MedGUIDE

ICT Integrated System for Coordinated Polypharmacy Management in Elders with Dementia

D1.2 1st version of MedGUIDE system architecture, user interfaces and services design

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VERSION HISTORY

Version	Authors	Date	Description
0.1	TUC (Tudor Cioara, Ionut Anghel)	7-11-2017	Initial structure and contribution requests
0.2	CCARE (Janna Alberts, Michelle Manen)	9-11-2017	Design requirements, initial example personas, scenarios and instructions
0.3	TUC (Tudor Cioara, Ionut Anghel, Viorica Chifu, Ioan Salomie, Marcel Antal, Claudia Pop)	21-11-2017	Draft version of sections 6 and 7
0.4	CCare(Michelle Manen, Janna Alberts), IVM (Els Dik), HU (Chantal Huisman, Bas Steunenberg), Materia (Sotia Nicolaou), Karde (Riitta Hellman)	24-11-2017	Integration of scenarios and personas from end-users.
0.5	CCare (Michelle Manen, Janna Alberts)	24-11-2017	First wireframe design
0.6	Karde (Erlend Øverby)	28-11-2017	Draft version of section 4
0.7	CCare (Michelle Manen, Janna Alberts)	29-11-2017	Addition of the wireframe design
0.8	IVM (Els Dik), Materia (Sotia Nicolaou), HU (Chantal Huisman, Bas Steunenberg, Helianthe Kort)	29-11-2017	Review Personas and Scenarios
0.9	Materia (Sotia Nicolaou), IVM (Els Dik), HU (Rob Heerdink), Karde (Riitta Hellman)	29-11-2017	Review Wireframes
1.1	CCARE (Jan Keijzer)	30-11-2017	Draft version of section 5
1.2	Karde (Erlend Øverby)	1-12-2017	Compiled all contributions into one document
1.3	Karde (Erlend Øverby)	3-12-2017	Finalised Executive summary and conclusion
1.4	Karde (Riitta Hellman, Erlend Øverby)	4-12-2017	Technical description updated
1.5	CCare (Janna Alberts)	20-12-2017	Updated wireframes section
1.6	Materia (Sotia Nicolaou) and Karde (Riitta Hellman)	21-12-2017	Review Section 1 User experience design
1.7	Ccare (Janna Alberts)	21-12-2017	Updated Section 1 based on feedback
1.8	Karde (Riitta Hellman, Erlend Øverby) and Ccare (Janna Alberts, Martijn Vastenburg)	22-12-2017	Merge Section 1 and 2
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2.2	Vigisense (Serge Grisard)	10-01-2018	Review D1.2
2.3	HU (Chantal Huisman, Bas Steunenberg, Helianthe Kort)	19-01-2018	Review D1.2
2.4	Ccare (Janna Alberts, Martijn Vastenburg) Karde (Riitta Hellman, Erlend Øverby)	31-01-2018	Final version D1.2

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1 Executive summary

This document presents the intermediate results of task 1.2 (architecture and services design) and task 1.3 (user experience design). The document is used to align and guide the development of the MedGUIDE platform including the applications for medication adherence for the benefit of people with dementia and their caregivers.

Section 1 describes the user experience design. Using wireframes, the MedGUIDE concept is sketched and explained. The wireframes will be evaluated with users in task 3.2; based on the feedback from users, the final design will be developed.

Section 2 describes the architecture and services design. Section 2 starts with a description of the system architecture, and then provides a detailed explaination of the components.

2 Introduction

The MedGUIDE project aims to improve the quality of life of older people, to support the network of informal caregivers, and to prevent reduction in the medication self-management capabilities of the elderly persons, all in order to prolong independent living. End-users of the MedGUIDE system are: people with dementia (PwD) (primary), formal and informal caregivers (secondary) and healthcare and pharmaceutical professionals (tertiary).

This document presents the intermediate results of the user experience design task (T1.2) and the architecture and services design task (T1.3).

Section 1 describes the user experience design. Using wireframes, the MedGUIDE concept is sketched and explained. The wireframes will be evaluated with users in task 3.2; based on the feedback from users, the final design will be developed.

Section 2 describes the architecture and services design. Section 2 starts with a description of the system architecture, and then provides a detailed explaination of the components. The section provides a starting point for understanding how the different components of the MedGUIDE system work together.

We decided to use the "4+1 architectural view model[1]" to prepare the architecture view of the MedGUIDE system. With a 4+1 architectureal view of the system we are able to capture the different perspectives and considerations that are behind the development of a complex system such as MedGUIDE, where several different categories (activity/medication/well-being/adherence) of information is collated and analysed.

In deliverable 1.2, the MedGUIDE components have been described by the technical partners responsible for each component. These "sub" architectures will guide the development of the specific part of that system. The resulting conceptual architecture will be used to align how the different sub-systems share and communicate data.

[1] https://en.wikipedia.org/wiki/4%2B1_architectural_view_model

Section 1: User experience design

3 Design requirements

D1.1 presents the user requirements resulting from the user research. Based on the user requirements, we have defined a clustered and prioritized list of design requirements, which combine the user requirements with the technical requirements as described in the MedGUIDE proposal. The design requirements serve as a basis for the next conceptualization phase. The design requirements are a first step in the analysis phase, in which the perception of the end-users and stakeholeders are deduced. The requirements consist of decisions that define the direction in which the solution will be sought. Writing the design requirements can therefore be seen as a design activity. Therefore multiple requirements can be developed which are equally suitable for the same problem.

The requirements have been clustered in functionality groups; this clustering reflects a first design step towards the MedGUIDE concept design. For each requirement, it is indicated whether the requirement is based on the user research, the proposal or a combination of both. In the second step, an overview of, the priorities of the requirements are indicated, see table 1. These are indicated based on the prioritisation of MoSCoW (Must, Should, Could and Wish). In the column furthest to the right, the requirements are linked to the target group. Some requirements are focused on all end-users but specific requirements might be only for a specific group of users. All caregivers include informal caregivers, and home care nurses which are both part of the secondary end user group. Professional caregivers such as the pharmacists, the general practitioners and specialists are part of the tertiary end-user group.

Table 1 Insight in wellbeing of PwD

	Description of the Requirement	Source	MosCoW	Target group
IW1	MedGUIDE should provide information about the daily patterns and changes in wellbeing to support the PwD and the care network.	User research	Must	All
IW2	MedGUIDE should provide insights about pro-/regression of the PwD.	User research	Should	All
IW3	MedGUIDE will support the PwD and care network in creating a personalized roadmap.	Proposal	Should	Secondary and Tertiary caregivers

[1] Achimugu, P., Selamat, A., Ibrahim, R., & Mahrin, M. N. R. (2014). A systematic literature review of software requirements prioritization research. *Information and software technology*, *56*(6), 568-585.

Table 2 Medication use & adherence

	Description of the Requirement	Source	MosCoW	Target group
MA1	MedGUIDE should support the PwD and the care network to easily communicate about changes made to the prescribed medication (for example the type, dose, colour or shape)	User research	Should	All
MA2	MedGUIDE should provide access to personalized information about safe and secure medication intake based on the type of medication and type of administration. Video's, photo's or other communicative materials will be complementary.	User research	Could	All
MA3	MedGUIDE should be able to provide positive feedback and motivating reminders to promote adherence.	User research	Should	PWD
MA4	MedGUIDE should support the PwD in taking the correct medication doses; and prevent double doses.	User research	Wish	PWD
MA5	MedGUIDE should facilitate the care network of the PwD in providing positive feedback and motivating reminders to promote adherence and contribute to a manageable care load	User research	Could	All caregivers
MA6	Reminders for medication intake should be visualized clearly. For example, presenting the time of medication intake in readble fonts or using a clock visualization, and the day of the week should be presented rather than a specific date.	User research	Should	PwD
MA7	MedGUIDE should avoid information overload by providing filtering mechanism to provide only needed or relevant information.	User research	Should	Professionals
MA8	MedGUIDE should provide insight into polypharmacy and possible contra-indications	User research	Could	All caregivers
MA9	MedGUIDE should provide the health care professionals information in the medication review process.	User research	Wish	Professionals
MA10	MedGUIDE will support the informal caregivers to provide personalized reminders to the PwD.	User research	Could	Caregivers
MA11	MedGUIDE will support the care network to assist in the medication adherence by checking if medication has indeed been taken.	User research.	Could	Caregivers
MA12	The system should give understandable information about medication management;	User research	Could	Caregivers
MA13	The system should be able to exchange information with - or be fed by - the pharmacy system, with regard to medication adherence information of the PwD	User research	Should	Professionals
MA14	The system should be able to provide more detailed information about medication adherence than the pharmacy system. For example by collecting data from the PwD.	User research	Should	All caregivers

MA15	Reminders for medication use should repeat itself until the PwD physically turns the alarm off. Informal caregivers will be notified and can act based on the information, by for example sending a new reminder.	User research	Wish	PwD

Table 3 Monitoring and triggers

	Description of the Requirement	Source	MosCoW	Target group
M&T1	MedGUIDE will support PwD and care network in improving the medication adherence by providing relevant information and sending medication reminders to the PwD.	User research	Must	All
M&T2	MedGUIDE should track and monitor possible (side-)effects of the medication, either by using sensors or by using self-reports.	Both	Should	All
M&T3	MedGUIDE can communicate/alarm the PwD and/or the care network when there is a deviation of daily behaviour, routine or medication intake.	User research	Could	All
M&T4	The PwD with support of the care network defines which medication alarms and information are communicated to the care network and notify specifically the central caregiver.	User research	Could	All
M&T5	MedGUIDE should detect deviation of daily behavior, routine or medication intake.	User research	Could	All caregivers
M&T6	To give the care network and PwD insight into the wellbeing and (adverse) effects medication and dementia can have, MedGUIDE will be able to track the daily patterns of PwD. Insight into the wellbeing can be created by tracking daily live patterns such as daily activity, door patterns, sleeping patterns, medication patterns, eating patterns, bathroom patterns, and wandering.	Both	Must	All
M&T7	The sensors used should be able to track the daily live pattern of the PwD without input from the PwD him/herself.	User research	Should	All
M&T8	The PwD with support of the care network defines what daily patterns will be monitored, what sensors will be used and where these needs to be located.	Both	Must	All
M&T9	MedGUIDE will use data from IoT devices used in and around the house.	Proposal	Wish	All
M&T10	The online tool should have a signal function. Signals can indicate to formal caregivers how things are going with the PwD. It should also provide information and have an alarm function when things go wrong or not as expected	User research	Should	All

Table 4 Self-reports

	Description of the Requirement	Source	MosCoW	Target group
SR 1	PwD are able to report and share information about their mental or physical wellbeing using self-report, for example their mood, or physical discomfort.	User research	Must	PwD
SR 2	PwD, informal caregivers, and healthcare professionals are able to enrich the sensor data by using self-reports and observations	Both	Must	PwD
SR 3	MedGUIDE will support the PwD and the care network to report activities, patterns, health data such as, their weight, appetite, but also about physical(dis)comfort, physical activity, and social interactions.	Both	Should	All
SR 4	MedGUIDE should support PwD and the informal caregivers to share self-reports with the care network (including pharmacists, doctors and home care nurses)	User research	Should	PwD and informal carer
SR 5	Medguide should provide the PwD and caregivers insight in daily lives through self-reports.	User research	Should	All

Table 5 Privacy

	Description of the Requirement	Source	MosCoW	Target group
P1	MedGUIDE should support the PwD and his/her informal caregiver to determine access rights: who will be granted access to what type of personal information?	User research	Must	All
P2	Sensitive information should be adequately protected, but should be accessible by relevant parties.	User research	Must	All

Table 6 Supporting the care network

	Description of the Requirement	Source	MosCoW	Target group

SC 1	MedGUIDE will give insight in the care network members involved in the care of PwD, for all stakeholders involved.	User research	Must	All
SC 2	MedGUIDe should facilitate communication between professionals, informal caregivers and PwD. MedGUIDE will be usedin addition to the medical systems (such as the personal health record), but will be mainly used to share insight into the network, for collaboration, information and awareness.	User research	Must	All
SC 3	The care network including the PwD must be able to share/upload relevant information on the wellbeing of the PwD, without overlapping with personal health record.	User research	Should	All
SC 4	MedGUIDE should support the care network in balancing care load.	User research	Could	All caregivers
SC 5	MedGUIDE should support the care network in keeping track of all information provided during visits to the professionals.	User research	Could	All
SC 7	MedGUIDE should support professionals to report only relevant information that is not shared via other tools (such as the personal health record).	User research	Should	Professionals
SC 8	MedGUIDE should take into account the experienced high care load of the informal caregivers, and if possible help decrease the experienced workload.	User research	Could	Informal caregivers
SC 9	MedGUIDE will support the care network to give insight into the wellbeing of the senior using a timeline which provides a visual and insightful overview of the self-reports as well as the monitoring data.	User research	Could	All caregivers
SC 10	Information of/and reports on online counselling could be shared with the care network using MedGUIDE.	User research	Wish	All caregivers

Table 7 Support in Daily lives

	Description of the Requirement	Source	MosCoW	Target group
SD 1	MedGUIDE should support the PwD with positive feedback to support their daily routines.	User research	Could	PwD
SD 2	MedGUIDE will support the PwD and the informal caregivers to know when to alarm and contact professionals	User research	Should	PwD and informal carer
SD 3	MedGUIDE should provide the informal care network access to information on how to support and take care of a person with Dementia related to medication adherence.	Both	Should	Informal carer

Table 8 Integration in care process

	Description of the Requirement	Source	MosCoW	Target group

IC1	MedGUIDE will provide a filtering mechanism, filtering the patietns information, in order for professionals to access the information they require.	User research	Could	Professionals
IC2	MedGUIDE should support professionals to easily access the needed information.	User research	Could	Professionals
IC3	Links to information systems of other organizations should be possible.	Both	Could	All
IC4	The system should remind PwD and informal carer to take medication or to go to an appointment.	User research	Could	PwD and informal carer
IC5	Notifications sent to professionals about missed medication should only be sent in cases of crucial medication in order to prevent an overload in their work/tasks.	User research	Wish	Professionals
IC6	Healthcare professionals should be able to exchange and add practical knowledge and skills with each other through the ''online tool'', which has to be efficiently for them (minimum extra effort and time required);	User research	Wish	Professionals
IC7	The system should not cost the GP and home care nurses too much time, since they state that time is very limited	User research	Should	Professionals
IC8	It should be clear to the GPs what the advantage of the system is for them, since they tend to refer to the formal caregiver for the mentioned tasks.	User research	Should	Professionals
IC9	The tool could support the medication review by making the review easier to organise.	User research	Wish	Professionals

Table 9 E-learning

	Description of the Requirement	Source	MosCoW	Target group
EL1	MedGUIDE will provide the PwD and the care network access to information about side- or adverse effects of the medication the PwD is using.	Both	Could	All
EL2	MedGUIDE should provide the PwD and the care network access to information about the effectiveness of the medication that are prescribed to him/her.	User research	Could	All
EL3	MedGUIDE should have an e-learning module for informal and formal caregivers about how to support PwDs – for example how to communicate to PwD in order to support the medication adherence.	Both	Must	All
EL4	MedGUIDE will support the PwD and the care network in understanding and defining symptoms.	User research	Could	All
EL5	MedGUIDE should provide the PwD and the care network information about symptoms related to Dementia Syndrome and what symptoms to expect for each phase.	User research	Should	All

Table 10 Implementation and user support

	Description of the Requirement	Source	MosCoW	Target group
I&U1	MedGUIDE should support users in using the platform by giving introduction and instruction on the interaction with MedGUIDE. For example an introduction video or instruction manual could be provided.	Both	Should	All
I&U2	MedGUIDE should be intuitive to use, user should be guided by MedGUIDE	User research	Should	All
I&U3	It is important that the PwD himself can see the advantage of the online tool; “What’s in it for me?".	User research	Must	PwD
I&U4	The location of the interactions of the user with the MedGUIDE platform should be adaptable to the routine ? people have at home.	User research	Should	PwD
I&U5	The system should be linked to a daily routine, such as reading the newspaper.	User research	Should	PwD

Table 11 Usability/Ergonomics

	Description of the Requirement	Source	MosCoW	Target group
U1	The threshold to use MedGUIDE should be low.	User research	Should	All
U2	The MedGUIDE interface is adaptive and can be adapted based on the needs of the users	Proposal	Could	All
U3	The MedGUIDE platform can be used on different devices, such as the computer and or tablet.	Proposal	Must	All
U4	MedGUIDE should take into account all level of ICT-skills	Both	Should	All
U5	The User Interface elements used (such as symbols and buttons), should be easily understandable	User research	Could	All
U6	The user interface contrast and font sizes used must be adapted to a PwD	User research	Wish	PWD
U7	The MedGUIDE device should take into account decreased hand, hearing or visual impairments.	User research	Could	PWD
U8	MedGUIDE should take into account the limitations in (functional) decline due to the dementia syndrome.	User research	Wish	PWD
U9	MedGUIDE should take into account users with all levels of health literacy	User research	Could	All
U10	The MedGUIDE tool should be easy to learn and to use and it should be a fluent process.	User research	Should	All
U11	The tool should name the days of the week, not the date. Or use a calendar.	User research	Could	PwD

U12	Use colours and pictures instead of text.	User research	Could	PwD

4 MedGUIDE user interfaces and services design

4.1 Personas and scenarios

Personas and scenarios have been developed for each end-user country by the end-user partners involved. The personas are used as tangible 'example users' which guide the designers throughout the design process. The scenarios illustrate how the MedGUIDE platform could fit in daily life, considering the local needs and context of the countries involved.

4.1.1 Personas (The Netherlands)

Primary end-users: Persons with dementia (PwDs)

Secondary end-users: Informal caregivers as well as nurses and other care professionals who provide care at home

Tertiary end-users: Pharmacist and physicians (GPs)

Lisa Smit-Verheij, 79 years old, Person with Dementia

Lisa is a social lady, who lives alone in an apartment in a small village. She lost her husband ten years ago due to cancer. She has three children and ten grandchildren. After getting married and having her first child at 23 years old, she became a housewife; she took care of the household and the children up until the youngest was 18 years old. She always loved to paint and sculpt and was very good at it. As soon as she started to get more time on her hands, she began working with her husband, who had a small accountancy firm next to the house, by doing administrative work and began to take art classes. When she eventually retired, she began teaching art at the local community house. Therefore, it is no surprise that Lisa likes to be as independent as possible. She likes to take a stroll every other day or do groceries on her own when she feels like it.

Currently, two of her three children live 'an hour's drive' away and all of them have busy work schedules. Her youngest, daughter Barbara, lives in a village nearby which allows her to provide Lisa informal care. Lisa takes medication for her rheumatism, high cholesterol, high blood pressure, sleeping pills 'when necessary' and calcium tablets for her bones.

Early onset dementia is not officially diagnosed, but she keeps forgetting things, such as taking her medication at the right time or the fact that she checks the mail 4 times a day. Barbara, but also Lisa's close friends, noticed this and thus Barbara warned Lisa's GP. Therefore, her GP has indicated that she should have a medication-roll. (GDS or baxter-roll; a medication container containing the needed medication for that day and time). The pharmacy delivers this medication-roll once a week at her apartment. She takes the medication herself although she doesn't know exactly what the medication does for her health, but based on her GP's advice she decides to take them anyway. Once a week, a community nurse gives her an injection with methotrexate for her rheumatism. Recently Lisa has been admitted to hospital for two days because of a fall. She is home again and all is well now. The specialist made some adjustments to Lisa's medication .

A month ago, Lisa has gotten an 'IPad' from her children for her birthday. She is eager to learn how to use it and is curious about its potential.

Barbara Pieters-Smit, 51 years old, informal caregiver

Barbara is a married woman with three children. She works fulltime as a communication advisor. Two evenings a week she volunteers at an asylum seekers' center. There she helps people learn the Dutch language. She loves walking with her family through the forest or at the lakeside, which is why she moved near to her home town. Her two siblings on the other hand, moved quite far away. They both live at least one hour away (without any traffic). This means that Barbara, next to her already busy schedule, feels responsible for the care of her mother Lisa.

Off course she loves her mother a lot, but sometimes she wishes her siblings could help out more. She does keep them updated via a group chat on WhatsApp whenever she has visited her mother. Last month when Lisa fell and was admitted to hospital, she kept them posted on what was wrong, what the injury looked like via photo sharing and what medication was given to her. This way, she can also share her concerns about their mother's mental health; Barbara has noticed that her mother is getting a little forgetful lately, confused and disorientated and the conversations she had with her mother's neighbors confirm this fact. That is why she warned Lisa's GP. She tries to come over every other day, and calls her daily to talk to her and to hear if she is taking her medication. She regularly has contact with Amy, Lisa's community nurse, who told Barbara she sometimes finds unused medication bags on the table or in the cabinet. Because of her concerns, Barbara doubts whether her mother can still live at home on her own. Her siblings share her concerns. They gave Lisa an IPad for her birthday so they can stay in touch more, like via FaceTime or Skype. This allows Barbara's siblings to also keep an eye on her mother and in this way Barbara feels a little less pressure.

Amy den Boer, 28 years old, formal caregiver at Home care organization 'Care4u'

Amy has been working as a community nurse for home care organization Care4u for the past 3 years. She is a 'level 3' carer (nurse assistant), which means she has had three years of professional education. She is not a nurse, but a 'helper' ('helpende, verzorgende IG'). She did not learn a lot about medication within her education. Care4u recently asked her to follow an e-learning course about medication for the elderly. Still, she is a bit insecure about whether she can recognize all the signals of unwanted medication use in the elderly she takes care of. Lisa is one of these elderly, Amy gives Lisa an injection of methotrexate once a week for her rheumatism. She does sometimes find unused medication bags on Lisa's table and when she does, she signals this to Lisa's daughter Barbara. She tries also to be in close contact with the GP but this is not always the case.. Amy wishes the communication lines were more direct, also because sometimes she has questions while she's working.

Tanja Barten, 35 years old, Pharmacist at Pharmacy 'Your health'

Tanja is a pharmacist in Pharmacy 'Your health', a medium size pharmacy in the village Lisa lives in. She finds it important that her team of assistants is customer friendly. Recently, her team has followed a course 'Handle people with dementia'. She has a good relationship with the five GPs in the village, but there is not always enough time to discuss individual patients.

Six times a year Tanja has Pharmacotherapy consultation with the five GPs in the village. During this consultation, they discuss medication guidelines in general and prescription data from the GPs which Tanja analyses for them. They try to perform medication review for seventy patients with polypharmacy and a risk factor (like cardiovascular risks such as heart failure), but often there is only time for evaluation of 30 patients per GP per year. PwDs are not evaluated in a medication review. The pharmacy works together with home care organizations. There used to be one in the village, but recently three new home care organizations provide services for patients in Pharmacy 'Your health'. Sometimes an independent caretaker has a contract with a patient from the pharmacy. Tanja does not have an overview of which patient receives which medication/help from whom. She would like to have this information.

Jos Kuijpers, 55 years old, general practitioner (GP) at General practice Kuijpers

Jos has a big and busy practice, with two colleagues. There is a nurse practitioner who does the 'follow up' diabetes care, asthma care and sometimes visits the frail elderly. Jos motto is 'no nonsense'. He does not like to be disturbed with small practical things about patients. He delegates these things to his practice assistant and his nurse practitioner. He is enthusiastic about new digital systems and the possibilities they provide, as long as they do not cost him too much time.

4.1.2 Scenarios (The Netherlands)

(CC/HU)

Actors: Lisa and Barbara	Getting insight in well-being and Improving medication adherence
Name: Lisa needs to take her medication on time	
Scenario: *Lisa starts with her usual morning routine by having a cup of tea and preparing breakfast. The sensors on Lisa's bed, fridge but also in her bathroom, signal MedGUIDE that Lisa is awake and about to start making her breakfast. MedGUIDE sends an audio and visual reminder to Lisa to take her medication. MedGUIDE knows that when Lisa is going to eat her breakfast, she has to take her medication. It is really important that she does this at breakfast and therefore MedGUIDE won't stop reminding her until the pills are taken out of the smart pillbox. MedGUIDE also asks Lisa for confirmation after taking her medication. Lisa confirms she took her medication by speaking to the system.* *In the meantime, Barbara is almost ready to go to work, but wants to check up on her mother before heading out. She sees that her mother is enjoying breakfast right about now and that she took her medication. Barbara is up to date and ready to go to her work without feeling concerned.*	

(IVM)

Actors: Tanja, Lisa, Jos, Amy	IVM Signals from the pharmacy
Name: Lisa forgets when she receives medication rolls	
Scenario: *Once a week Tanja's pharmacy delivers a medication roll at Lisa's apartment. Lisa (PwD) opens the door and receives the medication roll. Recently, Lisa phoned the pharmacy that she has not received the medication roll. Tanja sends a new role and makes a note in MedGUIDE. Two days later Lisa phones again: she does not have her medication role. Tanja sends a message to Amy (the nurse) to ask wether she will visit Lisa and discuss with her what happened to the medication. That day, when Amy visits Lisa, she notices that Lisa is is confused and doesn't know where the medication is. Amy sees medication bags lying in the kitchen drawer, on the couch and in the bedroom. She sends a message to Jos (the GP) and Tanja (the pharmacist), indicating that Lisa might be in need of regular medication support provided by a community nurse. At the same time, she contacts the main informal caregiver Barbara to update her on the situation, and to plan a meeting with the General practitioner Jos. The other children are also notified through MedGUIDE.*	

(HU/IVM)

Actors: Lisa, Barbara, Amy, Jos, Tanja, Lisa's other children	Supporting the care network, getting insight into well-being, and sharing information about the wellbeing of the PwD
Name: Monitoring and helping Lisa	
Scenario: *The first time MedGUIDE was introduced to Lisa and her care network, her daughter Barbara, Lisa and the general practitioner discussed what they would like to know about Lisa's wellbeing during the next few months. Therefore, MedGUIDE asks at predefined moments how Lisa is feeling, and if she is feeling any physical discomfort such as dizziness. They wanted to track Lisa's physical discomfort because they think it might be related to her medication. Lisa is asked wheteher she is feeling any discomfort based on the list of possible side effects related to her medication.* *MedGUIDE is also using sensor information about Lisa's daily pattern. The sensors in Lisa's living room, kitchen and on her front door indicate that Lisa has not been moving very much. She stays in her chair and does not go out any more. Lisa's children and Amy can see all the answers Lisa gives, as well as the sensor data.* *Barbara has a very busy week ahead of her, so she sends a message to Amy to ask her to be extra alert. MedGUIDE notifies Amy that she has a new message from Barbara. She reads it and checks the data from the self-report and sensors. Right away, she phones Lisa to ask if she can visit her today. It turns out that the dizziness is not very severe. Lisa and Amy discuss how she is feeling, and decide to wait and see how it progresses.* *The following week Lisa indicates that she is feeling worse. Also, the sensor data shows no improvement. As indicated during the introduction session of MedGUIDE, whenever Lisa is expressing that she is not feeling well, the care network will be alarmed. Amy sends a message to the GP, who can access the latest self-report and sensor data gathered from the PwD/Lisa. The same day, the GP's nurse practitioner opens the message box from Jos (the GP) and discusses the problem with him.* *Jos decides to send pharmacist Tanja a message to ask whether Lisa's medication could be the cause of the dizziness. Jos is not aware of any changes made to the prescribed medication, but thinks that there might be some changes made by a specialist. The specialist usually sends him a letter about it, but that can take some time. Tanja sends a message back via MedGUIDE with two possible causes for the dizziness. Jos phones Tanja and they conclude that the blood pressure medication, of which the dosage had gone up in the hospital, should be changed to the dosage before Lisa's stay in the hospital. Tanja registers the conclusions in MedGUIDE and the care network is updated on the situation.* *The next day the nurse practitioner asks Amy (the community nurse) if she can adapt MedGUIDE to track the dizziness level. The update will be shared with the whole care network, everyone in the network will be up to date. The nurse practitioner also adds Lisa to the list of all patients that will need a yearly medication review.* *Since the last update, the children agree to start visiting their mother more often, and set-up in the MedGUIDE agenda which day who will be visiting.*	

Actors: Lisa, Amy, Jos, Tanja	IVM Searching for the cause of dizziness and aftercare
Name: Lisa doesn't go out of bed and feels dizzy	
Scenario: *On Wednesday, MedGUIDE notices that Lisa has still not left her bedroom, even though usually Lisa would be in the kitchen around 9.00. MedGUIDE sends a notification to the care network indicating that something might be wrong. Amy responds to the message, and sends a message to the care network that she will visit Lisa. Fortunately, Lisa was feeling okay, but when standing up she felt so dizzy that she decided to stay in bed longer.* *Amy notifies Jos and the pharmacist via MedGUIDE, in order to start a discussion about the event that morning. Tanja answers the same day, via MedGUIDE, that the blood pressure medication can cause dizziness and even falling after getting up too quickly out of bed or out of a chair. But also, Lisa's sleeping medication weakens the muscles and can cause falling.* *During the next meeting, Jos, Lisa and Amy discuss to start tracking in more detail the dizziness level of Lisa. Now, Lisa's movements are being intensely followed. Her medication is adjusted and the dose of her sleeping pills is lowered. The whole network, including Lisa's children are notified with the latest changes.*	

4.1.3 Personas (Norway)

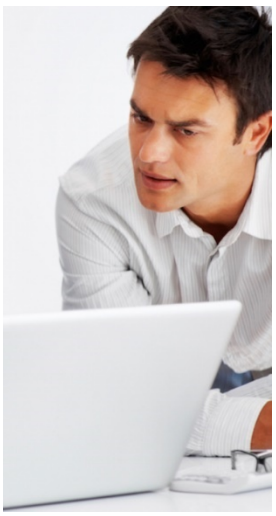
Eivind – PwD

Eivind (67) is a retired farmer. He divorced from his wife about twenty years ago. The ex-spouses agreed upon shared parenting, although Arne Olav would stay permanently with his father on the family farm. Eivind is an enthusiastic supporter of ecological farming. He has also been an eager fisher. Now, Eivind lives alone on the farm. Approximately one year ago, Arne Olav noticed that his father was experiencing memory lapses, more and more often.

Arne Olav had to convince his father to let their family doctor evaluate his memory skills. The result of the MMSE was crystal clear: Eivind suffered from a considerable memory loss and cognitive impairment. In addition to dementia, Eivind suffers from high blood pressure, glaucoma (pressure in the eye) and since his early years, Crohn's disease (a type of inflammatory bowel disease that may affect any part of the gastrointestinal tract).

Till being diagnosed, he managed to cope on his own. Today, Eivind receives services and formal care, such as medication support, meal service and care for personal hygiene, from the home care division of Oslo municipality. The provision of medication support is regulated by the healthcare law in Norway; municipalities are obliged to provide appropriate support. Eivind has now the medicine dispensing robot Evondos, located in his kitchen. The ambition is to eliminate the concerns caused by managing his complex medical treatment. This technology, together with his GPS watch and a fall detector – all provided by the municipality – helps in creating a stable and safe living situation. In addition, Eivind's son Arne Olav visits Eivind almost daily. Eivind will probably still be able to live in his home for months, if not a year or two.

Arne Olav – informal caregiver



Arne Olav (36) is the son of Eivind. He takes care of his father daily. Arne Olav works as a software engineer at an insurance company. His father Eivind was diagnosed with Alzheimer 4 months ago.

The situation is quite demanding for both father and son. Their family is small, and Arne Olav is the only relative and thus, family carer. He wants to learn – as swiftly as possible -- about dementia and the already prescribed medicines as well as the medications that his father receives to slow down the development of dementia. Arne Olav is an eager user of the MedGUIDE e-learning application. His ambition is to profoundly understand both the development of dementia and the different aspects of medications that his father receives. Arne Olav is also one of the first users of the MedGUIDE self-reporting app, in hope of being able to detect diverse effects or harmful interactions between the different medicines. His reports will not only be made available to the Oslo municipality's dementia team that takes care of the medical follow-up of Eivind, but also to a multi-disciplinary research team at the university of Oslo that investigates and develops innovative dementia therapies. As software engineer, Arne Olav is also engaged in suggesting improvements to the MedGUIDE system and its end user applications, which is greatly appreciated by the research team's pharmacists, physicians and ergotherapists.

Ann Catrin – home care assistant

Ann Catrin (24) is a newly graduated nurse. She wants to specialise in gerontology. Her approach is to work a couple of years in a municipal home care service for people with dementia. Her current status is 'trainee', which period will last for one month. After this, she will have the licence to visit the PwDs on her own..

Ann Catrin's job as a home care nurse will include such tasks as filling or loading the weekly or monthly medicine dispensing robots, performing and filling in a diary of diverse healthcare support activities (putting in eye drops, providing wound treatment, wearing and taking off compression stockings, serving meals and nutritional supplements, showering the PwD, maintaining toilet chairs, etc.). Ann Catrin visits 2 PwDs per hour, including driving from one home to another. During her night shifts, she only checks if the patients are in bed and sleeping well, and that the patients wear the alarm button. She has a very tight time schedule, and she experiences that the paperwork connected to the diaries and reports takes too much time. In her opinion, more time should be used on the PwDs' well-being in general. Her hope is to get more and better technology assistance for several tasks and so, be able to use some more personal quality time with the elderly.

Nina – regular general practitioner (RGP)

Nina (40) runs her own private general practitioner' clinic in Oslo. She is the regular GP (RGP) for about 1500 patients. Every person with an address in Norway is entitled to an RGP. The regular GP scheme is intended to promote continuity in the relationship between doctor and patient. Nowadays, an increasing number of Nina's patients are elderly people with MCI (mild cognitive impairment) or dementia. She experiences that it is sometimes difficult to handle all these patients with sufficient medical insights and knowledge of their actual situation. Very often, she struggles with decision-making that concerns the use of a broad range of different medications for the patient. The effect of the different medications can be difficult to evaluate due to the lack of suitable methods that can measure the effect, and because dementia is a progressive disease. Also, information about the particular patient's adherence to the prescribed medication is scarce, and symptoms that may indicate adverse effects or negative interactions between some of the medications, is missing. Also, the patients' dietary restrictions are difficult to follow up.

Nina uses in her practice standardised, highly secure ICT systems that are required by the Norwegian governmental heath authorities. Also, she has access to rich databases on medications and medication interactions. According to her own words, a more "direct line" from daily caregivers to her would be of great help, given that the arrangement would not substantially increase her current "ICT burden".

4.1.4 Scenarios (Norway)

Actors: Arne Olav, Eivind	**Sensor environment**
Name: Arne Olav installs sensors in the home and Eivind participates	
Scenario: In spite of dementia, Eivind is still able to live in his farmhouse home, given that he receives some support for his daily activities. MedGUIDE supports Eivind by assisting him with his "medicine regime". He takes several medicines and the daily rhythm and dietary requirements combined constitute a challenge for him. After a learning period, he is willing and able to use his medication dispenser. His caregivers – both son Arne Olav and his primary home care assistant Ann Cristin have noticed a few times that Eivind's pills that should be taken were lying on the kitchen table. The first time MedGUIDE was introduced to Eivind, his home care nurse and his son decided to use sensors to track his wellbeing. There is a sensor system available that observes motion in desired areas of the home, and based on usual movement patterns of the elderly the system can conclude what is about to happen. It is called MedGUIDE. Arne Olav has obtained this system from his municipality's home care division. He attaches the so-called beacon sensors close to the refrigerator, the water tap, the stove, and the kitchen closet where Eivind keeps his rye crisps, raisins, and Nescafe. Movements in these areas of the kitchen mean that Eivind is about to eat, drink and then take the pills which he has removed from the medicine dispensing robot. Eivind sets up the system so that the app sends to him and to the home care assistant on duty notifications or alarms whenever a specific medication has not been taken as planned. So far, the caregivers have been able to follow up Eivind and his medication intake at a sufficient level of precision, thanks to the sensor system. If this will not work they might be using the videocall linked to MedGUIDE, to assist Eivind in his medication intake.	

The next step they have planned is somehow to use Skype or similar to set up a video connection when it is time for Eivind to take the medicines, to see that it really happens.

The MedGUIDE sensor system can also be extended to cover observations of other aspects of the PwD's life than those related to the intake of medicines. It is possible to observe still-sitting, restlessness, sleeping patterns and use of the toilet. Such movement patterns may reveal diverse problems connected to medication. Eivind's caregivers have decided to wait with this installation until the kitchen installation of beacons is fully running and reliable.

Actors: Ann Cristin, Arne Olav, Eivind's neighbour	**E-learning**
Name: Ann Cristin and Arne Olav learn about dementia and polypharmacy	

Scenario:

Both Eivind's closest caregivers, son Arne Olav, Eivind's neighbour and Eivind's primary home case assistant Ann Cristin, would like to know more about dementia and all related aspects, such as polypharmacy management. Ann Cristin plans to become a specialised nurse in dementia care. For this endeavour, she has a special focus on medicine use in general, and dementia medicines and polypharmacy in particular.

Eivind's regular general practitioner has advised both to walk through a new e-learning app that covers just these topics. It targets "ordinary people" and formal caregivers such as home care service providers who need an easy-to-understand update regarding dementia, medicines, and the overall health situation of a PwD. The e-learning app provides concrete popular scientific presentations of how to support medicine adherence, information of interactions, side effects and adverse reactions, and what to observe if caregivers think that something is wrong that might depend on the PwD's medicine intake somehow. For formal caregivers, the app contains a bit more advanced information, for example access to international knowledge bases.

Both Ann Cristin and Eivind are eager users of the app. They have already agreed upon how to collaborate and exchange observations about the different aspects of Eivind's medication regime via MedGUIDE

Actors: Eivind, Ann Cristin, Arne Olav	**Self-reporting**
Name: Eivind, Ann Cristin and Arne Olav collect data through self-reporting	

Scenario:

Since Eivind suffers from several diseases, his medicine intake falls under the category of polypharmacy which in Norway is 5 or more prescribed medicines. This introduces a danger of side effects and adverse reactions, as well as negative interactions between the different medicines. Eivind's RGP has consulted several interaction databases to avoid problems. However, she has asked the caregivers to collect information that might reveal such problems. They should also advise Eivind to do a very simple self-reporting himself. Therefore, Arne Olav discusses this with his father, and decides that he will be tracking his well-being through MedGUIDE.

Eivind and his caregivers, informal and formal, all use a self-reporting function of MedGUIDE. Eivind has a tablet PC for this purpose, whilst Ann Catrin and Arne Olav use their version of the app on their smartphones. Eivind's self-reporting concerns a couple of very simple questions about mood, physical dis-/comfort such as diarrhea or dizziness, or weight. Eivind's self-reporting is configured so that he is cognitively able to answer the questions concerning well-being that may be connected to his medication in general or a particular medicine intake. Ann Catrin's and Arne Olav's self-

reporting part includes questions that are a bit more specialised and that require both observations and conversations with the PwD. Arne Olav knows the home well, so he registers if for example there are forgotten pills lying around, or too much meal left-overs in the bin. All information adds to the observation record of Eivind that will, as a short-term and long-term summary, be communicated to Eivind's RGP.

Actors: Nina, Eivind, Arne Olav	**Feedback to RGP**
Name: Nina receives the self-reporting feedback	
Scenario: Today, Eivind has an appointment at Nina's (RGP) clinic. Arne Olav joins him. Nina has access through MedGUIDE to the self-report from Eivind himself as well as his formal and informal caregivers Ann Cristin and Arne Olav. The report displays essential information on the latest self-reports, as well as descriptions of the last events and observations. Eivind is not too fond of doctors and tells automatically that everything is just fine. However, Nina senses that something is wrong. She can also see in the self-report that his mood and physical discomfort shows a change in pattern during the last few weeks. She small-talks and interviews Eivind gently, and is finally able to uncover that Eivind, in fact, experiences stomach pain and nausea quite often. This might indicate a problem connected to Eivind's medication. Nina is particularly worried about the broad range of medications that are prescribed for Eivind. She changes one of Eivind's medications for Crohn's disease. The self-report gave quite some insight in the wellbeing of Eivind, therefore Nina asks to keep on tracking and reporting. Because she is worried about his wellbeing, she also suggests that Arne Olav installs more home sensors that belong to the series that already is installed in Eivind's kitchen. Nina wants data that covers sleeping patterns and toileting frequencies, starting immediately.	

4.1.5 Personas (Cyprus)

Joseph Michael, 62 years old, person with early-stage dementia

Mr. Joseph is 62 years old and lives at home with his wife. He has two children, a son and a daughter, who do not live in the same house anymore. Both son and daughter have their own family to take care of. Mr. Joseph is currently working part-time at the arhitectural firm he has been working for, for the last 25 years, since after being diagnosed with mild dementia, he cannot work full-time anymore but he does not want to stop working completely. He gets frustrated when his impairment influences his work as this makes him feel embarrassed. He has cognitive enhancement sessions with a psychologist on a weekly basis in order to maintain his memory in a good shape. His goal is to be able to take his medication properly by himself and stay active, so that the impairment will not get worse. Joseph takes medication for blood pressure, cholesterol, dementia and 2 pills for sleep disorder and he takes medication for constipation, only when needed. Even though he tries to remember every day to take all his medication on time, sometimes he forgets to take them or doesn't remember if he already has. In order to remember his mediaction he is currently learning how to use a smartphone so that he can set the alarm as a reminder. So far he is having difficulty learning new skills, but he hopes he will improve soon.

Eleni Michael, 64 years old, informal caregiver

Mrs Eleni, is Mr. Joseph's wife. She worked in the past as a nurse and retired with an early retirement plan at 64. Her everyday life includes the household and the support in raising her grandchildren as well as taking care of her husband. Even though she has experience in taking care of people with dementia due to her profession, it is still difficult for her to cope with it. She has also other things to worry about, such as her own health issues which are less severe than her husband's but still take time and attention, as well as the daily activities. Recently, she started to feel tired due to the many tasks and responsibilities she has to take care of, so she keeps a diary in order not to forget appointments or important information and instructions given by doctors. Also, she decided to arrange home care for her husband once a week so she can have a free afternoon to herself for leisure. She does worry about Joseph, because she doesn't know what effects the dementia will have on the long-term.

Andreas Sofokleous, 29 years old, nurse

Andreas is a trained nurse who provides home care to Mr. Joseph, among other patients. Andreas visits Mr. Joseph once a week to support him with his daily routines. One of his main tasks is to check whether the patient took the medication properly. Andreas has regular contacts with Mr. Joseph , his wife and their daughter in order to be updated about changes in daily routines, behavior and/or medication. However, Andreas noticed that Mrs Eleni will inform him about changes in behavior mainly when they meet in person and not through the phone. Also, Andreas would prefer to have more regular contacts/updates from Mr. Joseph's doctor since he now receives this kind of information from the family. He currently uses a to-do list application on his smartphone in order to be able to keep track of important things he has to do for each patient.

Christos Savva, 43 years old, Pharmacist

Christos is the pharmacist of Mr. Joseph. He always provides him with his medication and instruction on how to take them, even if no changes in medication have occurred. Christos wants to take good care of his clients and provides them the best of services so he likes to be updated on anything new that comes to the market not exclusively for medication. Many of his clients have been visiting him for many years and he has an ongoing relationship with them. When patients or informal caregivers come

to his pharmacy for the medication he always talks with them and ensures that they have all appropriate information regarding their medication and the purpose/disease/impairment for taking the medication. He frequently provides support to informal caregivers because they feel comfortable to talk with him about the problems they confront with dementia. Therefore, he receives information about symptoms or side effects of medication and the overall well-being of patients but this information is not provided at the time being. However, he usually notices the results of poor adherence only when the consequences appear, and he wishes action could have been taken earlier.

4.1.6 Scenarios (Cyprus)

Actors: Joseph, Eleni, Andreas	
Name: Joseph forgets to take medication on time	
Scenario: It is Monday afternoon, Eleni had to take care of her grandchildren this afternoon unexpectedly and she did not know how much time she would need to spend there, so she prepared dinner for her husband, Joseph, and she placed it along with his pills on the table. Joseph returns home from his part-time work while Eleni is out. When he finds her note that she will be away, he decides to go to the local senior center of his neighborhood. At 7pm MedGUIDE system reminds him to take his medication, after dinner. By the time Joseph returns home he forgets to take his medication so the MedGUIDE system notifies his wife, who subsequently reminds her husband through the MedGUIDEsystem again in order for Joseph to take the medication, which he takes at a later time than was prescribed. Eventually, he does take his medication, and his wife receives a message that he did so. The next day, Andreas the home carer, sees that Joseph delayed taking the medication and that he noticed that Joseph has not had a bowel movement in 48hrs (the two events are not related). Andreas contacts Joseph and Eleni through MedGUIDE to inform them that they need to provide a self-report for Joseph's bowel movement the next day, because if the constipation continues for the third day, then he will provide an intervention according to Joseph's doctors instructions. Andreas also once again informs Joseph the importance of taking medication on time and updates MedGUIDE system on actions taken to deal with constipation.	

Actors: Joseph, Eleni, Andreas, Christos	
Name: Behavioural changes	
Scenario: It is Wednesday morning, Joseph had his regular visit with his neurologist who decided to change his medication prescription. The doctor updates the new information on MedGUIDE system so when Joseph and Eleni go to pharmacist, he is already aware of the change. Christos (pharmacist) discusses the medication and possible side effects with the family and refers them to MedGUIDE for further information as he does not want to overload them with information during the visit. Ten days after Joseph started with his new medication, he starts to get anxious and quite aggressive towards his wife. His wife has reported the change through by using the self-report, she shares how Joseph is acting. MedGUIDE alerts the care network about this behavioral change. Eleni looks at the information provided by MedGUIDE e-learning module on how to handle such situations in order to be prepared and she also fills in a self-report more frequently about the situation. The care network (the son, daughter and close friends), received the self-report and decide to coordinate and discuss what actions need to be taken. Based on this discussion, the daughter, Joseph and Eleni visit Joseph's doctor. Based on the changes in behavior, the doctor prescribes new medication which is	

shared through MedGUIDE. The pharmacist will receive an update on the newest medication prescribed. Five days later Joseph exhibits significantly better mood.

Actors: Joseph, Eleni, Christos, Andreas	
Name: Joseph is confused	
Scenario: The care network notices changes in the daily life pattern by looking at the sensor data as well as the self-report in MedGUIDE. Specifically, sleep, eating and bathing routines have changed for a few days. Eleni was very busy and did not make any self-reports lately but it seems that Joseph adheres to medication. Christos pharmacy has a good and personal relationship with all his customers. Therefore, when Christos (pharmacist) sees those changes, he calls Joseph to check if everything is okay and through their discussion he notices that Joseph cannot recall his routine and his speech is confused and more disrupted than the last time they met. Subsequently, Christos contacts Eleni to discuss this issue with her in order to find out what the problem is and they decide to schedule an appointment with Joseph's neurologist for reevaluation. Christos updates the MedGUIDE system accordingly. During Andreas' weekly visit, he also observes the same disorientation and deterioration in Joseph's behavior and he confirms Christo's input in the MedGUIDE system. Therefore, they all agree that Joseph is taking his medications correctly through the MedGUIDE system, and re-evaluation for Joseph by his neurologist is scheduled asap, to establish the reasons for deterioration.	

4.2 Wireframes

As a next step in the MedGUIDE participatory design process, wireframe designs were developed. The wireframes are a sketch-level design of the application. At this stage, on purpose, we will not design the application at pixel level - since we need user feedback on the concept as a whole rather than on specific visuals. The wireframes are used to validate design directions.

4.2.1 Design rationale

MedGUIDE aims to support the PwD in optimizing medication adherence, and to provide insight into the wellbeing of the PwD, including medication side effects. The platform brings together a diverse set of functionalities, including:

- Medication reminders
- Personalized medication plan
- Situation awareness based on sensors and self-reports
- E-learning
- Communication and coordination

The various user groups have rather different requirements:

- **PwD's** are generally primarily interested in 'here and now'; rather than looking at the 'bigger picture', they want to be reminded at the moment they need to take medication;
- The network of **informal caregivers** are interested to know about the 'bigger picture', want to be updated of changes in e.g. regime or patterns, and would like to be able to collaborate with other caregivers.
- **Professional caregivers** are interested to see the data collected by the system (through sensors and self-reports) in time, should be able to easily communicate with the PwD and the caregivers, and need to configure the reminders and self-reports.

In designing the wireframes, we have chosen to develop three distinct applications:

1. The MedGUIDE basic application for PwD
2. The MedGUIDE advanced application for informal caregivers
3. The MedGUIDE pro application for formal caregivers (including pharmacists, general practisioners, and (community) nurses)

Each of the three applications is described in detail in the sections below.

4.3 MedGUIDE basic application for PwD

For PwDs it can be challenging to learn how to use a new application, and in order to address as many PwDs as possible, the platform will need to be extremely simple-to-use, addressing varying levels of health literacy as well as technology literacy. Two versions of the MedGUIDE application will be developed for PwD: the **MedGUIDE basic application** and the **MedGUIDE advanced application.**

The MedGUIDE basic application for PwD will be a tablet-size web-app, presented in an always-on ambient display. The tablet will only be used for MedGUIDE, and it will be always on and visible as an ambient display. The display will be located where the PwD will often be present or walks by in their home. This location will be adapted to each PwD, based on their routine.

Avatar

In order to support the PwDs in improving their medication adherence, and tracking the wellbeing, MedGUIDE will help them personally using an avatar. The main goal of the avatar is to guide the PwD through medication reminders, asking for self-reports and guide the PwD during the use of MedGUIDE. This avatar will be the friendly face with personal messages to the PwD.

One of the key moments in which the user needs support and guidance, is during the first time use. This is the first moment when the avatar will introduce itself, and provide an introduction. The introduction is provided using a video which explains what MedGUIDE does and how it can support them. This avatar will be guiding the user whenever help is needed, and will be supporting in the medication adherence.

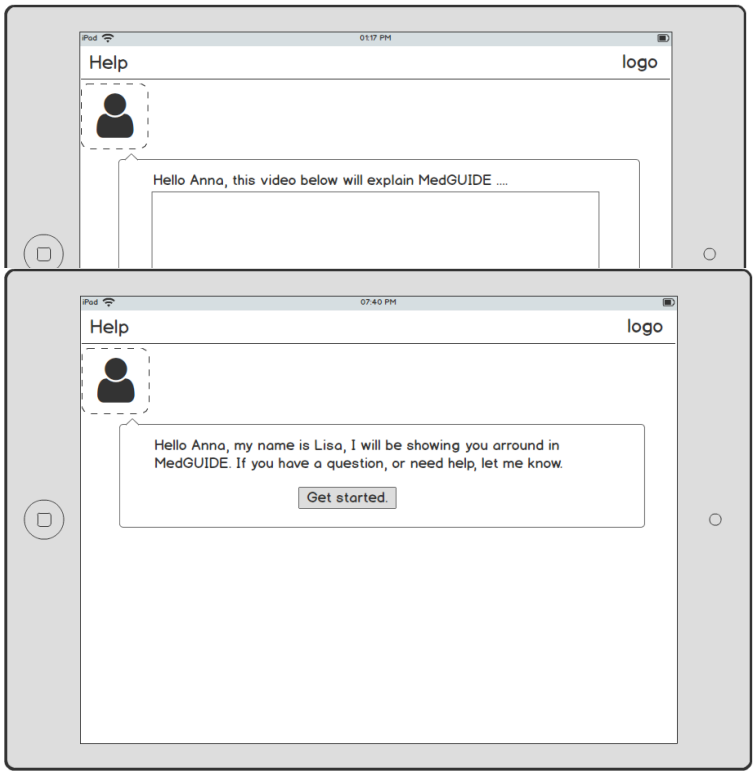


Figure 1 MedGUIDE basic application for PwD - Avatar

The MedGUIDE basic application for PwD consist of 4 main functionalities:

- Home
- My medication overview

- Ask for help
- E-learning

4.3.1 Medication reminders

PwDs experience difficulties with the day-to-day activities such as intake of their medication, or having a meal. Due to forgetfulness they tend to forget to take their medication or in some cases take double dosis of their medication. They do not remember when to take their medication or whether they have already taken the medication. MedGUIDE will support patients in improving their adherence through reminders and medication overview. The MedGUIDE platform in combinationwith the medication pillbox can be used as a tool to remind the patient to take his/her medication.

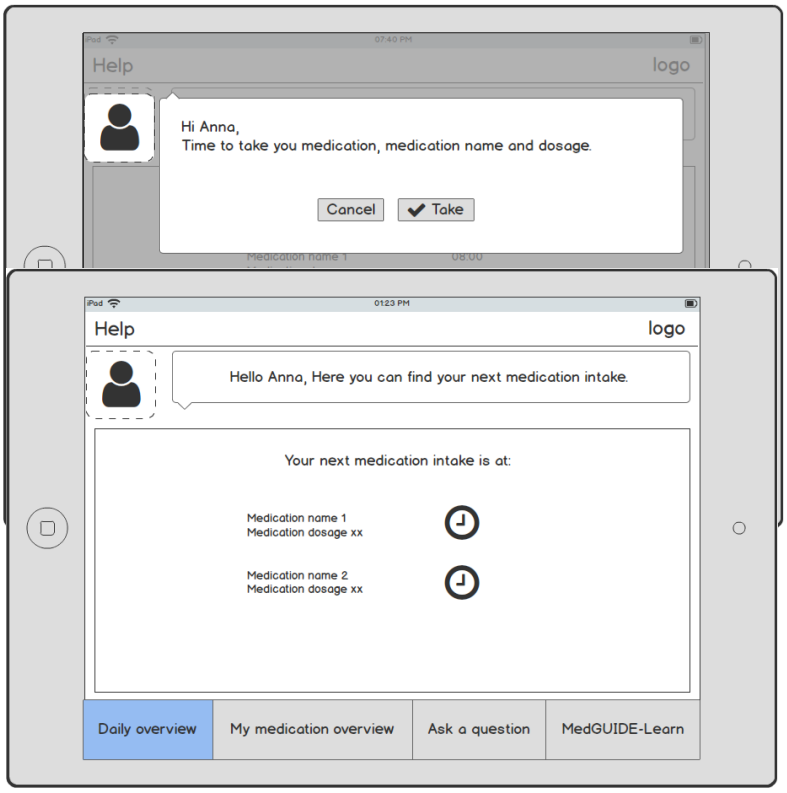


Figure 2 MedGUIDE basic application for PwD - Medication reminder

4.3.2 Medication overview

For PwDs it is not always clear to know which medication they are taking and how the medication can support the patient in their daily lives, or how it can improve their health. PwD want to receive comprehensible information on the medication they are prescribed. MedGUIDE will support the PwDs by providing them with comprehensible information on their prescribed medication. With a medication overview, and understandable information about their medication, the PwD gets better insight into their medication.

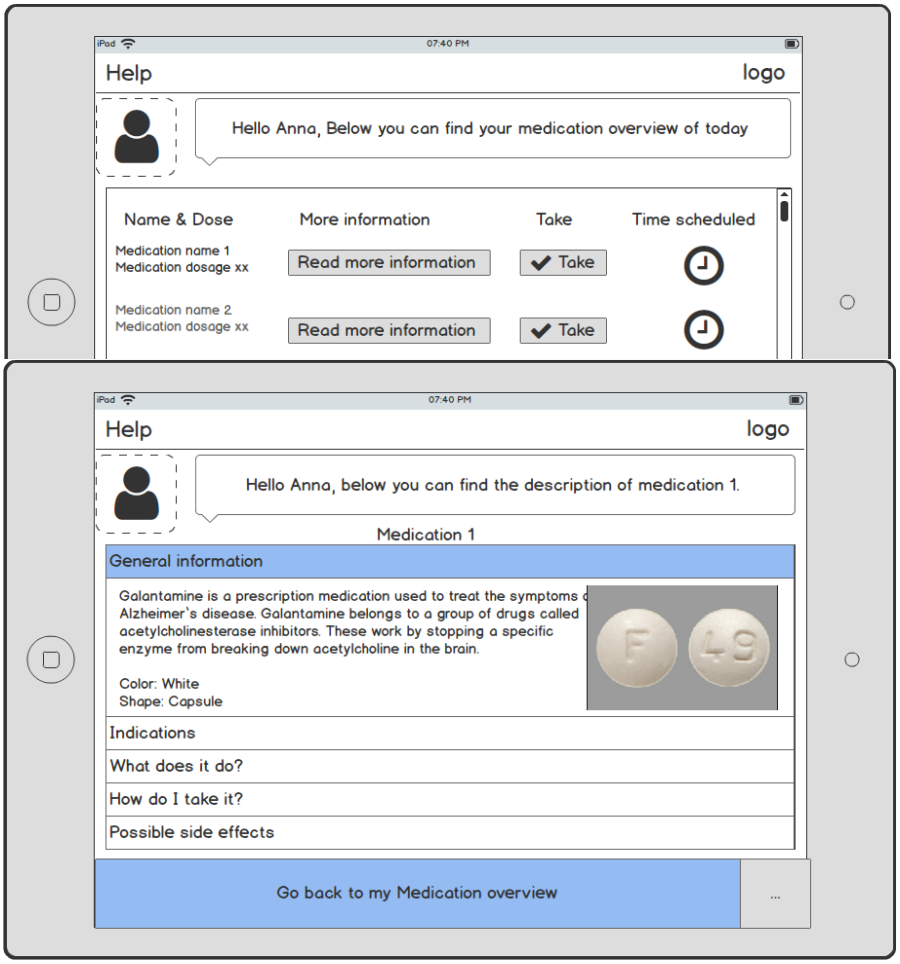


Figure 3 MedGUIDE basic application for PwD - Medication overview

4.3.3 Ask for help & e-learning

PwD might feel insecure about their medication or are in need of personal support. MedGUIDE can support them by helping them to easily get in touch with (informal) caregivers. Since the diagnosis of dementia the PwD might have a lot of questions, which might not all be answered at the same time during the visit to the GP. Therefore MedGUIDE supports the senior with this information through the E-learning platform. The E-learning platform will present information such as dementia, polypharmacy, adverse effects of medication, and possible assistive technology.

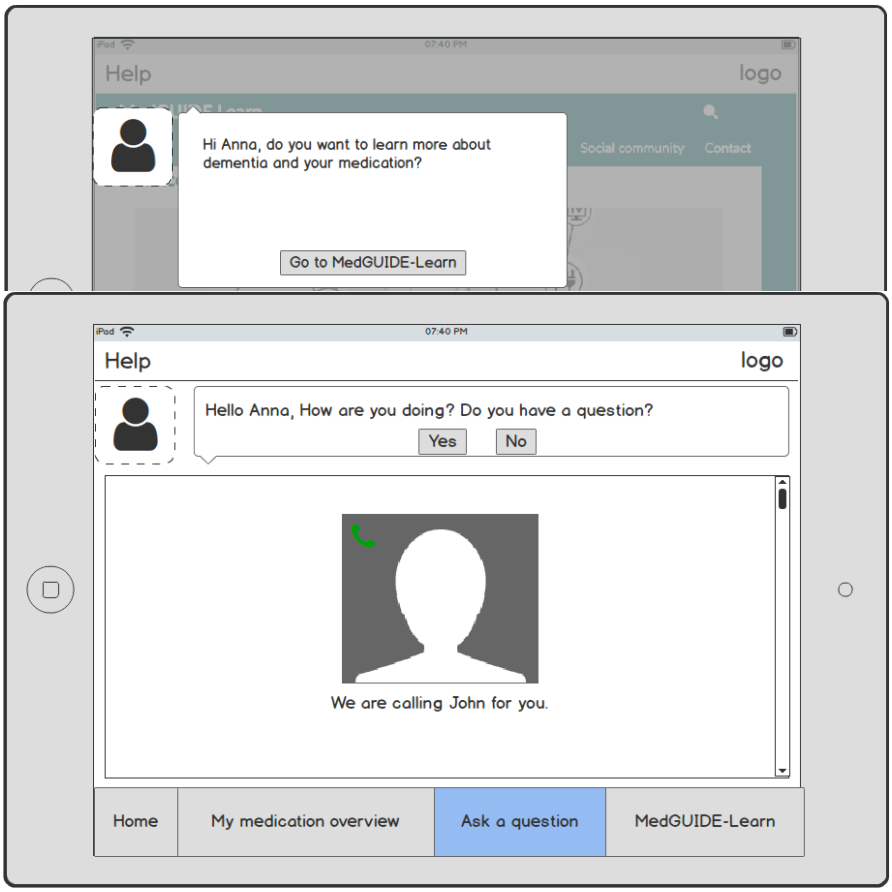


Figure 4 MedGUIDE basic application for PwD - E-learning & Ask for help

4.3.4 Self-report

The MedGUIDE platforms aims to support the PwDs and their network by tracking the wellbeing using sensor data presented in a timeline, **self-reports,** and journal messages. The self-reports will give the health professional better insight on how the PwD is feeling throughout the week/month.

The self reports can be triggered based on:

- Changes in sensor data
  - For example when changes in data are measured, MedGUIDE can ask the PwD how he is feeling, or what activity he is performing.
- Initiative from the care network whenever they think it is needed (ad-hoc)
  - Caregivers visit the senior and observe how they are doing. Whenever they are not able to visit the senior they still might want to know how the senior is doing and if he is feeling better. MedGUIDE can support caregivers to ask seniors to share their moods.
- Predefined moments set by health professional (pre-defined during first set-up)
  - MedGUIDE can be the eyes and ears of the health professionals. Through MedGUIDE caregivers can define and decide what information they would find relevant to track using self-reports.

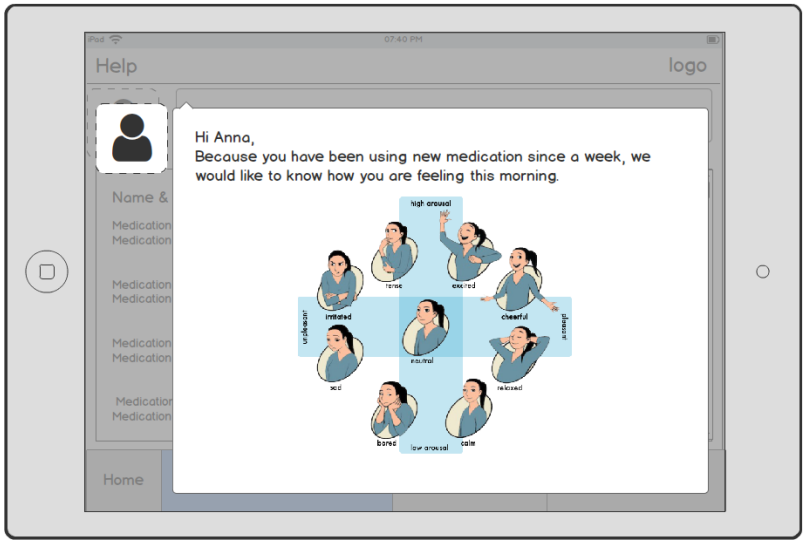


Figure 5 MedGUIDE basic application for PwD - Self-report

4.4 MedGUIDE advanced application for PwDs and informal caregivers

The MedGUIDE advanced application targets both PwDs who have adequate computer skills, and their informal caregivers. It combines the functionalities of the basic version with advanced functionalities: timeline, journals, and collaboration. As such, the advanced application supports the PwDs in tracking their own wellbeing, getting insights into deviations and side effects.

The advanced application is accessible for both PwDs and informal caregivers. It will support the PwD in tracking their own wellbeing, getting insights into changes and side effects.

The advanced application will include all functionalities from the basic application. Furthermore, the following functionalities will only be available to informal caregivers:

- Ability to send medication reminders
- Ability to ask the senior to self-report
- Respond to requests for help from the senior
- Self-reports asking how the caregiver is doing, or asking the caregiver how the senior is doing
- Ability to send medication reminders to patients

In order to support the PwDs in improving their medication adherence and support the caregivers in getting better insight into the daily behvaiour and medication use of the PwD, MedGUIDE will help them by using an avatar. The main goal is to guide the users through reminders, self-report as well as first introduction. As in the basic application, during first time use the avatar will guide the user by introducing itself and providing a video explaining what MedGUIDE can do to support them.

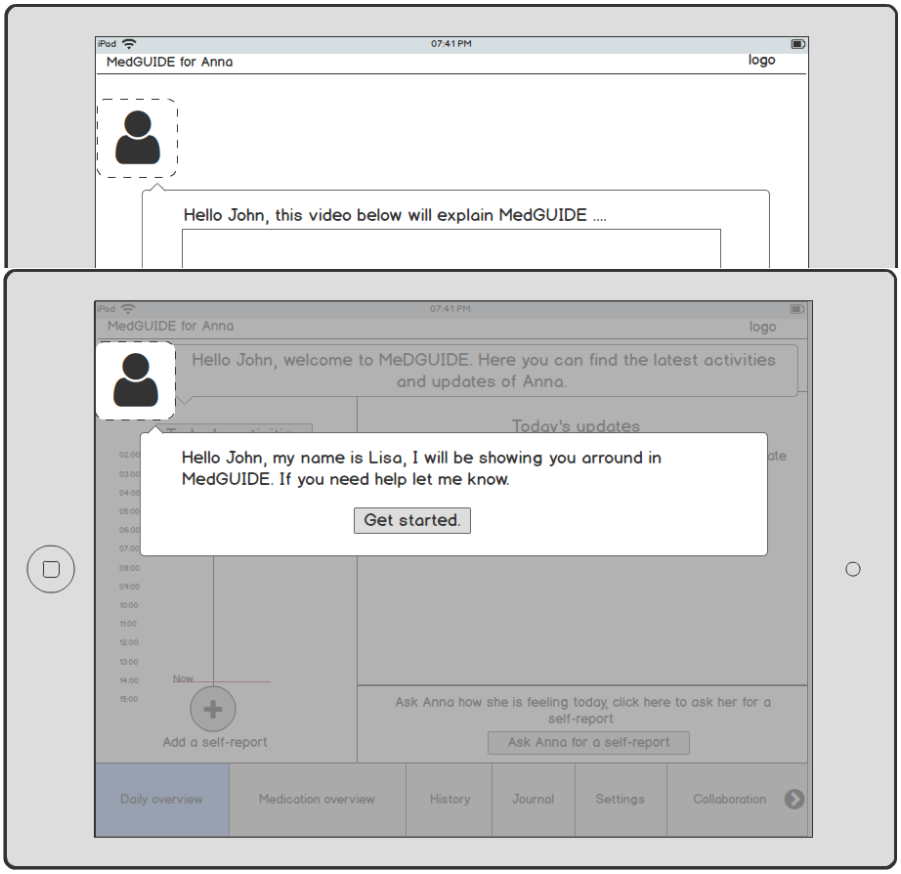


Figure 6 MedGUIDE advanced application for PwD & IC - Avatar

4.4.1 Setting-up

In MedGUIDE, the aim is to track the medication adherence as well a the daily pattern of the senior in order to give insight to the informal caregivers of the PwD. Through the use of sensors and self-report, caregivers can have a better view on the seniors' wellbeing. MedGUIDE can be introduced to the PwD and informal caregiver by either an informal or professional caregiver. During the set-up, the needed sensors, and self-reports will be explained and selected.

4.4.2 Medication guidance and collaboration

The MedGUIDE platform offers two distinct functionality groups: (1) **Polypharmacy management** (medication adherence, and tracking wellbeing/side effects), and (2) **Collaboration** and communication between the members of the network. In the design of the advanced application, we have clearly separated these two functionality groups, in order to simplify the user experience. Both funcationalities can be used by Informal caregivers as well as the PwD.

Polypharmacy management

- Daily overview
- My medication overview
- History
- Journal
- Settings

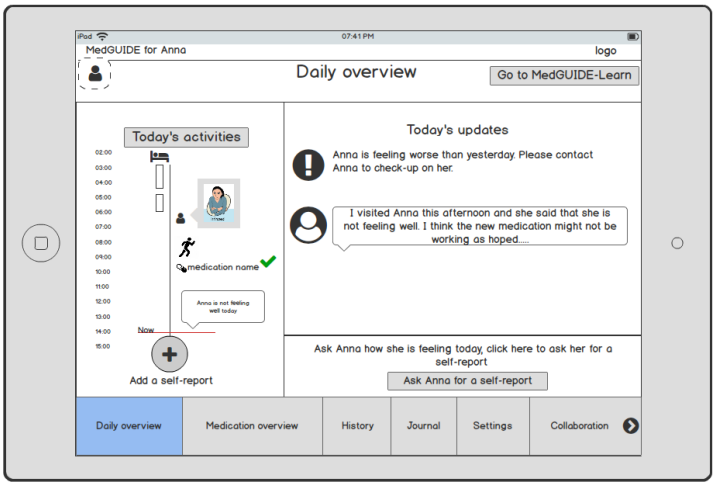


Figure 7 MedGUIDE advanced application for PwD & IC - Daily overview

Collaboration

- Home
- Messages
- Agenda
- To do list
- Collaboration guidelines
- Network map
- Settings

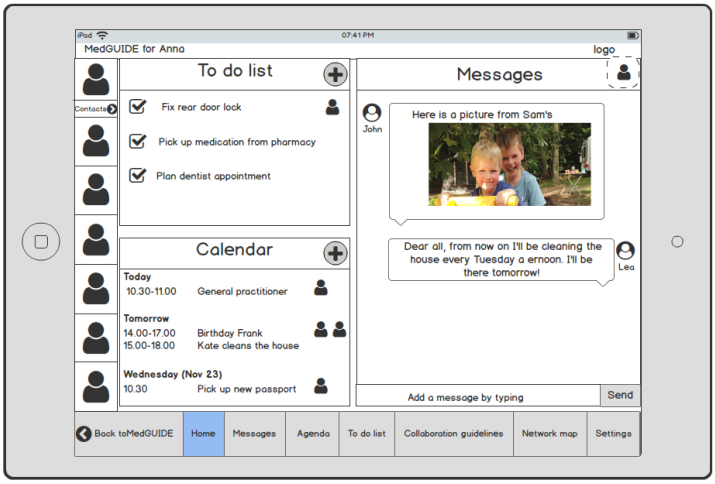


Figure 8 MedGUIDE advanced application for PwD & IC - Collaboration

4.4.3 Polypharmacy management – daily overview

Caregivers are not able to visit the senior on a daily basis, but would still like to keep an eye on how they are doing, or know whether they need any help or support. MedGUIDE supports informal caregivers by giving them insight in the daily lives of the senior. This information is collected using sensor data, self-reports by senior, or self-reports and observations noted by informal caregivers. A daily overview will give the caregiver insight into this information.

The daily overview will consist of:

- **Timeline:** The timeline will collect and show all information of all activities and reports performed, such as sensor data, self reports, smart pillbox as well as observational reports provided by informal and formal caregivers.
- **Self-report by caregiver:** Caregivers are able to add self-reports but can also ask seniors to self-report.
- **Today's update:** MedGUIDE can support caregivers by highlighting when there are changes in patterns, or whenever there is a new journal input.

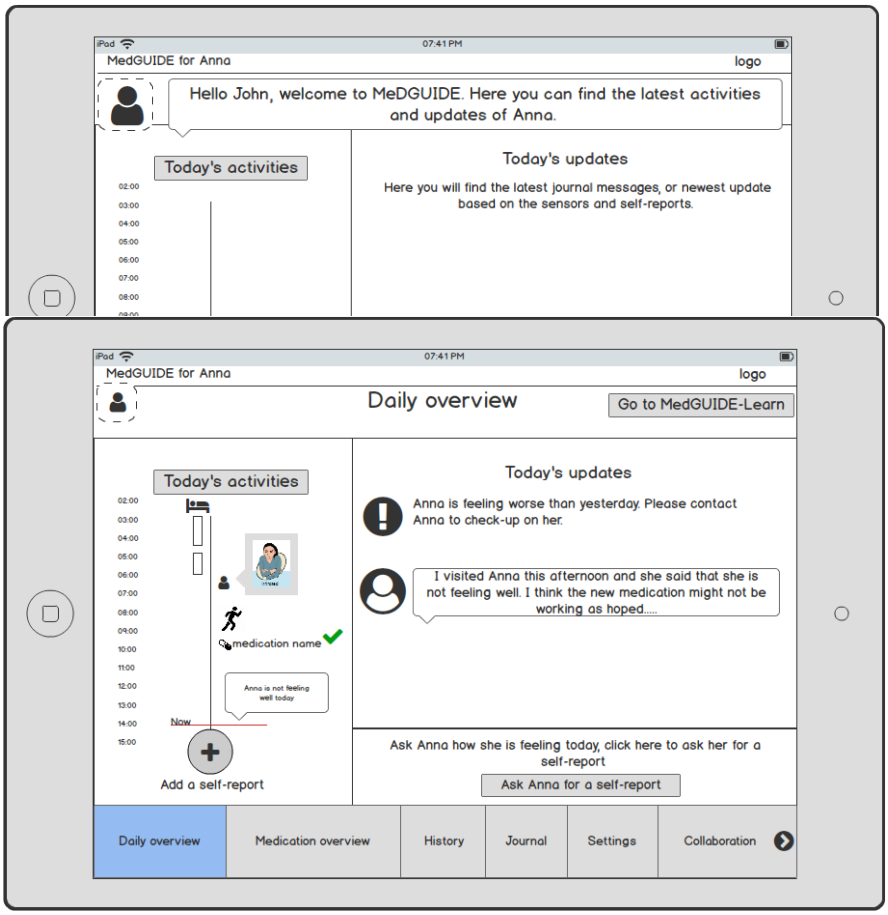


Figure 9 MedGUIDE advanced application for PwD & IC - Daily overview

4.4.4 Polypharmacy management – medication overview, sensors, self-report and journal

To support the caregivers in the care process, it is important for them to have all information concerning the polypharmacy management collected. MedGUIDE will support them by providing an overview of the medication prescribed, provide detailed information on the medication, present the sensor data and self-report information and daily patterns. With the data collected for care professionals and informal caregivers it is crucial to be able to share information and communicate with each other about the polypharmacy management. Therefore a journal can be used to communicate with each other, and share the latest updates observed, or decisions made.

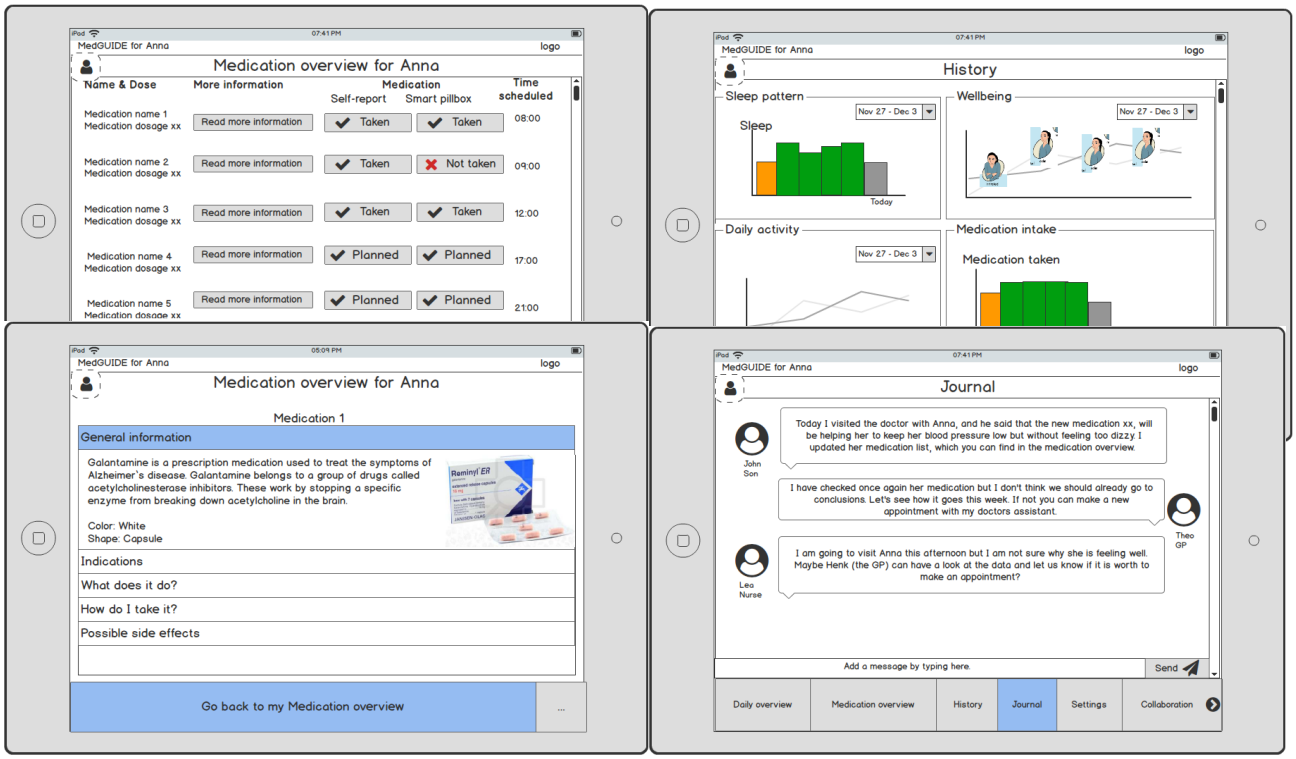


Figure 10 MedGUIDE advanced application for PwD & IC - Medication overview, History, Journal

The sensors, self-reports and account details have to be set-up for the PwD or informal caregiver to be able to edit these. These aspects will be displayed in a settings page where aspects as sensors and self-reports can be changed or updated.

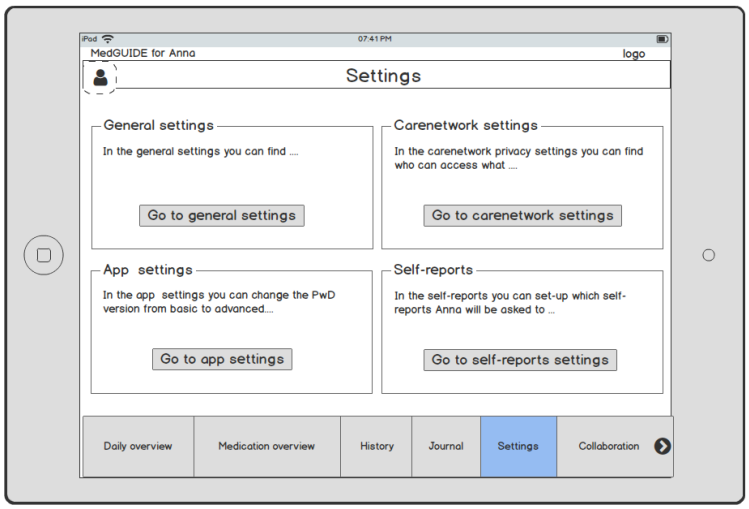


Figure 11 MedGUIDE advanced application for PwD & IC - Settings

4.4.5 Polypharmacy management – care network

It is well known that the careload distribution within the network is crucial, but that it is not always clear for the care network who are the people involved and what their roles are. Mainly for professional caregivers it is important to know who is involved in the care of the PwD. This will support the collaboration and communication between all care network members. A network map can support the caregivers to get a better insight in the role, but also in the balance within that network. Self-reports of informal caregivers can give insight into how they experience the care load. For privacy reasons it is also important to know which of these members will have access to the MedGUIDE. Therefore privacy settigns can be applied in the network map.

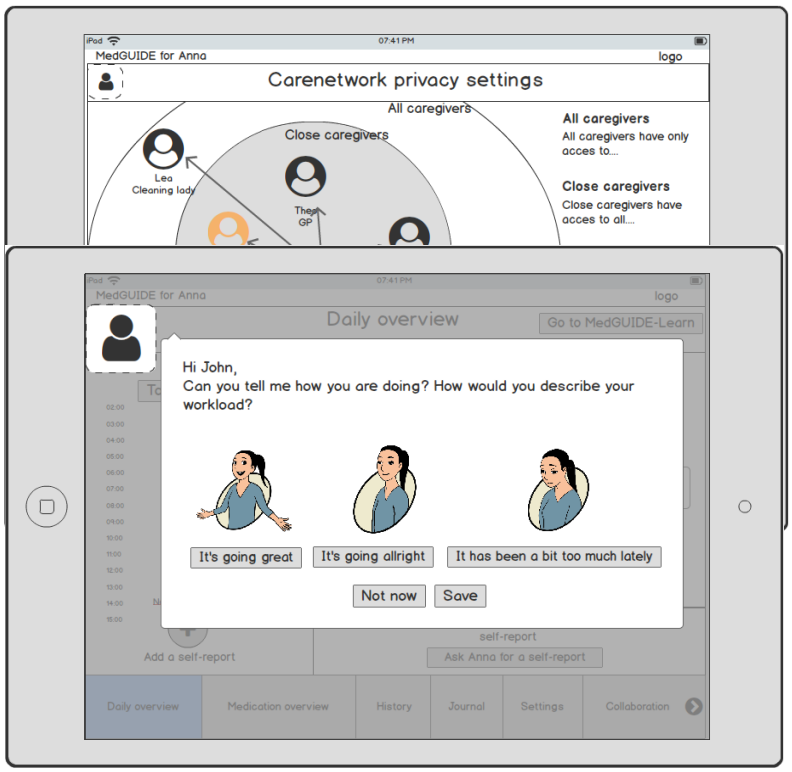


Figure 12 MedGUIDE advanced application for PwD & IC - Carenetwork & Self-report

4.4.6 Collaboration

MedGUIDE aims to improve communication and facilitate collaboration within the network of caregivers. PwDs using the advanced application and informal caregivers have access to a social communication and coordination module (the collaboration tool). The module provides acces to:

- Home > Quickview of main functionalities
- Contact list and call function (in order for the PwD to ask for help to a member or members to communicate directly with each other)
- Social group messages
- Group calendar
- Shared to do list
- Collaboration guidelines
- Care network map
- Settings
- Go back to MedGUIDE button
    - When the user clicks on this button, he will go back to the Medication platform.

In order to collaborate closely and have a good overview of the latest update, the collaboration tool will provide a quickview of the latest updates of the group messages, calendar and to do list. Since the goal is improving the collaboration within the care group, the contact list is a fixed element in the screen. Each user has his own contacts page, as well as the PwD, in order to easily acces each others contact details.

The to-do list and agenda caregivers can manage practical tasks and appointments. While using the messages, the caregivers can easily communicate with each other about the seniors wellbeing, or other practical descisions related to the care of the senior.

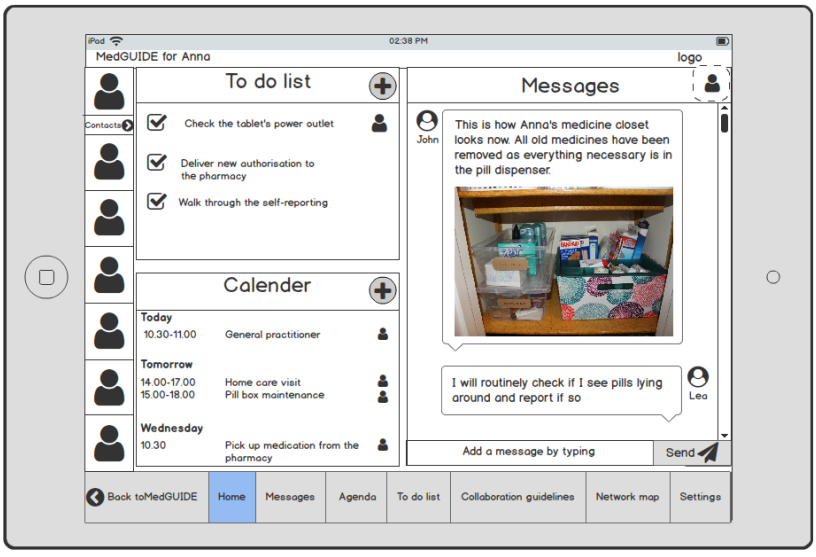


Figure 13 MedGUIDE advanced application for PwD & IC - Collaboration homepage

All collaboration functions needed to easily communicate with each other can also be presented in more detailed screens. In which detailed information can be provided to improve the communication.

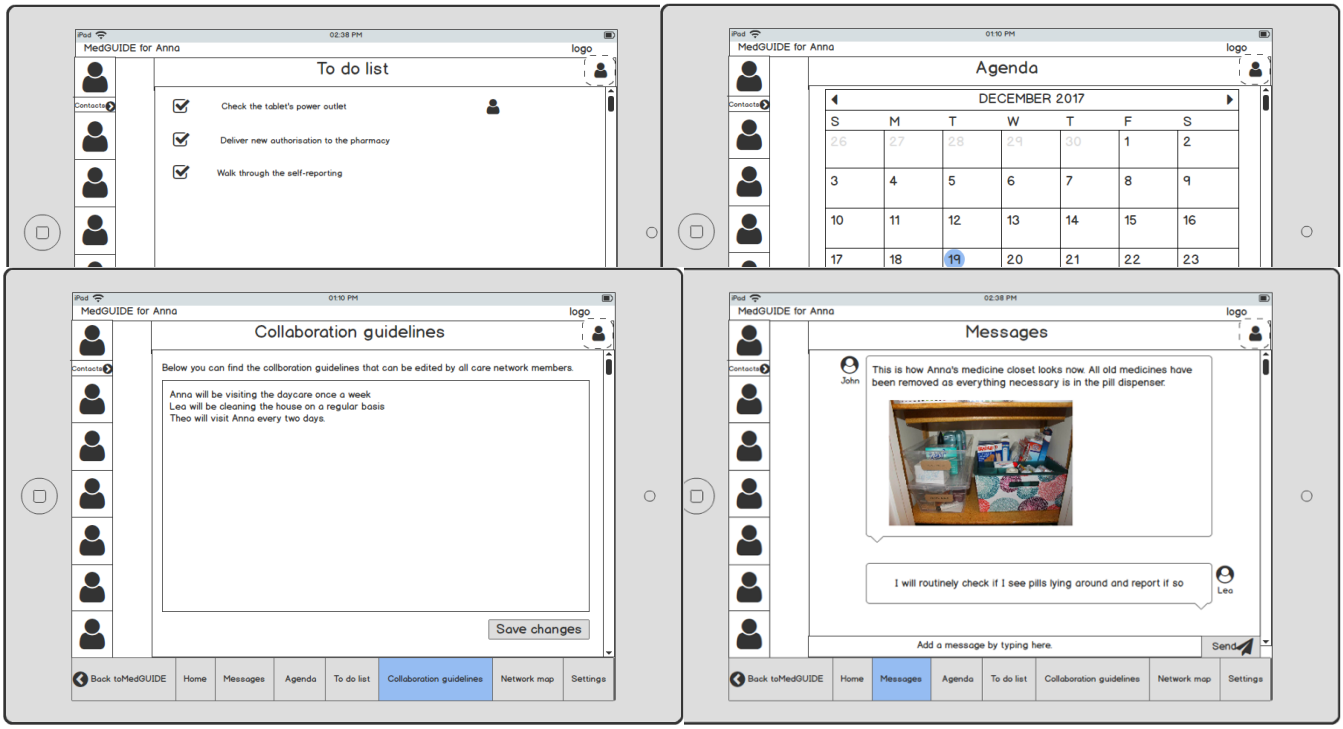


Figure 14 MedGUIDE advanced application for PwD & IC - Collaboration: To do list, Agenda, Guidelines & Messages

4.4.7 MedGUIDE pro for professional caregivers

The 'advanced application' will provide all functionalities from the basic application and the advanced PwD application / application for the informal caregivers. Furthermore, the following functionalities will only be available to formal caregivers:

- System configuration
- Ability to send medication reminders to patients and the informal caregivers
- Self-reports asking how the informal caregiver is doing and/or how the senior is doing

4.4.8 Polypharmacy management – configuration

Professional caregivers together with the PwD and his informal caregivers decide which aspects in the daily lives of the PwD are important to keep an eye on, and whether daily patterns of the senior need to be monitored. Together they can also discuss wether medication reminders and self-reports can help and support the PwD. This discussion will lead to the first configuration of the sensors used, self-reports and medication list.

As can be found in the basic and advanced platform, the avatar will also play a guiding role in the pro version for professionals. During the first visit the avatar will introduce itself and explain what MedGUIDE can do to support them.

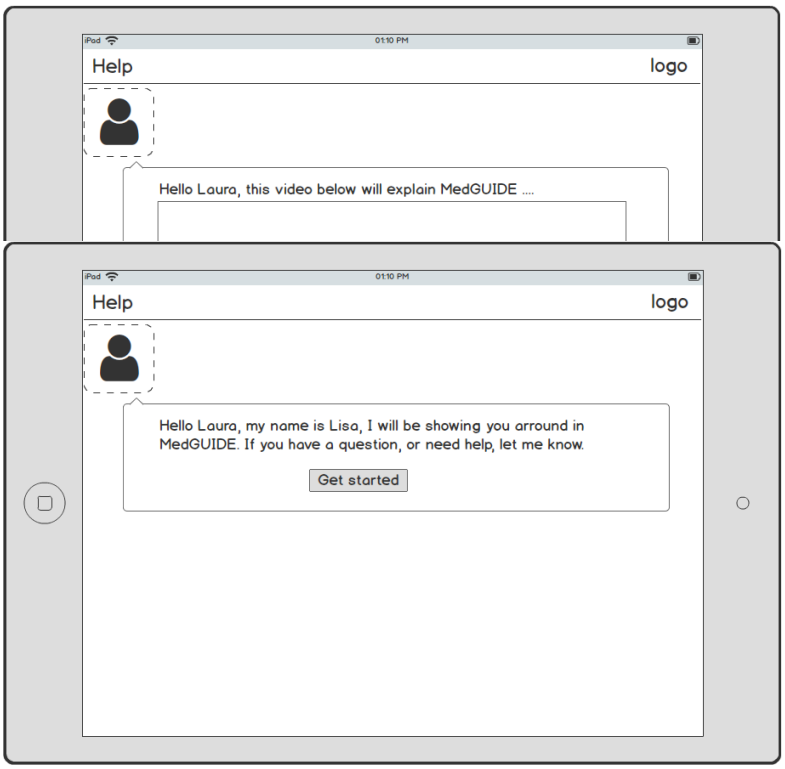


Figure 15 MedGUIDE pro application for professionals - Avatar

Professionals and informal caregivers, decide together with the senior, can decide which daily patterns would be important to monitor. These daily patterns will be created using the sensor data, self report as well as observations. Together, the caregivers and the PwD can decide which sensors and self reports they would like to use to track the daily patterns. Furthermore, the caregivers check the required medication list and define if reminders are needed.

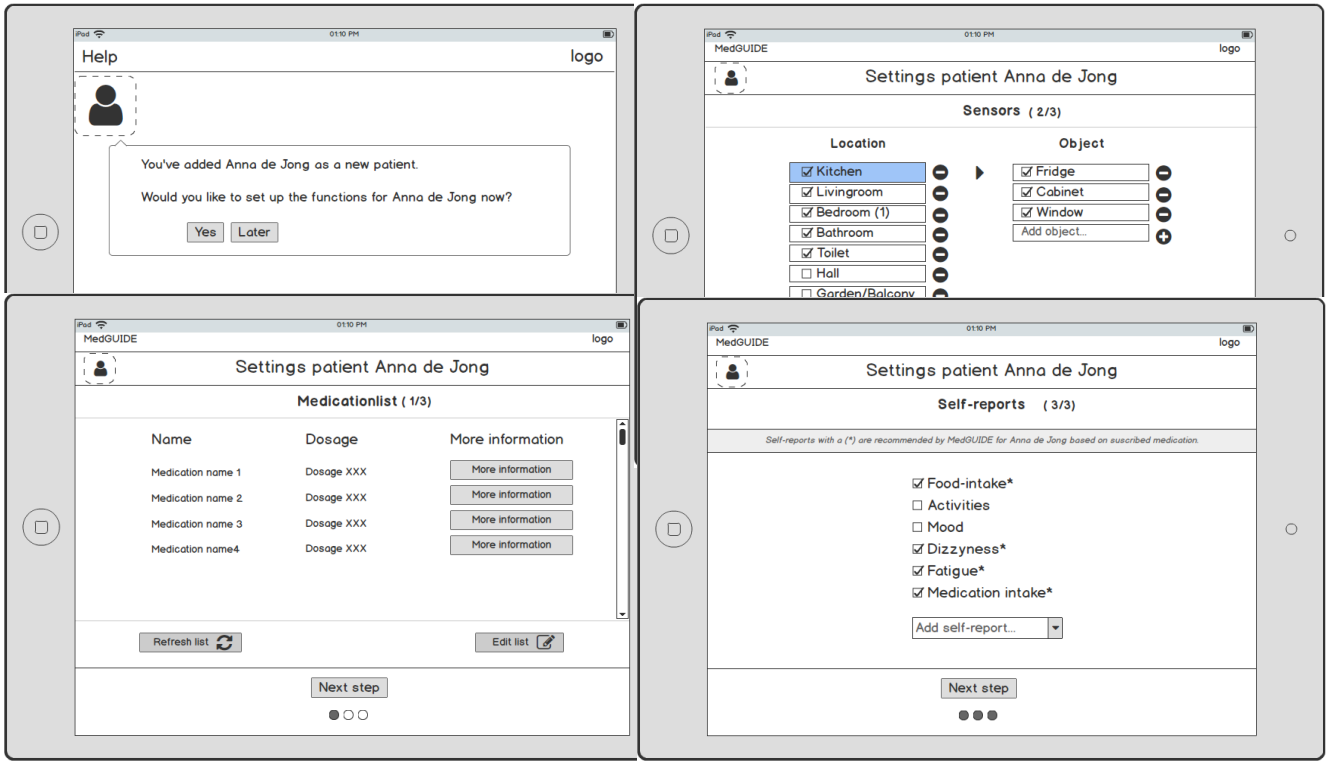


Figure 16 MedGUIDE pro application for professionals - Setting up patient, Sensors & Self-report

4.4.9 Polypharmacy management – tracking patients

Healthcare professionals have limited time for each patient. Therefore it is important to have a good and quick overview of all patients, and know which patients they have to pay attention to. This can be based on deviations in daily patterns, or based on the self-report provided by the patients or informal caregivers. MedGUIDE will support the professional by highlighting these cases with colors in order to know when to respond and how. Once the professional can view which patient needs attention, it can visit the patients dashboard where more information is provided. This dashboard is the same as presented later in chapter 5.7.2.1 MedGUIDE advanced application for PwDs and informal caregivers.

Furthermore it has to connect with their current information systems (so use of one –system only).

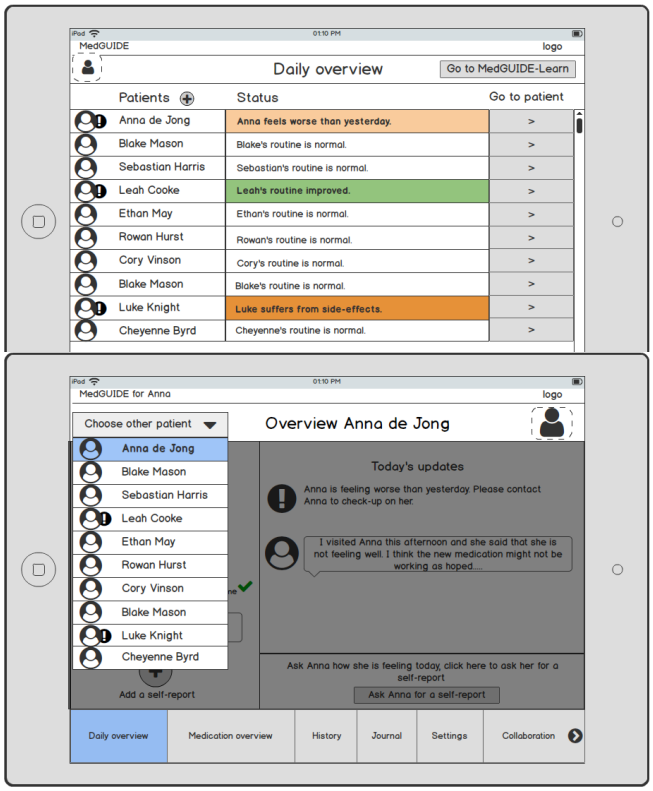


Figure 17 MedGUIDE pro application for professionals - Tracking patients

Section 2: Architecture and services design

5 MedGUIDE conceptual architecture

5.1 MedGuide architecture

In Figure 1 the conceptual architecture of the MedGuide system is presented.

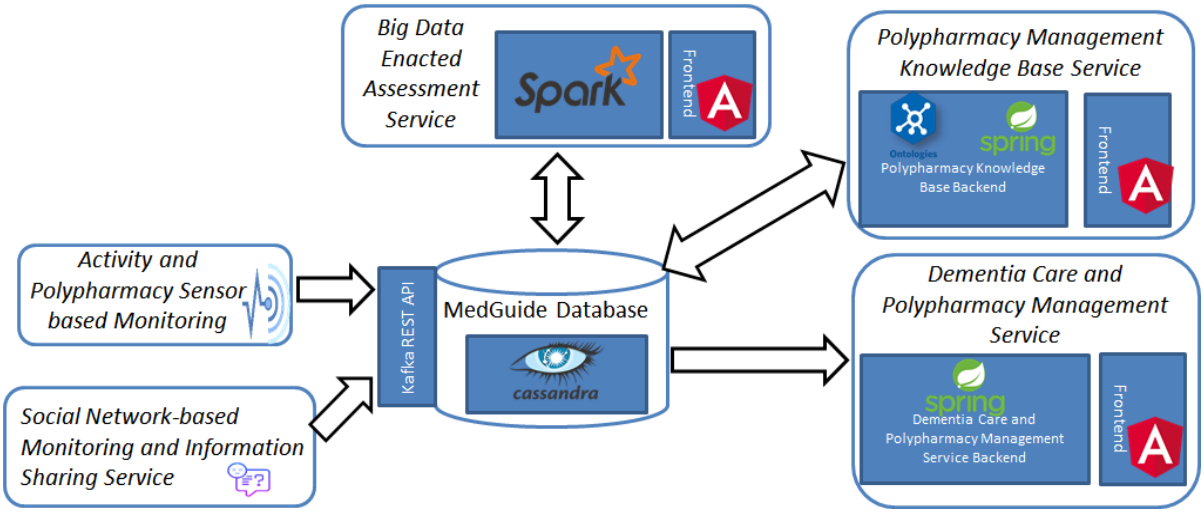


Figure 18 MedGuide system overall architecture

The system will feature five services each targeting the implementation of specific functionalities of MedGuide:

- ***Activity and Polypharmacy Sensor based Monitoring*** deals with monitoring and integration of various variables and distributed data sources describing the elder's: (1) Activity of Daily Life and Lifestyle such as physical activity, sleeping patterns, movement habits, nutrition and social interaction aspects and (2) medication intake and adherence to the prescribed therapy.
- ***Social Network-based Monitoring and Information Sharing*** brings the 'human perspective' provided by family, informal caregivers or the patient itself by using (self)-reports.
- ***Big Data Enacted Assessment Service*** leverages on big data techniques to analyse the heterogeneous and distributed streams of monitored data to establish the baseline Daily Life Activities for each elderly patient, and to detect deviations that represent changes, either sudden or gradual, in patients' activity routines which may signal progression of his symptoms, wellbeing decline or side effects of medication.
- **Polypharmacy Management Knowledge Base**, uses a polypharmacy management ontology allowing the doctors to annotate the deviations detected by the assessment service with potential side effects of polypharmacy in dementia treatment.
- **Dementia Care and Polypharmacy Management Service** provides personalized and coordinated guidance, motivation and support for all types of system end-users using specific dashboard interfaces.

[2] IEEE standard 1471-2000 Recommended Practice for Architectural Description of Software-Intensive Systems

[3] Philippe Kruchten, *Architectural Blueprints - The "4+1" View Model of Software Architecture*

5.2 The 4+1 architectural view model

The architectural overview should be at a high level of abstraction and it forms the basis for a shared understanding of the system across developers, marketing, management and potential users. The representation of the architecture allows the communication and the exchange of ideas among the members of the development team, in search of the best implementation solutions.

In MedGuide we have 4+1 architectural view model for the design of each individual service.

A view is a representation of one or more structural aspects of a software system and illustrates how the architecture addresses one or more concerns held by one or more of its end-users[2]. The model aim to provide a mechanism to separate the different aspects of a software system into different views of the system, as different stakeholders have different interests in a software system[3]. Some aspects of a software system are relevant to the Developers: they want to know about things like classes. Others aspects, like deployment, hardware and network configurations, are relevant to System administrators: they do not care about classes. Similar observations can be made for Managers, Testers and Customers.

The model aim to decompose the software system architecture into distinct views, so that stakeholders could get what they want. In his approach, there are 5 views, but he decided to call it 4 + 1, because, when all other views are finished, the fifth view, the use case view, is effectively redundant. However, the use case view is the basis for all other views: it details the high levels requirements of the system, while the other views detail how those requirements are realised.

The 4+1 views are below described:

- The **logical view** represents the object model of the design (when an object-oriented design method is used). It shows the functional requirements related to the final user. It is relevant to developers.
- The **process view** describes the concurrent processes within the system. It includes some non-functional requirements such as availability and performance.
- The **development view** focusses on software modules and subsystems.
- The **deployment** (or physical) **view** depicts the mapping of the software onto the hardware and it includes some non-functional requirements such as availability and scalability.
- The **scenarios** (or use case) **view** illustrates the system functionality from the perspective of the external world. All other views use the scenario view to guide them.

[2] IEEE standard 1471-2000 Recommended Practice for Architectural Description of Software-Intensive Systems

[3] Philippe Kruchten, *Architectural Blueprints - The "4+1" View Model of Software Architecture*

Different UML diagrams exists and can be useful to convey the information that you want to tell in a specific view. Moreover, some UML diagrams can be used in different ways, by emphasizing different elements present in the diagram, which makes them useful for multiple views. In the following, we will represent the 4+1 views as below described:

- **Logical view** through detailed components diagrams.
- **Process view** through activity diagrams.
- **Development view** through main components diagram.
- **Deployment view** through deployment diagram.
- **Scenarios view** through use case diagrams.

In the following sections each MedGuide service design is presented in detail using the 4+1 model views.

6 Activity and polypharmacy sensor-based monitoring

6.1 Logical view

The logical view is presented from the end-users perspective, and from the DoW we have decided that sensors should not be intrusive, as a consequence of that choice the user should not be affected by the sensors and monitoring services being deployed in the MedGUIDE project. Since we have not decided on the type of sensors being applied and the functionality of these sensors, it is not clear how intrusive and how this would be perceived by the end users. Due to cost and effectiveness of implementation the pilot we might decide that the end user should wear a lanyard with an activity sensor that captures the level of activity of the user this would also avoid that we track the activity of people visiting the PwD. Or we might decide to use only passive sensors that register movements and track the activity of the user, however what type of sensors and how these are deployed will not affect the architecture and the development of the system.

The view of the logical architecture of the activity and polypharmacy sensor-based monitoring system can be viewed in Figure 19

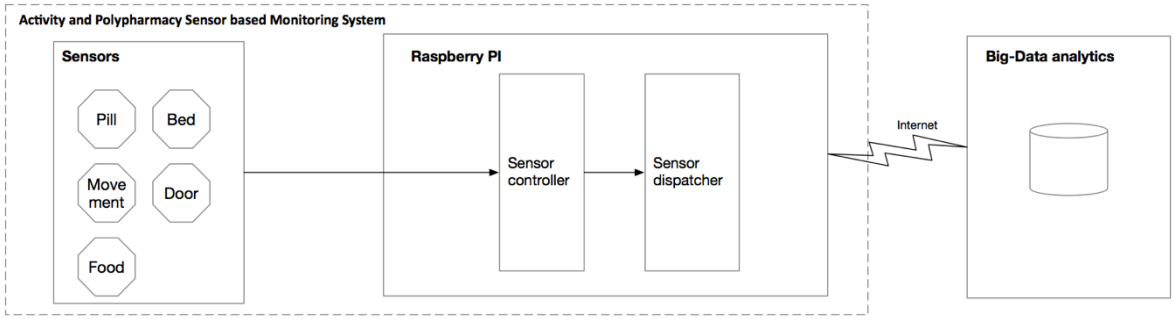


Figure 19 Logical view

Input and outputs

Input to the activity and polypharmacy monitoring system is based on triggering different sensors, and how they are set to work. In the following table we will illustrate the different sensors and their input/ouput parameters.

Sensor	Input	Output
Pill	When medication is taken, or when the pill-dispenser is moved	Signal of event or movement of pill dispenser is communicated
Movement of PwD	When there is movement in the room the sensor detects the movement, based on the sensor we could get distance and direction to the object that has moved	Signal of movement, direction and distance is communicated
Food	When a person takes food from the fridge, opens the drawers for cutlery etc. the sensors at the fridge or other food-	Signal of movement of fridge-door or food-container are communicated, and we would assume that the PwD have a meal

	containing containers are triggered	
Bed	When a person goes to bed, or when a person gets out of bed, bed sensors are triggered	Signal of movement and change of state in bed sensors are communicated
Door	When a door opens or closes the door sensors are triggered	Signal that a door is open or closed is communicated

Table 12 Sensor input and outputs

Examples of different output values are given in the following table:

Sensor	**Output message**
Pill	P1{ID=81239;T="2017-11-18 08:33:18:123 CET"} P1{ ID=81239;T="2017-11-18 08:33:22:432 CET"}
Movement	A1{ ID=81239;D=234;A=122/75;T="2017-11-18 08:33:25:543 CET"} A1{ ID=81239;D=320;A=145/85;T="2017-11-18 08:33:34:764 CET"} A2{ ID=81239;D=287;A=176/76;T="2017-11-18 08:33:35;032 CET"}
Food	F1{ ID=81239;T="2017-11-18 08:30:22:487 CET"} F1{ ID=81239;T="2017-11-18 08:30:47:876 CET"} F2{ ID=81239;T="2017-11-18 08:31:22:853 CET"} F2{ ID=81239;T="2017-11-18 08:32:54:764 CET"}
BED	B1{ ID=81239;T="2017-11-17 22:53:18:148 CET";S=true} B1{ ID=81239;T="2017-11-18 07:02:15:543 CET";S=false}
Door	D1{ ID=81239;T="2017-11-18 07:02:45:324 CET";S=open} D1{ ID=81239;T="2017-11-18 07:02:47:483 CET";S=close} D1{ ID=81239;T="2017-11-18 07:08:43:591 CET";S=open} D1{ ID=81239;T="2017-11-18 07:08:48:822 CET";S=close} D2{ ID=81239;T="2017-11-18 08:29:54:184 CET";S=open}

Table 13 Examples of sensor output values

6.1.1 Functional and non-functional requirments

The functional requirement is that the sensors should transmit data to the backend system for further analytics.

The non-functional requirement is that the system should work without any need for involvement by the persons living in the house. It is also a requirement that it should be possible to extend the type of sensors and the number of sensors being deployed in the house.

6.2 Process view

The processes involved in the activity and polypharmacy sensor-based monitoring system is rather simple. The sensors trigger an event, this event is communicated to the senors controller, and then

sent to the sensor dispatcher that sends the data to the backend for further analysis. The process flow could be viewed in Figure 20.

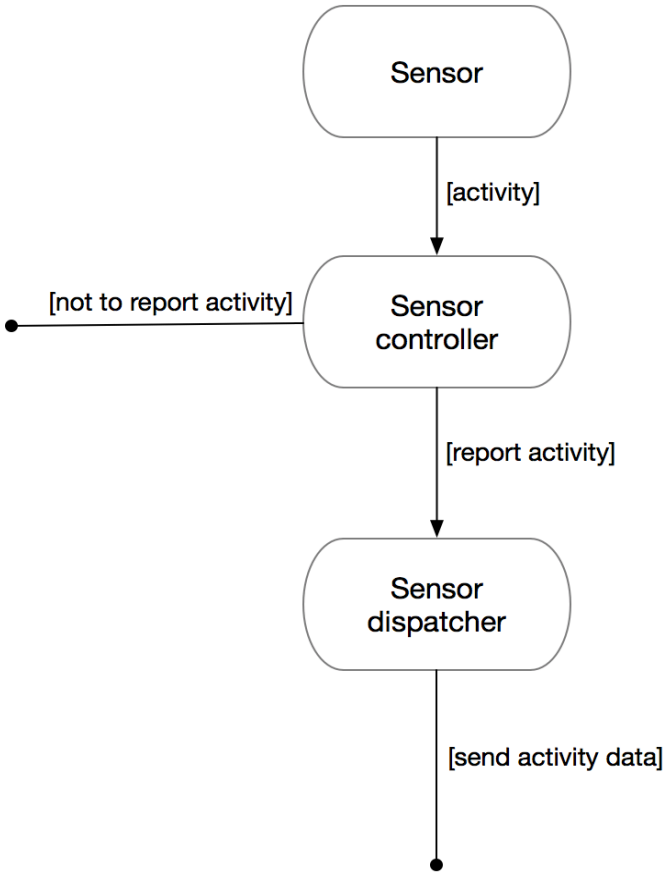


Figure 20 Process view

6.3 Development view

The development of the Activity and Polypharmacy Sensor-based Monitoring System (APSMS) be a small scale system that is intented to only capture, enrich and process data from a small set of sensors, and submit the sensor data to the backend for further analysis. There is also a need for a simple web-interface for connecting and configuring the different sensors, setting unique IDentificators for each sensor and apply semantics about what type of sensor it is. In addition, the timestamp of the event

needs to be added before the information is collated and submitted to the backend system for further analysis. A development view could be seen in Figure 21

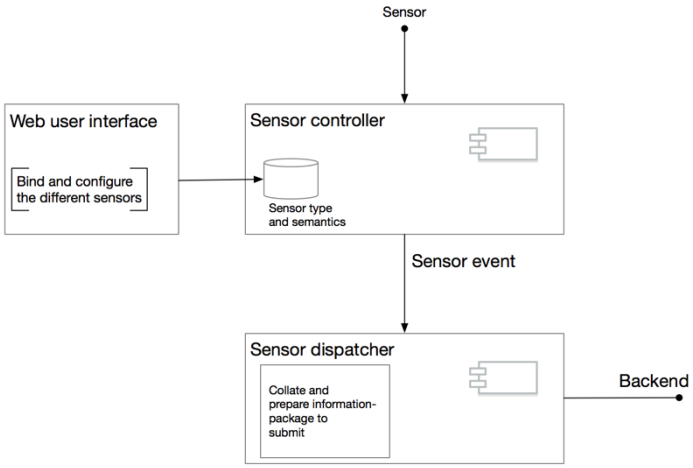


Figure 21 Development view

6.4 Physical view

The physical view of the APSMS consists of two different parts, the sensors that are deployed around the house based on what type of data we are interested in capturing. And the controller that receives data from the sensors, controls the variety of the data and transmits the data to the backend for further analysis. It is a prerequisite that the controller has access to the internet trough a wifi or cabled connection. The physical view could be seen in Figure 22.

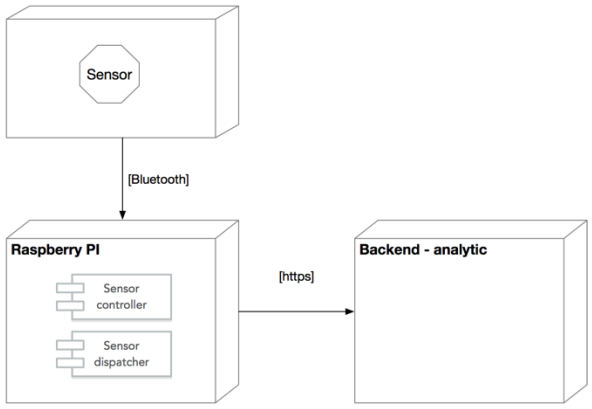


Figure 22 Physical view

6.5 Scenarios and use cases

The use cases of the APSMS consists of two different roles. The roles and their use cases are described below.

6.5.1 System technician

The system technician is the person responsible for configuring and setting up the MedGUIDE activity sensors in the apartment.

USE CASE	
Name	**Configure and set up MedGUIDE sensors.**
Storyline	When a person would like to be part of the MedGUIDE system for the first time, there is a need to first configure and set up the sensors so that it is possible to detect deviation in behaviour. The system technician will deploy and mount different sensors based on what information we would like to monitor and track. Based on the configuration of the home of the primary user (PwD), different sensors would be deployed. For the system to work we need to know what type of information the sensors captures. And we need to connect each sensor to the sensor controller to avoid false data.
Actors	System technician
Prerequisites	The house of the primary user has an internet connection.
Outcome	The sensors work effortlessly and the system submits relevant activity data to the backend for further analysis.

Table 14 Configure and set up MedGUIDE sensors

6.5.2 Primary user

The use case is not really about the primary user, however the primary user is an active agent of the system.

USE CASE	
Name	**Daily life of the primary user**
Storyline	The primary users live their daily life as normally as possible, they take their pills, eat their meals, and go about their daily routines that are captured by the sensors without affecting the behaviour of the primary users.
Actors	Primary user /PwD?
Prerequisites	-has mental an social skills to operate the device
Outcome	-is able to work with the MedGUIDE system

Table 15 Daily life of the primary user

7 Social network-based monitoring and information sharing

7.1 Logical view

This section presents the logical architecture of the **Social network-based monitoring and information sharing service**, its components and their interrelationships. The main objective of this service is to enable the PwD and his or her care network to communicate with each other and to interact with the other parts of the MedGUIDE application.

The **Social network-based monitoring and information sharing service** consists of two main groups of components:

- **Social network-based monitoring and information sharing front-end** – includes components related to the implementation of the service's user interface
- **Social network-based monitoring and information sharing back-end** – includes components related to the implementation of the service's back-end functionality

Figure 23 illustrates the logical architecture of the the **Social network-based monitoring and information sharing service**.

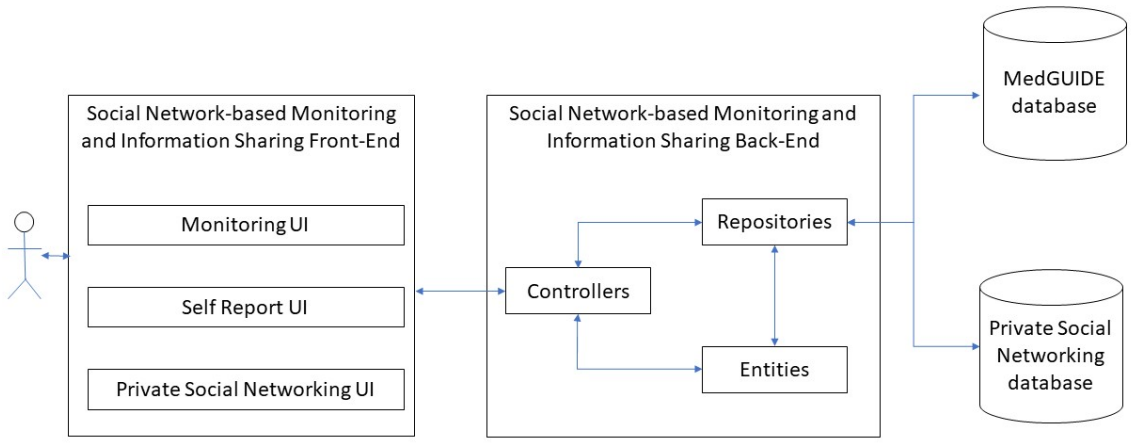


Figure 23 Social network-based monitoring and information sharing logical view.

The **Social network-based monitoring and information sharing front-end** component includes the following components related to the implementation of the **Social network-based monitoring and information sharing service**'s user interface:

- **Self reporting UI** - responsible for user interaction of the PwD and his or her formal and informal care network to give feedback about daily patterns and changes in wellbeing of the PwD.
- **Monitor UI** – responsible for the PwD and his or her formal and informal care network to monitor his or her situation (as a result of the information that has been aggregated in the MedGUIDE system).
- **Private social networking UI** – responsible for providing the PwD and his or her formal and informal care network the possibility to communicate with each other.

Through the service's user interface, the PwD and his or her formal and informal care network will be able to perform the following operations:

- To report and share information about the mental or physical wellbeing of the PwD
- To enrich the sensor data ie.
- To report activities and patterns such as their weight, appetite, physical (dis)comfort, physical activity, and social interactions.
- To give insight into the care network members involved in the care of PwD, for all stakeholders involved

The components of the **Social network-based monitoring and information sharing front-end** interact with the components of the **Social network-based monitoring and information sharing back-end** to (1) retrieve from **Social network-based monitoring and information sharing databases** and (2) store in **Social network-based monitoring and information sharing databases** all data related to the self-reports, monitoring data and the private social network information of the PwD and his or her formal and informal care network.

The **Social network-based monitoring and information sharing back-end** consists of the following components:

- **Controllers component** – includes the components that process the requests coming from the **Social network-based monitoring and information sharing front-end**
- **Repositories component** – includes the components that retrieve data from and store data in specific tables of the **Private social network database** or the **MedGUIDE database**.
- **Entities component** – includes auxiliary components that are used to model specific data types.

7.1.1 Input and outputs

Table 16 illustrates the (i) input collected from the **Social network-based monitoring and information sharing front-end** which is submitted to the **Social network-based monitoring and information sharing back-end** where it is processed, and (ii) the output of the **Social network-based monitoring and information sharing back-end**.

Table 16 Inputs and outputs of the polypharmacy management knowledge base service

Input collected from the social network-based monitoring and information sharing front-end	**Output of the social network-based monitoring and information sharing back-end**
Self reports	Information about the status and feedback on PwD well-being
Requests for monitoring information	Monitoring information
Private social networking inputs like tasks, appointments, messages, logbook activities	Task, appointment, message, logbook data.

7.1.2 Functional and non-functional requirements

Table 17illustrates the functional requirements to be satisfied by the **Social network-based monitoring and information sharing service**.

Table 17 Functional requirements for the social network-based monitoring and information sharing subsystem

ID	Name	Description
1	Self-reports	- The user should be able to easily enter the self-reports - The results should be presented in an self explanatory way - It should be possible to restrict access to the self-reports by the PwD or care network administrators
2	Monitoring services	- The service should be able to display in a user-friendly manner the results of the aggregate information of the MedGUIDE system to the PwD and his or her care network. - It should be possible to restrict access to the monitoring data by the PwD or care network administrators.
3	Private social network services	- The service should enable the communication in the care network of the PwD in a user friendly way. - It should be possible to restrict access to the services by the PwD or care network administrators.

Table 18 illustrates the non-functional requirements to be satisfied by the **Social network-based monitoring and information sharing service**.

Table 18 Non-Functional requirements for the social network-based monitoring and information sharing service

ID	Name	Description
1	Usability	The system should be developed to be simple and intuitive for the end users and easy to understand.
2	Extensibility	The system should facilitate the easy integration of new functionalities
3	Reliability	The system should be able to inform user about any malfunctions.

7.2 Process view

This section presents the dynamic aspects of the **Social network-based monitoring and information sharing service**. In this section, the UML Activity Diagrams will be used to illustrate the main processes of the **Social network-based monitoring and information sharing service**.

7.2.1 Self-reports process

The UML activity diagram for the **self-reports** process is illustrated in Figure 24This process is triggered when the user, i.e. PwD or one of the members of the care network logs in to the **Self report UI** of the **Social network-based monitoring and information sharing front-end.** The user will be asked whether he or she wants to perform a self-report. If so, he or she will be asked to fill out the self report UI. If the user response is valid the report will be handed over to the **Social network-based monitoring and information sharing back-end**. If the user wants to continue, the **Social network-based monitoring and information sharing front-end** will wait before it will ask the user to perform a self-report again or until the user opens the Self-Report panel him or herself. Automatic requests for self-reports can be switched off by the user.

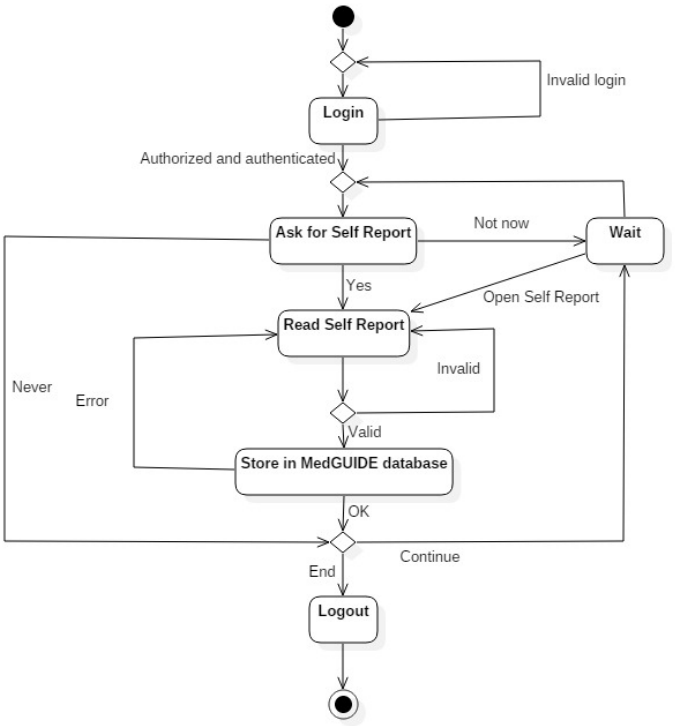


Figure 24 UML activity diagram illustrating the flow of the Self Reports process

After a valid self-report has been provided by the user, the **Social network-based monitoring and information sharing front-end** sends a request to the **Self reporting controller** (belonging to the **controllers** component from the **Social network-based monitoring and information sharing back end**) which hands it over to the **self report repository** (belonging to the **repositories** component) to store the self report in the **MedGUIDE database**. If no error occurs a success response will be send to the **Social network-based monitoring and information sharing front end**, otherwise a failure response will be send to the **Social network-based monitoring and information sharing front end**.

7.2.2 Monitoring process

The UML activity diagram for the **monitoring** process is illustrated in Figure 25. This process is triggered when the user, i.e. PwD or one of the members of the care network logs in to the **monitoring UI** of the **Social network-based monitoring and information sharing front-end.** At the moment a request to read monitoring data is sent to the to the **monitoring controller** (belonging to the **controller** component from the **Social network-based monitoring and information sharing back end**). The controller triggers the **monitoring repository** (belonging to the **repositories** component) to retrieve monitoring data from the **MedGUIDE database.** If new data is present, it will be returned to the **Social network-based monitoring and information sharing front-end,** which displays the monitor data.

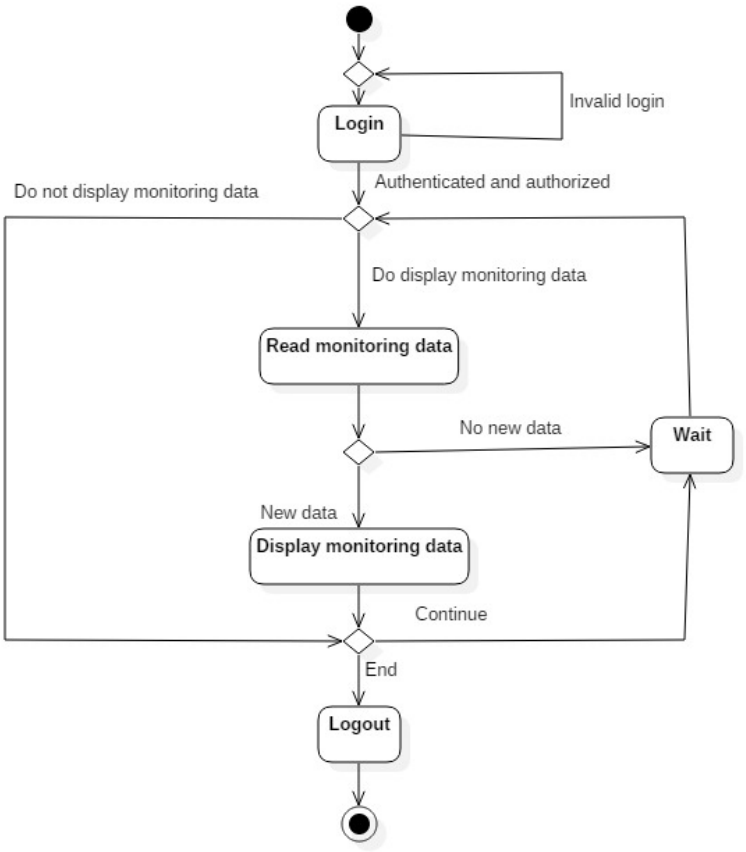


Figure 25 UML activity diagram illustrating the flow of the Monitoring process

7.2.3 Private social networking process

The UML activity diagram for the **Private social networking** process is illustrated in Figure 26. This process is triggered when when the user, i.e. PwD or one of the members of the care network logs into the **Private social networking UI** of the **Social network-based monitoring and information sharing front-end.** The user can then select any of several actions: Handle tasks, Handle messages, Handle appointments, Handle the logbook, Handle the care networks or manage settings. The requests are sent to the **task controller, message controller, appointment controller, logbook controller, care networks controller or the manage settings controller** (belonging to the **controllers** component from the **Social network-based monitoring and information back end**). The controllers

interact with the **task repository, message repository, appointment repository, logbook repository, care networks repository or the setting reposity** (belonging to the **repositories** component) to store

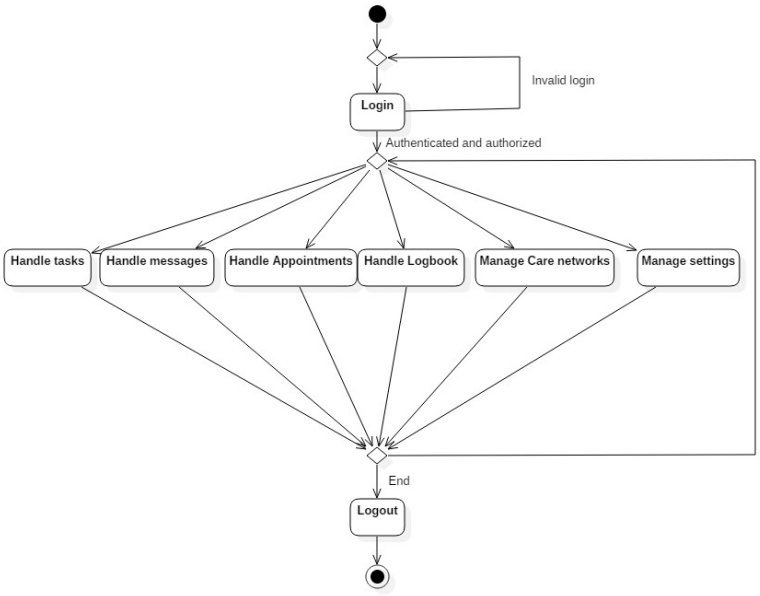


Figure 26 UML activity diagram illustrating the flow of the Private social networking process

and retrieve data from the **Social network-based monitoring and information sharing databases.**

7.3 Development view

Figure 27 illustrates the development view of the **Social network-based monitoring and information sharing service** as a UML component diagram. The **Social network-based monitoring and information front end** will be developed as an AngularJS application and will consist of the **monitoring UI**, the **self report UI** and the **private social networking UI**. Each component will be developed as an Angular component, consisting of an html file and a TypeScript file, and will use a specific service to retrieve and store information which will interact with the the **Social network-based monitoring and information sharing back end**.

The **Social network-based monitoring and information sharing back end** will consist of the following groups of components:

- **Controllers** – contains the following REST controllers that process HTTP requests coming from the the **Social network-based monitoring and information sharing front end**: **monitoring controller, self report controller, task controller, message controller, appointment controller, logbook controller, care network controller, and the settings controller**. These controllers interact with specific components from the **repositories** and **entities** groups of components.
- **Repositories**
    - Contains the following components responsible for the access to the **MedGUIDE database**'s tables: **monitoring repository**, **self report repository**
    - Contains the following components responsible for the access to the **private social networking database**'s tables: **task repository**, **message repository, appointment repository, logbook repository, care network repository, settings repository**
- **Entities** – contains the following components that provides various services to the subsystem: **security services**, **file services**, **Image services**, **calendar services** and **notification services**.

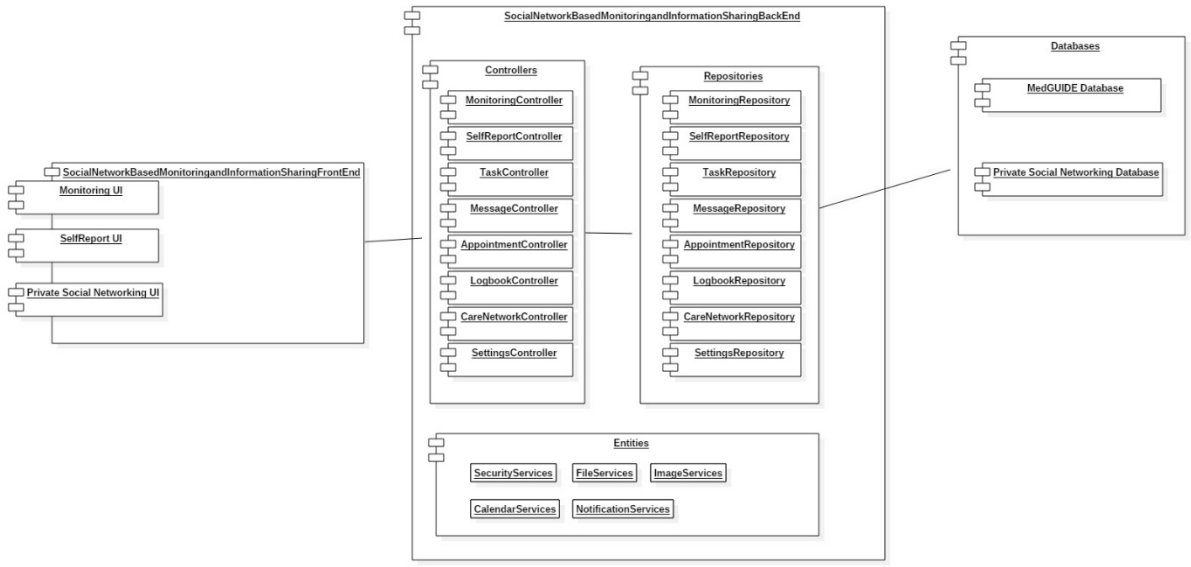


Figure 27 UML component diagram illustrating the development view of the Social network-based monitoring and information sharing service

7.4 Physical view

Figure 28 illustrates the deployment architecture for **Social network-based monitoring and information sharing service**.

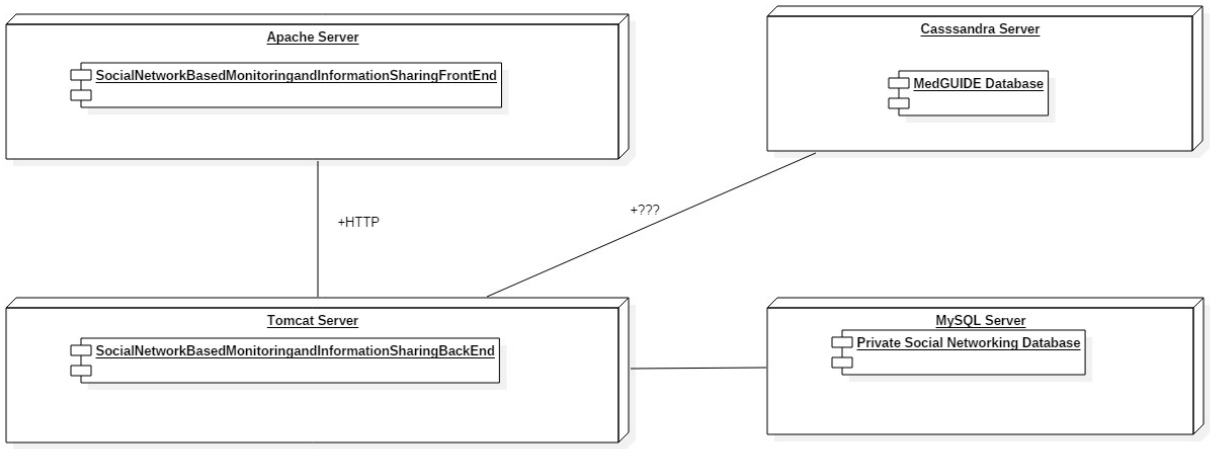


Figure 28 Deployment architecture for Social network-based monitoring and information sharing subsystem

The **Social network-based monitoring and information sharing front end** will be developed as an AngularJS project and will be deployed on an Apache Server which can serve Angular projects. The **Social network-based monitoring and information sharing back end** will be developed as a Spring Boot application which will be deployed on a Tomcat Server. The **Social network-based monitoring and information sharing front end** and the **Social network-based monitoring and information sharing back end** will communicate using the HTTP communication protocol. The **MedGUIDE database** will be hosted on a Cassandra server. The **Private social network database** will be hosted on a MySQL server.

7.5 Scenarios and use cases

The use-case diagram associated to the ***Social network-based monitoring and information sharing service*** is illustrated in Figure 29. The use cases are described in the following sub-sections.

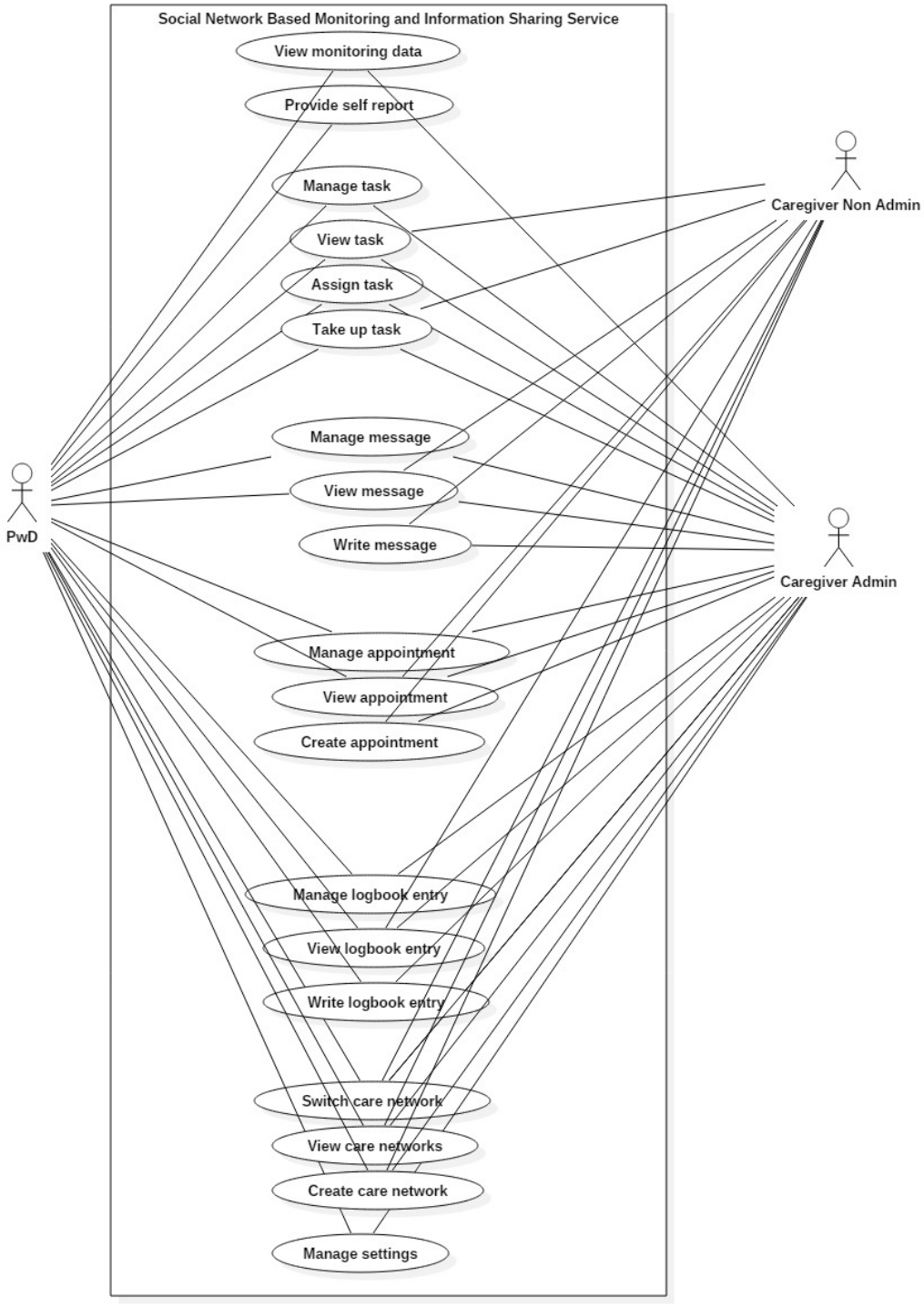


Figure 29 Use-case diagram for the Social network-based monitoring and information sharing service

a) Description of the "View monitoring data" use case

USE CASE	
Name	View monitoring data
Storyline	The PwD or the admin caregiver wants to see the monitoring data.
Actors	PwD, Admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The service displays the monitoring data.

Table 19 View monitoring data - use case

b) Description of the "Provide self report" use case

USE CASE	
Name	Provide self report
Storyline	The PwD fills out a self report and submits it to the system.
Actors	PwD
Prerequisites	The service is installed and active. The user has a login account and is logged in. The system triggers a request for a self report or the PwD wants to provide a self report.
Outcome	The self report is stored in the MedGUIDE database.

Table 20 Provide self report - use case

c) Description of the "Manage task" use case

USE CASE	
Name	Manage task
Storyline	The PwD or the admin caregiver wants to manage (i.e. create, update or delete) a task.
Actors	PwD, Admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The task has been created, updated or deleted.

Table 21 Manage task - use case

d) Description of the "View task" use case

USE CASE	
Name	View task
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to see the content of a task
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The service displays the task content.

Table 22 View task - use case

e) Description of the "Assign task" use case

USE CASE	
Name	Assign task
Storyline	The PwD or the admin caregiver wants to assign a task to one or more of the caregivers in the network of the PwD.
Actors	PwD, Admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The task has been assign to one or more of the caregivers.

Table 23 Assign task - use case

f) Description of the "Take up task" use case

USE CASE	
Name	Take up task
Storyline	One of the members in the network of the PwD wants to take up a task.

Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The task has been assigned to the user.

Table 24 Take up task - use case

g) Description of the "View message" use case

USE CASE	
Name	View message
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to see the content of a message
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The service displays the message content.

Table 25 View message - use case

h) Description of the "Write message" use case

USE CASE	
Name	Write message
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants write a message.
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The message has been stored in the database and is displayed to the user.

Table 26 Write message - use case

i) Description of the "Delete message" use case

USE CASE	
Name	Delete message
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to delete a message.
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in. The message is a message of the user himself.
Outcome	The message has been marked deleted is displayed as such.

Table 27 Delete message - use case

j) Description of the "Manage appointment" use case

USE CASE	
Name	Manage appointment
Storyline	The PwD or the admin caregiver wants to manage (i.e. create, update or delete) an appointment.
Actors	PwD, Admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The appointment has been created, updated or deleted.

Table 28 Manage appointment - use case

k) Description of the "View appointment" use case

USE CASE	
Name	View appointment
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to see the content of an appointment
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The service displays the appointment content.

Table 29 View appointment - use case

l) Description of the "Create appointment" use case

USE CASE	
Name	Create appointment
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to create an appointment.
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The appointment has been stored in the database and is displayed to the user.

Table 30 Create appointment - use case

m) Description of the "View logbook entry" use case

USE CASE	
Name	View logbook entry
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to see the content of a logbook entry
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The service displays the logbook entry content.

Table 31 View logbook entry - use case

n) Description of the "Write logbook entry" use case

USE CASE	
Name	Write logbook entry
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants write a logbook entry.
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The logbook entry has been stored in the database and is displayed to the user.

Table 32 Write logbook entry - use case

o) Description of the "Delete logbook entry" use case

USE CASE	
Name	Delete logbook entry
Storyline	The PwD, the admin caregiver or the non-admin caregiver wants to delete a logbook entry.
Actors	PwD, Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in. The logbook entry is a logbook entry of the user himself.
Outcome	The logbook entry has been marked deleted is displayed as such.

Table 33 Delete logbook entry - use case

p) Description of the "Switch care network" use case

USE CASE	
Name	Switch care network
Storyline	The user wants to switch to another care network.
Actors	Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in. The user is authorised to switch to the other care network.
Outcome	The user is switched to another care network.

Table 34 Switch care network - use case

q) Description of the "Display care networks" use case

USE CASE

Name	Display care networks
Storyline	The user wants to see the list of care networks he belongs to.
Actors	Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in.
Outcome	The service displays the list of care networks the user is part of.

Table 35 Display care networks - use case

r) Description of the "Create care network" use case

USE CASE	
Name	Create care network
Storyline	The user wants to create a new care network for himself or another PwD.
Actors	Admin caregiver, Non-admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The service creates a new care network for the user himself or another PwD.

Table 36 Create care network - use case

s) Description of the "Manage settings" use case

USE CASE	
Name	Manage settings
Storyline	The admin caregiver wants to manage settings of the care network of the PwD.
Actors	Admin caregiver
Prerequisites	The service is installed and active. The user has a login account and has logged in
Outcome	The settings are updated.

Table 37 Manage settings - use case

8 Big Data Enacted Assessment Service

This section presents the design of ***Big Data Enacted Assessment Service***, its components and their interrelationships. The *main objective* of this service is to provide the following functionalities to doctors:

- Detect the baseline daily life activities of a patient with dementia out of monitored data;
- Check whether the activities associated to a day in which the patient has been monitored contain significant deviations from the patient's baseline activities or not.

In case significant deviations from the daily life activities baseline, ***Polypharmacy Management Knowledge Base Service*** will allow the specialists to provide annotations on the potential drug-drug interactions and associated side-effects that might lead to these deviations.

8.1 Logical View

8.1.1 Description

The ***Big Data Enacted Assessment Service*** consists of two main groups of components:

- ***Big Data Enacted Assessment Service Front-End*** – includes components related to the implementation of the service's user interface;
- ***Big Data Enacted Assessment Service Back-End*** – includes components related to the implementation of the service's back end functionality.

Figure 30 illustrates the logical architecture of the ***Big Data Enacted Assessment Service***.

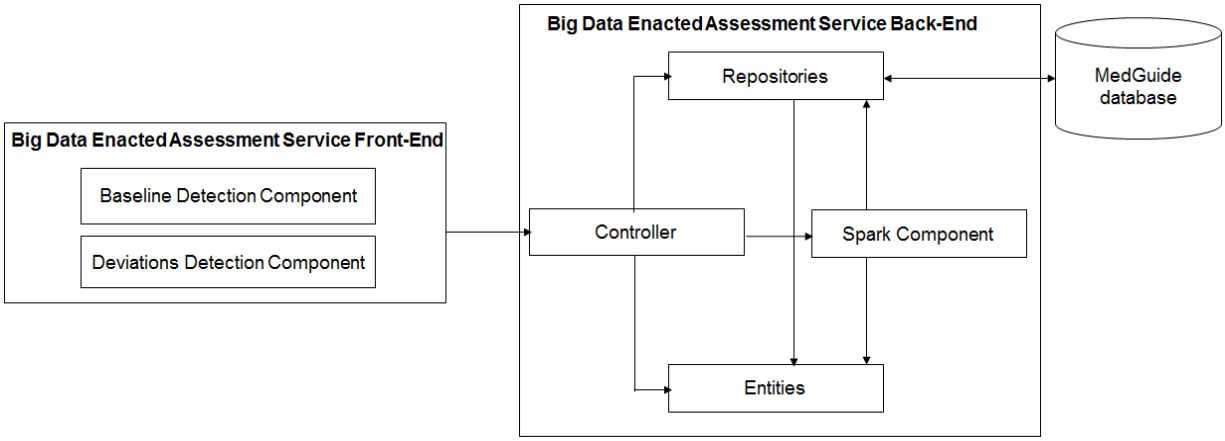


Figure 30 Logical architectural view of the Big Data Enacted Assessment Service

The ***Big Data Enacted Assessment Service Front-End*** includes the following components related to the implementation of the ***Big Data Enacted Assessment Service***'s user interface:

- ***Baseline Detection Component*** - responsible for displaying the baseline activities of a patient selected by the doctor.
- ***Deviations Detection Component*** – responsible for displaying whether a day selected by the doctor contains significant deviations from the baseline of the patient or not.

The ***Big Data Enacted Assessment Service Back-End*** consists of the following components:

- ***Controllers component*** – includes the components that process the requests coming from the ***Big Data Enacted Assessment Service Front-End***
- ***Repositories component*** – includes the components that retrieve data from specific tables of the ***MedGuide database***

- ***Entities component*** – includes auxiliary components that are used to model specific data types.
- ***SPARK Component*** – integrates specific Spark MLLIB machine learning algorithms applicable on big data to (i) identify the baseline of a patient, and to (ii) identify whether the activities performed by a patient in a monitored day contain deviations from the patient's baseline or not.

8.1.2 Functional and non-functional requirements

Table 38 illustrates the functional requirements to be satisfied by the ***Big Data Enacted Assessment Service***.

ID	Name	Description
1	Detect and display the baseline of a patient	The service should be able to detect and display in a user friendly-manner the baseline of a patient by analyzing the days in which the patient has been monitored.
2	Identifies whether a monitored day contains or not significant deviations from the baseline of a patient;	The service should be able to (i) identify whether a selected day contains significant deviations from the baseline of a patient and (ii) detect and display the deviations in a user friendly manner if they are identified.

Table 38 Functional requirements for the Big Data Enacted Assessment Service

Table 39 illustrates the non-functional requirements to be satisfied by ***Big Data Enacted Assessment Service***.

ID	Name	Description
1	Usability	The service should be developed to be simple and intuitive for the end users and easy to understand.
2	Extensibility	The service should facilitate the easy integration of new functionality.
3	Reliability	The service should be able to inform user about any malfunctions.
4	Scalability	The service should scale with the increasing among of monitored data providing reasonable responses to the front end requests.

Table 39 Non-Functional requirements for the Big Data Enacted Assessment Service

8.2 Process View

This section presents the dynamic aspects of the ***Big Data Enacted Assessment Service*** by using UML Activity Diagrams to illustrate the main processes.

8.2.1 Baseline detection and visualization

The UML activity diagram for the ***Baseline detection and Visualization*** process is illustrated in Figure 31. This process is triggered when the user, i.e. doctor, selects a patient from the ***Big Data Enacted Assessment Service Front-End*** for which he wants to view its baseline activities.

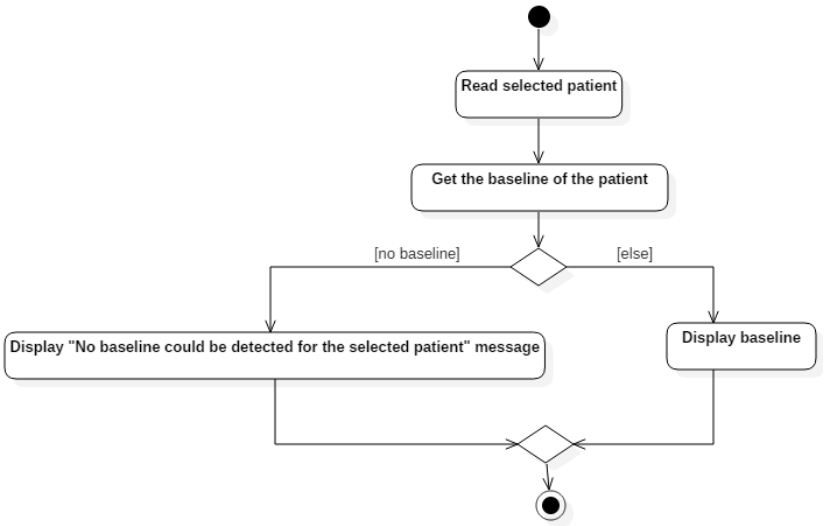


Figure 31 UML activity diagram illustrating the flow of the Baseline Detection and Visualization process

After the patient is selected, the ***Big Data Enacted Assessment Service Front-End*** sends a request to the ***Baseline Detection Controller*** (belonging to the ***Controllers*** component from the ***Big Data Enacted Assessment Service Back End***) which interrogates the ***baselines table*** from the ***MedGuide database*** using the ***Baseline Repository*** (belonging to the ***Repositories*** component) to identify the baseline of the patient. If a baseline for the patient is stored in the ***baselines table***, then the baseline is returned to the ***Big Data Enacted Assessment Service Front-End*** and displayed***.*** If no baseline is stored in the ***baselines table***, then the back-end's ***SPARK component*** will be used to identify the patient's baseline by processing the records from the ***activities table*** of the ***MedGuide database*** containing the monitored activities performed by the patient for a period of time. If the baseline can be detected then it is returned to the front end, otherwise if it cannot be detected due to the lack of monitored activities for the selected patient, the message "*No baseline could be detected for the selected patient*" is displayed in the service front-end.

8.2.2 Deviations Detection Process

The UML activity diagram for the ***Deviations Detection*** process is illustrated in Figure xx. This process is triggered when the doctor wants to see whether a day having monitored activities associated to a patient contains deviations or not. In the first step of this process, the doctor selects a patient and a day containing monitored activities from the service's front end. The front-end sends a request to the back-end where it is processed by the ***Deviations Detection Controller***. This controller uses the ***SPARK component*** to establish whether the day selected by the doctor contains deviations or not; in case deviations are found, the drug-drug interactions and the side effects that might cause the deviations are identified. The ***SPARK component*** will use the data stored in the ***annotations table*** from the ***MedGuide database*** as training set according to which it will establish whether the selected day contains deviations or not. The ***Deviations Detection Controller*** will return the response from the ***SPARK component*** to the service's front-end where it will be displayed.

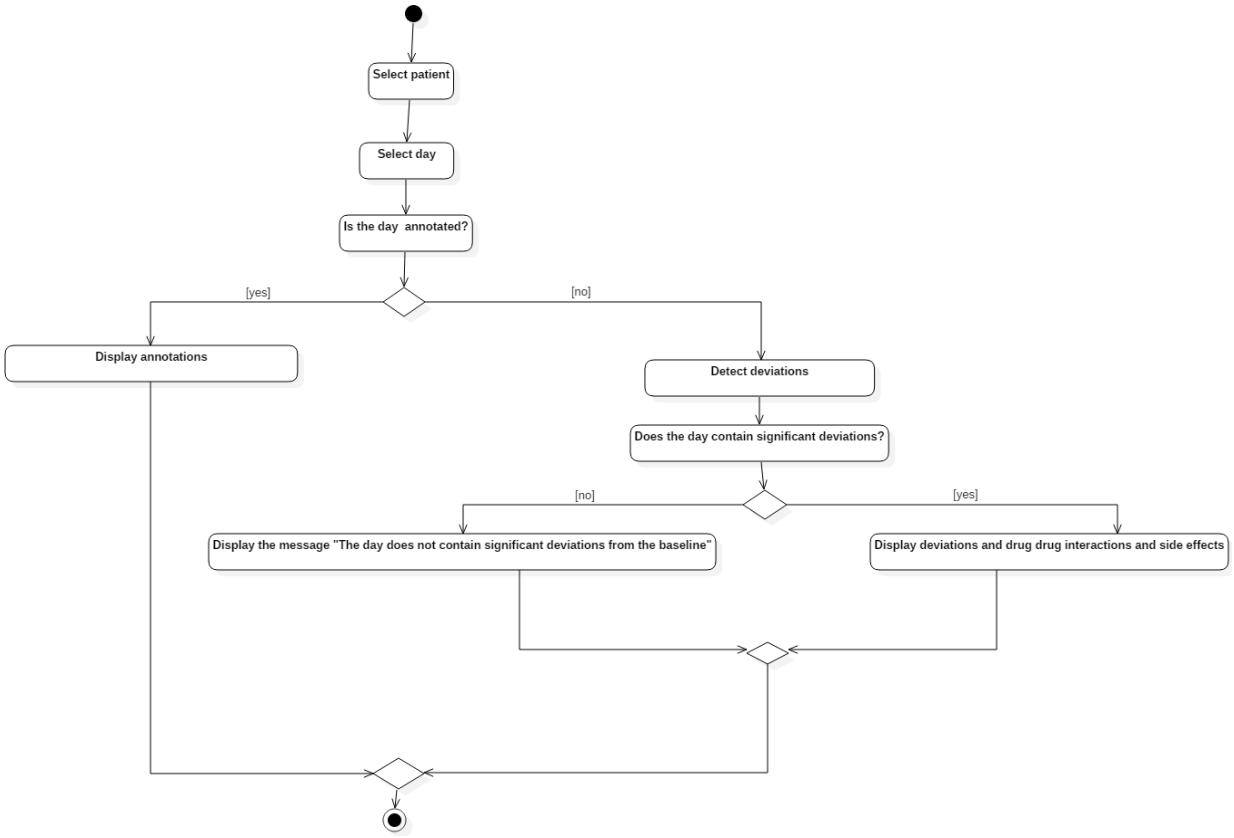


Figure 32 UML activity diagram illustrating the flow of the Deviations Detection process

8.3 Development View

Figure 33 illustrates the development view of the ***Big Data Enacted Assessment Service*** as a UML component diagram.

The ***Big Data Enacted Assessment Service Front End*** will be developed as an Angular 4 application and will consist of the ***Baseline Detection Component*** and ***Deviations Detection Component***. Each component will be developed as an Angular component, consisting of an html file and a TypeScript file, and will use a specific Angular service to get information which will interact with the ***Big Data Enacted Assessment Service Back End***.

Big Data Enacted Assessment Service Back End will consist of the following groups of components:

- ***Controllers*** – contains the following REST controllers that process HTTP requests coming from the ***Big Data Enacted Assessment Service Front End***: ***Baseline Detection Controller, Deviations Detection Controller***. These controllers interact with specific components from the ***Repositories*** and ***Entities*** groups of components.
- ***SPARK Component*** – contains specific components that enable the interaction with the SPARK MLlib library[4] to run big data machine learning algorithms for identifying the baseline of a patient and the deviations from the baseline; in case significant deviations are identified, the potential drug-drug interactions and associated side-effects that might lead to these deviations will be discovered.

[4] https://spark.apache.org/mllib/

- ***Repositories***
  - Contains the following components responsible for the access to the ***MedGuide database***'s tables: ***Baseline Repository***, ***Activity Repository***, ***Annotation Repository***, ***Medication Prescription Repository***
  - Contains the component ***Ontology Repository*** responsible for the access to the ***Polypharmacy Management Ontology***
- ***Entities*** – contains the following components that map on specific tables of the ***MedGuide database***: ***Baseline*** (maps on the table ***Baselines***), ***Activity*** (maps on the table ***Activities***), ***Medication Prescription*** (maps on the table ***Medication_Prescription***), ***Annotation*** (maps on the table ***Annotations***)

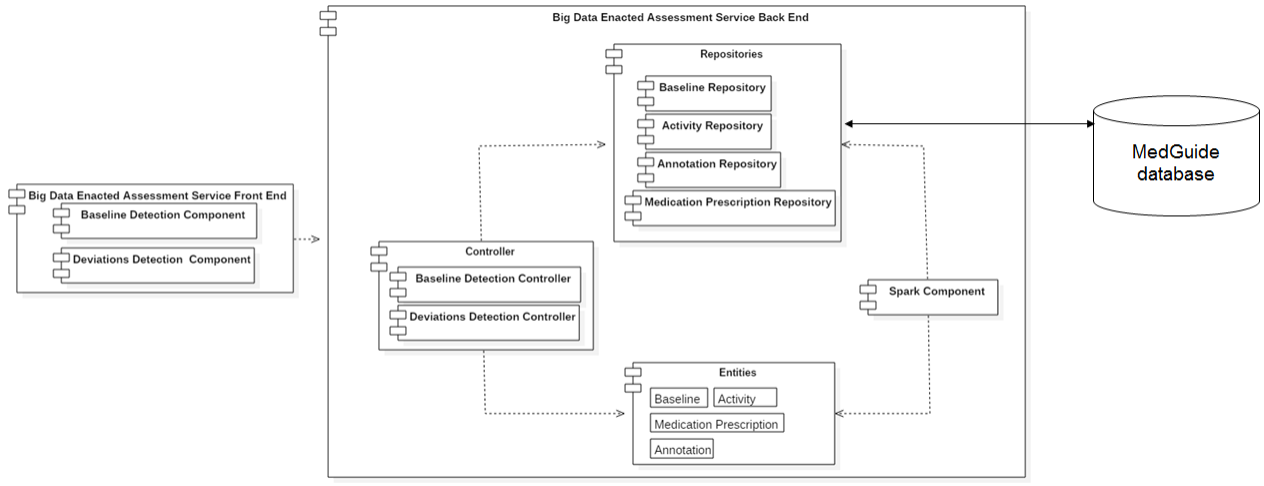


Figure 33 UML component diagram illustrating the development view of this service

8.4 Physical View

Figure 34 illustrates the deployment architecture for the ***Big Data Enacted Assessment Service***. The ***Big Data Enacted Assessment Service Front End*** will be developed as an Angular 4 project and will be deployed on an NGINX Server which can serve Angular projects. The ***Big Data Enacted Assessment Service Back End*** will be developed as a Spring Boot application which will be deployed on a Tomcat Server. The ***Big Data Enacted Assessment Service Front End*** and ***Back End*** will communicate using the HTTP communication protocol. The ***MedGuide Database*** will be hosted on a Cassandra server. ***SPARK MLlib*** will be deployed on a Spark Server.

The deployment of the ***Big Data Enacted Assessment Service*** is driven by a list of software requirements required for the operation of the service's components. These requirements are presented in Table 40.

Component	**Software requirement**
Big Data Enacted Assessment Service Front End	NGINX server 1.10.3
Big Data Enacted Assessment Service Back End	Apache Tomcat server 8.5.5
MedGuide Database	Cassandra server 3.10
SparkMLlib	Spark Server

Table 40 Software requirements required for the operation of the Big Data Enacted Assessment Service

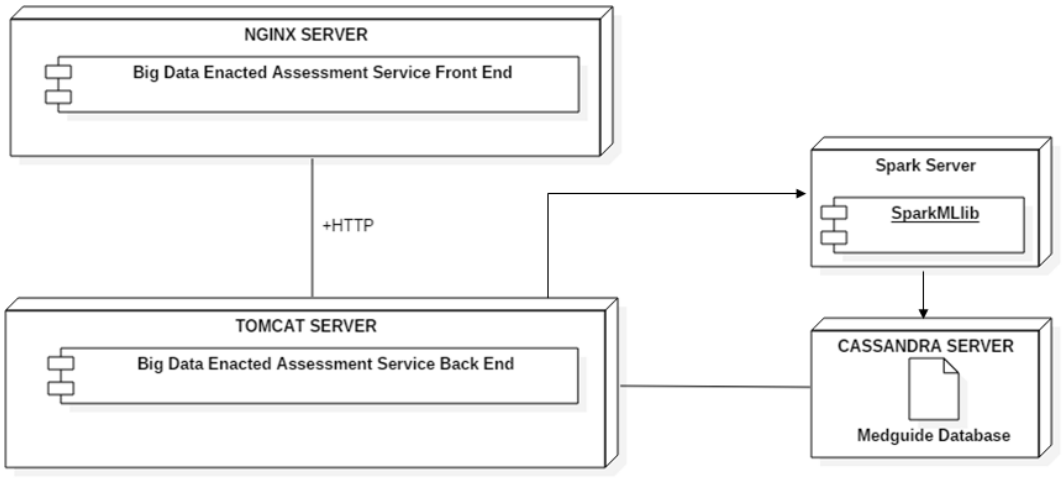


Figure 34 Deployment architecture for Big Data Enacted Assessment Service

8.5 Scenarios and use-cases

The use-case diagram associated to the ***Big Data Enacted Assessment Service*** is illustrated in Figure xx. The use-cases are described in the following sub-sections.

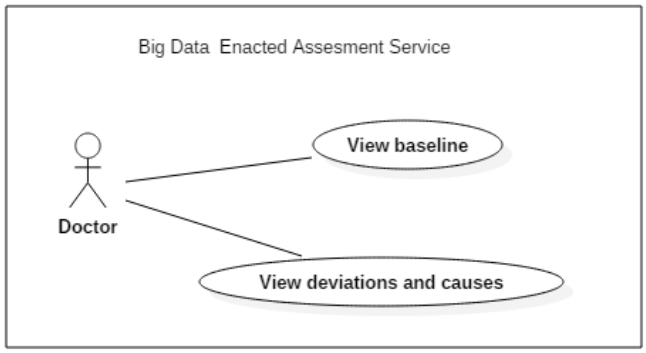


Figure 35 Use-case diagram for the Big Data Enacted Assessment Service

t) Description of the "View baseline" use case

USE CASE	
Name	View baseline
Storyline	The doctor selects a patient for whom he wants to view its baseline. The doctor visualizes the baseline of the patient.
Actors	Doctor
Preconditions	The service is installed and active. The doctor has a login account. The MedGuide database contains information about the activities performed by the patient for previous days (historical data).
Postconditions	-

u) Description of the "View deviations and causes" use case

USE CASE	
Name	View deviations and causes
Storyline	The doctor selects a patient and a date which he wants to check whether it contains deviations or not. If the selected date contains activities with significant deviations from the baseline, these deviations are shown to the doctor.
Actors	Doctor
Preconditions	The service is installed and active. The doctor has a login account.
Postconditions	-

Table 41 View deviations and causes - use case

9 Polypharmacy management knowledge base service

9.1 Logical view

This section presents the logical architecture of the **Polypharmacy management knowledge base service**, its components and their interrelationships. The main objective of this service is to enable doctors to manually correlate the days having activities with significant deviations from the baseline meaning as prescribed by the physician, of a patient with drug-drug interactions and associated side-effects.

The **Polypharmacy management knowledge base service** consists of two main groups of components:

- **Polypharmacy management knowledge base front-end** – includes components related to the implementation of the service's user interface
- **Polypharmacy management knowledge base back-end** – includes components related to the implementation of the service's back end functionality

Figure 36 illustrates the logical architecture of the **Polypharmacy management knowledge base service**.

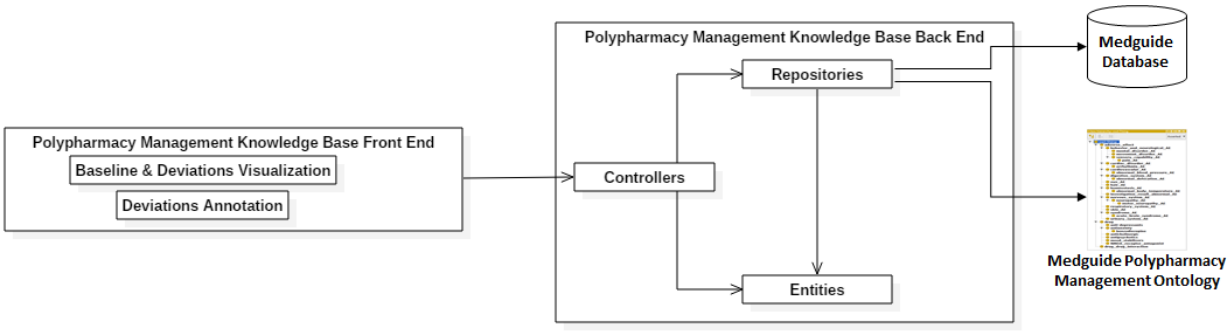


Figure 36 Logical architecture of the Polypharmacy management knowledge base service

The **Polypharmacy management knowledge base front-end** component includes the following components related to the implementation of the **Polypharmacy management knowledge base service**'s user interface:

- **Baseline and deviations visualisation component** - responsible for displaying (i) the activities performed by the patient in a specific day chosen by the doctor and (ii) the activities from the patient's baseline.
- **Deviations annotation component** – responsible for displaying the drug-drug interactions and associated side-effects, filtered according to the medication prescribed to the patient in the day chosen by the doctor.

Through the service's user interface, the doctor will be able to perform the following operations:

- Choose a day for which to view the activities performed by a patient and visually compare these activities with the patient's baseline activities
- Set the chosen day as having normal activities or as having significant deviations from the baseline
- In case significant deviations from the baseline are identified, annotate the chosen day with drug-drug interactions and associated side-effects, where the drug-drug interactions are filtered according to the patient's medication prescriptions that are active for the chosen day.

The components of the **Polypharmacy management knowledge base front-end** interact with the components of the **Polypharmacy management knowledge base back-end** to (1) retrieve the data

related to the activities and baseline of a patient and to (2) save the doctor's annotations in the **MedGUIDE database**. The **Polypharmacy management knowledge base back-end** consists of the following components:

- **Controllers component** – includes the components that process the requests coming from the **Polypharmacy management knowledge base front-end**
- **Repositories component** – includes the components that retrieve data from specific tables of the **MedGUIDE database** and from the **Polypharmacy management ontology**
- **Entities component** – includes auxiliary components that are used to model specific data types.

9.1.1 Input and outputs

Table 42 illustrates (i) input collected from the **Polypharmacy management knowledge base front-end** which is submitted to the **Polypharmacy management knowledge base back-end** where it is processed, and (ii) the output of the **Polypharmacy management knowledge base back-end**.

Table 42 Inputs and outputs of the Polypharmacy management knowledge base service

Input collected from the Polypharmacy management knowledge base front-end	**Output of the Polypharmacy management knowledge base back-end**
A date for which the associated activities will be compared with the activities from the baseline	- List of the activities performed by the patient for the given date, stored in the **MedGUIDE database** – will be shown in the user interface - List of activities from the patient's baseline stored in the **MedGUIDE database** – will be shown in the user interface
The status of the selected day, whether it contains normal activities or significant deviations from the patient's baseline	- Annotations stored in the **MedGUIDE database** associated to the day selected by the doctor

9.1.2 Functional and non-functional requirments

Table 43illustrates the functional requirements to be satisfied by the ***Polypharmacy management knowledge base service***.

Table 43 Functional requirements for the Polypharmacy management knowledge base service

ID	**Name**	**Description**
1	Baseline and deviations visualisation	The service should be able to display in an user friendly manner (1) the activities from a patient's baseline, (2) the activities performed by the patient in a day selected by the doctor, and (3) the deviations of the selected day from the baseline.
2	Deviations annotation	The service should be able to (i) display in a user friendly manner the drug-drug interactions and their associated side-effects, filtered according to the medication prescribed to the patient, and to (ii) save the annotations performed by the doctor in the ***Medguide database***.

Table 44 illustrates the non-functional requirements to be satisfied by the **Polypharmacy management knowledge base service**.

Table 44 Non-Functional requirements for the Polypharmacy management knowledge base service

ID	Name	Description
1	Usability	The system should be developed to be easy to handle and intuitive for the end users and easy to understand.
2	Extensibility	The system should facilitate the easy integration of new functionalities
3	Reliability	The system should be able to inform user about any malfunctions.

9.2 Process view

This section presents the dynamic aspects of the **Polypharmacy management knowledge base service**. In this section, the UML Activity Diagrams will be used to illustrate the main processes of the **Polypharmacy management knowledge base service**.

9.2.1 Baseline and Deviations Visualisation Process

The UML activity diagram for the **Baseline and deviations visualisation** process is illustrated inFigure 37 This process is triggered when the user, i.e. doctor, selects a date from the **Polypharmacy management knowledge base front-end** for which he wants to view the activities performed by a patient and to compare them with the baseline.

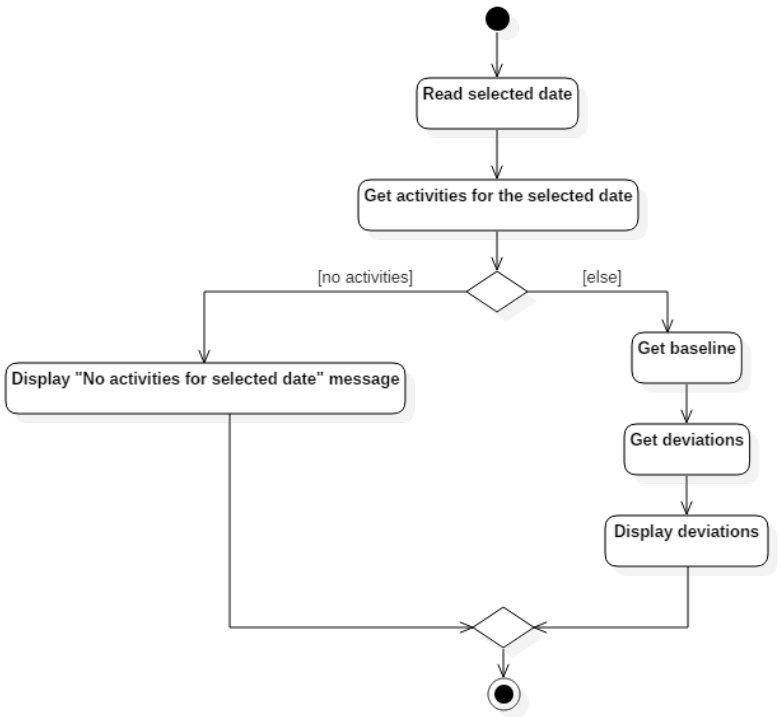


Figure 37 UML activity diagram illustrating the flow of the Baseline and Deviations Visualisation process

After the date is selected, the **Polypharmacy management knowledge base front-end** sends a request to the **Baseline and deviations controller** (belonging to the **controller** component from the

Polypharmacy management knowledge base back end) which interrogates the **MedGUIDE database** using the **activity repository** (belonging to the **repositories** component) to identify the activities performed by the patient in that day:

- If the patient has activities associated to that day, the **Polypharmacy management knowledge base front-end** sends two requests to the **Baseline and deviations controller**, one which interrogates the **MedGUIDE database** using the **baseline repository** to identify the activities of the baseline associated to the patient, and another one to get the deviations of the selected date from the baseline. After all this information is obtained from the **Baseline and deviations controller**, it is displayed in the **Polypharmacy management knowledge base front-end** using the Google timeline charts.

- If the patient has no activities associated to that day, a message is displayed in the **Polypharmacy management knowledge base front-end**.

9.2.2 Deviations annotation process

The UML activity diagram for the **Deviations annotation** process is illustrated in Figure 38. This process is triggered when the **Baseline and deviations visualisation** process ends and activities can be found for the date selected by the doctor in the **Polypharmacy management knowledge base front-end**. Consequently, after analysing the timeline charts illustrating the activities performed by the patient in the selected date, the activities associated to the patient's baseline and the identified deviations, the “doctor” can set the selected date as having normal activities or as having significant deviations from the baseline.

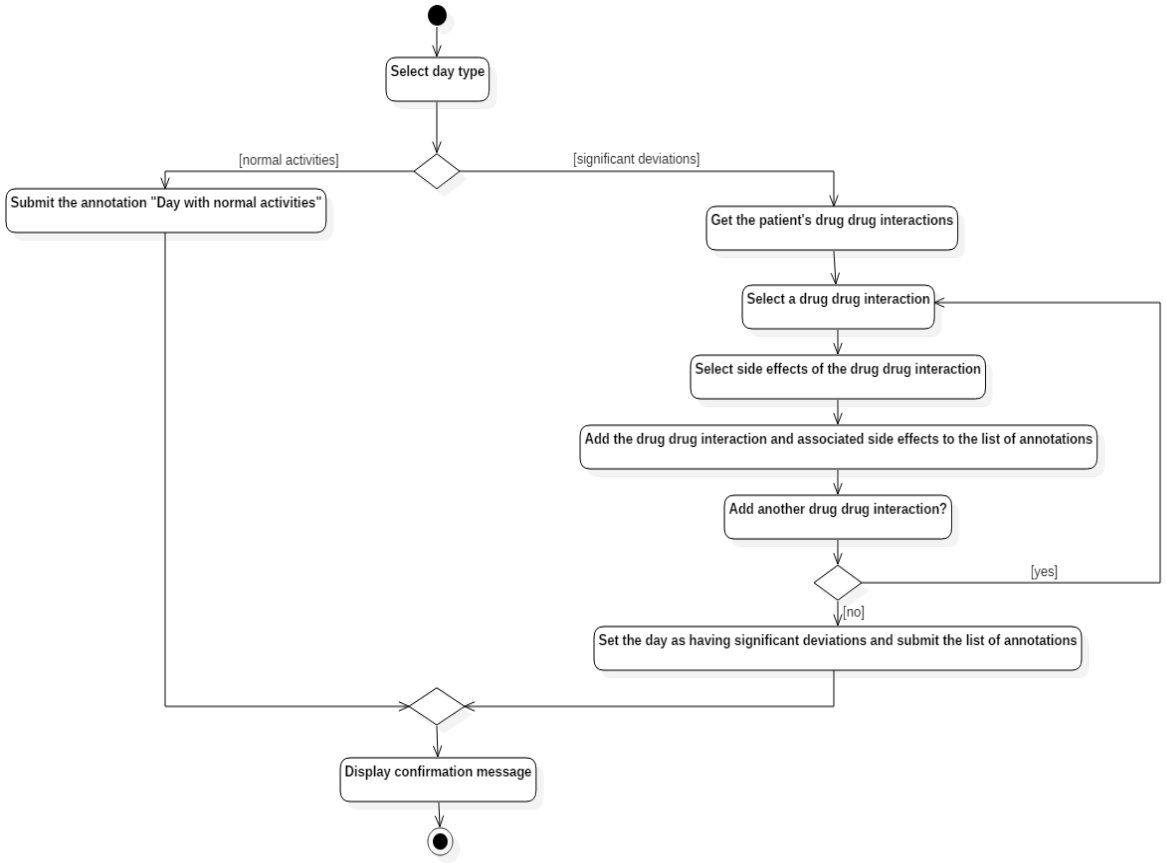


Figure 38 UML activity diagram illustrating the flow of the Deviations Annotation process

If the doctor sets the date as having normal activities, the annotation "normal activities" is submitted to the **annotation controller** (belonging to the **controller** component from the **Polypharmacy management knowledge base back-end**) which is further saved in the **MedGUIDE database** using the **annotation repository** (belonging to the **repositories** component). Finally, a confirmation message is displayed to the user in the **Polypharmacy management knowledge base front-end**.

If the doctor sets the date as having significant deviations, the following steps are performed:

1) The **Polypharmacy management knowledge base front-end** sends a request to the **ontology controller** (belonging to the **controllers** component from the **Polypharmacy management knowledge base back-end**) which interrogates the **MedGUIDE polypharmacy management ontology** using the **ontology repository** (belonging to the **repositories** component) to get the list of drug-drug interactions which is then filtered according to the medication prescribed for the patient for the selected date. To obtain the medication prescribed to the patient for a particular day, the **ontology controller** uses the **medication prescription repository** (belonging to the **repositories** component) which interrogates the **MedGUIDE database**.

(2) After the list of drug-drug interactions is displayed, the doctor can select a drug-drug interaction, and based on this selection, the **Polypharmacy management knowledge base front-end** sends a request to the **ontology controller** which interrogates the **MedGUIDE polypharmacy management ontology** using the **ontology repository** to get the list of side-effects associated to the selected drug-drug interaction.

(3) After the list of side-effects is displayed, the doctor can select multiple side-effects.

(4) The doctor can add an annotation containing the selected drug-drug interaction and associated side-effects to the list of annotations, and if he desires to add other annotations he can repeat the steps 2-4.

(5) The list of annotations is submitted to the **annotation controller** (belonging to the **controllers** component from the **Polypharmacy management knowledge base back-end**) which uses the **annotations repository** (belonging to the **repositories** component) to save the list in the **MedGUIDE database**.

(6) Finally, a confirmation message is displayed to the user in the **Polypharmacy management knowledge base front-end**.

9.3 Development view

Figure 39 illustrates the development view of the **Polypharmacy management knowledge base service** as a UML component diagram. The **Polypharmacy management knowledge base front end** will be developed as an Angular 4 application and will consist of the **baseline and deviations visualisation component** and **deviations annotation component**. Each component will be developed as an Angular component, consisting of an html file and a TypeScript file, and will use a specific service to get/save information which will interact with the **Polypharmacy management knowledge base back end**.

The **Polypharmacy management knowledge base back end** will consist of the following groups of components:

- **Controllers** – contain the following REST controllers that process HTTP requests coming from the **Polypharmacy management knowledge base front end**: **baseline and deviations controller, annotation controller, ontology controller**. These controllers interact with specific components from the **repositories** and **entities** groups of components.

- **Repositories**

    - Contain the following components responsible for the access to the **MedGUIDE database**'s tables: **baseline repository**, **activity repository**, **annotation repository**, **medication prescription repository**

    - Contain the component **ontology repository** responsible for the access to the **polypharmacy management ontology**

- **Entities** – contain the following components that map on specific tables of the **MedGUIDE database**: **baseline** (maps on the table **baselines**), **activity** (maps on the table **activities**), **medication prescription** (maps on the table **Medication_Prescription**), **annotation** (maps on the table **Annotations**)

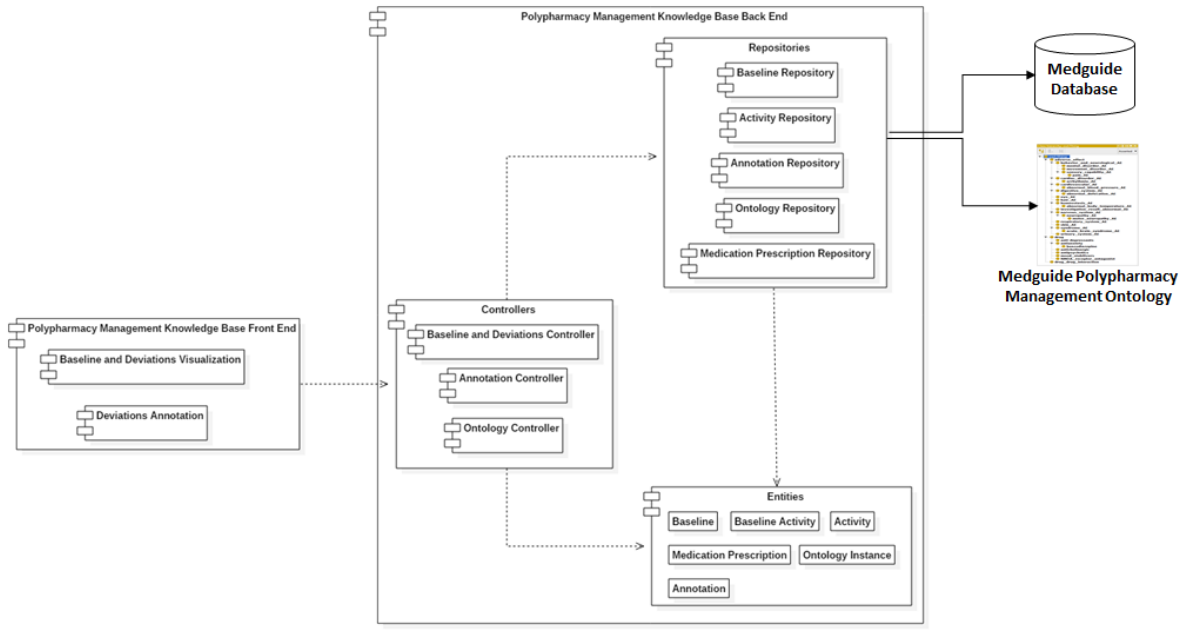


Figure 39 UML component diagram illustrating the development view of the Polypharmacy management knowledge base service

9.4 Physical view

Figure 40 illustrates the deployment architecture for the **Polypharmacy management knowledge base service**.

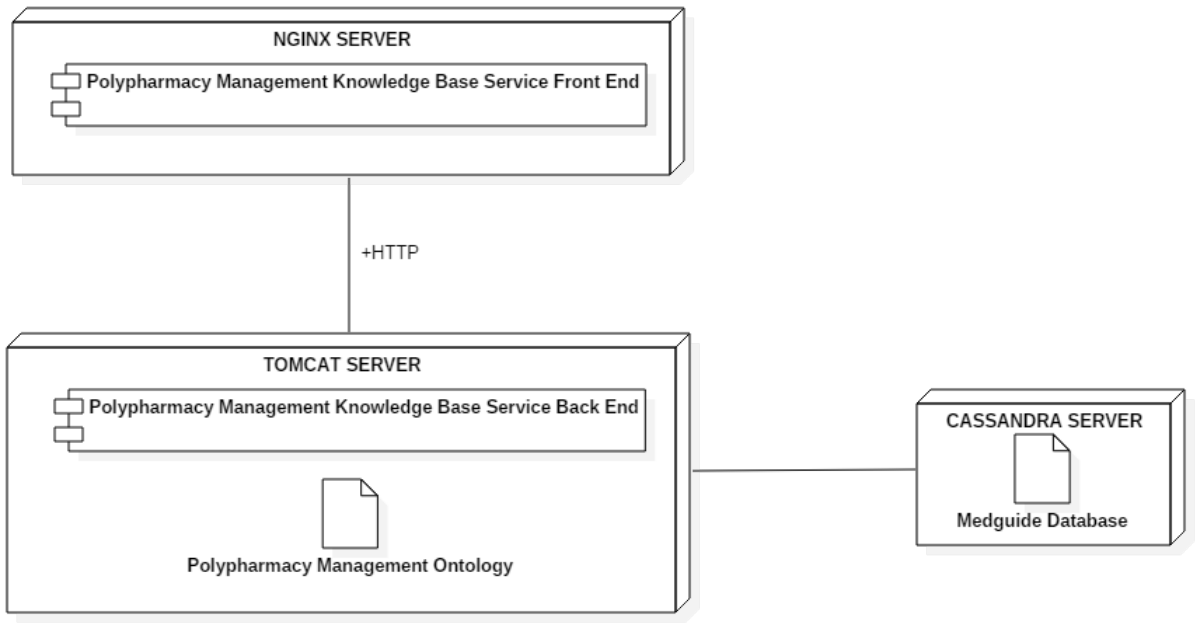


Figure 40 Deployment architecture for Polypharmacy management knowledge base service

The **Polypharmacy management knowledge base service front end** will be developed as an Angular 4 project and will be deployed on an NGINX Server which can serve Angular projects. The **Polypharmacy management knowledge base service back end** will be developed as a Spring Boot application which will be deployed on a Tomcat Server. The Tomcat Server will also host the **polypharmacy management ontology** stored as an OWL file. The **Polypharmacy management knowledge base service front end** and the **Polypharmacy management knowledge base service back-end** will communicate using the HTTP communication protocol. The **MedGUIDE Database** will be hosted on a Cassandra server.

9.5 Scenarios and use cases

The use case diagram associated to the ***Polypharmacy management knowledge base service*** is illustrated in Figure 41 The use cases are described in the following sub-sections.

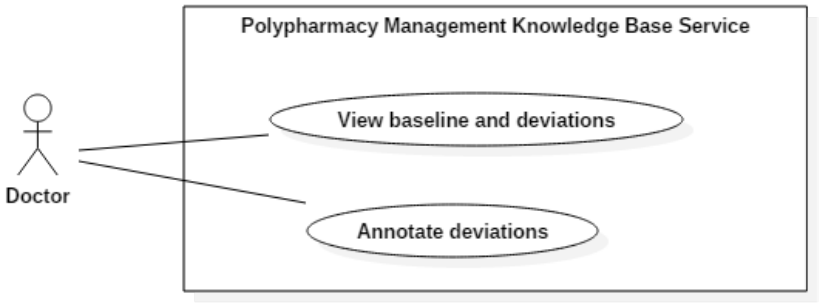


Figure 41 Use-case diagram for the Polypharmacy management knowledge base service

v) Description of the "View baseline and deviations" use case

USE CASE	
Name	View baseline and deviations
Storyline	The doctor selects a date which he/ she wants to compare with the patient's baseline. The doctor visualises the activities performed by the patient in the selected date, the activities part of the patient's baseline and the deviations.
Actors	Doctor
Prerequisites	The service is installed and active. The doctor has a login account and chooses a patient.
Outcome	The service displays using timeline charts (i) the activities performed by the patient in the selected day, (ii) the activities part of the patient's baseline and (iii) the deviations.

Table 45 View baseline and deviations - use case

w) Description of the "Annotate deviations" use case

USE CASE	
Name	Annotate deviations
Storyline	The doctor sets the date selected in the "View baseline and deviations" use case as having normal activities or as having significant deviations from the baseline. If the date is marked as "having significant deviations from the baseline", the user selects the drug-drug interactions, filtered according to the patient's medical prescription, and the associated side-effects, annotates the selected date with them and submits the annotations. If the date is marked as containing normal activities, the user submits this annotation.
Actors	Doctor
Prerequisites	The service is installed and active. The doctor has a login account, chooses a patient and selects a date for which the activities of the patient have been recorded.
Outcome	The annotations submitted by the doctor are stored in the MedGUIDE database.

Table 46 Annotate deviations - use case

10 Dementia care and polypharmacy management service

10.1 Logical view

This section describes the logical architecture of the **Dementia care and polypharmacy management service**. The main objective of this service is to create a platform that facilitates the communication between the users of the application: the doctors, the informal caregivers, the formal caregivers and the persons with dementia (PwD). A selection of the secondary objectives is represented by the visualisation of the daily living activities of the PwD's, the creation of medication plans and the monitoring of the PwD's using reports written by their caregivers.

The **Dementia care and polypharmacy management service** has two main parts:

- The **Dementia care and polypharmacy management front-end** – includes the classes and the components which are used for the implementation of the user interface of the service
- The **Dementia care and polypharmacy management back-end** – includes the classes and the components that are used for the implementation of the back-end functionalities of the service

The logical architecture of the service is presented in Figure 42.

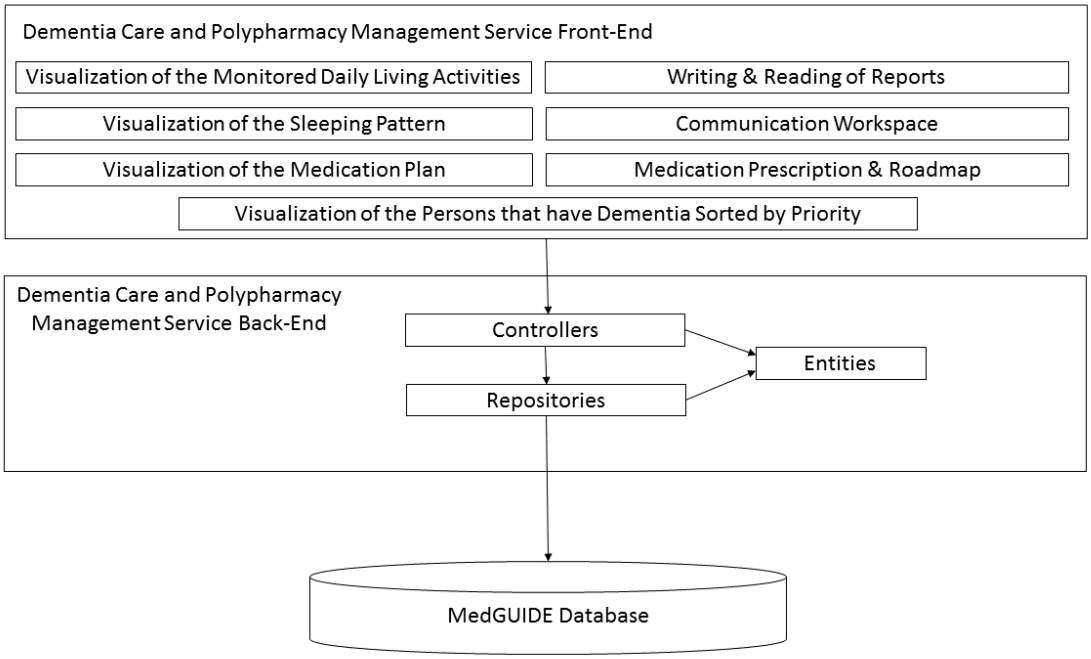


Figure 42 Logical Architecture of Dementia care and polypharmacy management service

The components that are included in the ***Dementia care and polypharmacy management service front-end*** are summarised in Table 47. The application provides services for four types of users: doctors, professional caregivers, formal caregivers and PwD. In the table, the generic term **"users"** refers to all four categories of users.

Component	Description
Visualisation of the Monitored Daily Living Activities	The users can see the monitored activities of the PwD's from: (1) The current day (2) The last seven days

Visualisation of the Sleeping Pattern	The users can see the sleeping pattern of the PwD's from: (1) The current day (2) The last seven days
Visualisation of the Medication Plan	The users can consult the adherence to the medication plan of the PwD's. The information is displayed for: (1) The current day (2) The last seven days
Writing & Reading of Reports	The reports complete the information that comes from the sensors that monitor the PwD's. There are two types of activities associated with the reports: (1) The writing of the reports – can be performed by the professional caregivers, the informal caregivers, the PwD's (2) The reading of the reports – can be performed by the doctors
Communication Workspace	The communication workspace is a place where the users of the application exchange messages.
Medication Prescription & Roadmap	The medication prescription and the roadmap are created by the doctors as follows: (1) The medication prescription – describes the medication plan that must be followed by the PwD's (2) The roadmap – describes recommendations that should be considered by PwD's
Visualisation of the Persons with Dementia Sorted by Priority	Upon the log in the application, the professional caregivers and the doctors can see all the PwD's sorted by priority. Special attention must be considered for the patients that have a higher priority.

Table 47 Dementia care and polypharmacy management service front-end components

The components of the **Dementia care and polypharmacy management service front-end** communicate with the components of the **Dementia care and polypharmacy management service back-end** through REST (Representational State Transfer) messages. The information displayed in the user interface is taken from the database and the information that is inserted in the user interface is integrated in the database. The **Dementia care and polypharmacy management service back-end** has three main components: controllers, repositories and entities. These components are further described in the next table.

Component	Description
Controllers	The controllers expose the endpoints through which the back-end can be interrogated.
Repositories	The repositories are classes that are used for the interaction with the database.
Entities	The entities are classes used by the repositories and by the controllers. They are mapped on the tables from the database. Type of entities: Entities for monitoring data, Entities for medication prescription, Entities that describe the users of the application, etc.

Table 48 Dementia care and polypharmacy management service back-end components

The MedGUIDE database contains the tables that are used by **Dementia care and polypharmacy management back-end** service. The database contains data that comes from the **Dementia care and polypharmacy management front-end** service and data that comes from the sensors that monitor the daily living activities and the medication intake of the patients that have dementia.

10.1.1 Input and outputs

The following table presents the inputs and the outputs of the **Dementia care and polypharmacy management service**. The first column presents the input that is collected from the front-end part of the service, the second column describes the back-end component that is responsible for the processing and the third column presents the output that is provided by the back-end.

Inputs collected from the Dementia Care and Polypharmacy Management Front-End	**Output of the Dementia Care and Polypharmacy Management Back-End**
Select "Patient Monitored Data" and "Daily Living Activities"	A list of activities performed by the patient for the given time interval
Select "Patient Monitored Data" and "Sleeping"	The sleeping pattern of the patient for a given time interval
Select "Patient Monitored Data" and "Medication"	The medication plan of the patient for a given time interval
Select "Send Report" or "Reports"	Depending on the request type (insert or retrieve) the back-end either inserts a new report or retrieves a list that contains all the reports
Select "Communication Workspace"	The back-end returns the list of all messages exchanged in the communication workspace among the users of the application and inserts new messages
Select "View Prescription"	In the case of doctor, the back-end updates the medication plan according to the doctor specifications, while in the case of the other users the back-end displays the medication plan and the roadmap
Log in the application as a doctor or as a professional caregiver	The list of patients that are associated with a doctor or with a professional caregiver in increasing order of the priority

Table 49 Inputs and outputs of the Dementia care and polypharmacy management service

10.1.2 Functional and non-functional requirments

The following table presents the functional requirements that must be satisfied by the **Dementia care and polypharmacy management service**.

ID	Name	Description
1	Visualisation of the Monitored Daily Living Activities	This service should display using charts the activities performed by a patient in the current day or in the last week.
2	Visualisation of the Sleeping Pattern	This service should display using charts the sleeping pattern of the patient for the current day or for the last week.
3	Visualisation of the Medication Plan	The objective of this service is to display the medication plan for PwD for the current day or for the last week.
4	Writing & Reading of Reports	This service has two main objectives: (1) All users, except for the doctors, should be able to write reports about the patients (2) The doctors should be able to read the reports written by the other categories of users
5	Communication Workspace	This service should ensure the communication between the four main types of users of the application: (1) The doctor (2) The formal caregiver (3) The informal caregiver

		(4) The patient
6	Medication Prescription & Roadmap	Depending on the type of users that have access to this service, there are two types of actions that can be performed: (1) The doctors should have the possibility to write a medication prescription and a roadmap that should be followed by the patients (2) The patients and the caregivers should be able to consult the medication prescription and the roadmap
7	Visualisation of the PwD's, Sorted by Priority	Upon their logging into the application, the doctor and the professional caregiver should be able to see a list of PwD's sorted in increasing order of priority

Table 50 Functional Requirements for the Dementia care and polypharmacy management service

In the next table are described the non-functional requirements that must be satisfied by the **Dementia care and polypharmacy management service**.

ID	Name	Description
1	Accessibility	The application should be accessible both for professional users and for PwD's
2	Extensibility	The system should be able to integrate new functions and services
3	Interoperability	The system should be able to work with other products or systems easily
4	Reliability	The system should perform consistently well
5	Usability	The system should be used easily by the professionals and by the PwD's

Table 51 Non-Functional Requirements for the Polypharmacy management knowledge base service

10.2 Process view

In this section are presented the dynamic parts of the **Dementia care and polypharmacy management service**. The UML Activity Diagrams illustrate the main processes of the **Dementia care and polypharmacy management service**. Some of the processes can be performed by all the users of the application while some of them can be performed only by specific categories of users. For each type of service will be mentioned the users for which the service is applicable. There are four major categories of users: PwD doctors, professional caregivers and family caregivers.

10.2.1 Visualisation of the monitored daily living activities process

Actors: the patients, the doctors, the family caregivers, the professional caregivers.

The diagram describes all the steps required to visualise the monitored data for a patient for a day or for a week. The following steps are identified:

Step 1 – From the **Patient monitored data** the user selects **Daily living activities**.

Step 2 – By default the option **Day** is selected. The application displays the normal pattern for the daily living activities on the top of the page and the actual monitored data for the daily living activities at the bottom of the page. If there is no data to be displayed, the message **No Monitored Data** is displayed.

Step 3 – If the user selects the option **Week** then the application displays the monitored data for the daily living activities for the last week. If there is no data to be displayed, the message **No Monitored Data** is displayed.

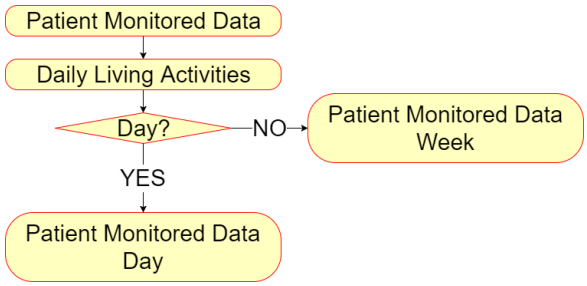


Figure 43 UML Diagram that describes the flow of the visualisation of the monitored daily living activities process

10.2.2 Visualisation of the sleeping pattern process

Actors: the patients, the doctors, the family caregivers, the professional caregivers.

The process involves the following steps:

Step 1 – From the **Patient monitored data** the user selects **Sleeping**.

Step 2 – By default the option **Day** is selected. At the top of the page is displayed the normal sleeping pattern that the patient should follow and at the bottom of the page is displayed the actual sleeping pattern followed by the user. If there is no monitored data, then the application displays the message **No Monitored Data**.

Step 3 – If the user selects **Week** then the application displays the monitored data for sleeping for the last week.

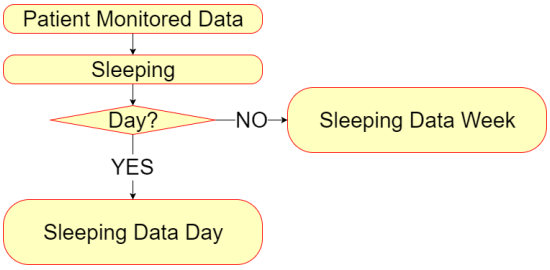


Figure 44 UML Diagram that describes the flow of the visualisation of the sleeping pattern process

10.2.3 Visualisation of the medication plan process

Actors: the patients, the doctors, the family caregivers, the professional caregivers.

The process can be summarized using the following steps:

Step 1 – From the **Patient Monitored Data** the user selects **Medication**.

Step 2 – By default the option **Day** is selected. The page displays a table which describes if the medication box was opened or not during the day. The following parts of the day are monitored: the morning, midday, the afternoon and before bed time.

Step 3 – If the user selects **Week** then the page displays how the patient adhered to the medication plan in the last week. The data is displayed for the last seven days and for each part of the day (the

morning, midday, the afternoon and before bed time) the application displays if the patient opened the pills box or not.

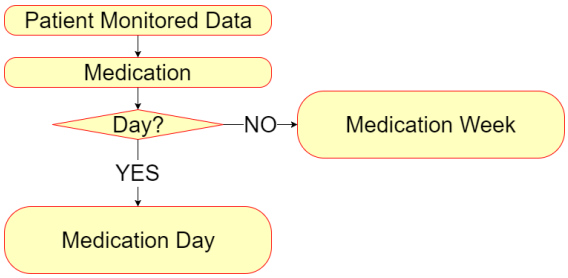


Figure 45 UML Diagram that describes the flow of the visualisation of the medication plan process

10.2.4 Writing and reading of reports process

This scenario contains two sub-processes: the writing of reports scenario (a) and the reading of reports scenario (b).

Writing Reports Sub-Process

Actors: the patients, the family caregivers, the professional caregivers

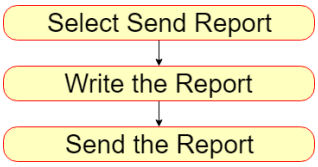


Figure 46 UML Diagram that describes the flow of the writing reports sub-process

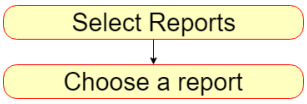


Figure 47 UML Diagram that describes the flow of the reading reports sub-process

This sub-scenario requires the following steps:

Step 1 – The user selects **Send Report**.

Step 2 – The user writes the actual report to be sent.

Step 3 – The user clicks on the **Send Report** button. The report is recorded in the **MedGUIDE database**.

Reading Reports Sub-Process

Actors: the doctors

This sub-scenario involves the following steps:

Step 1 – The user selects **Reports** from the user interface.

Step 2 – The user chooses a report from the selection. The selected report is expended and displays the message.

10.2.5 Communication workspace process

Actors: the patients, the doctors, the family caregivers, the professional caregivers

The **Communication Workspace Process** corresponds to the following two use cases from the Use Case diagram:

Send Messages to Doctor (the patients, the family caregivers, the professional caregivers)

Send Messages to Patient (the doctors)

The **Communication Workspace Process** consists of the following steps:

Step 1 – The user selects **Communication Workspace**.

Step 2 – The user writes the message in the text area.

Step 3 – Finally the user clicks on the **Add Message** button and the message is recorded in the database and displayed in the **Communication Workspace**.

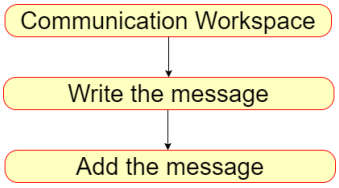


Figure 48 UML Diagram that describes the flow of the communication workspace process

10.2.6 Medication prescription and roadmap process

This process contains two sub-processes.

View Medication Prescription & Roadmap Sub-Process

Actors: the patients, the family caregivers, the professional caregivers.

This sub-process consists of the following steps:

Step 1 – The user selects **View Prescription**.

Step 2 – By default the option **Medication** is selected. The user can see for each type of drug the corresponding description and the days of week when the drug must be administrated.

Step 3 – If the user selects **Roadmap**, then a list of recommendations is displayed.

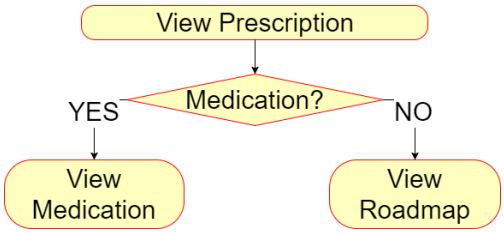


Figure 49 UML Diagram that describes the flow of the view medication prescription

Modify Medication Prescription & Roadmap Sub-Process

Actors: the doctors

This sub-process has the following steps.

Step 1 – From the user interface the user selects **Prescription**.

Step 2 – By default the option **Medication** is selected. The user can perform the following operations

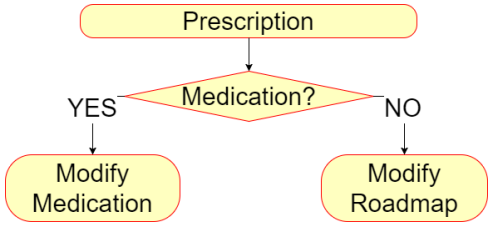


Figure 50 UML Diagram that describes the flow of the roadmap sub-process

on the medication: create, read, update and delete.

Step 3 – The user should be able to introduce new recommendations.

10.3 Visualisation of the Persons that have Dementia Sorted By Priority Process

Actors: the doctors, the professional caregivers.

The process consists of two steps:

Step 1 – The user logs into the application.

Step 2 – The user selects a patient from the **List of Patients** sorted in increasing order of priority. The patients with the highest priority are displayed at the top of the page and the patients with the lowest priority are displayed at the bottom of the page.

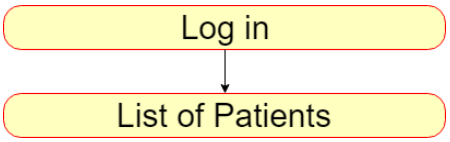


Figure 51 UML Diagram that describes the visualisation of the persons that have dementia sorted by priority process

10.4 Development view

The following figure presents the view of the **Dementia care and management service** using a UML component diagram.

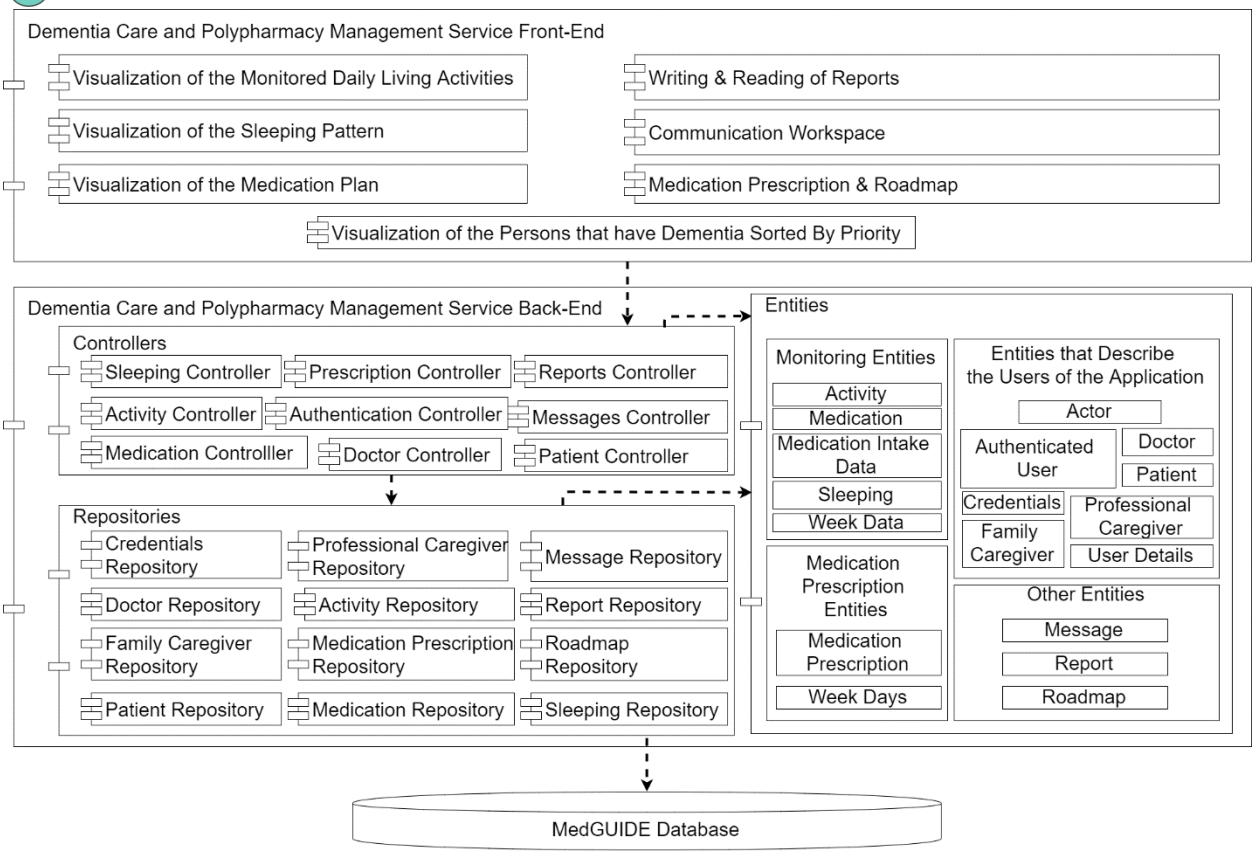


Figure 52 UML Component Diagram that illustrates the development view of the dementia care and polypharmacy management service

The Dementia Care and Polypharmacy Management Service Front-End is developed using Angular 4. The application will consist of several components such as: Daily Living Activities Component, Sleeping Component, Medication Component, Users Component, Reports Component, Communication Workspace Component and Medication Prescription Component. The Angular 4 components contain an html file and a TypeScript file and each one of them will use the appropriate service for the interaction with the Dementia Care and Polypharmacy Management Back-End.

The **Dementia care and polypharmacy management back-end** has three main groups of components:

- **Controllers** – REST controllers that can process the incoming HTTP requests from the **Dementia care and polypharmacy management front-end**
    - these controllers interact with the database through **Repositories** and **Entities**
    - the controllers which are used for the interaction with the front-end
- **Repositories** – are classes that are used for the interaction with the database
    - the repositories which are used by the **Dementia Care and Polypharmacy Management Service**
- **Entities** – are classes that are mapped to the tables of the **MedGUIDE database**
    - each table corresponds to an entity

- the columns of a table correspond to the fields of the associated entity
- the name of the entity is adjusted from the name of the associated table
- the entities are also used as model classes (POJO – Plain Old Java Objects)

10.5 Physical view

The deployment architecture of the Dementia Care and Polypharmacy Management Service is shown in Figure 53.

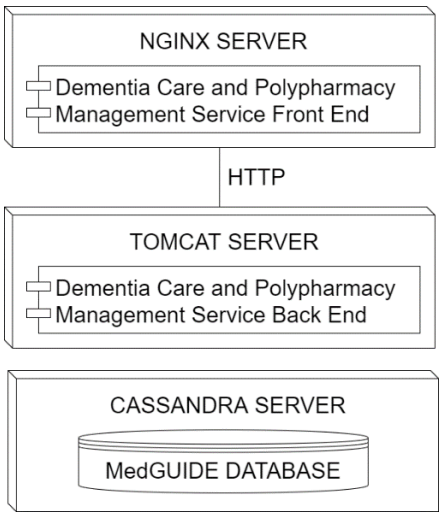


Figure 53 Deployment Architecture for the Dementia Care and Polypharmacy Management Service

As can be seen in the architecture there are three main nodes:

- **NGINX SERVER** – The **Dementia care and polypharmacy management service front end** application is deployed on this server. NGINX is a server for Angular applications.
- **TOMCAT SERVER** – The **Dementia care and polypharmacy management service back-end** application is deployed on this server. Tomcat is a server for web applications. The service must be deployed as a .war archive on this server. The communication between the front-end application and the back-end application is achieved through HTTP requests.
- **CASSANDRA SERVER** – The **MedGUIDE database** is stored on this server in the **MedGUIDE** keyspace. Using the back-end service, the classical CRUD (Create, Read, Update and Delete) operations can be performed on this data.

10.6 Scenarios and use cases

The use case diagram associated to the **Polypharmacy management knowledge base service** is illustrated in Figure 54The use cases are described in the following sub-sections.

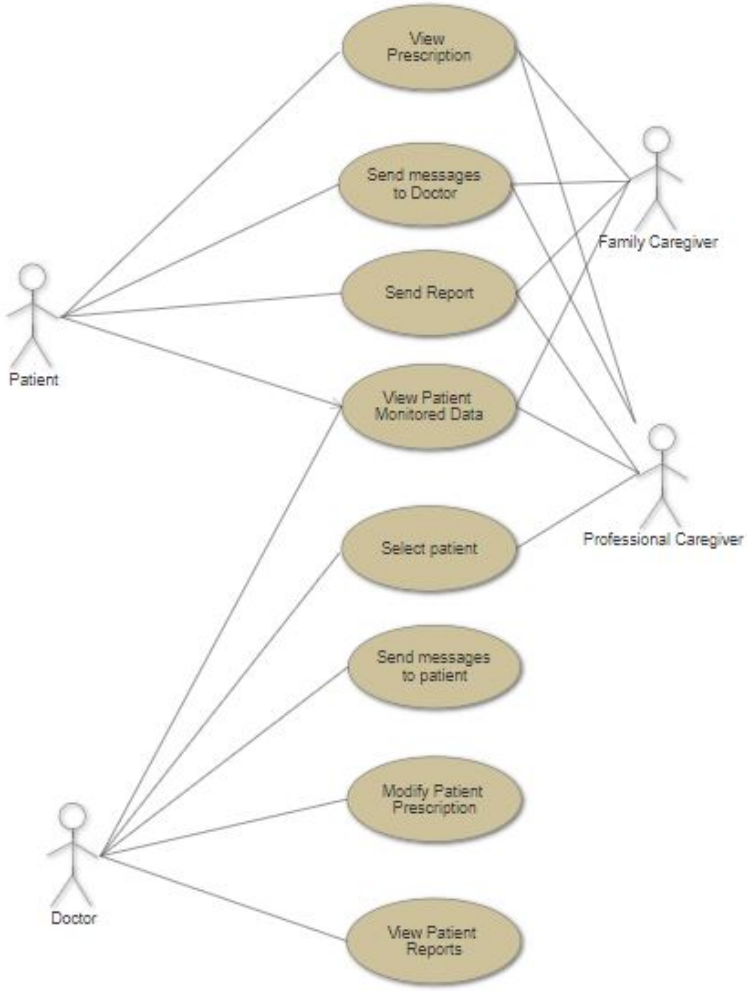


Figure 54 Use Case Diagram for the Polypharmacy management knowledge base service

a) Description of the "View prescription" use case

USE CASE	
Name	View Prescription
Storyline	Any actor except the doctor goes to the Prescription page and is able to see the medical prescription with the time to take it and other details and a set of daily life recommendations (roadmap).
Actors	Patient, Family Caregiver, Professional Caregiver
Prerequisites	The service is installed and active. A patient, a family caregiver or a professional caregiver who has chosen a patient is logged in.
Outcome	-

Table 52 View prescription - use case

b) Description of the "Send messages to doctor" use case

USE CASE

Name	Send messages to doctor
Storyline	Any actor except the doctor goes to the Communication page and is able to see all the previous messages (sent by the patient, caregivers or doctor) as a chat. They can post a message that could be seen by all the other users.
Actors	Patient, Family Caregiver, Professional Caregiver
Prerequisites	The service is installed and active. A patient, a family caregiver or a professional caregiver who has chosen a patient is logged in.
Outcome	The message thread of that particular patient is updated for all the associated caregivers and doctor.

Table 53 Send messages to doctor - use case

c) Description of the "Send report" use case

USE CASE	
Name	Send report
Storyline	Any actor except the doctor goes to the Reports page and is able to send a detailed report to the doctor regarding recent health state of the patient.
Actors	Patient, Family Caregiver, Professional Caregiver
Prerequisites	The service is installed and active. A patient, a family caregiver or a professional caregiver who has chosen a patient is logged in.
Outcome	The doctor is able to see the report sent by that user.

Table 54 Send report - use case

d) Description of the "View patient monitored data" use case

USE CASE	
Name	View patient monitored data
Storyline	Any user goes to the Monitored Data page and is able to see the Daily Living Activities and Sleeping timelines and data regarding Medication taken by the patient.
Actors	Patient, Family Caregiver, Professional Caregiver, Doctor
Prerequisites	The service is installed and active. A patient, a family caregiver is logged in or a professional caregiver or doctor who has chosen a patient is logged in.
Outcome	-

Table 55 View patient monitored data - use case

e) Description of the "Select patient" use case

USE CASE	
Name	Select Patient
Storyline	A logged in professional caregiver or doctor sees a list of patients and selects one.
Actors	Professional Caregiver, Doctor
Prerequisites	The service is installed and active. A doctor or professional caregiver is logged in.
Outcome	The user is able to see the dashboard specific to its use cases.

Table 56 Select patient - use case

f) Description of the "Send messages to patient" use case

USE CASE	
Name	Send messages to patient
Storyline	The doctor goes to the Communication page and is able to see all the previous messages (sent by the patient, caregivers or doctor) as a chat. They can post a message that could be seen by all the other users.
Actors	Doctor
Prerequisites	The service is installed and active. The doctor is logged in.
Outcome	The message thread of that particular patient is updated for all the associated caregivers and doctor.

Table 57 Send mesasges to patient - use case

g) Description of the "Modify Patient Prescription" use case

USE CASE	
Name	Modify Patient Prescription
Storyline	The doctor goes to the Prescription page and is able to view, modify, add and delete medication prescriptions or daily life recommendations.
Actors	Doctor
Prerequisites	The service is installed and active. The doctor is logged in.
Outcome	The patient or their caregivers are able to see the modified prescription.

Table 58 Modify Patient Prescription - use case

h) Description of the "View Patient Reports" use case

USE CASE	
Name	View Patient Reports
Storyline	The doctor goes to the Reports page and is able to view each report written by the patient or their caregivers.
Actors	Doctor
Prerequisites	The service is installed and active. The doctor is logged in.
Outcome	-

Table 59 View Patient Reports - use case

11 Next steps

This deliverable provides the intermediate results of the user experience design and the system architecture and services design.

The wireframes presented in section 1 will be evaluated with users, and based on their feedback the final design will be developed. The final design will be described in Deliverable 1.3 Final version of MedGUIDE system architecture, user interface and services design – improved based on first trials results.

The system architecture and services design will be further detailed and aligned, and will be updated to optimally address the user experience design (which is still under development).

Having a combined document of both the user-design aspects and the software architecture to be delivered provides good guidance for all partners in the MedGUIDE consortium.

This document will be used actively and in the development of the different services by all partners. D1.3 in M14 will reflect the discussions and changes taking place in the development of the architecture and user design over the next few months. In D1.3 a consolidated system architecture will be completed.