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### Opportunities And Challenges of E-Health and Telemedicine Via Satellite

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## Opportunities And Challenges of E-Health and Telemedicine Via Satellite

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# OPPORTUNITIES AND CHALLENGES OF EHEALTH AND TELEMEDICINE VIA SATELLITE

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## INTRODUCTION

The introduction of Information and Communication Technology (ICT) in the health scenario is instrumental for the development of sustainable services of direct benefit for the European citizen. The setting up of satellite based applications will enhance rapidly the decentralisation and the enrichment of the European territory driving it towards a homogenous environment for healthcare. Specific benefits obtained from the developments of eHealth and Telemedicine via Satellite services will essentially be:

- To support the take up of broadband services in rural areas; de facto contributing to the bridging of the digital divide.
- To enable public authorities to contain service costs and improve prevention strategies.
- Through the provision of healthcare services on moving platforms eHealth and Telemedicine via Satellite services will ubiquitously enhance the safety for European citizens.
- The only way to provide a European Early Warning System capable of predicting health threats and alerting populations in a timely fashion.
- The most robust way to provide healthcare emergency services in disaster situations.
- To enhance the provision of ubiquitous medical education services of direct benefit for the patient and the overall medical community.
- Due to its intrinsic capability of aggregating the demand, eHealth and Telemedicine via Satellite services will encourage the generation of European standards, legal and regulatory frameworks.

The relevance of the above mentioned benefits demands a coherent programmatic effort at European level. In this frame the European Space Agency has deemed necessary to set up a working group formed by representatives of different eHealth and Telemedicine user domains – i.e. the members of the telemedicine working group – in order to define key thematic areas where the programmatic actions should develop.

This publication describes the results of this *eHealth and Telemedicine via Satellite Working Group*. It covers needs and demands, problems to be solved, and both challenges of and opportunities for different areas in eHealth and Telemedicine. The issue is to improve health systems across Europe through the use of eHealth and Telemedicine via Satellite.

Europe, in this context, follows the definition of the United Nations Europe (UN Europe) which consists of 52 member states.

This poses great challenges of and opportunities for the use of satellites to improve information and communication within and across countries and therefore to support health and population development.

The use of information and communication technology in the health sector (digital data transmitted, stored and retrieved electronically for clinical, educational and administrative purposes, both at the local site and at a distance) is defined as eHealth (WHO HQ 2002; Mitchell 1999). To be able to transmit, store and retrieve, connectivity, understood as interoperability, is the key pillar.

For all areas of eHealth and Telemedicine, the concept of connectivity for and among individuals, healthcare services, and health systems is central. On the background of the *added value chains for an integrated healthcare approach*, healthcare services delivered by different providers must be interoperable on four levels of connectivity:

1. *Political interoperability* (policy, ethical, and legal aspects)
2. *Social interoperability* (professional and citizen mobility, citizen centred approach)
3. *Organizational interoperability* (health system and service integration and coordination of levels and individual and community: smooth collaboration according to patient-individual care plans is required, on basis of appropriate regulations, agreements and contracts.
4. *Technical interoperability* (communication networks, content standards, platform standards). A secure, reliable, and accessible communication infrastructure for health and social care is required as a prerequisite for broad deployment of eHealth and Telemedicine.

The publication introduces the perspective of health systems, the definitions of eHealth, current European health challenges, and the role of eHealth for supporting health system functional development is described. Key drivers are identified for the use of eHealth and Telemedicine with consideration for a multicultural approach and the current barriers to eHealth adoption. This section leads next to an explanation of the current practical challenges to be solved (sections 1 and 2).

The other sections describe special fields of application, regardless of the basic communication technology used. Each of these sections was identified as substantial to the progress of the work to be done (sections 3 to 9).

Section 10 describes a global visionary perspective of an eHealth and Telemedicine platform for applications and services via satellite. The next section shows how Satellite communications (Satcom) can play a key role in eHealth and Telemedicine applications and services (section 11).

Within section 12 the suggestions for ESA actions are described on the background of the elaborated results on the thematic areas and the global vision presented before.

The glossary in section 13 defines all relevant concepts used both in this text and in a modern international understanding of what eHealth and Telemedicine are today. The glossary is as far as possible based on definitions given by public authorities and standardization bodies.

Finally, references to political documents, strategy papers, scientific literature, both from printed media and Internet resources, are listed in the references section 14.

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# 1. BACKGROUND

Europe is a vast union of unique and diverse nations. The scope of Europe as defined by the United Nations includes all of the nations from Greenland in the west to the Russian Federation in the east, and Scandinavia in the north to the Mediterranean and central Asia in the south. The UN Europe comprises 52 countries with a variety of cultures, religions, languages, geographical accidents, economical development and socio-demographic trends. The EU with its 25 member states plus Iceland, Norway and Switzerland represent the western and reaches part of the continent, but as it is rapidly expanding to include all the nations of Europe, strengthen European health systems through this enlarged perspective is becoming and imperative.



*Figure 1.* Graphical map of UN Europe

*Table 1.* Countries of the UN Europe.

Albania	Finland	Luxembourg	Spain
Andorra	France	Malta	Sweden
Armenia	Georgia	Monaco	Switzerland
Austria	Germany	Netherlands	Tajikistan
Azerbaijan	Greece	Norway	The former Yugoslav
Belarus	Hungary	Poland	Republic of Macedonia
Belgium	Iceland	Portugal	Turkey
Bosnia & Herzegovina	Ireland	Republic of Moldova	Turkmenistan
Bulgaria	Israel	Romania	Ukraine
Croatia	Italy	Russian Federation	United Kingdom
Cyprus	Kazakhstan	San Marino	Uzbekistan
Czech Republic	Kyrgyzstan	Serbia & Montenegro	
Denmark	Latvia	Slovakia	
Estonia	Lithuania	Slovenia	

Some of the main features of the socio-demographic diversity can be summarized as:

- The UN European Region is home to some 870 million people in 52 countries - close to one fifth of the world's population.
- GDP per capita varies enormously in the region, from close to \$ US 30,000 in the West to several hundreds in the Central Asian republics. Healthcare expenditure increases ten-fold from East to West.
- Current developments in international trade, transportation, labour and migration have serious implications for health conditions and health development strategies.
- Many countries have experienced recent cutbacks in investment in public infrastructures and in services.
- The occurrence of health services globalisation in which the demand for health professionals and the market for health products operates has increased pressure on national economies.
- Resource allocation decisions must balance health and non-health priorities as well as individual and collective priorities (and rights).
- Public health competes for limited public funds with other sectors such as employment, social welfare, housing and education.
- Inter- and intra-country equity in the Region is thus a serious issue. The persons born in the West can expect to live on average 10 years more than those born in the East.

There are also big differences in digital divide, the use of internet and the number of hosts across countries.

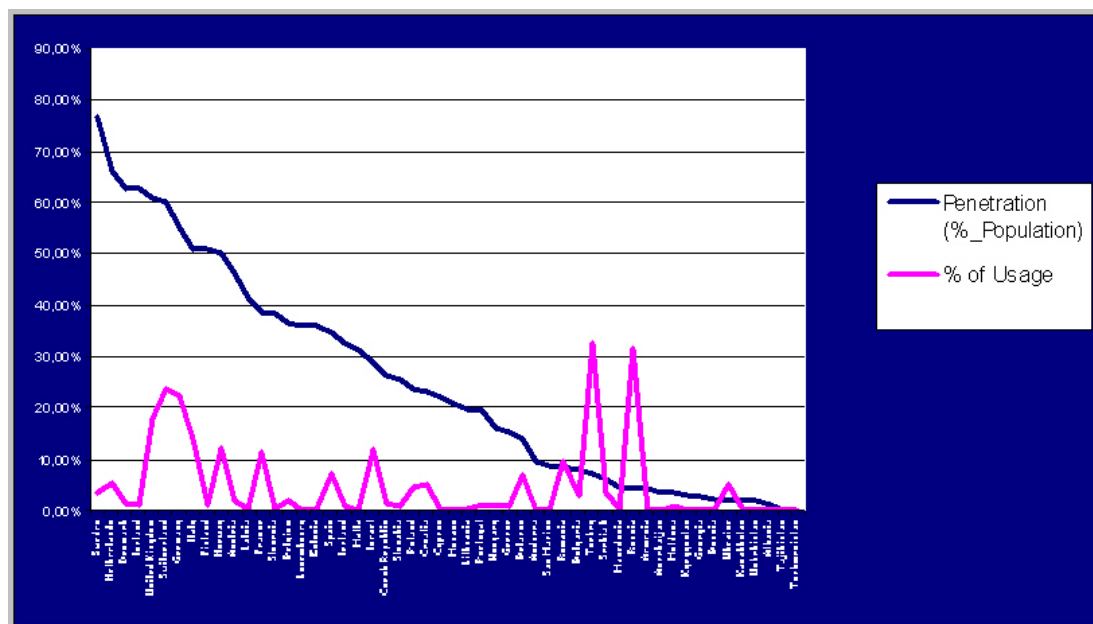


Figure 2. Internet users in European countries.

The level of infrastructure, not only related to communication, but to roads, healthcare services and appliances and human resources, brings high inequalities in the access and the quality of the health services provided. The use of IT facilities, including satellite communication, will support the achievement of a significant reduction of health inequities in the region. The reduction of inequalities has become a top priority and represents a political challenge for European citizens.



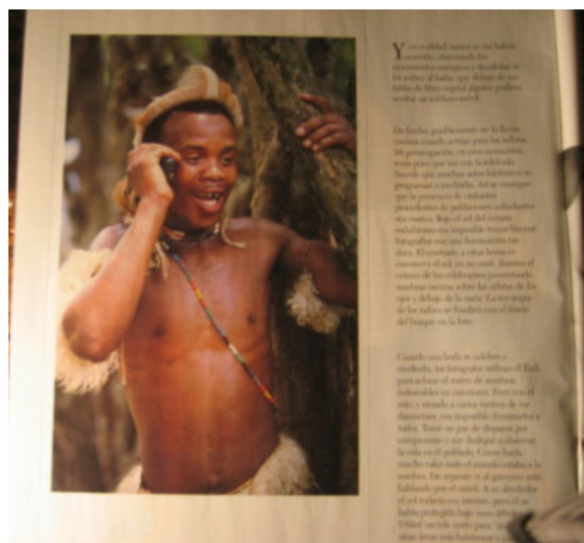


Figure 3. Tradition changes throughout time.

Even if terrestrial infrastructure is not available, mobile communication is reaching a large proportion of isolated populations providing an extraordinary opportunity for satellites to reach those communities for health and other purposes.

## DEFINITION OF TELEMEDICINE AND eHEALTH

Terms related to eHealth are sometimes confused or broadly used interchangeably. The scope of these terms is illustrated in the diagram below.

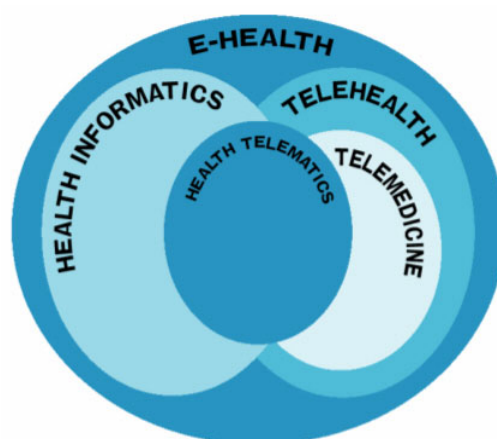


Figure 4. Relationship between the various terminologies associated with eHealth.

## DEFINITION OF TERMS

The definition of the terms *Health Telematics*, *Telemedicine*, *Telehealth* and *eHealth* follows the WHO policy paper (Kwankam). They are given, together with other terms, in the Glossary in section 13.

## COMPONENTS AND APPLICATIONS

eHealth applications can be grouped into four main areas (Mitchell 1999). These are

- eCare
- eLearning
- eSurveillance
- eGovernment / eAdministration

*Table 2.* The domains of eHealth.

eCare	<ul style="list-style-type: none"> <li>• Electronically facilitated citizen self help</li> <li>• Remotely promoted and monitored preventative healthcare programmes</li> <li>• Health and biological signal monitoring</li> <li>• Individual case management</li> <li>• Electronically assisted health assessment</li> <li>• Remote professional consultation and sharing of data amongst professionals, especially the provision of remote second opinions and access to specialised care</li> <li>• Assisted interventions by healthcare professionals</li> <li>• Emergency medicine and vital sign disasters monitoring, such as earthquakes or plane crashes</li> <li>• Access to and updating electronic healthcare records</li> </ul>
eLearning	<ul style="list-style-type: none"> <li>• Remote patient learning for preventative care and disease management</li> <li>• Remote professional learning and competence monitoring</li> <li>• Remote access to high quality health information including current literature</li> <li>• Remote access to evidence based medicine</li> </ul>
eSurveillance	<ul style="list-style-type: none"> <li>• Public health and disease reporting</li> <li>• Real-time epidemiological analysis</li> <li>• Research and electronic health statistical analysis</li> <li>• Management of consequences to health of natural and man-made disasters</li> </ul>
<i>eGovernance / eAdministration</i>	<ul style="list-style-type: none"> <li>• Billing and administrative data management to support the healthcare process</li> <li>• Aggregation and reporting of administrative data including quality, clinical outcomes, etc.</li> <li>• Improve decision making through access to information</li> <li>• Advocacy through modern technology</li> </ul>

The following stakeholders are influenced by or influence the application of eHealth:

- Healthcare professionals / healthcare providers
- Citizens / patients
- Policy makers
- Insurers / payers / purchasers
- Scientists / academics
- Educators

## KEY DRIVERS

A health system is defined in The World Health Report 2000, to include all actions whose primary purpose is to promote, restore or maintain health (WHO 2000). The document identifies the following *goals for a health system*:

- Improve the health of the population served (health – level and distribution)
- Respond to peoples’ legitimate expectations (responsiveness – level and distribution), and
- Provide financial protection against the cost of ill-health (fair financing)

The health system attains its goals by carrying out a number of functions (that is, groups of similar activities within the system). From this perspective:

- Services need to be *produced* (“*Service Provision*”).
- Funding has to be *ensured* (“*Financing*”).
- Inputs have to be “*created*” (“*Resource Generation*”).
- The whole system has to be *governed* (“*Stewardship / Regulation*”).

Health systems have always performed the above functions, although mostly in a non-integrated way. What is new is the attention paid to the separate functions and functional specialization as a preferred mechanism. As policy makers struggle with the immense health challenges of this century, they must consider all available means to develop these functions. eHealth, the combined use in the health sector of electronic communication and information technology, is a mechanism to support service provision, financing, resource generation and stewardship.

## DEVELOPMENT OF SERVICE PROVISION

The service provision function is the most familiar, and in fact the entire health system is often identified as service delivery. The classification here emphasizes that providing services is something the system does; it is not what the system is.

The *key service provision drivers* are:

- Available service solutions don’t reach vulnerable populations (remote communities, prisoners, soldiers, immigrants / refugees, the elderly / the young). High costs in the

transport of patients and travel of healthcare providers distort in-hospital or home care service provision.

- Poor coordination of healthcare services / continuity of care to reduce costs, reduce duplication, reduce error, etc. due to poor communication of data and information, lack of standards and regulatory frameworks, etc.
- Insufficient accountability for the quality of the systems further damaged by poor managerial and organizational skills.
- Lack of effective disaster relief and emergency systems in the countries most at risk.
- Inability to cope with uncertainty as to the precise health services needs in changing societies.

**eHealth** can play a very important role in **service provision** through **eCare** by improving access and equity and quality and accountability by connecting healthcare facilities and healthcare professionals and diminishing geographical or physical barriers (e.g. home monitoring and second opinion).

## DEVELOPMENT OF FINANCING

The components of financing include resource mobilization / revenue collection; pooling of risks and resources; resource allocation / purchasing of interventions.

The *key financing drivers* are:

- Insufficient resource base in poor countries / cost explosion in developed countries.
- Poor sustainability in revenue collection mechanisms further affected by changing policy frameworks between policy makers.
- Segmentation of risk pooling arrangements in favour of middle classes in poor countries of the region, thus making solidarity-based funding impossible.
- Resource allocation complicated by the 'double burden' of old and new diseases or balancing chronic disease demands with acute care and prevention.
- Out-of-pocket and under the table payments in some countries impact revenue collection and sustainability.

**eHealth** can provide an important impact on health system **financing** through **eAdministration** by improvement of information systems to support more effective resource allocation and purchasing (electronic pooling and purchasing where physical infrastructure does not exist will support transparency and efficiency - **eGovernance**).

## DEVELOPMENT OF RESOURCE GENERATION

The components of resource generation are human resources, knowledge and techniques, including pharmaceuticals, buildings, etc.

The *key resource generation drivers* are:

- Limited or no access to health services due to the scarcity of or inappropriate distribution of health professionals (urban vs. rural). Massive migration from the east to the west, from unstable communities, and from rural to metropolitan (brain drain of trained professionals, professional demography imbalances in terms of numbers and distribution, etc).
- Limited or no access to required equipment and facilities such as computers, laboratory equipment, electron microscopes, diagnostic equipment, pharmaceuticals. Poor countries face a lack of available drugs or appropriate and timely supply of drugs and non-existing or obsolete facilities.
- Limited or no access to health services due to the lack of advancements in other sectors which impact health (roads, education, etc.).
- Lack of infrastructure and methods to generate and exchange knowledge & experiences amongst decision makers (poor skills mix).
- Lack of adequate training of health professionals in prevention and management of key health problems (especially NCDs).
- Inability for providers to cope with the volume and complexity of the required knowledge.

**eHealth** has the potential to provide an important impact on health system **resource generation** through **eLearning** and by overcoming the lack of facilities through connectivity with existing resources in countries where infrastructure is unstable or does not exist.

## DEVELOPMENT OF STEWARDSHIP

Stewardship includes formulating health policy – defining the system vision and direction; regulating – establishing fair rules of the game; and intelligence – assessing performance and sharing information.

The *key stewardship drivers* are:

- Lack of reliable, timely data and information for health system planning and reform and lack of policy development skills.
- Ministries of Health unable to overcome the burden of failed past policy and planning approaches due to insufficiently skilled staff.
- In poor countries, lack of a fair regulatory system due to technical difficulties, inability to implement legal measures and widespread corruption.
- Policy initiatives which improve public health being rejected due to poor means to communicate the basis of decision and the predicted improvements.
- Control and management systems difficult to change and optimise.

**eHealth** has the potential to provide an important impact on health system **stewardship** through **eSurveillance** and **eGovernance** improving information systems for decision making and early response in emergency situations.

## ETHICAL ASPECTS

As stated in HEALTH 21 (WHO 1998), “The European Region is one of great contrasts, where rich countries rub shoulders with the poorest of nations, and the latter struggle with the consequences of social and political change, economic transition and the building of new institutions. It is but one part of a world undergoing profound change, where increasing globalisation of markets may widen the gap between rich and poor. The rapid development of science and of information technologies is spearheading further new developments, the full extent of which cannot yet be foreseen.”

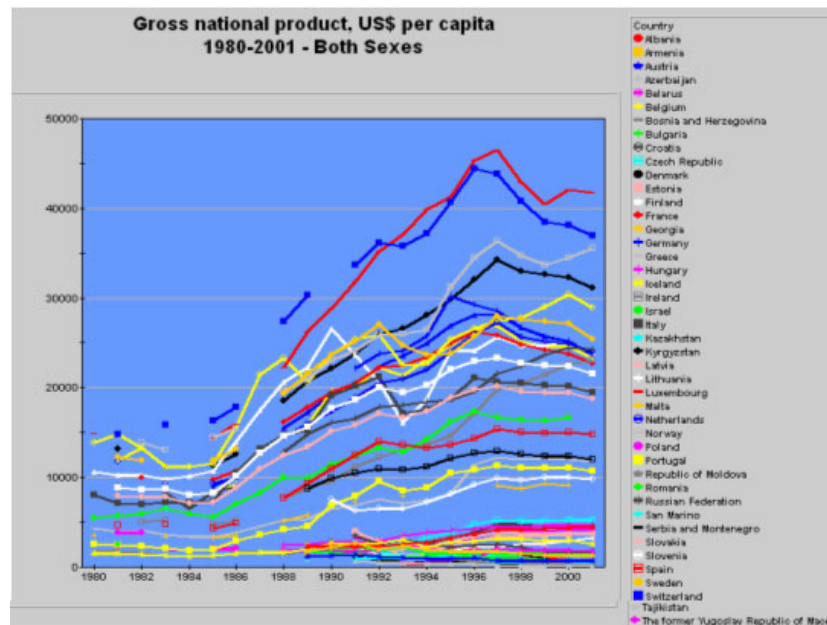


Figure 5. Gross national product in Europe (1980 – 2001) in US\$.

Even though the perspectives across the European Region are so very diverse, a common ground can be found based on the fixed values as stated in the 1998 World Health Declaration. The declaration reminds us that the enjoyment of health is one of the fundamental rights of every human being. Health is a precondition for well being and the quality of life. It is a benchmark for measuring progress towards the reduction of poverty, the promotion of social cohesion and the elimination of discrimination. Any actions towards strengthening health systems must then take into account the basic values of equity, access, cost containment, and sustainability.

Three basic values form the ethical foundation of HEALTH 21:

- Health as a fundamental human right.
- Equity in health and solidarity in action between and within all countries and their inhabitants.
- Participation and accountability of individuals, groups, institutions, and communities for continued health development.

HEALTH 21 goals are grouped into 5 action areas. They are not meant as a prescriptive list, to provide a framework for action for the Region as a whole. The 5 action areas include:

- *Solidarity and equity in health.* To foster stronger equity and solidarity in health development between Member States of the Region and better equity in health among groups within each country.
- *Better health for the people of the European Region.* Strengthening health throughout life and reducing the incidence and prevalence of diseases and other causes of ill health or death to the lowest feasible levels.
- *A multisectoral strategy for sustainable health.* To create sustainable health through more health-promoting physical, economic, social and cultural environments for people.
- *Changing the focus - an outcome-oriented health sector.* To orient the health sector towards ensuring better health gain, equity and cost-effectiveness.
- *Managing change for health.* To create a broad societal movement for health through innovative partnerships, unifying policies, and management practices tailored to the new realities of Europe.

We can see immediately the high impact eHealth can have in supporting these action areas across the region. This means that eHealth definitely should have the mandate to guarantee equal access to healthcare by involving all stakeholders. Participation of stakeholders is mediated through many different aspects described in the further sections.

## THE MULTICULTURAL DIMENSION - BUILDING A “EUROPEAN HEALTH IDENTITY” AND MAKING IT VISIBLE

In Europe, many different cultures exist. A common European identity is a very new concept and most citizens only speak and read their native language. This is a unique situation in the world having such heterogeneity inside a strong economic group. Behind this first analysis, these obstacles (identity, language) are in fact an extraordinary chance for the European Industry and satellite communication. To address this “European Paradox” eHealth is an appropriate tool and a challenge because good health is a common need and a common high value in all countries.

A good example of how the multicultural dimension can be integrated into eHealth practice is that of Paris. A suburb of Paris is home to roughly 70,000 people. Within those, 105 different cultures exist! This type of suburb can be used as a site to understand the impacts of cultural differences in order to support the reformation of modern health systems with an eHealth infrastructure. This model needs to be flexible enough to adapt to the challenges but could be expanded and used to develop a European health information system based on “cultural blocs”: French, English, Spanish, Portuguese, German, etc. This also would provide a platform for expanding the market in Latin America, Africa, India, Middle East, where countries have a common language with the European countries. No other place in the world can offer such a laboratory platform for the industry to address the multicultural challenge in information technology.

## MULTICULTURAL EADMINISTRATION, ESURVEILLANCE

Health system organization and administration varies widely within European countries. We can consider two main groups of countries according to collection of funds and pooling mechanisms to finance health services, countries based on insurance and countries based on

taxes and social security. Also there are two mechanisms for payment of services to providers, prospective mechanisms (per capita, budget or salaries, contracts) and retrospective mechanisms (fee-for service; outcome purchasing). While this create many complications in terms of “one economic market” for health services presents opportunities for eHealth use.

320 million Europeans travel to other European countries every year for business, holidays, pleasure, and retirement. More and more Europeans are travelling also to get the best care in Europe. The rulings of the Strasbourg court on reimbursement of services provided in different countries without previous authorization of the insurance company generate economic challenges for reimbursement of services rendered outside the insurance area.

*Table 3. Cross-border service cases.*

Cases	Country of services	Country of insurance	Services
Kohl, 1998	Germany	Luxemburg	Orthodontic
Decker, 1998	Luxemburg	Germany	Glasses
Molennar, 1999	France	Germany	Long term care
Vanbraekel, 1999	France	Belgium	Orthopedic Hos
Garaets-Smits 2001	Germany	Netherlands	Inpatient Parkinson
Peerbooms, 2001	Austria	Netherlands	Coma treatment

A first step in this direction has already been made by the introduction in June 2004 of a “European electronic card” replacing forms E111 and E112 for travelling (cards should be available for all citizens by 2007). The cards will provide information about the card holder and his/her insurance substituting the paper forms. Their implementation in the different healthcare systems is tested in the NETCARDS program.

The success of such a program offers a very concrete benefit for all European citizens. At this phase the information stored on the chip, including insurance rights, is displayed on the screen in the language of the country where the person is travelling. This understandable attestation prevents direct payment for the citizen and reduces uncertainty of reimbursements between countries. The next step is to link this initial system of cards with a network of national portals. In regions where the infrastructure is lacking for quick transaction the satellite transmission will provide a solution.

With the high mobility and immigration a European health surveillance system will make possible to follow health needs, plan resources and monitor activities to reduce and prevent growing inequities. While in some countries (mainly western countries) the different insurance systems have the most accurate and regularly updated information regarding their insured citizens, many countries are finding that they do not have any information available on citizens from other countries to which they have to provide services.

These citizens are also contributing to the change of the pattern of ill-health and illness. Countries that considered eradicated some illness from their environment, mainly communicable diseases such as tuberculosis, malaria, or sexually transmitted diseases are seen a revival of them. A European program has been created to agree on standard indicators for public health to monitor major diseases. The programme has identified areas where efforts have to be made in different countries to be able to implement a European eSurveillance system (e.g. introduction of the death certificate). Steps for harmonization by reducing the



cultural diversity for basic information gives a chance for a European eHealth system to be sustainable. Information system for basic health indicators (mortality, immunization) across countries is still in the middle ages but could be upgraded without major cultural obstacle. Satellite communication can be useful in the collection of health information in isolated areas where little information is currently available.

## MULTICULTURAL ECARE, ELEARNING

Citizens and health professionals, especially at primary care level, generally exchange information only in their native language. This makes communication in healthcare difficult in Europe. Language and cultural differences are reflected at national level, again mobility and immigration are contributing to increase cultural differences within countries. Healthcare professionals are challenged to deliver appropriate care to these foreign communities. The specific opportunity of eHealth is to provide a common structured language based on medical symptoms, diagnosis and procedures. Patient groups and healthcare professionals from one country can easily communicate with patient groups and professionals in another country, using a limited amount of words and pictures. The facility has been illustrated through cross-boarder care arrangements.

This is a useful observation for decision makers who have to develop strategies to face the increasing social and economic burden of diseases: Messages related to a disease can be illustrated by video clips taking culture and language of the actors into account. Thus a multicultural European database of messages could be set up and shared by all countries.

For example, monitoring home blood glucose for a Hungarian patient in France could be explained by the Hungarian video based on the Hungarian cultural approach. The total Hungarian community disseminated in Europe could benefit from the message and the French social security could save useless hospitalisation costs for training Hungarian patient on blood monitoring by French staff.

eHealth is most essential in the area of prevention because it facilitates information access to large numbers of the population. The WHO positive experience with the "Health Academy" in schools is a good model. In addition to such initiative, quick practical training for social workers and primary care teams is available in different countries although it is not accessible on large scale. Implementing a mechanism to share the existing material through IT use will contribute to an integrated Europe and the improvement of the quality of care provided.

Medicine is more and more complex and the fast turnover of accurate knowledge is a constant challenge. Although most specialists have the resources to attend national and international scientific meetings, however, most primary care team members do not have this opportunity. Developing virtual conferences and streaming of scientific events provides an opportunity to reach front-line healthcare professionals. Satellite can be used as a tool to facilitate the sharing of healthcare knowledge and expose the rest of the world to European achievements. In service training, which is also considered the best educational strategy for health care professionals, will be strongly supported by eHealth use.

## 2. PROBLEMS TO BE SOLVED

From the preceding section it has become very clear that there is a variety of both common problems and challenges. The healthcare systems, and the education of healthcare personnel, have to be re-organised to systems that function in a cross-border fashion. Prerequisites for this development shall be a specific emphasis on equity of access, interoperability and standardisation of systems and protocols, security and legal aspects.

There are technical, legal, organizational, and financial problems to be solved:

### TECHNICAL PROBLEMS

Although the technologies needed mostly do exist already today, there are still area-specific technical barriers that have to be overcome. The most prominent barriers are easy-to-use, intuitive, robust and smooth user interfaces and devices. The services must be offered to all users (in particular also to the elderly and the disabled) through such interfaces, and all of them have to be implemented in a uniform way. The access to the systems must be smooth and transparent to the users. Otherwise they won't achieve a good acceptance.

Also the lack of availability of data in an electronic format and the lack of modelling for some diseases and extreme weather events might reveal an important barrier for a global prediction and management of emergencies and natural disasters.

### LEGAL PROBLEMS

The legal barriers that have to be overcome are essentially the general ones applying to the whole health telematics field. Responsibility, confidentiality, liability and access only to certified professionals are some of the key issues.

### ORGANIZATIONAL PROBLEMS

There are serious organizational barriers, however, such as healthcare at home requiring smooth collaboration of different organizations. This requires a significant redesign of business processes, which is only possible if a *change from the enterprise-centric view to a system-wide perspective with the patient / citizen at the centre* is achieved. Today the paradigm of service chains in healthcare, built on ICT-based collaboration of service providers linked in a service provision network, is still in its infancy. However, the increasing interest in recent approaches like managed care, disease management, and case management, which are strongly related to this paradigm shift, shows that the necessity of changing the way in which healthcare systems are organized is more and more recognized and continually becomes transparent. Also country-specific factors, such as the roles of different providers of health and social care services, insurance companies, housing providers, local authorities, and telealarm providers, need to be taken into account when introducing healthcare at home.

### FINANCIAL PROBLEMS

The financial barriers largely depend on the different countries' policies. In countries with national healthcare systems these services will be a part of the overall healthcare system. In

insurance based countries, where services are reimbursed on a fee-for service basis, new codes will have to be established. In countries with market-driven healthcare systems the prices need to be adapted to market prices driven by the healthcare consumers. At this time there is little evidence on how the broad implementation of such eHealth and Telemedicine services will affect the financial situation of healthcare systems in total, and its participants in particular. The challenge is to create comprehensive systems (networks of services offering the basis for patient-individual service chains) which are financially beneficial for all players.

## OTHER PROBLEMS

Furthermore, the awareness of the great opportunities that eHealth and Telemedicine can help to solve the huge problem of an “elderly society” and the problem of isolated areas has to be promoted in both citizens and politicians.

Stakeholders, including health professionals, researchers, public officials, and the lay public, must collaborate on a range of activities. These activities include initiatives to build a robust health information system that provides equitable access, development of high-quality, audience-appropriate information and support services for specific health problems, and health-related decisions for all segments of the population, especially for underserved persons, training of health professionals in the science of communication and the use of communication technologies, evaluation of interventions, promotion of a critical understanding and practice of effective health communication both for end-users and for health professionals, and initiatives to gain knowledge about eHealth consumers’ use of and their needs and attitudes with regards to information and communication technologies in healthcare.

## BARRIERS

In spite of the potential which eHealth and Telemedicine have as a mechanism to support health systems, a number of barriers, at various levels, would need to be overcome for health systems to take full advantage of these opportunities. These barriers are not unidimensional, focusing on technical knowledge as previously assumed, but rather a multidimensional construct, encompassing technical knowledge, economic viability, organizational support and behaviour modification.

The Telemedicine Alliance, a collaboration between the World Health Organization, the European Space Agency and the International Telecommunications Union studied eHealth and Telemedicine adoption trends through personal interviews with 54 European telecommunications experts, health policy makers, and healthcare providers (2003). The three most important barriers to eHealth and Telemedicine adoption were identified as: the problem of interoperability (technical, cultural, systematic- financial reimbursement, inter-organizational workflow), acceptance of a “new” health system, and regulatory constraints. This emphasizes that European eHealth and Telemedicine implementation has to be accomplished by simultaneously horizontal and vertical multisectoral action.

## INTEROPERABILITY

Interoperability is a key challenge. This is the fragmentation problem - many pieces of information, in many formats, on many platforms, in many stakeholder environments, and in many geographic locations. The data sets are thus heterogeneous both physically (stored in

different locations) and logically (not organized in the same fashion) accentuating issues of interoperability that are raised by lack of compatibility of systems and equipment. The problem of interoperability is not limited to technical standardization as typically assumed, but encompasses the complex issues of integrating cultural, financial and workflow systems. Ensuring that the 'ways of working' of health systems are interoperable is a major challenge.

## ACCEPTANCE

Acceptance of eHealth and Telemedicine presents a particular challenge. It is important to promote the use of automated tailoring of information access and summaries to accommodate variations in culture, language, literacy, and health-related goals, as well as integrated decision-support systems that can proactively foster best practices. Unfortunately, collection and delivery of the necessary epidemiological and patient data on which such systems must be built are problematic. However, once collected, eHealth can be used for timely transfer of data to central services for planning and management purposes.

At the organizational level, revolutionary advances in medicine and technology as a whole during the past few decades have resulted in shifts in the boundaries between hospitals, primary healthcare, and community care. In the future, eHealth and Telemedicine is likely to add to this by changing the way in which health services are provided, from clinical messaging (advice, results and referrals), to distributed electronic health records, increased connectivity between health services, patient appliances to assist self-management, and the use of technology to improve communication (*Think tank 2000*). These changes need to be sensitive to acceptance concerns related to changing established medical traditions, professional autonomy and loss of control.

## REGULATORY CONSTRAINTS

Liability in connection with standards of care and medical malpractice, responsibility for security and confidentiality of patient-specific information are major legal challenges. Owing to the computerized communications involved in eHealth and Telemedicine, determining where transactions occurred, which laws apply and which courts have jurisdiction will be problematic. At the policy level, challenges include professional standards of providing care and licensing of care givers, and regulation of medical devices and eHealth and Telemedicine application software. eHealth and Telemedicine is currently unregulated, unlike all other aspects of the health system.

eHealth and Telemedicine also raises or accentuates ethical, legal and policy issues. Confidentiality of information, protecting the privacy of patients and safeguarding the integrity of information will present significant challenges with increasing use of eHealth and Telemedicine (*Think tank 2003*). There will also be gender issues to be addressed and model guidelines will be needed to resolve problems brought on by cultural differences among countries engaged in eHealth and Telemedicine activities (*Think tank 2003*).

### 3. INTERCONNECTIVITY FOR HEALTHCARE SERVICES

#### TODAY'S SITUATION

Interconnectivity comprises a lot more than merely devising and installing the technological infrastructure so as to be able to communicate and spread medical data through defined secured channels from one point on the earth to another.

Interconnectivity is responsible for several aspects of eHealth and Telemedicine service delivery when installing and running it:

- Technical aspects
- Organizational aspects
- Psychological aspects
- Social and socio-cultural aspects
- Financial aspects
- Legal aspects
- Political aspects
- Security aspects

All these aspects are intertwined with all the sections and contributions to be found in this document. Nonetheless, it is important to describe the major features since they may serve as important criteria to be observed and integrated for the development of “running telemedical systems”.

#### Technical aspects

With the availability of electronic patient record systems (Waegemann 1999) which try to integrate not merely both the stationary and the ambulatory medical workflow of diagnostics and therapy, but deliver real-time medical patient data in a ubiquitous fashion to hold these data available at any time and any location, the basis for a global data exchange in the field of medicine is given. The main stakes today comprise HL7 (HL7 2004) and information servers, CDA (CDA 2004), SCIPHOX (SCIPHOX 2004), and many other existing and to become documentation standards. More and more, the availability and performance of terrestrial communication lines becomes continually better: Back from analogue telephone line to digital ISDN and nowadays xDSL lines (Schlesinger et al. 1997). Whereas these communication line types are financially affordable usually for private and small business applications and services, such lines of even better quality (e.g. optical fibre) are today too expensive to compete adequately for a substantial market share in medicine.

#### Organizational aspects

The necessary forms of organization within hospitals and the medical practices are only partially compatible to each other. As of yet, there are no general recommendations as how to organize services which have to deal with a more thorough electronification of medicine (Klingler 2000). This, however, is independent of the underlying communication technology used.

## Psychological aspects

Many staff members in a medical setting – irrelevant of their hierarchical position – are still reluctant to use computer-based help in their daily routine work. It has clearly been shown that for physicians, the “option to possess a gadget” to handle medical instructions is interesting, but this interest soon enough loses intensity after a very short period of time. For the paramedics, however, such gadgets often become integrated for good into their medical routine, and they are thought to use them much longer, much more intensely, and with a greater understanding of the gadget’s practical value.

## Social and socio-cultural aspects

Many studies have shown that socio-cultural changes of a society towards the incorporation of electronic gadgets into daily life have great influence on the way people think and even expect how medicine should work. Technocracy has become one of the outstanding features of medicine in the opinion of most people. Irrelevant of whether this view is correct or adequate, medicine now is no longer in a condition to reluctantly defy all technological advances made. “The standard of ubiquitous communicability for man has to become a feature of medicine as well”. Furthermore, hierarchical structures no longer being accepted the way they used to be, a tendency can be noted which strengthens the individual’s “home right”: More and more applications and services are directly integrated into the consumers’ homes, and they are expected to be both safe and trustworthy (cf. section *Healthcare at Home*).

## Financial aspects

The ongoing everyday usage of Information and communication technology has given rise to telecommunication access solutions associated with continually decreasing and thus affordable prices which make this technology usable for the large majority of users. This is, however, true only for the conventionally used analogue and digital communication lines up to ISDN. The next line of quality, xDSL, demands a different and more expensive attitude. Whereas optical fibres are typically used in large enterprises and academic institutions, satellites still have not reached a general usability on behalf of their average communication costs.

## Legal aspects

The heterogeneity of legal preconditions for carrying out telemedical applications and services, invariant of the used communication technology (terrestrial or via satellites) still in many countries forms a broad barrier with a national and an international component. Many of these aspects are discussed in more thorough detail in prior text sections.

## Political aspects

Adjoining to the legal problems, the general attitude towards an ongoing electronification in many countries is apparent, the way and direction, however, in which these developments are brought to flourish, are potentially different. In this situation, some coordination actions on an international level are mandatory.

## Security aspects

Security threats – not merely in the sense of a technological impact (virus attacks, worms, malicious scripts, etc.), but also concerning human behaviour in carrying out national or international conflicts – are most imminent in people's minds when it comes to data security. This issue, however, has nothing to do with the underlying method of communication, but refers to the application and service layers to be applied.

## NEEDS AND DEMANDS

The most substantial needs and demands are identified here. It has to be noticed that the existing overlap with a several other needs and demands defined in other sections of this document. This fact is essential for both understanding that there is a red thread diving through all sections and for accepting that merely by these kinds of definitions applications and services for eHealth and Telemedicine via Satellite can be brought into existence.

## Technical aspects

The most important aspects which enable these “new” technologies to be widely accepted are (Cimino 1997):

- user-friendliness
- reliability
- error tolerance
- security and privacy
- service availability
- quality of service
- quality of workflow realization

Existing middleware must be integrated into more modern software concepts. Concerning the availability of communication services, ad-hoc networks must be installable within short periods of time. Adequate Quality of Service shall be provided. Different technological gadgets and equipments must be interoperable so as to work together and be compatible to each other on a large scale. Mobile units must be set up within few minutes to hours (quasi real-time deployment capability) after an incident (trauma, emergency, disaster, terror attack etc.) has taken place.

## Organizational aspects

Access to medical data must be authorized by the informed patient. The physician is not the proprietor of these data, whereby he may edit and manipulate them according to their “load of truth”. Medical data must be ubiquitous for mobility's and flexibility's sake.

## Psychological aspects

Clear structures of medical workflows must be elaborated and installed into both software and hardware concepts which allow for a digitalisation of medical data in every respect. The acceptance that by ongoing electronification routine aspects of work can be simplified and made more efficacious is crucial for the onset of technology apart from the postulation of user-friendliness and cognitive transparency.

## Social and socio-cultural aspects

The use of telemedical applications and services must go out of the hospitals and go into the homes of the health consumers. Healthcare is already being deliverable at home, and the electronic documentation needs to follow. Thus, the concept of continuous socialisation (with the family, with friends etc.) can be upheld better than before, and cases of hospitalisation with all their aspects of microbiological contamination and psychological deprivation and depersonalisation can be reduced significantly.

## Financial aspects

Establishing real world applications and services will, in the near future, definitively have the potential to help to save money, reduce redundancies, avoid a waste of resources, reduce the system-specific administrative overload and keep up and foster international bonds and treaties. Models will have to be developed which offer the same range of applications and services at the same or even better conditions (upstream and downstream velocity, data scrambling etc.) for both the health consumer and the healthcare professional based on the most suitable telecommunication access technology.

## Legal aspects

A unification of legal preconditions has to be proposed by each country. In Europe, a general legal framework will have to be imposed for developing the legal background for telemedical applications and services dealing with the transport of medical data both nationally and internationally.

## Political aspects

Regardless of each (European) country's healthcare policy, the general direction shall be an "opening of data transfer through closed channels" to transmit data safely from one point to another. Therefore, on the side of the policy makers, medically expert advisors and consultants who not only know the individual healthcare situation perfectly well, but also have deep knowledge of the technology to be used together with a vision of where the whole development is heading to, shall be introduced to offset up the new basic laws to foster the understanding of eHealth and Telemedicine on the one hand and help the development of the needed applications and services on the other.

## Security aspects

Data transfer has to be made safe and trustworthy. On the one side for the health consumer who wants to be assured that his medical data are not disclosed to anybody else but himself or herself. On the other side for the healthcare professional who does not want his medical workflow data exposed to unauthorized or forbidden benchmarking or other manipulation. Technologies must be developed which guarantee adequate amounts of privacy for all users of telemedical applications and services. Communication networks, thus, must exclude the possibility that their data stream is being logged and "reverse engineered" to something human readable and something which can be associated to a real human being. Furthermore, patients can have access to the log files of their medical data viewed by "authorized" persons thus implying a control mechanism for the accuracy and integrity of his/her own data (EHTEL 2002).



Most of the fore-mentioned aspects can be mingled into one singular concept when the following topic map is seen as a multi-layer approach to realizing a seamlessly integrated service chain model for eHealth and Telemedicine:

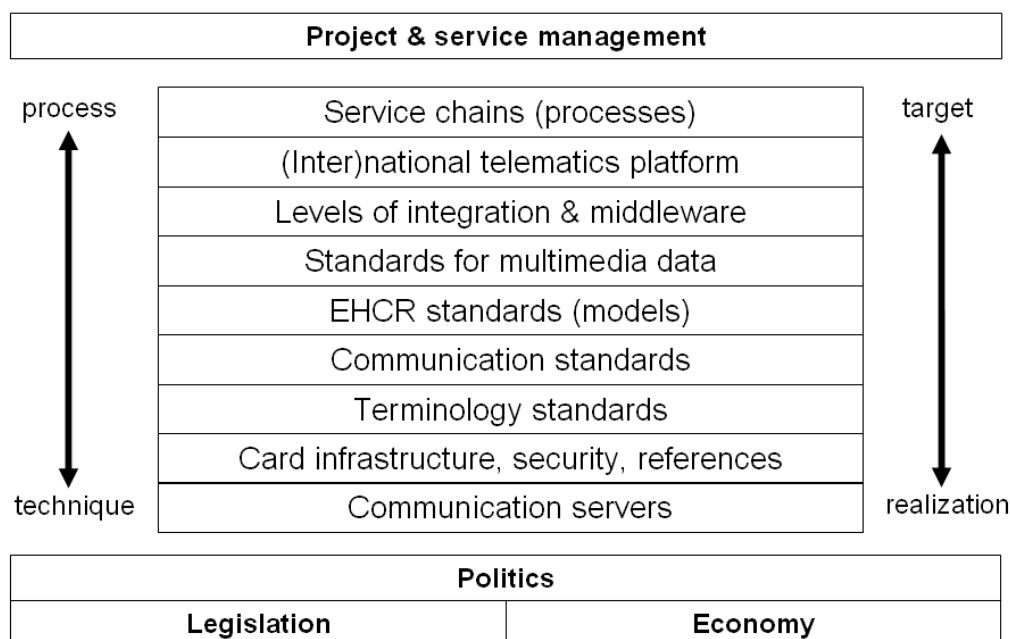


Figure 6. Proposed service chain model for eHealth and Telemedicine (Horsch et al. 2003).

## CHALLENGES AND OPPORTUNITIES

In conclusion, the technological basis to support the communication and integration of medical patient data exists and can be used. However, the heterogeneity of middleware in the healthcare sector reflects the real problems for the introduction, installation, and maintenance of such technology. And this situation seems to be mostly independent of the technological nature of communication: terrestrial or satellite communication is only one part of the solution of this problem as long as the integrative part is not included.

But apart from technological questions, the main stakes are to seamlessly integrate all of the mentioned aspects into one singular, possibly globally usable concept which enables the empowered citizen to take part in the best medical quality everywhere on this planet.

Therefore, some challenges and opportunities are addressed:

- The basic technology deals with communication of medical data. Thus, a standardized document format is needed. Best candidates are the XML-based HL7 together with the specification of CDA and SCIPHOX and other possible document formats to evolve.
- The applications and services presently used and to be developed are independent of the underlying communication carrier (terrestrial lines and satellites).
- Utilities to integrate existing middleware and to convert “older” data sets are needed. The software used has to be transparent and user-friendly to the maximum for all users.

- Technology has to go hand in hand with the health consumers' and the healthcare professionals' needs and demands and must not be used "en soi et pour soi" (role of "technology push" versus "demand pull").
- Socio-cultural changes need to be implicitly taken into account when it comes to developing systems which shall not only be used in a clinical context, but also be able to be integrateable into the health consumers' home.
- Terrestrial infrastructures are nowadays supporting the majority of existing and future applications and services in the eHealth and Telemedicine market. Only by developing competing financial models the spreading of the satellite technology will come into being demonstrating its values.
- Legal and political aspects have to be harmonized on both a national and an international level. This is the more important on behalf of the growing mobility and flexibility of today's populations.
- The basic demand for the individual's right to be proprietor of his or her own data is that adequate data security is a mandatory step which no longer needs any arguments. The medical data are owned by the patients. External interceptions cannot be tolerated.

*Technology push*, i.e. the existence and principal availability of technology without defining demands, thus, does not lead to the desired effect of a widespread use of telemedical applications and services via satellite as long as the *demand pull*, i.e. the users' demands and needs irrespective of existing or to-be-developed technology, is not correctly identified and integrated into one single concept.

**Interconnectivity for Healthcare Services** has many aspects (technical, organization, psychological, social and socio-cultural, financial, legal, political, security-associated) which play a substantial intertwined role (**network**).

Only this network texture enables both an efficient and efficacious performance of exchanging medical data through terrestrial and satellite communication structures.

With adequate definitions of both **existing demand** and **available technology** software applications and thereupon established services can be used to minimize efforts and redundancy and to maximize output and efficiency in medical data handling.

## 4. MANAGEMENT OF TRAUMA, EMERGENCIES, AND DISASTERS

### TODAY'S SITUATION

Large scale medical traumata, emergencies, and disasters are characterized by the same criteria (Balch/West 2001; MIL 2004; Plischke et al. 1999):

- Mostly unpredictable on behalf of when, where, with whom, how many persons;
- crucible of various qualitative and quantitative entities of possibly changing medical conditions, from the mildest which do not need immediate medical care to the worst which has to be treated instantaneously;
- optimal organization of medical infrastructure absolutely mandatory.

On a worldwide view, every year, natural catastrophes almost routinely kill a steadily increasing amount of person. In 1999 worldwide 14 large natural disasters have resulted in a damage of more than 1 billion US Dollars, 5 of which caused more than 1,000 deaths each. Some reasons for this increase are global trends such as continuing urbanization, growth of population, and both economic and technologic progress. The differentiation between natural and industrial (man-made) catastrophes gets blurred more and more. Further dangers are terrorist acts, politically instable countries, and warfare per se.

Other mentionable catastrophes were the earthquakes in Turkey, the floodings in Venezuela and Mozambique as well as those of the German rivers Odra (1997) (Feuerwehr 2002; Brandenburg 1997) and Elbe (2002) (MIL 2004), the famine in many African countries (e.g. Ethiopia) as well as the winter storms "Lothar" and "Martin" in Western Europe (Münchner Rück 2001).

Another example for man-made catastrophes with mass casualty incidents (MCI) are the air show crash in Ramstein in 1988 (MIL 2004) and the high-speed train crash in the German town Eschede in 1998 (Hüls/Oestern 1999; Oestern et al. 2000; Woltering/Schneider 2002), latter of which caused 96 immediate deaths and 108 prolonged heavy injuries.

Local data exist for the motor vehicle crash (MVC) analyses from many countries. To name the USA, only 23 % - 25 % of the population in the USA live in rural America, about 57 % of deaths caused by MVC occur in this population. Furthermore, only 15 states in the USA have statewide 911 or enhanced 911 systems. As a result, rural patients are at greater risk of traumatic death than their urban counterparts. In fact, patients involved in motor vehicle crashes in rural America have twice the rate of mortality when compared with those in an urban setting with the same injury severity score.

Some of the reasons for this astounding finding were identified: First, emergency room personnel in low volume trauma care "centres" often have limited experience with major traumas, which may lead to management errors and departures from the standard of care. In addition, many rural emergency rooms are not adequately staffed with properly trained personnel, and there are limits to the ability to provide continuing medical education (CME) to ER personnel and emergency medical service (EMS) providers in the rural setting.

Another reason for poor outcomes for rural trauma patients is the lack of access to immediate subspecialty care (trauma surgeons, neurosurgeons, orthopaedic, vascular or cardiac surgeons) in remote locations. Furthermore, the dispatch process from countryside to the next major trauma centre often takes too much time or does not have the adequate means for communication in a low-technisized rural region.

The described situation is not merely typical for the USA but is extendible to most of the European countries as well (Nerlich 2002).

Thus, a qualified national and international answer to and preventive measures against these threats are mandatory. Since it is common to both types of disasters that the pre-warning time is typically zero, detailed countermeasure plans and immediate establishment of ad-hoc communication technology by satellites are required.

The following table depicts the role and functions of telemedicine in medical trauma, emergency, and disaster management:

*Table 4.* Telemedicine in medical trauma, emergency, and disaster management

<b>Pre-hospital Assessment and Interventions</b>	<b>Hospital Care</b>	<b>Public Health Care Interface</b>
Deployable mobile telemedicine systems	Consultations with specialist and experts (emergency or other clinical situations)	Integrate diverse data sets
Digital ambulances and monitored patient transport	Continuous care (electronic intensive care units)	Education of patients and healthcare providers
Remote monitoring (clinical and administrative)		

The *rationale*, therefore, can be summed up in one sentence:

“To do the best for the greatest possible amount of injured persons at the right time and at the right place with any kind of technology which is reliable enough to work just in time.”

Thus, disasters like 9/11 in New York have largely opened the eyes of the administratively responsible persons to not only install and optimize suitable pre-warning instruments on both the technological and the human resource level, but also to enable access to ad-hoc installable communication networks.

## NEEDS AND DEMANDS

Apart from these rather instrumental working aids, the peculiarities of such disasters on behalf of the great number of involved authorities and organizations lead to a high-level demand for *Command, Control, and Communication (C3)*.

A retrospective analysis of several past MCI and disasters with emphasis on data and work flow in the medical treatment and its command system clearly showed following results (Hamilton 2003):

- The use of spoken radio communication causes transmission mistakes and radio-overload.
- Radio communication has its technical limits in concrete and other tight-fitting surroundings.
- Manual distribution of the same data for many receivers using different communication lines causes a time shift in the up-to-date communication.
- Language problems lead to longer reaction times.
- Up-to-date triage results as well as up-to-date transportation and hospital information are necessary for an effective medical evacuation process.
- The quality of disaster management largely depends on the quality of communication and information.

In conclusion, to cope with disaster scenarios there are three pillars of medical telematic tools:

- Computer-assisted Command and Control System (CCCS)
- telemedical support through *ad-hoc networks* and *running services*
- database-dependent resources network and medical intelligence

Here, the role of satellite communication comes clear into vision: Ad-hoc networks are with high probability no longer to be established based on terrestrial lines. High-throughput and – bandwidth satellite-based communication links have to be established within a short period of time (minutes after being on-site) so as to ensure a persistent, permanent communication quality. However, this is merely one side of the coin: The other is to have suitable applications and services, such as software for the safe placement of injured persons in regional and supra-regional hospitals, running on these lines.

## CHALLENGES AND OPPORTUNITIES

Satellite technology will play a major role in this field, despite great advances in other modes of data transmission and broadcasting used for telemedicine. The major application fields for satellite technology in trauma, emergency, and disaster handling are:

- Remote or inaccessible areas of the world (both in developed and developing countries) as well as
- Territories prone to natural and man-made disasters.

Examples of successful employment of satellite support in natural disasters are numerous, including the Mexico City earthquake 1985 when the ATS-3 satellite communications system provided critical support to international rescue efforts and the US-USSR space bridge for support to the Armenian earthquake in 1988. Similarly, in 1994, when a volcano disrupted the entire public communication system of Rabaul, the only line through which this community was able to communicate with the rest of the world was the satellite connections established for AMINE (The Asian Pacific Medical Information Network) project.

These examples can be extrapolated and applied into rural areas across the world, and most certainly in developing countries, but especially in remote and extreme conditions and

environments which lack conventional telecommunications systems, such as mountain and vast areas (e.g. Alaska, high mountains, jungle, and other regions around the world).

There is enough experience in establishing the configuration of such systems around the world, but one should benefit from the experience obtained from military sector. The military experience in establishing satellite connectivity has been well described elsewhere, especially during the most recent wars in Somalia, Gulf and Europe, Croatia, Macedonia, Kosovo as well as in natural disasters such as hurricanes using different satellite technologies and solutions (e.g. INMARSAT, EUTELSAT).

The future of satellite applications in telemedicine should take in consideration the advances made already and the experience from many projects in other countries. In a survey of interactive telemedicine projects via telecommunications satellite in Japan, it was suggested that VSATs (very small aperture terminals) be used, and the design of telecommunication channels should use TCP/IP based operation.

Thus, it becomes clear that telemedicine via satellite under the conditions of trauma, emergencies, and disasters become and even will become substantial fields of applications and potent market shares for the use of satellites in these settings.

Satellites are the most promising technological instruments to enable **mandatory ad-hoc broadband communication** in case of medical trauma, emergencies, and disaster situations.

Care must be applied, however, for the underlying software applications and services to enable a “real-time” placement for injured persons.

## 5. HEALTH EARLY WARNING FOR ENVIRONMENTAL RISKS

### TODAY'S SITUATION

In our global world, a disease outbreak in one country can spread internationally in a matter of hours or days (an example has been the SARS virus outbreak and diffusion). In controlling a disease outbreak, time is an essential parameter, and speed of reaction is of particular importance in the EC where products and people flow/migrate freely and controls at the borders have been abolished. Thus, a rapid and coordinated response to health problems and threats is critical.

With the intention of work more effectively on public health threats, the Council and European Parliament created a network for the epidemiological surveillance and control of communicable diseases in the EC back in 1988 (Decision 2119/98/EC) which was entrusted with the Europe-wide surveillance and setting up an European Early Warning System and Response (EWSR). After some years of running, institutions and scientists participating in this network have revealed the lack of an effective operational coordination, the need for more trained specialists, and the lack of shared data which have resulted in a segregation of specific disease-dedicated sub-networks and to a duplication of tasks and results (COM-441 2003). Also, prediction and management of extreme weather events represent a challenge for Europe requiring coordinated Early Warning Systems (EWS) with a global approach. The central European flood in 2002 is an example of an extreme meteorological event which involved several states and needed management on a supranational level.

It has been definitively demonstrated that some important health outcomes are tightly associated with environment, weather, and/or climate (Patz 2000). Among these are temperature-related morbidity and mortality, health effects of extreme weather events (storms, volcanoes, earthquakes, floods, droughts), air-pollution-related health effects, water- and food-borne diseases, and vector- and rodent-borne diseases. In order to predict and prevent these health threats, monitoring the environment and climate parameters and changes from the space is becoming mandatory.

At present there are a number of satellites involved in environmental monitoring functioning worldwide: Earth observation satellites (EnviSAT, Ikonos, SPOT, LandSAT, etc.), meteorological satellites (NOAA) and geostationary satellites (GOES, MeteoSat). Moreover, several satellite applications for monitoring disease distribution / transmission are currently under study.

Using near-real-time climate data and satellite imagery, NASA is developing the ability to map and monitor eco-climatic patterns associated with various disease outbreaks and provide advance warning of outbreaks important to human health.

Some important results have already been obtained such as the relationship between outbreaks of Rift Valley fever in Eastern Africa and the combination of both higher-than-normal Pacific Ocean temperatures associated with the El Niño and the western equatorial Indian Ocean (Harvell 2002); these outbreaks can be predicted up to five months in advance. Also the cholera outbreak in the American Pacific Coast (mainly in Peru) has been put in relation with

satellite-revealed ocean blooms of zooplankton-associated *Vibrio cholerae* caused by an increased seawater temperature derived from the El Niño alterations (Pascual et al. 2000; Gil et al. 2004).

Monitoring vector multiplication in vector-borne disease models (Rift Valley fever, malaria, West Nile virus, Lyme disease), observing ocean water colour for monitoring water-borne diseases (cholera), monitoring dust (micro-organisms, pesticides) clouds involved in airborne health outcomes such as asthma and allergy, monitoring movements of toxic or radioactive clouds and predicting storms in Europe by monitoring cyclones forming in the Atlantic ocean are examples of European space technology applications in medicine and public health which are currently “on the road”.

Data from each satellite channel may be used directly to describe epidemiological events or may be processed to produce indices useful in modelling. To this respect, data obtained from the space and concerning ocean conditions, earthquake activity, volcanic activity, meteorological conditions, and environmental parameters such as moisture, rainfall, greenness, temperature, and many others, have to be integrated with field, veterinarian, geographic, and clinical data to create biological models for communicable diseases and models regarding the origin and diffusion of dangerous meteorological events.

## NEEDS AND DEMANDS

A pan-European Health Early Warning System (HEWS) able to predict the risk represented by environment-related health threats needs:

- Modelling for communicable disease transmission patterns and the origin and diffusion of dangerous meteorological events
- Assessment of the risk for human health when environmental data indicate changing trends and “possibility of risk”
- Real-time transmission of data (outbreak / extreme event or risk of outbreak / extreme event)
- Very rapid transmission and diffusion of health risk alarms
- Real-time transmission of alarm on bioterrorism risk

However, a number of barriers and difficulties at present prevent the global and coordinating use of satellites in this field. Technical barriers such as

- the lack of field data and lack of ready-to-use data (data on paper, data on “private” archives),
- the lack of communication infrastructures, standardisation and networks coordination,
- the lack of biological models and climate models able to accurately project changes in disease transmission patterns and in extreme meteorological events, and
- the fact that the technology is unfamiliar and unproven in an operational environment

are limiting the exploitation of these very promising satellite-based applications.



Moreover, organisational problems can also be identified:

- Establishment of the “alert threshold”,
- “real” risk assessment tools,
- the need for methods to evaluate data accuracy and significance,
- the identification of the targets receiving the alert, and
- the timing and modalities of the alert communication

are some of these. It has also been revealed that there exists a lack of awareness regarding the potentiality of space technology and a general reluctance among health community to assimilate new technologies.

## CHALLENGES AND OPPORTUNITIES

The high amount of data provided by satellites in the explained context can be used to set up HEWSs capable of revealing any alarming data or changing trends and of rapidly communicating the alarm for adequate targets (centres, institutions, stakeholders). Satellite technologies can also be used in HEWS to centralise, make accessible and deliver databases to public health bodies, decision makers, and health information centres (e.g. the proposed European CDC (COM-441 2003)).

For the HEWS, the main challenge is to make a system available at European level capable of predicting communicable disease diffusion patterns, risk of disease outbreaks, and extreme meteorological event-related health threats in times allowing the setup of adequate protective measures for the citizens’ health safeguard.

Moreover, the health outcomes derived from the accidental or deliberate release of biological agents, which previously was considered only as an unlikely possibility, is now seen as an improbable but very dangerous event possibly leading to disastrous consequences. For this reason, it becomes crucial to integrate a dedicated warning system into the global HEWS to improve European preparedness.

Already-in-orbit satellites might be included in HEWS for the prediction of environmental-related health outcomes. More specifically, they will be mandatory in the following telemedical applications and services:

1. *Environment monitoring*: construction of an environmental database and construction of risk maps for water-, air-, vector-borne diseases and extreme meteorological events; necessity to ensure Earth-observing satellite data continuity in order to feed environmental databases in an operational manner.
2. *Rapid communication of data* to: i) an European Centre for Disease Control, ii) reference centres in each European country, iii) a system revealing any significant “change” (EWS), iv) integrative systems allowing database access to anyone (researchers studying modelling).
3. *Rapid diffusion of data* to/from any country, any centre (also to/from outside Europe)
4. *Rapid communication of the alarm* to adequate targets (institutions, stakeholders, decision-makers, media).
5. *Information / advice* on public health threats to remote and isolated areas
6. *Early warning and alarm diffusion on bioterrorism risks*.

## POTENTIAL SOCIO-ECONOMIC IMPACTS

Running systems (phone lines, optical fibres) are not easily installable in many countries and remote, isolated areas: satellites therefore can close these gaps in terrestrial communications. To lower costs, satellite co-usage has to be proposed for environment monitoring concerning communicable disease and extreme meteorological events early warning. Co-usage could also be acceptable for emergency management of natural and industrial disasters. To this respect, a tight coordination between satellite-based predictive and managing systems regarding natural disasters is desirable.

As far as the economical impacts of HEWS are concerned, costs to prevent or manage diseases (vaccines, antibiotics) and to evacuate and host people before extreme meteorological events or on account of a bioterrorism attack have to be considered. In any case, these services for the community have to be made available and funded by public authorities.

On other hand, space technology applications can induce a number of social benefits: Many human lives can definitely be saved by predicting and preventing emerging diseases and extreme events. The possibility of predicting dangerous events, such as natural disasters and bioterrorism threats and diseases, will consequently decrease fear, anxiety, and post traumatic stress disorders in people and will allow for a better management of extreme event consequences such as bacteria proliferation, water, and food contamination.

Sustainability of space technology and services involved in this field is based on the unique characteristics of this telemedical application.

A high market share and the entire population of a geographical region are concerned, also considering that the number of highly susceptible persons for these events are increasing and will increase in the future (poor, elderly, emigrants, immuno-compromised, chronically ill). The use of satellites in monitoring the environment is permanent and, thus, more data will accumulate during the years of observation, a better predictability of disease transmission and extreme event diffusion patterns will be possible.

There are increasing risk factors as regards environment-related health threats (increasing human impact in the environment, more pollution, accumulation of residues, desertification, increasing weather variability).

Earth-observing satellites provide simultaneous wide-area coverage allowing equal access for each population avoiding the isolation of remote areas.

The multidisciplinary nature of satellite-based earth monitoring is crucial and will be a determinant in lowering costs for permanent usage.

The **use of satellites is mandatory** to create in Europe an Early Warning System capable of predicting communicable disease diffusion patterns, risk of disease outbreaks and extreme meteorological event related health threats on the basis of an enlarging database constructed by continuously monitoring the environment.

Moreover, the **transmission, in real time, of alarming data via satellite** would allow prediction to occur in times compatible with the setup of adequate protective measures for the safeguard of the citizens' health.

## 6. EHEALTH EDUCATION

### TODAY'S SITUATION

eHealth education may be defined as the application of communications technologies to acquire new knowledge or skills across the whole range of areas which will affect healthcare professionals, and enrich their experience in rendering the best possible care to patients through out the process of medical care. eHealth education has the abilities to apply new concepts, and ideas in which the learner becomes an owner of that knowledge, without any respect to distance. As such, eHealth overall, and in particular eHealth education, is significant part of healthcare revolution, since the event of modern medicine. eHealth education process as a culture, uses for the most part, distance learning as the medium of dissemination of advanced information, and while it is an important aspect of today's education process, this medium should not be distracting, and the principles of learning and education should be unchanged. The addition of technology should not substitute for failed pedagogical process, but technology should allow that educational process, and the message to be disseminated, and tailored to individual groups and professionals, by retaining along some of the educational principles of traditional education. eHealth education centres on these principal issues:

- Distance learning
- Continuous Medical Education (CME) for medical professionals
- Advanced eHealth professionals education in the changing environment
- Patient's education in health related issues in the information age

### Distance learning

While distance learning benefits are not challenged by most, it is difficult to estimate the impact on education overall. Nonetheless, is becoming more and more prevalent around the world. In a survey of Internet found more than 3,000 programs and 1,100 accredited institutions using distance learning in 1,400 fields of studies, represented by over 50,000 courses.

The impact of distance learning should be measured by the content of the curriculum which should be based on the process, perception, product and the mode of delivery. As such distance learning and distance education process should be scrutinized just as traditional curriculum has been in the past and continue to be so. The only "change" should really be the medium of dissemination. Not the content per se, not the overall approach, and certainly not the end product, which is the education of the students, health professional and, the patients them self. The differences between classical teaching and learning, and new and modern form of teaching as well as learning is substantial in this new era. Instead of confined classroom teaching and learning, the entire universe has become a workplace, a learning environment, anywhere, anytime, 24 hours a day. This creates a sense of shared knowledge and virtual networking alliances.

The demand for distance learning stems from the common sense of its applicability, but it requires the same standards of production, and evaluation of such programs.

The main reasons to implement distance learning in health education are:

- Healthcare professional, in the information age, will acquire new skills and new knowledge without major disruption of their work
- The need to reduce the cost of obtaining such education on new information (travel expenses, lodging, registration fees on venues like clinical conferences, congresses, and other forms of meetings)
- Need for better convergence of information age healthcare professional in communication and computing technologies

## Continuous Medical Education (CME) for medical professionals

CME is an important aspect of healthcare professionals in order for them to maintain the acquired knowledge, and to gain new information, which will make possible:

- To offer the best possible care to their patients implementing current standards of care
- To satisfy governmental, institutional and scientific and clinical societies requirements for licensing, membership, and good standing in societies, associations and other organized forms of healthcare professionals
- To ensure that, they are up to speed with current medical practices

Distance learning and advances in technologies allows healthcare professionals to participate in CME programs without disrupting their daily routine work to participate in the traditional meetings. Furthermore, it allows and ensures consistency throughout the educational process among peers, institutions and countries.

## Current Status

The question how technology will change our world is not anymore relevant. The answer to this question is obvious. The advances in eHealth education have brought significant changes in health education overall. Advanced technologies such as computers, diagnostic imaging, robotics, voice-activating machines, and remote controls have changed hospitals and operating theatres in hospitals around the western world. In parallel with these developments, the patient has become an educated and informed consumer who:

- Questions the decisions of the practitioner and demand explanations and an evidence based medicine approach
- Validates his or her expertise through web sites and other forms
- Requires that the doctor offers care, current with world standards

Furthermore, today's patient can consult any expert in the field, in any country of the world, at any time without respect to geography and distance. At the same time, the world equilibrium has not followed the punctuation of the industrial world directed by the broad bandwidth rush, and there is a huge discrepancy between countries and continents.

Subsequently, there is a great need for eHealth education to become a *catalyst of equilibration among countries and nations as we move toward a perfect future and electronic globalization*. The wide application of eHealth education programs, will most likely narrow significantly, if not eliminate entirely, the gap between the countries delivery health systems, and between the imagination, dreams, and achievements of those who do not have the capability to apply new healthcare standards, and those who have such capabilities. For these radical changes to become a reality it will take time and investment, as well serious international collaboration,

but the concept of eHealth education has the potential to offer such radical changes, and for the most part, has been accepted, adopted around the world, and has raised hopes that it will create equality and equilibrium in the education of patients and healthcare professionals.

In particular eHealth education has potential to:

- Change the delivery of existing medical care and will create more efficient and economically sound healthcare systems, where advanced medical knowledge will prevent unnecessary transfers of patients to countries who can care for those patients, and/or prevent death and morbidity because country's medical professional will be well prepared

*Will bring together a coalition of new partners with innovative boundaries and clear vision*

This last element is most important, especially in developing countries, devastated by wars, suffering, political neglect or poverty.

The concept of eLearning, particularly in the health area, requires leadership. This leadership consists of a new generation of healthcare professional who are:

- Multi-dimensional and multi-tasked
- Have the passion to change the world
- Are not afraid to disturb the status quo, and are willing to share the knowledge among institutions and nations of the world
- View technology as the enabler of change, but not the sole answer itself

At the same time, this concept is a direct result of demands from the public and the consumers themselves. These demands call for:

Actions which include the transformation of the climate of health education process

- Fundamental reshaping of healthcare education system which needs to become a priority in a global sense, and not of focused, self-limited, institutional or driven by national interests
- Execution process of electronic learning and teaching in the health area which is no different from other e-leadership challenges that include speed, leverage, adaptation, management and organization of the entire process
- Creativity and adaptation of new education processes in ever changing environment

eHealth education is about breaking the old rules, changing the models of education, asking the toughest questions and facing the facts that break the silence, and challenges the assumptions of the status-quo.

## Advanced eHealth Education for the Health Professional

Education of health providers is a major issue in the current environment, as there is a great need for advancing the education process of all healthcare professionals. The report of the Institute of Medicine in 2001 states that clinical education simply *has not kept pace with or has been responsive enough to shifting patient demographics and desires, changing health system expectations, evolving practice requirements and staffing arrangements, new information, focus on improving quality and new technologies*. As such, healthcare providers have not been prepared adequately in either academic or continuing education venues to

address these major changes in patient population. Patients around the world are becoming better educated, are living longer and aging significantly, and are increasingly afflicted by one or more chronic illnesses. Only in the United States of America, 40% of its population or 125 million people live with some type of chronic condition, and about half of them live with multiple such conditions. Subsequently, they are more likely to seek more health information which challenges significantly the landscape of clinicians and their practices. Healthcare providers are more and more asked to work on inter-disciplinary teams, often supporting patients with chronic conditions, although they may lack the training and education that is based on a team-based approach. Based on multiple reports and analysis, *the twenty first century healthcare provider, and system, should ensure that all healthcare professionals be educated to deliver patient-centred care as members of an inter-disciplinary team, emphasizing evidence-based practice, quality proven approaches and informatics*. This approach should ensure the establishment of basic fundamentals of health professionals' education regardless of their discipline, in order to meet the needs of the twenty-first century health advances and care. The report by the Institute of Medicine of the National Academies, states *that many organizations, experts, health professionals, and increasingly the public, question whether quality healthcare can be delivered under the existing healthcare systems, noting that healthcare today harms way too frequently, and consistently fails to deliver its potential benefits*. These errors as documented by the authors of "To Err is Human: Building a Safer Health System" results in tens of thousands of American dying each year and hundreds of thousands suffering or being sick. Issues like these and the need for globalization of standards and creations of standards in the healthcare arena make eHealth education a very attractive avenue for providing such a medium where geography and distance become truly abstract nouns.

The proper techniques and methods of disseminating the existing knowledge and evidence-based medicine education programs and processes from renowned institutions and universities to countries around the world is a matter some debate. What is not a matter of debate at all anymore, is the fact that, this dissemination of knowledge and expertise should be a priority of those who possess the knowledge and skills to disseminate it. Such initiatives should come as an international concerted action and collaboration of eHealth and Telemedicine in order to facilitate the implementation of telemedicine or health telematics networks around the world.

The implementation of eHealth education as an expression of needs and demands from the public and healthcare providers is based on a growing concern for medical errors, advances of patient-centred healthcare systems; need to improve cost-benefit ratios and rationalizations of healthcare and citizen mobility.

Because eHealth has the ability to ensure improved quality of care, better access and cost benefit, there have been multiple examples on citizen-patient driven eHealth initiatives such as those of very common diseases (bariatric surgery as an example), rare diseases, general web portals, mental health services, and patient information that have been led by multiple organizations and institutions in USA and Europe. In addition, there are multiple professional eHealth applications and tools that have been provided by numerous organizations such as public and private teaching hospitals around the world, European scientific societies, the European Commission, universities and other public hospitals throughout Europe and the world. These include on-line databases and registries, clinic health records, hospital systems and electronic libraries and information services, distance education systems and telemedicine itself. Initiatives such as web surgery, virtual medical university, international virtual e-hospital and other global initiatives on education of patients and healthcare professionals have

demonstrated clearly that these health information networks not only are an absolute necessity, but are a way of future methods of education of patients and healthcare providers.

## NEEDS AND DEMANDS

The entire aspect of needs and demands as pertained to eHealth education process needs to be centred in described issues of distance learning, advanced eHealth professionals education in the changing environment, continuous medical education (CME) for medical professionals, and patient's education in health related issues in the information age, and change.

Furthermore, one should have in mind the core competencies needed for healthcare professionals that have been created and require common vision across the professions.

These competencies are:

- Patient centred care
- Work on inter-disciplinary teams
- Employ evidenced-based practices
- Apply quality improvement techniques, and
- Utilize informatics

The origin of these five competencies comes from the need to redesign better systems to address the health needs of the population. The Quality Chasm report has identified important rules that guide the transition to a health system, to better meet the patient's needs. Among these rules, most important one are those that make patient a central part of the entire equation.

While all five these competencies are extremely important, the utilization of informatics as an important element of eHealth can effectively:

- Reduce the medical errors
- Helps manage the knowledge and information, and support the decisions making process based on evidence based practice guidelines
- Ensures better communication between healthcare providers and patient
- Advance the goals of redesigning the healthcare systems

As a result, the core competencies help implement new evidence-based medicine protocols, and support the notion that, every citizen of the world need to receive the best possible existing care.

## CHALLENGES AND OPPORTUNITIES

The implementation of eHealth education process remains one of the most important issues among current health challenges, that are staggering and numerous, as illustrated by numerous studies:

- Only in the USA each year 98,000 people die from medical errors, more than those who die from motor vehicle crashes, breast cancer, or AIDS
- Other challenges include the lack of the "best system", poor accommodation of patients' needs, inability to assimilate the increasingly complex scientific advances, failure to address the growing consumerism among the patients



- Healthcare provider's workforce shortage and discontent

These are important issues that have led to medical errors, poor quality of care, and dissatisfaction among patients and healthcare providers

In this environment of technological advances, information technology and evidence based medicine has the potential for transformation of healthcare. The integration of more recent advances and visions with goals of the institutions, nations and more broadly of the world is the main challenge, however.

## Specific Challenges

The use of well defined education programs for healthcare providers will be the cornerstone of the new revolution of the "e-era". Current specific challenges in implementing eHealth education and other revolutionary advances for healthcare professions educations are:

- Lack of funding, lack of faculty and faculty development programs
- Lack of coordination and integration of, accreditation, licensing, and certification process at the governmental and institutional level
- Lack of application existing evidence based medicine
- Shortage of visionary leaders and champions
- Crowded curricula of medical education for healthcare professional, often with irrelevant courses
- Insufficient channels to share the information on the best practices, among medical professionals, governments and institutions

Few initiatives are designed exactly for this reason: *to share the knowledge and expertise and create the much needed channels of communications*. Surgical and other clinical eHealth education initiatives are worth mention. The goal of e-education in surgery, for example, as a clinical discipline through the International Academy for Surgical Training (ICAST) is to improve surgical education and training of surgeons in the developing countries, expand patient care, and improve healthcare delivery.

eHealth in surgical training could supplement greatly surgical education of surgeons in developing countries for example, without the expenses of moving those surgeons from one country to the other for supplemental education. Eventually, surgical education could be advanced to surgical telementoring which could assist in the provision of surgical care to underserved areas and potentially facilitate the teaching of advanced surgical skills worldwide. Although there are still multiple logistical, technical and legal barriers to the widespread application of telesurgical mentoring and telepresence surgery great progress has been achieved in this complex field.

## PROBLEMS TO BE SOLVED

eHealth education is a very important element of overall progress in the eHealth. In order to be able to advance this, as an accepted culture and part of the daily practice of healthcare professionals, there are many initiatives that need to be taken, or existing one to be supported. The public at large has great expectation for application of satellite technology. The following are the most important aspect of this use:

- Satellite technology applications have real potential in all aspects of health education world wide
- May help establish higher standards for medical education, CME, education of public and carrying out specific programs
- Has the technical capability to ensure dissemination of knowledge and create new standards, especially in developing countries since the satellite will be the method of choice for delivering not only direct medical care, but most importantly e-health education for both patients and healthcare professional even in the most remote sites of the world

Few issues that need resolved in order for eHealth education to prosper and be accepted are:

- “Product” acceptance by traditional medical educators, scholars, and legislators
- Changing the old style of education to the new one and thus breaking the “traditional” classroom medical teaching and learning methods
- Lack of capability and availability of technology in most of the world for disseminating the knowledge, or in other words lack of communications
- Language and cultural diversity
- Socioeconomic and political status of the countries in need for eHealth education
- Legislative policies and championships for new information age

While technological means for broadcasting and transmission of the e-health education programs and clinical data is becoming abundant around the world, there is a great part of the planet that is not covered by internet and will not have the ability to overcome the digital divide for decades to come. This should be our chance to advance the cause, and the issue, of eHealth education among the countries and the nations that need help, lack technological infrastructure and perhaps a vision in some cases. The satellite support of eHealth education programs has the most outstanding capacity to ensure this process has flourished. The benefits to mankind are enormous.

## 7. HEALTHCARE AT HOME

### TODAY'S SITUATION

Demographic developments, social change, and increasing costs of health and social care in Europe demand for new ways of care delivery. The increasing number of elderly boosts the need for intermediate and more to be expected permanent care. Healthcare at home through ICT promises to provide benefits to individuals as well as to strained health and social care systems (Niederlag et al. 2002). Within the EU member states demographic projections indicate that the proportion of elderly over 65 years of age will increase from 16% in 2000 to more than 25% over the next two decades (Barlow et al. 2003; Clasbrummel 2002). Although the situation with respect to age composition, the role of families, and in cost and availability of care staff, demographic trends combined with social and economic change are likely to make the provision of care increasingly difficult. Furthermore, consumer expectations are growing and there is an emerging "consumerism" with patients demanding greater choice over treatment and services.

However, not only elderly are a target group for healthcare at home. Other target groups are disabled individuals and patients with chronic diseases, regardless of their age. All these healthcare consumers differ in the extent of support they demand from telecare systems. Some just need to be reminded of taking their medication. Others need sophisticated daily medical follow-ups. A general requirement, however, should be to increase the autonomy of the patients.

Today, there are no comprehensive solutions for this area available on the market. Companies have big problems to create business cases due to the lack of legal and financial regulations for the whole health telematics sector.

### NEEDS AND DEMANDS

Beside the new demands for healthcare arising from the ageing population, the consumer expectations with respect to healthcare services are growing. Healthcare consumers are, in general, better informed and demand high quality and greater choice of diagnostic and therapeutic procedures. Both together lead to a couple of user needs.

#### Healthcare consumer needs

- *Participation in the community.* Homecare services must support that patients can participate in the community as much and for as long as possible (Barlow 2003).
- *Healthcare at home must be safe and trustworthy.* One of the most important driving forces for telehomecare is the increasing patients' wish to be safely maintained while staying at their home (Ohinmaa 2002).
- *Services must also allow mobility.* Healthcare at home must cover also episodes where the patient is travelling or staying for a certain time in another place, e.g. when visiting relatives or going on a vacation. This holds true also for the younger population of working persons: Due to an increasing rate of professional careers made abroad, personalized medical data must be available ubiquitously.

- *Technical needs.* Telecare systems must meet several technical requirements in order to be accepted by the users (Clasbrummel 2002): User-friendliness; reliability; fault-tolerance; security and privacy; service availability.
- *Security and privacy.* The sensitive health-related data of the patient must be stored and transferred in a safe way, so that the integrity and privacy of the data can be guaranteed. Access to the data must be authorized by the patient. Different policies are possible.

## Healthcare professional needs

- *Timely and reliable monitoring.* The data acquired from the patient must reliably be received and, depending on the severity of the patient's health problem, more or less frequently be presented to the health professional for routine checks.
- *Adequate presentation and analysis of monitoring data.* The monitoring data should be presented in a way that allows quick and accurate assessment by the health professional. Typically, this comprises time curves or statistical diagrams.
- *Generation of alarms.* If a monitored vital parameter runs out of the normal range, or if technical problems occur in the monitoring setting, the system must produce an alarm that is transmitted to the healthcare professional or the service provider, respectively.
- *Integration with electronic health record / nursing record.* Through telecommunication-based visits or consultations the physician and/or the nurse must be able to access historical as well as present physiological values recorded earlier. On the other hand, it must be possible to order follow-up examinations or alter the medication (analogous for nursing). All these actions have to be documented in the patient's health record and/or nursing record. (Clasbrummel 2002)
- *Security and privacy.* For the healthcare professional it is a legal duty to protect the patient data against unauthorized access.

## CHALLENGES AND OPPORTUNITIES

The great challenge on the way to overcome the huge problems of the 'elderly society' is to create comprehensive, modular systems of services which provide a flexible and efficient mean to implement healthcare at home on a broad scale, customized to the individual need of each user. The required services can be categorized in three basic types, with respect to the demand they can help to satisfy:

- *Exchange of health-related information from home.* Access from home to more or less all kind of exchange of medical information and to interaction which today needs the patient's physical presence at the healthcare institutions facilities.
- *Support of social contacts via telecommunication.* Access to mediation and communication services for a better social embedding of the patients, especially the elderly.
- *Support of day-to-day living.* Access to services that support or take over activities of the day-to-day living, such as household activities or shopping.

Components (systems, services, applications) for the area demanded today and – with increasing urgency – in the near future comprise (Hartvigsen 2003; Khoshshima 2004):

- *Intelligent houses.* For patients with reduced mobility and loss of physical power, a so-called intelligent house can offer the opportunity to continue living independently at their homes. In an intelligent house, components like windows, doors and household devices are networked and can be electronically controlled either manually or automatically (e.g. based on sensor data such as daylight sensors, temperature sensors or motion sensors).
- *Personal assistants.* These are small mobile devices assisting a person in organizing and reminding of activities. Such personal assistants shall be capable to communicate with various other homecare systems, e.g. with the control unit of an intelligent house or with emergency-rising systems.
- *Emergency services.* In case of an emergency such as a fall or a serious physical problem such services offer facilities for the rising of an alarm, either automatically (e.g. by a fall detector) or manually (e.g. by pushing one of the buttons installed at several places in the home). The service centre then initiates appropriate actions.
- *Positioning services.* The elderly and the disabled are not necessarily bound to their homes. They go out, and in case e.g. some sort of an 'accident' happens during an excursion, a positioning service (like the existing Global Positioning System GPS) has to deliver the position of the person. The challenge is to smoothly integrate such positioning services into other services, especially emergency and monitoring services.
- *Monitoring services.* These medical services comprise control of vital parameters acquired by the patient or automatically by monitoring equipment. The data measured is transferred to a medical centre and controlled by physicians. If parameters exceed a predefined non-risk range, alarms are produced. Nursing and medical staff are informed and act according to the respective situation. New technologies like e.g. Body Area Networks (BAN) combined with advanced biosensors, communicating wireless with a central link installed in the home, are important components of future monitoring systems.
- *Medication services.* Such services comprise e.g. intelligent pill dispensers, as well as electronic drug prescription and delivery services.
- *Nursing services.* Services of this sort cover nursing activities at the home of the patient, ranging from low-intensive to medium-intensive care packages. Due to the nature of these services, a big portion of the actions is personal action on site, complemented by telecommunication-based care functions.
- *General information services.* These services provide non-person-related information about health-relevant issues.
- *Record access services.* The appropriate (i.e. secure and reliable) access to medical and nursing records by both the patient and the health professional has to be provided through suitable services, on the basis of a health telematics platform. Such services are considered as basic services for efficient and high-quality healthcare.
- *Social communication services.* Such future services must offer the mediation of ad hoc and scheduled contacts between the patient and relatives, friends or other patients.
- *Provisional services.* A basic sort of services is to cover necessities of day-to-day living such as catering and shopping services.

From a technical point of view, every home on earth must be considered. On this background, the high mobility, the robustness, the broadband access from underserved areas, the multicasting and dissemination of multimedia contents is of *highly relevance* for the healthcare at home area.

## POTENTIAL SOCIO-ECONOMIC IMPACTS

The major social impact of healthcare at home evolves from an increase of independency and quality of life. For the majority of elderly and other target groups it is felt as a great benefit if they can stay at home and do not or less often face the need to be treated somewhere else. Of course, the social aspect should not be neglected: telecare must not substitute the face-to-face consultation. But in many cases these consultations can be reduced and (over-)compensated by intensive contact through telecommunication means.

Another big social impact will occur when exploiting the potential of modern telecommunication means and new services making clever use of their various options and alternatives. It is quite common today that the relatives of an elderly person live far away and/or are very busy in their professions and therefore do not have time for frequent visits. Close contact to relatives and other persons, institutions, and organizations through telematics, efficient and without time-consuming travelling, can significantly increase the frequency of contacts and the degree of social embedding.

In the long run, the economic potential of healthcare at home can be expected to be enormous. There are justifiable hopes that the potential of care delivery supported by Information and Communication Technology (ICT) to transform the healthcare system will slow the increase in the cost of care delivery while preserving the independence of elderly people in their own homes (Bayer et al. 2004). No doubt, homecare is a huge market. Figures from the US indicate that the ratio between care in private homes and in hospitals is 1:25 in the favour of homes (Clasbrummel 2002).

The existing terrestrial communication operators deploy their networks on the most densely populated regions, often exclusively for commercial reasons. Thus, a lot of rural, remote, and more in general low-density populated areas become underserved.

In this frame, the complementarity of the satellite infrastructure versus the terrestrial one seems to be very valuable to ensure a quality of service continuity regardless of the home location.

Satellites offer the unique opportunity to incorporate **homes in isolated areas** into the development of healthcare at home teleservices on the background of a new integrated care approach for the whole population.

A comprehensive health network gaining 100% coverage by **bridging gaps** of the terrestrial networks can prevent the exclusion of parts of the population from telematics-enhanced healthcare at home.

**Positioning services** provided by satellites (like GPS) are an indispensable component of healthcare at home, extending 'home' to the mobility radius of the respective citizen while keeping the smooth access help in an emergency case.

## SPECIAL APPLICATION - TELEMEDICINE IN PRISONS

Telemedicine in the prisons is one the most popular aspect of telemedicine in many countries as it offers a viable means to provide healthcare for prisoners. Due to multiple aspect and intricacies of prison populations, telemedicine represent one of the most ideal forms of delivering healthcare. While it is not clear the exact number of patients around the world who currently incarcerated in jails, it is very apparent that the number is very large especially in developed countries. In the USA for example the crowdedness of prisons is a real crisis, and this has pushed the government to allow opening of private jails. Prison population is increasing and there is a trend toward older offenders who are serving longer sentences and who have greater healthcare needs. Furthermore, most prisons are located in remote geographic areas where access to healthcare specialists is difficult to arrange thus providing specialized medical attention to prisoners is costly, and requires massive security for transport of prisoners and it is time-consuming.

Consequently, providing healthcare to this population represent a serious and, an expensive undertaken.

Based on current experience it is believed that telemedicine represent real attractive mode of providing specialized and even primary care for large number of prisoners. The main benefits of application of telemedicine to prisoners include:

- Decrease on cost services
- Provision of all required healthcare services in the secured environment avoid exposing the prisoners to the public scrutiny

Satellite technology is ideal forms of connectivity for delivering specialized healthcare to prisoners as well as educational programs for prisoners in attempt prepare prisoners to become useful citizens outside the jail walls.

## 8. SERVICES FOR THE CITIZENS

### TODAY'S SITUATION

In the developed part of the world the continuous development and advances of Information and Communication Technologies (ICT) has contributed to a shift in the way people “use” healthcare. While the traditional user of healthcare systems has been the “patient”, fulfilling his or her role as a relatively passive recipient of health, today's user is more active, better informed, more demanding and less deferential to professionals and authorities within healthcare systems. Moreover, the delivery of healthcare has widened from being delivered to the person being sick to being delivered to the general population. The concept of health consumer therefore includes patients, patients' friends and relatives and citizens in general.

Information and Communication Technologies are also contributing to increased globalisation in healthcare, thereby challenging healthcare systems and authorities on legal, ethical, technical and organisational issues. Citizens worldwide are using ICT to interact with others about their health, a phenomenon fuelled by the advent of inexpensive communication technologies, especially the Internet. Aided by ICT, people are discussing health issues in self help (peer-to-peer) communities, seeking advice from health experts, sharing personalized health biographies with the world at large, entering into therapeutic relationships and so forth.

Thus, this phenomenon is not just a health issue per se. It also forces us to reconsider some very basic assumptions about human communication, self perception and relationship formation. Development of new eHealth services at the patient point of care is to a large extent consumer-driven. That is, acceptability and adoption of services that directly involves consumers is unlikely unless the services are based on knowledge about consumers and their needs and attitudes.

Effective health promotion and communication initiatives adopt an audience-centred perspective, which means that promotion and communication activities reflect audiences' preferred formats, channels, and contexts. An audience-centred perspective reflects the realities of people's everyday lives and their current practices, attitudes and beliefs, and lifestyles. Some specific audience characteristics that are relevant include gender, age, education and income levels, ethnicity, sexual orientation, cultural beliefs and values, primary language(s), and physical and mental functioning.

### NEEDS AND DEMANDS

Key issues in the years to come will be, among others, to improve access to information, reduce costs, emerge technologies for mass broadcast of public health information / education (i.e. digital TV), security / confidentiality, direct interaction between health professional and patient / consumer, legal, ethical and technical issues related to healthcare delivery across boundaries and health economics.

Research on these issues must be accompanied by research from a social science perspective, for instance issues like medicalisation, doctor-patient relationship, media literacy, responsibility / empowerment and identity and health. Most initiatives made by healthcare



authorities or healthcare personnel are designed to increase consumer level of empowerment. In this context, empowerment has traditionally been conceptualised in an individualised sense where the person becomes able (through increased knowledge and power) and willing to take action with regards to his or her health. The concept thus implies a shift in the power balance between patient / consumer and healthcare personnel. It is currently unclear what effects this development may have on doctor-patient relationships and medicalisation. Issues here will be to study the patient's on line communication with healthcare provider, applications for monitoring / managing individual health, ambient, mobile, pervasive technologies, broadcasting technologies, self help / discussion forums and public health initiatives.

## CHALLENGES AND OPPORTUNITIES

As much of this development is consumer-driven, one major challenge will be to monitor European health consumer's use of, their attitudes to and their needs with regards to information and communication technology for health purposes. This is necessary in order to provide audience-centred information and services. It will also be the first step with regards to studying the effects of Information and communication technologies in health.

European research networks should be established to facilitate large scale evaluation / implementation of public health interventions. In addition, the knowledge obtained must be actively used in the education of healthcare staff.

## 9. MOBILITY

### TODAY'S SITUATION

The free movement of persons is a fundamental right of the European internal market, and gives citizens of the eighteen EEA countries the opportunity to live, work, establish business, and study in any of these countries. Community legislation in this field aims at eliminating all obstacles to the freedom of movement, and to give workers, self-employed persons, students, pensioners and family members within the European Economic Area the same rights by eliminating any discrimination on the basis of nationality.

More and more European citizens are on the move. In 2003, more than 400 million tourists travelled around Europe for short term stays both business and pleasure. 320 million of these (roughly four fifths) were Europeans travelling to other European Member States (WTO 2003).

Mobility in relation to health systems must take into account two distinct situations: *Citizens who move* for short, medium or long periods to another European country, and *citizens on the move*: those who are travelling by airplane, train, boat and automobile and citizens who are moved in emergency situations (ambulances, plains).

### Citizens who move

The contemporary understanding of *Mobility* includes those citizens who move from their home countries for short-term tourism, short-term migration and long-term migration.

- *Short terms stays* (tourism for pleasure, or business). “*Tourism* is defined as activities of persons travelling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes.” (Eurostat 1998)
- *Mid-term stays* (residents for part of a year, due to migratory labour, or as retirees). “A *short term migrant* is a person who moves to a country other than that of his or her usual residence for a period of at least three months but less than a year (12 months) except in cases where the movement to that country is for purposes of recreation, holidays, visits to friends and relatives, business, medical treatment or religious pilgrimage. For purposes of international migration statistics, the country of usual residence of short-term migrants is considered to be the country of destination during the period they spend in it.” (Eurostat 2000)
- *Long-term stays* (residents for more than a year, e.g. immigrants, foreign labour, and retirees). “A *long-term international migrant* is a person who moves to a country other than that of his/her usual residence for a period of at least a year (12 months), so that the country of destination effectively becomes his or her new country of usual residence.” (Eurostat 2001)

This classification of citizens by the length of stay of “their move” is important because it brings different possible benefits of eHealth applications and satellite use. Short stay

travellers can benefit mainly if a medical emergency occur by having the possibility of accessing patients' records.

Mid-term stay or short term migrants are those citizens who could benefit most from improved access to health systems and health information as they tend to spend some time of each year in one member state, and the rest of the year in another, therefore creating a need for coordination of healthcare systems. Additionally, mid-term stay citizens are often retirees who have a tendency to make greater use of the health system. Access to electronic records, communication with own physicians, long distance monitoring are some of the possibilities for eHealth applications.

In relation to the health system impact, we can consider two types of long term immigrants: those who has a regular income and a health insurance or those coming from poor countries usually with no income and no insurance and in most cases no records or registries on their own countries. For this second type communication with the own countries will not be useful.

Increased citizen mobility influences and is influenced by international and national health systems. Patient mobility has consequences for health services and medical care both in the country where the patient is insured and the country where care is provided. European citizens wish to receive high quality healthcare as quickly and as close to home as possible. However, when the citizen is not at home or in special cases where healthcare services are not available at home, the European Union provides freedoms for citizens to seek healthcare in other Member States, as confirmed by the European Court of Justice (EU-COM-301 2004).

**eHealth** can play a very important role in **service provision** through **eCare for citizens who move**, by improving access to records and to their own physicians and diminishing language and cultural barriers.

## Citizens on the Move

Under citizens on the move we can consider three different situations depending on different eHealth applications they can benefit from. One are citizens in big carriers such as boats and ships; the second will be patients being transported in ambulances and the third one patients that need constant or regularly monitoring.

In this section we will only deal with transport. Patients and ambulances will be covered under the section on trauma and emergencies and patients that need constant or regular monitoring under home care.

Transport, mainly airlines and cruisers, represent a special situation in with satellite can have a strong impact (Ferrer-Roca 2002). Presently travellers for professional, leisure and/or social reasons constitute an important population which will even increase in the future (ECAC 2004).

Providing medical assistance through the existing communication means has been a rule since the development of this technology. Well known examples are the Radio Assistance Services (RAS) to ships, aircrafts or persons in remote areas (Australia, Antarctica) and the phone based services of home assistance for the elderly.

On isolated areas as well as in main transport systems (airliners, cruisers) with an important population on board, the basic problem is to get the accurate diagnosis which in reality is often obtained by non-specialised attendants (Alvarez et al 2003). Therefore, the main aims are to provide the best possible care to the passenger and thus to avoid unnecessary flight diversions (i.e. flights landed at another airport than scheduled due to an on-board medical incident) or the need to send helicopters to cruisers or ships. Contrary to popular opinion, there are more such diversions once a physician is on board. Such a diversion takes place in a ratio of 1:1.000.000 passengers (US-DoT 2000). Therefore, the flight operators are not inclined to introduce the most recent telemedical infrastructure on-board; furthermore, merely new medical kits and first aid training are implemented by most airlines to tackle the problem.

Due to higher aircraft capacity, longer haul operations, and older passengers, the probability for a higher incidence of demands of medical care on board transportation systems will rise (Lyznicki et al. 2000).

In an attempt to improve the healthcare on-board, ground medical services may also provide a vital assistance if we are able to move the data instead of the patients. Current progress in technology furthermore allows to foresee the transmission of quality and confidential medical data from aircraft to medical facilities on the ground. The European Civil Aviation Conference (ECAC) recommends a harmonized development of telemedicine technique (ECAC 2004).

Presently, no healthcare assistant is on board as it used to be the case in former times (the first flight attendants on duty were nurses as well). It should be clearly reconsidered whether this role should not be reintroduced again with the additional feature of skills in on-board telemedical handling.

The current status-quo is that only the cheap communications systems (telephone, radio) with their limited bandwidths are widely used on behalf in these scenarios.

Thus, any future development will have to satisfy 3 criteria: *affordable*, *simple*, and *safe*.

## NEEDS AND DEMANDS

### Citizens who move

Facilitation of the mobility of persons and goods is one of the main goals of the European Union. The European Commission has communicated in (EU-COM-301 2004), the follow-up to the high level reflection process on patient mobility and healthcare developments in the European Union, that 4 main areas of activity related to mobility need to be addressed.

These areas are:

- European cooperation to enable better use of resources
- Information requirements for patients, professionals and policy makers
- European contribution to health objectives
- Responding to enlargement through investment in health and health infrastructure

## European cooperation to enable better use of resources

- Citizens who move need and demand a better understanding of their patient rights, entitlements and duties.
- Citizens expect health systems in Member States are coordinated so that over-capacity in one Member States healthcare system can be used to compensate for under-capacity in another (including allocation of healthcare professionals).
- Healthcare professionals demand that they have the right to practice in other Member-states just as any other member of the labour force.
- Citizens demand that patients throughout Europe benefit from care reflecting the latest advances in medical technology.

## Information requirements for patients, professionals and policy-makers

- Citizens who move require coordination of information so that the right information required for their diagnosis and treatment is available to the right person at the right time.
- To ensure accurate monitoring and planning, information on the volume and nature of patient flows for tourism, short term migration and long term migration is required. A European Public Health Portal is envisioned to facilitate dissemination of European-wide public health information.
- Citizens demand that their data is protected and the sharing of confidential data between Member States is done in a safe manner.

## The European contribution to health objectives

The health systems of the Member States also share fundamental principles: universal access on the basis of need, high-quality health provision, and financial sustainability on the basis of solidarity. Citizens expect that these principles are consistently applied no matter which Member State they received care.

## Responding to enlargement through investment in health and health infrastructure

- Citizens on the move demand that adequate investment is made in health and health infrastructure in all Member States.
- This investment will help to reduce the differences in health status between the states and will affect the numbers of citizens on the move

## Migrant labour - a special point

At the start of a new millennium, migration has become more pronounced than ever before. The World Health Organization in the publication *International migration, health and human rights*, December 2003, states that “the growing political instability coupled with the fact that economic growth is stagnating in a considerable number of countries means that uprooting and displacement – be it for political, environmental or economic reasons – will probably continue and become an even greater public health challenge. Efforts are required to maintain public health and social cohesion in an increasingly mobile world. In the absence of such efforts, migrants’ capacity to contribute to host societies will be constrained.

This population mobility has health and human rights implications both for migrants and for those they leave behind. Migrants often face serious obstacles to good health due to discrimination, language and cultural barriers, legal status and other economic and social difficulties. At the same time, migration policies may have significant public health consequences. In many parts of the world, the migration of health professionals can be a serious impediment to the delivery of healthcare in countries of origin.”

## Citizens on the move

Both patients and healthcare professionals will require simplicity and a highly intuitive usability of the system.

Taking into account the peculiarities of satellite communications, the *most relevant aspects* to be considered are:

- High mobility, robustness, and communications in emergency and disaster situations
- Broadband access from underserved areas

*Less important aspects* are:

- High capacity and fast deployment for temporary use (aircraft accidents)
- Multicasting / dissemination of multimedia contents

Travellers’ expectations will be higher in the future, including permanent accessibility to high quality healthcare. The development of a wide range of telemedical applications to be used on board of an airplane or a ship will certainly act as a trigger for mobility applications. And the awareness of the potential users can be increased in the future if the technology is used in daily practice.

## CHALLENGES AND OPPORTUNITIES

### Citizens who move

eHealth provides a means by which the needs and demands of citizens who move can be addressed. The reimbursement of services provided using eHealth means remains a major challenge. Currently eHealth services are reimbursed in Germany (partially), Greece, Norway, and Finland in appropriate cases.

The implementation of eHealth as a tool for supporting health systems to address these needs must take into consideration the legal and ethical issues surrounding the use of eHealth as a tool and its current challenges to implementation and use.

**eHealth** and **Telemedicine** have the potential to provide an important impact on facilitating the mobility of European citizens. eHealth offers the underlying tools to support all four recommendations of the EC communication on Mobility through

- European cooperation to enable better use of resources
  - eAdministration for managing and planning
  - eLearning for dissemination of information
- Information requirements for patients, professionals and policy makers
  - eSurveillance for monitoring and coordinating health system
- European contribution to health objectives
  - eCare provision for ensuring fair access, quality, solidarity and fair financing
- Responding to enlargement through investment in health and health infrastructure
  - eAdministration for managing and planning

## Citizens on the move

New technologies enable the access to broadband communications in isolated areas as easy to use. This holds especially true for the wireless satellite technology. By improving tediagnosis, teleconsulting and teletreatment, isolated transport systems like airplanes or ships definitely will benefit. The help in managing medical crisis situations will deliver a better qualified service for the mobility customer.

**eHealth** and **Telemedicine** may improve substantially the delivery of healthcare to people while on moving by air, sea or ground. Better diagnosis, treatment and management either to health or sick passengers identifying whether or nor to divert no matter the location and transport system be.

## POTENTIAL SOCIO-ECONOMIC IMPACTS

The potential socio-economic impacts brought by using eHealth for citizens who move are immense. The use of eHealth to enable better use of resources alone could account for the movement of millions of euros of healthcare expenditure not to mention the potential added benefit of a European Public Health portal and facilitation of the movement of healthcare professionals and healthcare services throughout the Union.

In the specific application of citizens who are on the move, the benefits of avoiding airplane diversions, particularly in the case of large aircrafts (small regional airliners are not suited for these services) would be realized.

## 10. A GLOBAL VISION

### CURRENT STATUS

The explosive developments in information and communication technologies (ICT) in the last decade allow for new kinds of healthcare scenarios. In the light of future demographic and economical developments, the current concepts of healthcare provision will have to move more and more *from patient care and disease management towards prophylactic services for healthy citizens*. The concept of health insurance, which currently mainly guarantees the treatment of illness and diseases, will increasingly have to focus on programmes to stay healthy. Consequently, a new type of industry (besides the already existing pharmaceutical industry and the industry for medical imaging devices, currently being the two largest industrial sectors in healthcare) will evolve in the healthcare domain that will serve the market with eHealth and Telemedicine products and services for *improved diagnosis and therapy for patients*, but will increasingly expand its product variety into the domain of *health preservation for the general citizens*.

In their current strategic planning for the next years, healthcare authorities at a European level have already set concrete deadlines up to the year 2008 for a range of concerted measures for improved healthcare by implementation of various ICT-based concepts. These include:

- Roadmaps for wide implementation of eHealth and Telemedicine systems and services (including reimbursement and liability issues)
- Deployment of health information networks using broadband infrastructures and GRID technologies;
- Promotion of open standards and open source solutions, interoperability of Electronic Health Records; introduction of Europe-wide patient identifiers;
- Promotion and adoption of the use of the electronic health insurance card;
- Provision of accredited online continuous education and training in eHealth for health professionals;
- Deployment of a European Public Health portal providing dedicated information to citizens for health education, safety at work and disease prevention;
- Introduction of legal, ethical and regulatory measures for eHealth and Telemedicine services such as standardised European qualification, increased certainty and liability also with respect to the increased mobility of citizens;
- Support and boosting of investments in eHealth and Telemedicine, support research and development in the combination of technological and organisational innovations, facilitating synergies between European programmes and national policies;
- Dissemination of best practice by international collaborations.

### NEEDS AND DEMANDS

#### GHOS – Global Health Over Satellite

Envisioned is the realisation of a satellite system with global coverage as communication platform for the concerted development and implementation of tools and services for health authorities and professionals, as well as for personalised health systems for patients and



citizens. This system should provide Global Health Over Satellite (GHOS) through dedicated 24/7 (i.e. 24 hours per day, 7 days per week) eHealth and Telemedicine services, offering interactive multimodal and multimedia communications. The system should support both point-to-point and multi-point communication in a fully meshed topology. The system should address and implement the following needs and demands:

### Reliable High Quality of Service

Past experiences have shown that appropriate and especially reliable Quality of Service (QoS) is a *conditio sine qua non* for good operation of the various medical services. In order to provide the required QoS needed from a medical point of view, *two dedicated network control centres* are needed (one in Western Europe e.g. Tenerife, Spain and one in Eastern Europe e.g. Athens, Greece). These control centres must be equipped with high-level technology and human resources, to guarantee continuous (24/7) and reliable high-level QoS. The set-up of two control centres (instead of just one) serves also to provide the necessary level of redundancy required for reliable operation of medical services.

### Use of open source and open standard solutions for integration and interoperability

To avoid and overcome the “island” character of many of the current eHealth and Telemedicine solutions, use of open source and open standard solutions is a prerequisite. Interoperability and integration of the various relevant information and communications systems and elements (e.g. the Hospital Information Systems – HIS) with the various data generating medical systems is needed for the provision of global solutions for global problems.

### Implementation of gateways to other communication networks

The GHOS system must be equipped with adequate gateways to other satellite-based and terrestrial communication systems, such as the satellite-based Global Positioning System (GPS) and the Galileo system (“Search and Rescue”), as well as various terrestrial communication networks using ISDN, DSL, ATM, UMTS, GSM, etc., as well as to global networks like Internet-II and to dedicated networks like GEANT, etc.

### Enhanced Telediagnosis by remote control of medical equipment

Combination of satellite-based communication with remote control of various diagnostic modules is a powerful tool. Not only in cases of disaster emergencies, where it can support the staff in the mobile field hospital at the disaster site in the very critical first golden hours. Provision of remote expertise, also during the early triage, can thus be realised (successfully demonstrated in the ESA-funded DELTASS project, 7/2001-12/2002). Such a system should be complemented by mobile miniaturised medical emergency centres.

Also as part of a global early warning system in endangered (endemic) regions, centres of first diagnosis, equipped with sensory and communication systems to identify and communicate potentially dangerous conditions, remote control of diagnostic medical and microbiological modules will enhance a timely and adequate action plan.

This combination of interactive satellite-based communication and remote control of medical equipment can be a powerful tool to bring tailored expertise to the regions where and when this is needed.

## Extension of targets from patients to healthy citizens

Some two thousand years ago, Romans enjoyed, wherever they went, thermal spas because they were aware of the healing and preventive effects this had for their physical well-being. The body needed to be taken good care of as good constitution for a healthy mind. In the sense of this old *Mens sana in corpore sano* one should move from disease management to health preservation. In our modern information-based and ICT-driven society, it is worthwhile to acknowledge that our mind and mental health can strongly influence our physical well-being and that therefore adequate, continuous and personalised education for citizens might prevent them from becoming patients: *Corpus sanum per mente sana*. Also in light of the increasing life expectancy, mental health services will become increasingly important. In the industrialised world, the average life expectancy has been steadily increasing since more than 160 years. In the year 1840 it was 45 years, whereas nowadays the average life expectancy is 85 years. More than 50% of today's newborns will reach an age of 95 and more. The major problem in ageing, however, is that the brain can still not be protected against deterioration. One effective strategy to reduce mental prostration is to ensure that older people remain mentally and intellectually active, by special educational programmes for citizen beyond a certain age (e.g. 50plus Virtual Universities as institutionalised opportunity for citizens beyond a certain age to enjoy a second / third education via eLearning). Moreover, the upcoming inversion of the demographic pyramid in the industrialised world will make it economically necessary that older citizens remain active in their profession for a longer time. In Europe, current budgets in health care are almost entirely spent for disease treatment (e.g. in Germany, yearly 2.600 € per capita) whereas only a negligible amount is spent for health preservation measures (in Germany, yearly 2 € per capita). Sick leave caused in Germany in the year 2002 a production drop out of 44 billion €, mainly by only three major categories of sickness and diseases: skeleton and muscle diseases (27%), injuries (17%) and diseases of the respiratory organs (16%).

In the light of these considerations it is important to extend the healthcare targets from the classical patient to the healthy citizen. Increased emphasis must be put on *mental / intellectual / educational e-services also to preserve physical health*. These “mental” services can contribute to a reduction of expenditures for physical healthcare services.

## New management tools and strategies

Inefficiency is currently a major burden in healthcare provision. The wide deployment of eHealth and Telemedicine services will influence the current workflow in many situations. Also the establishment and implementation of evidence-based medicine will allow for a number of improvements in the field of disease prevention, diagnosis and therapy. Increasingly it will become possible (e.g. through advanced body checks) to diagnose certain diseases even before any symptoms have become manifest. These new possibilities require a re-evaluation of the *medical workflow and decision-making tree*. *Process management and change management* studies are needed to identify and implement a newly optimised workflow to allow for a smooth, effective and efficient implementation of new processes and services. Implementation of *multi-focal management* strategies will allow for flexible and tailored management approaches.

eHealth and Telemedicine will increasingly involve the temporary formation of global virtual inter-organizational alliances, centring upon human cooperation and flows of information. Such partnerships rely on trust, which often needs to evolve swiftly due to tight deadlines.

When trust prevails, partners are more confident in being open with each other, knowing that information and ideas shared will be used for the benefit and advancement of the partnership. *Improved management in global virtual alliances* requires the implementation of new tools and strategies for developing and sustaining trust in the diverse and global digital human community, for building virtual communities among patients at global level, for developing virtual communities among medical experts to enable continuous teletraining for established medical experts as well as to support medical teleeducation in developing countries.

## PROBLEMS TO BE SOLVED

### Intelligent data mining tools and Health GRID computing

Collection of medical data is in itself insufficient to come to evidence-based medicine. In order not to get lost in the vastly expanding data jungle and to use the valuable information and insights contained in it, efforts in the field of bioinformatics need to result in new systems and architectures not only for data storage and archiving, but also for *intelligent data mining*.

Also, the implementation of dedicated GRID technologies will become inevitable to allow for effective utilisation of computing resources, as well as of hardware and software middle-layers by making them available to multiple users in the network by *dedicated Health GRID* infrastructures.

### Modular Personal Health Monitoring System with multiple micro-sensory and micro-actor elements

Personal health monitoring in homecare is increasingly enabled by the use of modular systems, containing various sensory elements capturing a set of vital parameters, integrated with communication elements that allow easy transfer of the data from home to the medical centre responsible for the patient's health. Future integration of intelligent miniaturised acting modules is mandatory to leave the dead-end street of remotely knowing all about the person's condition, but not being able to remotely improve this condition in an adequate way. Therefore, corresponding efforts in the field of telemonitoring must expand its focus to include also the design, development and integration of *suitable miniaturised acting modules* (based on e.g. Micro Electronic Mechanical System (MEMS) technology and/or nanotechnologies).

### Personalised avatars for Assisted Cognition

Assisted Cognition, where novel computer systems enhance the quality of life of people, is a powerful tool for personalised services for healthy citizens and patients. More and more, patients want to be actively involved in the process of finding the optimal treatment plan. Increased patient's competence (the ability to master the demands and strains resulting from a disease, while taking into account personal needs and goals) by provision of adequate information has been identified as a prognostic factor for curing success. Personalised avatars that function as virtual dialogue partner, acting and reacting in a task-oriented, user-specific, personalised and situation-dependent manner, can guide the patient / citizen to the required information. Artificial intelligence can support the communication between physicians, patients / citizens and avatars.

## Multilingual support and harmonisation of relevant legislation

Patient information is almost always captured in the local language. Cross-border exchange of health information will therefore require a tremendous translation effort. *Intelligent and self-learning translation tools* need to be designed and developed. Such tools should allow for reliable (i.e. standardised and accredited) translation in a timely manner (i.e. up to real-time). Implementation of cross-border eHealth and Telemedicine activities in daily routine is currently hampered by differences in applicable regional / national legislation and regulations (e.g. liability, reimbursement, etc.). *Harmonisation of the relevant legislation* is needed and requires the involvement of legal expertise and the commitment of political decision makers.

## CHALLENGES AND OPPORTUNITIES

### Raising awareness and consolidation of the demand

For successful deployment and uptake of eHealth and Telemedicine services, awareness of all end-users, key players and stakeholders is a crucial factor and a major challenge. International competence networks must be build in each of the various medical disciplines to raise awareness, to identify the needs for the various Classes of Services, as well as to initiate and coordinate the required international standardisation, respecting the ethnical and ethical manifold. Following effective creation of awareness, the following factors will be crucial for consolidation of the demand: 1) appropriate and reliable Quality of Service (QoS); 2) appropriate Classes of Services (CoS); 3) elimination of language barriers by intelligent self-learning translation tools; 4) adequate international legal basis for liability and reimbursement, 5) a catalogue of standardised services (QoS, CoS) including prices (relative to the qualification of the healthcare provider).

### Development of economic models for sustainability of the various services

On the long term, only those eHealth and Telemedicine services will be maintained that are economically sustainable. Development of suitable economic models for long-term sustainability is a major challenge. In this respect it is important to identify suitable pilot projects, which allow to study the selective introduction of perturbations in the models and to study the associated responses.

### Curative and preservative tourism

The increased attention to health preservation measures will induce a *shift from curative tourism towards health preservation tourism*, where healthy citizens call on dedicated prophylactic services in a more informal and relaxing atmosphere. In the light of the global coverage of the GHOS system, it offers a unique opportunity for provision of this kind of services, especially for mobile environments (e.g. cruise ships) and for the other various preferred curative sites (e.g. in the South Mediterranean).

### GHOS Consequences

The envisioned Global Health Over Satellite (GHOS) system has a lot of potential to make major contributions to improved healthcare and health preservation for patients and citizens. However, as developments in other scientific and technological fields (e.g. stem cell medical applications) show, it is never too early to also take into consideration ethical and privacy

aspects. Is the technologically feasible inherently desirable? Do we head towards the completely transparent ‘glass citizen’? Is health a human right or societal duty? The emerging picture seems to show sensors communicating every detail of the individual’s condition, experts telling the individual what to do and what not. Does this mean the end of the privacy and freedom of the individual? Not necessarily. As the famous German philosopher Hegel has noticed: *Freedom is the comprehension of necessity*. A good example of successful comprehension of necessity is the wide coverage and broad acceptance of non-smoking policies in many domains of society (e.g. airplanes, public transportation, working place, restaurants). Timely involvement of philosophical and ethical perspectives should address these issues and can build the basis for insight, confidence and acceptance among citizens towards these new emerging technologies.

## GHOS Future

The future of eHealth and Telemedicine is definitely satellite-based: Global Health Over Satellite – GHOS, as communication platform for a dedicated Health GRID system for the concerted development and implementation of tools for health authorities and professionals, as well as for personalised health systems for patients and citizens. Given the increasingly more complex, more specialised and more expansive healthcare provision, physicians, health policy- and decision-makers, as well as healthcare financiers need new and interdisciplinary guidelines for the quality assurance of medical care and treatment, for the definition of medical care standards and for patient protection. Since 2400 years, physicians pledge by the Hippocratic Oath to act towards the patient in a responsible manner. However, as healthcare has become substantially more complex and more specialised, and in the light of globally increasing healthcare costs, of emerging new and ever more expensive technologies, and of the globally ageing population, additional medical directives need to be introduced as new instrument to come to safer and more efficient medical care and treatment. These new internationally harmonised guidelines should avoid over- and/or under-treatment in medical care, and provision of the wrong medical care. It should build the basis for the practical design and implementation of medical care concepts, disease management and prophylaxis strategies. This process must be accompanied by development of an appropriate and adequate international legal basis, to avoid that concrete guideline-based medical treatments ends up in a liability trap.

The GHOS system will connect a variety of subsystems (hospitals, ships, aircrafts, space ships and –stations, mobile field hospitals, centres for first diagnosis, curative and prophylactic tourism centres, etc.) to allow for a broad spectrum of services for a variety of situations occurring on land, on sea and in the air, including events in the proximate outer space. Experiences and insights gained here can also be a good starting model for designing workflow schemes for medical services in outer space, like on the International Space Station (ISS), the moon or even Mars.

## 11. OPPORTUNITIES FOR SATCOM

Satellite communications (referred to as *Satcom*) can play a key role in contributing to promote and sustain the uptake of eHealth and Telemedicine applications and services.

Among the many different characteristics and factors that will likely shape the role of Satcom in support of eHealth and Telemedicine, three different perspectives can be considered for the sake of simplicity. The first considers the intrinsic strengths of Satcom. The second perspective takes into account the barriers that today are still potentially hampering the adoption of Satcom as a way to support eHealth and Telemedicine. The third perspective looks at a more generic potential in terms of socio economic factors that can be directly influenced by the availability of a Satcom based access.

### STRENGTHS

From the strengths' perspective, Satcom can be best regarded as a technology uniquely placed in terms of reach, performance and flexibility.

#### Reach

Reach is the ability to provide communication access where there is a need. Due to the intrinsic way Satcom works, access can be granted within the coverage area of the satellite regardless of the geographical location of the users. Furthermore, the Satcom reach is not adversely influenced by the User Density, in the sense that Satcom can provide effective solutions even if the density of users over the territory is very low. Finally, the Satcom reach is completely independent with respect to pre-existing terrestrial Infrastructure.

#### Performance

Satcom can make available broadband communications in the area of coverage as a self-contained solution, regardless of the status of availability of the broadband terrestrial solutions. In addition, due to the ability to broadcast and multicast content over the coverage areas, Satcom provides a very effective solution when the same content has to be distributed over a wide community of users.

#### Flexibility

With the availability of transportable terminals with small and easy to install antennas, the set up of a Satcom based communication infrastructure can be done very quickly even in the most remote region of a developing country. This fast deployment, associated with the ability to quickly dismantle the user terminal, can enable Satcom to provide very effective solutions whenever the communication infrastructure is needed only for temporary use.

Another aspect contributing to the Satcom flexibility is the ability to adapt the amount of resources available to a particular user, such as communication bandwidth and connectivity pattern to other users, depending on the specific requirement of the particular communication session.

## BARRIERS

Despite the points of strength summarised above, Satcom is still affected by a number of issues that partially hamper the possibility for Satcom to become used in eHealth and Telemedicine applications and services.

### Propagation Delay for Geostationary Satellites

Whenever a Satcom system involves communication satellites in the geostationary orbit, a propagation delay of 250 ms contributes to the end-to-end delay perceived by the users. This imposes a limitation in cases of highly interactive and delay sensitive applications such as telesurgery. The propagation delay can also potentially decrease the performance in terms of transmission speed and download time for TCP/IP based applications. To counteract this performance degradation effect, so-called Performance Enhancing Proxies have been developed and are now widely adopted to guarantee the performance.

### High Cost of Satcom Access

The current generation of Satcom based system providing access to the Internet via interactive terminals is still more expensive (typically by a factor of 5 in early 2004) than the baseline access cost for the terrestrial ADSL offer (whenever this is available). Driving cost factor for Satcom is related to the cost of the user terminal and to the cost of the satellite capacity. This cost is however decreasing with the progressive commercial deployment of Internet via satellite networks.

### Integration Issues

With the progressive commercial uptake of the DVB-RCS standard, the satellite terminal at the user premises is becoming more and more similar to a simple "Direct To Home" dish, the one used to receive satellite TV in the homes. Despite this trend, a number of set up and integration issues have to be tackled at the user premises before a user terminal becomes operational. While the licensing issues are getting easier and more coordinated almost everywhere, issues arising from permission and installation constraints (cable lengths, visibility, building regulations, pointing procedures) can still play an adverse effect on the Satcom uptake.

### Satellite Service Prejudice

A Satcom based system often represents just one element of the end-to-end service connectivity chain (a typical case is when, for instance, a Wireless LAN infrastructure is used to provide the access to several users via the same satellite interactive terminal). Whenever a communication problem arises, experience shows that end users tend to blame the Satcom section of the link, even when other elements of the connectivity chains are the actual source of the trouble. This element of prejudice tends to generate a misperception of the Satcom Quality of Service. In addition, Satcom is often unjustly perceived to be too complicated and unaffordable, or only appropriate when used on a wide scale by large institutions.

## Fragmentation / Dispersion of the Market

Satcom is often targeted at providing solutions in response to a sparse demand distributed over a wide geographical area. Despite the potential ability of Satcom to aggregate demand (a point which is presented further in this document), Satcom solutions are proposed in a market which, in its early phase of development, is rather fragmented and dispersed. The dispersion of the market also impacts the level of quality of after-sales services, especially the mean-time-to-repair when action has to be taken at the user's premises.

## Technical Implementations Not Yet Fully Mature

The main technical aspects of the end-to-end Satcom link are today well covered by standards like DVB-S and DVB-RCS. However a number of implementation issues such as the complete interoperability of terminals and applications, the support for a fully manageable Quality of Service, the installation procedure and the mobility of user terminals are all subjects to be further improved. This is reflected in a number of operational limitations that could be seen today as a set of barriers that still prevent the full operational utilisation of Satcom in the domain of eHealth and Telemedicine.

## Dominant Positioning of Terrestrial Operators

The market that Satcom can tap is a small niche with respect to the market addressed by terrestrial Telecom operators. This puts Satcom in a position of intrinsic weakness compared to the weight and influence of terrestrial Telecom actors.

## GENERIC POTENTIALS

Telecommunication satellites can provide a substantial contribution to satisfying the European Union's ambition to develop within its 25 countries a new society based on information as a key driver for the growth of its economy as well as for social progress. This strategic positioning of telecommunication satellites is substantiated by the following arguments:

### Avoid eExclusion

Satcom offers a strong technological alternative to providing wireless broadband for remote locations that cannot be economically connected via other technologies. For all terrestrial technologies, per unit cost rises with decreasing user density, making services to homes and businesses outside towns very expensive. On the contrary, satellites offer a unique way to provide customers in the most remote rural areas with the same quality of service provided to those in urban areas, eliminating geography and location as a cost factor.

### Demand Aggregation

Telecommunication satellites have the key potential to aggregate a diversified user demand allowing the transition from a fragmented user scenario to a more homogenous service to any given set of users independently of their location, which would otherwise be too sparse to justify the development of a telecommunication infrastructure. Demand aggregation will further promote two key requirements for the sustainability of any service: the standardisation and its large scale economic implications together with the implementation of suitable regulatory and legal measures capable to guarantee a satisfactory service provision.



## Stimulate Demand

Telecommunication satellites with their intrinsic global reach capability are de facto a robust instrument for stimulating the awareness of potential users in broadband services. As satellite television broadcast technology has clearly demonstrated, in many developing countries that just a few years ago were totally dependent on terrestrial based television services the late advent of satellite television has resulted in an important enlargement of the customer base.

## Key Element in an Early Warning System

Telecommunication satellites are the heart of any Early Warning System conception. The seamless capability to interact rapidly with the covered territory regardless of any ground infrastructure gives satellites this unique positioning. Due to its centralised trans-national nature space infrastructure offers a robust answer to the need to gather data of various natures from a variety of sources and input it in a suitable manner to different global models.

## Promote Quality of Contents & Processes

The possibility brought by Satcom to reach isolated communities not only contributes to the dissemination of knowledge, but promotes the realisation of peer-to-peer relationships among people operating in different environments, with different procedures and different levels of expertise. The establishment of forms of stable and productive professional collaboration will certainly be accompanied by the set up of common rules aimed at controlling the quality of content to be exchanged and the quality of procedures to be followed in implementing the collaboration. Eventually, the deployment and the utilisation of these networks could become an incentive to stimulate the improvement the quality of the professional environment in which the users operate.

## Support Socio-Economic Cohesion Policies beyond National Borders

The European society of tomorrow will be a 'knowledge society' in which access to knowledge is for all. Information outreach must therefore be considered as a major objective for Europe. This means extending access to e-services to everyone, notably in those regions of our continent which until now have been disadvantaged or neglected (rural and mountainous areas, islands, remote and/or underdeveloped regions). Equal access to the latest information technologies will spell improved services and will encourage fruitful exchanges and economic development. The solutions offered by satellite systems are not only solutions that can be activated to bridge the divide in terms of access to data circulating on the web. There are important elements of key problem solving domains which present strong positive externalities for society. The development of such domains will promote a rapid and balanced development of European society and its social cohesion. The satellite specificity in promoting trans-national / trans-regional interactions will be instrumental in achieving the overall cohesion objective.

## Reduce Need to Move People

Space systems offer a solution of *continuity* through the entire pan-European territory. The continuity of the access to broadband services means that users who need on-line connection for a specific service utilization, whatever their location could receive this in the European territory. It also means that specific health services could be provided at any point in the

European territory, which implies positive economic externalities in terms of utilisation of transport infrastructures.

### Support for Disaster / Emergency

The development of satellite systems may also be considered as a robust solution that not only provides a complement to, but also a back-up for terrestrial telecommunication infrastructure, bringing essential means to reduce loss of life and human suffering in case of major disasters or the diverse needs of rapid intervention in a given remote area. Satellite systems might provide a pan-European overlay to national networks for crisis management.

## SATCOM FOR eHEALTH AND TELEMEDICINE

The peculiarities of Satcom associated to the opportunities identified in the seven different eHealth and Telemedicine areas drive to a clear and straightforward conclusion: Satcom is a potential key element in the provision of an end-to-end solution for eHealth and Telemedicine.

## 12. THE NEED FOR ESA ACTIONS

As it became evident in the previous sections, satellite technology offers a variety of opportunities for providing better healthcare in different application areas. So, what are the actions ESA should take in order to accomplish the exhaustive utilization of satellites for respective applications and services?

The current section describes these actions. In a *first phase* (supported by this programme) eHealth and Telemedicine via satellites should be developed in a vertical approach, i.e. bringing dedicated applications and services of high demand towards operational deployment. Then, in a *second phase* – now following a horizontal approach – the final goal is creation and implementation of a comprehensive telematics platform for Global Health over Satellite.

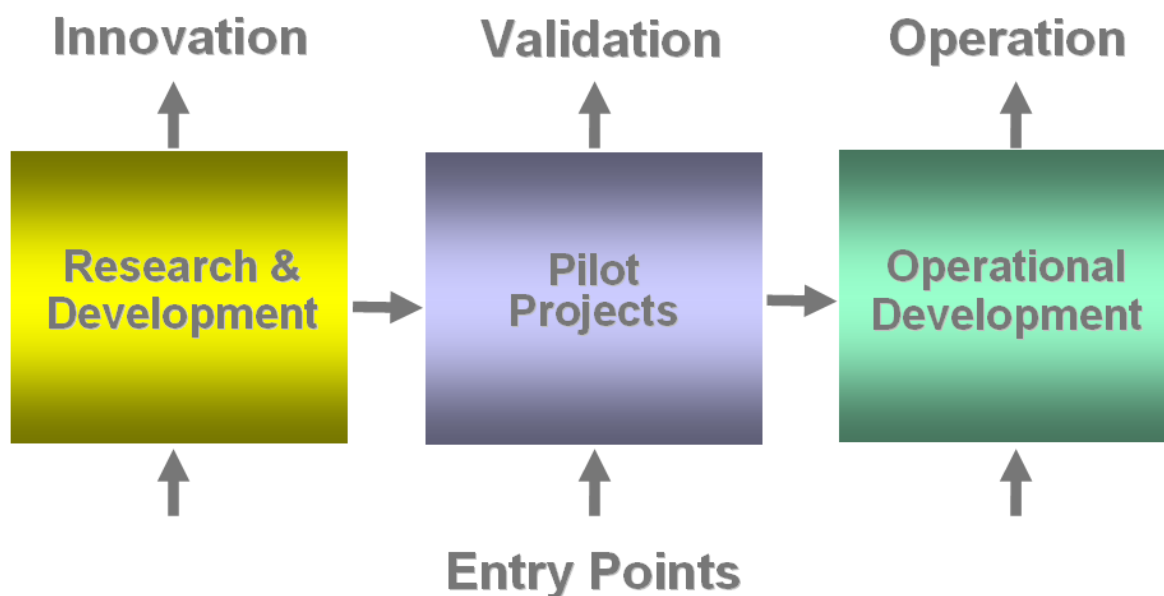


Figure 7. Building Blocks of ESA Telemed Programme.

### BEYOND THE EXPLORATORY PHASE

The market for eHealth and Telemedicine systems and services is very large. However, this market is, so far, to a large extent still untapped. As identified in the sections before, Satcom can play a crucial role for eHealth and Telemedicine. Starting from 1996, several exploratory activities have been launched by ESA through the different Elements of its Telecommunication Programme ARTES (Advanced Research in Telecommunications Systems) to develop the role of Satcom in eHealth and Telemedicine. They addressed opportunities not yet mature for a fully operational deployment, due to a number of barriers, as indicated during the ESRIN Telemedicine Symposium of May 2003. Such barriers are technical and operational immaturity, lack of consolidation of the demand, resistance to changes, lack of the appropriate legal and financial framework, and others, as described in detail within the previous sections. It has to be noted that the majority of these barriers remains mainly outside the control or the power of influence of the exploratory activities. One can say that, in a way, eHealth and Telemedicine via Satellite seems to be ‘stuck at the starting blocks’. This creates a clear need for action to overcome the deadlock.

The socio-economic effects of eHealth and Telemedicine become tangible only when the broad spectrum of services offered by eHealth and Telemedicine become an integral part of the healthcare operational environment. Only at that point healthcare stakeholders will gather evidence of the benefits, and will accept eHealth and Telemedicine. There is a need to complement the supply-driven approach pushed by those who sell eHealth and Telemedicine, with a demand-driven approach pulled by those who buy eHealth and Telemedicine. The difficult transition from small test and evaluation scenarios to sustainable service settings requires support from ESA. There is a need to supplement R&D activities with pilot and operational development in order to move beyond the exploratory phase (Figure 7).

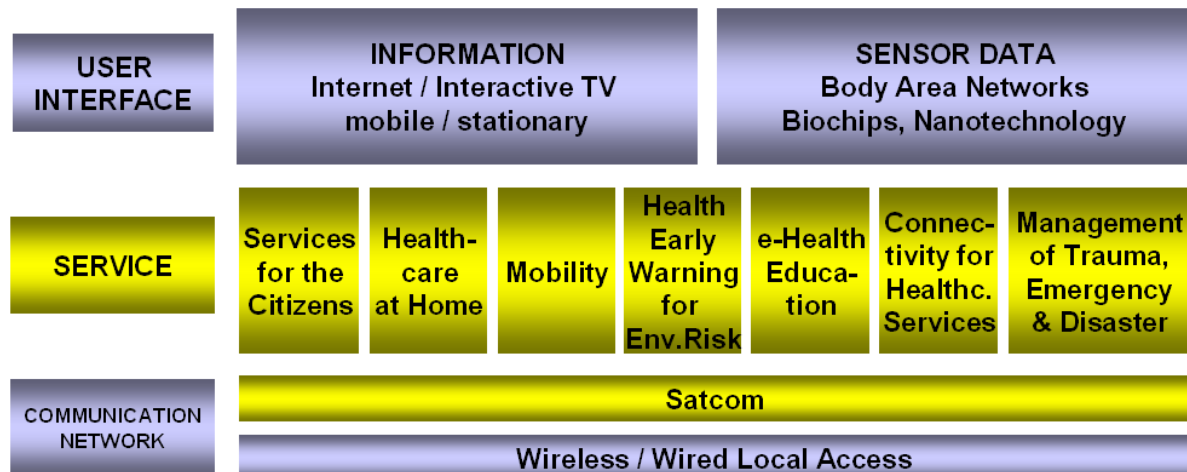


Figure 8. Building Blocks of eHealth and Telemedicine via Satellite.

## BUILDING BLOCKS OF EHEALTH AND TELEMEDICINE VIA SATELLITE

The building blocks of the eHealth and Telemedicine area can be considered on the layers *communication network*, *service* and *user interface* as shown in Figure 8. On the first layer, Satcom is the main technology within this programme. Other communication technologies, wireless and wired ones are used where appropriate, too. On the second layer, services within the areas analysed in the previous sections are shown. The main actions of the programme will be focused on doing piloting and operational development of such services in a well defined user driven fashion with the aim to drive them towards sustainability. On the third level, user interfaces are depicted for information flow between the service and the user as well as for sensor data acquired from the user such as biosignals. The actions of the programme will mainly exploit available technology, unless dedicated development of missing technology is done through Research and Development activities.

### Research and Development

Technology research and development, including demonstration as proof of concept, should be done where building blocks (consisting of hardware and/or software) representing key elements in the end-to-end eHealth and Telemedicine via Satellite system are affected. The priority of the activities shall be put on missing elements in the provision of Satcom integrated solutions for suitable eHealth and Telemedicine service offers. Deliverables, such as open

source software, shall be made available to other ESA initiatives to facilitate the uptake of the specific eHealth and Telemedicine opportunity.

Examples of research and development fields are:

- Advanced model-building tools based on computer simulation methodologies; computer programs which model diseases related to real life situations; models for end-to-end forecasting of extreme meteorological event risks.
- Mobile, personal assistants for elderly and disabled persons, with wireless connection to intelligent house control units, alarm rising and other eHealth service components for healthcare at home.
- Personalised avatars for patients and citizens enabling assisted cognition for an optimised and tailored access to information relevant to disease management and to health preservation.
- Global access to own health information for citizens. Intelligent agents for cross-border, cross platform interoperability. Smart, intuitive and ergonomic user interfaces including variants for the disabled.
- Open source implementation of secure interactive teleconsultation applications.

These actions will be based on a fertile environment. A huge number of demonstration activities have been carried out during the passed decade both at national and international level. Their results shall consequently be used. *Demonstration activities* must prove the practical applicability of the new technologies within realistic, i.e. practice-relevant scenarios.

## Pilot Projects

Pilot projects shall cover the development of innovative service concepts based on commercially available technology or technology developed in the R&D programme phase to be integrated and exposed to a pilot period of utilisation within a friendly user community (community of “champions”). They shall in a so to speak ‘pre-operational environment’ prove their ability to satisfy real user needs and prepare the operational development. Existing experience and competence shall be recognized.

An important aspect to be explored and validated during each pilot project is the viability of the business model of the proposed eHealth and Telemedicine service. This has to be done in conjunction with the utilisation phase, to an extent that will depend of the operational readiness of the service and the maturity of the potential market for the specific application.

The overall outcome of these activities should be a stable and credible provision of eHealth and Telemedicine via Satellite services. Following a partnership approach, the risks shall typically be shared with the eHealth and Telemedicine via Satellite service supply side. The procedures of medical evaluation shall be enhanced by a formal approach in order to produce trustworthy and un-biased measurements of the services’ efficacy. Incentives shall be created to facilitate the transition of the pilot projects to the successive line. The fulfilment of certain conditions, such as the achievement of strategic objectives, the commercial perspectives, the status of alliances, and preliminary business agreements, are the criteria.

Some examples of services that could be piloted are:

- *Health Early Warning (EW) for environmental risks.* Several known successful projects have shown the importance of epidemics prediction with good results, e.g. for

Rift valley fever and malaria. Some small pilot projects should be applied to very specific problems such as: 1) EW of heat waves to intensify medical monitoring of elderly and chronic patients, offered as part of healthcare at home services, in countries like France, Italy, and Spain; 2) Environmental monitoring to predict West Nile virus disease outbreaks; 3) Monitoring of the water and air quality in East Europe.

- *SAT-based monitoring of ocean water colour and temperature to predict and prevent in the Mediterranean basin outbreaks caused by autochthonous waterborne pathogens (*Vibrio cholerae* and other vibrios).* Environmental parameters influencing the survival and multiplication of microbial agents and the diffusion of Water-Borne Diseases (WBD) diffusion can be monitored on a large/global scale using “already-in-orbit” satellites which continuously provide us with a large amount of data regarding hydrological parameters and data concerning the ocean conditions. These data can be used in early warning of waterborne diseases risks but also, integrated with epidemiological, ecological, veterinarian and clinical data, in predictive models to obtain communicable disease transmission patterns and micro-organism diffusion trends allowing medium- and long-term prediction of WBD outbreaks/epidemics/pandemics. This kind of sat-based service would give the possibility of large coverage-environmental monitoring including poor or isolated areas (little islands, North Africa underdeveloped areas) thus avoiding the differences currently existing between north and south Mediterranean areas as regards incidence of WBD.
- *Environmental data management and processing service.* Environmental data collection, processed environmental data collection and production of indices (useful for modelling), data collection on climatic and meteorological medium and long-term trends. Archiving data collected, processing of data and individuation of changing trends, risk assessment, communication of alarm to E-CDC/health centres/public health institutions/civil protection, communication of the risk / alarm to decision makers/media/population.
- *Real time eEducation as well as Store-and-forward services for all medical specialties.* These pilot projects will validate the sustainability of applications of eEducation via Satellite to many geographically remote areas of Europe and the world, as well as to developing countries and countries in transition. Satellite technology provides an excellent platform for collaboration of renowned universities and medical institutions around Europe and beyond with medical institutions of these countries. Such programs need to be developed and supported in less developing countries and regions in Europe such as the Balkans and Eastern part of Europe, in particular where there is a lack of terrestrial infrastructure, but where there is expertise and human capacity present and great political will of the governments to apply eHealth and Telemedicine services. Establishment of infrastructure to help execute educational services would have significant importance for these countries and would help establish protocols for the use of satellite technology in this field, to be applied in other regions.
- *Real-time Telemedicine services for Enhanced Emergency Response.* In case of disaster emergencies, the combination of satellite-based communication with remote control of various diagnostic modules is a powerful tool to support the staff at the disaster site in the very critical first golden hours. Provision of remote expertise during the early triage and in the mobile field hospital (MFH) at the disaster site can thus be realized. Now a pilot operation phase must validate the operation of these services in more routinely situations. For this, 2-3 MFH already in use for real-life emergency measures by WHO should be equipped with various telemedicine and communication

modules. This validation phase should evaluate the various services with respect to real operations and should allow for improved and optimized telemedicine support as part of an Enhanced Emergency Response capability. The development of digital ambulances should be a necessary complementary development for this specific thematic area of the Telemedicine via Satellites programme.

- *Military hospitals and civil protection.* In situations of emergency, war and disaster, a comprehensive service comprising a *digital twin* giving (almost) unlimited access to all available information about the individual through the controlled access to shared medical records, and a complete bundle of telemedicine services such as telaboratory, telecardiology, telecounseling, telemonitoring, and so forth, shall be available to deliver help for soldiers and disaster victims. A pilot project with military hospital and civil protection connection shall be done to study disaster situation in real conditions.
- *Aeronautical telemedicine for commercial flights.* Pilot projects need to be implemented firstly at high density long haul operations in order to demonstrate the availability of this new system aboard. They shall involve professional schools teaching Emergency Medical Systems personnel (e.g. SAMU, 112) or other professionals working in isolated environments (sea technicians, cabin crews) the first aid techniques.
- *Healthcare at home.* For introducing integrated care models in the area of healthcare at home, nursing homes and other long term care facilities pilot projects must cover solutions for efficient management and service operation with a specific emphasis on households in remote communities where the need of satisfactory patient health management together with the undisputable role of space communications becomes extremely relevant. Positioning services via Satellite must enhance the 'home' to the actual mobility sphere of the client.
- *Telemedicine services in the prisons.* In many countries, telemedicine in the prisons is one the most popular aspects of telemedicine, as it offers a viable means to provide health care for prisoners. The main indications for applications of telemedicine in prisons include: Healthcare costs for prisoners are increasing, similar to the health care outside prisons; prison population is increasing and there is a trend toward older offenders who are serving longer sentences and who have greater healthcare needs; and most prisons are located in remote geographic areas where access to healthcare specialists is difficult to arrange, thus providing specialized medical attention to prisoners is costly and requires massive security for transport of prisoners, and it is time-consuming. Telemedicine has the potential to minimize and avoid all of the above, and provide required healthcare services in the secured environment and without exposing the prisoners to the public scrutiny. All medical services can potentially be provided via telemedicine, but routine primary care and specialty are most common one than can be safely delivered to prisoners.
- *Curative and prophylactic tourism.* Increased mobility of citizens has lead to new forms of tourism like curative tourism, where the final phase of the patient's cure is performed intentionally not in a classical patient environment (e.g. hospital), or at home, but instead in a more relaxing setting. Increased attention to health preservation measures will also induce a shift from curative tourism towards prophylactic tourism, where (healthy) citizens call on dedicated prophylactic services in a more informal and relaxing atmosphere. In the light of the specificity of telecommunication satellite system (i.e. wide coverage, robustness, etc.), it is very suitable for the provision of this kind of services, especially for mobile environments (e.g. cruise ships) and for the other various preferred curative sites (e.g. in the South Mediterranean). In the first pilot operation phase, 2-3 centres for curative and prophylactic tourism must be

connected to the satellite system for optimisation of the technology used, for validation of the medical services offered, as well as for evaluation of the corresponding costs for this kind of services.

## Operational Development of Services

The operational development of services includes activities based on stable technologies, responding to consolidated needs. The implementation shall be done within the fully operational context of the end user environment. The user community is mixed, i.e. not only 'champions' but also users with different affinity to innovative services. Special attention and adequate amount of resources shall be dedicated by this type of projects to the process of change management required to introduce eHealth and Telemedicine services in the user organization. With respect to what is done in Pilot projects, where part of the risk is taken by the supply side, in case of Operational Development the risk will usually be shared between supply and demand side (both public and private sector) through the financial participation of the target end customers. A suitable transition towards competitive commercial offers associated to a progressive exit strategy for ESA shall be envisaged wherever the presence of the market forces would allow this.

Examples where an operational development of services seems reasonable are:

- *Health Early Warning (HEW) for environment-related infectious disease outbreaks.* Environment-related (air-, water- and vector-borne) diseases have become a good example for new or recurrent and rapidly spreading diseases in the USA and in Europe. This fact is due to many different factors including climate changes; for this reason, the monitoring with satellites of environmental factors involved in infection transmission and persistence would be very useful in predicting the risk of outbreaks. Results obtained in the proposed pilot projects regarding prediction of West-Nile virus and vibrios-related infections could be used as models easily applicable to other environment-related infectious diseases emerging and re-emerging in Europe (dengue, malaria, water- and food-borne diseases, Lyme disease, meningitis).
- *Integration of satellite services in existing bio-terrorism EWS for a global approach (environmental and epidemiological data).* Monitoring of environmental factors favouring spread of a pathogenic agent released in a bio-terrorism attack could make the difference in rapidly blocking its diffusion via air or water. Satellite services would provide real-time communications when there are no adequate terrestrial communications.
- *SAT-based eHealth and Telemedicine services for the Euro-Mediterranean basin.* In order to optimize the infrastructures for disease management and to support the implementation of Evidence-Based Medicine in the whole Euro-Mediterranean basin, various SAT-based real-time eHealth and Telemedicine services shall be deployed (e.g. telesurgery, telepathology, teledermatology). This can be the first step towards the realization of the visions for a Virtual Euro-Mediterranean Hospital that aims to avoid and bridge the digital divide in the region, and provides equal access to high quality health care all over the region.
- *Maritime telemedicine on board of cruise ships.* On ships, the population is "healthy", well mixed in terms of age, background, medical history, etc. that remain for a limited time within the action radius of the services. They will call upon the services only in case of sudden changes in their physical condition. This makes it a very suitable model to study the provision of a broad spectrum of medical services for disease management and health preservation measures. Ships' broad band access used for other purposes



(internet access, leisure, communication, etc.) becomes a tool for telemedicine services. – Similarly, Telemedicine broadband services may also be implemented to improve the medical consultations that are currently and regularly performed via radio all around the world, with excellent results. Telediagnosis and teletreatment are provided by different national reference centres (e.g. Maritime Radio Medical Centres of Toulouse, Rome and Madrid).

## NEED TO FEDERATE THE DEMAND

For optimal development of the demand for appropriate eHealth and Telemedicine and eHealth services both public and private healthcare providers and stakeholders need to cooperate in a concerted manner to stimulate and guide demand development. The ESA Telemed Programme shall stimulate the adoption of solutions going beyond the regional and national limits, allowing mobility of data, people and services on one side and enabling the reach of economy of scale on the other side. In general, projects of the ESA Telemed Programme shall direct the development of demands towards a reasonable direction for better health for all with optimal use of available resources. The projects shall end up in sustainable services and powerful standards-in-use settings which then allow the industry to produce products to serve the evolving markets around such settings. For instance the area of Health Early Warning for Environmental Risks is a public health affair to protect populations and prevent epidemics environment-related health outcomes. Related services must be provided to the European citizen as public health services.

In order to consolidate the demand it will be important to consider appropriate and reliable Quality of Service (QoS) and appropriate Classes of Services (CoS), to eliminate language barriers by intelligent self-learning translation tools, to reach an adequate international legal basis for liability and reimbursement, as well as a catalogue of standardised services including prices dependent of QoS and CoS, relative to the qualification of the health care provider. A European Early Warning System via Satellite could be applied to the services of a European Centre for Disease Control (E-CDC). This would consolidate the demand from all the centres working in the “E-CDC orbit”. The diffusion of the results obtained in pilot projects and medium/large scale deployments which have proven to be satisfactory would consolidate the demand of similar services or same services in other areas or countries. Some examples are: Emergence of imported diseases (malaria) due to climatic changes, or of new diseases like SARS, or toxic clouds from terrorist attacks.

In the area of Healthcare at Home (here with a focus on isolated areas) and other complex areas, initiatives must focus on service chains and comprehensive support of the patient with a network of service packages composed individually to meet the specific needs of the person addressed. Other ‘home healthcare’ places include: long term facilities, rehabilitation units (patient with chronic wounds and other medical problems), homes for elderly or nursing homes that require constant, but less intensive medical care. Integrated care patterns must be an economical and quality benefit for all parties involved. In particular, this comprises an adequate reimbursement of telemedicine services and actions. To negotiate appropriate agreements between the stakeholders and to provide the necessary legal framework is a big task, but it is a basic component in consolidating the demand. Concrete examples: clarification through teleconsultation prior to referral to hospital; incorporation of telemedicine procedures in clinical guidelines and DRGs. Homes in isolated areas must be integrated in these service chains. This is only possible through satellites.

Where applicable, a business plan with evidence of provided services and clients should be made in order to demonstrate the service sustainability.

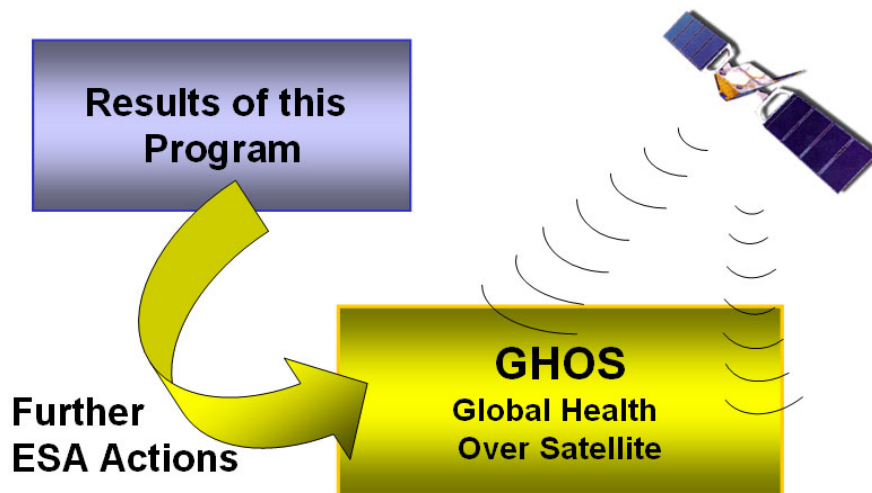


Figure 9. Further ESA Actions to Reach the Final Goal.

## FURTHER ESA ACTIONS

The set of actions envisaged in the framework of the programme shall pave the way towards a Satellite-based platform for eHealth and Telemedicine (Figure 3). Further actions shall take the results of the programme and bring them into operational use in order to build this platform:

- Establish network control centres for 24/7 high-level Quality of Service (QoS).
- Implement gateways to other communication networks.
- Create open source and open standards solutions for integration and interoperability of services.
- Establish high-end teleconsultation services (incl. remote control of medical equipment) for emergencies, disaster and as part of global health early warning system.
- Extend actions to more comprehensive e-services which support citizens in preserving their physical and mental health.
- Develop innovative tools to support management of global virtual alliances for health services delivery.

This shall lead to the Global Health over Satellite platform:

## GHOS – GLOBAL HEALTH OVER SATELLITE

The final goal of the activities shall be the Global Health over Satellite (GHOS) platform. It shall be a

- *Comprehensive Communication Platform for eHealth and Telemedicine*
  - for service development and implementation
  - for health authorities, professionals, patients, citizens

- *Connecting* hospitals, ships, aircrafts, space ships & -stations, mobile field hospitals, first diagnosis centres, curative and prophylactic tourism centres, etc.
  - for a broad spectrum of services and a large variety of situations occurring on land, on sea and in the air, including events in the proximate outer space

GHOS might be a dedicated Health GRID system for the concerted development and implementation of tools, applications and services for health authorities and professionals as well as for personalised health systems for patients and citizens. Given the increasingly more complex, more specialised and more expansive health care provision, physicians, health policy- and decision-makers, as well as health care financiers need new and interdisciplinary guidelines (beyond the Hippocratic oath) for the quality assurance of medical care and treatment, for the definition of medical care standards and for patient protection. These internationally harmonised guidelines should support evidence based medicine by helping to avoid medical over- and/or under-treatment as well as the provision of wrong medical care. It should build the basis for the practical design and implementation of medical care concepts, disease management and prophylaxis strategies. This process must be accompanied by development of an appropriate and adequate international legal basis, to avoid that concrete guideline-based medical treatments ends up in a liability trap. Altogether, the GHOS shall substantially help reduce the digital divide.

## 13. GLOSSARY

**Advanced Research in Telecommunication Systems (ARTES).** The main programme of ESA dealing with development of Technology, Systems and Applications in the area of Satellite Telecommunications.

**Assisted Cognition.** Synthesis of Artificial Intelligence and ubiquitous computing technology designed to help people with the cognitive limitations associated with Alzheimer's disease and similar conditions (Kautz et al. 2003).

**Asynchronous Digital Subscriber Loop (ADSL).** Technology that enables rapid transfer of digital information through regular telephone lines installed at the user premises, with user speed in the user download direction higher with respect to the user upload one.

**Asynchronous Transfer Mode (ATM).** Super fast data rates from 155-625 Mbps. This mode of transmission requires very specialized equipment and is very costly (Telemedicine Directorate 2004)

**Avatar.** (1) In Hindu mythology, the incarnation of a god. (2) Among people working on virtual reality and cyberspace interfaces, an avatar is an icon or representation of a user in a shared virtual reality. (The Jargon File 2003).

**Class of Service (CoS).** A network or Internet service provider offering that prioritizes which traffic is delivered before other traffic. When a service provider's network is not congested, all traffic is treated equally. When the network is congested, however, traffic that has been designated as a higher priority will be delivered first, while lower priority traffic will be held in a queue until the higher-class traffic has been transmitted (Gartner 2004).

**Continuity of Care.** An organisational principle, where one or more health care providers deliver several health care services to a subject of care. This organisational principle focuses on the time-related links between those different health care services (CEN 2000a).

**Diagnosis Related Groups (DRG).** A grouping of ICD codes based on costs of treatment, to be used for budgeting and hospital reimbursement (Handbook MI Glossary).

**Digital Subscriber Line (DSL).** Technology that enables rapid transfer of digital information through regular telephone lines installed at the user premises.

**Digital Video Broadcasting / Return Channel via Satellite (DVB-RCS).** A standard that specifies a satellite terminal that supports a two-way DVB satellite system.

**Distance Learning.** Learning in a setting where the source of information is at a different location than the learner.

**Earth Observation Satellite.** A system orbiting around the earth devoted to collect information on the surface, waters and atmospheric conditions through passive and/or active sensors (such as optical, radiometers, radar).

**eAdministration.** The term denotes the use of Information and Communication Technology to support the communication and information transmission in and outside the public authority (CC eGov 2004).

**eCare.** (1) eCare is about better and more joined up care, advice and assistance to the citizens through the use of computers and communication technology. With the individual's consent eCare enables secure information-sharing between professionals – such as doctors, nurses, social workers and teachers – in public and voluntary agencies. The most obvious

benefits are in: Giving members of the public easier access to their own information; reducing the amount of time service users have to spend repeating information they have already given to some other person or agency; helping the practitioner to have complete and up to date information before making an assessment or diagnosis (eCare Scotland 2004). (2) e-Care: Medical Expert System for Continuity of Care and Healthy Lifestyle. EU 6th Framework project IST-2001-33261

**eGovernance (synonym: regulative eGovernment).** Configuration of the basic conditions of the Information Society by the government or by private parties. Thereby it is irrelevant if these conditions have been built up by the government or by private parties. The matter in which the government influences the basic conditions directly reflects its direction of impact within the field of Information and Communication Technologies. According to that, the governmental part of the eGovernance is called ePolicy (CC eGov 2004).

**eGovernment.** The integrated delivery of information and services by federal, state, and local governments to citizens, private businesses and public entities through electronic channels, usually the Internet (CC eGov 2004). eGovernment refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that have the ability to transform relations with citizens, businesses, and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth, and/or cost reductions (The World Bank Group 2004).

**eHealth.** The use of information and communication technology for health at the local site and at a distance (WHO 2004a). The combined use in the health sector of electronic communication and information technology (digital data transmitted, stored and retrieved electronically) for clinical, educational and administrative purposes, both at the local site and at a distance (WHO HQ 2002; Mitchell 1999). eHealth refers to the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers (EU 2003).

**eLearning.** The process of formal and informal learning and training activities, processes, communities and events via the use of all electronic media like Internet, intranet, extranet, CD-ROM, video tape, TV, cell phones, personal organizers et cetera (de Leeuwe 2004).

**eSurveillance.** Using information and communication technologies to carry out or support surveillance. Surveillance: routinely collecting data to examine the extent of a disease, to follow trends, and to detect changes in disease occurrence, e.g. infectious disease surveillance, postmarketing surveillance (Handbook MI Glossary 2004).

**ENVironment SATellite (EnviSAT).** Launched in 2002, Envisat is the largest earth observation spacecraft ever built. It carries ten sophisticated optical and radar instruments to provide continuous observation and monitoring of the earth's land, atmosphere, oceans and ice caps.

**EUTELSAT.** One of the world's leading satellite operators, operating 24 telecommunication satellite. Eutelsat's satellites offer a broad portfolio of services that include television and radio broadcasting for the consumer public, professional video broadcasting, corporate networks, Internet services and mobile communications.

**Evidence Based Medicine.** Selection of diagnostic or therapeutic methods on the basis of scientifically based empirical evidence (Handbook MI Glossary).

**Early Warning System (EWS).** A system or procedure designed to warn of a potential or an impending problem.

**Early Warning System and Response (EWSR).** A system designed to warn of a potential threat and to respond to it by applying adequate protective measures.

**Geostationary Operational Environmental Satellites (GOES).** Circle the Earth in a geosynchronous orbit over the equator. This means they observe the Earth from the exact same place all the time. This allows the GOES satellites to continuously monitor a single position on the earth's surface.

**Global Health Over Satellite (GHOS).** A satellite system with global coverage as communication platform for the concerted development and implementation of tools and services for health authorities and professionals, as well as for personalised health systems for patients and citizens. Offers dedicated 24/7 (i.e. 24 hours per day, 7 days per week) eHealth and Telemedicine services for interactive multimodal and multimedia communications.

**Global Positioning System (GPS).** System used to determine latitude, longitude, and elevation anywhere on or above the earth's surface. This system involves the transmission of radio signals from a number of specialized satellites to a hand held receiving unit. The receiving unit uses triangulation to calculate altitude and spatial position on the Earth's surface.

**GRID Technology.** Resources sharing is conditional: each resource owner makes resources available subject to – often stringent – constraints on when, where, and what can be done. Sharing relationships can vary dynamically over time in terms of resources involved, the nature of the access permitted and the participants to whom the access is permitted (Beolchi 2003).

**Health.** A state of complete physical, social and mental well-being, and not merely the absence of disease or infirmity (WHO 1946).

**Health Early Warning System (HEWS).** An Early Warning System for health-related problems.

**Health GRID.** A GRID system supporting eHealth.

**Health Telematics.** (1) A composite term for health-related activities, services and systems, carried out over a distance by means of information and communications technologies, for the purposes of global health promotion, disease control, and healthcare, as well as education, management, and research for health (WHO 1997). (2) The combined use of informatics and telecommunications as applied to health delivery (G7 Information Society Initiative 1999).

**Health Telematics Platform.** Comprehensive network for electronic communication available for all participants in social and healthcare, which satisfies all ethical and legal requirements of this sensitive cf. application area; comprises the following services and tools: a) identification services for patients and healthcare professionals; b) identification services for entities and documents; c) e-signature services; d) security and confidentiality services; d) reference services to find patient records; e) standardised EPR/EHR communication messages; f) user directories; g) identification tokens like Smart Cards; h) Trusted Third Party services (e.g. PKI services) (ISfT Glossary 2004).

**Healthcare.** Broad term that directly refers to different activities and means used to prevent or cure different processes of morbidity (CEN 2004).

**Healthcare Services.** Service provided with the intention of directly or indirectly improving the health of the person or populations to whom it is provided (CEN 2000).

**Hospital Information System (HIS).** An information system used to collect, store, process, retrieve, and communicate patient care and administrative information for all hospital-affiliated activities and to satisfy the functional requirements of all authorized users (Handbook MI Glossary).

**Ikonos.** The first of the next generation of high spatial resolution satellites. Ikonos data records 4 channels of multi-spectral data at 4 metre resolution and one panchromatic channel with 1 metre resolution. This means that Ikonos was the first commercial satellite to deliver near photographic high resolution satellite imagery of anywhere in the world.

**Information and Communication Technology (ICT).** The seamless merging of information processing and transfer of information through the use of computer and network technologies.

**International Society for Telemedicine (ISfT).** Non-profit organization to support telemedicine.

**INMARSAT.** Inmarsat is a global mobile satellite communications operator, delivering broadband communications solutions to enterprise, maritime and aeronautical users around the globe. Inmarsat operates a constellation of geostationary satellites that extend mobile phone, fax and data communications to every part of the world, except the poles.

**Integrated Care.** An organisational principle, encompassing at the same time each of continuity of care, shared care, and seamless care (CEN 2000a).

**Integrated Services Digital Network (ISDN).** A digital telecommunications channel that allows for the integrated transmission of different types of services such as voice, video, and data. A protocol for high-speed digital transmission (Telemedicine Directorate 2004, modified).

**International Space Station (ISS).** The International Space Station, jointly developed and built by 10 European countries (represented by ESA), the United States (NASA), Japan (NASDA), Canada (CSA) and Russia (RKA). ISS is the world's largest international cooperative programme in science and technology to date. When ISS is completed it will cover an area as big as a football pitch and weigh 455 tonnes.

**LandSAT.** A family of Earth Observation satellites launched by NASA. The Landsat Program is the longest running enterprise for acquisition of imagery of the earth from space. The first Landsat satellite was launched in 1972; the most recent, Landsat 7, was launched on April 15, 1999.

**MeteoSat.** The family of geostationary meteorological satellites launched and operated by the Eumetsat international organisation.

**National Oceanic and Atmosphere Administration (NOAA).** Has launched meteorological satellites.

**Quality of Service (QoS).** A negotiated contract between a user and a network provider that renders some degree of reliable capacity in the shared network (Gartner 2004).

**Satellite.** A man-made object (such as a spacecraft) placed in orbit around the Earth, another planet or the Sun. (ESA Science Glossary 2004)

**Satellite communications (Satcom).** The use of orbiting satellites (geostationary and non-geostationary) to relay transmissions from one earth station to another or to multiple earth stations (Gartner 2004, modified).

**Seamless Care.** A quality principle, focusing on the timely and appropriate transfer of activity and information, when responsibility for the delivery of health care services is wholly or partly transferred from a health care provider to another (CEN 2000a).

**Shared Care.** An organisational principle where two or more health care providers jointly co-operate to provide health care services to a subject of care for a continuing health issue. This organisational principle focuses on joint objectives and responsibilities (CEN 2000a).

**Teledermatology.** Dermatology in which images of the skin are digitally transmitted and examined by a dermatologist at a remote location.

**Telediagnosis.** Diagnosis made at a distant location on the basis of electronically transmitted information.

**Telehealth.** The integration of telecommunications systems into the practice of protecting and promoting health in the field of public health (WHO 1998). The application of information technology and telecommunications for diagnostic and treatment services, educational and support services and the organization and management of health services (including health information management and decision support systems) (Buckley et al. 1996). The use of electronic information and communication technologies to support long-distance clinical healthcare, patient and professional health-related education, public health and health administration (US-DoH 2001).

**Telemedicine.** The delivery of healthcare services, where distance is a critical factor, by healthcare professionals using information and communications technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interest of advancing the health of individuals and their communities (WHO 1997).

**Telepathology.** Pathology in which the image of the specimen is digitally transmitted and examined by a pathologist at a remote location (Handbook MI Glossary).

**Telesurgery.** Surgery in which the surgeon guides an operation or operates via robotic equipment on a patient at a distant location (Handbook MI Glossary).

**Teletreatment.** Treatment of a patient at a distant location.

**Transmission Control Protocol / Internet Protocol (TCP/IP).** TCP is one of the main protocols in TCP/IP networks. Whereas the IP protocol deals only with packets, TCP enables two hosts to establish a connection and exchange streams of data. TCP guarantees delivery of data and also guarantees that packets will be delivered in the same order in which they were sent.

**Universal Mobile Telecommunications System (UMTS).** Represents an evolution in terms of services and data speeds from “second generation” mobile networks. As a key member of the “global family” of third generation (3G) mobile technologies identified by the ITU, UMTS is the natural evolutionary choice for operators of GSM networks.

**Very Small Aperture Terminal (VSAT).** A type of interactive (transmit and receive) satellite earth station typically installed at users’ premises and generally characterised by a small antenna dish.



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