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# Personal Location Aware Health Care In Europe--The Challenges From Prototype To Product: The CAALYX Experience

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## Abstract

The advent of technological novelties into modern homes has enabled the provision of assistive technology based products and services that promote safe and protective living environment, for vulnerable groups such as elderly. Within this context, the objective of this paper is to report the progress made by the Complete Ambient Assisted Living eXperiment (CAALYX) European Union-funded project.

Assistive technology is becoming increasingly popular among both the elderly and health care providers due to its unobtrusive nature and potential cost effectiveness. CAALYX goes beyond the current assistive technologies that are limited to the user's home, by proposing an additional mobile solution. This is in response to an increasingly mobile elderly population, a demographic group that wishes to remain autonomous and independent, yet is vulnerable enough to still require the attention of care givers.

This paper describes the main components of CAALYX that deliver a complete service enabling location awareness, 24/7 clinical and wellbeing monitoring of the elderly and timely response when needed. These components include a Home System, a Caretaker's System, and a Mobile System. The latter is composed of a mobile computer-phone and a Wearable Light Device (WLD) that bundles a number of sensors amongst which is a robust Fall Detection Sensor developed by the project. The challenges faced by the project consortium in developing this functionality in a successful product prototype are also discussed.

## Background

The majority of countries in the developed world are investigating and implementing eHealth solutions in order to alleviate the stress placed upon their burgeoning health care systems. It has been recognised that there are several important issues that have to be addressed regarding the provision of elderly health care services, including the increased demand of health care due to an increasing elderly dependency ratio and changed lifestyles leading to an increase in chronic diseases; the demand for increased accessibility to care outside hospitals, moving health services into the patient's own homes; the need for increased efficiency, individualisation and equity of quality-oriented health care with limited financial resources; and the difficulties of recruiting and retaining personnel in the services in general, and in-home and elderly care in particular [1].

These issues have made the adoption of eHealth a key priority for many countries. Funds are being invested that allow implementation to occur within the health service industry, both within Europe and abroad. In the United Kingdom, the Preventative Technology Grant (£80 million) was made available by the Department of Health in July 2004. The purpose of the grant was to advance the use of telecare within the UK, in order to enhance and maintain the independence of the elderly (a 160,000 increase of recipients was envis-

aged). The expected benefits of implementing this initiative in telecare are as follows [2]:

- Reduce the need for residential / nursing care;
- Unlock resources and redirect them elsewhere in the system where they would be better utilized;
- Increase choice and independence for services users;
- Reduce the burden placed on care givers and provide them with more personal freedom;
- Contribute to care and support for people with long term health conditions;
- Reduce acute hospital admissions;
- Reduce accidents and falls in the home;
- Support hospital discharge and intermediate care;
- Contribute to the development of a range of preventative services;
- Help those who wish to die at home to do so with dignity;
- Permit early patient discharge; and
- Reduce the costs incurred because of old age.

It must be noted that the expected benefits envisaged from implementing a telecare strategy place significant emphasis on residential location dependent health care, be it at the provider's location (residential/nursing care centre) or within the elderly person's own home. There is no clear strategy for the provision of mobile health care. As advances in location awareness technologies continues, the opportunity for introducing innovations, and the potential benefits for mobile health care beckon.

The growing importance placed upon caring for the elderly has led to the recently introduced European technology and innovation funding program, entitled 'Ambient Assisted Living (AAL)' [3]. Fourteen European States together founded the AAL association on 19th September 2007 in Brussels. It aims to address the needs of the elderly in society, reduce market barriers for new innovative technologies and also lower social security costs. Through the adoption of effective, intelligent products, it is anticipated that the elderly will be able to enjoy increased autonomy within their everyday lives. The first call for proposals under the new funding program was announced in 2008. From 1st September 2004 to 31st December 2006, preparatory work for this new funding opportunity was supported by the Specific Support Action project 'Ambient Assisted Living' under the Information Society Technologies (IST) priority within the 6th European Framework Program (FP6).

The importance placed upon using ICT to balance the demands of the consumer and the providers of health care cannot be overemphasised. High quality health care may be deemed a balancing act between the patient and the provider. Unless substantial health care is made available, demand will outstrip supply, resulting cost increase and reduction in access. Assistive mobile health care research projects such as CAALYX constitued an example of health care innovation to address this problem.

**The State Of The Art In Personal Health Care Assistive Technologies.**

At the 'World of Health IT 2007' conference and exhibition that was held in Vienna, Austria, in October 2007, and involved some of the leaders in the European Commission, the consensus was that a sustainable health care system can only be achieved by shifting resources from acute care to chronic care and prevention, by integrating social and health care, by encouraging patient empowerment and self-care, and by promoting clinical governance. To achieve these goals, there needs to be a collaboration on the care process and open communication between all parties and people involved, rather than a simple focus on clinical document/knowledge sharing, interoperability, and nation-wide EHRs (Electronic Health Records). Politicians have not traditionally focused on prevention because it does not have public aapeal. They are more focused on fighting acute "wars", like a champion riding a white horse and delivering people in acute crises (to use the same words of Dr Ilias Iakovidis, Deputy Head of Unit, ICT for Health, European Commission, Belgium, during his speech [4] at the conference). Iakovidis suggested that eHealth leaders should "speed up

the feeling of crisis" in order to stimulate movement in the right direction, and to make ideas about prevention and long term sustainability sellable to politicians. They should shift the core message of eHealth services toward 'patient safety'. Today, twice as many people die in and around health care providers because of a lack of proper communication than those who die in road accidents. While Europe for a long time has focused on eHealth organisational infrastructure and health care systems, the next frontier according to Iakovidis, is personal health care. This includes: **(1)** genomics; and **(2)** the effects of physical/biological and psychological environments and **(3)** the interaction between the two to help us understand and manage disease, thereby addressing almost 90% of factors affecting health status. Personal medical devices, telemonitoring and wearable or implantable monitors, and advanced miniaturization like [5].

The European Commission continues to provide funding for research of Personal Health Management Systems (PHMSs). It is expected that a PHMS will provide the ability to link an individual to a health care provider/information network, thus allowing personal health care to be managed by both the individual citizen and the state. The Sixth Research Framework Programme of the European Commission focused upon the provision of personalised health care via lightweight, wearable eHealth systems [4].

An eHealth system provides a solution that can utilise several information technologies, including the Internet. Several of the wearable eHealth systems have concentrated on the ability to monitor the body's vital signs and measure body temperature, pulse or heart rate, blood pressure, and electrocardiogram (ECG). Medical sensors have been employed either as part of a body worn system or alternatively integrated within a smart fabric garment. Recent developments have made use of intelligent wirelessly linked body plasters with embedded sensors [5]. Ancillary sensors that monitor physical behavior allow a history of activities to be added to current well being attributes, in order to better understand the current state of the person. The added benefits of utilising location-based technologies allow both health and location to be monitored when a person is mobile. Data gathered from the sensor devices are communicated to a central processing unit that can respond either locally or remotely. The use of wireless communication allows the sensor management system to pass messages/alerts to a remote service. The state of innovation in personal health care monitoring systems is reviewed by Gatzoulis and Iakovidis [6]. There is clearly work to be done before cost effective products are available in the global health market. The continued pattern innovation in technology is providing several examples of effective, eHealth prototypes.

The competition to design, develop and market a mobile health care solution that is safe, reliable, easy to use, and cost effective, and which also appeals to the elderly population is strong, with more than 5,000 relevant Small to Medium Enterprises (SMEs) currently operating in Europe and a forecasted trend for expansion of the market [7]. Research teams and business organisations throughout the globe continue to push towards the goal of ubiquitous health care. Local and regional demands and design considerations have shifted to cross-border initiatives.

To be successful, eHealth prototypes must secure a clearly defined place in the relevant markets based on actual need in a challenging climate of market fragmentation and lack of interoperability [7]. The investments made to date by the European Commission and those about to be made under the new AAL program were allocated with the expectation that further research in novel uses of ICT will ultimately result in innovative prototypes empowering individuals to manage their health and decrease the load on the state health care infrastructure. But the majority of EU projects that have received funding so far are concerned with innovative uses of ICT within the home environment. This is only one aspect of the elderly's life. Two other interrelated vital aspects are exercising and the maintenance of an active social life, both of which contribute to self-confidence and a positive psychological state. Who is going to be watching for them when they go out and about their daily outdoor activities? This kind of 'mobile health care monitoring' is what CAALYX and some other projects, e.g., [6,8,9,10,11] have focused on, without overlooking the home environment component.

**Complete Ambient Assisted Living eXperiment (CAALYX)**

CAALYX is a two-year eHealth project funded by the European Commission under FP6 [12,13].

It integrates the efforts of eight partners from six countries across Europe (Figure 1), with the common objective to develop a service for remote monitoring of the vital signs of elderly users while they are mobile and also at home, and respond proactively to adverse events such as falls.

Key features of the CAALYX system include vital signs monitoring, fall detection and location awareness [13]. The CAALYX project aims to analyze information captured by several wearable sensors, but also to consider historical information before triggering an alarm. By analyzing such information, the system will be able to detect and validate health alterations, with minimal false alarms. An initial prototype has been developed and is currently being tested. The CAALYX system will adopt existing industry standards and technologies in order to reduce initial and on-going system costs (e.g., the use of readily available mobile phone and medical sensor products). An overview of CAALYX is shown in Figure 2.

As shown in Figure 2, the CAALYX service enables efficient communication between the elder users, their family and a specialised caretaker site. While at home, the condition of an elder user is monitored through the Home System. This is an integrated Personal Computer / Television with access to the Internet and specialised software developed by Synkronix Ltd, UK (SYNK). This part of the system is used to relay data from various wearable sensors to the caretaker site and also to deliver content (such as questionnaires) or perform video conferencing between the caretaker site/family and the elderly. The Caretaker's Site, developed by Telefonica Investigacion y Dessarolo, Spain, implements the functionality required for specialized personnel to monitor the elderly and respond to their condition [14]. This completes the part of the system that is used to monitor an elder while at home. To enable elders maintain their confidence and lead active social and outdoors life, CAALYX complements the Home System with a Mobile System. This has been built around a common mobile computer-phone (a Nokia N95) with Global Positioning System (GPS), in addition to a Wearable Light Device (WLD) bundling a set of wearable sensors.

The WLD, developed by Corscience GmbH & Co, Germany, is used to process and measure specific vital signs of the elderly (e.g., pulse, blood pressure, temperature and ECG); to detect adverse events (for example, an elder person falling down), and to communicate automatically in real time with the caregiver in case of an emergency. Specialized software developed by the Instituto de Engenharia de Sistemas e Computadores do Porto, Portugal, runs on the mobile phone and monitors the measurements produced by the WLD. When it detects an emergency, it triggers a suitable response based on the severity of the situation wherever the elderly person happens to be, at home or abroad. Emergency information can be directed to the personal caretaker and/or the 112 Emergency Service, and it includes the geographic position of the elderly alongside specific health information to enable the recipient to initiate and direct a timely response. The templates for the clinical observation patterns that could indicate potential adverse health conditions are actively researched by the Hospital Sant Antoni de ABAT, Spain, and can be individualized, updated and delivered to the Mobile or Home Systems through a connection with the Caretaker's Site [15]. Apart from off-the-shelf sensors, CAALYX also utilizes a robust fall sensor contributed by the University of Limerick, Ireland [16,17]. (The WLD and its sensors are common to both the Home and Mobile Systems and can communicate with both, but in the home environment additional non-wearable/home-fixed sensors can also be provided, e.g., such is an electronic weighting scale.)

**A Service Design Informed By Stakeholder And Market Needs**

In order to design and implement a system of personal health care, both prototypes (research work) and products (real world products) need to be assessed. Under this perspective, the CAALYX consortium at the University of Plymouth, UK, interviewed a small, targeted and informal convenience sample of five key health care professionals from the United Kingdom in August 2007. They included a director of a private telehealth company, a telecare project manager at county council, a telecare project officer at a city council, a consultant clinical scientist at the NHS (National Health Service) Trust, and an NHS associate director of quality assurance. Although limited in scope, this survey helped in assessing the availability of Assistive Technology (AT) solutions for UK elders, together with their anticipated benefits. Key AT solutions available to support the elderly within their home in the UK are shown in Table 1.


**Figure 1.**
Countries participating in CAALYX.

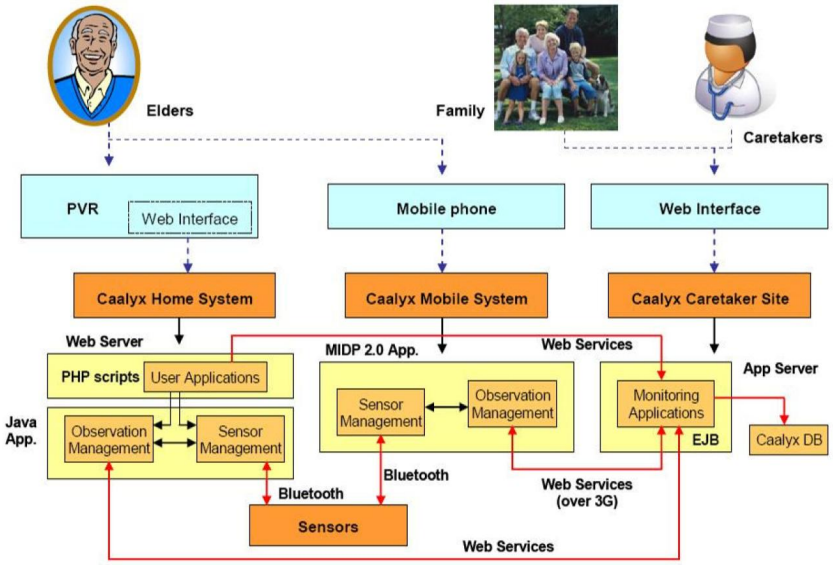


**Figure 2.**
**CAALYX overview**
PVR: Personal Video Recorder/Media Centre PC; PHP: Hypertext Preprocessor, a server-side scripting language; MIDP: Mobile Information Device Profile; 3G: 3rd Generation of mobile phone standards and technology; EJB: Enterprise JavaBeans; App: Application; DB: DataBase.

| | INTERVIEWEES | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1. Motion detectors linked to an alarm call centre | Yes | Yes | | Yes | Yes |
| 2. Smoke detectors to an alarm call centre | Yes | Yes | | | Yes |
| 3. Fall detectors worn on person | Yes | Yes | Yes | Yes | |
| 4. Flood detectors located in bathroom/kitchen | | Yes | Yes | | Yes |
| 5. Carbon monoxide detectors | | Yes | Yes | | Yes |
| 6. High temperature extreme sensors to detect fire | | Yes | Yes | | Yes |
| 7. Low temperature extreme room sensors | | Yes | Yes | | Yes |
| 8. Bogus caller detection fitted near home entrance | Yes | Yes | | | Yes |
| 9. Wandering client devices for dementia sufferers | Yes | Yes | Yes | | Yes |
| 10. Pressure mat detectors located at the bedside | | Yes | | | |
| 11. Bed and chair occupancy sensors | | Yes | Yes | | Yes |
| 12. Environmental assistive devices that open windows/doors | Yes | Yes | Yes | | |

**Table 1.**
Assessment of availability of AT for UK elderly.

The most frequent examples of AT devices provided by the interviewees were pendant alarms worn by the elder, fall detectors and bogus call detection systems fitted near the home entrance. Feedback from the interviewed professionals indicated that the lightweight personal pendant alarms were very popular with older people. Expected benefits of AT gathered from this survey were:

- Improved communication
- Faster emergency response
- Improved personal safety
- Self health monitoring
- Improved standards of living.

It was noted that during the survey no mention of weight monitoring was made. Health issues related to a major shift in weight gain/loss could be recognized through the use of intelligent weighting scales, e.g., fitted to toilet seats. Weight can be useful in monitoring fluid retention, e.g., in rapidly developing heart failure, and other clinical conditions. Often, simple solutions to personal health management, such as weight monitoring, are overlooked in favor of more complex technology based solutions.

Although widespread, the use of AT is usually installed according to the specific needs of the elderly person. The majority of AT solutions are residential location-dependent and fixed within the home environment. Specialized AT solutions, though personalized to the needs of the individual, may not be cost effective. The purchase and installation of several specialized AT devices may result in both expense and difficulties in relocating the installed technologies, if the elderly user has to re-locate. Dis-

parate, heterogeneous health care systems may also be difficult to support and integrate (i.e., the crucial cost factor), and also complex for gathering patient information (information collection, exchange and interpretation). The fact that these systems can suffer from poorly defined information exchange interfaces, there is increased potential for breaches in patient information security and malpractice.

In order to produce an exploitable eHealth system, several market influences including cost, information interchange and data security need to be addressed. Moreover, a full understanding of older people's behavior, motivation, and criteria for their acceptance of wearable biomedical sensors and 24/7 monitoring technologies is crucial for designing successful technical solutions for this user group [18].

In addition to the mini-survey, the results of research performed at early stages of the CAALYX project, which involved representatives (actual or proxies) of the key stakeholders of the anticipated service/product helped in outlining a series of issues that informed the definition of service specifications. This investigation was carried out through carefully composed questionnaires and included 52 elders, direct users of the CAALYX service, 32 family members and 15 caregivers. The issues identified and criteria are as follows:

- The integration of the CAALYX system with existing telecare/eHealth systems would reduce costs and promote adoption.

- Integration of new technology solutions with existing equipment already installed within an elderly person's home would increase user acceptance and reduce system expense.

- Several vital signs, including blood oxygen measurement (pulse oximetry), are required for gauging health status.

- A personalised system is required. Different age/language groups may require different services.

- Simple system functions are required, accessible through appropriate, user-friendly interfaces.

- The opportunities of location awareness services via GPS should be exploited, e.g., the retrieval of lost Alzheimer sufferers.

- Acceptance and use of technology may prove difficult, if the elderly are not given adequate training and education.

- Reliable access is required to immediate technical support in case of need.

- Insufficient circulation of existing health care service information to the elderly could be improved through the Home Monitoring System.

Moreover, to improve the elderly care at home and outside, the monitoring system should support the adequate exchange of health care information between different devices and health record systems, as necessary. Several eHealth solutions have been proposed in recent years that have concentrated on the use of cutting edge technology to provide a home/mobile personal health care solution, at the expense of actual exploitability in the real world. Such research initiatives have met their short term objectives. But at the end of their funding cycle, they failed to provide the elderly with a real world product that they can make benefit from. CAALYX seeks to continue its lifespan from prototype design to product development by considering key market influences on system implementation. Thus, the elderly should benefit from the research investment.

Currently, the development of the individual hardware and software components of CAALYX has reached a mature enough stage to be tested as a "complete" service. Trials with real elderly subjects are scheduled to take place in October 2008, in collaboration with COOSS MARCHE ONLUS Soc. Coop. p.a., in Ancona, Italy. Two groups of 10 representative users each have been selected to test the system in the controlled environment of an elderly nursing home, but also independent users in rural areas. The duration of the trial for each group is one month with one week of installation/familiarization with the system, followed by three weeks of actual use. During this time, the functionality of the individual components as well as the service as a whole will be tested, would and ultimately provide hard evidence whether the developed solution addresses the concept of Ambient Assisted Living (AAL) and what actual improvements it offers ofr independent living.

**Cost Issues**

The purchase, installation and maintenance of an eHealth solution must be cost effective/justifiable for the service to be viable on the long term. It has long been recognised that novel eHealth solutions must be financially justifiable or they may never evolve past the prototype stage, ending up as an expensive, singular and shelved experiment.

Plans call for offering CAALYX as a complete end-to-end monitoring service to the very complex and heterogeneous European health care environment. At this stage of development, it is worthwhile to review the strategic choices made by the consortium in order to maximize the value offered to the user versus initial estimates of cost.

In general a key component can increase the value of a service or product is the adoption of standards, especially in a project with limited funding (such as CAALYX). The adoption of open standards should also prove flexible and not dependent on closed, proprietary and usually more costly solutions. Standard hardware, off-the-shelf equipment such as sensors with the smaller scale development of the WLD and Fall Sensor, and standards-compliant software components and tools have been chosen, developed and adopted, in order to reduce both initial prototype costs/time-to-market and make CAALYX a viable, interoperable and easily expandable solution in the long term. These devices do not limit the user to the functionality provided by CAALYX, as a multitude of other interesting daily activities can also be undertaken through these powerful and small devices. As these devices increase in functionality and offer more information services, the challenge for CAALYX and other eHealth innovations will allow other information systems to interoperate with other products and services in a synergistic manner.

In order to ensure proper intra and inter-system interoperability, i.e., 'plug and play', the hardware and software components in CAALYX have been integrated within a flexible, generic and scalable design that can further evolve according to the individual needs of the users and providers, and the current and future states of technology.

Additional value is provided through the set of capabilities that the service plans offer to the elderly and most importantly to their families. They will be presented with a more complete way of quickly getting in contact with, and checking the condition of, their elderly relatives. The choice of the project consortium to invest in a robust fall sensor offers the project the possibility of alleviating the economic cost of falls. Just in the UK and Ireland, this cost of falls for people aged over 60 is estimated to be in the order of millions of pounds [19,20].

The target group to which these features of CAALYX are offered are users aged 65 and older, living off their pension and in, or close to, an urban environment. Their health is mainly hindered by physical instability problems and fears of falling that are rather common in this age group, which affect their self confidence and social life. They might be receiving some routine medication, and they interact with their doctors from time to time through the telephone or appointments. The user's knowledge and relationship with ICT is reasonable, since they are required to be able to interact with a common television set (or media center home computer equivalent), landline phone or mobile phone, and be financially able to support a broadband Internet connection. According to the available Eurostat figures [21], the population of Europeans between the ages of 65 and 89 years is approximately 80 million elders, and is projected to increase.

Ongoing work on the project's utilization plan reveals an inherently difficult to get accurate cost estimates that these benefits might accrue [22]. However, with a current Research & Development expenditure by the project consortium in the order of millions of Euros, and the current consensus that investments in eHealth are profitable in the long term. The project is looking at a four to five year plan to establish and operate a business entity managing the delivery of the services and products.

**Standards and the CAALYX Project**

The selection and use of standards is influenced by several parameters, including politics and the commercial marketplace. It may be argued that selection of a standard is similar to the selection of a technology brand. Its choice may be determined by the location of the user group. Europe is still struggling to meet and combine the needs and demands of its member states. The flexibility to choose and adopt several ICT standards has led to many health

care information systems that are not interoperable.
The commercial stakes are high. The user 'buy-in' to technology has allowed some business organisations to grow and prosper. Moreover, commercial entities have grown so large and wealthy, that anti-monopolistic legal actions have had to be enforced in some instances.

As Norman Worth explains, standards are meant to help subsystems and components to be replaced or added without replacing the entire system. But unfortunately, the standards now seem to have a lifetime not much longer than the components'. Standards also often change solely for competitive reasons, not because of technical inadequacy [23].

ICT companies may seek to enforce their de-facto standards in order to strengthen their market position and exclude other competitors, e.g., are there any alternative strong products available, instead of Microsoft Office? – Other than perhaps OpenOffice.org (which is even boasting its compatibility with Microsoft Office document formats as one of its important features).

The CAALYX Consortium has realised the benefits of adopting open standards and interfaces, in order to allow wider adoption of the project's output. Research undertaken by the University of Plymouth, UK has identified seven areas demanding careful choices of standards within the CAALYX system components depicted in Figure 2. For each of these areas, a range of available standards was identified and the best solution selected. These standardization areas are:

- Interoperability
- Device Communications
- Location-Awareness
- Security and Privacy
- Video
- Medical Devices
- User Interface: Presentation and Interaction

Interoperability is a key feature in today's world of interconnected systems. Any communication of CAALYX with external systems, such as a national medical information system to retrieve patient information, should conform to the HL7 (Health Level 7 [24]) standard version 2.3 or higher [25,26,27,28]. Communications between devices in the Body Area Network (BAN) are occurring over the Bluetooth standard, while Location-Awareness is provided through the use of Assisted Global Positioning System (A-GPS) built within the user's mobile computer-phone (Nokia N95 in the current prototype). The important issues of user Security and Privacy when communicating over the internet are addressed through the adoption of the Transport Layer Security (TLS), also employed by other applications handling sensitive user information, as well as service-wide audit trail logs. Video communications between the user's Home System and the Caretaker's Site are carried over standard protocols and Personal Computer equipment with Internet connectivity. In terms of medical device communications, CAALYX will be conforming with the IEEE 11073 Point of Care (POC) standard [29], which will also make it interoperable with a multitude of available devices conforming to this standard, which is now at the centre of the Continua Health Alliance Certification Programme [30]. Finally, in terms of User Interface, an area where standards are relatively young, a set of 'best practice' guidelines and feedback from user testing are to be followed.

CAALYX is making extensive use of standards, capitalising on tried and tested solutions to speed up its development and also make it interoperable with a range of existing and future systems and devices.

Although it is a relatively small European project, CAALYX has some potential at influencing, or at least introducing, the novel use of the Sensor Web Enablement (SWE) specifications[31] within its location awareness and data collection functionalities, as the first such use of SWE in a health care context anywhere in the world.

Standardization seems to be a two-edged sword that research and development teams have to manage properly, in order to conform to existing standards and better "sell" their project (i.e., by linking with existing standards frameworks), and yet demonstrate innovative use by overcoming the existing standardisation constraints (i.e., they have to 'conform yet not-confirm!' in order to innovate). This introduces the danger of making one innovative step forward, followed by two steps backwards.


**Figure 3.**
'Standard, open systems' for increased project exploitation.

To conclude, the fact that the EU has yet to standardise upon monetary currency, language, and even basic electricity appliance plug type, emphasises the difficulties faced by global standardisation bodies. Research and development eHealth projects have to negotiate the quagmire of standardisation. Long standing, existing societal components may prove difficult to overcome. One may argue that ICT allows a bridge to be built, to allow the various societal-system components to be linked. Already efforts are being made to connect different system components together. Disparate systems exist and will continue to do so. System re-engineering will continue to be necessary, in the short to medium term, in order to 'hook up' different ICT systems. Flexible, service-oriented architecture provides a useful methodology for the creation of a virtual standardisation/information system bridge, with added value (e.g., customer focused information services). Any framework will be useful within its initial basic conceptual form. If the framework design changes due to the pulls and pushes from several standards adopters, the ability of the framework to remain an effective standard may weaken. Early standards adopters may be forced to update their ICT systems or suffer from standards obsolescence; e.g., the NHS is still in the process of adopting Health Level Seven (HL7) version 2.3 in some of its systems; however the HL7 standard framework has already evolved to HL7 version 3 (which is significantly different from version 2.3, and which the NHS is also currently considering)!

One of the key research task's that will be undertaken in due time is to develop a detailed open-standards-based marketing strategy that will allow CAALYX to establish itself in the European eHealth market (Figure 3).

**Conclusion**

The cost of providing any customer service may become excessive if growing large scale demand outstrips a finite supply. A key supply determinant is the availability of financial resources. If a health care service provide cannot afford to supply or maintain a particular service, that service may be lost. The novel use of technology is deemed one measure to enhance and maintain the capacity of the health care provider. Intelligent design and development of effective products will continue to be vital. The adoption of global standards will address individual and state concerns over safety, interoperability and data privacy issues. Standardisation efforts may seriously constrain technical innovation and exploitation, unless novel approaches are discovered. The livelihood of both the customer (the elderly citizen) and the supplier (the state health care provider) are at stake. In the past, a large capital outlay was made to implement ambient assisted technologies located within the elderly's homes. Such investment has indeed benefited thousands of elderly and continues to do so. An elderly person, who is provided with static assistive technologies within his/her own home, may be at risk as soon as he/she travel outside. The elderly may become reluctant to leave the safety of their home, becoming isolated and lonely.

In order to promote autonomy and well being, health care for the elderly has to be provided both in the home and outside. People are on the move, both young and old. Today's increasingly transient populations, must be provided with 'health care anyplace and anytime'. It is vital that the elderly are provided with a 'safety zone', both inside and outside their home, at work and at play. CAALYX is an eHealth research initiative aimed at providing a personalized, non-intrusive mobile health care

system. By developing remote monitoring systems, that can capture vital physiological signs and detect life threatening falls, it is hoped that the elderly may enjoy a safe, autonomous lifestyle, both at home and outside.

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