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CAALYX-MV

Complete Ambient Assisted Living Experiment – Market Validation

D2.3 Market Analysis and Study

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Executive summary

This document describes the different aspects concerning the European e-health market. The goal of D2.3 is to provide a market analysis description to D2.2, to develop marketing strategies for the CAALYX-MV services and end-users. In order to do so, first the potential users of CAALYX-MV are presented and an estimation of the market is discussed. Furthermore, it is explained how the different partners will match with the business model and market players. Information is provided about the current market trends and a competence analysis is presented. A comparison between similar products provides an understanding about the competitive positions and the categories in which there is a potential market for CAALYX-MV.

The market description section introduces the different kinds of consumers that might use the CAALYX-MV service, e.g., patients, carers, doctors and relatives. Moreover the section provides numbers on the size of the European market related to telemonitoring, chronic disease management, remote patient monitoring, and ambient assisted living. In addition, the burden that is generated by chronic diseases is discussed. The chapter concludes by providing information on world-wide e-health market.

In chapter three, different roles taken by the CAALYX-MV consortium are described within the framework of the chosen business model. Market players are described in detail and economic relations between them are presented. There are nine different partners in the CAALYX-MV project and therefore it is discussed who is providing what, how much devices/services are provided, and who will be responsible for providing the service to the Health care service provider.
In the market trends section, a comprehensive study of the current products has been carried out by comparing their different functions and services. First of all, the needs of the market have been identified from different angles (e.g. communication, compensation of co-morbidity, home safety, medical assistance, etc.). Then, the CAALYX-MV solution is described and the market needs. Finally, other products are described and compared to CAALYX-MV. At the end, the T-Shirt is discussed, because it is one of the most exclusive products of CAALYX-MV.

The final section provides a systematic analysis of the collected information and synthesises the information in order to present the competences of CAALYX-MV. The main rationale for this analysis is to provide an overview of the current e-health market and the market opportunities of CAALYX-MV within this market. If there are some, CAALYX-MV will have the possibility to cover a market in which there is room for competitors and new innovations, and therby increasing the opportunities to be successful. Furthermore, this information will be valuable for D2.2 on the external determinants and to implement marketing strategies. The last chapter concludes by summarizing the main results of the deliverable.

1 Introduction

In order to be able to sell a product like CAALYX-MV, the consortium should rather gather an in-depth understanding of the current situation in the e-health market. The turnover on this market, the existing products, the market trends and the potential users are issues dealt in this document.

1.1 Purpose and content of this deliverable

D2.3 provides an analysis of the e-health market in order to give preliminary conclusions that will support potential successful marketing techniques for the selected marketable services (i.e. D2.2). In the following sections, we elaborate on these conclusions by discussing the potential market, the market players, the market trends (from different points of view) and finally an enhanced competence analysis is performed.

1.2 Methodology

The main outcome of WP2 is the description of a set of marketable e-health services and the strategy to deploy them on the market. In order to do so, a description of the CAALYX-MV services is outlined in D2.1. Then a benchmarking study is performed in D2.3. Both documents will provide input for D2.2 about the final marketing strategies. D2.1 is providing input for D2.3 and D2.2. In D2.3 this input is used to compare CAALYX-MV services with current market options, and in D2.2 to propose the e-health services that will be filtered on D2.2 using a marketing logic. The following figure (Figure 1.) provides an overview about this methodology.

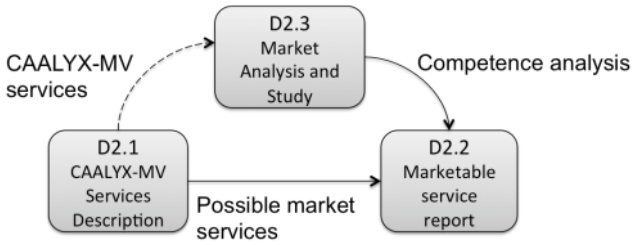

Figure 1 - WP2 methodology

1.3 Outline of this deliverable

In chapter two, the potential CAALYX-MV end-users are discussed in detail to provide an estimation of the e-health market. In chapter three the key actors are described that play a role in the chosen business model. The next chapter presents the market needs and other solutions similar to the one provided by CAALYX-MV. Chapter five provides an overview of the market potentials that the consortium could consider as opportunities for the CAALYX-MV services. Finally, chapter six ends with a discussion and conclusion of the deliverable.

2 Market description

2.1 Who are the potential users of CAALYX-MV?

CAALYX-MV is an ICT-based solution focused on improving the older people quality of life by prolonging the time they can stay safer, autonomous and independently at home, by monitoring and controlling their social and health status and providing them with tools and services to support their daily home-activities in terms of comfort, security, energy efficiency and communications.

The previous deliverable D2.1 defines the target users of CAALYX-MV solution. According to the analysis, there are 4 potential users:

- **Older people,** who will benefit from CAALYX-MV by increasing the time they can stay safe and independent at home and by providing accessible contact opportunities with caretakers, doctors and relatives.
- **Doctor** users consist of Family Practitioners or specialists.
- **Carers**, who attend alerts produced by CAALYX-MV and contact older people to kindly show concern for their state or to remind activities.
- **Relatives and friend** users are the family members who provide a care contribution according to their circumstances from their own home/place.

Those 4 groups of users are the actors involved in the usage of CAALYX-MV. However, there are **other actors** who may not use the ICT-based solution in a direct way but that are actually interested in doing business through it. Therefore, those actors also determine the size of the market and should be considered in the analysis.

In order to consider the actors interested in take profit of ICT-based solutions for ageing well, a stakeholder analysis of Ambient Assisted Living must be performed. Thus, not only users but also companies, professionals and organizations which also determine the size of the market will arise.

The stakeholder analysis provided by BRAID[1] is an available report which determines the interested parties in the Ambient Assisted Living field by categorizing them into six groups:

1. **End users**

   This category includes senior citizens, those with disabilities, their family members and any carers. It is divided into two subcategories:
   - Living persons, who require help with day to day activities,
   - Healthy persons, who need ICT to ensure continued good health.

   Their needs include accessible products and services, lifelong learning including training and education in the use of ICT, opportunity to work longer, increased quality of life, improved health care, respect for their dignity, privacy and personal data

[1] Report on mechanisms for stakeholder co-ordination, BRAID (2010)

2. Industry

Industry is understood as the professional users of ICT services who are on the front lines of addressing the needs of older people (such as healthcare providers) and private companies concerned with providing ICT solutions through research and development. Thus, this category can be divided into 2 subcategories:

- **Professional users** of ICT for ageing solutions. They have a B2C-relation to the end users (they sell ICT for ageing solutions to clients) and a B2B-relation to ICT suppliers.
- **Suppliers** of ICT for ageing solutions. Some of the suppliers may have a B2C-relation to the end users (mainly large enterprises), but the rest of them have a B2B relation with professional users of ICT for ageing solutions. Examples:
  - Public and private research organizations
  - Large enterprises with a business in tele-medicine or tele-care (e.g. Bosch, Phillips, Tunstall)
  - Providers of the IT infrastructure: networks (telecoms) and databases (data warehouse providers for creating personal health records).
  - Small and medium sized enterprises: hardware and software and or service provision.

3. Civil Society Organizations (CSOs)

They are the primary avenue through which the needs and interests of end users are represented within the ICT sector. Large pan-European or international organizations such as the AGE Platform or Privacy International are to have accessible products and services for senior citizens available, engaging citizens in social networking, overcoming ageist discrimination, lifelong learning and active ageing policies,

4. Public authorities

This category includes governmental organizations on the supra-national, national and local level and, therefore, includes the European Commission, the governments of Member States and regional or local governments. This group of policy makers is politically and economically the most important stakeholder category in relation to the deployment of ICT technologies, as the future development of the regulated market depends on their decisions. Their needs are active ageing and opportunities for senior citizens to work longer, encouraging industry to produce accessible products and services, lifelong learning, ethical issues associated with ICT (e.g. privacy, data protection, informed consent, etc.), overcoming digital divides and extending broadband to all citizens, interoperability of electronic health records and reducing administrative burdens and regulatory barriers and increasing opportunities for European industry.

5. Academics

This category of stakeholder shares much in common with stakeholders from industry; they are differentiated by their financial dependence on stable funding sources to support research and development.

6. Media

The media have a relatively neutral level of political or economic power, and a relatively low knowledge about ICT solutions for e-inclusion, although this is increasing. It is an important stakeholder group because, in some ways, they set the public agenda and as such, can meet many of the needs of other categories of stakeholder by increasing the visibility of ICT solutions and impacting levels of knowledge about e-inclusion.

The following table summarizes the potential users and the stakeholders which should be considered in the market description:

Category	User / Stakeholder
Private users	**- Senior and impaired citizens** **- Private caregivers**, usually members of relatives
Professional users of ICT	**- Medical professionals**: tele-medicine operators, professional care providers, care homes. **-** Other **service providers**, like housing associations
Suppliers of ICT	**- Tele-medicine or tele-care large enterprises** (e.g. Bosch, Phillips, Tunstall) **- IT infrastructure network providers** (e.g. Telefónica, Vodaphone) **- IT databases providers** (data warehouse providers for creating personal health records, network providers can perform this task). **-** Small and medium sized enterprises: **hardware and software providers** (e.g. specific hardware vendors such as fall sensors or software providers for mobile phones). - Public and private research organizations
Supporters of ICT ageing solutions	**- Policy makers** **- Insurance companies** **- Public administrations** **- Standardisation organizations** **- Civil society organization** **- Media**

Once potential users and interested parties are identified, the next step of to obtain a detailed market description consists on defining the scope of CAALYX-MV market and characterizing it. This section presents the market in which CAALYX-MV is included and the following subsections characterize them in terms of size and incomes.

CAALYX-MV is an ICT-based solution which aims to improve older people quality of life. In line with other European initiatives such as BRAID[2], the term “ICT for ageing solutions” is considered to include the widest spectrum for marketable products, services or combinations of both. ICT for ageing stands for any information and communication technologies or devices and/or services based thereon that increase:

- the potential for a self-determined independent living of senior citizens, and
- the productivity of professional and non-professional users that work with senior citizens.

In order to identify the various market segments that are related to AAL technologies, needs of older people should be recognized. Although they are very heterogeneous, they can be grouped in a manner that maps loosely to the three main ‘market’ segments that typically structure the service delivery landscape in Europe – social care, health care and housing. A new, cross-cutting element that is, at least in principle, enabled by technological developments concerns provision of services

[2] http://www.braidproject.eu/

and supports on a mobile basis (ICT & Ageing[3]). The four domains and the overlap between the domains are represented in figure 1. CAALYX-MV focuses on initiatives in all four identified domains to do justice to the broad range of solutions that can support aging well. In terms of products and services that are of interest for CAALYX-MV, the approach taken in the ICT and Ageing report is adopted.

2.1.1 Smart-homes market

Smart homes integrate and incorporate new services that support comfort, remote control, security, energy management, healthcare and wellness, information, entertainment and remote working[4]. The financial recession in most Western societies go hand in hand with in a reduction of incomes and job losses which consequently have an effect on the domotics market development. Nevertheless, it is expected that after a couple of years, the Western European domotics market will increase and reach around 4 billion Euros in 2016 with a composed annual growth rate of approximately 15% per year. The expectations are based on the current low penetration of home automation appliances in existing homes and in new constructions, from high expected growth of home networking and from the development of remote services. Web 2.0, smart phones, iPad and portables PCs - integrated with new domotics functionalities - will support the market success of Smart home functionalities and the further development of home automation[4].

As presented above, the smart home services vary from leisure to health and the smart homes market that is most relevant to CAALYX-MV is presented in Figure 2: Assistive Technologies, Ambient Assisted Living (AAL), and Home health systems/devices. CAALYX-MV focuses on initiatives in all four identified domains to do justice to the broad range of solutions that can support aging well. In the last decade, more and more European countries work on small local telehealth or telemedicine pilots similar to CAALYX-MV, mostly concerning tele monitoring applications for chronic disease management, access to care from a distance, patient data sharing, and coordination of services between health and social care providers. Main objectives of these initiatives were initially to provide responses to factors such as the ageing population, the growing prominence of chronic diseases and financial challenges in controlling overall healthcare spending. However increasingly a shift is taking place from looking at the issue from a problem oriented point of view to an opportunity point of view. Ambient Assisted Living (AAL) technologies or technologies for aging well – integrated in smart homes – represents a substantial market where European industry can play a leading role via the provision of innovative technological and organisational solutions[5]. To reach this ultimate goal a mature market for AAL solutions is needed, yet, at the moment this market hasn't reached maturity yet.

[3] ICT & Ageing European Study on Users, Markets and Technologies (2010)
[4] CMT Research (2010). Market Outlook: Domotics And Home Automation Market In Western Europe, Main Trends And Forecast, 2010-2016. Retrieved December 19, 2011 from: http://www.cmtresearch.com/details/report-94.htm
[5] Valeri, L., Giesen, D., Jansen, P., Klokgieters, K. (2010) Business Models for eHealth. Prepared for ICT for Health Unit DG Information Society and Media European Commission

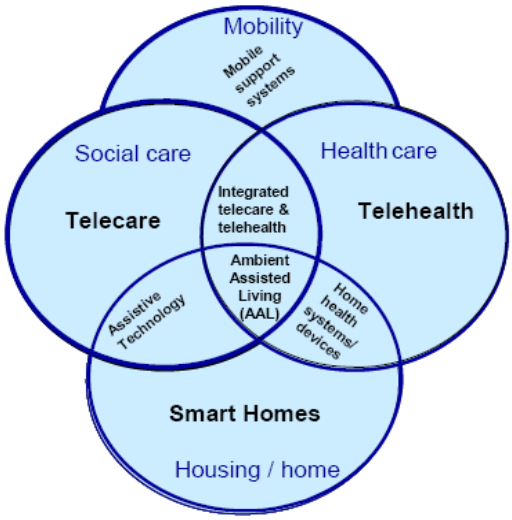

Figure 2 – Three core technology domains (Source: ICT & Ageing Final Report[4]) with mobility associated as a fourth dimension (Source: BRAID: Identification and characterisation of the main stakeholder groups for "ICT for Ageing" solutions, p. 5)[1]

At present, the most mature market in the field of AAL concerns social alarms (first generation telecare, see[6]). For more advanced (second generation, see also[6]) telecare, involving provision of additional sensors to enhance basic social alarm services, only in the UK is the situation approaching anything close to mainstreaming as of yet. For the most advanced (e.g., CAALYX - third generation) telecare, involving extensive activity monitoring, data gathering and lifestyle analysis, implementation to date has mostly been in pilots/trials, although a few examples of mainstreamed services can already be identified[7].

Home telehealth is less mainstreamed than telecare at present, at least in comparison to basic first generation telecare. No country has 'full' mainstreaming in the sense that the relevant healthcare providers, in all parts of the country, include such services within their repertoire. At the smart home end of the spectrum, the evidence suggests that there are a lot of RTD projects, trials and demonstrators but no well advanced mainstreaming in most countries to date[6].

Table 1 provides an overview of the evolution of 'smartness' in telecare[8]. This notion of evolution will be used to determine the innovative character of exemplars and the CAALYX solution. A dimension that will also be investigated is the transition between the generations and lessons learned that supported the transition.

[6] http://www.verklizan.com/index.php?id=3&L=0
[7] ICT & Ageing European Study on Users, Markets and Technologies (2010)
[8] Berlo, A. (2011). Smart Homes.

Table 1: Evolution of "smartness" in telecare

	Traditional tele-care (alarms & monitoring)	Smart houses	Fixed + mobile intelligence
1st generation	Social alarms	Social alarms + sensors + actors	Smart house + independent robot
2nd generation	Social alarms + sensors + tele-monitoring	Connected sensors + actors+ some intelligence	Smart house + integrated robot
3rd generation	Social alarms + sensors + tele-monitoring + anticipatory software	Connected sensors + actors+ intelligence + anticipatory software	Smart house + integrated autonomous robot + embedded anticipatory software

To gain a deeper understanding of the AAL market, the approach taken must be in line with and take into account the variety and complexity of the market as indicated in the paragraphs above. For this reason, in the CAALYX-MV project, a multidisciplinary and multifaceted approach towards business models is chosen.

At the moment, e-health services that are to be implemented in the healthcare market show great potential in increasing the healthcare quality and efficiency[9]. Despite the promising potential of these innovative services, a successful commercialization seems to be a major stumbling-block. For the CAALYX-MV project, a deeper understanding is needed of why certain solutions do well in the R&D and roll out phase by proving an added value to the traditional services, while they fail when the new ICT solutions are introduced into the market and need to become financially independent. For future market success of AAL technologies like CAALYX, it is essential to overcome this barrier. For that, a multidisciplinary and multifaceted approach is clearly needed that focuses on both added value as well as sustainability of the solutions. In the following sections we will further discuss – in more detail – the AAL tele-health and tele-care markets.

2.1.2 Tele-health & Tele-care market (UPC)

Tele-health refers to the provision of healthcare services at a distance through use of ICT. It is used in situations where the health professional and the patient (or two health professionals) are not in the same location. It involves secure transmission of medical data and information, through text, sound, images or other forms needed for the prevention, diagnosis, treatment and follow-up of patient.

Tele-care refers to the provision of care services from a distance supported by means of telecommunications and computerised systems services using ICT. The services offered may be simply social services or, more specifically, services which can contribute to the management of chronic diseases from the home.

[9] Boyne, J.J.J., Vrijhoef, H.J.M., en Gorgels, A.P.M. (November, 2011). Telebegeleiding bij patiënten met hartfalen Evaluatie van de effecten van telebegeleiding bij patiënten met hartfalen. Retrieved, December 7, 2011 from http://www.unimaas.nl/prv-limburg/PRV/Onderzoeksprojecten,%20rapporten%20en%20adviezen/rapporten/Telebegeleiding%20bij%20pati%C3%ABnten%20met%20hartfalen.pdf

E-health Market and Telemedicine

The market study presented in 2010[10] estimated the European e-health Market at €14.269 M in 2008 and projected to reach €15.619 M by 2012 with a compounded annual growth rate of 2.9%. The following figure shows that France, Germany, Italy, Spain, the United Kingdom, The Netherlands, and Sweden are the largest European e-health markets:

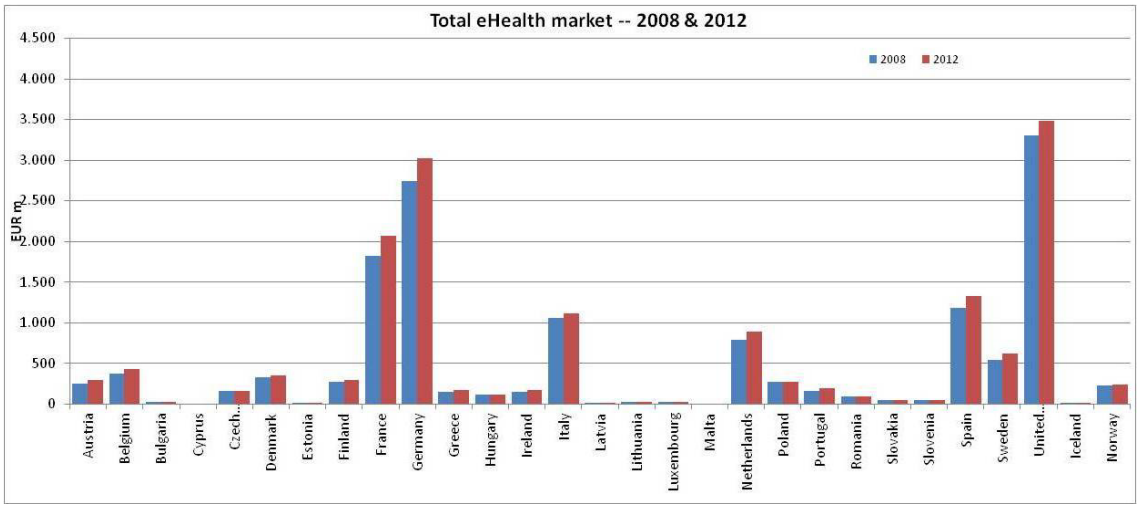

Figure 3 – Total e-health market 2008-2010

The e-health market is divided into the following segments:

Market	Description	Composition
Clinical Information System (CIS)	(a) Specialised tools for health professionals within healthcare institutions (e.g. hospitals). Examples are radiology information systems, nursing information systems, medical imaging, computer-assisted diagnosis, surgery training and planning systems; (b) Tools for primary care and/or for outside care institutions, such as general practitioner (GP) and pharmacy information systems.	22.5%
Secondary Usage Non-clinical Systems (SUNCS)	This category includes: (a) systems for health education and health promotion of patients/citizens, such as health portals or online health information services; (b) specialised systems for researchers and public health data collection and analysis, such as biostatistical programs for infectious diseases, drug development, and outcomes analysis; (c) Support systems such as supply chain management, scheduling systems, billing systems, administrative and management systems, which support clinical processes but are not used directly by patients or healthcare professionals.	71.60%
Telemedicine	Personalised health systems and services, such as disease management services, remote patient monitoring (e.g. at home), teleconsultation, telecare, telemedicine and teleradiology.	0.9%
Integrated Health Clinical Information Network (IHCIN)	Distributed electronic health record systems and associated services, such as e-prescriptions or e-referrals	5%

Telemedicine accounted for a mere 0.9%, however the market for telemedicine systems and applications is expected to grow more rapidly with respect to the other segments suggesting that true adoption of this technology by providers, professional and medical staff as well as patients will provide strong business opportunities.

[10] Valeri et al., Business Models for eHealth, 2010.

Telemonitoring

Telemonitoring may be considered as part of tele-health and tele-care. It may be used in health services in order to monitor vital signs, which are reported to doctors and also may be used in care services when a caretaker controls e.g. the weight of a patient. Some studies describe telemonitoring without distinguishing between tele-care and tele-health, so the study details should be applied to both markets. This is the case of a Deloitte study[11], which describes telemonitoring systems across Europe. According to the study, the availability of these systems in EU hospitals is not common: only 8% use telemonitoring. In terms of geographic coverage, the hospitals in Denmark, Ireland, the Netherlands and Sweden lead in terms of the use of telemonitoring systems. In these countries, around one-quarter of the hospitals surveyed have a telemonitoring system in place. The survey shows that 11 countries do not offer telemonitoring services to out-patients. This is particularly the case in a number of new Member States and small-older Member states. Among the large Member States, telemonitoring is more common (Italy, Spain and the UK), see Figure 4.

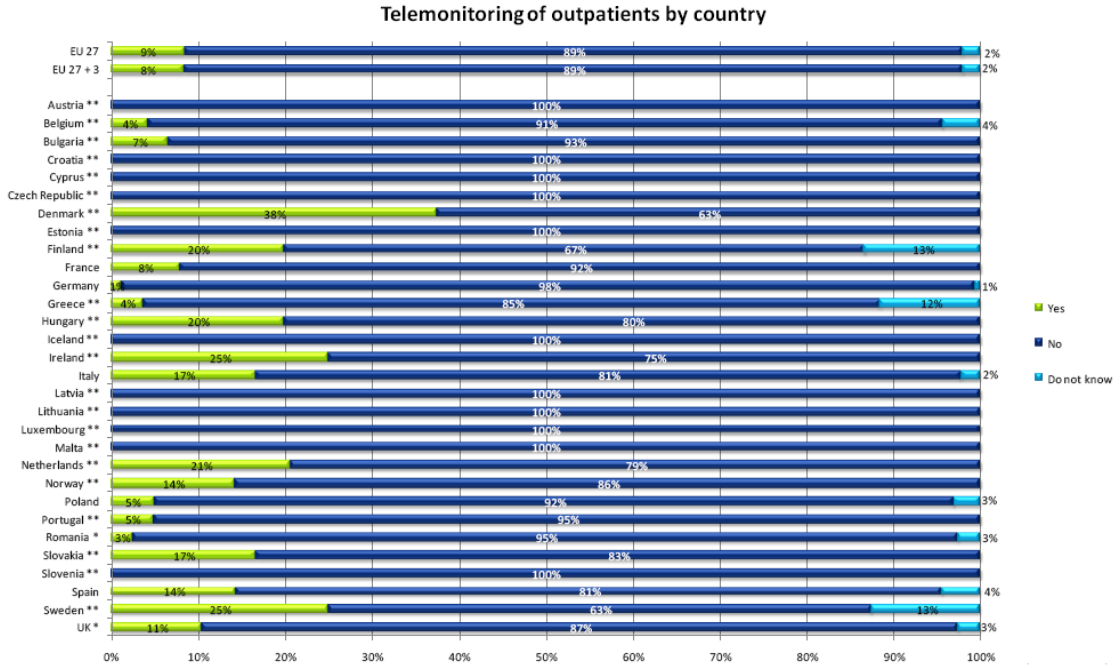

Figure 4 –Telemonitoring patients

Chronic Disease Management

Chronic diseases are diseases of long duration and generally slow progression. Self-management techniques in terms of the treatment or handling of chronic diseases or conditions are becoming more and more popular. Certain aspects of online support, facilitated by the use of computers or telecommunications, can facilitate the self-management of chronic diseases by patients.

Online programmes are often used with patients who are affected by chronic diseases, such as diabetes, heart disease, and cancer. Patients can learn how to maintain their conditions stable at home. They can be helped to reduce risk and acute care episodes. Many patients with a chronic condition or multiple chronic conditions spend time in acute hospitals because they experience an episode that is implicitly due to a mismanagement of their condition. Improving a patient's knowledge of chronic diseases (see[12]) and helping him or her to avoid acute care episodes can make a positive difference to the patient.

[11] European Comission, eHealth Benchmarking III, SMART 2009/0022 Final Report, Deloitte & Ipsos Belgium 13th April 2011
[12] Kato, P.M., Cole, S.W., Bradlyn, A.S., & Pollock, B.H. (2008). A video game improves behavioral outcomes in adolescents and young adults with cancer: a randomized trial. *Pediatrics, 122*, e305.

According to the same study[13], online chronic disease management capabilities are offered to patients in more than four out of ten hospitals that have telemonitoring systems. Diabetes is the most common disease for which the service is available followed by Heart Diseases, Chronic Obstructive Pulmonary Disease, Chronic Renal Diseases, Cancer and Asthma.

Remote Patient Monitoring

A study presented in 2010 by Frost & Sullivan[14] describes the Remote Patient Monitoring market. This market is conveniently segmented into tele-care and tele-health and they are defined in a very similar way than used here before. The study was performed in 2009 but it is considered that no major change in each country's market has occurred.

The study is focused in describing the Remote Patient Monitoring (RPM) market as devices for tele-care and tele-health. Thus, it only considers companies and divides the market into 3 tiers according to the revenue obtained by the companies. Tier I include the biggest market share holders in the European RPM Market such as Phillips, Biotronik and Tunstall. They serve all countries and have a vast product portfolio with huge clientele from service providers to healthcare institutes involved in RPM. Tier II comprises of companies such as Bosch, Aerotel, Vivatec, Fold Telecare, etc., which have a significant market share in their region, but their pertinence is limited to few countries. This group of companies is high competitive. Tier III includes Card Guard, TSB GB, RSL Steeper, etc., which are companies mostly small in terms of revenue earned from RPM. Their core focus areas may not be RPM and are present in limited countries.

The study also analyzes the market share for each country. The dominating countries in the Remote Patient Monitoring are UK with 25% market share and Germany with 21%. Other prominent markets include France (15%), Italy (15%) and Benelux (11%). Spain has 6% of share and Scandinavia 7%. The scenario was considered to likely remain the same throughout the following 5 years.

The remote patient monitoring market, which is considered in the study to be composed of tele-health and tele-care markets, registered revenues of $ 325.0 milion and is expected to double its annual revenues by 2015. The market was expected to witness a CAGR of 12.2% during the forecast period between 2010 and 2015. However, the market was growing at the 10.0% in the period between 2006 and 2009.

Ambient Assisted Living in Europe

A study also presented in 2010 by Frost & Sullivan[15] describes the Ambient Assisted Living market. AAL is understood in the study as the intersection between the domains of tele-care, tele-health and smart homes and it analyzes UK, Germany, France, Spain, Italy, Scandinavia and Benelux. The technology trends of the AAL market are described as a usage of broadband communications, wi-fi, networking capacity and efficient integration of multimedia devices. The demographic trends, which is an increase of elderly population, pushes the demand of AAL technologies.

The market generated $154.9M in 2009 and Germany was the biggest market with 32.9% of share. The CAGR is expected to be 22.6% between 2010 and 2015. The revenues per country in 2009 were: Germany 32.9%, UK 27.8%, France 16%, Scandinavia 14.7%, Italy 4.1%, Spain 3.0% and Benelux 1.5%.

[13] European Comission, eHealth Benchmarking III, SMART 2009/0022 Final Report, Deloitte & Ipsos Belgium 13th April 2011
[14] http://www.slideshare.net/FrostandSullivan/european-remote-patient-monitoring-market
[15] http://www.slideshare.net/FrostandSullivan/assisted-living-in-europe-technology-and-market-trends-2010

Telemedicine Market

A recent market study also from Frost & Sullivan[16] divides the tele-medicine market in various disciplines: tele-dermatology, which provides care for patients suffering from skin diseases; tele-pathology, which is in charge of transferring image-rich pathology data to remote locations for the purpose of diagnosis and analysis; tele-dentistry, which uses ICT for dental-care-related consultation and analysis, tele-oncology, which allow cancer patients to remotely connect to a specialist in order to provide analysis, consultation and appointment; and tele-psychiatry.
The study describes the overall trends of healthcare in Europe. According to it, e-health methods are being adopted since reduce the need for physical movement of patients and improve the scope of healthcare coverage. Due to the increase of healthcare expenditures, governments are forced to use tele-medicine approaches since they are cost-effective solutions, mitigate lack of specialists in certain regions and make delivery of healthcare in remote areas.

The telemedicine market is estimated in this study to be $432.0 M in 2010. Telecardiology, which is the usage of ICT to avail the services of a radiologist who is located in a remote location, and Telecardiology, which is the remotely monitoring, reporting and diagnosis of cardiology data from patients, are considered to be the most developed segments of telemedicine. Some branches as teledermatology, telepathology and telepsychiatry are described to be still under debate. Telecardiology and Teleradiology contribute to the market with $274.4 M and $186.6 M respectively.

The maximum future market size of tele-medicine market is considered to be in $1,247.3 M and the base year market growth rate 13.5%. The number of competitors is 25 and is expected to be increased, with a high-degree of competition and a medium degree of technical change.

Managing Chronic Disease in Europe

The report 'Managing chronic disease in Europe'[17] analyzes the economic impact of chronic diseases in Europe. First of all, chronic conditions and diseases are considered to be the first cause of mortality and morbidity in Europe. It was estimated that in 2005 77% of all Disabled-Adjusted-Life-Years (the number of years lost) and 86% of premature deaths in the WHO European region are related to non-communicable diseases. The condition which was expected to increase most dramatically is dementia.

The economic implications are serious: chronic diseases depress wages, earnings, workforce participation, labour productivity and hours worked, and may also lead to early retirement, high job turnover and disability. The cost of chronic diseases and their risk factors, as measured by cost-of-illness studies, is sizeable, ranging up to 6.77% of a country's Gross Domestic Product (GDP).

[16] Strategic Analysis of the European Telemedicine Market, Frost Sullivan, August 2011
[17] Managing chronic disease in Europe, Prof. Dr. Reinhard Busse, Miriam Blümel, David Scheller-Kreinsen, Dr. Annette Zentner. The Initiative for Sustainable Healthcare Financing in Europe, Presented at 'Securing Europe's Healthcare Future' conference, Prague, February 18th, 2009

2.2 Total market

Different market studies related to the AAL market have been presented in the previous section. They provide interesting data which may allow us to take decisions from them in order to adapt CAALYX-MV into the market. The most relevant characteristics obtained from market analysis are:

Telemedicine market size	$ 432 M (by 2010)
UK	$ 129,8 M (29%)
Germany	$ 97,2 M (22%)
France	$ 39,7 M (9%)
Italy	$ 28,3 M (6.4%)
Spain	$ 37,5 M (8.5%)
Scandinavia	$ 63,5 M (14.4%)
Benelux	$ 43,5 M (9.9%)
Remote patient monitoring market size	**$ 350 M (by 2009)**
UK	25%
Germany	21%
France	15%
Italy	15%
Benelux	11%
Spain	6%
Scandinavia	7%
AAL market size	**$ 154.9 M (by 2009)**
Germany	32.9%
UK	27.8%
France	16%
Scandinavia	14.7%
Italy	4.1%
Spain	3%
Benelux	1.5%

Other interesting information regarding chronic diseases is summarized below:

Estimated chronic diseases cost	6,77% of a country's GDP
Most common chronic diseases which are being already managed through telemonitoring services	1. Diabetes 2. Heart Diseases 3. Chronic Obstructive Pulmonary Disease 4. Chronic Renal Diseases 5. Cancer 6. Asthma

3 Market players

In the traditional Health Care systems most of the burden due to technological equipment lies at the hospitals/clinical centres where patients go to follow-up and health checks (e.g. blood pressure, analysis, monitoring, etc.). The new e-health models shift that burden to the patients' homes in order to cut costs on appointments and monitoring supervision. The main idea behind that is making the life of people more independent and qualitatively better while at the same time reducing the expenses. In this section, the different actors playing on this new system are described and linked to the current partners in the CAALYX-MV project.

3.1 Key actors

In the upcoming e-health scenario, there are new actors that will have an important role when the time comes to deliver a real service at patients' homes. For instance, there will be companies providing technical support for incidents that might happen. The following list presents the most important actors on the future e-health care system:

- **Patient:** Person who uses the devices and the technology provide by the e-health service provider.
- **E-health Service Provider:** Nowadays the current clinical centres, either public or private, would take this role. Thus, they will provide an e-health service to patients and will be the patients' point of contact for any issue. At the end of the day, patients will deal with clinical professionals anyway even though there is a technological support between them.
- **Technology Service Provider:** The clinical centre, even though being the main interface for the patient, it is not specialised in technology. In order to provide an e-health service, it needs a company that is able to do so for the clinical centre. This technology service provider - in most of cases - will act as an umbrella of other companies (i.e. other service and devices providers) to simplify the management with the e-health service provider.
- **Technical Support Service:** This role is important in the new model since the high number of devices and the increase of technology at the patients' homes likely results in different incidents that will need to be solved. Also, they will provide support on the clinical centre side whenever there is a problem with the tele-health systems.
- **Device Providers:** These are the companies providing all the different devices to provide a monitoring environment at the patient's home. Usually, the Technology Service Provider will have contact with these companies to get the value for money on devices.
- **Technology providers:** These are the companies providing an e-health platform/service and are usually hired by the Technology Service Provider. These companies must give training to show users how to get acquainted with the platform.

In the CAALYX-MV consortium there are many different partners that will cover most of these roles:

- E-health Service Provider: **ABAT** and **COOS** will play this role as a starting strategy for business deployment. They are, in fact, the contacts with the regional authorities. They offer health care services in their respective countries. Also SmH could take this role on the Smart Homes trials.
- Technology Service Provider: **Telefonica** would be a suitable partner to fulfil this role. It has experience providing nation-wide services on both communications and e-health fields. Right now there is a specific centre working in tele-health located in Granada, Spain and many services have been deployed in many different hospitals in Spain. Moreover, Telefonica has a worldwide structure that will help to deploy the CAALYX-MV service in other countries.
- Technical Support Service: During the trials, the same partners will provide this service but in a real business scenario, a specialized company will take care of this service.
- Device Providers: **CORS, UPC, SmH** provide different kinds of devices for the system.

- Technology providers: **AICOS, CET, TID, INESCP** provide technological services in different parts of the system. AICOS is focused in the set-top box (STB), CET on the smart T-Shirt and the communication with the mobile phone. TID and INESCP provide services on the e-health platform.

In this model, is important to understand that the Technology Service Provide either hires or buys devices/services from Device ad Technology providers. Next figure shows how partners could fit in the e-health business model and what kinds of relations are between them:

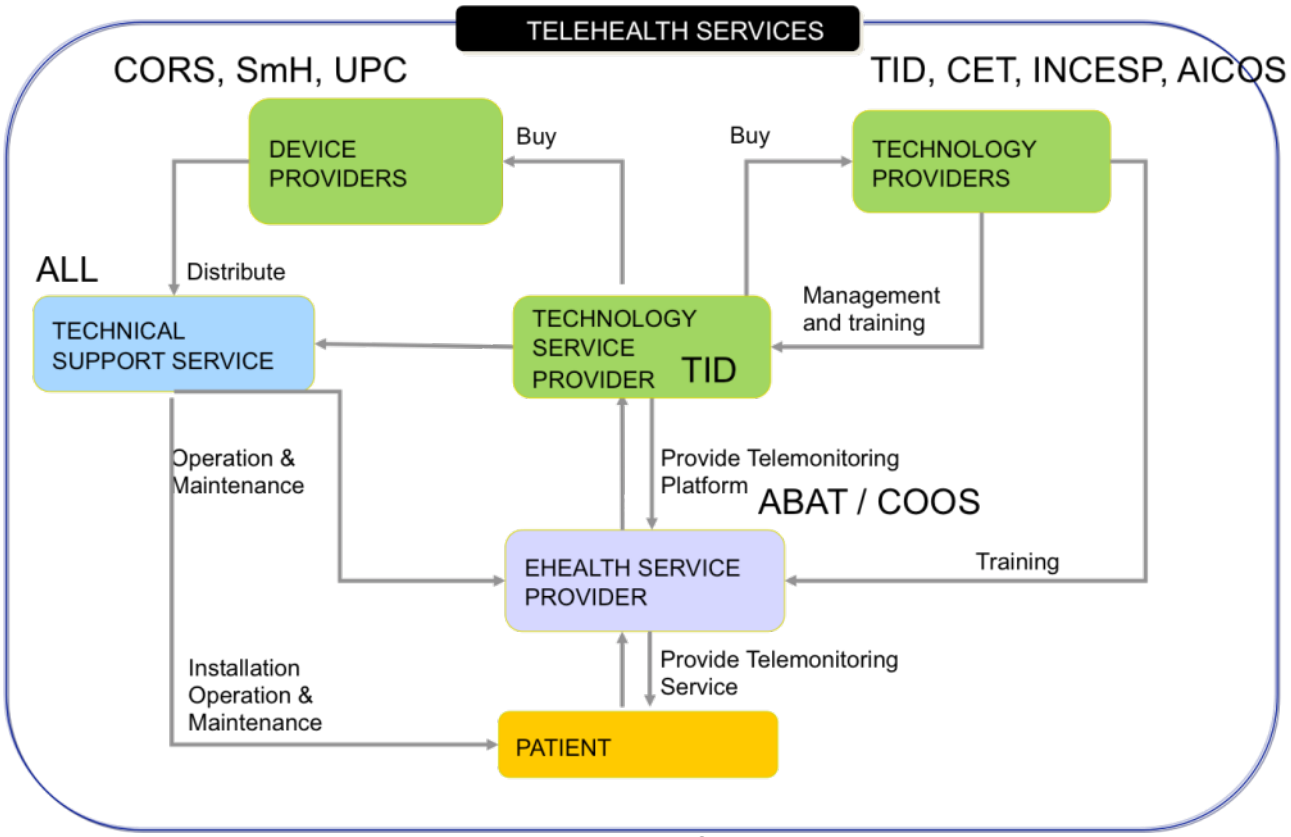

Figure 5 - Business Model CAALYX-MV actors

3.2 CAALYX-MV value chain

The CAALYX-MV system is an e-health service that links patients with clinical professionals through a Technology Service Provider. On one side, the Technology Service Provider provides patients all the needed devices (i.e. blood pressure, pulsioximeter, smart T-shirt). These devices cannot work by themselves. They need to communicate through a gateway to send all the collected information to the e-health platform. These are the different steps that are followed on the patient chain.

On the clinical professionals sites, doctors use a web interface to follow-up their patients. For this reason, there must be communication through the platform to collect the information that has been stored and that came from the patient side. Both sides collide on the e-health platform. Each of these links involved different market players (i.e. device providers, technology providers, technology service provider, etc.).

The following picture shows how the CAALYX-MV value chain looks like:

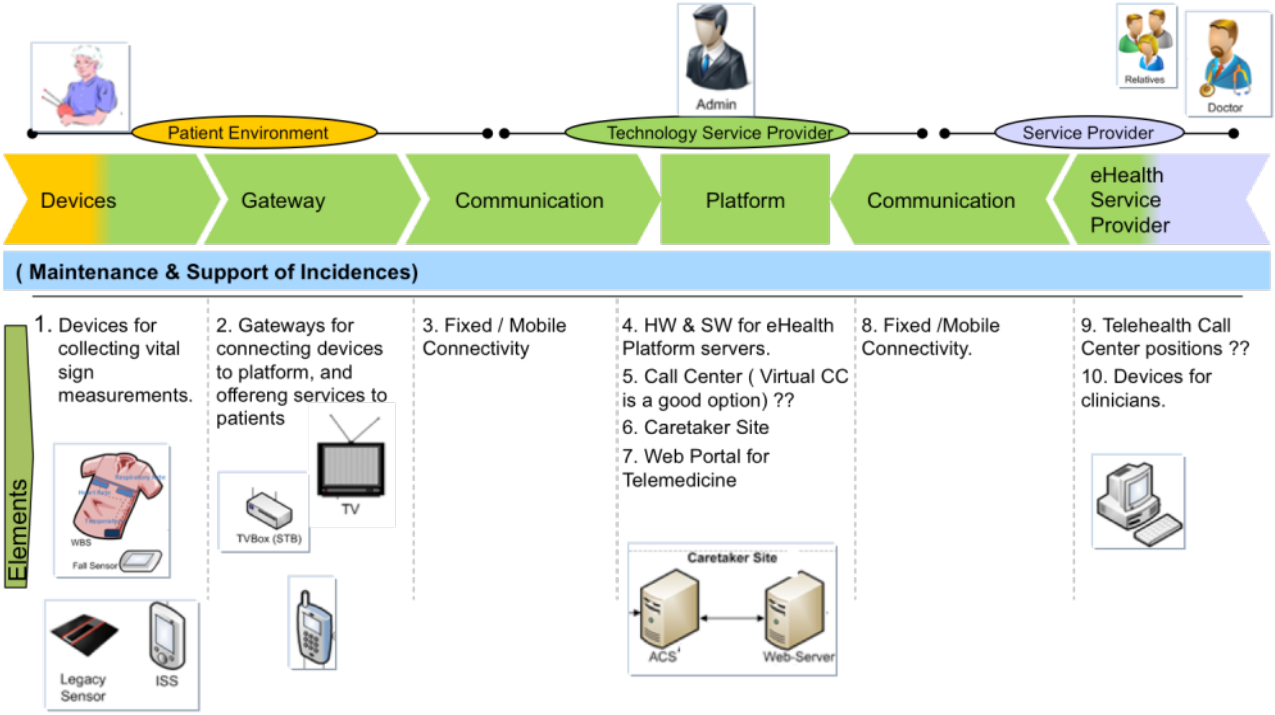

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Figure 6 - CAALYX-MV value chain

3.3 CAALYX-MV business models

The CAALYX-MV business model is based in a Technological Service Provider supplying the e-health service to a specific e-health Service Provider. This e-health Service Provider could be the Public Health System, a private hospital or a private health insurance, which eventually pays the Technology Service Provider for this service. The strategy on how this payment must be done will be described in D2.2. In CAALYX-MV the Technology Service Provider will be Teléfonica since has already an international structure. Moreover, Telefónica could deploy e-health services world-wide since it has contacts with Devices and Technology providers and also controls the communication networks that eventually support the services.

Thus, the CAALYX-MV uses a **Technology Service Provider oriented business model** (i.e. in previous picture it can be seen how this player is the middleman of the model). The relations between Telefónica and the rest of the partners will follow the next logic:

- CORS, UPC, SmH: Telefónica will buy all the different devices through these companies.
- AICOS, CET, INESCP: Telefónica will buy the services provided by these companies and they will provide training to Telefónica's employees.
- ABAT COOS: CAALYX-MV will be deployed on Spain and Italy (as well as Netherlands) to be market validated. Next step would be that Telefónica and these health care centres establish a contract agreement to offer the service in a real business scenario. Afterwards, Telefónica should carry on deploying this services in other hospitals.

4 Market trends

4.1 Needs of the market

Older people will live longer and together with the demographic development of society we will see that the ratio of older people in the population will rise. For 2050 it is assumed, that in Europe about 50 % of the people will be older than 60 years.

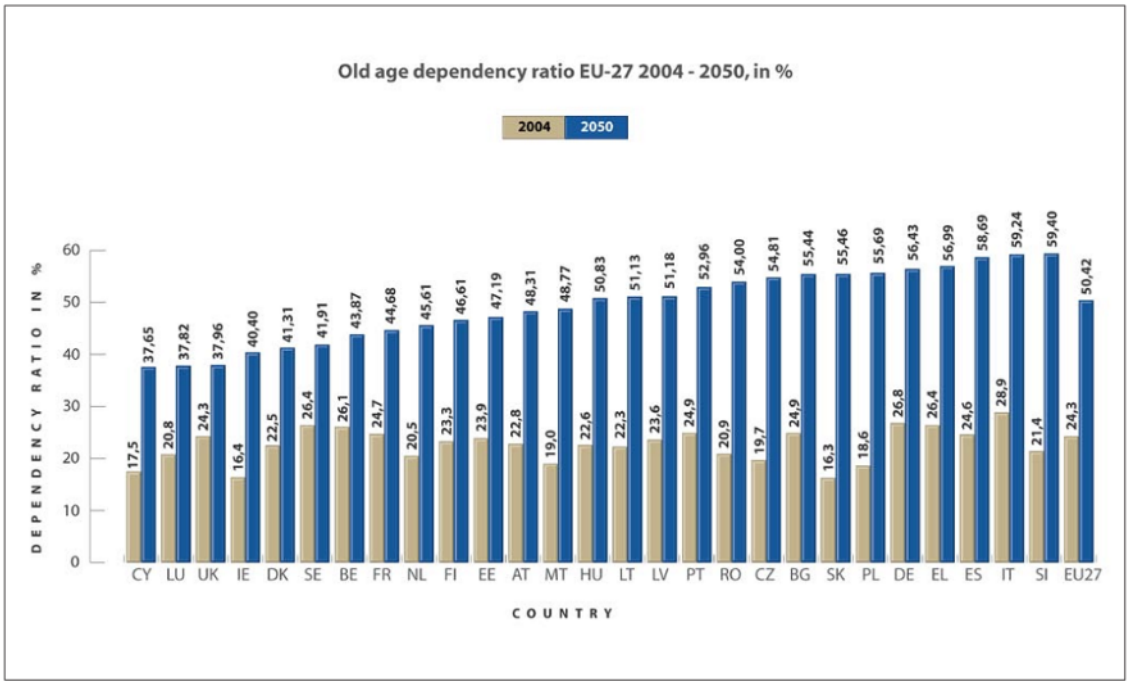


Figure 7 - Estimation of ratio of elderly people in EU for 2050[18]

The consequence of the demographic changes is that a rising number of older people will face a decreasing number of care taking nurses. This gap can only be closed by a consequent usage of AAL solutions. These AAL solutions have now to be developed to give us the chance to obtain this challenge. Innovative AAL solutions have the potential to

- reduce high expenses for health and care services
- provide individual solutions and hence to meet individual needs
- improve living standards
- open new business opportunities.

The technical support by AAL is especially helpful for those areas of daily life that cannot be covered by the family. Measures that e.g. enable older persons to participate in society or to manage their home situation are mostly connected with ICT[19]. However, administrations and laws regulating the use of ICT in care services do not exist yet. National differences can be seen when a new project has to be started and because of this the situation becomes complex and non-

[18] European Commission: Special Report No 1: The impact of ageing on public expenditure: projections for the EU25 Member States on pensions, healthcare, long-term care, education and unemployment transfers (2004 -50). Report prepared by the Economic Policy Committee and the European Commission (DG ECFIN). Page 49. Data on Bulgaria and Romania has been added on the basis of current numbers to be found on the website of Eurostat (http://ec.europa.eu/eurostat).

[19] http://www.andrew.cmu.edu/course/60-427/aisd/elderly.pdf

transparent, since clear regulations are missing for many fields. AAL can help elderly people in many areas of daily life. In the following paragraph the needs of the marked are discussed.

4.1.1 Communication

Communication devices help older people to maintain their social contacts, obtain information, get consultancy and benefit on educational contents. Developers of communication devices and content providers have to take into account the specific user problems of older people, such as hearing or visual impairments. In this regard, communication devices have to be designed for the inability of a specific group[20].

4.1.2 Compensation of Morbidity

Most older people have multimorbidity and age-related changes in visual and auditory perception, and motor control. Therefore, a demand for devices compensating such sensory impairments exists. The well known components like hearing aids, glasses and rollators are widely accepted. Yet, new IT concepts need time to be accepted and liked by older people. Melenhorst[21] found that older individuals are motivated to invest in new communication technology provided they perceive enough benefit for their purposes. The perception of a lack of benefits, irrespective of perceived costs, is reason sufficient to reject a new technology.

Home Safety

Older people often feel inconvenient at home. Due to age-related changes in perception, cognition and motor control, certain tasks may take much more time when one was younger and are prone to injuries. Increasing home safety is therefore an important goal of AAL projects. The decrease in bodily and mental abilities has to be substituted by technologies within the domestic area that prevent accidents and increase the sense of safety[19]. This usually is followed by security applications, such as surveillance systems as well as customised alarm systems. Current safety and security products however have generally not been developed for use by older people for a broad costumer group.

4.1.3 Medical Assistance

Technologies have to be designed to support family members or nursing staff during their everyday healthcare procedures for older people. Such products are focused on medical applications and the target is to provide a simple and easy to learn way of usage for standard vital sign sensors. In the design of these products it is important to ensure accessibility for people who face difficulties interacting with new media.. The medical devices provide the possibility to remotely measure blood pressure, blood glucose independent of help from nurses. Another field are lifting or mobility aids, special bathroom technologies, emergency and fall alarms.

Tele-monitoring and telemedicine are recent technological developments in the field. Telemedicine allows older people with chronic diseases or certain impairments to be treated and monitored within their domestic environment. The great advantage of tele-medical applications is that the patients do not have to travel to a medical institution[19] to be monitored and treated appropriately. Information on vital parameters can be taken from the patient by devices and transmitted to medical institutions in order to control them and to interfere if necessary. Overall, telemedicine and tele-monitoring products increase autonomy for older patients.

In order to identify the services to be supported by next generation technologies in healthcare service system, an overview of the trends within such a specific market is reported here.

[20] Dr. Katrin Gaßner, Michael Conrad; Institute for Innovation and Technology; "ICT_for_Elderly"; March 2010; ISBN 978-3-89750-160-7
[21] Melenhorst, A-S (2002) *Adopting communication technology in later life. The decisive role of benefits.* Doctoral dissertation. The Netherlands: Eindhoven University of Technology.

With regard to ICT in the healthcare market, growth forecasts seem lower than the forecasts for the ICT market in general, but such a market is not yet systematically monitored and there are no specific analysis; interesting indication on the use of WLAN is contained in the Report EITO 2005 (European Information Technology Observatory, www.eito.com): 33% of health facilities in Western Europe already uses WLAN and about 11% plan to take by 2005, but as much as 44% think that it will adopt. Also as part of the technologies of communication are not to forget the satellite and DTT (Digital Terrestrial Television). With WiFi wiring the building of a hospital, with a laptop, notebook, PDA (Personal Digital Assistant), tablet PCs, health professionals, doctors and nurses are free to work on the move while remaining. For example, they can always have the patient records, view X-ray images, consult databases, make a diagnosis and prescribe treatment without having to transfer from one department to another, which sometimes means a building to another, updating directly to the patient's medical record. But when the communication has to come out from the walls of hospitals mobile networks is required. Some innovative applications based on GPRS are, for example: the "localization" systems, transmitting biomedical parameters, first of all the ECG through the use of Bluetooth, generally useful in Tele-cardiology, access to medical record for viewing or updates, access to e-mail.

Regarding the use of UMTS in emergency medicine, Vodafone has launched a number of experiments with German university hospitals and already sees a future where you can heal, thanks to systems that allow continuous monitoring of your body and training both in the gym or outdoors, constantly checking the physical and emotional state through sensor bracelets and "communicator" that interact with the bike. It will also be possible to use mobile detection through a GPS (Global Positioning System) to be able to control where you are. The University of Uppsala and Telia Sonera (Finnish mobile telecommunications operator) are instead experiencing the ability to track patients through sensors, initially for cardiac problems, but already suggest other diseases (diabetes, asthma, ...).

There are many projects where the satellite travels Telemedicine: without going far away, for example, offers Telbios infrastructure and applications to medical support to the Italian military contingents working abroad, with links and exchange of clinical information among doctors in field hospitals and specialists Celio Military Hospital of Rome and also Telbios uses the platform of e-learning (Skymed and Skynurse) for distance learning via satellite of doctors and nurses. Television, too, that evolves and becomes interactive with the DTT can, thanks to its set-top box, become the conduit for the transmission of biomedical signals, an experiment in this direction has been presented to Congress by Telbios SatExpo in subsequent editions.

The Electronic Medical Record or EPR (Electronic Patient Record), born from the need to have a tool that stores the medical history of each witnessed (events, diseases, treatments, ...) and is available in real time, Regardless of where you are and the clients are healthcare professionals who are paying for service. This avoids, for example, that in case of emergency, the emergency room is in the position of having to carry out a series of inquiries, including when they would be available, and recent surveys have found certain diseases (eg allergies or intolerances to drugs, etc.) .

Currently, the implementation of electronic health records is a priority of health systems in the western world: a project in the U.S. is designated as a national priority to be achieved by 2010 and Europe is included among the medium-term objectives of the Plan ' Action e-health, but that needs to be made primarily on the availability of a broadband computer network that connects the healthcare facilities around the country and, in the near future, enabling interoperability among multiple countries. The issues related to the development of electronic health records relate, essentially, three areas: integration of clinical data from disparate information systems within and outside of a hospital, legal and organizational aspects of the medical department; continuity of care, the link with health and social services and management services for the elderly (see also the ADI, in-depth panel "The National Health System Partner").

But a collection of data on all significant health and social events in the life of an individual can not be confined to the possibility of a single health care organization to access only what is known. So the definition of personal health records must also address the problem of integration of health information systems of the different health that have occurred in the course of diagnosis and treatment of the client, with the definition of a general reference model for "components "HERP operating systems (Health Enterprise Resource Planning), the Electronic Medical Record (EPR), to personal health records (EHR Electronic Health Record). A goal that requires a consistent contender on many fronts and that commitment has led to the formation of a network, the Prorec *, more than ten national centers for the promotion of electronic health records and, in particular, to disseminate high-quality systems, through : discussion of issues related to the introduction of electronic health records, the collaboration between the various actors involved to raise awareness about the various problem areas, and help you find the best solution, and the provision of basic services and documentation of distribution, regulation, training and standardization. Italy also has its center Prorec that, in particular, provides for the establishment of coordination between groups of homogeneous types of actors: end-users (including scientific societies and professional); suppliers, healthcare companies, particularly among those responsible for organizational and business information services in collaboration with ASIS (Italian Association for Information Systems in Health), the national and regional institutions and the recipients (patient groups). The EHR is a tool that will revolutionize the process of management of social and health locally, nationally and internationally. Something to talk about it, but unfortunately still does not exist, except for some private initiatives that provide a service to manage their clinical data, of a sort of "non-line medical record" you subscribe to a service, fill out a card with their clinical data and then you can see on the Internet, from anywhere in the world and keep it constantly updated from time to time by adding new data.

Summarizing, we can identify several main areas of the healthcare system where next generation technologies can have a significant impact in order to reach two essential goals: the reduction of costs for the healthcare (and the national government recently cut down of 50% such expenditures due to the financial crisis) and the promotion of independent and healthy ageing. The main areas to be supported are:

- Tele-medicine;
- Tele-cardiology;
- Remote monitoring;
- Patient's clinical data online;
- eAccessibility;
- eHealth.

4.1.4 Mobility

The general age-related decrease in cognitive, perceptual, and physical capabilities often causes a decrease in mobility. Walking and driving a car can become very difficult or even impossible, depending on the severity of the ailment. Creating devices that are capable of restoring or even increasing the mobility of elderly people therefore is important in order to secure their well-being. Such applications may be walking aids, like wheel chairs or step lifts, but also assistive devices, for instance to be able to drive a car or to do sports.

4.1.5 Smart home

A consequence of multi-morbidity is that older people often have trouble performing daily tasks, such as making the bed etc. Automatic and intelligent devices and services capable of performing, or at least facilitating, such requirements of everyday life are a great help, e.g. remote-controlled doors and gates, microwave or normal stoves with various sensors or online services offering tele-shopping or tele-banking, etc.

4.2 Type of AAL Components on the Market

AAL is still a quite new market. Products which originally where developed for different areas of application now are adapted for the AAL market. An analysis of the ratio among the AAL product groups[22] demonstrates this.

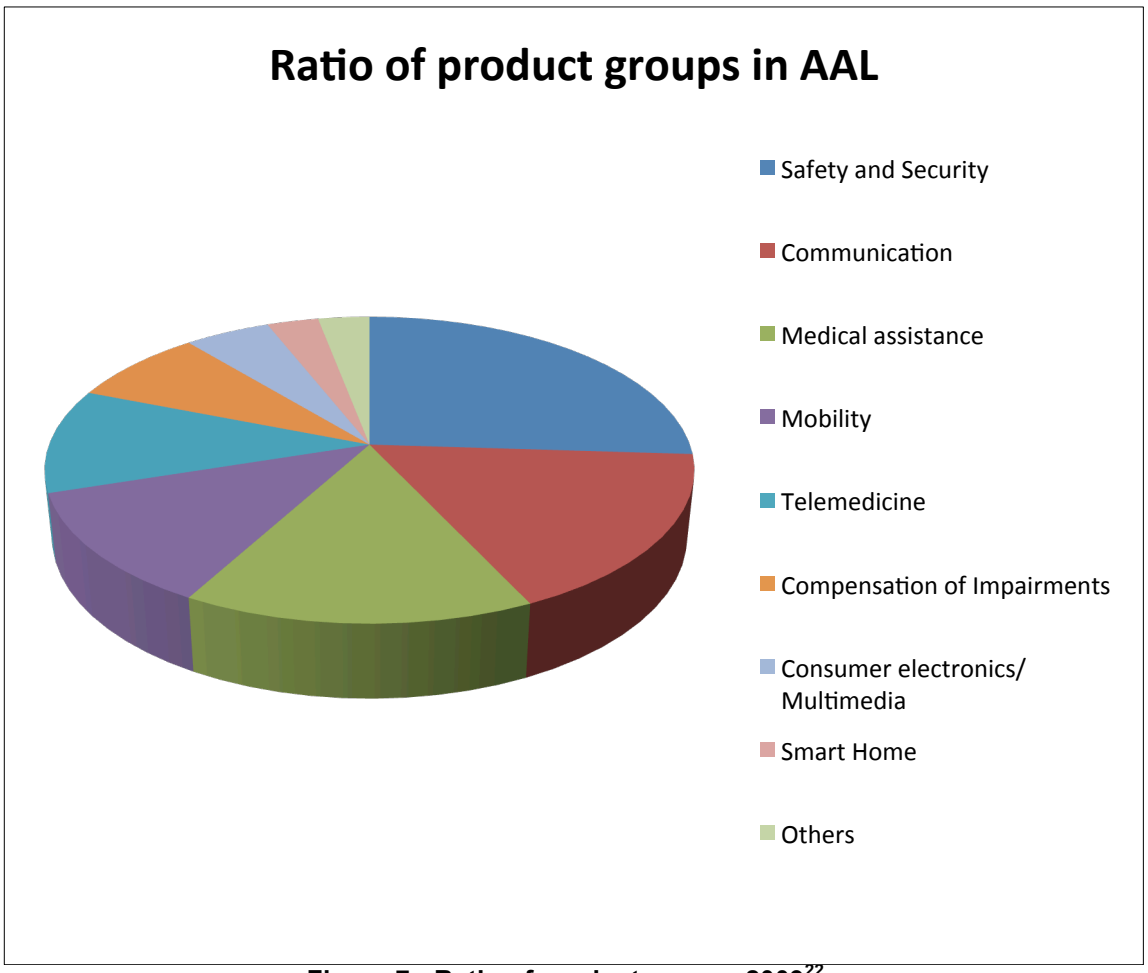


Figure 7 - Ratio of product groups 2009[22]

At first sight, it seems that there are application areas with more marketable solutions than others. This implies that there are currently more marketable products for safety and security than for any other product group: about one fourth of all AAL products have been developed to provide and increase the need for safety of elderly people. Yet, this does not necessarily imply that the ratios represent the overall economic interest of product providers in the field of AAL. On the contrary, it is likely that these ratios will change in line with future technological progress, enabling and increasing the development of marketable solutions for other application fields.

Sectors like “Smart Home” and Compensation of Impairments seems to be completely underrepresented in the percentages. New innovative technologies can generate new sections in this new market field.

[22] Dr. Katrin Gaßner, Michael Conrad; Institute for Innovation and Technology; "ICT_for_Elderly"; March 2010; ISBN 978-3-89750-160-7

4.3 CAALYX-MV solution

CAALYX-MV tries to cover a wide range of the AAL areas, as described in section 2.1.1. It ties to build a comprehensive system, which offers ready to use functionality in each branch, while being expandable by the used standards.

4.3.1 Fields covered by CAALYX-MV

4.3.1.1 Safety and Security

The wearable body sensor (WBS) is a standard T-shirt, which consists of a heart rate sensor, a body temperature sensor, a respiratory sensor, a fall detector with GPS locator and a 3G mobile phone for transmitting these vital signs to the caretaker server. The WBS was developed to get a continuous overview of the vital parameters daily life. The WBS can also be used to send scenario based alarms. Alarms can be initiated by e.g. the fall detector. But also a combination of respiration, temperature and heart rate can trigger a alarm. Together with the GPS coordinates these event/alarms are sent to the caretaker server, which directly prompts for help and support .

4.3.1.2 Communication

The CAALYX-MV set-top box is the central user interface for older people. The set-top box can switch the TV from standard receiving mode into an easy to use information centre. Timed messages can interrupt a standard TV program and remind older people on meeting with friends or family

4.3.1.3 Medical assistance

The set-top box also assists the user by recording daily or weekly vital parameter like weight, ECG, SpO_2 and NIBP (blood pressure). All devices are connected by wireless Bluetooth technology to the caretaker server. All vital signs are stored at the server and can be accessed by the users. Also the caretaker and the physicians have access to this information. In the background of the caretaker server the data is continuously checked by previously defined scenarios to detect a slowly deterioration of the health state or acute illness.

4.3.1.4 Mobility

The WBS allows to expand the monitoring also on external sites. Even if the user visits events or participates in external physical training programmes, CAALYX-MV can provide help and safety to the user.

4.3.1.5 Telemedicine

The CAALYX-MV system provides also video telephony functionality. Users can so directly contact the caretaker or physician visually from home. This provides a cost effective way for consultation. For many older people, consultations of a few minutes per day are necessary to establish a feeling of comfort and safety. Such short consultations can only be cost effective if the setup time for this consultation is low (driving into next town, sitting in the waiting room, having the consultation and driving back to home can be substituted by a five minute video call)

4.3.1.6 Smart Home

CAALYX-MV also integrates the approach for smart home. The system provides access to a multi IO interface. Depending on the home actors and sensors can be connected to this IO interface to get additional information from the user's current status (light is switched on or off, patient is in bed or is sitting in the armchair, ...)

4.3.2 Market Needs covered by CAALYX-MV

During the CAALYX-MV project, an innovative and efficient ICT-based solution will be validated, which is focused on improving older people's quality of life by prolonging the time they can stay safer, autonomous and independently at home. The system monitors vital parameters and provides tools and services to support their daily home activities in terms of comfort, security, energy efficiency and communications[23].

CAALYX-MV has a number of main objectives:

Extending and adapting in three pilots the innovative service which was successfully deployed through the CAALYX project, combined with other best practices[23]

- As smart homes and smart textiles. Furthermore to make the management of social and health care monitoring systems, especially within modern homes, more efficient and to facilitate its wider implementation by:
    - Providing a robust and auto-configurable home health care system that:
        1) Is efficiently manageable at large scale and suitable for long-term monitoring;
        2) Is easily expandable, and thus adaptable to the changing condition(s) of older people; and
        3) Integrates currently deployed equipment and standards, and in the end results in a commercially viable solution.

- Requiring minimal ICT personnel intervention and no technical expertise from the user to be able of interact with the system.

- An innovative global system which succeeds in producing new added value by means of attracting and encouraging all actors (among older people and their relatives as well as carers and related public authorities) to use effective health and care monitoring systems by:
    - Covering ethical and privacy requirements to make the system trustable for all;
    - Assessing - through guidelines, educational material, etc - all stakeholders in the health and aging well market about best practices to provide integrated care solutions within modern home infrastructures.

[23] CAALYX-MV: Ambient Assisted Living to Market; Albert SAMÀ, César GÁLVEZ-BARRÓN, Pedro SALEIRO, Jordi ROVIRA, Henk Herman Nap, Rui CASTRO, Andreu CATALÀ, Alejandro RODRÍGUEZ-MOLINERO

CAALYX-MV offers a quite complete set of AAL functionality under one integrated concept. The following diagram shows the Sensors and Services offered by CAALYX-MV:

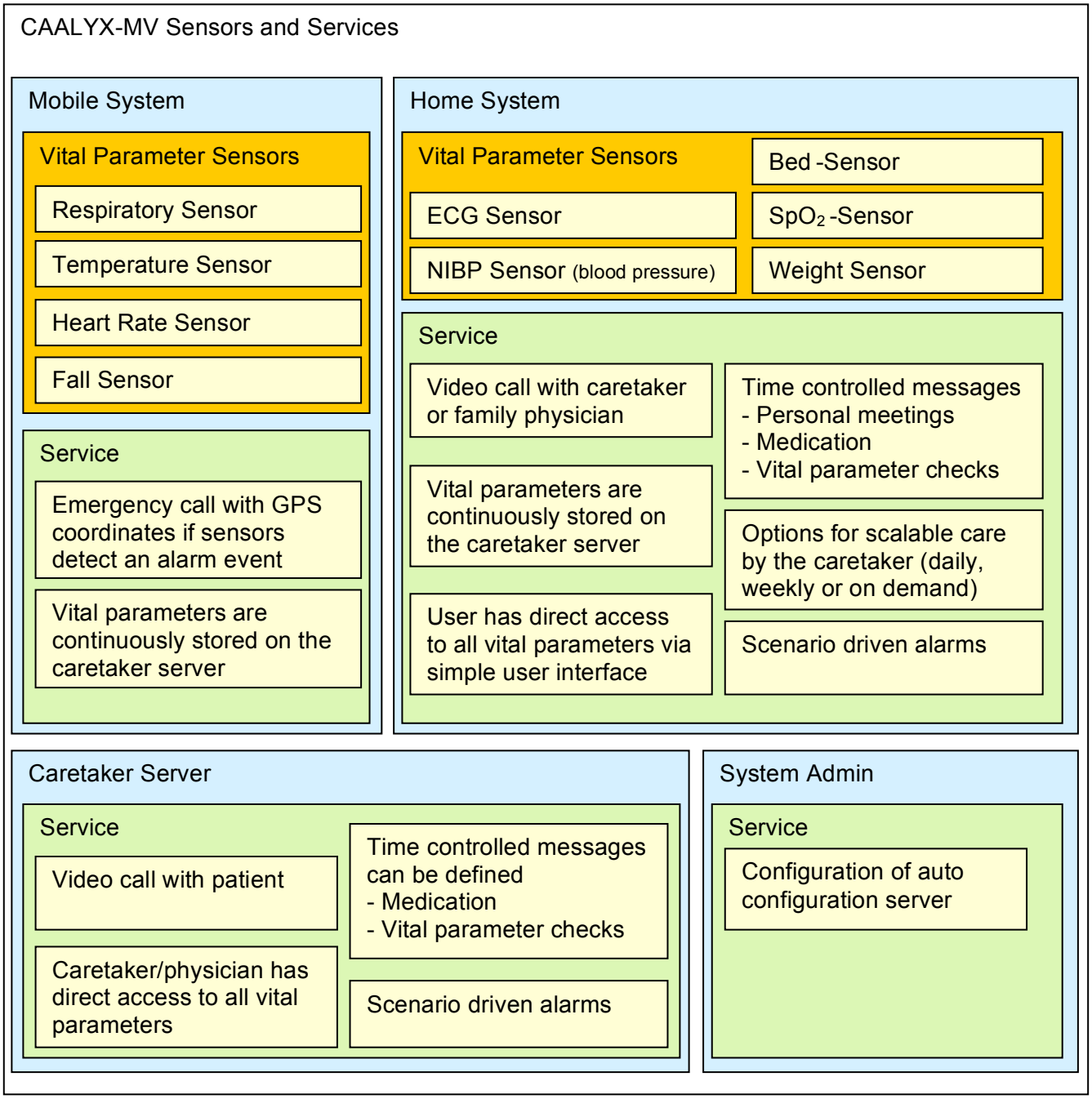


Figure 8 – CAALYX-MV ICT and service structure

5 Benchmarking

This section is intended to look for all the different products similar to CAALYX-MV, analyse them in a comprehensive way and see if there is a competitive opportunity on the market for CAALYX-MV. If some gaps are found, CAALYX-MV services will be able to be customized to reach a specific target that is not covered in the market. Because nowadays, e-health technology is an upcoming trend but not integrated yet in the patients' homes, this chapter discusses similar projects and other similar products used in CAALYX-MV that are already in the market.

5.1 Other similar solutions to CAALYX-MV

The need of finding new ways to provide the aging society a comfortable and safe environment at home, is not only the aim of the CAALYX-MV project. There are a number of private and public funded projects running in this field. Most of these projects are funded by the AAL-Joint Programme, which is initiated by the European Commission to offer a platform for all AAL projects.

5.1.1 MyHeart

5.1.1.1 Approach

The target of MyHeart[24] is the lowering of mortality rate of patients with cardio vascular disease (CVD) and their related costs. The participating patients are covered by a permanently early diagnosis of acute events. The technical components developed for MyHeart should lead to a permanent healthier lifestyle. A continuous monitoring of the current health status and lifestyle gets the base information. For MyHeart the following requirements where defined:

- Continuous Monitoring
- Continuous Personalised Diagnosis
- Continuous Therapy
- Feedback to user
- Remote Access and Professional Interaction

From technical side MyHeart brought the following technical innovations:

- wearable textiles with integrated sensors
- on body diagnosis
- user feedback and motivation concept
- forwarding records to experts for diagnosis

5.1.1.2 MyHeart / CAALYX-MV

MyHeart has a very specific approach. It is designed only for patients with cardio vascular disease. While CAALYX-MV is developed and targeted to support and monitor people from different backgrounds with a variety of possible diseases, of which cardio vascular disease is one of the target areas. The result of both projects can be joint together. MyHeart is ideal for patients with acute cardio vascular disease. CAALYX-MV can provide care if the patient is stable, but the cardio vascular vital signs should be kept monitored to see any deterioration in this parameter.

[24] MyHeart Homepage; http://www.hitech-projects.com/euprojects/myheart/; Project funded by the IST programm of the European Commission.

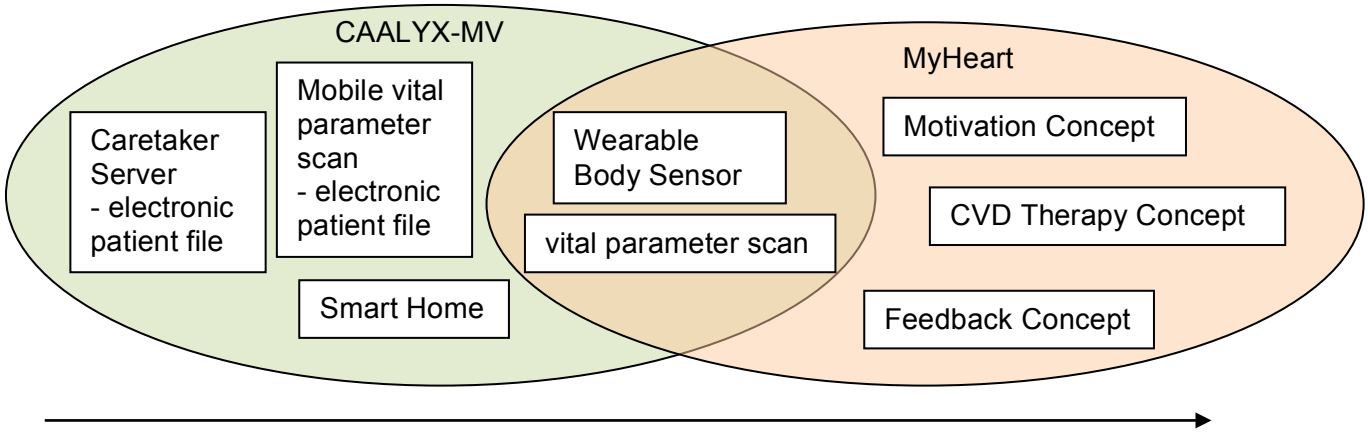


Figure 9 – CAALYX-MV vs MyHeart

5.1.2 SOPRANO

5.1.2.1 Approach

Soprano[25] is designed to be the next generation of systems for ambient assisted living in Europe. It is highly context-aware, uses existing smart home environment devices to build an innovative and integrative service-orientated architecture. Soprano supports a uniquely broad set of natural and comfortable interfaces for older people at affordable cost, so elderly people can live longer independently in their preferred environment. The Soprano system acts not as a traditional "smart home", passively receiving user commands, nor as pure "remote care", by alerting outside staff to act in case of an alarm. Instead, Soprano acts as an informed, friendly agent, taking orders, giving advice or reminders and ready to help, and get help when needed.

Particular account is taken in the design of the needs of older people suffering from various forms of cognitive ageing. This group is important for two reasons. The first is because society's resources are being severely stretched to offer a safe, comfortable and independent life, and the second is that designing Soprano to meet their needs poses a particularly strong challenge to usability in design. To be effective, the Soprano system must achieve an entirely flat learning curve, so that the users can learn from their home environment rather than learn how to use it. However, the Soprano design process also takes into account the needs of a full range of home users to ensure that mainstream requirements are equally met[26].

The Soprano system is designed to give users access to the world outside home, including general online services and new forms of eCare. It will demonstrate how to interact with all users in a way that does not challenge their abilities, motivation and patience to the extent of many of today's ICT-based services and in this way creating a path to an Information Society for all. Soprano is has a service oriented architecture (SOA), so it is saleable. Each user can define his own Soprano. In addition, in some cases system components are alternatives to each other (for example, sensors substitute for radar) rather than complementary to each other. As a result the SOPRANO system can be provided without components, which may face acceptance problems in some sub-groups.

[25] SOPRANO Homepage: http://www.soprano-ip.org/ecportal.asp?id=277&nt=18&lang=1
[26] SOPRANO Leaflet: http://www.soprano-ip.org/Documents/SOPRANO_A4_leaflet.pdf

5.1.2.2 SOPRANO / CAALYX-MV

SOPRANO provides ICT driven base technology for older people to provide a comfortable, save and longer stay at home. CAALYX-MV is more oriented on medical care and vital parameter scan. So also for SOPRANO and CAALYX-MV there are some fields, which are overlap, and some fields which are unique features of this project.

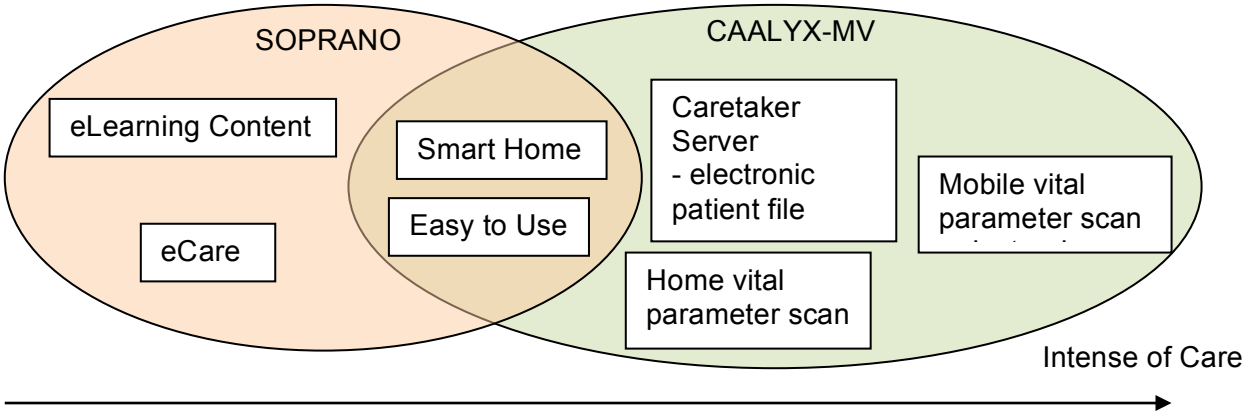


Figure 10 - CAALYX-MV vs SOPRANO

5.1.3 AmIE

5.1.3.1 Approach

The main objective of AmIE[27] (Ambient Intelligence for the Elderly) is the development and testing of a home platform, including non-intrusive sensing and vital signs monitoring combined with context awareness. The platform is intended to offer assistive services with the focus on individual adaptation. Its target is to improve the quality of life according to the individual's specific situation, and in a non-intrusive and respectful way. The system shall be able to individualise its medical and homecare assistance by adapting to the users' needs, preferences and characters. In order to implement such an intelligent system, concepts for characterisation models, rules engines and ontology and adaptive interfaces are used. Within the scope of the project first prototypes shall be developed in order to build one or more demonstrators to show the functionalities of the system in a real environment, with real users. This also allows the analysis of the acceptance of such systems by elderly people. The AmIE project has developed an intelligent software-based system advising elderly people on their health and wellbeing, while monitoring their status and daily lives.

The objective is to help a rapidly-ageing population overcome isolation and loneliness to enable them to stay in their own homes for as long as possible. Innovations include fully-configured systems and multimodal interfaces depending on location, adapted to specific users in existing situations, which were acceptable and understandable to an older population without being intrusive. Ageing is a growing challenge as Europeans live longer than ever thanks to economic growth and advances in healthcare. It affects individuals, families, communities and nations, and may have profound consequences for the economies of European states – and all other developed countries around the globe. It will not only make it more difficult for families to take care of an increasing number of ageing relatives but also impact the cost of medical and social-care systems. Exploiting new technologies AmIE targeted the development and use of new technologies to provide care and independence to the elderly, enabling them to enhance their quality of life in a

[27] AmIE Project Presentation: http://www.medetel.eu/download/2008/parallel_sessions/presentation/day2/ambient_intelligence.pdf

non-intrusive, helpful and friendly way. The result is increased autonomy for the elderly through tele-monitoring and home support. Innovations include:

- Use of multimodal interfaces depending on the location of the user determined by an indoor location system;

- Assessment and tracking of users' health using medical devices and new applications to facilitate prevention and diagnosis of illnesses.

- A habit-tracking system (HTS) tracks user habits and detect deviations. Some health deterioration can be predicted by analysing night-time activity and preventive action taken.

- HTS builds on home-sensor information, involving a bracelet worn by the user and a set of beacons distributed around the home. The bracelet interconnects with the beacons through ZigBee technology and these with a central node via Wi-Fi.

Such ICT functions help the elderly overcome isolation in their own homes, increasing the possibilities for keeping in contact with friends and extending their social networks. Applications include electronic alarm systems, tele-health monitoring and home automation for remote control of heating, lighting and fridge contents. The AmIE platform also opens the way for further technical developments oriented to user needs improving access to applications. Many older people face barriers in exploiting ICT products, services and applications to their full potential.

5.1.3.2 AmIE / CAALYX-MV

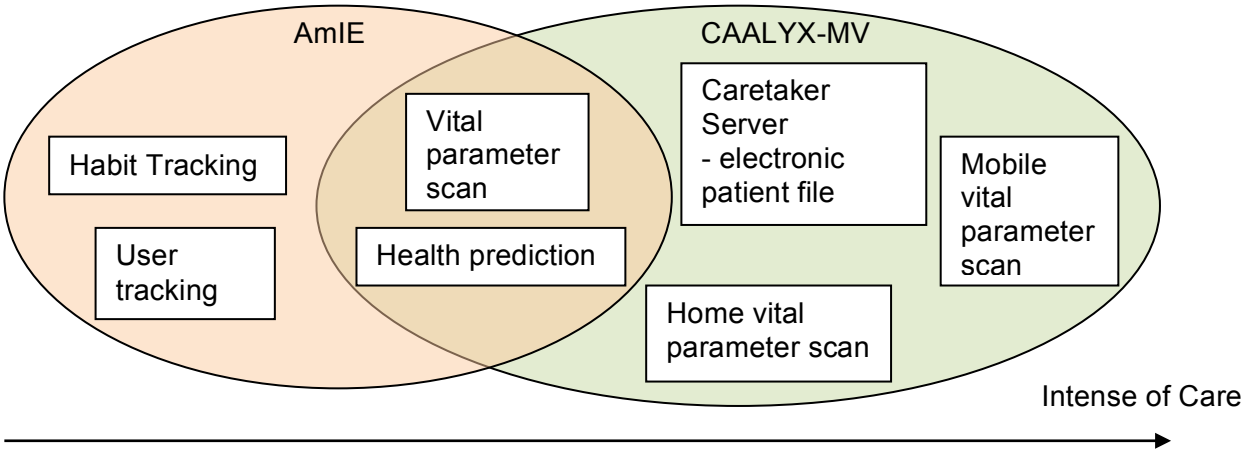


Figure 11 - CAALYX-MV vs AmIE

5.1.4 Belami

5.1.4.1 Approach

Belami[28] provide an intelligent environment that reacts in a sensitive and adaptive way to the presence of humans and objects in order to provide various services to people. Belami provides assistance not only at home, but also at work or when driving.

5.1.4.1.1 Assisted Living

The demographic development leads to an increasing number of older people with age-related changes in perception, cognition, and motor control, and the need for medical attention. In addition, the demand for services that emphasize on comfort during every day life rises. Our society is faced with the responsibility to care for these people in the best possible human but also economical ways. As a consequence, a growing number of older people today have to leave their homes and spend the rest of their life in nursing homes. Living assistance for older people focuses on the support of mainly older persons and to some extend of handicapped people for their living at home. Those kinds of living assistance systems aim at extending the potential of older people for living in their own home as long as possible and by making their life as healthy, save, and comfortable as possible. The tasks of such an assisted living systems can be separated into several main areas:

- **Monitoring and Assistance** – e.g., helping older people to keep a structured everyday life; reminding to take medicine, to drink and eat; warn users when "best before" dates are expired; monitoring vital functions and communicate the data to the doctor; the system recognizes falling down or cardiac infarction of older people.
- **Interaction** – e.g., enable the older people to communicate with friends, relatives, or medical and care personal.
- **Medication** – e.g., controlling the medication of older people by reminding them to take, for example, pills or by explicitly dispensing medication.

Living assistance systems aim at extending the potential of older people for living in their own home as long as possible. Such systems provide services that help older people to sustain their structured everyday life, to perform daily tasks, to keep contact with friends and medial/care persons, to keep healthy, and to inform others when an emergency occurs.

5.1.4.1.2 Assisted Working

The Belami system can be used in a "smart workshop" environment to help activities like transportation within the workshop, detecting events etc.

5.1.4.1.3 Assisted Training

Training assistance systems are conceivable for quite different application domains. We focus on the sport domain.

5.1.4.1.4 Assisted Driving

Driver assistance systems help car drivers to make driving more convenient and safe, and to avoid potential accidents. They can be categorized into inter-car driver assistance systems and intra-car driver assistance systems. Inter-car (or more generally transportation-) assistance systems use

[28] AmIE Project Presentation: http://www.medetel.eu/download/2008/parallel_sessions/presentation/day2/ambient_intelligence.pdf

inter-car communication in order to achieve their mission. Intra-car driver assistance systems restrict communications with objects inside the car.

5.1.4.2 Belami / CAALYX-MV

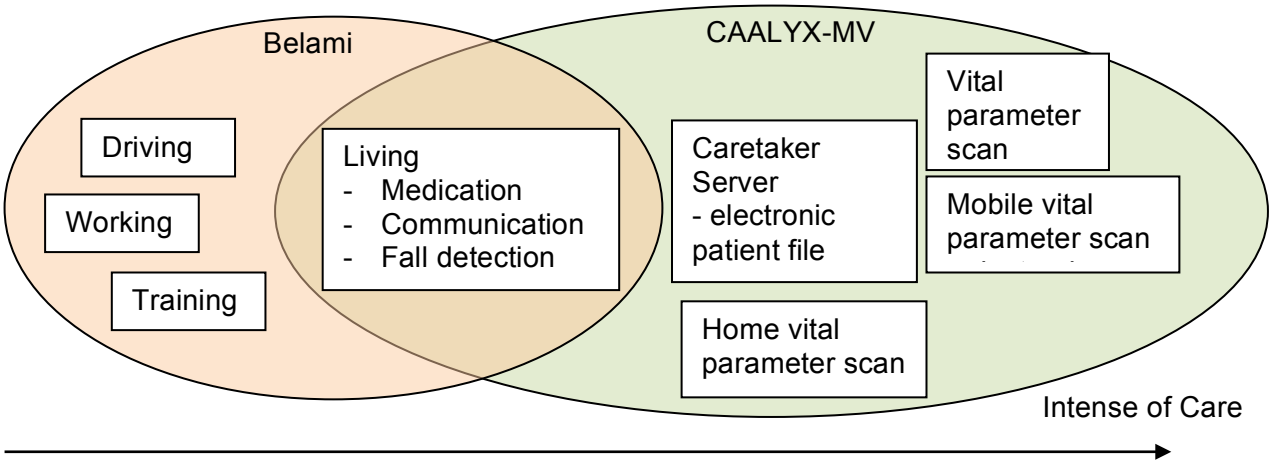


Figure 12 - CAALYX-MV vs Belami

The CAALYX-MV covers a wide area of AAL services.

5.2 Other existing wearable T-Shirt products

The purpose of this section is to study models of cardio-respiratory biometric shirts on the market. In each, we will analyze the supplier, the main features and technology used in the implementation indicating possible prices of the solutions. In the following figure there is a classification of the solutions analyzed in terms of implementing a type of service, platform, product and technology. Furthermore, within this classification, indicates whether a solution is rather for personal use or if they are solutions for professional use.

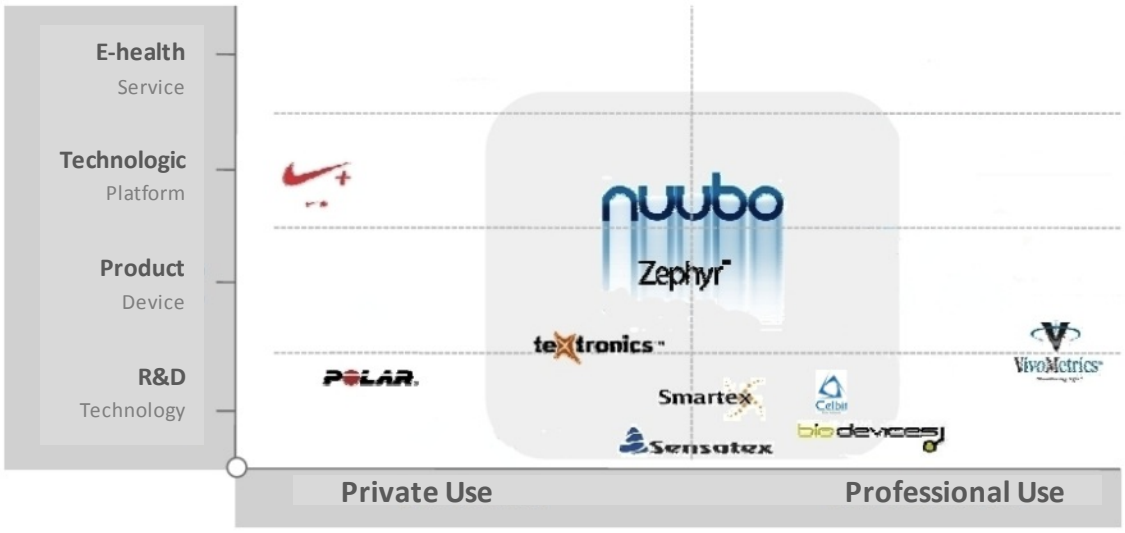


Figure 13 - Functional classification of commercial shirts. Source: (Nuubo, 2009)

5.2.1 LifeShirt

LifeShirt is a device developed by U.S. company VivoMetrics that allows real time monitoring of vital signs of people. It acts as a continuous ambulatory monitoring system, analyzing and reporting data about the health of the individual. It is commercially available in two formats: an adjustable band or a wearable shirt. The band format consists of a textile belt that includes all the necessary sensors to take measurements. This belt is adjustable to the individual's chest. This solution is typically used to meet the needs of professionals who come into contact with hazardous materials, fire, industrial cleaners and staff dedicated to security.

The other option is a comfortable shirt, lightweight (227gr) and can be washed (it's LYCRA), within which are distributed a series of sensors that can capture information from the patient's vital parameters. This solution is used in patient monitoring and follow-up of athletes. Some applications and clinical studies with LifeShirt include (Grossman, 2004): Diagnosis of sleep, heart disease, lung disease, cardiopulmonary rehabilitation, early discharge, pre and post-operative monitoring, human modelling and behavioural medicine, ergonomics (Kanaujia, 2007).

The complete system is also composed by a data logger (LifeShirt Register) and analysis software for PC. The measured variables by LifeShirt are:

- Activity
- Respiratory Rate
- Heart Rate
- Posture
- ECG

Figure 14 - LifeShirt band format (left) and T-shirt format (right). Source: (RAE Systems, nd / LifeShirt, nd)

Optionally, it has the ability to add simple sensors. Some of them would get data from the patient such as:

- Pulse Oximeter
- EEG/EOG
- Blood Pressure
- Skin temperature
- Capnometry
- Monitoring noise (breathing and heart)

It is being considered the possibility of integrating GPS technology, so that the patient's position would always be accessible by the doctors. All data is stored in the Register LifeShirt, both collected by the sensor and subjective on the patient, and analysis software is responsible for conducting a study in which graphs and waveforms of high resolution are displayed and show together with other 30 parameters derived from the measurements, all in real time. It is also possible to generate summary statistics and reports in order to support clinical diagnoses.

This device allows the definition of a series of physiological limits or thresholds, which if achieved, will result in the appearance of an alarm event reporting. The shirt has been tested more than 38,000 hours during the course of 90 studies on 1750 subjects. It has all the permits and compliance with the regulation in Europe and in Canada and the USA. With regard to the possibilities of communication, LifeShirt older versions had a RS-232 interface plus the ability to connect to a modem RAELink2, allowing you to integrate into AreaRAE network. Currently, communication is done completely wirelessly using mobile cellular, Bluetooth and ZigBee.

In December 2008, it was announced (Hughes, 2008) VivoMetrics integration as a member of Continua Health Alliance, with the primary objective that their products, among which LifeShirt, part of interoperability solutions for medical devices such association offers.

5.2.2 NuMetrex

Numetrex t is a line of intelligent biometric Textronics American brand. It contains a series of sensors that are woven together with the material that makes up the shirt. These sensors are in contact with the individual's body, sensing your heart rate and sending it to a small transmitter. The transmitter is located in a front pocket of the garment, and forwards the signal to a clock that implements a heart rate monitor, in which the user can see this information in real time.

Figure 15 - Different models of the smart shirt Numetrex. From left. to right.: Men's Cardio Shirt, Women's Racer Tank Heart Rate Monitor Chest Strap Bra and Fabric. Source: (NuMetrex, nd)

Both the transmitter and compatible watches are POLAR. The transmitter is WearLink +, and uses a proprietary protocol and format (W.I.N.D.) for the transmission of information to the clock. Such information may be stored in the clock itself (most recommended by NuMetrex are POLAR models RS200 and FS1) and then be downloaded to your computer using an application called UpLink. This requires a USB pendrive style that captures the clock information via the same wireless ad hoc protocol.

Current prices of available devices though Web stores are:

- NuMetrex Men's Cardio Shirt: 58,95$
- NuMetrex Women's Racer Tank: 49,95$
- Heart Rate Monitor Sports Bra: 49,95$
- NuMetrex Fabric Chest Strap: 29,95$
- POLAR WearLink+: 54,95$
- POLAR RS200: 169,95$

- Stick POLAR Datalink: 54,95$

Figure 16 - Polar WearLink transmitter and watch / pedometer POLAR RS200. Source: (POLAR, nda)

5.2.3 Nuubo

Nuubo is a complete solution that allows biomonitorizar remotely, non-invasive (using smart garments), other than a patient's vital signs has been developed by the Spanish company with the same name. The vital parameters possible to measure in real time and though mobile platforms are:

- ECG
- Heart rate
- Activity
- Position

Figure 17 - Intelligent Biometric T-shirt Nuubo. Source: (Nuubo, nd)

The system operation is as follows: there are several electro-textile sensors built into the fibres of the shirt or garment that capture vital signs. A sensor that easily attaches to the T-shirt called nMote, acts as a wireless transmitter, processing and sending the biometric signals to the wireless access points (mobile, PODs or routers) that capture this information and direct it to the software platform. The health professionals can perceive - in real time via the web - where you are. In addition, this information is stored and used by the professional for better control and monitoring of the patient.

Figure 18 - NMote Transmitter (left) and a view of the sensors in the Nuubo shirt fibres (right). Source: (Nuubo, nd)

The possibilities of communication is one of the strengths of this biometric textile solution, since is employing wireless networks for distributed communications (WSN: Wireless Sensor Networks) and a multi gateway middleware for communication (Wi-Fi ®, Bluetooth ®, ZigBee ™, ANT ™ and RFID). To accomplish all this architecture, Nuubo offers a wide range of products and services included into three business lines:

1. ***Hardware***: Includes Textron garments like the electro-textile sensors to capture vital signs, wireless transmitters that send biometric signals processed and wireless access points (mobile, PODs or routers) that capture this information and address it to the software platform.
2. ***Software***: Includes bio monitoring platform (NUUBO Monitoring Suite) and end-user applications built on it for different market segments.
3. **Services**: Includes activities such as training, maintenance and consulting services that are aimed at creating added value around the software platform.

The price of a complete solution ranges between 500 and 1000 €. In addition, Nuubo plans working on certification and standardization:

- CE
- Compliance with the UNE EN 60601-1-2 electrical equipment.
- General requirements for basic safety and essential performance - Collateral standard: Electromagnetic compatibility - Requirements and ensayos.1
- ISO / IEEE 11073: interoperability standard for medical devices and their application in patient monitoring. The standard for medical device communication undertaken within the European Union is the ISO / IEEE 11073 (X73). The data can then be sent to a remote control or storage of electronic medical records (EMR) and is allowed to build complete systems that constitute global solutions.

Another point in favour of Nuubo is their participation as a member of Continua Health Alliance, which aims to be an incentive to establish a system of interoperable solutions and market Socio-Health Platform Interoperable within the ecosystem of devices and healthcare information systems.

5.2.4 SmartShirt

SmartShirt is a smart shirt developed by U.S. company Sensatex. It involves the development and marketing of Georgia Tech Wearable Motherboard shirt detailed before. It is designed to collect vital physiological signals and to detect motion of the individual. The system collects analogue signals through conductive fibre sensors and passes the information captured through a network of fibres woven into the shirt. A textile connector sends the analogue signals to a small personal control stored in a shirt pocket. The controller digitizes the signals and transmits them to a Bluetooth or ZigBee receiver linked to the central station where the information is collected, displayed and stored.

Figure 19 - Operating mode of the Smart Shirt. Source: (Sensatex, nd), as amended

In addition to activity monitoring, the potential vital signs that can be measured are the following:

- Respiratory rate
- Heart rate
- Body temperature

Applications of this shirt are medical monitoring (diseases, infants, and obstetrics), clinical trials, monitoring of athletes, feedback biomedical and military applications.

5.2.5 Visuresp

Visuresp is a product of the French company rbi-instrumentation, which allows monitoring of the patient's breathing and helps in pulmonary rehabilitation by using visual feedback.

Figure 20 - T-shirt Visuresp. Source: (RBI Instrumentation, nd)

The biometric variables measured by this shirt are:

- Rib cage volume
- Respiratory Rate
- Abdominal volume
- Ventilation
  Tidal volume

This patented system allows recording of real-time measurements and for a long term. In addition, monitoring is non-invasive and can be used for programming a customized rehabilitation service. The operating principle is controlling thoracic and abdominal movements by an inductive plethysmograph. The calibration of the Visuresp sensors is done by classical method, using a spirometer or airflow meter. It includes software that provides the steps to be performed during the calibration.

The purchase kit includes:

- T-shirt (in 3 sizes)
- Data acquisition board with sensors
- Integrated electronic connector
- Software management application, registration and calibration
- Optionally you can purchase additional coats, an analogue output card, a thoracoabdominal plotter and a PC controller.

Among the applications currently using this device are:

- Clinical and scientific uses.
- Training in paraplegics and quadriplegics who have the ability to breathe on their own. It can be used to compare involuntary vs. breathing assisted.
- Prevention of collapse in the alveoli (atelectasis).
- Separate training of the chest or diaphragm.
- Monitoring of breathing during sleep, with RIP signal calibration.
- Training for the correct use of aerosol therapy.
- Off-line processing parameters for Vt, Ti and Te in different positions during sleep.
- Training phase of mechanical ventilation.

5.2.6 VitalJacket

Biometrics is a shirt ViatlJacket intelligent Biodevices Portuguese brand. It allows continuous monitoring of the heart wave up to 5 days, using miniaturized components that are not intrusive. This generates a very precise ECG signal, which can be analysed and stored by special analysis software.

Figure 21 - Complete set of intelligent biometric VitalJacket shirt. Source: (Biodevices, nd)

The concept was created based on the long experience and tradition in biomedical instrumentation and telemedicine of R & D group of IEET (Institute of Electronics and Telematics Engineering of Aveiro), University of Aveiro. VirtualJacket is a system capable of acquiring, storing and analyzing (both online and offline form) the ECG and the patient's heart rate. These signals are sent for analysis in real time to a PDA using wireless technology (Bluetooth) at the same time are recorded on an SD card for later analysis with the program VitalJacket Desktop Pro.

Figure 22 - Functional diagram of the VitalJacket monitoring system. Source: (Biodevices, nd)

The complete kit includes a shirt, a box with the hardware to integrate a set of 25 electrodes, a battery charger and a CD with instructions and software for analysis. Its price is about 600 €. There is also the possibility of purchasing additional T-shirts; there are 5 different models, one of which is special for baby monitors.

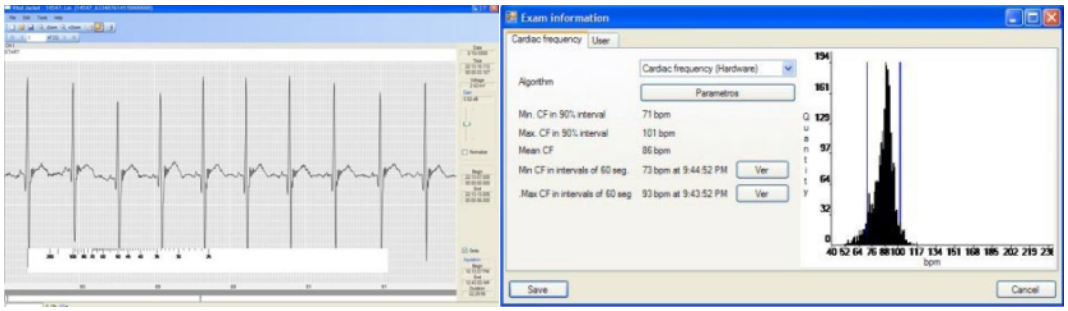


Figure 23 - VitalJacket Desktop Pro Application Screenshots. Source: (Biodevices, nd)

VirtualJacket Desktop Pro software, allows you import data stored on an SD card and then display it for analysis and creating profiles for each user. It also has other tools that facilitate, among others, to detect arrhythmias, check marked events, work in multiline mode, find a specific date / time and generate reports ... as well as enabling online data if sent via GPRS or Internet through a PC or PDA. The mobile version requires Windows Mobile 5.0 PDA with Bluetooth, the PC version requires at least Pentium V - 1GHz, Windows Vista / XP with USB 1.1, 1 GB RAM, CD-ROM and SD card reader. The main applications of this smart shirt are those related to monitoring the patient's heart condition, both in hospital and at home, while taking into account the possibility of mobility or for those who need frequent monitoring of their signals life with high quality.

5.2.7 Wealthy and Wearable Wellness System

Wealthy and Wearable Wellness System are two biometric smart shirt developed by the Italian company Smartex. Wealthy is a wearable fully integrated system capable of acquiring, simultaneously and in a natural environment, a set of patient's vital physiological parameters, such as ECG, respiration rate, posture, temperature and rate of movement / activity. Sensors and connections are integrated into the textile structure, and conductive fibres are woven with elastic threads.

The system is composed of 6 ECG electrodes and, 4 and 8 impedance isolated connections. In addition there is a portable patient unit (PPU), which is the core of the communication system. The PC connection can be made via radio or via USB. The operation of the system is simple: after initial pre-processing of the ECG data, they are sent to a monitoring centre, where all data is displayed, processed and stored in a database. The feedback of patient health care is possible at any time, and in case of alarm, the doctor can act immediately.

Wearable Wellness System is an advanced version of Wealthy. It is based on the motherboard SEW3 developed by the Centre Suisse d'Electronique et de Microtechniques (CSEM). Includes a 3-axis accelerometer more precisely, in addition to allowing more power within the device itself pre-process the data on the ECG, heart rate, respiratory rate, level of movement and energy expenditure. Data can be stored internally in this case, or transmitted to a PC via Bluetooth (Smartex, ndb).

Figure 24 - Wealthy biometric T (left) and PPU unit (right). Source: (Smartex, nda)

5.2.8 BioHarness BT

It is a device manufactured by U.S. company Zephyr, which enables the capture and transmission of physiological information via mobile carrier and fixed data networks, allowing remote monitoring.

Figure 25 - Zephyr BioHarness BT device. Source: (Zephyr, ndc)

Among the critical parameters that can be measured are:

- Heart rate: It consists of a 32bit microprocessor dedicated to ECG analysis. The measures include ECG, heart rate, RR, HRV, ECG and amplitude noise ECG.
- Respiratory rate: It consists of a 32bit microprocessor dedicated to the analysis of the respiratory waveform using a patented chest sensor.
- Temperature: medical grade pyrometer
- Posture: Use to do a 3-axis accelerometer. The device eliminates the effect of gravity and can determine whether an individual is lying or standing, providing important information about what you are doing.
- Activity: Level of activity Magintud Vector Units (VMU), which can be used to determine the METS and calculate energy expenditure (calories) more accurately.

BioHarness BT to store information on a continuing basis of functioning up to 31 days. Such information can be transmitted in real time or after a computer or phone with a radio transmitter. The transmitter can be implemented in different technologies, including Bluetooth and found a 880/921 MHz ISM band custom are currently working to include more types of transmitters. Cardiac and respiratory sensors are contained within an adjustable band to the chest of the wearer, while the accelerometer activity meter thermometer and are located near the transmitting device in a front box. In total, the device weighs about 85g, including battery, which can last up to 8 hours of continuous operation and can be recharged via USB.

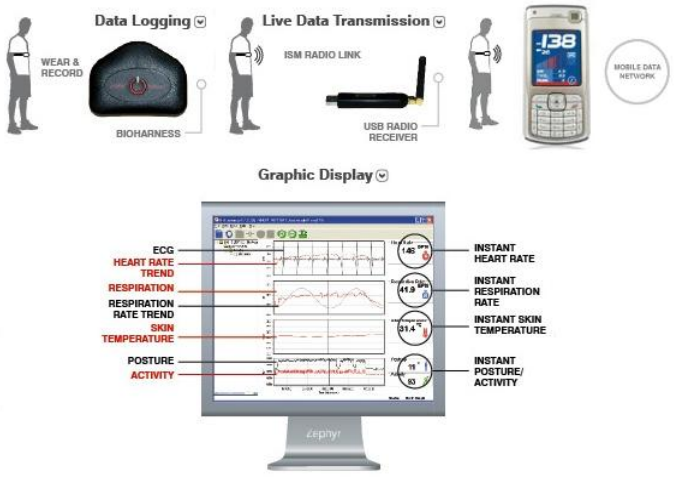


Figure 26 - Operating Modes BioHarness BT and software application screenshot and zephy Zephyr PC Phone. Source: (Zephyr, nd), as amended

There are two monitoring applications:

- **Zephyr PC**, which allows visualization and online and offline analysis of the data transmitted by the device. Such transmission may be continuous, regularly transmission of the average and spike regularly or periodically transmission of reports and summaries.

- **Zephyr Phone**, which allows local viewing on a mobile phone of the information, in addition to the physiological thresholds set. It has three types of broadcast: streaming, for sample and threshold.

There is a SDK available, which includes messaging and communication protocols, and test and configuration utilities. In this way, you can integrate into applications BioHarness party software. Some practical applications of BioHarness (Zephyr, ndb) are training sports teams, track sick and wounded, monitoring activity and state first responders.

5.2.9 Electrodoctor

Electrodoctor is a smart jacket developed by the Colombian company, Celbit, dedicated to the care and prevention in health, monitoring and analysis of vital sign parameters. This jacket held devices capable of measuring real-time biometric bodily functions and parameters, among which are:

- Electrocardiogram
- Blood Pressure
- Heart rate
- Body temperature

Measurements are made in real time by using small sensors easily connected to the user, and then are collected and processed by the main module embedded in the shirt called Electrofisiógrafo. This device analyzes the information acquired by using specialized software to make a permanent carrier pre-diagnosis, becoming a valuable tool for the user who obtains the health information instantly. Furthermore, the signal can transmit information via phone, via Bluetooth or via the Internet.

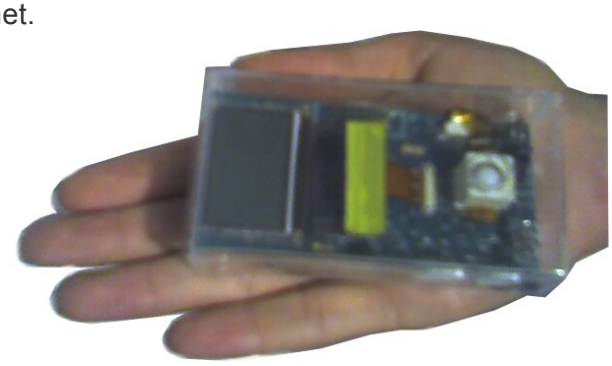


Figure 27 - Electrofisiógrafo module. Source: (Celbit, nd)

The current price of this device multiparameter monitor is $ 99. The first products will be distributed starting in 2011, and can be ordered from now on. Delivery will be made in the same order of orders. Among the possible applications are Electrodoctor optimizing the management of patients with heart deficiencies and older adults at risk.

5.2.10 Nike+

Nike and Polar have launched the Polar WearLink ® + compatible with Nike +. This new product works with the Nike + SportBand and Nike + iPod Sport Kit allows users to run and train with heart rate for the first time.

Figure 28 - Nike +: Nike + Ipod with application, Nike + SportBand and band sensor / transmitter Polar WearLink +. Source: (POLAR, ndb)

This new device fits comfortably around the chest and passed through a system of communication and protocol themselves, the heart rate at the Nike + iPod Sport Kit or SportBand. Users can see their beats per minute while running with Nike + SportBand or listen to auditory feedback during your workout with the Nike + iPod. After the training session, data is transferred to the nikeplus.com web service. Users can keep track of time have run in your target heart rate zone and see how it evolves along to every workout.

The new Polar WearLink ® + is also compatible with most Polar training computers (all using the technology of transmission 5 kHz). This allows simultaneous use Nike + system with a Polar training computer. The fabric tape is lightweight, flexible and easy to fit around the chest, matching the user's body shape and provides complete freedom of movement during training session. You can also machine washable. Batteries can be changed by the user to increase the ease of use.

It works with Nike +, Polar WearLink ® + works with all compatible fitness equipment that is Polar most fitness models of the major manufacturers. Therefore, users who use the WearLink + can track your heart rate compatible machines in your gym. The coded transmission ensures that Nike + devices and Polar training computers receive the signal and not for another user, avoiding interference. The Polar WearLink ® + compatible with Nike + will be released in the near future in the United States, Canada and some EU countries.

5.3 Other devices used in CAALYX-MV vs. the market ones

This information is listed in the Appendix since is playing in a more low level.

5.4 Competence analysis

The next tables synthesise both existing solutions vs. CAALYX-MV solution and T-Shirts that are already available in the market vs. the T-shirt used in CAALYX-MV.

Solutions	Target patients	Chronic management system	Self assessment	Continuous monitoring	Smart homes	Social Care	Ambulatory Care	Emergency Care	Cheap solution?
CAALYX-MV	To be defined in D2.2	x	x	x	x	x	x	x	Devices can be expensive, especially the T-Shirt
MyHeart	Only cardio-vascular patients			x			x		Devices can be expensive
SOPRANO	Older people, making them independent				x	x			Intended to be cheap
AmIE	Isolated Older people			x	x	x	x		Regular
Belami	Older people with physical and mental problems				x	x	x	x	It seems cheap

Table 1 - CAALYX-MV vs other solutions

Next table shows a comparison between the different T-Shirts/textiles available in the market:

Project	CAALYX-MV	LifeShirt	MuMe trex	Nuubo	Smart Shirt	Visures p	VitalJac ket	Wealthy & Wearable	Bio Harness	Electro-doctor	Nike +
Activity		x		x				x	x		
Respiratory rate	x	x			x	x		x	x		
Fall detection	x										
Heart rate	x	x	x	x	x		x	x	x	x	x
Pulse	x										
Posture		x		x					x		
ECG		x		x			x	x		x	
Pulse Oximeter		x									
EEG/EOG		x									
Skin temperature	x	x			x				x	x	
Blood Pressure		x								x	
Capnometry		x									
Rib cage volume						x					
Abdominal volume						x					
Ventilation						x					
Tidal volume						x					
Monitoring noise (heart & breath)		x									
Price	≈ 400€	-	50 – 170 $	500 – 1000 €	-	-	600 €	-	700 – 1400 $	99 $	70 $
Manufac-turer	Spanish	US	US	Spanish	US	French	Portu-guese	Italian	US	Colom-bian	US

Table 2 - CAALYX-MV T-shirts vs other products

5.1 Niche markets

From table 1 it appears that most solutions are targeted for older people, except MyHeart which is intended specifically for people with cardiovascular problems. Because CAALYX-MV is strongly designed to support chronic disease management (e.g. treatment, patient history, medication, questioners, patients' progress, assessment, etc.), , Deliverable 2.2 should rather focus on specific diseases that are related to aging (i.e. chronic diseases) and try to find an optimal compromise between suitable diseases and cost savings in respect to the CAALYX-MV method.

Self-assessment by using questionnaires seems to be a differential value on CAALYX-MV and that should rather be administered in the first disease stages or even for people who are at risk having a specific disease. By means of self-assessment, people become aware of their disease or risks as such that healthier behaviour could be initiated and thereby supporting prevention and reducing the costs in health care. Moreover, most existing solutions either are smart-home oriented or medical care oriented; yet, do not combine both in such a way that it can be useful for enhancing the Health Care system to its full potential. Nevertheless, the economical efficiency must be a priority, since sensors and related systems are still rather expensive. A possible way to face this issue is to provide combined solutions to patients that benefit the most from constant care at home Whenever the homes become more intelligent, care personnel could be reduced and could focus more on 'warm care' instead of 'cold care', and ultimately reducing the total costs in health care.

Furthermore, the provision of a proper emergency system provides independence to older people and could increase their living comfort and perceived safety. In addition, CAALYX-MV functionalities like fall detection and the geo-positional alarm can strengthen people's mobility, independence, and quality of life. It is important that people's independence does not have an impact on the social contact with the carers and relatives (i.e., 'warm care'), and therefore CAALYX-MV supports social interactions by a videoconference function that will mediate communication and social connectedness between doctors and patients, but also between the patients and their relatives.

As for the devices used in CAALYX-MV, the T-Shirt is competitive with regards to what it is currently available in the market; yet, the costs are still relatively high (i.e. 400 euros is expensive). The CAALYX-MV solution is able to monitor temperature, falls, respiratory rate, heart rate and pulse and that has to be provided to patients that really have serious mobility problems and need constant monitoring and care. So, CAALYX-MV uses competitive devices (i.e. in the appendix, ISS, ECG, weigh scale, pulsioximeter). They have a good prize/functions score. Compared with other devices on the market, the ISS is small, provides the measurement of 3 vital signs, it is easy to use, and also from pricing in the range of the competitors. The current price is calculated for 50 to 100 devices per year. If the ISS is running in volumes of 5000 devices/year or more the list price can be at 50% down to 30 % of the currently calculated 2800,00 €. So that is an expensive price even though is aligned with the competence, we have to work to increase the production and put down the prices. Therefore, they should be used only on the selected feasible target users (i.e. that will be analysed in D2.2). For instance, a patient with chronic pulmonary disease will use the pulsioximeter but not the weight scale.

In summary, CAALYX-MV could provide high value by managing the different stages associated to chronic diseases ranging from prevention to the provision of constant care and monitoring to patients in their later stages of a disease. In the current economic situation, it is advised to design this in a gradual way. For prevention and for patients in their early stages of a disease, CAALY-MV can provide a relatively low-cost e-health solution which can easily be enhanced and extended by additional sensors and monitoring equipment for patients in their later stages of a disease. Thus, CAALYX-MV could be presented to the Health care system as a sustainable tool that improves the quality of life of patients and which could ultimately reduce the increasing costs in health care.

6 Conclusions

The market analysis and study presented in this deliverable provide a rich and in-depth insight in the potential strengths of CAALYX-MV in comparison with competitive solutions and projects. First of all, relevant information about the current state of the telemedicine markets is provided as such that D2.2 will be able to integrate these in a suitable way to produce sustainable marketing strategies. Moreover, market players and key actors have been described in detail. This is critical when considering that the CAALYX-MV project consists of nine different partners from different economic regions. The analysis paves the way for a realistic business scenario for Europe. After that, a comprehensive analysis of the market trends provided us the insights to perform a competence analysis which is also relevant input to face D2.2 whenever the time is there to define who the CAALYX-MV target users are and how CAALYX-MV will be marketed. At this point it is most likely that CAALYX-MV should be focused on chronic disease management and a good strategy must be set in D2.2 to target the right patients and to adapt its services for them.

7 Appendix

7.1 Intelligent Sensor Systems (ISS)

7.1.1 CAALYX-MV SpO2, ECG and NIBP Sensor

The Intelligent Sensor System combines a SpO_2, an ECG and a NIBP measurement unit in one small handheld device. This is a unique combination of the 3 most often needed vital parameters. So long, no competitor has a comparable solution for remote measurement of these parameters in one system. Also the user interface is unique. The ISS has a 7" high resolution touch screen as interface for the user. The software is specially developed for older people. The device only has to be switched on. It the ECG recognizes a valid input signal, the ECG function is automatically started. The same applies for the pulse oximeter. Only the blood pressure unit must be started manually. To simplify the start of this function, a schema for the blood pressure measurement scenario is displayed. The older person only has to press the start button to start the measurement.

From these primary vital signs a number of other vital signs can be extracted:

- Heart rate (ECG)
- Pulse rate (Pulse oximeter)
- Respiration rate
- Pulse transit time

More sophisticated algorithms can be used to perform a more thorough analysis of the acquired data and extract additional data:

- Arrhythmias
- Atrial fibrillation

Additionally the availability, stability and quality of the vital sign measurements can be improved by making use of a combination of different sensors:

- Heart rate can be determined by each of the three primary sensors, if one is not used or does not deliver the necessary quality.
- The PTT can be used to estimate the blood pressure and therefore gives the opportunity to reduce the amount of measurements using the cuff and continuous measurement.

- The quality and precision of the blood pressure meter can be improved by using the Pulse oximeter sensor as an additional source of information.

Technical Data ISS Device:

Parameter	Specification
Wireless transmission	Bluetooth, approved in accordance to R&TTE directive
Temperature range storage:	-20 °C – +70 °C
Relative humidity storage:	95 % max, no condensing
Temperature range operation:	0 °C to 45 °C
Relative humidity operation:	80 % max, no condensing
Operating voltage:	+12 VDC (11.0 VDC to 13.0 VDC)
Max. operating current:	750 mA
Operating mode:	Non-supervised continuous operation

Fulfilled standards and regulations	
EN 60601-1 + A1 + A2	
EN 60601-1-2	
EN 55011, Class B	
EN 60601-2-30	
EN 1060-1	
EN 1060-3	
DIN 58130	
ANSI/AAMI SP-10	
RF Emissions CISPR 11	Compliance to group 1: The ISS uses RF energy only For its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions CISPR 11	Compliance to class B: The ISS is suitable for use in all establishments, including domestic establishments and those directly connected to the public low0voltage power supply network that supplies buildings used for domestic purposes.
Electromagnetic compatibility (EMC) In acc. With 60601-1-2 - Noise suppression - Immunity to interference	 EN 55011 EN 61000-4 parts 2, 3, 6, 8
Classification in acc. With 60601-1 - Type of protection against el. shock - Degree of protection against el. shock	Device with internal power supply Type BF

Blood Pressure Measurement Unit (NIBP):

Parameter	Specification	
Type of measurement:	Oscillometric	
Pressure range:	0 – 300 mmHg	
Measurement ranges: pSYS: pDIA: pMAP:	Adults: 25 – 280 mmHg 10 – 220 mmHg 15 – 260 mmHg	Neonates: 20 – 150 mmHg 5 – 110 mmHg 10 – 130 mmHg
Accuracy: - Pressure transducer accuracy - Measurement accuracy, mean deviation - Measurement accuracy, standard deviation	Measured: ± 1 mmHg < 1,7 mmHg < 5,6 mmHg	Required according to international standards: Max. ± 3 mmHg Max. ± 5 mmHg Max. ± 8 mmHg
Resolution:	1 mmHg	
Leakage rate of the system:	< 3 mmHg / minute	
Overpressure limits:	300 mmHg adult mode	150 mmHg neonatal mode
Shutdown and pressure release after exceeding (first fault condition):	330 mmHg adult mode	165 mmHg neonatal mode
Time required for BP measurement:	typical (normal) 20 s max.: adults 90 s max.: neonates 60 s	
Heart rate range/accuracy:	30 – 240 bpm / ±2 bpm	
MTBF:	250.000 cycles of blood pressure measurements	
Calibration interval:	2 years	

Pulse Oximetery Unit:

Item	Specification
O2-Saturation range:	0 – 100 %
O2-Saturation accuracy:	SpO2 > 85 % ± 1,5 % 75 % < SpO2 < 85 % ± 2,0 % 50 % < SpO2 < 75 % ± 3,0 %
Heart rate range/accuracy:	30 – 250 bpm / ± 2 %
Quality range:	10 (low) – 0 (high)
Response modes:	Sensitive, normal, stable; adjustable by monitor; default: normal
Alarms:	Sensor disconnected, finger off, signal low, error messages. All alarms are detected in the module and reported to the monitor via the communication link.
Transmission:	Resolution: saturation: 1 Hz pulse rate: 1 Hz quality signal: 1 Hz pulse wave: 100 Hz
Digital filter:	50/60 Hz and 100 Hz neon light

ECG Unit:

Feature	Value
Product class in acc. With 93/42/EWG (MDD)	II b
Air pressure range	700…1060 hPa
Current consumption at 3 V - Operation - Stand-by	 148 mA (BT12) 37 mA (BT12)
Electrodes	Standard ECG electrodes

ISS target list price 2800,00 €

7.1.2 Meditech ECG and NIBP Device

The Meditech CardioTens device provides ECG and NIBP measurement within one device. The Meditech device is designed as a recorder which is applied by a physician. The display of the Meditech CardioTens is quite simple and can only be used by trained staff. The quality of data acquisition is compliant to the medical standards. The Cardio-Tens cannot be used by older people.

Technical Data

Item	Specification
Power supply	4 x AAA rechargeable batteries
BP measurement	Oscillometric method, stepwise deflation, piezo-resistive sensor
Measurement range	Blood pressure 30-260 mmHg, pulse rate 40- 200 bpm
Passive accuracy	+-3 mmHg or 2% of measured value
ECG parameters	Two channels 200 Hz sampling, 12 bi t A/D resolution
BP storage capacity	Max 1000 ABPM measurements
ECG storage capacity	24 hour ST, ST-slope, HR and HRV; at least 4 hours of 2 channel ECG recordings
Interface	RS232; optical cable transmission, 115200 baud

List prices from internet:
Meditech CardioTens 3200,00 €
Meditech CardXplore 5500,00 € (= CardioTens with software)

7.1.3 DATRIX ECG Recorder

The DATRIX VX3+ is a pure ECG recorder with display. The user interface is designed for professional use. An older person will have problems to use the DATRIX VX3 ECG recorder with no support by a nurse or physician. The device is made for continuous long term monitoring. The device has no interface to provide the recorded data to a server.

DATRIX VX3+

Technical Data

Item	Specification
Power supply	1 x AAA rechargeable batteries
Temperature Range	0°C -40 °C
Humidity Range	10-90%
ECG parameters	3 channels 128-1024 Hz sampling, 10 bi t A/D resolution
ECG storage capacity	24 hour 3 channel ECG recordings
Interface	SD-card

List prices from internet:

DATRIX VX3+ 1200,00 €

DATRIX VX3+ (+Analysis Software) 3600,00 €

7.1.4 Vasomedical ECG and NIBP Recorder

The Vasomedical BIOX 2302 is a combined ECG and NIBP recorder. The device has a small mono chrome alpha numeric display. The device is designed for professional use. The use of this device by older people seems to be too difficult. The standard application is 24 h recording of NIBP and ECG vital parameter. The device has no interface to enable a server to store the recorded data automatically.

General:

Item	Specification
Accessories:	• 2 GB SD memory card • USB SD memory card reader • 5 or 7 lead ECG patient cable (Model 2301) • 10 lead ECG patient cable (Model 2302) • Carrying case & strap • Blood pressure cuff (Standard adult) • Infrared communication adapter • Recorder user manual • User Software CD
Recording time:	24 hours
Storage medium:	SD card
Memory size:	1 GB or more
Data transfer:	Full disclosure transfer via USB card reader; Setting and real-time data transfer via infrared port
Batteries:	4 “AA” size alkaline batteries
Dimensions:	4.88 x 2.68 x 1.22 (inches3) / 124 x 68 x 31 (mm3)
Weight:	6.34 oz / 180 g (without batteries)
Regulatory compliance:	FDA cleared / CE Marked / Health Canada Listed ISO 13485 Certified

ECG:

Item	Specification
No. of ECG Channels:	12
Pacemaker detection:	Independent channel
Input dynamic range:	+5 mV ECG, +300 mV offset voltage
Input impedance:	>10 MΩ
CMMR:	>80 dB
Gain accuracy:	Maximum amplitude error <10%
Gain stability:	Change <3% over a 24-hour period
System noise:	<50 µVp-v
Multi-channel crosstalk:	<0.2 mVp-v
Bandwidth:	0.05 Hz - 40 Hz (±3 dB)
Minimum feature size:	50 µVp-v
Timing accuracy:	Overall error during 24-hour period <30 s
Sampling rate:	256 Hz/channel 2048 Hz/channel (pacemaker detection)
Resolution:	12 bit

NIBP:

Item	Specification
Method of measurement:	Oscillometric
Indicating range:	0 - 300 mmHg
Recording range:	Systolic: 50 - 260 mmHg Diastolic: 30 - 180 mmHg
Pressure precision:	<3 mmHg

List prices from internet:

BIOX 2302 2300 €

7.1.5 Comparison

ECG:

Item	BIOX 2302	DATRIX VX3+	CardioTens	ISS
No. of ECG Channels:	12	3	12	12
Pacemaker detection:	Independent channel	-	Independent channel	Independent channel
Input dynamic range:	+5 mV ECG, +300 mV offset voltage	-	-	+10 mV ECG, +300 mV offset voltage
Input impedance:	>10 MΩ	-	-	>10 MΩ
CMMR:	>80 dB	-	-	>80 dB
Gain accuracy:	Maximum amplitude error <10%	-	-	-
Gain stability:	Change <3% over a 24-hour period	-	-	-
System noise:	<50 µVp-v	-	-	-
Multi-channel crosstalk:	<0.2 mVp-v	-	-	-
Bandwidth:	0.05 Hz - 40 Hz (±3 dB)	-	-	-
Minimum feature size:	50 µVp-v	-	-	-
Timing accuracy:	Overall error during 24-hour period <30 s	-	-	-
Sampling rate:	256 - 2048 Hz/channel (pacemaker detection)	128-1024 Hz	200 Hz	500 Hz
Resolution:	12 bit	10 bit	12 bit	12 bit

NIBP:

Item	BIOX 2302	CardioTens	ISS
Method of measurement:	Oscillometric	Oscillometric	Oscillometric
Indicating range:	0 - 300 mmHg	0 - 300 mmHg	0 - 300 mmHg
Recording range:	Systolic: 50 - 260 mmHg Diastolic: 30 - 180 mmHg	Systolic: 30 - 260 mmHg Diastolic: 40 - 200 mmHg	Systolic: 50 - 260 mmHg Diastolic: 30 - 180 mmHg
Pressure precision:	<3 mmHg	<3 mmHg	<3 mmHg

Pulse Oximetery Unit:

Item	ISS
O2-Saturation range:	0 – 100 %
O2-Saturation accuracy:	SpO2 > 85 % ± 1,5 % 75 % < SpO2 < 85 % ± 2,0 % 50 % < SpO2 < 75 % ± 3,0 %
Heart rate range/accuracy:	30 – 250 bpm / ± 2 %
Quality range:	10 (low) – 0 (high)
Response modes:	Sensitive, normal, stable; adjustable by monitor; default: normal
Alarms:	Sensor disconnected, finger off, signal low, error messages. All alarms are detected in the module and reported to the monitor via the communication link.
Transmission:	Resolution: saturation: 1 Hz pulse rate: 1 Hz quality signal: 1 Hz pulse wave: 100 Hz
Digital filter:	50/60 Hz and 100 Hz neon light

Pricing

Item	BIOX 2302	DATRIX VX3+	CardioTens	ISS
List Price	2300,00 €	1200,00 €	3200,00 €	2800,00 €

The ISS is in all technical data state of the art. It is currently the device with the highest level of integration and offers the simplest user interface available. Due to this simplification of the user interface some internal recorded and via Bluetooth transmitted values are not displayed to avoid confusion. The pricing corresponds to the features.

7.2 None Invasive Blood Pressure Meter

7.2.1 CAALYX-MV NIBP Device

The blood pressure measurement unit built in the ISS showed some issue during the qualification. So an alternative solution is provided if these issues could not be fixed within the qualification. The alternative device is a CE certified Bluetooth blood pressure measurement device from BOSO: “boso medicus prestige Bluetooth”.

NIBP:

Item	Specification
Method of measurement:	Oscillometric
Indicating range:	0 - 280 mmHg
Recording range:	Systolic: 50 - 260 mmHg Diastolic: 30 - 180 mmHg
Pressure precision:	<3 mmHg
Method of measurement:	Oscillometric

List price: 200,00 €

7.2.2 PressureTel with Bluetooth

The PressureTel BT blood pressure measurement device is quite similar to the BOSO device. The display of PressureTel is quite small. This makes the PressureTel not so good suited for older people.

NIBP:

Item	Specification
Method of measurement:	Oscillometric
Indicating range:	0 - 280 mmHg
Recording range:	Systolic: 70 - 260 mmHg Diastolic: 40 - 240 mmHg
Pressure precision:	+-3 mmHg
Measurement duration	30 s
Method of measurement:	Oscillometric
Interface	Bluetooth class II (RF range < 10 m)

List price: 180,00 €

7.2.3 Comparison

NIBP:

Item	PressureTel	BOSO
Method of measurement:	Oscillometric	Oscillometric
Indicating range:	0 - 280 mmHg	0 - 280 mmHg
Recording range:	Systolic: 70 - 260 mmHg Diastolic: 40 - 240 mmHg	Systolic: 50 - 260 mmHg Diastolic: 30 - 180 mmHg
Pressure precision:	+-3 mmHg	+-3 mmHg
Measurement duration	30 s	30 s
Method of measurement:	Oscillometric	Oscillometric
Interface	Bluetooth class II (RF range < 10 m)	Bluetooth class II (RF range < 10 m)

Pricing:

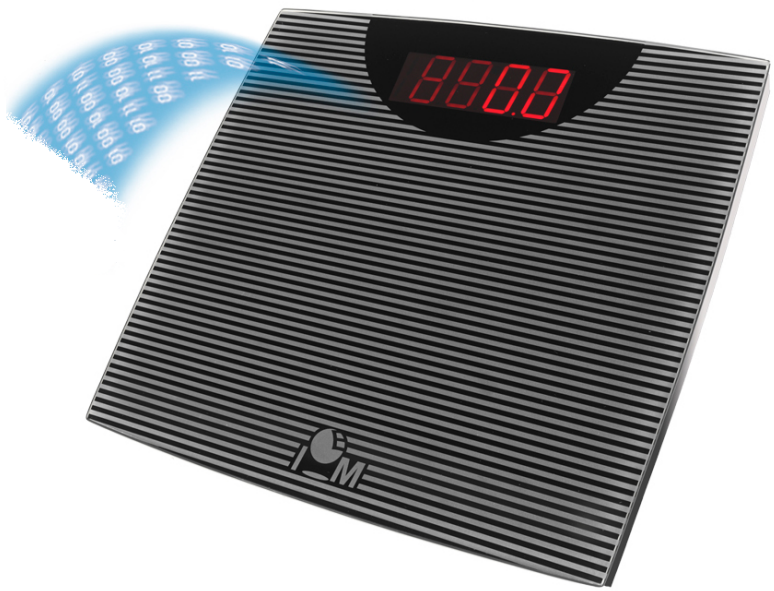
Item	PresureTel	BOSO
List Price	180,00 €	200,00 €

The BOSO blood measurement device is the most used blood measurement devices in German medical practices. The quality of mechanic and user interface meets the needs for CAALYX-MV. The price is reasonable.

7.3 Bluetooth Scale

7.3.1 CAALYX-MV Scale

The scale selected to be used for the CAALYX-MV trial is the Libro-O-Graph scale by IEM. The Libro-O-Graph scale provides the simple to use tap on initialisation. The measurement is started by taping once on the scale. The scale is than switching on and doing a zeroing with calibration. When the scale displays 0.0 the scale is ready for operation. The older person can now enter the scale and wait until the displayed weight is stable. The scale automatically transfers the measured weight to the CAALYX-MV gateway.



Technical Data:

Item	Specification
Zeroing, temperature compensation and switching on	Tap-on technology
Precision	0,6 % + 100 g
Range	0 - 180 kg
Display	red LED 38 mm
Interface	Bluetooth, class I; Profile SPP/DUN;

List price: 200 €

7.3.2 Tanita HD 351 BT Scale

The Tanita scale is currently only available for the US-market. The scale corresponds with the precision and the functions to the scale selected for the CAALYX-MV trial.

Technical Data

Item	Specification
Zeroing and switching on	Tap-on technologie
Precision	+- 100 g
Range	0 - 200 kg
Display	LCD 42 mm
Interface	Bluetooth, class I; Profile SPP/DUN;

List price: 250,00 €

7.3.3 Comparison

Item	HD 351 BT	Libo-O-Graph
Zeroing and switching on	Tap-on technologie	Tap-on technologie
Precision	+- 100 g	+-6%+- 100 g
Range	0 - 200 kg	0 - 180 kg
Display	LCD 42 mm	LED 38 mm
Interface	Bluetooth, class I; Profile SPP/DUN;	Bluetooth, class I; Profile SPP/DUN;

Pricing

Item	HD 351 BT	Libo-O-Graph
List Price	250,00 €	200,00 €

There are only a few Bluetooth scales on the market. Already 2 of the Bluetooth scales integrated into CAALYX-MV reached to their end of life.

7.4 Pilot site in The Netherlands (Smart homes):

10x Barix Barionet 50 (139 Euros for 1) = 1390 Euros
http://www.broadcastpartners.nl/barix-barionet-50.html

20x Medline Pressure Mats - last for 90 days – (113 Euros for 5) = 452 Euros
http://www.bettymills.com/shop/product/view/Medline/MEDMDT8005.html

10x Cat5e UTP PatchCable - 30m - (8 Euros for 1) = 80 Euros
http://www.mnm-computers.nl/kabels-netwerk-patchkabels-patchkabels-meter-cat5e-patchcable-grijs-p-409817.html

8 Glossary

BP = Blood Pressure

bpm = beats per minute

ECG = Electrocardiography

EEG = Electroencephalography

EOG = Electro-oculography

GPS = Global Positioning System

ICT = Information Communications Technology

mmHg = millimetres of mercury

SOA = Service Oriented Architecture

SpO2 = Saturation of peripheral Oxygen

SWOT = Strengths, Weaknesses, Opportunities, Threats

WBS = Wearable Body Sensor