OLA – Organizational Life Assistant

FOR FUTURE ACTIVE AGEING

D5.4 Final Management Report

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1 Executive Summary

This document presents the effort performed by the OLA consortium during the project lifetime. An introduction to the project opens the description of the project management considerations in an administrative and financial mater. The results obtained from an end-user and technical perspective are presented to explain the objectives on which the partners were aiming in these two aspects. Following these, the dissemination and business strategy results achievements are described. The second part of the report includes a more detailed description of all the project achievements, from the user requirements capture to the final validation of the OLA system by the end users.

2 Document Context

2.1 Role of the Deliverable

INOVA+ as the project leader, guided the OLA consortium during the project activities, performing a continuous control over the time, scope and quality of all the tasks associated in the project. During the whole time INOVA+ was leading OLA, it had a priority to establish a maintain an active communication with all partners, with the maximum responsibility and respect to everyone involved in this project.

This document, by describing the results achieved during the project lifetime, is a reflect on the effort and commitment from all partners on their individual tasks and on the overall project to achieve a solution which can meet the end-user needs and expectations. The effort from the consortium by the coordination of INOVA+ are reproduced on the project outcomes achieved from the overall project activities, which is the main goal of this report to describe.

2.2 Relationship to other Project Deliverables

This Final Report is related to all project deliverables, since each contribution made by the partners are in here described and analysed.

2.3 Target Audience of the Deliverable

This document is a public deliverable. Still, it is mainly intended for the project partners and the European Commission services thus the document will be made public, but not specifically disseminated on a wider scale.

3 Project Description

3.1 General Description

This project aims to offer an answer to the societal challenges by providing an innovative Organizational Life Assistant (OLA), a virtual presence that supports instrumental activities relating to daily living needs of older adults allowing them to be more independent, self-assured and to have a healthier, safer and organized life, while easing caregivers work.

OLA will mediate and facilitate interaction (communication and collaboration) between senior citizens and their informal caregivers or other services or professionals, through technological devices such as standard computers, mobile devices (tablets) and home automation modules. These ICT (Information and Communications Technology) devices will be based on an innovative multimodal model, embracing various physical/healthy and cognitive characteristics of the older adults and will be specifically oriented to increase the level of independence of the elderly, by supporting the possibility of caregivers' assistance remotely and by improving the accessibility to existing services on the Web, such as on-line shopping services.

Moreover, the OLA will also provide personalized well-being and safety advices to older users to avoid unwanted age-related health and safety situations in their own home. Such a well-being and safety advisor makes uses of a combination of user information that is collected (personal physical/health and cognitive characteristics) and extracted through emotion recognition and various sensors.

OLA also addresses a major issue that elderly face related to memory degradation and gradual decreasing of their cognitive capabilities, enabling them to remember primary health care and fiscal obligations (e.g. personal hygiene, medical and tax compliance) or helping them to find everyday items such as eyeglasses, wallet or keys. It is based on speech dialogue interfaces and space and object reconstruction and classification to capture and store daily routines and their related contexts.

The primary end-users are the big group of 65+ adults living alone with or without light physical or cognitive age-related limitations, who need support from care systems. Secondary end-users are both formal and informal caregivers from public or private sectors, supporting them to cope with the increased demand for care.

3.2 System Description

OLA addresses specifically the following main issues:

- **Well-being advisor**: based on the combination of the collected user information (personal, healthy characteristics) and user interaction information (extracted through emotion recognition, sensors settings and contextual recorder capturing the routines as done by the older adult), the system will propose to the older adults personal advice adapted to their situation contributing to their preservation and well-being status in home environment. In case of risk (e.g. irregular heart rate, extreme fatigue) the system may ensure an alert to a local medical emergency service.
- **Collaborative care organizer**: based on the ISCTE-IUL and LM's knowledge of developing human-computer interaction platforms (HCI), OLA will provide online care collaboration between family and professional caregivers, by enabling a local care network to communicate, access sensor data, and coordinate care tasks. With the OLA assistant, seniors will be able to actively participate in the care organization through voice, even when they are unwilling or unable to use traditional web applications.
- **Safety advisor**: based on the combination of collected user environment information through real-time analysis and augmented reality settings, the system will propose suggestions of environment changes that interfere with accessible paths and provide alerts for intruders or other situations that can create hazard situations. In case of risk (e.g. checking intruders or fire), the system may contact local emergency services.
- **Every day instrumental daily living activities memory support**: the system will anticipate medical and fiscal compliances, remember primary health care and food requirements and could help elderly to find displaced everyday items.
- **Environment analysis**: algorithms for real-time object recognition and scene understanding will be developed based on a number of inputs (i.e. 3D object and space reconstruction by using time-of-flight and augmented reality technology) in order to analyze and decide which action to be taken in order support the elderly by suggesting environment changes and providing hints/advices for safety and accessible environments.
- **Multimodal interaction for elderly**: An adaptive organizational life assistant, a virtual presence will be developed in order to facilitating communication and collaboration between older-adults and informal caregivers or other services or professionals. This will be a user-friendly system that uses multimodal approaches based on non-invasive

and minimally obtrusive technologies (i.e. speech, silent speech, touch, gestures, RGB-D sensors).

The overall OLA system will be an easy to download and install software making use of multimodal integrated settings. OLA is in essence a service that enables the elderly user to reduce the demand of care through prevention and self-management, while at the same time also facilitating the supply of formal and informal care assistance.

A series of well-selected use cases where older adults have been supported by caregivers and care professional services will be developed, as well as pilots representing different use cases. Care units will use the system over a one-year period. A new evaluation approach will be used during the pilots, investigating up to which point the OLA services alleviate caregivers support and maintain, or even improve the self-management, health and safe lifestyle of the older adult at home.

4 Project Management

4.1 Administrative Considerations

The Initial OLA consortium was composed by MSFT (coordinator), SSW, ISCTE-IUL, BZN, LM and CKPT.

In the kick-off meeting the consortium decided that changes to the scheduled delivery dates were necessary to insure the correct implementation of the OLA Project. These dates were later reviewed, discussed and adjusted at our regular consortium meetings. Additionally, the delays in the contract signing process with the local NCP's meant that the partners had to use their own financial means, causing delays in the kick-off meeting and official project start and delays in the delivery of user requirements and other user dependent tasks. Despite these issues had prevailed for a long period, initially be the guidance of Microsoft and later by the guidance of INOVA+, it was always possible to find the best solution for managing the project's problems.

MSFT exited OLA consortium at the end of the project's first year, being replaced by INOVA+. MSFT project activities and budget were distributed across INOVA+, which become the new coordinating partner, and ISCTE-IUL (both Portuguese institutions), keeping the overall project deliverables and responsibilities previously granted to MSFT. This reconfiguration of the Portuguese partnership did not involve any funding increase, regarding the OLA project approved by the AAL Association. This alteration was approved by the Portuguese NCP and was be officially communicated in March 2016. MSFT did not ask for reimbursement of any expenses on the period covered by this report.

For over the last months of 2016 the consortium lost contact with one partner – SSW. The partner stopped to cooperate with the consortium and with the participation on the weekly meetings. INOVA+ contacted SSW and their NCP (NCBiR) on supporting this issue to not put the Project performance in risk, on which SSW had expressed their disappointment on the funding rate modification but also expressed that they did not want to leave the consortium to justify this action. It is the consortium opinion that this situation was stalling the project's results and could not continue, as it was affecting the project and the consortium performance. All the remaining partners from the consortium would very much like to have SSW fully on board, but since they were not very responsive for a significant period, the consortium was forced to shift the pilots' location and assume SSW's future tasks. This amendment was formally communicated and approved to the NCPs and AAL Association.

4.1.1 Gantt Chart

The OLA project started on March 2015 until April 2018, with a total duration of 38 months.

Within the extension of 8 months suggested in the Midterm-Review, the Project was in line. As explained in Mid-Term Review, the administrative changes / obstacles caused obviously an impact to the scientific / technical progress of the project, which is of course the origin for almost all the tasks which were being performed at that period.

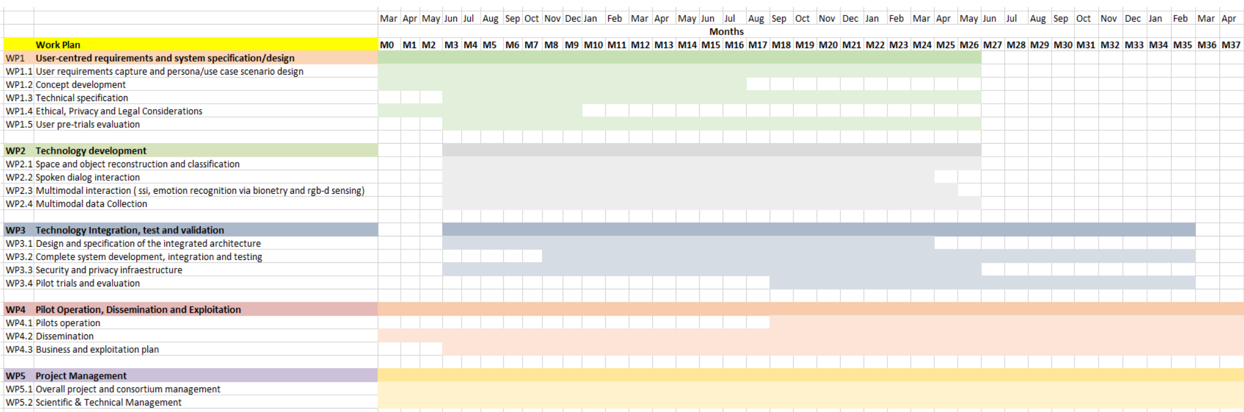

FIGURE 1 - GANTT CHART

4.1.2 Milestones

The delays caused in the project beginning caused affected a delay on the achievements of the evaluation of the field trails and on the availability of an integrated OLA solution. After the mid-term review occurred in May 2017, the project was back on track, beneficiating from an extension of 8 months, where the pilots' assessments and results were presented at the end of the project, running in parallel with continuous improvements on OLA and participation on dissemination activities. The project milestones are presented on table 1.

MILESTONES	DUE DATE	RESPONSIBLE PARTNER	ACHIEVEMENT DATE	REMARKS
M1	03/2017	CKPT	05/2017	M1 corresponds to the first evaluation of field trials and it's directly related to D1.5. Since D1.5 was extended due to the delays on technology integration, this milestone needed to be too (same reasons).
M2	08/2016	INOVA+	08/2016	M2 corresponds to the midterm assessment of the project. Achieved and supporting verification provided. Note to the significant improved achievements on 05/2017.
M3	05/2017 02/2018	CKPT	06/2017 02/2018	M3 corresponds to the pilot applications. The pilot trials evaluation on D3.4 was completed with a review over the pilots' methodology and evaluation metrics. The pilot activities assessments are described in D4.1.
M4	04/2018	INOVA+	06/2018	M4 corresponds to the final review of the project. The report was pushed to June 2018 due to the report on the last technical improvements, dissemination actions and the continuous follow-up on the pilot activities.

TABLE 1 - PROJECT MILESTONES

4.1.3 Project Resources

As it is mentioned on the Annual Reports, the cutbacks performed on the planned grants and the contract signing with most of the NCPs was delayed for many months. In fact, until the end of the project, the three Portuguese partners were refunded only by a small percentage of the costs, where none of the human resources associated funds were funded, the consortium still managed to deliver the work that was supposed, albeit with some delays. It cannot be denied that the lack of national funding (and the underlying decision-making) is having negative impact on the time-dimension of the project, while the quality dimension made the best effort to put into practice all the know-how and skills of the consortium. The continuous delay on the NCPs had result on several impacts:

- Delay on the handover of deliverables;
- Delays affecting project timeline because of the delays which occurred during 2016 – this situation could only be solved with the amendment suggest on the Project Midterm Review;
- The lack of cooperation in the project from one partner – SSW;
- Shift of the pilot location from Poland to Hungary was possible by the commitment of Hungarian partner (BZN), but the request for additional Hungarian co-funding for the Hungarian pilots has been rejected by the NCP, enforcing some barriers to achieve the pilots in perfect conditions;
- Impossibility to allocate more resources to the tasks which would ease and improve the efficiency of the tasks related to the pilot operations – monitoring and reporting.
- Only a great commitment from the partners could disguise the financial difficulties found in Portugal and in Hungary.

The summary of OLA consortium efforts made on the OLA project, considering the actual efforts VS planned effort are described on table 2.

OLA Consortium Efforts	Actual effort in person/ months for the reporting period	Planned effort in person/ months for the reporting period
First Report	67,5 PM	88,5 PM
Second Report	72,5 PM	101 PM
Third Report	131,16 PM	91,43 PM
TOTAL	271,16 PM	280,93 PM

TABLE 2 - OLA CONSORTIUM EFFORTS

4.2 End-user and technical overview

The project started with the user requirements collection. After preparing 3 different questionnaires for quantitative studies (including seniors, formal and informal caregivers), the consortium interviewed, and altogether more than 160 individuals in Portugal, Sweden and Poland. To complete the questionnaires' analysis, the consortium also organized in-depth interviews in Poland and in Sweden. during this reporting period, after identifying general user characteristics and considering OLA's multifunctional features, the OLA partners managed to prepare a document with personas and scenarios representing the prototypical users of the future platform (seniors, formal and informal). what regards end-user services, the OLA project focus on the following areas:

- Communication with friends and family through social networks and new technologies;
- Easy communication with formal and informal caregivers;
- Explore alternative HCI modalities like speech and touch and how they can be combined;
- Senior health and physical activity tracking (with the option to give caregivers access to health information);
- Interactive agenda and reminders.

For the conceptual development, visual artists have designed near-live concept designs of the upcoming platform that commit to the scenarios/requirements previously gathered by end-user partners. Regarding the ethical and privacy compliance: a rather extensive analysis of the national-wide guidelines for data usage and end-user participation was made, with the project having all necessary information so far to be able to conform to these requirements. In Portugal the green light was achieved with ISCTE's ethical commission, while in Sweden and Hungary (replacing Poland for the pilot location) the specific conditions of the foreseen data handling of OLA clear it for operation. The specification that steer the technical development of the architecture's advisor components was defined.

For the technological efforts of the project, the consortium was restless by putting together innovative technical artifacts that make up the final solution. We were following technical advances in the areas of speech technologies, multimodal human-computer interaction and environmental analysis:

- We specified and worked on the development of OLAs' Speech Recognition (SR) and Text-to-Speech (TTS) voices for Portuguese, Swedish and Polish. During this period, we developed a first version for European Portuguese and Polish SR elderly adapted models and began working on for a TTS Swedish voice. Personalized TTS for European Portuguese and Polish (first versions) are already in-place. For Swedish, we have created 5000 phonetically rich sentences that were integrated in the data collection platform that recorded the TTS voice talent. Both SR and TTS were developed for the OLA platform as a service for human-computer interaction.
- We explored the synergies between gaze and speech for Human-Computer Interaction (HCI). The rationale to explore these modalities is that gaze information has the potential to benefit HCI tasks, particularly when combined with speech.

We concluded that gaze can improve our understanding of the user intention, as a secondary input modality, but due to reduced timeframe we opted to use it as the main input modality for users with some level of permanent or temporary impairments. Additionally, we have explored gesture for HCI based on Kinects' capabilities and verified high potential for big screens, e.g. Televisions and Video Projections. In the usability evaluation of field trials was concluded with the collection and analysis of the participants' feedback collected, improvements suggested from CKPT, the end user requirements update and an individual evaluation on the technologies used on the field trials the context of OLA, we have developed a multimodal HCI system prototype which supports speech, gaze and gestures. The system has been developed mainly with Active Assisted Living scenarios in mind.

- In the context of the environment analysis module, we developed a 3D object and reconstruction system. This technology is the core module of the environment analysis system proposed by the consortium in WP 2. This system envisages to identify possible barriers and hazard situations that interfere with seniors' home security and their quality of life. This software relies on a hand-held Kinect 3D scanner, runs at real-time (25Hz) and is suitable to reconstruct the geometry of static indoor scenes/rooms, although currently limited to 3m3 with 5 mm of accuracy due to hardware limitations.
- The Environmental Analysis module was decided to be a research topic. In the scope of this effort an additional feature of the standalone application to recognize 3D objects (miniatures of furniture), was made to determine distances between neighboring objects and therefore to detect an eventual architectural obstacle in the simplified mockup scenario.

After the project review, there were still significant technological improvements achieved which enable to deliver an enhanced solution and closer to the market needs.

- A Web App was developed to have access to the measured health data of the elderly that is stored in the cloud. This Web App was designed to complement the IRINA App, for reporting purposes by the OLA staff. It gives full access to health data that is collect from one specific senior user.
- A web portal for the Agenda was exclusively developed for OLA, allowing the formal and informal caregivers to use a shared agenda with the seniors. This portal lets the caregivers to schedule events for the seniors to do (for example

appointments with medical doctors, take medication, do measurements), giving a feedback from the elderly users to the caregivers, when the events are completed.

- A Balance Scale: The aim of the Balance Scale is to measure the weight and balance condition/ability of elderly people several times a day developed exclusively for OLA project. The heart of the device are four load sensors located at each corner of the device directly connected to the legs of the scale. Measured data are collected and sent to OLA cloud by OLA gateway (or tablet application in on-line mode) where the OLA system processes and evaluates the information. The aim of the continuous balance measurement is to determine the mental and physical condition of elderly people derived from the data gained by balance measurements.
- The NFC technology was added to some health data monitoring kits, enabling to use a set of measuring devices, of a given kit, by several users. Consequently, it is optimized the use of the sensors by the elderly and the analysis of the health data by the formal and informal caregivers.

WP3 is the work package that begins to put together the technologies produced in WP2. A very important part of this endeavor is the platform-wide architecture that was in constant changes since the very beginning of the project. According with the decision to focus on the technologies that were developed from WP2, the WP3 consisted on selecting those technologies are existed and integrate them on a coherent and secured platform, leaving the other technologies, also important to be used only as research.

The selected technologies became available to be part of pre-pilots near the end of 2016. The OLA features and devices which were selected for integration on the WP3 are mentioned below.

Features:

- A robustly secured platform of the OLA solution with the cloud for storage and accessing the data;
- Creation and management of events, reminders and alerts (medication intake, agenda appointments, irregular physiological values, etc.);
- Communication (sending and reading messages and emails, calling and requesting help);
- Physiological data that includes heart rate, blood pressure, myoelectric signals, electro-dermal activity (EDA), blood oxygen level (SPO2), body and weight. This

information may be retrieved automatically by sensors or entered manually by the user (using speech or touch) in case of device malfunction or lack of communication capabilities (such as offline weight scales);

- Physical activity data that includes number of steps taken, distance run, speed and (the rest can be inferred, such as calories burned); this information is exclusively retrieved by sensors present in wearable devices;
- Interaction data that includes any type of information needed only for assessing what the user wants (commanding), such as speech and touch;
- Indoor localization that detects and then enables technology near communicate.

The Devices are:

- Tablets.
- Bands and wearables.
- Well-Being devices (Blood Pressure, Glycose, Weight and Variance Meter).
- Panic Button.
- NFC readers.

For the Pilot Trials, the Methodology of the Pilots was defined starting with the participants selection, an initial evaluation on health status of those participants by two surveys, monitoring the pilot trials by supporting users during their performance, evaluation of the users from their participation is collected on a different surveys according to their action/role (senior, formal or informal caregivers) and final report drawn the conclusions of the trials and the inputs which were used for refinements on the solution. The Pilots operations had one-year period, planned with three major phases: 1st Phase: 2 groups of users from charities (institutions) were tested and ending with an analysis of the groups; 2nd Phase: 2 groups of seniors without need of daily support and formal caregivers. In Portugal, the pilot in the institution was changed to the second Phase, while in Sweden, the pilots could not be performed on an institution (this subject is explained on the pilots' operation description.) The Pilot Operations ended with the Third and Final Phase, consisting on an elaboration of a Final Report combining all the results and informal feedback from the pilots' participants. Three pilot applications were deployed to primary end-users in real-field conditions in Sweden, Hungary and Portugal. Each pilot included the two OLA's services, dealing with the areas of well-being and health. Pilot deployment aimed at demonstrating the success of the idea and the usability and acceptability of the overall OLA system.

4.3 Dissemination

During the whole project life cycle, the consortium has developed and participated on different dissemination activities. There was a great contribution from all partners to be involved in the project dissemination results and on the commitment to keep the pilot activities after the end date planned (February 2018) which will be keep running even after the project finishes (April 2018). From the analysis of the dissemination activities it is also evidenced the great effort made from the beginning of 2017 until the end of the project, participating actively, especially on workshops and conferences, benefiting from the development of dissemination material and promotional of these events on the web. The Dissemination, coordinated by INOVA+, performed continuous updates on the website with relevant news and dissemination activities planned and performed. The Dissemination Plan was updated with a semester evaluation on the dissemination activities.

The preparations for exploitation and commercialization of the OLA project results were done by LM in the first half of the project. The Exploitation plan provides an overview of the market and long-term opportunities relevant to the OLA project and the Final Business Model covers the practicalities that need to be considered in bringing OLA to market. All the partners participated in a discussion on the development of the Business Model canvas for OLA, adding their inputs according to their specific expertise. INOVA+ contributed to the analysis of the market and OLA competitors, managing with all the partners the IPR issues. The Business Model was improved during the last year of the project, benefiting from a continuous discussion on the skype meetings and with the consortium meetings, important achievements could be met – giving OLA business side a high priority matter along with the solution validation. The consortium achieved the following papers and articles submitted:

- "Arch4maps: a mobile augmented reality tool to enrich paper maps";
- "Organisational Life Assistant-How gaming logics can raise the Environmental Analysis module acceptance";
- “Rch4models - A tool to augment physical scale models”;
- “Organizational Life Assistant for future active ageing”;
- “Organizational Life Assistant – the virtual presence on care assistance”.

Since the beginning of the project, the consortium has participated in several conferences, highlighting the participation on the following international conferences:

- SimAUD 2016, London, United Kingdom (16-18 May) - Filipe Gaspar presented the paper "Arch4maps: a mobile augmented reality tool to enrich paper maps." co-author be Steven Gomes, Ricardo Resende, Sara Eloy, Miguel Sales Dias, Mariana Lopes and Nuno Faria.
- 41st IAHS World Congress, Albufeira, Portugal (13-16th September) Ricardo Resende presented the paper "Arch4models: a tool to augment physical scale models" co-authored by Fábio Costa, Sara Eloy, Miguel Sales Dias, Filipe Gaspar, Mariana Lopes, Nuno Faria.
- 11th International Space Syntax Symposium (SSS11) Ourique, L., Eloy, S., Resende, R., Dias, M.S., Pedro, T., Miguel, R., Marques, S., 2017b. Spatial Perception of Landmarks Assessed by Objective Tracking of People and Space Syntax Techniques, in: Proceedings of the 11 The Space Syntax Symposium. Presented at the 11th Space Syntax Symposium, Lisbon, Portugal.

4.4 Business and Exploitation Plan

The lessons learned during the pilots performed in the three countries led OLA consortium to pivot regarding our market strategy. Instead of targeting end users directly we decided to instead target long term care facilities. The successful tests in Portugal, and especially in Hungary, showed both a need and a demand for a service like OLA that can help the LTC professionals to manage and monitor the health situation of the elderly end users. OLA was much appreciated by both the elderly and the care workers who experienced several benefits in their daily work activities such as efficiency gains and a better monitoring of the health state of the patients (we have estimated a 25% reduction in costs of professional nursing per client). The pilot activities also revealed that the system is overall proving to be easy to use, with both caregivers and seniors finding it a great advantage to use OLA for communicating and health data sharing; despite the technology limitation associated with the short range of the panic button, the end users feel safer about having this functionality available in OLA; furthermore, not only did the users find the agenda a great functionality, the caregivers are also reporting that the system is as an extremely useful feature for today's market. These initial results from the pilot activities are showing good reasons for being optimistic about presenting OLA into the challenging but exciting silver market. The Final Business Model was designed considering what we learned while testing the OLA prototype in the pilot trials in 3 countries and from discussions with the stakeholders and the contacts that were established with the different end-users – elderlies, informal and formal caregivers. The Canvas Model is presented below.

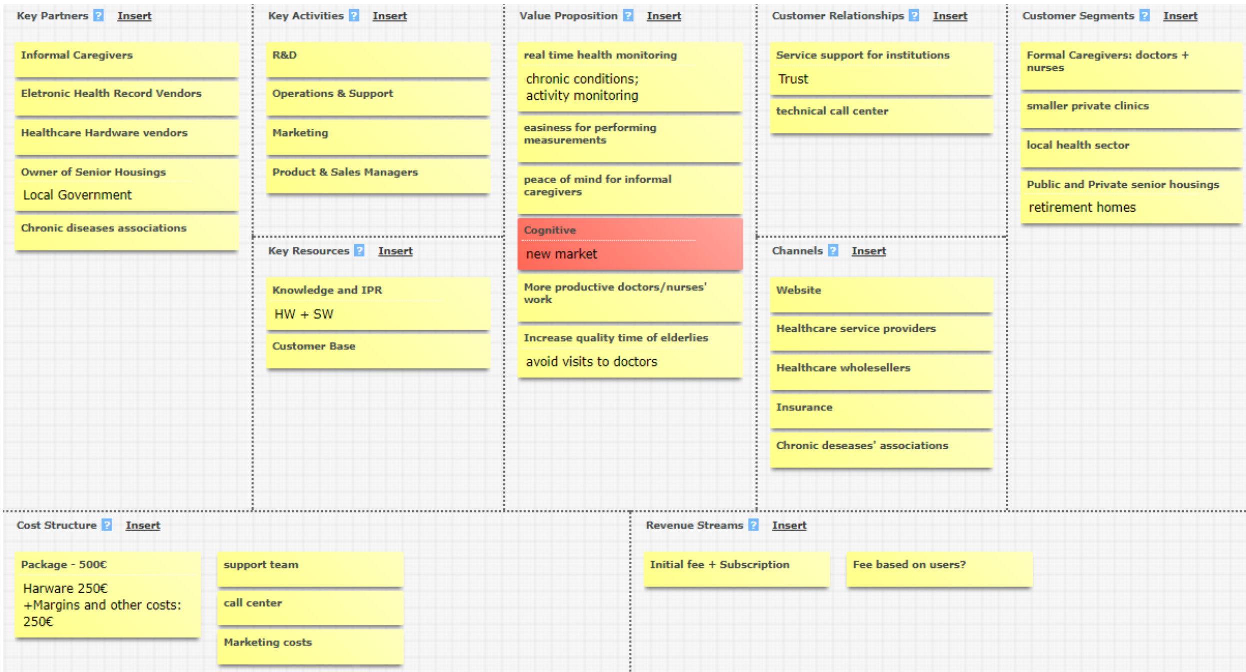

FIGURE 2 - OLA CANVAS MODEL

The OLA system is overall proving to be easy to use, with both caregivers and seniors finding it a great advantage to use OLA for communication and health data sharing; despite the technology limitation associated with the short range of the panic button, the end users feel safer about having this functionality available in OLA; furthermore, not only did the users find the agenda a great functionality, the caregivers are also reporting that the system is as an extremely useful feature for today's market. These initial results from the pilot activities are showing good reasons for being optimistic about presenting OLA into the challenging but exciting silver market.

At sign on fee of 500€ per kit for the purchase of the OLA system covers the costs for the technical components and deployment. A monthly fee of 5€ per month per user is charged for the OLA connected services and basic support. At this price point it is estimated that also institutions that are subject to strict budgetary constraints can be potential buyers.

The OLA attractiveness to customers are the life quality improvement of senior population by increasing their autonomy and safety while monitoring their health conditions, with personalized alerts, providing an easier access to healthcare services. The availability of OLA to health professional by **improving** the **efficiency** of their services, **reducing costs** associated with patient monitoring, avoiding appointments or enabling shorter time responses.

OLA eases communication processes between the triangle elderlies, informal caregivers and formal caregivers, providing informal caregivers with tools that enable a constant support to the elderly, releasing their effort for monitoring and giving them a feeling of peace of mind to them, as also to the respective informal caregivers. This **triangle linking** allied with the functionality to share the same kit with **multiple users** will give OLA a competitive advantage in the market, with a solution already in **full compliance with GDPR**.

5 Project Outcomes

5.1 Outcomes of user requirements and system specification

This project aims to provide an answer to societal challenges through an innovative Organizational Life Assistant (OLA), a virtual presence that supports instrumental activities relating to the daily living needs of older adults, allowing them to be more independent, self-assured and to have a healthier, safer and organized life, while at the same time facilitating caregivers by supporting them on offering high-quality assistance.

A group of surveys and questionnaires were conducted, gathering an important information for the envisaged solutions, producing concepts to analyse the needs of older adults and caregivers in terms of managing both daily activities and specific requirements for system services. The surveys target to reach the number of 180 participants, including 60 seniors, 60 informal caregivers and 60 formal caregivers.

There were two methods that were used for collecting information directly from the selected seniors, informal caregivers and formal caregivers: the quantitative questionnaire survey method and qualitative workshop methodology (focus group-like).

The results on the social perspective, reflected the following aspects:

- Average age is 75.5 years old;
- Most Female responses;
- More significant are widowed, married and divorced level of education Senior High School and Primary, retired;
- Most of participants live alone, with good conditions, in urban areas and easy access;
- Have good physical conditions, do not suffer falls regularly;
- Portugal - Frequency of 57.1% Homecare; 14.3% for Social Centers, Seniors Universities and Others;
- Poland - Frequency of Community Centers / Social Centers;
- Sweden - Community Center frequency with the other to have an almost equal distribution in the responses;
- Usually attend these places during the day.

The results considering the health conditions and needs are the following:

- Health Perception - Good to Fair;

- More expression responses in Healthy Groups and Chronic Disease;
- No problems in cognitive aspect;
- Relevance to have health solutions, with greater focus on Physiotherapists, Psychologists and Rehabilitation Clinic;
- No major difficulties in Basic Activities of Daily Life (BADL) related with the self-care and mobility tasks;
- More concern in Instrumental Activities of Daily Life (tasks related to home, i.e. housekeeping, clothe, cooking, driving, etc.);
- Strong family support;
- Safety needs:
    - Biggest fear of robbery; being home alone; stairs without handrails;
    - Need for solutions for fall on the bathroom, floor and stairs.

The results on the technology perspective identified the following considerations:

- Most have mobile phone or smartphone;
- 50% do not have and never use a computer;
- 50% do not have internet connection;
- Almost 50% (46,8%) never use the internet, while 21% always use the internet;
- Technologies / Devices:
    - Most do not use technological devices; less than half always uses;
    - Receptive learning to use;
    - Confidence level high / medium;
    - Willing to pay 1 to 14 € / month.

The user-centered requirements and system specification was designed and adapted considering the user needs focused on two use case scenarios:

- **Health Scenario**
- **Well-being Scenario**

The requirements' collection task identified a list of 37 needs and preferences of the seniors, informal and formal caregivers. The list of requirements available in D1.1, presents the needs and preferences classified by type and priority. The OLA solution shorts the distance between seniors and caregivers, enabling functionalities to evaluate and prevent chronic diseases and general status of the elderly, supported by a calendar to schedule important tasks of the elderly and also the disposal of alarms when the values measured are not in the range of values which the doctors consider normal. Considering that the number one reason why Informal Caregivers spent more time on internet is related to the necessity and usefulness the email brings into people nowadays. One of preferable ways to communicate between Informal Caregivers and the persons which they have in care would be by email – and ease communication process and health data sharing between the formal caregivers and the informal caregivers.

The OLA solution was validated by the three different type of users: Seniors, Informal Caregivers and Formal Caregivers by the criteria mentioned above. Both the Informal Caregivers and Formal Caregivers identify the high advantage to have an Agenda for monitoring the seniors' activity, a shared agenda between the seniors and the caregivers to ease the communication and the monitoring process between them. To become an effective and cost reduced system, the OLA system needed to be an integrated system for multi users. By this method, the OLA system will be significantly reducing the costs for the Health Services interested to acquire the solution as the devices can be shared. The Formal Caregivers also requisite the functionality for managing the general information of all users, including the contacts and historical diseases, by having a control of the data inside the institution easing the communication process of the different levels of departments and medical staff.

The personas and the respective scenarios were created to explain how a solution could address the personas issues and result to a considerable benefit for them. The scenarios are divided into Health and Well-being scenarios (the 3D reconstruction and the augmented reality are part of research field and not to be incorporated on the envisaged solutions).

Health Scenario (more dependent users): in this setup, seniors with a chronic disease are addressed to showcase how their conditions can be better and more easily monitored with OLA - sensors and measurements for glycose, weight and blood pressure;

Well-being Scenario (seniors low rate of mobility and activity levels, either at home or when in their community): analyses several types of activity-related information to monitor, detect abnormalities and suggest daily-life changes, such as walks taken, distance ran, calories burned, cardiac frequency, body balance amongst others.

In drawing the basic concept for OLA to elderlies and caregivers, it was found a dynamic multi modal system to be the most useful. Modalities such as speech has the advantage of speed and the graphic, that of overview and the text that of clarity the design concept is that of combining them. The design concept for OLA is a multimodal interface that uses voice commands, speech and graphic interface to maximize efficiency, understanding and user experience. While the gestures are still problematic to be used e older adults, gestures is a lack visual feedback for the users coupled with the superiority of graphic interfaces in giving an overview of the possible choices in a given state. Speech, on the other hand, is a form of communication that the users are already comfortable with. An avatar interface was on the original scope but was not included to integrate the OLA solution for pilot trials.

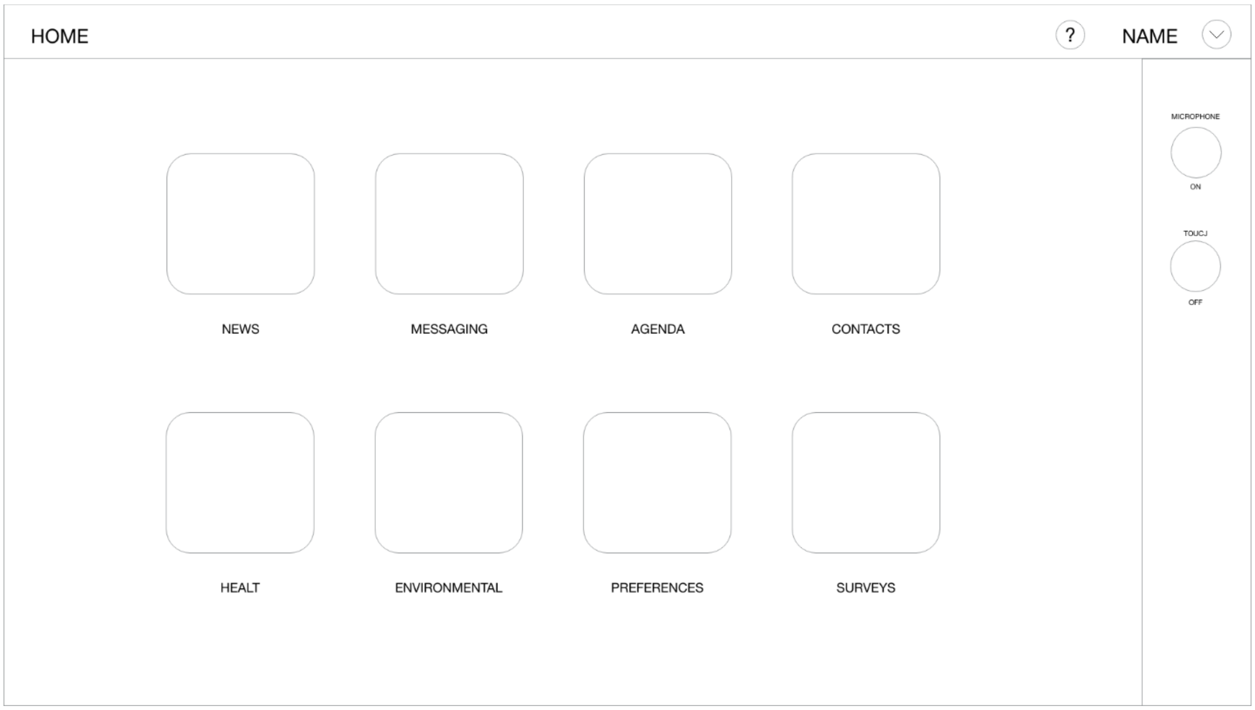

FIGURE 3 - MAIN MENU MOCKUP

The graphic interface chosen was a simplistic and a user-friendly approach to be understandable by seniors and caregivers. The homepage includes the OLA features, presenting only the necessary information and options useful to the user. The simplicity in interface design provides efficiency, with the assistance from the speech commands to enable a wider spectrum of possibilities at any given stage. In introducing a system to a user, the learning threshold will need to be taken into consideration. For each learned functionality, the expected pay-off should be higher than the perceived learning threshold or effort from user. The goal of the design process was to maximize the motivation by minimizing the effort and maximizing the usability. While the avatar would add entertainment, the speech engine provides responsivity by always responding when the user attempts to interact with the system. In the in depth interviews performed in D1.1 a reappearing concern that surfaced several times, was the insecurity felt by both seniors and informal care givers regarding not knowing when to expect a visit by a care giver and not knowing who that would be. The agenda lists events relevant to the user – Figure

4. The OLA users will have their activities regarding their care or their care schedule registered on the Agenda.

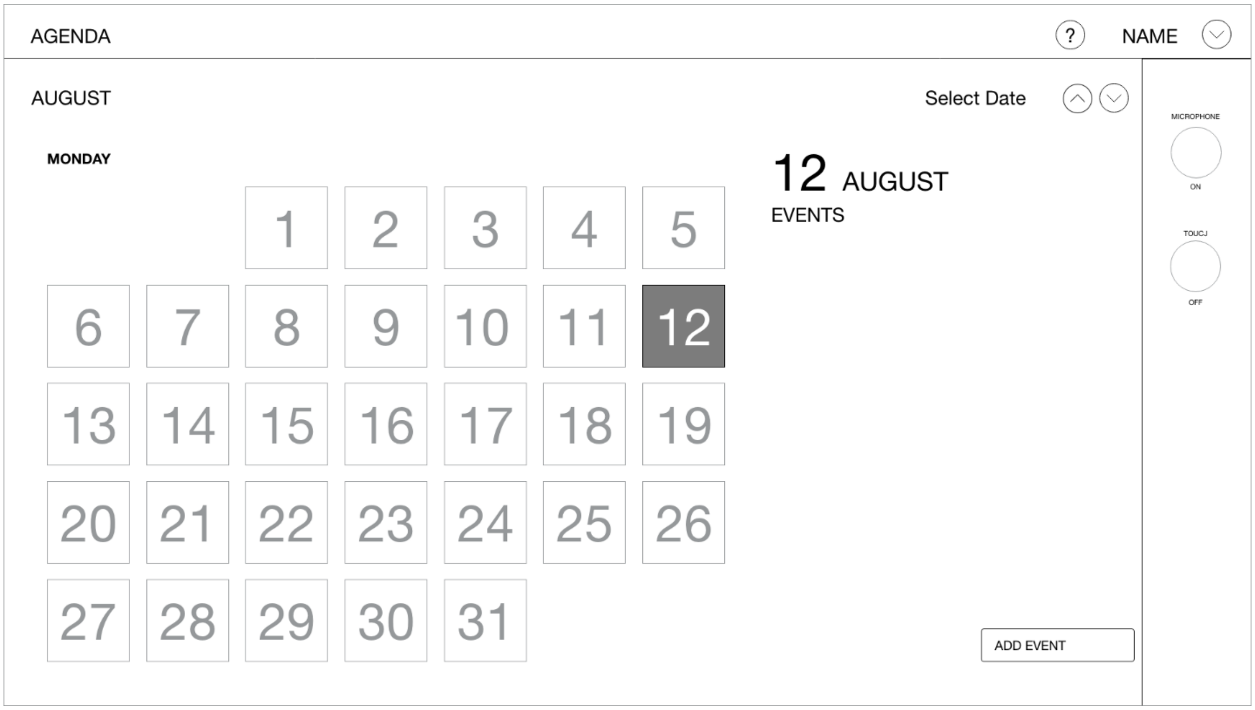

FIGURE 4 - AGENDA MOCKUP

Regarding the communication functions, the OLA users will have their contact list with visualize and use it for contacting their family members or caregivers in an easy way – Figure 4.

Figure 5 - Contacts Mockup

The safety advisor (from identification of hazard situations) and the environment analysis (from the suggestions of actions to environment changes and providing hints/advices for safety and accessible environments) were initially planned together with well-being advisor (from the collection of health data and alert possible risk situations). The description of what modules and their functionality, including the security module and protocols, will be explained on the following chapter.

The Technical Specification describes the Advisors Support Service group of components (Safety advisor, Well-being advisor and Everyday living support service) – core to the system as it represents the main bridge between the cloud services and the user.

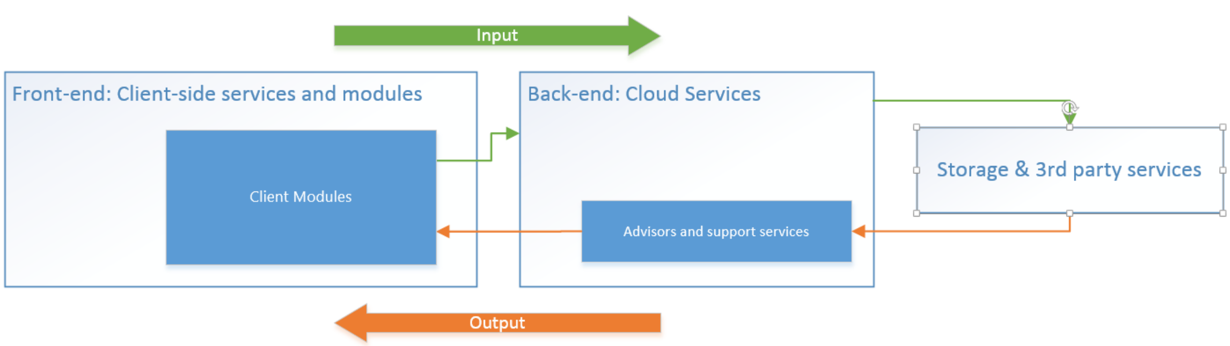

Figure 6 - Input and Output between Modules

The deliverable 1.3 presents the sequential view of how the data flows throughout the system, from the first input to the final user-friendly feedback, including:

- **Safety advisor**: used within a limited scope, deals with security and safety issues such as intruders or fire at home, as well as providing advices for environmental changes like relocating pieces of furniture to allow a more accessible path and avoid hazard situations.
    - OLA-Environment Analysis – to evaluate the accessibility of their homes and whether there's any misplaced furniture that could generate hazardous situations.
    - Home security – detection of open doors and windows when the user leaves the house to prevent him/her from leaving them open and facilitate the breaking in of potential intruders
    - Fall detection – continuous data input from gyroscopes and accelerometers, providing alerts to caregivers and services to assist if a hazardous situation occurs.
- **Well-being advisor**: personal advice adapter to the situation of the older adult being monitored, based on real-time data collected by biometric sensors.
- **Health** – manages the health monitoring and helps turning it into useful information for the user.
- **Everyday living support**: accesses the calendar in order to remember the user about a series of events, including personal events and medical obligations or advices.
    - Schedule – creation of events, considering the use of keyboard, mouse, touch, as well including the eye tracking behavior and touch.

The OLA overall architecture is depicted in Figure 7. It's a cloud-based, service-oriented architecture which resorts to industry standards such as REST, web sockets and HL7/FHIR to ensure interoperability both with components developed in the project, as well as outside components by 3rd parties.

OLA architecture

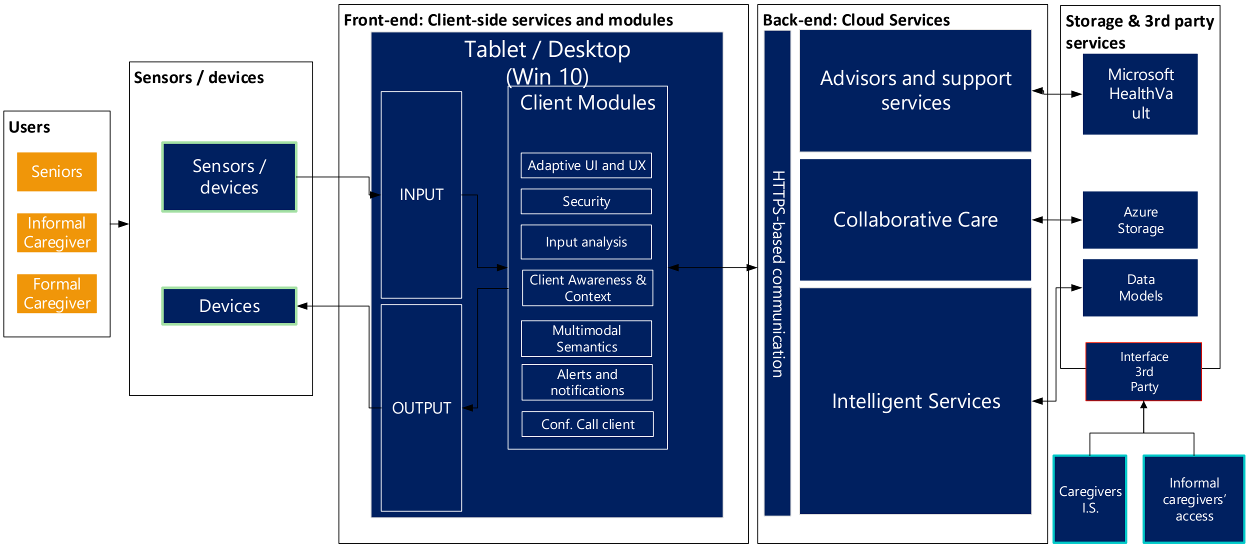

FIGURE 7 - OLA SYSTEM ARCHITECTURE

There are 4 layers of system architecture on a user-server flow:

- The **sensors and devices** layer are responsible for data retrieval from several types of sensors and capture input to feed the services on the server side as well as to output processed information in form of alerts, notifications or any other kinds of advice to the user.
- The **front-end layer** receives the input and data coming from the sensors/devices to give to the client modules, as well as receiving processed data from the back-end on the client modules and providing it to the output modalities.
- The **back-end** is host to the services that are to be developed inside the consortium. Additionally, this layer also includes a filter for authorizing requests and the HTTPS-based communication.
- The **Storage and 3rd Party Services** encompasses the Microsoft Azure Storage, IoT Hub, Service Bus and Data Models that are taken off-the-shelf and are outside the scope of development of this project.

Sensors and devices were selected to support common chronical disease monitoring scenarios such as high blood pressure, diabetes, heart conditions, but also to support wellbeing scenarios at home and while on the go via devices. A panic button was also considered to allow for notifications via, for example, SMS, email or via a frontend app, for requiring support to caregivers.

The ethical, privacy and legal considerations according to the different countries where pre-trials and trials were performed in the OLA project. The initial scope included the pilot location in Poland, which due to the exchange to Hungary, the considerations of these two countries are covered in D1.4, as the unchanged pilot locations Portugal and Sweden.

This document shows the different regulations regarding the data collection and storage, including performance data, health data and personal information. As the data treatment during the project is a serious issue to protect privacy, the data protection issues, ethical and legal regulations in the several countries were presented and analysed.

Throughout the tasks where users are involved, the following issues are ensured:

- Correct recruitment considering the identification of users who were testing OLA system, including older adults and caregivers.
- Correct involvement of end-users;
- Informed consent – An informed consent to present the project and the solution to the participants for the trials, informing detailed information regarding the system, as well the security of it and the level of trust regarding their data. The persons willing to participant signed the document freely, without coercion, and could quit at any moment, without financial or other consequences.
- Transparency.

Following the research on ethical directives of Portugal, Sweden and Hungary, the ethically-complying administrative activities in these countries involved the contact of local committees to validate the ethical matters for the pilot activities.

From the directives analyzed in the pilot locations, is was elaborated a set of technical requirements that are common country-wise and need to be employed by the OLA technology infrastructure to effectively achieve ethical compliance:

- The separation between demographic data and health data;
- The anonymization of the health data;
- The application of security mechanisms for the transmission of data across the wire, wirelessly or using public networks (such as encryption);
- The application of specific security criteria for the usage of passwords;
- The application of backup strategies;
- The application of logging / auditing strategies;
- The naming of an administrator of information security.

The usability evaluation of field trials for the three pilot locations are presented on the Deliverable D1.5. The following steps for the pre-trials evaluation were identified:

1. Create an initial questionnaire to collect user information, responsible of the user information, living and health conditions and an initial evaluation of the devices which the user were testing;
2. Create a usability evaluation survey;
3. Make availability OLA modules;
4. Devise usage guidelines;
5. Supervise OLA modules usage;
6. Filling of surveys.
7. Analyze the results;
8. Execute refinements extracted and implemented.

The OLA modules were identified and classified as an important part of the usability tests made in the pre-trial stage. The modules used on trials were the following:

1. **Interface application**: use of the overall interface application that is the core of the OLA project; although some of the following modules are embedded into this, they have an increased importance by themselves and so it was evaluated separately;
2. **Speech synthesis**: test to assess whether the speech technology already available and produced by the technical partners is adequate for a normal usage scenario of the users, including attributes as cadence, volume, clarity and voice tone used;
3. **Speech recognition**: users got in touch with the familiarity of having to dictate commands and phrases into the application, checking the speed by which commands are translated into actions, the frequency of a correct understanding of their voices and the difficulties felt;
4. **Sensor usage**: test the usability of the processes for measuring the data from the usage of the sensors.

The technology started to be tested (for the pre-trials) spread by the three countries where those had better mean of being adequately tested. For the pilot activities, the OLA solution was tested in full composition at all three countries of the named pilot locations.

The partner LM conducted a survey and a series of in depth interviews concerning attitudes regarding the OLA system and the use of an avatar as a part of the communication interface. In the interviews, the participants could elaborate their thoughts about OLA system and the use of avatars as means of communication. The participants in the study are mostly positive to the use of an avatar in the OLA interface. The main points of interest being contacting a doctor and reminding to take medicine. The grading of the avatar seemed not to relate to age or ethnicity. We have seen an indication that a glad or strict appearance that could be positive in different situations. That could be a relevant subject for further study. A successful implementation of the avatar and the voice interface can be an important feature to address the concerns on learning how to use the system (Note: The avatar was not included on the OLA solution tested in the pilot activities).

Important remarks from the evaluation of technologies and devices:

- The user interface in the overall was attractive and easy to use;
- The informal caregivers expressed their interest and were enthusiastic to see the measurements on the report;
- The SR needed some adjustments.
- Both informal caregivers and seniors stated a great advantage to use OLA for communicating and sharing health data.
- The users pointed that the panic button should work with a wider distance from the Raspberry Pi, nevertheless they feel safe on having this functionality available in OLA.
- The users found virtual assistance in the Agenda reminding to take medicines a great functionality. The agenda had a structure different from normal, which was a barrier identified by a few users.

Considering that the monitoring of activities was a continuous process with the collaboration of all partners, the feedback collected from the pilot activities caused the identification of new user requirements (which were updated on de Deliverable D1.1):

- Agenda functionality to attribute actions to the seniors' events with the caregivers - an agenda that is shared between patients and caregivers, where the caregivers can monitor not only the health data, but also the events linked to a determined senior.
- Graphic designs adjustments.
- The panic button should work with a wider distance from the Raspberry Pi (not doable due to the limitations of the technology).
- SR more user-friendly and adjusted for OLA end users.

A set of adjustments and improvements were made during the tests, where at the end was made an analysis of the technology and devices performance on OLA system.

The user interface in the overall was attractive and easy to use and stated a great advantage to use OLA for communicating and sharing the health data. The informal caregivers, particularly, expressed their interest and were enthusiastic to see the measurements on the report. OLA users found the Agenda a great functionality for them to have a (virtual) assistance helping them to remind taking medicines.

The margin to improve was considering the communication performance, speech technology and agenda functionality. It was verified instability between the router and the Raspberry Pi was verified in the beginning of the pre-trials, which caused some inefficiency at some periods of time. The SR sometimes was not easy to use, as there were some commands that were not the best option to represent the actions the users needed to navigate in the platform. New voice data was collected to enable an improved experience. The TTS demonstrated lack of commands to change that specific interaction between the users and the platform. The fact that the agenda had a structure different from normal, which was a barrier identified by a few users.

5.2 Outcomes of Technology Development

This Work Package starts by defining an environment analysis system which envisages to identify architecture barriers and hazard situations that may interfere in seniors' home security and quality of living. To this purpose the following are defined: i) a system to reconstruct the geometry of a room; ii) the range of possible domestic barriers that can affect older people as well as the definition of a set of standard solutions for those barriers; iii) and logic rules to act on the hazard situations detected by proposing changes to the space. The core technology that was developed related to i) is a software system of 3D object and space reconstruction (3DOSR) that works hand-held Kinect 3D scanner, runs at real-time (25Hz) and is suitable to reconstruct the geometry of static indoor scenes/rooms. Figure 8 illustrates the output of 3DOSR system. Objects and space are represented in a gradient of colours. 3DOSR provides 3D geometric information in a known reference coordinate system. The remaining sub-systems of Environment Analysis (EA) module are built upon the 3D reconstruction module in a pyramid of technology dependencies – Figure 9 – where the only input device is a Kinect sensor and the output device is the user tablet running Windows 10:

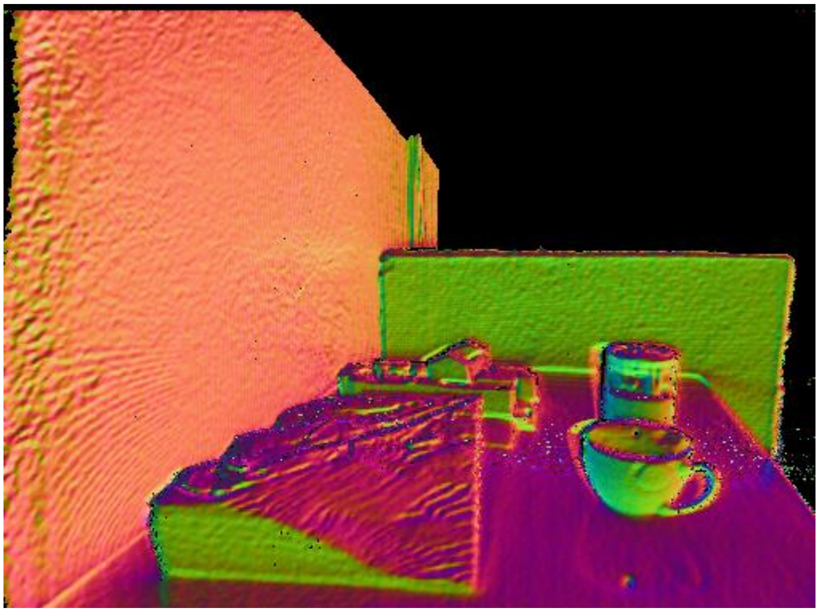

FIGURE 8 - VISUAL REPRESENTATION OF 3D GEOMETRY SCANNED BY 3DOSR SYSTEM.

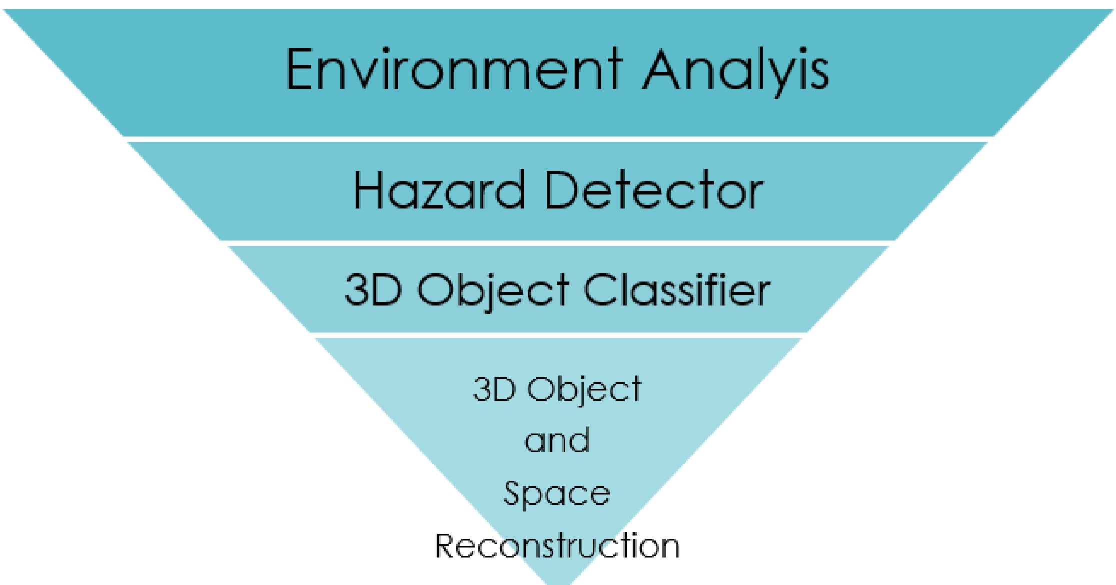

FIGURE 9 - ENVIRONMENT ANALYSIS PYRAMID OF TECHNOLOGIES

As part of the hazard detector component of the system, the software platform can determine the distance between the bounding boxes of neighbouring objects, to detect a possible domestic barrier, in a simplified scenario using miniatures of real sized objects (Figure 10).

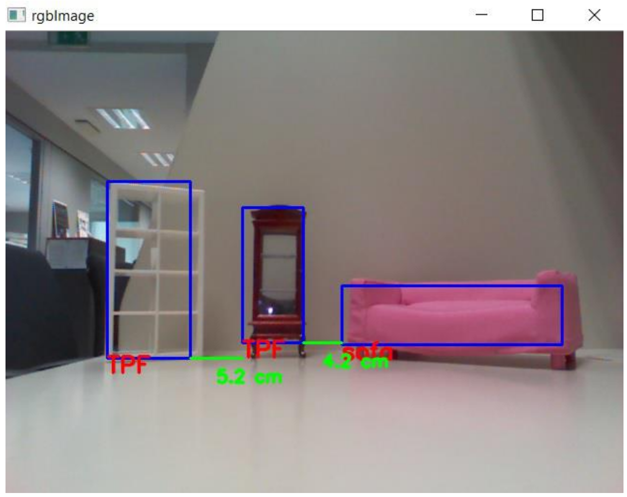

FIGURE 10 - DISTANCES BETWEEN NEIGHBOURING OBJECTS

Following, this Work Package tackled the development of Speech output and input interfaces, to ease the navigation in the OLA App by elder users. Two systems were envisioned an Automatic Speech Recognition (ASR) and a Text-To-Speech Synthesis (TTS) in the target market languages, Portuguese (pt-PT), and Swedish (sw-SW). For the pt-PT the development was made on especially adapted systems for the elder user, since ASR and TTS language packages are already available by technological companies such as Microsoft and are freely and publicly offered to developers worldwide. As for sw-SW the focus was on the development of a new language package since this language is not currently available.

The first step for creating the new elderly ASR engines was to collect data from elderly adults. This was done using the dedicated platform Yourspeech, developed by the MLDC - Microsoft Language Development Center.

The next step is the development of Specialized Acoustic Models, which are contained in the Microsoft Speech Platform Runtime (Version 11). A new language pack is being developed for Swedish (sw-SW). For Portuguese the acoustic models (AMs) have been optimised for elderly speech by updating AMs trained with young to middle-aged adults' speech with the elderly speech collected during the OLA project.

Language	ASR vocabulary	LM perplexity (test set)	OOV words (test set)	WER (%) Baseline AMs	WER (%) Specialised AMs	WERR (%)
Portuguese	8934 words	60.0	219	18.3	**16.4**	10.4

TABLE 3 - ASR RESULTS WITH SPECIALIZED ACOUSTIC MODELS (AMS)

In Table 1 are presented the results for ASR using specialized AMs based on the Language Model (LM) Perplexity that is an information theory derived measure of how well a probability model (the LM) predicts a sample (the test set utterances); the Out Of Vocabulary (OOV) rate of the test set; Word Error Rate (WER) figures obtained on the test set by the baseline and the specialized AMs; and the Word Error Rate Relative Reduction (WERR).

The final step of this part of the Work Package, deals with personalized Text-To-Speech Voices. Since the TTS voices that are publicly available were generated based on young adults, and the elder users feel more related to and preferred elder voices, the goal of the OLA project was to create one elderly TTS voice for each country of the project. Two architectures were used for TTS voice generation on the OLA project. The Microsoft Hidden Markov Models-based Text-to-Speech system (HTS) System (for Portuguese), and the Swedish HMM-based TTS.

This Work Package also dealt with the design of the user interface of the IRINA OLA App, which was made to mediate and facilitate the interaction between senior citizens and their informal caregivers, other services or professionals, as well as, with friends, through technological devices such as standard computers, tablets and home automation modules. The interface was designed to ensure the compatibility of the various interaction input devices - keyboard, mouse, touch, and voice – and to enable customization. Windows 10 Universal Design Guide was used as a base for the layout design which is a fully responsive design (Figure 11).

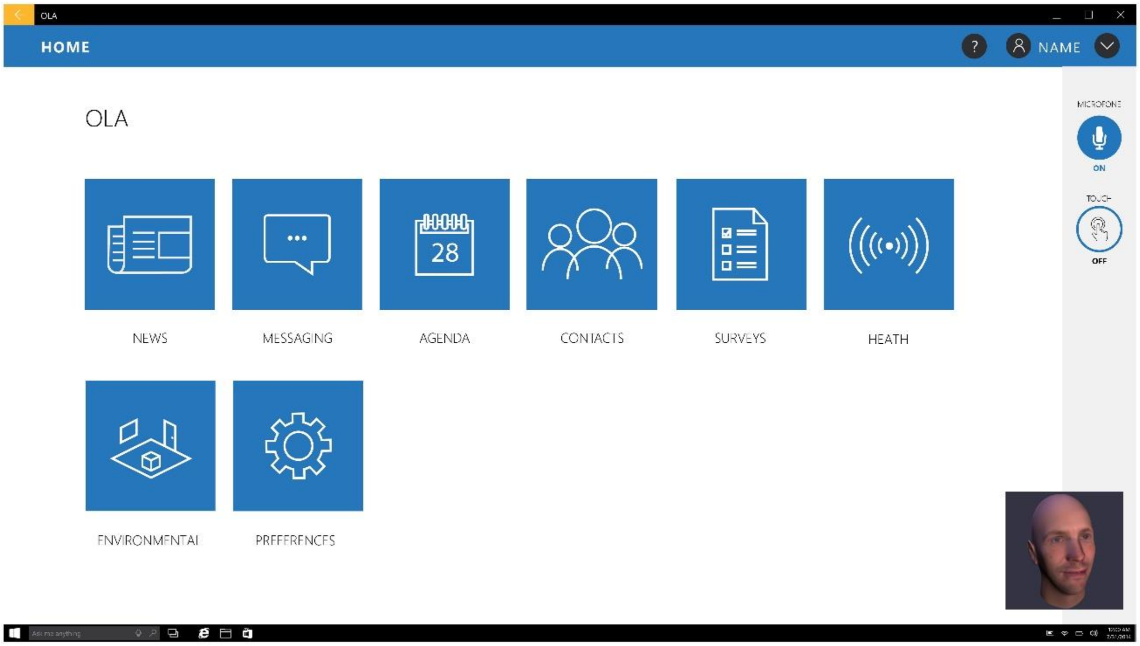

FIGURE 11 - HOMEPAGE MOCKUP

In addition to the voice synthesis system an avatar – Figure 12 was envisaged to be added to the application and can be enabled to complement the voice synthesis system giving it a virtual persona.

FIGURE 12 - AVATAR

The final part of the Work Package 2 is related to the description of the Off-line Data Collection Platform. This data collection is closely linked to the Environmental Analysis Module of OLA and constitutes the ISCTE-IUL RGB-D Dataset and Collection Setup that is used in the object classification module of the OLA platform.

The ISCTE-IUL RGB-D Scanner (Figure 13) is a low-cost setup that allows cheaply and quickly scan small-sized objects. This research was the first step for the creation of ISCTE-

IUL Dataset which was made publicly available and was added with the collection of new objects and categories for the OLA project.

FIGURE 13 - RGB-D SCANNER

In the context of the OLA project and by utilising the low-cost RGB-D Scanner, described in the previous paragraph, ISCTE-IUL added new object categories to a previously publicly made available dataset, mainly furniture, through new scans of scale models (Figure 14). With these new categories of objects this dataset can be utilized in the OLA Environmental Analysis Application, in the object classification module.

FIGURE 14 - EXAMPLE OF FURNITURE SCANNED

5.3 Outcomes of Integration, test and validation of Technology

The Technology Integration, test and validation consists on the presentation of the technologies to integrate OLA system.

The OLA architecture is presented on the diagram below (Figure 15), following the developments made on the WP2.

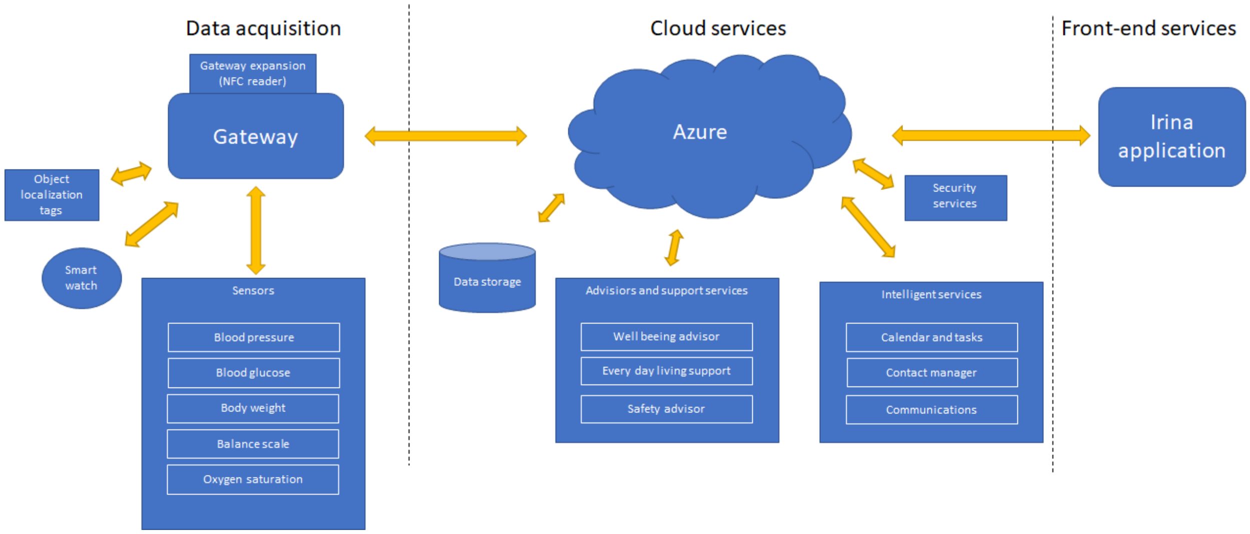

Figure 15 - OLA Architecture

In here presents OLA technologies integrated in the application (IRINA) presenting:

- The **data acquisition** module is responsible for the health, environment data collection. All components are installed at the users' premises and operated by either the end users or formal caregivers.
- The **cloud services** are responsible for the data storage, security services, advisors and support services and finally the intelligent services.
- The **front-end service** application is the main surface of all user interface functions. It can display all information, data and diagrams for the user and can receive their input to control the operation of the OLA system.

From the selection of the more matured technologies, the system was designed for the Well-being and Health Scenario, presented and described in D1.1.

The OLA Modules are:

1. **Security Module**: This module, in full compliance with GDPR, handles the basic user information of the user. All users of the OLA system need to have an entry in the

User authentication & authorization database maintained by users and system administrators. This module is clearly described on D3.3. The security infrastructure that is present on the data platform of the OLA project, which is based on three concepts: authentication, authorization and auditing.

a. **Authentication -** makes sure that any person interacting with the OLA platform is registered within the system and is indented to be using it. This person may pertain to any of the roles foreseen by the project, such as the elderly, an informal caregiver (including family) and formal caregiver. The authentication itself is made through the insertion of two pieces of information: username and password.

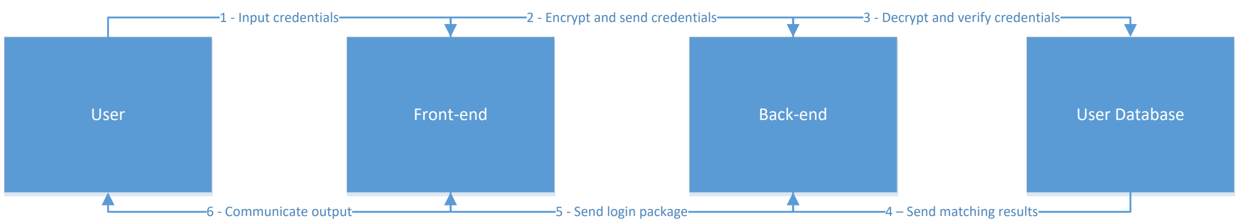

FIGURE 16 - OLA AUTHENTICATION

b. **Authorization -** makes sure that accesses to the back-end's data, for whatever reason they are made, are authorized (using the login package and token information presented earlier).

c. **Auditing** - This mechanism exists within the back-end part of the framework to register all of the accesses made to the platform's data, allowing OLA staff to analyze and monitor if all accesses are made within the assumed normal security conditions of the environment it is put in, while also to comply with any data requests made by the stakeholders / users and legal requirements.

The team behind OLA feels that the security and privacy-related specifications adequately cater and fulfill the legal requirements that were previously researched. According to the requirements collected in D1.1, this deliverable can confirm a robust security platform, where the seniors' data can be safely stored and users be able to recognize a trustful and secured solution (requirement #13), the prototype enables the assessment of Health data of the persons in their care at any time (requirement #19), the health data of the patients is shared to the caregivers which are assigned to them (requirement #32) and the information can be managed at the caregivers' portal (requirement #29).

2. **Collaborative Care**:
    a. **Calendar** - helps to the seniors and caregivers to maintain the list of the important events and notifies the user in advance. It might be an appointment or to perform a measurement, and it is also possible to define notes and reminder type of events.
    b. **Contact manager** - maintains the contact list of all users of the OLA system to make easier the communication between seniors and caregivers; it can store personal contact list of persons outside the OLA system to make communication easier with them. The contact list is personalized and can be maintained by the senior or caregivers.
    c. **Communication** - provides services for all users of the OLA system to easily access each other using either voice or text (email) based communication.

The list of sensors integrated on the OLA solution are presented in this document:

- Blood pressure meters: the device needs user intervention. Based on the measurement plan the user is noticed about the necessity of the measurement, after the measurement is carried out by the user, measurement results are automatically transferred via the build-in communication interface to the database of the system for further processing/viewing.
- Glucose meters: used to diagnose diabetes, and to monitor glucose control for those people who are already known to have diabetes.
- Body weight sensors: provides information about the seniors' weight and most of the cases BMI (Body Mass Index) change too.
- Body balance sensors: measures the 2D position of the body center of gravity, allows analyzing postural control of the cared person.
- Heart rate sensors: Heart rate is the speed of heartbeat measured by the number of contractions of the heart per minute (bpm).
- "Activity" - distances and counting step taken by the user.

OLA uses a gateway (a small single board computer) for transferring data from various sensors to the cloud. The gateway is directly connected to the internet and it is capable of the appropriate authentication and authorization functions. The initial integration was made with a **Simple gateway**: only the single board computer is used without any additional hardware expansion, was designed to use by single person, so the gateway is assigned to the person and no further identification is required - *Suitable for usage in the own home of the elderly people*.

The technical partners managed to develop a **Gateway expanded** with the NFC reader card. The user identification is done by using NFC card, so the same system can be shared among several users. *Suitable for operation on the nursing home* where the elderly people periodically can visit the room of nurses for health examination.

This last version also available in a **Portable gateway** with NFC reader, powered by batteries. This system is *suitable for home of elderly where nurse visits periodically the elderly people to check their health status*. The nurse can carry easily the system together with the power source and the users are identified by used NFC card

The description and its functionalities are described on the Gateway Integration and Gateway Extension documents. The sensors and devices integrated on OLA are presented on figure 17:

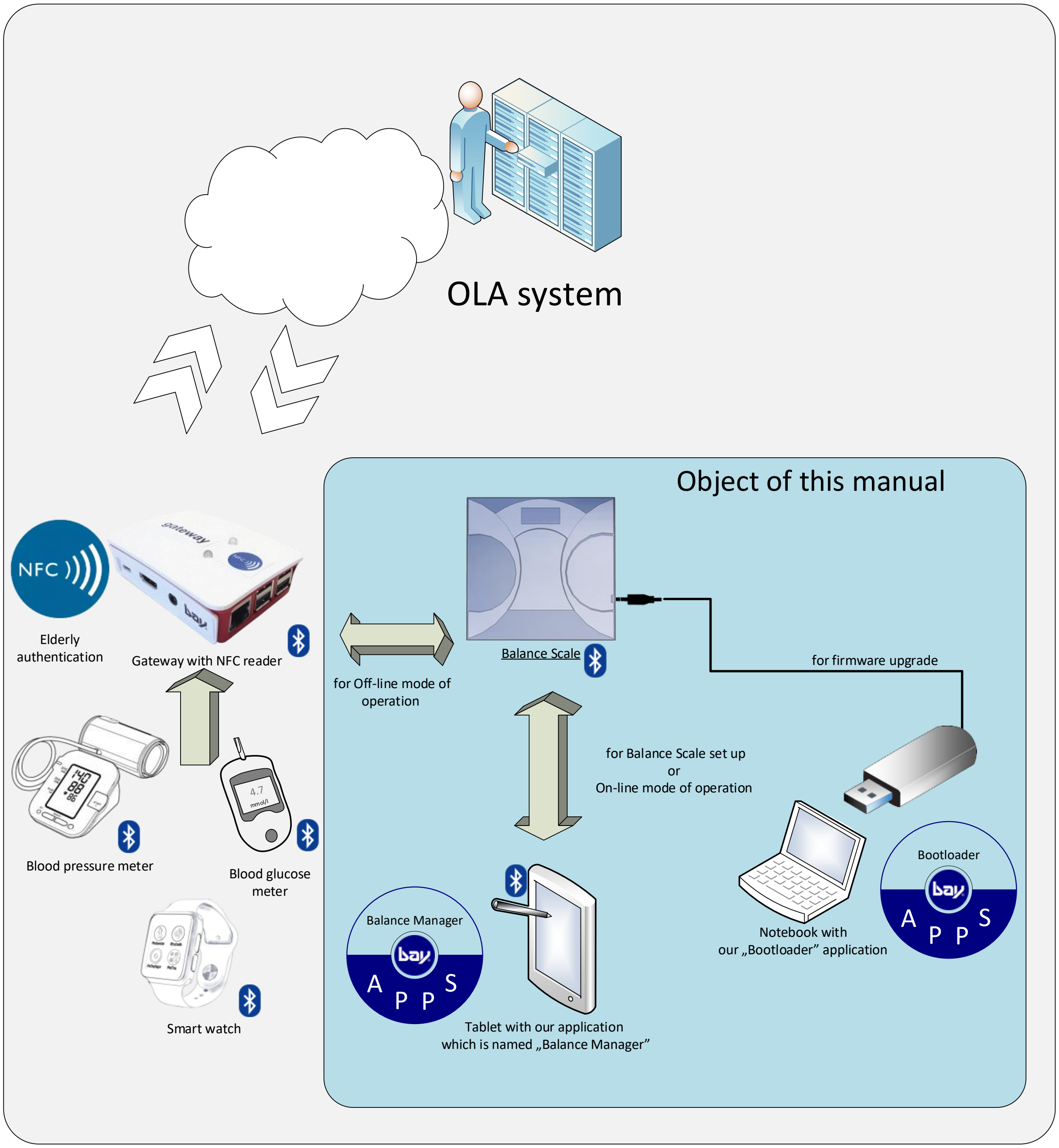

FIGURE 17 - GATEWAY INTEGRATION

Regarding the research on the object localization available on the Indoor Localization the Bluetooth localization system has acceptable accuracy and it is suitable for finding objects in a room environment. Using this technique, we can tell exactly a person's or any object's exact location. It can be used in many fields of everyday life, but our most important purpose with installing this system is to help elderly people, their caregivers and family members. Since the Bluetooth tags are relatively cheap it is affordable to equip all important belonging of an elderly people with Bluetooth tag.

The last deliverable of the WP3 aimed to develop a trial execution plan for evaluation of the OLA system in real daily life setting and conditions.

The Pilots Methodology was planned to contain the description of the activities which were performed during the 12 months.

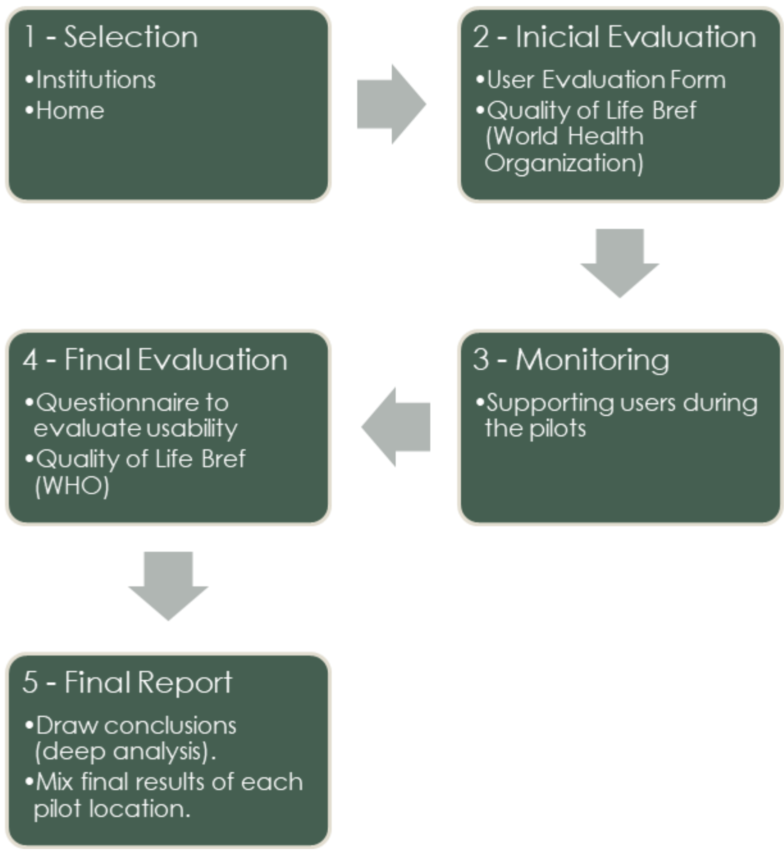

FIGURE 18 - OLA PILOT METHODOLOGY

Besides the development of the informed consent, user guides were also developed to support the training and assistance provided during the trials. The Methodology for OLA pilots consisted of 5 major steps:

1. **Selection** – The participants must have persons from both sex, some with diabetes, others with hypertension, with support dependency and others with total independence, which took in two different real environments:
    a. Institutions

    b. Home of participants

This distribution was made different in the three countries, where in Sweden was only performed at Home, in Portugal was performed at Home and institutions and in Hungary was mainly performed in the Institution.

2. **Initial Evaluation** – The initial evaluation to collect personal information and the health status and quality of life of the participants;
3. **Monitoring** – During the operations, it was given the necessary support to the participants, helping them to feel comfortable by using each device provided for the pilots. This support consists on the following group of activities:
    a. Preparing the equipment, sensors and registers;
    b. Designing a practice guideline report;
    c. Presenting the Modules (Health, Messages, Contacts, Agenda & Surveys).
    d. Training the participants.
    e. Analyzing current issues;
    f. Evaluating improvements;
    g. Bridging technical partners and the participants.
4. **Final Evaluation** – This last stage was made and evaluation of all the participants from Portuguese, Swedish and Hungarian operations (included on D4.1). The evaluation was made from the usability surveys collected at the end and from the continuous contact established between the participants and the pilots' coordinators in each country.

The OLA functionalities available on the OLA app for the trials were:

- Health - Health functionality includes the following health and well-being measurements, including:
    - Glucose Meter
    - Blood pressure Meter
    - Activity level Meter
    - Weight and Variance Meter
    - Panic Button
- Contacts – Managing contacts for contacting
- Messages - contact via email, send and receive email (including the use of speech).
- Agenda - electronic calendar for an effective event management
- Surveys – option added to perform the surveys electronically.

5.4 Outcomes of Pilots Operation

In here, the technical issues are presented, describing the necessary adjustments managed and performed by the consortium. During the pilot operations, some difficulties in the interconnection of the meters and the data repository were identified. To overcome this difficulty, we isolated the possible causes, but the difficulty in finding a cause of the instability has made the pilot's profitability been affected. Parallel to the pilot activity in the institution, there were internal tests and reconfiguration. Two kits were tested internally to be reconfigured. Following this reason, it came possible to perform additional tests to analyse the system. One of these kits had the Raspberry Pi device replaced and another was replaced the memory card of the same device and made a new configuration. The kits were sent for testing and only in one of them was detected the difficulty in communicating the glucometer data. By the end of the pilots, the feasibility of using NFC technology was putted into practice (as the institution in Portugal revealed their interest to keep the pilot activities running even after the project conclusion), which allows the institutionalised users to share the measurement equipment by several users. This advancement in technology would respond to the need of institutions, significantly increase the productivity of caregivers, as well as represent a more profitable service to the institution due to the possibility of sharing the equipment in the care unit. In spite of not being on the scope of the project, the consortium addressed this possibility as a major need from the end users, as the OLA solution will increase significantly the productivity and easiness on the caregivers' side, while will also represent a more affordable system for this customer segment.

The OLA platform was designed with high security concerns both in what is related to the authenticity of the data and to the authorization of the users to have access to the collected data. The performance of the OLA platform in authenticity guaranties that the measured data from a given senior indeed belongs to the person that made the measurement. This authentication process handles the different user roles of the system and permissions assigned to each role/user. The following three basic user roles exist: seniors, formal caregiver and informal caregiver.

5.4.1 Pilot Activities in Portugal

In the Portuguese trials, the feedback on OLA system evaluation was collected from Seniors, Informal Caregivers and Formal Caregivers. During the first phase, it was tested at Seniors home, and at a later stage in an institution. In comparing with the second phase, occurred at the institution, the continuous monitoring was performed with the formal caregivers, where the evaluation was focused more on them considering that they represent the primary customer segment. The measurement protocol for each of the two measuring devices was as follows: the informal/formal caregiver transports the equipment to the user, performs the measurement and then takes the equipment next to the kit for transmitting the data to the Raspberry Pi (gateway). A note regarding the recruitment for the difficulty of incorporating in this pilot the caregiver in an earlier stage, since most of the seniors involved are almost totally autonomous or without family member responsible for it. Nevertheless, at a later stage was possible to assess OLA centred on the caregivers' perspective, to evaluate their interest, perception and a general evaluation of the product.

5.4.2 Pilot Activities in Hungary

Initially, both the elderly volunteers and the caregivers were concerned about the need to use new tools and new processes (e.g. data upload) but because of the trainings that had taken place several times, these concerns have quickly disappeared, and the participants confidently, properly and safely used the OLA tools. Due to the nursing home environment, it was necessary to customize the tools used in the OLA system. The reason for the necessary modification was that in the pilot each device is used by several older people (users) and caregivers perform and help performing all measurements. Automation of authentication proved to be a good solution: NFC tag was used to reliably and quickly identify users. Similarly, to the Portuguese practice initially system deployment, infrastructural improvements and tests took a considerable amount of time.

5.4.3 Pilot Activities in Sweden

The Pilots in Sweden has been focused on home support as institutions are hard to approach in research cooperation. The institutions and private companies in elderly care are underfunded with high penetration of technology and with a problem of understaffing. The penetration of smartphones is relatively high in Sweden and increasing fast due to elderlies learning to use them and new generations coming in to the segment. The consequence is that communicational and planning aspects of OLA gains a very little interest. On institutional level the system OLA competes with already established technology and will get attraction by presenting it as an easy to use, stable and economical alternative.

5.5 Technical Evaluation

The frequency of the measurements varied from one measurement per day to five measurements per day for glucose and ranging from one to three measurements per day for heart beat and blood pressure. This frequency was adjusted to the health condition of the elderly, namely the existence of a diabetic condition and heart problems. The performance of the OLA platform in what is related to the time to upload the data was in the order of a few minutes if the data was successfully transmitted to the cloud and to the IRINA App, but lasted significantly longer in other, not rare, instances when communication problems between the measurement devices and the platform were observed. These problems are related to the Bluetooth communication protocol that handles the data transfer from the measurement device to the gateway. The caregivers had access to IRINA account where all the measurements from all the kits, part of the pilot, were available. Through this tool the caregivers could monitor the evolution of the pilot. There was a positive feedback from the main caregiver in what relates to the use of this IRINA account. It was regarded as very positive the availability of graphical output of the measurement data, through the history of the collected data, and the simplicity and ease of use of the application. Nevertheless, it was pointed out in the meetings that took place with the caregivers of the Portuguese institution, the valuableness of having an alert mechanism to signal when the measured data are outside the normal values. Through this caregiver account of the IRINA App there is the possibility of fostering the communication with the elderly, and its most direct formal caregivers regarding the results of the measurements of the biometric data in a timely manner. This communication that is enforced by the OLA Platform creates an efficient channel between the seniors and the caregivers to exchange not only health data, but also agenda events and general-purpose messages.

The use of the OLA platform and the IRINA App by the elderly, gives them the notion of having their overall health being carefully monitored by the caregivers, allowing them to feel more secured about the need of proper treatment if any health problem arises, when reflected by changes in the biometric data. They understand the need of their health data being stored and transmitted by the OLA platform, since appropriate security mechanisms are enforced, of which they are aware. The OLA Box proved to be effective as a monitoring tool of biometric data from the elderly users, apart from the data transmission difficulties that were encountered.

5.6 Participants Evaluation

During the OLA pilot activities seniors, formal and informal caregivers tested and validated the OLA system. Most of the participants in the pilot used at least occasionally blood pressure and blood glucose meter, while panic button, balance scale or smart watch or band were unknown to all participants. With these tools, special attention was paid to training and according to their utilization special attention was paid for the safety, needs and expectations of both for the elderly and caregivers.

5.6.1 Seniors

From the feedback received on the surveys, the seniors revealed that their preference and interest is mainly on the Health module. In fact, the seniors in Portugal are still far from the technology use and are still suspicious on the use of the devices and applications and when it comes to the use of their health data they also want to be sure that is a trustful solution and only their doctors or familiar persons can check their data. The seniors have found difficulties on using the agenda, as they revealed that they are not so interested on using the agenda functionality. The agenda, as well the communication, should be centred on the caregivers' perspectives and needs. Nevertheless, it is important to point that the seniors find OLA an easy application to use and understand, as the senior participants shared that OLA is good platform regarding usability, a simple mechanism of accessing the different options and the data collected is well represented and easy to track.

The feedback from Hungary showed that elderly people are primarily interested in the Health Module because it seems to be the most useful and most accepted service for them. It was sufficient for them, when caregivers reported and showed them the actual and the previous measurement results after the measurements to see.

The elderly themselves as the Swedish pilots were performed with elderly people living at their own homes. The health module was their preference of choice since all of them had other preferred means of planning and communication, mostly smartphones. They were very satisfied with the function of visualizing historical data to see their changes over time. There were some problems with the transmission of the data already mentioned that were solved by reboots of the gateway. In the Swedish trials performed with elderly in their own homes showed that the main interest in the OLA system lies in the health module.

5.6.2 Formal Caregivers

During the pilot researchers always tried to co-operate with caregivers without putting unnecessarily heavy burdens on them and cause as little change in their daily activities, schedules and routines as possible. The Formal Caregivers in Portugal have expressed, even though not so clearly as the Informal Caregivers, an easy impression on the action for checking the Health Status. In parallel with the Informal Caregivers, these caregivers also struggle to use the application to enter in contact with the respective informal caregivers. The nurses in the overall, found the system is user friendly, with an agenda easy to use - this in contrast with the informal caregivers. It is important to notice that the nurses are used to use technology as there was not identified any barrier between them and the use of OLA system. Nevertheless, there were some important justifications given by the few doctors who shared their difficulties on performing some tasks when using the agenda: Difficulties on copying the events over the week and that there was a margin to still improve the process of registering events. The nurses could not be more satisfied with OLA in terms of its utility to support care on seniors, as they all expressed clearly this aspect. In fact, OLA can make the life of caregivers much easier, improving the productivity of the caregivers and in the overall department of the institution. The possibility of accessing the data on an application and sharing if necessary this information with the informal caregivers avoids the unnecessary appointments and improves the quality of the appointments with the senior to discuss results on their health conditions. The Formal Caregivers are in line with the Informal Caregivers in respect of giving them a sense of trust and confidence to the relationship between them and seniors, as well as time and cost saving, with significant improvements on their productivity level of work. The two major advantages pointed by the formal caregivers regarding OLA are:

- the display of measurement data and graphs are useful and highly welcome but due to Hungarian regulations manual recording of measurement data are still required and cannot be omitted;
- NFC key-holders needed to assign measurements to persons cannot be released to the elderly residents because they often lose and cannot find them; it is necessary to be retained by formal caregivers and passed on to elderly users prior to measurements and then safely removed again after authentication;

5.6.3 Informal Caregivers

The Informal Caregivers have shared interesting and important information which should be used to analyze and consider implementing before OLA's market introduction. All the informal caregivers have shared the easy process for accessing the data and analysis – the informal caregivers revealed that the graphics illustrating the results with the respective results represents a huge benefit for them by giving them a sense of safe for the seniors under their responsibility. A significant percentage of Informal Caregivers found it hard to use the agenda on the seniors, also found by the Formal Caregivers – this point is clearly a feature that must be improved as already mentioned before. Nevertheless, it should be considered that the communication process can be improved, by optimizing the options for contacting and assuring a good level of usability. The Informal Caregivers have expressed clearly that the OLA solution gives a sense of trust and confidence to the relationship with seniors as nowadays is extremely difficult for the informal caregivers having a continuous physical presence with their relatives, at least as much as they would like to and feel they should. A clearly perspective by the Informal Caregivers is also expressed by the time and costs saving advantages of OLA, as in terms of logistics and communication, the possibility to monitor the health conditions of the senior gets cheaper and easy by using only an application.

5.6.4 Next Steps

Some improvements were identified by the nurses regarding OLA system:

- Incorporate the Agenda Web Portal in IRINA app and make it more user-friendly;
- Possibility to print the reports to present to family's doctor;
- Improve interface between informal caregivers and themselves;
- With the dependency on the Bluetooth connection, it is necessary to fix connectivity uncertainties that occurred relatively often to make the data upload more secure, reduce the number of unsuccessful data uploads;
- Improve speed on registering activities.

Final Considerations

From the feedback collected, the end users shared that OLA is very useful for both type of users, since regular monitoring of the measured data (weight, glucose, blood pressure and heart rate) gives users a positive sense of personalized follow-up on their overall health status and more particularly for those who has a chronic disease. In this way, it allows them to increase the degree of trust on both informal and formal caregivers in this process. It is also more natural for informal caregivers and even for users to detect situations that motivate medical intervention early, which may be summarized, as appropriate, to a review of the medical prescription that has an impact on the measured parameters.

This platform is also particularly useful in the centralized management by the formal caregivers of the users in charge who are using this system. It is thus possible to save human and material resources during this process, as the system allows a single formal caregiver to have access to the data of users under their responsibility. In this way, the formal caregiver can combine own actions with the corresponding informal caregivers and other formal caregivers, to respond to situations reproduced in measured health parameters, possible new pathologies, the aggravation of others already known pathologies or the improvement of the user's state of health. Consequently, when using this platform, the formal caregiver can increase their effectiveness, mainly in the tasks of monitoring the seniors also on communicating with the respective informal caregivers, allowing the caregiver to be available to other tasks that need attention of this specific caregiver.

OLA offers an important initial step on incorporating an agenda in a such application that is focused on improving and easing the daily tasks of the formal caregivers, while owns the functionality to monitor chronic diseases in an easy and portable way for multiple users.

In the future an additional effort should be made regarding the training of the seniors to explain the advantages of using other features of the OLA solution, like Messaging and Agenda, eventually with the help of informal caregivers, that could improve the overall experience of using this solution.

The platform maintenance and development require a long-term investment in qualified personnel and the corresponding infrastructure. There is also other needs to be an easily reached contact point available for every language/region supported by OLA. Physical setup staff for installation of sensors etc. will be based locally, although this can be solved through local partnerships for the OLA operation to stay lean. Market supporting activities including advertising will be needed to grow the customer base. This will initially be done market for market and could at a later stage scale towards a multinational setup depending on the similarity and level of maturity of markets. The data collected needs to be analysed and refined to sift out valuable knowledge that will used to improve the OLA platform. Statistical insights, once depersonalized, can be marketed to commercial entities or used by research organizations.

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