AAL-45061

Deliverable D 2.1
Title: State-of-the-art and Requirements Analysis

Deliverable Type:	**PU***
Nature of the Deliverable:	**R****
Date:	**26/02/10**
Distribution:	**WP2**
Code:	**HERA-SILO-WP2-D21-final**
Editor:	**SINGULAR LOGIC SA**
Contributors:	**All partners**

*Deliverable Type: *PU= Public, RE= Restricted to a group specified by the Consortium, PP= Restricted to other program participants (including the Commission services), CO= Confidential, only for members of the Consortium (including the Commission services)*

** Nature of the Deliverable*: P= Prototype, R= Report, S= Specification, T= Tool, O= Other*

Abstract: This document represents the deliverable D2.1 – State-of-the-art and Requirements Analysis. The aim of this deliverable is to gather the requirements from user perspectives, to define the functional and technical requirements of the HERA platform and its components, to define a set of use cases following the captured requirements and to perform a state-of-the-art analysis related to Ambient Assisted Living, focused on the technological area of HERA.

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ABBREVIATIONS

3G	3rd Generation, a family of standards for mobile telecommunications
A	
AAL	Ambient Assisted Living
ACL	Agent Communication Language (agent systems context)
ACL	Access Control List (user authentication/authorization context)
AD	Alzheimer's Disease
ADSL	Asymmetric Digital Subscriber Line
AID	Agent Identifier
AJAX	Asynchronous JAvascript and XML
AmI	Ambient Intelligence
API	Application Programming Interface
C	
CDA	Clinical Document Architecture
CMD	Command
CORBA	Common Object Request Broker Architecture
D	
DCOM	Distributed Component Object Model
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4th Edition
DTD	Document Type Definition
DVB	Digital Video Broadcasting
DVB-S	Digital Video Broadcasting forward error coding and modulation standard for Satellite television
DVB-T	Digital Video Broadcasting–Terrestrial
DTT	Digital Terrestrial Television
E	
ECG	ElectroCardioGram
EJB	Enterprise Java Beans
EMG	ElectroMyoGram
F	
FIPA	Foundation for Intelligent Physical Agents, http://fipa.org
G	
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
GUI	Graphical User Interface
H	
HDMI	High-Definition Multimedia Interface
HL7	Health Level 7

HMI	Human-Machine Interface
HTML	Hyper Text Markup Language
HTTP	Hyper-Text Transfer Protocol
HTTPS	Hyper-Text Transfer Protocol Secure

I	
ICD	International Classification of Diseases
IEEE	Institute of Electrical and Electronics Engineers
INR	International Normalized Ratio
IST	Information Society Technologies
IP	Integrated Project
IP	Internet Protocol
IrDA	Infrared Data Association

J	
JADE	Java Agent Development Environment, http://jade.tilab.com/

M	
MAS	Multi-Agent System
MCI	Mild Cognitive Impairment
MDA	Model-Driven Architecture
MDE	Model-Driven Engineering
MHP	Multimedia Home Platform
MMSE	Mini Mental State Examination

N	
NF	Non-Functional (requirement)
NFC	Near Field Communication

O	
OMG	Object Management Group, http://www.omg.org
OSGi	Open Services Gateway initiative, http://www.osgi.org
OWL	Web Ontology Language

P	
PA	Personal Assistant
PC	Personal Computer
PDA	Personal Digital Assistant
PSTN	Public Switched Telephone Network
PT	Prothrombin Time

R	
RDF	Resource Description Framework
RFID	Radio Frequency IDentification
RMI	Remote Method Invocation
RO	Reality Orientation

RPC	Remote Procedure Call
RPG	Requirements per Goal document
RS-232	Recommended Standard 232

S

SMS	Short Message Service
SoA	Service-oriented Architecture
SOAP	Simple Object Access Protocol
STB	Set-Top-Box

T

TCP	Transmission Control Protocol, one of the core protocols of the Internet Protocol

U

USB	Universal Serial Bus

W

Wi-Fi	Wireless network technology
WP	Work Package
WSDL	Web Services Description Language

X

XML	eXtensible Mark-up Language
XSD	XML Schema Document

1. INTRODUCTION

The HERA project aims to provide a platform with cost-effective specialised assisted living services for the elderly people suffering from MCI or mild/moderate AD or other diseases (diabetes, cardiovascular) with identified risk factors, which will significantly improve the quality of their home life, extend its duration and at the same time reinforce social networking.

The HERA platform will provide the following main categories of services:

- **Cognitive reinforcement services:** These services enhance the cognitive functions of the users and aim at delaying the progression of the disease.
- **Physical reinforcement services:** These services aim at promoting the physical fitness and the health of the elderly.
- **Patient specific home care services:** This service category includes social reinforcement services, reality orientation support services and services capable to monitor several disease risk factors.
- **General home care services for elderly:** This service category includes medication reminder services, information services as well as alarm services in cases of abnormal health conditions.

HERA will apply technological solutions for aiding users managing their daily lives. Thus, by using the HERA system, the time to be at home, rather than in an institution, will be prolonged and relieve them from visiting the specialists often, while keeping them able to perform their daily activities and social interactions.

This document represents the deliverable D2.1 – State-of-the-art and Requirements Analysis, which is the result of Task 2.1 "Review of state-of-the-art and identification of technological requirements" and Task 2.2 "Definition of the requirements from the elderly perspectives" in WP2. The aim of this deliverable is to gather the requirements from user perspectives, to define the functional and technical requirements of the HERA platform and its components, to define a set of use cases following the captured requirements and to perform a state-of-the-art analysis related to Ambient Assisted Living, focused on the technological area of HERA.

1.1 SCOPE

The general scope of this deliverable is to gather and analyse the user requirements, primarily originating from the user groups, as well as, AAL practices consolidated in other research or commercial activities, with the aim to conclude in a comprehensive set of requirements addressing all HERA components.

Regarding user requirements capturing, this deliverable is concerned with two (2) main user group categories, namely:

- People suffering from MCI or mild/moderate AD (HYGEIA).
- People suffering from diabetes and cardiovascular diseases with identified risk factors (ROTES KREUZ).

Further to user requirements, information regarding issues related with the functional requirements of the HERA system is collected by the relevant user groups in a structured manner (i.e. that of use cases).

The deliverable is also concerned with issues related to the technical requirements of the HERA AAL platform, such as:

- *System architecture*, what components typically constitute such a system, how are they

interconnected, what do elderly people need for interacting with a platform such that of HERA, what standards exist in this application domain.

- *Services*, what services are available in the market, what requirements exist for such services.
- *Hardware*, what kinds of devices are currently available in the market.

This deliverable serves to outline the future work in the HERA project by:

- Identifying and analysing available state-of-the-art technologies and devices, with a view to select and exploit some them in the specification of the overall HERA architecture in the deliverable D2.2 "HERA Specifications and Validation Plan".

- Defining the functional and non-functional requirements for the HERA architecture as the basis for future work in the project (D2.2, WP3 and WP4 deliverables).

- Defining the candidate services to be deployed in the trials phase of the project (WP6).

1.2 DELIVERABLE STRUCTURE

The deliverable is structured in seven chapters:

- Chapter 1 is the introduction of the document.

- Chapter 2 documents the user requirements along with the methodology for capturing them. Firstly, the HERA user groups are identified and then their representatives explain their needs regarding the use of the HERA system, but also with regard to the importance of the different HERA services for each user group. Information regarding issues related with the functional requirements of the HERA system is collected by the relevant user groups in the form of use cases.

- Chapter 3 reports the different technological approaches to AAL in the area of HERA. The architectural approaches include issues such as communication and middleware technologies, agent and argumentation technology for AAL, data modelling, human-machine interfaces and security issues.

- Chapter 4 presents a set of standards that are relevant to HERA. Standards relevant to communication, medical data exchange, human machine interfaces and agent technology are catalogued.

- Chapter 5 provides a survey of software services relevant to the HERA objectives. Both the requirements for such services, but also the major representatives in the market are discussed. These include services for cognitive, physical and social reinforcement and information services, along with services for reality orientation and monitoring vital parameters.

- Chapter 6 provides a set of candidate devices for use in HERA. Three important hardware categories, i.e. the set-top-box, the application server and the medical devices (or sensors) are surveyed and the most important candidate products for HERA are discussed in detail.

- Chapter 7 draws conclusions and provides the captured requirements consolidation. Conclusion summarizes the findings of this document trying also to provide a quick reference to the HERA requirements. Towards this end, it catalogues the requirements and associates them to the HERA use cases. It also summarizes the services needs per user group in one table.

A set of annexes includes information such as use cases capture templates as well as the set of questionnaires used during requirements capturing.

1.3 METHODOLOGY

To end up with a set of HERA requirements, a specific methodology has been followed. A diagram presenting the methodology is depicted below.
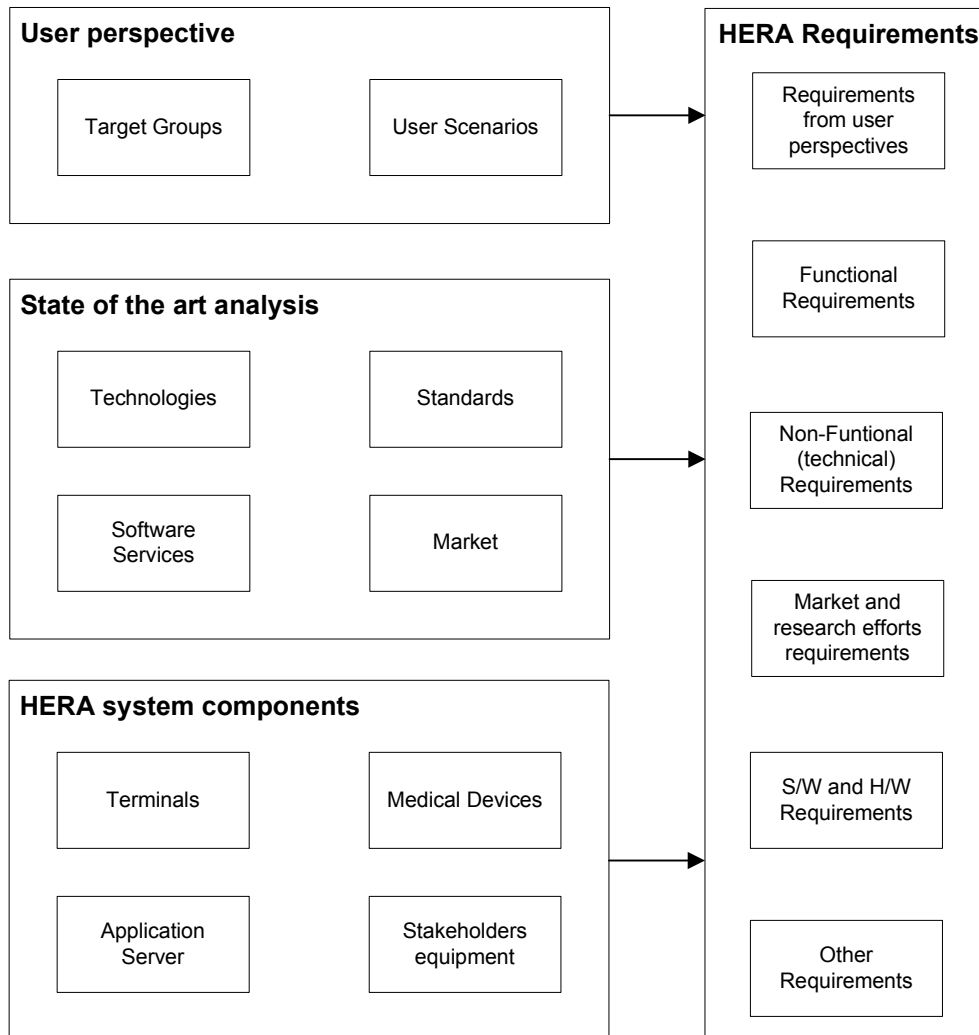
Figure 1: Methodology followed for requirements capturing

Firstly, the target user groups of the HERA system were identified. Regarding the requirements elicitation from the user perspective, a general methodological framework was defined, which was then further elaborated by HYGEIA and ROTES KREUZ, based on the different user groups special needs and their expertise. This information is documented within chapter 2. Information regarding issues related with the functional requirements of the HERA system is collected by the relevant user groups in a form of use cases.

The state-of-the-art analysis in AAL technological approaches in the area of HERA includes surveys in the relevant literature as well as market surveys focused on technologies, standards and available software services and hardware products. These include terminals, medical devices, the Application Server and its communication and interfacing capabilities with other stakeholders' equipment of the HERA system. This way generic architectural requirements, as well as market and requirements from other research efforts have been derived.

2. USER REQUIREMENTS ANALYSIS

This chapter defines the Requirements capture methodology and then presents the relevant results. Thus, its first section (§2.1) presents a brief common requirements gathering methodological framework, which is then specialized in the following chapters for specific user groups data gathering. Two large user groups' requirements were gathered by HYGEIA and ROTES KREUZ, the first for persons with mild and cognitive AD and MCI, and the second for persons with cardiovascular diseases and diabetes. Both gathered general elderly people's requirements.

Section 2.2 documents the requirements gathering methodology application for the diabetes and cardiac diseases user group. The next section (§2.2) is about the requirements of the other general user group, i.e. that of MCI and AD. The results from these surveys are presented in the last two paragraphs, the first cataloguing the defined use cases (§2.4) and the second presenting the ranking of the HERA services for each user group (§2.5).

2.1 HERA USER GROUPS AND REQUIREMENTS CAPTURE METHODOLOGY

2.1.1 REQUIREMENTS GATHERING METHODOLOGICAL FRAMEWORK

The following general steps were decided to be followed for gathering the HERA requirements:

1. Read in the literature and analyze previous works and document

    a. User needs

    b. Ethical issues

    c. Regulatory framework

2. Perform semi-structured interviews with professionals (six to eight representatives)

3. Conduct discussions with each patient and possibly family care givers user group (10 representatives)

4. Possible second round of interviews with professionals

5. Cross check the technical annex scenarios with the results of points 1-4 and expand-elaborate the scenarios in the form of use cases. The use cases were documented using the relevant template and guidelines that are included in annex A of this deliverable

Taking into account the diversity of the user groups (see next paragraph) we decided that the user representative and requirements gathering organizations, i.e. HYGEIA and ROTES KREUZ would use this general methodology as a guideline and proceed in requirements gathering.

This methodology specialization and use cases elaboration is presented graphically in Figure 2. HYGEIA and ROTES-KREUZ specialize the general methodological framework according to the special cases of their user groups and gather requirements in free text format. Then, we identify and catalogue specific requirements and create use cases to address them. However, the use cases are defined with regard to HERA unique functionalities and not related to the definition of existing services. HERA services are supposed to be used from the market or be similar to those existing in the market, thus they are presented in chapter 5 in the form of services market survey.
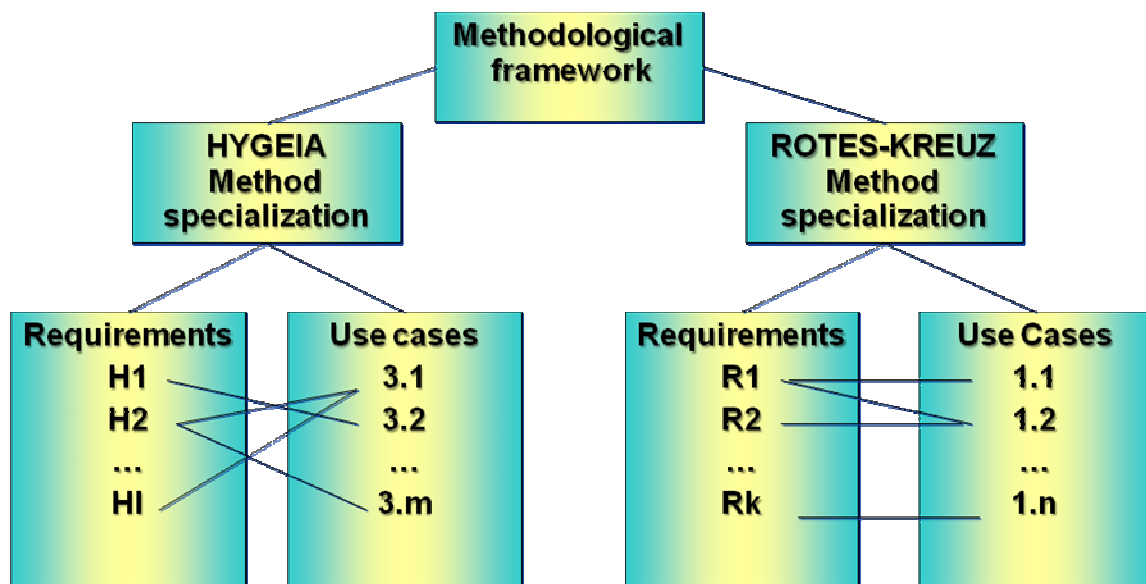
Figure 2: Requirements gathering and Use cases extraction in HERA.

2.1.2 USER GROUPS

The following user groups were identified for the HERA system:

- Patients

    o Mild AD > 65 years

    o Moderate AD > 65 years

    o MCI > 65 years

    o Elderly – persons > 65 years

    o People with Cardiovascular diseases > 55 years

    o People with diabetes without need of insulin > 55 years

- Professionals (nurses, psychologists, doctors)
- Family care givers (people that live under the same roof with the patient)

The reader should note that the people with Mild Cognitive Impairment (MCI) have been separated from those with Alzheimer's Disease (AD). On the one hand, MCI is a transitional state between normal aging and mild dementia. It is used to describe a group of elderly subjects who have cognitive impairments, often involving memory, not of sufficient severity to warrant the diagnosis of dementia. Implicit in the MCI concept is the idea that these subjects are at increased risk of developing dementia. Depending on the cohort source and definition, between 19 and 50% of MCI patients progress to dementia (usually AD) over 3 years. On the other hand, AD is a progressive, fatal neurodegenerative condition characterized by deterioration in cognition and memory, progressive impairment in the ability to carry out activities of daily living and a number of neuropsychiatric and behavioral symptoms. AD is the most common form of dementia among elderly and accounts for approximately two thirds of cases of dementia.

However, even the AD users are further divided in two user groups, as they have different characteristics, symptoms, needs and, possibly, requirements. In brief:

- Mild AD: Frequent recent memory loss, particularly of recent conversations and events. Repeated questions, some problems expressing language. Depression and apathy can occur. Personality changes may accompany functional decline. Need reminders for daily activities, and difficulties with sequencing impact driving early in this stage.

- Moderate AD: Can no longer cover up problems. Pervasive and persistent memory loss impacts life across settings. Rambling speech, unusual reasoning, confusion about current events, time and place. Potential to become lost in familiar settings, sleep disturbances and mood or behavioral symptoms accelerate. Nearly 80% of the patients exhibit emotional and behavioral problems which are aggravated by stress and change. Need structure, reminders, and assistance with activities of daily living.

2.2 DIABETES AND CARDIAC DISEASES USER GROUPS REQUIREMENTS

This section presents the results of the user-requirement analysis concerning patients suffering from diabetes and cardiac diseases.

2.2.1 INTRODUCTION

The goals of the following report were to identify the user needs, ethical issues and relevant aspects of the regulatory framework. This was achieved by means of a literature review and by carrying out and analyzing qualitative semi-structured interviews with 3 physicians and 4 registered nurses.

A person's quality of life is strongly affected by his or her health and is an important factor for economic and social performance.

Health status is determined to a great extent by the occurrence of long-lasting, i.e. chronic diseases and complaints and by mental health and social wellbeing. Chronic diseases can severely limit the ability to perform everyday activities, and not only impair the quality of life of those affected but may also involve high treatment costs. In 2006/07 84.3% of the interviewed Austrian citizens in the age from 60 to75 year suffered from effects of a chronic health problem, as can be seen in Table 1.

Table 1. Prevalence of at least one chronic disease 2006/07

Age	2006/07	
	Persons in 1.000	min. one chron. disease
	Overall	
Overall	**6.991,9**	**64,8**
15 up to 30	1.545,5	43,7
30 up to 45	1.957,7	55,2
45 up to 60	1.665,7	71,7
60 up to 75	1.172,6	84,3
75 and more	650,3	91,5

Q: STATISTIK AUSTRIA, Austrian Health survey 2006/07. (Created on: 14.10.2009)

Suffering from a cardiovascular disease or diabetes requires constant monitoring and therapy adjustment to avoid complications; the use of telematics has opened up opportunities to improve the quality of care for people requiring regular monitoring. More than ten years ago a published article promised: "Telematics in the healthcare domain has been found to lead to significant improvement in health care services" (Beltrame et al. 1998).

2.2.2 METHOD

For the literature research the Pubmed, Medline and Cinahl database were used as well as google scholar. Articles published within the last three years have been included. Keywords were: telemonitoring, telecare, ethics, chronic disease, usability and self management.

For this review three categories were defined (user needs, ethical aspects and regulatory framework) in which the literature was integrated.

Telemonitoring is defined as the use of information technology to monitor patients at a distance (cp. Meystre 2005).

2.2.3 LITERATURE REVIEW RESULTS

2.2.3.1 USER NEEDS

Patient-centered telemedicine has generally produced positive results and older people are increasingly using new technologies in their homes (e.g. computers, medical devices etc.).

It was difficult to find relevant scientific research papers for the topic "user needs" within the last three years. As a consequence of this we extended the time limit for published literature to the last ten years, and came to the result that until now social science did not engage very ambitiously in this topic.

Few findings can be detected in project reports but universally valid data rarely exists. This leads to the awareness, that user needs have to be seen much in an individual context for each project.

This view reveals that we increasingly enter the field of human norms and the possible infringement of these. The step from measuring physical functions to performing an intervention requires interpretation of the health information.

Decisions must be correct, prudent and taken at the right moment. Yet who determines when that is the case? Who programs that? Different needs and interests often need to be weighed up against each other in healthcare (cp. Schuurman et al. 2009).

Assistive Technology has the potential to narrow the gap between an individual´s capacity and their environment, and therefore to make it easier for people to remain in their existing accommodation. But as Mc Creadie and Tinker (2005) note, the heterogeneity of older people and the diversity of their living circumstances mean that individual preferences will play a strong part in people´s attitudes.

Jakob Nielsen's heuristics are probably the most frequently used usability heuristics for user interface design. Nielsen developed the heuristics based on work together with Rolf Molich in 1990. The final set of heuristics that are still used today were released by Nielsen in 1994.The heuristics as published in Nielsen's book "Usability Engineering" are as follows:

- Visibility of system status: The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

- Match between system and the real world: The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms.

Follow real-world conventions, making information appear in a natural and logical order.

- <u>User control and freedom:</u> Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

- <u>Consistency and standards:</u> Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

- <u>Error prevention:</u> Even better than good error messages, a careful design prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

- <u>Recognition rather than recall:</u> Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

- <u>Flexibility and efficiency of use:</u> Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

- <u>Aesthetic and minimalist design:</u> Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

- <u>Help users recognize, diagnose, and recover from errors:</u> Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

- <u>Help and documentation:</u> Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

Paré et al. (2007) discussed systematically in their review the nature and magnitude of outcomes associated with telemonitoring four types of chronic illnesses: pulmonary conditions (18 studies), diabetes (17 studies), hypertension (14 studies) and cardiovascular diseases (16 studies). Based on the results of this review, home telemonitoring of chronic diseases is a promising patient-management approach that produces accurate and reliable data, empowers patients, influences their attitudes and behaviors, and potentially improves their medical conditions. Nevertheless they note that more studies are required to build an in-depth body of knowledge related to its clinical effects, cost effectiveness, impact on the utilization of health services, and acceptance by health care providers.

One of the finding of the review was that there is a strong connection between user needs and ethical aspects which recommends the usage of a holistic approach to this topic.

2.2.3.2 ETHICAL ASPECTS

The ethical perspective has relevance and can be applied at all levels in the process of supporting independent living and homecare for older people. Ethics in this field have importance for researchers who develop and test technologies, and for designers who define their features and functions. They are also important at the policy and governance levels.

Long term care for older people is a multidisciplinary process, often including elements of both social and medical care, and it has been argued that existing traditions in medical ethics may not be well-tuned to the issues that arise in this context.

The ethics of telemonitoring have received less attention to date, even though this is at the core of home telehealth for older people with chronic conditions or after early discharge from hospital. The issue of the handling of medical calls / data by non-medical personnel is becoming an increasingly important issue. Following the ten ethical principles specified by Tannahill (2008): do good, do no harm, equity, respect, empowerment, sustainability, social responsibility, participation, openness and accountability Kubitschke et al. (2009) defined ethical aspects applicable for Telemedicine.

Overview of ethical aspects (*Kubitschke et al. 2009*)

The principle of *informed consent* is the basis for any participation in research because telecare and home telehealth are service innovations that potential users will not generally be very familiar with. The fundamental principle should be that people know what they are signing up for. This is linked to the more general issue of *transparency*, where the key ethical principles revolve around clearly explaining what the services intend to do and how they operate.

The principle of *proportionality* requires that the level of intervention should be restricted to what is really necessary for the situation. Thus technology overkill should be avoided, in the sense that functionalities and equipment should be selected because they are really needed, not because they are available.

Technology supported monitoring and surveillance also raise key ethical concerns about issues of *privacy* and personal and family *dignity* as it relates to privacy. The key issue is, what data is collected and what types of processing / interpretation / presentation are permitted, and who has access to this.

Apart from the main care-related functionalities discussed above, ethical issues also arise in relation to the more general technical design features of the technologies to be installed in the home. One aspect concerns *usability* and general age-friendliness for the user groups. Issues of *user control* are also important – how much control does the user have, can they switch off systems if they want to?

An important perspective for the application of technologies in the care sector is to consider the overall socio-technical system, not just the technology itself. One aspect concerns the *codification of responsibilities and actions* – who is to be alerted when care is required – formal care services or family? Who is to be called first?

The process of implementation of the technology into the home also needs careful attention from an ethical perspective, including installation, adjustment and removal. Many older people live in old homes, so the necessary infrastructure for a telemonitoring system may require adjustments (e.g. wiring) that could cause considerable *disruption* in the daily life. A question that arises is how much control is given to the user (e.g. to switch off the technology).

2.2.3.3 REGULATORY FRAMEWORK

For Austria there are several laws to consider.

- **Nursing Care Law** (in German *Gesundheits- und Krankenpflegegesetz*) Main important facts of this law are the specified regulations which control the workflow between the medical part and the part of the professional caregivers.
    1. The self-dependent field of action (§ 14)
    2. The jointly responsible field of action (§ 15)

3. The interdisciplinary field of action (§ 16)

URL:

http://www.jusline.at/index.php?cpid=f04b15af72dbf3fdc0772f869d4877ea&law_id=293

▪ **Federal Act concerning the protection of Personal Data** (in German *Datenschutzgesetz*)

URL:

http://www.ris.bka.gv.at/Dokument.wxe?Abfrage=Erv&Dokumentnummer=ERV_1999_1_1 65

▪ **Medical Device Law** (in German *Medizinprodukte Gesetz*)

It includes the maintenance of equipment the inspection and the service of medical devices.

URL:

http://www.ris.bka.gv.at/Dokument.wxe?Abfrage=Erv&Dokumentnummer=ERV_1999_1_16 5

▪ **Governing the Liability for a Defective Product** (in German *Produkthaftungsgesetz*)

URL:

http://www.ris.bka.gv.at/Dokument.wxe?Abfrage=Erv&Dokumentnummer=ERV_1999_1_1 65

▪ **Product Safety Act** (in German *Produktsicherheitsgesetz*)

URL:

http://www.ris.bka.gv.at/Dokument.wxe?Abfrage=Erv&Dokumentnummer=ERV_2005_1_1 6

2.2.4 EXPERT-INTERVIEWS RESULTS

2.2.4.1 METHOD OF EVALUATING EXPERT INTERVIEWS

Qualitative semi-structured interviews were carried out with 3 physicians and 4 registered nurses. They thematically focussed on the usability of telemonitoring of vital parameters as well as user needs and relevant legal aspects. The interviews were transliterated according to recommendations of *Meuser and Nagel* (2005). According to that the following five steps were carried out:

- Transliteration
- Paraphrase
- Titles
- Categorisation and Conceptualisation

Expert-Interviews for Telemonitoring

For gathering an impression of how a telemonitoring system could work, interviews with care and medical experts were carried out. This approach was encouraged by Gaikwad and Warren (2009) where they wrote: *"A particular shortfall of the existing literature is in the collection of physician's views with respect to home-based chronic management technologies. These are obvious reasons for this omission, due to the difficulty and cost of recruiting physicians for input" (Gaikwad and Warren* 2009: 131*).* On the other hand the access to people with chronic diseases (e.g. cardiovascular diseases, diabetes, and obesity) was not given at the time of this study.

Who is an expert?

Following *Bogner* and *Menz* (2005: 46) the definition of expert and expert interviews: An expert has technical knowledge, process and interpretation knowledge that is linked to his/her professional or job related context. He/she has the chance to enforce his/her knowledge. He/she has the power to influence the actions of other protagonists. The explication and reconstruction of the different forms of knowledge and its practical impact is the focus of the expert interview and the analysis.

Goals of Expert-Interviews

The main goal of this study was to find out how a telemonitoring system could be implemented in the homes of aged people. Furthermore we wanted to find out which disease-monitoring makes sense in the application for aged. The knowledge of professional caregivers and medical experts about legal aspects and courses of termination are used as a basis to gather impressions how a telemonitoring system can be implemented.

2.2.4.2 USER NEEDS

Target group for telemonitoring

- Oriented people who have no limits in their cognitive function and can handle the technical equipment.

- People who would like to reduce their weight and need support.

Usability

Some patients are not familiar with technical equipment; they would appreciate a linguistic and visual instruction via the terminal. (Int. 2 / 5)

Transmission of the measured dates

The measured data should be transmitted to the attending physician. (Int. 2)

There is an agreement with the physician in which frequency the measured dates are transmitted. Based on this the physician instructs the patient to take or change medication or to follow further arrangements. Information of the measured dates is also relevant for the responsible nurse. (Int. 4)

Frequency of measurement

According to the recommendations of the physician and in case of need. (Int. 5)

Course of action in case of emergency

If the measured data reaches a critical level, nurses inform the attending physician.

In case of critical measured data a notification to the attending physician or the emergency coordination centre follows. The people who are employed in the emergency coordination centre are specially trained and follow a specified and standardised questionnaire. With the help of this questionnaire they can suggest adequate measures.

The questionnaire used by the emergency coordination centre is made for emergency situations and contains pointed questions with corresponding actions. It is a kind of workflow describing step by step what to do in particular situations.

Even family members can be instructed what to do with the patient in case of critical situations

by an expert paramedic. The coupling of the HERA system to the emergency coordination centre of the Red Cross would make sense.

For emergency situations, doctors who arrive in case of emergency it would be very useful to have an overview of measured data.

Because time is always short to make decisions how to proceed, it would be very useful for the emergency doctors to have a look in the anamnesis to see the last electrocardiogram.

The measured data has to be seen critically and individually and depends much on the medical history of each person. For example: if someone suffers from high blood pressure for a long time he/she will not be limited in daily living and without measurement the high blood pressure will not be realized by the patient.. Over a certain limit - a measured value is 220 / 110 in any case an emergency procedure has to start.

There is no medical causal connection between pulse and blood sugar. Therefore a hyperglycaemia or hypoglycaemia cannot be deducted by pulse measurement.

Hypoglycaemia is felt very subjectively

A causal connection between high blood pressure and a blood sugar drop-down does not exist.

In case of high measurement results a contact between patient and emergency dispatch centre should take place. Only emergency dispatchers have the expertise to give instructions in emergency situations.

Data measured within a crisis need different handling than monitoring for therapy optimization.

In home care situations when a critical data is measured the attending physician is consulted and he decides about all following measures. (Int. 1/2/3/4/5)

Reactions to measurement of a medical expert (doctor)

In case of anomalous measured data a change in therapy only should take place after the consultation of a medical expert.

In case of anomalous measured data in a home care situation the nurse asks the doctor how to proceed.

A continuing measurement over a long time allows the attending physician to control the effectiveness of the therapy.

Measured data have to be seen individually for each patient. For telemonitoring the prescriptive limits have to be defined by the attending physician corresponding to the individuality of each person.

The volume of data has to be observed. If all patients for whom it is useful are watched by telemonitoring a large amount of data in generated which cannot be administrated any more by a general practitioner.(Int. 1/2/3)

Reaction of care regarding to measured dates

The nurse measures vital parameters following the instructions of the attending physician or if it is required due to the condition of the patient. The instructions which are written down in the medical records at the patient's house contain a catalogue of measures. (Int. 4)

Measurement / definition of prescriptive limits

For prescriptive limits there will still be the need of a home visit by the attending physician who evaluates the situation.

The definition of prescriptive limits has to be performed individually for each patient. It depends to existing risk factors or comorbidity.

Blood sugar measurement devices measure the sugar in the blood plasma; a critical value has to be set individually for each person. This has to be done by the attending physician. (Int. 1/3)

Mistakes in measurement

In case of minor variations another measurement should follow after three minutes.

Measurement variation can arise through wrong usage of the measurement device. The handling of the device should be easy to minimize measuring mistakes.

Mistakes in measurement could also result from feeding measurement data manually into the HERA-System.

An inadequate instruction to the patient due to a mistake in measurement could cause risks for the patient.

If the patient is afraid or worried about his/her illness, it can influence the measurement.

A continuous maintenance of the measurement device has to be performed to avoid false measurement data in case of defect.

In case of measuring blood sugar measuring faults are rare.

An abnormal measured data can be ignored, if it is once only. Continuous abnormal measurements have to be handled seriously and significantly.

Staff members of home care services assist patients to organize the repairing of defect measurement devices. (Int. 1/2/3/4/5)

Measured dates of blood sugar

The attending physician prescribes the measures related to the measurement data. This is documented in the medical records at the patient's home.

Patients with diabetes are experienced with the management of their disease and do not need support.

Patients who are in need of insulin are well skilled in handling their illness.

People with diabetes type 2 can be treated with a diet and don not need medication. Additionally to that recommendations for physical workout would make sense.

Patients who are measuring their blood sugar autonomously overtake the responsibility of their illness, which has positive influence on their illness-behavior.

For patients who are treated with insulin continuous measurement makes sense because there is always the possibility of hypoglycemia.

For diabetics with a basis-bolus therapy (Insulin therapy with two different types of insulin) constant measurement is useful.

Continuous transfer of measurement data enables the diabetologist to perform previous actions and adjust the therapy.

Even for diabetics treated without insulin the risk exists to fall in hypo- or hyperglycemia. For that instructions of an emergency paramedic over the HERA-System can be useful. (Int. 1/2/3/5

Blood pressure data

The individual state of the patient has a lot of influence on the measured blood pressure.

The measurement should always take place under the same conditions and after a short relaxing phase.

High blood pressure does not raise problems for a long time and patients are not aware of their condition for a long time. If symptoms arise, the function of the myocardalmuscle already has changed for the worse. Blood pressure monitoring could prevent that.

Measurement should take place one to three times a day. (Int. 1/2/4)

<u>Pulse data</u>
Measuring of pulse data is relevant for people with atrial fibrillation. An arrhythmic pulse refers to atrial fibrillation. (Int. 1/2)

<u>Oxygen saturation</u>
The measurement of the oxygen saturation in the exhalation air with a Kapnometer is complex and expensive.

For patients who suffer from chronic obstructive pulmonary diseases limiting values have to be seen individual. Oxygen saturation is not measured at home; if variations occur they come to hospital. If someone shows cyanotic effects he gets first aid and the ambulance is called. (Int. 1/2/3/4)

<u>Weight</u>
It is important to talk with patients about their nutritional habits. Recommendations for physical workout have to be matched to the individual constitution of the patient.. Continuous memorization to drink enough and eat fruits makes sense. (Int. 3)

Continuous weight control is important in case of cardiac insufficiency to watch the water elimination and perform interventions in time and also to adapt medical therapy. (Int. 1)

<u>Feedback to the patient</u>
In case of a critical measured data a visual feedback to the patient is useful.

The feedback should be performed personally. It should be visual and acoustic, possibly with the voice of a family member or the patient's own voice.

A feedback in the form of a private consultation is more effective than an impersonal feedback. (Int. 1/3/4)

<u>Communication with the medical expert</u>
The electronic transfer of measured data will lead to less home visits by the doctor.

The relationship to the patient should be in the center of the therapy. Older people often consult their attending physician because they are in need of more communication.

The communication between professional caregivers and the attending physicians is performed through telephone, mail or fax or with home visits.

Home visits are low-paid. The frequency of home visits depends on the motivation of the attending physician. (Int. 3/4/5)

<u>Storage of measured data</u>
Data storage should not exceed one month

Storage of weight one day, only the difference is important, Measurement data of oxygen

saturation do not have to be stored. (Int. 1)

Critical thoughts

Electronic communication cannot replace personal communication with the attending physician. A condition for successful treatment is the relationship of trust between patient and attending physician .

The personal contact between attending physician and patient has a surplus compared to the electronic measurement transmission. A personal contact is regarded to a more serious relationship than an electronic one.

The possibility for the attending physician to reduce home visits is alluring, but the quality of support might be reduced.

In a face-to-face counseling the patient can express his/her worries. An understanding of the illness can be established. Sometimes pain disappears with the help of communication.

The compliance of a patient is related to the mutual trust between attending physician and patient. Trust (confidence) can be raised with personal contact. The focus has to stay on communication. (Int. 3)

Patients which suffer from comorbidity and immobility are usually visited by their general practitioner once a week to observe changes of the condition. In those cases telemonitoring has no advantage.

For patients who are independent enough to perform the measurement alone, a feedback from the HERA-System does not make sense. They already discussed what to do in which case with their attending physician and are able to manage their illness alone. Those patients could possibly see the HERA-System as a burden.

Patients might be afraid of their attending physician reducing the home visits if vital parameters are transferred in electronic way to him/her. They would miss the personal contact to their attending physician.

With home visits the attending physician not only controls the measurement data, he/she also gets an overall impression of the patient. He/she gets to know important details concerning the consultation/therapy for the patient. (Int. 5)

Maybe older people are not able to handle technical devices and therefore refuse to use them. (Int. 3)

Not only medical or care aspects are important for older people, they often suffer from loneliness and the supporting staff has fundamental effect to reduce social isolation. (Int. 4)

Ideas for further use cases

Instructions for selective workout - matching to the patient's situation. Balance training.

Measurement of cholesterol

Nutrition consultations

(Int. 1)

2.2.4.3 ETHICAL ISSUES

No statements were made by the experts.

2.2.4.4 REGULATORY FRAMEWORK

The work of registered nurses and also nurse assistants in home care is based on the instruction of a physician in charge. (Int. 4)

The prescription of medicine must be done by a physician. (Int. 1)

In home care several professionals are employed, their activities and competences are regulated through laws. (GuKG und WHG).

A nurse assistant is allowed to assist the patient with measuring his vital parameters, but is not allowed to document them. She is also not allowed propose measures.

In some cases care- and supporting staff has the obligation to inform the attending physician . (Int. 5)

Medical records

The attending physician and the care staff have to document all actions with the patient in the collective medical records at the patient's house. Prescriptions of the attending physician are the basis for the work of the care staff. (Int. 4)

2.2.5 CONCLUSION AND RELATION TO THE GENERAL METHODOLOGICAL FRAMEWORK

In order to gather the best and elaborated results for the user group the requirement analysis was conducted on the basis of a literature review and interviews with experts (defined as medical experts and registered nurses) because of this fact that the emphasis of the analysis was put on arranging an adequate process flow for telemonitoring. It was essential to take into account legal and ethical issues and how the telemonitoring process should be arranged from the perspective of the experts in order to adequately and effectively support the management of these diseases.

The experts explained in the interviews how telemonitoring can be used in a successful way for the target group. Acting differently - starting the exploration with interviews of the user group - would have led to a more narrow view of self-reflection from the users. As work packages in a later state will focus more on the usability of the HERA system it seemed to be the best way to explore the field of telemonitoring.

Main findings of the literature review and the expert interviews:
User needs
- In selecting the target group it has to be taken into account that telemonitoring of vital signs assumes that the users have no limits in their cognitive function and are also able to handle technical equipment.
- In case of a critical measurement results the patient and/or his/her relative should be connected with an emergency dispatch center and should receive concrete support from a doctor on call or a paramedic.
- In case of emergency the doctors on call can handle the situation easier and more safely if he/she has an access to the measured vital parameters of the last days. Therefore authorized persons should have access to the system.
- Each feedback should be visual and vocal e.g. voice of a family member, or the patient´s own voice.
- Data storage should not exceed one month.

Ethical issues:

- Ethical aspects were not pointed out in a particular way by the interviewed experts. This verifies the assumptions made in the literature review that user needs correlate with ethical aspects. As the interviewed persons mention, the main ethical demand is to fulfill the user requirements in the best possible way. In this field the most important aspects are:

  - Informed consent
  - Transparency of the system
  - User control
  - Usability
  - Privacy

Regulatory framework:

- According to the experts there are several legal aspects in Austria which have to be considered, but the main focus should be on a secure data transfer. Continuous maintenance of the equipment has to take place.

- Monitoring people with chronic diseases has to be performed with the knowledge of a medical expert. Only an expert is able to define individual limits of measured data. Even the frequency of the measurement has to be defined individually. Prescriptions of drugs and other instructions have to be done by the attending physician.

Methodology use case selection:

The measurement of the pulse and a measurement of the oxygen saturation are not useful. Oxygen saturation is not measured at home - if variations occur patients have to visit the hospital.

Patients who suffer from diabetes are mostly experts at handling their illness, so they would not need support by a telemonitoring system. Only in the case of diabetes type II nutrition counseling may help to stabilize or reduce weight.

Suffering from cardiac diseases often makes it necessary to monitor blood pressure. A change of the status can be seen only if the measurement is performed over a certain time.

Continuous weight control is also important in the case of cardiac insufficiency to watch the water elimination and perform interventions right in time; to adapt medical therapy.

Based on the results of these interviews with experts the following use cases turned out to be expedient to support patients to manage their diseases with telemonitoring.

1. Routine blood pressure measuring
2. Body weight
3. Nutrition counseling

2.3 MCI AND AD USER GROUPS REQUIREMENTS

The purpose of this section is to describe the methodology for collecting requirements from the HERA users. The user requirements collection methodology strives as much as possible to incorporate results from direct contacts with users (i.e. patients', family caregivers' and healthcare professionals' perspective), as well as from the academic/scientific literature on the

field.

User requirements collection and analysis aims at providing insights on user needs, as well as on the nature of HERA services. The requirements process targets the following groups:

- Group I: patients with MCI or AD
  - Subgroup A: elderly people aged 65+ with MCI, according to the Petersen et al., 2001 criteria – MMSE score 26-30.
  - Subgroup B: elderly people aged 65+ with mild AD, according to the DSM-IV criteria ([3]   American Psychiatric Association, 1994) – MMSE score 20-25.
  - Subgroup C: elderly people aged 65+ with moderate AD, according to the DSM-IV criteria – MMSE score 14-19.
- Group II: caregivers of patients with MCI or AD
  - Subgroup A: primary family caregivers of elderly people with MCI
  - Subgroup B: primary family caregivers of elderly people with mild AD
  - Subgroup C: primary family caregivers of elderly people with moderate AD

At this point, it would be useful to note that we consider the primary family caregiver to be a member of the patient's family (e.g. spouse, adult child, sibling) living in the same house with the patient who has primary responsibility in terms of time and commitment for the active care and welfare of the patient.

- Group III: healthcare professionals interacting with patients suffering from various degrees of cognitive impairment and their families.

The user requirements methodology followed by HYGEIA in the scope of the present deliverable includes the following methodological steps:

Step I: A set of cognitive tests first run on the patients in order to reliably classify them and their primary family caregivers in the subgroups A (MCI), B (mild AD) and C (moderate AD). The short cognitive screening included the following tests:

o Mini Mental State Examination (Folstein, Folstein and McHugh, 1975; Fountoulakis et al, 2000)

o Clock Drawing Test: 10-point scoring method (Sunderland et al, 1989)

o Geriatric Depression Scale: 15-items version (Fountoulakis et al, 1999; Yesavage et al, 1983)

Step II: Quantitative interviews using questionnaires were performed with *patients* (Group I) and their *primary family caregivers* (Group II) (5 persons from each subgroup, i.e. 15 patients and 15 caregivers in total) in order to solicit their everyday needs and expectations from the HERA project. Each participant was interviewed separately. In the beginning of each interview, the user was introduced to HERA by summarizing the main points of the project (objectives, services etc). The questionnaires were developed by the healthcare professionals of HYGEIA participating in the HERA project and structured in a way that facilitates processing the results (multiple-choice questions). The questionnaires were self-administered, with the exception of patients with moderate AD. The cognitive deficits of this user subgroup made it necessary for the healthcare professionals supervising the process to thoroughly explain each question to the patient in order to avoid misunderstanding. Interviews also included demographics (age, sex, years of education, profession). It should be noted that after the end of the quantitative interviews, the users were encouraged to provide additional comments about the project, the

procedures etc. The participants' answers on the questionnaires were used to develop the templates depicting the services needs for user groups. The questionnaires used are annexed at the end of this document (annexes B and C).

The main results of the quantitative interviews with the *patients* are the following:

- Interestingly and despite their differences in terms of cognitive functioning, patients belonging to all subgroups (MCI, mild and moderate AD) seem to share the same opinion on the usefulness of the HERA services, with the exception of: a) phone numbers reminder service and b) mentally challenging games, which were lower-rated by moderate AD patients (i.e. "maybe useful" and "fairly attractive", respectively).

- The only HERA services negatively rated (i.e. "not useful") were the ones related to social networking (chatting and sharing photos with friends/relatives etc). It is highly probable that this negative rating results from the very low level of technology acquaintance characterizing the majority of the Greek elderly, which discourages them from using new technologies to perform daily activities usually carried out through conventional means.

- As already mentioned, the patients' answers on the question regarding computer usage were in accordance with the fact that the majority of the elderly are technologically illiterate. However, almost all of the patients mentioned that they use TV on everyday basis. The fact that the HERA services are offered through an ordinary TV-set was characterized as a very positive and encouraging figure of the HERA project.

- On the question "Do you like mentally challenging games, such as crosswords and mazes?" most patients answered "fair" to "much". It should be highlighted that the vast majority of the interviewees stated they would like to participate in a mental stimulation program aiming to train their cognitive skills through TV-based exercises, on condition that the instructions would be simple and easy to follow.

- On the question "How often do you exercise (walking, swimming etc)?" most patients answered "often". However, they seem to be moderately positive towards the idea of participating in a physical reinforcement program aiming to improve their physical condition through exercises shown on TV.

The main results of the quantitative interviews with the *primary family caregivers* of the patients are the following:

- Family caregivers belonging to all three subgroups (i.e. caring for patients with MCI, mild and moderate AD) shared the same opinion on the usefulness of the HERA services. Also, in most cases, they shared the same opinion with the patients, as well. The only difference is that the caregivers are more positively predisposed towards the possibility of their patients' participation in a physical reinforcement program aiming to improve their physical condition through exercises shown on TV.

- In accordance with the comments of the patients, the family caregivers think positively of the participation of their beloved ones to a cognitive reinforcement program, yet on condition that the instructions would be simple and easy to follow.

- Again, the only HERA services negatively rated (i.e. "not useful") by the family caregivers were the ones related to social networking (chatting and sharing photos with friends/relatives etc), for the reasons explained before.

- The fact that the HERA services are offered through an ordinary TV-set was characterized as a very positive and encouraging figure of the HERA project by the family caregivers, as well.

- The family caregivers insisted on the need of a 24/7 helpdesk were they could refer to in case of any (mainly technical) difficulties envisaged.

Step III: Quantitative interviews using questionnaires were performed with healthcare professionals (doctors, psychologist, social workers) interacting with MCI and AD patients (Group III, 10 in total). The healthcare professionals interviewed were selected with the criterion of having at least two years of experience on the care of patients with cognitive deficits. The questionnaires were developed by the healthcare professionals of HYGEIA participating in the HERA project and structured in a way that facilitates processing the results (multiple-choice questions). Interviews also included demographics (age, sex, years of education, specialty). It should be noted that after the end of the quantitative interviews, the users were encouraged to provide additional comments about the project, the procedures etc. The users' answers on the questionnaires were used to develop the templates depicting the services needs for users groups. The questionnaire used is annexed at the end of this document (annex D).

The main results of the quantitative interviews with the *healthcare professionals* are the following:

- Broadly speaking, the healthcare professionals questioned shared the same opinion on the usefulness and the appropriateness of the HERA services for each patient subgroup (MCI, mild and moderate AD).

- Four of the suggested HERA services were considered to be irrelevant to the needs of patients with MCI and AD. Namely: a) chatting/sharing photos application, b) expert support/advisory application, c) "open pharmacies" application and d) "simplified appliances manuals" application. It would be useful to note that the patients and family caregivers were not asked about the usefulness of three of the four above-mentioned services (i.e. expert support/advisory application, "open pharmacies" application and "simplified appliances manuals" application) since the clearly negative attitude of the healthcare professionals had already been recorded in informal discussions preceding the development of the questionnaires.

- The remaining services were all rated as useful and appropriate for both patients with MCI and AD (mild and moderate stages), with the exception of the TV-based phonebook application, which most healthcare professionals rated as inappropriate for patients with moderate AD.

- On the question "What would be the attitude of the patients and caregivers against the possibility of participating in the HERA project?" the healthcare professionals answered "probably positive" to "positive", which is in accordance with the actual positive attitude of the patients resulting from their interviews.

- The majority of the healthcare professionals believe that the HERA services would be very beneficial for the patients and caregivers participating in the project.

- The healthcare professionals agreed with the family caregivers on the need of a 24/7 helpdesk were the caregivers could refer to in case of any difficulties envisaged.

2.4 USE CASES

Three main categories of use cases were identified and detailed in the following three paragraphs, a) the diabetes and cardiac diseases use cases, b) the MCI and AD use cases, and c) the general home care services. The latter are described separately as they are more general than the two main user groups but are used by both of them.

2.4.1 DIABETES AND CARDIAC DISEASES USE CASES

2.4.1.1 USE CASE 1.1 ROUTINE BLOOD PRESSURE MEASURING

Use Case ID:	1.1		
Use Case Name:	Routine blood pressure measuring		
Created By:	Verena Moser-Siegmeth Erentraud Weiser	Last Updated By:	Verena Moser-Siegmeth
Date Created:	29/10/2009	Date Last Updated:	04/02/2010

Actors:	Patients suffering from a cardiovascular disease who have to monitor their blood pressure under the supervision of their doctor.
Description:	A blood pressure (RR) minutes are written down over a long period. Date, hour and results are written down. The systolic and diastolic blood pressure (RR) value and the frequency of the pulse are measured. The outcome is a protocol where a change of the condition can be seen. If necessary medical steps can follow this use case. In critical situations an alarm is activated.
Trigger:	This use case is activated by a blood pressure measurement. Optional there can be a reminding function (SMS, Pop up on TV, telephone call).
Preconditions:	Relevant information from the medical history / patient history is stored in the HERA system. A medical expert defines the limits of the blood pressure individually for each test user.

Postconditions:	What are the expected and measured results of this use case and which post conditions exist?
	
	1. measured value of Pulse and systolic and diastolic blood pressure (mmHG)
	2. recording over several series maximal hourly
	3. storage time is minimum one day, maximum one month
	4. analysis and interpretation, feedback
	   4.1. Patient:
	      4.1.1. patient gets a feedback, he/she can see the trend over the last week (date, hour, RR, pulse) in form of a diagram
	      4.1.2. he/she becomes a interpretation of the measured value and a feed back (pop-up, or text to speech)

	4.1.3. he/she can print out the protocol or it can be delivered with the post as a service from TA 4.1.4. optional the delivery to the medical expert following the telematic law once a week 4.1.5. measured values are transferred to central care center for further intervention 4.2. <u>HERA Care Center (HYGEA):</u> analysis and interpretation 4.3. <u>attending physician:</u> extended documentation and active action only in case of a patient visit, the physician has to be involved in the communication 4.4. <u>nursing staff (FRK)</u>		
Normal Flow:	**Step**	**Akteur**	**Basic Flow**
	1.	Testuser	Gadget is switched on
	2.	Testuser	Blood pressure (RR) sleeve is attached
	3.	Testuser	RR measurement starts
	4.	System	Measured data is transmitted
	5.	System	Analysis of measured datas
	6.	System	Measured data is registered in a protocol
	7.	System	Feedback to test users is given
	8.	Testuser	Feedback of System is accepted by test users
	9.	System	Transmission of data takes place after agreement of test users
Alternative Flows:			
Exceptions:		**Exceptions, Extensions**	
	7.1	Measurement invalid; repeat measurement	
	7.2	Measurement and data o.k. – continue as prescription	
	7.3	Measurement critical – another measurement follows	
	7.3.1	Measured date is o.k.; continue at 7.2	
	7.3.2	Measured data is still critical – consultation of medical expert is recommended	
	7.4	Measured data is life threatening – contact with a emergency unit – if hospital visit is necessary	
	7.5	Gadget is broken (empty battery) replacement	
Includes:			
Priority:			
Frequency of Use:	Minimum once a day to maximum three times a day depends to the		

	medical command.
Business Rules:	
Special Requirements:	▪ device has to be user-friendly ▪ feedback has to be easy understood, clear and adapted to the test users ▪ data transfer has to be secure ▪ agreement who has access to the data ▪ storage of the data: 1 month
Assumptions:	
Notes and Issues:	There has to be a continuous maintenance of the blood pressure device by the service provider

2.4.1.2 USE CASE 1.2 BODY WEIGHT

Use Case ID:	1.2		
Use Case Name:	Body weight		
Created By:	Verena Moser-Siegmeth Erentraud Weiser	Last Updated By:	
Date Created:	2/02/2010	Date Last Updated:	

Actors:	People suffering from diabetes type 2; high blood pressure; overweight
Description:	• Overweight and obese insulin resistant individuals, modes weight loss has been shown to reduce insulin resistance • Weight reduction reduces risk factors for cardiovascular patients
Trigger:	Use case is triggered by using the scale. Optional the can be a reminding function (SMS, Pop up on TV, telephone call)
Preconditions:	1. Relevant information from the medical history / patient history is stored in the HERA system. 2. User identity is verified 3. Medical expert has identified overweight 4. Medical expert defines goals for reducing weight
Post conditions:	1. Weight is measured 2. Data is delivered 3. Interpretation and analyses of system or expert 4. User receives feedback and is informed what to do 5. Protocol follows if required

Normal Flow:	Step	Akteur	Basic Flow
	1.	Testuser	Gadget is switched on
	2.	Testuser	Patient/Testuser measures his/her weight
	3.	Testuser	Measurement starts
	4.	System	Measured data is transmitted
	5.	System	Analysis of measured data referring to the goals
	6.	System	Measured data is registered in a protocol
	7.	System	Feedback to test users is given
	8.	Testuser	Feedback of System is accepted by test users
	9.	System	Transmission of data takes place after agreement of test users to the attending physician
Exceptions:		**Exceptions, Extensions**	
	7.1	Measurement invalid; repeat measurement	
	7.2	Measurement and data o.k. – continue as prescription	
	7.3	Measured date is o.k.; continue at 7.2	
	7.4	Gadget is broken (empty battery) replacement	
Alternative Flows:	-		
Includes:	-		
Priority:	-		
Frequency of Use:	Following the instructions of the attending physician		
Business Rules:	-		
Special Requirements:	• Scale has to be compatible to the HERA-System • Measurement has to be performed always at the same time and under the same conditions		
Assumptions:	-		
Notes and Issues:	There has to be a continuous maintenance of the scale		

2.4.1.3 USE CASE 1.3 NUTRITION COUNSELLING

Use Case ID:	1.3		
Use Case Name:	Nutrition counselling		
Created By:	Verena Moser-Siegmeth	Last Updated By:	
Date Created:	2/02/2010	Date Last Updated:	

Actors:	People suffering from diabetes type 2 and/or have overweight
Description:	Tracking what you eat can help to manage diabetes and prevent cardio vascular diseases and support weight reducing. Education for healthy nutrition.
Trigger:	Connection with the HERA nutrition counselling System For instance: http://www.diabetes.org/food-and-fitness/food/my-food-advisor/ http://www.diabsite.de/diabetes/ernaehrung/be-tabellen/a-z_a.html Use case is triggered by selecting the nutrition counselling System. Optionally can be a reminding function (SMS, Pop up on TV)
Preconditions:	1. HERA nutrition counseling System knows relevant information from the medical history / patient history is stored in the HERA system. 2. User identity is verified 3. Medical expert has identified the need of change the nutrition habits 4. Medical expert defines goals
Post conditions:	Patient's compliance increases.

Normal Flow:	Step	Akteur	Basic Flow
	1.	Testuser	Monitor is switched on and connected to the nutrition counselling system
	2.	Testuser	Test user enters the food he/she wants to consume
	3.	System	System gives feed back about: • Carbohydrate/bread units • Calories • Saturated fat

			• Cholesterol • Sodium food contains. In case of diabetes the system knows about individual diet regulations and calculates consumed und remaining carbohydrate/bread units.
	4.	Testuser	Follows instructions

Exceptions:	No need of nutrition counselling, patient is already skilled and knows the composition of food
Alternative Flows:	Patient uses a written version of nutrition advices
Includes:	-
Priority:	-
Frequency of Use:	Always before ingestion
Business Rules:	-
Special Requirements:	• Nutrition counselling system has to be adaptive for the HERA-System • Easy to use
Assumptions:	-
Notes and Issues:	-

2.4.2 MCI AND AD USE CASES

2.4.2.1 USE CASE 2.1. BE REMINDED ABOUT TASKS (MEDICATION, RENDEZVOUS)

Use Case ID:	2.1		
Use Case Name:	Be reminded about tasks (medication, rendezvous)		
Created By:	Nikolaos Spanoudakis	Last Updated By:	Olga Lymperopoulou
Date Created:	16/12/2009	Date Last Updated:	28/12/2009

Actors:	Patients with MCI, mild AD and moderate AD
Description:	
Trigger:	A scheduled activity in the user's calendar is about to take place
Preconditions:	1. The user is at home using the HERA system 2. The user has to take a prescribed pill in the next half an hour OR the user has a scheduled rendezvous with a professional (nurse, psychologist, doctor) in the next 2 hours OR the user wants to be reminded of his favourite TV series starting in 15 minutes
Postconditions:	5. The user has clicked on a button indicating that he got the message
Normal Flow:	1. The system makes a specific audible sound to alert the user 2. A message box indicating the scheduled activity is presented both in the user's screen and in audio. The message box is not withdrawn until the user reads the message and clicks OK. 3. The user reads the message and clicks OK
Alternative Flows:	If the user fails to respond to the system message in 5 minutes, then a text message is sent to the family caregiver indicating that the patient hasn't taken his pill or the professional with whom he has a rendezvous
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	5-6 times a day
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.2.2 USE CASE 2.2. ASSIGN EXERCISES FOR COGNITIVE REINFORCEMENT

Use Case ID:	2.2		
Use Case Name:	Assign exercises for cognitive reinforcement		
Created By:	Nikolaos Spanoudakis	Last Updated By:	Olga Lymperopoulou
Date Created:	16/12/2009	Date Last Updated:	28/12/2009

Actors:	Professionals (psychologists, doctors)
Description:	
Trigger:	The professional must select the appropriate cognitive reinforcement exercises for the patient.
Preconditions:	1. The professional has opened the HERA HMI and is logged in
Postconditions:	1. New cognitive reinforcement exercises have been assigned to the patient
Normal Flow:	1. The professional inserts the username of the patient 2. The professional browses through the available cognitive training exercises and selects those best suited for the specific patient
Alternative Flows:	If the patient is not a user of the system, the professional must first create a new record.
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	4-5 times per week
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.2.3 USE CASE 2.3. ENGAGE WITH COGNITIVE REINFORCEMENT EXERCISES

Use Case ID:	2.3		
Use Case Name:	Engage with cognitive reinforcement exercises		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last	

			Updated:	

Actors:	Patients with MCI, mild AD and moderate AD
Description:	
Trigger:	It's time for the user to engage with the cognitive reinforcement exercises specifically selected for him by the professional
Preconditions:	1. The user is at home using the HERA system 2. The user has to engage with the cognitive reinforcement exercise in the next 5 minutes
Postconditions:	1. The results of the exercises are sent to the professional by email
Normal Flow:	1. The system makes a specific audible sound to alert the user 2. A message box indicating the scheduled activity is presented both in the user's screen and in audio. 3. The user reads the message and clicks OK 4. The instructions of each exercise are presented both in the user's screen and in audio 5. After the instructions have been presented, the user may click either PLAY, REPEAT INSTRUCTIONS or QUIT EXERCISE 6. The exercises are successively presented in the order defined by the professional 7. The results of the exercises are sent to the professional by email
Alternative Flows:	1. The system makes a specific audible sound to alert the user 2. A message box indicating the scheduled activity is presented both in the user's screen and in audio 3. The user reads the message and clicks REMIND ME LATER 4. Steps 1 and 2 are repeated after one hour 5. The user reads the message and clicks OK 6. Steps 4-7 presented in the Normal Flow are followed OR If the user fails to respond to the system message in 5 minutes, the message is withdrawn from the screen and presented again after one hour.
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	4-5 times per week

Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	There is a possibility that the actor has been assigned more than one tasks for the same time (e.g. by different caregivers) or that he has specific preferences (e.g. to watch a TV series at a particular time of day. In the case of conflicts the following priorities will hold: Priority no1: take the assigned pills Priority no2: watch his favourite TV series Priority no3: engage with the cognitive reinforcement exercises Priority no4: engage with the physical reinforcement exercises In the case that the actor selects a specific time (but different than the assigned one) for at least three times in a row it would be more convenient if the system learns that the patient wants to have his exercises later every day.

2.4.2.4 USE CASE 2.4. ASSIGN EXERCISES FOR PHYSICAL REINFORCEMENT

Use Case ID:	2.4		
Use Case Name:	Assign exercises for physical reinforcement		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last Updated:	

Actors:	Professionals (psychologists, doctors, nurses)
Description:	
Trigger:	The professional must select the appropriate physical reinforcement exercises for the patient.
Preconditions:	1. The professional has opened the HERA website and is logged in
Postconditions:	1. New physical reinforcement exercises have been assigned to the patient
Normal Flow:	1. The professional inserts the username of the patient 2. The professional browses through the available physical training exercises and selects those best suited for the specific patient
Alternative Flows:	If the patient is not a user of the system, the professional must first create a new record.

Exceptions:	
Includes:	
Priority:	
Frequency of Use:	2-3 times per week
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.2.5 USE CASE 2.5. ENGAGE WITH PHYSICAL REINFORCEMENT EXERCISES

Use Case ID:	2.5		
Use Case Name:	Engage with physical reinforcement exercises		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last Updated:	

Actors:	Patients with MCI, mild AD and moderate AD
Description:	
Trigger:	It's time for the user to engage with the physical reinforcement exercises specifically selected for him by the professional
Preconditions:	1. The user is at home using the HERA system 2. The user has to engage with the physical reinforcement exercise in the next 5 minutes
Postconditions:	1. The results of the exercises are sent to the professional by email
Normal Flow:	1. The system makes a specific audible sound to alert the user 2. A message box indicating the scheduled activity is presented both in the user's screen and in audio. 3. The user reads the message and clicks OK 4. The instructions of each exercise are presented both in the user's screen and in audio 5. After the instructions have been presented, the user may click either OK, REPEAT INSTRUCTIONS or QUIT EXERCISE 6. The exercises are successively presented in the order defined by the professional 7. The results of the exercises are sent to the professional by email

Alternative Flows:	1. The system makes a specific audible sound to alert the user 2. A message box indicating the scheduled activity is presented both in the user's screen and in audio 3. The user reads the message and clicks REMIND ME LATER 4. Steps 1 and 2 are repeated after one hour 5. The user reads the message and clicks OK 6. Steps 4-7 presented in the Normal Flow are followed OR If the user fails to respond to the system message in 5 minutes, the message is withdrawn from the screen and presented again after one hour.
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	2-3 times per week
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	See notes for use case 2.3

2.4.2.6 USE CASE 2.6. MAINTAIN A FAMILY CALENDAR / A PHONE BOOK / A DIGITAL MEMORY BOOK

Use Case ID:	2.6		
Use Case Name:	Maintain a family calendar / a phone book / a digital memory book		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last Updated:	

Actors:	Patients with MCI, mild AD, moderate AD, family caregivers
Description:	
Trigger:	The user wants to enter new data in the family calendar / the phone book / the digital memory book
Preconditions:	1. The user is at home using the HERA system
Postconditions:	1. The user has successfully entered the new data in the system

Normal Flow:	1. The user enters the family calendar / the phone book / the digital memory book application 2. The user enters the new data 3. A verification message is presented on the screen 4. The user clicks OK
Alternative Flows:	If the information entered is not correct, the systems guides the user on how to make the appropriate corrections
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	Whenever needed
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	Here we provide some definitions of the terms used in this use case. **Memory book**: A memory book is a collection of information presented in different mediums to help represent specific times or milestones. They are similar to a 'newborn' book where events and time are recorded for future reference. A memory book can help someone with dementia celebrate wedding anniversaries, significant birthdays or just a special holiday. The development of a memory book is something in which all the family, young and old can participate and contribute something personal to a loved one, who may have difficulty remembering their names at times. **Photographs and Images**: Images are very powerful, particularly photographs of particular events and celebrations. Those who suffer from dementia, often can recall in detail, times from very long ago as if it were yesterday. Once they are provided with a visual prompt without being urged to just 'remember', their recollection of the event can be quite detailed. For example for a special wedding anniversary, include photos taken before the ceremony and at regular intervals since then. These could include, special birthday celebrations, birth of children, family holidays. Snapshots and formal photographs can be collected from the whole extended family. **Written Memories and Accounts**: Family and friends can help to jolt memories of those struggling to remember special times. Written accounts of a humorous event, poems, dedications by children and grandchildren all help to trigger recall. These are not only of benefit to those who suffer from dementia but also for their partners, who may have forgotten certain elements. Young children can become involved by

	producing paintings and drawings to be included. Family and friends develop a sense of participating in the celebrations at the same time as supporting a loved one in feeling stressed and excluded.

2.4.2.7 USE CASE 2.7. ORIENT THE PATIENT IN TIME AND PLACE

Use Case ID:	2.7		
Use Case Name:	Orient the patient in time and place		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last Updated:	

Actors:	Patients with MCI, mild AD and moderate AD
Description:	
Trigger:	The user must be oriented in time and place
Preconditions:	1. The user is at home using the HERA system
Postconditions:	
Normal Flow:	1. The day, date, month, year and time are constantly presented on the TV screen
Alternative Flows:	
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	everyday
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.2.8 USE CASE 2.8. UPDATE THE PATIENT ABOUT THE TOP NEWS OF THE DAY / THE WEATHER FORECAST

Use Case ID:	2.8		
Use Case Name:	Update the patient about the top news of the day / the weather forecast		
Created By:	Olga Lymperopoulou	Last Updated By:	
Date Created:	28/12/2009	Date Last Updated:	

Actors:	Patients with MCI, mild AD and moderate AD
Description:	
Trigger:	The user must be updated about the top news of the day / the weather forecast
Preconditions:	1. The user is at home using the HERA system
Postconditions:	1. The user has clicked on a button indicating that he got the message
Normal Flow:	1. The system makes a specific audible sound to alert the user 2. A message box with the top news titles (3-5) / the weather forecast is presented on the TV screen everyday at 9.00, 14.00 and 21.00. 3. The user reads the message box and clicks OK
Alternative Flows:	If the user fails to respond to the system message, the system automatically withdraws the message after 10 minutes.
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	everyday
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.3 GENERAL HOME CARE

2.4.3.1 USE CASE 3.1. BE REMINDED ABOUT MEDICATION

Use Case ID:	3.1		
Use Case Name:	Be reminded about medication		
Created By:	Nikolaos Spanoudakis	Last Updated By:	Christina Kotsiopoulou
Date Created:	16/12/2009	Date Last Updated:	02/02/2010

Actors:	Elderly home care users
Description:	
Trigger:	The user has to take the indicated medicine as scheduled
Preconditions:	1. The user is at home using the HERA system 2. The user has to take the right pill on the right time 3. The user has to be indicated which pill to take (ie., according to colour and/or shape) in order to make sure that is taking the right medicine 4. The user has to know where the medicine is stored
Postconditions:	1. The user has clicked on a button indicating that he got the right pill 2. The system has to make sure that the specified user has clicked the button and took the pill
Normal Flow:	4. The system makes a specific audible sound to alert the user 5. A message box indicating the prescribed pill is presented both in the user's screen and in audio describing the colour and the shape. The message box is not withdrawn until the user reads / sounds the message and clicks OK. 6. The user reads / sounds the message and clicks OK
Alternative Flows:	If the user fails to respond to the system message in 5 minutes, then a text message is sent to the family caregiver indicating that the patient hasn't taken his pill
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	According to the prescribed medication during the day
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.3.2 USE CASE 3.2. INFORM THE ELDERLY ABOUT THEATRES / FILMS / EVENTS / WEATHER FORECAST

Use Case ID:	3.2		
Use Case Name:	Inform the elderly about theatres / films / events / weather forecast		
Created By:	Olga Lymperopoulou	Last Updated By:	Christina Kotsiopoulou
Date Created:	28/12/2009	Date Last Updated:	02/02/2010

Actors:	Elderly home care users
Description:	
Trigger:	The user can be updated with interesting films / theatres / events that are running and/or the weather forecast
Preconditions:	1. The user is at home using the HERA system
Postconditions:	1. The user can have the opportunity to choose on what he wants to be informed. 2. The user has clicked on a button indicating that he got the information that was interested.
Normal Flow:	1. The system makes a specific audible sound to alert the user. 2. A message box with the available information and/or the weather forecast is presented on the TV screen everyday at predefined time-slots. 3. The user reads the information and clicks OK.
Alternative Flows:	If the user fails to respond to the system message, the system automatically withdraws the message after 10 minutes.
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	Everyday
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.4.3.3 USE CASE 3.3. ALARM SERVICE

Use Case ID:	3.3		
Use Case Name:	Alarm service		
Created By:	Olga Lymperopoulou	Last Updated By:	Christina Kotsiopoulou
Date Created:	28/12/2009	Date Last Updated:	02/02/2010

Actors:	Elderly home care users
Description:	
Trigger:	The user can have the opportunity to inform the relative / caregiver that is not feeling well
Preconditions:	1. The user is at home using the HERA system
Postconditions:	1. The user clicks a red button (alarm button) indicating that is not feeling well
Normal Flow:	1. The user clicks the button 2. The system makes a specific audible sound 3. The relative / caregiver is informed through the HERA system that the user is not feeling well
Alternative Flows:	
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	Any time there is a need from the user
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

2.5 SERVICES NEEDS PER USER GROUP

The HERA services were ranked regarding our patients user groups:

- Patients
    - Mild AD > 65 years
    - Moderate AD > 65 years
    - MCI > 65 years
    - Elderly – persons > 65 years
    - People with Cardiovascular diseases > 55 years

– People with diabetes without need of insulin > 55 years

The users ranked the service as "very important", "important", "not so important", "irrelevant" for the different user groups. They also had the possibility to add a new service not foreseen by HERA. In the "expected functionality" field they discussed how they expected each service to function.

Ranking was filled out by experts in the field of homecare including the results of the literature review and the conclusions of the interviews with experts.

2.5.1 PATIENTS WITH MILD AD > 65 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	*Very important*	*Maintain/improve cognitive functions. Stay mentally active*
Physical Reinforcement	*Important*	*Maintain good physical condition. Improve their mood*
Chatting	*Not so important*	*Come in contact with beloved ones. Familiarize with technology*
Sharing photos	*Not so important*	*Come in contact with beloved ones. Familiarize with technology*
Getting support and advisory information from specialists	*Irrelevant*	-
Maintaining a family calendar	*Very important*	*Be reminded about name days, birthdays etc*
Maintaining a phone book	*Important*	*Easy access to telephone numbers*
Reality orientation *Time/day/date/month/year* *Place (e.g. address)* *Top news of the day*	*Very important*	*Orientation in time and place. Update about the major events of the day.*
EGC monitoring	*Irrelevant*	-
BP monitoring	*Irrelevant*	-
Heart rate monitoring	*Irrelevant*	-
Oxygen saturation monitoring	*Irrelevant*	-
Body weight monitoring	*Irrelevant*	-
Pill reminder	*Very important*	*Be reminded to take their medication in proper dosage and at correct time*
Other reminders	*Very important*	*Be reminded about appointments, "to do" lists, favorite TV series etc.*
Alarm	*Irrelevant*	-

Service type	Rank	Expected functionality
Open pharmacies	*Not so important*	*Easy access to relevant information*
Weather forecast	*Important*	*Easy access to relevant information*
Simplified appliances manuals	*Not so important*	*Easy access to relevant information*
Digital memory book *Various chapters (e.g. family tree, work life, family life etc) with pictures and relevant information.*	*Very important*	*Enhance creativity and patient-caregiver interaction. Support autobiographical memory. Easy access to personally relevant information.*

2.5.2 PATIENTS WITH MODERATE AD > 65 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	*Very important*	*Maintain/improve cognitive functions. Stay mentally active*
Physical Reinforcement	*Important*	*Maintain good physical condition. Improve their mood*
Chatting	*Irrelevant*	-
Sharing photos	*Irrelevant*	-
Getting support and advisory information from specialists	*Irrelevant*	-
Maintaining a family calendar	*Very important*	*Be reminded about name days, birthdays etc*
Maintaining a phone book	*Important* ** In the case of patients with moderate AD, the service will be used mainly by the caregiver*	*Easy access to telephone numbers*
Reality orientation *Time/day/date/month/year* *Place (e.g. address)* *Top news of the day*	*Very important*	*Orientation in time and place. Update about the major events of the day.*
EGC monitoring	*Irrelevant*	-
BP monitoring	*Irrelevant*	-
Heart rate monitoring	*Irrelevant*	-
Oxygen saturation monitoring	*Irrelevant*	-
Body weight monitoring	*Irrelevant*	-
Pill reminder	*Very important*	*Be reminded to take their medication in proper dosage and at correct time*

Service type	Rank	Expected functionality
Other reminder	*Very important*	*Be reminded about appointments, "to do" lists, favorite TV series etc.*
Alarm	*Irrelevant*	-
Open pharmacies	*Not so important* ** In the case of patients with moderate AD, the service will be used mainly by the caregiver*	*Easy access to relevant information*
Weather forecast	*Not so important*	*Easy access to relevant information*
Simplified appliances manuals	*Irrelevant*	-
Digital memory book *Various chapters (e.g. family tree, work life, family life etc) with pictures and relevant information.*	*Very important*	*Enhance creativity and patient-caregiver interaction. Support autobiographical memory. Easy access to personally relevant information.*

2.5.3 PATIENTS WITH MCI > 65 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	*Very important*	*Maintain/improve cognitive functions. Stay mentally active*
Physical Reinforcement	*Important*	*Maintain good physical condition. Improve their mood*
Chatting	*Not so important*	*Come in contact with beloved ones. Familiarize with technology*
Sharing photos	*Not so important*	*Come in contact with beloved ones. Familiarize with technology*
Getting support and advisory information from specialists	*Irrelevant*	-
Maintaining a family calendar	*Very important*	*Be reminded about name days, birthdays etc*
Maintaining a phone book	*Very Important*	*Easy access to telephone numbers*
Reality orientation *Time/day/date/month/year* *Place (e.g. address)* *Top news of the day*	*Very important*	*Orientation in time and place. Update about the major events of the day.*
EGC monitoring	*Irrelevant*	-

Service type	Rank	Expected functionality
BP monitoring	*Irrelevant*	-
Heart rate monitoring	*Irrelevant*	-
Oxygen saturation monitoring	*Irrelevant*	-
Body weight monitoring	*Irrelevant*	-
Pill reminder	*Very important*	*Be reminded to take their medication in proper dosage and at correct time*
Other reminders	*Very important*	*Be reminded about appointments, "to do" lists, favorite TV series etc.*
Alarm	*Irrelevant*	-
Open pharmacies	*Not so important*	*Easy access to relevant information*
Weather forecast	*Important*	*Easy access to relevant information*
Simplified appliances manuals	*Not so important*	*Easy access to relevant information*
Digital memory book *Various chapters (e.g. family tree, work life, family life etc) with pictures and relevant information.*	*Very important*	*Enhance creativity and patient-caregiver interaction. Support autobiographical memory. Easy access to personally relevant information.*

2.5.4 ELDERLY – PERSONS > 65 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	*Important*	*Maintain cognitive functions. Stay mentally active.*
Physical Reinforcement	*Important*	*Maintain good physical condition. Improve their mood*
Chatting	*Very important*	*Come in contact with others. Improve their social activation. Familiarize with technology*
Sharing photos	*Very important*	*Come in contact with others. Improve their social activation. Familiarize with technology*
Getting support and advisory information from specialists	*Irrelevant*	
Maintaining a family calendar	*Very important*	*Be reminded about name days, birthdays etc. Improve their social activation.*

Service type	Rank	Expected functionality
Maintaining a phone book	*Very Important*	*Easy access to telephone numbers. Familiarize with technology*
Reality orientation	*Irrelevant*	
ECG monitoring	*Irrelevant*	
BP monitoring	*Irrelevant*	
Heart rate monitoring	*Irrelevant*	
Oxygen saturation monitoring	*Irrelevant*	
Body weight monitoring	*Irrelevant*	
Pill reminder	*Very important* **In case they are on drug therapy*	*Be reminded to take the right medicine at the right time. Improve drug compliance and effectiveness of therapy*
Other reminder	*Very important*	*Be reminded about appointments, "to do" lists, favorite TV series, theatres, cinemas, etc.*
Alarm	*Important*	*Improve their safety and quality of life*
Open pharmacies	*Not so important*	*Easy access to relevant information*
Weather forecast	*Not so important*	*Easy access to relevant information*
Simplified appliances manuals	*Not so important*	*Easy access to relevant information*
Other (please describe it)		

2.5.5 PEOPLE WITH CARDIOVASCULAR DISEASES > 55 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	Not so important	Maintain/improve cognitive functions. Stay mentally active
Physical Reinforcement	important	Maintain good physical condition. Instructions for selective workout – matching the patients situation
Chatting	Not so important	contact with friends and family
Sharing photos	Not so important	contact with friends and family
Getting support and advisory information from specialists	Very important	Support to manage their disease

Service type	Rank	Expected functionality
Maintaining a family calendar	Not so important	
Maintaining a phone book	Not so important	
Reality orientation	irrelevant	
EGC monitoring	Important	In case of emergency situations
BP monitoring	Very important	Support to manage their disease
Heart rate monitoring	Very important	Support to manage their disease
Oxygen saturation monitoring	Not so important	
Body weight monitoring	Very important	Esp. in case of cardiac insufficiency to watch the water elimination, to perform interventions right in time and to adapt the medical therapy
Pill reminder	Not so important	
Other reminder	Not so important	
Alarm	Very important	Activating an alarm in case of abnormal values of the patient's vital parameters.
Open pharmacies	Not so important	Easy access to information
Weather forecast	Not so important	Easy access to information
Simplified appliances manuals	Not so important	Easy access to information
Other (please describe it)		

2.5.6 PEOPLE WITH DIABETES TYPE 2 > 55 YEARS

Service type	Rank	Expected functionality
Cognitive Reinforcement	Not so important	Maintain/improve cognitive functions. Stay mentally active
Physical Reinforcement	Very important	Risks can be reduced by a healthy lifestyle, continuous exercise 150min/week refers to a healthy weight.
Chatting	Not so important	contact with friends and family
Sharing photos	Not so important	contact with friends and family
Getting support and advisory information from specialists	Very important	Support to manage their disease
Maintaining a family calendar	Not so important	
Maintaining a phone book	Not so important	

Service type	Rank	Expected functionality
Reality orientation	irrelevant	
EGC monitoring	important	In case of emergency situations
BP monitoring	Very important	Support to manage their disease
Heart rate monitoring	Very important	Support to manage their disease
Oxygen saturation monitoring	irrelevant	
Body weight monitoring	Very important	Reducing risk factors
Pill reminder	Not so important	
Other reminder	irrelevant	
Alarm	Very important	Activating an alarm in case of abnormal values of the patient's vital parameters.
Open pharmacies	Not so important	Easy access to information
Weather forecast	Not so important	Easy access to information
Simplified appliances manuals	Not so important	Easy access to information
Other (please describe it) Nutrition counseling	Very important	E.g.: MyFoodAdvisor™ is a unique calorie and carbohydrate counting tool that can help with diabetes management and nutrition. http://www.diabetes.org/food-and-fitness/food/my-food-advisor/

3. TECHNOLOGICAL APPROACHES TO AAL

Ambient Assisted Living (AAL) is about creating products and services helping for the well being of a person through providing unobtrusive support for daily life based on context and the situation of the assisted person. It is currently one of the most important and better funded research and development areas, because of the increasing average age of the total population, especially in the developed countries, that can lead a) to creating large costs for the public but also for individuals for the intensive care for the elderly people at home and b) to reduced quality of life of these people as their social skills diminish (Kleinberger et al., 2007; Nehmer et al., 2006).

HERA is concerned with addressing the non-trivial task (Nehmer et al., 2006) of engineering an AAL system addressing the needs of the elderly suffering from moderate and mild Alzheimer Disease (AD) as well as from Mild Cognitive Impairment (MCI) and those elderly suffering from cardiovascular diseases and diabetes (referred to as users from now on). This application domain is about offering indoor assistance aiming to enhance the autonomy and quality of life of the user. A number of challenges are related to engineering such systems (Kleinberger et al., 2007):

- *Adaptivity*. No two human beings have the same needs or everyday life habits. An AAL system must be able to adapt to a particular user.

- *Natural and anticipatory Human-Computer Interaction (HCI)*. The people that need assistance very often have limitations and handicaps.

- *Heterogeneity*. AAL systems are expected to be capable of being integrated with several subsystems developed by different manufacturers (IT equipment, sensors, electrical equipment, etc).

In order to address these challenges we need to review and assess the relevant state of the art. Adaptivity depends on intelligent techniques and the agent technology brings ideas and techniques (originally from the artificial intelligence domain) mainly from the area of personal assistance field. HCI depends on system architecture for service instantiation and delivery and at the user's home multimodal user interfaces. Heterogeneity depends on the use of standards but also on architecture such as a service oriented architecture that claims to address this non-functional requirement.

3.1 ARCHITECTURAL REQUIREMENTS - OVERVIEW

System architecture is concerned with identifying the components that constitute a system, how are they interconnected, which standards are used, etc. The HERA architecture is depicted in Figure 3. The architecture shall be designed to implement the HERA services concepts. The main components of the architecture shall be:

- The TVset/Set-Top-Box, that constitutes the main interface for the elderly.

- The Bluetooth Medical Devices.

- The Health Center Information Server.

- The mobile phones, home PCs and other terminals of the elderly relatives.

- The HERA Application Server.

The stakeholders of the HERA system shall include:

- The elderly person or user.

- The family caregivers of the elderly users.
- The Health Center (Hospital, Specialised Center).
- The ISP – Service Provider.

The Set-Top-Box/ TVset shall be the main user interface for the elderly to communicate with the HERA system. It shall offer multimodal web-based user interfaces for this communication. It shall employ every technology that simplifies the interaction of the user with the computer.
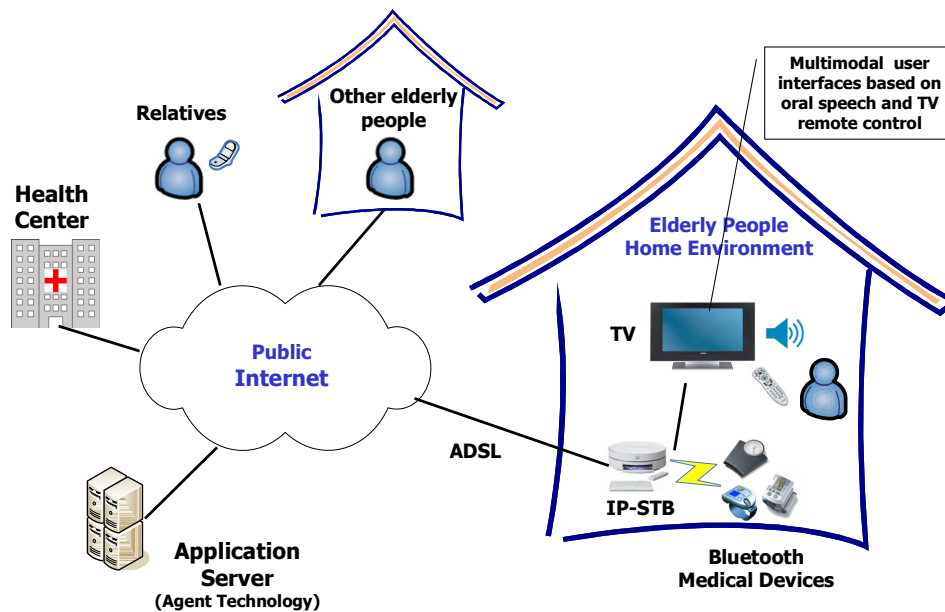
Figure 3: HERA Architecture Overview

The Medical Devices shall communicate directly with the STB over a wireless communication interface such as Bluetooth providing with users' medical data such as BP, heart rate, body weight.

The Health Center Information Server shall accept emergency messages from the HERA system regarding the user needs and/or critical changes to their health situation.

The relatives' terminals are devices that give the opportunity to the HERA system to communicate with them in case of an emergency. Such devices are Mobile phones, PDAs, home PCs etc.

The HERA Application Server shall constitute the core of the HERA System. It shall host the execution environment of the HERA services and shall run the identity management, the module that shall implement user authentication and services personalization.

The core component of the HERA architecture shall be the Application Server. It shall be composed of a set of sub-systems including:

- A web server for deploying the HERA applications and services.
- Multimodal user interfaces for human machine interaction.
- A personalization module for providing intelligence to the HERA services.
- Interfaces to home devices for making available to the user agent the information from a medical device at home.
- Security and privacy control for allowing access to user information such as his profile

only to the relevant personal assistant agent and for securing communication channels from the home environment to the application server

- Interfaces to external services such as the medical server services and public web resources such as weather information.
- A database for storing user related information such as user profiles and user-related policies.

Most of the aforementioned subsystems shall be based on the INHOME architecture subsystems.

3.2 WIRED AND WIRELESS COMMUNICATION INTERFACES

This section provides an overview of the communication interfaces, which shall be used for the communication between the components of the HERA system according to the required architecture. The interfaces shall be either wired or wireless and in some cases both wired and wireless technologies shall be used. Their difference lies in the implementation and the achievable bandwidth. The table below presents the different interface types together with commonly used device types.

Table 2: Wired and wireless communication interfaces for HERA

Interface type	Appliance Type	Popularity
ADSL	STBs, Application Servers	High
Bluetooth	PCs, Medical Devices, Mobile Phones, PDAs, PC peripherals (printer, scanner, etc)	High
Wired Ethernet	STBs, PCs, Application Servers	High
Wi-Fi (IEEE 802.11 a/b/g)	PCs, Laptops, Wireless routers, Application Servers, SmartPhones, PDAs	High
USB	PCs, Application Servers, STBs, printers, Mobile Phones	High
RS-232	PCs, Application Servers, STBs, Medical Devices	High
NFC	Medical Devices, Access Points (PDAs, PCs, Mobile Phones)	Medium
DVB-S	STBs	High
GSM/ GPRS	Mobile Phones	High
3G	Mobile Phones, Laptops, PCs, PDAs	High

Depending on every different communicating device and on the type of the communication (different bandwidth and data rate for different types of data exchanged, e.g. multimedia content needs a big data rate connection) there are several feasible communication technologies. Also the user is acclimatized with some technologies, usually these that are used every day. These technologies are preferred instead of unknown and low popularity technologies. All these issues must be taken in account.

3.2.1 COMMUNICATION WITH TERMINALS

In HERA there are different terminals. The terminals shall be distributed to the server and client

sides of the system and shall use a set of technologies for their communications. Some terminals shall be: the STBs located in the elderly environment, the relatives' mobile phones and any other devices that let the interaction of the client side components with the server-side (Application Servers).

The table below summarises the technologies used for the communication of the terminals. The interface points for such a communication are clearly given.

Table 3: Communication with Terminals

Technologies and Protocols	Interface Point 1	Interface Point 2
ADSL, Ethernet, IP, HTTP	Application Servers	Set-Top-Boxes
GSM, SMS, 3G	Application Servers	Relatives Mobile Phones
ADSL, IP, HTTP	Application Servers	Relative PCs
ADSL, IP, HTTP	Application Servers	Health Center
RS-232, Bluetooth	Set-Top-Boxes	Medical Devices
HDMI	Set-Top-Boxes	TVset
NFC	Elderly Mobile Phones	Medical Devices

As shown in the table, special weight is given to the communications of the Application Server with the terminals, since the Application Server is the centre of the HERA System. The Application Server provides all the corresponding networking technologies for interconnection with the HERA terminals, appliances and networking devices such as PDAs, Mobile phones STBs etc.

Since the Application Server is needed to communicate with many terminals located in different spots, a mechanism of identifying the different terminals must be implemented. The Internet Protocol (IP) is the best solution here since it supports the communication of the terminals and includes automatic detection, real-time transfer of data and secure data transmission.

On the application layer, there are several protocols able to connect a service and to exchange data based on queries and responses. They are commonly used Web based protocols that use description languages such as HTTP, XML, SOAP etc.

However, the communication between terminals also deals with the communication of the Medical Devices with the Set-Top-Box and between the Set-Top-box and the TVset.

Lately, medical devices use RS-232 cabled connection to connect with Access Points (PC, STB etc.). However, wired connections are not so convenient since the user is bounded to be close to the computers or other terminals, the Medical Devices are tend to adopt wireless technologies (Bluetooth, NFC, etc) and some of them already support Bluetooth technology.

The Set-Top-Box in combination with the TVset is a User Terminal by itself. It supports different kind of wired connections with the TVset, where the user can also receive messages from the Application Server.

The figure below depicts the connections from the Medical Device to the STB and from the STB to the Television.
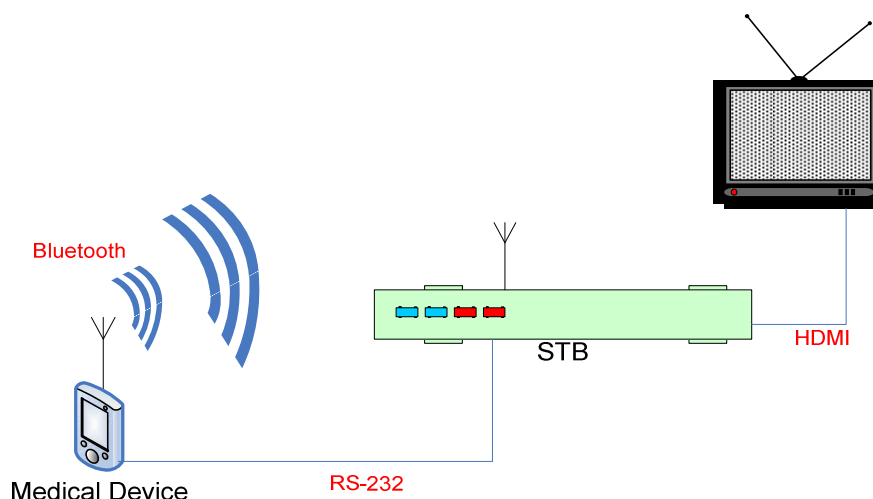
Figure 4: Medical Device – STB – TVset connectivity

3.2.2 COMMUNICATION WITH MEDICAL DEVICES

Over the last years, wireless network technologies have made great progress and they are now integrated in many mainstream applications which expose the advantages of the wireless networks. With all these advances in wireless networks, it is normal that such technologies will be used in the HERA system to improve its functionality and make its operation more efficient.

Because there are multiple technologies that implement wireless connectivity, the choice of the one which will be used is usually based on the intended use of the device. In addition there are some more attributes which should be considered like: power consumption, data rate, network breadth, usability etc. Then it is important to use these features to compare candidate technologies and choose the most appropriate one. For example Bluetooth is the lowest power consumption after the IrDA technology and unlike IrDA, the Bluetooth can be used in a small area network. This gives to the Bluetooth approach a great advantage taking also in account that in order to use Bluetooth, no IP addressing is involved in order to set up easy small networks.

Table 4: NFC-Bluetooth comparison

	NFC	Bluetooth
Network Type	Point-to-point	Point-to-multipoint
Range	<0.2m (about 10 cm)	10m
Frequency	13.56 MHz	2.4-2.5 MHz
Bit rate	424 kbits/s	2.1 Mbits
Set-up time	<0.1 sec	6 sec
Compatible with RFID	YES	NO
Operates even if one of the two devices is one of them is not powered	YES	NO

Another communication technology which enables the exchange of data between devices is the NFC (Near Field Communication). NFC is a short-range high frequency wireless communication

technology, primarily used in mobile phones, that has an advantage the short set-Up time (<0.1 s). A comparison between the NFC and Bluetooth is provided in the following Table 4.

The advantage of the NFC is the small set-up time and the fact that the connection between two devices is established at once instead of performing a manual configuration to identify Bluetooth devices. However the Bluetooth protocol supports:

- bigger range,
- a better data rate

and is more widely adopted by the industry than NFC.

3.3 MIDDLEWARE TECHNOLOGIES

The state-of-the art for middleware technologies of the HERA system contains many candidate technologies for the implementation of the message transmission processes.

A modern approach to middleware architecture is that of service orientation. According to Cervantes and Hall (2004), service orientation uses the idea of assembling a system from modular building blocks, with the difference that these building blocks are services. The difference between services and components is that the first are contractually defined in a service description that contains syntactic, semantic and behavioural information. Components, on the other hand need to describe more than that, actually how they would be integrated in a computer program. Thus, the idea of services is that not only they do not need to be integrated physically in a new program or deployed with a new system, but they may have to be searched for and executed on run time, that is there may have been no knowledge about them during the time of system (or new services) development.

Bennett et al. (2000) argue that in the future, software will be delivered as a service within the framework of an open marketplace. In this sense SoA can be considered as a marketplace, where a service is an individual shop/trader in the market. Two are the most successful modern SOA frameworks that have been standardized and become accepted by diverse vendors, web services and the Open Services Gateway initiative (OSGi).

The middleware technologies are going to serve as a transport medium between the different HERA components. Specifically, seven technologies, namely CORBA, DCOM, Java/RMI, Web Services, Mobile Agents, Enterprise Java Beans and TCP sockets are described and their main characteristics and features are presented.

- CORBA - CORBA is a standard defined by the OMG that enables software components written in multiple computer languages and running on multiple computers to work together. It is a mechanism in software for normalizing the method-call semantics between application objects that reside either in the same address space (application) or remote address space (same host, or remote host on a network)

- DCOM - DCOM is a proprietary Microsoft technology for communication among software components distributed across networked computers. It provides the communication substrate under Microsoft's COM+ application server infrastructure.

- Java/RMI –Java RMI is a Java API performs the object-oriented equivalent of remote procedure calls (RPC). It enables the programmer to create distributed Java technology-based to Java technology-based applications, in which the methods of remote Java objects can be invoked from other Java virtual machines, possibly on different hosts. RMI uses object serialization to marshal and unmarshal parameters and does not truncate types, supporting true object-oriented polymorphism.

- Web Services – Web Service is traditionally defined by the W3C as "a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically Web Services Description Language WSDL). Other systems interact with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other web-related standards. Web services today are frequently just Application Programming Interfaces (API) or *web APIs* that can be accessed over a network, such as the Internet, and executed on a remote system hosting the requested services.

- Enterprise Java Beans – EJB technology is the server-side component architecture for Java Platform, Enterprise Edition (Java EE). EJB technology enables rapid and simplified development of distributed, transactional, secure and portable applications based on Java technology.

- Mobile Agents - A Mobile Agent is a composition of computer software and data which is able to migrate (move) from one computer to another autonomously and continue its execution on the destination computer. More specifically, a *mobile agent* is a process that can transport its state from one environment to another, with its data intact, and be capable of performing appropriately in the new environment. Mobile agents decide when and where to move. Movement is often evolved from RPC methods.

- A TCP socket is defined as an *endpoint for communication*. A socket consists of the pair `<IP Address,Port>`. A TCP connection consists of a pair of sockets. Sockets are distinguished by `client` and `server` sockets. A server listens on a port, waiting for incoming requests from clients.

3.3.1 THE OPEN SERVICES GATEWAY INITIATIVE

The Open Services Gateway initiative (OSGi) technology provides a service-oriented, component-based environment for developers and offers standardized ways to manage the software lifecycle. It is elaborated herein as an example of a service-oriented architecture paradigm and shows that such paradigms can also be connected with agent platforms.

OSGi offers the following possibilities:

a. Firstly, in the same virtual machine, bundles (that is how the OSGi components are named) can be installed, started, stopped, or uninstalled, dynamically on runtime. This feature allows for the best utilization of resources of nomad devices (low computing power).

b. Secondly, a bundle can import but also export java packages when installed. In Java, there is normally a single classpath that contains all the available packages and resources. The OSGi framework caters for controlled linking between different software modules, as they are installed on runtime. This allows, for example, the exportation of the ontology by one bundle and its use by all others that are installed afterwards.

c. Finally, the bundles can locate and invoke services offered by other bundles. This allows for dynamic interoperability between our different components. Services definition and advertisement is easy and intuitive, as it is based on common Java interfaces definition. Then, these interfaces' implementation classes are started by an OSGi mechanism that undertakes the task of advertising the implemented interfaces in the framework. Then the OSGi Application Programming Interface (API) can be used for locating and invoking the services.

Spanoudakis and Moraitis (2007) defined a methodology for integrating JADE (a FIPA agent platform) in the OSGi framework. The proposed integration of the FIPA agent platform and OSGi satisfied the following goals:

- To provide an architecture where agents can simultaneously execute in both the agent platform where they are created and the OSGi architecture integrating the above platform. That means that agents built so that they execute in the selected agent platform can also execute normally in the context of the platform's integration in the OSGi architecture.

- To allow the agents to use the OSGi services in an agent instance independent manner. For example, software agents invoke existing web services in a standardized way, having the only prerequisites that the agent has access to the internet and that the service is available. Following this paradigm, the agent should have access to existing OSGi services with the only prerequisites that the agent's platform is integrated with an OSGi platform and the services are available.

- To allow the agents to offer themselves services to the OSGi framework in order to seamlessly integrate with different software modules.

In order to realize the above goals we integrate the agent platform in the OSGi framework and instantiate it as an OSGi service. In Figure 5 the reader can see the operating system on top of which a Java virtual machine executes and the OSGi framework. Different bundles are instantiated, one of which is the agent platform bundle. This approach is more efficient because the OSGi framework offers an environment where any kind of application can execute.
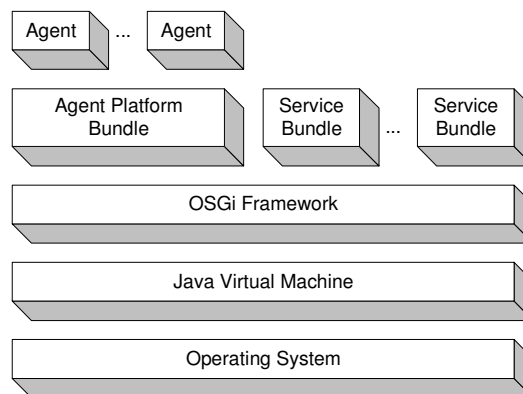
Figure 5: OSGi – JADE Computing environment structure (five layers)

The drawback of OSGi is that it manages the interaction of services only for a single machine and allows for implementation only in the Java language.

3.3.2 MIDDLEWARE TECHNOLOGIES FOR HERA

The following characteristics and features have been selected for comparing the different available technologies (see Table 2).

- Transport and communication technology, which characterises the network technology used as a communication bearer as well as the protocols supported.

- Programming Languages, which characterises the programming languages supported.

- Cost, which characterises the cost for using the respective messaging technology.

- Ease of use, which characterises the simplicity or the complexity for the developments.

- Extensibility, which characterises the capability to add new components without modifications to the base technology.

- Dynamic Service Deployment, which characterises the flexibility of the architecture by dynamically adding new functionality.

- Security, which characterises the capability to provide data and users with secure functionality.

- Performance, which characterises the capability to serve network or applications procedures with time critical constraints within specific time boundaries.

Table 5: Middleware technologies for HERA

Middleware/ Messaging Technology	Transport and Communication Technology	Programming Languages	Cost	Ease of Use	Extensibility	Dynamic Service Deployment	Security	Performance
CORBA	IP-based, Internet Inter-ORB Protocol (IIOP)	IDL, programming language independent	Not free - costs for development and runtime licences	Not so easy to use – Add on to the language	No significant redesign, since it is based on object model.	Limited – build specific applications	Provides Corba Secure Services	Very good
DCOM	IP-based, Object Remote Procedure Call (ORPC)	IDL	Not free - comes with Microsoft products	Not so easy to use	No significant redesign, since it is based on object model.	Limited – build specific applications	DCE Kerberos security and proprietary APIs	Very good
Java/RMI	IP-based, TCP, Java Object Serialisation	Java	Free	Simple to use – Integrated into platform	No significant redesign, since it is based on object model.	Limited – build specific applications	Provides SSL by Java	Good
Web Services	IP-based, TCP, HTTP, SOAP, XML	XML, programming language independent	Free	Very simple to use – XML based	No significant redesign, since it is based on object model and XML.	Ideal – registered and can be located through a UDDI	Provides SSL by Java	Enough
Enterprise Java Beans	IP-based, TCP, RMI over IIOP	Java	Not free for commercial purposes	Simple to use – Integrated into platform	No significant redesign, since it is based on object model.	Limited – build specific applications	Provides SSL by Java	Good
Mobile Agents	IP-based, TCP, Java Object Serialisation	Java	Free	Simple to use – Add on to the platform	No significant redesign, since it is based on object model.	Limited – build specific applications	Provides SSL by Java	Enough
TCP sockets	IP-based, TCP	Java, C	Free	Simple to use – Integrated into platform	-	Limited – build specific applications	Requires IPsec or SSL secure sockets	Very good
OSGi	Java	Java	Free	Simple to use	No significant redesign, since it is based on object model.	Allows for service start, stop and monitor for service start	Is intended for a single machine	Good

3.4 HUMAN MACHINE INTERFACES

The Human Machine Interface (HMI) constitutes the meeting point of people and technology. Its task is to make the function of technological products self-evident to users. In every technological solution the effectiveness of the HMI can predict the acceptance of the entire solution from the user. Often, as far as consumers are concerned, the user experience, perceived from the use of the interface of the product/service, is far more important for its commercial success than the internal architecture of the product/service itself.

The Human-Machine Interfaces have a very important role within the HERA project. This is because an objective of the HERA project is to offer efficient and adaptable interfaces to achieve a user-friendly communication between the HERA System and the users. Taking also in account that the main users of the HERA Systems will be elderly people not very familiar with technological issues, it makes clear that the HMI must be chosen and designed very carefully.

HERA shall design and develop multimodal HMIs taking into account the interaction needs of the elderly people and shall measure their effectiveness by a number of components such as learnability and productivity.

The most common user interfaces which are currently in use are:

- Graphical User Interfaces (GUIs) – GUIs accept inputs by handling events occurred on devices such as keyboards, mouse, touch screens and joysticks and provide an appropriate output on the computer monitor. There are many principles used in GUI design. Most important of them are: the OOUI (Object-Oriented Interfaces) and the Application Oriented Interfaces.

- Web-based user interfaces – Web user interfaces accept inputs and based on them they generate web pages and return them as output. The web pages are transported via the Internet and viewed in appropriately designed web browsers. Newest versions of the web browsers support also technologies for asynchronous message transportation such as AJAX. Such technologies allow the update of the web page's content without needing to refresh like on old HTML based web browsers.

There are also some interfaces common in fields outside desktop computing:

- Touch interfaces – Touch interfaces are GUIs that use a touch screen display and let the user interact with the application not using a mouse and keyboard but the monitor. In this type of interfaces the monitor is both input and output device. Such interfaces are used in many industrial machines such as: Photoplay games, self-service vendor machines etc

- Command Line Interfaces – CMD Line Interfaces allow user to send input by typing commands and giving input parameters. The users use the keyboard as an input device and the monitor as an output device. However this kind of HMI is recommended only for advanced users.

There are also some other types of user interfaces:

- Batch Interfaces – Batch interfaces let the user specify all the details of the job that the batch will perform and receives the output when the processing is done. Such interfaces are non-interactive.

- Gesture Interfaces – Gesture interfaces allow accepting inputs such as hand gestures or mouse gestures sketched with a computer mouse or a computer stylus.

- Multi screen User Interfaces – Multi screen interfaces are suitable for multimedia applications and games. The interface uses more than one screen to display the output

> providing a more flexible interaction.

- Telephone User Interfaces – Telephone interfaces accept voice input and provide voice output which is transported over a phone network.
- Zero Input Interfaces – Zero input interfaces take input from sensors and/or other event monitoring devices and provide output to monitor devices. The user is not providing any input himself.
- Zooming User Interfaces – Zooming interfaces are GUIs that have a scalable output and let the users to zoom and view the output in a more detailed level.

An addition to the previously described Human Machine Interfaces is some speech based methods used for the implementation of them. Speech based Interfaces are relatively new but they are easy to use since everyone is familiar to them. Their usage involves the development of technologies and standards related to the adoption of common APIs, the design and the realization of the speech related databases (VoiceXML) etc

VoiceXML (VXML) is the W3C's standard XML format for specifying interactive voice dialogues between a human and a computer. It allows voice applications to be developed and deployed in an analogous way to HTML for visual applications. Just as HTML documents are interpreted by a visual web browser, VoiceXML documents are interpreted by a voice browser. A common architecture is to deploy banks of voice browsers attached to the Public Switched Telephone Network (PSTN) so that users can use a telephone to interact with voice applications. Currently developed industrial software applications that use the VXML are applications for: order inquiry, package tracking, driving directions, emergency notification, wake-up, flight tracking, voice access to email, customer relationship management, prescription refilling, audio newsmagazines, voice dialing, real-estate information and national directory assistance applications

3.5 DATA MODELLING

Data modelling has to do with how to model the data participating in the successful functionality of a system. Data modelling is very important in collaborative projects as it is the means by which all developed modules communicate. They are used for defining communication and application programming interfaces.

When the interfaces are defined in a common programming language then it is useful that data are also defined using this language. In the case of an object oriented language it is best to define an ontology in a class diagram (see one in Figure 6) and then also export it in a package. See Figure 7 for an illustrative example for defining such interfaces with the Java language.

If the interfaces are diverse and include the use of different communication technologies implying the need to transform them to different formats then the best way to define them is in a standardised language such as XML. XML (Extensible Markup Language) is a set of rules for encoding documents electronically. A sample XML document is shown in Figure 8.

Well-formed XML documents must adhere to the XML language, e.g. they must have a root element (like *<note>* in Figure 8) and each element must have a closing tag (in this case the *</note>*). In addition to being well-formed, an XML document may be *valid*. This means that it contains a reference to a Document Type Definition (DTD) or XML schema document (XSD). DTDs or the later schemas define specific grammars for XML. XSDs also use an XML-based format, which makes it possible to use ordinary XML tools to help process them. See a sample XSD in Figure 9 for the XML presented in Figure 8. The *note* element is defined as a complex type that aggregates four simple elements , i.e. *to, from, heading, body*, all of type *string*.
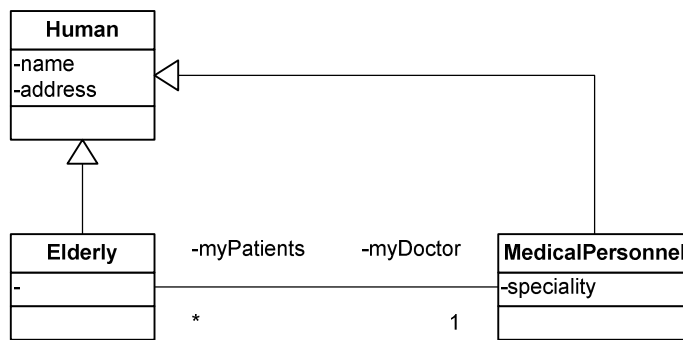
Figure 6: A class diagram defining an ontology.

```java
package whatever_package.interfaces;

import whatever_package.ontology.AnyConcept;
import whatever_package.ontology.AnotherConcept;

public interface AnyServiceName {

      public AnotherConcept anyServiceName(AnyConcept aParameter);
}
```

Figure 7: A Java interface definition. It includes the ontology package and defines the service signature. Concepts defined in the ontology can be in and/or out parameters.

```xml
<?xml version="1.0"?>
<note>
   <to>Tove</to>
   <from>Jani</from>
   <heading>Reminder</heading>
   <body>
      Don't forget your appointment with Dr Louis on 12/01/2010 on 13:00
   </body>
</note>
```

Figure 8: A sample XML document (source: www.w3schools.com).

Specific middleware technologies also define their own type of data with which to define their interfaces (like OSGi with the Bundle concept). Another possibility that includes the above if handled properly is to use a specialized ontology definition tool such as protégé (http://protege.stanford.edu) which gives the possibility to transform the developed ontology into different formats including semantic web technologies such as RDF or OWL.

```
<xs:element name="note">
<xs:complexType>
  <xs:sequence>
    <xs:element name="to" type="xs:string"/>
    <xs:element name="from" type="xs:string"/>
    <xs:element name="heading" type="xs:string"/>
    <xs:element name="body" type="xs:string"/>
  </xs:sequence>
</xs:complexType>
</xs:element>
```

Figure 9: A sample XML schema document (source: www.w3schools.com).

Of course all data are stored in a database in the end so in any format that they are defined they will have to be stored in a relational database such as MySQL or Oracle. MySQL is an open source database while Oracle is a well known vendor.

3.6 AGENT TECHNOLOGY FOR AAL

AAL can be seen as a special case of Ambient Intelligence (AmI). Lee et al. (2009) define AmI as a ubiquitous environment of computing, networking, and interfacing that is aware of and reactive to the presence of people. Before AAL emerged as a research area, Abascal (2004) had already suggested that the elderly and disabled people compose a segment of the population that would benefit from AmI, under the condition that AmI was accessible. Nehmer et al. (2006), state that AAL systems should exhibit characteristics such as pro-activeness and adaptation, and as we will show here-in cooperation, which relate to basic motivations that would make someone utilize agent technology (Weiss, 1999).

3.6.1 STATE OF THE ART

Previous works in this area (Bravo et al., 2008; Corchado et al., 2008) introduced agent based systems for AmI for assisting in taking care of people with Alzheimer but they on one hand required the aid of a nurse or caregiver and on the other hand used RFID tags (Corchado et al., 2008) or NFC technology (Bravo et al., 2008). Both technologies are used to identify the location of the user using radio frequency identification technologies that require the use of sensors in different places at home and the use of another sensor on the user's body for identifying his location.

More particularly in Corchado et al., (2008) the ALZ-Mutli-Agent System (ALZ-MAS) is composed of four different types of agents: the Patient agent who manages the patient's personal data and behaviour (monitoring, location, daily tasks and anomalies). This agent validates every hour the patient location, monitors the patient state and sends a copy of its memory basse (patient state, goals and plans) to the manager agent in order to maintain backups. The second type is the Manager agent who plays two roles the Security role that controls the patient's location and manages locks and alarms and the Manager role that manages the medical record database and the doctor-patient and nurse-patient assignment. The third type is the Doctor AGALZ agent who treats patients. The Doctor agent interacts with the Patient agent to order a treatment and receive periodic reports and with the Manager agent to consults medical records and with AGALZ agent to ascertain the patient evolution. The forth type is the AGALZ type who schedules the nurse's day obtaining dynamic plans depending on the tasks needed for each assigned patient. AGALZ manages nurses' profiles, tasks available time and resources. The

generated plans must guarantee that all the patients assigned to the nurse are given care. So the above multi-agent system is dedicated to the location of Alzheimer suffering patients in a given environment like a medical or nursing residence as well as to the coordination of the nurses and doctors daily work along with the supervision that all these patients are given the decided by the doctors' care.

In (Bravo et al., 2008) the authors address issues in Alzheimer care in two kinds of environments: day centres and homes. They are using two key technologies namely *context modelling through ontology* and *context sensing and phone-mediated natural interaction with NFC* (Near Field Communications). The caring setting (day centre or home) is divided in four important aspects: a) the *user* who is an active entity requiring and consuming services that interact implicitly with an intelligent environment, which is aware of the user's identity, profile, schedule, location, preferences, social situation and activity, b) the *services* concerning all the activities that the system might offer to user to satisfy their needs, c) the *environment* which is everything surrounding the user; that is all the physical entities that could be found, d) the *devices* which are mechanism capable of modifying the context, by yhe explicit or implicit interaction of the user, or collecting information about the context of users. The aim of this system is on one hand to provide help to caregivers giving them the possibility through the use of Bluetooth-enabled NFC mobile phones to easily record incidents that patients may have and on the other hand to propose a therapy activity support for the patients. In the first situation the information concerning these incidents could be send in a personalized way to other caregivers, assistants or relatives. Thus physicians would receive clinical information, while assistants and caregivers would obtain just the behavioural incidences. In the second situation the activities (e.g. answers to questions that will be useful for each patient as information about celebrities, books, TV series, or information related to some patient's relatives along with some clues, etc.) proposed to the patients could be displayed in any screen from the server. It is possible to visualize an exercise on any public display knowing just the activity and the patient tag (i.e. id). Regarding the home case, this device could be a common television with DTT enabled. This complement o therapy could be managed at the patient's own home too. The device used to send the application to the DTT television is DVB-T (Digital Video Broadcasting–Terrestrial) decoder with MHP technology. This device decodes the interactive application distributed in a television channel and offers the interactivity demanded by the activity plan. Finally in order to keep control the patient's health when they are at home or at the day centres it is necessary to monitor their vital signs which are measurements of the basic functions of the body and these measurements can lead to several reactions. For example when they are over some limits the mobile phone could tell the patient what to do. The recommendation will depend on the patient's medical record. If the measurements are dangerous the mobile phone could send a message to the primary doctor or to some relative.

Another application for medicine usage management using agent technology which might concern different health problems is the one proposed in (Hoogendoorn et al., 2009). This application explores and analyses possibilities to use automated devices such as an automated medicine box, servers and cell phones as non-human agents, in addition to human agents such as the patient and s supervisor doctor. Two world components are present in this system: the medicine box and the patient database; the other components are agents. The (ambient) Medicine box agent monitors whether medicine is taken from the box, and the position thereof in the box. In case, for example, the patient intends to take the medicine too soon after the previous dose, it finds out that the medicine should not be taken at the moment (i.e. the sum of the estimated current medicine level plus a new dose is too high) and communicates a warning to the patient by a beep. All information obtained by this agent is passed to the (ambient) Usage Support

Agent. Thus all information about medicine usage is stored in the patient database by this agent. If the patient tried to take the medicine too early, a warning SMS with a short explanation is communicated to the cell phone of the patient, in addition to the beep sound already communicated by the Medicine Box agent. On the other hand in case the Usage Support agent finds out that the medicine is not taken early enough it can take measures as well using a similar protocol.

Agent-based computing is also considered as one of the most appropriate technologies for ambient assisted living systems in an interesting survey presented by Becker (2008). Another interesting survey on agent-based intelligent decision support systems to support clinical management and research can be found in (Foster et al., 2005). Finally interesting information about the characteristics of residential monitoring applications designed to be used in consumers' personal living spaces and more particularly to be used by persons with dementia is presented in (Mahiney et al., 2007).

What is missing from such systems and which we have to address in HERA is to increase the autonomy of the user, to automate the ambient assistance (without requiring the use of managers, caregivers or nurses), to act unobtrusively and to minimize the use of hardware, aiming to a commercial solution to home care for people suffering from dementia and having cognitive problems. Moreover the assistance of the user by a group of agents modelling different kind of experts is in accordance, as it is pointed out in (Mahoney et al., 2007) that people with Alzheimer are assisted by multidisciplinary teams.

3.6.2 ARGUMENTATION TECHNOLOGIES FOR AAL

Autonomous agents, be they artificial or human, need to make decisions under complex preference policies that take into account different factors. In general, these policies have a dynamic nature and are influenced by the particular state of the environment in which the agent finds himself. The agent's decision process needs to be able to synthesize together different aspects of his preference policy and to adapt to new input from the current environment. Argumentation (see e.g. CaponDunne) is very well suited for modelling the decision making capability of autonomous agents in such dynamic and adaptive environments. Argumentation can be abstractly defined as the formal interaction of different conflicting arguments for and against some conclusion due to different reasons and provides the appropriate semantics for resolving such conflicts. The nature of the "conclusion" can be anything, ranging from a proposition to believe, to a goal to try to achieve, to a value to try to promote. Thus, argumentation is very well suited for implementing decision making mechanisms for multi-expert teams of agents where different conflicting points of view expressed by the different expert agents have to taken into account and where a compromise is is necessary in order to make a collective coherent decision.

Argumentation has been used successfully in the last years in different situations, e.g. for deliberating over the needs of a user with a combination of impairments in an AAL application (Moraitis and Spanoudakis, 2007), for selecting the funds that should be included in an investment portfolio (Spanoudakis and Pendaraki, 2007), for decision making about product pricing policies in the retail business sector (Spanoudakis and Moraitis, 2009), or for group decision making in a more general setting in ambient intelligence environments (Marreiros et al, 2007). More particularly in (Marreiros et al, 2007) it is proposed a multi-agent (simulator) argumentation based system whose aim is to simulate group decision making processes. The simulator considers and supports the emotional factors of participants (agents) and their associated processes of argumentation. This system is integrated in an ubiquitous agent based group decision support system and is intended to be used for intelligent decision making, part of

an ambient intelligence environment where networks of computers, information and services are shared. A potential scenario it is considered a distributed meeting involving people in different locations (some in meeting room, others in their offices, etc.) with access to different devices (e.g. computers, PDAs, mobile phones, etc.). However to the best we know it is the first time that argumentation is used in the context of the ambient assisted living context.

The closer of these works to HERA is the one presented in (Moraitis and Spanoudakis, 2007). This work was developed in the course of the ASK-IT IP (IST-2003-511298) project. It concerns an architecture with multiple intelligent agents on a user's with a combination of impairments nomad device, that address the ambient intelligence issue and cooperate with a family of dedicated expert agents for each type of impairment, who are located on the server side. In this work, argumentation has been used for the distributed decision making of the coalition of assistant agents, each of them being expert on a different type of impairment. Indeed, when a user suffers from a combination of impairments, the above mentioned coalition of expert agents, are engaged in an argumentation-based dialogue for agreeing on the needs of the user. In the HERA project argumentation will be used in a similar way. The only difference is that users are suffering from Alzheimer, which, however, implies the supervision of patients by different experts as well and, therefore, a coherent collective decision is needed to be reached each time a particular suggestion has to be made to the patient.

3.7 SECURITY ISSUES

Security is an important aspect in software systems. We identified the most important aspects of security, which are:

- Authentication, which is a process for verifying that someone is who he claims to be. This usually involves a username and a password, but can include any other method of demonstrating identity, such as a smart card, retina scan, voice recognition, or fingerprints. Authentication is equivalent to showing an identity card at the check-in counter at the airport.

- Authorization, which is about finding out if the person, once identified, is permitted to have access to one or more resources. This is usually determined by finding out if that person is a part of a particular group, if that person has paid admission, or has a particular level of security clearance. Authorization is equivalent to checking the guest list at an exclusive party, or checking for your ticket when you go to the opera.

- Secure Communication, which is the process for securing network-based communications from eavesdroppers

- Privacy, the ability to control what information one reveals about oneself over the Internet, and to control who can access that information

3.7.1 AUTHENTICATION

Authentication is the process of determining whether someone or something is, in fact, who or what it is declared to be. In private and public computer networks (including the Internet), authentication is commonly done through the use of logon passwords. Knowledge of the password is assumed to guarantee that the user is authentic. Each user registers initially (or is registered by someone else), using an assigned or self-declared password. On each subsequent use, the user must know and use the previously declared password. The weakness in this system for transactions that are significant (such as the exchange of money) is that passwords can often be stolen, accidentally revealed, or forgotten.

For this reason, Internet business and many other transactions require a more stringent authentication process. The use of digital certificates issued and verified by a Certificate Authority (CA) as part of a public key infrastructure is considered likely to become the standard way to perform authentication on the Internet.

Logically, authentication precedes authorization. As these issues are usually managed together the different approaches are discussed in the next paragraph.

3.7.2 AUTHORIZATION

Authorization is the process of giving someone permission to do or have something. In multi-user computer systems, a system administrator defines for the system which users are allowed access to the system and what privileges of use (such as access to which file directories, hours of access, amount of allocated storage space, and so forth). Assuming that someone has logged in to a computer operating system or application, the system or application may want to identify what resources the user can be given during this session. Thus, authorization is sometimes seen as both the preliminary setting up of permissions by a system administrator and the actual checking of the permission values that have been set up when a user is getting access.

Authorization in web-based application servers can be applied either by explicitly stating which web resources are accessed by which system user (directory or file permissions to specific users or user groups). Such a case is the use of the apache [1] web server. This kind of authentication and authorization is used by those referred to as stateless web applications (Williams and Lane, 2002).

Another type of applications uses stateful authentication/authorization. However, building stateful web applications requires special care because of the stateless nature of HTTP. Using session management, we can build stateful applications.

In telecommunication, a *session* is a series of interactions between two communication end points that occur during the span of a single connection. Typically, one end point requests a connection with another specified end point and if that end point replies agreeing to the connection, the end points take turns exchanging commands and data ("talking to each other"). The session begins when the connection is established at both ends and terminates when the connection is ended.[2]

Thus, a user can be authenticated and start a valid session. If, however, there is also the need for authorization for accessing specific services the session must be associated to a user account where the privileges are stored. This is achieved through the interaction of the web application with a data base. Thus, authentication systems can contain an Access Control List (ACL) that lists user credentials and matches them to assigned system privileges. Credentials are typically a user name and password pair. System privileges let users to access or modify data, and enable them to execute subsystems or subroutines.

3.7.2.1 IDENTITY MANAGEMENT DATA MODELLING

Building an identity management data model can vary from the simple to the complex. The simplest model is a single table containing the ACL for your application. Unfortunately, this model only works with basic HTTP/HTTPS authentication.

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[1] Authentication, Authorization and Access Control in Apache HTTP Server Version 2.2 URL: http://httpd.apache.org/docs/2.2/howto/auth.html

[2] What is a session? Definition from whatis.com

The simplest way to implement cookie and session authentication requires at least two tables. One table contains the ACL, and the other contains the session data. Figure 10 depicts a basic model, where the table on the left contains the system user data and the table on the right associates a specific session to a specific user.
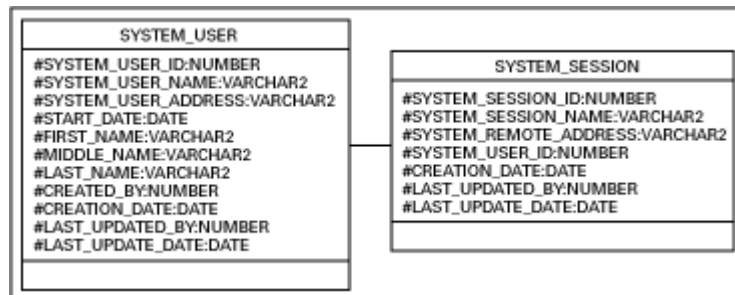
Figure 10: Basic authentication data model[3]

3.7.3 SECURE COMMUNICATION

Network security may be provided through the use of firewalls and intrusion detection systems (IDSs). A firewall is a system that is the sole point of connectivity between the site it protects and all other networks. It is usually implemented as part of a router, although a personal firewall may be implemented on an end-user machine. Firewall-based security depends on the firewall being the only connectivity to the site from outside. A firewall provides access control by restricting which messages it will relay between the site and other networks; it forwards messages that are allowed, and filters out messages that are disallowed. In effect, a firewall divides a network into a more-trusted zone internal to the firewall, and a less-trusted zone external to the firewall. A firewall may also impose restrictions on outgoing traffic, to prevent certain attacks and to limit losses if an adversary succeeds in getting access inside the firewall.

However, irrespective of the protection and prevention mechanisms in place, it is possible that security attacks succeed and proceed in an organization's network. It is extremely important to detect such attacks at the earliest onslaught, so that action can be taken to stop further damage. Intrusion detection systems are, hence, used for identifying the fact that a security attack has occurred (or is occurring). There is no single method for identifying attacks; typically, three methods are used. In host-based intrusion detection, audit trails, logs, deployment of suspicious code, logins, and so on are monitored to detect the occurrence of a security attack. In network-based intrusion detection, the packets entering a network are examined to see if they correspond to signatures of known security attacks. Anomaly-based intrusion detection looks for abnormal usage of network or system resources and flags potential problems.

Communications security may be provided by means such as the Secure Sockets Layer (SSL) protocol or the Transport Layer Security (TLS) protocol. These are used in order to establish a secure communication connection between two TCP-based machines.

Web-services are based on the exchange of messages. The use of open and machine-processable standards makes the messages particular prone to manipulation and unauthorized disclosure. In

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[3] Database-Based Authentication for PHP Apps, Part 1, URL: http://www.oracle.com/technology/pub/articles/mclaughlin-phpid1.html

such systems, security measures may span across multiple domains.

At the network level, firewall policies can be applied to limit access to Web services, because SOAP messages are transmitted via HTTP, typically on Transmission Control Protocol (TCP) port 80, or via HTTPS on TCP port 443. These can form the first line of defense, by reducing the available attack surface.

At the transport level, Web services are often secured through use of the SSL and HTTPS protocols. However, SSL provides only point-to-point encryption and other techniques need to be applied, if the security of the SOAP messages is to be maintained beyond an SSL session.

At the message level, the WS-Security standard may be employed in order to provide secure interactions via particular extensions to SOAP. The specification utilizes:

- **XML Signature** providing for integrity and authentication of XML data through the use of digital signatures. The latter may be enveloped, enveloping or detached. Enveloped signature refers to a signature on XML data, whereby the Signature element is contained within the body of the XML. Enveloping signatures contain the XML content that is being signed, and this is where the Object element is used to contain the data that is signed. Finally, the detached signature type signs content that is external to the XML signature, defined by an URI, which may be external digital content, but can also include elements within the same XML data such as sibling elements.

- **XML Encryption** providing data confidentiality through a mechanism for encrypting XML content that relies on the use of shared symmetric encryption keys. Standard key exchange techniques based on public-key cryptography provide secrecy for the shared key. Typically the shared key is included within the XML message in an encrypted form, is referenced by name or URI, or is derived from some key exchange data.

- **Security Tokens** providing assurance that the message originated from the sender identified in the message. There are three categories of security tokens that are defined: username tokens, binary security tokens, and XML tokens. Examples of security tokens are usernames and passwords (UsernameToken), Kerberos tickets (BinarySecurityToken), X.509v3 certificates (BinarySecurityToken), and SAML (XML Token).

WS-Security also allows for the inclusion of time stamps within the SOAP security header. Time stamps can be required to determine the time of creation or expiration of SOAP messages. Finally, WS-Security defines how to add attachments to SOAP messages in a secure manner by providing confidentiality and integrity for attachments.

As the World Wide Web became popular and commercial enterprises began to take an interest in it, it became clear that some level of security would be necessary for transactions on the Web. The call for and desire for security and privacy has led to the advent of several proposals for security protocols and standards. The most popular is by far the HTTPS protocol, the secured version of the HTTP. As previously stated, it uses the SSL protocol to secure the channel between a client and a server. The default HTTPS port number on an SSL-enabled web server is 443. SSL requires a server certificate such that the server can be authenticated by a browser according to an RSA public / private key encryption scheme. Subsequent web traffic is encrypted with a 128-bit or longer session key generated by a symmetric cipher.

3.7.4 PRIVACY

Privacy can be divided into these concerns:

- What personal information can be shared with whom
- Whether messages can be exchanged without anyone else seeing them
- Whether and how one can send messages anonymously

The main concern in this paragraph is the first as the second has already been addressed with securing communications in the previous paragraph and the third is beyond the scope of HERA.

To address this issue, access to user data must be given after authorization to specific users. This authorization must be known to each user and the system must enforce it by adding specific logic to the existing authorization scheme (see §3.7.2). The latter must be sophisticated using, e.g., dynamic Access Control Lists (ACL). Such lists allow the application to define access privileges dynamically based on system operation (e.g. allow medical personnel to define the patients of a specific doctor, and thus give to that doctor the privilege to access the user's medical data).

4. STANDARDS

Standards are important for the future success of a project as they provide easy connection with existing hardware and services.

4.1 COMMUNICATION STANDARDS

The following sections provide a short description of a set of communication standards in the home environment. Additional communication standards and technologies were described in section 3.3 of this deliverable.

4.1.1 DSL FORUM

The DSL Forum is a world wide consortium of about 200 companies which are part of the different divisions of the telecommunication and information technology sector. Members include wire-line service providers, broadband device and equipment vendors, consultants and independent testing labs (ITLs).

The DSL Forum aims to develop specifications and share practices that set effective deployments and continuing global DSL growth. It develops Technical Reports on the capabilities, testing, management and network architecture for the most effective deployment and operation of DSL from the network itself through to the home. All these specifications drive to results to the increase of DSL Forum experience and provides inputs to standard bodies.

The DSL-Forum consists of several working groups (see Figure 11) with different technical and strategic objectives.
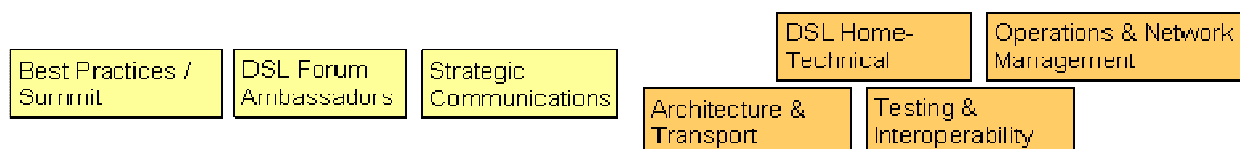
Figure 11: Overview DSL-Forum working groups

4.1.2 IEEE 802.X

IEEE is the world's largest technical society with more than 360.000 members in 175 countries. It promotes the engineering process of creating, developing, integrating, sharing, and applying knowledge about electro and information technologies and sciences.

IEEE covers a very broad scope of technical standardization. The most important working groups for the home network area are listed in Figure 12.
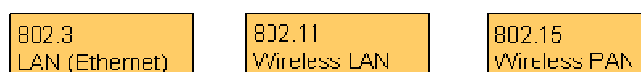
Figure 12: Important IEEE working groups in the home networking area

The 802.3i,u,ab working groups defined the different kinds of wired Ethernet standards. Responsible for the wireless data transmission standards are the working groups 802.11a,b,g. For

the short range wireless personal area networks the working group 802.15.1 defined the Bluetooth standard, while the working group 802.15.4a developed an alternative PHY for low rate Ultra Wide Band devices.

4.1.3 UPnP FORUM

The Universal Plug and Play Forum, formed in 1999, is an association of more than 700 vendors and individuals who are industry leaders in customer electronics, computing, home automation, home appliances, computer networking, and mobile devices. The objective of the UPnP Forum is to promote the emergence of easily connected devices and to simplify the implementation of networks in the home and corporate environments. The UPnP Forum tries to achieve this through the definition and publication of device and service descriptions based on open, Internet-based communication standards.

Like the creation of Internet standards, the UPnP initiative involves a multi-vendor collaboration for establishing standard Device Control Protocols (DCPs) such as SDDP and GENA. Similar to Internet-based communication, these protocols and descriptions, based on wire protocols and expressed in XML, are communicated via HTTP in an UPnP network. Additionally, the site provides the on-device architecture, templates for device and service descriptions, as well as guidelines for device and service description design. Hence, vendors and implementers that plan to develop UPnP enabled devices can publish the corresponding device and service description in the proper format and thus ensure their conformity and interoperability.

The UPnP-Forum consists of several working groups (see Figure 13) with different focus and objectives. Not all working groups are active at the moment. Only if there is demand to work on a certain topic a working group meeting will be established.
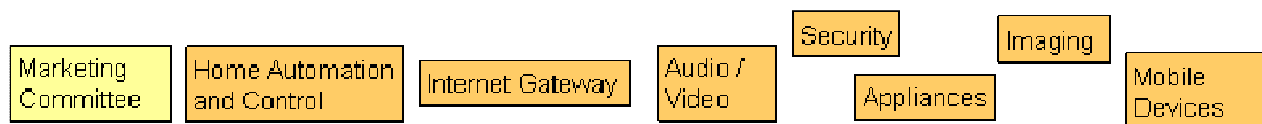

Figure 13: Working groups of UPnP-Forum

4.2 MEDICAL STANDARDS

There are some medical standards used to store and communicate medical data. The most well known of them are:

4.2.1 HL7

Just as people from different countries with completely different native tongues are only able to communicate with each other if they can speak a common language, computer applications can only share information if they communicate with a common protocol. For people or computers to be able to share clinical data with one another, they must both:

  1. have functions to be able to physically communicate, e.g. speak & hear, send and receive documents and data files, share data and information. This is called "functional interoperability".

  2. speak a common language (in terms of nouns, verbs, grammatical structure, etc.) and share the same vocabulary that allows them to understand complex medical conditions and processes. This is called "semantic interoperability".

A group of healthcare computer systems users started developing the HL7 protocol in 1987 to

create a common "language" that allows healthcare applications to share clinical data with each another. Over time the HL7 interoperability protocol became a nationally, internationally and globally accepted and accredited standard.

The term "Health Level 7" ("HL7") is used both for the organisations involved in developing and supporting the healthcare standards as well as for the Version 2.x and Version 3 Standards themselves and other standards developed by the HL7 local organisations in ~30 countries. HL7 creates international standards for inter-system and inter-organisation messaging, for decision support, clinical text document mark-up,

4.2.2 CLINICAL DOCUMENT ARCHITECTURE (CDA)

CDA is an XML-based markup standard for the representation and transfer of clinical documents.

"CDA is a document markup standard that specifies the structure and semantics of a clinical document (such as a discharge summary or progress note) for the purpose of exchange. A CDA document is a defined and complete information object that can include text, images, sounds, and other multimedia content. It can be transferred within a message and can exist independently, outside the transferring message." (Dolin et al, 2006)

The CDA leverages XML, the HL7 Reference Information Model (RIM), HL7 v3 data types, and coded vocabularies and "is being used also in electronic health records projects to provide a standard format for entry, retrieval and storage of health information."

4.2.3 INTERNATIONAL CLASSIFICATION OF DISEASES (ICD)

ICD-10 was endorsed by the Forty-third World Health Assembly in May 1990 and came into use in WHO Member States as from 1994. The classification is the latest in a series which has its origins in the 1850s. The first edition, known as the International List of Causes of Death, was adopted by the International Statistical Institute in 1893. WHO took over the responsibility for the ICD at its creation in 1948 when the Sixth Revision, which included causes of morbidity for the first time, was published. The World Health Assembly adopted in 1967 the WHO Nomenclature Regulations that stipulate use of ICD in its most current revision for mortality and morbidity statistics by all Member States.

The ICD is the international standard diagnostic classification for all general epidemiological, many health management purposes and clinical use. These include the analysis of the general health situation of population groups and monitoring of the incidence and prevalence of diseases and other health problems in relation to other variables such as the characteristics and circumstances of the individuals affected, reimbursement, resource allocation, quality and guidelines.

It is used to classify diseases and other health problems recorded on many types of health and vital records including death certificates and health records. In addition to enabling the storage and retrieval of diagnostic information for clinical, epidemiological and quality purposes, these records also provide the basis for the compilation of national mortality and morbidity statistics by WHO Member States.

4.3 HUMAN MACHINE INTERFACES STANDARDS

HERA intends to use the corresponding international standards and provide, where applicable, contributions. Relevant international standards include:

- ESD-TR-86-27: Guidelines for designing user interface software.

- Instrumentation, Systems, and Automation Society (ISA): HMI Focus.
- ANSI/AIAA G-035, Human Performance Measurements.
- W3C, Multimodal Interaction Working Group Charter.
- ISO SP101: Human-machine interfaces, which defines the requirements for the evaluation, design, development, implementation, and maintenance of efficient, effective, user-friendly HMIs.
- Microsoft Corporation - Effective Web Design Considerations for Older Adults.
- Human-Computer Interaction & Usability for Elderly (HCI4AGING).
- ISO/IEC 13714. (1994). User Interface to Telephone-based Services: Voice Messaging Applications.
- ISO-IEG 11581 "Graphical Symbols on Screens"
- ISO 14915 also produced by TC159/5C4/WG5; Standard on multimedia. It deals with the design of controls and navigation and individual media requirements.
- Human Factors and Ergonomics Society Standards: HFES-200 Committee.
- W3C Voice XML standard. It covers automatic speech recognition (ASR) and text-to-speech synthesis (TTS)

4.4 AGENT STANDARDS

The Foundation for Intelligent Physical Agents (FIPA) is the relevant standardization body. The most relevant standards for HERA are expected to be the:

- **SL Content Language Specification (SC00008I):** The SL language will be used in order to implement the message content for inter-agent messages.
- **Communicative Act Library Specification (SC00037J):** Communicative acts are to be used between all agents interactions. There is a possibility for proposing an extension for the acts in the case that argumentation-based dialogs will be standardized.
- **ACL Message Structure Specification (SC00061G):** The agent communication language will be used between all agents interactions.
- **Agent Message Transport Service Specification (SC00067F):** Agents use this service for exchanging messages.
- **Abstract Architecture Specification (SC00001L):** A specification that defines architectural elements and their relationships. Guidelines for the specification of agent systems in terms of particular software and communications technologies (Guidelines for Instantiation). Specifications governing the interoperability and conformance of agents and agent systems (Interoperability Guidelines).

5. SOFTWARE SERVICES SURVEY

This chapter aims to survey state of the art available/existing software services related to HERA but also consult the literature regarding requirements for such services. Four main categories of services have been identified and they are examined separately in the following paragraphs:

- Cognitive reinforcement services
- Physical reinforcement services
- Patient-specific home care services
- General home care services for the elderly

5.1 COGNITIVE REINFORCEMENT SERVICES

We firstly examine what is a cognitive reinforcement service, then identify the targets of such services and identify the service categories. Then we present some indicative services for each category (for an exhaustive list see Staehli et al., 2009). These are also referred to as games, e.g. memory games, language games, etc.

5.1.1 COGNITIVE SKILLS CLASSIFICATION

The word "cognition" is defined as "the act of knowing" or "knowledge." Cognitive skills therefore refer to those skills that make it possible for us to know. Human beings have cognitive skills or abilities by means of which they are able to integrate, gather and give meaning to all the information existing in their environment. It should be noted that there is nothing that any human being knows, or can do, that he/she has not learned. This, of course, excludes natural body functions, such as breathing, as well as the reflexes, for example the involuntary closing of the eye when an object approaches it. But apart from that a human being knows nothing, or cannot do anything, that he has not learned. Therefore, all cognitive skills must be taught, of which the following cognitive skills are the most important:

- **Attention**. Attention is a multidimensional construct that categorizes a variety of processes distributing elaboration resources on several dimensions. Attentive processes are necessary to perform complex tasks like planning or problem-solving; aging reduces the flexibility in selecting the correct solution. Subcategories of attention include:
  - **Selective and Focused Attention.** Selective attention is the process of selecting a certain information to elaborate it, filtering out the irrelevant information;
  - **Divided Attention and Attentional Switch.** Divided attention is the distribution of processing resources among multiple simultaneous tasks or its rapidly switching from a task to another.
  - **Automatic and Voluntary Processing.** Automatic processes are not affected by aging, while voluntary processes, which require a certain amount of attentional resources and awareness, decrease with aging (like fluid intelligence, see above); practice can reduce this decrease through a process of automatization even though its effectiveness depends on the kind of task: for instance, visual search needs attentional resources even after a long practice (Fisk and Rogers, 1991).
  - **Sustained Attention and Vigilance.** Sustained attention means to maintain the focus on the same task under continuous stimulation. Vigilance means to keep the focus on waiting for a rare event.
- **Memory** is a process which allows us to register, encode, consolidate and store

information in such a way that it can be accessed and retrieved when needed. It is, then, essential in the learning process. Like other cognitive constructs the memory is a heterogeneous category of processes, each one specifically affected by aging, its subcategories include:

- o **Learning** is affected by interacting factors like affective processes, motivation, strategic approach and metacognition (the knowledge of an individual about her own cognitive abilities): for instance, older people's under-confidence in their abilities can obstacle the efforts to approach new technologies.

- o **Implicit versus Explicit processes.** One of the first characterizations could be implicit (procedural and performance-related) processes versus explicit (declarative and conscious) processes: the first ones seem unaffected by aging (Light and La Voie, 1993), in opposition to second ones. This situation induces an unbalance in cognitive control in older people, which ends up being mainly governed by the unimpaired processes, producing for example false memories.

- o **Working Memory** is conceptualized as a temporary and limited workspace for the manipulation of the present and active fragment of information available to awareness to accomplish a task (Baddeley and Hitch, 1974); it includes the following processes: central executive, phonological loop, visuo-spatial sketchpad, episodic buffer (Baddeley, 2000). Craik et al. (1990) observed a large decrement of working memory performances in older adults according to task complexity. Reducing the number of options and the speed of item presentation in an interface menu may positively affect the demand for cognitive resources and information manipulation (Reynolds et al., 2002).

- o **Prospective Memory** is the "remembering to remember" (the memory of a task to be accomplished in the future); studies revealed significant age-related increases in errors rate (Cockburn and Smith, 1991), more for time-based tasks (acting after a certain time span) than for event-based tasks (acting after a certain event). The use of cues facilitates this recollection, but depends on the nature of the task (Einstein and McDaniel, 1990).

- **Executive functions** (EF) refer to the high-level or metacognitive mental processes by means of which we voluntarily resolve internal and external problems. Executive functions are complex mental activities necessary to plan, organise, guide, review, regulate and evaluate the necessary behaviour to achieve goals. In several cases, the prediction of the consequences of a certain choice has a high degree of uncertainty (Dawes, 1998). Older people seem to have a tendency to search and consider less relevant information when in the process of making a decision, and to perform more slowly the choices (Sanfey and Hastie, 2000).

- **Language.** Some learning activities start from text reading; reading is relatively preserved in non-visually impaired old people; problems may emerge with texts that do not semantically refer to the readers' knowledge, as happens with instructions of home medical devices. Hancock et al. (2001) found that understanding improved by reducing the number of inferences needed. The perspective of cognitive load theory suggests "to optimize schema acquisition by stimulating an efficient use of working memory"; some proposals in this direction include: presenting goal-free problems (without a specific solution) to stimulate the exploration of the domain, distributing information over different modalities, avoiding split attention, presenting problems along with already found solutions, leaving out redundant information.

- **Space-Time Orientation** (also referred to as **Visuospatial Skills**), Shepard and Metzler (1971) defined spatial ability as the function of manipulating images or patterns. Processes related to space (even visuo-spatial attention and working memory) or to its mental representations decline during normal aging (Salthouse, 1992). Space orientation and environmental cognitive psychology is a field central in aging applied research aimed at improving the older people's quality of life by redesigning their everyday life space or integrating it with tools and general cues supporting losses in memory or attention (Sundstrom et al, 1996).

5.1.2 MEMORY GAMES

5.1.2.1 AROUND THE WORLD IN 80 TRIPS (WWW.HAPPY-NEURON.COM)

Around the World in 80 Trips game is a tour through the regions on earth. The player is asked to memorize the itineraries of two tours that may select from a list of destinations, including Sri Lanka, Madagascar and Brazil (see a screenshot in Figure 14).

Figure 14: Around the World in 80 Trips game overview.

This exercise trains visual and spatial memory pertaining to environmental information, and needs good orientation and perceptual skills in order to be succeeded. Various hints are suggested that may help to improve memorization capacities. The primary areas of the brain that are exercised in this game are the right parietal cortex and the right temporal cortex.

Visual-spatial skills allow individuals to visually perceive objects and the spatial relationships among them. Spatial memory can be considered a subcategory of visual memory because it relies on a cognitive or mental map whereby an individual can acquire, code, store, recall, and decode information about the relative locations and characteristics in one's spatial environment. These are the skills that enable to mentally manipulate and rotate information in space by taking different perspectives.

Good visual-spatial skills are needed to orient yourself in a neighborhood or city, or to retrace your steps along a winding back road or through a forest. You also need those skills to find your

car in an airport parking lot or even to estimate distances from a map. These skills are crucial to your everyday life.

5.1.2.2 BRAINMETRIX (HTTP://WWW.BRAINMETRIX.COM/)

Memory improvement is part of this memory game, the process can be done with few steps that can be easy and performed effortlessly. Many people have trouble remembering faces or names. How to remember things is only a technique that needs to be utilized. This memory game activates some areas of brain responsible for memory acquisition which therefore can help memory to be improved. It is pretty simple since the only thing the user has to do, is to find the pairs that are hidden beneath the table and try to finish before the time limit (see Figure 15).
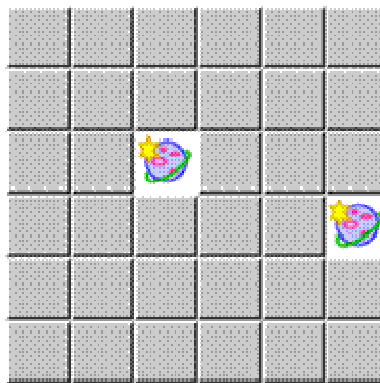
Figure 15: Memory Improvement game overview.

5.1.2.3 MEMOREYES (PLAYWITHYOURMIND.COM)

MemorEyes (see Figure 16) is a game that tests visual memory. There are four different stages that cycle through in this game. The first is a colour round where the player has to remember colours, the second deals with letters and fonts, the third deals with photographs and pictures, and the last deals with shape and orientation.
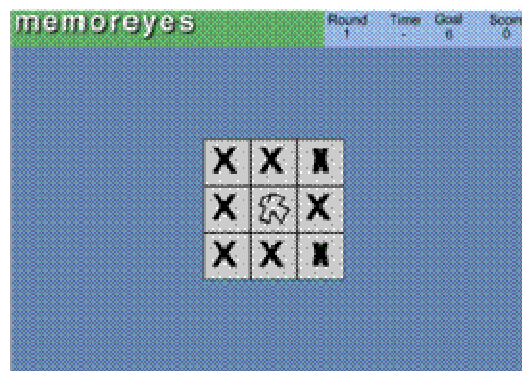
Figure 16: Memoreyes game overview.

In each round, the player will be given a grid to memorize. The first grid will be 3 x 3, but grid

size will increase with each four-round cycle. The player soaks in the contents of the grid and then hits the button to move on to the recall stage. This stage, starts off with a blank slate and must cycle through each grid point and try to remember which objects belong where. Each time the player clicks on a square of the grid, will cycle through the possible options.

5.1.2.4 FOOD MEMORY (WWW.PLAYITONTHEWEB.COM)

In this game some pictures of foods are presented to the player on a tabloid made of squares for approximately one minute and after they have disappeared it is requested to put them in the correct order on the tabloid (see Figure 17).

Figure 17: Food Memory game overview.

5.1.3 ATTENTION GAMES

5.1.3.1 10 COUNT RECOUNT (WWW.GAMESMASS.COM)

In this game the player has to click the numbers 1-10 as they pop up, and has a certain amount of time before losing. Circles with green cross give points and circles with red minus sign take away points (see Figure 18).

5.1.3.2 12 MANY (WWW.FREEONLINEGAMES.COM)

12 Many is a game where the stars that are appeared should be counted. If the answer is exactly right it gives as much points as the stars, but if it is mistaken even for one star it doesn't give any points at all. The stars appear only for 1 second so the player must be very quick and careful counting them (see Figure 19).

5.1.3.3 CLICK IT (WWW.EYEGRID.COM)

In the Click it game there are four buttons on the screen the "click" button, the "push" button, the "pull" button and the "hit" button. What the player must do is to push the right button that appears to the screen without being misled from the colour of the screen (see Figure 20).
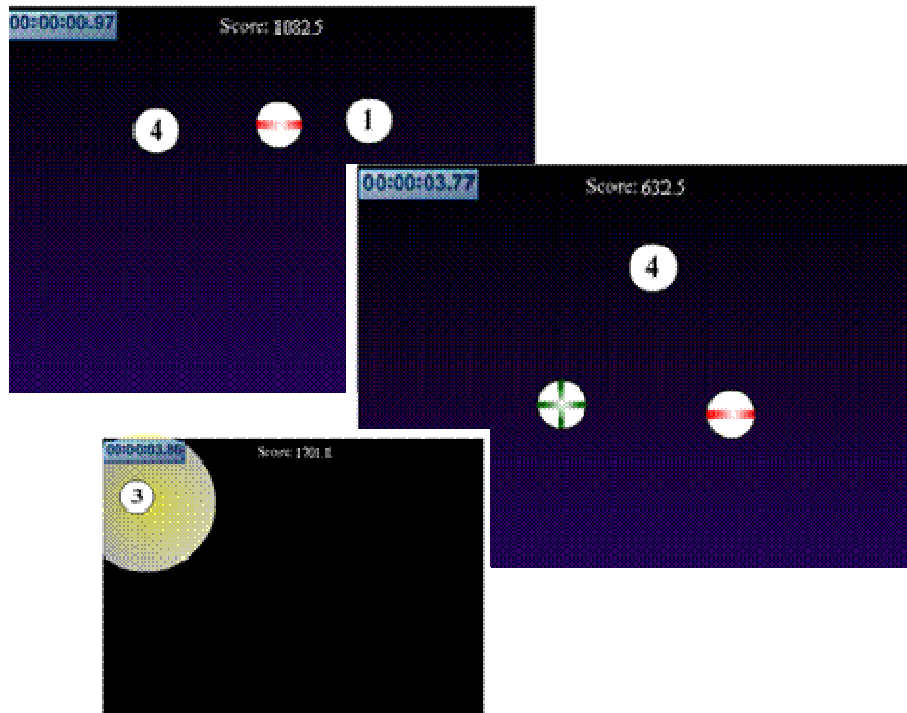
Figure 18: 10 Count Recount game overview.
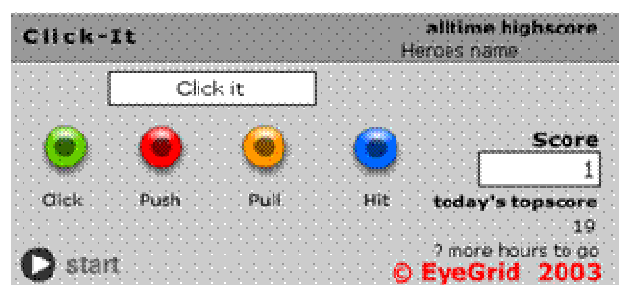
Figure 19: 12many game overview.
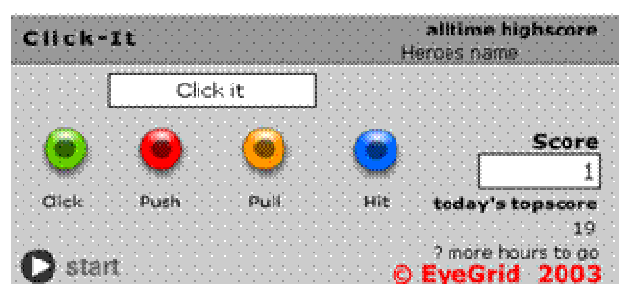
Figure 20: Click it game overview.

5.1.3.4 CRYSTALLITE BLOCK BUSTER (WWW.SMALLGAMES.GR)

In the Block Buster game the player uses the mouse to click on the blocks in ascending order to blast them off into outer space. The numbers are colour coded and the order is: orange, blue and

green. The blocks must be blasted off, all inside the time limit (see Figure 21).
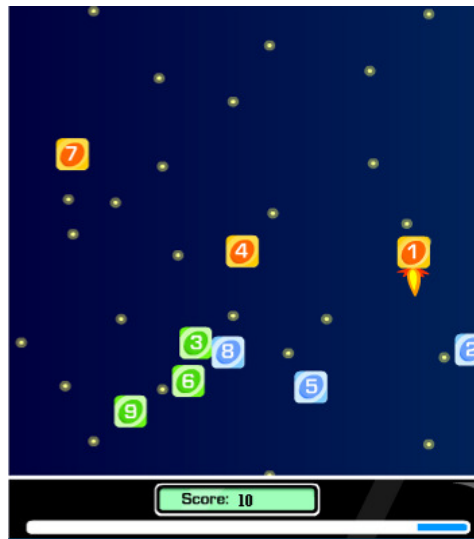
Figure 21: The Crystallite Block Buster game overview.

5.1.3.5 SKEARS DX (WWW.ADDICTINGGAMES.COM)

In this game the player must touch all the purple skears before they reach the central dot (see Figure 22).
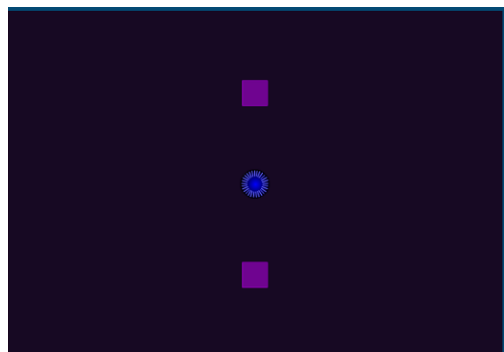
Figure 22: The Skears DX game overview.

5.1.3.6 CATCH THE LADYBUG (WWW.HAPPY-NEURON.COM)

In this exercise the user needs to click as quickly as possible on the Ladybug that appears randomly on the screen. The challenge is that the more ladybugs you catch, the smaller and faster they become. Focus is needed to be paid on the task at hand and resistance to any distraction that might arise (see Figure 23).

People receive a lot of stimulation from the world around us, too much for the brain to process in detail simultaneously. Much of this input, however, is not always important or relevant to us. Ideally, people should spend more time and resources processing the important things and less

time on the unimportant things. Attention skills help doing just that, by selecting and processing what is really important to us.

This game requires concentration and good visuo-spatial skills. First, the main area of the brain exercised is the posterior parietal lobe of the cortex. This brain centre is crucial for orienting visual attention and shifting it from one location to another. The second brain area exercised is the right frontal cortex. This area is crucial for maintaining alertness.

One definition of Attention is the cognitive process of selectively concentrating on one aspect of the environment while ignoring others. We use our attention skills when we are driving and searching for a street address, when we are trying to focus on breaking news on television while children are at play nearby, or when we are working on an important project while co-workers are talking in the adjacent area. The examples are numerous. We constantly use our attention skills and these skills are such a basic component of our very awareness.
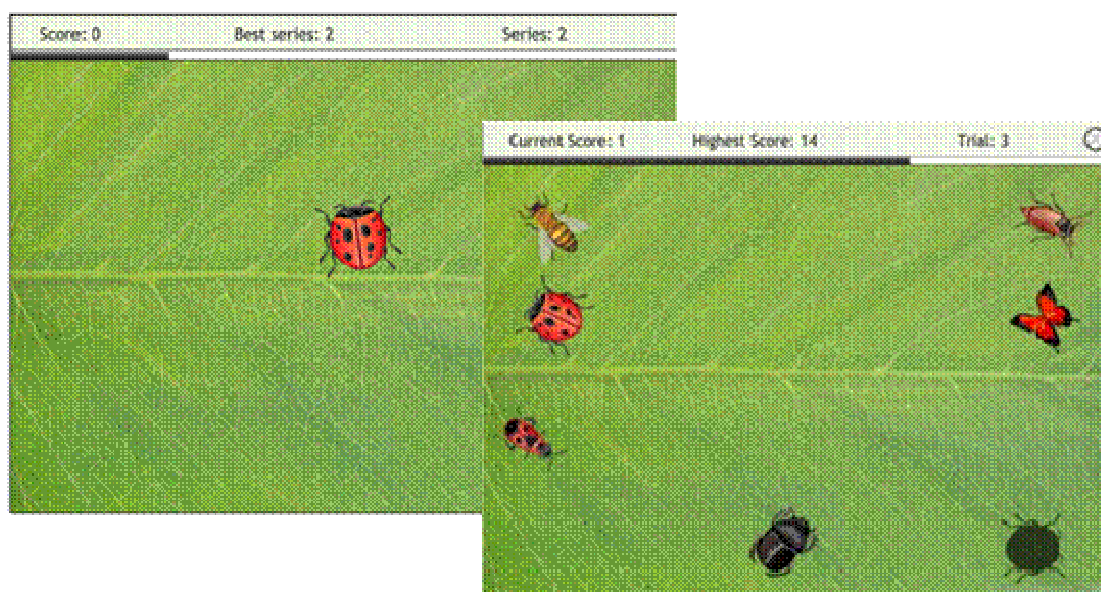
Figure 23: Catch the Ladybug game overview.

5.1.4 LANGUAGE GAMES

5.1.4.1 THIS STORY IS FULL OF BLANKS (WWW.HAPPY-NEURON.COM)

In this game the player is supposed to be an editor for a day by going through a text in which words are missing. He/she must then choose the correct word out of a list of words provided, and to make it more creative and interesting, there is an option of choosing between prose, drama or poetry (see Figure 24).

The main brain area at play is the left temporal lobe where the seat of language is located for most people who are right-handed. This exercise requires concentration, a solid vocabulary and good semantics which refer to aspects of meaning, as expressed in language.

Everyday, we use the various aspects of language, oral comprehension and expression, and reading and writing. We exercise our vocabulary and grammatical skills when we write a letter, an essay or a report. We try to carefully choose the right word that expresses what we mean. On a daily basis we need to build coherent texts and in order to do that we must judiciously choose relevant and grammatically correct words out of our repertoire.
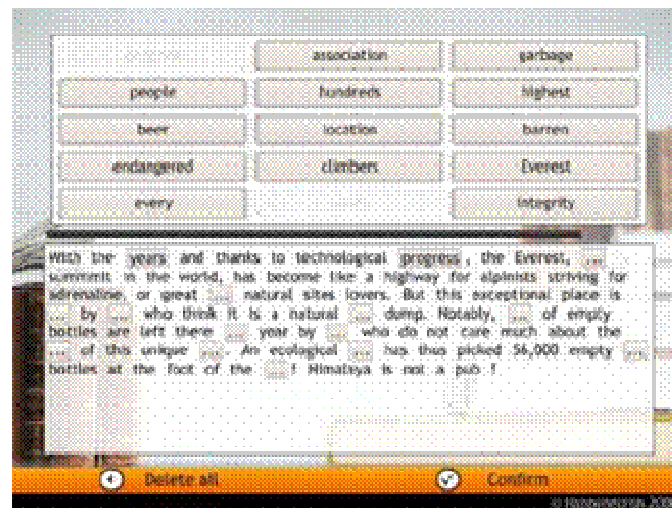
Figure 24: This Story is Full of Blanks game overview.

5.1.4.2 SPLIT WORDS (WWW.HAPPY-NEURON.COM)

This game requires to form words from fragments as quick as possible by combining syllables from the game table. Target words are categorized into themes and there is a choice of working with two or three syllables (see Figure 25).
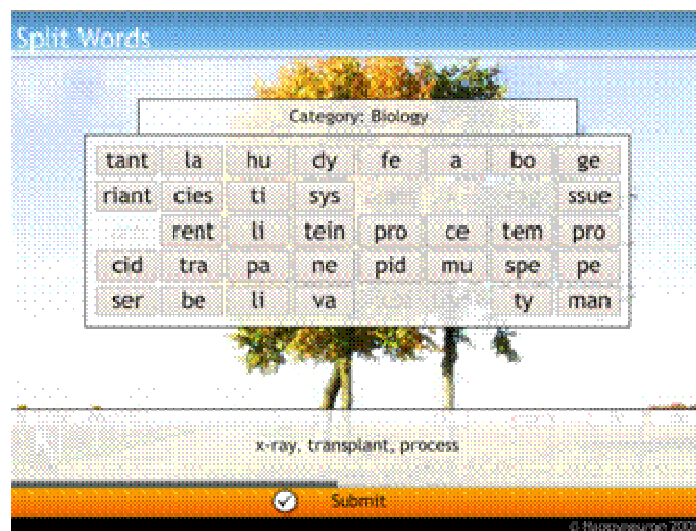
Figure 25: Split words game overview.

A memory must be acquired, stored, and accessible to be successful. Although memory is achieved through multiple phases, memory retrieval is the only way a memory can be measured. The brain area exercised in this game is the left temporal lobe, which gets activated when information retrieval is called upon. This task helps practicing on quickly retrieve words from the language repertoire. Each syllable can be seen as a phonetic cue that facilitates word

retrieval.

One of the most frequent complaints relates to something called the "tip of the tongue" phenomenon, the universal experience of trying to think of a word you know but cannot instantly retrieve. As one gets older, he or she may have more of these "tip of the tongue" experiences so it is important to address these concerns as soon as possible.

We talk to people everyday and it is important to have a fluent conversation with others and to convey precisely what we mean to say. When giving a speech, teaching a class or describing a complex idea, it is important to have easy access to an extensive vocabulary. One needs to practice using his or her language; it is the key to helping memory retrieval. By reading language, producing language and thinking about language, one can strengthen connections to specific sounds and this facilitates retrieval of words.

5.1.5 EXECUTIVE FUNCTIONS GAMES

5.1.5.1 THE TOWERS OF HANOI (WWW.HAPPY-NEURON.COM)

This game is an exercise for problem-solving skills. In this game, the coloured rings must be configured on a series of pegs in order to match a target. Only the top-most ring can be moved on each peg to another peg, only one ring at a time and you can never put a larger ring on top of a smaller ring. From time to time, a given peg may not hold any rings: you may move any available ring you like on to an open space (see Figure 26).
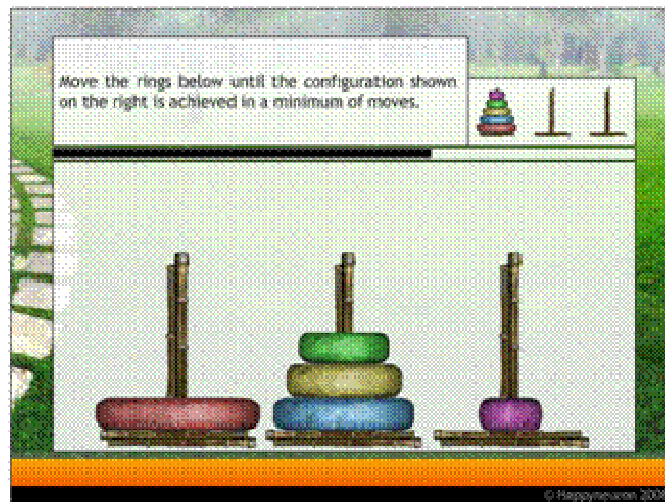
Figure 26: The Towers of Hanoi game overview.

This game requires problem-solving skills that call on the brain's executive functions. A strategy to reach a desired outcome and a calculation of the right moves to reach the solution in the shortest possible time must be defined. Training in this kind of thinking is helpful as a guide to use in other problem-solving situations. The area of the brain at play is the pre-frontal cortex, the anterior portion of the frontal lobe important for the "higher cognitive functions" and the determination of personality.

You use your executive functions when managing your time, planning a presentation or a pairing menu, outlining a report or even taking care of several children simultaneously. In every day activities, we must often develop a strategy to solve a problem. Developing the strategy involves analysis of the goal to be reached, analysis of the action steps needed, as well as any constraints

that may block attainment of the goal. Along the way, we must evaluate obstacles, choose among methods for evaluating various decision paths, and compare the effects and trade-offs of each possible move. Sometimes, solutions to problems are readily available but we have to figure out a winning strategy and specific action steps ourselves.

5.1.6 VISUOSPATIAL GAMES

5.1.6.1 ENTANGLED OBJECTS (WWW.HAPPY-NEURON.COM)

In this game three entangled objects, like flowers, fruit, animals, geometrical figures, or amoebas, are presented and are taken together making up a more complex figure. These three entangled graphical objects are compared to a multiple choice of similar or different objects that are possible components of the complex entangled figure. The player must choose the one that is part of the entangled figure (see Figure 27). To choose the correct object, the complex figure must be mentally disentangle into its component parts. This task is easier with identifiable objects or geometrical figures, but it is harder with abstract figures. An object seen in its typical context is more easily recognized than one that is isolated. One way to figure out the different components is to look carefully at the separate elements and then mentally visualize them together into one figure. Identification is easier when the figures are meaningful (objects, geometrical figures), so details are more relevant than the analysis of the whole figure. However, recognition will be more difficult with abstract figures. Naturally, such a complex task takes great concentration.
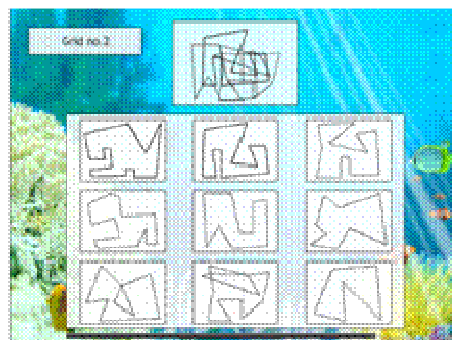
Figure 27: Entangled Objects game overview.

This exercise trains spotting the identifying characteristics of an object, store them in working memory, and then transform the details into a whole by visualizing it in mind and holding it there while accomplishing the same tasks for the other objects. The game trains visual and spatial skills and working memory.

When you look at something, you usually recognize it easily because you match what you see with the image stored in your long-term memory. To be able to make the match in everyday situations, we rely upon thousands of stored images, associations, and categorizations in our memory. We use these skills each time we try to separate figure from ground in a visual display, visualize ways to redecorate a room or even analyze patterns of traffic when driving.

5.2 PHYSICAL REINFORCEMENT SERVICES

Patients with dementia are susceptible to muscle disuse atrophy, which can be delayed by adequate physical exercise and nutrition. A regular supervised exercise program (e.g., 15 to 20 min/day of walking) is recommended. According to a preliminary report by Mechling and Brach (2007), these programs can be extended to 60 min/day twice a week with people showing mild and moderate symptoms. Exercise can reduce restlessness, improve balance, maintain cardiovascular tone, help improve sleep, and reduce frequency and severity of behavior disorders and falls (Hauer and Becker, 2006). A supportive environment includes encouragement of and opportunities for physical and mental activity and social interaction. These activities may help to slow cognitive, physical, social, affective, and functional decline. Delaying the onset of symptoms of dementia and slowing the vicious circle to dependence will not only help the individual affected but also caring relatives, nursing staff, and society as a whole (Baumgarten et al., 1992).

Physical activity can reduce the risk of dementia (Larson et al., 2006) and cognitive performance can be improved by physical exercise and by increasing the physical fitness level (Kramer et al., 2003). However, the adequate forms of intervention, i.e. what type of physical activity and training program (intensity, frequency, duration) is required for achieving positive effects on cognition is still an open issue (Mechling, 2008).

Physical reinforcement is envisaged to be done through the proposition of exercises on the TV. They could be done through the projection of a video showing an avatar executing the exercises. Following the recommendations of the American Diabetes Association (ADA 2010: 5) , the type 2 diabetes risks can be reduced by a healthy lifestyle. Continuous exercise 150min/week refers to a healthy weight.

Following the recommendations of the American Diabetes Association (ADA 2010: 5) , the type 2 diabetes risks can be reduced by a healthy lifestyle. Continuous exercise 150min/week refers to a healthy weight.

Wii Fit Plus (http://www.wiifit.com/) is an example of a physical reinforcement service as it allows the user to create his own tailored workouts and introduces balance games. It is used with the Wii Balance Board peripheral and its solid presentation make it an ideal tool for those wanting to improve their fitness without having to trek to the gym such as our user groups. It has some preset routines bundled into different target groups. The Form group, for example, has three routines (each made up of three individual exercises) which target hips and behinds, arms, and figures. The user can also create a routine from scratch. In Figure 28 the reader can see the user selecting an exercise for strengthening the lower body.

Wii Fit Plus also provides a way of tracking the user's health plan's progress, relying on body mass index (BMI) measurements. BMI is a widely accepted indicator of whether a person is overweight, but any health professional will tell you that it's reliant on age and muscle mass, points that Wii Fit doesn't take into account.

Figure 28. Wii Fit Plus exercise selection.

5.3 PATIENT SPECIFIC HOME CARE SERVICES

This service category shall include social reinforcement services, reality orientation support services and services capable to monitor several diseases' risk factors.

5.3.1 SOCIAL REINFORCEMENT SERVICES

This service category shall serve to increase older people's social activity and make physical and mental activity more enjoyable. The scenarios belonging to this service category shall aim to enable older people to use widely used ICT based communications in order reduce their stress levels and help maintain their brain cells' healthy condition. Such services shall include Instant Messaging and SMS that strengthen the social interactions with younger people and friends or relatives, as well as Social Networking Utilities that let people to share photos among each other.

5.3.1.1 INSTANT MESSENGERS

Instant Messengers are applications capable of forming real-time communications between two or more people based on typed text. The text is conveyed by devices connected over a network such as Internet. In the Market, many Instant Messengers exist (most of them are open source) since such applications are very sociable to the young people. A summary of them is given in the table below.

Table 6: Online Instant Messengers

Online Instant Messengers	Web Link	Features Description
AOL Instant Messenger(AIM)	http://aimpro.premiumservices.aol.com/	• File Sharing • Video and Voice calls • Emoticons • Available on mobile phones
eBuddy	http://www.ebuddy.com/index.php	• Themes Changing • Personal Status changing

Online Instant Messengers	Web Link	Features Description
Gizmo5	http://gizmo5.com/pc/download/	• Free internet calls • Calls recording • File Exchange • Landline - cell phone calls • Ideal for professionals • Available on mobile phones
Meebo	http://www.meebo.com/	• Chat history • Emoticons • Personal status changing • Available on mobile phones
Skype	http://www.skype.com/intl/en/	• Video and Voice calls • File exchange • Personal Status changing • Internet calls • Landline - cell phone calls • Ideal for professionals • Available on mobile phones
Tencent QQ	http://www.tencent.com/en-us/index.shtml	• File transfer • Video and voice calls
Windows Live Messenger (previous MSN)	http://download.live.com/?sku=messenger	• Video and Voice calls • File exchange • File Sharing • Themes Changing • Personal Status changing • Emoticons • Available on mobile phones
Yahoo! Messenger	http://messenger.yahoo.com/	• Video and Voice calls • File exchange • Themes Changing • Personal Status changing • Emoticons • Available on mobile phones

Currently in the market, there are not any similar services for the elderly, however elderly people can use them, depending of course on their experience with technology. HERA services shall include a set of the aforementioned services' features for providing chatting capabilities with other elderly people or their relatives in an easy and convenient manner.

5.3.1.2 SOCIAL NETWORKING UTILITIES

Social networking utilities and services focus on building online communities of people who share interests and activities, or who are interested in exploring the interests and activities of others. Most social network services are web based and provide a variety of ways for users to interact, such as e-mail and instant messaging services, as well as sharing photos between them.

Currently in the market, there are not any similar services targeting the elderly, however elderly people can use them, depending of course on their experience with technology. HERA services shall include a set of the aforementioned services' features for providing social networking utilities for the elderly.

Table 7: Social Networking Utilities

Social Networking Utility – Photosharing applications	Web Link	Features
Facebook	www.facebook.com	• Photo upload
Twitter	www.twitter.com	• Photo sharing
Flickr	www.flickr.com	• Photo organisation in albums
Picasa	http://picasa.google.com	
Hatebook	www.hatebook.com	• Friendlist – Contactlist
MySpace	www.myspace.com	• Message exchange
Student Talk	www.studenttalk.com	• Common interests Groups
Friend Scene	http://www.friendscene.com/	• Chatting
Hi5	http://hi5.com/	

5.3.1.3 WEB CALENDAR UTILITIES

Calendar utilities and services help people maintain their social activity. They let the user organize his/her program reminding him some special events. The web calendar applications give also the opportunity to the user to share his schedule with his online friends as well as to see the schedule of his online friends. An indicative set of such applications are provided in the following table.

Table 8: Calendar applications

Calendar applications	Web Link	Features Description
Google Calendar	www.google.com/calendar/	• Free to use • Event Sharing • Calendar sharing • Access to the calendar from the mobile • Event reminder by email

Calendar applications	Web Link	Features Description
WebCalendar	http://www.k5n.us/webcalendar.php	• 30 supported Languages • Auto-detection of user's language through browser language • Calendar sharing • Access to the calendar through the iCalendar iPhone application
Absolute Web Calendar	http://www.xigla.com/awebcalendar/	• Non free • Event sharing • File sharing

Currently in the market, there are not any similar services targeting the elderly, however elderly people can use them, depending of course on their experience with technology. HERA services shall include a set of the aforementioned services' features for providing calendar and reminder utilities for the elderly.

5.3.1.4 PHONEBOOK UTILITIES

Phonebook utilities and services help people to store and retrieve important for them phone numbers. They are very useful applications since the number of phones that someone is able to remember is bounded. Such applications use also a querying functionality to help the user find fast and easy the phone number they search for. Phonebook utilities are integrated almost in every mobile phone. Phone numbers of friends can also be stored in Social Networking Utilities (e.g. Facebook) or in E-mail User accounts.

HERA services shall include phonebook utilities for the elderly in order to allow easy storage and retrieval of important phone numbers for their communication with their doctors, care givers and relatives.

5.3.2 REALITY ORIENTATION SUPPORT SERVICES

Reality orientation (RO) was first described (Taulbee and Folsom, 1966) as a technique to improve the quality of life of confused elderly people, although its origins lie in an attempt to rehabilitate severely disturbed war veterans. RO involves the presentation of orientation and memory information, relating, for example, to time, place, and person. This was thought to provide the person with a greater understanding of his or her surroundings, possibly resulting in an improved sense of control and self-esteem.

A prominent focus of classroom RO is often the "RO board," which typically displays information such as the day, date, weather, name of next meal, and other details (Holden and Woods, 1995). There has been criticism of RO in clinical practice, with concern that it has sometimes been applied in a mechanical fashion and has been insensitive to the needs of the individual (e.g., Powell-Proctor and Miller, 1982). Moreover, it has been argued that constant relearning of material can actually contribute to problems in mood and self-esteem (Butler and Lewis, 1977).

The results of the study of Spector et al. (2000) showed that RO had significant positive effects on both cognition and behavior. Results for cognition were more precise, due to a sample size of

125, compared with 57 for behavior. Moreover, the study of Breuil et al. (1994), in which participants were given the least amount of RO (10 hr), was the only one to yield significant positive findings favouring RO. Thus, RO is not to be used all the time.

5.3.3 VITAL PARAMETERS MONITORING SERVICES

The service category deals with the monitoring of vital parameters of the elderly like ECG, blood pressure, heart rate, oxygen saturation, body weight etc. Specialists and doctors are able to have a medical opinion according to the monitored values and in case of a danger an alarm service may be activated for example. In order to monitor several diseases risk factors, many devices/sensors can be used. The devices are connected on an intelligent agent gateway which is capable of generating a risk assessment result taking in account all the vital parameters of the patient. Currently in the market, there are commercial Telecare and Telehealth solutions, a set of which is provided in Table 9.

Table 9: Telecare products

Product	Web Link	General Features	Medical Features
Remote Nurse	http://www.hometelehealthltd.co.uk/	• Audio capability in many languages • Connects to multiple medical devices via USB, RS232 or BT • Large 8"touch screen designed for use by frail elderly people • Supports Data Management and Reporting • Sends educational content reminders • Supports Programme Reporting – compliance, trends, threshold violations, image storage/capture	• Vital Signs Monitoring • PT/INR • Fluid Monitor • Glucometer • Pulse • Medication reminders
UMO	http://www.verklizan.org/exec/verklizanweb.exe?lang=UK&page=Pagina/UMO.html	• In home wired solution • IP based communication • Video communication with relatives/specialists • Video monitoring for security • Home Control (Electricity, Gas control) • Social Alarming • House security and sensor measurements	• Blood Pressure Monitoring • ECG • EMG • Blood Sugar • Weight • Registers telemedicine measurements • Analyses measurements - specialists consulting
COPD	http://www.tunstall.co.uk/Our-products/Telehealth-solutions	• Multiple Language support • Screen with configurable screen	• Intelligent Symptom questions to the patient • Blood Pressure Monitoring • Pulse Rate • Blood Oxygen Level

Product	Web Link	General Features	Medical Features
CDM	http://www.tunstall.co.uk/Our-products/Telehealth-solutions	• Multiple Language support • Screen with configurable screen	• Intelligent Symptom questions to the patient • Blood Pressure Monitoring • Pulse Rate • Blood Oxygen Level • Weight Monitoring • Body Temperature Monitoring
Lifeline Connect+	http://www.tunstall.co.uk/products.aspx?PageID=127	• Event-based configuration • Virtual sensor processing • Advanced local programming • Inactivity monitoring	• Reminder messages • Critical visits management facility

5.4 GENERAL HOME CARE SERVICES FOR ELDERLY

This service category scopes to support elderly people and people with long-termed needs to live independently by effectively managing their health and well-being. The realization of such kind services aims to reduce the time that the relatives of the elderly must consume every day to take care of them, letting them deal with their own problems.

5.4.1.1 ALARM SERVICES

This category shall include services which aim to make safer elderly's life. The vital parameters monitoring service shall be able to activate the alarm services in case of abnormal values of the patient's vital parameters. In this case the specialists, doctors and relatives shall also be informed about patient's health condition.

Table 10: Alarm Services

Product Supporting Alarm Services	Web Link	Description
RemoteNurse	http://www.hometelehealthltd.co.uk/	• Bidirectional communication between the specialist and the patient • Message is sent to the specialist in case of abnormal health condition monitored.
UMO	http://www.verklizan.org/exec/verklizanweb.exe?lang=UK&page=Pagina/UMO.html	• Social Alarms • Mobile Alarms

5.4.1.2 REMINDER SERVICES

This category aims to realize services for reminding important events to the elderly. It is very important for the elderly people to have a reminder able to support them especially if they suffer from any chronic diseases. The reminder services are able either to remind daily activities to the elderly such as pill reminder, medication reminder, measurement reminder or not so usual events such as important dates, appointments with the doctor etc. The table below presents some product solutions that support reminder services.

Table 11: Reminder products and services

Product Supporting Reminder Services	Web Link	Description
Lifeline Connect+	http://www.tunstall.co.uk/products.aspx?PageID=127	Pill reminder service
RemoteNurse	http://www.hometelehealthltd.co.uk/	Send medication or educational content reminders
UMO	http://www.verklizan.org/exec/verklizanweb.exe?lang=UK&page=Pagina/UMO.html	Reminder service

5.4.1.3 INFORMATION SERVICES
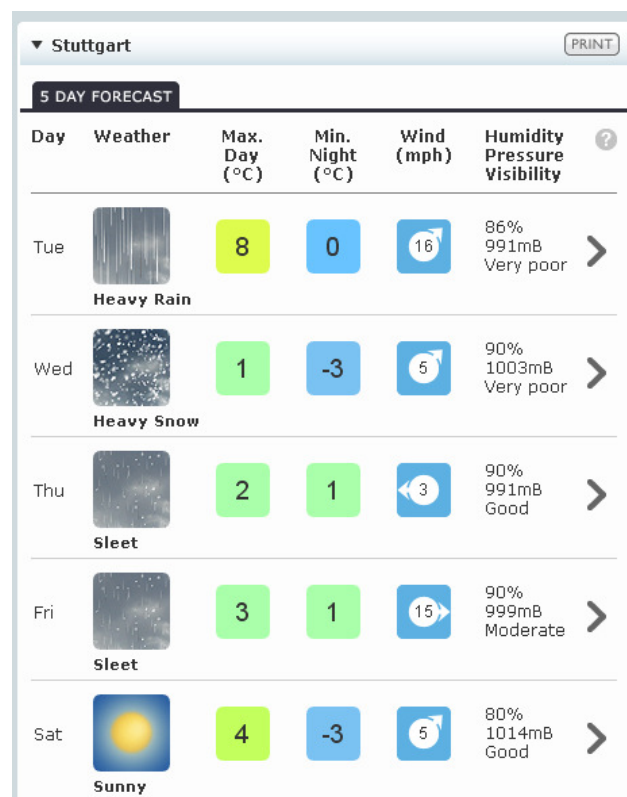
Figure 29: Weather Forecast Service (http://news.bbc.co.uk/weather/)

The scope of this service category is to provide elderly with several types of information. Some of the information that the elderly user can have and can be provided in the form of services include open pharmacies, simplified user manuals, weather forecast services etc. Currently there are hardly commercial applications available providing the users with information on open pharmacies. However, there are several applications, mostly web sites, which provide the users with weather forecast information (see e.g. Figure 29).

6. HARDWARE PRODUCTS SURVEY

This chapter is reporting the findings of a market survey based on the initial requirements of the HERA project. Generally, the AAL idea supports flexibility of users in their well known surrounding. In addition to that, usability of entities to be considered and usability of services are of very high importance in order to enhance the quality of life. The following devices have been found following a survey considering the aforementioned criteria as well as the fulfilment of the initial architectural and services requirements of the HERA system. However, this list of devices cannot be seen as compulsory or comprehensive, it constitutes an indicative list, which may be extended in order to make a selection of the devices to be used in the HERA system.

The main categories of hardware that are documented here-in are the set-top-boxes, the various sensors or medical devices and application server. The most representative products are presented aiming to show what technologies are available in the market. For each hardware product, a brief description is given, followed by a list of key features (such as memory, speed, etc) and supported communication standards. A photo of the product is also included.

6.1 SET-TOP-BOX

This section presents different models of Set-Top-Box equipment which are commercially available and are suitable for use within the HERA System. STBs shall be installed at the houses of the elderly. The medical devices shall communicate with the STB or other devices and send the monitored data to the HERA Application Server. The STB shall also be connected with a TV to display the HERA services data. In that sense, the STB shall be the main user terminal and human machine interface for the elderly.

6.1.1 ADB-3800 W

The ADB-3800 W is an interactive digital set-top box optimized for IP-based telecommunications networks. It supports an HDMI interface that allows connectivity with a HD TV and an Ethernet interface to connect with a router. It also allows other devices to be connected on it through a USB 2.0. Some other key features of the ADB-3800 W are:

- DDR RAM memory up to 192 MB
- Flash memory up to 68MB
- Linux OS
- Firefox Mozilla Web browser
- Compatible with MS Windows CE 5.0 BSP
- 1920x1080 Video resolution
- Supported by ADB JavaScript API for IPTV and DVB
- HDD MP3 Player & Photo Album
- UPnP Media Player & Server
- Video Telephony

Figure 30: ADB-38000 W

6.1.2 AMINO A130

The Amino A130 is an IP-STB offering an end-to-end digital HD TV as multicast, Video-on-Demand (VoD) and multi-room IPTV services. It is supported by a comprehensive ecosystem of middleware, browser and security applications to offer advanced service features. It connects with HD TVs through an HDMI interface and with routers with an Ethernet connection. Some key features of this STB are:

- DDR RAM memory up to 192 MB
- Flash memory up to 68MB
- ETS 300-019-1-3 Class 3.1 operating environment
- HD graphics up to 1280x720
- Video Resolution Up to 720p and 1080i

Figure 31: Amino A130

6.1.3 THOMSON DBI2210

The Thomson DBI2210 is an STB/IPTV which delivers SDTV, HDTV, streaming media services, IP TV and Electronic TV guide, Video on Demand over xDSL or FTTH IP networks. It supports HDMI interface to connect with an HD TV, an Ethernet port for the connection with the router and USB port to interface with any other device. Its web browser supports HTML 4.01, Javascript 1.3, JS extensions APIs, SSL, CSS, DOM, Cookies. Some key characteristics of the Thomson DB12210 are:

- RISC / 400 DMIPS @ 266 MHz processor
- 192 Mbytes (up to 256 Mbytes) RAM memory
- 32 Mbytes Flash memory
- Teletext and subtitling
- 24 bits / pixel RGB, 8 bits / Alpha colours
- Video resolution Up to 1280x720p and 1920x1080i

Figure 32: Thomson DBI2210 STB/IPTV

6.1.4 SONY VAIO VGX-TP1E

The Sony Vaio VGX-TP1E is a Media Center PC able of creating a home network and operating a STB machine. The machine supports several types of interfacing with a TV, Bluetooth Devices (can be Bluetooth Medical Devices) or any other machine. Some characteristics of the VAIO VGX-TP1E are:

- 1 x Intel Core 2 Duo T5500 / 1.66 GHz (Dual-Core) processor
- 2 MB L2 Cache memory
- 1 GB (installed) / 2 GB (max) - DDR2 SDRAM - 667 MHz RAM memory
- 1 x 500 GB - standard - Serial ATA-150 HDD
- Intel GMA 950 Dynamic Video Memory Technology 3.0 graphics controller
- Microsoft Windows Vista Home Premium OS
- Digital and analoge TV - DVB-T TV Tuner
- Integrated Card Reader
- Sound Card
- USB and Ethernet Ports

Figure 33:SONY VAIO VGX-TP1E

6.2 SENSORS – MEDICAL DEVICES

This section presents the different Medical Devices which may be used in the HERA system. The devices deal with monitor blood pressure, heart rate, body weight and oxygen saturation monitoring. Such candidate medical devices are provided in the following sections.

The Bluetooth Medical Devices can send their data to any Bluetooth transceiver. The transceiver can be a Bluetooth supporting cell phone or a BL Analog.

BL Analog is a modem with an integrated Bluetooth transceiver, which was specially developed for the remote connection to mobile Bluetooth sensors. It supports special protective mechanisms, since it is specially suited for transmitting medical data into a web-based database. Also the BL Analog one of the best Bluetooth hubs since it has a 30m range and acts as both a transmitter and a receiver. The Bluetooth cell phone or BL Analog then sends the medical data to the server for manipulation.

Figure 34: CORscience BL Analog   *Figure 35: Bluetooth compatible Cell Phone*

6.2.1 UA-767 BP MONITOR (A&D)

The UA-767 Blood Pressure Monitor is specifically designed for telemedicine applications. It is available with wired (UA-767 PC uses an RS-232 port) or Bluetooth wireless communication (UA-767 BPT). The device is capable of communicating and uploading data to compatible Access Points (PC, PDA) It has a memory enough to store up to 280 (UA-767PC) or 40 (UA-767PBT) readings. The wireless device is also available in a plus (UA-767 Plus) version having 90 readings memory recall and supporting the irregular Heartbeat feature. Some more features of the device are:

- Large digital display
- One button operation
- Fast measurement

Figure 36: UA-767 BP Monitor

6.2.2 UA-767 T BLOOD PRESSURE MONITOR (A&D)

The UA-767T Blood Pressure monitor is a BP monitor designed for telemedicine application which is also conformed to vision impaired patients' needs. It has the same features like the UA 767 BP monitor but also supports a clear voice announcement of pressure and pulse every time that the patient performs a measurement. The device is highly adaptable since it supports voice adjustment contains an ear phone jack.

Figure 37: UA-767T BP Monitor

6.2.3 705IT BT (CORSCIENCE)

The 705IT BT measures blood pressure on the upper arm. The measurement is carried out like in conventional devices with. The CORscience has equipped the 705IT BT with a wireless interface, which automatically transfers the measured value to a central archive via a base station. The 705IT BT wirelessly sends the measurement with a time stamp to the base station. The base station can be a Bluetooth-capable cell phone or an approved Bluetooth modem (e.g. BL analog). From the base station, the measurement is transmitted to an electronic health record. There the measurements are stored and analyzed for deviations which could indicate a pathological disorder. Some features of the device are:

- Establishment of a Bluetooth connection to GSM/GPRS/UMTS devices or approved Bluetooth modems (e.g. BL analog)
- Sends text SMS via mobile phone
- Storage of non-transmitted data
- Transmission of stored data blocks at next measurement

Figure 38:705ITBT

6.2.4 UC-321 WEIGHT SCALE (A&D)

The UC-321 is a weight scale designed for telemedicine applications. It is available with wired (UC-321PL uses an RS-232 port to connect to the PC) or Bluetooth wireless communication (UC-321PBT). The device is capable of communicating and uploading data to compatible Access Points (PC, PDA). It has a memory enough to store and retrieve up to 31 measurements. The weight scale is accurate even if the patient is unsteady during the measurement and can display results both in lb or kg.

Figure 39: UC-321 Weight Scale

6.2.5 BS 9930 BT (CORSCIENCE)

The BS 9930 BT is a body scale which not only offers weight scale measuring but can also transmit the measured weight wirelessly for documentation purposes. It aims to monitor the patients at risk in telemedical networks and in an efficient way without installation effort.

The weight scale device offers a convenient way of transmitting data wirelessly to the physician,

medical center or disease management provider.

Once the weight is measured, the scale automatically establishes a Bluetooth connection to an analog model and sends a message with the current weight to a service center. When the weight is measured, the entire communication between the scale and the analog model is processed automatically. Alternatively a cell phone can also be used to transmit the data as an SMS message. Thus, the device can be integrated in networks having a Bluetooth interface. This allows the development of easy systems, which transmit the measured weight wirelessly and automatically in a clinical information system. Some features of the device are:

- Establishment of a Bluetooth connection to GSM/GPRS/UMTS devices or approved Bluetooth modems (e.g. BL analog)
- Sends text SMS via mobile phone
- Storage of non-transmitted data
- Transmission of stored data blocks at next measurement
- Speech output (optional)

Figure 40: BS 9930 BT Weight Scale

6.2.6 NONIN-4100 PULSE OXIMETER (A&D)

The Nonon-4100 plus oximeter is also designed specifically for telemedicine applications. It measures the patients' pulse oximeter. Some of its characteristics are:

- SpO2, Heart rate
- Bluetooth-enabled
- Class II Bluetooth radio (30 feet range)
- Battery life of 5 days when operating in power saving mode
- Communication protocol disclosed by the manufacturer and well documented

Figure 41: Nonin-4100 Pulse Oximeter

6.2.7 COAGUCHEK XS-SYSTEM (A&D)

The CoaguChek XS system uses technology to give fast and accurate results from a fingerstick test – a convenient way of testing. It enables monitoring (measure) of coagulation (PT/INR) status at home, usually upon a prescription from a treating healthcare professional and after a short training. The device can be connected to a computer and can display the data stored in the system. It also supports data storing, printing or sending via e-mail (last one or several ones over time) and trends over time. Some of its features are:

- Simple user interface with icon based LCD and On/Off-, Memory-and set-Button
- Capable of storing up to 100 test results with time and date
- Small fingerstick sample – just 8 µl

Figure 42: CoaguCheck XS-System

Since the CoaguCheck XS-System does not support Bluetooth connectivity, it uses the CoaguChek device to upload the monitored patient information on a PC. The CoaguChek Connect device is an instrument for uploading INR results from a CoaguChek XS System to a computer for easy interpretation and action. It is plugged to the PC over a USB connection.

Figure 43: CoaguChek XS Connection

6.3 APPLICATION SERVER

Application server constitutes the core system of the HERA platform. It hosts all the applications logic based on the agent technology, the interfaces to external services, the user profiles data and the associated policy as well as it handles security and privacy issues. There are currently several Application Servers commercially available from major manufacturers such as SUN, HP, Dell, and other.

Figure 44: SUN T5220 Application Server

The server equipment characteristics are more or less the same. The following text provides the basic features of the SUN T5220 Server as an example. The basic features of the SUN T220 server are:

- Intel Sun 8-Core 1,2 GHz T2 processor
- 32 GB DDR2 RAM (can be upgraded up to 64GB) 4MB installed cache
- 292 GB HD Capacity
- OS: SunSoft Solaris 10
- 4x USB 2.0 ports
- 1x serial port
- Expansion slots: (2) PCI-Express x8, (2) PCI-Express x4, (2) PCI-Express x4
- Physical Dimension: 3.5"h x 16.7"w x 28.1"d

7. CONCLUSION AND REQUIREMENTS CONSOLIDATION

This report has gathered all the information needed for designing the HERA system architecture and services. The user requirements were presented followed by a survey on technological approaches to AAL along with existing services, hardware devices and relevant standards.

In this deliverable we presented the HERA system requirements and positioned them in the AAL type of applications. In order to address the challenges of adaptability, HCI and heterogeneity that are inherent in AAL systems, the following architectural choices are planned:

- *Adaptability*: A group of expert agents on specific user types shall be instantiated.
- *Natural and anticipatory Human-Computer Interaction (HCI)*: The use of the TV set is ensuring a quick learning curve for users.
- *Heterogeneity*: The use of a service oriented architecture allows the different sub-systems to be connected in a plug and play manner in a standardized way.

Throughout the technological chapters several non-functional requirements of the HERA system were identified. We reviewed all the issues pertaining to the successful development of an AAL system and pointed out the candidate technologies for communication, HMI, etc. along with the relevant standards so that D2.2 "HERA Specifications and Validation Plan" can effectively come up with a state of the art system architecture based on the documented items herein.

The following sections provide:

- a consolidation of the derived requirements in a tabular form associating them with a unique identification number.
- a direct linking between the derived requirements and use cases.
- a consolidation of the candidate HERA services ranking by the different user groups.

7.1 REQUIREMENTS ANALYSIS RESULTS

Requirements belong in two categories, functional and non-functional requirements. In general, *functional requirements* define what a system is supposed to do whereas *non-functional requirements* define how a system is supposed to be. Non-functional requirements are often called qualities of a system. Other terms for non-functional requirements are "constraints", "quality attributes", "quality goals" and "quality of service requirements," and "non-behavioral requirements" (Stellman and Greene, 2005). In systems engineering and requirements engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors.

The following notation was followed for documenting the HERA requirements:

- R1XX : User requirements.
- R2XX : Requirements from the state of the art analysis.
- R3XX : Architectural requirements coming from the HERA DoW.

In the following table the requirements are presented in a tabular format. The first column contains the requirement unique identification string following the format presented above. The

second column defines the requirement in free text. The third column contains the chapter or paragraph number in which the requirement has been defined. Finally, the requirement has a type that is functional or non-functional (NF). Functional requirements are further divided in the *user need*, *ethical* and *law* types.

Table 12. HERA requirements.

Requirement ID	Requirement Description	Reference §	Type
R101	For the system to perform an intervention the decision must be correct, prudent and taken at the right moment	2.2.3.1	User need
R102	The system should always keep users informed about what is going on, through appropriate feedback within reasonable time	2.2.3.1	User need
R103	The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms	2.2.3.1	User need
R104	The system should follow real-world conventions, making information appear in a natural and logical order	2.2.3.1	User need
R105	Support undo and redo	2.2.3.1	User need
R106	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions	2.2.3.1	User need
R107	Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action	2.2.3.1	User need
R108	Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another.	2.2.3.1	User need
R109	Instructions for use of the system should be visible or easily retrievable whenever appropriate	2.2.3.1	User need
R110	Accelerators may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions	2.2.3.1	User need
R111	Dialogues should not contain information which is irrelevant or rarely needed	2.2.3.1	User need
R112	Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution	2.2.3.1	User need
R113	Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large	2.2.3.1	User need
R114	The principle of *informed consent* is the basis for any participation in research because telecare and home telehealth are service innovations that potential users will not generally be very familiar with. The fundamental principle should be that people know what they are signing up for.	2.2.3.2	Ethical
R115	The principle of *proportionality* requires that the level of intervention should be restricted to what is really necessary for the situation	2.2.3.2	Ethical

Requirement ID	Requirement Description	Reference §	Type
R116	Technology supported monitoring and surveillance also raise key ethical concerns around issues of *privacy* and personal and family *dignity* as it relates to privacy	2.2.3.2	Ethical
R117	Some patients are not familiar with technical equipment; they would appreciate a linguistic and visual instruction via the terminal	2.2.4.2	User need
R118	The measured medical data should be transmitted to the attending physician	2.2.4.2	User need
R119	There is an agreement with the physician in which frequency the measured dates are transmitted. Information of the measured dates is also relevant for the responsible nurse	2.2.4.2	User need
R120	The frequency of medical data measurement must be according to the recommendations of the physician and in case of need	2.2.4.2	User need
R121	If the measured data reaches a critical level, nurses inform the attending physician	2.2.4.2	User need
R122	In case of critical measured data a notification to the attending physician or the emergency coordination centre follows. The people who are employed in the emergency coordination centre are specially trained and follow a specified and standardised questionnaire	2.2.4.2	User need
R123	Even family members can be instructed what to do with the patient in case of critical situations by an expert paramedic	2.2.4.2	User need
R124	For emergency situations, doctors who arrive in case of emergency it would be very useful to have an overview of measured data	2.2.4.2	User need
R125	Because time is always short to make decisions how to proceed, it would be very useful for the emergency doctors to have a look in the anamnesis to see the last electrocardiogram	2.2.4.2	User need
R126	Over a certain limit in blood pressure measurement an emergency procedure has to start	2.2.4.2	User need
R127	Medical data measured within a crisis need different handling than monitoring for therapy optimization	2.2.4.2	User need
R128	In case of high measurement results a contact between patient and emergency dispatch centre should take place. Only emergency dispatchers have the expertise to give instructions in emergency situations	2.2.4.2	User need
R129	In home care situations when a critical medical data is measured the attending physician is consulted and he decides about all following measures	2.2.4.2	User need
R130	A continuing medical data measurement over a long time allows the attending physician to control the effectiveness of the therapy	2.2.4.2	User need
R131	Measured medical data have to be seen individually for each patient. For telemonitoring the prescriptive limits have to be defined by the attending physician corresponding to the individuality of each person	2.2.4.2	User need
R132	The volume of data has to be observed. If all patients for whom it is useful are watched by telemonitoring a large amount of data in generated which cannot be administrated any more by a general practitioner	2.2.4.2	User need

Requirement ID	Requirement Description	Reference §	Type
R133	The nurse measures vital parameters following the instructions of the attending physician or if it is required due to the condition of the patient. The instructions which are written down in the medical records at the patient's house contain a catalogue of measures	2.2.4.2	User need
R134	For prescriptive limits there will still be the need of a home visit by the attending physician who evaluates the situation	2.2.4.2	User need
R135	Blood sugar measurement devices measure the sugar in the blood plasma; a critical value has to be set individually for each person. This has to be done by the attending physician	2.2.4.2	User need
R136	In case of minor variations to blood sugar measurement, another measurement should follow after three minutes	2.2.4.2	User need
R137	Measurement variation can arise through wrong usage of the measurement device. The handling of the device should be easy to minimize measuring mistakes	2.2.4.2	User need
R138	An inadequate instruction to the patient due to a mistake in measurement could cause risks for the patient	2.2.4.2	User need
R139	A continuous maintenance of the measurement device has to be performed to avoid false measurement data in case of defect	2.2.4.2	User need
R140	An abnormal measured data can be ignored, if it is once only. Continuous abnormal measurements have to be handled seriously and significantly	2.2.4.2	User need
R141	People with diabetes type 2 can be treated with a diet and do not need medication.	2.2.4.2	User need
R142	People with diabetes type 2 recommendations for physical workout would make sense	2.2.4.2	User need
R143	For patients who are treated with insulin continuous measurement makes sense because there is always the possibility of hypoglycemia	2.2.4.2	User need
R144	For diabetics with a basis-bolus therapy (Insulin therapy with two different types of insulin) constant measurement is useful	2.2.4.2	User need
R145	Continuous transfer of measurement data enables the diabetologist to perform previous actions and adjust the therapy	2.2.4.2	User need
R146	Even for diabetics treated without insulin the risk exists to fall in hypo- or hyperglycemia. For that instructions of an emergency paramedic over the HERA-System can be useful	2.2.4.2	User need
R147	The measurement of blood pressure should always take place under the same conditions and after a short relaxing phase	2.2.4.2	User need
R148	Blood pressure measurement should take place one to three times a day	2.2.4.2	User need
R149	Continuous memorization to drink enough and eat fruits makes sense	2.2.4.2	User need
R150	Continuous weight control is important in case of cardiac insufficiency to watch the water elimination and perform interventions in time and also to adapt medical therapy	2.2.4.2	User need
R151	In case of a critical measured medical data a visual feedback to the patient is useful	2.2.4.2	User need

Requirement ID	Requirement Description	Reference §	Type
R152	The feedback should be performed personally. It should be visual and acoustic, possibly with the voice of a family member or the patient's own voice	2.2.4.2	User need
R153	The communication between professional caregivers and the attending physicians is performed through telephone, mail or fax or with home visits	2.2.4.2	User need
R154	Medical data storage should not exceed one month	2.2.4.2	User need
R155	Storage of weight one day, only the difference is important, measurement data of oxygen saturation do not have to be stored	2.2.4.2	User need
R156	For patients who are independent enough to perform the measurement alone, a feedback from the HERA-System does not make sense. They already discussed what to do in which case with their attending physician and are able to manage their illness alone. Those patients could possibly see the HERA-System as a burden	2.2.4.2	User need
R157	The prescription of medicine must be done by a physician	2.2.4.4	Law
R158	MCI and ADs need to improve their cognitive skills trough TV-based exercises	2.3	User need
R159	Service usage instructions must be simple and easy to follow	2.3	User need
R201	Adaptivity. The system must be able to adapt to a particular user	3	NF
R202	Natural and anticipatory Human-Computer Interaction	3, 3.4	NF
R203	Heterogeneity. AAL systems are expected to be capable of being integrated with several subsystems developed by different manufacturers (IT equipment, sensors, electrical equipment, etc)	3	NF
R204	Depending on the use cases, HERA shall use a set of the communication interfaces presented in §3.2 to implement the physical connectivity between the users, medical devices, user terminals and application servers	3.2	NF
R205	The IP shall be mainly used for the network layer	3.2.1	NF
R206	On application layer HERA shall use most common protocols and service architectures	3.2.1	NF
R207	HERA Medical Devices shall support both wired and wireless connectivity. The wireless connection shall provide advantages such as ease of use and mobility	3.2.1	NF
R208	HERA Set-Top-Box and TVset shall support HDMI or SCART connectivity	3.2.1	NF
R209	One or more middleware technologies must be selected for service components interaction	3.3	NF
R210	An ontology will be used for defining common HERA concepts and they will be used for defining the interfaces between the different components	3.5	NF
R211	The HERA personal assistant agent's decision process needs to be able to synthesize together different aspects of his preference policy	3.6.2	NF
R212	HERA will offer a service allowing for cognitive reinforcement training	5.1	User need
R213	HERA will offer a service for encouraging physical reinforcement	5.2	User need

Requirement ID	Requirement Description	Reference §	Type
R214	HERA shall consider the realization of a service that lets older people to chat among others or with their relatives	5.3.1.1	User need
R215	HERA shall consider the realization of a service that lets older people sharing multimedia content among them and their relatives	5.3.1.2	User need
R216	HERA shall consider to provide to the elderly the opportunity to maintain a family calendar with relatives' contact details. The calendar might also support event reminding functionality to remind special events such as birthdays, social obligations etc. to the elderly	5.3.1.3	User need
R217	HERA shall let the elderly to maintain a phone book with the contacts of doctors, specialists, emergency number etc	5.3.1.4	User need
R218	HERA shall include specific contact information in shared multimedia content, chat partner, calendar event for reality orientation. Such can be the type of relation with the specific counterpart, e.g. "chatting with George, your nephew from your sister Hera"	5.3.2	User need
R219	HERA shall provide to the users services able to monitor several diseases risk factors like blood pressure, weight, pulse rate, body temperature, blood oxygen level etc	5.3.3	User need
R220	HERA shall provide the elderly users with services that handle the emergency events and generate an alarm	5.4.1.1	User need
R221	HERA shall provide the elderly users with services that remind to them either special events or daily activities	5.4.1.2	User need
R222	HERA shall provide the elderly users with services supporting their general informational needs	5.4.1.3	User need
R301	The Set-Top-Box shall provide multimodal user interfaces for the communication of the elderly user with the system in a user friendly manner. TTS and SR techniques may be included	3.1	NF
R302	Both Set-Top-Box and Medical Devices shall be able to communicate via wireless interfaces such as Bluetooth	3.1	NF
R303	The Medical devices which shall be capable of getting measurements such as blood pressure and body weight	3.1	NF
R304	The Health Center shall communicate with the HERA System over the Internet	3.1	NF
R305	The relatives shall provide at least one communication point allowing the system to contact them in case of an emergency	3.1	NF
R306	The Application Server shall implement an authentication/authorisation logic that authenticates the user and permits/denies user access	3.1	NF
R307	The Application Server shall implement an authorisation logic identifying the user's special requirements for service execution	3.1	NF

7.2 REQUIREMENTS TO USE CASES MAPPING

Information regarding issues related with the functional requirements of the HERA system is collected by the relevant user groups in a form of use cases, which are provided in detail in section 2.4. They provide functional input towards the definition of the HERA services to be developed and deployed. The defined use cases are mapped to the requirements which they

satisfy in Table 13 below.

Table 13. Mapping of Requirements to Use cases

Use case ID	Requirement IDs
1.1	101-120, 122-132, 134, 136-140, 147, 148, 151, 152, 154, 157, 159, 201
1.2	103-110, 112-117, 136, 137, 139, 149, 150, 155, 159, 201
1.3	103-110, 112-117, 152, 201,
2.1	101-107, 159, 201, 221, 305-307
2.2	158, 201, 212, 304, 306-307
2.3	158-159, 201, 212, 306-307
2.4	201, 213, 304, 306-307
2.5	159, 201, 213, 306-307
2.6	159, 201, 216-218, 306-307
2.7	159, 201, 221-222, 306-307
2.8	159, 201, 221-222, 306-307
3.1	159, 201, 221, 305-307
3.2	159, 201, 221-222, 306-307
3.3	123, 153, 159, 220, 305-307

7.3 HERA SERVICES RANKING

For the convenience of the reader we provide the results from the services needs per user group in Table 14. This table shows the needs of each HERA user group and can be used by the developers of the services for assembling them for each user group, but also by the marketing personnel for knowing what features of the system are more attractive for each user category.

Table 14. Consolidated services needs per user group.

Service type	Mild AD	Moderate AD	MCI	Elderly	Cardiovascular	Diabetes
Cognitive Reinforcement	Very important	Very important	Very important	Important	Not so important	Not so important
Physical Reinforcement	Important	Important	Important	Important	Important	Very important
Chatting	Not so important	Irrelevant	Not so important	Very important	Not so important	Not so important
Sharing photos	Not so important	Irrelevant	Not so important	Very important	Not so important	Not so important
Getting support and advisory information from specialists	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Very important	Very important
Maintaining a family calendar	Very important	Very important	Very important	Very important	Not so important	Not so important
Maintaining a phone book	Important	Important	Very Important	Very Important	Not so important	Not so important
Reality orientation	Very important	Very important	Very important	Irrelevant	Irrelevant	Irrelevant
EGC monitoring	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Important	Important
BP monitoring	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Very important	Very important
Heart rate monitoring	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Very important	Very important
Oxygen saturation monitoring	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Not so important	Irrelevant
Body weight monitoring	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Very important	Very important
Pill reminder	Very important	Very important	Very important	Very important	Not so important	Not so important
Other reminders	Very important	Very important	Very important	Very important	Not so important	Irrelevant
Alarm	Irrelevant	Irrelevant	Irrelevant	Important	Very important	Very important
Open pharmacies	Not so important	Not so important	Not so important	Not so important	Not so important	Not so important
Weather forecast	Important	Not so important	Important	Not so important	Not so important	Not so important
Simplified appliances manuals	Not so important	Irrelevant	Not so important	Not so important	Not so important	Not so important
Digital memory book	Very important	Very important	Very important	Irrelevant	Irrelevant	Irrelevant
Nutrition counseling	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Irrelevant	Very important

REFERENCES

[1]   Abascal, J.: Ambient Intelligence for People with Disabilities and Elderly People. In ACM's Special Interest Group on Computer-Human Interaction (SIGCHI), Ambient Intelligence for Scientific Discovery (AISD) Workshop, Vienna, April 25, 2004

[2]   ADA (American Diabetes Association); Executive Summary: Standards of Medical Care in Diabetes 2010, URL: http://care.diabetesjournals.org/content/33/Supplement_1/ S4.full.pdf+html

[3]   American Psychiatric Association. DSM-IV sourcebook. Washington (DC): American Psychiatric Association; 1994

[4]   Baddeley, A.D. (2000) Working Memory. APA Encyclopaedia.

[5]   Baddeley, A.D., and Hitch, G.J. (1974). Working memory. In Bower, G.H. (ed.), Recent Advances in Learning and Motivation, 8, New York: Academic Press.

[6]   Baumgarten M, Battista RN, Infante-Rivard C, Hanley JA, Becker R, Gauthier S (1992) The psychological and physical health of family members caring for an elderly person with dementia. J Clin Epidemiol 45:61–70

[7]   Becker M., Software Architecture Trends and Promising Technology for Ambient Assisted Living Systems, Dagstuhl Seminar Proceedings 07462, Assisted Living Systems-Models, Architectures and Engineering Approaches, 2008

[8]   Beltrame F., Maryni P., Orsi G. (1998) On the Integration of healthcare emergency System in Europe: The WETS Project Case Study. IEEE Transaction on Information technology in Biomedicine. Vol. 2 (2)

[9]   Bennett, K., Layzell, P., Budgen, D., Brereton, P., Macaulay, L., and Munro, M. 2000. Service-based software: the future for flexible software. In Proceedings of the Seventh Asia-Pacific Software Engineering Conference (December 05 - 08, 2000). APSEC. IEEE Computer Society, Washington, DC, 214.

[10]   Bikakis, A., Antoniou, G.: Distributed Defeasible Contextual Reasoning in Ambient Computing. In: Ambient Intelligence (AmI-2008), LNCS, vol.5355, pp. 308--325. Springer Berlin / Heidelberg (2008)

[11]   Bravo, J., de Ipiña, D.L., Fuentes, C., Hervás, R., Peña, R., Vergara, M., Casero, G.: Enabling NFC Technology for Supporting Chronic Diseases: A Proposal for Alzheimer Caregivers. In: Ambient Intelligence (AmI-2008), LNCS, vol.5355, pp. 109--125. Springer Berlin / Heidelberg (2008)

[12]   Breuil V., De Rotrou J., Forette F., Tortrat D., Ganansia-Ganem A., Frambourt A., Moulin F., Boller F., 1994. Cognitive stimulation of patients with dementia: Preliminary results. International Journal of Geriatric Psychiatry 9:211-217.

[13]   Butler R. N., Lewis M. I., 1977. Aging and mental health: Positive psychosocial approaches C.V. Mosby, St. Louis, MO.

[14]   Cervantes, H. and R. S. Hall. Autonomous Adaptation to Dynamic Availability Using a Service-Oriented Component Model. Proceedings of the 26th International Conference on Software Engineering (ICSE'04), 23-28 May, 2004, pp. 614-623.

[15]   Cockburn, J., and Smith, P. T. (1991). The relative influence of intelligence and age on

everyday memory. Journals of Gerontology, Series B, Psychological Sciences and Social Sciences, 46, 31-36.

[16] Craik, F.I.M., R.G. Morris, and M.L. Gick. (1990). Adult age differences in working memory. In Dawes, R.M. (1998), Behavioral decision making and judgment. In D.T. Gilbert, S.T. Fiske and G. Lindzey (Eds.), The handbook of social psychology, 1, 497-548. New York: McGraw-Hill

[17] Dolin RH, Alschuler L, Boyer S et al. HL7 Clinical Document Architecture, Release 2. J Am Med Inform Assoc. 2006 Jan-Feb;13(1):30-9.

[18] Einstein, G.O., and McDaniel, M.A. (1990). Normal aging and prospective memory. Journal of Experimental Psychology, 16(4), 717.726

[19] Fisk, A.D., and Rogers, W. A. (1991). Toward an understanding of age-related memory and visual search effects. Journal of Experimental Psychology: General, 120, 131- 149.

[20] Folstein, M., Folstein, S., McHugh, P.: Mini-Mental State: A practical method for grading the cognitive state of patients for the clinician. Journal of Psychiatric Research, 12, 189-198. (1975)

[21] Foster, D., McGregor, C., El-Masri, S. A Survey of Agent-Based Intelligent Decision Support Systems to Support Clinical Management and Research, in, Proceedins MAS*BIOMED'05, Ultrecht, Nederlands, 2005

[22] Fountoulakis, K.N., Tsolaki, M., Iacovides, A., Yesavage, J., O'Hara, R., Kazis, A., Ierodiakonou, C.: The validation of the short form of the Geriatric Depression Scale (GDS) in Greece. Aging, 11, 6, 367-372. (1999)

[23] Fountoulakis, K.N., Tsolaki, M., Chantzi, H., Kazis, A.: Mini Mental State Examination (MMSE): A validation study in Greece. American Journal of Alzheimer's Disease and Other Dementias, 15, 6, 342-345. (2000)

[24] García, O., Tapia. D.I.,Saavedra, A., Alonso R.S., García, I: ALZ-MAS 2.0; A Distributed Approach for Alzheimer Health Care. In: 3rd Symposium of Ubiquitous Computing and Ambient Intelligence 2008, pp. 76--85. Springer (2008)

[25] Hancock, H. E., Fisk, A. D., and Rogers, W. A. (2001). Comprehension of explicit and implicit warning information in young and older adults. Proceeding of the Human Factors and Ergonomics Society 45th annual meeting, Santa Monica, California.

[26] Hauer K, Becker CU, Beyer N (2006) Effectiveness of physical training on motor performance and fall prevention in cognitively impaired older persons. Am J Phys Med Rehab 85:847–857

[27] Holden U. P., Woods R. T., 1995. Positive approaches to dementia care 3rd ed. Churchill-Livingstone, Edinburgh, Scotland.

[28] Hoogendoorn M., Klein M., Treuer J., Formal Design and Simulation of an Ambient Multi-Agent System Model for Medicine Usage Management, In: M. Muhlhauser, A. Ferscha, and E. Aitenbichler (eds.), Constructing Ambient Intelligence: AmI-07 Workshops Proceedings. Communications in Computer and Information Science (CCIS), vol. 11, Springer Verlag, 2008, pp. 207-217

[29] Kakas. A. and Moraitis, P. Argumentation based decision making for autonomous agents, in: Proceedings of the 2nd Int. Conf. on Autonomous Agents and Multi-Agent Systems (AAMAS03), July 14-18, Australia, 2003.

[30] Klein, M., Schmidt, A., Lauer, R.: Ontology-Centred Design of an Ambient Middleware for Assisted Living: The Case of SOPRANO. In: Towards Ambient Intelligence: Methods for Cooperating Ensembles in Ubiquitous Environments (AIM-CU), 30th Annual German Conference on Artificial Intelligence (KI 2007), Osnabruck, Germany, (2007)

[31] Kleinberger, T., Becker, M., Ras, E., Holzinger, A. & Müller, P.: Ambient Intelligence in Assisted Living: Enable Elderly People to Handle Future Interfaces. In: Universal Access to Ambient Interaction, LNCS, vol. 4555, pp. 103--112. Springer Berlin / Heidelberg (2007)

[32] Kramer AF, Colcombe SJ, McAuley E, Eriksen KI, Scalf P, Jerome GJ, Marquez DX, Elavsky S, Webb AG (2003) Enhancing brain and cognitive function of older adults through fitness training. J Mol Neurosci 20:213–221

[33] Kubitschke L. et al. (2009) ICT & Ageing: Users, Markets and Technologies. Compilation Report on Ethical Issues. URL: http://www.ict-ageing.eu (access on: 19.01.2010)

[34] Larson EB, Wang L, Bowen JD, McCormick WC, Teri L, Crane P, Kukull W (2006) Exercise is associated with reduced risk for incident dementia among persons 65 years of age and older. Ann Intern Med 144(2):73–81

[35] Lee, Y., Khorasani, E.S., Rahimi, S., Nulu, S. : A Generic Mobile Agent Framework towards Ambient Intelligence. In: Studies in Computational Intelligence series, vol. 170, pp. 175—192. Springer Berlin / Heidelberg (2009)

[36] Light, L. L., and LaVoie, D. (1993). Direct and indirect measures of memory in old age. In P. Graf & M. E. J. Masson (Eds.), Implicit memory: New directions in cognition, development, and neuropsychology (pp. 207-230). Hillsdale, NJ: Erlbaum.

[37] Mahoney D.F., et al., In-home monitoring old persons with dementia: Ethical quidelines for technology research and development, Alzheimer's & Dementia 3 (2007) 217-226

[38] Marreiros C. et al., Argumentation-Based Decsions Making in Ambient Intelligence Environments, J., Neves, M. Santos and J. Machado (Eds): EPIA 2007, LNAI4874, pp. 309-322, 2007, Springer-Verlag

[39] McCreadie C., Tinker A. (2005) The acceptability of assistive technology to older people. Journal of Ageing and Society. Vol 25. pp 91-110

[40] Mechling H: Dementia and physical activity. European Review of Aging and Physical Activity 2008, 5:1-3.

[41] Mechling H, Brach M (2007) fit für 100—Förderung der Mobilität und Selbstständigkeit für Hochaltrige. Praxisleitfaden zur Einrichtung von Bewegungsangeboten für alle Bereich der Altenhilfe (Fit for 100—improvement of mobility and independence in high aged people. An orientation for the implementation of physical activity in all types of old age homes). Deutsche Sporthochschule, Köln

[42] Meystre S. (2005) The Current State of Telemonitoring: A Comment on the Literature. Journal of Telemedicine and e-Health. Vol 11/ 1

[43] Moraitis, P., Spanoudakis, N.: Argumentation-based Agent Interaction in an Ambient Intelligence Context. IEEE Intelligent Systems, Special Issue on Argumentation Technology, 22(6), 84-93 (2007)

[44] Nehmer, J., Karshmer, A., Becker, M., Lamm, R.: Living Assistance Systems – An Ambient Intelligence Approach. In: Proceedings of the International Conference on

Software Engineering (ICSE), May 2006

[45] Nielsen J. (1993). Usability Engineering, Morgan Kaufmann

[46] Nielsen J., Mack R. (1994). Usability Inspection Methods, John Wiley & Sons Inc

[47] Paré G., Jaana M., Sicotte C. (2007) Systematic Review of Home Telemonitoring for Chronic Diseases: The Evidence Base. Journal of the American Medical Informatics Association. Vol 14/3

[48] Powell-Proctor L., Miller E., 1982. Reality orientation: A critical appraisal. British Journal of Psychiatry 140:457-463.

[49] Rahwan, I., Moraitis P. and Reed, C., eds., Argumentation in Multi-Agent Systems, Lecture Notes in Artificial Intelligence, 3366, Springer-Verlag, Berlin, Germany, 2005.

[50] Reynolds, C., Czaja, S.J., and Sharit, J. (2002). Age and perceptions of usability on telephone menu systems. Proceeding of the Human Factors and Ergonomics Society 46th Annual Meeting, Santa Monica, California.

[51] Salthouse, T.A. (1992). Reasoning and spatial abilities. In F. I. M. Craik and T. A. Salthouse (Eds.), The handbook of aging and cognition. Mahwah, NJ: Lawrence Erlbaum Associates.

[52] Sanfey, A.G., and Hastie, R. (2000). Judgment and decision making across the adult life span: A tutorial review of psychological research. In D. Park and N. Schwarz (Eds.) Aging and Cognition: A Primer. Philadelphia, PA: Psychology Press

[53] Schuurman J., El-Hadidy F., Krom A., Walhout B.(2009) Ambient Intelligence - Viable future or dangerous illusions? Rathenau Institut

[54] Shepard, R.N., and Metzler, J. (1971), Mental Rotation of three-dimensional objects. Science, 171, 701-703.

[55] Spanoudakis, N., Moraitis, P.: An Ambient Intelligence Application Integrating Agent and Service-Oriented Technologies. In: Proceedings of the 27th SGAI International Conference on Artificial Intelligence (AI2007), Peterhouse College, Cambridge, UK, December 10-12, pp. 393--398 (2007)

[56] Spanoudakis N, Pendaraki K (2007) A Tool for Portfolio Generation Using an Argumentation Based Decision Making Framework. In Proc of the Annu IEEE Int Conf on Tools with Artif Intell, Patras, Greece, October 29-31

[57] Spanoudakis N., Moraitis, P.: Automated Product Pricing Using Argumentation. In: Proceedings of the 5th IFIP Conference on Artificial Intelligence Applications & Innovations (AIAI 2009), Iliadis, Lazaros; Vlahavas, Ioannis; Bramer, Max (Eds.), IFIP Advances in Information and Communication Technology Book series, Vol. 296, Springer, Thessaloniki, Greece, April 23-25, 2009

[58] Spector, A., Davies, S., Woods, B., & Orrell, M. (2000). Reality orientation for dementia: A systematic review of the evidence for its effectiveness. Gerontologist, 40 (2), 206–212.

[59] Staehli B., Chalkia E., Touliou K.: SoA on brain trainers and stress management systems. OASIS – Open architecture for Accessible Services Integration and Standardization GRANT AGREEMENT # 215754. Document ID: OASIS-CS-WP2.4-R1 (2009)

[60] Statistik Austria (2009) Prevalence of at least one chronic disease 2006/07. Austrian Health survey. URL: http://www.statistik.at/web_de/statistiken/gesundheit/

gesundheitszustand/chronische_krankheiten/index.html (access on: 19.01.2010)

[61] Stellman, Andrew; Greene, Jennifer (2005). Applied Software Project Management. O'Reilly Media. p. 113. ISBN 978-0-596-00948-9

[62] Sunderland, T., Hill, J.L., Mellow, A.M. et al.: Clock drawing in Alzheimer's disease: a novel measure of dementia severity. J Am Geriatr Soc, 37, 775-779. (1989)

[63] Sundstrom, E., Bell, P.A., Bubsy, P.L., and Asmus, C. (1996), Environmental Psychology 1989-1994. Annual Review of Psychology, 47, 485-512. Van Gerven, P. W. M., Paas, F. G. W. C., Van Merriënboer, J. J. G., and Schmidt, H. G. (2000). Cognitive Load Theory and the acquisition of complex cognitive skills in the elderly: towards an integrative framework. Educational Gerontology, 26(6), 503- 521.

[64] Petersen, R.C., Doody, R., Kurz, A., Mohs, R.C., Morris, J.C., Rabins, P.V., Ritchie, K., Rossor, M., Thal, L. & Winblad, B. (2001). Current concepts in Mild Cognitive Impairment. Archives of Neurology, 58, 1985-1992.

[65] Tannahill A. (2008) Beyond evidence – to ethics: a decision-making framework for helath promotion, public health and health improvement. Health Promotion International. Vol. 23/4

[66] Taulbee L. R., Folsom J. C., 1966. Reality orientation for geriatric patients. Hospital and Community Psychiatry 17:133-135.

[67] Vallar G. and Shallice T. (Eds.), Neuropsychological impairments of short-term memory, 247-267. Cambridge University Press, Cambridge, UK.

[68] Weiss, G. Multi-Agent Systems: A Modern Approach to Distributed Artificial Intelligence, MIT Press, 1999

[69] Williams H.E. and Lane D. Web Database Applications with PHP, and MySQL. O'Reilly Media, March 2002

[70] Yesavage, J.A., Brink, T.L., Rose, T.L. et al.: Development and validation of a geriatric depression screening scale: a preliminary report. Journal of Psychiatric Research, 17, 37-49. (1983)

ANNEX A: USE CASES DOCUMENTATION TEMPLATE

We would like to thank Karl E. Wiegers (2004) for sharing his use cases template as it has been used as a basis for this document. Document each use case using the template shown in the Appendix. Sections 2 and 3 provide a description of each field in the use case template.

Use Case Identification

Use Case ID

Give each use case a unique integer sequence number identifier. Alternatively, use a hierarchical form: X.Y. Related use cases can be grouped in the hierarchy.

Use Case Name

State a concise, results-oriented name for the use case. These reflect the tasks the user needs to be able to accomplish using the system. Include an action verb and a noun. Some examples:

- View part number information.
- Manually mark hypertext source and establish link to target.
- Place an order for a CD with the updated software version.

Use Case History

Created By

Supply the name of the person who initially documented this use case.

Date Created

Enter the date on which the use case was initially documented.

Last Updated By

Supply the name of the person who performed the most recent update to the use case description.

Date Last Updated

Enter the date on which the use case was most recently updated.

Use Case Definition

Actors

An actor is a person or other entity external to the software system being specified who interacts with the system and performs use cases to accomplish tasks. Different actors often correspond to different user classes, or roles, identified from the customer community that will use the product. Name the actor that will be initiating this use case and any other actors who will participate in completing the use case.

Trigger

Identify the event that initiates the use case. This could be an external business event or system

event that causes the use case to begin, or it could be the first step in the normal flow.

Description

Provide a brief description of the reason for and outcome of this use case, or a high-level description of the sequence of actions and the outcome of executing the use case.

Preconditions

List any activities that must take place, or any conditions that must be true, before the use case can be started. Number each precondition. Examples:

1. User's identity has been authenticated.
2. User's computer has sufficient free memory available to launch task.

Postconditions

Describe the state of the system at the conclusion of the use case execution. Number each postcondition. Examples:

1. Document contains only valid SGML tags.
2. Price of item in database has been updated with new value.

Normal Flow

Provide a detailed description of the user actions and system responses that will take place during execution of the use case under normal, expected conditions. This dialog sequence will ultimately lead to accomplishing the goal stated in the use case name and description. This description may be written as an answer to the hypothetical question, "How do I <accomplish the task stated in the use case name>?" This is best done as a numbered list of actions performed by the actor, alternating with responses provided by the system. The normal flow is numbered "X.0", where "X" is the Use Case ID.

Alternative Flows

Document other, legitimate usage scenarios that can take place within this use case separately in this section. State the alternative flow, and describe any differences in the sequence of steps that take place. Number each alternative flow in the form "X.Y", where "X" is the Use Case ID and Y is a sequence number for the alternative flow. For example, "5.3" would indicate the third alternative flow for use case number 5.

Exceptions

Describe any anticipated error conditions that could occur during execution of the use case, and define how the system is to respond to those conditions. Also, describe how the system is to respond if the use case execution fails for some unanticipated reason. If the use case results in a durable state change in a database or the outside world, state whether the change is rolled back, completed correctly, partially completed with a known state, or left in an undetermined state as a result of the exception. Number each alternative flow in the form "X.Y.E.Z", where "X" is the Use Case ID, Y indicates the normal (0) or alternative (>0) flow during which this exception could take place, "E" indicates an exception, and "Z" is a sequence number for the exceptions. For example "5.0.E.2" would indicate the second exception for the normal flow for use case number 5.

Includes

List any other use cases that are included ("called") by this use case. Common functionality that appears in multiple use cases can be split out into a separate use case that is included by the ones that need that common functionality.

Priority

Indicate the relative priority of implementing the functionality required to allow this use case to be executed. The priority scheme used must be the same as that used in the software requirements specification.

Frequency of Use

Estimate the number of times this use case will be performed by the actors per some appropriate unit of time.

Business Rules

List any business rules that influence this use case.

Special Requirements

Identify any additional requirements, such as nonfunctional requirements, for the use case that may need to be addressed during design or implementation. These may include performance requirements or other quality attributes.

Assumptions

List any assumptions that were made in the analysis that led to accepting this use case into the product description and writing the use case description.

Notes and Issues

List any additional comments about this use case or any remaining open issues or TBDs (To Be Determineds) that must be resolved. Identify who will resolve each issue, the due date, and what the resolution ultimately is.

Use Case Template

Use Case ID:			
Use Case Name:			
Created By:		Last Updated By:	
Date Created:		Date Last Updated:	

Actors:	
Description:	
Trigger:	
Preconditions:	
Postconditions:	
Normal Flow:	
Alternative Flows:	
Exceptions:	
Includes:	
Priority:	
Frequency of Use:	
Business Rules:	
Special Requirements:	
Assumptions:	
Notes and Issues:	

ANNEX B: QUESTIONNAIRE FOR USER REQUIREMENTS (ELDERLY WITH COGNITIVE IMPAIRMENTS)

Please fill in your date of birth: _____

Please fill in your sex (male / female): _____

Please fill in your school level (years of education): _____

Please fill in your profession: _____

User's cognitive classification: _____

1. Would it be useful to be reminded about your appointments through notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

2. Would it be useful to be reminded to take your medication through notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

3. Would it be useful to be reminded about important dates (e.g. birthdays etc) through notifications show on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

4.Would it be useful to be reminded about personally meaningful events of the past through a digital memory book?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

5. Would it be useful to be reminded about phone numbers through a TV application?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

6. Grade your level of computer literacy in the following scale.

    0 = I have never used a computer

    1 = I use the computer to listen to music / view photos / play simple games (e.g. solitaire)

    2 = I use the computer to write texts

    3 = I use the computer to send emails / look up information in the Internet

    4 = I fully tap all of my computer's features

7. How often do you use TV?

    0 = never   1 = seldom   2 = sometimes   3 = often   4 = very often   5 = every day

8. Do you like mentally challenging games, such as crosswords and mazes?

    0 = not-at-all   1 = not so much   2 = fair   3 = much   4 = very much

9. Would you participate in a mental stimulation program aiming to train your cognitive skills (memory, attention, judgment etc) through TV-based exercises?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

10. How often do you exercise (walking, swimming etc)?

    0 = never   1 = seldom   2 = sometimes   3 = often   4 = very often   5 = every day

11. Would you participate in a physical reinforcement program aiming to improve your physical condition through exercises shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

12. Would it be useful to be informed about the top news of the day through regular notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

13. Would it be useful to be informed about the weather through regular notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

14. Would you like to be able to come in contact with your friends and relatives through internet (chat, share ph.)?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

ANNEX C: QUESTIONNAIRE FOR USER REQUIREMENTS (FAMILY CAREGIVERS)

Please fill in your date of birth: _____

Please fill in your sex (male / female): _____

Please fill in your school level (years of education): _____

Please fill in your profession: _____

Patient's cognitive classification: _____

1. Would it be useful for your beloved one to be reminded about his/her appointments through notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

2. Would it be useful for your beloved one to be reminded to take his/her medication through notifications shown on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

3. Would it be useful for your beloved one to be reminded about important dates (e.g. birthdays etc) through notifications show on TV?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

4. Would it be useful for your beloved one to be reminded about personally meaningful events of the past through a digital memory book?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

5. Would it be useful for your beloved one to be reminded about phone numbers through a TV application?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

6. Grade your level of computer literacy in the following scale.

    0 = I have never used a computer

    1 = I use the computer to listen to music / view photos / play simple games (e.g. solitaire)

    2 = I use the computer to write texts

    3 = I use the computer to send emails / look up information in the Internet

    4 = I fully tap all of my computer's features

7. How often do you use TV?

    0 = never   1 = seldom   2 = sometimes   3 = often   4 = very often   5 = every day

8. Would you like your beloved one to participate in a mental stimulation program aiming to train his/her cognitive skills (memory, attention, judgment etc) through TV-based exercises?

    0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

9. Would you like your beloved one to participate in a physical reinforcement program aiming to improve his/her physical condition through exercises shown on TV?

   0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

10. Would it be useful for your beloved one to be informed about the top news of the day through regular notifications shown on TV?

   0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

11. Would it be useful for your beloved one to be informed about the weather through regular notifications shown on TV?

   0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

12. Would it be useful for your beloved one to be able to come in contact with friends and relatives through internet (chat, share photos etc)?

   0 = no   1 = probably no   2= maybe   3= probably yes   4 = yes

ANNEX D: QUESTIONNAIRE FOR USER REQUIREMENTS (PROFESSIONALS)

Please fill in your date of birth: _____

Please fill in your sex (male / female): _____

Please fill in your school level (years of education): _____

Please fill in your profession: _____

In your opinion…

1. Which patients would benefit from a TV-based appointment-reminder service?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

2. Which patients would benefit from a TV-based pill-reminder service?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

3. Which patients would benefit from a TV-based family calendar application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

4. Which patients would benefit from a TV-based digital memory book application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

5. Which patients would benefit from a TV-based phone book application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

6. Which patients would benefit from a cognitive reinforcement program aiming to train their cognitive skills through TV-based exercises?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

7. Which patients would benefit from a physical reinforcement program aiming to improve their physical condition through exercises shown on TV?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

8. Which patients would benefit from a TV-based chatting/sharing photos application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

9. Which patients would benefit from a TV-based expert support/advisory application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

10. Which patients would benefit from a TV-based "open pharmacies" application?

    0 = none   1 = MCI   2= mild AD   3= moderate AD

11. Which patients would benefit from a TV-based "simplified appliances manuals" application?

   0 = none   1 = MCI   2= mild AD   3= moderate AD

12. Which patients would benefit from a TV-based reality orientation service (time, place, top news of the day)?

   0 = none   1 = MCI   2= mild AD   3= moderate AD

13. Which patients would benefit from a TV-based weather forecast service?

   0 = none   1 = MCI   2= mild AD   3= moderate AD

14. What would be the attitude of the patients and caregivers against the possibility of participating in the HERA project?

   0 = Negative   1 = Probably Negative   2 = Thoughtful   3= Probably Positive   4= Positive

15. How beneficial would the HERA services be for the patients and caregivers participating in the project?

   0 = Not at all beneficial   1 = Not Very Beneficial   2 = Quite Beneficial   3 = Beneficial   4 = Very Beneficial

ANNEX E: INTERVIEW GUIDE FOR NURSING STAFF

Date:

Interviewer:

Interviewee:

Professional category:

A) Introduction
The HERA project aims to provide a Telemonitoring system for aged people suffering from cardiovascular diseases or Diabetes Type II, which will significantly improve the quality of their home life and extend its duration.
The part of FRK is to survey the user requirements and also the needs and demands of the nursing system related to the Telemonitoring system. Thank you very much for supporting us with your expertise.

Is it ok for you, when we tape-record this interview?

B) Interview guide

1. **What is the field of your responsibility within your organisation?**
   - Leading management position
   - Coordinator
   - Administrative tasks
   - Others

2. **What do you know about Telemonitoring?** (If there is no answer, give an explanation: *Telemonitoring is part of telemedicine. Remote patient monitoring uses devices to remotely collect and send data to a monitoring station for interpretation. Such "home telehealth" applications might include a specific vital sign, such as blood glucose or heart ECG or a variety of indicators for patients with restricted mobility. Such services can be used to supplement the use of visiting nurses.)*

3. **Do you already use devices for data transmission in your organisation?**

4. **Who makes the measurement of vital signs (blood pressure, pulse rate, respiration rate)**
   - The patients themselves
   - The registered nurses
       - If yes, is there a periodical maintenance and calibration of the devices?
   - The attending physician
   - others

5. Which vital signs are measured? Is there a task sharing between the attending physician and the registered nurse, e.g. the attending physician measures the blood pressure, the registered nurse only the weight?

6. Are there legal foundations and regulations for the measurement of vital parameters?

7. How many times are vital signs measured?
- Based on an medical prescription
- In case of need

8. How are the measurement results recorded?

9. Do the measurement results have an effect on the performance of the care process?

10. What is the procedure, if there is a critical measurement?

11. Who should give the feedback, how should it be designed (how many times, written onscreen or verbally, on the phone,…..)?

12. **What do you think is the benefit of telemonitoring system for your clients/patients?**
- to receive help at the moment
- to feel confident because of monitoring of vital signs
- in case of incertitude there is the possibility to ask an expert, there is no need to alert the rescue service
- fewer consultations as normally necessary
- vital signs reveal an upcoming crisis

13. **Which disadvantages could be for your clients/patients?**
- ethical concerns
- incertitude

14. **What do you think is the benefit of telemonitoring system for your organisation?**

ANNEX F: INTERVIEW GUIDE FOR MEDICAL EXPERTS

Date:

Interviewer:

Interviewee:

Professional category:

A) Introduction

The HERA project aims to provide a Telemonitoring system for aged people suffering from cardiovascular diseases or Diabetes Type II, which will significantly improve the quality of their home life and extend its duration.

In the HERA-Project the patients get measuring devices to measure their vital signs. The measuring data will be transmitted to a heath care centre and will be analysed and interpreted there. The patients will get a feedback including a suggestion, what to do. In cases of critical measurements an emergency medical service will be alerted.

The part of FRK is to survey the user requirements and also the needs and demands of the health care system related to the Telemonitoring system. Thank you very much for supporting us with your expertise.

Is it ok for you, when we tape-record this interview?

B) Interview guide

13. **What do you know about Telemonitoring?** (If there is no answer, give an explanation: *Telemonitoring is part of telemedicine. Remote patient monitoring uses devices to remotely collect and send data to a monitoring station for interpretation. Such "home telehealth" applications might include a specific vital sign, such as blood glucose or heart ECG or a variety of indicators for patients with restricted mobility. Such services can be used to supplement the use of visiting nurses.)*

2. **Is there a norm for measurements of vital signs or is it necessary to set up the measurement limits related to every individual patient?**
   - Blood pressure (RR):
   - Pulse rate (P):
   - Blood glucose
   - Weight: regarding sex and size
   - Oxygen saturation

3. **Patients with hypertension realise an aggravation of cardiac function tardily (Hönighaus 2009). Would this imply that it would be possible to set interventions at an early stage in case of abnormal measurements?**

4. **Already days before the patient gets into the need of interventions his/her weight changes and the blood pressure becomes instable (Braden 2007). Are there any standards existing therefore?**

5. **How correlate the different vital signs?**
   - Blood pressure (RR):
   - Pulse rate (P):
   - Blood glucose
   - Weight: regarding sex and size
   - Oxygen saturation

6. **Which information about the patient must be available in the HERA-System to be able to create an appropriate feedback?**
   - Blood pressure (RR):
   - Pulse rate (P):
   - Blood glucose
   - Weight: regarding sex and size
   - Oxygen saturation

7. **Frequency of the measurement (max.)**
   - Blood pressure (RR):
   - Pulse rate (P):
   - Blood glucose
   - Weight: regarding sex and size
   - Oxygen saturation

8. **How long is it necessary to store the data?**
   - Min:

   - Max:

9. **How to deal with extreme measurements? Could this measurements be ignored if a second measuring shortly afterwards is within a normal range?**

10. **Which professional qualification is required from the personnel of the health care centre to provide a competent guidance to the patients in case of emergency?**

11. **From your point of view which health services could be supported by technical solutions?**

15. **Which disadvantages could be for your organisation?**

16. **How could the telemonitoring system be integrated in the existing health care delivery system? How could it be integrated in the nursing process?**

17. **What do think about the involvement of the general practitioners/the attending physicians in the telemonitoring system?**

18. **Which health services could be supported by technical solutions from your point of view?**