WP 2 – Concept, Role Definition and Strategy Consensus

D2.1: Strategy Consensus Document

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Within this central deliverable of the ALFRED approach, the overall project vision in terms of its general positioning, the project's business and its research and technological objectives will be revealed. For that a story will be utilized to demonstrate typical use cases where different user groups can benefit; the logical structure and the theoretical structure of the ALFRED framework will be described, which will serve as basis for the ALFRED App as well as for the ALFREDO marketplace.

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Executive Summary

This ALFRED deliverable, D2.1 – Strategy Consensus Document, represents a central deliverable within the ALFRED approach and will act as a guideline along the overall course of the project. All partners will rely on it to keep in mind and stay focused on the project's main ideas and goals.

The deliverable provides a clear description of four aspects of the project:

1. The generic concept of ALFRED is revised. This is done by describing the logical structure of the project without strong consideration of the technical approach. This allows a common ground and common understanding bridging the worlds between the user partners and RTD providers plus academic partners.
2. The roles of the stakeholders are defined. This is done by creating a connected ALFRED story with recurring personas. The story provides an easy access to the use cases of ALFRED.
3. The strategy of ALFRED will be described how ALFRED aims to achieve its impact into society and into the day-to-day life of older people. This is going to be achieved by pilots.

In addition to these four aspects of the project, this deliverable also provides a first positioning regarding possible business and research opportunities in order to show the possible impact of the project. This will be detailed in D2.3, D8.1 and D9.1.

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1 Introduction

ALFRED – Personal Interactive Assistant for Independent Living and Active Ageing – is a project funded by the Seventh Framework Programme of the European Commission under Grant Agreement No. 611218. It will allow older people to live longer at their own homes with the possibility to act independently and to actively participate in society by providing the technological foundation for an ecosystem consisting of four pillars:

- **User-Driven Interaction Assistant** to allow older people to talk to ALFRED and to ask questions or define commands in order to solve day-to-day problems.
- **Personalized Social Inclusion** by suggesting social events to older people, taking into account their interests and their social environment.
- A more **Effective & Personalized Care** by allowing medical staff and caretakers to access the vital signs of older people monitored by (wearable) sensors.
- **Physical & Cognitive Impairments Prevention** by way of serious games that help the users to maintain and possibly even improve their physical and cognitive capabilities.

Within this deliverable, the overall project vision in terms of its general positioning, the project's business opportunities and its scientific and technological objectives will be revealed. To this end, a story will be utilized to demonstrate various use cases where different user groups can benefit; the logical structure of the ALFRED project will be described; the theoretical structure of the ALFRED framework will be described, which will be the basis for the ALFRED application, as well as for the ALFREDO marketplace.

1.1 ALFRED Project Overview

One of the main problems of western societies is the increasing isolation of older people, who do not actively participate in society either because of missing social interactions or because of age-related impairments (physical or cognitive). The outcomes of the ALFRED project will help to overcome this problem with an interactive virtual butler (a smartphone application also called ALFRED) for older people, which is fully voice controlled.

The ALFRED project is wrapped around the following main objectives:

- To empower older people to live independently for longer by delivering a virtual butler with seamless support for tasks in and outside the home. This virtual butler (the ALFRED app) aims for a very high end-user acceptance by using a fully voice controlled and non-technical user interface.
- To prevent age-related physical and cognitive impairments with the help of personalized serious games.
- To foster active participation in society for the ageing population by suggesting and managing events and social contacts.
- And finally, to improve caring by offering direct access to vital signs for carers and other medical staff as well as alerting in case of emergencies. The data is collected by unobtrusive wearable sensors monitoring the vital signs of ALFRED's users.

To achieve its goals, the project ALFRED conducts original research from a user centred perspective and applies technologies from the fields of Ubiquitous Computing, Big Data, Serious Gaming, the Semantic Web, Cyber Physical Systems, the Internet of Things, the Internet of Services, and Human-Computer Interaction. For more information, please refer to the project website at http://www.alfred.eu.

1.2 Deliverable Purpose, Scope and Context

The purpose of this deliverable is to act as a guideline along the project. It will be used by all partners to stay focused on the main ideas and goals of the project even in complex and technical phases of the project. To achieve this, the Strategy Consensus Document provides information about the general positioning of the ALFRED project, the business and scientific/technological objectives, its stakeholders, the underlying vision enablers, and some preliminary application scenarios.

The Strategy Consensus Document provides information on a rather high level. In order to get a deeper insight into the project, please refer to the upcoming deliverables D2.3 (User Stories and Requirements Analysis), D2.4 (Architecture Definition and Functional Specification) and D2.5 (Technical Specification).

1.3 Document Status and Target Audience

This document is listed in the Description-of-Work (DoW) as “public”, as it provides general information about the goals and scope of the ALFRED project and can therefore be used by external parties in order to get according insight into the project activities.

While the document mainly aims at the project’s contributing partners, this public deliverable can also be useful for the wider scientific and industrial community. This includes other publicly funded research and development projects, which may be interested in collaboration activities.

1.4 Abbreviations and Glossary

A definition of common terms and roles related to the realization of the ALFRED project as well as a list of abbreviations is available in the supplementary document “Supplement: Abbreviations and Glossary”, which is provided in addition to this deliverable. Further information can be found at http://www.alfred.eu.

1.5 Document Structure

This deliverable is broken down into the following chapters:

- **Chapter 2: The ALFRED Story** involves all the stakeholders of the ALFRED platform in a coherent story.
- **Chapter 3: Logical Structure – ALFRED Pillars** explains the core elements of ALFRED giving a brief overview about the main concepts behind the project.
- **Chapter 4: Theoretical Structure – ALFRED Framework** describes the technical point of view of the project by referring to the underlying framework, which will be created in the course of the ALFRED project.

- **Chapter 5: Older Persons and ALFRED** describes the pilot test that will be conducted in order to get direct feedback by the main target group of the ALFRED platform.
- **Chapter 6: Positioning** provides first considerations for possible business and research opportunities of the ALFRED project.

2 The ALFRED Story

This chapter illustrates typical situations where the ALFRED platform can be used. The created personas and the ALFRED story demonstrate the various possibilities that are offered to the different user groups.

2.1 Introduction

The main target group of the ALFRED application are older persons, living independently at home. This primary user group are persons who are over 60 years old, who want to pursue an independent lifestyle and who may or may not suffer from typical age related health problems. For this target group, the ALFRED application appears as a “virtual butler”, helping them to stay independent and assisting them inside and outside home.

In the ALFRED story, *Otto the Older Person*, and *Olivia the Older Person*, represent this target group. Otto and Olivia both use the ALFRED app indoors and outdoors as they want to pursue their independent lifestyle despite of their increasing health problems and reduced mobility. For Otto and Olivia, ALFRED offers support in their activities of daily living but it also monitors their state of health and helps to prevent health problems.

However, older persons are not the only target group of the ALFRED project. It also targets secondary user groups who are also described in the ALFRED story.

The ALFRED platform represents important benefits for both formal and informal caregivers. ALFRED allows the caregivers to be in direct contact with the older person and to get up-to-date status information. In this way, the ALFRED platform can be used as an important support tool for caregivers who are often worried about their older relatives or the clients they are taking care of.

In the ALFRED story, *Carl the Carer* relies on the ALFRED system to take better care of his wife Olivia who has physical and psychological problems since her retirement. He is an informal caregiver, who is also older. The ALFRED platform enables Carl to follow Olivia’s status and stay in contact with her even when he is on a business trip abroad.

Formal caregivers such as doctors, nurses and other hospital staff can also benefit from the ALFRED platform and provide more efficient care through direct communication with the patients. *Mike from the Medical Staff* is a nurse who frequently checks Otto’s health status. For Mike, ALFRED is a very efficient working tool that enables him to communicate and monitor his patients even at distance.

Developers and app creators can be considered as another (tertiary) user group. They will specifically benefit from ALFREDO. ALFREDO is the open platform of ALFRED that provides a framework for app development and distribution over the ALFRED marketplace to its user. In the ALFRED story, *Dave the Developer* learns about the new business opportunities provided by ALFREDO and he starts to develop an app for the ALFRED platform.

The following section will first describe these stakeholders and their related personas. These personas are then described in short use cases, reflecting the interaction with the ALFRED platform. These use cases will be further elaborated in D2.2.

2.2 Personas

Personas represent archetypes of persons, reflecting typical users by describing their biography, home or work situation, preferences and interests. These personas will serve as a reference throughout the course of the project and project development. Each persona will interact with the ALFRED platform from different needs and in their own ways, as will be observed in this section.

2.2.1 Otto the Older Person

Otto is 83 years old and he lives alone in a rural area. Otto enjoys his life at home and he would love to live at home as long as possible. Otto has a healthy lifestyle; he eats a balanced diet and does some exercise, hiking in the country side. However, due to his age, Otto has some health trouble; he suffers from high blood pressure that needs to be monitored on a regular basis and he follows a medical treatment for the hypertension.

Even though Otto is happy to live alone, sometimes he does feel a bit lonely. He has been a widower for five years now, and as his son's family is living 200 km away, he cannot see them as often as he would like to. Luckily, Otto has some old friends in his village who he meets at least once a week.

Technology usage: Otto is generally sceptical about technological devices. He has a mobile phone that his son gave to him, which he occasionally uses when he is on a trip. He likes watching TV.

2.2.2 Olivia the Older Person

Olivia is 66 and recently retired. She is living in a city with her spouse Carl who is still in the professional life. They do not have children. Right after her retirement, Olivia suffered from depression as she did not know how to use all her new free time and she felt she wasn't contributing to society anymore.

Little by little, she is adapting to her new lifestyle that is full of different activities; Olivia loves to go the movies and to visit exhibitions. Her real passion, however, is cross-country skiing during the winter time. Unfortunately, she has had an accident while skiing a few months back and now her mobility is reduced for months to come. The rehabilitation of her broken foot takes patience and time. During the rehabilitation period, she needs to use crutches. Due to her reduced mobility, she cannot go out on her own anymore and thus has to stay at home on her own when her husband Carl is out and about.

Technology usage: Olivia has a desktop PC, but she rarely uses it. Olivia rather prefers to use her tablet computer where she can easily check the latest news and the weather. Also, she has a mobile phone that she normally takes along when she is going outdoors. She likes to try out new things and tries to stay informed on new technologies.

2.2.3 Carl the Carer

Carl is 63. He is Olivia's husband. Being a bit younger than his wife, Carl is still working as an accountant. Carl is in good physical condition. Carl and Olivia always had a strong and good relationship. However, since Olivia got retired, Carl noticed that his wife is depressed and a bit lost and that she apparently has a hard time getting used to her new situation. One of Olivia's hobbies is skiing, but when she broke her foot, Carl was scared that his

wife would become even more depressed. Carl is trying to come home earlier now to take care of his wife and to keep her company. But Carl is worried because he cannot be at home all day long and he knows that when Olivia is down, she can forget to take her medicine or do her rehabilitation exercises. So when Carl is at work, he is calling home regularly to make sure that his wife good.

Technology usage: Carl uses the Internet and a computer. He mainly uses an accountancy program for his work. He likes technology, but he is not a very advanced user. Normally, his wife is the one who tries out new things and then he follows.

2.2.4 Mike from the Medical Staff

Mike is a nurse of 43. He is doing his job since 20 years and he likes it. He likes to take care of people. Since 10 years, Mike is not working at the hospital anymore; he is a home-care nurse now. Mike is spending a lot of time in his car because he is living and working in a rural area. For a couple of weeks now, Mike has been taking care of Otto. Otto is an uncomplicated patient who does not have any severe problems besides his blood pressure, which is a bit high. So Mike is going regularly to visit Otto to monitor his blood pressure. Twice a week, Mike is calling Otto on the phone to ask him about his health status. Mike is aware that Otto does not meet a lot of people and so he wants to make sure that Otto is in a good shape and that he treats his blood pressure.

Technology usage: Mike has a smartphone in order to coordinate his work. He uses it for his personal affairs as well. At home, he has a laptop with an Internet connection which he uses almost every day.

2.2.5 Dave the Developer

Dave works for a start-up company that develops applications for mobile devices. Dave heard about ALFRED through his friend working in the same field who had created apps for the ALFREDO open platform. He had a good experience with this. Dave learnt that ALFREDO provides developers with simple and easy to use programming interfaces that allow them to access services related to health care as well as to integrate new apps to the ALFRED platform. Dave was happy to learn that ALFRED aims to facilitate the developers' work with good documentations and tutorials.

As a result, Dave has proposed his manager to develop a new health app for ALFRED that would enable the users to monitor their health state in real time. The manager approved Dave's idea as he learnt that the ALFRED apps could generate some additional revenue for their small company.

Technology usage: Dave uses state-of-the-art technology at his work as well as at home.

2.3 Use cases

The use cases will describe in small stories how a persona might use the ALFRED app, referred to in this subchapter only as ALFRED. These use cases also create a common understanding of the functionalities of ALFRED. The following use cases are initial use cases, which will be validated and improved during task 2.3 with the involvement of end-users in focus groups. From the focus groups and the use cases, the user stories will be derived that are specific interactions of a person with ALFRED.

2.3.1 Use Case 1: Set up with Care Organization

Involved personas: Otto the Older Person, Mike from the Medical Staff

The *Home Care* organization is implementing ALFRED as part of its new innovation programme, offering better and more efficient services to its clients. As part of the programme, Otto receives a smartphone from the organization, which comes with ALFRED pre-installed. The costs of ALFRED are covered by his health insurance package.

Mike brings Otto the smartphone and together they set up the user profile of Otto. He indicates his hobbies and interests and he lists his contacts, namely his friends and his son. During the setup process, there are also some questions regarding his health status as well as his medication. Apart from the setup, the only technical task that Otto has to take care of is to frequently charge the battery of the smartphone that ALFRED is running on. All other interaction with the system is simply by voice.

2.3.2 Use Case 2: Personalized Social Inclusion

Involved personas: Otto the Older Person

The first few days, Otto tries to get acquainted with the ALFRED voice that talks to him and answers his questions. ALFRED reminds Otto every day to take his medicine. Sometimes, Otto is confused and asks for a clarification. ALFRED then explains which medicine it refers to and what the box looks like. ALFRED also makes suggestions to Otto to do the grocery shopping twice a week and it suggests nice recipes. Once every two days, ALFRED suggests to Otto to call one of his friends or his son. If Otto agrees, ALFRED dials the number directly. ALFRED asked Otto if he might be interested in participating in the billiard evening at the local activity centre. Otto decided he would go and since then, ALFRED reminds him every week. ALFRED suggested adding some of the contacts from the billiard evening to his own contacts; these people are also using ALFRED.

2.3.3 Use Case 3: Effective and Personalized Care

Involved personas: Otto the Older Person, Mike from the Medical Staff

Supported by the caregiver functions of ALFRED, Mike can now easily follow up on Otto's health status. Instead of just giving Otto a phone call twice a week, Mike can now also have video calls with Otto. This gives Otto more social interaction and it gives Mike a better impression of how Otto is really doing, making it easier to estimate if he must pay him an extra visit or not.

Mike gave Otto a small bracelet that he wears around his wrist. After pairing the bracelet with the ALFRED app, Otto has to grant Mike the right to read the data recorded by the bracelet. Mike can now regularly check on Otto's blood pressure with a glance at the ALFRED platform.

2.3.4 Use Case 4: Set up by Older Person

Involved personas: Carl the Carer

Since Carl was worried about his wife he has been looking for a solution that can both help Olivia to get better and also give Carl some more support in his care for her. He heard about ALFRED through a friend. He bought two packages at the telecommunication shop. Each package consists of a smartphone with the ALFRED app pre-installed, an Internet flat rate plan and a simple step-by-step manual.

Together, they configure the ALFRED app in the mobile phone. Carl assigned the role of informal carer to himself. Additionally, they took a look at the easy-to-use ALFREDO marketplace for additional apps providing functionalities that are interesting for their specific situation. Based on their initial choices, ALFRED made suggestions for other apps.

2.3.5 Use Case 5: Physical and Cognitive Impairment Prevention

Involved personas: Olivia the Older person

Olivia now uses ALFRED to do her rehabilitation. ALFRED reminds her to start the exercises of the rehabilitation and tells her exactly what she has to do. When she asks for clarification, ALFRED shows her a video with an example. When she feels bored, she asks ALFRED what to do and it might suggest a new fun game that she can play from her chair. She can also play together with a friend over the Internet, and together they can pass long moments playing.

2.3.6 Use Case 6: Effective and Personalized Care

Involved personas: Carl the Carer, Olivia the Older person

ALFRED now also indicates to Olivia when she has to take her medicines. Carl can check on it by asking ALFRED if Olivia took her medicine. This way, Carl does not have to annoy Olivia by asking her, and he feels more at ease. ALFRED also starts a video call when Carl asks for it. Because Carl is so busy with work and taking care of Olivia, he uses ALFRED to do the grocery shopping. He can ask ALFRED to make an order with the products for home delivery. ALFRED even reminds Carl to buy the yoghurt that Olivia likes so much.

In urgent situations, Olivia can also ask for help from ALFRED. ALFRED then checks on which of her carers who are closest by and calls them to check up on Olivia. This is also a great relief for Carl, who has been feeling much less stressed lately.

2.3.7 Use Case 7: Personalized Social Inclusion

Involved personas: Olivia the Older Person

ALFRED suggests activities for Olivia together with friends in the neighbourhood, so she can go out with them using her crutches. ALFRED also suggests Olivia to take a taxi to her book club that she usually attends. Sometimes she does not feel up to it, but lately she is getting more enthusiastic about going out again.

2.3.8 Use Case 8: Marketplace ALFREDO

Involved personas: Olivia the Older Person, Dave the Developer

Olivia wants to check whether she is making enough progress on her rehabilitation and asks ALFRED for an update on her health status. However ALFRED indicates that this is unfortunately not possible.

The ALFREDO marketplace then takes up this requirement, together with other requirements received from ALFRED. When Dave the Developer checks the latest search trends at the ALFREDO marketplace, he notices that many people are interested in monitoring their health status more intensively. He decides that this is an opportunity for a new application and starts the development process with the goal of distributing this new app via the ALFREDO marketplace.

3 Logical Structure – ALFRED Pillars

This chapter describes the logical structure of the ALFRED project by explaining the four core concepts (“pillars”) of ALFRED.

3.1 User-Driven Interaction Assistant

In order to empower people with age-related dependencies to live independently for longer, the ALFRED project will deliver a virtual butler with seamless support for tasks in and outside the home. This user-driven interaction assistant is the first pillar of the ALFRED project and will be implemented as the ALFRED app, which allows users to ask questions and contact real people by using their voice. In a sense, this functionality will provide a “Virtual Butler” to older people, helping them to get information, performing tasks and getting in contact with other people.

The virtual butler “ALFRED” will run on a mobile device as an application and will have a very simple graphical user interface with essentially one big button. This button causes ALFRED to listen to the user’s voice. When a question or command has been spoken by the user, ALFRED responds with its own voice, and/or performs some action such as initiating a phone call.

ALFRED will support two kinds of interactions: the first type includes questions that can be answered by ALFRED itself. For example:

- “What is the fastest way to get home?”
- “Where is the next super market?”
- “What time is it?”

The second type includes activities related to other people. For those activities, ALFRED will access the address book of the user from the phone and allow a direct contact. Example:

- “Please call my son”
- “Send a text message to Otto. I’ll be two hours late today”
- “Please call me a taxi”

Functionalities within ALFRED, such as providing navigation instructions and sending text messages, will be provided by apps that may be developed by third parties. To this end, connections between phrases spoken by the user and app functionalities will need to be provided by app developers, according to a well-defined formalism. The formal structure of such mappings will be addressed within this pillar, as well as their implementation in the ALFRED app. This essentially means that any kind of voice-enabled functionality may potentially be added to ALFRED.

In addition to supporting specific use cases provided by the core platform and third-party apps, ALFRED will also have more general interaction capabilities. Most importantly, ALFRED will learn from the communication with users and improve its quality with every interaction. For example, the phrase “please call my son” may not be answered by ALFRED at the first time unless ALFRED knows who the son of the user is already.

ALFRED will therefore ask a follow-up question in order to get this information and it will remember the answer for future usage:

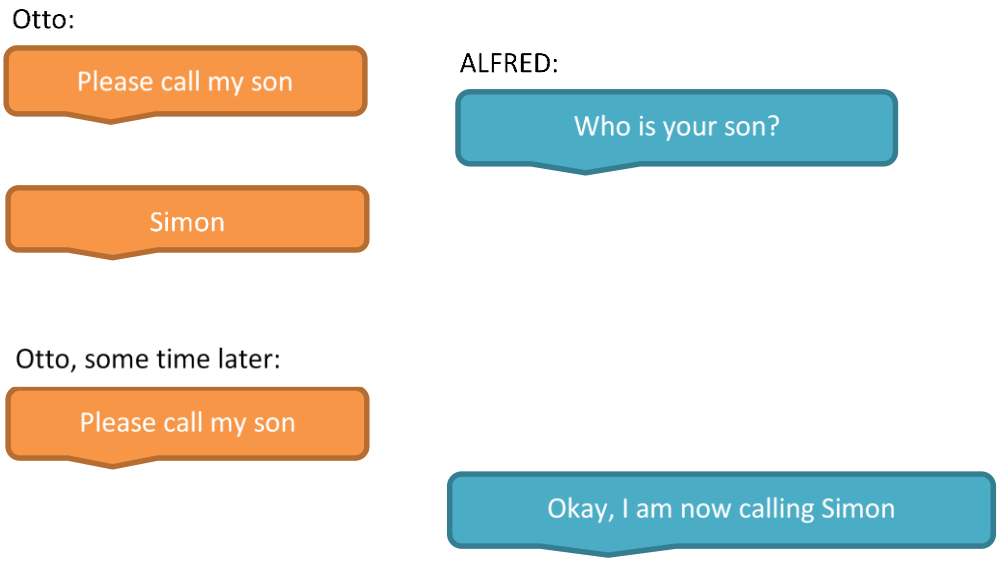

Figure 1: Voice interaction – example of follow-up question and self-improvement

In addition to learning things about the user, ALFRED will also improve its capability to hear and understand what the user says. Automatic speech recognition is a technology which is prone to errors, and dialogue systems need to be able to deal with uncertainties stemming from failed or weak speech recognitions.

In the ALFRED project, this challenge might be even larger than normally as speech recognizers are not adapted for older users. To meet this challenge, several strategies will be developed and explored during the ALFRED project:

- Fast and detailed feedback from the system
- Support for correcting the system
- Self-improvement based on usage history

The first two strategies – feedback and correction – enable the user to quickly detect ALFRED's potential misunderstands and to correct them. Using the third strategy, ALRED learns from its mistakes. ALFRED will also improve its capability to understand what the user says by identifying usage patterns. More specifically, it will inspect all the possible hypotheses returned by the automatic speech recognizer at any given time, and reconsider their likeliness in the light of ALFRED's knowledge about the user. For example, if Otto commonly calls his son during the weekend, ALFRED will be more likely to hear "call my son" at those times, than potential competing recognitions such as "call my grandson". For a more detailed look at strategies related to speech recognition, see section 4.2.

Finally, this pillar will also contribute to the ALFRED concept by supporting some specific basic use cases. Concretely, the pillar will provide five focused and practical apps, such as an app for sending text messages or interacting with the user's calendar. The selected apps will be strongly oriented to the real world. The focus groups with older persons will help to define new and innovative apps that respond to older persons' needs in a practical

sense. These apps will manifest a proof-of-concept of the general interaction capabilities provided by this pillar, as well as paving the way for further apps and use cases to be integrated into the ALFRED platform.

3.2 Personalized Social Inclusion

In order to foster active participation in society for the ageing population, the ALFRED platform will provide tools to suggest and to manage events and social contacts. The services to provide such functionalities to the ALFRED platform are the second pillar of the ALFRED project.

The ALFRED project intends to provide close interpersonal, meaningful, and positive social relationships and contexts to older people in the society as they age, preventing their societal exclusion. The ALFRED platform revolves around connecting users with events. The user of the ALFRED app participates in discussions, shares experience and information and tends his or her relationships. ALFRED will allow users to connect to each other in order to consider the personal social network of a user when recommending events.

The ALFRED app aims to stimulate and prolong their independent and active living in an environment through an advancement in older people social interaction, thus contributing positively to their wellbeing. Older people are often in a situation where they do not actively participate in society. There are plenty of reasons for this process: Friends may have died or their health condition may not allow them to perform specific hobbies anymore. ALFRED aims to foster active participation in society for the older people as they age, preventing or reducing the risk of psychological deterioration and societal exclusion.

Based on the user profile and preferences, incentives will be part of the ALFRED app and will be developed to stimulate the elderly to retain interest in making use of the ALFRED services. During the focus group session participants will be asked to think of new and innovative incentives that can stimulate older people to participate actively in society. For example, an incentive could be linked to user's interaction with ALFRED apps; it could be based on the count of previous events attended by users. The user who attended all or most events suggested by ALFRED apps can be rewarded.

Intelligent decision making techniques on current context and past activities will be used for the incentives creation. Remote training will be provided by developing intelligent explanation generation systems which, through specialized user interfaces, will help the elderly to make use of the serious games in the ALFRED app. Historical data regarding user behaviour will be used for the identification of changes in the older people. Daily activities, recorded as the user ages, will trigger an evaluation of her physical status and related adaptation of the provided services. Adaptive user profiling techniques, such as considering user feedback, the user's preferences and history data, will be used to send an invite for an event or a social gathering.

ALFRED will foster the inclusion of older people by re-integrating them into social activities. For finding the right suggestions to the user, ALFRED will start by creating the profile of the users and the social context. This will be done based on popularity, tags, temporal patterns, weather, location and hobbies. Users will be asked questions at the first time ALFRED is started and it may be extended via the apps from the ALFRED marketplace.

Based on this information, ALFRED will start talking to the user from time to time and will focus to find events and activities that can be of interest and integrated into the person's normal routine with minimum disruption like:

- Suggest events to ALFRED users based on their preferences and other details like hobbies, location, patterns and history of events attended
- Reminder for appointments, important phone numbers and things to do
- Suggest (serious) games to be played now or later, alone or together with others

For realizing the event recommendation, the ALFRED platform will provide two data sources. Firstly, data mining techniques will be used to extract information from the ALFRED cloud storage and transform it into an understandable structure for further use. Secondly, events may be manually entered using the web UI of the ALFRED Platform. This will allow organizers to add own events. For example, an organization may publish that they are creating a swimming course or an evening get-together. The web UI will also allow the maintenance, update and deletion of event entries that have been mined.

The ALFRED project will encourage and support active participation, communication, mutual assistance and self-management of the older people, promoting seamless connection and interaction of different people from all ages at any time and any place. The ALFRED app will increase the social activities for older people and it will add up to their sense of independence and thereby bolster their confidence.

ALFRED will make use of an integrated event database and will have mining functionality for collecting and sending new event information.

3.3 Effective & Personalized Care

In order to achieve an improved care process, vital signs will be accessible for carers and other medical staff. In addition, alerts can be sent in case of emergencies. The data is collected using unobtrusive wearable sensors monitoring the vital signs of older people. The services to provide such functionalities to the ALFRED platform are the third pillar of the ALFRED project.

The aim of this pillar is to provide services to monitor the health status of a user, by having different sensors embedded in textile. The use of these sensors will permit carers, relatives and doctors to follow the health status of the user. All the data collected by the sensors will be provided as a service to the ALFRED platform.

Different user profiles will be defined in order for the ALFRED platform to focus its provided health care services to their concrete needs. These profiles will help to manage the data from the sensors in an efficient way.

Once the profiles are defined, different apps will be created to collect data from the health sensors and present the results graphically to the user and carers. Additionally, a combination of sensors will be established for each user’s profile depending on the pathology. A set up of sensors and app configurations will be established for each user’s profile.

The solution proposed will be a set of sensors, which are integrated and embedded in textiles, using smart fabrics and intelligent textiles. These sensors will monitor: temperature, pulse and heart rate, breathing, skin impedance and body posture. This will help to have an early detection of heart attacks, falls, apnea, flu, among other issues. All sensors selected will be implemented into the garment by embroidery with conductive yarns. The sensors will be completely washable or otherwise easily removable, implemented into the garment with snaps. The following sensors will be used:

- **Temperature sensor:** Chosen for this application will be standard thermistors, having an accuracy of ±0.02ºC and a resolution of 0.01ºC. The temperature sensor will be embroidered near the armpit for a good data acquisition.
- **Pulse and heart rate sensor**: For the present case, it will be necessary to use a yarn with capacity to acquire the electrical signals of the heart of the user. It is considered that the most suitable yarn will be a polyamide yarn coated with silver which has excellent electrical conductivity properties. The best results with these electrodes can be expected when they are embroidered at the upper chest.
- **Breathing sensor**: The detection system is intended to be based on the record of the variation of the intrinsic electrical resistance of the tissue, due to the elongation experienced by the conductive yarns of the garment, caused by human breathing mechanism, as a result of the volume increase and decrease experienced in the chest area.
- **Skin Impedance/Conductivity Sensor**: Through the integration of textile sensors capable of measuring galvanic skin resistance (GSR, Galvanic Skin Response) will obtain information useful to determine the stress level of the users. The stress detection system proposed will be able to respond in real time and able to detect a degree of stress, which is far beyond current systems where the stress detection is only considered as a level classifier.
- **Extremities position and body posture sensors**: Accelerometers will be used to monitor the user body posture. Through the use of these accelerometers the position with regard to the three axes (x, y, z) of different parts of the body could be monitor. The analysis and processing of this data will give information about the user posture.

The third pillar of ALFRED will mainly focus on the hospital and health care process in order to achieve Effective & Personalized Care.

The ALFRED platform may detect abnormalities automatically and will send an alert to the carer, e.g. to a medical staff of a hospital. The ALFRED app will send this data in encrypted format to the storage (see chapter 4.3) and will allow trusted persons to access it.

3.4 Physical & Cognitive Impairments Prevention

As pointed out in chapter 2.1, ALFRED's core users will be older people above the age of 60. While some persons suffer greatly from aging and eventually lose their independence, others are able to lead fulfilling lives even in old ages. Some of the factors that determine the severity of the effects of aging are non-influenceable, such as a person's genetic predisposition, but it is known that an active and healthy lifestyle is always likely to be beneficial. For instance, both mild physical activity [LCF+08] and frequently carrying out

intellectually demanding tasks [HHS+99] may reduce cognitive decline. In this regard, the fourth pillar of ALFRED focuses on mechanisms that motivate regular physical and/or cognitive activities in order to help reduce the effects of aging on the system's user(s), and ALFRED does this by way of so-called "serious games".

Generally speaking, serious games use game mechanics to motivate the user to perform a task that she would otherwise consider dull or tedious, such as learning or working out. Scientific studies have shown the positive effects of such games regarding short-term motivation and long-term behaviour changes [BBT+08]. Depending on the intended effect, serious games can be grouped into categories, such as learning and puzzle games or exergames. The latter term denotes games that require physical activity in order to be played, and there are examples for both stationary exergames played at home and examples for mobile exergames that run on a smartphone or another mobile device. A well-known stationary exergame is Nintendo's *Wii Fit*, and evaluation studies have shown that playing this game increases the perceived sense of physical, social, and psychological wellbeing of older users [WMS+10].

Many games, and especially serious games, are designed to be played by a single player only, although it is known that playing with – or against – other players both trains social skills and increases motivation [Reu13]. The reason why many new games are nevertheless designed for a single player only is that good and entertaining multiplayer games are significantly harder to create, both technically and design-wise. For example, one additional design decision that affects the gameplay of multiplayer games is the question of whether the gameplay should be synchronous or asynchronous. In synchronous games, all participating players are playing the game at the same time, usually on different devices, while in asynchronous games they take turns to play the game.

In order to both foster the social interaction of ALFRED users and to increase their motivation for playing the serious games provided, some of these games will feature multiplayer elements to allow players to play and compete with other users of the ALFRED system, thus contributing to their social inclusion [SBL+13]. These multiplayer elements may be both synchronous game mechanics and asynchronous game elements, such as leader boards, performance comparisons, and a bonus/achievement system meant to provide for a long-term motivation and sense of accomplishment [Yee06]. To this end, the fourth pillar will resort to the components provided by the second pillar ("Personalized Social Inclusion") to acquire information on the player's social relations and the availability of possible co-players.

4 Theoretical Structure – ALFRED Framework

The ALFRED framework is the functional and technological environment of collaboration that will be built by the contributing partners during the project. The objective to be achieved is a whole functional and services platform that forms the ALFRED foundation. These foundations will support the partners during the project development, and also be beneficial to the future developers of apps for older people that adopt ALFRED as their development platform.

The ALFRED framework will be based on the following main modules:

- **Knowledge and Information Storage**: This is the component for storing and receiving information within the project. This module will be responsible to provide storage information and compiled knowledge to any other framework components, or third parts.
- **Context-Aware Speech Recognition**: The module will implement the main user interface for the assistant through a spoken dialogue system with the users. This interface will be integrated into the pilot apps, and it will be possible to incorporate it into future apps.
- **Personalization and Data Mining:** This module will allow to define properties for each user and to relate them to each other based on a personal profile. This functionality will be used to propose suggestions or recommendations to the user, according to his or her characteristics or preferences, and will be complemented by the user answers too.
- **Game Manager:** This is the central component for all serious game related tasks. It will provide services around the usage of serious games, e.g. to start, stop and resume a game.
- **The Marketplace:** Targets external app developers and ALFRED users. This module will provide a set of documents, guidelines and code examples for developers showing them how to create apps that run inside the mobile assistant. It will also contribute a specific marketplace for apps based on the ALFRED framework.

Each main module will provide the interfaces needed to communicate with it and to grant access of its full functionality to the rest of the framework components and external app developers. The app developers working within the ALFRED framework will only have to implement the specific characteristics of their apps. The general functionalities which are described above are solved by the ALFRED framework.

4.1 Knowledge and Information Storage

The *Knowledge and Information Storage* is one of the core services of the ALFRED framework. Other ALFRED services and apps of the ALFREDO platform depend on the ability to easily and quickly access the latest, most relevant and consistent data and information content (in various formats such as documents, databases, multimedia, etc.) in order to acquire critical knowledge. The technologies and tools used will contribute to the effective storage, codification and archiving of knowledge.

The storage system which will be used to store ALFRED's data has to satisfy the following requirements:

- To keep sensitive data private and to prevent access by ALFRED stakeholders which should not have access to patient related data
- To be sufficiently performant in fetching required data out of large amounts of data collected from different sources
- To reliably maintain user-specific information and properties and their relationship to each other

In order to meet the first requirement, it is necessary to keep the data of a patient separated from the data of other patients so that every stakeholder (including external persons and systems) only has access to the data storage of its own user. The owner of such data storages (called data buckets) can grant access to their data to other stakeholders explicitly. Data buckets are storage areas dedicated to individual users, preventing unwanted leakage of data across users.

The second requirement can be met by using cloud storage data systems. The benefits of cloud storage are:

- **Easily extendible storage capacity**: Additional cloud storage can be booked instead of buying new hardware.
- **Large amount of redundancy**: Cloud storage systems can provide much more redundancy at comparatively low cost. This is important in order to provide reliable data management for ALFRED.
- **Lower costs**: Due to the fact that hardware will be maintained by the storage provider the costs of cloud data storage is usually less than hosting data in an own data centre with appropriate redundancy and bandwith.

Thirdly, an ontology for invidividual user profiles needs to be provided. It should be able to represent various user-related information, for instance data related to social activities and communication between users. A user's personal profile can become complex and therefore has to be flexible. Cloud storage using data buckets can be used to store information without a fix structure (such as relational database systems or semantic repositories). This will simplify the creation of new relations between stored information (e.g., the daughter's telephone number which ALFRED does not know at the beginning but can be assigned dynamically when needed). A lot of information provided by several users from different activities will be stored in the ALFRED storage. From this information, the ALFRED app will need to know for example, who tagged which resources or when a specific information is shared. This could be a difficult task if the content is not organized and categorized.

4.2 Context-aware Speech Recognition

Automatic Speech Recognition (ASR) for older people is going to be a challenge in the ALFRED project. Already for people who are skilled and experienced in the use of modern information technology, the use of automatic speech recognition can be troublesome. To let older people with little experience of modern IT use it may lead to interesting challenges. Voice quality, pauses, speed etc. are likely to influence the quality of the results that the ASR delivers.

One obvious solution to the problem would be to develop a new speech recogniser specialised for older users. This is however a large and expensive task which is well out of the scope of the ALFRED project (see section 6.3). Instead, the project will try to make the best use of existing ASR technologies by applying relevant post processing, dialogue management and language modelling. The following strategies will be explored:

- Interactive and incremental grounding
- Re-ranking of ASR hypotheses
- Language model optimization

A more detailed discussion about these strategies follows below.

4.2.1 Interactive and Incremental Grounding

Grounding is the consolidation process of all participants in a dialogue on what has been said in the dialogue and what it meant. The grounding process can be said to follow a protocol. Messages used in the grounding protocol are often referred to as feedback, and can consist of a range of expressions from continued attention via gestures, short utterances (“hmm”, “okay”, “pardon”) all the way to reformulations of the latest utterance.

Dialogue systems typically deal with input and output on the level of utterances. First, a complete utterance is recognised. Then, the utterance is parsed, the interpretation of the complete utterance is sent to the dialogue manager, and so on. Feedback from the system is thus given after the whole user utterance has been uttered, recognised, interpreted and processed by the dialogue manager.

This can be seen in to contrast to how humans perform grounding. Grounding among humans is a process that occurs incrementally and in parallel to the other dialogue functions. Positive feedback can be emitted in parallel to other utterances, while negative feedback can interrupt any utterance. The listener rarely waits until the speaker has finished her utterance before providing her with feedback.

The human grounding protocol seems to be more efficient than the de-facto standard dialogue system protocol, and it is likely that users would benefit from a more elaborate grounding system. Improved grounding behaviour can be expected to alleviate some of the disturbances arising from weak speech recognitions.

During the ALFRED project, such increment grounding capabilities will be used, by incremental features of existing modern speech recognisers in the speech recognition phase. Additionally, a grounding protocol with support for incremental feedback will also be explored. This service will be provided transparent to the ALFRED platform by the ALFRED framework.

4.2.2 Re-ranking of ASR Hypotheses

ASR units typically output speech recognitions in the form of so called n-best lists, containing multiple hypotheses about what the user has said. In this list, each hypothesis is assigned a confidence score. In most dialogue systems, the top ranked hypothesis – the one with the highest score – is assumed by the system to be the most correct. However, this assumption is not always correct. Research suggests that though the correct recognition can often be found in the top hypotheses provided by the ASR, the correct recognition is not necessarily the one with the highest score. It is also suggested that

humans have the ability to select the correct hypothesis from a list given some extra contextual information (recent dialogue history, activity etc.).

The most straightforward way of re-ranking n-best lists uses exactly such contextual information. For example, recent dialogue history may favour selecting the second recognition in the n-best list, rather than the first, if the second makes more sense in the dialogue context.

In the ALFRED project, this idea will be extended further by applying machine learning approaches. Knowledge about usage patterns will be used to favour recognitions that fit what the system knows about the user. The acquired user model will be capable of answering questions like “When uttered at this location at this time, what does this utterance usually mean?” or “Who does the user usually want to call at this time of the day?”. This kind of individualized re-ranking of ASR hypotheses has the potential to improve accuracy and prevent misrecognitions.

4.2.3 Language Model Optimization

Many ASR units employ a wide language model, trying to cover a maximum range of possible utterances from the user. Such dictation oriented speech recognition typically has a statistical base in observed language use. Optionally, some ASRs can be fed a domain-specific language model, narrowing the range of utterances that the ASR can hear to a pre-determined list of words and/or grammatical rules. This improves recognition accuracy for utterances within the language model, at the expense of coverage for utterances outside of the language model. Finally, it is also conceivable to employ a hybrid approach, combining a domain-specific recognizer to achieve high accuracy for expectable phrases, and a wide, statistical recognizer for less expected words and utterances.

With either of the approaches, there is no guarantee that phrases uttered by the user are covered by the language model. For instance, if the user refers to a person by name, and the name is not in the language model, the ASR will hear something else. In such cases, language model optimization can be used to learn words from the user. For instance, if the user says “call Irena” but ALFRED hears “call Irene A”, the user may correct ALFRED by saying “No, I said ‘call Irena’”. In this case, the system backtracks and offers alternative interpretations, letting the user choose the correct one. The system then incorporates this new knowledge into the language model.

By dynamically adapting the language model to the user and letting the model reflect the actual language use of the user, the ASR performance and coverage is expected to increase. In ALFRED, this idea will be explored as a means to address potential problems with failed recognitions.

4.3 Personalization and Data Mining

4.3.1 Data Mining

In the course of the ALFRED project a large amount of data will be gathered. In order to analyse this data, sophisticated data mining processes and algorithms will be needed. The motivation behind the data analysis is to identify possible relations between new and existing information (e.g. a user’s hobby which could also be the hobby of some of the

user's friends). ALFRED will therefore interact with several third party data sources (e.g., social platforms, event web sites, etc.).

This data mining mechanism will be realised as a separate component that offers itself as a service which can be used by other framework components and third party apps. For example: the game manager component (see section 4.4) could call the data mining component to search for games one of the user's friend likes to play in order to encourage the user to play this game as well. Another example: An event app wants to look for events provided nearby the user's home location which may be of interest and suggests the user to participate (perhaps because one of the user's friend takes part of this event, too).

To be able to retrieve valid information from the data sources, it is necessary to store the data in a systematic manner.

The core process of data mining can be described as follows (source: Wikipedia[1]):

- Focus: collect new data as well as already know information
- Pre-processing: integrate all sources and clean up the data (for example by removing incomplete sets of data)
- Transformation: transform the data into formats suitable for analysing processes
- Data Mining: perform analysing steps
- Evaluation: perform operations depending on the analysis results

The task of the data mining can be described as reducing a diverse range of data into a compact and structured form, without losing any relevant information. For example, the ALFRED app will suggest to the user to join his or her friend's activities. To achieve this, the ALFRED platform retrieves information from different kind of sources (friends' activities and events, the user's preferences, etc.) and assembles them in a compact representation, without losing any detail. Some data may be collected from websites (web mining).

The whole work of setting the right parameters for data requests and transforming the result into a useful format will be encapsulated by a component described above. This will keep the effort the caller has to generate as small as possible.

4.3.2 Personalization

User-specific information within the ALFRED platform will be handled by a personalization component. This framework will encapsulate every access from any stakeholder to any user information.

The user's personal profile will contain information about her hobbies, any physical restrictions and her social context. Social information can relate to events taking place nearby the user (e.g. swimming courses), events which a user's friend participates in (e.g. that Claire takes part in a Bingo event) or decisions the user made earlier.

To achieve this goal the personalization component uses the data mining services to retrieve event data, analyse it and combine it with other user profiles such as the user's friends (e.g. to be able to tell Jane that her friend Claire participates in the Bingo event tonight).

[1] http://en.wikipedia.org/wiki/Data_mining

In the course of the ALFRED project, the ALFRED app will be able to create a personalized profile of what the user likes to do (hobbies), games she likes to play or events the user has chosen to participate in because friends of her participated as well. This personalized profile will allow all components of the ALFRED platform to better adapt to the specific user.

4.4 The Game Manager

Within the fourth pillar of ALFRED, at least five serious games for physical and cognitive impairment prevention will be developed, including both stationary and mobile exergames (exercise games, controlled by/encouraging physical movements). The connection between these games and the ALFRED application will be provided by a component called Game Manager. Whenever ALFRED finds that it is time for a game, it suggests this to the user. If the user agrees to play a game, then the Game Manager component is launched and depending on various criteria such as the time of day, the user's location, and her gaming history, the Game Manager selects and starts the best suited game from the list of currently available games. As older people enormously differ in their mental and motor capabilities, not only the game selection process but also the games themselves should take these varying types of players into account. To this end, the Game Manager is capable of configuring the games to a certain degree, for instance, by setting the time given to the player for solving specific tasks. Additionally, the Game Manager will also monitor the gameplay and use this information to both refine the game selection and adaptation process in future gaming sessions and to store it for later analysis, similar to the data gathered by the wearable sensors (see section 4.1). The following figure shows the interdependencies of the Game Manager component.

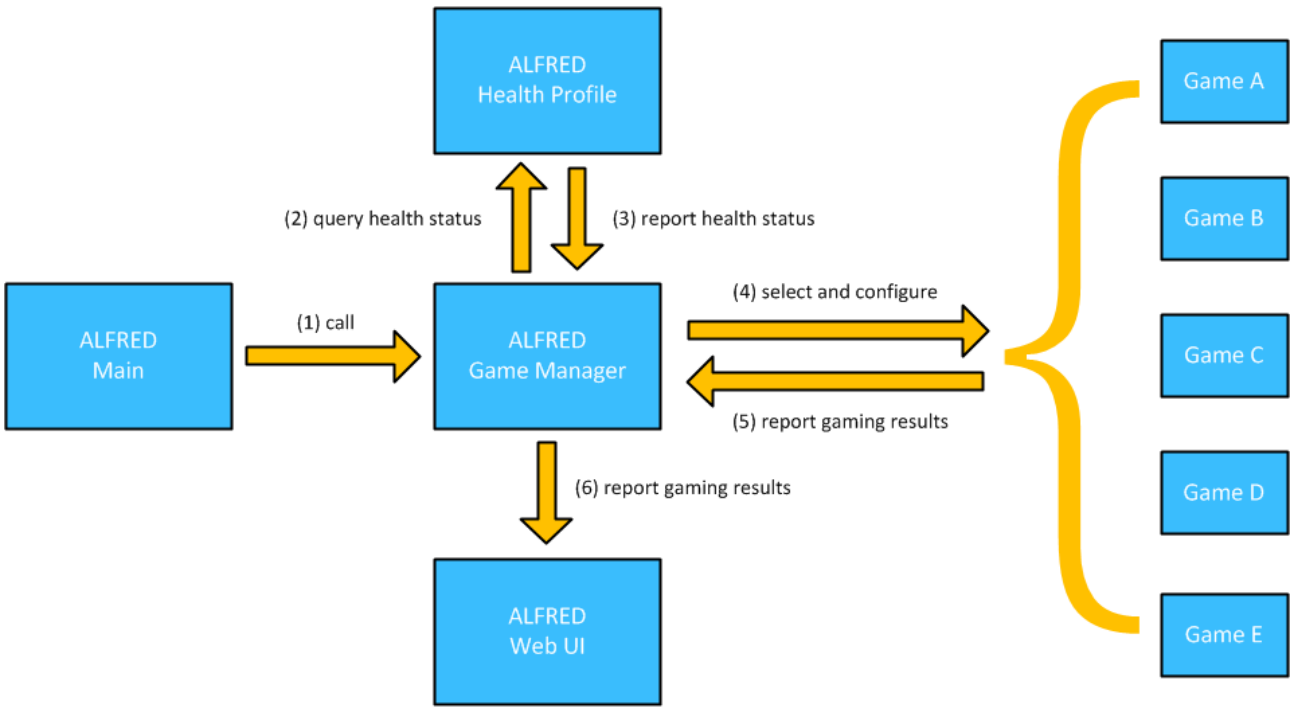

Figure 2: Interfaces of the Game Manager component

4.5 The Marketplace

As extending the ALFRED app with applications from third party developers is an essential goal of the ALFRED project, it is necessary to provide a mechanism for deploying and updating apps. The platform dedicated to offer such mechanisms will be called ALFREDO.

The ALFREDO implementation is scheduled for three phases.

4.5.1 First Phase

One first version of ALFREDO will be developed as a private marketplace to be used by the partners of the project consortium. It will consist of a component (as a part of the ALFRED app) and a website for managing and testing the mobile apps of ALFRED.

ALFREDO is designed to facilitate app distribution and their management. It will allow the delivery of mobile applications after following an approval process (similar procedure as already know from the Apple App Store).

The approval process is designed as shown in Figure 3.

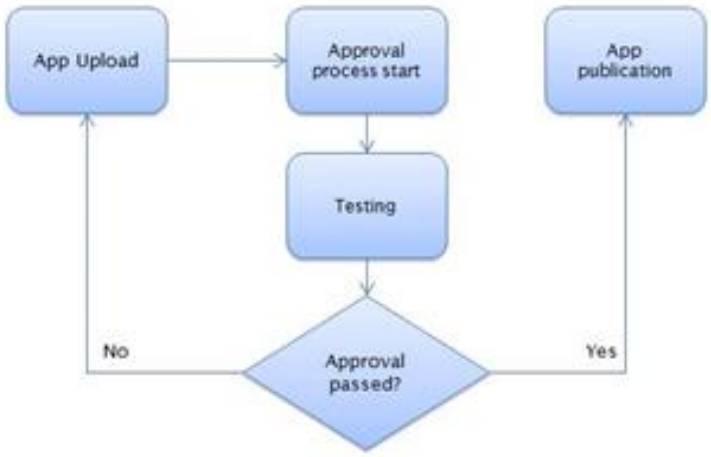

Figure 3: Approval Process in the Marketplace

ALFREDO comes with a web based management console which allows the management of mobile applications. Using this management console, it will be possible to pass through the approval process, to upload binaries, to define test scenarios, and to approve / decline the app and finally publishing it.

Apps will be provided with some metadata and some media information. This information has to be provided by the developer of the app. The web based management console will be used by the following user groups:

- **Developer:** This is the application author. The developer can upload new apps and updates.
- **Approver**: will be responsible for approving the application.
- **Tester:** has access to app submitting tools and also to approval test tools. Test applications and forwards the comments to Approver
- **Administrator:** this will be the typical super user role with ability to reproduce any other role and take care of security and role assignment. Can see all data without any content filter.

Users of the Approver group can define test cases through the approval process. These test cases can be assigned to a specific app and specific testers. Each test can be marked as “passed” or “not passed”. Depending on the test results, the Approver has to notify the test results to the Developer. Even if all tests have been passed, the Approver can still deny the publication of the app.

The approval process may also contain pre-defined checklists containing steps to check for each application tested by the Tester. For testing application specific functionalities Developers have to provide application specific testing plans.

Like common market places, such as the Goole Play Store or the Apple App Store, ALFREDO will provide the ability to search for apps by words or browse through the available apps grouped by categories. It will also show all apps the user has downloaded.

Users will also have the ability to read comments and ratings from other users or even contribute own comments. These comments can be seen from within the management console (e.g. to give feedback to Developers).

4.5.2 Second Phase

The objective for the second phase of ALFRED development is to extend the website functionality, make the marketplace public for showing the catalogue of ALFRED apps and offering public areas for experts and developers.

The public web will show the available apps in ALFREDO, with a short description for each app and a score given by the users and experts as well as their opinions and comments.

ALFREDO will offer an area especially for experts with an option to register online. These experts will be involved in the development of mobile apps or in the care of the older people. Their collaboration will contribute to the improvement of the apps and will encourage the ALFREDO utilization.

In this phase of ALFREDO, a development area will be incorporated. The developers interested in ALFRED collaboration will have an online register option. After their registration, they will have access to the guidelines and documentation of ALFRED development.

In order to give developers a basic understanding of how to integrate their applications into the ALFRED app, the ALFRED project will provide aiding material such as code snippets, tutorials, code templates and descriptions of the application programming interface (API).

The ALFRED project may encourage third party developers to extend their application repertoire and open up to new business areas (particularly with regards to the ability to apply their own pricing and licensing models).

4.5.3 Third Phase

The goal of the third phase is for ALFREDO to become the reference website for mobile apps regarding older people.

The future evolution of ALFREDO should include the monetizing of the apps stored within the marketplace. Some payment services should be implemented and integrated with ALFREDO.

In this phase it will be considered to integrate ALFRED with other commercial marketplaces as well as with social networks.

5 Older Persons and ALFRED

The ALFRED platform will be developed with the active contribution of older persons as primary target end user group of the ALFRED approach. This means that older people will be involved throughout the entire project and will have an active role in the (user-centred) development during the ALFRED project, where the concept will be transformed into concrete functionalities. Instead of having a technology push, where advanced solutions are developed that cannot find their way to the market, this project aims to foster a market pull, where (lead) users express their needs and ideas in the framework of our concept. These needs and ideas will be used as a basis to perform further research and technological development. Different methods and end users will be involved at different stages of the project. A total of three pilots will be organized to validate the results of the different pillars, complementing each other.

The following sections will describe the methods for end-user involvement and the three pilots in WP2 and WP8.

5.1 User Requirements - Focus Groups

Focus groups will be created at the beginning of the project. These focus groups will help to further develop the initial ALFRED concept and scope the specific needs of older end users.

The end-user organizations have divided the ALFRED pillars according to their expertise in order to increase the focus of the end user involvement. Each focus group session will discuss one pillar. The following table shows what pillar each organization focuses on.

Table 1: Focus Groups for the Pilots and the Involved Organization

Organisation	ALFRED pillar	ALFRED pillar
NFE	Pillar 1	Pillar 2
CHU	Pillar 3	Pillar 4 (in the perspective of rehabilitation)
ESE	Pillar 1	Pillar 4 (in the perspective of prevention)

A total of six focus groups will be organized. The focus groups will consist of five to six older persons or stakeholders. This is considered an adequate amount, where everybody will actively participate. The group size is manageable for a good discussion and brainstorm.

The persons that participate in the focus groups are the so called ‘lead users’. Lead users are persons who are ahead of the majority in their ideas and in their needs. Many lead users are innovators, as they develop their own business to cover their needs [Hip86]. Among older persons there are also many creative minds that can have a good grasp on the ALFRED objectives from their own needs and can help to further define the ALFRED concept with their ideas and needs.

Hence lead users are partly the target group, as described in section 2, but they go beyond the target group as they can envision the larger scope of the project.

The partners will define for each pillar a question for an innovative solution in relation to the objectives of the pillar. The participants will then think of innovative solutions, using different methods, e.g. brain writing, Walt Disney method, brain storming, role playing, etc. The result of this discussion will be innovative ideas for ALFRED, based on older people's needs.

In the second half of the meeting the participants will be asked to develop a prototype of the idea. This will mainly be achieved through sketches and building blocks. These sketches and building blocks can serve as specific input for AFLRED apps.

The results of the focus groups will be transcribed and categorized. Each statement of the categorization process is one user story, which can be used by the technical partners.

Participants will be extensively informed on the project objectives and made known that they can leave the meeting at any time. They are asked to sign an informed consent. The focus groups will be filmed as much as possible. Outcomes will be used for the user stories.

5.2 The Pilots

ALFRED will realize three different pilots to perform user driven innovation and validate technological results. The pilots are composed of a usability driven use case, a hospital driven use case and a use case performed by associations for elderly people. During the ALFRED project not just prototypes within artificial use cases will be produced. Instead it will accompany the prototypes with three very practical pilots that start very early in the project.

Each pilot will consist of different steps: (i) The piloting of the current ALFRED prototype and (ii) the validation of the results by collecting feedback and providing it to the consortium.

Please note that each pilot will perform more than just user interviews and trials. It will also create everything that is needed for the pilot. More precisely, this means that the pilots will create pilot specific apps in close collaboration with the app building tasks of the work packages, namely 4.5, 5.5, 6.5 and 7.4. While WP4-7 will concentrate on the core technical aspects of the app development, the WP8 activities will concentrate on providing the pilot specific data and the logic as well as the app conceptualization and all other elements that go beyond the pure build and deployment process.

Pilots of ALFRED will be performed in different EU member states. The first pilot will be performed in the Netherlands, the second one in Germany and the third one in France. It can, however, not be expected from elderly people to speak or understand proper English in call cases. As such, each prototype will start with a localization of the project results. This localization will include the translation of apps and component elements into different languages but it will also include the adaptation of other cultural environments such as units or time zones. Each pilot contains one or more technical partners which will support this adaptation process from a technical level.

Finally, it should be noted that some countries may require certifications for bringing ALFRED to the market, such as the German *Medizinproduktgesetz* (MPG, Medical Product Law). Although this will happen during the commercialization, the exploitation plan

of T9.1 and also the use case preparation of T8.1 will consider this and discuss steps that may be necessary to prepare the market introduction of ALFRED.

5.3 Pilot – Individual Usability

This pilot will focus on optimizing the usability and user interaction of the ALFRED target group (see section 2). This pilot will focus on:

- Pillar I: User-Driven Interaction Assistant
- Pillar II: Personalized Social Inclusion

In order to avoid unnecessary costs in technological development, the study will start early, using the mock-ups created in month 12 from Task 2.5 to test with older persons. This way, any user interaction issues can be identified and solved in an early stage, avoiding unnecessary development costs and making sure that the applications can be used well by the end-users.

From month 12 the usability tests will run iteratively on all the different prototypes that come out in Pillar I and Pillar II. The prototypes range from low-fidelity prototypes, such as mock-ups, up to high-fidelity prototypes and the final apps.

The usability tests will consist of short iterative cycles of tests with five users. According to usability theories, with five users, more than 80% of the usability problems can already be eliminated [Nie00]. The usability tests contain five steps as described in the following sections.

5.3.1 Workbook

A set of tasks will be defined in the prototypes. These tasks will be explained in a workbook. The user will work in a controlled environment from the workbook and perform the tasks independently. The observer will interrupt as little as possible.

5.3.2 Think Aloud

The participants will be asked to think aloud during the tests. This way their intentions are clear, telling what they expect from every interaction. This will make it easier for the observer to encounter the problems. Things to look out for include:

- Navigational problems:
  - What did the participants do?
  - What did they expect the system to do after their action?
  - Do they understand what part of the services they are in right now?
- Functional problems:
  - Do they realize what a certain element does?
  - What do the participants expect to happen when doing certain actions?
  - Are they able to use functions without any problems?
  - Do they understand what certain functions do / mean?

The encountered usability problems will be reported back to the technical partners together with the ASQ results (see section 5.3.3).

5.3.3 Questionnaires

After each task, the user will fill in an After Scenario Questionnaire (ASQ) to measure different aspects of usability [Nie00]. The resulting scores can take values between 1 and 7, with lower scores indicating a higher degree of satisfaction. This survey belongs to the family of Standardized Usability Questionnaires [SLe12]. These scores will be reported back to the technical partners together with the usability problems.

5.3.4 Back-up Material

As back-up material, videos may be compiled to demonstrate the main usability errors. This film material will show the interaction, with the explicit consent of the participant. The film material will be used in accordance with privacy rules and ethical regulations.

Additionally technical partners will be invited to assist to the tests with participants.

5.3.5 Final Validation

The final validation study in this task will take the form of a pilot study with ten end users in two phases with the final prototypes. This validation study is focused on the impact of ALFRED Pillar I and II on the activities of daily living of older people. The validation will start with the definition of SMART (Specific, Measurable, Attainable, Relevant and Time bound) goals in order to define the impact expected of ALFRED.

The test subjects will be asked to keep a diary about the experiences related to the ALFRED prototype testing period. The advantage of this method is that it diminishes memory errors which may occur in retrospective interviews, and it helps to better understand the life world of the test subjects and the impact on this life world. Diaries can be used as an independent data collection method or combined with other methods.

Based on the diary, a questionnaire and the SMART goals, the impact of ALFRED on the social inclusion of older people can be measured.

5.4 Pilot – Hospital Environment

The second pilot will do pilot tests with elderly people within a clinical environment involving patients and their carers from project month 26 onwards within a non-medical device trial. This pilot will be performed by the Geriatrics Research Group of the Charité-Universitätsmedizin Berlin.

In contrast to the pilot of task 8.2, this pilot will be performed in a clinical environment with a larger group of people and it will focus on different aspects of ALFRED. Task 8.2 will mainly focus on the social interaction with elderly people meaning that it will focus on the usability aspects on the one hand and the day-to-day usage in a small group for e.g. event recommendation of WP5 or for validating the question-answer elements of WP4. In contrast to this, task 8.3 will focus on the well-being or health conditions of elderly people and will therefore focus on testing the other two pillars: The effective and personalized support of elderly and the physical and cognitive impairments prevention with serious games.

The pilot will be performed by the staff of the German Charité hospital and start with the health profile definition for a validation group. Afterwards, a set of non-medical health

sensor values will be measured over a period of time and a set of anomaly reports will be simulated. Based on the health profile, serious games will be selected and tested by the users within the course of the pilot.

ALFRED pillars that will be tested in this pilot:

- Pillar III: Effective & Personalized Care
- Pillar IV: Serious Games for Physical & Cognitive Impairments Prevention

5.5 Pilot – Day-to-Day Usage

The third pilot will even go beyond this point and apply ALFRED in day-to-day situations within an association for elderly people from project month 29 onwards and will be performed by the E-Seniors association. The following ALFRED pillars will be tested in this pilot:

- Pillar I: User-Driven Interaction Assistant
- Pillar IV: Serious Games for Physical & Cognitive Impairments Prevention

5.5.1 Goal of the Pilot

In contrast to the first two pilots, task 8.4 will be performed on a completely different level of piloting. The pilots of task 8.4 will not be performed by experts or medical staff or trained seniors. Instead, those pilots will be performed by "normal" people from the E-Seniors association.

The older persons who will participate in the ALFRED pilot organized by the organisation are voluntary seniors from the association who are between 60 and 95 years old. The shared characteristic of all these test subjects is that they are still actively involved in the society and that they live in an autonomous way. Also these persons are in relatively good health state and they do not suffer from serious health problems. However, some of them take some medicines that treat age-related illnesses, such as high blood pressure, cholesterol, diabetes or osteoporosis.

This approach will allow ALFRED to get real-world feedback, especially in the first two pillars and it will allow ALFRED to identify usability issues in a very honest and direct way. Within the task, the stakeholders' impressions and experiences will be captured using different methods (i.e., surveys, focus groups and face-to-face interviews) to assess ALFRED main outcomes, especially in regards to the usability and usefulness of the software development environment, and perceived benefits in the form of its impact.

All the participants in the pilots will be trained for the use of ALFRED solution, so that they can test the solution in an independent way and in the real life environment. The prototype will be tested with a group of association's members who are eager to try out new technological devices.

Firstly (Pilot Step 1), the ALFRED will be tested by five individual users from the primary target group (i.e. the older persons of the association) in a day-to-day usage for a defined period. During the testing period, the test subjects are asked to keep a diary about their experiences related to the ALFRED prototype testing period, which will diminish the occurring memory errors in retrospective interviews. After the testing period of the prototype, all the test subjects will be surveyed in order to understand the usability and the

usefulness of ALFRED in a day-to-day usage. This phase will be documented and the results are shared among all the project partners.

After this, a group discussion will be organised with around 10 users where the prototype will be tested and discussed in a group. This session will gather the elderly who tested the ALFRED prototype in a real life environment for a defined period as well as some of their informal caregivers. The aim of this session is to enable the different target groups to share their experience in the usage of ALFRED and record the different reactions and point of views. This session (Pilot Step 2) will be recorded and transcribed and all the data will be shared with the project partners.

These mixed methods will enable to gather a wide range of the pilot users' perspectives as well as to verify the usability and usefulness of ALFRED among the different target groups.

5.5.2 Common Methods

All the test subjects that participate in the pilot step 1 will be following the common testing scheme guide in which details the services and functionalities of the ALFRED platform that are to be tested. The test subjects are trained briefly for the use of the prototype after which they will carry out tasks defined in the testing scheme. In case of dysfunctions, they will be supported by the test administrators. The common testing scheme details the data collection methods for the pilot phase. During pilot step 1, the test subjects are asked to keep a diary about their testing experience. After the pilot step 1, all the test subjects that participated in this phase will be surveyed in order to document their experience with the ALFRED prototype. The methodology of this survey will be detailed in the testing scheme guide. All the data provided by the test subject will be communicated to the ALFRED project partners.

Regarding the pilot step 2 (the focus group), E-Seniors will plan a structured session that will be recorded and documented for the ALFRED project partners.

6 Positioning

6.1 Business Opportunities and Objectives

As of today, the demographic change is leading to more and more challenges in the world and Europe is no exception. The aging of populations, accompanied by one of the lowest birth rates ever, is already having a significant impact in Europe as a society and as a leading player in the world's market. The future previsions are for this tendency to aggravate, with the share of the population aged 65 years and over rising from 17% in 2010 to 30% in 2060 (Eurostat Population Projections 2010-based EUROPOP2010: Methodology and results of a long-term scenario of demographic convergence).

To cope with the changes that will hit the top industry regions in Europe, it is essential to stay competitive. In addition, the actual economic crisis calls for innovative ways for solving these problems. The actual moment is definitely unique regarding its challenges but also regarding the new needs and business opportunities it creates.

An especially relevant issue is to give people tools for living healthier and independently for longer with an active participation in society. Far greater emphasis needs to be placed on a more proactive approach to medicine, with more active, better informed patients who are focused on disease prevention rather than on disease management. On top of that, older people are often facing social problems: their descendants are working full time and managing their own families, while many times their spouses and same generation friends are no longer alive. As a result, many older people are living alone.

Information and Communication Technologies (ICT) can be used to drive this change and facilitate healthcare, social care, remote management of older people in their own homes or anywhere else. The new model will facilitate and increase efficiency in the healthcare sector and will contribute to a more sustainable healthcare system.

The ALFRED project aims at providing solutions for these problems. ALFRED will foster this by providing an interactive assistant for older people. It will provide them with a personalized, digital butler and help them with challenges inside and outside home. The support of sensors (e.g. heart rate sensors integrated into textile) will allow medical staff to react more effectively to measurements and to adapt the care process to the individual measurement values of a person. Finally, the social interaction component of ALFRED will foster the active integration of older people into social events and will help to ensure that people stay active for a longer period of time.

6.1.1 ALFRED's Position in the EU eHealth Action Plan 2012-2020

The first official EU eHealth Action Plan was adopted in 2004. Since then, the European Commission has been developing targeted policy initiatives aimed at fostering widespread adoption of eHealth throughout the EU. In December 2012, the new EU eHealth Action Plan 2012-2020 was published by the EU.

This action plan goes hand in hand with the main pillars and goals of ALFRED, described in detail in previous sections. The ALFRED project will not only work towards the vision elements and objectives but will also address the barriers to deployment identified in the Action plan (see Figure 4)

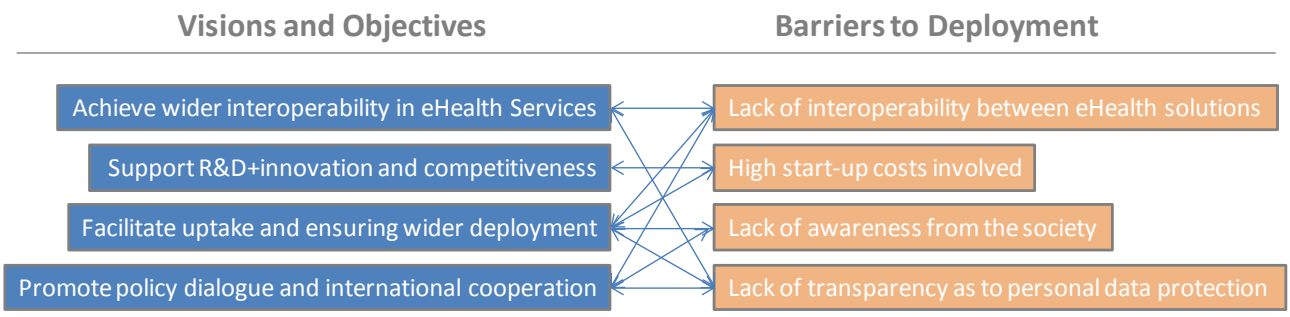

Figure 4: EU eHealth Action Plan 2012-2020 main conclusions. Visions and objectives and barriers to deployment are identified, highlighting the relation among these aspects

According to the new action plan, despite the economic crisis, the market potential of eHealth is strong. The global telemedicine market has grown from $9.8 billion in 2010 to $11.6 billion in 2011, and is expected to continue to expand to $27.3 billion in 2016, representing a compound annual growth rate of 18.6%.

The well-being market enabled by digital technologies (mobile applications, devices) is rapidly growing and the ALFRED platform may contribute to this market. ALFREDO allows developers to create new apps for extending the platform and to gain additional value for its users. Apps may be published on a free or on a commercial base or on a mix between them (e.g. via a "freemium" business model). The ALFRED project will therefore provide economic chances, especially for European SMEs (small and medium-sized enterprises) in the ICT domain.

It is well known that there are many old and newer players in the eHealth market. The range of possibilities ITC offers nowadays are understood by many people, who try to develop tools for helping the different aspects of living – something the ALFRED project is also aimed at. Nonetheless, it is considered that there are very few integrative tools embracing the broad range of issues addressed by the ALFRED project.

6.1.2 Facilitation of Business Innovation

SMEs play an important role in the ALFRED project. Five of the partners are SMEs themselves, representing 50% of the consortium. In addition to this, partners TUDA, OUD, ATOS and IESE are engaged in standardization and interoperability of software components and act as enablers on the interface between research and industry. Their vision is to make the virtual, voice-controlled assistant of ALFRED reality and to foster European SME innovation to increase the impact and influence of European SMEs. To this end, the project has created an open approach in task 9.5 “Sustainability: The ALFRED Open Platform” and also an app concept allowing SMEs to easily extend the ALFRED platform with new apps and ideas. This app concept will be a key pillar towards large impact as it will allow companies and organizations to create new apps for the platform.

The business segment of SME is the most important in terms of workforce employment and GNP (Gross National Product) share in Europe. SMEs exist in every industry and in every country of the European Union. However, SMEs have not benefited fully from the advantages offered by modern business strategies and sophisticated technology. So far, these advantages have mostly been limited to major companies. Although the above mentioned are facts that are valid at European and international level, still the SMEs

demonstrate the following needs which make ALFREDs results extremely important for them, in order to face market demands and competition and in order to make use of advantages offered by the latest development of technology in the eHealth domain.

Regarding market demands and competition, it is absolutely mandatory to perform a constant market analysis, to be able to be aware of competitors (both technologies and businesses), and to create means to be ahead of them. Task 2.2 of ALFRED will perform a market and applicability watch. This task will essentially provide three outcomes: It will start by creating a unified glossary for the project. Secondly, the task will analyse the market by collecting existing approaches, products and research projects. This market watch will keep the project in sync with the outside world and ensure that there is a structured way of feeding in new information into the project. Finally, the task will watch the applicability of the project results. While the market watch will be focused on new approaches and developments, the applicability watch will be focused on the usage of ALFRED in real world environments. New rules and regulations of the different EU member states will be considered. Task 2.2 will therefore be performed in close collaboration with the policy and standardization work of ALFRED, performed in task 9.6.

6.1.3 Post-Project Commercialization of ALFRED

The post-project commercialization of the ALFRED project will depend largely on the exploitation plans and dissemination and standardization activities performed in WP9. Those activities will take place throughout the duration of the project but the majority of activities such as the exploitation activities and final workshops will take place in the second half of the project. WP9 will also cover an active involvement of a project advisory board. This board will contain experts who will meet on a regular basis during the project in order to guide the project as well as to give recommendations from an external and neutral point of view.

The primary goal of this work package is to prepare the exploitation, create wide dissemination and coordinate the standardization of the project results. This will ensure that the project results will be used on a long-term base and that a high market impact will be achieved. The work package will contribute to standardization efforts for making the project results sustainable.

Protection of arising intellectual property is an essential feature as a way of keeping ahead of competitors. Task 9.1 will create a plan for identifying the intellectual property rights of the project results. This plan will be the base for real-world exploitation of project outcomes. It includes a detailed planning of the exploitation efforts and a collection and presentation of the exploitation results. Partners will be collaborating on this closely and create exploitation strategies as well as a set of exploitation and marketing tactics.

The consortium will make every effort to exploit knowledge generated throughout the project. The task leader responsible for exploitation in WP9 will oversee actions related to the protection of knowledge generated through task 9.1. The BOP will discuss proposals with regard to knowledge ownership, especially in cases where more than one partner contributed to the generation of knowledge (single vs. joint ownership).

Equally important are the foreseen dissemination activities. Through the different planned actions, namely the ones regarding industrial dissemination, the goal is to address SMEs directly. In order to generate awareness within the business community, two workshops

will be organised to spread the project's word and results. The organisation of such events is under responsibility of the project partners and will be managed by the dissemination work package lead.

6.2 Research and Technological Objectives

6.2.1 Key Research Questions

Chapter 1.1 lists the main objectives of the ALFRED project. In order to be able to fulfil these objectives, the ALFRED project will have to utilize findings from a set of different scientific fields, such as Human Computer Interaction, Semantic Reasoning, Ubiquitous Computing, and Serious Gaming, among others. And while the project consortium has no intention of reinventing the wheel and will thus try to build on the results from previous research and development projects, it is in the nature of ambitious projects such as ALFRED to highlight gaps in the scientific knowledge that need to be closed by the project consortium in order to be able to deliver a satisfying result.

One example for such a research challenge is the question of how to create pervasive mobile serious games for older players and thus, how to make the potential benefits of such games available to this specific group of users. Since the introduction of the first iPhone in 2007, smartphones have become extremely widespread and are now the prevalent type of personal computer. In contrast to classic gaming platforms such as PCs or gaming consoles, many users carry their smartphones with them during almost all of their daily activities. This brings the possibility of creating pervasive applications that can adjust to the user and her contextual situation rather than requiring her to adjust to the gaming device by having to go to a specific place and to remain there for a given amount of time. Consequently, because they can be played wherever and whenever the user pleases, serious games that integrate the concept of pervasiveness into the game design potentially have a much larger (positive) impact on their players as compared to "static" serious games. However, older people are known to be reluctant when it comes to the use of smartphone-based applications and as such, games for this group of users may benefit from certain design elements or game mechanics that make such games more attractive to their intended users and thus make them more likely to be played in the first place. What kind of game elements such may be, however, requires scientific research.

6.2.2 Research-related Activities

The ALFRED project provides a frame that enables the consortium's scientific partners (AITEX, CHA, IESE, and TUDA) to conduct research on open scientific questions as pointed out in the previous section. Many of these research challenges will be proposed to undergraduate, graduate, and Ph.D. students as potential topics for student theses and as such, they will provide these students with the opportunities to participate in a European-level research project, to contribute to its results, and help them to prepare for their chosen career paths.

The scientific findings that result from the ALFRED project will be published as research papers on scientific conferences to make them available to the (European) scientific community. In order to also foster ALFRED's industrial impact, the project partners will aim to jointly publish articles in peer-reviewed international scientific and trade journals.

Furthermore, all lecturers involved in the ALFRED project are highly encouraged to incorporate the project's vision and results in their readings and presentations (where applicable) and to thus contribute to the scientific dissemination of the project.

The scientific management of the project is headed by Prof. Dr. Ralf Steinmetz of partner TUDA. The scientific managers will consult the project in all scientific questions, they will monitor the "scientific performance" of the project consortium and, if required, they will drive the submission of conference and journal papers in order to spread knowledge of the project's findings.

6.2.3 Post-Project Exploitation Plan

As pointed out before, work package 9 will coordinate the exploitation activities of the ALFRED project during the project's runtime. These activities will start in the second half of the project and, in the case of scientific exploitation, will mainly focus on the publication of scientific papers and journal articles based on the scientific findings made.

The scientific post-project exploitation plan for ALFRED has three objectives. First, the project consortium (or parts of it) will apply for successor research projects, either on an international (European) or a national level. These follow-up projects will build on the results of the ALFRED project and will aim to improve and extend the ALFRED system in aspects that were out of the original project's scope. Second and independently of the first objective, the scientific project partners will strive to make the knowledge acquired within ALFRED available to their other scientific and industrial contacts that were not part of ALFRED's project consortium (but only with proper consideration of the intellectual property rights of the other project partners). Finally, the bachelor, master, and Ph.D. theses that will be conducted as part of the research activities of the project are likely to spawn opportunities for "further research", which may then in turn be offered as thesis topics to other students.

6.3 Out of Scope Areas

The following sections describe research and technical areas that are related to the ALFRED vision, but have been considered to be out of the project's scope. As mentioned above, such areas may instead be addressed as part of post-project exploitations.

6.3.1 Conversational Dialogue

The main purpose of the voice interaction capabilities in ALFRED is to allow end users to get information and contact people. Such goal-oriented voice interaction can be contrasted to other types of dialogue systems, such as conversational agents with the purpose of allowing dialogues about any subject matter. In contrast to such approaches, ALFRED is not an "artificial friend" with whom the end user can chat about anything. Instead, ALFRED focuses on more specific use cases. Natural spoken dialogue between the user and the assistant is here seen as a means to an end, rather than a goal in itself.

6.3.2 Development of Speech Recognition for Older People

Automatic Speech Recognizers (ASRs) are prone to errors, and ALFRED will adopt several strategies to meet the challenges raised by these limitations. However, it is important to note that ASR technologies as such will not be developed within the ALFRED

project. Instead, dialogue strategies and self-improvement capabilities will be adopted to improve the capability to make sense of input from the user. More concretely, this may amount to inspecting the entire list of hypotheses returned by the ASR, rather than just the one with the highest confidence value.

From a cognitive point of view, the “ASR improvements” in ALFRED can be seen as expectation-driven, top-down processes, guiding ALFRED’s “perceptions” towards interpretations that fit ALFRED’s current knowledge. The bottom-up aspects of the perceptual ability – provided by ASRs developed outside of the project – will not be addressed in the project.

6.3.3 Fully Multimodal Interaction

In ALFRED, speech will be the main mode of communication between the user and the system. Graphical user interfaces and touch interactions will only be used in situations where speech is inadequate, such as for displaying maps. Additionally, letting the user provide input using the screen may also be considered as a last resort if voice interaction fails, for instance due to weak speech recognition.

This approach to multimodality, namely placing voice in the centre of the interaction, can be contrasted to more symmetric approaches where both voice and graphics/touch are always available. For example, some systems always give their output visually as well as aurally, and enable users to provide their input by either voice or touch. This kind of fully multimodal interaction will not be targeted in ALFRED. Instead, voice will be the favoured modality.

6.3.4 Web-based Interface for ALFRED Users

In the ALFRED project, there will be a web-based user interface for creating events. The UI will be developed as a form with different required inputs to create an event. However, the project has no ambition to develop this web UI into a full-fledged social media site such as Facebook

6.3.5 Personalization Editor

In the ALFRED project, the users will be modelled based on a personalization framework. This personalization framework will utilize an ontology describing different properties of an ALFRED user. There will be an Editor to annotate and link properties. This Editor will provide the basic functionality of annotating objects, but will not be a fully-fledged ontology editor like Protégé.

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