



PersonAAL



Deliverable 3.2b

Medication Monitoring Demonstrator and Field Trial Plan

Responsible Unit: IBM

Contributors: All partners

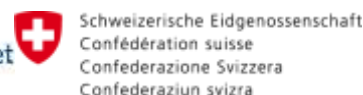
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1 INTRODUCTION

This document describes the specifications of a system that supports elderly persons at home, with their daily medication intake, and how the technology developed in PersonAAL will be applied in this application.

The deliverable contributes to Work Package 3, and specifically to the tasks T3.1 – Demonstrator Development and T3.2 – Field Trial Development. It extends and supersedes the deliverable D3.2a [11].

The main goal of the PersonAAL project is to extend the time elderly people can live in their own home environment, by increasing their autonomy and assisting them in carrying out activities of daily living by means of intelligent and intuitive web applications.

PersonAAL primarily address elderly users that can be starting to suffer from some kind of functional (temporary or permanent) limitations or impairments typical of older age (vision, hearing, motor and/or cognitive).

In order to facilitate the daily lives of elderly people, the PersonAAL platform monitors their behaviour through appropriate sensors and adaptively renders health-related information and suggestions improving quality of life on various devices existing at home through intuitive user interfaces.

Professional and especially informal caregivers, who generally have no specific professional technology training but have an intimate knowledge of the elderly, are our secondary users. The PersonAAL project builds easy-to-use environments exploiting novel metaphors, empowering caregivers to intuitively create, configure and personalize interactive services (e.g. patterns/scripts that could trigger specific events like notifications, warnings or alarms), to support older users in effectively managing and carrying out their daily tasks.

The outputs of PersonAAL are a platform for adaptation and personalization and three applications.

The platform [1] includes an authoring environment that supports the specification of personalization rules, and a run-time support able to adapt and customize previously authored care applications to elderly users, their changing abilities, their environment and device characteristics.

This demonstrator shows the main features of the medication monitoring application and how it will be integrated to the PersonAAL platform.

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2 DEMONSTRATOR DESCRIPTION

2.1 Objectives

According to the DoW [2] the medication monitoring application aims to implement the personalization technology in an integrated ICT environment which offers co-operative support to elderly patients and their caregivers in the management of their medication intake. The original early prototype for the medication monitor application (presented by previous partner) was based on an existing application. This version of the application is built from scratch.

The purpose of the application is to improve medication adherence, and thus to prevent secondary complications and medication-related safety risks. The application will assist formal and informal caregivers in monitoring medication intake, assessing adherence and persistence to treatment as well as offer elderly citizens personalized guidance in self-management of medication intake in the form of reminders, education and motivation.

The main functionalities are to allow elderly patients and caregivers to manage multiple medications, and to use the technology that is developed in this project to create a personalized experience for each of the stakeholders, through each of the interfaces with which they interact with the system. The application will incorporate a responsive web application that will function on PC, tablet and smart phone, and an app for tablet and smart phone to receive push notifications. The application will have an administrative view for registering a profile and medication plan, and a simple user interface for the patient to get notified when and what medicines to take and register that they have been taken.

During the design of the application we have used the requirements findings [3] and output from our design thinking sessions [9]. For security requirements, we refer to the "Privacy and Security in PersonAAL Platform" section in the PersonAAL Architecture Specification [1].

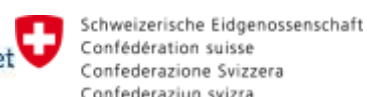
The UI has been developed using angular2 [7] and bootstrap [8] open source frameworks.

2.2 User Groups

The medication monitoring application will address three different groups of users:

- i) Primary users: The main target group is older adults living at home using medication.

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- ii) Secondary users/the informal caregivers; Family, friends, charity services, etc.
- iii) Secondary users /formal caregivers; General practitioners, physicians, etc.

2.2.1 Primary end-users

The objective is primarily to assist elderly users at home to adhere to their medication plan by the use of technology.

The low threshold user-friendly interface will allow elderly users with low or no computer literacy to use the application on a tablet.

The application provides services such as self-reporting and monitoring the day-to-day medication plan.

2.2.2 Secondary users; informal caregivers

Friends and family and other informal caregivers are important contacts of the primary users, being the secondary users. The application will facilitate support of the daily lives of elderly people, by empowering informal caregivers who often do not have specific skills for the use of ICT but have an intimate knowledge of the elderly user at home. These informal caregivers will have access to the medication plan and will receive notifications for how the elderly is adhering to the medication plan. The informal caregiver can be given access, based on acceptance of the primary user, to the medication plan.

2.2.3 Secondary users; health care providers

The general practitioner (GP) issues the prescription based on his/her individual assessment of the patient. If requested by the primary user, the prescription can be added in the application by the caregiver, the GP can get an overview of the elderly's medication plan and see the possible side-effects documented by the end-user.

2.3 Functionalities

The application supports the following main tasks, detailed in section 2.4. Specifications and in section 2.5 UI mock-ups.

For the primary user (elderly person):

- A homepage welcomes the user and provides an overview of the current medication plan (medication list, time to take medicine, days to take medicine, and a button *Take Medicine/Medicine Taken*). Through the homepage the user can access and manage:

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- Logon authenticating with PersonAAL Auth0. If user has not been registered an account can be created with Auth0 and then the user profile for the medication monitor application is updated.
- Profile (Basic Information: first name, last name, username, e-mail, Language: Set preferred language, Caregivers: Add Caregivers)
- My Medication (This is the page where the medication plan is created and where the user can register that medication has been taken after being notified).
- Logout
- Notifications. For example, the application will provide a warning notification and sound signal prior to the actual time for medication intake. Another possible notification is to remind the user to bring their medication/dispenser when leaving home. Such possibilities are configured via Rules Editor and Adaptation Engine.

For the secondary user (caregiver):

- Notification (E.g. the application will notify caregivers if the primary user does not follow the medication plan).
- Possibility to receive an alert if a problem is detected (E.g. the application will send alert if the user has not taken planned medication for a longer period or consistently forgets to take their medication).

The details about the medication can be inserted by the user herself or by the caregiver. The personalization rules are edited through the authoring environment described in [1].

Integration with the PersonAAL Context manager server

The medication monitoring application connects to the context manager server and sends events for when a user is notified to take medication and when they register to have taken the medication. This allows other applications connected to the PersonAAL platform to use these events.

Integration with the Adaptation module

The application is integrated with the adaptation engine that sends notifications to the user on the PersonAAL Notification App, a simple android and iOS app for receiving push notifications. This is also an entry point for the Medication Monitoring and Physical Rehabilitation applications. See section 2.4.2.1.

Integration with the Persuasion module

The Persuasion module is integrated with the PersonAAL Notification App through the Personaal Adaptation engine to send persuasion notifications to the user.

Integration to the central authentication (OAuth) server

The demonstrator is integrated to the central authentication (OAuth) server.

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Context manager server username in User profile

The context server username value is used to map a auth0 user to a user defined in the context manager server. This is a temporary solution until the context manager server uses the auth0 username.

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2.4 Specifications

The application will have a simple user interface for the patient to get notified when and what medicines to take, and register when the medicines have been taken.

The application is available in Norwegian, English and German language. The user is able to choose between these languages in a visible drop-down menu.

2.4.1 System context

The system context shows the main components the application interacts with.

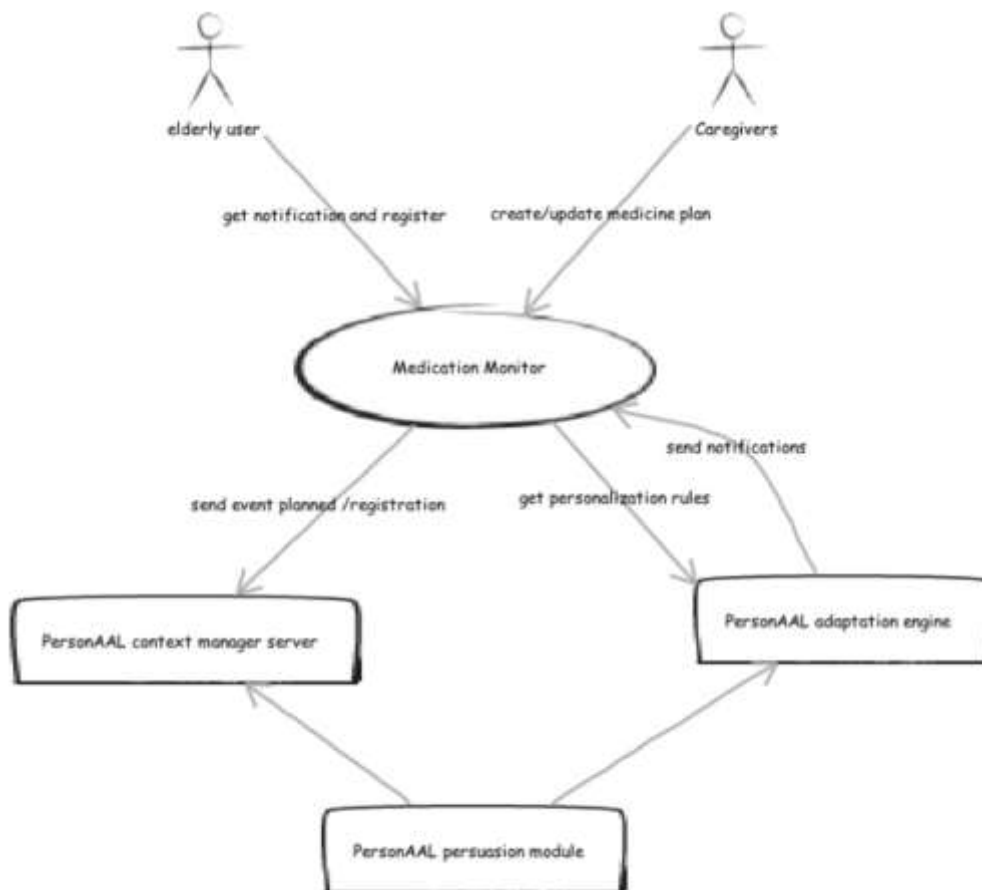
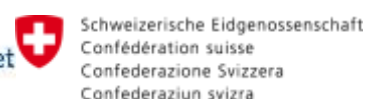


Figure 1 System Context for the Medication Monitoring Application

The Medication Monitor integrates with the PersonAAL Context Manager server for sending event for planned and occurred medication, and receives notifications from the PersonAAL adaptation engine.

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2.4.2 Architecture

The following diagram shows the components for the Medication Monitoring application.

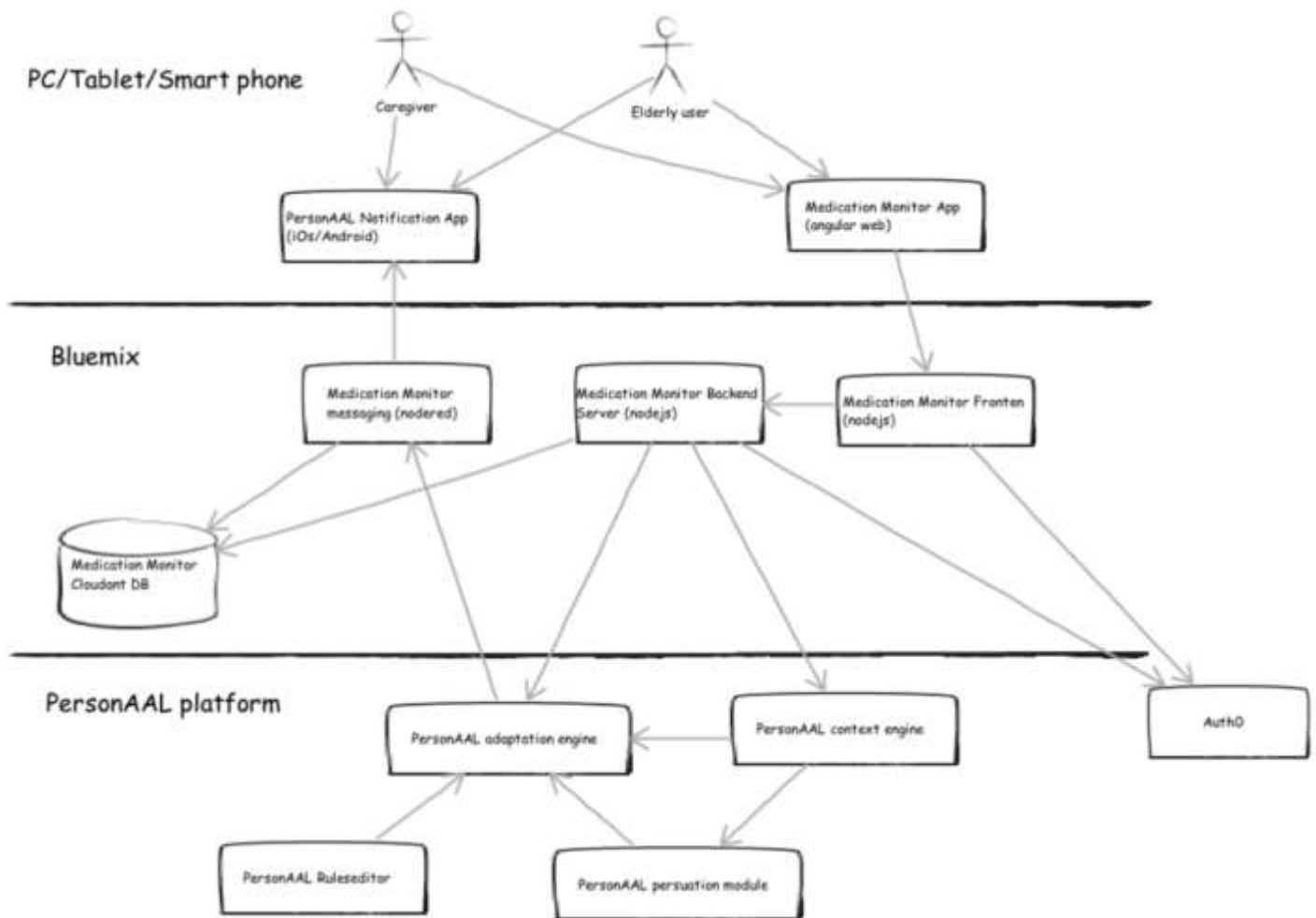
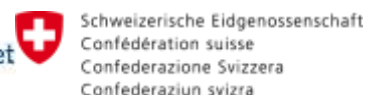


Figure 2 Architecture for the Medication Monitoring application

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2.4.2.1 Front-end

The application is a responsive webapp to be used on tablets, and other communication platforms. The infrastructure includes the following apps:

- i. Medication frontend webapp
 - ii. PersonAAL Notification app (Android and iOS)
- i. Medication frontend; the user interface for an application allows elderly users with low or no computer literacy to use the application on a tablet, based on a low threshold user friendly interface allowing simple and very inclusive 'service interaction' on a tablet. The application is based on responsive web application frameworks and will be tailored for working on tablets and smart phone devices. The registration of the medication plan will be best viewed on a larger screen (Computer or tablet).
 - ii. PersonAAL notification app: An app (Android and iOS) to be installed on tablet or smartphone. The app receives push notifications from the backend server when the user should take their medication. The app will interact with the Medication frontend web app where the user can see the plan and register taking their medication. The app is also used to send persuasion messages to the user from the Persuasion module.

2.4.2.2 Back-end

The Medication Monitor backend components consists of the following parts:

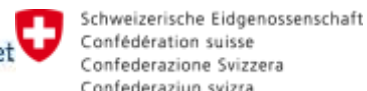
- i. Medication monitor messaging (nodered)
 - ii. Medication Monitor backend server
 - iii. Medication Monitor Cloudant database
- i. Medication messaging; this is a nodered application which handles message flows. This component is responsible for checking the Medication Monitor database to find medications at a certain time that should be taken and initiates sending a push notification to the PersonAAL Notification app. The component also acts as a Context Delegate sending "medication planned" events to the Context Manager server. This is done in the same flow as sending push notification to the notification app. The component also exposes a REST service that other PersonAAL components can use to send notifications to the notification app. This is used by the Persuasion component to send notifications to the user.

URL: <https://ext-nodered-personaal.eu-gb.mybluemix.net/sendPushMessage>

Type: POST

Payload: {"username", "message"}

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- ii. The Medication backend is developed in node.js and runs on a cloud foundry or docker container environment. During the project, the application server will be run on the Bluemix cloud platform. The backend server uses a Cloudant database provisioned via the Bluemix platform.
- iii. Cloudant database running on Bluemix. The database is encrypted.

The backend server communicates with the PersonAAL platform components Context Manager Server and Adaptation Engine through REST service calls.

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2.4.3 Key features

2.4.3.1 Login

The login page shows the PersonAAL authentication service logon and signup capabilities. If the user is not already registered as a PersonAAL user the user must register using the "Sign Up" feature. This creates a user in the PersonAAL user registry. Before the user can access any PersonAAL application the user must verify their email used for registering. After the user is registered the user must create their userprofile for the Medication Monitoring application. See 2.4.3.2



Figure 3 Log in screen

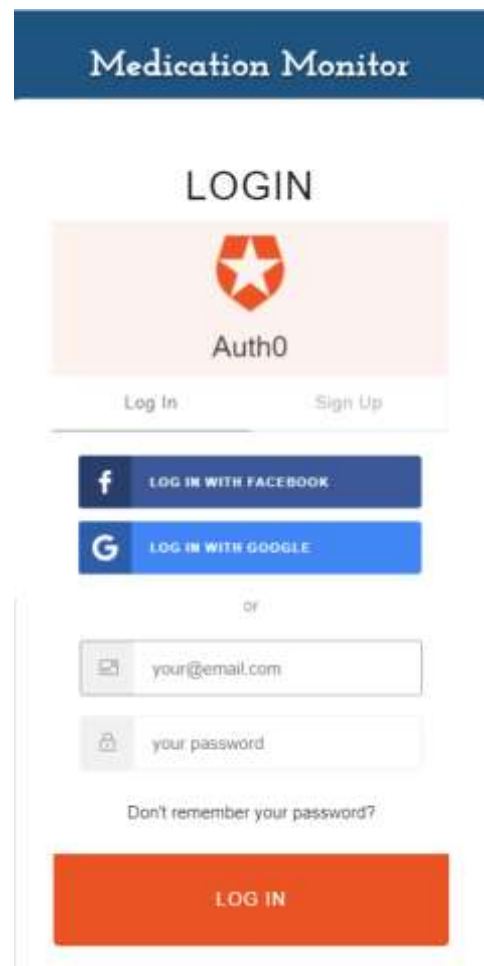
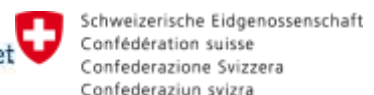


Figure 4 Log in screen on smart phone

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2.4.3.2 User profile

This page allows the primary user or the caregiver to update a profile for the application. The user has to verify him/herself with Auth0 before finishing the registration progress.

The following information must be provided when registering a profile:

- Basic Information (First name, Last name, User name, E-mail, contextengine username)
- Language (Preferred Language)
- Caregivers (Add caregivers). See section 2.4.4.5 Caregiver.

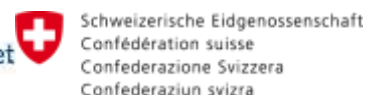


Figure 4 Complete user profile screen



Figure 5 Complete user profile screen on smart phone

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The **context engine username** should be the same username as used in the PersonAAL rules editor and context manager server. This is used until the **context manager server** uses the Auth0 username. This username is used when communicating with the personaal platform components.

In the Basic information tab the user can change their First name and Last name. Email address and username can not be changed here as it is linked to the Auth0 user account.



Figure 5 Edit profile screen

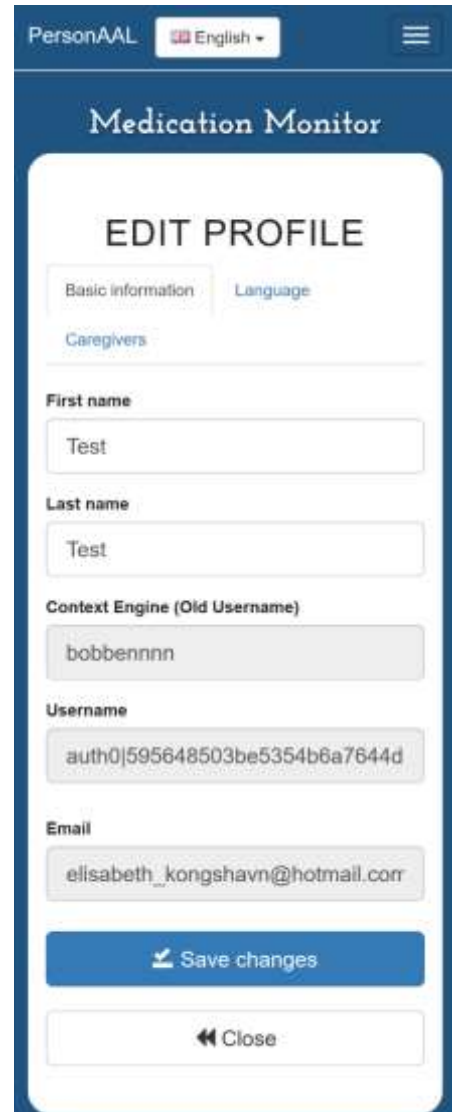


Figure 6 Edit profile screen on smart phone

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On the Language tab the user can select a default language to use. This will be the language used when the user logs on. User can still change language using the language selector in the top menu.



Figure 7 Caregiver screen

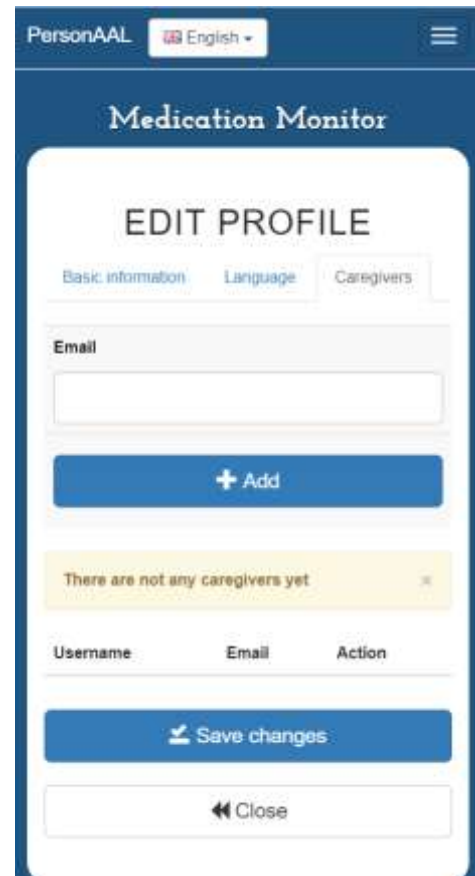


Figure 8 Caregiver screen on smart phone

In the caregiver tab the user can add caregivers that should have access to his/her medication plan. See more details about the caregiver functionality in 2.4.3.6

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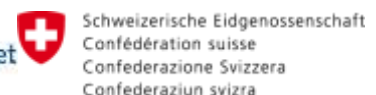




Figure 9 Add caregiver screen

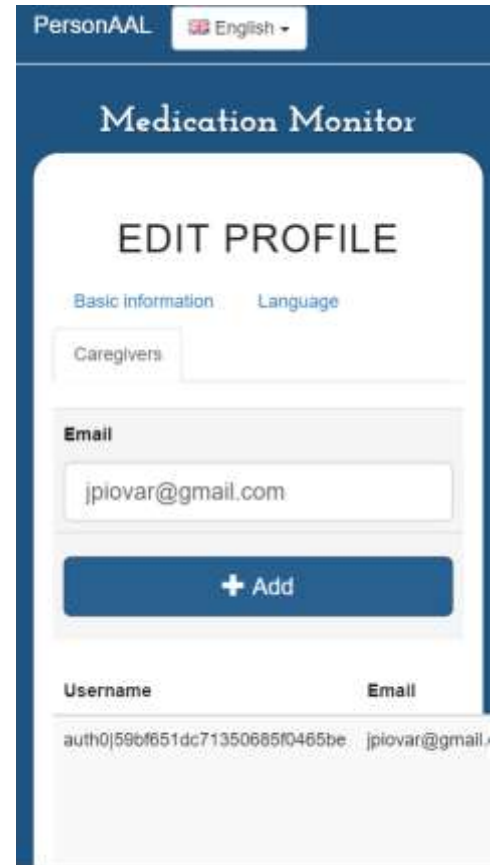


Figure 10 Add caregiver screen on smart phone

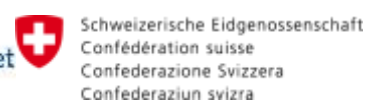
To add a caregiver the user enters the email for the caregiver and clicks the “Add” button. The system will only add the caregiver if he/she is already registered in the application with a user type = “caregiver”. See Figure 4.

2.4.3.3 Home

This page welcomes the user and provides an overview of the current medication plan (seen as medication list, time to take medicine and status).

The user can also filter out medication by showing either today or the full week. The user can check medication for previous day and next day.

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Through the homepage the user can access and administer:

- Profile
- My Medication
- Log out



Figure 11 Home screen (week view)



Figure 13 Home screen on smart phone



Figure 12 Home screen (day view)

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2.4.3.4 My Medication

The medication view presents medication details. Each medicine has its own box. If there is no medication registered, the view will be empty.

This is the page where the medication plan is created and medicines are registered. The medications are presented to the user and the user can register that medication has been taken after being notified. The following information about a medication is registered and presented:

- Name of medication
- Start-date and end-date
- Which days to take medicine
- Time(s) to take medicine
- Dosage type (Fluid, cream or pill)
- The dosage amount (Fluids and creams get standard note "X description about usage and amount", while user can edit dosage amount for pills with numbers).
- Notes from doctor
- Notes made by elderly (e.g notes about side effects to be discussed with the general practitioner)

The details about the medication(s) are based on the prescriptions from the physician and must be manually added in the application.



Figure 14 My medication screen



Figure 15 My medication screen on smart phone



When the user clicks the “Add medicine” button a modal window is presented where the user enters the details for the medication.

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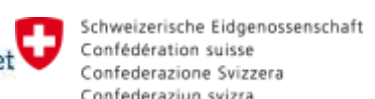




Figure 16 Add medication screen

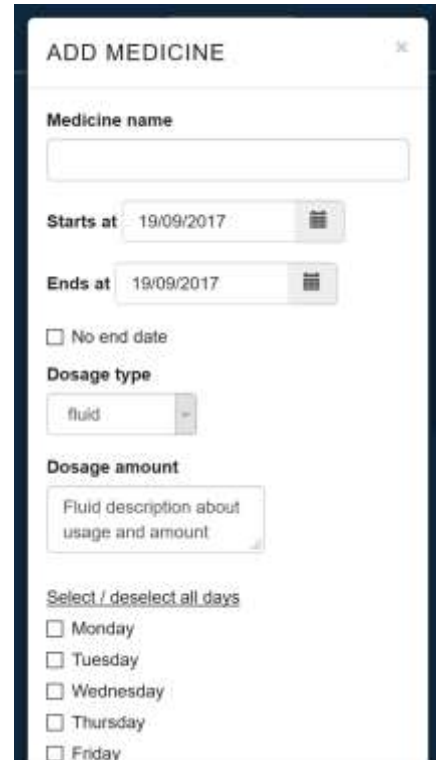


Figure 17 Add medication screen on smart phone

Register taking medication

When the user is notified to take their medication, the user should confirm that the medication has been taken by registering this. This is done by pressing the "Take medicine" button. A modal window is presented where the user can change the 'time taken' to the actual time for taking the medication.

If the user has selected several times to take the medication during the day, the user must also select the time of the day the medicine is taken.

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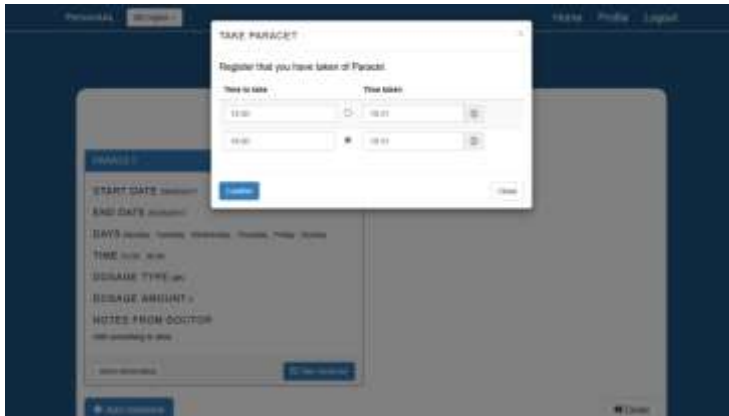


Figure 18 Register medicaton taken screen

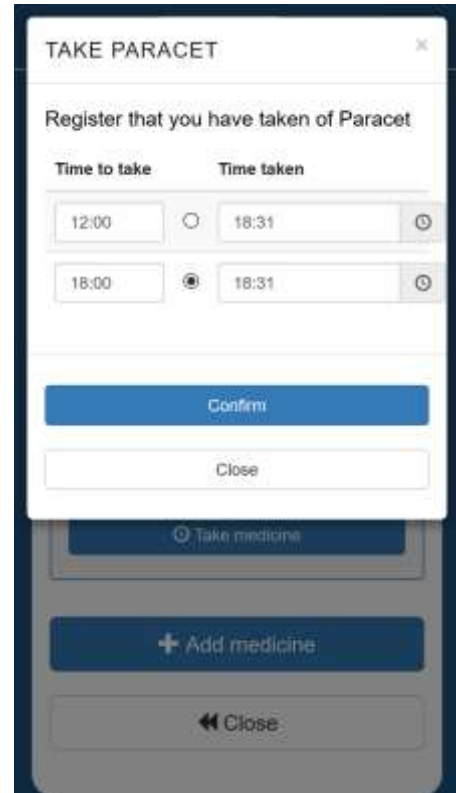


Figure 19 Register medication taken screen on smart phone

After the user has registered taking the medication, the “Take medicine” button is changed to green, and the caption changes to “Medicine taken”. The user can easily see that the medication has been taken and can not register taking it again on the same day. If the medication should be taken several times a day, the button changes when all instances for the day have been registered as taken.

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Figure 20 Register medication taken screen



Figure 21 Register medication taken screen on smart phone

2.4.3.5 Notification

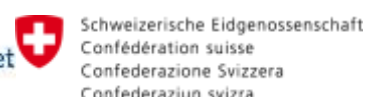
Notification to the primary user:

- The application will provide a warning notification and sound signal prior to the actual time for medication intake. This will continue until the user registers that the medication has been taken.

Notification to the caregiver:

- The application will notify caregivers if the primary user does not follow the medication plan. The caregivers can use this information to encourage the medication intake.

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2.4.3.6 Caregiver

To add a caregiver, the caregiver must first register as a user. This is done by selecting "Sign up" in the Auth0 sign-in.

After the user is created in Auth0 the user is presented with a page to create a user profile for the Medication Monitor application. When registering the user profile, the user type, "Caregiver", needs to be selected. After the userprofile is created the user also needs to verify their email before they are allowed to login.

Now the users can add the caregiver to their userprofile to allow the caregiver access to their data.

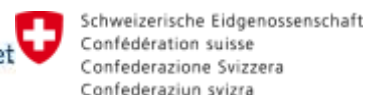
The user logs on and opens their Profile. There they select the Caregiver tab and search for the caregiver user (Caregiver's e-mail), and add the selected caregiver e-mail.

When the caregiver logs on in the home page, the caregiver is presented with a list of users he/she has been given access to. When selecting a user, the caregiver gets access to all the users data and can help create and administer the medication plan for the users.



Figure 22 Home screen for caregiver user.

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When the caregiver selects the user to view or help create the medication plan he / she gets the same view as the user, but has a green button on the top bar to go back to the caregiver home screen. For security, all changes the caregiver does to a user's data is traced in the database with the caregiver userid.



Figure 23 Home screen (seen by caregiver)

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3 PERSONALISATION

This section describes how we use the PersonAAL Platform [1] to provide the user with personalized assistance, customized on his/her individual needs, requirements and characteristics through the specification of trigger-action rules [5] [6].

3.1 Trigger-Action Rules

For this application, we will identify an initial set of trigger-action personalization rules, listed below and grouped in four main categories. In futures releases more rules could be added depending on the end-user feedback.

3.1.1 Improve page readability depending on user characteristics and surrounding environment.

- IF Age is more than 70 AND Light Level is less dimmed, DO Change Font Size to 18px and contrast
- IF Light Level is less than 5, DO Change Background Color
- IF View Ability is colour blind, Do Change Font Color

3.1.2 Send personalized reminders to user.

- IF User is leaving home AND Medication_Planned is less than 2 hours from now, DO send a reminder by notification (Did you remember to bring your medication)?

3.1.3 Send alerts to caregiver if user behavior appears not normal.

- IF Medication is not taken today, DO Alarms

3.2 Context detection/engine

The medication monitor application has a context delegate component that sends data to the context manager server when a medication is planned (entity: medication_planned) and when the user registers to have taken the medication (entity: medication_occured).

4 FIELD TRIAL PLAN

4.1 Objectives and measurements

The field trial plan will be conducted jointly for the platform and for the three applications, with the objective to measure:

- User acceptance and comfort level: collected through questionnaires: comfort level, perception of being controlled or in control, perception of added value, security of information, limited installation and maintenance required at the consumers house, usability comparison with/without personalization, persuasion/behaviour analysis.
- User activity: involves mainly measurements: usage time, event logging (use of different functionalities, number of rules, and number of errors).
- Social support effectiveness: The feedback will be collected both in Switzerland and in Norway, ideally involving 8-12 users in each site.

4.2 Requirements

4.2.1 End users

The end users will be required to use the application in their homes for a period of time sufficient to gather useful information. They should then:

- Be available for 6-8 weeks testing using the application for getting notifications for when to take their medication and register taking the medication using the application on a smartphone or tablet.

The personal information that is collected through using the application will be treated in line with security and privacy practices. The users can use fictive names and create email addresses that will only be used for the test period. This will keep the data anonymized. We will also only store the data for the time required to provide the service.

Before enrolling in the field trial, participants will be informed of all aspects that are relevant to the subject's decision to participate and will be required to sign a written informed consent according to guidelines from the fields of medical ethics and research ethics. Moreover they will be allowed to dropout at any time if they wish to.

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Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

4.2.2 Hardware requirements

In order to test the Medication Monitoring application, the hardware required is as follows:

- Laptop PC with internet browser and Android Tablet or Android phone 3G, WiFi and Bluetooth, to access the Notification App and Web application.
- Sensor to detect when user leaves home integrated with the Context Manager server

4.3 Timeline

The hypothesis and ideas driving the plan are listed below:

- Field test will last from 1 Oct '17 to 30 Sep '18.
- Allow 3 months (Oct – Dec '17) for application rework after Usability and Accessibility tests completion, integration and on-site preparation.
- Leave 3 weeks for application rework after Usability and Accessibility tests completion (and then start on third week of October)
- Leave 2 months (August and September '18) for analysis of results and implementation of final version of application.
- Each user should test for at least 6 weeks
- Involve 8-12 users per site (Switzerland and Norway)
- Consider to have 4 full set of hardware equipment (based on the costs).
- Allow some rework time to improve the applications and platform between the different test sessions.

We plan three rounds of tests:

- First round with friendly users, focusing on User acceptance and Comfort level. The users will be required to fill a (for example) weekly feedback form reporting their experience.
- Second round focusing on User adherence to using the app. Feedback on improvements made from the first round. Verifying new rules and extended integration with the other PersonAAL components.
- Third round focusing on getting feedback on the enhancements made during the first and second round. Testing the cognitive capabilities (natural language understanding, image recognition, voice)

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Site	Nov '17	Dec '17	Jan '18	Feb '18	Mar '18	Apr '18	May '18	Jun '18	Jul '18	Aug '18	Set '18	
			User Satisfaction		Usage/Effectiveness			Usage/Effectiveness (social activity/persuasion)				
CH	Preparation work		2 users		2 users		2 users		2 users with full equipment + up to 4 with partial equipment			
NOR	Preparation work		2 users		2 users		2 users		2 users with full equipment + up to 4 with partial equipment			
Results analysis and Rework												
App version			2.1		2.2			2.3			3.0	

Figure 24 Field Trial Plan

The application will evolve as follows during the third year of the project:

V2.1:

- Incorporate the feedbacks from Usability and Accessibility evaluation;
- Enhance integration with other PersonAAL modules.

V2.2:

- Integrates the recommendations from the User Acceptance and Comfort Level test round;
- Incorporates behavior analysis;
- Exten the application with cognitive capabilities using IBM Watson technologies, examples are user can communicate with system using natural language and voice for select languages.

V2.3:

- Integrates the recommendations from the User Activity test round;
- Further extentions

V3.0:

- Final version of the application

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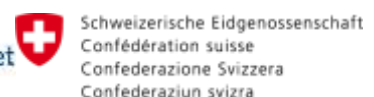
5 CONCLUSION AND FUTURE DEVELOPMENT

This document describes the medication monitoring demonstrator and how the demonstrator will be integrated to the PersonAAL platform.

Additional functionality to be included in future versions of the demonstrator could be:

- Analytics functionality, including statistics and reports to the primary and/or the secondary user that shows adherence to medication plan and notifications, e.g. for the last week / month.
- Watson Chatbot, a cognitive add-on where Watson can talk directly to the elderly users of the application. Watson Chatbot uses machine learning, and can be learned to answer many questions. If the user has difficulties with navigating through the application, Watson Chatbot can help. It is also possible to teach Watson about conditions and feeling. For example, if the user writes to Watson and says he/she is not feeling very well, Watson can ask why and come to the conclusion if the caregiver should be notified [10].

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