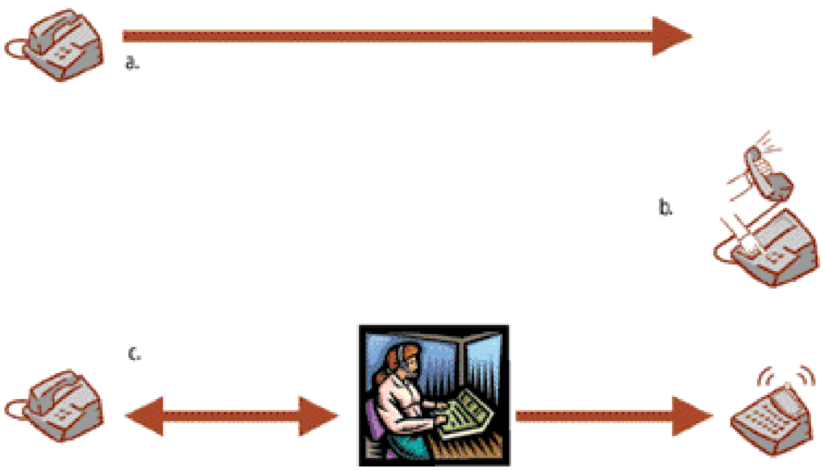

Figure 2.25.

a. An incoming call to a voice telephone cannot be answered by the relay service user.

b. The relay service user requests connection via the Relay Service for Text Telephony by a simple action.

c. The Relay Service for Text Telephony takes the call and calls up the user.

Transferring an ongoing voice call so that it is connected via the relay service

If one party in an ongoing voice call wishes to hand over the call to a relay service user, it is not possible today to transfer the call being made as a voice call, but the call must be ended and either party called up through the relay service's two-step process. This is so intricate that users in many cases refrain from transferring the call, and the call is conducted without the participation of the relay service user. This often results in inadequate participation and independence for people with disabilities.

A function that allows voice telephone users to transfer calls to a relay service user via the relay service is important to avoid these situations. This would make things much easier for all parties and a significant step towards equality to be able to say "Please hold and I'll connect you to Lasse" instead of saying "call 020280020 and request a connection to lasse.larsson@sip.omnitor.se".

Today it is usual for a voice telephone and text telephone to be on the same number and telephone connection. For users who wish to retain this form of connection, it is desirable that the transfer can be implemented so that the call reverts as a text call to the same number after having been connected through the relay service.

There may also be a need for other similar transfers. It may be a call between two individuals with disabilities who have a direct conversation in text or sign language between themselves, and then the need arises to transfer the call to go through the relay service to a voice telephone user. Another variant is the need to transfer a call that started with the relay service invoked to go directly between the call parties or to another relay service user.

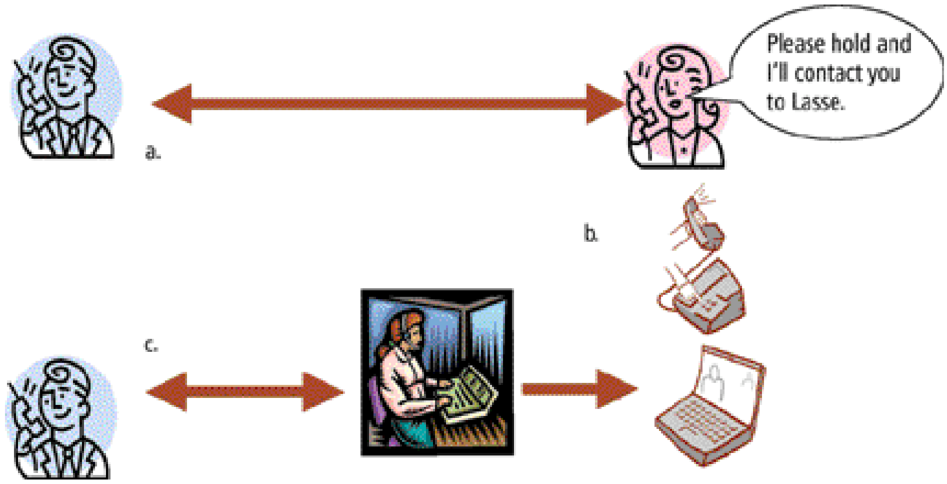

Figure 2.26.

a. Two voice phone users are having a conversation.

b. One of the voice phone users requests by a simple action transfer via the Relay Service for Video Telephony.

c. The other user is then connected to a relay service user via the Relay Service for Video Telephony.

Conditional invocation and performance of a relay service

There are many further potential improvements for the methods to invoke the relay service. Facts about the two call parties and their terminals can provide an information base for decisions for the relay service to be invoked and how this should be performed. Such functions can mean that it becomes even simpler for the users to have access to convenient telecommunications.

Information that may be desirable to form a basis for such decisions includes, for instance:

- *The capacity of the terminal to deal with various media, such as video, text and audio*
- *The user's preferences as regards medium for his/her communication*
- *Languages which the parties and the relay service prefer and have a command of*
    - *Among spoken languages*
    - *Among written languages*
    - *Among sign languages*
- *Subject areas for calls, so that the relay service can choose staff with the appropriate competence*
- *Desires or needs for the performance and kind of relay service, for example relay services that deal with sign language, text or voice, for simultaneous speech and text, for typed text voice calls, etc.*
- *Need to pre-plan the call with the relay service*
- *Customer relations and account information.*

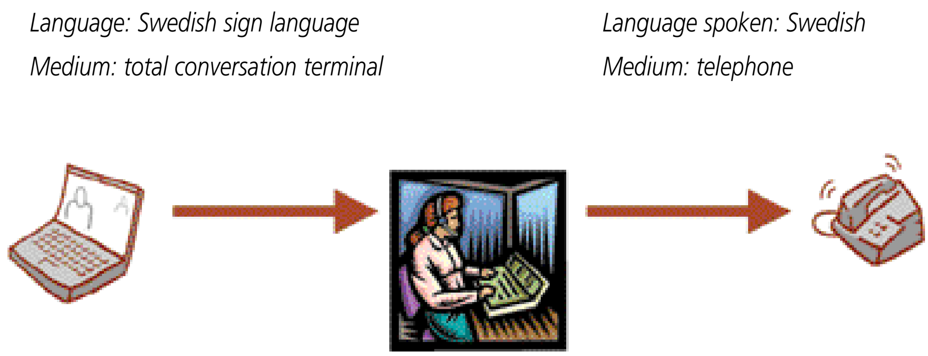

Figure 2.27.

The relay service user has specified 'Swedish sign language' and rings to a voice telephone user who has specified 'spoken Swedish'. The call is then connected automatically through the Relay Service for Video Telephony.

The information that is required as a basis for decisions can be sent with the connection, stored in the network or stored in a database at the relay service. Decisions can be made by users, terminals, network components or communications assistants.

There are many other possibilities with such functions. When a call is connected, a relay service with adapted qualities may be included in the call. A relay service for video telephony can, for instance, be invoked between a relay service user who has been registered for using Swedish sign language and a voice phone user who is registered to only be able to use Swedish spoken language.

Emergency calls (112, 911 etc.)

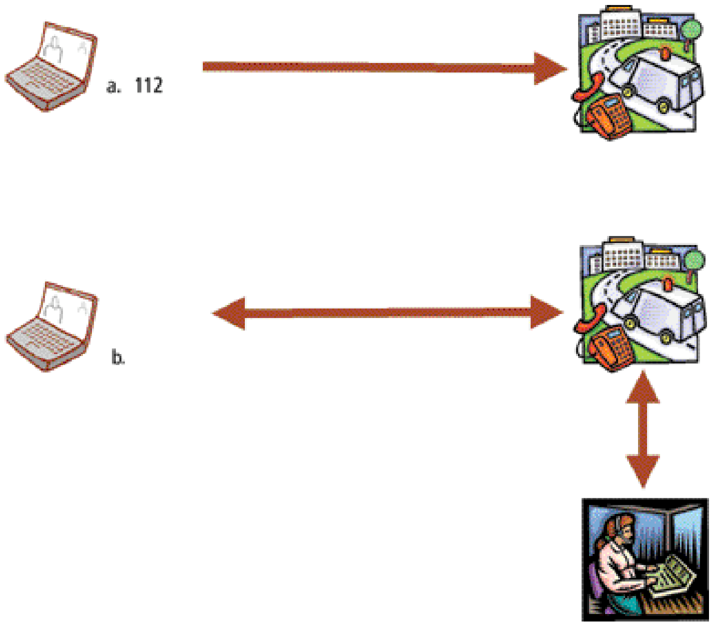

Figure 2.28.

a. The relay service user dials 112 for an emergency call on his/her text telephone.

b. The Emergency Centre or the relay service user requests assistance from the Relay Service for Text Telephony which is invoked for the call.

It is a tradition in Sweden that everybody, also people with disabilities, should be able to call 112 for emergency calls. This is an important principle, which avoids having to learn different numbers for different ways of making emergency calls. Nonetheless, it may with an emergency call be very valuable to be supported by a relay service that can deal with sign language, text or voice.

It may occur with such calls that the party calling and the relay service have common media that cannot be presented in the Emergency Centres (known as 'SOS Centres' in Sweden), but translated to and from speech by the relay service. This primarily applies to sign language in a video channel. It is necessary to determine which cases it would be reasonable to perform in this way.

It is necessary to be able to invoke a relay service in a convenient way into an emergency call on the initiative of the relay service user or of the Emergency Centre.

Invocation of relay service in two steps

In order to make the description of the connection cases complete, a description is provided here of the two-step method. This is currently the most usual method of invoking a relay service for a call. This method should be retained even when more convenient methods have been introduced, as it provides good opportunities to discuss the service performance without first having to provide any destination address.

The relay service's own address is only used to connect a call between the party calling and the relay service. In calls with the relay service, the calling party states the address that is to be called up, following which the relay service connects to the address, and relays the call between the parties. The initiative for the connection can be taken by either of the parties.

Figure 2.29.

The voice telephone user rings the number to a relay service.

In calls with the relay service, the number is transferred on a text telephone.

The relay service rings the text telephone and relays the call.

Connection of ordered relayed call

One method of getting a relay service for a call is to order the call. This possibility is available today, and is included here only to make the analysis complete.

An order can, for example, be placed for a call at a specified time. The relay service receives an order to perform a relayed call at a particular time. The service then makes calls to both parties and relays the call between them.

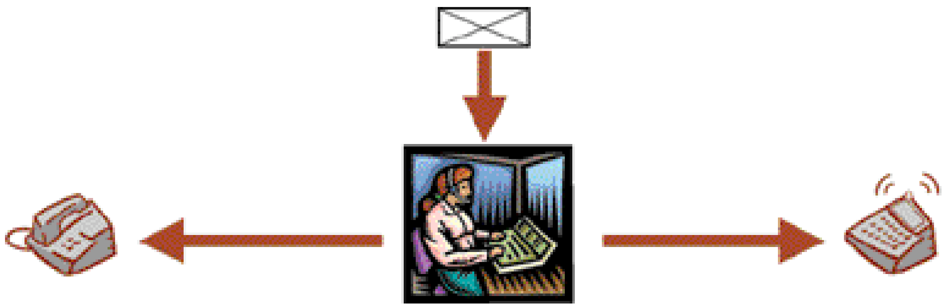

Figure 2.30.

The relay service receives an order to perform a relay.

The relay service calls a text telephone user and a voice telephone user.

When both calls are connected, the relay can be performed.

The described call cases can be implemented in various network environments. One key component is to have a mechanism that takes a call to a specific number to the user through the relay service. Most other call cases can be implemented by adding various supplementary services to that basic solution.

One smooth way of developing the solutions is to use the ENUM-mechanisms for translating telephone numbers to SIP-addresses and use VoIP and IP Multimedia technologies for routing the calls.

A report from the project initiated by the National Post and Telecom Agency in Sweden (Post- och telestyrelsen, PTS) gives details on implementation opportunities in various network technologies and relay services [PTS, 2006].

References

PTS (2006). “Convenient invocation of Relay Services - A pre-study conducted by Omnitor, commissioned by the PTS - PTS-ER-2006:5”.
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2.3.4 Ways of using mobile telephones by people with dementia

Erland Winterberg

Dementia conditions

Dementia is the name of a number of symptoms of malfunctions in the brain. There are several forms of dementia; the most frequent is Alzheimer's disease. Other causes of dementia are blood clots and brain haemorrhages, Parkinson's disease, alcohol abuse, etc.

Some forms of dementia can be cured, medicine can delay the development of certain forms, but in the majority of cases, the illness worsens during the course of a few years.

Dementia shows itself primarily with failing memory and reduced ability to function in day-to-day life. Problems with concentration, arithmetical skills, sense of locality and language appear as well. Dementia develops gradually into serious problems of managing daily life. In the concluding phase, the majority of dementia sufferers will completely lose the ability to live in their own homes and must live in a nursing home.

In Western Europe and North America the number of people with dementia is expected to increase due to the rising life expectancy. The older you are, the greater the risk of developing dementia.

In Denmark, which has a population of approx. 5.5 million, there are approx. 40 000 persons with medium to severe dementia. The annual costs today of dementia in Denmark are estimated to be approx. 2.3 billion euro.

Due to the population's rising life expectancy, it is expected that society's costs for dementia will increase markedly in coming years.

Mobile technologies

At the moment, there are a number of mobile technologies that are relevant in relation to being able to offer solutions that can help people with early-stage dementia to live longer in their own homes in a dignified manner:

1. Mobile communication with the help of GSM has the affect that the user with aphasia outside the home can come into contact with relatives and care personnel and vice versa, either via verbal communication or by text or symbol communication.

2. Positioning with the help of GPS positioning equipment can inform the user, the relative or care personnel about the user's position.

3. Various applications are realised on an SMS server which the user, relatives or care personnel have access to and which offers various services.

A number of the solutions which are used today in connection with people with dementia are also used by the transport and security sector and by ordinary consumers. This entails that the prices of equipment and services are often favourable.

What problems can be solved or limited by using mobile technologies?

With the help of mobile technologies, different solutions and services are developed which are relevant in relation to providing help to the user with dementia to function more independently and with greater safety:

1. *Help to structure daily life for people with dementia:*

   (daily plan, reminder, feedback)

2. *Help to find his/her way around*
3. *Remote vocal communication when the need arises*
4. *Finding and tracking a user*
5. *Alarm/reminder when a specific geographic area is vacated*
6. *Combinations of points 1 - 5.*

The users' needs

1. Many users with early-stage dementia need help and support to live a good and dignified life in their own residences. With the right support it will be possible to extend the time the user can remain living in his/her own residence.

2. Spouses and relatives need relief and to reduce their uncertainty and nervousness due to the family member with dementia.

3. Personnel at nursing homes need a tool, which, with a minimum amount of effort, makes them able to ensure that the demented patient does not disappear or have an accident.

Examples of solutions and products

1. Thought, structure and memory support

Comai (www.comai.se) is a new product developed in Sweden that can function on Symbian-based mobile telephones. The system helps the user structure his everyday life by giving the user a reminder about things that must be done (take medicine, get up, do shopping, etc.). The reminder is shown on the mobile telephone with a picture, text and sound. It can be individually set if the user must acknowledge after the activity has been completed or begun, and an alarm can be sent to relatives if the system does not receive the acknowledgement.

Via a website, the user can alone or together with a relative, organise activities in the system's calendar which is placed on an SMS server.

In technical terms, the system comprises an SMS server which communicates with the connected mobile telephones. The messages are managed between the SMS server connected to the Internet via a computer and the mobile telephone in a two-way communication.

The mobile telephone can at any time be used in the usual manner.

2. Help to find the way

X-road Navigator (www.x-road.com) is a user-friendly GPS navigation system, which functions on hand-held units (PDA or navigation unit) in combination with the unit's integrated GPS receiver or an external cable, Compact Flash, SD or Bluetooth GPS receiver. The unit with X-road Navigator can be fitted in the car for navigation whilst driving, but it can also be used outside of the car as a digital map or as a hand-held navigator. If one is a pedestrian or a cyclist, the system takes pedestrian and one-way streets into account and shows the nearest pedestrian and bicycle routes.

Furthermore, X-road Navigator provides the option of receiving a position from another person via a text message. The function is only available if you have a PPCPE unit (Pocket PC Phone Edition).

To be able to transmit a position, the sender must also have a PPCPE unit, which runs X-road Navigator. The text message will contain a position to which you can navigate.

Beforehand, the user or a relative can code in the address of the place the user is to visit. With the help of the map and directions on this as well as synthetic vocals it can guide the user to the destination. A new address can be sent via the navigator.

3. Vocal communication when the need arises

Many persons with early-stage dementia will feel secure by having the possibility of talking with relatives and possibly asking for help when they are outside of the home. The relatives will be given better opportunity to support the user and at the same time be able to carry out the daily tasks unhindered.

Many people with dementia in the early stages of the illness can benefit well from normal mobile telephones.

Many will gradually have difficulty in managing and operating ordinary mobile telephones.

Soneco CC (www.soneco.fi) is a specially designed GSM mobile telephone, which is very simple to operate for persons who have reduced cognitive functions, including people with dementia.

The user interface of the telephone comprises only one button and three lamps with different colours. The three lamps represent three pre-programmed numbers which the user can remember with the help of the colour. Calls and the answering of calls are done by pushing the button.

Another option is to use Philiphone 4 (www.bertlandpihl.se), which is fitted with only 4 large buttons that can be marked with either a name or a picture of the person who has the pre-programmed number. Calls to the telephone are answered by pushing one of the 4 buttons.

The telephone comprises an ordinary standard telephone of the type Sony Ericsson T290, Sony Ericsson K300i as well as some older Sony Ericsson models which are fitted into a special cover and connected to the 4 buttons.

4. Find and track user

Today there are a number of units from various manufacturers that are able to track and find the position of a person carrying the equipment concerned. There is a GSM modem and a GPS receiver built into the unit.

The equipment's position can, at any time, be notified by sending an enquiry – from a mobile telephone – about the equipment's position via a special SMS server. After a few seconds, the equipment's exact position, street name, house number, etc. is received or the distance and direction from the nearest address.

The position can also be notified by connecting to the system's website and enquiring on the position of a given unit. After a few seconds, a section of a map is shown with information about position and appurtenant address.

Furthermore, the equipment can be supplied with an emergency button. If the button is activated, relatives or personnel will immediately be informed and notified of the equipment's position and address.

Micro-Tracker (WWW.safelink.dk) is an example of such equipment.

Some of the equipment can combine the tracking function with two-way GSM communication.

Over and above a pre-programmed emergency number, Safelink s-911 (www.safelink.dk) has two call-up buttons for pre-programmed numbers.

There is also equipment that contains automatic alarm functions which entails an alarm being sent if the equipment is positioned horizontally for a longer period. In this way, a fall for example can be registered so that the situation can be dealt with immediately.

Lommy (www.lommy.com) is an example of such equipment.

5. Alarm/reminder when a specific geographic area is vacated

It is often appropriate if the user can freely move about within a given area. This could be a nursing home and its surroundings or a local area known to the user (neighbourhood). If the user leaves this area, it is necessary for an alarm to be sent to the nursing home personnel or relatives.

The SMS server from Safelink (www.safelink.dk) contains the option of setting up a "fence" on a selected map in the system. If the user of a given unit moves outside the specified "fence", an alarm is set off.

Research

The utilisation of mobile technologies to help people with dementia is relatively new. This means that only very few validations have been conducted of the utilisation value of the new solution.

However, experience that has been gained until now shows that the users, the relatives and nursing home personnel are very satisfied with the new possibilities that are made available and the utilisation is gaining ground.

It will however, be necessary – through further research – to clarify in more detail how the new solutions must be used and how they have the greatest value in relation to alternative solutions. In this way a greater certainty is achieved that the solutions suit the users' needs, are ethically responsible and have a reasonable economy in relation to alternative solutions.

It is expected that in line with the development of new generations of mobile services and terminals with strongly increased data transmissions and data processing capacity, it will be possible to develop new equipment and services that can further support people with dementia in living a good life and reducing the costs for care in the future.

2.3.5 Implementation of an SMS-based emergency service in Finland

FICORA-Working group for emergency communications
Drawn from report, published by FICORA

This section is drawn from the FICORA Working Group report for emergency communications, a full version of which can be found at [FICORA, 2005]. It describes a system where the universal emergency number 112 is easily and reliably accessible also by means of a text message within the technical restrictions of the service. The system is intended for users with a disability (such as people with a hearing impairment), but it may be useful for anyone in an emergency situation. In this system all 112 emergency text messages are routed to one centralised answering point. The centralised answering point sends an acknowledgement message and locates the mobile telephone by means of the positioning system for emergency calls. The emergency response centre appointed as the centralised answering point may deliver the 112 emergency text message or corresponding information to the nearest emergency response centre on the basis of the location data.

2.3.5.1. Foreword

The directives on electronic communications, which in Finland have been implemented through the Communications Market Act, include a requirement that people with a disability must have access to emergency services equivalent to that enjoyed by other users. This is also one of the key topics of the European Union's INCOM[1] working group. The Finnish strategy for accessible communications, which has been through public consultation, contains several recommendations, one of which was to adopt an SMS-based service for the emergency number 112 by the end of 2005.

An SMS-based service for 112 is not a new issue as it has already been one of the targets of the Ministry of the Interior for the last decade. Until now, deaf and hard of hearing people have been able to make emergency calls by means of text telephones and by sending text messages to separate mobile telephones placed with the individual emergency response centres. The numbers for these mobile telephones were only given to those requiring the service among users with a disability. From 2002, the Emergency Response Centre Administration has prepared the transition to a national emergency response service based on text messages. In this system, planned to be introduced in 2007, the general emergency

[1] INCOM stands for Inclusive Communications.

number 112 is easily and reliably accessible also by text messages. The service is expected to help all people in emergency situations, not only users with a disability.

The 112 short message number was reserved for emergency purposes in the short message numbering scheme of the Finnish Communications Regulatory Authority (FICORA) some time ago. Also, barring of calls to the general emergency number 112 is prohibited through FICORA's regulations. SMS to 112 required some adjustments to the regulations.

2.3.5.2. SMS-based emergency services elsewhere in Europe and the development of standards

There are no European standards for emergency text messages. The propositions of this report are based on the normal SMS-based service. For solutions exceeding the presented basic solution it is important to follow corresponding projects in other countries as well as the development of standards.

Since 2003 the National Post and Telecom Agency in Sweden (Post- och telestyrelsen, PTS) and the operator of the emergency service in Sweden (SOS Alarm Sverige) have evaluated emergency alarms to 112 via SMS in a study and trial project. Since October 2006 the possibility to send SMS to the emergency number 112 has been launched as a service during a two year period and it is available for people with disabilities.

2.3.5.3. Practical implementation of a SMS-based emergency service in Finland

Basic solution

If emergency text messages were always routed directly to the nearest emergency response centre, short message service centres and possibly also other network elements would require additional functionalities. Therefore, direct routing does not seem to be a technically and economically feasible solution. Instead, it seems that the best way to handle 112 emergency text messages is to route all messages to one specified answering point where the calling mobile telephone is located by means of the positioning system for emergency calls. The emergency response centre, which is to be determined later as being the answering point, then submits the emergency text message or corresponding information to the emergency response centre nearest to the sender on the basis of location data.

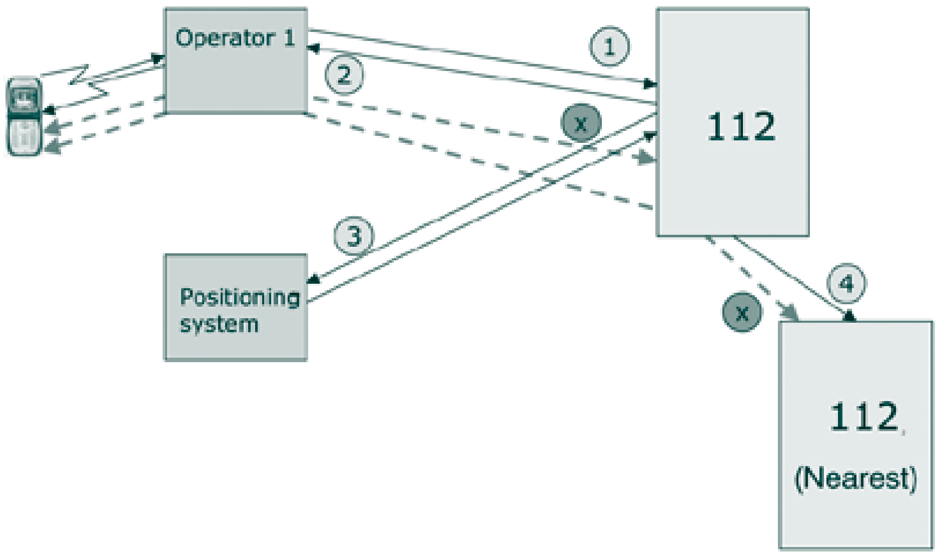

Figure 2.31. Basic solution for the SMS-based emergency service

1. Transfer of the 112 emergency text message to the centralised answering point.

2. Acknowledgement message from the answering point.

3. Location of the sender.

4. Transmission of data to the emergency rersponse centre nearest to the sender.

x. Posible text message conversation between the emergency response centre and the sender (may take place in two phases).

The Emergency Response Centre Administration will designate the centralised answering point. This centralised model may be adopted, provided that the answering delay will not be too long. It is possible to keep the answering delay at a moderate level, when the first acknowledgement message is sent from the centralised answering point as soon as the sender of the emergency message is located. The new positioning system for emergency calls adopted at the beginning of 2005 will enable the location to be identified. To keep the delays short, it is appropriate to integrate the reception of 112 emergency messages and other related activities into the general emergency centre system. The situation can be further clarified through a text message conversation between the centralised answering point and the person needing emergency help. From the centralised answering point the emergency text message or related information can be transmitted to the emergency response centre nearest to the person needing emergency help. For the conversation between the nearest emergency response centre the person needing emergency help, some other number than 112 must be transmitted in the answering message from the nearest emergency response centre.

Restrictions in the SMS-based emergency service

Common restrictions or problems that may occur in the SMS-based emergency service are described below.

The normal SMS-based service may be unreliable and slow:

- *Text messages are transmitted via the network rather reliably, operators estimate that reliability exceeds 99%*
- *Also when a message is not transmitted to the receiver, the reason for this is usually found in the terminal equipment*
- *Operators estimate that the average delay for text messages is 2 seconds, thus problems may occur in some special situations, such as mass voting.*

Text messages to 112 are barred in the cases described below:

- *Barring of All Outgoing Calls (BAOC) is activated. It bars not only calls but also text messages. The subscriber can activate this function on his or her telephone*
- *Barring of All Incoming Calls (BAIC) is activated. It bars not only calls but also text messages (this means that it is not possible to receive the acknowledgement message from the centralised answering point). The subscriber can activate this function on his or her telephone*
- *Operator Determined Barring of Outgoing Calls (OBO) is activated. It bars also text messages. The service operator may activate this function, for instance, when the limit for the call balance is reached2*
- *The limit for the prepaid account balance is reached (note: some operators support free-of-charge SMS services, which means that also the SMS-based emergency service may be free and the service may be used although there is no balance for the prepaid account)*
- *The SIM card is missing*
- *The caller is in a shadow region of his or her own operator's network*

[2] FICORA Regulation number 35 on barring categories in telecommunications contains the following point: "Traffic to the general emergency number 112, emergency number for the police 10022 and the operator's number for fault reports shall not be barred with any category". This applies also to text messages.

• *All radio channels are busy in connection with mass events.*

Foreign roaming customers cannot use the service as text messages are routed to the short message service centre of these customers' home network.

Malicious messages are possible.

Tracing malicious messages becomes easier as the emergency response centre can see the number of the sending mobile telephone and locate the mobile telephone of the person needing emergency help.

Malicious messages are, however, not regarded as a serious problem for the emergency response centre when they are sent via the Internet, anonymously or with a fault calling line number, as such sending is only possible towards a mobile telephone.

Working group's proposal for solution

The working group suggests that the SMS-based 112 emergency service be implemented according to figure 2.32. If the text message conversation is also implemented between the sender of the emergency text message and the nearest emergency response centre, the implementation takes place according to figure 2.33.

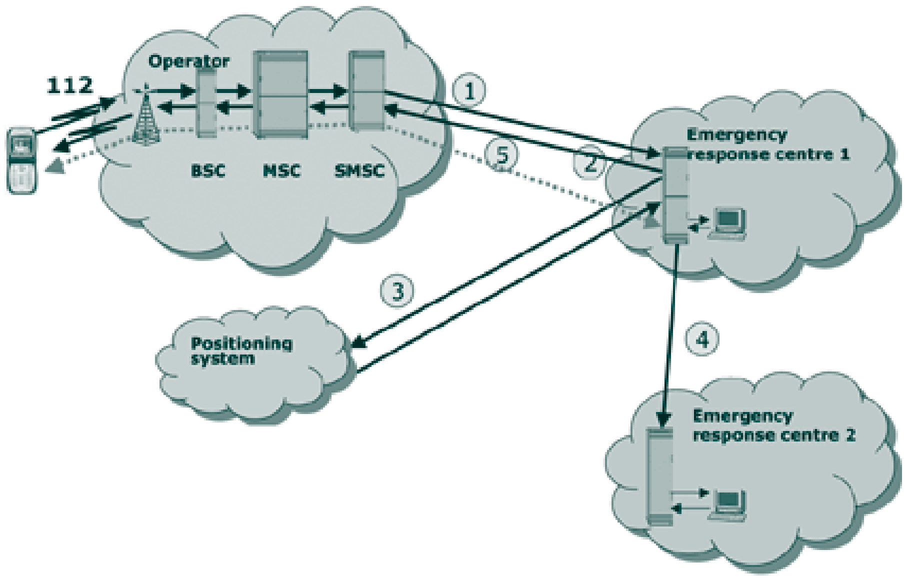

Figure 2.32. Implementation of the SMS-based 112 emergency service (possible text message conversation only from the centralised answering point).

1. Transfer of the 112 message to the centralised answering point.

2. Acknowledgement message from the answering point.

3. Location of sender.

4. Transmission of data to the emergency response centre nearest to sender.

5. Possible text message conversation between the duty officer at the answering point and the sender.

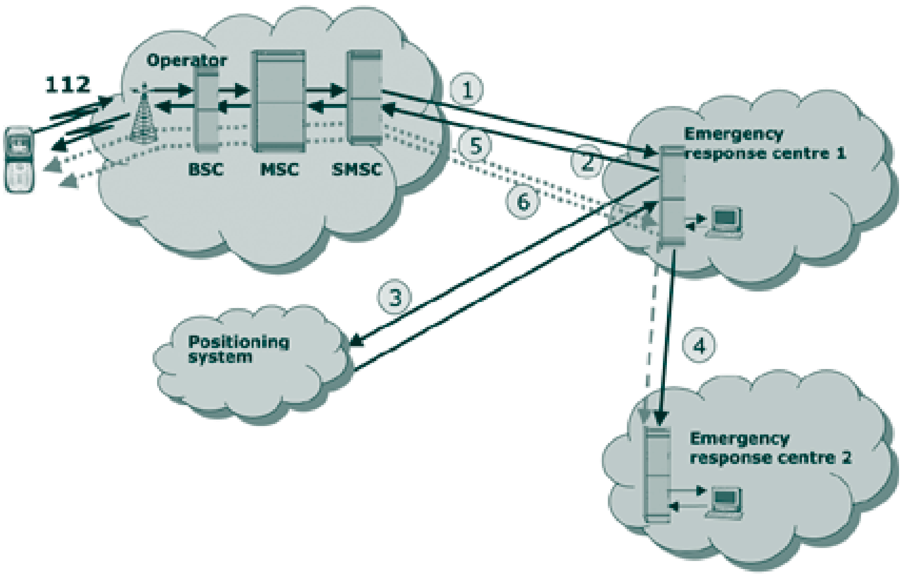

Figure 2.33. Implementation of the SMS-based 112 emergency service (possible text message conversation also from the nearest emergency response centre).

1. Transfer of the 112 text message to the centralised answering point.

2. Acknowledgement message from the answering point.

3. Location of sender.

4. Transmission of data to the emergency response centre nearest to sender.

5. Possible text message conversation between the duty officer at the answering point and the sender.

6. Possible text message conversation between the nearest emergency response centre and the sender.

2.3.5.4 Costs for the provision of emergency text messages and call itemization

Users can send emergency text messages to 112 free of charge and text messages to 112 must not be included in the call itemization of a bill. These requirements are based on section 55 of the Communications Market Act (393/2003), which states that users must be able to access the universal emergency call number 112 free of charge. According to the preamble to the Act, this means calling an emergency number or, for instance, sending a text message to an emergency number, if it is technically possible, or some other technical way to connect an emergency number which may be provided in the future. According to section 24 of the Act on the Protection of Privacy in Electronic Communications (516/2004), a call itemization for a subscriber connection may not contain identification data for services for which no fee is charged.

The acknowledgement message of an emergency text message can be compared to call back, which in some cases is used in connection with a normal emergency call. This call-back is a normal call for which a fee is charged, and therefore also the acknowledgement message is a normal chargeable text message.

In a text message conversation, messages sent to 112xx by the person needing help are also emergency text messages for which no fee is charged. In a text message conversation, the emergency response centre's messages to a normal subscriber number are text messages for which a normal fee is charged.

According to FICORA's interpretation, the emergency response centre does not pay compensation to operators for those 112-calls which are cost-free for users. The same principle applies to 112 emergency text messages.

The emergency text messages are routed from each operator's short message service centre directly to the emergency response centres' centralised answering point, which means that there will be no inter-operator text message fees. If, however, such costs should occur, the operators must mutually agree upon them.

2.3.5.5 Implementation and maintenance costs

Costs for the implementation and maintenance of the SMS-based emergency service are mainly composed of four parts:

> *1. changes that operators must make for routing 112 text messages to short message service centres – the working group sees that these costs form a part of the normal operation costs and do not cause any additional costs*

2. transmission connections from short message service centres to the centralised answering point. The aim is to use existing (IP) connections between the emergency response centres and the operators, but costs may occur for VPN specifications; if there are no usable connections they must be acquired

3. acquirement and maintenance of receiving interface and/or adaptor at the emergency response centre (update as necessary, probably not very frequently)

4. personnel costs at the emergency response centres (training, etc.).

Items 1 and 2 involve costs which may be compensated to operators. As stated above, item 1 does not cause any costs. Item 2 causes some costs which, however, can be defined more precisely

after the Emergency Response Centre Administration decides which transmission connections are adopted and selects the centralised answering point.

Costs incurred of items 3 and 4 are emergency response centres' own costs and the Emergency Response Centre Administration is the most aware of these costs. Costs for item 3 depend on the solution decided by the Emergency Response Centre Administration (interface software as part of the emergency response centres' own system / separate adaptor).

2.3.5.6 Implementation schedule

The first phase includes: transmission of the 112 emergency text message to the centralised answering point, acknowledgement of the emergency text message, location of the mobile telephone, and transfer of information to the nearest emergency response centre, where necessary. For text message conversation, the schedule is open and a more precise schedule can be done only after the first phase has been put into practice.

From the operators' point of view, the implementation in this time frame was regarded as realistic at the time this report was published. Question about the interface/adaptor implementation requires fast decision-making on the technical details at the Emergency Response Centre Administration.

2.3.5.7 Further development

The first-phase implementation contains some restrictions and problems, but some of them may be abolished in the longer term. Some of the restrictions and problems require that amendments are made to international standards or other international agreements. FICORA's working group for emergency communications follows the international development both in standardisation and in other countries' solutions (e.g. Sweden) and contributes to international development as necessary.

The following list contains those restrictions and problems that have been discovered for the first phase:

- *reliability and delays of 112 text messages*
- *effect of barrings on 112 text messages*
- *other reasons that prevent the sending of 112 text messages.*

routing of 112 text messages in special cases (foreign roaming customers in Finland – the messages are routed to short message service centres of these customers' home networks; Finnish roaming customers abroad – the messages are routed to short message service centres of these customers' home networks and from there to the centralised answering point in case of those operators that take part in the SMS-based emergency service);

service operators who provide short message services to Finnish customers but whose short message service centre is located abroad and who do not want to join the system (such cases are not known for the time being, but may occur in the future) dimensioning/expansion of the system in case of a dramatic increase in the use.

2.3.5.8 References

FICORA, (2005). Implementation of an SMS-Based emergency service in Finland ficora.fi/englanti/document/WGReport022005.pdf.

2.4 Evolution of text telephony

2.4.1 The recommendations of the Nordic countries regarding functionality for text telephony

Robert Hecht

Foreword

The following recommendations about the future functionality of text telephony were compiled by the Nordic Forum for Telecommunication and Disability (NFTH)[1] by mandate of the NFTH meeting held in Reykjavik in May 2005 [NFTH, 2005].

Introduction

The next generation of text telephony in the Nordic countries and Europe is under development. The next generation of text telephony means telephony that is Internet (IP) based, and also various mobile terminals. The objective is to clarify the Nordic standpoints, in order to in this way contribute to increased harmonisation within the area.

The Nordic standpoints concerning traditional text telephony and text telephony for everybody

Mobility

Text telephony should be operator-neutral and independent of terminal manufacturer. Mobile text calls should function in 3G, GSM and future terminals. The terminals that are also in common use now should also be able to cope with mobile text, i.e. 'smartphones' should not be a basic requirement. A smartphone combines the functionality of a mobile telephone and a laptop computer in one and the same terminal. It is desirable that terminal manufacturers facilitate the use of both voice and text channels simultaneously during a call.

[1] The Nordic Forum for Telecommunication and Disability (NFTH) is a collaborative body established in 1987 by The Nordic Cooperation on Disability (NSH) under the Nordic Council of Ministers. NFTH is financed by The Nordic Development Centre for Rehabilitation Technology (NUH), which is a subsidiary of the NSH. The purpose of NFTH is to discuss relevant topics in the field of telecommunications that concern disabled persons and to support the Nordic countries' endeavours to integrate disabled persons into the information society. NFTH does this by making recommendations and guidelines dealing with the current and future problems of the new information society. http://www.nuh.fi/NFTH_eng.htm

Internet

Text telephony should be possible through downloaded software or via the Internet, on computers with the most common operative systems (Windows, Macintosh, Linux, etc.). Text telephony should be possible from various computers with Internet access, including Internet cafés. Between computers, it should be possible to speak and hear simultaneously as text is being used.

Service interoperability

Within the Nordic countries text telephony between computers, common kinds of mobile terminals and the analogue text telephones that are used within the Nordic countries, including Speak directly-functionality, should function. Text telephony should, if possible, also offer interoperability with common 'Instant Messaging' (IM) services, such as MSN Messenger and Yahoo, among others.

Service interoperability can be achieved in various ways. It may, for example, relate to a central 'gateway' solution, or the production of a common technical solution. It should be possible for text telephony to be used through the various networks that are common and available in various contexts.

Continuous transmission of text

During a text call it should be possible to transmit continuously so that the conversation is fluent. A text call should be perceived as occurring in real time and correspond with a voice conversation, where it is possible to interrupt each other at any time.

When text is sent at approximately one second intervals, the party conversing senses the fluency mentioned above. Sending text as blocks ('chat') is a supplement, but it does not completely satisfy the need for a text conversation corresponding to a conversation that speaking persons experience.

Interoperability for text telephony across IP

With analogue text telephony, several different standards have emerged. Interoperability for text telephony via IP should apply within the EU area, and preferably globally. The ongoing work to achieve interoperability for text telephony over IP is of great importance.

Relay services for text telephony

Relay services facilitate calls between persons with hearing, persons who have speech impairment, deaf persons and deaf-blind persons. These are crucial services that assist in creating communication between persons with disability and persons with hearing. Relay services may be either manual or automatic.

It should be possible to connect relay services the easiest way possible. It is appropriate that the person calling up should not need to know that, for example, a certain telephone number leads to a hearing or a deaf person and that the call is automatically diverted via a relay service when this is necessary.

It is also important that relay services for text telephony and relay services for video telephony use voice/audio and text in the same way, so that interoperability is achieved to the highest possible degree between text telephones, video telephones and total conversation units.

References

NFTH, (2005). The recommendations of the Nordic countries regarding functionality for text telephony. http://www.nuh.fi/NFTH_2-2005.doc

2.4.2 Mobile and IP–based text telephony Flexible text communication services in Sweden

Robert Hecht

Rationale

It is estimated that there are around 6 000 – 8 000 sign language users in Sweden today who use mobile phones for either SMS or video calls. This project opens a possibility of using the mobile phone for text calls with other mobile telephones, with Internet users and traditional text telephones.

There are in addition a large number of users in Sweden today who are classified as post language deafened, who cannot use sign language and who use speech for outgoing communication. These users cannot at present use the Internet efficiently, i.e. say what they want to say and receive text instead of speech.

The emergency number 112 and the Text telephone Relay Service in Sweden are examples of services that can be reached using a mobile text client or a web-based client.

Mobile IP Technology

This service addresses a clearly emerging need to communicate using text communication through the mobile, for example when 3G coverage is lacking or it is impossible to interface in real time with other text telephones or services which are compatible with legacy text telephones (V.21, EDT, DTMF, Baudot, V.18, etc.) on the PSTN network, such as emergency services, text relay services, etc.

To complement the mobile communication, a web-based client is used. Both clients can be downloaded and used from anywhere, such as Internet cafés, office environment, etc.

The service supplements existing investments in text and image communication, e.g. for users who do not use 3G telephones or when coverage for image communication by 3G does not exist or for deaf adults who do not use sign language.

The service is also operator independent, which is a big advantage with regard to the user preferences.

Call traffic

The following calls can be made using the service.

- *Mobile text clients to: legacy text telephones, other mobile text clients and/or web-based clients that use the open standard specified below*
- *Web clients to: legacy text telephones, other mobile text clients and/or web-based clients that use the open standard specified below*
- *Text telephones: to mobile text clients and/or web-based clients that use the open standard specified below.*

Open standard

The mobile data network puts several constraints that make it almost impossible for P2P communication between mobile devices. That is the reason for that in the service it was decided to generate a communication model using standard, existing and allowed protocols.

The solution adopted in the service is to use an application server that relays the dataflow between mobile terminals, web interfaces and legacy text telephone.

One of the goals of the service is to allow any software or terminal to connect to the application server and get the possibilities to communicate with mobile terminals, web interfaces and legacy text telephone.

The protocol used in the mobile terminals is http(s) and XML-RPC schemas[1] that fulfil the recommendation of the ITU-T T-140[2]. The web interfaces are using the http(s) protocol and SOAP-XML web protocol[3] that enables the service to use the protocol and thereby avoid the annoying "firewall" problem, as described in SOAP-XML[4].

[1] It's a specification and a set of implementations that allow software running on disparate operating systems, running in different environments to make procedure calls over the Internet.

[2] Mobile text telephone: XML mobile text protocol.

[3] SOAP is the Simple Object Access Protocol, a way to create widely distributed, complex computing environments that run over the Internet using existing internet infrastructure. SOAP is about applications communicating directly with each other over the Internet in a very rich way.

[4] Web text telephone: SOAP XML web protocol.

Features

Users who utilize text primarily for remote communication will have good and equal facilities for effectively contacting each other, authorities or relatives and alarm services which have a text telephone interface.

A number of important features in the service are discussed below.

Client downloaded to mobile phones and/or PCs

To download the software to be used in the mobile phones:

- *The mobile client is downloaded from a specific URL Customers that have downloaded the software can use it from their mobile phones.*

Text client for PC:

- *The text client is a Java application accessible via a web page.*

Communication with text telephones:

- *The service or platform has a so called gateway for communication between text telephony between mobiles, the Internet and text telephones*
- *The following gateways are in use today: Sweden (V.21), Denmark (V.21), Germany (V.18 with EDT text telephones).*

Mobile users

The mobile test pilots will send and receive text calls with their mobile phones which support Java functionality as per MIDP 2.0. For incoming calls it is assumed that the phone vibrates and depending on whether the user is registered in the system the call will be initiated by two different user procedures. It is possible to apply existing T9/dictionary functions in the mobile phone when texting.

The service is also operator-independent, which is a big advantage as far as the users' preferences are concerned.

Due to limits in the ergonomics of standard mobile phones available in the market today, a communication block wise ("chat") has been chosen.

Voice carry over (VCO) feature cannot be used from the mobile phone because today's mobile phones cannot use the data channel and the Internet connection at the same time.

Internet users

A web-based client is used by users, relatives, authorities and others to send and receive text calls from PCs connected to the Internet. The user has to be logged into the platform in order to be reached.

The web-based client is built as an applet and downloaded directly on the PC. This means that the users always download the latest version of the client.

The Voice carry over (VCO)/Hear carry over (HCO) features will be implemented during autumn 2006. The text function in the web client is "character by character".

In order for it to be possible to be reached by a web-based client the user or the relative must register in the service.

Text telephone access

Calls from a traditional text telephone to an Internet client and web/mobile client:

- *users who have a traditional V.21 phone (the text telephone user) dial a fixed-line phone number. The call is automatically answered by the service*
- *the service answers with the following text, e.g. welcome to web service for text communication. Which phone number do you want to call?*
- *the text telephone user then writes the phone number (or name) of the person sought*
- *the call will then be connected to the Internet client (web or mobile)*
- *If the Internet client does not answer the call, the text phone user can leave a message*
- *the text telephone user pays the current call charge to the service.*

During autumn 2006 the service had approximately 100 registered users using the service on a daily bases. The field trials with users are continuously evaluated. Conclusions in the final phase of the project will be vital in the decision making process within the National Post and Telecom Agency (Post- och telestyrelsen, PTS) of launching this functionality as a public service in Sweden during 2007.

References and further information

www.flexitext.net

2.4.3 Mobile text telephony based on GPRS Communications

Santiago Aguilera

Rationale

Text telephones allow deaf people to communicate remotely. However, even if the advent of text telephony has brought great improvements in remote communication for deaf people, current text telephony still has some limitations:

- *The need for specific terminals with small production volumes, increasing production costs in comparison to more widely used terminals*
- *The fact that deaf people have to pay higher telephone bills. This is due to the fact that to exchange the same amount of information, text communications require more time than voice conversations. Since the cost of a call is charged according to its duration, the cost of text calls is higher than for voice calls*
- *Text telephones used in many of the different countries are incompatible, making it very difficult to establish international text telephone calls.*

As previously mentioned, deaf people can be economically discriminated against due to the higher cost of telephone calls. This is due to the fact that the rates to be paid depend on the connection time and not on the transmitted data. Therefore, the objective of this project was to create a text telephony system based on GPRS[1] (2.5 G) data mobile communications, because GPRS considers for billing purposes, only the transmitted information. Since the amount of data is very low in text conversations (and is independent of the duration) the cost of calls will be much lower.

For the sake of mobility, the terminals used were Personal Digital Assistants (PDA) with Pocket PC or Palm operative system. The system was designed using Internet technology (TCP/IP protocol), allowing communication with any kind of terminals with the TCP/IP protocol, such as mobile telephones or PCs. For PCs a client text telephone program was implemented. On the other hand, a WAP text telephone client, able to communicate with the PDA text telephone client, was developed by the Spanish Vodafone Foundation.

[1]GPRS (General Packet Radio Service) run over GSM networks and offer the possibility of charging according to the amount of data sent rather than connection time.

Previous experience

In order to provide deaf people with the advantages of mobile telephony, in 1998 a commercial terminal, the Nokia 9110 (see figure 2.34), was adapted to text telephony. This programmable terminal was provided with specific compilers and its own operating system. The developed programs were therefore not portable [Roe, 2001].

Figure 2.34 Nokia Communicator working as text telephone.

This text telephone was widely accepted among the deaf community. More than 5 000 terminals are currently being used in Spain. It is worth mentioning that this project was nominated by European Union as an example of good practice in eliminating communication barriers and of "Design for All".

Nevertheless, this terminal was not able to solve two specific problems:

- *Text conversations take much more time than voice communications. Since GSM[2] telephony billed users according to the length of the call, deaf people paid much higher bills*
- *The software designed for text communication was not portable to new terminals coming on to the market.*

Text Telephone Based on GPRS Mobile Communications

The objective was to apply the new technological solutions that have appeared over the last few years to solve the previously mentioned problems: high cost of the calls and dependence on the terminal (no portability).

To solve the first issue, an application based on 2.5 mobile generation (2.5 G) was designed with the possibility of also using GPRS data communication [Andersson, 2001] [Heine & Sagkob, 2003]. This application allows the customer to be billed

[2]GSM (Global System for Mobile Communications) is the second generation of mobile phone systems. Invoices are based on connection time.

only for the amount of information transmitted, which is very low in the case of text telephony, in comparison to traditional billing based on call duration.

To solve the problem of the dependence on the terminal the application was programmed in C/C++ for the three different mobile terminal families, which cover almost 100 % of programmable terminals currently used by the vast majority of people:

- *PDA with Pocket PC [Makofsky, 2003] [Krell, 2002]*
- *Palm OS [Foster, 2002] [Bachmann, 2002] and*
- *PC with Windows OS.*

Client software

The system has a client/server architecture. The client terminal can be a PDA (Personal Digital Assistant) or a PC. The software for the client terminal was designed to allow the user to swap languages. Three languages, Spanish, English and Portuguese are currently supported. Its main functions are:

- *To access GPRS network for connection and obtaining a single IP address for identification a san IP client on the Internet. This IP address is dynamically provided by the GPRS network to the different devices connected to it (figure 2.35)*
- *To register itself (as a client terminal) in the text telephone server, communicating the obtained IP address (figure 2.36)*
- *To allow the user to make a call to other registered terminal*
- *To inform the user of the calls in the process of being received from other terminals. For people with hearing difficulties, the indication (event signal) is visual (blanking the screen terminal) and tactile (activating the vibrator included in the terminal)*
- *To register in the user terminal all non answered calls (lost calls)*
- *The last and most important function is to offer the possibility of real-time telephone conversation between two users.*

Figure 2.35 PDA connection with GPRS network. Dynamic IP assignation by the GPRS network. IP is fixed while connection is on.

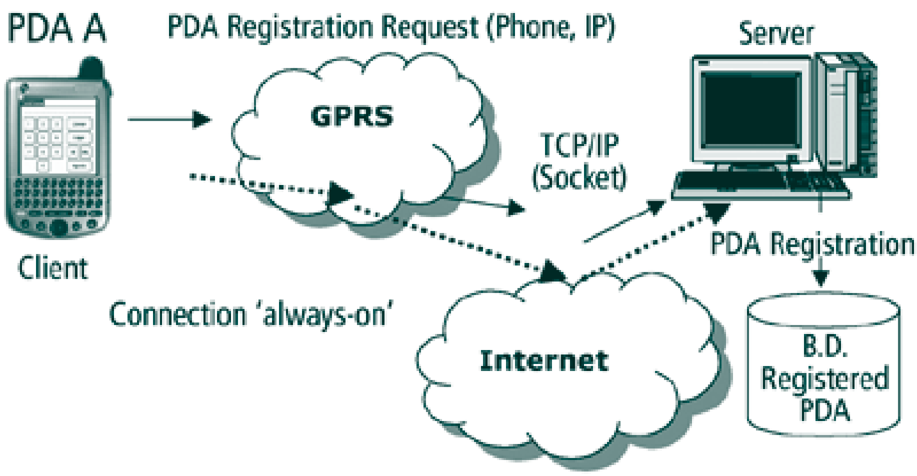

Figure 2.36 Registration process into the server by a PDA A. This PDA is connected to the server through the GPRS and Internet networks on a permanent basis ("always-on") to be able to access the service at any time.

Server Software

The server software, running in a remote computer connected to the Internet, carries out the following functions:

- *To allow the registration of the client terminals to be able to communicate among themselves. This process assumes information is stored in a database to identify each user: telephone number and IP address assigned by the GPRS network (figure 2.37)*
- *To detect the communication request from a caller trying to communicate with another user. If the called terminal is not registered in the server, the caller will be warned that no conversation is possible. If the called user is registered and not busy, he/she will be informed of the caller's intention to establish a text conversation with him/her (figure 2.38)*
- *When a called user accepts an incoming call, and the communication channel is on, the server drives the information traffic between them (figure 2.39).*

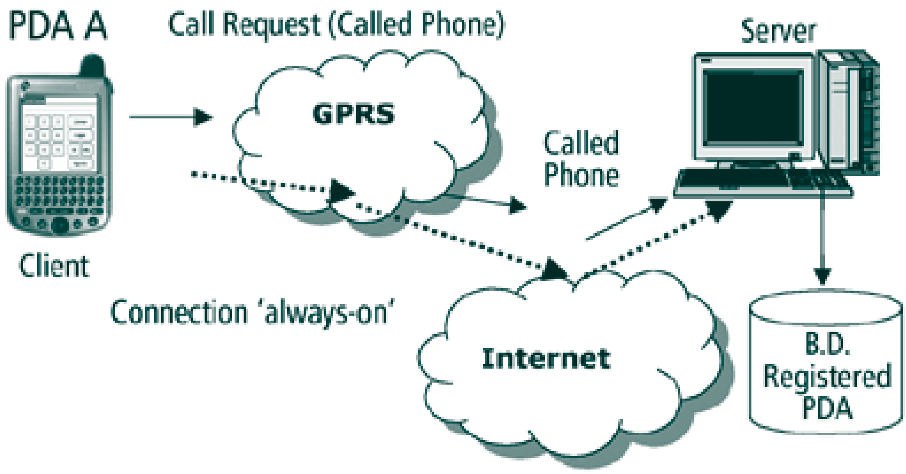

Figure 2.37 Call request to the server from a registered PDA A.

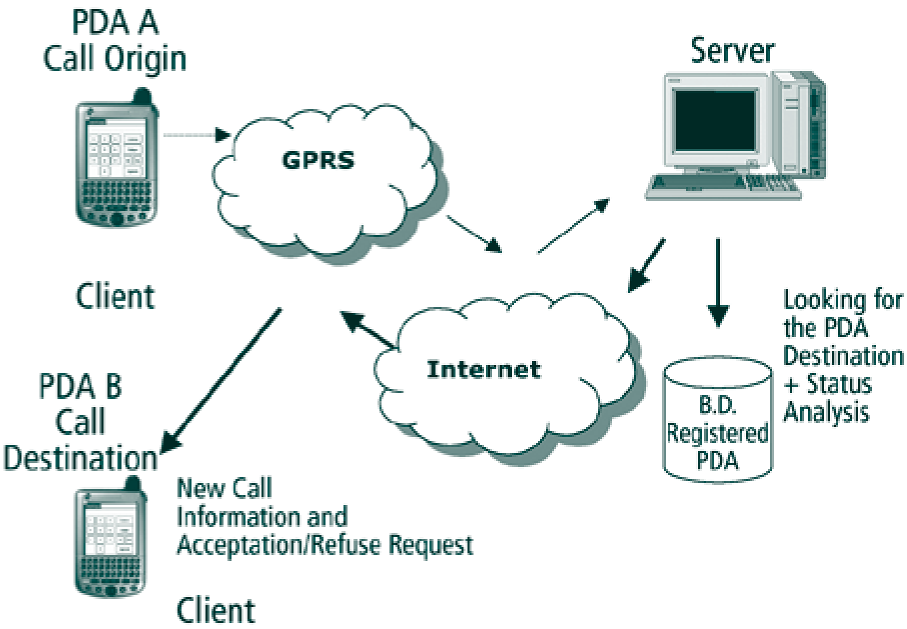

Figure 2.38 Localization of PDA B (call destination) and analysis of its status (no connected / busy / free) by the PDA A (call origin), through the server.

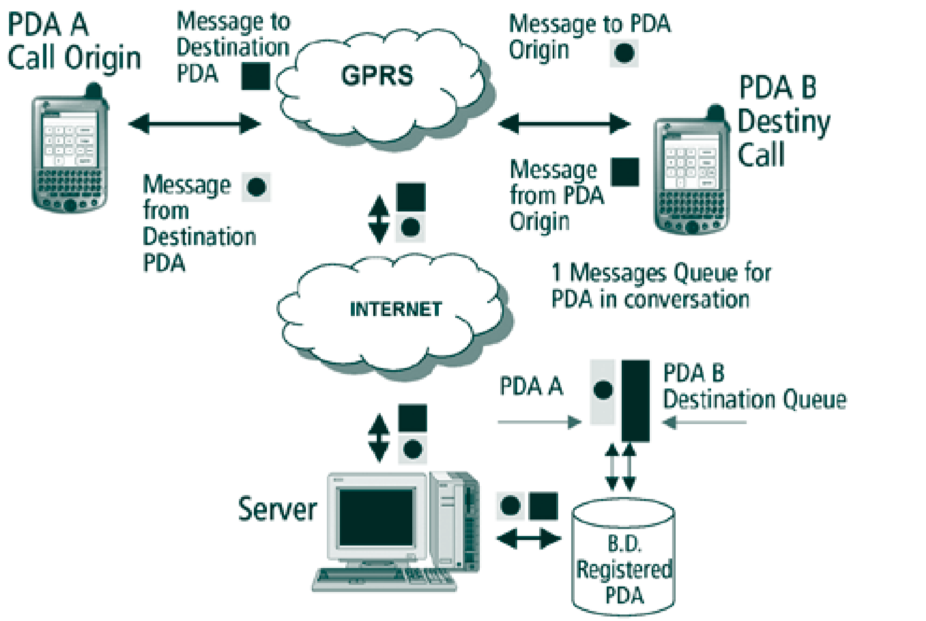

Figure 2.39 Details of the process in the server during an established conversation between a PDA A and a PDA B.

Evaluation

The evaluation phase started at the beginning of 2006. Around 60 PDA terminals were distributed among deaf users belonging to the Spanish Deaf Organization Foundation (FCNSE), which was a partner of the project. The objective of the evaluation was to detect any operational problems that may occur in a large-scale user trial. Furthermore, new functionalities that may be of interest to add to future versions of the GPRS text telephone were studied.

The system proved to be very efficient for the following reasons:

- *Due to the fact that the billing system is based on data traffic rates, which is quite low in the case of text conversations between two deaf users. Furthermore, this form of real-time textual communication is more effective than SMS conversations*
- *This solution allows a great variety of different terminals to be used in a rapidly changing market where new, lower-priced PDA terminals with better characteristics and functionalities are continuously appearing*
- *It allows communication with any user who has a PC, without the need for special terminals.*

Additional functions to be considered for the next versions are:

- *To allow communication with conventional text telephones connected to the fixed telephone network, through a gateway that carries out the protocol translation*
- *To add functions offered by conventional telephony: voice mail, telephone agenda, party calls, etc.*

This project was developed by the Universidad Autónoma de Madrid and the Universidad Politécnica de Madrid under the direction of Professor Santiago Aguilera, with the collaboration of the Spanish Deaf Association Foundation. It was funded by the Spanish Vodafone Foundation. The project was awarded with the prestigious IMSERSO-Infanta Cristina 2003 grant, given by the Spanish Social and Labour Ministry.

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2.5 User participation in technology

2.5.1 Example of procurement specifications Functional specification for terminal procurement in Sweden

Andreas Richter

Procurement of technical aids for electronic communication

The Swedish Handicap Institute (HI) supports the Swedish principals in purchasing technical aids for people with disabilities. This is done through procurements resulting in call-off contracts, from which the local health authorities can call off directly at fixed prices and conditions. HI provides the principals with this service for many categories of technical aids, among which are text telephones and videophones. As this text is written, HI has just provided the principals with a call-off contract for text telephones, videophones and total conversation terminals, i.e. terminals for communicating with video, text and sound simultaneously. The procurement started in December 2005 and the contract runs from July 1st 2006 until June 30th 2008.

Qualification of suppliers included, among other parameters, requirements on the suppliers' economic stability and ability to provide service to end users.

Requirement specification

Qualification of tenders in the procurement included testing of terminals (text telephones, videophones or total conversation terminals) according to the requirements in *Requirement Specification – Total conversation Units, Text telephones and Videophones*[1] (requirement specification). The requirement specification was put together by the Swedish Handicap Institute along with Post- och Telestyrelsen (PTS, the National Post and Telecom Agency in Sweden) and experts from Tolkcentralen i Örebro, which runs the Swedish video relay service for deaf and hard-of-hearing persons. The intended terminal user is a hard-of-hearing person, a deaf person, a speech-impaired person or a relative of either of these.

The requirements listed in the document are functional, in that they are designed according to the intended user's needs, not the specifications of terminal

[1] Requirement specification – Total conversation units, text telephones and video telephones, Hjälpmedelsinstitutet 2005-09-01, http://www.hi.se/templates/Page____806.aspx.

equipment occurring on the market. The terminal equipment can thus follow any standard and any configuration, given that the requirements are fulfilled. It is assumed that the suppliers and manufacturers find it in their common interest to assure interoperability in between terminals, since terminal equipment which cannot be used to communicate with terminals from other manufacturers will not likely be prescribed.

Two kinds of requests are issued, requirements and guidelines. Terminals have to meet the requirements in order to qualify for the contract. The guidelines, however, are looser in that they suggest functionality that a lot of users may wish for but don't need for basic communication. The guidelines point out functional aspects that may become requirements in a later edition of the requirement specification.

Functionality

Requirements on functionality can be divided into several parts, based on communication method. The following types of requirements can be identified:

- *General requirements: applies to text telephones, videophones and total conversation terminals*
- *Requirements for video communication, e.g. frame-rate, resolution, blur, frame delay. These requirements are mainly based on the video quality needed for sign language*
- *Requirements for text communication, e.g. definition of the minimum window of displayed text, possibility to delete characters on own and other party's screen, maximum delay between input and transmission of characters.*

The requirements on video communication are applicable only on videophones and total conversation terminals and the requirements on text communication are applicable only on text telephones and total conversation terminals.

General requirements

These are requirements on the terminal's user interface, instructions for use and other factors independent on the type of communication.

Some of the most important general requirements are listed below:

- *Text on and beside buttons shall be in Swedish*
- *The supplier shall inform in the product information about the requirements on computers and supplementary equipment intended to be used with the*

terminal. Information about appropriate firewalls and routers should also be provided by the supplier

- *The supplier shall provide HI with information about the terminal's compatibility with terminals from other suppliers*
- *Information on how to call "112" (the Swedish emergency number) shall be available to users or prescribers of terminals*
- *Two way communication – the call parties shall be able to talk at the same time with each other*
- *Secrecy – the user shall be able to turn off the microphone and/or speakers, and there shall be a visual indication when microphone or speakers are turned off*
- *All events indicated with an acoustic signal shall also be indicated with a visual signal*
- *Possibility to connect alert system equipment so that the user can be informed of incoming calls.*

Requirements for video communication

The requirements for video communication focus on video quality, temporal effects and screen and camera quality.

The requirements are, in part, based on the document from the International Telecommunication Union: ITU-*T Series H: Audiovisual and multimedia systems – Application profile – Sign language and lip-reading real-time conversation using low bit-rate video communication*[2].

The requirements considered to be of most importance for sign language communication are:

- *Audio and video simultaneously*
- *Frame-rate equal to or above 20 frames per second. This requirement is necessary for sign language in normal speed*
- *At least CIF*[3] *resolution, i.e. 352 x 288 pixels*

[2] Series H: Audiovisual and multimedia systems – Application profile – Sign language and lip-reading real-time conversation using low bit-rate video communication (05/99), International Telecommunication Union

[3] Common Intermediate Format. Frame format defined in ITU-T H.261 from the International Telecommunication Union. Each frame consists of 352x288 pixels.

- *Delay of image and sound between two terminals shall not exceed 0.4 s. This is necessary to avoid calling parties interrupting each other*
- *Possibility to see own image during call as well as other party's image*
- *If the terminal includes camera, the camera angle shall exceed 42°.*

General requirements for text communication

The requirements for text communication are mainly based on requirements inherited from outdated requirement specifications for text telephones[4]. Even if the communication network has changed from switched telephone networks to packet-based data networks, the user's needs have not changed.

The most important requirements for text communication are:

- *Possibility to use 'speak-directly/listen-directly', i.e. to alternate between text mode and voice mode*
- *Possibility to delete the final character on own and other party's display*
- *The delay between input from the sender and presentation at the receiving end shall not exceed 1 second*
- *Interoperability with legacy text telephones still in use in Sweden.*

Requirements for legacy text telephones

In recent years, there has been a remarkable development in communication networks and services, and many videophones and total conversation terminals use IP networks for communication. Fast Internet access is available to the general population in Sweden, and most deaf people using sign language can use video telephony to communicate to each other and the video relay service. There is, however, a group of people who have special needs, in that they cannot sign and have limited experience of computers and advanced technical equipment. Elderly people who have become deaf or hard-of-hearing at an age when they have fully developed speech usually aren't motivated or have the need to learn sign language. For some of these people, the best solution for telephone communication is the legacy text telephone, since it is usually designed for the sole purpose of text telephony and hence is simple to use.

The need for legacy text telephones will persist until solutions for IP-based text telephony with equally simple handling procedures appear.

[4] Kravspecifikation – Texttelefoner, Hjälpmedelsinstitutet 2002-03-01

Requirements on legacy text telephones are:

- *Communication compatible with ITU-T V.21*[5]
- *Text coding in ASCII with Swedish supplement.*

Future use of requirements

By forming the requirements out of the user's needs, they won't have to be updated too frequently.

A revised version of the requirement specification was accepted in May 9th 2006 by the Nordic Forum for Telecommunication and Handicap (NFTH) as a set of guidelines for testing of stationary text telephones, videophones and total conversation terminals[6]. NFTH consists of representatives from national telecommunication agencies, suppliers and national institutes for technical aids for the disabled in Sweden, Norway, Denmark, Finland, Iceland an Greenland. By agreeing to use the same set of requirements for text and video terminals, the users in the Nordic countries can benefit from each other's experiences and from the fact that the suppliers will have a broader market to provide terminals to.

The guidelines from NFTH and the corresponding Swedish requirement specification are documents which will require updating at a regular interval, since the pace of product development is very fast.

http://www.hi.se/templates/Page_____806.aspx (English version).

The guidelines issued by The Nordic Forum for Telecommunication and Handicap can be found at www.nuh.fi/nfth.htm.

[5] ITU-T V.21 (1988), International Telecommunication Union

[6] Guidelines – Total conversation units, text phones and videophones (NFTH 4/2006), http://www.nuh.fi/NFTH_2-2005.pdf

3. Smart home environment

Ilse Bierhoff, Ad van Berlo, Julio Abascal, Bob Allen, Anton Civit, Klaus Fellbaum, Erkki Kemppainen, Noemi Bitterman, Diamantino Freitas, Kristian Kristiansson

3.1 Introduction

"Improving the quality of life for disabled and the increasing proportion of elderly people is becoming a more and more essential task for today's European societies" [Steg, Strese, Loroff, Hull & Schmidt, 2006], where the percentage of people over 65 years of age is due to rise to 20% by the year 2020 [OECD, 2005]. One way to improve the quality of life is by making the home environment a more comfortable place to live in by turning it into a smart home environment.

The terms smart homes, intelligent homes, home networking have been used for more than a decade to introduce the concept of networking devices and equipment in the house. According to the Smart Homes Association the best definition of smart home technology is: the integration of technology and services through home networking for a better quality of living.

Other terms that are related to smart homes are aware house, changeable home, attentive house and ambient intelligence. These terms are used to emphasise that the home environment should be able to respond and modify itself continuously according to its diverse residents and their changeable needs. For instance ambient intelligence is defined as a digital environment that is sensitive, adaptive and responsive to the presence of people [Aarts & Marzano, 2003]. Ambient intelligence will encompass the home, car, clothing, work and public places. Reading this definition one could conclude that ambient intelligence is something that will happen in the far future. However there are many examples that ambient intelligence is something that is happening today. For instance cars adjust the settings of the chair and mirrors to a specific driver and large crowds are analysed by cameras and intelligent software to detect specific persons. With regard to the home environment there is a growing amount of digital equipment present in the home to support the residents. This doesn't mean that there are always the high-tech solutions that are present in the homes but also existing low-key technological devices which are readily available can make a contribution. In this sense smart homes are considered to be a first step in the process of creating a sensitive, adaptive and responsive home environment.

From a user perspective it is important to realise that residents consider their home to be a safe and comfortable place to live in. Sometimes technology is seen as an intruder in their safe environment, residents are afraid to loose control over their home. Some people even fear the use of technology in their home. So technology and the home environment are not naturally a perfect fit. With respect to smart home technology for elderly and disabled people another aspect is important. Some solutions are implemented to reduce the need to do things but it is also important to implement solutions that increase the participation of the resident in an activity. The goal of equipping the home environment with technology isn't just to automate all the tasks that are carried out by the residents. The objective in design is to provide tools and services that empower and enable people themselves to address their social, rational, and emotional needs. Equality, autonomy, and control are the goals of empowering design.

Furthermore technology is not the solution to create a perfect home environment but has the ability to make a useful contribution. The environment as a whole, including for instance social contacts and location of the home, is responsible for the overall satisfaction of the residents.

After this introduction the chapter continues with an overall description of smart home technology, relevant trends and stakeholders, referred to as the smart home framework. In the next three sections several aspects of the smart home environment are described in more detail. Each of these sections uses a different viewpoint. The viewpoints are: technological, products and services and user interaction. The sixth section is devoted to realized projects, which are divided in projects with residents and research facilities. The chapter ends with a section discussing the challenges for smart home technology in the near future.

3.2 Smart home framework

Developments in the field of smart homes are not an isolated case. First of all the developments take place within the society and are influenced by trends within that society. Furthermore in order to create added value the focus should be on the smart home environment instead of only on the used technology. Thirdly creating smart environments to support elderly & disabled persons has enormous potential. To live up fully to the expectations is however a complex process which involves various stakeholders.

3.2.1 Demographic trends

The major trend throughout Europe is the aging society caused by an increasing life expectancy and decreasing birth rates. Not only the group of people over 65 will become a large proportion of the European society but there will also be a significant increase in the number of people over 80. The proportion of population aged over 65 and over is rising in all countries, however differences can be observed. The ratio for Iceland, Ireland, Slovak Republic and Turkey lie well below the average for Europe, whereas the ratio for Finland, Germany, Greece, Italy and Sweden lie far above the average for Europe [OECD, 2005].

"It is a common understanding that population ageing, along with the increasing survival rates from disabling accidents and illnesses, will lead to an increase in the proportion of the population with impairments, disabilities or chronic illnesses." [European Commission, 2004] For instance the number of people with dementia in The Netherlands is expected to rise from 250 000 in 2005 to 350 000 in 2020 and over 580 000 in 2050.

The way in which we are going to deal with this problem could differ among the European countries for instance depending on the family structure, the availability of broadband and the national healthcare system. "In southern Europe more people live with their children than in the north of the continent. On the other hand, broadband access to the internet, seen as vital for delivering AAL (Ambient Assisted Living) services such as telemedicine, is more commonly available in northern European countries." [IST report, 2006]. Also the way in which health care is financed and organized varies considerably among various countries. Schmidt, Egler and Geursen (2001) define three types of health care systems present in Europe.

- *Tax-financed system, examples: Scandinavian countries, U.K., Italy, Greece and Canada*
- *Premium financed system, examples: Japan, Germany, France, Belgium, Netherlands, Austria*
- *Private insurance system, examples: USA, Switzerland.*

3.2.2 Hierarchical classes of smart homes

During the past years as a result of technical developments the possibilities of smart environments have risen tremendously. This increase in possibilities is physically visible in different types of realized smart homes. In order to classify smart homes, a functional perspective can be used. Since smart home technology is changing rapidly the functional perspective provides a better framework than a technological point of view.

With a focus on the functionality available to the user Aldrich proposes five hierarchical classes of smart homes [Aldrich, 2003]:

1. *Homes which contain intelligent objects – homes contain single, stand-alone applications and objects which function in an intelligent manner*

2. *Homes which contain intelligent, communicating objects – homes contain appliances and objects which function intelligently in their own right and which also exchange information between one another to increase functionality*

3. *Connected homes – homes have internal and external networks, allowing interactive and remote control of systems, as well as access to services and information, both within and beyond the home*

4. *Learning homes – patterns of activity in the homes are recorded and the accumulated data are used to anticipate users' needs and to control the technology accordingly*

5. *Attentive homes – the activity and location of people and objects within the homes are constantly registered, and this information is used to control technology in anticipation of the occupants' needs.*

Since broadband is becoming more widespread, available smart homes are shifting within the hierarchy from homes which contain intelligent, communicating objects to connected homes. Learning and attentive homes do exist but only in demonstration settings. The technology used in those homes is in most instances still experimental. From the viewpoint that a home should make a substantial contribution to the quality of life, the home should at least be qualified as a connected home. For the delivery of services to the home, a connection to an external network is essential. This opinion is also expressed by CENELEC, the European Committee for Electrotechnical Standardization. Within the eEurope context they have defined a working model of the Smart Home environment, with its three separable interest areas as follows [Tronnier, 2003]:

1. *The Smart House/Home and its in-house networks and applications, i.e the clients*

2. *The access point to the Smart House, often referred to as residential gateway*

3. *Provision of services in a standardized way to the Smart House and related access networks.*

3.2.3 The stakeholders

The stakeholders when building intelligent environments are very diverse. They all play a different role in the process and have different preferences and opinions. The challenge is not only to develop concepts that are technically possible and reliable but to create a concept that is supported and accepted by the large group of stakeholders. Stakeholders are for instance architects, housing corporations, project developers, electricians, builders, care takers, service suppliers, product suppliers, advising agencies, insurance companies and last but not least the end consumer.

Regardless of whether a resident, home-owner, guest or whoever is being considered, the home is always a physical setting, a house, in a relation to a person. People use equipment by themselves, with other persons or they are used entirely by other persons, for example by home help services. Other persons have different roles.

Important roles are also those which are related to money, safety, responsibility and social relations. If a person buys products or services, there is an issue of product liability. It is more complicated if there are several service providers whose products should work together.

In recent years smart home technology was mostly implemented in new homes. This meant that smart home technology had to be fitted into the existing building process. In Sweden a specific consultant in the area of smart home technology was added to the project team. This consultant operated together with the architect, the structural consultant, the mechanical consultant and the electrical consultant [Sandström, Gustavsson, Lundberg, Keijer & Junestrand, 2005]. In most projects in the Netherlands there is no specific smart home subcontractor or consultant for smart home technology. In stead the electrical sub contractor is responsible for the implementation of smart home technology. More specialized electrical subcontractors call themselves system integrators in order to express their knowledge about smart home technology.

With respect to the building process it is important to realize that the possibility to make changes without huge investments declines during the building process [Willems, 2003]. At the starting point of a building process the main decisions are taken by architects, project developers, housing corporations and on very few occasions by the end consumer. Therefore it is remarkable that the parties who are going to benefit from the smart home technology only get to express their preferences during a stage in the building process where changes to the original plan are very expensive (figure 3.1).

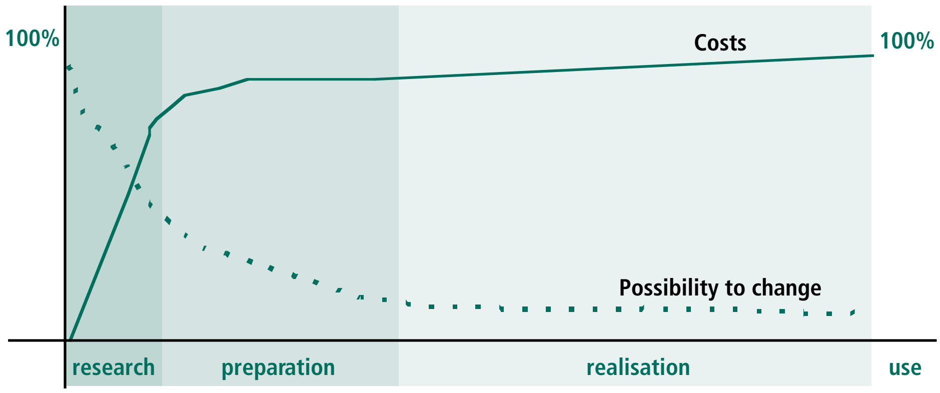

Figure 3.1 Building process with an indication of the costs and the possibility to change [Willems, 2003].

This opinion is also expressed by the Delta Centre in Norway [Laberg, Aspelund & Thygesen, 2005]. They describe the following advantages of installing smart home technology during the building process:

- *Cheaper*
- *Part of a totality*
- *Savings also for parts of conventional installations*
- *The installation can be concealed.*

When the home is constructed it can be owned or hired. In some countries there can be a separate service house which is owned and maintained by a public or some other organisation. The resident may have to pay a rent or various fees. The market structure varies from country to country.

It is often typical for the market of assistive technologies that a third party finances the equipment. It can be an insurance system, welfare organisation or public administration. In some countries public administration may have a role in providing, e.g., alarm systems, fixed assistive technologies or environment control systems which are needed by an older person or a person with disabilities. It may arrange the installation, pay for it wholly or in part, and arrange related services.

The functioning of a social alarm system in fact presupposes that the alarm goes to somebody who can react. They can be private or public service providers of various kinds, e.g. home help services, or emergency services. When considering services, the picture is more complicated than in case of single devices. Societies are different and consequently national differences are greater. That is why one should not too quickly promote only one service model [Stakes, 1998].

3.3 Smart home technology

The use of stand-alone equipment for helping people carry out everyday activities – assistive technology – is widespread [Barlow, Bayer & Curry, 2003]. By integrating stand-alone equipment into systems, the possibility to create a far more customized and integrated approach to healthcare increases but also the complexity of the system.

As computer-based systems and artefacts penetrate more and more into people's everyday lives and homes, the 'design problem' is not so much concerned with the creation of new technical artefacts as it is with their effective and dependable configuration and integration [Dewsbury, Rouncefield, Clarke & Sommerville, 2002].

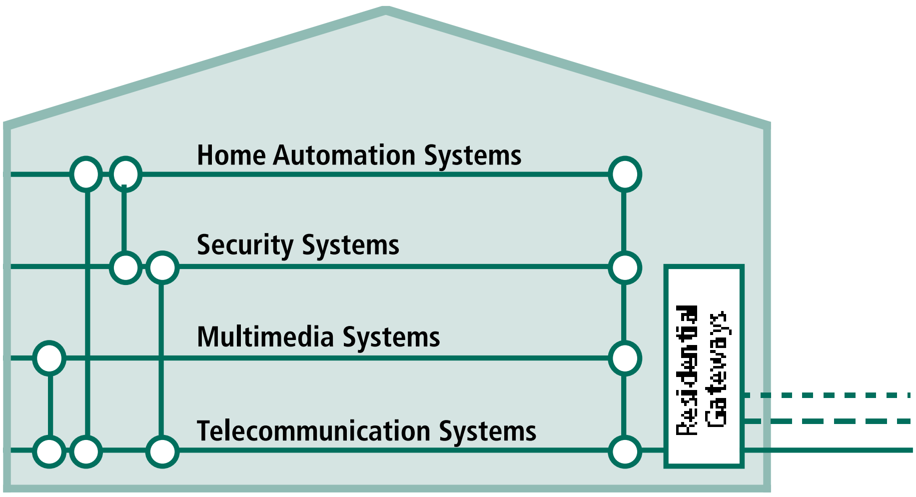

Figure 3.2 schematic model of a technical structure of a smart home [Junestrand, 2004].

Smart home technology is the integration of technology and services through home networking for a better quality of living. At the moment smart home technology is shifting from being purely concerned with the integration of electrical equipment within the home to a broader perspective, which also includes ICT functionalities. This is visible in the home environment (figure 3.2) in terms of different networks for work & productivity, entertainment, communication and information and home automation that are merging and connected to the outside world by a residential gateway(s) [Junestrand, 2004].

The value of the home network does not depend on one single system but on the way the different systems are connected to each other and supplement each other. Furthermore the process is not static but the preferences and desires can change over time. This section starts with general technological developments that could provide benefits for assisted living. Thereafter the focus is on technology for the home environment. Four topics concerning the home environment are covered in this section: infrastructure, integration and interaction, wired versus wireless and speech technology.

3.3.1 General technological developments

"There is a technology race for smaller, cheaper and faster processors, for terabit memories, and ever greater communication bandwidths. At the same time, advances in sensor technologies, microsystems, displays and software, are paving the way for new systems and applications characterized by intuitive, flexible and more autonomous behaviour. Breakthroughs are also expected by pursuing ICT research in combination with other disciplines, for example those related to new materials, bio- and life sciences and from the knowledge base of the cognitive, biological and social sciences" [ISTAG, 2006].

These new technologies will become part of the environment in which people fulfil their tasks and in which people live. User interfaces will disappear and interaction will be with a federation of devices like sensors, actuators and microcomputers. The communication in these intelligent surroundings will be based on conversational interaction technologies such as speech, gesture and emotions. In such an environment human-computer interaction will be transformed into human-computer co-operation. In this sense Weiser's vision of "Machines that fit the human environment instead of forcing humans to enter theirs will make using a computer as refreshing as a walk in the woods" [Weiser, 1991] could become reality.

All technological fields and options that meet the user needs and demand, or help to solve general Ambient Assisted Living challenges are relevant for smart home technology. Nevertheless, fields of higher priority can be identified:

- *New materials (e.g. polymer technologies)*
- *Micro- and nanoelectronics (nanocoatings, polymer actuators)*
- *Embedded systems (e.g. as in smart textiles)*
- *Micro System Technology, including biomicrotechnology (biochips, sensors to measure values like blood pressure, temperature, weight, respiration, urine output and to observe activity patterns nutrition, gait sleep)*
- *Energy generation and control technologies (energy harvesting)*
- *Human Machine Interfaces (display technologies, natural language communication)*
- *Communication (e.g. body area network)*
- *Software, web & network technologies (e.g. tele-services)*

[Steg, Strese, Loroff, Hull & Schmidt, 2006].

This list emphasizes again the complexity of the field of smart home technology. A lot of technological developments could create new possibilities for assisted living. It is a challenge to keep track of all the developments and to combine results from different technological fields into useful concepts.

3.3.2 Infrastructure

The development of smart home technology during the past years is best described by using a model consisting of three layers:

- *Network layer*
- *Platform layer*
- *User layer.*

The network refers to the familiar cables which we already have to a large extent, both inside and outside the house: telephone cable, TV cable and the power supply network. It also refers to the extra infrastructure which in most cases does not exist yet: computer cables and lower voltage cables. It refers to infrared (IR) and radio frequent communication (RF).

Products of traditional suppliers contain a protocol, which allows communication between the products, remote control and central control by the resident. Ideally, all products of the different manufacturers can communicate via the same protocol. In practice, this is however not the case.

A homebus is a physical wire, a special low voltage cable, which is used to transfer signals within the house via a certain protocol. Generally, two types of homebus systems can be distinguished: the systems with fixed, built-in intelligence and the systems which can be programmed via a PC. Next to the homebus systems there are the powerline systems and the RF systems to transfer signals within the home. From the powerline systems, the X10 is the oldest one. Improvements on this protocol resulted in the so-called A10 system, which has a growing popularity for use in both newly built and existing houses, because of its low pricing. Recently, various RF-systems are coming on the market, facilitating installation of smart technology in existing dwellings.

All media are different in their properties and have both, advantages and disadvantages. The right selection is also a question of cost. As a general rule, more data speed means higher costs. However, the demand of bandwidth or bit rate strongly depends on the application. In general, for control data transmission, a bit rate of some kbps is sufficient. This holds for the most of the smart home components (sensors, actuators, control and visualization units). However, for telecommunication purposes (above all video communication), the bit rate exceeds to the Megabit range. Figure 3.3 shows an overview of several transmission media that exist.

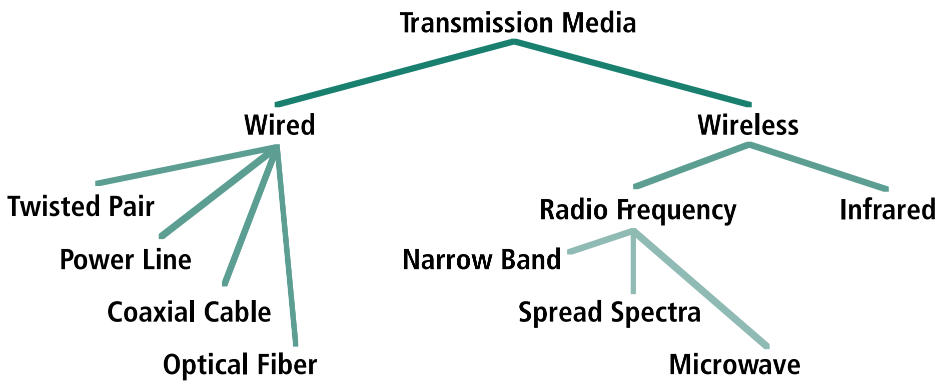

Figure 3.3 Transmission Media [Fellbaum, 1999]

In accordance with this overview Laberg, Aspelund and Thygesen (2005) state that the following standards are at the moment the most relevant standards:

EIB

EIB (European Installation Bus) is an open standard widely used in Europe. EIB is available for powerline, signal cable and radio. The single cable version is currently the most widely used in smart homes.

KNX

KNX is a new standard resulting from an amalgamation of three European bus standards, with EIB being one of them. KNX is expected to replace EIB in the near future. KNX fully complies to the EN 50090 series, the European Standard for Home and Building Electronic Systems.

LON

LON (Local Operating Network) is a proprietary standard, used for energy-control, steering machinery and access control systems in industry and larger buildings. The standard is mostly known for powerline signalling, but also supports signal cables, coaxial cables, radio and fibre optical transmission.

X10

X10 is a standard for powerline signalling, widely used for management of domestic electrical commodities, like lamps and radiators. It is also used in environmental control systems in single houses. The protocol has small range of commands, limited to start and stop.

BACnet

BACnet is a standard developed in the USA for the control of functions in larger buildings, but has so far not been observed in European smart homes. BACnet is supposed to easily communicate with the EIB.

Internet Protocol (IP)

Internet Protocol (IP) is not used as a bus system, but is relevant for communicating in and out of local networks during re-programming and maintenance. IP is also becoming more and more important for communication within the local network.

This list shows that there is not just one standard for smart home technology, but there are several. Standardization is however an important issue for the success of smart home technology. The end user, housing operator and real estate management should have the freedom to choose the applications and services they want to use and should not be forced to buy products from one specific supplier. They also should have the possibility to expand the system with little effort. In that way the end user can always adjust the home to their specific wishes and the housing operator and real estate management have homes that have a good market value for a long period of time. According to CENELEC interoperability must be addressed at different levels such as terminal devices, content delivery and presentation across different platforms. Furthermore standardization agreements do not restrict competition, if the standards are adopted by recognized standards organizations, which work according to open, non-discriminatory and transparent procedures.

In this context two initiatives are mentioned here. The first is the KNX standard. An important aspect of this standard is that it supports different media types. Owing to the 4 different supported media types in the KNX Standard, installers can use the media best suited for the transport of KNX messages (e.g. Twisted Pair in new installations, Power Line or Radio Frequency in renovations or retrofit). KNX messages can also be transported inside IP messages: KNX and Internet can in this way be linked (www.konnex.org).

The second initiative is the SmartHouse Code of Practice developed by CENELEC [Pattenden, 2005]. This code is a document that provides a "system designer" working to implement a SmartHouse (to be used as dwelling and as a home office) with a source of information on sensible and pragmatic guidelines for the design, installation and maintenance of SmartHouse systems and the services and applications provided. It is recognized that providers and installers must work within diverse regulatory environments and must be free to make choices appropriate to their business objectives (which in relation to this document focus on meeting the needs of domestic and small-office users, not large-scale commercial premises). Therefore, standards should be considered as enablers and leave prescriptive aspects to local regulation. The aim is to provide a useful reference document to ensure that the user may exploit the benefits of a consistent systemarchitecture by utilizing European and International Standards and other generally accepted specifications in the design of the Smart House system. This code of practice delivers a route to investment synergies, flexibility of services and useful and usable applications that satisfy the individual consumer's needs and requirements.

But for now and the near future, an optimum solution is a hybrid network, consisting of Power Line as well as other cables (if already existing) and wireless components (WLAN).

3.3.3 Integration and interaction

A major problem with smart home design is the integration and interaction among heterogeneous subsystems, which may probably not be designed to interact with each other. Assistive technologies are very heterogeneous when attending needs due to individual and temporal variations. Moreover, devices are usually designed by different manufacturers using different technologies for heterogeneous applications. The Design-for-All concept considers the lack of simplification usually made when considering a standard user. At the same time, this lack of standardization and individual diversity and variability increases heterogeneity in subsystem development, both in terms of applications and services, in a kind of vicious circle. The result may be called "islands of functionality": solutions adapted to specific users in particular environments.

A smart home should be able to support the interaction of heterogeneous devices, networks, services and applications. First, there is a need to interact at the internetworking level. At this level, the necessary mobility of the user implies that interconnectivity cannot be guaranteed at all times so communications should be asynchronous. Clients asking for a service and devices offering it may not be connected at the same time. Therefore, the communication paradigm should be connectionless (vs. connection oriented), well suited for intermittent connections. In smart homes, if a backbone fixed infrastructure is available then a Nomadic system may be better than an ad hoc system: mobile devices connected through wireless links to a fixed wired network. For instance the backbone network may be based on the IP protocol, a robust and contrasted solution, which has demonstrated its success in the interconnection of heterogeneous devices (a good example is the Internet). Most devices can be connected through this IP network while secondary, maybe simpler, devices (e.g. sensors) may be connected using non-IP communications. In this case a gateway is used to interconnect IP and non-IP sub-networks. This solution permits environmental control in a remote mode via a web page as well as direct Internet access in home automation through residential gateways.

Second, interoperability should include dynamic service discovering (periodically or triggered by determined events), service description (including actions that may be performed, properties that may be useful), and service control (actions and modifications of state or attributes of a service in a sub-network from another device connected to a different sub-network). Services and information from a given subsystem should be described using common languages and media formats to be accessible to other subsystems. Interaction between context-aware subsystems requires common context representations that are independent of the applications. But it is not just a simple problem of using a common format. Further issues are how this context information is interchanged among subsystems, how services are discovered or offered, and how they are integrated in user interfaces. A number of available architectures can support these functions: HAVi, Jini, UPnP (Universal Plug and Play).

This interaction is usually a syntactic interaction, without considering the "meaning" of discovered and shared services. However, in the future a higher level of semantic interactions may be possible allowing services to be pre-selected to offer adapted assistive services to the right people or to adapt or empower the functionality of existing applications according to new services. New applications may become available based on the new services.

A typical example of this interaction could be a sensor network monitoring physiological parameters (heart rate, blood pressure, sugar level). Some of the sensors may be body-worn, using a low-rate WPAN like 802.15.4. Others, may be integrated into the surroundings (chair, bed, building), probably connected through a backbone network like EIB or a WLAN like 802.11g. One of the body sensors may act as a bridge to the ambient sensor network, providing interconnectivity at the network level. But additionally, these devices may interoperate themselves at a higher level. As an example, in a health monitoring application alarms or drug doses may be adapted using information from the ambient sensors, for instance inferring the user activity state (e.g. driving, sleeping, exercising, or talking to someone).

3.3.4 Wired versus wireless

Wireless technologies have clear advantages and drawbacks when applied to the smart home environment. Among the advantages, flexibility and easy installation are clearly important characteristics in this type of networks. Among the drawbacks, clearly safety and security can't reach the levels which can be obtained with wired networks, deterministic response times are not possible and RF emissions might cause some user concern.

Research investigating spread spectrum techniques in the 2.4 GHz range which allow a protected transmission to solve the security problem are being conducted [Fellbaum, 1999, van Berlo, 1999 and Flikkema, 1997]. They are robust against sinus- and noise-like disturbance sources and wall reflections and they avoid crosstalk effects between the different RF channels. There is only a serious problem if a microwave oven is used. This device produces a wide band disturbance signal which can easily blot out the control and communication signals, even if the oven is carefully shielded.

However, it is clear that, in many cases the advantages overcome the drawbacks and wireless network become the most feasible alternative for home automation.

Originally wireless smart home networks were based on protocols specifically designed for this purpose but currently, due to the huge penetration of computer and telecom wireless networks, this is not always the case. To be more specific, three different network families are currently used to support smart homes:

- *Traditional RF Home automation networks: These are usually based on relatively low frequency carriers and modulation techniques are usually quite basic, thus available bandwidth is usually very small (a few kbits/s or lower). Examples of these protocols include X10 over RF (at 200MHz) or KNX over RF (at 868MHz). Many proprietary networks based on RF remote control frequencies (433MHz) are also widely used*

- *Wideband RF protocols: These protocols were originally designed for computer networks and provide relatively high bandwidth (currently up to hundreds of Mbits/s). They usually operate at 2.4GHz or 5GHz. Currently the most popular among these type of networks is the WiFi family (IEEE 802.11a/b/g). These networks are very useful for relatively complex devices but for simple devices, the costs per node and especially power consumption rule them out*

- *Generic Low power networks: These networks have been designed very specifically for mobile device and optimized for low power usage. Bluetooth is currently the most widely used but its protocols are relatively complex and its power requirements are not suitable for devices that have to run on a small battery for years (or get the power somehow from the environment). Zigbee is a new type of very low power, low complexity network with some built in localisation capabilities that seems to be very promising for smart home applications.*

Probably in the near future most smart home networks will be based on a mix of WiFi and low power networks interoperating possibly with some wired segments as well.

3.3.5 Speech technology

The principles of electronic speech processing as well as applications for persons with disabilities have already been presented in Chapter 2.2.2. In this section the focus will be on the use of speech technology in smart homes, especially for elderly people.

A serious problem of a lot of technology in the home environment is an adequate control of these systems. Let's consider a person with some mobility problems, sitting in a chair in front of a TV set. Usually a remote control is available. A first idea could be to extend the number of keys of the remote control in order to add more control functions. However, with more keys the number of malfunctions will significantly increase and, especially with elderly people, the user acceptance will dramatically decrease. With a voice controlled system, virtually all control functions can be executed by voice, which also includes a voice output (with the aid of a small built-in loudspeaker), a visual component is however indispensable to remind the user about the functionality he is controlling. The right 'mixture' of audio and visual information, in other words, the ergonomics, has a strong influence on the acceptance by the user [Hampicke, 2000].

In an Ambient Intelligence environment (see chapter 4) walls and objects of everyday use have intelligence. In the case of speech processing the walls have built-in microphones, mostly arranged in arrays, loudspeakers and enough processing power to fulfil all speech processing activities being used for recognition and synthesis: the walls can listen and speak. Moreover, displays which are needed, also in a speech dialogue application, can appear everywhere on the walls. The above scenario, which may sound like science fiction, is quite feasible today.

While speech recognition tries to detect the content of a spoken utterance, speaker recognition investigates the identity of the speaking person. The main application for speaker recognition is access control. It can be the access to houses and/or rooms or the access to computers or household appliances (including voice-controlled cooking or washing). The reliability of systems that are on the market sometimes isn't sufficient. The reliability of the total system can be improved by combining speaker recognition with other forms of control, for instance face recognition by a camera.

3.4 Products and services

Within the field of smart home technology products and services play an important role in creating benefits for users. In general products and services can be divided into six categories:

1. *Comfort*
2. *Energy management*

3. Multimedia and entertainment

4. Healthcare

5. Security and Safety

6. Communication.

The division is not strict, the different categories overlap. Mostly people don't choose just one category but several. The different categories strengthen each other leading to the fact that overall functionality of several categories combined is more than the sum of functionality of the independent categories.

It is impossible to give an extensive overview in this chapter, or anywhere else for that matter, since new products and services are developing at such a rapid pace whilst by combining solutions new products and services are formed.

The emphasis in this section is on products and services belonging to the categories healthcare, security and safety and communication, giving some examples of solutions that fall within the different categories. For a broader perspective a list compiled by the Ambient Assisted Living Initiative is available [Steg, Strese, Loroff, Hull & Schmidt, 2006].

3.4.1 Healthcare

On a global level healthcare solutions can be divided in the following categories:

- *Active alarm systems: utilize remote emergency systems – usually telephone based – installed in the home of older persons*
- *Passive alarm systems: do not require the interaction of the person. For example, devices include sensors that are able to recognize the danger of a fire and send an emergency call automatically*
- *Remote support for care staff: include all kinds of telecommunication-based activities supporting the work of field staff*
- *Remote support for family carers: includes all kinds of telecommunication-based activities supporting family carers*
- *Advanced services using video telephony: include remote monitoring and video-based alarm services*
- *Telemedicine*

[European SeniorWatch Observatory and Inventory, 2002].

Alarm systems play a very important role in Smart Home applications. However, the systems, existing so far, are very often too complicated or not reliable enough. The key issue is the setting off of alarms. If, for instance, persons have an accident (fall, injury), a fire breaks out or a person suddenly becomes unconscious, then there is normally no time or possibility to operate a telephone or even an alarm button on their wrist or around their neck. Although there were many alarm systems on the market and several research projects have looked into this particular issue (e.g. the TIDE projects FASDE and ASHoRED) exist, there is still a large knowledge gap as to how persons react in a dramatic situation, be it panic or a collapse or simply because they are confused or have memory problems (forget that they are wearing an alarm button).

Probably the best solutions to overcome these problems are passive systems. Passive means an automatic control of vital functions (e.g. pulse, blood pressure, oxygen saturation), their evaluation and an automatic alarm being set off when the values of the vital parameters exceed predefined limits. The reliability of the alarm being set off can be dramatically increased when several different observations and decisions are combined. Among the measurement of vital parameters as described above, the person’s activity (leaving and entering rooms, using water, electric light, TV and radio and many more) can give important additional information.

In order to avoid false alarms the receiver of the alarm (e.g. call centre or relatives) sends back a signal to the user for instance by telephone or via a message that appears on the alarm module worn on the wrist or around the neck. In the case of a false alarm, the user can answer the phone or press the button of the module indicating that no help is needed thus avoiding unnecessary attendance. If, on the other hand, the user does not react, it can be assumed that the alarm is serious [Hampicke, 2004].

One huge problem in healthcare is wandering and wayfinding. There are systems to detect where a client leaves the house where this would be inappropriate or dangerous for the client. These systems consist of magnetic contacts or pressure mats at/near hall door connected to local area (family) paging. The system, of course, does not restrict egress, but merely alerts a carer that the client has left. Similarly, for wayfinding (at night) lighting strips and passive infra-red light switches can assist and reduce the likelihood of a fall or disorientation around the house at night.

An area that receives an increasing amount of interest is telemonitoring or personal health monitoring is based on the idea that persons can monitor themselves in their home using medical devices. Health care monitoring at home enables continuous measuring of physiological parameters. It is possible to embed sensors in different places or objects at home (e.g. in the furniture, electrical appliances), or to make them wearable by integrating them into clothing "Smart Shirt" or small apparel items such as watches and jewellery. By combining these wearable sensors with measurement devices embedded in home surroundings, advanced multiparametric health monitoring may be achieved [Korhonen, Pärkkä & van Gils, 2003].

Recording of physiological and psychological variables in real-life conditions could be especially useful in management of chronic disorders or health problems; e.g. for high blood pressure, diabetes, anorexia nervosa, chronic pain, or severe obesity [Korhonen, Pärkkä & van Gils, 2003]. Telemonitoring could also be used to provide feedback about someone's health in the form of behavioural feedback in order to prevent diseases.

Obviously telemonitoring has many advantages for both, the patient and the medical institutions. The patient can stay at home and does not have the inconvenience, associated with a visit of the doctor or in the hospital, and the medical institution saves time because there is no need for spending time with routine work and in the hospital enormous costs for the bed and the care of the medical staff can be saved. In several telemonitoring applications the data are not directly transmitted to the medical institutions but to a kind of 'call centre', which performs a first data evaluation.

3.4.2 Security and safety

Top priority for many older people is the feeling of living safely and securely in their own house. In general, people like to know who is at the central access door of the flat and at the front door of the own apartment, before opening the door. In many projects this access control has been facilitated via remote control by phone, on TV and electronic locks on central access door and own apartment door. In some projects an intrusion alarm is present. Residents have to enter a code or use a proximity key to switch off the alarm.

A smoke detector is installed in all projects, as near as possible to or in the kitchen. In some cases there are even smoke detectors in kitchen, living room and bedroom. If smoke is detected an alarm signal is given to a call centre automatically. First, the call-centre operator will speak to the resident via the safety alarm phone if there is a real fire. The smoke detector can be accompanied by other sensors to create an even safer environment.

Older people have a more frequent nightly toilet visit than younger people. With automatic light switching on when the legs are put out of the bed, one can better orientate and find the way to the bathroom without risks of falling.

In most cases the electric or gas cooker can be switched off via an extra button, which also switches off the light on the working area. On the other hand the cooker cannot be used if the light on the working area is not switched on. There are also examples where there are two switches: one switch to activate the cooker and one to turn on the light. If the resident leaves the house, the cooker is automatically switched off. The same is true when the tenant goes to sleep and uses the button "day/night" above the bed or in case of an alarm.

3.4.3 Communication

One of the most commonly used smart home technologies is internal and external Intercom systems, providing elderly and disabled people with a method of communicating with those calling at their door and to other rooms in the home.

Many mobility impaired persons will require an intercom system in order to safely answer the front door without having to go to it. Going to the door may be (a) impossible or (b) difficult or slow causing danger transferring to a wheelchair or missing the caller due to the delay. Using CCTV in addition can enhance personal security when admitting visitors and may also provide verification that the visitor has actually left the house if they have been visiting a person in an inner room.

The video signal can be distributed to a TV or any other kind of screen within or outside the home. It is also possible to send the signal from the front door to a call centre where a person at the centre can talk to the visitor. This could be helpful when it is late in the evening and the resident feels insecure when answering the door bell.

Communication isn't restricted to 'normal' activities in the home environment it can also be used for remote learning. In order for remote learning to be successful, the technical infrastructure must be in place. In today's technology, this means the student should have access to a wireless network, web cams, a microphone, keyboard access and full telecommunication infrastructure linking the home to the outside world. All of these can be set up exactly to the user's requirements, in a manner that would be extremely difficult or even impossible in a classroom environment.

Remote learning carried out in a smart home would need to take place as part of a designed educational system, and could not be put in place piecemeal. An assessment of the needs of the student would also need to be carried out to insure that the student will be able to access all parts of the course he or she has enrolled for.

Once the correct structure is in place, the potential benefits are impressive; a student will have access to the expertise needed to complete the course, the student experience will have an immediacy to it, as the student would not need to invest time and energy travelling to a class. Their needs would be addressed in a very individual way. Education delivered to a smart home would overcome geographical or environmental barriers to such services. It would allow direct communication with the instructor, and gives access to resources immediately: educational as well as personal, health and social care. Because a smart home also gives access to wider society (for example, e-government, shopping and entertainment), a student would have more time available to him or her, so their quality of life would improve.

For many, accessing good and reliable information about suitable technology is a significant barrier to using technology that meets their individual needs. The Central Remedial Clinic in Ireland, provides a vendor neutral information and evaluation service. People with disabilities, their families, carers and other service providers can get up to date information about the technologies currently available in Ireland and can receive guidance in terms of how such technology may be installed and set up for use in their own homes. Staff at the Central Remedial Clinic works to identify the reasons why a person is seeking such technologies and then devise a solution based on the supports that are available to the person and contextual and environmental factors such as the location of their home. Smart home solutions usually comprise recommending a range of technologies that are to be placed in a person's home environment and a method of controlling these that is suited to a person's individual needs.

3.5 User interaction

The advent of smart homes is part of the overall pattern of convergence that is occurring in technology. Through the exploitation of advances in high tech networks, the smart home allows the convergence of the different environments of an individual's life, the personal, leisure, workspace and educational environments. The greatest advantage of the smart home is that it uses non-intrusive technology that can be completely personalised to the individual. During the past years the user has taken a more central place in the development of smart home technology. This is only logical since the acceptance of products depends mainly on the reaction of the user.

This paragraph is divided into three sections. The first section is devoted to acceptance. The second section focuses on adaptive and intelligent user interfaces and the last section is devoted to ethical issues.

3.5.1 Acceptance

Use and acceptance of technologies and technical devices depend on various factors: adequate design, financial resources, the housing situation, which functions shall be compensated or strengthened by technologies and which skills and competences still exist [Mollenkopf, 1994].

Although it is quite true that use and acceptance of innovations can only be roughly estimated today we nevertheless can list a set of important aspects that should be considered when speaking about user requirements and acceptance:

- *People do not accept everything that is technologically possible and available*
- *Ambient Assisted Living concerns a heterogeneous group, where solutions therefore are accordingly multifaceted. There is no such thing as a typical, standard user or use rather a diversity of users and uses*
- *Acceptance by a user depends on the obvious advantages, functionality, utility, usability, price/financial resources, (data)security and adequate (barrier free, no stigmatisation) design of the device as well as on her biographical and technological experiences*
- *New products should consider 'old' habits of the users*
- *The systems should stay user-determined. At any time an user intervention has to be possible*
- *Information, training for usage, support, error diagnosis and error removal has to be appropriate for the target group*
- *Technologies should provide an additional aid to improve social life conditions; they can never replace social interaction*
- *The new living environment/ambience should not generate new risks*
- *Integration into existing infrastructure should be easily accomplished*
- *Possibility of easy expansion/upgrades of products or integration of new devices according to (changing) user requirements and financial boundary conditions should be given*

- *Multifunctionality of physical and electronic user interfaces ('universal remote control', 'Internet-TV') should be provided services. People own technologies but may not use them; people use technologies but may not have confidence in them.*

[Steg, Strese, Loroff, Hull & Schmidt, 2006].

3.5.2 Adaptive and Intelligent user interfaces

A smart home may provide an extremely large number of choices and some of them may be quite complex. An interface that directly offers all the possibilities to the user may result cumbersome and complex. On the contrary, the user interface should act as an intelligent intermediary between the complex system and the user. Adaptive intelligent interfaces can be designed by means of Artificial Intelligence methods and techniques.

Intelligent interfaces are able to adapt to the user physical, sensorial and cognitive features that may be restricted due to aging or disabilities. In addiction, some of these characteristics can change quite quickly -for example along the day- due to fatigue, and changes in motivation. To this end, the interface has a model of the user and is able to make some assumptions about the actual situation of the user from the current value of a number of parameters.

Another important characteristic of the human interfaces for smart homes is the spatial dependency. Many features depend on the position of the user. For instance, the sentence "switch on the lights" must be differently interpreted according to the place where is has been said. Provided that the user is located with enough precision, the interface needs a spatial model to be able to decide what is possible or not at this place. The dialogue can be very much simplified when the position of the user is known, because many ambiguities can be solved (for instance, there is no need to ask "what lights?"). In addition, the services that can be offered to the user are restricted to the ones present in its current location.

Adaptive intelligent interfaces can also have problems, the most important one being misadaptation. The adoption of erroneous assumptions about the user may make communication impossible. For instance, if the system misunderstands the user and adopts a voice interface, instead of text communication, when interacting with a deaf person.

Another problem could be "over-automation". Even if the smart home usually can take most of the decisions, the user can also take many of them. Some decisions (about energy, safety, etc.) may be boring for the user and he or she will be happy to be relieved of them. Nevertheless, it is very uncomfortable when the system takes decisions for which the user wants to keep control. The complete automation can also lead to user's passivity. Shared control is a better approach to this problem. In this case the system should be able to detect which kinds of decisions are retained by the user. It is necessary to include this information in the user model, taking into account that the set of choices of the user may change with the context, his or her mood, etc.

3.5.3 Ethical issues

The design of human interfaces for smart environments poses in general many ethical questions, as mentioned by numerous authors [Langheinrich, 2001 and Beresford & Stajano, 2003]. However, when the system will be used by people with sensorial, physical or cognitive restrictions, the matter is even more difficult [Pompano, 2000]. These issues are treated in chapter 4.3. Nevertheless, let us mention some basic ideas.

In order to avoid possible negative impact over user rights caused by Assistive Technology, Casas [Casas et al, 2006] state that designers should (1) be aware of the possibility of producing technology having side effects over social and personal issues; (2) know how to identify and face ethical issues, or be able to contact experts that can do this task, (3) have at their disposal design methodologies and tools that do not impede ethical aware design; and (4) master methodologies and tools for evaluation and test of the results including evaluation of ethical impact.

Smart homes frequently include devices and services that may have an impact on the privacy and the autonomy of users. Often these effects are deeply embedded in the technology used to develop them and can not be removed when the system is finished. However, designers are predisposed to ignore these issues, due frequently to the lack of knowledge and supporting methodologies, guidelines, tools, etc. In this sense, Abascal and Nicolle (2005) discuss the need of providing designers with ethically aware guidelines to help them to detect possible ethical impacts produced by their designs, and provide a preliminary set of ethically aware design guidelines.

Within specific projects, researchers a trying to deal with the ethical issues by focusing on the exact nature of required information. In a project researching automated analysis of nursing home observations, the researchers along with medical experts concluded that the end goal wasn’t perfect video analysis. In stead capturing trend information over time was critical for patient assessments and diagnoses [Hauptmann, Gao, Yan, Qi, Yang & Wactlar, 2004]. Other projects focus on ways to extract silhouettes from persons in a video signal in order to identify activity but not identity. Their approach was to extract the human body from the background and fill the corresponding image region with white pixels so as to block the identifying features [Chen, He, Keller, Anderson & Skubic, 2006]. While only using a silhouette it is still possible to identify whether a person is standing or lying down. Coupled with information about a person's location, this information could be useful in establishing if someone has fallen down.

3.6 Realized projects

This paragraph is divided into two sections. The first section focuses on projects with residents and the second on research facilities. In this chapter a brief overview of projects is given. More detailed information about realized projects is available in the form of two short term scientific reports and a working group report also compiled within COST 219ter [Hampicke, 2004, Bierhoff, 2006 and Bierhoff et al., 2007].

3.6.1 Projects with residents

In a way everybody can benefit from smart home technology. However, as described earlier the process of implementing smart home technology is very complex. Especially with regard to living independently in their own home various stakeholders are not used to working together. Therefore the most important knowledge is gained while actually implementing smart home technology in the home environment. This paragraph starts with some examples of target groups for smart home technology. After that some evaluation methods are discussed. The third part of the section is devoted to examples from different countries. The section ends with overall results and recommendations.

Target groups

Not everyone is an early adopter of new technologies. Some people like new gadgets or having the latest technologies in their cars, homes and workplaces. However, many people are either suspicious of new technology, or in some cases frightened by it. Concerns about security, safety and privacy are widespread. Europeans in particular seem less inclined to accept new technologies that their counterparts in the United States and the Asia-Pacific region.

A distinction commonly used by project developers and real estate managers makes use of age and family situation. Specific attention is also paid to elderly people as a target group. In table 3.1 the priorities for specific functions are displayed. The number of dots indicates the priority by the different target group. When more dots are displayed the priority level is higher.

With a marketing point of view other lists are composed using the stage in life a person has reached, mass customisation and the way a person experiences the home environment as a reference.

Research regarding smart home technology in relationship to lifestyles is still at an early stage. Some target groups are defined but is not yet clear whether or not the classifications are useful in evaluating smart home environments. Gann, Barlow and Venables, (1999) define four households that have the most to gain from smart home systems:

- *Households in which both partners are employed*
- *Highly mobile, single-person households*
- *Families in middle age*
- *Older persons with limited physical abilities and people with disabilities.*

	< 35 years 1 or 2 persons households	**35-55 years family**	**> 55 years 1 or 2 persons households**	**Elderly in need of care**
Security	•	••	•••	•••
Comfort	••	••	•••	••
Services	•••	••	•••	•••
Care			•	•••
Communication	•••	•••	••	••
Data systems	•••	•••	•	••
Entertainment	•••	•••	•	••

Table 3.1. Overview of priorities within the home environment.

Evaluation methods

When evaluating smart home projects the main areas of interest are utility, usability and accessibility. In order to make a useful evaluation the residents need to live in their smart home for some months. In that period of time they are used to living in a smart home and are able to express a deliberate opinion.

The project team for a smart home project consists of many different members. When evaluating projects you need to involve all the members. Opinions about the process can be gathered by conducting interviews. It is important to speak with the nursing and maintenance staff. They know about most complains that are expressed by the residents.

For a first impression of a smart home a walk through can be a very useful method. In a very short time span, the evaluator gets an overview of the applied applications and services. An important aspect is to look at the way an application is installed.

At the interview and walk through stage, it is time to talk to the residents. At this point most of the major problems have been identified and are familiar, so extra focus can be on specific experiences from the residents. A very informative method is conducting task analyses. Not only is a good impression obtained of the way residents operate the system, but many residents also give comments while they are carrying out tasks that contain information about the way their mind works while operating the system. Sometimes a small misunderstanding about how to properly operate of the smart home can lead to not being able to operate the system at all.

Examples from different countries

The Netherlands

[van Berlo, 1997,1999, 2002, 2005; Bierhoff, 2006, 2007]

The Smart Homes Association started in 1993 as a pioneer in realizing smart home technology projects in the Netherlands. During the first, experimental, smart home projects a list of 10 desired functionalities was composed after panel sessions and interviews with the future residents. During the evaluation of the experimental projects it was concluded that a lot of residents didn't want all of the applications installed in their home. Therefore in the following projects packages of applications were offered. For instance there was a package 'Security' and a package 'Comfort'. Residents could choose between the different packages and could also make combinations of packages. But still the desired functionalities were pre-defined. Another approach is to divide applications and services within the smart home into categories by using the functionalities available to the residents as a basis, making it clear to the residents in what area they can expect the benefits of the installed technology to occur.

Most of the applications and services refer to independent, safe, secure and comfortable living of senior citizens. Evaluations have been carried out in many of the projects. The overall conclusion is that, despite some shortcomings in lay-out and human interfaces, there is an overall feeling of safety and security among the residents of the smart home projects. People feel protected with a guarantee of follow up if something happens. Those residents who still feel well and active do not want all applications to be active from the beginning. They are very satisfied with the options in the house in case they really need them. The subjective feeling of mastering one's own life, without being dependent on the help of other persons, is an important aspect of smart home technology, to strengthen one's self-respect and quality of life.

The number of projects with smart home technology is gradually growing and the discussion about the possibility of the use of smart home technology starts earlier in the design process than some years ago. The main characteristic of the early projects is that they have a fairly large amount of home automation, but that they are not web-based controlled. This is however rapidly changing. Recent projects are equipped with residential gateways that collect large amounts of data from the home environment. From that data trends are derived and automatic actions are performed or residents are provided with advice. This development is accompanied by the awareness to create an open technical infrastructure for instance by using the IP-protocol. The supplier market in The Netherlands has come to the point that they realize that no one is able to reach a breakthrough in the market of smart home technology on their own and that it is necessary to work together.

Another important development is the rise of e-services, not only in The Netherlands but throughout Europe. Driven by technological progress and competition, fixed and wireless broadband infrastructures have been rolled out, allowing the delivery of services in new ways, to new places, through different payment schemes [Special Eurobarometer 249, 2006]. In the Netherlands the basics are covered for the provision of e-services. More than seven in ten households in the Netherlands have a computer, 80% of the households have Internet at home and the Netherlands top the broadband Internet access ranking with a figure of 62% [Special Eurobarometer 249, 2006].

With the availability of a broadband network the possibilities for services rise. For instance during the past several years over five projects that deliver care via a screen-to-screen contact have started and are already out of the pilot phase and are available for the public. This was recognized by funding committees that made it possible to refund screen-to-screen contact in the same way as a physical visit.

Development of useful and profitable services and research on how to interpret all the information collected by sensors in the home environment are important next steps in the area of smart home technology. Smart Homes Association is involved in several projects where these issues are covered.

Sweden

Within Sweden broadband has been widely available for several years now. Resulting is several services that are developed like for instance the booking of common facilities in an apartment building, energy measurement within apartments and the development of a national IT-infrastructure for Healthcare in Sweden. Within the Swedish Handicap Institute a programme called ”IT in Practice” started in the year 2000 and funded projects and pre-studies for a period of three years. The aim of the project was to develop and apply IT for various categories of users [Spindler, 2001].

An example of a nation wide infrastructure is Sjunet (figure 3.4) which is part of Carelink (the national cooperation to develop the use of IT in Swedish health care) and is a platform for:

- *Healthcare cooperations*
- *National telemedical knowledge centres*
- *Reducing lead time in the care process*
- *Electronic Trade*
- *Videoconferences*
- *National Healthcare projects.*

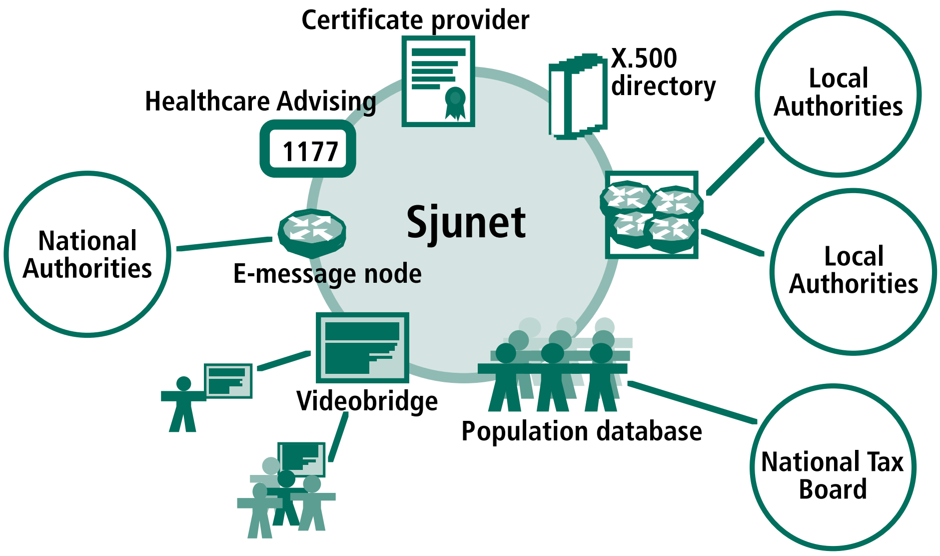

Figure 3.4 Services within Sjunet (Carelink).

An evaluation of Sjunet resulted in the following benefits:

- *Increased collaboration*
- *Increased access to higher knowledge/competence*
- *Increased use of advanced equipment*
- *Less physical transport*
- *Increased opportunities for external communication with health care*
- *Reduced costs for staff*
- *Increased access to medical information*
- *More effective education.*

These results show that with the availability of a good infrastructure, not only within the home environment but also nation wide, the possibilities for supporting independent living increase immensely.

Finland

Smart building started in Finland, like elsewhere, in the office environment. This has often meant a complex communication and safety environment. In the early 1990's there was a smart house project, which created the Finnish concept of a smart house. The basic idea was that the longest lasting parts of building like walls, piping, and mains should be the smartest. This project was implemented in an office environment.

At about the same time, housing automation was widely introduced, meaning the control of heating, ventilation, lightning etc. EU's large project ASHoRED in the beginning of 1990's started a more organized and planned phase in building smart homes for elderly and disabled people in Finland. Most of the cases in ASHoRED and its continuation in STAKES' SH program were anyway quite small units. But these have probably served as example of good practice for other organizations. In the 1990's there were some ten smart home projects in Finland. About half on them concentrated more on housing solutions and the rest on modern communication technology such as video telephones.

Within Finland there are several thousand of private homes for more or less severely physically disabled people who have individual solutions mainly for environmental control. These systems are usually realized in the existing normal housing environment, often in combination with making those homes barrier free. There are also more institutional kinds of housing units with specialized individual solutions. There are also organisations that promote the possibilities of people with disabilities to live within a community in normal environments in independent homes with the services they need.

In Finland about 15 000 elderly people live in sheltered housing units (about 4% of 75+). Most of those units were built at the end of 1980's or in 1990's and they are all more or less 'smart' including systems such as:

- *barrier free design*
- *automatic fire alarm systems, nowadays mostly with address (indicating the apartment / room, not only the building)*
- *alarm phone with wrist ban systems opening automatically an audio and two dimensional connection between the person needing help and the personnel in or outside the building, in a few buildings the system indicates who and where (inside the building or in the yard/garden) he/she needs help, the normal one indicates only who needs help*
- *automatic light switches (in corridors, at the entrance)*
- *automatic door opening systems (at the entrance, in public spaces of the buildings)*

- *automatic door controls in dementia units (also in lifts)*

- *occasionally extra sensors, detectors.*

Some ten housing / sheltered housing units for elderly people, built after 1994 were designed especially on a smart house basis. This meant better networks and extra cabling reservations for future (unknown) needs. In most cases these reservations have not been used (due to the lack of knowledge and/or time among the personnel in charge, and of money – of course). Those that are built for people with physical disabilities include smart environmental control systems.

Within elderly care and senior living in Finland new smart house concepts include the idea of universal / barrier free design and being prepared for the future with ready built networks. The development of housing in general will perhaps follow the principle: broadband access > home portal > digital home > digital living (what ever it will be). The broadband phase has been reached in several new "normal" housing projects.

One big problem is the financing: no-one seems to be willing to pay the extra investment costs – even though important savings could be made in the running costs. When new houses / apartments are to be built, the investment costs (EUR/m2) are a very important focus point, and they should not exceed the "normal" level. This problem concerns especially all housing projects that are financed by the Housing Fund of Finland (governmental loans for municipalities, organizations, private people etc) or Finland's Slot Machine Association RAY (investment support for non-governmental non-profit organizations).

Living services and technical solutions for people with a disability will always be "tailor-made" according to the person's needs. The funding in these cases is not self evident, but not as great a problem as it is within elderly care.

Results

The most important knowledge is gained while actually implementing technology in the home environment.

Overall conclusions from realized smart home projects:

- *No agreement on technical standards*

- *No agreement on flexible infrastructure*

- *Not enough skills in installation business*

- *Installers traditionally from electro technical mono discipline*

- *Consumer not aware of possibilities and opportunities*
- *Human – machine interaction permanently underestimated*
- *Basic control system relatively expensive*
- *Full networked and smart houses are still rare*
- *But current socio-economic and technological drivers will rise an enormous interest for home automation and electronic services within the next decades*
- *Wired or wireless is not the question: wireless will always demand new wire and a connected world will demand cable for external and internal infrastructure*
- *Major barriers for quick introduction are disagreement about internal infrastructure and failing awareness*
- *Ageing societies have big needs for home automation and electronic services, but kids introduce new electronic lifestyles*
- *Market is technology driven, little user involvement*
- *Technology is expensive*
- *Implementation is stuck in the pilot phase*
- *There is no dominant network, too many standards*
- *There is a gap between research and actual implementation*
- *There is a lack of spreading knowledge*
- *It's important to develop solutions for existing homes*
- *Benefits are clear for disabled persons*
- *Entertainment good starting point on the market, people have an image of the possibilities*
- *Communication between all involved parties is essential*
- *Little practical solutions can have a major impact*
- *Simple user interface that is adjustable to specific user requirements*
- *Technical solutions should be inspiring and supporting not making decisions for the user.*

3.6.2 Research facilities

A comment made about the first steps in the direction of pervasive computing was: "If these efforts sound a bit outlandish, there's a good reason: the devices are solutions in search of a problem [Huang, Ling, Ponnekanti, Fox, 1999].

This way of looking at technological development is changing. There is a belief that ambient intelligence, but also smart home technology in general, will not be widely accepted and used, unless users are deeply involved in the shaping of these technologies [Kidd, 2004]. Developers need to do more than just bring new technologies to users to ask them what they think. A novel two-way relationship needs to be established between those that develop new technologies and those that use them. Users should be integrated into the processes of R&D, and new product creation and introduction. Users should be part of the innovation process, a source of ideas, and not just a resource to evaluate ideas generated by professionals.

All over the world research facilities arise. Hereafter three facilities are described in more detail. To give a broader overview of existing projects a list of projects and facilities with websites is included in the appendix.

The Smartest House of The Netherlands, Smart Homes Association

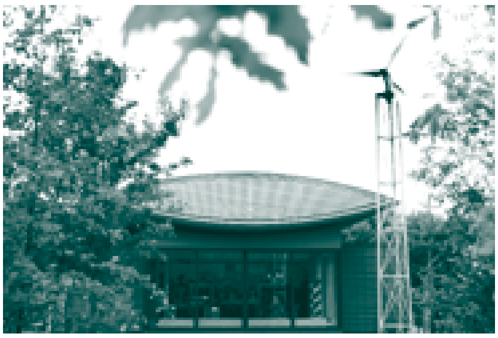

Figure 3.5 The Smartest House of the Netherlands.

The Smartest Home of the Netherlands is an innovating, 160 m^2 demonstration home, with lots of smart technology and home networks. The goal of the home is to let its visitors experience the possibilities of smart home technology. It was built in accordance with the latest recommendations for construction of new houses. Using lasting materials, optimizing the atmosphere and using energy saving applications are considered to be smart as well. Above all, the house is flexible and can be disassembled, which makes it easy to move frequently to different locations within the Netherlands. The first location was chosen to be in Tilburg. At the moment the house is located in Amsterdam, its sixth location.

New locations for the "Smartest Home" are carefully chosen by participants and local governments. Initiated by the Dutch Government and with the cooperation of parties in the market and social organizations, a location will be equipped with high quality ICT networks and more electronic services.

The "Smartest Home" of the Netherlands is the successor of the removable 'Model home for all Ages', which was a main information centre from 1994 until 2000. Initiator of this 'Model home for all Ages' and 'The Smartest Home of the Netherlands' is the association 'Smart Homes' in Eindhoven, the Netherlands.

The German SENTHA project

[Fellbaum & Hampicke, 2006]

SENTHA stands for Everyday Technology for Senior Households. (Seniorengerechte Technik im häuslichen Alltag). The aim was to improve the living environment of older persons. The project, financed by the Deutsche Forschungs-gemeinschaft (DFG), started in 1997 and ended in 2004.

The project SENTHA deals, among others, with the development of outdoor and indoor communication networks in the personal environment and their applications. The focus is on the use of new communication facilities (e.g. videophones), emergency call systems and speech processing devices. Furthermore, the project investigates internal networks for the control of household technologies and environmental factors such as light, temperature and air humidity. The aim was to achieve an optimum adaptation to the needs of older people.

In the SENTHA project, the TV set was used as the central unit for the control, analysis and for communication tasks which arise from Smart Home applications. The idea was to facilitate older peoples' access to new technologies by using equipment which is familiar to them and already present in their surroundings, such as the TV set.

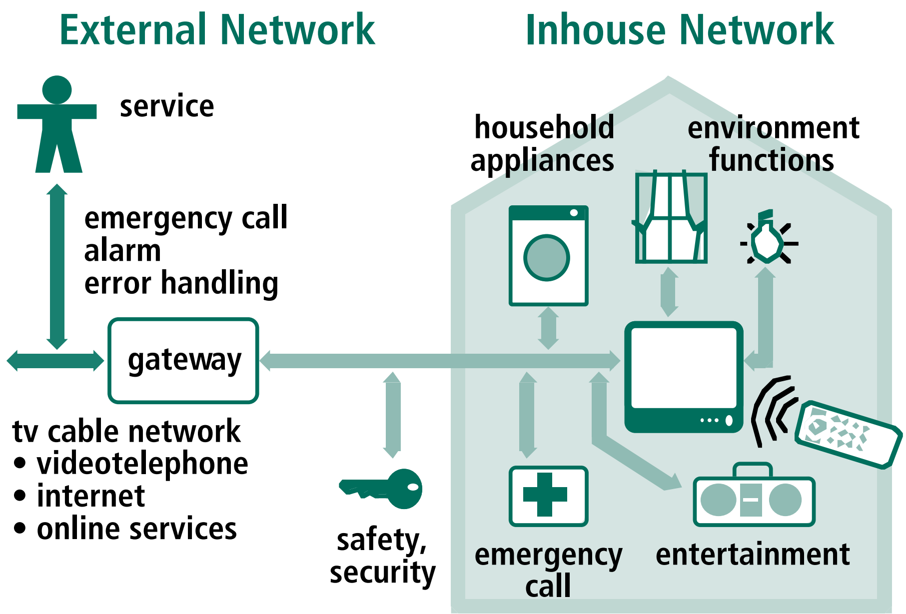

Figure 3.6 Interconnected residence with multimedia TV as central control unit [Hampicke, 2000].

Some of the results of the SENTHA project (concerning the smart home aspect) can be summarized as follows:

- *Safety and security play a dominant role. These are, among others: automatic opening and closing of the windows, alarm set off and transmission, surveillance of the front door. The same holds for the energy management, above all, light and heating control*
- *Education and entertainment (edutainment) are also favourite areas, above all when the access to information is effectively and senior-friendly designed*
- *The control of food stocks and tele-shopping (the well-known fridge with automatic order functions) is of minor interest. Also the automatic order of a repair service (when devices or systems are defect) is undesirable, because it is seen as an intervention in the personal independence and most seniors prefer to leave it under their own responsibility*
- *With increasing disabilities the willingness for more technical support is also increasing. Health-related functions (telemonitoring, emergency-call and others) are becoming dominant and – which is very interesting and important – also a preference for cultural contents was identified; in the investigations a strong preference for a virtual visit of a museum was identified.*

SmartLab, Swedisch Handicap Institute

Figure 3.7 SmartLab.

SmartLab is a resource for testing and assessing in homelike surroundings. SmartLab can be used as a research environment, where the use of ICT solutions can be studied. SmartLab is a place for experience and inspiration.

The Swedisch Handicap Institute runs SmartLab to:

- *show technology that opens new doors*
- *show technology that exists, but can't always be seen*
- *show applications that put assistive technology into a broader perspective*
- *and to help give elderly and people with disabilities greater security and independence in their homes.*

SmartLab brings technology into real life. This includes products for:

- *Environment control*
- *Safety in the home*
- *Care in the home*
- *Communication with the world around.*

3.7 Challenges

Improving the quality of life for disabled and the increasing proportion of elderly people is an important task which can be partly accomplished by creating a smart home environment. Within the Ambient Assisted Living context the contribution that can be made to this task is described as follows: "Ambient Assisted Living aims to prolong the time people can live in a decent way in their home by increasing their autonomy and self-confidence, the discharge of monotonous everyday activities, to monitor and care for the elderly or ill person, to enhance the security and to save resources" [European Commission, 2006].

To make sure that a contribution can be made for a longer period of time the home environment should be able to respond and modify itself continuously according to its diverse residents and their changeable needs. Furthermore the objective in design is to provide tools and services that empower and enable people themselves to address their social, rational, and emotional needs.

Creating smart environments to support elderly and disabled persons has enormous potential. To live up fully to the expectations is however a complex process which involves various stakeholders. The challenge is therefore not only to develop concepts that are technically possible and reliable but to create a concept that is compiled, supported and accepted by the large group of stakeholders.

The aspects described in this chapter all contribute to reaching this target. The changes that take place due to technological developments have a huge impact on life. "ICT does not just enable us to do new things; it shapes how we do them. It transforms, enriches and becomes an integral part of almost everything we do" [European Commission, 2006].

A lot of technological developments could create new possibilities for assisted living. It is a challenge to keep track of all the developments and to combine results from different technological fields into useful concepts.

The overall conclusion of the evaluation of realized projects is that despite the shortcomings there is an overall feeling of safety and security among the residents of the smart home projects. The subjective feeling of mastering one's own life, without being dependent on the help of other persons, is an important aspect of smart home technology, to strengthen one's self-respect and quality of life.

Until now the main reason to apply smart home technology was to provide the prior conditions for independent living for elderly people. Every day more people are realizing that smart home technology can facilitate comfort, communications, energy saving, and enhance both personal and building security for everyone.

Real smart homes with all network islands and possible applications are limited to demonstration houses so far. Home automation has been implemented in thousands of houses world wide, but is still in its infancy. Several economic and socio-cultural factors will cause changes in society, which are favourable for a breakthrough of smart home technology.

Other factors that still account for the slow progress are: costs, lack of standardisation, problems with the integration and interaction of subsystems and missing skills at installers. The Internet, broadband and wireless are keywords in an irreversible move to further introduction of smart home technology. The question is at which speed of progress. But it is absolutely certain that in the near future all houses will be connected to the electronic highway. As the logic goes, these houses will by themselves be smart by networking all devices and equipment in order to get maximal benefit and fun. The benefit and usefulness has been demonstrated in homes where older people live.

Currently Ambient Assisted Living markets are still very fragmented and have a rather low level of maturity. Furthermore, national differences as for organisation of social care and culture exist [Steg, Strese, Loroff, Hull & Schmidt, 2006].

There also seems to be a lot of knowledge about accessible housing, universal design or design for all, but less research on related service systems. Service systems are really context related, related to market, social relations and culture, and that is why it is more difficult to make generalizations in that area. But there are some ways to look at possible issues.

Also user involvement is essential in order to make a smart home something where you can and will live. The user point of view implies also ethical issues, which include, for example, the person's possibility to control the system, and privacy. It should be possible for the user to switch the systems on and off and change the rules according to which they operate.

All proposed requirements are goals. But the real challenge is HOW to achieve them. It is about measures, which really are context related: some are possible and function somewhere, others in other places. That is why one could add a requirement that the smart home is a part of local social systems.

But standardized solutions and procedures are also needed. It is important to look at how these goals can be financially, legally and organizationally achieved. With such a consideration and action the goals could become closer.

In order to achieve goals, the five main orientations in Europe's ICT research effort are [European Commission, 2006]:

1. *Addressing complexity and the need for a systems approach. The successful exploitation of these technologies requires the integration in managed services and solutions to be applied across broadening range of sectors and markets*

2. *Fostering interdisciplinarity and synergies. There is a need for stronger involvement of domain expertise and for greater interaction with other science and technology disciplines. Thus the range of interactions around ICT research must be both wider and deeper*

3. *Creating an open engagement with users. Users should be integrated into the processes of research and development, and new product creation and introduction. Users should be at the centre of the innovation process, a source of ideas, and not just a resource to evaluate ideas generated by professionals*

4. *Stimulating the consumption side (services and content). Networks become service- and application centric and will be visible for the user*

5. *Focus on value chains and ecosystems. Successful exploitation of ICT research results requires not just innovative technology but also innovative business models. While keeping user needs centre-stage, the user focus needs to be shifted from discrete systems to the value chains of which they are a part and the societal challenges to which they are applied.*

The efforts should lead to ICT that "will enable the creation of systems that are more intelligent and personalized, and therefore more centred on the user" [European Commission, 2006]. In the end the user is the key factor in realizing the goal of improving the quality of life for people with a disability and elderly persons.

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Further information

Overview of research projects and research facilities:

- *Adaptive House: http://www.cs.colorado.edu/~mozer/nnh/*
- *Agent-based Intelligent Reactive Environments (AIRE): http://aire.csail.mit.edu/*
- *Ambiente roomware: http://www.ipsi.fraunhofer.de/ambiente/english/index.html*
- *AMIGO: http://www.hitech-projects.com/euprojects/amigo/*
- *AVIARY: http://cvrr.ucsd.edu/aviary/*
- *The Aware Home: http://www-static.cc.gatech.edu/fce/ahri/*
- *Changing Places/House_n: http://architecture.mit.edu//house_n/*
- *Creative Studio Lab: http://www.francetelecom.com/en/group/rd/activities/vision/customer/studio_crea.html*
- *Cybermanor: http://www.cybermanor.com/*
- *Domolab Ikerlan: http://www.ikerlan.es/pub/ingl/index.htm*
- *Duke SmartHouse: http://www.smarthouse.duke.edu/*
- *E-House: http://www.e-house.us/*
- *Elite Care assisted living facility: http://www.elite-care.com/*
- *Essex Intelligent Inhabited Environments (IIEG): http://cswww.essex.ac.uk/intelligent-buildings/index.htm*
- *Elux House: http://nweb.waymaker.se/bitonline/2000/09/11/20000911BIT00760/bit0002.pdf*
- *Futurelife: http://www.futurelife.ch/*
- *Gloucester Smart House: http://www.dementia-voice.org.uk/*
- *Humboldt State CCAT: http://www.humboldt.edu/~ccat/*

- IBM Wired Home: http://www-306.ibm.com/software/info1/websphere/index.jsp?tab=products/mobilespeech
- Icepick Technologies: http://www.webcam.nl/
- Inamilab: http://www.hi.mce.uec.ac.jp/~inamilab/en/lab/index.html
- InHaus: http://www.inhaus-zentrum.de/en/index.htm, http://www.inhaus.de/index_flash2_engl.html
- Intel Proactive health: http://www.intel.com/research/prohealth/
- Intelligent Building Group: http://www.ibgroup.org.uk/index.asp
- Intelligent Home Project: http://mas.cs.umass.edu/research/ihome/
- Intelligent Space Project: http://dfs.iis.u-tokyo.ac.jp/~leejooho/ispace/
- Internet Home Alliance: http://www.caba.org/iha/
- Italdesign: http://www.italdesign.it/dinamic/index.html
- Joseph Rountree Foundation Demonstration Project: http://www.jrf.org.uk/housingandcare/smarthomes/
- MavHome: http://www.uta.edu/
- Medical Automation Research Center: https://smarthouse.med.virginia.edu/
- Microsoft Easy living: http://research.microsoft.com/easyliving/
- MIT media Laboratory: http://www.media.mit.edu/
- Philips Homelab: http://www.research.philips.com/technologies/misc/homelab/
- PRIMA: http://www-prima.imag.fr/Prima/
- SENTHA: http://www.sentha.tu-berlin.de/
- Singapore connected home projects:http://www.ida.gov.sg/idaweb/broadband/infopage.jsp?infopagecategory=&infopageid=I2122&versionid=1

- *Smart Homes: http://www.smart-homes.nl/engels/index.html*
- *Smart Medical Home Research Laboratory:*
  http://www.futurehealth.rochester.edu/validation/smart_home.html
  http://www.futurehealth.rochester.edu/smart_home/
  http://www.rochester.edu/pr/Review/V64N3/feature2.html
- *Smart Spaces Lab NIST: http://www.nist.gov/smartspace/*
- *Stanford Interactive Workspaces: http://iwork.stanford.edu/*
- *Sun Dot Com Home:*
  http://www.sun.com/smi/Press/sunflash/2000-01/sunflash.20000106.1.xml
- *Swindon SmartHouse:*
  http://archive.thisiswiltshire.co.uk/2005/2/26/92647.html
- *Telenor Home of the Future:*
  http://press.telenor.com/PR/200110/837959_5.html
- *TRON Intelligent House:*
  http://tronweb.super-nova.co.jp/tronintlhouse.html
- *Toyota Dream House PAPI:*
  http://tronweb.super-nova.co.jp/toyotadreamhousepapi.html

[1]In the literature, reference is made to the same concept but using other terms: for example, "ubiquitous computing" or "pervasive computing".

[2]http://www3.who.int/icf/icftemplate.cfm

4. Ambient Intelligence and implications for people with disabilities

4.1 Introduction

Ambient Intelligence (AmI)[1] is considered one of the possible instantiations of the emerging Information Society and a debate is going on about the possible impact of this emerging environment on the socio-economic integration of all citizens and, in particular, of older citizens and citizens with disabilities.

As all technological innovations, ambient intelligence is not good or bad per se, but its impact on people will depend on how it is deployed and used, the time and scale of deployment and the care devoted to involve people in its development, taking care of their needs, requirements and preferences (design for all approach).

This chapter is a contribution toward the identification of new opportunities and challenges for the socio economic integration of older people and people with disabilities in an AmI environment. It is divided in two parts. The first part, starting from European development scenarios that describe possible activities to be carried out in future ambient intelligence environments, aims at anticipating to what degree and how people with different disabilities will be able to cope with the foreseen activities. People are considered as "immersed" in the described environments and a preliminary analysis is carried out about the potential integration of individuals who cannot see, hear, speak, manipulate objects, move around or have difficulties with memory, concentration or problem solving. The second part considers the ethical and legislative issues related to AmI and some of the technology necessary for its implementation. The discussed problems include privacy and transparency, product safety, and trust can be cited.

[1] In the literature, reference is made to the same concept but using other terms: for example, "ubiquitous computing" or "pervasive computing".

4.2 The ISTAG scenarios: a case study

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4.2.1 Introduction - The information society

It is commonly accepted that contemporary society is undergoing a fundamental transition, from the present industrial society towards an information society. Among the possible embodiments of the emerging information society, an interesting and widely discussed potential instantiation is the Ambient Intelligence paradigm. The information society is not seen as being characterised by an increased diffusion and use of present-day computers and telecommunication terminals, but as the emergence of an environment in which "people are surrounded by intelligent intuitive interfaces that are embedded in all kinds of objects and an environment that is capable of recognising and responding to the presence of different individuals in a seamless, unobtrusive and often invisible way" [Ducatel et al., 2001, p.8]. This concept provides a vision of the information society in which emphasis is put on greater user-friendliness, more efficient support of services, user-empowerment, and support for human interaction. Interaction is intended as taking place through "natural" interfaces in the context of an environment which meets the requirements of being unobtrusive (that is, it impinges on people's consciousness only when needed), personalisable, adaptive to different user needs, and anticipatory (that is, it tries to anticipate user needs).

The emergence and shaping of AmI is currently subject to debate. In order to produce a structured way for obtaining an impression on how an information society could emerge, a scenario planning exercise was conducted in Europe in 2000, leading to the publication of the report "Scenarios for Ambient Intelligence in 2010" [Ducatel, 2001]. In this document, the vision of an information society is based on ambient intelligence as defined in the previous paragraph. The presented scenarios offer a view of a potential future, based on anticipated developments in technologies, society, the economy and networks which are necessary for implementing an environment in which the scenarios could actually become a reality. They are not technology forecasts, but descriptions of potential activities to be carried out in future ambient intelligent environments.

Despite the current limited knowledge on how AmI will materialise, it is commonly recognised that it is likely to bring about new opportunities for all citizens in the Information Society, including people with disabilities and older people, but, at the same time, new challenges for access to computer-based products and services.

The purpose of the present chapter is to analyse, through the ISTAG (IST Advisory Group) scenarios, the potential impact and consequences of AmI for people with activity limitations. This implies analysing how the scenarios would be affected in the case that their characters would not have all the abilities that are usually taken for granted for a "typical" user (for example if they cannot see, hear, move independently, and manipulate objects or they do not have the required cognitive abilities). An interesting issue to take into account is that, in the case of AmI, society is not facing the introduction of a new technology, but of an integrated set of technologies, which are supposed to have a profound impact on the way people live, work, learn, communicate, socialize and on the performance of everyday activities. Therefore, an analysis of such an impact should in principle be multidisciplinary, involving psychological, economic, and sociological aspects. However, this is outside the scope of this chapter and the expertise of the authors. The preliminary analysis presented in this chapter is meant to start discussion with people who are producing the new technology and are influencing its production at a policy level, according to the Design for All approach.

The analysis is based on some assumptions, which must be made explicit to clarify the scope of the adopted approach. First of all the scenarios are considered as "true", that is, it is taken for granted that the technology and services are available with the foreseen characteristics. For example, it is assumed that translation systems are available for all languages, including sign languages. Therefore, feasibility of technological developments is not considered in the analysis, and technology is considered at the functional level. The functions are considered as available irrespective of the real implementation. Second, the AmI environment is considered as available everywhere, not taking into account that economic factors could impede a real general deployment of the corresponding technology, Third, the AmI environment is considered as continuously available (without faults). An analysis of what could happen in case the last two assumptions do not hold has been presented in the SWAMI dark scenarios [SWAMI 2006], and applies also to people with reduced abilities (who have an higher risk of being in the less affluent part of the society and, therefore, forced not to use the most sophisticated technology).

Clearly, this approach shows some limitations. It can be considered as rather incomplete, because it does not consider all user groups, and reductionist, because the problem has been simplified up to the point to be manageable with the currently available resources. Moreover, only problems connected with access to information and interpersonal communications are considered. However, the results of this analysis are believed to provide a useful starting point for further investigation, offering some interesting conclusions, which constitute a building block for the construction of a more complete and holistic picture.

The Chapter is organised as follows. Section 4.2.2 briefly discusses the ISTAG Scenarios and the related technologies. Section 4.2.3 introduces some methodological considerations regarding the performed analysis of scenarios. Section 4.2.4 discusses AmI technologies from the perspective of the potential advantages that they can introduce from the point of Assistive Technologies for disabled and elderly people. Subsequently, sections 4.2.5 and 4.2.6 provide an analysis, based on the reworked scenarios, of the potential advantages of AmI in terms of functionality and interaction respectively. Based on the previous discussions, section 4.2.7 put forwards the need for adopting a Design for All approach in the development of AmI technologies and of the AmI environment itself. Finally, section 4.2.8 points out the main challenges that emerge towards developing AmI environments accessible to, and useful for, all citizens.

4.2.2 ISTAG scenarios and related technology

Four scenarios were produced by ISTAG [Ducatel et al., 2001]. A short summary of them, pointing out the main activities of the involved characters, is included in this section in order to support the subsequent discussions. The complete scenarios are reported in appendix I.

4.2.2.1 The ISTAG scenarios in brief

Scenario 1: Maria - the road warrior

Maria is an employee of a big company who is travelling in a far-away country for business. She needs to navigate in an unknown environment (airport, city), to live and work in hotel rooms, to be supported in her business presentation, and to be in contact with her family and home environment. She is supported by a personal communicator, which is continuously in connection with the AmI environment, including the airport, the traffic guidance system in the city and the hotel room. The AmI system knows where she is located and is able to connect her not only with the surrounding environment, but also with any place in the world. The emphasis is on the seamless and intuitive support while moving around. Maria, thanks to AmI, can concentrate on the purpose of her trip without taking care of details, but still remaining always in control of the situation.

Scenario 2: Dimitrios - the digital me (D-Me)

Dimitrios is an employee of a multinational company. His main problem is to be connected continuously with people, even during the coffee break in which the scenario takes place, but without being disturbed if not really necessary. His communication agent, which learns from Dimitrios' way of dealing with different situations, is able to conduct most of his communications on his behalf, taking decisions on his behalf and speaking with his voice. When contacted by his wife about their child's homework, in order to find information about everyday life in another country (Egypt), a videoconference with a girl in Egypt, made possible by real-time translated conversation, is used to solve the problem. This scenario emphasises mainly the intelligence in the environment, which can capture, process and share information about human beings, and the expansion of human relationships. Interconnected D-Mes create networks, which allow people to be defended from outside interference and create new contacts and relationships.

Scenario 3: Carmen - traffic, sustainability and commerce

Carmen lives in a city where many services are available for taking care of everyday problems. She lives in an intelligent house that is interconnected with the network, and has access to an e-commerce system facilitating the purchase of everyday life goods. A shared-car system is available for her to go to work. This is part of the city system, which takes care of following her during travel and gives advice regarding traffic. The city can also regulate the behaviour of the vehicle, when necessary. In the scenario, the main emphasis is on an efficient and user friendly urban environment, through the use of very large-scale systems and services.

Scenario 4: Annette and Solomon - environment for social learning

Annette and Solomon are in an environment that is able to adapt itself to the needs of different learning groups and individuals with different ages, knowledge and interests about problems of environmental management. The environment can restructure itself also physically, offering, when necessary, interaction "islands" for different groups (the islands are virtual islands, where sound and visual spaces are confined) and very advanced presentation facilities (e.g., 3D holographic rendering). Contents, presentation speed, and complexity are controlled by AmI. The environment is aimed at the establishment of social relations in continuous interaction with the individuals. The scenario deals mainly with the empowerment of users in a learning environment and with the support of social processes, through the use of a communication network and a collective memory.

4.2.2.2 Key enabling technologies for AmI

From a technological perspective, the following 'Key Enabling Technologies' covering a broad range of ICT and smart material technologies, are considered as a basis for the emergence of an intelligent environment:

- *Embedded Intelligence*
- *Middleware and distributed systems*
- *IP mobile and wireless*
- *Multi-domain network management*
- *Converging core and access networks*
- *Micro and opto-electronics*
- *Trust and confidence enabling tools*
- *Cross-media content*
- *Multi-modal and adaptive interfaces*
- *Multi-lingual dialogue mode.*

Finally, the following requirements are considered as crucial for the development of technology concurring to the implementation of the AmI environment.

Requirement 1: Very unobtrusive hardware

Miniaturisation is assumed to produce the necessary enabling developments in micro and optical electronics. Molecular and atomic manipulation techniques will give rise to advanced and smart materials and nanotechnologies. In addition, the following are required: self-generating power and micro-power usage; breakthroughs in input/output systems including new displays, smart surfaces, paints and films that have smart properties; sensors and actuators integrated with interface systems in order to respond to user senses, posture and environment; smart materials that can change their characteristics and/or performance by stand alone intelligence or by networked interaction (e.g., smart clothing).

Design emphasis is supposed to be on human factors, so that the widespread embedding of computers produces a coherent AmI landscape, rather than just a proliferation of electronic devices.

Requirement 2: Seamless mobile/fixed web-based communications infrastructure

Complex heterogeneous networks need to function and to communicate in a seamless and interoperable way. This implies a complete integration of mobile and fixed networks. To deliver the full AmI vision (e.g., the 3-D real-time holographic rendering in the Annette and Solomon scenario) there will eventually be a need to move towards ultrafast optical processing in the fixed network. These networks will have to be seamless and dynamically reconfigurable. They will require more advanced techniques for dynamic network management (see Requirement 3).

Requirement 3: Dynamic and massively distributed device networks

The AmI landscape is a world in which there are almost uncountable interoperating devices. Some will be wired, some wireless, many will be mobile, many more will be fixed. The requirement will be that the networks should be configurable on an ad hoc basis according to a specific, perhaps short-lived, task, with variable actors and components. Databases, whether centralised or distributed, should be accessible on demand from anywhere in the system. This implies: new computer and communications architectures, new systems software that can adapt to changing hardware configurations, the development of networked embedded intelligence and distributed data management and storage systems. Key to this aspect of AmI will be the development of middleware and agent technologies (Requirement 4).

Requirement 4: Natural human interfaces

A central challenge of AmI is to create systems that are intuitive in use. This will need 'artificial intelligence' techniques especially dialogue-based and goal orientated negotiation systems as the basis for intelligent agents and real time middleware that can operate across domains to very general levels. These techniques will be equally important for developing intuitive machine to machine interaction, which are supposed to be multimodal (multi-user, multilingual, multi-channel and multipurpose) using speech, gesture, and pattern recognition. It should also be adaptive to user requirements providing context sensitive interfaces, information filtering and presentation, and cross-media content.

In the scenarios, voice, gesture and automatic identification and localisation are implicitly used to synchronise systems, so that services are available on tap when people require them.

Requirement 5: Dependability and security

The AmI-world must be safe, dependable and secure, considering all physical and psychological threats that the technologies might imply and giving important emphasis on the requirement for robust and dependable software systems components.

4.2.3 Methodological considerations

In the ISTAG scenarios, the deployment of innovative technology is reported, and possible activities to be carried out in the resulting intelligent environment are described. A fundamental problem is to consider how people are able to perform the foreseen activities, according to their abilities in the AmI environment, defined as the combination of the physical environment, the network, its data bases, etc. Living in the environment includes the use of general purpose services and local interactions. This is important for all potential users, but crucial for people who have limitations in some of the required abilities. For example, in the scenarios it is taken for granted that people can see screens, hear speech and sounds, and speak.

Several approaches can be chosen to draw conclusions about the level of integration of people with different activity limitations. The first is to construct new specific scenarios for these target groups, trying to describe situations which identify new opportunities offered by the integrated use of AmI technology, and emphasise potential problems. A second approach is to modify the ISTAG scenarios in order to adapt them to the needs of people with different activity limitations. Both approaches have their advantages and could lead to interesting results, in terms of identifying examples of integration or segregation of people in the emerging information society.

Instead, as previously stated, a mainstreaming approach was chosen, whereby characters with different activity limitations are introduced in the ISTAG scenarios, identifying how they can carry out necessary activities in such an environment. This is made possible by the fact that one of the interesting new characteristics of the ISTAG scenario exercise is that the user appears at the centre of interest, adopting a holistic, citizen-centred view [IST Advisory Group, 2003]. This is also shown by the approach used in investigating future developments. Instead of starting from new technology and trying to figure out how this can be used to implement new services and applications, the analysis starts from application scenarios that exemplify at the activity level the use of different aspects of the intelligent environment.

What is considered important is that, in the formation of the scenarios, people - and not technology - are at the forefront of the information society. The scenarios do not make explicit reference to people with activity limitations; however, as they are mainly based on activities in defined contexts, they lend themselves to an easy analysis of the possibility of access to these activities by persons with different characteristics.

The approach is also in line with the one at the basis of the preparation of the new WHO "International Classification of Functioning, Disability and Health (ICF)"[2], where a balance is sought between a purely medical and a purely social approach to the identifications of problems and opportunities for people in their social integration.

When dealing with the problems of people who experience some degree of activity limitation or participation restrictions, "ICF uses the term disability to denote a multidimensional phenomenon resulting from the interaction between people and their physical and social environment" [WHO, 2001]. This is very important, because it allows grouping and analysis of limitations that are not only due to impairments. For example, people are not able to see because they are blind, or have fixation problems due to spastic cerebral palsy, or are in a place with insufficient illumination, or are driving and therefore cannot use their eyes for interacting with an information system.

People may have impairments, activity limitations or participation restrictions that characterise their ability (capacity) to execute a task or an action (activity), but their performance is influenced by the current environment. The latter can increase the performance level over the capacity level (and therefore is considered a facilitator) or can reduce the performance below the capacity level (thus being considered as a barrier).

The purpose of the work presented in this chapter is to analyse how people perform in the situations foreseen in the AmI environment to characterise it as a facilitator in the required activities, or as a barrier, hopefully also pointing out possible ways to overcome such a barrier. For this purpose, ISTAG scenarios are divided into activities, and some user groups having activity limitations are "virtually observed" while performing the corresponding necessary tasks.

In order to structure the work, tables have been constructed with several rows (activities) and four columns: (1) an ISTAG scenario fragment describing an activity or a set of related activities, (2) problems (barriers), and (3) possible solutions and (4) AmI opportunities (increase in performance). An example is given in appendix II, where for presentational reasons, the activities of column 1 come under the heading "original scenario" (in black) and columns 2, 3 and come under the headings "problems", Possible solutions and AmI opportunities respectively (in colour). The comments in the columns are clustered and used to draw conclusions at a general level. Obviously, starting from the comments in columns 3 and 4, ISTAG scenarios, modified to take into account problems of people with activity limitations, can be produced.

[2] http://www3.who.int/icf/icftemplate.cfm

Due the enormous variability of the possible individual impairments, activity limitations or participation restrictions and the number of necessary activities to be carried out for a satisfactory integration in the information society, it is impossible to analyse all possible combinations corresponding to the ICF classification. Therefore, a set of examples are worked out, using some typical profiles concerning activity limitations in connection with the activities foreseen in the ISTAG scenarios.

Five different user groups were considered. The first two groups address people with sensorial limitations (also caused by contextual factors), and precisely people who cannot see at all and people who cannot hear at all. The third group addresses people with mild or moderate limitations in memory, language, orientation and problem solving (cognitive limitations), mainly made up of older people. Cognitive resources are crucial for successful and independent living. Cognition comprises human information processing functions and domains that allow people to access and maintain knowledge. Relevant domains are, for example, memory, language, orientation and problem solving. Impairments of cognitive functions such as recall and recognition (e.g., the ability to identify faces, objects and events), attention, learning and executive control processes interfere with daily functioning and severely degrade the quality of life. The prevalence of pathological cognitive changes increases with age. Its most prominent form, dementia, can render the affected subjects incapable of taking care of themselves. Less severe forms of cognitive impairments are classified as age-associated memory impairment (AAMI) or mild cognitive impairment (MCI). Regardless of severity, cognitive impairments result in diminution of social contact, leading to social exclusion, loneliness and depression. In the scenarios reference is mainly made to people who have mild or moderate memory, language, orientation and problem solving problems that normally do not impede their independent living, suitably supported. Then, people with manipulation problems (that is control of fine manipulation operations necessary in the use of a keyboard or a mouse), fixation problems and/or difficulties in expressing themselves using voice (e.g. caused by spastic cerebral palsy) are considered. In the discussion, only problems related to access to information and interpersonal communication are considered. Therefore, it is assumed that people considered in the analysis are able to move around without using a wheelchair. Finally, people moving in a wheelchair are considered, dealing only with their problems of access to information and interpersonal communication.

It has been previously said that, for the purposes of the performed analysis, the ISTAG scenarios have been used in their original form. This must not been considered literally, because some changes have been introduced to make them credible, particularly in the case of cognitive limitations. For example, it is very unlikely that an older person acts as a "road warrior". Therefore, Maria in the specific scenario is a tourist going to a foreign country and living in a hotel. She is not supposed to give a presentation. Correspondingly, Carmen, in the revised scenario, does not go to the city to work, but to visit a friend.

4.2.4 New technology, systems and services

Traditionally, the problem of integration of people with activity limitations has been tackled through an adaptation approach, whereby systems and services are adapted after development to the needs of different user groups and/or the abilities of people are augmented with the use of assistive technologies. In section 4.2.7, the limitations of this approach will be discussed, particularly with reference to the new technological developments, advocating a new approach, namely the design for all approach.

However, before delving in the general analysis of the scenarios, it is useful to comment briefly on some of the technologies that are anticipated to emerge, and their integration in systems and services from the perspective of the users and in relation to assistive technology. The aim of this discussion is to provide hints on the possible smooth transition from the present situation and AmI. As a matter of fact, some emerging technologies can offer interesting possibilities for improvements in assistive technology in the short and medium terms, aiming in the long term at a confluence of concepts developed in the assistive technology environment in the development of mainstream technology.

In looking back at the efforts to produce interfaces to computers and terminals adapted for people with disabilities, the technology necessary in order to support an intelligent environment seems to have much to offer.

One of the main prerequisites of the intelligent environment is that interactions must be multimodal and alternative input-output systems must be available. In principle, the different modalities can be used concurrently so as to increase the quantity of information made available or, alternatively, to present the same information in different contexts, or, redundantly, to address different interaction channels, both to reinforce a particular piece of information or to cater for the different abilities of users. Voice synthesis and recognition can be considered as a simple example. For recognition, the set goal is the recognition of connected speech in noisy environments. This can obviously be very important in producing efficient inputs for people who cannot use keyboards or object manipulation techniques due to activity or contextual limitations. Correspondingly, voice synthesis is anticipated not only to achieve better quality, but also to incorporate personal characteristics (in the Dimitrios scenario, his network agent is able to speak with his voice). From the perspective of people who have problems in speaking, this should make possible the implementation of speech prostheses using a voice chosen by the user. Another design target is the development of automatic translation up to the point of being used in real-time conversation between people speaking different languages. Even if, at least in an initial phase, this will be probably possible only in limited communication contexts, the related technology can eventually be extended to the translation between non-conventional languages (for example, speech to Bliss symbols and vice versa).

Input prediction, which was initially developed in the disability area and is now widely used for writing SMSs in GSM telephones, will be extended, with obvious advantages for the group of people for whom it was initially developed.

Special vibrating materials for alerting people are considered important, and will increase the efficiency of many alarm systems that have previously been used by people who cannot receive messages using auditory signals. These developments are also related to the study of materials capable of sensing touch or producing tactile presentations of information. These technologies, which were initially developed for virtual reality systems in order to sense force information or to emulate interaction with objects, are progressively acquiring importance in many different environments, including not only in touch screens, but also in systems capable of transducing information into a tactile presentation. Moreover, tactile presentation of information should also be three-dimensional: that is, materials capable of reproducing three-dimensional forms in real time are being sought. This might make the present transitory Braille displays obsolete, because any output tactile screen could be capable of reproducing Braille. It could also be an answer to the need of people who cannot see to access graphical and pictorial information.

GPS and other localisation systems are likely to become standard in many pieces of equipment and services. This will solve the problem of tracing people who risk being lost in open spaces, and will help in navigation (e.g., for people who cannot see). GPS localisation should be integrated by the deployment of networks of sensors [Estrin, 2002; Lorincz, 2004], e.g. based on ultrasound beacons, floor sensors to determine the positions and movements of individuals, weight sensors, worn badges that emit IR pulses, and smart tags to identify objects.

Smart tags are another important technology necessary for the development of an intelligent environment. They can signal the presence of objects in the environment, and can provide detailed information about the objects to which they are attached. In the Carmen scenario, they are used to give Carmen information about what is contained in the refrigerator, and to produce the list of goods to be bought in the supermarket, which is directly transmitted by the refrigerator itself. This technology could have a number of very important applications for people with disabilities. A person who cannot see, equipped with a simple radio transducer could be directly informed about the items on the shelves of a supermarket. For each object, s/he could have information about weight, expiring date, composition, and so on. At home, the same person could be able to locate all kinds of small objects, for example a box of pills or spectacles, and when necessary, have information about the medicament and the dosage. The pill box could also be authorised to make the person aware of its presence, if s/he tends to forget about medication. The tags on objects in the house could be used as a means to help elderly or people with memory problems by making available, when necessary, information concerning their presence and use.

Gesture recognition [Geer, 2004] is an additional important component of a new generation of systems for people with activity limitations. It can be used both to implement virtual keyboards on any surface and virtual pointing devices, and to produce interfaces for the manipulation of objects on the screen, as it is now possible with computer games. The traditional switches used by people with manipulation limitations to activate controls or to interact with computers could become virtual switches. The mouse could become a virtual mouse, whose movements can be controlled through movements in space of any predefined form, using a TV camera and appropriate image processing algorithms or mio-electric signals [Wheeler, 2003]. Other, more sophisticated interfaces can also be conceived, such as interfaces based on the recognition of lip movements and their "transduction" into text. Sign-language interfaces could be implemented with the use of gesture recognition. Correspondingly, animation technology developed for game or film production can be used to produce good-quality avatars that are able to sign or to move lips for lip reading.

Visualisation technologies are considered of paramount importance [Abowd, 2002]. The idea is that screens should be available everywhere. Any surface in the environment could be easily transformed into a screen. New materials are under study to produce screens that are lightweight and foldable, thus making possible visual presentation systems that follow the user while moving (nomadicity and availability). Alternatively, the presentation screen could be virtual, using projection systems, and the presentation of 3-D information should be possible.

The importance of concepts and technologies related to intelligent agents also needs to be emphasised. People in the information society will be represented by different digital agents which will sometimes be disembodied representations of the individuals; at other times, they will be visual and audio representations (avatars). At a lower level, these should be able to explore the network in order to extract information of interest. At a higher level, they will represent users in negotiations with people and other agents. For example, in the Maria scenario, her agent negotiates to have a rented car at a reduced price, to obtain a discounted permit to enter the city centre where cars are allowed only on the basis of payment, and to book a parking place in the hotel. In Dimitrios' scenario, D-Me, an intelligent agent which represents the owner (not visually, but speaking with his voice), is allowed to negotiate with a person in asking help for a medical problem (the agent decides to follow an impersonal strategy, without revealing the identity of the person represented) and with Dimitrios' wife. Obviously, in the latter case, the agent rightly loses and allows direct communication with Dimitrios on the basis of the "emotion" it can feel in the woman's voice (based on emotion understanding approaches). This technology - with obvious problems of privacy and control for the user - is very promising in different situations. People who cannot see can be supported by agents able to access visual information for them and to "transduce" information produced by them into visual form for sighted people. The same is true for people who cannot hear regarding accessing and producing auditory information. An intelligent agent could also take care of helping people with cognitive difficulties due to disability or age in acquiring information from the environment, and could anticipate their needs for communication and environmental control.

Lastly, a common requirement of new technology is miniaturisation. Many technologies are conceived as hand-held or wearable, taking also advantage of the fact that intelligence can be embedded in the environment in order to support the individual personal system. This means being light-weight, which can be important for some people and in some environments, but also availability. It is taken for granted that people can have with them everything necessary for performing even complex tasks. An example is Maria, whose only technological item (sufficient for carrying out navigation, environmental control and making a complex business presentation) is a personal communicator that she wears as a wrist bracelet.

From the above, some conclusions can be drawn about general characteristics of systems and services in the intelligent environment. Systems and services are nomadic, that is, they follow people. The basic system for accessing communication or information is personal (a personal communicator). It is simply a portable interface with the infrastructure where the intelligence resides. It is small, wearable, and also implantable, as well as personalisable as much as is it necessary. Consequently, digital services are ubiquitous in the environment, wherever and whenever people need them, and there is no need to look for terminals, as terminals are always with people. Additionally, the infrastructure can help people to navigate and find objects in the environment (for example, medications, etc).

4.2.5 The environment as a general facilitator

So far, as already mentioned, the integration of people with activity limitations has been based on some complementary approaches: adaptation of systems addressing the needs of individual user groups (e.g., human computer interfaces), adaptation of services of general use (e.g., alarm services), and creation of special services (e.g., relay services).

Some interesting conclusions can be drawn from the scenarios, with reference to services available in the environment. In order to simplify the discussion, this section addresses issues related to the environment's foreseen functionality, envisaging how it can potentially impact on integration, while section 4.2.6 deals with issues related to interaction.

4.2.5.1 Environmental control systems

First of all, environmental control systems, introduced for the independent living of persons with motor disabilities, become an integral part of the living environment. Probably, the environment will not be equipped by default with robot-type systems useful for taking care of certain needs of people with motor disabilities, for such as feeding them or moving them around. However, it will be able to integrate this additional technology if it is has been designed in such a way as to be extendable to incorporate additional facilities (either for general purposes, e.g., robotic systems, or for specialised support, e.g., assistive technologies).

4.2.5.2 Relay services

Another type of service (relay services) of interest for people who cannot hear/and or speak is available by default in the Ambient Intelligence environment, where voice recognition and synthesis, automatic translation, gesture recognition (sign language and lip reading) and animation (synthetic sign language and lips movements) are available. Relay services may be a default facility if the environment is developed following with a design for all approach (see section 4.2.7). Alternatively, a personal communicator, such as the one described in the Dimitrios' scenario, can be used as a personal relay service.

4.2.5.3 Agent-based information, communication and negotiation services

The real winning factor is the intelligence in the environment (intelligent agents). To plan her travel, Maria relies on an environment populated by agents (the intelligence in the environment), which can look for relevant information and negotiate on her behalf to get what she needs at the best possible prize. Another agent helps her in localising her presentation according to local preferences (colour schemes, the use of language). This possibility, of interest to everybody, can be crucial for people who have some hearing or speech problems that can reduce interpersonal communication or sight and manipulation problems that can reduce efficiency in accessing complex information services. The possibility of delegating to an agent the transactions needed for organising a trip abroad can also be crucial for an older person with cognitive limitations. The same holds for the Carmen scenario, where agent-based support systems help her in organising the travel to the city using a car pooling system and in her e-shopping activities. This can be useful not only to help Carmen when she is really unable to perform required tasks, but also to reduce stress. In the negotiation for travel arrangements to the city, the agent knows the needs of Carmen (for example she is travelling in a wheelchair) and can fine tune the choice of a suitable car and driver. In e-shopping the agent can look for the information which is useful for the user and present it in the suitable form. If Carmen can see, the goods on the supermarket shelf can be shown on a screen. If Carmen cannot see, or has fixation problems, the agent can read information on the intelligent tags attached to each item. If Carmen has cognitive limitations, it may be that she needs guidance through the required actions. The level of support by AmI can be matched to the severity of Carmen’s problems. In cases of mild cognitive problems, AmI can remind and provide suggestions, just like a friend in the house (for example, Carmen is reminded that she will have guests for dinner and is suggested a selection of menus extracted from her known preferences). In case of more severe problems, AmI can completely control the situation: preparing a balanced diet for Carmen based on past habits, checking the availability of food, ordering it, caring for its delivery at home, and suggesting all the steps necessary for its preparation. Obviously, it can also supervise the preparation of food from a security perspective. This can be done autonomously or in cooperation with a relative or carer. The level of control by Carmen can be set at any possible or desired level.

The Dimitrios scenario is completely about an agent (avatar), called D-Me, that takes care as far as possible of his communication with the outside world, and can manages services (e.g., choosing the best telecommunication means for Dimitrios’ child). Before being overridden by Dimitrios’ wife, who is able to pass through the

D-Me barrier, D-Me is able to deal with routine calls, facilitating him if he has sensorial or speech problems that reduce his communication capabilities, avoiding the use of complex interfaces. If Dimitrios has cognitive problems, being continuously in contact can be very useful. His D-Me can overcome some of his problems with memory and problem solving. Automatic learning can improve in the long term the agent's adaptation to Dimitrios' behaviour, and assist with the short term fluctuations of his capabilities. Moreover, in social contacts mediated by telecommunication, where Dimitrios is directly interacting with other people, D-Me can try to overcome Dimitrios' cognitive problems, if present, by dealing with complex tasks, interactions and problem solving functions. It can also hide other activity limitations (e.g., sensorial) of Dimitrios, who is apparently performing in a "normal" way. Only when Dimitrios is communicating with his wife or in other situations that need his personal intervention his limitations are exposed.

4.2.5.4 Navigation services

When arriving at her destination, Maria is connected with the environment that guides her through the customs and to the taxi, and then in her navigation through the city. Navigation systems and services are an integral part of the intelligent environment, and can be useful in many circumstances. They are present or can be used in all scenarios for different purposes. If Maria is not able to see, the P-Com in communication with AmI guides her through the airport (e.g., by voice, or using haptic cues). This requires the knowledge of her position in the airport (granted by AmI) and the possibility of controlling the presence of unpredictable obstacles (people, baggage, etc.), obtainable through the use of features of the AmI itself (e.g., a control system able to monitor tagged objects in real time and communicate with the P-com of passengers). If Maria has cognitive limitations, the navigation system may tune the level of support to the known abilities or to the perceived present difficulties (for example, Maria may be confused by the crowd in the airport). Dimitrios and Annette, if unable to see, need navigation help in the cafeteria and in the room where learning activities are taking place. Even if the two environments are reconfigurable, it is reasonable to think that AmI knows the position of all potential obstacles (e.g., by reading RFID on objects or through direct optical inspection by pattern recognition), and is able to guide them. Carmen, while moving towards the meeting point with the car driver, may need to be reminded the route to follow, as well as help for orientation. The car is part of a very complex navigation and traffic control system. Carmen does not interact directly with the system, but the system knows her characteristics and is able to suggest a reasonable alternative when she needs to leave the car and use an alternative transportation system. For example, the UAN (Underground Network

Area) registers Carmen as a client who cannot see and suggests routes and paths that are not too busy at that point, so she can manage to be at work on time. Alternatively, The UAN registers Carmen as an older client. It connects with the control centre to verify whether Carmen may be allowed to travel alone with the metro or she must be assisted. If she can travel alone, the P-com takes care of guiding her through the space and advising her about the tasks necessary for arriving to her friend's house. The level of support can be easily tuned to Carmen's capabilities (probably changing in time). If Carmen is moving around on a wheelchair, AmI can suggest an accessible route to destination. When Carmen must meet with the driver, if she cannot see, it may be that unexpected obstacles are on her way. AmI can advice her, but it is more likely that she relies on her virtual[3] or real dog. If she has cognitive problems, AmI can guide her to the meeting point.

4.2.5.5 Learning activities

The space where the Annette and Solomon scenario is located, as well as the organisation of the learning activities, are particularly interesting from the perspective of people with activity limitations. A first very important feature of the environment is its possibility of being tailored physically (organization of space and availability of multimedia support) and conceptually (type of learning material, speed of presentation) to individual users. Moreover, there is a mix of social exchanges (with other learners, the mentor and external experts) that can be of invaluable help for this user group. The mentor himself is not an expert in the topics to be learned, but a mediator between different interests and needs. Not only the efficiency of learning is addressed, but also the emotions of individuals and groups. A continuous support is granted by AmI that is able to adapt to the users and to their emotional states.

From a technical perspective, the cooperation of the personal communicator with AmI can allow the structuring of the environment to allow easy physical navigation by all the potential users. For example, the space can be arranged to allow a person on a wheelchair to move around without any problem. Moreover, the possibility of creating virtual spaces allows the optimisation of each working place for the individual user or a group of users with different capabilities. Different user groups can interact with the system and people can use the approaches already described in the previous example to interact with other people and access information.

[3] A virtual dog is set of sensors (e.g., a worn T.V. camera, or some type of ultrasound or laser) able to spot obstacles.

4.2.5.6 Alarm and support/control services

The entire AmI is a pervasive and very sophisticated alarm and support/control system. This may be very important for people with cognitive problems. AmI can continuously control Maria's behaviour in the various environments according to her known habits and intervene if necessary, for example reminding her of tasks and helping her perform them. When necessary, AmI can also contact the family or a carer for advice and help. If Maria cannot see AmI is able, if necessary, to describe its layout and functionalities, as well as the functionalities of its devices (e.g., the remote control of the hotel room). Moreover, since Maria cannot do two acoustic activities simultaneously, AmI is able to organize sequentially the flow of information and the performance of the necessary tasks, allocating the necessary time. In the Dimitrios scenario, D-Me can be part of a control system, in continuous contact with relatives or helpers. In the Carmen scenario, the P-com can transmit the news that Carmen is leaving home to a control centre or to a relative. A continuous connection can then be established, and Carmen can be tracked during her trip. Moreover, the micro-payment system frees Carmen from financial transactions. On the way home, the shared car system senses a bike on a dedicated lane approaching an intersection on their route. The driver is alerted and the system anyway gives preference to bikes, so a potential accident is avoided. The same service could be very useful for a person who is on a wheelchair and for a person who cannot see. This can also be an invaluable help for Carmen when going around alone. If the system becomes aware of Carmen's problems, for example evident confusion in finding her way and problems in coping with the environment, it can connect with a relative or a control centre. The connection can be granted by Carmen's P-com without infringement of her privacy. A complex situation also arises when Carmen must leave the car to use a public transportation service. However, the navigation system takes care of that, and a support/control system can intervene if she has particular problems or has a reduction in cognitive capacities.

4.2.5.7 Broadband communication facilities

The additional opportunities offered by AmI are related to the availability of broadband communication facilities. Maria' scenario offers a presentation of advanced telecommunication facilities, in the car, in the hotel room and in the presentation room. When Maria is driving, she is tracked by the navigation system and people know (if she wants) that she can be contacted. If she is contacted in a difficult situation and she does not want to answer, a D-Me type agent can deal with the calls when they are not considered important or advice that she should call back as soon as possible. In the hotel room there is an audio/video system, the video scenes of which are described if she cannot see, and automatically captioned, if she cannot hear. The audio/video system can be used also for communication with her daughter, with whom she can not only communicate, but also go through the news as they watch them at the same time from different environments. Obviously, if she cannot see, she listens to the news, while if she cannot hear she can read the news, which is automatically captioned. Conversation with her daughter takes place through AmI and the P-Com (relay service).

4.2.5.8 Audio/video interpersonal communication services

The fact that Maria and her daughter are able to converse on an audio/video system and cooperatively access information, is very important from two different perspectives. The first is that it introduces a remote socialisation component, which can be crucial to reduce stress, and through which Maria can be supported. Even if support by technology can be of invaluable value in some circumstances, support by other people can be more efficient and acceptable in some situations and activities. It can introduce a personal dimension, which increases acceptability and efficiency in the intervention. AmI, with its emphasis on cooperative activities, whereby people can remotely carry out common activities with audio and visual contact, can increase the feasibility of the approach. When people are not able to perform some actions, they can ask a relative, a friend or a support organisation. Maria, for example, if she cannot see, can show the hotel room to her daughter and get from her a personalised description that a computer system would had probably given in a functional form. If Maria knows that she has left an object somewhere in the room, her daughter can localise it. If Maria has cognitive problems, her daughter can instruct her when performing difficult tasks. In this case the advantage is reciprocal, because the daughter can "control" that everything is all right without being too intrusive.

The same applies to the tasks related to the localisation of the presentation. If Maria does not trust the suggestion made by the localisation agent and she cannot see them, she can easily connect with a colleague in the office and ask for advice.

4.2.6 The individual interacting with the environment

After having examined the possible impact of services of general use on people who have some activity limitation, it is necessary to focus on the individual user and consider interaction with AmI in order to perform the tasks necessary to be integrated, at home, in closed spaces (e.g., the airport, the hotel, the cafeteria, and the learning environment), as well as in open spaces.

It is clear that the main key to open the doors of the information society is the personal communicator and the related set of agents, which are able to grant connection to the environment itself and to all its facilities for accessing information and interpersonal communication. Its characteristics are not precisely defined. It does not have a specifically defined interface, but it can in principle make available all the interaction technologies described in the previous sections in order to adapt the environment to the type of interaction suitable for the user and the context of use, for example, audio when eyes are necessary for other tasks (for driving in the Maria's scenario), or visual or tactile in noisy environments. It is very likely that the interface is not part of the communicator itself, but of the environment. The communicator is a disembodied functionality supported by the ambient intelligence with different interfaces. Maria wears it as a bracelet. In the case of Dimitrios, the communicator (D-Me) is embedded in his clothes but can be also implantable. It is adaptive, and learns from Dimitrios' interactions with the environment. It offers communication, processing and decision-making functions. Its functions may either be based on on-board intelligence or on distributed intelligence in the infrastructure. Both ways, it offers Dimitrios the necessary services. It deals with calls. When necessary, it becomes an avatar-like system and deals with most of his social communication, using his own voice. In the Carmen scenario, the communicator does not have a specific embodiment. It is a function, enabling contacts with other persons (for example, her host driver in the shared vehicle service) or with services (for example, the supermarket information system or the city payment system). There are some characteristics of the communicator important for all people: it is personal, lightweight, wearable, and continuously available.

Finally, it is interesting to observe that the personal communicator must not necessarily be a highly sophisticated piece of equipment, the performances of which are limited by size, weight, and power. The intelligence necessary to support the transduction of information necessary to address the different modalities and to support the user can be in the environment and in the network. The same is true for the complex interaction peripherals. In principle, the only limiting factor can be bandwidth.

Taking into account that all the characters in the scenarios have with them a personal communicator, it is interesting to discuss how they can interact with AmI in the information society if they have some activity limitations.

The simplest situation is at home or in other closed environments (e.g., the hotel room), because personal spaces are easier to personalise to the needs of different users, even if, as shown in the previous section, the distinction between close and open environments in AmI is blurred due to the ubiquitous deployment of functions. Carmen interacts with her fridge. If she is not able to see, she can receive audio messages. If she is not able to speak at all, she can use gesture recognition or text, and if she is not able to speak perfectly the voice recognition system can be trained to match the characteristics of the produced audio signal. Output can be given in any modality matching to the capabilities of the user. For example, when Carmen is connected to the shop, all the information stored in tags is translated in a properly encoded format for her to receive. Carmen may choose to see the goods of interest or hear or read (e.g., in Braille) brief descriptions of them, or to have a full presentation of a particular product or store shelf. Presentations may contain information about the product characteristics (size, colour, and weight), the packing, the price, potential offers or alternative selections and other information that will help her to make her choice. Carmen's P-workstation enables her to explore and manipulate 3D models and artefacts by means of tactile interaction.

The same approach can be used in communication with the car driver, who can have been made aware of Carmen's abilities, and thus use the most appropriate communication channel. Alternatively, the driver's and Carmen communicators can cooperate to transduce the information in a suitable modality.

The situation is more complex when a private but not personal space (e.g., the hotel room) is used. Even if the room is adapted to Maria's personality as she enters, i.e., the room temperature, default lighting and a range of video and music choices are displayed on the video wall according to her preferences, interaction with the room can pose some problems. Obviously, interaction with the room for adjusting features to the varying needs of its inhabitant can be solved using the same methodology used at home for interacting with the fridge, but some difficulties remain. The first is that Maria may have problems with the room itself, if she cannot see or has some cognitive problems. In this case, a description of the room and its facilities may be provided by AmI. If cognitive problems are present, the number and complexity of facilities to be made available can be chosen according to Maria's profile. If necessary, the room can make all choices automatically. Otherwise, suggestions can be offered by relatives or carers.

Similar problems can be experienced with the remote control of the room, if Maria cannot see, or she cannot manipulate it or understand its functioning. A first efficient solution to the problem is for Maria to use her P-Com, which obviously can be programmed to mimic any remote control. Support by personal equipment well known by the user is very important, because the same approach can be used in different environments, without the need of learning new interaction styles and patterns of presentation of information each time. However, this is due not only to the use of adapted equipment, but also to its integration with AmI. Alternatively, AmI can describe to Maria the layout and the functionalities of the remote control available in the room, and its functions can be simplified according to her characteristics and preferences

In the Maria's scenario, she gives a presentation. If she cannot see, she needs to know who is in the room, when she can start her presentation, and how to control the pace of the presentation. The P-Coms communicate and exchange the information on who is attending the meeting. She gets a multi-modal confirmation (voice through earphone plus vibrator) that the presentation is ready for display. There is a tactile display in the room or she can use her personal tactile display. The tactile display has a copy of the presentation plus additional control functions (active functions), pointing facilities and control of slide content details. In AmI, the wide availability of tactile displays is part of the built-in virtual reality interfaces. Otherwise the presentation can be controlled using a gesture recognition system. If Maria is not able to hear, but is able to speak, she does not have problems for the presentation. Otherwise she can use a speech synthesizer (see Dimitrios scenario). During the discussion, a speech recognition system is used. She can type answers to be read or synthesised. Alternatively, she can use sign language, translated into voice in real time.

Dimitrios' physical environment is not described in any way. It is the only scenario in which some incongruence is present. Dimitrios has a very advanced D-Me system, that according to the script is "equipped with voice, pattern and patch recognition capacity. It has to identify places and people, but also to register enough data to record the relevant events of Dimitrios' life to process it in its D-Me profile and offer it to other D-Me's". Then, in AmI there is an abundance of screens (real and virtual) and audio communication channels. Any surface, in principle, can become a screen, both because of the smart material of which it is made and because images are projected on it. But when Dimitrios needs to speak with his wife, he has to move to a displayphone, a device coming from the prehistory of telecommunications. However, such a displayphone can use all the capabilities of AmI. If Dimitrios cannot see, the displayphone is able to describe any drawing eventually present on the screen. On the other hand, if Dimitrios cannot hear, it can convert his wife's voice into text. It is obviously able to convert sign-language to voice (probably supported by the D-Me, in this case playing an ancillary role) or can be used as a simple text telephone. Correspondingly, the output of a speech recogniser can be translated to lip movements and/or sign languages. If Dimitrios cannot speak and does not know sign language, he can use a (virtual) keyboard and a prediction system. If Dimitrios has cognitive problems, the displayphone can adapt itself to his preferences and mimic the functionalities and interface of a system he is normally using. The complexity of the displayphone (functions, tasks to be carried out to use it, etc.) can be matched to Dimitrios' capabilities. Support is automatically given if necessary.

Interactive simulation and projection facilities are enhanced not only regarding technical performance (for example 3D presentations), but also regarding their capability of adaptation to the needs of the users, both guiding them through the tasks needed for presentation and tailoring performance to the complexity of the required presentation. Nowadays, interactive simulation systems are inherently based on interaction paradigms using direct manipulation of objects and on complex (also three-dimensional) visual presentations. In the AmI environment, the system will have evolved to be multimedia and multimodal. For example, a possible solution for a person who cannot see could be the evolution toward a virtual reality system based on sound and tactile interactions (tactile exploration of virtual objects both for input and output of data). The new technology developed for the implementation of the intelligent environment (e.g., tactile display technology, virtual reality, tactile input technology) can contribute to an easier access to information by people who cannot see.

When Maria arrives in the airport of a far away country, she is relieved of the fact that she can travel with hand baggage only, because everything she needs for interacting with the information and communication environment is the P-Com. She does not need any computer or terminal. Computing power is available everywhere, along with suitable peripherals for interacting with it. Even if not all the people going around need complex systems as the ones necessary to Maria for giving her business presentation, any simplification in the type and complexity of necessary devices can be particularly useful for many user groups (for example, people with spastic cerebral palsy and people moving in a wheelchair).

However, some people may prefer a personalised system. For example, if Maria cannot see, her P-com can be equipped with a specialised interface (e.g., a foldable tactile interface). Even if tactile presentations are in principle available for all users, she prefers to carry her own device so as to avoid potential problems during her trip. When necessary, the P-com can communicate with sophisticated peripherals (e.g., a tactile 3-D system) available in the environment. When going through the airport, she can be guided by the environment to avoid unexpected obstacles (for example a piece of baggage left unattended). Alternatively she can use a personal system (e.g., a virtual guide dog). RFID on objects can be used for signalling the presence of obstacles to the virtual guide dog.

When navigating in the airport, if Maria cannot see or has fixation problems, information is conveyed using the speech channel of the P-Com, whereas, if she cannot hear, information is presented through text or maps (for example, on a visual display embedded in her spectacles). If Maria has cognitive problems, the single tasks to be performed can be conveyed though her preferred modality and explained in details. If necessary, she can be put under control of a relative or a service centre to follow her way through the airport and help and reassure her if she has difficulties.

4.2.7 Design for All in the context of AmI

It is commonly accepted, also officially in political European documents [European Council, 2000; i2010], that the emerging information society will have to be universally accessible to all citizens. These include people who have functional, sensorial or cognitive limitations due to disabilities or age. In the same documents, explicit reference is made to the need of developing the new society (in terms of technology as well as services and applications) using a Design for All approach. Within the context of Universal Access, Design for All has a broad and multidisciplinary connotation, and refers to the design of interactive products, services and applications that are suitable for most of their potential users without the need for any modification [Stephanidis, 1998], [Stephanidis, 1999], [Stephanidis, 2001].

This change of paradigm, as compared with the Assistive Technology approach, which is based on the adaptation - on behalf of people with disabilities - of systems and services produced for the general market, is often criticized on the basis of various arguments. In particular, there is a line of argumentation raising the concern that "many ideas that are supposed to be good for everybody aren't good for anybody" [Lewis& Rieman, 1994 - Section 2.1, Paragraph 3]. However, Design for All in the context of Information Society Technologies is not to be conceived as an effort to advance a single solution for everybody, but as a user-centred approach to providing products that can automatically address the possible range of human abilities, skills, requirements and preferences. Consequently, the outcome of the design process is not intended to be a "singular" design, but a design space populated with appropriate alternatives, together with the rationale underlying each alternative, and critical property of interactive artifacts becomes their capability for intelligent adaptation and personalisation. Clearly, in a complex and dynamically evolving technological environment such as AmI, accessibility and usability by users with different characteristics and requirements cannot be addressed once the main building components of the new environment are in place. Instead, the need arises for more proactive approaches, such as Design for All, which can optimally exploit the adaptation and personalisation capabilities built-in in the environment.

In such a context, therefore the concepts of Universal Access and Design for All acquire critical importance towards streamlining accessibility into the new technological environment through generic solutions, and the requirement emerges of redefining the role and scope of assistive technologies in the new environment emerges [Emiliani & Stephanidis, 2005].

The point made in this chapter is that the two approaches can be considered as complementary and converging towards the creation of a more accessible information society through the continuous redefinition of problems in accordance with the developments of both fields, with the overall objective of producing barrier-free technologies. Complementarity and convergence are intended both at a specific and at a general level. At a specific level, individual characteristics of users are so varied that it will be very difficult, (if not impossible, to actually integrate the requirements of all individuals within the specifications of new products and services, and therefore Assistive Technologies are necessary for specific cases. At a general level the lessons learned in Assistive Technology will be fundamental in shaping the new environment. The integration of the two approaches will make the use of Assistive Technology in Design for All environments simpler and more effective.

The emerging situation can thus be addressed through an evolutionary approach. In the shorter term, the development of ambient intelligence can be supported by a technology which enhances the possibilities offered by Assistive Technology, merging in the medium term into systems and services and, in the long term, into an intelligent environment, which has the potential of being usable by most users if their needs are taken into account proactively during the design phase. Through such an evolutionary approach, Design for All emerges not as an abstract methodology, but as a necessary and efficient approach for maximising the potential advantages of introducing new technologies, and for minimising inherent risks of the increasing exclusion and segregation of specific groups of people. The effectiveness of this approach is essentially due to the fundamental fact that the core of the Design for All approach combines user-centeredness with automatic adaptation and personalisation.

4.2.8 Emerging challenges

In reading the previous sections, one could be led to conclude that the information society offers a panacea for the problems of people with disabilities. However, before arriving at such a conclusion, some challenges need to be addressed.

The first challenge is related to the intelligence that is considered as an integral part of the emerging environment. Considering the current state of the art in Artificial Intelligence, it is clear that significant improvements are needed in order to realize the environment foreseen in the ISTAG scenarios. For example, even if speech recognition and speech synthesis are improving, the introduction of intonation in synthetic speech, the recognition of speech outside specialist domains, and the translation between different languages require fundamental improvements in the semantic interpretation of messages. The same is true for those aspects of the intelligent environment that are related to people's emotions or difficulties in executing tasks. Obviously, without fundamental improvements with respect to present possibilities, the environment could interfere in the life of citizens in unacceptable and negative ways.

Second, it must be considered that the analysis presented above is related only to problems of access to information and communication and to other activities that can be supported by improving the possibility of being integrated into the information and communication community. This will obviously not solve all the problems of people, and in any case needs a proactive Design for All approach in order to take full advantage of new possibilities. For example, having speech synthesis or transitory Braille displays as a standard feature of the environment does not automatically mean that all information will be available to people who cannot see, because this will depend on how the information is stored and structured. Since it is clearly impossible to adapt all the databases connected to the network, it will be necessary to use a Design for All approach (for example, the WAI guidelines) to represent information in a form that is amenable to a "transduction" using text (speech or Braille). But this is not sufficient. For example, if information about accessibility is not available in a hotel database, no guideline regarding the representation of information and no adaptation will help.

This applies to the development of all the technologies foreseen in the scenarios, which must have embedded all the characteristics necessary for the integration of all potential users. Gesture recognition is considered as a very important technology, but additional research efforts are necessary in order to be able to extract information from a spastic movement. Speech recognition can be very important for interfacing with the environment for people who cannot use a keyboard or a pointing device, but the training system must be robust enough to accept not only "standard" voices, but, for example, voices of people with cerebral palsy.

Translation between different languages has the potential of eliminating the barrier among different countries, languages and cultures, but, obviously, the level of integration will depend on the languages that are considered. For example, different sign languages and symbolic languages (such as Bliss) will need to be part of the set of considered languages.

Many other aspects of the development of an intelligent environment must be discussed as to their impact on the population at large and on people with disabilities in particular. First of all, it is necessary to investigate how human functions will be engaged in the emerging forms of interaction and how this interaction will affect individual perceptive and cognitive spaces. The emerging environment will be very complex and stimulating, from both a sensorial and cognitive perspective. It is not clear whether people will be able to cope with the hyper-stimulation and the corresponding cognitive load. This is particularly true for people with reduced abilities, and principally for people with cognitive limitations. The environment must be developed in such a way that the capabilities of people are taken into account, for example, in order to balance the distribution of tasks between the user and the intelligent environment itself.

This introduces another very important aspect. The acceptance of the new environment by the citizens will also depend on their trust in it and, therefore, on their level of acceptance of delegation. This may be a particularly sensitive point for people with disabilities, who might need to delegate more than other users and have additional problems in conceptualising the situation. Therefore, the environment must both incorporate all the adaptation and personalisation facilities needed by all the groups of potential users, as well as provide to users the possibility to really understand the facilities available and the implications of delegating certain tasks to the intelligent environment.

Impact on emotion, vigilance, information processing and memory must be considered with particular attention when people with disabilities are involved. On a lower level, it is necessary to avoid forms of interaction that may lead to negative consequences such as confusion, cognitive overload, and frustration. This, for example, requires a distribution of input/output facilities in the environment that is continuous, in order not to create frustration or confusion, flexible, so as to adapt itself to the different contexts of use, and coherent throughout the environment. This is a particularly important characteristic, because the fact that the interaction maintains an internal coherence in every situation will obviously facilitate interaction and favour acceptance. It is also important, when different modalities and, therefore, different sensorial channels, are used. It is essential that the requirements of users with disabilities are taken into account, because the optimisation of information transfer is more critical for them.

Another challenge involves privacy and security. The possibility of adapting the environment to different types of users requires the availability of information about them. In the case of people with disabilities, this information may be very sensitive. It is therefore of paramount importance that users can trust the privacy guaranteed by the system. Privacy has always been a very important problem in any control system. The problem is made more sensitive now by the fact that the control will not be effected by a dedicated system, but by an omnipresent intelligent environment.

Lastly, security is another very import aspect. The intelligent environment, including also the support infrastructure, is a very complex system. It has recently been demonstrated that complex systems are prone to collapse (electrical blackouts due to the collapse of the distribution system are a well-known example). This could be very dangerous if human society is organised around a complex information and communication system such as the one envisaged in the AmI scenarios. This has particularly importance for people with disabilities, who will rely more heavily on the available facilities. Therefore, backup strategies, redundancy and error checking facilities will have to be available in the system and must be understandable by end users.

4.2.9 Conclusions

From the preliminary analysis of the possible impact of the development of the Information Society as an Ambient Intelligence environments, it seems that if the new technology is developed and deployed taking on board the needs, requirements and preferences of all potential users, i.e., all the citizens of the emerging Information Society, and if ethical problems are taken into account, the emerging situation could be an opportunity for favouring socio-economic integration.

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4.3 Ethical and legislative issues with regard to Ambient Intelligence

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4.3.1 Introduction

The scenarios discussed by COST 219ter demonstrate the potential benefits of the development of Ambient Intelligence (AmI) for people with disabilities (see sections 4.1 & 4.2). They show how the technology can assist people with disabilities in their day to day living, allowing more access to services and information than ever before through the interaction with their environment and the automation of tasks. However, these advances bring with them their own difficulties, for example, with the storage of personal information and the ethical issues that arise from the automation of tasks.

Where AmI means for many of us an increased comfort and better and faster functioning, the same issues can mean for people with disabilities a passing of a threshold between dependency (much need for human care support) and autonomous living. We could speak of enhanced leverage in case of a disability.

For example, firstly, people with a cognitive disability or any impairment related to mental and intellectual functioning might have great benefits from AmI. Travel support is one of the examples where AmI can assist in coping with a chaotic society. Secondly, smart homes while giving new possibilities for environment control can provide more independent living at home.

Thirdly, (human) care needed for daily living is, for people with disabilities, a matter of making them more dependent on human will and the costs can be relative high when compared with technological support. It is sometimes seen as a disadvantage that the human aspect in delivering care is then reduced as technology plays a greater role. This might be re-addressed as a design effort where AmI provides care functions in a user friendly and effective way. Fourthly, mental and physical health are closely related and the potential of AmI is to motivate and stimulate people to enhance their functionality and their way of coping with society. Based on intelligent analyses, AmI will stimulate people into learning and rehabilitation within the scope of their abilities. Fifthly, what all people need, and people with a disability even more so is secure and safe living. Telemedicine (often referred to as tele-monitoring) offers many possibilities for disabled and chronically ill persons as it is implemented in AmI surroundings.

The organisation of those AmI services is costly and needs a high level of common infrastructure. Thus it is expected that AmI will have opportunities for a rapid innovation and development when the larger institutions (social security, funds, hospitals, commercial companies etc.) include it in their future policy.

From a consumer point of view, the most relevant AmI scenario is represented by the concept of a smart house (see chapter 3) which is the combination of three elements: home automation, a communications network and intelligent control. Provided that consumer aspects are properly addressed, this can mean increased safety, comfort, convenience, security and energy savings for most groups of consumers, including elderly people and people with disabilities.

But there are also risks. Dark scenarios have been analysed in depth by Safeguards in a World of Ambient Intelligence (SWAMI) project. SWAMI scenarios are 'dark' since they include applications that go wrong or do not work as expected with the aim of highlighting the vulnerabilities and weaknesses and likely adverse impacts. Four dark scenarios have been elaborated around two axes that encompass both individual and societal concerns, on the one hand, and private and public concerns, on the other hand.

All citizens should have equal rights to benefit from the new opportunities that AmI technologies will offer (equal rights and opportunities). This will promote the removal of direct and indirect discrimination, will also foster access to services and encourage targeted actions in favour of under-represented groups, such as people with disabilities and older persons.

In the following section some important issues with regard to Ambient Intelligence are discussed either from an ethical or legal point of view.

4.3.2 Access to terminal equipment and services

Accessibility is a fundamental requirement for technology from a human point of view. Applications of AmI can mean access to society, for example to transport, housing, working life and communication. Technologically, accessibility relates to user interfaces. With regard to AmI it is even more important than with regard to individual devices, because AmI can be the kind of system and a network where one cannot choose to be in or out.

Access to control devices and control is a key issue from the point of view of the individual. It concerns, for example, various personal devices, or in the field of services, alarm call services.

Therefore, accessibility is required in order to support the inclusive participation (user acceptance), awareness and learning of users. Thus, this point may embrace different sub points, such as equal rights and opportunities, usability (vs. complexity), training/education and dependability.

Usability will promote system design according to a user-centric approach. Better usability will then support easy learning (i.e. learning by observation), user control and efficiency, thus increasing satisfaction and, consequently, user acceptance.

Training/education will promote education programmes to learn how to use new technologies and will increase the user awareness about the different possibilities and choices offered by AmI technologies and associated devices. This action is useful to increase the feeling of control and the awareness on the possible uses and consequences of the technology, thus reducing any misunderstanding on how the technology works.

The dependability challenges are to be addressed by an effective implementation of AmI technologies by taking into account both technical constraints and harmonized human-machine interfaces. Technical constraints are for example the scale and pervasiveness of applications/services and volume of components, heterogeneity of technologies and diversity of life cycles, intelligence and autonomy. The harmonized human-machine interface mainly encompasses the compatibility between technology and human systems and the technology-push in terms of social impact. Thus, dependability is essential in order to address almost all facets of dependency leading to exclusion or discrimination.

A relevant field which is covered by legislation is telecommunications. Central to the legal framework are the telecommunications directives, especially the Directive on Radio and Telecommunication Terminals (RTTE) (see section 5.1).. However, for the time being, standardization is a more important tool in the promotion of accessibility. Standardization has a lot to say about control devices, which act as a link between a person and ambient intelligence.

Another often quoted important piece of legislation is the Universal Service Directive which states in relation to the a universal service in Article 3 in Chapter II that Member States shall ensure that the services set out in this Chapter are made available at the quality specified to all end-users in their territory, independently of geographical location, and, in the light of specific national conditions, at an affordable price. The Chapter, entitled 'Universal service obligations including social obligations', covers the provision of access at a fixed location, directory enquiry services and directories, public pay telephones and special measures for disabled users. Special measures to be used by Member States are to be targeted to ensure access to and affordability of publicly available telephone services, including access to emergency services, directory enquiry services and directories.

AmI could represent an entirely new way of using electrical installations, appliances and communication services, in a way that consumers are unaccustomed and unfamiliar with. If the technology is difficult for consumers to operate and maintain, some consumers will be disadvantaged, i.e. will not be able to enjoy the potential benefits (energy savings, integrated alarms, etc.) offered by the system. The groups, such as elderly people and people with disabilities, that might gain the most benefit from such systems, might not be able to operate them. Different groups of consumers may achieve different benefits (e.g. people with physical disabilities can use remote control to operate all devices in the home, as opposed to having to move to individual devices round the home to control them). So it is important that different consumer needs are addressed by Design for All principles.

When considering products and services that relate to the Information Society, then the term e-Accessibility is sometimes used to mean the integration of all users i.e. older people, people with disabilities and also people placed in impairing environments. This will only come about as a result of designing mainstream products and services to be accessible by as broad a range of users as possible.

4.3.3 Privacy and transparency

Is AmI watching you? It is a form of monitoring. It is collecting information. It is not only collecting pieces of information, but it is creating configurations of information.

Profiling activities are essential in order to achieve the objectives of delivery of services in an AmI environment. Profiling activities require a seamless collection and processing of a broad range of data from numerous sources which are related to a user's identity, his/her activities, characteristics and preferences in specific contexts.

In general profiling in AmI facilitates applications of interest to society enhancing social inclusion or enabling services making the everyday life easier. However, several social issues are stemming from profiling in AmI. The main issues related to privacy are:

- *Erosion of privacy: right balance between security and privacy. Profiling activity requires some monitoring or surveillance of the users for the detection of physical activity for example. Monitoring and surveillance may erode privacy. Perhaps most people view privacy as a right that can be sacrificed, at least to some extent, if it leads to greater security*
- *Erosion of individual liberties. Indeed, profiles can limit freedom of choice of users by confining them within the limited set of options on offer by the providers. Profiles tend to govern opaque decisions about individuals concerning their access to services, such as obtaining credit or a position*
- *Inadequate profiling caused by privacy invasion. Problems of inadequate profiling can occur with regard to two main situations: attribution conflicts in case of numerous users leading to misinterpretations of users' needs. However, some problems may stem from malicious actions (i.e. a kind of privacy invasion). Inadequate profiling may lead to discrimination, exclusion and victimisation.*

Individual persons want to know what personal information is stored, and why. They want to know whether the information is to be transferred somewhere, and who will be permitted to use it, and who will not. Another issue concerns how long information will be stored within systems. The questions are geared to what other people are allowed to know about you.

One of the great benefits of AmI is its versatility, and the many uses that the same information can have in interacting with indoor and outdoor environments. While the information will be obtained fairly, will it be possible to use the information for one single purpose, especially when it may have to be shared among a wide range of other 'trusted' networks? If the data is replicated, will all the data be kept up to date? It is possible to see someone's physical requirements changing due to a debilitating disease, but this change not being notified to parts of the extended network. Retaining information 'as long as necessary' will almost certainly be irrelevant, as the data will be used indefinitely on a day to day basis. One of the great challenges faced by AmI won't be technical, it will be the ability to abide by these guidelines.

What is privacy protection? Article 8 of the European Convention on Human Rights and Fundamental Freedoms (1950) states that all persons have the right of respect for their private and family life, their home and their correspondence. There shall be no interference by a public authority with the exercise of this right except such as in accordance with the law and as is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others.

In the field of Information Society, European Union law includes the Directive on the processing of personal data, the Directive on the protection of privacy and the processing of personal data in the telecommunications sector and Directive concerning the processing of personal data and the protection of privacy in the electronic communications sector. In addition, there is detailed national legislation in the Member States.

Article 8 the EU Charter of Fundamental Rights (2000) summarizes important principles:

1. *Everyone has the right to the protection of personal data concerning him or her*

2. *Such data must be processed fairly for specified purposes and on the basis of the consent of the person concerned or some other legitimate basis laid down by law. Everyone has the right of access to data which has been collected concerning him or her, and the right to have it rectified*

3. *Compliance with these rules shall be subject to control by an independent authority.*

Each European country has its own implementation of the EU directive on privacy and personal information, but they conform to the principles of the protection of data, fairness in processing the data, and access to the data held about them. Ireland's data protection guidelines are fairly typical, and are cited here to give an example of the difficulties that AmI faces:

1. *Obtain and process information fairly*

2. *Keep it only for one or more specified, explicit and lawful purposes*

3. *Use and disclose it only in ways compatible with these purposes*

4. *Keep it safe and secure*

5. *Keep it accurate, complete and up-to-date*

6. *Ensure that it is adequate, relevant and not excessive*

7. *Retain it for no longer than is necessary for the purpose or purposes*

8. *Give a copy of his/her personal data to that individual, on request.*

Hence, many interests are involved in the transfer of information. It is the task of legislation to balance these interests. The complexity of interests reveals that the legislation is also complicated.

It is the role of legislation to provide common solutions to ethical issues and conflicts of interests and to prescribe confidentiality or public access. As mentioned, with regard to AmI, many sectors of legislation can be relevant. Mail and telephone calls, but also health and social sectors are traditionally important fields.

Privacy in public electronic networks is protected by legislation. The Privacy and Electronic Communications Directive ensures that the protection of confidentiality is guaranteed for all forms of private communications over public electronic networks. Confidentiality is the main focus (Article 5). There are also legitimate reasons for having exceptions. A very specific example can be found in the field of telecommunications. Where the calling-line identification (CLI) is offered, the user must have the possibility of preventing CLI (Article 8). However, it is justified to override the suppression of CLI and location data in the case of emergency calls (Article 10 (b)).

This example shows that in different situations there are really different and sometimes conflicting interests. It is in fact one of the fundamental ideas of law that it balances different interests, with principles and rules. Hence, laws do not only have to link to ethics, but contribute to the functioning of a society.

The information profile of a person monitored within an ambient intelligent system can itself direct ambient intelligence and it should also be possible for a person in turn to control the profile. This leads to a moral requirement: It should be possible for persons to control and make choices concerning the functioning of ambient intelligence, e.g. concerning their own profiles or the system's operation. This is an implication of the moral principle of autonomy.

Those are the difficulties posed through the authorised use of the system. But what about the unauthorised access? Identity theft is already common on the internet. AmI works through the use of wireless technology, meaning that all information has to be broadcast. A worrying possibility is that someone may breach the security system, capture these details, and use them elsewhere. Careful design of the system becomes essential.

Although there are many difficulties with the adoption of AmI with regard to privacy and ethics, these problems are not insurmountable. In order to protect the privacy of the individual, a secure system for the broadcast of information is required.

Adherence to the data protection guidelines needs to be made explicit in the development of AmI systems. This would mean that a 'specified explicit purpose' can be agreed upon, that only the relevant information is stored or transmitted by the system. A regular review of the information needs to be built in, in order to ensure that information about a person is accurate, and to give the person an opportunity to request the removal of information from the system as required.

Critical data entering or leaving the system, for example via the smart house gateway, should be secure. The electronic system should ensure that filtering of incoming data (e.g. from the Internet) meets the consumers' requirement. The electronic system should ensure that critical outgoing data (e.g. credit card details, personal medical data and information related to personal security) is secure and adequately encrypted.

Privacy is the interest that individuals have in sustaining a 'personal space', free from interference by other people and organisations. It is an interest that has several dimensions:

- *privacy of the person. This is concerned with the integrity of the individual's body. Issues include compulsory immunisation, blood transfusion without consent, compulsory provision of samples of body fluids and body tissue, and compulsory sterilisation*
- *privacy of personal behaviour. This relates to all aspects of behaviour, but especially to sensitive matters, such as sexual preferences and habits, political activities and religious practices, both in private and in public places*
- *privacy of personal communications. Individuals claim an interest in being able to communicate among themselves, using various media, without routine monitoring of their communications by other persons or organisations*
- *privacy of personal data. Individuals claim that data about themselves should not be automatically available to other individuals and organisations, and, even where data is possessed by another party, the individual must be able to exercise a substantial degree of control over that data and its use.*

4.3.4 Product safety

What if something goes wrong? Who is behind ambient intelligence? Who can I contact if the system is not working?

A possible answer can be found in product liability. According to European legislation, a product is deemed safe once it conforms to specific Community provisions, national regulations or certain principles. The general safety requirement is imposed by the Directive on general product safety on any product put on the market for consumers or likely to be used by them, including all products that provide a service.

A product is deemed safe once it conforms to the specific Community provisions governing its safety. In the absence of such provisions, the product's compliance is determined in certain other ways.

Obligations have been laid on manufactures and distributors. The manufacturers must put on the market products that comply with the general safety requirement. They must also provide consumers with necessary information. Distributors are obliged to supply products that comply with general safety requirements, to monitor the safety of products on the market, and to provide the necessary documents to ensure that the products can be traced. If the manufacturers or distributors discover that a product is dangerous, they must notify the competent authorities, and if necessary, co-operate with them.

The Members States put in place structures that are responsible for monitoring a product's compliance with safety requirements and taking the necessary measures in this regard, e.g. prohibiting products that fail to comply from being marketed. The Member States can take restrictive measures by informing the Commission, which communicates the information to the other Member States.

There is also legislation on specific sectors. The Low Voltage Directive seeks to ensure that electrical equipment within certain voltage limits provides a high level of protection for European citizens.

Beyond these legal requirements there are also moral requirements. User involvement is important for the development of good products but it also has value in itself. It builds up trust in the production process. Products should correspond to the needs of users. Users themselves are the best experts in that. But in complicated technologies user involvement is not an easy task. There are methods for user involvement, but perhaps even more effort should be put to the development and dissemination of these methodologies.

Producers should thus listen to consumers. In addition to this co-operation, consumers have some other opportunities. They can make their choice in the market.

For the electrical and mechanical safety of appliances and home automation there are three situations to consider:

- *The inherent safety of the device as a stand-alone appliance or application. This is covered by the existing safety standards [CENELEC EN 60335-1: safety of domestic appliances (Low voltage directive)] and in many cases the device would be considered as an "unattended" appliance. (Note, those standards contain a clause that exclude the use of domestic appliances by "children and infirm people without supervision". This is contested by consumers associations and could be a problem in smart house standardisation for the "caring" aspects of smart houses)*
- *The safety of the device when used as a stand-alone automatic or remotely controlled application, but not as an integral part of a smart house. Here the safety mechanisms and detection systems have to be built into the device*
- *The safety of the device when controlled and operated as an integral part of the system. In this situation the safety mechanisms may be those of the house itself.*

This means that safety requirements in AmI may have to go beyond those required by the existing safety standards called up by current EU directives.

In addition to the above issues, consumers are also concerned with Electro Magnetic Compatibility issues that can affect compatibility. To comply with the EU directives [Directive 89/336/EEC on the approximation of the laws of the Member States relating to electromagnetic compatibility and RTTE Directive 1999/5] individual components have the "CE" mark to show compliance. Consumers will be reassured if they know that EMC could also be guaranteed for the whole AmI system, not just the component parts, this principal is not always addressed by the existing EMC standards. Many components in a system will be used in close proximity to each other and radio devices may share frequency bands. The EMC directive and standards do not always address close proximity use. Some components such as heart pacemakers, wheelchairs and other medical equipment will require special attention in this respect.

From a consumer's view, AmI technical solutions should be based on open standards; otherwise companies controlling the infrastructure will dictate the preconditions. In reality, the cost and complexity of such systems will inevitably result in a number of proprietary systems together with a degree of commercial vertical integration. Consumers may therefore find themselves financially or physically 'tied-in" to a system. Interoperability standards must exist to ensure consumers can change their system or service via the home 'gateway' without major redesign and appliance replacement or loss of functionality or safety.

4.3.5 Market

Who pays? This is always an important question. As ambient intelligence can refer to so many areas of application, like smart homes, environment control, monitoring systems, traffic information, etc., it is not possible to give an answer here. The point here is that this is an important question which should be made transparent.

In the market there is supply and demand. There is design, manufacturing, selling, buying, using. In many cases ambient intelligence is a very complicated product. In addition to ordinary roles in the market, AmI may add a challenge to mastering the whole system.

In addition to the question of getting money, there is a question that how the money is used. Public procurement describes a system how money is used. There is European legislation in regard to public procurement. Ensuring sufficient quality criteria in public procurement is also in the interests of the end-user.

There is a further dimension. An individual product, for example a walking aid, requires adjustment and maintenance. What is important for the user is not the product alone but the service where arranging a product for use is an essential part.

Hence, when thinking of AmI as a product, it can be arranged by the service provider and in the end it is financed by the user, via the price of a product or user fees or taxes. Some systems can be based on public financing as a part of a public infrastructure, e.g. traffic information. In some cases assistive devices can be financed by the public sector.

Public procurement is actually a remarkable market force. In Europe, public procurement in each of the 25 Member States must follow the rules outlined in the EU's Public Procurement Directives. The primary purpose of these Directives is to ensure that there is a properly functioning internal market so suppliers from any Member State can have equal access to the public procurement markets in any Member State. More recently attention has begun to be given to how these instruments can be used to further other objectives of public policy, including environmental and social objectives. In this context, there have now been revisions made to the Directives that, inter alia, encourage the inclusion of accessibility criteria in public procurement by the Member States (International workshop on accessibility requirements for public procurement in the ICT domain).

The preambles to the revised Directives [paragraph 29 of Directive 2004/18/EC and paragraph 42 of Directive 2004/17/EC] now state that: "Contracting authorities should, whenever possible, lay down technical specifications so as to take into account accessibility criteria for people with disabilities or design for all users." In addition, the specific Articles on technical specifications [Article 23, Paragraph 1 of Directive 2004/18/EC and Article 34, Paragraph 1 of Directive 2004/17/EC] now state that: "Whenever possible [these] technical specifications should be defined so as to take into account accessibility criteria for people with disabilities or design for all users" (International workshop on accessibility requirements for public procurement in the ICT domain).

4.3.6 Trust

Trust is based on many conditions which have been discussed in this chapter. AmI requires a user to 'trust' the IT systems around them. It is this trust that is the root of many of the potential difficulties. As everyone is aware, computers will do exactly as they are instructed, including implementing errors. Because of this danger, one question that must be asked is what can we trust these systems to do? If a system is relied upon to open doors automatically, systems need to be put in place to ensure that there are other means of carrying out this function. If there is an automatic emergency function, can it be guaranteed that it will work when it is required? And on what basis does it make the 'decision' to call? If an attempt at contact is made, and the person's 'me' electronic device refuses to allow contact, on what basis does it do this?

Indeed, trust is necessary for any technology dealing with information related to user's personal data and it is the basis of the users' willingness for their participation. Indeed, establishing public trust is a key point for any successful implementation. The trust concept encompasses different points, such as the user requirements, the trust model, the management of the trust and the solutions enabling trust. The notion of trust has not only technical aspects but also social, cultural and legal aspects. In the dark scenarios of SWAMI project, trust is raised in different connections: trust and confidence, lack of trust (from loss of control, unwillingness to provide some data, contextual misunderstandings) and honesty.

Also, if the system is set up for someone with disabilities, decisions are being made in some cases for people, and this in itself is an ethical issue. Procedures need to be put in place to ensure that if possible the person contributes to the making of these decisions, and if this is not possible that the decisions made are really in the interests of the end user affected.

Many consumers do not appreciate the holistic concept of AmI; instead they will understand separate parts (home automation or broadband internet being the most obvious). The industry and European governments need to provide information explaining the concepts for general education and to counter potential misleading media reports.

Trust of technology and services is needed, but even something more is needed. An organised society requires trust between persons. Trust requires privacy protection and confidentiality. On the other hand, trust requires transparency to a certain degree. The user must know the principles according to which data is transferred.

4.3.7 Ethically aware design guidelines

Many of the previously mentioned ethical issues may be rooted in the technical design and implementation of the intelligent environment. Some design decisions about what information about the user is required, how is that information stored, transmitted or processed, what kind of decisions are automatically taken by the system without human intervention, etc., very much condition the impact on privacy and personal autonomy produced by the system.

In most cases these decisions are taken for the sake of better efficiency of the system, ignoring non-technical aspects. After the completion of the design and implementation phases –maybe during the user testing or even after the deployment of the system– the impact over autonomy and privacy is detected. Frequently, these effects cannot be removed without a complete redesign of the system, leading to a situation where users must accept the system "as it is" or just reject it.

Designers adduce that they only need to cope with technical problems, leaving social and moral problems under the responsibility of policy makers, service providers, care givers, familiars, etc. But, if they were aware of existing regulations and basic principles, they would be able to avoid these effects.

Therefore, in order to prevent undesired ethical impacts, it is necessary to provide designers with ethical or moral guidelines that help them to avoid unnecessary collisions with users' civil rights. The need and convenience of inclusive and ethically aware design guidelines is studied and discussed by Abascal and Nicolle [Abascal and Nicolle, 2005].

Ethical guidelines are not yet well established and disseminated. Nevertheless, examples of good practice, compiled by diverse research groups, user associations, institutions, etc., may help people interested in developing ethical impact-free applications and systems. For instance, the effects of tagging systems on elderly people affected by dementia are carefully studied by Nicolle [Nicolle, 1998]. On the other hand, Casas et al., [Casas et al., 2006], analyse the type of information that can be stored and transmitted by indoor location systems for fragile elderly people in institutions, and provide useful design guidelines.

Several ethical issues in Ambient Intelligence environments do not only affect people with disabilities and elderly people as shown in [Bohn et al., 2005] and [Robinson et al., 2005]. For instance, the impact over user's privacy of location systems -and technical alternatives to decrease it- are recurrently discussed, by [Myles et al., 2003], [Beresford and Stajano, 2003], [Clarke, 1999], etc. Civil rights protection of common users would have evident benefits in protecting the rights of people with disabilities and elderly people. Nevertheless, some basic protective requirements, such as "informed consent", are hardly extensible to the case of people with cognitive restrictions, which require further discussion.

4.3.8 Conclusion

Below is a brief Strengths Weaknesses Opportunities Threats (SWOT) analysis summarising the issues and possibilities:

Strengths

- *Allows an end user more personal freedom, and better access to their environment*
- *Potential to give full access to places previously unavailable*
- *Increased safety, comfort, convenience, security.*

Weaknesses

- *Data is broadcast, open to interference*
- *Updating of the systems: possible that the information can become out of sync*
- *Computers will do what they are programmed to do, so are liable to make the incorrect choices in some situations.*

Opportunities

- *Improved security to ensure no interception of information*
- *Regular reviews to ensure customer satisfaction, relevant information*
- *Ability to review the 'automatic' decisions made by the system.*

Threats

Misuse of information

AmI benefits may be negated by numerous threats such as accidental or intentional misuse of the components of AmI systems (tags, sensors, readers, other smart devices and so on) and associated databases, and by a wide range of issues such as privacy and personal well-being (societal and ethical issues). Indeed, various issues related to pervasive security problems can lead to enlarged privacy violations committed by insiders and outsiders, e.g. misuses of databases associated with RFID tag information, or remote surveillance whenever AmI devices are vulnerable (lack of security guarantee).

The difference between misuse and abuse of data is that misuse refers to the case where an organisation for example does not protect its systems adequately and has its data stolen through a computer attack. Abuse refers to an organisation that sells personal data to a second one.

Illegal use of information

Danger of identity theft: most actions in everyday life carry identity information and to be able to perform them, people need to present identity for identification or authentication purposes. Hence, identity theft is becoming a very serious problem which compromises the safety of people and the integrity of the identity of each individual. The Internet and the increasing importance of electronic transactions and subsequent digital traces exacerbate the problem as it becomes easier for an identity thief to carry out fraud:

Incorrect decisions made automatically, without the awareness of the end user

Safety shortcomings.

These are some of the issues which should be addressed when developing AmI applications. However, human beings need other people who cannot be replaced by AmI. But sometimes technology can help in everyday life. Ethics is about the relationship between persons but can also be expected to say something about people when they use technology. It is important how technology is used: what can it be used for and how should it be developed? When agreement is reached in a parliament, it can turn into law. Ethical discussions, policies, guidelines and legislation are needed to overcome the challenges posed by Ambient Intelligence.

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5. The regulatory scene

5.1 Regulation at the crossroads

Tony Shipley

The future of European regulation on Telecommunications, and more generally, on Electronic Communications, is in the balance. As this book goes to press, the European Commission is consulting on proposed revisions to the set of Directives on Electronic Communications – the so-called 'Framework Directives'. Revision of the Radio and Telecommunications Terminal Equipment Directive – the RTTE Directive – has been placed on hold while any changes to the Framework Directives are considered. At the same time, the review of Relevant Markets is proceeding and an outcome is expected early in 2007. Each of these processes offers the possibility of profound change in the regulatory approach or, in the absence of agreement on changes, an acceptance of the status quo. COST 219ter and its member bodies will be taking part in the consultation processes and submitting comments and proposals, informed by the studies and debates that have formed part of this COST Action. There is of course no certainty that the revisions that COST 219ter would like to see put in place will form part of the final decisions. There is the possibility that profound changes could radically alter the ways in which the declared objective of COST 219ter would have to be approached, in the years following the conclusion of this particular Action. This Chapter will explore some of the issues which will influence the future of regulation and it will attempt to assess the effects of the possible outcomes. Legislators will be faced with a choice of directions, each one having a different regulatory impact, so it is fair to make the comment that regulation is indeed 'at the crossroads'.

5.1.1 The shape of regulation now

The Framework Directives

Five Directives were proposed in 2000 and subsequently enacted. These were:

- *A common regulatory framework for electronic communications networks and services*
- *Universal service and users' rights relating to electronic communications networks and services (Universal Service Directive)*

- *Access to, and interconnection of, electronic communications networks and associated facilities*
- *The processing of personal data and the protection of privacy in the electronic communications sector*
- *The authorisation of electronics communications networks and services.*

These five Directives, together with the RTTE Directive of 1999, make up the current European regulatory framework for Electronic Communications. There are further Directives, such as 'TV without Frontiers', which specifically cover Broadcasting.

The 2006 Review

By 2006, the Framework Directives were due for review as part of the regular process for updating EU Directives. Review of the RTTE Directive had commenced a year earlier. There are several stages to the review and the process began with an examination of the scope of universal service. This was followed by wide consultation on the general and specific matters to be considered in the review, with the EU Member States as well as all other interested parties being invited to make submissions. In June 2006, having taken into account the views expressed in this consultation, the Commission tabled its formal proposals for the revisions to the Framework Directives.

COST 219ter has contributed to this consultation in various ways – by direct response to the invitation and by responses from its national Reference Groups – by putting views to Member State Governments to inform their own comments – and by discussion and debate in the INCOM (Inclusive Communications) Committee set up by the European Commission. In the direct response COST 219ter made the points which follow, and this submission encapsulates the policy which the members of this Action wish to promote.

COST 219ter Submission to the Preliminary Consultation Round

"Our main area of interest is the Universal Service Directive which, in addition to defining the minimum set of service provisions guaranteed through universal service, also sets out the statutory rights of users. We believe that it is necessary for these universal service obligations and users' rights to be extended fully to mobile networks, and also for enabling powers to be given to national regulators to apply similar obligations within their own territories to broadband services and to new generation networks and services. We are aware of the argument that

regulation may have a stifling effect upon innovative services, and we are also aware that the Commission has previously shown reluctance to extend universal service coverage to sectors where roll-out across the EU is incomplete. We wish to counter these lines of argument by emphasising that users' rights will be greatly devalued if they are confined to types of service delivery that are approaching obsolescence. Furthermore, patterns in new generation services will have developed very significantly by the time that the outcomes of the next review of the Framework Directives can be applied, and any undesirable features that have become entrenched will then be very difficult to correct. We are not pressing for a more intrusive regulatory regime, but instead we are asking for national regulators to be empowered to introduce regulation in new generation services, including broadband, where they consider it to be essential. We are supportive of the principle that regulation is necessary only where the market has failed to deliver, but we contend that it is inherent to this principle that regulators must be able to intervene rapidly, through subsidiarity powers if appropriate, where market failure is evident. If fast moving technologies are being brought to the market at differing rates across the EU's Member States, then observation and – where necessary – corrective intervention, must be applied nationally.

On the specific features of the Universal Service Directive, we would hope to see further clarification of the obligations in respect of calls to the 112 emergency number. The present requirement relates only to the connection of such calls and leaves open the manner in which the calls are handled, so that there is an almost complete reliance upon voice calls. In our view, this is inappropriate for modern networks and is contrary to the spirit of the Directives and their emphasis upon universality. We will argue that 112 should be accessible to all users in the telecommunication modality that they normally use – in other words, if the network offers any particular modality for public communication, 112 access should be provided in that modality. Linked to this, we want to see clarification of the definition of a Publicly Available Telephone Service, so that access to emergency numbers is seen as an obligation on all networks offering telecommunication services to the public.

The availability and affordability of accessible terminals for disabled users is a matter which continues to be a cause for concern and, in our view, this is a service provision issue which goes beyond the technical requirements of the RTTE Directive. If market forces alone, in respect of the terminals manufacturing industry, have not delivered obtainable and affordable equipment, we believe there is a case for intervention as a universal service issue, for otherwise the goal of a set of services accessible to all users cannot be achieved. While the recent revision of the Public Procurement Directive will eventually lead to an improved *perception of the accessibility features that are required, we take the view that this objective can be advanced and accelerated if national agencies can use the mechanisms of universal service funding to stimulate the market for accessible terminals. Without wishing to advance any particular service models, we note that some Member States have mechanisms in place to promote the supply of terminals that would not otherwise be available. We believe that this is a legitimate use of universal service funding resources that should be specifically encouraged in a revision of that particular Directive".*

In making these comments, COST 219ter was aware that there was great reluctance within the Commission to propose extension of universal service rights and obligations across the mobile and broadband sectors throughout the EU, presumably on the grounds that the roll-out of such services was uneven and Member States would therefore raise strong objections where they considered that application of universal service principles would be premature. Similar objections would be raised in respect of New Generation Services (and networks). The proposed alternative was therefore to allow freedom to National Regulators to apply such extensions once the services in their territories had reached an appropriate degree of maturity. COST 219ter members were acutely aware that technological and commercial developments in electronic communications service delivery move at a rapid pace, with the result that new patterns of service can become established before the regulatory bodies are able to take action. The balance between encouraging novel and welcome developments, on the one hand, and maintaining the basic user safeguards, on the other, can be a delicate one. If the introduction of new types of service across the EU Member States is not uniform, and there is no reason why it should be, then it is vital that regulators at a national level should be empowered to act when they consider that the time is right.

The empowerment of National Regulators does not mean that the principles of the Single Market have to be discarded, for national differences in service delivery patterns are already recognised, particularly in the application of universal service. The Commission's Communications Committee (COCOM), which monitors the implementation of the Electronic Communications Directives, is able to foster a harmonised approach in subsidiarity issues, that is to say, those areas of regulation which are devolved to Member States because fully centralised regulation would be heavy-handed or inappropriate. Use of this mechanism, instead of waiting for a further revision of a centralised Directive, offers a vitally important method of ensuring that users' rights and safeguards are maintained in evolving services. It should also ensure that the delivery of the set of basic services, defined as universal service, is not consigned solely to traditional networks which may be facing obsolescence.

The emphasis in COST 219ter's submission - above - upon the manner of making 112 emergency calls arose because this facility was seen as an important indicator of the availability of basic services. Traditionally a feature of PSTN networks, it has become obligatory for mobile services available to the public, but only for voice calls. Some Member States have relay services which can interconnect fixed line Textphone terminals with the 112 voice call bureaux, but not by using the 112 number, and a few can handle emergency calls using Short Message Service (SMS) text from mobile handsets. In general, the facility for making emergency calls has lagged far behind the vanguard of developing services.

The Commission's Communication – June 2006

On 29th June 2006 the Commission issued a Communication (COM(2006)334 final) setting out its proposals for the revision of the Framework Directives, following the earlier consultations. A further period of public consultation on the content of that document ran until 27 October, following which the detailed revisions would be prepared for the Council of Ministers and the European Parliament.

As expected, the thrust of the Communication was towards a reduction and simplification of the legislation applying to the electronic communications sector, rather than an extension with added detail regulation for newer types of service. The Commission pointed out that the primary intention of the original legislation – to limit the market dominance of the former monopoly incumbents – had largely been achieved. Openly competitive services do not require economic regulation beyond that provided by the general competition rules, so sector-specific legislation can be dispensed with. The Communication emphasised that the purpose is to deal with markets, not technologies, in the furtherance of an open and successful internal market in the EU. As each part of the electronic communications market becomes fully competitive, the relevant regulation can be withdrawn and the National Regulators can step back.

In addition to economic regulation, the Framework provided for various consumer protection measures, with legal obligations on privacy, data protection, universal service and users' rights. So the questions inevitably would arise of whether and how these will be maintained once the regulatory system and its enforcement mechanisms had been withdrawn. Proposals on this theme were not contained in the June Communication. Instead, the Commission announced its intention to produce a Green Paper on universal service in 2007, 'to launch a wide ranging debate'. No time scale for this debate was suggested but it is likely to be lengthy. As with economic regulation, the removal of sector-specific requirements implies a reliance upon more general horizontal legislation to ensure adequate protection but not all of this horizontal legislation actually exists. Nevertheless, it is already apparent that the growing convergence of electronic communications technologies is rendering detailed sector controls unworkable, so the principle of a more general consumer protection framework ought to be welcomed.

The topics that were covered by specific proposals were:

- *Spectrum management, to ensure most efficient use of the radio spectrum*
- *Streamlining the process of Market Reviews, to determine where competition is effective*
- *Consolidating the Internal Market, with greater consistency in national measures*
- *Strengthening Consumers' and Users' Rights*
- *Improving Security (and modernising the approach on network integrity), and*
- *Better Regulation, with the removal of outdated provisions.*

The examination of relevant markets, to show which market sectors had achieved full and open competition, is being carried out largely as a separate exercise with a shorter time-scale than for the main review. This will be an important aspect of the overall review process, for it could result in fully competitive sectors being removed from the scope of legislation. Directory and Directory Enquiry services were specifically noted as being ready for de-regulation.

There were some issues relating to accessibility for disabled users, addressed in the June proposals, instead of waiting on the outcome of the Green Paper and its ensuing debate. A point of particular interest was a proposal to adapt the regulatory framework on services to cover telecommunications terminal equipment, which is a move that COST 219 has long advocated. The Communication noted the anomaly that consumer terminal equipment used in broadcasting is covered by the framework, whereas telecommunications terminals are subject to the quite separate RTTE Directive. As a first step in removing the anomaly, it was proposed to review the definition of a Network Termination Point (NTP) in the Universal Service Directive and to relax the RTTE obligation on network operators to publish their NTP interface specifications. The effect of these changes was not clear; it seemed to be the intention to allow equipment manufacturers and network operators to collaborate on the introduction of proprietary (ie non-harmonised) innovative services. Whether such a move would benefit users with a disability has yet to be proved, since one of the problems arising from the terminals/networks division has been a diversity of equipment protocols leading to incompatibility between terminals on the same network.

A further proposal was to amend the Universal Service Directive so that separate obligations are applied to providers of access infrastructure and to providers of services. This was said to be to facilitate a future review of these obligations and it would require updating the definition of a Publicly Available Telephone Service (PATS), which is another issue that COST 219 has advocated.

Directory and Directory Enquiry services are proposed for removal from regulation under the framework, on the grounds that these are fully and openly competitive and therefore sector regulation is redundant. It would not then be possible to use the framework powers to ensure that such services are accessible to people with a disability, although in Member States that have horizontal legislation on avoidance of discrimination in place (such as the Disability Discrimination Act in the UK) this obligation could be maintained. This may be seen as an example of how other, horizontal, legislation is necessary if problems with the withdrawal of sector-specific legislation are to be avoided.

A further proposal was to amend Article 7 (on Special Measures for disabled users) so as to strengthen the right of disabled users to access the emergency services by means of the 112 number. The Communication noted, appropriately, that the nature and extent of the requirement (for access via 112) needed to be clarified, but simply underlining an existing obligation may not address the issue. Another proposal in the Communication was that there should be a procedure whereby Member States could be encouraged to agree common requirements related to networks or services, and current work in COCOM on the interface between network operators and public safety answering bureaux was cited as an example. It would seem highly desirable to extend this area of negotiated common requirements to cover the ways (eg text, fax, SMS, multi-mode, as well as voice) in which emergency calls are transmitted across the networks, transferred to the public services, and answered.

There was a further proposal to create a mechanism to enhance eAccessibility. It envisaged the creation of a group consisting of Member States, industry associations and disability organisations. This group could be tasked with identifying appropriate action to address eAccessibility problems, but it was not clear what the outputs of the group might be, given that it would have to work alongside established legal and consultative structures.

Next Steps in the Review

By the end of 2006, a further round of open consultation (this time on the Commission's July 2006 proposals for revisions of the Framework Directives) will be complete. The Commission will then proceed with a formal paper to Member States, setting out the drafts of the revised Directives. The official negotiating stage will then commence. This stage could take up to 18 months, depending upon the degree of agreement among the 25 Member States. Although the Commission will have been aware of the views of these 25 nations, as a result of the earlier consultation stages, it is probable that there will be several points of contention that have to be reconciled in the course of the negotiations. The views from industry and from consumer groups will have been made known during the consultations and these are likely to diverge sharply on the general issue of more, or less, regulation as well as on specific details. Member State Governments will also have listened to these views and they will have been influenced to varying extents by them. However, it is in the nature of negotiations that some points will be conceded in order to gain acceptance of others of greater importance, so each Member State will have prioritized its objectives according to this principle. Such negotiations between 25 nations are inevitably lengthy, but eventually an 'official position' will be reached.

The official position will then be considered by the European Parliament. It is very probable that the industry associations and consumer groups will seek to lobby Parliament, in an attempt to restore clauses that they had originally pressed for but had lost in the negotiating process (or to delete others that they objected to). MEP's will have their own views, which may be coloured by representations from their constituents. As a result, Parliament may amend the official position document and the Council of Ministers (the senior representatives of the Member States) will have to decide whether to accept the amendments. Further exchanges between the Council and Parliament may take place and, in the absence of agreement, 'conciliation procedures' may be commenced. At the end of this stage, there will either be agreement upon a compromise or the entire Directive will fall. As there are five Directives here, all interlinked, a very complicated situation could arise. Also, at some stage in this process, the review and possible revision of the RTTE Directive has to be recommenced.

When there is agreement following these procedures, the Directives are enacted and there will be a time set for implementation by the Member States. This may be between one and three years, depending upon the complexity of the obligations. There may also be a transition period, if time is needed to set up new regulatory arrangements or if industry is obliged to introduce new processes or procedures.

Time Scales

It is unlikely that any revisions to the Electronic Communications Directives will produce practical results before 2011 at the earliest. If revised Directives are enacted by the end of 2008, and there is an implementation period of two years, the Member States should have their amended national legislation in place at the start of 2011. Previous experience suggests that not all the EU Members will meet the target. Time is then needed for the new national legislation to take effect, making it quite probable that the effects of the revisions now under discussion will not be observed before 2012 or 2013. If implementation of the revisions hinges upon the availability of a new batch of technical standards, the time scale could be even longer. Given the fast-moving pace of electronic communications technology, it is evident that effective regulation cannot be introduced by means of Directives alone.

The legislation contained in EU Directives has to be future-proofed, as far as that is possible, setting out fundamental requirements and leaving the detail to be elaborated by other means. Those other means will chiefly be European harmonized standards, but although it is quicker and easier to up-date standards than it is to revise Directives, the consultation and comment steps involved still make the preparation of formal standards a lengthy process. In some instances, there is scope for use of Codes of Practice as an alternative to formal standards, and if these are drawn up by National Regulators working in partnership with industry and consumers they can be available in a relatively short space of time.

It is the view of COST 219ter that the regulatory system must be able to move quickly enough to deal with problem issues as new technology is introduced, and therefore any new or revised Directives need to provide enabling powers to facilitate this – without compromising the basic barrier-free trading principles of the Single Market within the European Union. If regulation of 'state of the art' service delivery can be initiated at national levels, in those Member States where problems have arisen, and harmonized informally through COCOM, this objective could be achieved.

The RTTE Directive

Although the review of the RTTE Directive commenced before that of the Framework Directives, it has been put on hold until the future direction of telecommunications legislation has become clearer. It is not yet clear whether that clarification will emerge from the 2006 Review process. One possible outcome is that there will be very little change; some minor adjustments might be incorporated while leaving a more dramatic recasting of the legislation to a subsequent review. If that is the result, then a similar approach could be adopted for the RTTE Directive.

Two significant areas of revision were proposed in the early stages of the RTTE review, and they were mutually exclusive. This explains the need for a 'steer' based upon the future direction of the Framework, before reaching a conclusion in the case of RTTE.

The RTTE Directive of 1999 was itself a deregulatory Directive. It removed the pre-market approval regimes for most terminal types, keeping a formal approval system only for the more critical uses of the radio spectrum. Fixed line terminals were effectively treated as ordinary consumer equipment, subject to general provisions on consumer safety and avoidance of electrical interference. Without pre-market approval, the enforcement of requirements for this category of equipment was necessarily left to the usual consumer protection authorities, typically Trading Standards bodies. One proposal put forward in the review was to take this process to its logical conclusion, by dropping fixed line terminals from the Directive altogether and leaving the more general Directives to apply – these being the Low Voltage Directive on electrical and mechanical safety, and the Electromagnetic Compatibility (EMC) Directive on electro-magnetic interference. It was argued that this would make no difference in practice, as it would simply be a recognition of the current reality. Another proposal ran counter to this in that it proposed more specific use of Article 3.3(f) of the 1999 Directive; this article empowered the Commission to make regulations concerning the accessibility of terminal equipment for people with disabilities. Although this was a potentially important power, its application had been actively debated from the time that the Directive was under negotiation, that is prior to 1999, and no practical means of drafting and enforcing such regulation had been discovered. So the future shape of the RTTE Directive was going to be determined by the answer to the fundamental question – more regulation or less? That same question would be posed in respect of the Framework Directives, so it was logical to wait on the answer reached there before completing the RTTE review.

Review of Relevant Markets

A further issue linked to the Review process, but following different rules, is the consideration of 'relevant markets'. The Framework Directives are all Single Market Directives, aimed at promoting barrier-free trade within the EU. If barrier-free trade already existed, there would be no need of such Directives. Equally, if a state of barrier-free trade were to be brought about, the Directives (for that sector) would become superfluous. This highlights an aspect of the Framework Directives which is largely invisible to the consumer but is vitally important to the industry. Barriers to trade can take various forms; the most obvious being that of national tariff barriers, which have long since been dismantled within the EU. Second to that is the imposition of technical barriers in the form of national requirements for product safety, compatibility or quality; the Single Market Directives aim to harmonise such requirements so that goods may be moved across national frontiers without hindrance.

A further type of barrier arises from the presence of operators with Significant Market Power (SMP) in a particular territory. This has been a very significant form of barrier in the telecommunications markets, because the former monopoly suppliers – the national telephone utilities – owned the fixed line infrastructure and could control access to it by competitors. These competitors could replicate the trunk line infrastructure by leasing lines, obtaining wayleaves or using radio and satellite links, but they could not economically duplicate the local loop that provides the final connection to a subscriber's premises. Unbundling the local loop was therefore a major objective in the first round of telecommunications liberalisation and, being a complex issue to unravel, it is still to be completed. While this is perhaps the most significant example, there are other instances where a particular operator can dominate a market sector by being able to control access to critical facilities.

A crucial part of the package of Framework Directives has therefore been to identify and then to limit the exercise of SMP by dominant operators. It can be claimed that this is the most important role of the National Regulators in the telecommunications sector. Without the special features of the traditional fixed line market, any abuses of a dominant market position could be dealt with by means of the general EU legislation on competition and the avoidance of anti-competitive practices. Arguably, there is no particular need of harmonised legislation covering technical standards for telecommunications; market forces will ensure compatibility, as it is not in the interest of any operator to have a network which cannot terminate calls originating from others. There is a recognised need for spectrum management harmonisation in the radio arena, but there is an effective mechanism for this which pre-dates the Electronic Communications Directives. A reasonable conclusion would therefore be that it is the proper aim of the telecommunications regulators to work themselves out of a job, in as much as eliminating the dominance of organisations with SMP would then render the sector-specific legislation redundant.

National Regulators are charged with the task of examining all the 'relevant markets' and reporting on those where market dominance continues to cause a distortion. Some 15 market sectors have been defined and are being examined. Only in a very few cases is there evidence of full and free competition actually operating, but some parts of the mobile market seem to be close to this point. If operators can justifiably claim that their market is fully competitive, they can ask to be exempted from the obligations of the Framework Directives, and removed from the scrutiny of the National Regulators. The outcome of the review of Relevant Markets will be decided by the Commission early in 2007. If a sector is so exempted, the user safeguards afforded by the Framework Directives could cease to apply. However, it does appear that exemption from a Single Market Directive would also remove the prohibition on the introduction of non-harmonised national legislation. Decisions on this aspect of the review could therefore be of great significance, both for suppliers and consumers.

Issues for the future

'More regulation or less?' That question is clearly going to be a key issue in the future of all the EU Single Market Directives. The original purpose of the Single Market had been to establish a trading bloc in Europe with a strong and barrier-free domestic market, in order to avoid political and economic dependence upon the North Americas or the Pacific Rim. Much has changed since the 1957 Treaty of Rome, and the growing pressure now is to harmonise trading practices between the three great economic Groups and, at the same time, to limit their dominance over smaller and poorer trading nations. The horizon is now recognised as global, and not simply European. The influence of the World Trade Organisation in promoting fair trade is increasingly observed.

It could be that the pattern of World trade will evolve much as the European Single Market evolved, over a period of 50 years, with the elimination of tariff barriers, the harmonisation of technical barriers, and concerted action to reduce the power of dominant market traders. There are agreements on tariffs and trade which aim to promote a free-trading environment in which market distortions such as internal subsidy and 'dumping'of production surpluses are curtailed. Even the large trading blocs are concerned about the power of global corporations and their ability to dictate market conditions, so there is a readiness to curb the activities of multi-national operators where they are seen to be anti-competitive. In the field of formal standards, there has for some years been a policy of moving towards acceptance of international standards, rather than territorial standards, because this is the logical way to promote trade in a global market-place. All of these measures are brought about by negotiated agreements and Treaties, and the process may be slow and difficult, but the effort being applied to it indicates the political importance attached to such moves by the World's nations.

Applying these principles of global trade to areas such as agriculture may require long and difficult negotiation, but the electronic communications market is already intrinsically global. Because it is a relatively new market, the entrenched protectionist positions found in some of the more traditional sectors have not developed and, because it is based upon a fast-moving set of technologies, it is unlikely that they will. There is little point in seeking to protect a market state that will be quickly rendered obsolescent by technological progress. Therefore, it is probable that the effects of globalization will be felt in electronic communications legislation long before they are seen elsewhere. The key question is 'How soon?'

Globalization is tantamount to having less regulation applied to the market-place, if only because of the impossibility of defining detailed trading rules in all market sectors and acceptable to all the trading nations. Broad cross-sector principles apply, in relation to fair competition and the prohibition of restrictive trading practices. This approach is at odds with the view expressed by many consumers, to the effect that more market-place regulation is necessary in order to protect the most vulnerable consumers from exploitation or from neglect of their interests. Disabled and elderly consumers are particularly vulnerable, especially if they have little economic power, because suppliers fighting for the large emerging markets have little enthusiasm or incentive for considering their needs. If the legislative direction should happen to be that of less regulation, then the question of how to protect the interests of those who are disenfranchised in a free market becomes all-important.

If market legislation should shift towards broad principles of market-place conduct, rather than more detailed sector-specific rules, a probable answer would be to introduce equivalent broad principles for protection of consumer interests. Horizontal measures for protection of citizens' rights, including such issues as disability discrimination, would be needed to off-set the dilution of legislation that is currently contained in specific market sector rules. This need not be a cause for alarm. Most market sectors are not covered by specific legislation at present, so there is reliance upon more general obligations. It would simply reflect the situation that arose a decade ago, when telecommunications liberalisation in the EU outlawed many of the older national approval rules, some of which were becoming obsolete because of technological advances. It created an opportunity to re-frame the obligations in a broader and more far-reaching manner, with emphasis upon principles rather than ephemeral detail. Less regulation is not necessarily to the detriment of vulnerable users, provided that careful attention is given to other means of safe-guarding their interests.

The Crossroads

At some stage, European legislators will be faced with three main options; to try to hold the present direction with only minor adjustments, to move firmly towards a global position with some loss of European autonomy, or to enhance the protection afforded to Europe's traders and consumers by means of additional sector-specific legislation. Whether that stage has been reached in the present review round of the EU Directives remains to be seen. What is of vital importance is the need to foresee the impact of these options, and to be able to define an adequate set of measures that will ensure that vulnerable users are not overlooked. COST 219ter members welcome the policies of ensuring that Europe's Information Society is inclusive and accessible to all. They strongly support these policies while recognising that there may be many routes to their achievement.

Which Road to Take

Although it is not be possible at present to predict the direction in which regulation of Electronic Communications will develop after the 2006 Review, COST 219ter members are fully agreed that there are some essentials that must be observed if the disadvantages faced by people with a disability are to be diminished. First and foremost, it must be recognised that the commercial forces that drive a free market do not automatically deliver offerings that are appropriate to the needs of those consumers who are outside the mainstream. Various means of protecting their interests are therefore needed and there can be no single approach. For people with a disability, many methods have been tried with differing degrees of success and it is not even obvious that a common approach throughout the EU would be attractive. The key to acceptance lies in part in national cultures and traditions, making this a subsidiarity issue for the EU's Member States, but the EU's declared policy of non-discrimination is clear and some overall legislative statement is a fundamental requirement. The following section describes the approaches taken in some non-EU Countries.

Within the EU, the picture is coloured by the history of telecommunications provision. In an era of public service provision, telecommunications was a natural extension of Posts and Telegraphs and became the responsibility of the same bodies, the PTTs. Even broadcasting, if not part of the PTT function, was managed by similar public service bodies. So the availability of specific facilities for disabled users was ensured as a matter of course within this public service ethos, often matched by complementary services from other public sector organisations. For example, central or local Government bodies might undertake the supply of terminal equipment for people who could not otherwise obtain, or afford, it. With this background, as liberalisation of electronic communications was promoted, it was a simple matter to write into the legislation a continuation of these safeguards for vulnerable users, generally in the guise of 'Universal Service'.

For as long as sector legislation continues to apply in this field, it ought to be possible to preserve the universal service concept. The Commission's decision to review universal service outside the 2006 Review framework is perhaps a pointer towards a time when the Single Market no longer requires specific legislation for this sector and so alternative user safeguards have to be found. It may not be effective to retain the sector-specific safeguards as a piece of 'stand alone' regulation after that time, for the surveillance and enforcement functions would have been dispersed. The experience of trying to apply regulation to non-radio terminal equipment – following the de-regulation of that area under the RTTE Directive – is a clear indicator of that. COST 219ter members believe that regulation will always be an essential lever for maintaining and improving the accessibility of services and equipment for people with a disability. What form that regulation needs to take in order to be effective surely will depend upon circumstances.

Regulation in other Countries

In Australia the Disability Discrimination Act (DDA) 1992, the Telecommunications Act 1997 and the Telecommunications (Consumer Protection and Service Standards) Act 1999 are the primary legislative drivers for improving accessibility in telecommunications. The DDA was used to establish that a user with a disability was discriminated against when his telecommunications service provider failed to supply him with a rented terminal suited to his needs. This finding led to the expansion of the disability equipment program by the universal service provider.

The principles of universal service were taken up in the Telecommunications Act, with obligations on the designated providers that are somewhat similar to those found in the EU. However, it is important to note that the definition of the Standard Telephone Service in the Telecommunications (Consumer Protection and Service Standards) Act 1999 is a carriage service for the purpose of voice telephony (or its equivalent, for example, if the person has a hearing impairment) and that it meets the any to any connectivity test. This in effect means that the Standard Telephone Service is technology-neutral. However, the definition of STS is currently under review in terms of its applicability to the various types of VoIP. This has important implications with regard to mobile telephony and the provision of IP-based telephony and other next generation network services. The definition of the universal service obligation in the Act is the obligation "to ensure that standard telephone services are reasonably accessible to all people in Australia on an equitable basis, wherever they reside or carry on business".

There have been amendments to a range of clauses in the Telecommunications Act reflecting the increasingly liberalized aspects of telecommunications in Australia. An example is that previously carrier licences for all operators included a condition that an industry development plan must be provided, and one aspect of this plan was the notification of the carrier's activities in research and development including those of benefit to people with disabilities. This requirement is no longer there. There is extremely limited research in Australia on IT and telecommunications solutions for people with disabilities. On the other hand, consumer representation is accepted as important and the Act provides for Government funding for this purpose. There are also legislative requirements on the government regulator and the universal service provider to have formal consumer consultative processes in place.

In the USA, there are three legislative drivers: the Americans with Disabilities Act, Section 255 of the Telecommunications Act and Section 508 of the Rehabilitation Act. The ADA enshrines the rights of people with a disability to make use of facilities and services that are available to the general public. It does not include a demand that manufacturers must make products that are accessible – it is the access to the goods, rather than the goods themselves, that must not exclude anyone on grounds of disability. In contrast, Section 255 of the Telecommunications Act does require the manufacturers of telecommunications equipment to make products that are accessible wherever that is readily achievable. Section 508 of the Rehabilitation Act goes further by stipulating that the Federal Government and its agencies should give preference in their purchasing of ICT equipment to models which are accessible, unless it would present an undue burden to do so. For the purposes of Section 508, the task of defining accessibility is undertaken by an Access Board. This Board drafts the relevant standards for use by the General Services Administration – the procurement Authority for Federal Agencies. The Administration purchases commercial 'off-the-shelf' products, rather than special designs for Government contracts, and the Access Board updates its standards to keep abreast of best business practice in accessible ICT equipment. In this way the Administration can encourage the commercial market in ICT to keep up with the leaders in providing accessibility features, using the possibility of gaining Government contracts as a lever. The Access Board has established an Advisory Committee comprising members from government, industry and consumer bodies to review the Section 508 Guidelines in relation to updating them and considering accessibility guidelines developed by international standards bodies such as ISO and ITU-T. This review is expected to be completed in late 2007 and may result in a broader set of accessibility guidelines taking into account new technologies.

In Japan, the situation is that there is a public procurement system – mainly applicable to websites – which takes into account the accessibility requirements.

Two laws, the Basic Law on the Formation of an Advanced Information and Telecommunications Network Society enacted in 2000 and the Persons with Disabilities Fundamental Law amended in 2004 explicitly mention about the necessity of accessibility in governmental websites. Under the two basic laws, the government developed Basic Plans and annual implementation plans in which target dates are determined. One example is that e-Government system which is under-development will increase information provisioning in accessible format in the fiscal 2006. The Persons with Disabilities Fundamental Law also requests local governments to develop local basic plans. Many local basic plans express their schedule to develop accessible websites.

Parallel to the enactment of these laws, Japan Industrial Standard on Web Content Accessibility (JIS X8341-3 Guidelines for older persons and persons with disabilities - Information and communications equipment, software and services - - Part 3: Web content) was developed and published in 2004. Central and local governments refer to the above-mentioned JIS in developing accessible websites. The JIS has sold more than 4 000 copies, which is said to be remarkable. Website development of these central and local governments is usually contracted to system integrators. In order to get contracts, system integrators develop and publish free of charge web accessibility checking tools. Also system integrators develop helper tools installed in governmental websites such as voice synthesizer tool which "reads" website. System integrators are now eager to sell Content Management System to central and local governments.

The number of accessible governmental websites is increasing. But problems remain. One problem is the usability. Government websites use a lot of jargons only understandable by government officials. One example is that a "motor bike" is a "light weight vehicle" in the governmental websites. The other problem is that websites are designed based on the structure of the office; therefore, people who do not know the structure find difficulty in obtaining information. The general usability must continue to be improved after the accessibility for people with a disability is achieved.

The movement above has triggered accessible website development in the private sector. Examples are websites provided by newspaper publishers.

One interesting point is that the laws do not impose punishment. Every movement is done voluntarily. The "greying" of Japanese society is considered to have triggered the movements. According to the 2005 edition of the White Paper on the Aged Society, Japanese people aged 65 years or older accounted for about 20% of the national population and this figure is expected to top 26% (approximately 33 million people) by 2015. This big population encourages profit-making corporations to address the needs of older persons including the accessibility needs. There is no doubt that central and local governments also need to consider accessibility.

This very brief summary of national legislation points to the difficulties of making regulatory demands upon manufacturers of electronic communications equipment, so as to influence the accessibility of terminal equipment. The problems are fewer with services, because avoidance of discrimination in service delivery can be demanded. The Americans with Disabilities Act in the USA stops short of a requirement that goods should be accessible. It is 'access to goods', meaning the ability to use the services of shops and other suppliers selling goods, that must be available to people with disabilities. (The Disability Discrimination Act in the United Kingdom adopts the same principle, but if the goods are supplied as part of a service – for example a rented television set or an introductory service pack for a mobile phone – then the non-discrimination obligations extend to the goods, with the onus being on the service provider rather than the manufacturer). The Australian Disability Discrimination Act has been interpreted by the Human Rights and Equal Opportunity Commission to mean that carriage service providers, if they provide equipment as part of a bundled service such as mobile phone handsets, they are obliged to provide equipment which enables equivalent access to people with disabilities, on the same terms and conditions (including price) as standard customer equipment. Under section13 of the Telecommunications (Consumer Protection and Service Standards) Act, it allows for regulations to be made prescribing customer equipment for compliance with the Disability Discrimination Act. Regulations have been made to ensure access to a Standard Telephone Service with the regulations including a range of features which are provided by the USO provider. Such features include voice amplification, a hands-free telephone, visual alert, a handset with one-touch dial memory a lightweight handset and built-in hearing aid coupler.

Although it is not possible in a free market to tell manufacturers what they should make, it is possible to impose general requirements – such as those for product safety – on the items which they do decide to make. If formal Standards that defined a broad consensus on the concept of accessibility existed, in the manner of product safety standards, then the situation might be different. Section 255 of the US Telecommunications Act imposes accessibility requirements, although there might be debate as to what precisely these should be, but the EU has deliberately dismantled the regulatory environment which is needed to make such rules enforceable. Similarly, the government preference exercised in ICT equipment purchasing could be subject to challenge if applied in an EU Member State, because of the rules on fairness and transparency, unless the accessibility requirements were set out in a formal standard accepted throughout the Community. These issues will be considered in the next section.

5.1.2 The role of standards in promoting accessibility

In the European Union, the concept of using formal Standards in support of legislation has been developed to a very high degree. This has come about largely because of the complexities of the laws establishing the Single Market, where detailed harmonization is effectively impossible if all of the material has to be set out in the legislative documents. In order to overcome this problem the 'New Approach' was conceived, and in the New Approach formal Standards have a very specific role.

Standards and the 'New Approach' Directives

In the 'New Approach', market sector Directives aim to set out the legal obligations in as broad and technologically neutral a manner as possible. Removal of non-tariff barriers to trade, which was the primary objective of the Single Market, requires the alignment – or harmonization – of technical requirements for goods and services. These requirements have typically been imposed by Member States for the reasons of safety, compatibility and quality of products placed on the market within their territories. For products which are potentially dangerous, such as electrical apparatus, pressure vessels or medical devices, these technical requirements may be very specific and detailed. If these specific details were all to be set out in Directives, the negotiation of new Directives would be excessively difficult – even when the EU had far fewer than 25 Member States – and revisions would be necessary at frequent intervals as new risks were exposed or new technologies were introduced. The 'New Approach' was devised to overcome this difficulty by setting out legal requirements in the broadest of terms, and then relying upon published Standards to provide the detail.

There is a particular aspect of the use of Standards in the New Approach that is crucial when considering their role in promoting accessibility. With very few exceptions, the use of standards is voluntary and the linking of a particular Standard to a Directive does not give it any legal force.

Formal European Standards from the Standards bodies CEN, CENELEC and ETSI, form the basis of most of the standards called up in legislation in the EU. Compliance with a relevant standard is then 'deemed to satisfy' the associated legal requirements set out in a Directive. Therefore, suppliers will usually adopt the route of standards compliance as a straightforward and valuable means of demonstrating that their products or services meet those requirements and are fit for purpose. It is inherent in the nature of standards that compliance can be checked by different organisations, in different places at different times, and the result should be the same in each test. A compliance assessment carried out in one competent Test House will therefore have validity throughout the European Union. This makes the use of formal standards very convenient for assessing compliance with the technical requirements of a Directive, but it is not the only way of doing so. The supplier usually has the option of demonstrating, from first principles, that the Directive's requirements have been met, as an alternative to using a published standard. The results may not be so readily accepted by the regulatory bodies as would a conformity claim based upon the use of standards, but the route allows for the acceptance of an innovatory offering that is not catered for in currently existing standards.

This leads to a double problem when considering the possibility of mandatory accessibility requirements in the EU. Firstly, it becomes necessary to define in broad terms just what is meant by 'accessibility' as an essential requirement (in, for example, an EU Directive), so that even without a published standard a supplier can demonstrate that a legal requirement has been complied with. Secondly, there is the difficulty that suitable accessibility standards are not yet readily available except for physical access situations (such as wheelchair entry). Much work is being done in various bodies, ETSI Human Factors Group, ITU-T (SG 26/16) and ISO (TC 159 - Ergonomics) being just a few examples, that may eventually lead to formal European standards suitable for complementing legislation, but there is a long way to go. This double problem is linked to the very great diversity of function and need that is fundamental to the areas of sensory and cognitive disability. If the legislators cannot define 'accessibility' sufficiently to meet the purposes of Directives, it is expecting a very great deal of the standards writing bodies to remedy the deficiency. In pushing for accessibility requirements to be addressed in equipment and services, it must be accepted that these bodies are being asked to undertake a major task in setting out practical and achievable requirements. CEN/CENELEC Guide 6, which is closely based upon the equivalent ISO/IEC document, provides an invaluable starting point for standards writers but this is at the beginning of the extended standards writing process. Furthermore, the task will call for the closest co-operation, not only between different standards sectors such as disability categorization and the technical considerations, but also with user representatives. A much closer involvement of organisations representing people with a disability is now recognised as vital. Although the Commission is issuing mandates for the production of relevant standards, it is already clear that this is a non-trivial problem.

What is Accessibility?

A considerable debate has opened up on the meaning of the term 'accessibility'. It is not easy to define as it has acquired a range of meanings in common usage with particular interpretations in specific contexts. However, effective and widespread use of formal standards requires that a common meaning must be adopted. Use of the term 'accessible' is even more problematic. Gregg Vanderheiden, at the Trace Center, was pointing out in 2001 that this term should not be used without some qualification. An offering may be 'more accessible', 'less accessible' or even accessible to a very specific group of people, but never just 'accessible'. We might think of a facility as 'accessible to English-speaking people', 'accessible to people with low incomes' or 'accessible to people with a disability' but, in each case, we are silently acknowledging that it will not be accessible to all of them. Then what is an 'accessible' telephone? Can there ever be such a thing? There could be a telephone which meets all of the criteria in a published set, which is a useful categorization but its usefulness is only as good as the criteria themselves. Any attempt to extrapolate beyond the intended context leads to difficulties, with the risk of finding that there are people who cannot use the so-called 'accessible' facility. The authors of criteria sets are generally aware of the limits of their work but others may use the description 'accessible' as a convenient shortform, with the danger that a particular set of criteria comes to be seen as the practical definition of what is 'accessible'.

The starting point for 'accessibility' is 'usability'. Usability is taken to mean the ability of a defined group of people to make use of the product or service. A book is usable by people who can pick it up, turn the pages, view the content and comprehend it. It is not usable by people who, because of disabilities, cannot handle it or see it. If it contains text written in (say) German, it will not be usable by people who do not understand that language. The book can be made usable for many of these people in various ways, although it may not then be the same book, or even a printed book at all. For all the people who are excluded from comprehension of the book for whatever reason, it is not accessible to them and will remain so unless steps are taken to improve its usability in their particular circumstances. 'Accessibility' therefore can be regarded as a measure of the extent to which groups of people other than the originally intended users can be offered the experience of using the item in question.

Two points emerge from this simple example. Firstly, with traditional technologies the intended users are defined by custom and usage. Printed books have always been aimed at users who can access and appreciate them, so the task of improving their accessibility has fallen largely to agencies outside the mainstream book trade. With new technologies there is an expectation that accessibility issues of all kinds will be addressed at or even before product launch, which is a culture shift that is not apparent to all. The message for developers of standards is that this is now a mainstream issue and not something to be addressed in niche markets. Secondly, it is not a once for all issue. Improved accessibility is a continually advancing objective requiring constant examination of the types of people who are not given access. The consequence is that a wider skills base is now called for in standards Committees.

Inclusive Design - Design for All

The points raised in the previous section can be addressed by the process of Inclusive Design, also known as Design for All. While it does not mean that all intending users can be given immediate access, it does signify an iterative process to improve accessibility by widening the target user population each time the design of a product or service is re-visited. This process ought to be as fundamental to the design function as the inclusion of quality parameters, that is, an integral component and not a feature to be added at the last moment. As with quality, there are general standards for the Inclusive Design process, which can and should be cross-referenced in the standards for specific items.

Standards complementing Directives

This section has so far been concerned with the standards that amplify the New Approach in EU Directives, that is to say, those standards which are accepted as describing how the essential requirements of a Directive might be met without claiming to be the only route to achieving conformity. These standards are still voluntary, in that other methods of showing conformity with a Directive may be utilised, although these may be less straight-forward or less convenient.

It is unusual for exact compliance with a standard to be demanded by legislation, but there are other ways of giving a standard legal force. One such way is through a legally binding contract and contracts in the public procurement arena offer a most important example.

Standards in Public Procurement

A new Public Procurement Directive, which Member States were required to implement by 31st January 2006, replaces a set of earlier Directives and amendments dating back to 1992/93. These themselves replaced previous Directives. The importance of Community legislation in this area arises because public sector contracting could otherwise lead to serious breaches of the open principles of the Single Market. Public bodies would often frame contractual procedures in ways that were familiar only to the regular bidders for the contracts, and this made it very difficult for an outsider to get an invitation to tender. The variety of national approaches and technical specifications acted as a deterrent to bidders from other nations and such processes were fundamentally incompatible with the Single Market rules of transparency and fairness. The Community has devoted considerable effort to legislating for open procedures in public purchasing, with strict rules for advertising and awarding contracts. These rules also eliminate the use of technical specifications that would favour particular groups of bidders.

The series of Public Procurement Directives has pushed purchasing bodies towards reliance upon European technical standards and specifications, or the national standards which transpose them, and Member States which persisted in using non-harmonized national standards have been fined heavily. It is possible for a public purchasing body to use non-harmonized specifications, where there are over-riding reasons for doing so (such as the need for compatibility with installed equipment), but the procedures for sanctioning this are lengthy and involve additional work. The simplest course is, as was intended, to use European technical specifications. However, one effect of this has been to deter Member States from writing accessibility requirements into their public purchasing specifications, as such requirements are not commonly found in European technical standards used for procurement purposes. Public procurement has in consequence provided less of a lever to promote accessibility in Europe than it has in the USA, for example, where Government purchasing has had a pronounced positive effect on the availability of accessible ICT equipment.

The new Directive recognised this problem and it goes some way towards adopting accessibility principles while still keeping to the fundamental rules of transparency and fairness. Recital 29 includes the comment "Contracting authorities should, whenever possible, lay down technical specifications so as to take into account accessibility criteria for people with disabilities or design for all users". It adds "The technical specifications should be clearly indicated, so that all tenderers know what the requirements established by the contracting authority cover". In other words, it is not sufficient to require that the items must be accessible in some form or other; the manner of achieving this accessibility must be specified in a way that allows the tenderer to prove compliance. Recitals are not binding, but the Articles of a Directive are. Article 23 requires technical specifications to be set out in the contract documents, and includes the wording "Whenever possible, these technical specifications should be defined so as to take into account accessibility criteria for people with disabilities or design for all users". This is expanded in an Annex, which deals with the way in which technical specifications define the characteristics required in the purchased items; among the listed types of characteristics are "design for all requirements (including accessibility for persons with a disability) and conformity assessment".

With this new Directive it will be possible to use accessibility criteria in public procurement even where accessible features are not immediately essential to the purchaser's objective. But in order to do this, there will need to be appropriate European standards which set out the criteria unambiguously and include tests for conformity. Developing these will entail dealing with the same issues that have been described in previous sections. The Commission has published a mandate to the European Standards bodies in order to urge this work forward, but there are no doubts as to the magnitude of the task .

Mandate M/376 requests CEN, CENELEC and ETSI to develop European accessibility requirements for public procurement of products and services in the ICT domain. The main objectives of the Mandate are:

- *to harmonize and facilitate the public procurement of accessible ICT products and services by identifying a set of functional European accessibility requirements for public procurement of products and services in the ICT domain, and*

- *to provide a mechanism through which the public procurers have access to an electronic toolkit, enabling them to make use of these harmonized requirements in procurement process.*

It is hoped that some drafts can be available in 2008. There will be involvement by key stakeholder groups including disability organisations and close cooperation on an international level with other standards bodies. This should give an opportunity for comparison with the U.S. Section 508 Accessibility Guidelines, which are to be reviewed in 2007.

It is especially important with public procurement standards that the tenderer is able to know, at the time that the bid is submitted, whether the offering meets the technical conditions of contract. Transparency rules prohibit a public purchaser from lining up the submitted items and making a subjective choice, or even a choice based upon the outcome of a user evaluation. The conformity tests to which the offerings will be subjected must be described in the tender invitation, and they must be capable of replication in any test situation or laboratory. This places further demands upon the Standards writers to produce precise objective criteria that are capable of independent conformity verification.

Several European public procurement authorities have already been considering how to address accessibility issues in their tendering and some have successfully introduced their own sets of accessibility criteria but, in the absence of harmonized European Standards, these criteria have to be approved case by case through a process involving consultation with all the EU Member States. It is clear that a set of appropriate European Standards, that can be simply called up in any invitation to tender, has to be available before public procurement can become a really effective lever in promoting more accessible products.

Verification and Certification

Wherever conformity to a Standard is required or claimed, there is necessarily a procedure for verifying that conformity. The supplier may carry out his own assessment, using the test procedure laid down in the Standard, or an independent body may perform the testing. In EU legislation, only the most critical or potentially dangerous products have to be tested by an independent approved test house. For most items, a self-certification by the manufacturer or supplier is considered adequate, and this form of certification will usually form a part of the Declaration of Conformity that is obligatory in the Single Market Directives (leading to the application of the CE mark). Self-certification is not an easy option. The supplier will be guilty of making a false trade description if the claimed compliance is found to be unwarranted, and the penalties can be severe, especially if compliance is a legal requirement, for example as part of a Directive or a condition of contract. With independent testing, it is the test house which is liable if the report is in error. For this reason, many suppliers will use an independent test house rather than their own test facility in order to achieve greater confidence in the outcome.

Mostly, however, conformity with accessibility criteria is not a legal obligation in the EU, and sanctions are only likely to apply if a false claim is made by a supplier in the course of trade. A supplier may make a very non-specific claim as to the accessibility of his offerings, without referring to any particular Standard, or no claim at all, so that disappointed users would have no redress – and no information as to which products on the market might suit their particular needs. In these circumstances, users have to rely upon post-market testing by evaluation organisations, that is to say surveys and test reports aimed at giving independent information to consumers. The procedures here are very different from formal conformity assessment. The evaluators are free to use whatever evaluation protocols they consider appropriate, and will often recruit panels of users to carry out actual or simulated 'real life' assessments of the products. The evaluation body may even award its own certification mark to products that perform well, but this is for the information of potential users and has no legal status. For as long as formal accessibility standards are embryonic, however, there will be a possibility that post-market evaluation of this kind is more effective than reliance upon the standards. In other words, the standards themselves need to be tested.

Quality Standards

There is an extensive and well-established set of European and International Standards dealing with quality. Quality, like accessibility, is not a fixed quantity; a product or a service may be intended to have a particular quality level. The object of quality assessment (or quality assurance) is to ensure consistent quality at the desired level. Quality approvals are given to suppliers by registration bodies, who periodically audit the in-house procedures operated by those suppliers to ensure that they are both robust and fully observed. This process could be applied to a supplier's approach to accessibility issues, for example by writing an accessibility assessment section into the Design Manual and the Production Manual. The same results could be obtained from a quite separate registration system, but this may be superfluous if an Accessibility Guide could be drafted for inclusion in the already familiar structure.

5.1.3 Conclusion

The thrust of European Regulation in the ICT sector has been primarily to support the principles of the Single Market and to recognise the contribution of this sector to the European economy. Consumer protection elements have concentrated upon privacy and confidentiality matters, with some acknowledgement of public service issues such as universal service in telecommunications. However, the latter has tended to centre upon legacy notions of fixed line telephony practice and little heed has been paid to newer technologies which have been rolled out unevenly across the EU Member States. Liberalization of the former state monopoly networks has created a division between networks and terminal provision, such that the market for terminal equipment is now driven almost entirely by market forces. The regulatory regimes are chiefly concerned with the avoidance of anti-competitive practices and, while the commercial freedoms have encouraged a vigorous development of new and attractive services, those consumers who are not well served by the forces of a highly competitive and innovative market have little protection. Chief amongst these disadvantaged consumers are those disabled and elderly people who have little economic power and consequently find that their needs go unheeded. The future trends in regulation are now being determined but it seems that the ultimate direction is likely to be one of less regulation to suit a global market-place, rather than one of more regulatory control over the EU's internal market.

If this is to be the scenario, it poses the question of how best to protect the interests of disadvantaged users without hampering innovation and investment. Horizontal anti-discrimination legislation would be one approach but it would appear that the expanding EU Community is not yet ready for this. An extended and up-dated concept of universal service would be another; the EU has plans to look at this in 2007. Writing specific requirements into existing Directives, as they come due for review and revision, would also be possible but the scope is limited because of the diversity of needs and the necessity of keeping the basic types of legislation technologically-neutral and future-proofed.

A quite different approach – which is not mutually exclusive – is to make use of other forms of leverage which could influence the attitude of commerce and industry towards disadvantaged consumers. Awareness of needs and business opportunities is one such. The population size is considerable and although there is a great range of needs – not to be met in a single action – there is potential for a growth in market share with relatively small changes in design concepts. The Inclusive Design/Design for All approach is based upon this notion, with a gradual – not a sudden – expansion of the target user base until, with repetition, a much larger segment of the general population is catered for.

The effective use of standards is crucial to such approaches. Even where standards are voluntary, it is usually in the best interests of manufacturers and suppliers to comply with them rather than seek to support their product claims by other means. In public procurement contracts, standards take on a legal significance that can influence a supplier's attitude towards serving his other customers. The inclusion of Inclusive Design/Design for All principles in a whole range of standards should become as commonplace as reference to quality standards. The scope is enormous and so is the task, for there is need of many more standards that take account of accessibility needs of people with a disability in the ICT sector. However, there are many bodies worldwide that are giving serious attention to this task and, with co-operation, a raft of European Standards that could support and complement regulation will eventually appear. Not least, standards are an important force in industry and trade, which is why these sectors are actively involved in preparing them. Causing the Standards Organisations to take a pro-active role in looking at accessibility issues for people with a disability will automatically engage the industry bodies.

There is good reason to believe that this process has not only begun but is gathering momentum.

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5.2 eAccessibility: European developments and targets

Ima Placencia

5.2.1 Introduction

We live in an information society. Information and Communication Technologies (ICT) permeate almost every aspect of our lives. They can be powerful tools for bringing people together, adding new value to life and creating new wealth, health, welfare, making for a richer and more rewarding professional and social life.

However, in Europe (and elsewhere) millions of people cannot fully reap these benefits and a significant percentage are effectively cut off from them: today, people with disabilities are estimated to make up close to 15% of the European population or 90 million people. Many of them encounter barriers when trying to use ICT products and services. In fact it is difficult to imagine how people with disabilities would be able to enjoy their fundamental rights when accessibility to ICT is not a reality.

The prevalence of both disabilities and other minor functional limitations is strongly related to age. It is estimated that 45% of those persons above 75 years of age are impaired in one way or another in their daily life. The ongoing demographic shift in Europe, as a result among others of a greater life expectancy, will cause a noticeable increase in these numbers over the coming years -- 18% of the European population was aged over 60 in 1990, while for 2030 that percentage is expected to rise to 30%.

Accessible (ICT) can improve the quality of life of people with disabilities significantly.

The European Commission has the ambitious objective of achieving an Information Society for All. This means overcoming the barriers that technology creates for people with disabilities, elderly people and many other users. The Commission wants to ensure an inclusive digital society that provides opportunities for all and minimises the risk of social exclusion.

To achieve the goal of developing such an Information Society for all it is necessary to pay attention to groups at risk of exclusion because of accessibility problems, namely to people with disabilities and in certain cases older persons, who form a large group that represents about 20% of the population in Europe.

* Disclaimer: The views expressed in this article are those of the author and do not necessarily reflect the official European Commission's view on the subject

5.2.2 The eAccessibility Communication

The Community relevance of this subject is well reflected in the initiative launched in 2005 that is called "i2010 – A European Information Society for growth and employment". The i2010 initiative presents a new strategic framework and broad policy orientations to promote an open and competitive digital economy, emphasising (ICT) as a driver of inclusion and quality of life. One of the 3 pillars of the i2010 initiative is intended to develop "An Information Society that is inclusive provides high quality public services and promotes quality of life".

In order to raise the visibility and provide policy guidance on these issues the Commission proposes, among others, to publish an eAccessibility Communication. The Communication was published on September 13, 2005. The main objective of this Communication is to promote a consistent approach to eAccessibility initiatives in the Member States on a voluntary basis as to foster industry self-regulation. Two years after the publication of the Communication a follow-up on the e-Accessibility situation will be made. The Commission may then consider additional measures, including new legislation if deemed necessary. Community action is needed to ensure the inclusion and participation of all Europeans.

In the context of achieving the goals of the Lisbon agenda it is important to mention that large differences exist in employment rates of people with disabilities when compared with the general average in the population in Europe. While 52% of people with disabilities are economically inactive the average in the general population is 28%. Furthermore 42 % of people with disabilities are employed compared to a general average of 65%.

Considering the European goal of improving the level of employment of people with disabilities, and the fact, reflected in the European competitiveness report of 2004, that average government employment is 16,7 of total employment in EU 15 (some countries go up to 30%), with general expenditures in 2003 of 49% of GDP it is evident that governments have an opportunity to promote employment of people with disabilities through accessible workplaces.

Coordinated action by EU Member States is needed to make information and communication technologies more accessible to people with disabilities and older persons.

Public consultation

The Communication took into account the answers of a public online consultation in the domain of eAccessibility launched in January 2005 by the European Commission. The respondents provided a good coverage of the target groups users, industry, public authorities and accessibility experts. It is important to mention that 55% of the respondents were experts or professionals in the area of accessibility and 1 out of 4 respondent stated that they were users of some kind of eAccessibility product or service. Furthermore, 90% of the 500 respondents (public agencies, ICT goods and service suppliers, universities, business associations and user groups) say that requirements to make (ICT) goods and services accessible to elderly and disabled people should be laid down in public procurement contracts. Stakeholders also say that EU institutions should take the lead in proposing these measures (88%). Although there is clear support for some form of product certification or a "labelling" scheme (72%), stakeholders are fairly evenly divided on whether this scheme should be voluntary, mandatory, and/or rely on self-certification with checks.

5.2.3 New eAccessibility approaches

In the Communication, the Commission fosters the use of three approaches not yet widely used in Europe as well as strengthening and continuing several activities that are already underway.

The three new approaches are:

1. Public procurement:

The revised Directives on public procurement contain specific references to using Design for All and accessibility requirements as possible criteria for selecting among tenders. There is a strong need for consistency of accessibility requirements in public procurement in Europe in the ICT domain. The experience in the US with section 508 of the Rehabilitation Act has shown the positive influence of public procurement in promoting accessibility. The European public sector ICT average spending is 0.8% of the GDP. The European Commission held an international workshop on harmonisation of eAccessibility requirements for use in the public procurement of ICT products and services. Main findings are summarised in a publicly accessible report:

http://europa.eu.int/information_society/policy/accessibility/regulation/
index_en.htm.

Taking all this into account, the European Commission proposed to the Member States the development of a European standard for a toolkit for eAccessibility requirements to be used in public procurement. A mandate was issued at the end of 2005 to the European standardisation organisations CEN, CENELEC and ETSI. The work for the Mandate is expected to have started by the end of 2006.

http://europa.eu.int/information_society/policy/accessibility/deploy/pubproc/eso-m376/index_en.htm.

The main objectives of the mandate M-376 are to harmonise and facilitate the public procurement of accessible ICT products and services and to provide a mechanism through which the public procurers have access to an electronic toolkit, enabling them to make use of these harmonised requirements in procurement process.

Even though the most significant field of application of the results of the mandate is public procurement, the results might be useful for other purposes like procurement in the private sector. Public purchases constitute an important market: total public procurement in the EU (15) amounts to €1.500 billion or 16% of the Union's GDP.

The work will be done by two combined project teams, an ETSI Specialist Task Force (STF) and CEN Project Team (PT).

The work of ETSI will consist of:

- *An inventory of ICT products and services (grouped in technical areas) that are usually bought by public procurers*
- *A list of existing functional accessibility requirements in Member States and internationally for those ICT products and services within each technical area, particularly those currently in use in public procurement*
- *In each technical area gaps will be identified where no accessibility requirements exist and suggestions will be provided for developing missing or additional requirements*
- *A list of existing national, European and international standards and technical specifications will be identified which might comply with those requirements. An assessment will be made on whether the above mentioned requirements can be used as either technical specifications or as criteria for awarding public contracts*
- *Finally a proposal will be made for a standardization work programme for the development of requirements and award criteria that still do not exist.*

CEN will establish a Project Team to provide an analysis on testing and conformity schemes of products and services meeting accessibility requirements. The analysis will refer to existing schemes of this nature at European and international levels. The analysis will consider the full range of possible solutions, including supplier self-declaration, certification/ accreditation of suppliers, and third party certification schemes.

The results of both CEN and ETSI will be submitted to open public consultation and will be approved by both organisations.

In this context of accessibility and public procurement, a dialogue has been established between EU and US on the "Exchange of information regarding the planned use of ICT standards in support of Regulations and other Public policies", in the field of Accessibility policies.

2. Certification:

Possibilities for the development, introduction and implementation of certification schemes for accessible ICT products and services will be explored. The goal is to provide guidance to customers and recognition to manufacturers and service providers. The various possible schemes will be investigated and the different options will be compared for their effectiveness. In that context the International workshop on conformity assessment supported by the Commission in 2006 clarified the need for clear, unambiguous testing methodologies that lead to consistent results whether the testing is done in house or by third parties.

In the above mentioned mandate the Commission has asked the European standardisation organisations to prepare a report that will present an analysis on testing and conformity schemes of products and services meeting accessibility requirements. The analysis shall refer to existing schemes of this nature at European and international level. The analysis shall consider the full range of possible solutions, including supplier self-declaration, certification/ accreditation of suppliers, and third party certification schemes.

The analysis shall also address existing or propose requirements for suppliers' technical capacities and abilities in the accessibility domain, which can be used for the selection of suppliers or in support of the conformity process. The intention is to submit this report to an open and accessible review process to facilitate feedback from all interested parties.

It is important to mention that in the 2005 consultation of the Commission mentioned before, there was a clear support for issues like accessibility certification and labelling but with a significance variance between 80% support in groups related to "public agencies" and individuals with disabilities, only 61% of manufactures providers or sellers support it while 32% reject it outright.

3. Explore legal measures.

Legislation demanding accessibility exists already in some Member States and in countries outside Europe. This trend is increasing. There is risk of market fragmentation if accessibility requirements are similar but yet with small divergences, this should be avoided in Europe. In Europe, several legislative documents already have provisions which can be used to enforce eAccessibility. The full potential of this legislation will be be explored in order to advance eAccessibility in a coherent manner.

The new regulatory framework for electronic communications entered into force in July 2003.

Under the New Regulatory Framework a committee called the Communications Committee (COCOM) with Member State representatives was established to assist the Commission in exercising its powers. In February 2003, the COCOM established a special working group called Inclusive Communications (INCOM).

Throughout its work, INCOM has focused on the user perspective, identifying the constraints and problems users with disabilities face in accessing and using electronic communications as well as potential problems and opportunities relating to new and future technologies and applications. The new regulatory framework contains a series of rules and principles that ensure that the liberalisation of the electronic communications market does not occur at the expense of end-users, but brings benefits to them. It assumes that competition and market forces are the most effective means to satisfy user needs, but provide national regulatory authorities (NRAs) with the necessary powers to act to protect users where they need to do so.

Disabled users must enjoy the same rights arising from the Directives as any other end-user. This applies whether these rights stem from the provisions relating to universal service obligations placed on designated undertakings or from other specific provisions (e.g. number portability) which allow end-users to derive maximum benefit in terms of choice, price and quality.

This INCOM report refers to areas, where users have encountered serious problems. Some are directly related to articles in the Directives, in particular the Universal Service Directive and the Framework Directive but some go beyond the Directives. The key urgent topics identified are:

- *Access to national emergency services*
- *Access to telephone services for deaf/hard of hearing/speech impaired/deaf-blind persons*

- *Access to public pay telephones*
- *Access to mobile telephones*
- *Access to directory services*
- *Access to broadcasting, digital television and related services.*

The report provides a series of recommendation to address each of the issues and solve these accessibility problems suggesting concrete actions by public authorities, regulators, industry, operators and users.

The mandate of INCOM was subsequently extended to foster the implementation of the suggestions laid down in the above mentioned report and to provide input on accessibility matters in the revision process of the Electronic Communication Directives package.

In April 2005, a questionnaire was sent to the Member States through COCOM on "the Electronic Communication Package: issues related to disabled users". The aim was to assess the implementation of the legal provisions dealing with disabled users in the Member States, to ensure follow-up of the key problems identified in 2004, and to identify best practices.

The information provided through the questionnaire reveals that the problems identified in the 2004 report remain, confirming the frequently disadvantaged situation of disabled users in Europe, in relation to availability, choice, quality and price of electronic communications. Furthermore, there is very often a lack of information in the Member States on the practical situation of disabled users vis-à-vis access to and use of publicly available telephone services, and of the problems they are confronted with in everyday life. As a consequence, the national provisions do not – or seldom – address specifically disabled users' concerns. Furthermore, the implementation of the provisions of the Directive into national legislation has often appeared to be a "copy-paste" exercise of the compulsory provisions, while the potential of the non compulsory ones have not been exploited.

More worrying is the fact that the problems identified in 2004 do not seem to have been addressed since then as there is still no comprehensive solution in all Member States for disabled users to call the single European emergency number 112; the accessibility to public pay phones is not addressed in a harmonised way in the Member States; text telephones used by deaf users are not interoperable across Member States or across networks; etc.

Some countries are showing some examples of Best Practices by adopting specific measures in the interests of disabled users. For instance, some Member States impose special tariffs to ensure affordability for disabled users; some countries propose text telephones and relay services for deaf and hearing impaired users; some countries impose a legal obligation to provide terminal devices enabling hearing impaired people to access publicly available telephone services, free access to information services for visually impaired users, special telephone number for deaf users to access 112; some countries impose an obligation upon service providers to provide copies of contracts and bills in a form suitable for visually impaired customers. However, there does not seem to be a comprehensive and a coherent action to address the needs of people with disabilities. One of the probable reasons for this could be the lack of information in the Member States about the situation of disabled users.

The INCOM group made a set of the recommendations that will be provided as input to the review process.

In the current legislative framework, telecommunication terminals fall under the Radio and Terminal equipment directive. The group of Member States representatives that support the implementation of the Directive is called TCAM. In 2004, in order to improve accessibility of terminals and to address the issue of real time text communication, discussions were held in TCAM on the need for regulation to ensure accessibility to telecommunications services. Notably the aspects of real-time text communications related to cross-border (and international) communications and access to emergency services (112). Market forces have as yet failed to ensure seamless service, interoperability and access to 112. There furthermore was a risk of fragmentation resulting from national procurement practices and financial support structures. In March 2005 a subgroup was created with Industry and NGOs and were given the task to propose a road map to identify and tackle bottlenecks in this area. There were 2 working groups, the first one on accessibility requirements for conversational systems for deaf and hard of hearing persons in particular text and video communication and the second on accessibility features of mainstream products. The results of both groups were inconclusive. While there were very relevant technical contributions it was evident that no agreement was reached on the drafting of a road map. Furthermore, it became apparent that industry was not in a position to commit to a roadmap.

Demonstrations made at the recent meetings show that technical solutions are possible in the area of text communications. These use the flexibility offered in current state of the art terminals that have multimedia capabilities to provide real time character by character text communication. Investments to run the service seem moderate and mainly consist of running a server and develop some add on software for the terminals. These systems are however still in the trial phase and therefore charge and management costs are as yet unknown.

These solutions have been developed nationally with local funding, but moreover are not interoperable among themselves or across networks and are often platform dependent. They provide a limited solution for a local community often driven by a user organisation. They furthermore are not designed to interface with mainstream instant messaging services (e.g. MS messenger) and their users therefore are deprived from using a single messaging service

As regards the accessibility features of mainstream products, it was observed that currently add-ons such as separate key boards do not have standardised interfaces and remain device or platform specific. Technologies responding to disabilities other than hearing impaired, seem to be less developed. In addition user associations, that develop special solutions report on difficulties to get information on terminal proprietary software and note inconsistencies in functionalities of the interfacing making it difficult to interact with assistive technologies.

Since the attempts to arrive at a voluntary roadmap have failed, TCAM should now consider which consequences should be drawn.

It remains uncertain whether market forces will lead to a level of harmonisation that will enable seamless and ubiquitous services and interoperable terminals. Public authorities, certainly where they are supporting certain technical developments, should give prominent attention to the need for seamless cross-border and multiplatform services.

TCAM is reflecting on the adoption of regulations under article 3.3.f, which would ensure that no barriers are caused by terminal equipment to establishing pan-European interoperable services and proposed the committee an outline for a first Commission Decision to address these issues. The Commission is consulting the Member States and further action will depend on the results of these discussions.

5.2.4 Ongoing activities at EU level

Several types of actions have been promoted by and supported by the Commission for more than 10 years having a clear impact on eAccessibility in Europe. However it is clearly identified that further action is needed in this field. In order to reach the goal of a Knowledgeable and Sustainable European Society for All, two fundamental challenges must be met to continue making new technologies and technology-based systems accessible to all and continue to apply technology to the task of genuinely empowering all citizens to play a full role in society. Designing ICT products and services from the very beginning so that they can be used by the widest possible population following "Design for all" methods instead of retrofitting accessible solution is essential for the creation of a sustainable Information society for all.

1. Accessibility requirements and standards. European Standards on eAccessibility would contribute to the proper functioning of the Single European market. The Commission continues to support the development of Accessibility standards also in the ICT domain while at the same time promoting their implementation and use.

2. Design for All: It is important to spread widely the knowledge and use of Design for All methods, practices and tools. Introducing Design for All in the education of future information society professionals is a way of investing in a more accessible information society. The Commission is promoting the work on the ICT European Curriculum in Design for all and enhancing the cooperation of key actors through the EDeAN network created under the eEurope action plan. The basic skills and knowledge for a European Curriculum for "Design for All" has been developed by the idcnet project http://www.idcnet.info/home The results can be found at the European design for All and eAccessibility network of National Centres of Excellence (EDeAN): http://www.edean.org which provide a resource centre in Design for All and exchange of information on courses. Furthermore in order to raise awareness on Design for All, the European Commission issued the first European Awards "Innovation in Design for All and Assistive Technologies" at the REHACARE International in Düsseldorf in November 2004,

3. Web accessibility : The eEurope 2002 Action Plan included one action line on improving the accessibility of public Web sites by adoption of the Web Content Accessibility guidelines (WCAG 1.0) developed by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). The nominated actors for this action line were The European Commission and the Member States. The Commission produced a Communication[1] including many recommendations for implementation. Other EU Institutions responded to this Communication, supporting the actions undertaken and suggesting further measures. One of the actions requested by the Council is a common methodology for the evaluation of the progress made in order to obtain comparable data. To date all the Member States and EU institutions are applying the guidelines to public sites at European and national however, a common monitoring mechanism is still to be put in place the results of the various studies however show agreement on the fact that there is still a very low level of accessibility on the public web sites in Europe today. There is a need to have results of the monitoring exercises published in order to

[1]COM(2001) 529 final of 25.09.2001

benchmark the improvement in Europe. Benchmarking will stimulate each country to energise their process.

Also in the long run, accessibility should not be treated as a separate issue but should be integrated in relevant government activities in particular all global Web quality control mechanisms at all levels (Web masters procedures, administrations audits, etc).

Furthermore, the need to formally assess and certify accessibility of public web sites has emerged as a priority in the Member States after the adoption of the Web Accessibility Guidelines and is currently under exploration. A number of projects are developing a European methodology to monitor web accessibility of public websites in Europe: project BenToWeb, http://bentoweb.org/home ; Project EIAO, http://en.ftb-net.de/projekte/eiao.html; Project Support-EAM, http://www.support-eam.org; The first version of the methodology has been released in October 2005. The Information Society is rapidly developing to respond to these changes, the WAI is now preparing its second version of the guidelines, to follow these technological developments. The Commission is supporting the research work on web accessibility in W3C through Project like the WAI TIES http://www.w3.org/WAI/TIES/.

4. Benchmark and monitor. The eAccessibility Communication recognised the need to set targets for accessibility and monitor progress. Several Member States are introducing benchmarking for accessibility and monitoring in their national legislation. It is essential to have European data comparable across Member States. In order to measure eAccessibility progress in Europe the Commission issued a study with the objectives of identifying measures (e.g. policy, legal, industrial, …) that have a significant positive impact on eAccessibility and that support the Community eAccessibility strategy. The idea is to assess how ICT products and services available in Europe take into account eAccessibility and Design for All. The study will develop indicators to assess the eAccessibility situation in Europe and to measure its evolution quantifying the impact of the proposed approaches and measures. Furthermore it is important to assess the implementation of successful measures, that can serve as policy recommendations in the eAccessibility domain.

Some of the expected results are the identification of existing methodologies and indicators and the development of a methodology to monitor and identify the existing use of the 3 proposed approaches mentioned above and other existing positive actions.

A methodology and adequate indicators will be developed to measure the rate of eAccessibility in the Member States, experienced by people with disabilities and older people, as well as the rate of eAccessibility, experienced by other stakeholders.

The first measurement and analysis of the data is expected by the end of this year. A second measurement and analysis of the data will happen a year later and this will enable measurements to be compared and evolution to be assessed. The final report including conclusions and policy recommendations and two workshops to disseminate and validate the results of the methodology, measurements and the conclusions will serve to provide evidence for the report that the eAccessibility Communication announces for two years after publication.

5. Research remains a key instrument to investigate new technological solutions to address the needs of people with disabilities and older persons. It is a fundamental element in the way towards an accessible Information Society for all.

DG Information Society and Media has worked since 1991 in Research and Technological Development for people with disabilities and older persons in several programmes: Tide (technology initiative for disabled and elderly. Basically in 15 years about 200 Million Euros have been spend in funding approximately 200 projects in all areas of eAccessibility dealing with technologies for people with disabilities and older persons. Projects have developed Assistive solutions including restoration and enhancement of function, access to technology and related services, life at home and remote care, access to mobility and transport, applications services for elderly and disabled users and for their carers, Design for All of mainstream ICT and Long Term Research on a deeper understanding of the cognitive, perceptual and sensory processes in relation to disability and technology), and within the Framework programmes.

The European Commission has issued several call for proposals within the 6th Research Framework Programme. On going RTD projects can be found at http://www.cordis.lu/ist/so/einclusion/home.html

The first call for proposal for FP7 is under preparation. In the Commission proposal for the 7th RTD Framework Programme there is a section called ICT and inclusion that addresses inter alia disability and ageing (see more at http://www.cordis.lu/ist/so/einclusion/) as well as a proposal for an initiative based on Article 169 particularly relevant for older persons with multiple disabilities. As technology evolves and new ICT products are introduced in the market on one hand new opportunities for accessibility emerge. However, RTD work on eAccessibility remains essential to prevent new accessibility barriers and develop state of the art assistive solutions. Many of the above policy actions that have been and are undertaken complement RTD work and are important for the take up of RTD results in the market so that they can be incorporated in products in the market.

Finally, the Commission will measure progress on eAccessibility and present a report in 2 years proposing new measures including new legislation if deemed necessary. This action is part of the i2010 initiative.

Regarding the involvement of disability organisations and disabled users, although there is no mandatory requirement, since 1991 it has been common practice to involve them at the consultation level when preparing the work programmes, at the evaluation level (inviting experts with disabilities in evaluations) and in the project execution level.

5.2.5 Conclusion

The commitment of the Member States and the European Commission towards the actions carried out under the umbrella of i2010 and announced in the eAccessibility Communication have been confirmed by the Riga declaration.

http://ec.europa.eu/information_society/policy/accessibility/eincl/policy/2006-riga/index_en.htm

Member States agreed not only to support the actions proposed in the eAccessibility Communication but also to explore the possibility of making mandatory by 2010 European eAccessibility standards and common approaches in public procurement for ICT products and services.

Furthermore they confirmed their commitment to ensuring accessibility of all public web sites by 2010, through compliance with the relevant W3C common web accessibility standards and guidelines.

Finally, during the next two years the Commission will continue to raise awareness, promote the use of the proposed instruments, gather evidence and consult stakeholders in order to take informed decisions in the eAccessibility domain. This work will be used by the Commission to evaluate policy options and identify additional measures if deemed necessary to improve the eAccessibility domain.

6. The role of evaluation of accessibility

6.1 Introduction

Steve Tyler

A key objective of COST 219ter is to devise a mechanism through which industry can engage with and deliver on the development of devices and systems that are accessible to the widest possible audience. Not only do we want to ensure full accessibility to people with disabilities or for those that find technology challenging to use (to allow full participation in modern society and life), but there is clear evidence that by engaging this market with products that are genuinely usable, take up and income generation possibilities are potentially extremely lucrative.

Marketing in this particular sector is notoriously challenging not least because manufacturers and service providers are not clear about the benefits of their products, not clear how to assess benefits and usability, and not clear which channels to use to guarantee maximum effectiveness. As a result, the sector as a rule has been treated as "niche" or "specialist".

This is odd since in fact users with any form of disability largely want to be a citizen and communicate with people in the same way as everyone else does. The needs of user groups are no different in terms of services in many cases - but the way in which products are used or interacted with may be very different.

Additionally, it is clear in any research in this area that good accessibility and usability design is good accessibility and usability for all users. Many of the products we take for granted today are direct results of well-designed products originally developed for the disability community; they have stood the test of time either because of good design principles or because they address user requirements that turn out to be very mainstream - OCR systems, the typewriter (qwerty keyboard of course being a natural derivative) and the original gramophone are all good examples.

Understanding the challenges of and working with the manufacturing and service provider industry has led the COST 219ter Action not only to focus on what we mean by accessibility and usability for end users, but most importantly, how we could devise systems and processes that industry could follow - systems and processes that could be easily implemented, that fit in to frameworks of testing and evaluation that already exist.

To achieve this most comprehensively, the team:

- *Worked closely with industry through discussion and presentation to understand next generation products, device development timescales and processes, and costs around delivery*
- *Established latest mainstream research indications of future technology direction along with checking with industry*
- *Built up a picture of how industry expected users to be taking advantage of new technologies along with scenario building and testing of these assumptions.*

As a result of this work, this chapter describes the process by which we arrived at the development of the evaluation toolkit - a toolkit we believe is probably the most valuable way of achieving our objective - and we believe the objective of the service provider and manufacturer community - selling more good quality, well designed products that will appeal to the maximum number of users.

We adopted the following process:

- *Establishing how manufacturers used their own testing facilities and/or testing laboratories across Europe*
- *Establishing where they were located*
- *Sending a questionnaire that painted a picture of the regular work currently undertaken as well as the level of existing knowledge in the subject of accessibility*
- *Home in on the subset that displayed some accessibility knowledge to find out if there were any existing best practice methods or protocols currently used.*

Having trawled for knowledge in the field, a similar exercise was conducted in the disability community across organisations and research institutions. From this work, a team of Ergonomist's derived an industry usable methodology that could be imbedded in to standard practice and that would measure the accessibility of network services and terminals.

In new and next generation mobile services, networks are often intrinsically linked to the handsets, often using back-end systems that represent information to users appropriate to the device, browser, etc. Services and devices are inextricably linked and form a unified offering. Evaluating these poses real challenges. The next sections describe how we arrived at our methodology as well as giving a current example of accessibility testing and the benefits it can bring to design principles.

6.2 Evaluation trends

Edward Chandler, Elizabeth Dixon and Steve Tyler

An initial piece of work was undertaken to establish what types of evaluation or usability assessments were carried out by test houses, industry laboratories and other institutions that currently conduct testing on behalf of manufacturers.

It is clear that testing and evaluation for usability or ergonomic design does take place in some domains more than others - Web Accessibility Testing for example is extremely common as an approach to legislative compliance or good user experience. This and other areas were examined to assess whether or not there were usable tools that were transferable into the telecoms industry.

Finally, an existing methodology currently being used by RNIB that adopts a pan-disability approach was modified and tested with live users to find out if it was possible to achieve a high correlation between real user experience and reported results on the one hand and the expert evaluation toolkit output on the other, modified through experience of this project, the toolkit could be validated.

6.2.1 Review of web accessibility evaluation

Julio Abascal, Myriam Arrue, Markel Vigo, Elizabeth Dixon and Steve Tyler

From the inception of the W3C (Worldwide Web Consortium), the Web Accessibility Initiative played a vital part, in that it has played and plays a monitoring role with a keen eye on accessibility. As new guidance and recommendations are produced by Consortium members, accessibility testing and accessibility requirements are added in to the emerging recommendation.

As a result of this approach, the methodologies and toolkits developed in this sphere are instructive since accessibility is so closely allied to anything published by the consortium. Furthermore, the web as a carrier and distributor of information or a network from which telecoms and personal devices derive information, plays an increasingly important role in telecoms services - directly or as a value-added provider.

Vital lessons can be learnt from the evolution of the evaluation of web pages for accessibility. The evaluation of the web page involves the evaluator(s) initially checking the web page against a set of accessibility guidelines manually. This was found to be laborious at times and prone to errors with the guidelines being frequently misinterpreted. Therefore in order to help speed up the evaluation process and minimize potential errors some of these guidelines were automated. These tools are usually in the form of a software program or online service. Telecommunication devices may also benefit from having such tools to use as a basis for a wider approach to accessibility evaluation.

Tools for automated web accessibility evaluation (including those for repair) are currently very advanced. These tools are usually able to search the (X)HTML code to check the accomplishment of accessibility guidelines. Other features, such as CSS or XML code conformance with standards can also be automatically checked.

The Web Content Accessibility Guidelines (WCAG) 1.0 [Chisholm et al, 1999] issued by WAI are recognised worldwide as useful recommendations for web accessibility evaluation. Marincu and McMillan, 2004 state that these guidelines are now a reference point in achieving Web accessibility in many of the E.U.'s member states.

Some countries have released their own interpretation of these accessibility guidelines. E.U. member states which have included or adapted the WCAG 1.0 into their web accessibility program include:

- *Ireland whom have the Irish Guidelines for Web Accessibility*
- *UK where guidelines can be found for UK Governmental Web sites*
- *France where there is the Circulaire du 7 octobre 1999 relative aux sites internet des services et des établissements publics de l'Etat*
- *Germany, which implements the Barrierefreie Informationstechnik–Verordnung*
- *Sweden, which conforms to its own guidelines known as the "Vägledning 24-timmars webben 2.0"*
- *Italy, the "Stanca Law", passed in February 2006, which forces Italian government agencies to make their Web sites fully accessible.*

In the USA there is the "Section 508 of the Rehabilitation Act in the USA" which provides the equivalent information to the WCAG.

Nevertheless, due to the different formats and structures used for defining accessibility guidelines, interpreting them and determining the possible conflicts between them require a great amount of effort from web developers. Moreover, the ambiguity and the low level of expressiveness in the definition of some accessibility guidelines may result in different interpretations of the same guideline. In this situation, web accessibility evaluation is a complex task which can be simplified by using an automatic accessibility evaluation tool.

There are several free automatic evaluation and repair tools such as WAVE and A-Prompt which are based on specific accessibility guidelines sets. These evaluation tools have a strict guideline specification since guidelines are implemented within the evaluation tool. However, there are some more flexible evaluation tools that are able to verify the accomplishment of any set of guidelines specified in a machine-readable language, usually a version of XML such as GXML [Abascal et al, 2004], GDL [Bereikdar et al, 2005] and GAL [Leporini et al, 2006]. This allows for easy updating to the last version of accessibility guidelines, to define specific guidelines for groups of users such as the elderly [Kurniawan et al, 2005], and also to evaluate any other characteristic that can be expressed using the adequate language.

Research to create or adapt tools that can automatically evaluate the accessibility in other domains can provide a first step for people interested in accessibility evaluation. In this way, experiences with automatic evaluation of the accessibility of web content can be transferred to a limited extent to evaluate web pages for small screens. This can be used as a first step forward to enlarging the field of automatic accessibility evaluation. In this sense, Mobile Web Best Practices are being discussed and a web accessibility evaluation tool has been adapted in order to evaluate mobile web interfaces [Rabin and McCathieNevile, 2006 and Arrue et al, 2006].

It is evident that the possibility of performing a considerable part of the accessibility evaluation automatically would make it cheaper and more popular. For this reason, efficient tools and sound methods are needed to facilitate all phases of a complete evaluation. For instance, one of the problems of manual evaluation is reporting the results in a way that is useful for developers. Therefore, evaluators – experts and users – must be provided with tools for reporting accessibility failures in an efficient and understandable way.

A conclusion that can be drawn from this is that testing and compliance or usability tools can be written for wider software applications and platforms. Accessibility checkers and methodological toolkits are being developed for Microsoft Windows programs focussing on such issues as "Is there a keyboard shortcut for all mouse commands?", "Does the software conform to standard keyboard expectations (e.g. Alt - o for open?)" etc.

Clearly this can be extended to mobile phone and PDA handsets - indeed, the Symbian 60 phones and most other products from Nokia conform to a common look-and-feel interface.

In the web environment, although much can be automated, experience shows that real user testing or at least a clear methodology carried out by experts is still the most accurate mechanism for establishing the accessibility level of a website and/or software.

Next generation mobile devices will become more reliant on mobile web-based or wireless services - the interaction between phone software, network based services and web-based (external) systems will become more seamless - accessibility and usability testing in all of these environments will become crucial if the end user experience is to be a pleasant and productive one. A joined up holistic approach to accessibility testing is therefore crucial.

6.2.2 Current trends in accessibility evaluation

Web accessibility evaluation has provided an exemplar of the widespread resources available which developers can use to develop accessible web sites. However, for the evaluation of other products and services, accessibility evaluation is still very much in its infancy with little resource available to assist. To determine the extent of the problem it was crucial to establish what the current trends in industry were by:

- *Investigating which organisations evaluate for accessibility*
- *Investigating how much industry really knows about evaluating for accessibility*
- *Where they exist, establishing which evaluation methodologies are being used*
- *Establishing which areas of industry are being evaluated.*

To fulfil the objectives a two stage questionnaire process was carried out:

- *Stage one identified how many of the most likely and what types of European organisations there were, how many knew about accessibility evaluation and how many evaluated next generation network services and terminals for accessibility*
- *Stage two identified that of those that stated that they did know about accessibility testing, which methodologies organisations were using and which domains were being evaluated.*

Two hundred European organisations that tested products or systems received the stage one questionnaire. Of these, only twenty-six responded. Twenty-four organisations informed COST 219ter that they conducted research into the accessibility of next generation network services and terminals for disabled and elderly people. The results showed that of the twenty-six respondents, nineteen performed evaluations in usability and accessibility, with four evaluating for accessibility only and three evaluating for usability only. Finally twenty-three organisations agreed to take part in stage two of the process. A list of organisations that test/evaluate accessibility can be found on the COST 219ter website (http://www.cost219.org).

The second stage questionnaire was distributed to the twenty-three organisations that agreed to take part. Twelve of these responded. The results showed that popular methods used included questionnaires, interviews, observations, focus groups, expert groups and panels, task analysis, user groups and user panels, scenarios, prototyping and finally heuristic evaluations. This information links well with the literature, which cites all these methods as popular [Stanton et al, 2005].

Popular areas of industry that were found to be evaluated included; mobile phones and services, telecommunication services, software, computers, PDA's and handsets, and finally, smart homes.

The results of the questionnaires suggested that there was only a limited amount of work being carried out into the evaluation of next generation network services and terminals for accessibility with fewer than 15% responding to the first questionnaire. Interestingly, the results from the first questionnaire showed that most of the organisations evaluated for accessibility and usability with only a minority stating they only tested for accessibility or usability. Further information about the findings of the questionnaires can be obtained from the report written by Anna-Liisa Salminen on the COST 219ter website (http://www.cost219.org).

The results also showed that a variety of methodologies were used covering various domains for evaluating next generation of network services and terminals for disabled and elderly people.

Finally, the results of both questionnaires evidently make it clear that the evaluation of next generation network services and terminals is only being conducted to a limited degree. The research has demonstrated that although a number of evaluation methodologies exist and are being used, it is not obviously apparent that any are thorough and specific enough to evaluate mobile phones for accessibility and ease of use across various disabled user groups and the elderly population in any depth.

6.2.3 Methodologies used by COST 219ter members

As part of the process of looking at current trends in industry for evaluating for accessibility of next generation of network services and terminals, it was important also to investigate what members of COST219ter were currently using. The Royal National Institute of the Blind (RNIB), a member of COST 219ter, had indicated that it carried out extensive evaluations on products and systems, including mobile phones. COST 219ter felt that the methodology used by the RNIB should be reviewed to understand it in greater detail and determine if anything could be learnt from this evaluation methodology. The aim of this work was to determine if a methodology exists which is suitable for recommendation for implementation across industry by COST 219ter.

This visit identified that RNIB carried out extensive user evaluations on products to ensure that they were accessible for blind and partially sighted people. From the knowledge and expertise gained from these evaluations, RNIB created a simple set of guidelines as a means of assessing products initially without involving end users.

However, these guidelines had some shortfalls. Firstly, they were not specifically aimed at next generation mobile phones and as such were not detailed enough to cover the exact requirements needed to fully evaluate a device such as a mobile phone. This included the physical aspects unique to a mobile phone, the operating system and the services that users can access from their mobile phone. Secondly, these guidelines only considered the needs of blind and partially sighted people and finally, the guidelines were only written at a very top level without any detail. Further information about the findings of this work can be obtained from the report written by Kristian Kristiansson on the COST 219ter website (http://www.cost219.org).

After further analysis, it was decided that the evaluation method used by RNIB showed potential for being used by COST 219ter for evaluating next generation mobile phones. In order to fulfil the objectives of the Action it was recommended that these guidelines be adapted to address the above issues.

Analysis showed that the specialist organisations that carry out evaluations of any description in the blindness sector across Europe did not have as robust a mechanism as used by RNIB and it was clear that certainly within the sector in Europe, its techniques were verifiable, consistent and replicable in terms of methodology and result.

6.2.4 Suitability of these methodologies for implementation across industry

The results of the COST219ter research showed that at present there is no evaluation methodology that addresses the needs of disabled and elderly users for ensuring that next generation mobile phones are designed to be inclusive. Therefore a toolkit is needed to address this gap to ensure that mobile phones are developed to be as inclusive as possible.

Whilst this toolkit needs to evaluate accurately and effectively the accessibility of a mobile phone, it also needs to be usable by the person or persons using it. Without the usability of the toolkit being accounted for, there would be a danger of having a solution which would not be accepted by the telecommunications industry due to its own complexity. Therefore any toolkit should not assume prior expertise or knowledge, yet it should be easy to understand and complete.

The research has shown that a toolkit could be proposed using RNIB's evaluation guidelines as its foundation. Such a toolkit would need to encompass the accessibility needs of various disabled user groups and also need to be developed so that it is aimed specifically at next generation mobile phones.

The example of automatic evaluation has been advantageous in web site accessibility. This example deserves attention to determine if similar tools can be produced to evaluate the accessibility of mobile phones particularly for evaluating the accessibility of mobile web pages. This would satisfy manufacturers who do not wish to extend design and manufacturing times whilst satisfying the needs of users that are currently being excluded from using mobile phones.

6.3 Mobile phone evaluation toolkit

Edward Chandler, Elizabeth Dixon and Steve Tyler

The toolkit is a simple methodology which is capable of evaluating the accessibility of a mobile phone. The toolkit comprises three sets of heuristics which cover the basic accessibility features of the physical part of the phone, the operating system and the services.

Each set has approximately 14 heuristic principles (rules of thumb). For each principle, checkpoints are given to objectively measure the accessibility/usability of the device against a set pass/fail criteria. Accompanying each set of heuristics is a completion form which includes a fail criterion for each checkpoint. It also shows whether or not the checkpoint is a high or low priority and provides a comments section. Finally, it includes a section for any additional information and recommendations for future work on that phone. The heuristic principles are as follows:

Hardware principles

- *Promote easy identification and orientation of the product*
- *Provide clear print (visual information)*
- *Provide clear visual information (non print)*
- *Promote the location of the buttons, switches, dials, and joysticks by sight*
- *Promote the location of the buttons, switches, dials, and joysticks by touch*
- *Promote the location of the connectors, sockets, battery, battery compartment/back cover, SIM card holder, memory card and memory card holders by sight*
- *Promote the location of the connectors, sockets, battery, battery compartment/back cover, SIM card holder, memory cards, memory card slot by touch*
- *Provide clear tactile information (texture/size/differences)*
- *Promote clear audible information*
- *Enable the battery, SIM card and memory card to be used easily*
- *Enable the product to be physically easy to use*
- *Promote compatibility with other devices*
- *Provide clear Instructions*
- *Provide easy to use packaging.*

Software principles

- *Allow choice over the input and output method*
- *Optimise the input method*

- *Optimise the output method*
- *Allow personalisation of the input*
- *Allow personalisation of the output*
- *Allow personalisation of the alerts*
- *Promote flexibility*
- *Promote consistency*
- *Provide easy to understand menus*
- *Provide intuitive prompts and informative feedback*
- *Promote easy to use soft keys*
- *Aid recovery and prevent errors*
- *Promote easy connectivity and compatibility with other devices and/or software*
- *Aid task completion.*

Web services principles

- *Allow flexible access to the service*
- *Enable user style sheets*
- *Optimise colour and contrast*
- *Use text effectively to improve readability*
- *Consistent page layout*
- *Provide content that can easily be scanned*
- *Easy to use navigation*
- *Provide meaningful links*
- *Provide accessible forms*
- *Use JavaScript carefully*
- *Promote accessible multimedia*

- *Provide informative feedback and prompts*
- *Aid recovery and prevent errors*
- *Aid task completion.*

Further information about these heuristics and their checkpoints can be obtained from: www.cost219.org/toolkit.

It is important to remember that these heuristics may be applied at any time during the design phase or at later stages of the development process or once a product has been released to market. However, it is recommended that these guidelines should be applied as soon as an initial mock up or paper prototype of the device becomes available to minimise design costs.

This toolkit should never be used in isolation as a total evaluation process for evaluating mobile phones. It is intended to highlight basic accessibility issues which currently inhibit disabled users from using a mobile phone.

6.3.1 Development

When the toolkit was in development, it was clear from previous work that the scope of the toolkit needed to be closely specified, it should be a simple methodology capable of evaluating the accessibility of a mobile phone and finally it would have to be validated against end user requirements.

Prior to commencing work on the toolkit, it was important to carry out a scoping exercise defining the parameters of the toolkit. Evaluating a mobile device could potentially include a vast array of possibilities. Therefore as part of this process the following questions were addressed:

- *What would be the main focus of the toolkit?*
- *What is the common core functionality found across different mobile devices?*
- *How would a toolkit cater for the growing and varying array of functions across devices?*
- *How can the toolkit be designed to be future proof (what are the key functions that are likely to persist in the future?) Would there be an increase of multimodal access to mobile phones?)*
- *Could the toolkit cover all user needs yet remain usable?*

To take all these points into consideration, adapting and creating a toolkit to address every functionality/service would be impractical. Therefore rather than adapting the toolkit to cover every possibility, the scope of the mobile phone evaluation toolkit was limited to cover:

- *The physical part of the mobile phone (hardware)*
- *The core functionality (including the operating system and the software installed)*
- *Mobile web based services.*

Additional guidelines would be needed in the future to cover other functionalities such as GPS software. These have not been included at this stage as it is likely that these would require separate guidelines specific to technologies and deployed services. Another area likely to require guidelines is for the creation of accessibility advice for SMS services. However, it is vital to focus on the core functionality of the phone first so that disabled and elderly users can use the phone.

The toolkit includes a list of guidelines for creating accessible mobile web services that are provided over the mobile internet. These guidelines build on the foundations already in place for web accessibility for larger screens.

In order to develop a simple methodology it was decided that detailed checkpoints should be provided under each heuristic principle to guide the evaluator completing the evaluation with the type of issues to check for, as well as providing a completion form alongside the heuristics for ease of completion. During the development of the toolkit the heuristic principles were adapted to accommodate their new checkpoints for each principle.

Several types of mobile phones were analysed during the development of the heuristics and their accompanying checkpoints so that a range of different phone features could be accommodated by the methodology.

As part of this work the RNIB worked alongside other parties close to disabled end users. These included the Swedish Handicap Institute, The Royal National Institute for Deaf people (RNID) and Special education and Rehabilitation department of faculty of Human Kinetics (FMH), Lisbon. The Swedish Handicap Institute drafted their own set of heuristics for people with learning difficulties. RNID and FMH, Lisbon provided recommendations to consider the needs of deaf and hard of hearing users, people with limited dexterity and people with learning difficulties. Each organisation provided recommendations in the form of checkpoints which they felt needed to be added. These were inserted under the relevant heuristic principles.

It was vital that the guidelines accurately reflected the accessibility issues that most users frequently found so these guidelines could be used to accurately evaluate a mobile phone. This would enable evaluators with practically no prior knowledge of accessibility issues of mobile phones to be able to use these guidelines to identify and resolve frequently found accessibility issues.

Once a full set of heuristics was available, it was essential that the heuristics were validated to determine whether they accurately evaluated the accessibility of a mobile phone. This validation involved comparing the results of the heuristic evaluation against end user requirements. The results of the comparison would show whether the heuristics and their checkpoints were successful in identifying accessibility shortfalls in a mobile phone.

6.3.2 End user evaluation and toolkit validation

The aim of the validation was to identify whether or not the toolkit was successful at identifying the accessibility issues which users found during the evaluation.

In order to achieve the validation of the toolkit, a project was organised which would perform an evaluation of a mobile phone using the toolkit as well as an in-depth end user evaluation. This study encompassed four user groups:

- *Blind and partially sighted people*
- *Deaf and hard of hearing people*
- *People with limited dexterity*
- *People with learning difficulties.*

These users were recruited by Intercollege in Cyprus, the Special education and Rehabilitation department of faculty of Human Kinetics (FMH) in Portugal, RNID and RNIB in the UK. The results were gathered using focus groups, interviews and questionnaires for each group of end users. The results of the user trials in the UK, Cyprus and Portugal were amalgamated and then compared with the results of an expert evaluation using the heuristic principles. Further information about the findings of this work can be obtained from the report written by Edward Chandler, Elizabeth Dixon, Leonor Moniz Pereira and Cristina Espadinha on the COST 219ter website (http://www.cost219.org).

During the evaluation, there were a number of unexpected results. A summary of these has been highlighted below as well as a summary of the validation study as a whole.

In general, the blind and partially sighted participants found they could dismantle and assemble the phone although most had not done this before. These participants stated that they would get a friend/relation or shop assistant to dismantle and reassemble the phone due to the perceived complexity of the task.

As well as this, most of the UK based blind and partially sighted people had avoided predictive text before the evaluation as they found it impossible to use. However, the majority of the blind and partially sighted group thought that using predictive text was fairly easy to do and would consider using it more. These results were mimicked by the participants with learning difficulties too.

Other unlikely results were linked to menu customisation. The results showed that most users wanted to be able to move menu items as required. This showed that these users liked to make the phone easier to use for them in terms of menu structure. Linked to this, there was almost a 50/50 split between whether to display the menu as a grid format or as a list format. These results highlight the need to make the operating system of the phone highly customisable.

Finally, the results showed that nearly all of the participants liked to change profiles on their mobile phone. There was a strong demand from end users to be able to alter how the mobile phone responds in different environments. This highlighted the importance of user profiles and the benefits of user profiling.

The comparison of the results between the toolkit evaluation and the end user evaluation confirmed whether or not the toolkit provided guidance for the type of problems that users typically found. It showed where the toolkit matched typical problems that users found, as well as highlighting any areas where the results did not match. Checkpoints which did not match were highlighted for review.

The validation study has shown that generally the toolkit match what users with disabilities require to determine if mobile phones are accessible and easy to use. The study also identified that additional work was needed to refine some elements of the checkpoints further. This would make the toolkit more precise.

6.3.3 Outcomes

An evaluation methodology has been designed which can assess the accessibility of a mobile phone. This evaluation methodology uses a series of heuristic principles with detailed checkpoints, which can be used to identify the level of accessibility of a mobile phone. The checkpoints have been specifically designed to evaluate the features of a mobile phone only and would need to be modified further to evaluate another product or system.

This methodology can be used to evaluate a mobile phone when it is being designed, the most ideal use of it being during other testing protocols or design checking, or when it is out on the market. It can also be used by someone who has limited or no prior knowledge of heuristics and evaluation for disabled people as the toolkit guides the person completing it.

As the toolkit has been validated with end users, this is a robust method of evaluating the accessibility of a mobile phone.

We will monitor the effectiveness of the toolkit as new generations of technology emerge and modify it accordingly.

6.4 Case study: an example of how evaluation may change the design: ATM project in Portugal

Leonor Moniz Pereira, António Cordeiro, João Brisson Lopes, Cristina Espadinha, Manuel Ribeiro

6.4.1 Introduction

In today's society ATM machines play an important role in providing financial services at any time, facilitating daily life routines to a large number of people. However, people with disabilities and elderly people may experience many problems using them.

In fact some services may be unavailable to certain groups, e.g., payments and other services not designed with the needs of people with blindness, motor impairment, learning difficulties, those who are cognitively impaired or even the elderly in mind during design.

According to Gill (1998) people with disabilities and elderly people may have accessibility problems using ATMs at least in one of the following behaviours:

- *locating a terminal (ATM)*
- *accessing the terminal*
- *reading and understanding instructions*
- *inserting the card*

- *reading the screen*
- *using the keypad*
- *using the touch screen*
- *listening to audio output*
- *reading printed output*
- *retrieving the card.*

Some disabilities have a stronger direct impact than others on the individual ability to use ATMs. The ability may also change in accordance with the level of impairment.

With the intention of improving the situation of ATM usage for disabled people in Portugal, SIBS (Portuguese Inter-bank Society) sponsored the project. SIBS is responsible for the software of all ATMs available in Portugal, and influences the acquisition and the installation process of all the service providers

The project was developed and coordinated by the Technical University of Lisbon during 2005. Three faculties were involved in this project: the Design department of Faculdade de Arquitectura (Faculty of Architecture), the Computer Science department of Instituto Superior Técnico - IST (School of Engineering) and Special Education and Rehabilitation Department of Faculdade de Motricidade Humana - FMH (Faculty of Human Kinetics).

6.4.2. Objectives and Methods

The project aims were:

- *To identify areas of software improvement and development of new software*
- *To create guidelines for the installation process*
- *To establish some recommendations for the acquisition of new ATMs.*

In order to identify the needs of people with visual, motor or cognitive Impairment and elderly people, a set of questions were generated:

- *What services need to be improved?*
- *What services do not exist and need to be implemented?*
- *What are the users' priorities?*

- *What are the activity limitations imposed by equipment design and installation which may be solved?*
- *Which environmental barriers may be avoided?*

In order to answer these questions, an inclusive design approach was used which focused on the following work areas:

- *The analysis of accessibility and usability of ATMs for the elderly and people with disabilities (blind, partially sighted / low vision, learning difficulties / cognitively impaired, people with mobility or dexterity or arm movement limitations)*
- *The development of an interface which meets user's requirements*
- *The creation of a checklist covering the installation and interaction of ATMs and the available services*
- *The production of recommendations for good practice, follow up and future issues.*

In order to cross-reference information and check data consistency, a combination of methods was used (interviews, questionnaires, focus groups and observation of user performance).

To prepare the interviews, the questionnaires and the user trial protocol, a survey of ATM's was carried out as well as a task analysis of the different ATM services focusing on the interaction process (by vision, touch, sound and keyboard usage).

Considering the critical points observed previously, interviews with two users of each group were carried out. These were used to identify potential missing aspects and to ensure that the user's point of view was taken into account. Based on this, a questionnaire was developed in order to identify difficulties and constraints of ATM usability.

The results from the interviews and questionnaires were applied to a trial phase where alternative hardware and software solutions were assessed and validated with an ATM test bed. For this phase, users were asked to trial the most commonly used services and express their opinions.

Finally, a set of recommendations was established.

6.4.2.1. Questionnaire

The questionnaire comprised three parts. The first part dealt with user data (gender, age, profession, level of education, etc). The second part dealt with ATM usage focusing on the critical issues enumerated below and the third part related to improvements that the user would like to see in the future.

The critical issues in Part II of the questionnaire cover:

- *ATM location and environmental access including lighting conditions, light glare on the screen, etc.*
- *ATM design and location of devices – keys beside the screen, command keys, keys' layout, the cash and receipt dispenser, card entry, etc.*
- *Interaction*
- *Use of touch screens*
- *On-screen prompts versus keyboard responses*
- *Reading display or using alternative cues (tones and sounds) or alternative expectations whilst performing the service task (e.g. reading from left to right and up to down in the occidental culture)*
- *The time given to perform more complex tasks like payments*
- *Dialogue analysis*
- *Audio interface analysis.*

The majority of the questions required a "yes" or "no" answer or a classification using a 1 to 5 Likert scale. In a group of "yes" or "no" questions there was also an area for users to highlight the three most critical issues. It was also possible to add additional comments that the users considered important which had not been elicited.

The questionnaire was distributed to associations of disabled persons, day centres, clubs and other institutions frequented by elderly and disabled persons. It was completed by the user or by the researcher if he/she was not able to do it by him/herself. An electronic version of the questionnaire was developed and distributed to blind people.

6.4.2.2. User Trials

The main objective was to check if the potential solutions for the user's problems improved significantly or made ATM usage possible.

The trial was composed of three stages. An interview took place to identify the users' main concerns and priorities in relation to ATM usage; the users performing two scenarios, which were explained to the users beforehand; interactions were tested.

User performance was recorded in two different ways. An automatic log file was produced every time a key was pressed (giving information about the number of mistakes and time spent to perform the task), and information was noted regarding quality of the performance (effort, insecurity, and remarks). The last stage consisted of a final interview to evaluate accessibility and to identify the most important issues from the user's point of view.

6.4.2.3. Sample

The questionnaire sample was completed by 346 disabled people. Of those, 74 were blind or partially sighted (44 were blind and 30 partially sighted), 74 had motor impairments (25 were wheelchair users, 28 used assistive walking devices, 9 were amputees, 7 had limited dexterity and 5 used an electrical wheelchair and had limited dexterity), 118 were cognitively impaired and 80 were elderly people (aged 65 or over). 206 of the participants were ATM users and 150 were not. Deaf and hard of hearing people were not included in this study as all ATM terminals in Portugal can be operated using visual information.

The user trial group included elderly people, blind and partially sighted people, people with learning difficulties, people with limited dexterity, people with limited arm movements (range of movement in the elbow and shoulders) and people with limited mobility.

A sub-sample of 24 people was selected from the participants who had completed the questionnaire to perform the user trial. The purpose of this was to determine if the solutions enable disabled users to use ATM's or improve usage for all users or whether some of the alternatives would prove problematic for other user groups. The sample consisted of people who experienced at least one of the following barriers/perspectives:

- *Difficulties pressing a key and introducing a card in a slot*
- *Wheelchair or any walking assistive device usage*

- *Height less than 1.35 m or more than 1.85m*
- *To be able to read small sentences and numbers or "read" using audio systems*
- *To be able to follow instructions*
- *Older than 80 years of age.*

6.4.3. Summary of Results

The participants were asked to provide reasons why they wouldn't use an ATM. Below is a summary of these reasons.

Fear of being robbed:

- *83% of visually impaired participants (this is primarily due to the lack of privacy when using audible information)*
- *77% of elderly participants*
- *66% of mentally impaired participants.*

Not handling their own money or needing help getting money from the ATM:

- *97% of mentally impaired participants*
- *90% of visually impaired participants*
- *81% of elderly participants.*

Not trained to operate the ATM:

- *53% of mentally impaired participants.*

Could not use the ATM (reach the buttons, see the screen or get to the ATM):

- *92% of mobility impaired participants*
- *90% of visually impaired participants.*

The ATM is installed to high from the ground:

- *84.6% of mobility impaired participants.*

The Card entry slot is installed too high from the ground:

- *77% of mobility impaired participants.*

The keys situated next to the screen could not be reached:

- *69% of mobility impaired participants.*

The participants were asked to comment on the equipment design and installation of the ATM. Below is a summary of the comments by participant group.

Comments by visually impaired participants on the design and installation of ATM's:

- *90% stated glare and contrast with the background especially in bright daylight was a problem*
- *55% stated non numerical keys which are not always in the same position (enter clear and cancel) made the ATM difficult to use*
- *51% stated that identifying the place to insert the card on different ATM models with different layouts was difficult, without any additional information*
- *50% stated not having enough information about ATM location (orientation information to where they are in relation to the ATM)*
- *38% stated that identifying the place of money withdrawal on different ATM models with different layouts was difficult, without any additional information.*

Comments by mobility impaired participants on the design and installation of ATM's:

- *85% stated that the installation was generally considered too high which made reaching card insertion and screen-side keys difficult*
- *85% stated glare and contrast with the background especially in bright daylight was a problem*
- *79% stated that obstacles such as kerbs, ramps, steps as well as other obstacles around the ATM made it difficult to use*
- *71% stated that it was difficult to use the ATM whilst carrying mobility aids and papers related to using the ATM*
- *68% stated that there was not enough space to stand and move whilst using the ATM*
- *67% stated not having a hand rail was a problem*

- *62% stated difficulties getting to ATM's located within the foyer of a bank as a problem*
- *56% stated not being able to get their wheelchair under the ATM so they could access it from the front was a problem*
- *46% stated that buttons which are related to the screen are difficult to reach and press.*

Comments by Mentally Impaired participants on the design and installation of ATM's:

- *79% stated glare and contrast with the background especially in bright daylight was a problem*
- *55% stated difficulty in determining what the tactile symbol meant in relation to the button functionality.*

Comments by elderly participants on the design and installation of ATM's:

- *83% stated glare and contrast with the background especially in bright daylight was a problem*
- *71% stated that it was difficult to use the ATM whilst carrying mobility aids and papers related to using the ATM*
- *34% stated that difficulty in determining what the tactile symbol means in relation to the button functionality.*

A summary of the main interaction difficulties experienced by visually impaired participants:

- *91% stated font size and shape*
- *89% stated the foreground/background contrast*
- *63% stated the system timing out before a task was completed.*

A summary of the main interaction difficulties experienced by mobility impaired participants:

- *87% stated the system timing out before a task was completed*
- *80% stated reading a high positioned screen.*

A summary of the main interaction difficulties experienced by mentally impaired participants:

- *39% stated PIN code memorisation*
- *30% stated the system timing out before a task was completed.*

A summary of the main interaction difficulties experienced by elderly participants:

- *36% stated the system timing out before a task was completed.*

The following comments were also obtained about the design and installation of the ATM:

- *Lack of audio information when ATMs are not operational or service availability (e.g. ATM temporarily out of order or without money)*
- *Lack of consistency on audio information to perform the task*
- *Poor default sound level and no method of adjusting the volume*
- *Sound option unavailable for some operations*
- *Poor illumination in many ATMs*
- *Difficulties in understanding when it is necessary to press keys near the monitor or the ones on the keypad*
- *Difficulties in understanding and memorising the symbols used on the non numerical keys*
- *Difficulties in understanding the more complex dialogs.*

Practical application of evaluation and recommendations

The users involved in the trials did not show signs of dislike or discomfort towards the adaptations of the ATM, for instance, the ATM installation in lowered position for tall users.

Moreover, the lowered ATM installation was considered an advantage for small users because it allows them to use their body as a shield against sun reflexes or against other people that can stare at the operations with bad intentions.

The evaluation showed the following solutions as being beneficial to the users:

- *Allow the user to change the ATM profiles according to their needs (e.g. press 1 to activate a symbol based system, 2 for simple text based system)*
- *Use standard 3.5" headphone sockets*
- *Provision for everyday headphones to be used for accessing the audio services*
- *Spoken information of all on screen information that can be activated by the user*
- *Interactivity of the ATM with mobile devices*
- *Card insertion and cash withdraw at the same level of the keyboard*
- *Tactile information on the pavement to indicate the location of the ATM*
- *ATM installation in a lowered position*
- *Wheelchair users can access the ATM from the front rather than positioning themselves parallel to it*
- *The ATM screen should be angled so that more people can read the screen.*

In summary, the main recommendations of the research were:

- *Interior lighting should be given to inform users about the ATM operational status*
- *Provide tactile clues in the surrounding environment leading towards the location of the ATM (floor surface built with different materials, colour and/or texture)*
- *Give clear access to the ATM with 1.50 m wide path around it (less than 6% longitudinal slope and 2% transverse slope)*
- *Incorporate shelters for ATMs located outside to protect them from environmental conditions*
- *Provide labels and instructions. All labels should be both pictographic and in Braille (Braille labels should be positioned at least with a 45 degree angle from the horizontal plan, to facilitate fingertip reading)*

- *All external features that are interactive (such as the keypad, card entry slot and cash retrieval slot) should be placed in a middle central position, to minimize the users' arm movement*
- *The audio jack socket (3.5 mm) should be located in the lower left corner*
- *Provide a key that the user can use to adapt the ATMs to their preferences (e.g. press one key to have audio feedback, or to use only the numerical keypad) before entering the card*
- *Cards are embossed and have a notch incorporated in the trailing edge*
- *The audio feedback feature should:*
- *Automatically be activated when the audio jack is plugged in*
- *Describe the ATM layout and services*
- *Speak all information that is displayed on the screen*
- *Ask for confirmation of any action before carrying it out*
- *Before the system times out, the last message that was displayed or heard should be repeated*
- *Read the total amount inputted as well as the individual numbers*
- *Add more languages, besides Portuguese.*

6.4.5 How evaluation will change the ATM project design in Portugal

The project finished with a presentation of the results to SIBS and all the recommendations and results were welcome. SIBS asked the partners to disseminate the findings to the Portuguese banks in order to facilitate the establishment of the installation procedures. Moreover, they have shown interest to influence the next ATM machines acquisitions of more accessible models. At the present moment SIBS is analysing its software and upgrading it in order to reflect the project recommendations.

6.5 Recommendations

Steve Tyler and Edward Chandler

This chapter has identified that involving users and evaluating for accessibility and usability is paramount so that the needs of the users are met. This work has identified a number of recommendations which should be carried forward by the telecommunications industry and interested standards groups to achieve inclusion by the largest audience possible in services and terminals for next generation mobile networks. These are outlined below.

1.

Utilisation of the Toolkit: the toolkit has been developed for utilisation by testing laboratories, designers, in-house evaluation, etc. The toolkit has been shown to be robust and accurate and it allows industry and manufacturers alike to get a broad idea of product fit to user requirements. The approach adopted is derived from a well tested methodology focused in determining the accessibility of products and services by people with disabilities.

2.

User Interface Profiles: the concept of user interface profiles is further developed and adopted by service provider and manufacturer communities (this concept can be broadly defined as: "a set of parameters that can be altered or implemented that allow a device to deliver or receive information using alternative interfaces"). See opportunities section for more information.

3.

User Interface Consistencies: as the links between service provider and manufacturer become ever tighter and more seamless, so the need for consistency in operation becomes greater, certainly ideally within manufacturer products. A simple example of this might be the long key press of key 1 access voicemail as a speed dial function, or menu behaviours that are consistent throughout the system. The simplest test of this concept is to take any two of a single manufacturer's products - by learning the first, it is theoretically possible to use the second. The best examples of user interface consistency include Nokia Series 60 and 80 products.

It is recommended that:

- *Manufacturers/service providers adopt consistent user interfaces across product groups or families*
- *To adopt and build on the guidance given by the Australian Communications Alliance in its ACIF C625:2005 "Information on accessibility features for telephone equipment."*

In addition, it is further recommended that a certification mechanism is utilised, ideally one currently in existence, that embraces accessibility and user requirements of this kind. Mechanisms of this nature do currently exist such as in the Microsoft certification process; the Symbian Signed process is an example of a mechanism that could be used.

4.

User Testing: Although the toolkit is designed to give accurate and robust, replicable information, user testing and user panels are ideal ways of ensuring that a product really does meet user requirements in terms of access. There are various ways of obtaining these and information is available at http://www.tiresias.org to facilitate field tests of this nature. It is recommended that user trials should be built into any manufacturing and development process encompassing the needs of people with disabilities.

5.

Toolkit Guidance Development: It is recommended that:

- *The toolkits currently recommended are adopted, updated and refined by the telecommunications industry in collaboration with appropriate organisations representing disabled people*
- *Further toolkits specific to other domains are researched and developed.*

6.

Within the toolkit developed by COST 219ter and in all research surrounding the area of accessibility, it is clear that the issue of access by people with varying abilities can only satisfactorily be dealt with through implementing optional alternatives to information output and input. This can be done through building support into devices that enable multimodal input and output. It is recommended that:

- *Open standards, drivers and communication protocols are developed such that devices can support alternative ways of inputting data (for example alternative keyboard devices, joysticks etc)*

- *Open standards, drivers and communication protocols are developed such that devices can support alternative data output methods (for example screen readers, larger screens, or specialist assistive devices).*

The recommendations above support access to telecommunications systems by communities of people who would otherwise be classified as a "niche market"; by adopting open and supportive standards, people using specialist or niche assistive devices can access mainstream products through these bridging tools.

7.

As an absolute minimum it is recommended that:

- *At least one product in any given range or family is manufactured adopting the design principles outlined here*

- *Manufacturers and retailers outline the benefits of product features in a way that consumers can readily comprehend including making information available in alternative formats (for example audio, large print and Braille)*

- *To put in place systematic and regular disability and equality awareness training of staff members and training on the accessibility features of the products and services being marketed and sold as well as awareness raising of customers and audiences with varying access needs.*

In order for mainstream access to become a reality for the vast market of people with disabilities, standard advertising and delivery through retail outlets is a way of breaking the circle which currently exists - There is no market as there are no products. This of course does not mean to negate preferred look and feel of products that manufacturers wish to promote - in fact, entirely the opposite; in general, people with disabilities or older people want to access the same devices, services and systems that friends and colleagues are accessing.

8.

To commit to continuous and structured dialogue and consultation between industry bodies and all users – including people with disabilities and older people. This mechanism would review and report on the progress in activities aimed at building a full inclusive telecommunications sector.

9.

It is recommended that:

- *At the standards setting stages, to commit to incorporating CEN/CENELEC Guide 6 (the various aspects of disability that should be taken account of by standards makers); and*
- *Product developers to follow the standard for Inclusive Design - BS7000-6 (Design management systems. Managing inclusive design) or equivalent.*

6.6 Opportunities and Challenges

Steve Tyler, Edward Chandler and Tony Shipley

As a result of the research and work carried out in COST 219ter and specifically the work attached to the toolkit development, a number of issues have emerged which would seem to present opportunities for research, development and standards groups as well as some challenges to us as a telecommunications industry in meeting the needs of users. These are outlined below.

1.

User Interface Profiles: as an output to research being carried out by COST 219ter, the concept of "user interface profiles" appears to be gaining momentum and from a user perspective the potential of this development is extremely great.

This concept can be broadly defined as: "a set of parameters that can be altered or implemented that allow a device to deliver or receive information using alternative interfaces".

The simplest example of how this approach operates is as follows:

Case Study 1

A totally blind user on receipt of the phone switches it on. The phone displays and announces itself and offers various settings either in user oriented language or interface oriented language. For example: "How would you prefer to access the screen - select from the following options". The options may include audio output. If audio output is selected the various third party screenreader offerings can be made and downloaded on request to the phone.

Case Study 2

A user who has dexterity problems accesses the phone for the first time. On this occasion, he has a specially designed point and click device. On being asked how he wishes to input information to the phone he might pick the "alternative access device". A selection of these would be displayed and the appropriate drivers downloaded to the phone.

Case Study 3

A user has vision. Figures released from mainstream sources (Microsoft) (Vodafone) indicate that just below 50 per cent of users cannot access the screen, either due to not being able to understand the concepts, or not being able to read the letters on screen. Simple magnification, colour contrast, iconic based menu items, extra written help, etc, are possible solutions for this user.

2.

Out of the Box: although it is vital to ensure good usability and accessibility functionality in terminals and services, it is vital to ensure accessibility has been considered from the point of customer interaction with the sales chain and onwards through the experience. For example, the idea of large print, audio or Braille user manuals being available or an audio help system (phone based), obvious and unconfusing ways that allow connection to power chords or chargers, consistent placement of sockets with obvious visual and raised symbols, are crucial considerations in design. Uncomplicated pictorial or descriptive text in Getting Started manuals mean a quick start as well as easy access to those better suited to accessing text compared to graphics, and vice versa.

The out of the box experience for a person with disabilities or alternative user requirements is at least as important as that of an able-bodied person. The dividends in getting it right first time though are very much greater - user loyalty to the brand is likely to be substantially greater if a product appears to be accessible from the outset without a struggle.

3.

Devices are able to deliver any piece of information in at least two modalities (audio, visual, tactual etc). Subdivisions may also be implemented when considering any one of the modalities (for example various fonts, background and foreground colours, size of text and icon versus text information; or in the audio modality, volume, pitch, speed, level of punctuation).

4.

There is a need to research and develop a set of acceptable logos, kite marks or certification which clearly articulate to the consumer the type of accessibility offered by the product.

5.

There is a need to put in place an ongoing mechanism to review requirements for accessibility features, standards and guidelines, providing up to date and clear guidance on product and service development in a dynamic marketplace. This ongoing work could be supported by industry and part of its commitment to accessible design.

6.

Equality and disability access: in a number of countries notably the United Kingdom, USA, Canada and Australia, among others, varying levels of disability discrimination legislation as well as additional duties such as the Disability Equality Duty mean a need to comply with a variety of legislative frameworks. It is clear however that although different requirements exist at present the need to address access for people with disabilities is rising up the agenda on a global level. We need to devse a mechanism that allows global manufacturing and service provider companies to make decisions in developing products safe in the knowledge that legislative duties are met.

General anti-discrimination legislation of the kinds mentioned imposes an obligation to treat a disabled person no worse than any other member of the public. The manner of treatment is not specific and anyone who can prove their case can claim redress in the courts of civil law, but only within the scope set by the legislation. The courts will come to a view as to what does constitute discrimination in particular contexts, usually through a body of established case law, and this will develop over time as cultures and technologies change. Anyone defending such an action may cite published standards or codes of practice to show that their attitude had been reasonable, so it is crucial for all parties that these standards and codes are updated in line with public expectations. Compliance with specific standards or codes might be a regulatory requirement in certain jurisdictions and a demonstration of this compliance - by use of test and appraisal procedures - would satisfy the regulator. It would not necessarily satisfy the civil courts, especially if the regulatory requirements were out of date or inadequate. Awareness of disability issues and the state of the art actions would be the best safeguard.

There is no easy answer - suppliers have to be aware.

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7. What obstacles prevent practical broadband applications from being produced and exploited?

Yiannis Laouris and Marios Michaelides

7.1 Executive summary

This chapter summarizes the results of two workshops, that were held in Ayia Napa, Cyprus and in Seville, Spain. The purpose of the workshops was to develop a shared understanding regarding the obstacles that prevent the exploitation of broadband technologies and to build commitment within the COST 219ter community to an action agenda for collaboratively addressing the problem. The workshops were organized using the "Interactive Management" methodology.

7.2 Introduction to interactive management format

The methodology used was chosen carefully to serve the needs of the COST 219ter Action. The authors have extensive experience in the method and have used it in many other forums to facilitate organizational and social change (vide infra).

The specific objectives set for this workshop were:

1. *To create a shared understanding regarding the obstacles that prevent the exploitation of broadband technologies.*
2. *To build commitment within the COST 219ter community to an action agenda for collaboratively addressing the 'system of obstacles', and*
3. *To serve as a model for other European networks working on analogous problems, thus forging a 'chain of interactions' that will embrace the variety of stakeholders to collaborate towards the development and the implementation of an agenda to overcome the system of obstacles.*

To achieve these objectives the Interactive Management (IM) methodology was chosen [Banathy, 1996; Warfield & Cardenas, 1994]. This methodology has been used extensively by Christakis and many of his associates to enlighten and "structure" analogous situations [Christakis and Bausch, 2006, Broome, 1997, Laouris, 2004; Hays & Michaelides, 2004]. IM is specifically designed to assist inhomogeneous groups to deal with complex issues, in a reasonably limited amount of time. It enables the integration of contributions from individuals with diverse views, backgrounds and perspectives through a process that is structured, inclusive and collaborative [Alexander, 2002; Christakis, 1973; Christakis & Brahms, 2003]. A group of participants who are knowledgeable of the situation are engaged in collectively developing a common framework of thinking based on consensus and shared understanding of the current state of affairs. IM promotes focused communication among the participants in the design process and their ownership of and commitment in the outcome. IM seeks to appropriately balance the behavioural demands of group work with technical assistance that makes it possible to deal with the complexity of issues [Christakis, 1996]. It is designed to prevent groups from prematurely focusing on decisions before they have adequately defined the situation. The typical application of IM integrates the five synergistic components of group decision-making summarized in table 7.1. The right column of the table highlights the specifics in the case of our application.

	Components of a typical IM application	Specifics of our application of IM
1	A group of knowledgeable participants who represent the variety of perspectives that need to be brought to bear in dealing with the situation.	26 experts from 15 countries (21 are national representatives within COST 219ter).
2	Trained facilitators who are able to guide the group through the decision-making process.	The authors.
3	A computer-assisted consensus-building methodology to help the group generate structure and select ideas.	Interpretive Structural Modelling.
4	An appropriate computer program to increase efficiency and productivity of group work.	The Cogniscope™ software.
5	A specially designed physical environment that includes visual display space for ideas and structures promoting transparency and communication among the participants.	Hotel conference rooms in Ayia Napa, Cyprus and Seville, Spain.

Table 7. 1 The five synergistic components of the group decision-making process as applied in a typical IM workshop (left column) and the specific implementation arrangements relevant to the application of the methodology in the context of the COST 219ter workshops (right column).

Two different, but complimentary, scientific methods were exploited in the context of two workshops, one in Ayia Napa, Cyprus (7 October, 2005) and one in Seville, Spain (7-8 March, 2006): the Nominal Group Technique (NGT) and the Interpretive Structural Modelling (ISM) technique. The NGT was chosen, because it allows individual contributions to be captured and pooled effectively and is adequate for situations in which uncertainty and disagreements may exist. Its application in our case involved the following steps:

1. *A triggering question was formulated one month before the first workshop and was sent by email to all participants. The purpose was to stimulate the participants' creativity and encourage them to begin generating their ideas before the actual meeting. It also served to reduce the time required to explain the methodology at the onset of the workshop. The triggering question was: "Considering the availability of powerful broadband technologies and the development of relevant scenarios, what are the obstacles that prevent us from producing practical applications?"*

2. *During the following weeks and until the day just before the workshop, participants were allowed to forward their ideas in writing by email sent to the authors.*

3. *All ideas were recorded by the authors, entered into the program (see below) and a compilation mailed back to all participants before the actual workshop.*

4. *The workshop took place in a spacious conference room equipped with comfortable chairs, screen, computer, and beamer. The availability of space, the surrounding walls (where messages can be posted) and the overall structure and organization of the room is very important for the success of an IM workshop.*

5. *At the beginning of the workshop all ideas already collected, printed on A4 pages (one per page), were posted on the surrounding walls. They were also distributed in the form of a list to all participants. The author of each idea was requested to provide a short explanation. No more than 1-2 minutes per author were allowed at this stage.*

6. *For the rest of the workshop, one of the facilitators was engaged in facilitating the process of democratic idea generation, collection and explanation and recorded them on flip-chart paper. The other facilitator was responsible for recording the ideas with the help of the Cogniscope™ software, project them on the screen using a beamer for immediate*

plenary control, print them on A4 pages and post them on the walls surrounding the group. Whenever needed, participants were allowed to discuss the current idea for clarification of its meaning.

7. *Participants were given five stickers each and were asked to choose (while still seated) the five most important ideas. This process of voting served to choose those ideas which received the highest votes for further processing.*

Figure 7.1 Set-up of the working space. The facilitator has easy eye contact with all participants. The co-facilitator (not visible; sitting opposite of the first) documents on the computer all contributions and manages projections using the beamer. Contributions are printed and posted on the surrounding walls. Access to the walls is easy and comfortable. Some Internet stations are available for participants to perform quick look ups of an issue and access information necessary for them to make educated decisions.

The Interpretive Structural Modelling (ISM) and the Cogniscope™

The Interpretive Structural Modelling (ISM) is a computer-assisted method that helps the group identify the relationship among ideas and impose structure on the complexity of the issue. The ISM software utilizes mathematical algorithms that minimize the number of queries necessary for exploring relationships among a set of ideas. ISM can be used to develop several types of structures such as influence, priority and categorization. The five steps of ISM are:

1. *Identification and clarification of a set of ideas (using NGT).*

2. *Identification and clarification of a 'relational question' (e.g. does A support B?).*

3. *Development of a structural map by using the relational question to explore connections between pairs of ideas.*
4. *Display and discuss the map.*
5. *Amendment of the map by the group, if necessary.*

For the purpose of this workshop we have used a license of the Cogniscope™ software kindly provided free of charge for usage in the context of the COST 219ter workshops by Dr. Aleco Christakis from Leading Design International (www.leadingdesign.org).

7.3 Results

The results presented in detail below stem from two workshops, one held in Ayia Napa (Cyprus: 7 October, 2005) and one in Seville (Spain: 7-8 March, 2006). In the Napa workshop 26 experts from 15 countries participated for 3.5 hours. In the Seville workshop, which lasted for a total of 6 hours spread over two consecutive days (7th and 8th of March, 2006), the number of participants increased to 32. With the exception of 4 persons, all other participants were the same in both workshops. During the first workshop, the NGT (see Methodology section) was applied. Some (i.e., 5) of the participants had submitted their contributions to the authors a few days before the Cyprus workshop. These were presented to all participants at the beginning of the workshop and were used as examples in order to accelerate the process and to reduce the need for lengthy explanations at launch time of how the method actually works. After a 15 minute introduction to the method and presentation of the first 12 contributions already submitted by some of the participants it was time to move on to the phase of creative generation of contributions. One facilitator served as the person communicating with the participants, while the other served as the person recording their ideas and entering them into the Cogniscope™ software. In total, the participants identified 64 obstacles. During the coffee break, a printout of each idea produced was posted on the walls surrounding the seminar area. In the next step, one of the facilitators projected one idea after the other on the screen, and pointing to each element, he asked the person who proposed it to clarify to the group what did s/he mean by that. After each item was clarified, the facilitator checked it of with a marker and moved to the next item, until all contributions were clarified. The clarifications were also recorded, entered in the Cogniscope™ software and a complete list of the obstacles with their clarifications was produced and circulated to the participants. The complete list of the factors is given in Table 7.2.

7. What obstacles prevent practical broadband applications from being produced and exploited?

#	Factor
1	Absence of common standards
2	Difficulty in prioritising EU work is clear when country assignments are in focus
3	Difficulty to find small and efficient EU projects for all the big ones
4	Absence of practical interest
5	There are conflicting interests
6	Lack of personal character in the service
7	Lack of data protection information
8	Weakness of available videoconference systems on the internet
9	The lack of services in different countries
10	Too high communication costs
11	Lack of standards on content specification for diverse users
12	The absence of good technology transfer
13	Low awareness of technological solutions to functional limitations
14	Poor connection between statements of user needs and specific design requirements
15	Public sector disability programmes are too focused on assistive technology
16	The absence of human touch
17	The high-tech innovative image (look)
18	Weakness in advertising and marketing products for elderly people
19	The fear of the customers from the 'big brother' syndrome
20	The problem of conservatism
21	Lack of standardised services across the country
22	High communication costs
23	Lack of standardised communication
24	Authorities favour young adult user groups
25	The absence of a control authority against misuse
26	Low awareness of different user groups
27	Absence of an institution for permanent function control and maintenance
28	Low awareness how to reach the state if high tech
29	The absence of knowledge about the user needs of people with disabilities in mainstream industry
30	The lack of money for programmes that include the need of users with disabilities in mainstream products
31	The weaknesses of legislation and standards make it very difficult to motivate the mainstream industry
32	The difficulty of the 'handicap community' to agree on and to define what accessible products and services really mean
33	The absence of technologies that help you feel secure and safe
34	The absence of knowledge to prevent loneliness
35	Lack of understanding privacy issues
36	Applications requirements are becoming very complex

37	There is a lack of funding in application oriented programmes
38	Teams are not stable enough for continued sustained growth
39	Insufficient consideration of human factors in application
40	Difficulty for users to understand the concept behind the smart home technology
41	Lack of awareness about Ambient Intelligence
42	Difficulty to cope with privacy and security aspects
43	Difficulty to address diverse needs simultaneously
44	Difficulty to determine what is appreciated intervention
45	The lack of incentives for the industry
46	The absence of development tools to support the real life application of Design for All
47	There is a need for more effective standardisation
48	Lack of good market incentives or business models
49	Lack of skills of 'accessibility for all' principles within companies
50	Lack of understanding of the market potential
51	The absence of finances or subsidies
52	Absence of appropriate portals / easy to use services
53	Inability to integrate a range of technologies in a seamless user experience
54	The absence of commercial drivers
55	The difficulty of forecasting take-up and use
56	The lack of fully appropriate user data
57	The weakness of other supporting evidence
58	The absence of special needs awareness
59	The lack of low cost availability of broad-band
60	The weakness of broad thinking from the disability lobbies
61	The difficulty to obtain disability related marketing information
62	Difficulty to identify real user needs
63	Unawareness of accessibility for all principles within companies
64	Lack of ability to engage with mechanisms that will bring specialist products or services to market

Table 7.2 List of all "obstacles" generated by the participants of the Cyprus (Ayia Napa, 7th October 2005) workshop in response to the triggering question: "Considering the availability of powerful broadband technologies and the development of relevant scenarios, what are the obstacles that prevent us from producing practical applications?" Participants have generated a total of 64 factors.

Time was then devoted to an open discussion and negotiation among participants to cluster the factors into different categories. At the end of this process 10 clusters were created. These are summarized in Tables 7.3 to 7.12.

1	Absence of common standards
12	The absence of good technology transfer
18	Weakness in advertising and marketing products for elderly people
27	Absence of an institution for permanent function control and maintenance
30	The lack of money for programmes that include the need of users with disabilities in mainstream products
31	The weaknesses of legislation and standards make it very difficult to motivate the mainstream industry
37	There is a lack of funding in application oriented programmes
45	The lack of incentives for the industry
48	Lack of good market incentives or business models
50	Lack of understanding of the market potential
54	The absence of commercial drivers
64	Lack of ability to engage with mechanisms that will bring specialist products or services to market

Table 7.3 Cluster 1 Lack of financial incentives to deliver (commercial). The participants grouped 12 factors under this category.

15	Public sector disability programmes are too focused on assistive technology
22	High communication costs
30	The lack of money for programmes that include the need of users with disabilities in mainstream products

Table 7.4 Cluster 2 Lack of financial incentives (public sector). The participants grouped 3 factors under this category.

7	Lack of data protection information
25	The absence of a control authority against misuse
35	Lack of understanding privacy issues
42	Difficulty to cope with privacy and security aspects

Table 7.5 Cluster 3 Concerns over privacy / data protection. The participants grouped 4 factors under this category.

13	Low awareness of technological solutions to functional limitations
16	The absence of human touch
17	The high-tech innovative image (look)
19	The fear of the customers from the 'big brother' syndrome
20	The problem of conservatism
28	Low awareness how to reach the state if high tech
40	Difficulty for users to understand the concept behind the smart home technology
41	Lack of awareness about Ambient Intelligence

Table 7.6 Cluster 4 Low user appreciation of technology. The participants grouped 8 factors under this category.

1	Absence of common standards
11	Lack of standards on content specification for diverse users
31	The weaknesses of legislation and standards make it very difficult to motivate the mainstream industry
32	The difficulty of the 'handicap community' to agree on and to define what accessible products and services really mean
47	There is a need for more effective standardisation
63	Unawareness of accessibility for all principles within companies

Table 7.7 Cluster 5 Lack of formal standards. The participants grouped 6 factors under this category.

49	Lack of skills of 'accessibility for all' principles within companies
55	The difficulty of forecasting take-up and use
57	The weakness of other supporting evidence
61	The difficulty to obtain disability related marketing information

Table 7.8 Cluster 6 Lack of interest or priority for technology transfer. The participants grouped 4 factors under this category.

2	Difficulty in prioritising EU work is clear when country assignments are in focus
3	Difficulty to find small and efficient EU projects for all the big ones
38	Teams are not stable enough for continued sustained growth
46	The absence of development tools to support the real life application of Design for All

Table 7.9 Cluster 7 Lack of support for continuing R & D. The participants grouped 4 factors under this category.

4	Absence of practical interest
5	There are conflicting interests
6	Lack of personal character in the service
14	Poor connection between statements of user needs and specific design requirements
26	Low awareness of different user groups
29	The absence of knowledge about the user needs of people with disabilities in mainstream industry
32	The difficulty of the 'handicap community' to agree on and to define what accessible products and services really mean
33	The absence of technologies that help you feel secure and safe
34	The absence of knowledge to prevent loneliness
36	Applications requirements are becoming very complex
39	Insufficient consideration of human factors in application
43	Difficulty to address diverse needs simultaneously
44	Difficulty to determine what is appreciated intervention
52	Absence of appropriate portals / easy to use services
53	Inability to integrate a range of technologies in a seamless user experience
56	The lack of fully appropriate user data

58	The absence of special needs awareness
60	The weakness of broad thinking from the disability lobbies
62	Difficulty to identify real user needs

Table 7.10 Cluster 8 Lack of attention to users / user profiles. This was the largest cluster. The participants grouped 19 factors under this category.

8	Weakness of available videoconference systems on the internet
9	The lack of services in different countries
21	Lack of standardised services across the country
23	Lack of standardised communication
24	Authorities favour young adult user groups

Table 7.11 Cluster 9 Lack of national infrastructure. The participants grouped 5 factors under this category.

10	Too high communication costs
51	The absence of finances or subsidies
59	The lack of low cost availability of broadband

Table 7.12 Cluster 10 User costs perceived at 'too high.' The participants grouped 3 factors under this category.

The third step of the process involved the selection of those obstacles, that were thought to be the most important. Each participant received five coloured stickers and was asked to look at the walls and decide which factors he or she thought were the most significant and, subsequently, select those five items by placing the stickers next to them. The facilitator counted the votes and compiled them to produce the priority list shown in Table 7.13. Only those items (i.e. 24) which received more than 4 votes were considered for further analysis.

#	(Votes) Factor
31	(11) The weaknesses of legislation and standards make it very difficult to motivate the mainstream industry
29	(10) The absence of knowledge about the user needs of people with disabilities in mainstream industry
30	(8) The lack of money for programmes that include the need of users with disabilities in mainstream products
42	(8) Difficulty to cope with privacy and security aspects
62	(7) Difficulty to identify real user needs
13	(6) Low awareness of technological solutions to functional limitations
49	(6) Lack of skills of 'accessibility for all' principles within companies
58	(6) The absence of special needs awareness
63	(6) Unawareness of accessibility for all principles within companies
1	(5) Absence of common standards

14	(5) Poor connection between statements of user needs and specific design requirements
32	(5) The difficulty of the 'handicap community' to agree on and to define what accessible products and services really mean
60	(5) The weakness of broad thinking from the disability lobbies
10	(4) Too high communication costs
18	(4) Weakness in advertising and marketing products for elderly
19	(4) The fear of the customers from the 'big brother' syndrome
37	(4) There is a lack of funding in application oriented programmes
41	(4) Lack of awareness about Ambient Intelligence
45	(4) The lack of incentives for the industry
46	(4) The absence of development tools to support the real life application of Design for All
48	(4) Lack of good market incentives or business models
50	(4) Lack of understanding of the market potential
54	(4) The absence of commercial drivers
61	(4) The difficulty to obtain disability related marketing information

Table 7.13 Prioritisation of Factors. The numbers in the left column correspond to the numbering performed for the coding of the proposed factors (i.e., same as in Table). The middle column contains the number of votes cast for each element. Elements that received less than four votes were not used in subsequent phases. One element received 11 votes, one received 10 votes, two received 8 votes, one received 7, four received 6 votes, four received 5 votes and eleven elements received 4 votes each. A total of 24 elements were used to structure the influence map shown in figure 7.3, whereas the remaining 41 elements were not considered further.

Figure 7.2 Participants engaged in the voting process.

Following the definition and clarification of all factors, participants are given five stickers each to use as votes. After they decide how to vote, they are asked to go to the walls and place their five stickers on their chosen factors. The co-facilitator counts them and enters the number of votes each factor has received on the computer software (see table 7.13). The factors with the highest votes are used for the next phase. In most cases only about half of the factors are used for the next phase.

Using the ISM method (as explained above), participants were encouraged to engage in a structured dialogue with aim to develop a "map of obstacles." The items were projected on the screen in pairs with the following Relational Question:

> *If obstacle X was successfully addressed, will that SIGNIFICANTLY support addressing obstacle Y?*

During each comparison, the participants were engaged in a focused dialogue aiming to explore the particular relationship as it was projected on the screen. This usually presents an opportunity for participants to refine the meanings, uncover relationships and dependencies and generally to develop a much better understanding of the situation. This discussion also serves as an educational exercise, because it helps all participants achieve the same level of understanding and knowledge about the particular field. The technique uses the simple mathematical concept of 'If A>B and B>C then we can safely assume A>C,' to minimize the number of combinations needed to examine the influence interrelation between a number of statements in a reasonable amount of time. The fact that we are not dealing with quantities, but with ideas makes it necessary to go deep into the meanings of the statements thus supporting the process of creating a common knowledge base.

After going through all the necessary pair comparisons, a schematic presentation of the "obstacles map" was created automatically by the Cogniscope™ software and projected on the wall. This inter-relationships diagram is given in figure 7.3. This particular tree has seven levels. The items shown at the top of the chart are those with the lowest influence. The ones with the greatest influence or the "deep drivers," as they are usually referred to, are gathered at the bottom of the tree. This method of presenting the results makes the interpretation of the outcome of the participants' observations easy and visual. One should read the map as follows:

> *The deepest driver is Factor 32, i.e., the difficulty of the 'handicap' community to agree on and to define what accessible products. This is the obstacle, that must be addressed first. Its resolution will significantly help address all other obstacles.*

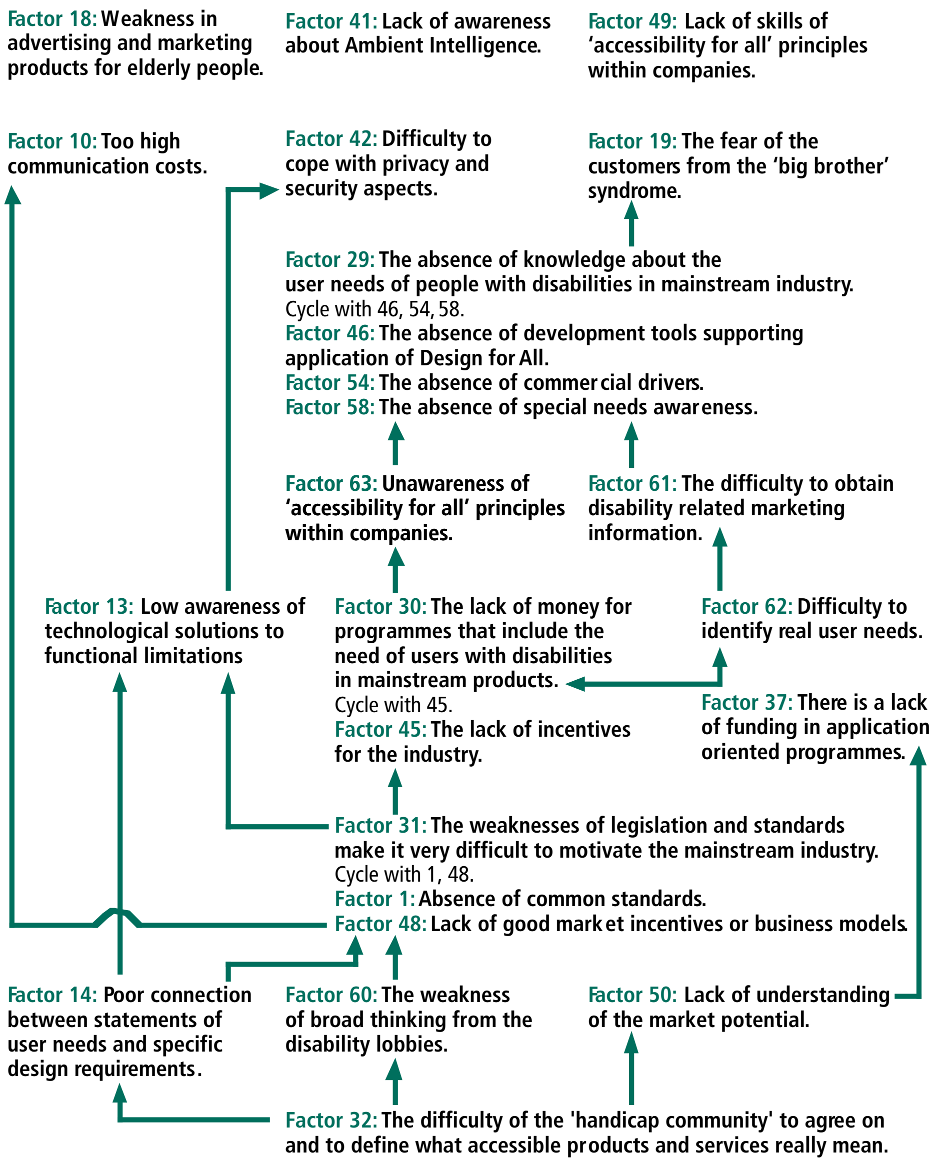

Figure 7.3 Influence tree of obstacles. The way to "read" this map is by using the direction of the arrow: Resolving obstacle A – lower level – significantly enhances the possibility of addressing and resolving obstacle B – higher level. Items at the bottom of the tree must therefore be given higher priority and are usually easier to resolve. The tree was generated by the participants of COST 219ter during two workshops in 2006.

7.4 Discussion of the results

The resulting tree of influences of the obstacles features 18 boxes or clusters organized in seven layers. Three boxes remained unconnected. An additional 6 factors are cycled with other factors within the same box. In the following paragraphs we discuss this tree in greater detail addressing the various features.

Interpreting clusters

First, the cases in which the factors are clustered together in the same box are addressed. In figure 7.3 the term, "cycle with …", is used to explain this phenomenon.

Cycle on layer 3

Factor 31:	The weaknesses of legislation and standards make it very difficult to motivate the mainstream industry
Factor 1:	Absence of common standards
Factor 48:	Lack of good market incentives or business models

These three factors exhibited similar behaviour when participants were requested to relate them with other factors. Looking at these three factors in isolation, they all seem to have a correlated meaning, i.e., the absence of standards, incentives, business models and legislation is held responsible for the low motivation of the mainstream industry to produce relevant applications.

Cycle on layer 4

Factor 30:	The lack of money for programmes that include the need of users with disabilities in mainstream products
Factor 45:	The lack of incentives for the industry

These two factors cluster together and, at first glance, they seem to be very similar with the ones of the previous cluster. However, they have clustered at one layer higher than the previous one. One might ask "Why?" To be able to answer this question it is useful to study the subtle differences in the wording of these factors and, of course, to refer back to the discussions that took place during the workshop among the participants. As stated earlier in this chapter, one of the main tasks of this methodology is to enable participants reach a deeper understanding of the problem situation and achieve a consensus as to what are the real obstacles that prevent the efficient resolution of the problem. Moreover, the method is supposed to help stake holders highlight such small differences and structure the situation in ways that help them address the problems. In our case, studying the two cycles more carefully, it becomes obvious that in the first cycle the issue is more about standards, about business models and about legislation that secures the framework within which such developments should evolve. However, the second cluster focuses more on the availability of material incentives, i.e., funds, programmes, tenders etc. When one considers these differences more carefully, it becomes a lot easier to understand why the collective wisdom of the group has placed this cluster one layer higher than the other. This is because business models, legislation and decision making is a necessary condition that needs to precede the actual creation of funding programmes or the engagement of investors willing to put their money in relevant products.

Cycle on layer 5

Factor 30:	The lack of money for programmes that include the need of users with disabilities in mainstream products
Factor 45:	The lack of incentives for the industry

Cycle on layer 6

Factor 29:	The absence of knowledge about the user needs of people with disabilities in mainstream industry
Factor 46:	The absence of development tools to support the real life application of Design for All
Factor 54:	The absence of commercial drivers
Factor 58:	The absence of special needs awareness

Interpreting unconnected elements

Three elements remained unconnected in the final influence tree:

Factor 10:	Too high communication costs
Factor 41:	Lack of awareness about Ambient Intelligence
Factor 49:	Lack of skills of accessibility for all principles within companies

This means that the group of experts failed to identify any relationships, i.e., any influences of these factors upon other factors and vice versa. The way to interpret this type of data is by concluding that,

> *"high communication costs, lack of awareness about ambient intelligence and the lack of skills of accessibility within companies do not play significant roles and are not to be considered significant obstacles that prevent us from producing practical applications."*

Priorities highlighted

One factor invariably "sank" at the foot of the tree making it stand out as the most significant. This is Factor 32: **The difficulty of the 'handicap' community to agree on and to define what accessible products and services really mean.** This finding is extremely important and it was also quite unexpected among the members of the group. According to the IM methodology, Factor 32 must receive top priority in any actions. Making progress in overcoming this obstacle will facilitate the resolution of the three factors that lie at the next layer up (i.e., layer 6):

Factor 14:	Poor connection between statements of user needs and specific design requirements
Factor 60:	The weakness of broad thinking from the disability lobbies
Factor 50:	Lack of understanding of the marketing potential

In other words, when the 'handicap' community agrees on and defines what accessible products are, progress will be easier to achieve in the three following arenas:

1. *It will be possible to gain a better understanding of the relationships between user needs and specific design requirements.*
2. *The disability lobbies will have achieved a broader thinking.*
3. *The marketing potential of such technologies will much better understood.*

Interpreting elements at the top layers

The following elements have clustered at the top of the tree. Usually this means that elements at this level are perceived by the participants as the most important.

Factor 10:	Too high communication costs
Factor 42:	Difficulty to cope with privacy and security aspects
Factor 19:	The fear of the customers from the 'big brother' syndrome

Cluster Factor 29 Cycle with 46, 54, 58

This is indeed the case here for two of the factors, 42 and 29, which were both in the top 4 factors in terms of votes cast (see table 7.13).

What this method offers is very important because it helps stakeholders not only understand the relative significance of each obstacle, but also to develop a roadmap to effectively address these obstacles. Although elements at this layer are indeed most important, they are usually too vague, too general and certainly too difficult to resolve. Their resolution will be significantly facilitated once elements at lower layers are addressed and resolved.

Location of the most important factors

It is also interesting to analyse where the factors, that were identified by the participants as being the most important, are located in the influence tree of obstacles shown in figure 7.3. The instinctive expectation is often be to think that they will be located at the foot of the tree (layer 7) and would therefore be the first issues that need to be addressed. This is clearly not the case here: of the five factors that received the most votes, one is in the top layer (factor 42), one is in the second layer (factor 29) two are in the fourth layer (factors 30 and 62) and one is in the fifth layer (factor 31). This means that other issues, not perceived by the "collective wisdom" of the experts as the most important factors, have to be addressed first in order to resolve what are perceived as the most important issues, and herein lies the strength and true value of this methodology. It yields a structured road map, that none of the individual experts could have foreseen, let alone drawn up, showing the order in which the obstacles need of be tackled in order to address the triggering question of why there are not more practical broadband applications being produced and exploited for elderly people and people with disabilities.

Future application

According to pioneer IM expert, Dr. Christakis two things are always required to achieve systemic change: (1) intent and (2) procedure. The work described in this chapter aspires to offer a well-established, democratic procedure to address the problem. The method is well-established and pioneers as a structured dialogue approach, which attempts to develop consensus based on full and free communication between stakeholders regardless of rank or power. The methodology completely separates content from process and takes advantage of demosophia, the collective wisdom (demosophia is a Greek word) of the people.

It was an achievement by itself that such as diverse group of participants, from almost every country in Europe, with such diverse backgrounds and expertise managed to explore the problem space and come up with 64 well-defined obstacles, generate 10 clusters, prioritize the 24 most important and reach a consensus as to which obstacles need to be addressed first. Moreover, the participants developed a road map that could guide their efforts over the next few years to develop strategies and design activities to systematically address these obstacles and make progress regarding their resolution. Because the methodology has supported them to develop an influence map, they can save time, energy and funds by addressing obstacles in the "right"' order, i.e., address and resolve those obstacles first whose resolution will make it easier to address the others. In summary, the methodology is very efficient in terms of providing consensus and practical results in such a short amount of time.

The goal of workshops like the one described in this paper go beyond the identification of the obstacles and the construction of an obstacle map, which supports stakeholders understand underlying mechanisms and their inter-dependencies and design appropriate solutions. The goal of the "root cause mapping" approach is not limited to solving a complex problem by appropriately addressing various obstacles, but moreover to prevent it from re-surfacing again. However, in order to achieve these goals one needs to design follow-up workshops in which stakeholders deal with the "design of alternatives." Such workshops undergo exactly the same process and result to the drafting of an "options map." If the group aspires to engage in practical action and the planning of activities to address the issues that surface in the action map, it will be useful to invite stakeholders for the next phase who hold relevant power. The action phase can then incorporate management practices such as having the various stakeholders discuss and accept responsibilities, agree on schedules for implementation of various strategies and actions etc.

In every day life, it is quite often that we witness cases in which opportunities to achieve change are lost or missed. What is unfortunate is that opportunities for systemic changes are rarely lost, because those who oppose change are too powerful. In most cases, it is the inability of those involved that is to blame. This inability comprises of the inability to understand the problem situation and to collectively design a solution for which consensus is needed.

Credits

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8. From concept to reality

John Gill, Gunela Astbrink and Patrick Roe

Developing a novel product or service, rather than a new version of an existing product or service, is always a challenge. With the increasing number of people with disabilities, many of whom will be over retirement age, it is wise to include them as potential consumers. However, for companies with limited experience working in this area, there are a number of pitfalls which could easily be avoided with appropriate planning.

The points outlined below are mainly derived from the detailed analysis in the previous chapters and may assist developers in meeting the needs of the growing market of older people and people with disabilities.

8.1 New technologies

There are finite resources which can be allocated to research and development, so it is important to optimise this allocation. A useful indicator is services which have proven to be beneficial in one country even if they have not been adopted in others.

- SMS-based emergency services are useful for deaf people.

Chapter 2.3.5

Other services proven to be useful:

- Broadband for deafblind users
- Distance education for people with mild aphasia
- Digital distribution of talking books
- Broadband for people with an intellectual impairment
- Distance education using sign language.

Chapter 2.3.1

As well as developing novel services, more basic research will be essential if people with disabilities are to fully benefit from next generation networks.

Research priorities:

- Improve robustness of speech recognition systems
- Accurate sign language recognition
- Conversion of pictures and graphics into a non-visual format for blind users.

Chapter 2.2.2

There has been significant interest in developing location-based services to help people with disabilities but none are in widespread use at the present time.

Location and navigation services:

- Satellite navigation systems have potential to help disabled travellers
- Use appropriate combination of technologies depending on the environment (e.g. GPS outdoors with RFID in a shopping mall)
- Unmet need for these services, but sufficiently detailed accurate digital maps are not readily available.
- Maintain consistent user interface irrespective of the technology employed.

Chapter 2.2.1

Frequently it is the ability to connect a range of devices with adaptable user interfaces which determines the potential usefulness to people with disabilities. This is particularly important in the area of smart housing.

Smart housing:

- The availability of domestic broadband offers many new possibilities
- Short-range wireless systems significantly reduce the cost of installation, but the lack of maturity of this technology is a hindrance
- Adaptable and adaptive user interfaces will make systems easier to use by people with disabilities.

Chapter 3

In the longer term, ambient intelligence could have a major beneficial effect on the lives of people with disabilities. However for this to happen the telecommunications industry needs to radically rethink their approach to developing services for customers with disabilities.

Ambient intelligence:

- The potential of ambient intelligence to help people with disabilities is considerable
- User centred design will be essential to ensure that real needs are addressed
- Guidelines are needed to cover ethical and privacy aspects.

Chapter 4

8.2 The development process

The development of new products and services has often been led by designers thinking of what could be provided rather than by demand from their customers. This is not a major problem when the designers have a good understanding of the needs and aspirations of the user group, but this is rarely the case when the users are people with disabilities.

• It is vital to commit to continuous and structured dialogue and consultations between industry and all users - including people with disabilities and older people.

Chapter 6

8.2.1 Assess user requirements

Technology industries have developed a number of tools to assist in assessing user requirements but there have been problems in using these tools with people with disabilities. One issue is the range of impairments that can affect individuals differently. Two people who appear to have the same combination of impairments can have very different requirements for a telecommunications service.

Too often designers have worked with simplistic concepts of disability (for example, the fallacy that all visually impaired people are totally blind, read Braille and have bionic hearing), and then tested the prototypes on a very small number of unrepresentative users. Not surprisingly the resultant products frequently fail to sell in significant quantities.

Most people with disabilities are reluctant to use a product if it looks as if it had been designed for “the disabled”. For domestic use the aesthetic design of the product must be appropriate; in the case of older users, this may mean a conventional look. The size of the product is also important since space in the living room may be limited, so devices with a small footprint are often preferred.

There is no simple solution to assessing requirements for people with disabilities. However some steps may alleviate the situation:

(a) Provide disability training to the product designers

(b) Use existing guidelines

(c) Test with an appropriate cross-section of potential users.

Once a realistic estimate has been derived for the likely take up of a new product or service, it will be necessary to allocate resources to undertake the research and development. Since there will be a finite limit on these resources, it will be necessary to prioritise. Some services might be of enormous benefit to a small group (eg those who are both deaf and blind) whereas others may be of modest benefit to a very large number of users.

- Mobile telephony can help people with dementia.

Chapter 2.3.4

8.2.2 Quantify potential demand

The prevalence of various disabilities can be based on clinical measures (e.g. so many dBs of hearing loss at a particular frequency) which can be useful for the medical profession. The advantages of these measures are that they are repeatable, but the disadvantage is that they give little indication of the user's needs particularly for those with multiple disabilities.

Therefore there are a number of functional definitions in use. These define a particular task and then measure the number of people who cannot do the task or have great difficulty doing it without the use of assistive devices. These measures give a better indication of the numbers but only apply for the task specified. For instance about 0.1% of the population in Europe has to rely on non-auditory methods of communication (eg text telephony) but about 6% have problems using a conventional telephone; this number might rise to 10% if the telephone was in a noisy environment such as on a bus.

The prevalence of various disabilities, however measured, has little relation to the take up of novel telecommunication products and services. This is for a number of reasons including the high average age, the reluctance to use technological systems which may not work 100% of the time, a lack of awareness of what is available, and a caution in investing money in systems which may be obsolete within a couple of years. Reliable, easy-to-use products that are marketed in innovative ways will have more success.

Often a product or service is developed, and user groups are asked to participate in usability testing once the product or service is ready to go to market. This is often too late as users may provide feedback stating that significant changes should be made; these changes represent time and money for industry. If the changes are not made, then the product or service may not meet the users' needs and consequently fail in the marketplace.

- Remote sign language interpretation using 3G video telephony has had high take up when priced affordably.

Chapter 2.3.2

It is therefore important to involve user representatives early in the product design cycle. This is referred to as user-centred design. Some large international corporations employ this technique to assist development teams produce more appropriate products. It focuses on the active involvement of the user in the design process, trying to obtain a clear understanding of the exact task requirements, involving an iterative design and evaluation process, and utilising a multi-disciplinary approach. The key focus of user-centred design is that users play a critical role in the design of easy-to-use products throughout the entire development process. Interaction throughout the design process is necessary between users and developers in order to understand and define the context of use, the tasks, and how users are likely to work with the future product or system.

8.2.3 Training of user repreentatives

An important part of any development process, be it research or standards-writing, is the training of consumer representatives. While some organisations may claim to represent specific user groups, it is necessary to include a broad spectrum of user groups. There are several components of user testing. The most traditional is usability testing of a product or service prototype. This may include a large number of users in a variety of situations. While laboratory testing with users is the favoured method, being economical and easily managed, it may not give the most accurate results. Field testing using a combination of observation and interviews will provide a more well-rounded result as it reflects the real life of the end-user. However, it may be more costly. There needs to be a balance between the various approaches.

Evaluation:

- Accessibility, like quality, needs to be considered at all stages in the design process
- Testing of accessibility features, with an appropriate cross-section of potential users, should be the norm in the telecommunications industry.

Chapter 6

There should also be a reference group of skilled user representatives that interacts with the design or production team on a regular basis. This group will offer a more wide-ranging and strategic view and may even input into the development process itself.

To achieve a body of skilled user representatives, there needs to be training and mentoring programmes. These ensure that user representatives may learn more about technologies as well as the legislative and regulatory framework. In addition, skills can be taught such as meeting procedure, public speaking and the principles of representing group interests rather than their own accessibility interests. Some of this may seem common sense to industry professionals. However, people with disabilities need to learn to combine their personal experience of disability with professional skills in order for the best results to be achieved.

There have been user representative training programmes developed under European Commission projects. However, these need to be ongoing and further developed in more European countries.

8.2.4 Service providers

The organisation offering telecommunications services may be different from the manufacturer of the terminal or the network operator. This means that there needs to be close collaboration between all parties when developing new services. The development of a business case may be complex if various parts of the supply chain are in different countries since different countries may apply different levels of subsidy to various services for people with disabilities.

8.2.5 Appropriate marketing

With a new feature for an existing service, consumers can often quickly appreciate the potential benefits. However if the service is totally new, it is often only by trailling a system that it is possible to estimate whether the service is likely to be commercially viable. Even then developers can seriously under or over estimate the likely take up; SMS is just one example.

Marketing to people with a disability can present particular challenges since the normal marketing techniques may be inappropriate; for instance printed advertisements may have little impact on blind customers. There are additional problems in explaining to people with intellectual impairments the potential benefits of a new service; this may go some way to explaining the low take up of new telecommunication services by this group of customers.

Some unmodified services are popular with people with disabilities if they are affordable; for instance SMS is heavily used by many deaf people. Other services use standard terminals in conjunction with a service centre. For people with an intellectual impairment, a mobile phone can transmit location information and a picture of the immediate environment to a remote service centre where a human operator can guide the user to their required destination. Such a service would be invaluable to an intellectually impaired or blind person travelling alone on public transport when there is a disruption to their routine.

Marketing which is directed at a particular section of the disability community with a product "for the disabled" can be less effective than marketing the same product to the general public and mentioning that it can also be of benefit to people with impairments. Many consumers, particularly those who are ageing, do not like to consider themselves 'disabled' but do admit that their abilities are not as good as they used to be.

8.2.6 Training and support

Customers with disabilities will need support which may be additional to that provided to non-disabled customers. For instance a blind user may not be able to read the instructions for setting up and using the equipment; in this case it may be necessary to provide the instruction books in alternative formats on demand (e.g. Braille, large print and audio) or at least in electronic format that can easily be converted into formats offering speech output. For a deaf person, customer support centres might need to able to respond to text calls. For someone with an intellectual impairment, the instruction book might need to be written in a language which is easy to understand and has clear pictures or diagrams.

It is vital to ensure accessibility has been considered from the point of customer interaction within the sales chain and onwards through the experience.

A particular problem is when the system has a malfunction, since it may not be easy for the user with a disability to ascertain where the fault is located or to run diagnostics even with help over the telephone. Therefore consideration needs to be given to providing appropriate support services. However, identifying the source of a fault is difficult for the majority of end-users and therefore an intuitive system backed up with well-trained staff in customer service are essential for any customer-oriented company.

8.3 Legislation and regulation as drivers

When the market does not deliver the required result, national regulators have stepped in with mandatory requirements. In addition some countries have discrimination legislation such as the Disability Discrimination Act in the UK; such legislation can also be found in countries such as USA and Australia. However the trend is towards less regulation in the telecommunications area, so the role of legislation at national or European level may become more significant. Legislation such as European Directives tied to particular standards may become more significant in future. This is particularly the case with the Public Procurement Directive.

In the USA, government procurement requirements have been used as a way of influencing manufacturers to provide information and communication technology systems which incorporate accessibility features. Since there is no easy way to measure accessibility, the approach has been to take each technology component and specify accessibility requirements. Although this approach does improve accessibility and is measurable, it has the disadvantage that it does not look at the ease of use of the whole system by people with disabilities.

A mechanism needs to be devised that allows manufacturing and service provider companies to make decisions in developing products safe in the knowledge that legislative duties have been met.

The European Commission has indicated through a Directive that it intends to use government procurement to require accessible systems. Traditionally the European approach has been to use formal standards (eg from CEN, CENELEC and ETSI), and then have Directives which make particular standards mandatory. This is likely to be the case with public procurement incorporating accessibility requirements. The European Commission will call upon the standards bodies to develop accessibility guidelines to be referred to from the Directive.

In addition, the U.S. accessibility guidelines for public procurement purposes are being reviewed in 2007 and it is anticipated that there will be collaboration between the European and U.S. guidelines developers. This will provide a clearer path for product developers in designing equipment that meets accessibility requirements and thus for industry to more successfully increase their sales through supply to government agencies as well as to the wider market.

Regulation:

- While there is a trend towards less regulation in the telecommunications sector, the question of how to protect the interests of disenfranchised people in a free market will become a key issue and consideration needs to be given to the provision of services for people with disabilities
- The scope of the Universal Service Directive could have significant implications
- Government procurement can require the provision of accessible equipment, but what is accessible will need to be defined in standards
- Inclusion of Design for All principles in standards should become as commonplace as reference to quality standards.

Chapter 5

8.4 Conclusions

This outline of some of the measures taken to successfully bring many of the concepts detailed in previous chapters to reality should indicate that catering, for many companies, to a new and strongly emerging market of older people and people with disabilities can bring rewards. These rewards may result in several positive benefits.

Firstly, in a saturated market such as mobile phone terminals, the development of products and services that are more user-friendly as well as providing suitable features for older people and people with disabilities can offer companies who are prepared to be flexible and adapt their practices, additional market share and very likely increased income. This may also apply to highly competitive emerging technologies such as VoIP and next generation networks.

Secondly, the provision of more accessible and usable products and services to older people and people with disabilities means that industry participates as good corporate citizens and contributes to their triple bottom line. This will naturally improve their corporate image. The dividend in getting it right first time though are very much greater - user loyalty to the brand is likely to be substantially greater if a product appears to be accessible from the outset without a struggle.

Finally, people with disabilities have the opportunity of participating more strongly in the community, increasing their employment prospects and contributing to society and their economy.

If the future is going to be truly inclusive, organisations need a coherent strategy for moving from concept to reality in the development of new services.

Challenges:

- The disability community, together with key stakeholder groups, needs to agree on and define what makes a product accessible
- Development of methodology for specifying design requirements from a statement of user needs
- Need for increased understanding among disability organisations of the potential offered by next generation networks
- The use of appropriate marketing strategies by telecommunication companies.

Chapter 7

Appendix I

Scenarios for people who are not able to see

1. Maria

The environment is assumed to be totally unknown to Maria.

Being a blind person, Maria has a foldable tactile presentation system. Even if tactile presentations are in principle available for all users, she prefers to carry her own device so as to avoid potential problems during her trip.

Original scenario

After a tiring long haul flight Maria passes through the arrivals hall of an airport in a Far Eastern country. She is travelling light, hand baggage only. When she comes to this particular country she knows that she can travel much lighter than a decade ago, when she had to carry a collection of different so-called personal computing devices (laptop PC, mobile phone, electronic organisers and sometimes beamers and printers). Her computing system for this trip is reduced to one highly personalised communications device, her 'P–Com' that she wears on her wrist.

AmI opportunities

Maria's P-com can be equipped with specialised interfaces (e.g., a foldable tactile interface). When necessary, the P-com can communicate with sophisticated peripherals (e.g., a tactile 3-D system) available in the environment.

Maria calls the P-Com her 'key of keys' because it almost invisibly unlocks the doors she meets on her trip. It allows her to move around in an ambience that is shaped according to her needs and preferences. In the past travelling involved many different and complicated transactions with all sorts of different service vendors, often with gaps and incompatibilities between the different services. In the past few years, a series of multi-service vendors (MSVs) have emerged offering complete packages of services linked to the P-Com that tailor the user's environment according to their preferences. User preferences are set up during an 'initiation period' during which personal agents (personal-servants or perservs) are instructed or learn how to obey their master's wishes. These agents are in continual negotiation with those of participating service providers (such as shops, rental companies, hotels and so on).

AmI opportunities

This new situation, of interest for all people, can be particularly interesting for blind people, who may presently have problems in accessing complex information services.

A particular feature of this trip is that the country that Maria is visiting has since the previous year embarked on an ambitious ambient intelligence infrastructure programme. Thus her visa for the trip was self-arranged and she is able to stroll through immigration without stopping because her P-Com is dealing with the ID checks as she walks.

Problems

Navigating the environment.

Possible solutions

The P-Com in communication with AmI guides Maria through the airport (e.g., by voice, or using haptic cues).

This requires:

- The knowledge of her position in the airport (granted by AmI);
- The possibility of controlling the presence of unpredictable obstacles (people, baggage, etc.).

The second prerequisite can be addressed through two approaches:

- The first is based on the features of the AmI itself, which could contain a control system able to monitor tagged objects in real time and communicate with the P-com of passengers;
- The second is based on a personal system (artificial virtual guide dog), that is a set of sensors (e.g., a worn T.V. camera, or some type of ultrasound or laser) able to spot possible obstacles. RFID on objects can be used for signalling the presence of obstacles to the virtual guide dog.

AmI opportunities

Navigation in the environment is considered as a problem for a blind person. Instead of creating new obstacles, AmI has the potentiality of offering a solution to the mobility of blind people in all environments where its facilities are deployed.

Tracking people and offering context related information is supposed to be one of the standard features of AmI.

A rented car has been reserved for her and is waiting in an earmarked bay. The car opens as she approaches. It starts at the press of a button: she doesn't need a key. She still has to drive the car but she is supported in her journey downtown to the conference centre-hotel by the traffic guidance system that had been launched by the city government as part of the 'AmI-Nation' initiative two years earlier.

Problems

Maria cannot drive.

Possible solutions

She uses a taxi.

a) Her P-Com can guide her to the taxi rank or

b) The taxi driver was informed from Maria's arrival beforehand and he picks her up at the door of the arrival lounge.

The taxi driver's and Maria's P-Coms can communicate so that the driver can locate Maria.

AmI opportunities

See previous point.

Downtown traffic has been a legendary nightmare in this city for many years, and draconian steps were taken to limit access to the city. But Maria has priority access rights into the central cordon because she has a reservation in the car park of the hotel. Central access however comes at a premium price, in Maria's case it is embedded in a deal negotiated between her personal agent and the transaction agents of the car-rental and hotel chains. Her firm operates centralised billing for these expenses and uses its purchasing power to gain access at attractive rates. Such preferential treatment for affluent foreigners was highly contentious at the time of the introduction of the route pricing system and the government was forced to hypothecate funds from the tolling system to the public transport infrastructure in return.

In the car Maria's teenage daughter comes through on the audio system. Amanda has detected from 'En Casa' system at home that her mother is in a place that supports direct voice contact. However, even with all the route guidance support Maria wants to concentrate on her driving and says that she will call back from the hotel.

AmI opportunities

Maria has the advantage of being able to speak immediately with her daughter.

Maria is directed to a parking slot in the underground garage of the newly constructed building of the Smar-tel Chain. She is met in the garage by the porter – the first contact with a real human in our story so far! He helps her with her luggage to her room.

Her room adopts her 'personality' as she enters. The room temperature, default lighting and a range of video and music choices are displayed on the video wall.

Problems

The traditional remote control is not accessible.

Possible solutions

Maria can use the P-Com. Alternatively, AmI can describe to her the layout and the functionalities of the remote control.

AmI opportunities

AmI knows itself and its components. If necessary, it is able to describe the layout and the functionalities of the remote control and of the entire room.

She needs to make some changes to her presentation – a sales pitch that will be used as the basis for a negotiation later in the day.

Using voice commands she adjusts the light levels and commands a bath.

Problems

Maria cannot do two acoustic activities simultaneously.

Possible solutions

The actions must be sequenced, or an alternative interfaces (Braille) addressing a different modality may be used.

AmI opportunities

AmI is able to organize sequentially the flow of information and the performance of the necessary tasks, allocating the necessary time.

Then she calls up her daughter on the video wall, while talking she uses a traditional remote control system to browse through a set of webcast local news bulletins from back home that her daughter tells her about. They watch them together.

Problems

She can not watch the news, she can listen to the news.

Possible solutions

Listening to the news and communicating with her daughter must be sequenced in some way.

AmI opportunities

The possibility of watching the news together and being able to comment them adds a very important social dimension to the interaction.

Later on she 'localises' her presentation with the help of an agent that is specialised in advising on local preferences (colour schemes, the use of language). She stores the presentation on the secure server at headquarters back in Europe. In the hotel's seminar room where the sales pitch is to take place, she will be able to call down an encrypted version of the presentation and give it a post presentation decrypt life of 1.5 minutes.

Problems

Maria cannot see her presentation (neither the colour scheme).

Possible solutions

The agent that advises on preferred colour schemes should be reliable enough to detect and correct eventual contrast and related problems. Alternatively, a connection with the office is established through the broadband network, in order to allow a visual inspection of the results.

If Maria had not been born blind and knew colours, she can be informed vocally of the colour scheme.

AmI opportunities

The additional opportunities offered by AmI are related to the availability of broadband communication facilities. Maria can be helped by colleagues, who can work cooperatively across the network. In many situations human support can be more effective and acceptable than technological support.

The hotel offers neutral third part hosting of presentations but Maria wants to be sure for her own peace of mind that some of the sensitive material in the presentation will not sit around on a 3rd party server for prying eyes to see. To do this work, Maria is using hardware provided by the hotel, but with security clearance and access to her personal home workspace guaranteed by her P-Com.

AmI opportunities

Security is built in the system.

She goes downstairs to make her presentation…this for her is a high stress event. Not only is she performing alone for the first time, the clients concerned are well known to be tough players. Still, she doesn't actually have to close the deal this time. As she enters the meeting she raises communications access thresholds to block out anything but red-level 'emergency' messages.

Problems

Maria needs to know who is in the room.

Maria needs to know when she can start her presentation.

Maria needs to control the pace of the presentation.

Possible solutions

The P-Coms communicate and exchange the information on who is attending the meeting.

She gets a multi-modal confirmation (voice through earphone plus vibrator) that the presentation is ready for display.

There is a tactile display in the room or she can use the personal tactile display. The tactile display has a copy of the presentation plus additional control functions (active functions), pointing facilities and slide content details.

AmI opportunities

Probably a normal handshake could be as efficient and more pleasant.

In AmI the wide availability of tactile displays is part of the built in virtual reality interfaces.

The meeting is rough, but she feels it was a success. Coming out of the meeting she lowers the communication barriers again and picks up a number of amber level communications including one from her cardio-monitor warning her to take some rest now.

The day has been long and stressing. She needs to chill out with a little meditation and medication. For Maria the meditation is a concert on the video wall and the medication….a large gin and tonic from her room's minibar.

2. Dimitrios

Original scenario

It is four o'clock in the afternoon. Dimitrios, a 32 year-old person working in a food - multinational, is taking a coffee at his office's cafeteria, together with his boss and some colleagues. He doesn't want to be excessively bothered during this pause. Nevertheless, all the time he is receiving and dealing with incoming calls and mails.

He is proud of 'being in communication with mankind': as are many of his friends and some colleagues. Dimitrios is wearing, embedded in his clothes, a 'gateway' or digital avatar of himself, familiarly known as 'Digital Me' or 'D-Me'. A D-Me is both a learning device, learning about Dimitrios from his interactions with his environment, and an acting device offering communication, processing and decision-making functionality. Dimitrios has partly 'programmed' the D-Me himself, at a very initial stage: it was, he says, a great personal experience to formalise somehow his identity and the way he envisaged his relations. At the time, he thought he would 'upgrade' this initial data periodically. But he didn't. He feels quite confident with his D-Me and relies upon its 'intelligent PDA-like' reactions.

AmI opportunities

Even if blind people do not normally have problems in interpersonal communication help in processing of the complex flow of communications and decision making can be very interesting.

Dimitrios has a '3P/3CAG D-Me'-it allows him to specify three privacy levels (3P) for personal data matched to three separate 'closed access group' (3CAG) memberships.

AmI opportunities

Privacy is a built in facility of AmI.

At 4:10 p.m. following other calls of secondary importance - answered formally in a smoothly multilingual reproduction of Dimitrios' voice and typical accent, a call from his wife is further analysed by his D-Me. The D-Me confronts available data registered from Dimitrios' environment (voices, themes, location, other 'patched' objects) to match the situation with this private call (Dimitrios' wife's voice, theme, emotional level). In a first attempt, Dimitrios' 'avatar-like' voice runs a brief conversation with Dimitrios' wife, with the intention of negotiating a delay while explaining his current situation.

Simultaneously, Dimitrios' D-Me has caught a message from an older person's D-Me, located in the nearby metro station. This senior has left his home without his medicine and would feel at ease knowing where and how to access similar drugs in an easy way. He has addressed his query in natural speech to his D-Me. Dimitrios happens to suffer from similar health problems and uses the same drugs. Dimitrios' D-Me processes the data available to offer information to the senior. It 'decides' neither to reveal Dimitrios' identity (privacy level), nor to offer Dimitrios' direct help (lack of availability), but to list the closest drug shops, alternative drugs and contacts to a self-help group and medical contacts nearby in case of emergency. This information is shared with the senior's D-Me, rather than with the senior himself, to avoid useless information overload.

The D-Me is equipped with voice, pattern and patch recognition capacity. It has to identify places and people, but also to register enough data to record the relevant events of Dimitrios' life to process it in its DMe profile and offer it to other DMe's.

AmI opportunities

Functions of pattern and patch recognition can have an important impact on access to information by blind people.

Meanwhile his wife's call is now interpreted by his D-Me as sufficiently pressing to mobilise Dimitrios. It 'rings' him using a pre-arranged call tone. Dimitrios takes up the call with one of the available 'Displayphones' in the cafeteria. Since the diffusion of D-Me, fewer people run around with mobile terminals. Public and private spaces have display terminals and your D-Me can point at the closest….functioning one!

Problems

Possible problems in localising the displayphone.

Possible solutions

The P-com can communicate with the displayphone and, in cooperation with AmI, helps navigation to it.

Alternatively Dimitrios can wear a special P-com that allows him to communicate directly with his wife.

AmI opportunities

The selection of different telecommunication facilities is available.

Dimitrios' wife hates his D-Me. She suspects him living parallel lives and whatever the practical aspects, she definitely would prefer having himright away on the phone. It has been a source of conflict from the start.

The 'emergency' is about their child's homework. While doing his homework their 9 year-old son is meant to offer some insights on everyday life in Egypt. In a brief 3-way telephone conference, Dimitrios offers to pass over the query to the D-Me to search for an available direct contact with a child in Egypt. Ten minutes later, his son is videoconferencing at home with a girl of his own age, and recording this real-time translated conversation as part of his homework. All communicating facilities have been managed by Dimitrios' D-Me, even while it is still registering new data and managing other queries. The Egyptian correspondent is the daughter of a local businessman, well off and quite keen on technologies. Some luck (and income…) had to play a part in what might become a long lasting new relationship.

AmI opportunities

For a blind person, normally communicating by voice an automatic translated conversation could be particularly useful.

Managing a service while choosing the best telecommunication means for the videoconference forms part of the role of the D-Me.

3. Carmen

Original scenario

The driver is part of a carpooling scheme of the transport management systems in the urban area where Carmen lives. Advanced payment and transactions systems are in place, which are able to calculate the amount of money that goes to the driver and the amount that goes to the transport operators.

It is a normal weekday morning. Carmen wakes and plans her travel for the day. She wants to leave for work in half an hour and asks AmI, by means of a voice command, to find a vehicle to share with somebody on her route to work. AmI starts searching the trip database and, after checking the willingness of the driver, finds someone that will pass by in 40 minutes. The in-vehicle biosensor has recognised that this driver is a non-smoker – one of Carmen requirements for trip sharing. From that moment on, Carmen and her driver are in permanent contact if wanted (e.g. to allow the driver to alert Carmen if he/she will be late). Both wear their personal area networks (PAN) allowing seamless and intuitive contacts.

Problems

Need of special arrangements for travelling and meeting.

Possible solutions

For the trip sharing, the Carmen's AmI informs the driver of her profile's data related to her disability, the destination and time details of the desire route, the way that he or she will recognise her at a meeting point, and the parameters for establishing (PAN) connection from the moment that they will agree.

The driver is notified of Carmen's disability as this may have certain implications, for example in arranging the meeting point.

AmI opportunities

AmI knows the abilities/disabilities of Carmen and, if authorised by her, can use this information for helping in arranging her travelling to work.

Objects can be tracked through radio-frequency identification tags. These e-tags are very small, maximum of the size of a grain of rice and can be embedded in everyday objects. Everyone carrying a device equipped with a reader could access additional information and services relating to the tagged item.

AmI opportunities

Tags can be very useful for blind people. They can offer information to the blind persons or can be interrogated by them.

While taking her breakfast coffee Carmen lists her shopping since she will have guests for dinner tonight. She would like also to cook a cake and the e-fridge flashes the recipe. It highlights the ingredients that are missing: milk and eggs. She completes the shopping on the e-fridge screen and asks for it to be delivered to the closest distribution point in her neighbourhood. This can be a shop, the postal office or a franchised nodal point for the neighbourhood where Carmen lives. All goods are smart tagged, so that Carmen can check the progress of her virtual shopping expedition, from any enabled device at home, the office or from a kiosk in the street. All goods are smart tagged, so that Carmen can check the progress of her virtual shopping expedition, from any enabled device at home, the office or from a kiosk in the street. She can be informed during the day on her shopping, agree with what has been found, ask for alternatives, where they are and when they will be delivered.

Problems

Need of alternative communication with the environment.

Possible solutions

Carmen's P-com in communication with her e-fridge voices the recipe.

The system concludes by listing the missing ingredients.

Carmen completes the shopping list through brief voice commands.

When Carmen is connected to the shop, all the information stored in tags is translated in a properly encoded format for her to receive. Carmen may choose to hear or read (e.g., in Braille) brief descriptions of the goods, or to have a full presentation of a particular product or store shelf. Presentations may contain information for the product characteristics (size, colour, and weight), the packing, the price, potential offers or alternative selections and other information that will help her to make her choice. Carmen's P-workstation enables her to explore and manipulate 3D models and artefacts by means of tactile interaction.

AmI opportunities

The wide availability of speech interfaces is very important for blind people.

Tags in connection with telecommunication networks can help in exploring the local and remote environment.

Tactile displays are supposed to be widely available.

In this scenario the environmental management system is not only connected to sensors that control vehicle engines or the police, which in case of accidents can transfer information to the traffic control network to re-route traffic. The system is also able to alert individuals with allergies to certain types of pollutants when a dangerous threshold is reached. Individuals will be informed of the unhealthy atmosphere and can decide whether to go out or stay home.

Forty minutes later Carmen goes downstairs onto the street, as her driver arrives. When Carmen gets into the car, the VAN system (Vehicle Area Network) registers her and by doing that she sanctions the payment systems to start counting.

Problems

Difficulties in reaching the meeting point (navigation).

Possible solutions

A sound notification from AmI informs Carmen that she should leave her flat, as her driver is arriving. While moving towards the meeting point, her "e-guide dog" (see Maria scenario), plugged-in to the P-com, informs her about any non-familiar physical obstacles that are on her way as her neighbours are moving out and the corridor is full of obstacles such as furniture and boxes. Carmen's "e-dog" voices proper directional instructions and guides her safely to the meeting point arranged with the driver.

AmI opportunities

AmI offers new and efficient support for navigating the environment, relying on information available in AmI and in personal support systems (e-guide dog).

A micro-payment system will automatically transfer the amount into the e-purse of the driver when she gets out of the car.

In the car, the dynamic route guidance system warned the driver of long traffic jams up ahead due to an accident. The system dynamically calculates alternatives together with trip times. One suggestion is to leave the car at a nearby 'park and ride' metro stop. Carmen and her driver park the car and continue the journey by metro. On leaving the car Carmen's payment is deducted according to duration and distance.

Problems

Possible navigation problems.

Possible solutions

The UAN (Underground Network Area) registers Carmen as a blind client and suggests routes and paths that are not too busy at that point, so she could manage to be at work on time. Her "e-guide dog" is waiting for her to decide about the way they will follow. A sound alert from the e-dog indicates that time is passing, so she has to quickly decide the direction to take.

AmI opportunities

AmI can support the mobility of Carmen in the city and give her context relevant information. The "e-guide dog", integrated in AmI, increases her autonomy in the environment.

Out of the metro station and whilst walking the minutes to her job, Carmen is alerted by her PAN that a Chardonnay wine that she has previously identified as a preferred choice is on promotion that day. She decides to add it to her shopping list and uses the opportunity to tell her wearable when she plans to leave work and where she wants to go. Carmen arrives at her job on time.

On the way home the shared car system senses a bike on a dedicated lane approaching an intersection on their route. The driver is alerted and the system anyway gives preference to bikes, so a potential accident is avoided.

AmI opportunities

The system adds security to a blind person walking through the city.

A persistent high pressure for the last ten days has given fine weather but rising atmospheric pollutants. It is rush hour and the traffic density has caused pollution levels to rise above a control threshold. The city-wide engine control systems automatically lower the maximum speeds (for all motorised vehicles) and when the car enters a specific urban ring toll will be deducted via the Automatic Debiting System (ADS).

Carmen arrives at the local distribution node (actually her neighbourhood corner shop) where she picks-up her goods. The shop has already closed. But the goods await Carmen in a smart delivery box. By getting them out, the system registers payment, and deletes the items from her shopping list. The list is complete. At home, her smart fridge screen will be blank.

Problems

Possible problems in accessing the smart delivery box.

Possible solutions

The distribution point offers tactile accessibility features for the blind. However, Carmen prefers to interact with the delivery system through her P-com.

Coming home, AmI welcomes Carmen and suggests to telework the next day: a big demonstration is announced downtown.

4. Annette and Solomon

Original scenario (Annette and Solomon)

It is the plenary meeting of an environmental studies group in a local ‘Environment for Social Learning’. The group ranges from 10 to 75 years old. They share a common desire to understand the environment and environmental management. It is led by a mentor whose role it is to guide and facilitate the group’s operation, but who is not necessarily very knowledgeable about environmental management. The plenary takes place in a room looking much like a hotel foyer with comfortable furniture pleasantly arranged. The meeting is open from 7.00-23.00 hours. Most participants are there for 4-6 hours. A large group arrives around 9.30 a.m. Some are scheduled to work together in real time and space and thus were requested to be present together (the environment accesses their agendas to do the scheduling).

A member is arriving: as she enters the room and finds herself a place to work, she hears a familiar voice asking “Hello Annette, I got the assignment you did last night from home: are you satisfied with the results?" Annette answers that she was happy with her strategy for managing forests provided that she had got the climatic model right: she was less sure of this.

Problems

Navigation in the environment.

Possible solutions

Simplified version of Maria navigation scenario (the room is simpler than the airport).

AmI opportunities

AmI knows the individuals in the learning environment and can adapt itself to their needs.

Annette is an active and advanced student so the environment says it might be useful if Annette spends some time today trying to pin down the problem with the model using enhanced interactive simulation and projection facilities. It then asks if Annette would give a brief presentation to the group. The environment goes briefly through its understanding of Annette's availability and references for the day's work. Finally, Annette agrees on her work programme for the day.

Problems

Problems with interactive simulation and projection facilities.

Possible solutions

Nowadays, interactive simulation systems are inherently based on interaction paradigms using direct manipulation of objects and on complex (also three-dimensional) visual presentations. In this future environment the system will have evolved to be multimedia and multimodal. A possible solution for a blind person could be the evolution toward a virtual reality system based on sound and tactile interactions (tactile exploration of virtual objects both for input and output of data).

AmI opportunities

The new technology developed for the implementation of the intelligent environment (e.g. tactile display technology, virtual reality, tactile input technology) is contributing to easier access to information by blind people.

One particularly long conversation takes place with Solomon who has just moved to the area and joined the group. The environment establishes Solomon's identity; asks Solomon for the name of an ambient that 'knows' Solomon; gets permission from Solomon to acquire information about Solomon's background and experience in Environmental Studies. The environment then suggests Solomon to join the meeting and to introduce himself to the group.

In these private conversations the mental states of the group are synchronised with the environment, individual and collective work plans are agreed and in most cases checked with the mentor through the environment. In some cases the assistance of the mentor is requested. A scheduled plenary meeting begins with those who are present. Solomon introduces himself.

Annette gives a 3-D presentation of her assignment. A group member asks questions about one of Annette's decisions and alternative visualisations are projected.

Problems

Annette needs to know who is in the environment.

Annette needs to know when she can start her presentation.

Annette needs to control the pace of the presentation.

Possible solutions

The P-Coms communicate and exchange the information on who is attending the meeting.

She gets a multi-modal confirmation (voice through earphone plus vibrator) that the presentation is ready for display.

There is a tactile display in the room. The tactile display has a copy of the presentation plus additional control functions (active functions), pointing facilities and slide content details.

AmI opportunities

In AmI the wide availability of tactile displays is part of the built in virtual reality interfaces.

During the presentation the mentor is feeding observations and questions to the environment, together with William, an expert who was asked to join the meeting. William, although several thousand miles away, joins to make a comment and answer some questions. The session ends with a discussion of how Annette's work contributes to that of the others and the proposal of schedules for the remainder of the day. The environment suggests a schedule involving both shared and individual sessions.

During the day individuals and sub-groups locate in appropriate spaces in the environment to pursue appropriate learning experiences at a pace that suits them. The environment negotiates its degree of participation in these experiences with the aid of the mentor. During the day the mentor and environment converse frequently, establishing where the mentor might most usefully spend his time, and in some cases altering the schedule. The environment and the mentor will spend some time negotiating shared experiences with other environments – for example mounting a single musical concert with players from two or more distant sites. They will also deal with requests for references / profiles of individuals. Time spent in the environment ends by negotiating a homework assignment with each individual, but only after they have been informed about what the environment expects to happen for the rest of the day and making appointments for next day or next time.

AmI opportunities

The knowledge of the user profiles and the availability of technologies addressing different modalities allow the structuring of the space(s) in a way that is suitable for the different users.

Appendix II. Glossary of acronyms used in book

3G:	3rd Generation network
AAMI:	Age-Associated Memory Impairment
ACCS:	Aural Cascading Style Sheet
ACD:	Automatic Call Distribution
ACIF:	Australian Communications Industry Forum
ADA:	Americans with Disabilities Act
AGPS:	Assisted Global Positioning System
AmI:	Ambient Intelligence
ANEC:	European Association for the coordination of Consumer Requirements in Standardisation
ASCII:	American Standard for Coding Information Interchange
ASL:	American Sign Language
ATAG:	Authoring Tool Accessibility Guidelines
ATM:	Automatic Teller Machine
AUI:	Aural User Interface
BAOC:	Barring of All Outgoing Calls
CCTV:	Closed Circuit Television
CD-ROM:	Compact Disk-Read Only Memory
CEN:	European Committee of Standardisation
CENELEC:	European Committee for Electrotechnical Standardisation
CIF:	Common Intermediate Format
CLI:	Command Line Interface
CLI:	Calling-Line Identification
COCOM:	Communications Committee
COST:	European Cooperation in the field of Scientific and Technical Research
COST 219:	Future telecommunications and teleinformatics facilities for disabled people and elderly
COST 219bis:	Telecommunications: Access for Disabled and Elderly People
CSS:	Cascading Style Sheet
DAISY:	Digital Accessible Information System
DDA:	Disability Discrimination Act
D-Me:	Digital Me
DTMF:	Dual Tone Multiple Frequencies
EDeAN:	European Design for All eAccessibility Network
EDT:	European Deaf Telephone
EMC:	Electromagnetic Compatibility
EIB:	European Installation Bus
ETSI:	European Telecommunications Standards Institute
EU:	European Union
GDP:	Gross Domestic Product
GPRS:	General Packet Radio Service
GPS:	Global Positioning System
GSM:	Global System for Mobile Communications (originally: Groupe Spécial Mobile)
GUI:	Graphical User Interface
HAVi:	Home Audio Video Interoperability
HCO:	Hear Carry Over
HF:	Human Factors
HTML:	Hypertext Markup Language
ICF:	International Classification of Disability, Functioning and Health
ICT:	Information and Communications Technologies
IEEE:	Institute of Electrical and Electronics Engineers
IEC:	International Electrotechnical Commission
IM:	Interactive Management
INCOM:	Inclusive Communications Committee
IM:	Instant Messaging services
IR:	Infrared
IP:	Internet Protocol
ISDN:	Integrated Services Digital Network
ISM:	Interpretive Modelling Structure
ISO:	International Standards Organisation

Appendix II. Glossary of acronyms used in book

IST:	Information Society Technologies
ISTAG:	IST Advisory Group
ITU:	International Telecommunication Union
JIS:	Japan Industrial Standard
LON:	Local Operating Network
MCI:	Mild Cognitive Impairment
MIDP:	Mobile Information Device Profile
NFTH:	Nordic Forum for Telecommunications and Disability
NGT:	Nominal Group Technique
NRA:	National Regulatory Authority
NTP:	Network Terminal Point
OBO:	Operator determined of Barring of Outgoing calls
OCR:	Optical Character Recognition
PATS:	Publicly Available Telephone Services
P-Com:	Personal Communicator
PDA:	Personal Digital Assistant
PDF:	Page Description File
PPCPE:	Pocket PC Phone Edition
PSTN:	Public Switched Telephone Network
RF:	Radio Frequency
RFID:	Radio Frequency Identification
RTTE:	Radio and Telecommunications Terminal Equipment
SD:	Secure Digital
SIBS:	Interbank Services Company
SIP:	Session Initiation Protocol
SMP:	Significant Market Power
SMS:	Short Message Service
SOAP:	Simple Object Access Protocol
STF:	Special Task Force
STS:	Standard Telephone Service
SWAMI:	Safeguards in a World of Ambient Intelligence
SWOT:	Strengths, Weaknesses, Opportunities, Threats
TCAM:	Telecommunications Conformity Assessment and Market surveillance committee
TC HF:	Technical Committee Human Factors (ETSI)
UAN:	Underground Network Area
UMTS:	Universal Mobile Telecommunications System
UPnP:	Universal Plug and Play
VoIP:	Voice over Internet Protocol
VCO:	Voice Carry Over
W3C:	World Wide Web Consortium
WAI:	Web Accessibility Initiative
WAN:	Wide Area Network
WCAG:	Web Contents Accessibility Guidelines
WER:	Word Error Rate
WHO:	World Health Organisation
WiFi:	Wireless Fidelity (IEEE 802.11b/g)
WLAN:	Wireless Local Area Network
WPAN:	Wireless Personal Area Network
WSIS:	World Summit on Information Society
XML:	Extensible Markup Language

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COST

COST is an intergovernmental European framework for international cooperation between nationally funded research activities. COST creates scientific networks and enables scientists to collaborate in a wide spectrum of activities in research and technology. COST activities are administered by the COST Office.

Further information: http://www.cost.esf.org

COST 219ter

The main objective of COST 219ter is to increase the accessibility of next generation telecommunication network services and equipment to elderly people and people with disabilities by design or by adaptation when required. In cases where this cannot be achieved, the Action will promote the establishment of appropriate supplementary assistive services and equipment. Taking always into account inclusive design in telecommunications, especially in the mobile field, the objectives are to:

- *Extend the existing COST 219 website for designers to better understand consumers and their requirements, so that many more people with disabilities and elderly people can be catered for in mainstream design*
- *Support the exchange of information on inclusion and accessibility issues so that these can be freely explored with developers, researchers and representatives of the telecommunications industries and service providers*

so that

- *People with disabilities and elderly people can share in the benefits of new mobile communication systems.*

The signatory countries of the COST 219ter Action are:

Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Malta, Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Switzerland and the United Kingdom. Australia, Japan and the USA participate as non-COST members.

Further information: www.cost219.org