D2.8 Integrated PIA home and technology documentation

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Coordinator	KARDE	Karde AS
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Author(s)/Editor	Lars Thomas Boye, Jesús Fontecha Diezma (MAmI), Chris Nugent and Joe Rafferty (Ulster), Michael Kohn (Stickyworld)	
Peer reviewer(s)	Jesús Fontecha Diezma (MAmI) Joseph Rafferty (UU-SERG)	

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1 Introduction

This deliverable is the final documentation of the technical implementation in the PIA project. It follows the system design of D1.2, the description of the first prototype system (D2.1) and the descriptions of the main parts of the final system (D2.4-2.7). We will give an overview of the final version of the system produced in the project. The details are documented in the referred deliverables.

The central concept in the project is to deliver context-sensitive instructive media to assist people with mild cognitive impairments. Around this concept is a larger support system targeting their carers, to assess the situation and assistive needs, help producing the instructional media, and manage the system and keep track of its use and effects. Video is the primary medium for instructions, and NFC technology was selected as the primary way to trigger video playback on mobile devices. Apart from the application running on the mobile device, the system consists of various cloud-based services, for video-sharing and discussion, configuration of logic, monitoring and analysis. Work in the project has partly been on designing and implementing the various parts, partly integrating them by specifying APIs and implementing the sub-system communication.

After the initial work on requirements and system design, there have been two prototype iterations, each followed by testing and validation. The first prototype represented a basic, minimal PIA solution, to allow testing the core functionality and verify the technical principles. For the second iteration, the various sub-systems were further developed, with two new web applications in addition to the further developed video sharing and social network application, and with a better integrated and more user-friendly mobile application.

This deliverable will first give an overview of the system, followed by a summary of each part.

2 Prototypic system overview

The PIA system has been developed in two prototype iterations. Two previous deliverables describes the whole of the PIA system. D1.2 – Requirements with system design description – was written after the early technical specification and design work, and describes the original system design. It introduces the partitioning of the PIA system into sub-systems, and the device and sensor infrastructure. Functional requirements are given for each sub-system. A detailed design is given for the first prototype. The deliverable also includes guidelines for developing accessible user interfaces, and paper prototypes.

D2.1 – Prototypic system of the PIA concept – followed the first prototype iteration and describes the implemented system. It has a slightly updated architecture for the first prototype, and descriptions of each of the four sub-systems, as developed in the first iteration. It also describes sub-system integration in detail, and includes the mobile app user guide as an appendix.

For software architecture, the PIA solution is divided into four sub-systems. This sub-division is based on the functional needs and system sketch from the Description of Work, and the four implementing partners in the project. There are four technology partners who each have developed one sub-system, based on the needs of the project and their respective technologies and competencies. Figure 1 shows an overview of these four parts and their main interconnections.

PIA app is the Android application for tablets and phones. More precisely, several app prototypes have been developed: offline and online versions for the NFC-based video playback, and also a prototype system for voice-based interaction. However, we will talk about the mobile application in this document, meaning the NFC-based solution if not specifying otherwise. This is the only place the primary user interacts with the PIA system. The application senses tags, and video playback is started as a result. The carer uses the app to set up the system, recording videos and registering tags. The app can stand on its own as a minimal PIA solution, registering tags and recording and storing tags locally. But the app is also the main point of integration in the system – it can be connected to the other sub-systems. Each of the other three sub-systems is a server-based system which comes from different application domains. Each makes up a distinct but important part of the full solution.

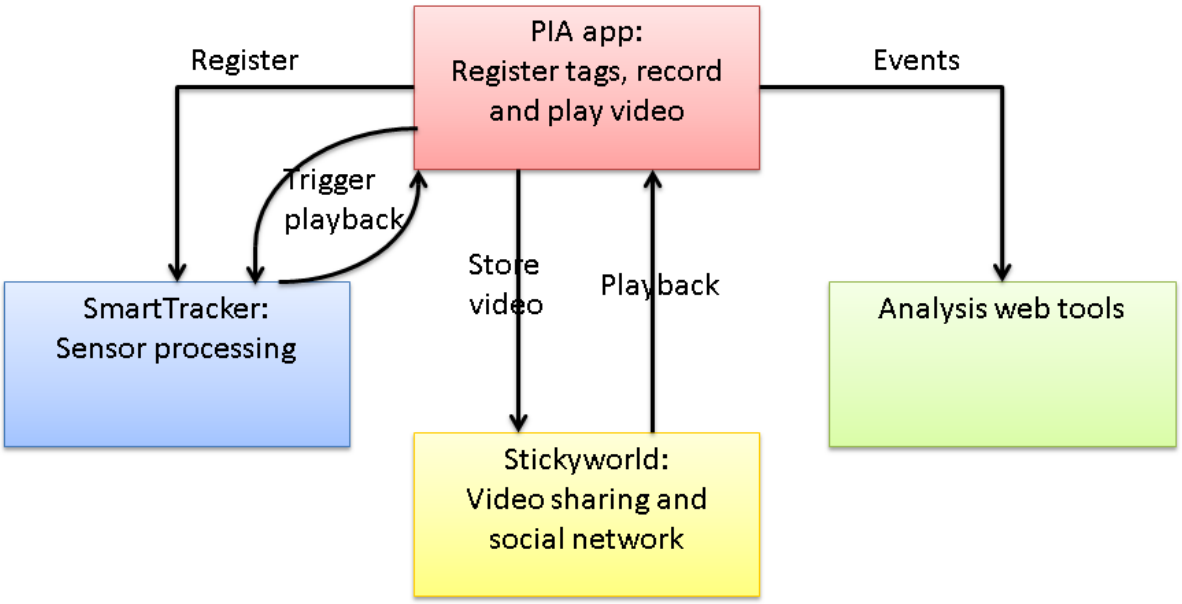


Figure 1: PIA system overview.

PIA's main technological innovation lies in how we combine and integrate different technology and services around the central NFC-instruction concept. At the same time, we have wanted to keep the sub-systems as loosely coupled as possible, as modules which can be included or not in a deployed solution. This approach provides flexibility for a commercial solution. Modules are included based on the market segment and needs of the customer. It should also be possible to replace a module with another providing similar functionality, only needing to replace parts handling the communication between sub-systems (APIs).

The **video sharing and social network** provided by Stickyworld's platform includes encoding and hosting of videos as well as management of the users and video meta-data, with sharing and comments. Connecting the app to this service places the videos in the cloud. In addition to uploading videos from the app, videos can be uploaded through the web interface, where videos can be shared and discussed with others. The app and this service comprise a possible minimal viable product for private users caring for family members.

Tellu's SmartTracker platform handles **sensor processing** and administration. The PIA app can be connected to this to move the triggering of video playback into the cloud, where it is handled by a rule engine which allows configuring more advanced service logic. It allows configuring and monitoring multiple installations remotely. The primary users and their devices and tags are represented here. The server can start video playback on the device, using the Google Cloud Messaging push channel to reach the device. A PIA-specific web interface has been developed for rule configuration.

The **analysis web tool** is another server-side system with web interface. It is a tool to create forms and analyse data, to measure Quality of Life, carer stress and other parameters. It has web forms for collecting information, and a database to hold this information as well as events of user interaction. An API has been developed and deployed, so that the mobile application can post events here.

The technical integration of the sub-systems has been a major task in the project. An API has been specified and developed for each of the three server-side systems. Another issue is integration in the user interface level. While the clear sub-division into loosely coupled sub-systems is good in terms of software architecture and flexibility, it creates a challenge in terms of usability and user experience. It is detrimental to usability when the user needs to use several systems, with separate user interfaces and authentication. We quickly saw a need for an overarching "PIA" part to tie together the four sub-systems, and this was planned for in the previously mentioned deliverables (D1.2 and D2.1), for the second prototype. However, work on the second iteration was directed more towards development of the various sub-systems, and an important realisation was that not all modules were equally viable for a commercial solution.

The status at the end of the project is that we have the four modules and have been testing them individually and in specific combinations. Each of the three server-side systems has its own web application. Which modules to integrate and how to integrate them is still an open question, but one key concept is to integrate the web services used into one web application, using APIs and modules from the individual sub-systems.

3 Device and sensor infrastructure

The device and sensor infrastructure used in PIA is first described in D1.2, Chapter 2. D2.4 – Sensor sub-system – gives an updated description of the NFC tags, sensor part of the mobile application, and the sensor processing and administration sub-system (covered here in Chapter 6). A summary of the device and sensor infrastructure is given here.

NFC (Near Field Communication) was found to be the most promising sensor technology to position the user in relation to the objects of interest. NFC is an industry standard for radio-frequency data transfer between mobile devices. A device such as a tablet or phone can communicate with another device or with a simple, unpowered tag. The range is only a few centimetres, and it is meant for small amounts of data, typically an ID or address which can then be used to initiate communication via the internet.

Tags come in the form of thin circular stickers, costing around 0,50 €, alternatively as hang tags. The tag has a small, writable memory, and the device can write a unique ID or video URL to a tag. The idea in PIA is that an NFC tag represents a place or item for which instructions should be available to the user. The sensor infrastructure is then a set of tags and a mobile device (tablet or phone) to read

them and play the instructional media. Someone needs to deploy this infrastructure – place the tags and register them in the PIA system. This is part of the carer role.

Figure 2: NFC tags used in PIA.

Android was chosen as the mobile device/sensor platform for PIA. It continues to be the most viable mobile platform with NFC support, in terms of market share and developer community. NFC support is now expected in mid-to-high-end phones, but still lacking in many tablets. Two tablets were suggested for use in the project: the Google Nexus 7 (7-inch screen) and Sony Xperia Tablet Z (10-inch screen). Nexus 7 was selected as the primary target for the mobile application and the trials.

Figure 3: Nexus 7 tablet.

The mobile application, described in the next chapter, handles the reading and writing of tags. For a minimal solution, the mapping from tag to video can be stored locally on the device. However, we also have the capability in the PIA solution of placing the tag-video logic in a sensor processing server, described in chapter 6.

4 Mobile application

The mobile application is where the primary user interacts with the system. "Mobile" does not mean mobile phone – the application is for devices the user can carry around. In screen size this could mean anything from a small phone to a 10-inch tablet. The primary focus in the project has been 7-inch tablets, as this provides a good balance between screen size and ease of use, but technically the applications can run on a range of devices.

Several prototypes have been produced in the project:

- Offline prototype: This early prototype has the basic functionality of recording video, registering tags and linking them to video, and playing back video based on tag readings, but is limited to playing back videos stored in the device, as it is not connected to any of the server-side services. The app was distributed in Google Play.
- Online prototype: This prototype has a login to the video sharing and social network service, so that it can play videos stored here. It is also connected to the sensor processing server, but to a hard-coded account for testing and demonstration. This application has continued to be developed and improved based on feedback. It is available in Google Play.
- Voice assistant prototype: As an alternative to NFC triggering, research has been done on voice-based interaction. An application for phone/tablet has been implemented. The user asks for assistance using natural language. A speech recognition service is used to get a transcript of the voice input. A query/ transcription processing web service obtains metadata from the video sharing sub-system. In addition, a video analysis system provides transcription of the videos themselves. Metadata from these two sources are used to find a suitable video based on the transcript of the user's question.

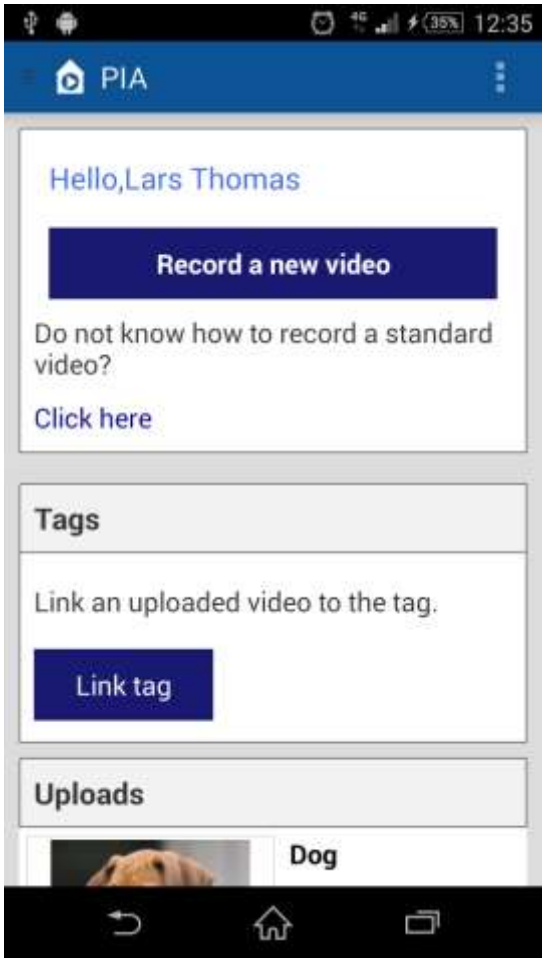


Figure 4: PIA online app.

The work on voice-based interaction is described in deliverable D2.7 (Media processing and voice-based interaction system). D2.1 has a description of the NFC-based mobile application (Chapter 6) and the user guide of the application (Appendix 1), and D2.4 also describes the NFC-based application.

For the integration with the sensor processing sub-system, the Google Cloud Messaging service is used for the server to be able to initiate actions in the mobile application. The application must register with this service and send its ID to the sensor processing server. It can then use this ID to reach the application. The interaction between mobile application and sensor processing server is described in detail in D2.4, Chapter 5.

5 Video sharing and social network

This sub-system consists of a video encoding service, storage of video, users and discussions, an API used by the mobile application to interact with this service, and a web application. The web application is the carer's website for multimedia content management and personalisation. It is also a social

network, where carers can have discussions. Figure 5 is a screenshot from the final version of the web application.

The first prototype is described in D2.1, Chapter 3. The final version of the website is documented in D2.6 – Carer's website for multimedia content management and personalisation. See these deliverables for details.

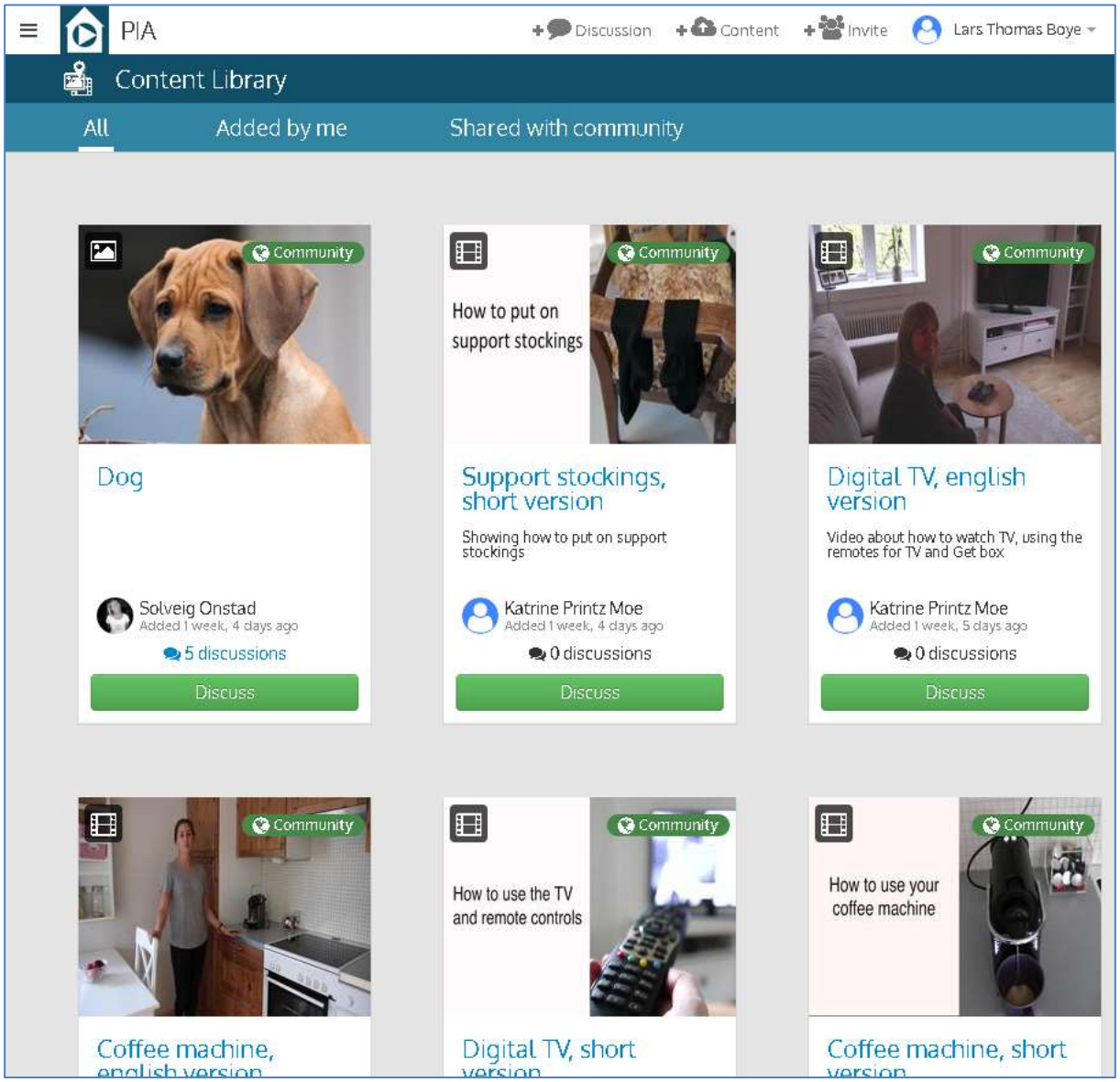


Figure 5: Carer's website for multimedia content management.

The implemented web application is available at the following URL:

https://my.stickyworld.com/community/pia/

Online documentation for the API is available here:

https://my.stickyworld.com/content/api-help/

The social interaction is based on communities. A single community, called PIA, has been set up and managed for testing and demonstration in the project. The platform supports any number of communities. For real usage, each country needs a separate community, so that discussions and videos are limited to a single language. A care organisation using the system would also typically want its own community.

An account is needed to access a community. A community manager can send out invitations, or people can request access from a form on the website, for the community manager to accept or deny. Users may also invite other potential users. A user can upload video and images, to share with the community or keep private. The content items available to a user are his/her content library. In addition to content items, the other main entity is that of discussion. A discussion is related to a content item, but there can be many discussions related to the same content item. A discussion typically starts with a question or new comment about a video, and then other users can join in with their feedback.

6 Sensor processing and administration

This is the sub-system which places the tag-video mapping, and potentially more service logic, into the "cloud". It uses Tellu's SmartTracker platform, which is a generic and highly configurable platform for sensor-based services. It handles receiving of data from a heterogeneous set of sensor devices and protocols, the storage of this data into an internal data model, processing of this data by a rule engine, a web application for management and data access, and a REST API for access to the data. We have also made a prototype PIA web application based on the API, for rule configuration.

This sub-system is described in D2.4 (Sensor sub-system). Chapter 4 describes the sub-system itself, with SmartTracker and its use in PIA. Chapter 5 describes the details of the integration with the mobile application. Here we will give a summary.

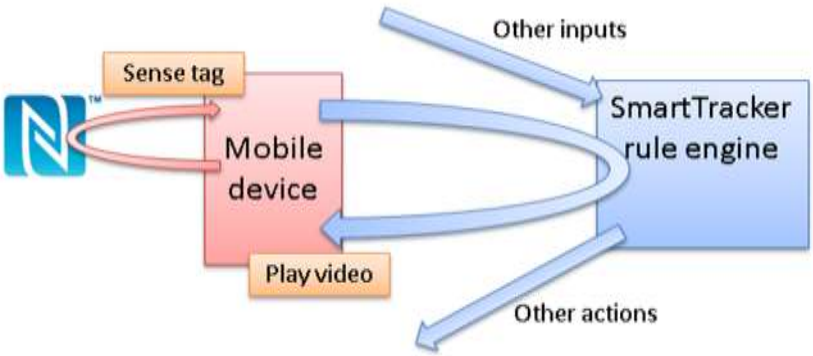


Figure 6: Sense-rule-video loop.

Primary users, NFC tags and videos are represented in SmartTracker. The mapping between tags and videos is configured as rules in SmartTracker. Figure 6 shows the sense-rule-video loop: a tag is sensed by a device, this observation is sent to SmartTracker where it is processed by the rule engine, and in this case a rule is triggered which sends a message to the device to play a video. What is gained with this approach is the ability to define more complex service logic, and also integrate the service with other inputs and actions. Video playback can be started by any rule, based on any input. The service configuration is also independent of the devices used, and can be done remotely.

A SmartTracker instance has been set up for use in the project. It is available at the following URL: http://ri.smarttracker.no. It has a web interface which is used for administration. It has been set up with a PIA service provider to hold PIA accounts.

An end user web application prototype is available at the following URL:

http://ri.smarttracker.no/pia

This web interface primarily shows the tags registered in the SmartTracker account. Name, description and the number of times the tag has been scanned is shown. Selecting a tag, rule configuration can be done. Videos to play can be selected from among the videos registered for the user. It is possible to specify which time of the day and which days of the week to play a video from this tag, so that different videos can be played at different times.

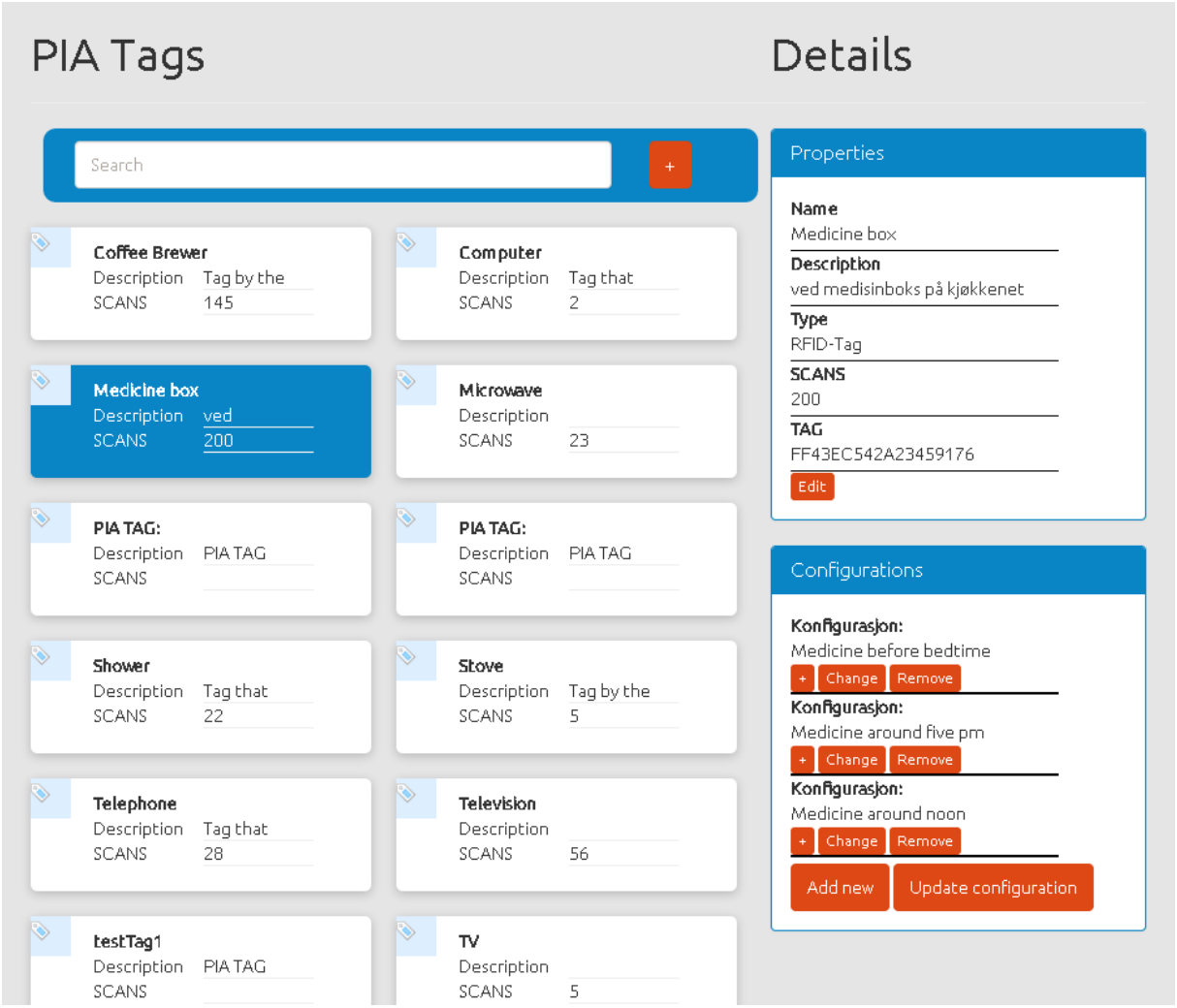


Figure 7: Rule configuration web application prototype.

7 Analysis web tools

This sub-system consists of a web application with multiple modules and user roles, a database holding users, tests and inputs received from other sub-systems, and an API to receive inputs. The web application has user interfaces for three types of users: carers, researchers and administrators.

For carers, it delivers tests in the form of questionnaires, and recommendations based on test results, in the three categories carer stress, IADL and QoL. Researchers can create/edit and assign tests, and view results. Administrators can manage the information in the system, such as users and their privileges.

The web application is available at MAmI's server, at the following URL:

http://161.67.140.37/PIAToolv16/web/

The web application is described in detail in Deliverable D2.5: Web-based tool for IADL, carer stress and IADL-related QoL analysis. Another key Deliverable is D1.4 – Methodology for IADL, carer stress and IADL-related QoL analysis – which describes the methodology. Chapter 5 of D2.1 (Prototypic system of the PIA concept) describes the system as it was at the end of the first prototype iteration.

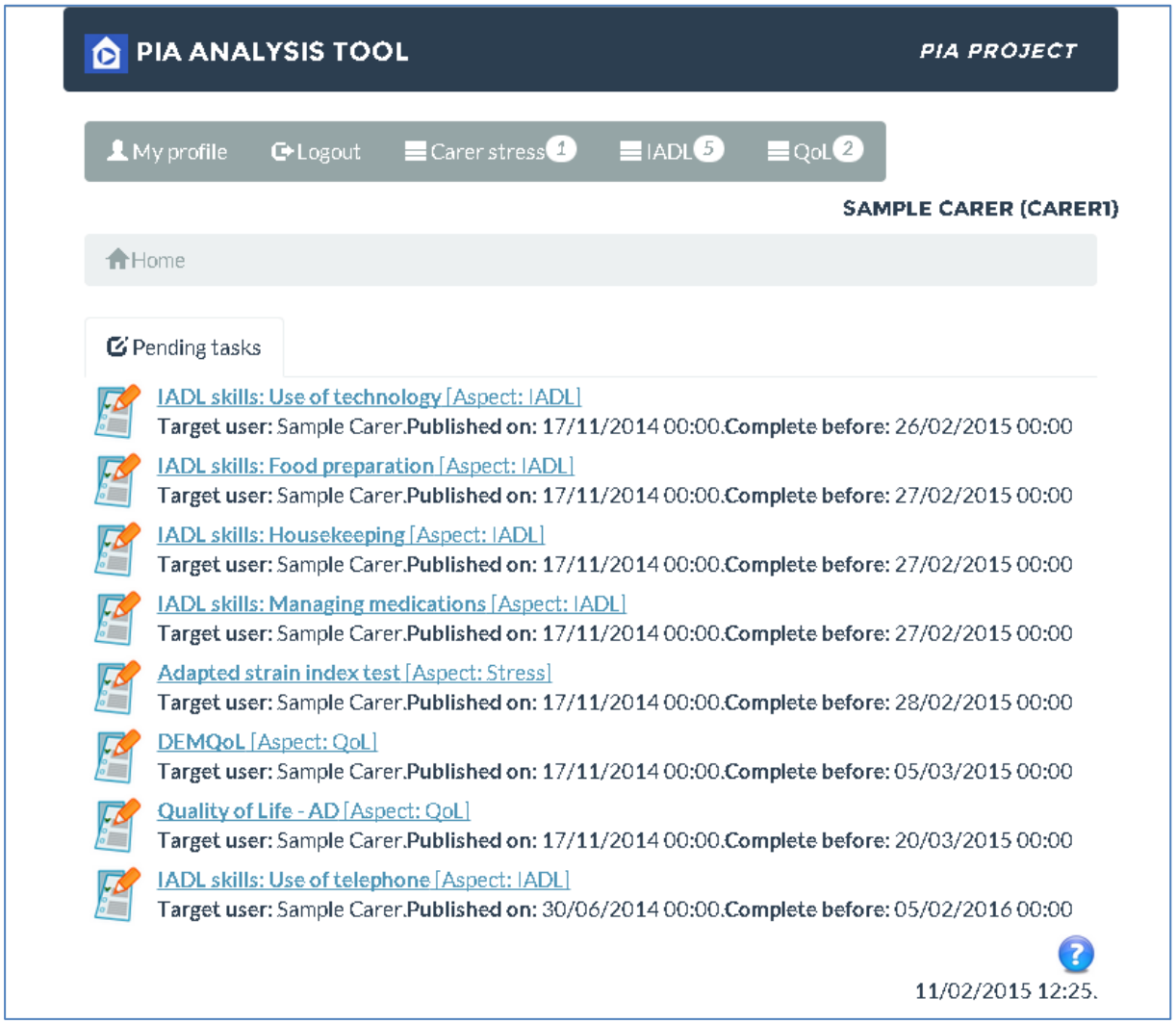


Figure 8: PIA analysis tool web interface for carers.

8 Appendix 1: PIA mobile application user guide

8.1 Introduction

The following documentation provides an overview of the operation of the PIA application for smart devices.

8.2 Application overview

This application provides two distinct modes of operation; one is targeted at end users and the other is targeted at carers.

The mode targeted at end users provides a mechanism to read a tag that has been affixed to an item in an environment and play an associated video.

The second mode allows a carer to record a video, upload it to the PIA cloud and associate it with a tag that is placed in the environment.

End user mode

In order to use the application in this mode an end user does not need to access the PIA application. Instead this capability to read tags and provide assistance is always available to end users whenever their smart device is unlocked (with its screen is on) and the PIA application is not being used.

Carer mode

The PIA application will operate in this mode when a carer has opened the application and has logged in. In this mode the following capabilities will be available.

- Record videos
- Upload videos to the PIA cloud
- Review uploaded videos from PIA cloud
- Select a primary user
- Link uploaded videos to tags
- Change application defaults (e.g. volume level)
- Logout

8.3 Obtaining the PIA application

In order to obtain the PIA application you will need to download it from the play store. This can be achieved by searching for the PIA application using its unique package name. Although this is an unfriendly name it provides an unambiguous way to find the application ensuring the correct software is installed.

This can be found using the web version of the play store which will allow the PIA app to be downloaded to your android device, at the following URL

https://play.google.com/store/apps/details?id=com.uu.serg.pia.

Alternatively this can be installed from the device accessible version of the play store by searching for "pname:com.uu.serg.pia" (without quotes).

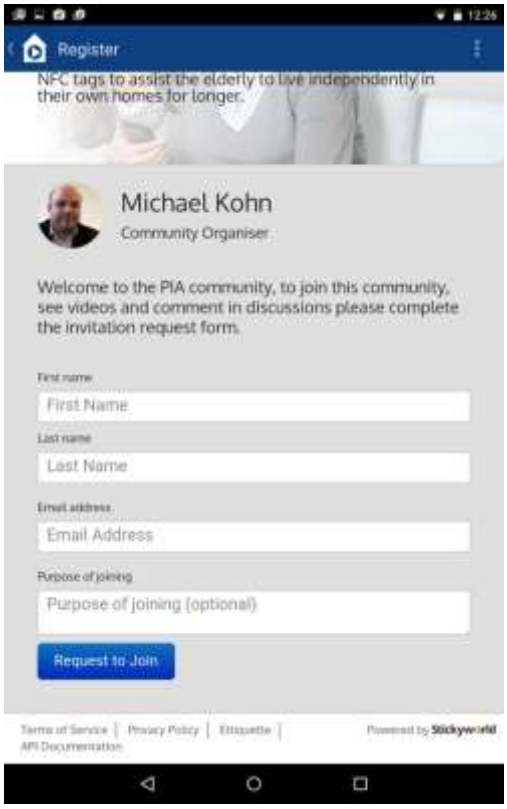
8.4 User guide – Carer mode

Currently the carer mode requires a username and password in order to use it. First open the application by selecting its icon from either the home page or the application's drawer.

When the app is launched it will either present the user with the main interface or if they are not logged in, present them with a login/register screen.

Register screen

If a user selects the register option they are presented with a form to sign-up to the service.



Once the necessary information has been supplied and the Request to Join is submitted an email will be sent to the supplied email address for the user to acknowledge. Once acknowledged, the login will become active.

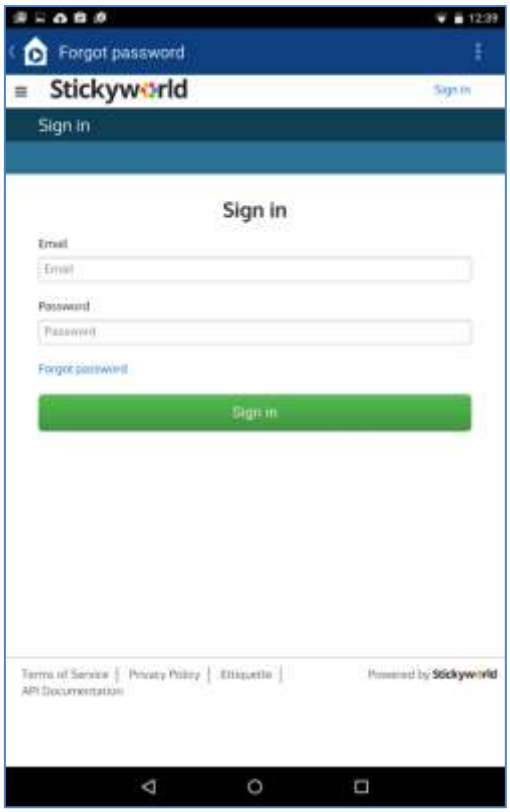
Login screen

When a user selects Sign-in they are presented with the above interface, they may provide login credentials and specify if they wish to be remembered by the app. Once credentials have been provided the sign-in button may be selected and the main interface will be shown.

Alternatively, if a user has forgotten a password they may select the Forgot password button.

Forgot password form

Use of the Forgot password option presents the following form. This will send a reset link to the registered e-mail account.



Once the user has have supplied these details the main interface will be displayed.

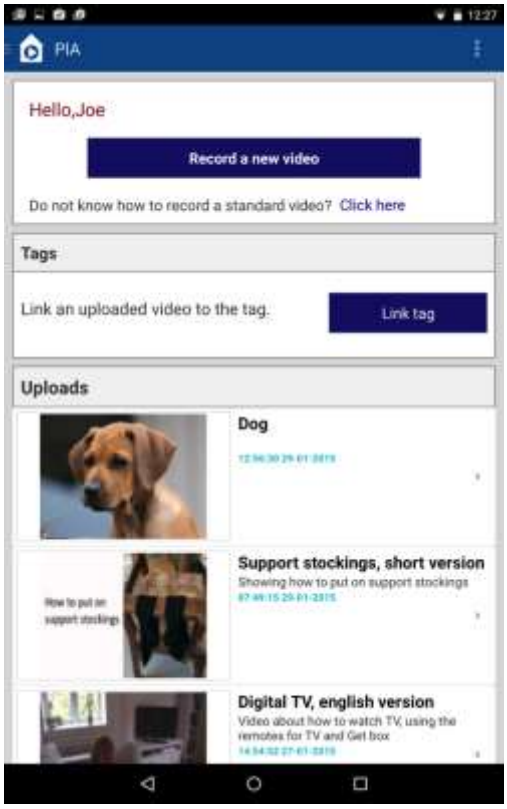
This interface allows users to:

- Record videos
- Upload videos to the PIA cloud
- Link videos on the PIA cloud to NFC tags
- Review videos that have been uploaded to the PIA cloud
- Select a primary user
- Change settings
- Logout

On the initial view of the main interface, an interstitial help screen will be displayed to help users become accustomed to the app.

Main interface

The main interface allows a user to record a video, link a tag or review recent video uploads.



Recording and uploading a video

When the 'Record a new video' button is selected, the record video and upload files to the PIA cloud workflow is initiated. In the initial view you may use the viewfinder to line up the shot and then press the Record/camera icon to begin recording the video.

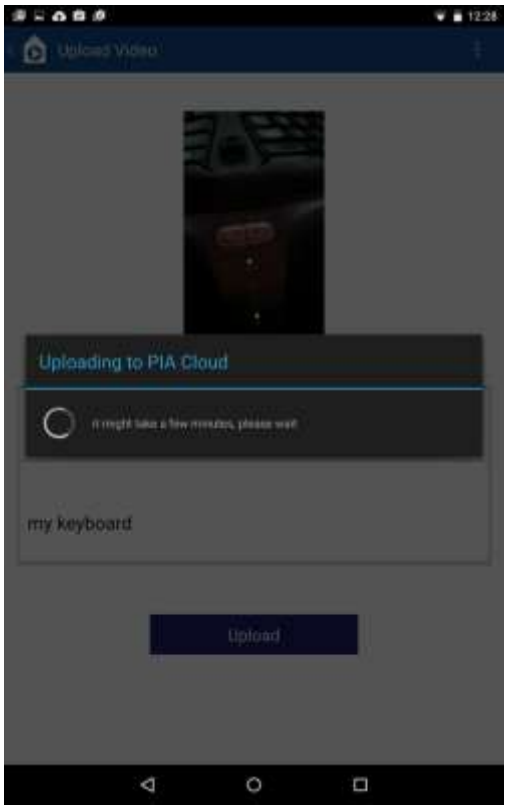
Once recording has begun, the user is presented with an option to stop recording via the square icon.

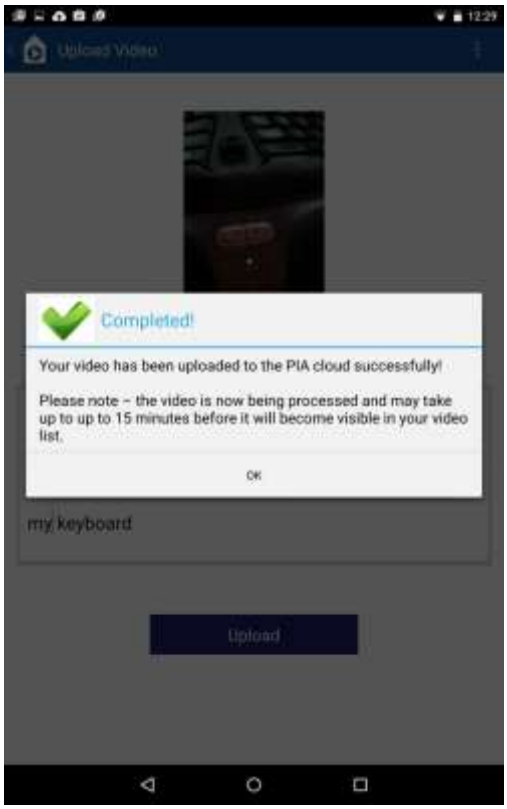
After the stop button has been selected, and interface to review the video is presented. By selecting the play button the video is played for review. By selecting the tick icon the video is marked as acceptable and stored on the device. By selecting the cross icon the video recording is abandoned and a new recording may be made.

On selecting the tick icon an interface to select a video to upload is selected, in the below screenshot the only video shown is the one recorded in previous steps depicted here. Tapping a video will allow a user to begin the upload process to the PIA cloud.

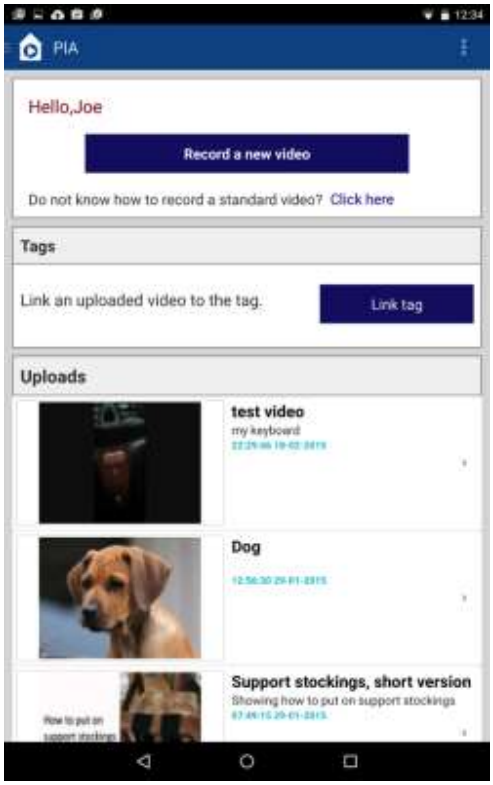
To upload a selected video a title and description must be supplied. In the screenshot below the title is "test video" and the description is "my keyboard". Once supplied, the upload button can be selected and the upload process will begin.

The user will be notified of the upload process activity and when it has been completed.





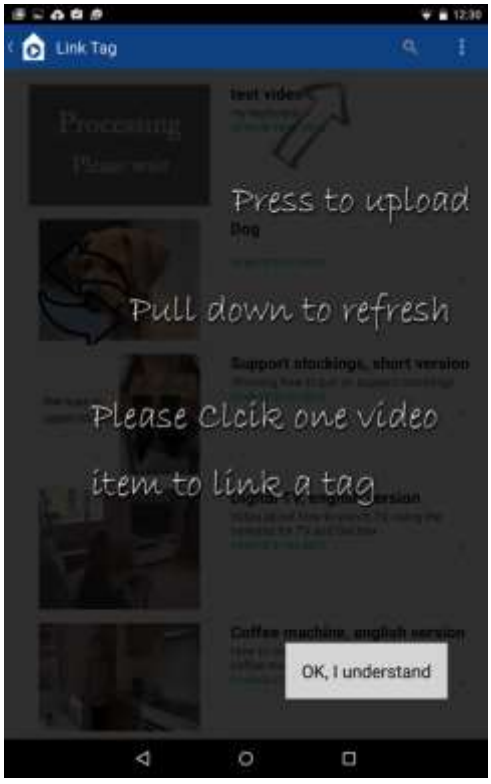
Once the upload is complete the main interface is presented, note that the recent video uploads now shows the video that has just been uploaded.



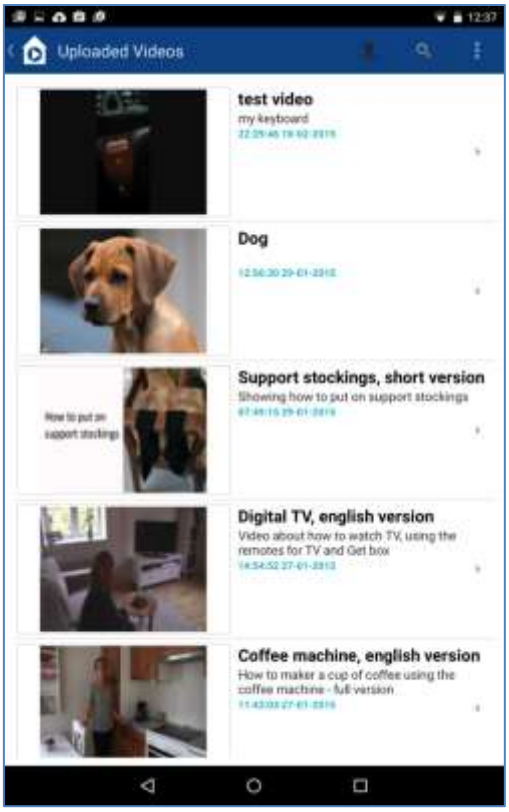
Linking a tag

By selecting the link tag button the tag linking process begins.

On the initial activation of this activity, an interstitial help screen is first shown.



A list of uploaded videos is then shown, when one is selected the linking process progresses.

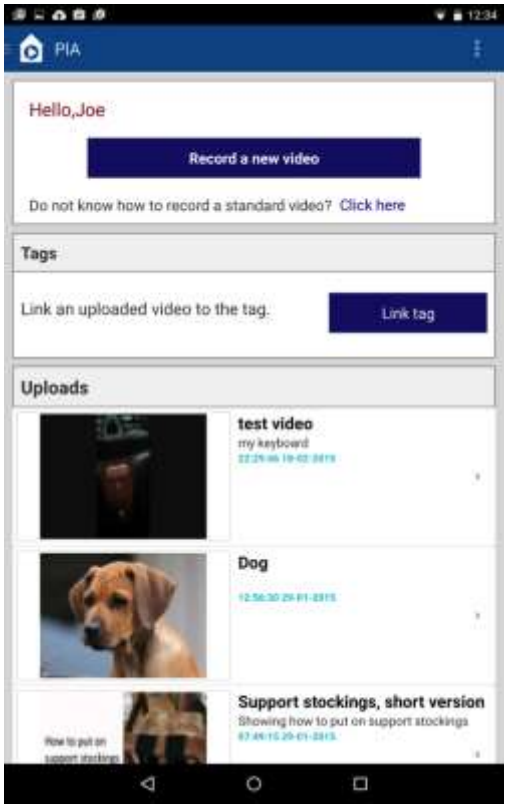


If this is the initial activation of this activity, an interstitial help screen is shown.

The link tag interface is then presented explaining how to link a tag. In order to link a tag the smart device should be aligned to the tag and positioned in close proximity to it

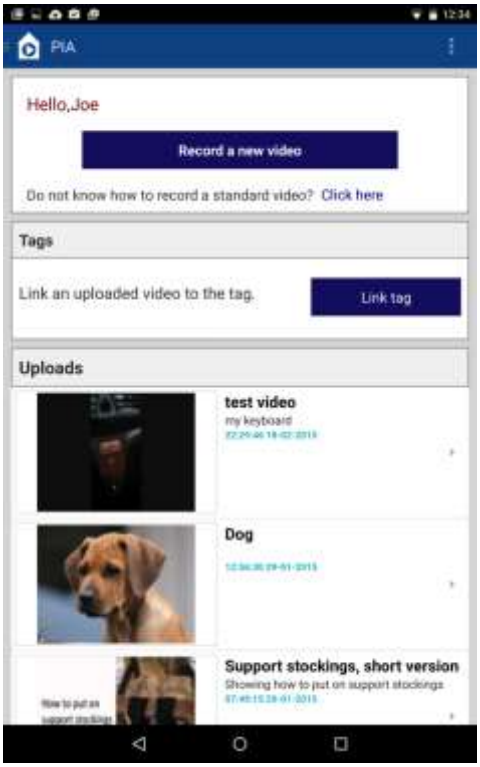
Once the tag is linked a message will be shown.

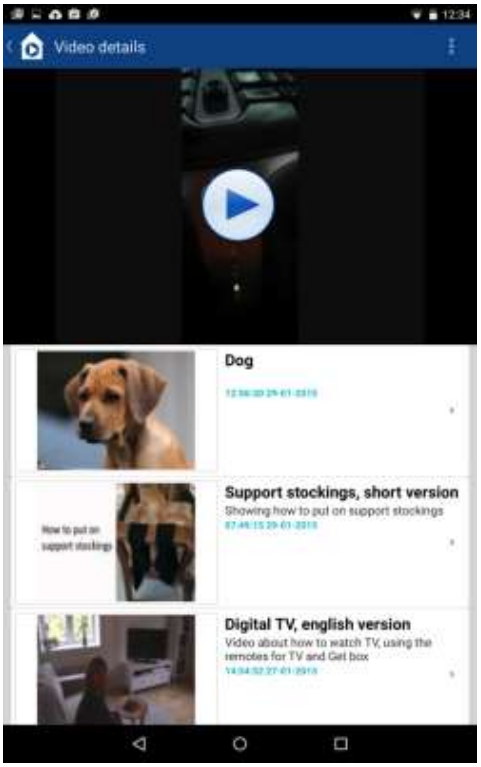
After the linking process the main interface is then presented.



Viewing a recently uploaded video

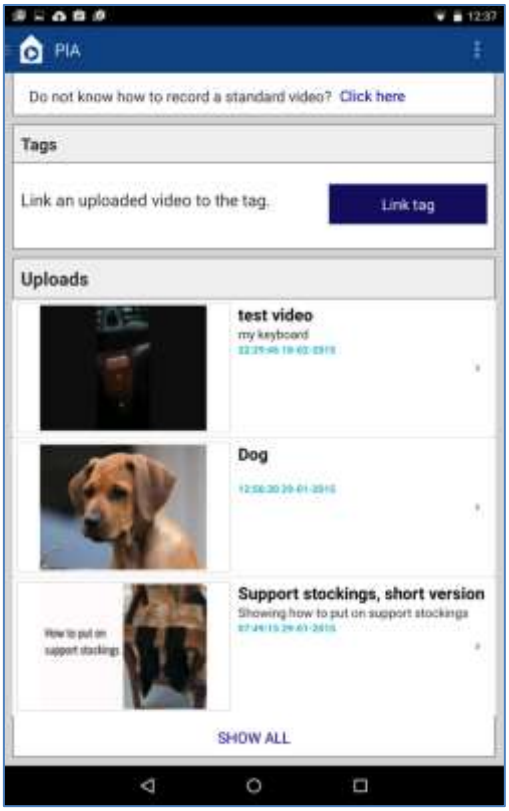
In order to view an uploaded video the user can click on the recent upload presented in the main interface. To do this click a video, this will present the review panel and then click play. Once play is selected the video will download and begin playing.



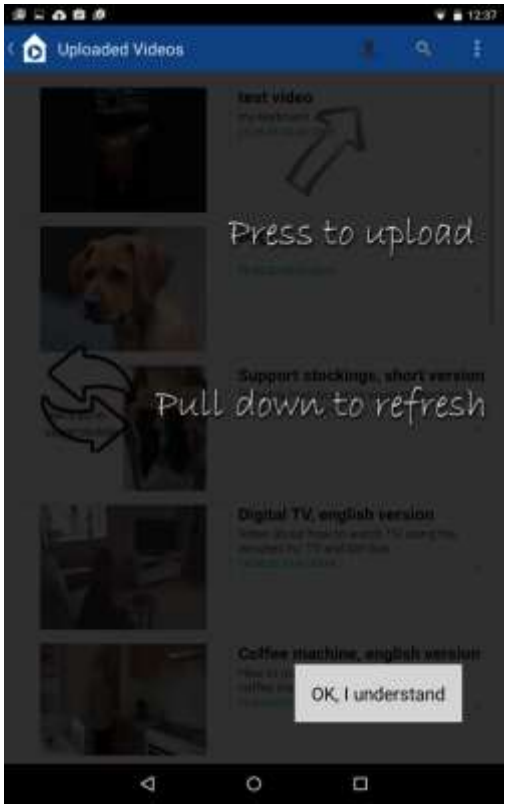


Viewing any available uploaded video

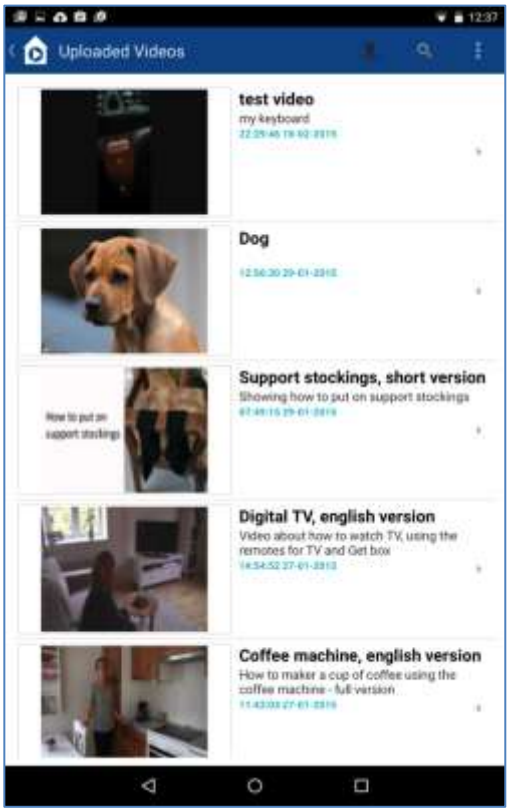
In order to view any uploaded video the user can scroll to the bottom of the main interface and select the 'SHOW ALL' button. This will present a scrollable list of all the videos present on the PIA cloud that the logged in user can access.

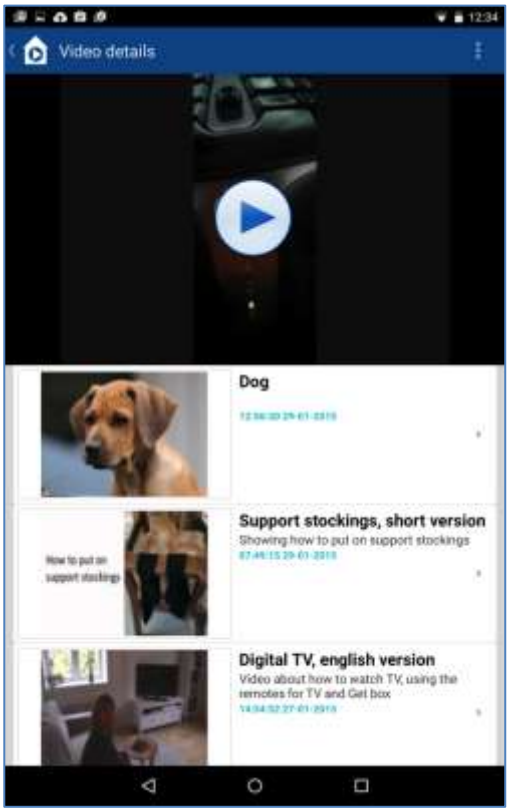


If this is the initial activation of this activity, an interstitial help screen is shown.



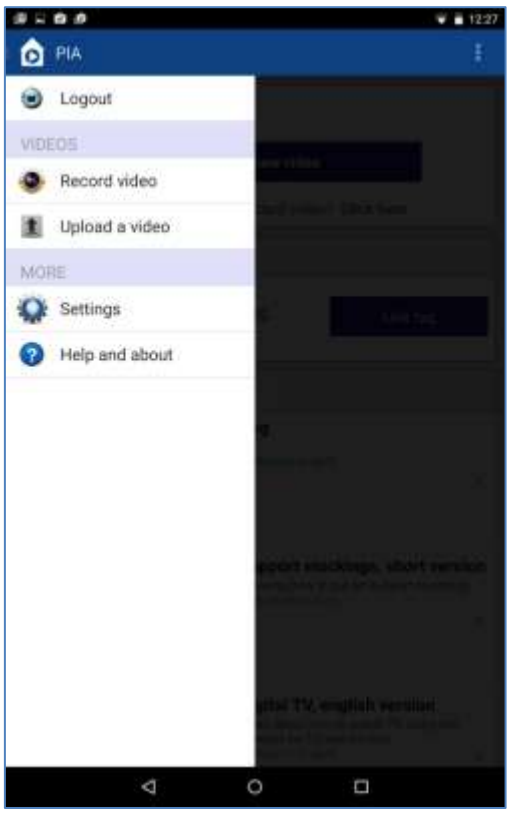
One the list of videos is presented any can be viewed by selecting it. Selection of a video this will present the review panel with a play button. Once play is selected the video will download and begin playing.





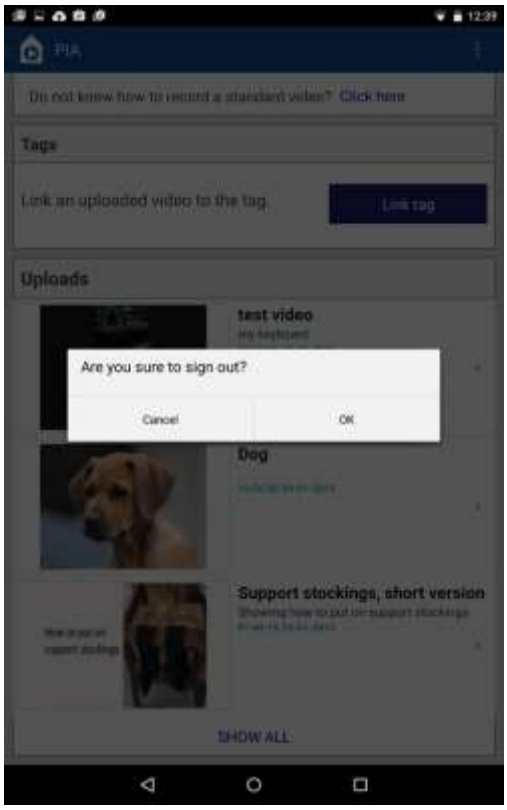
Additional functionality

Additional functionality can be accessed from the menu drawer by clicking the PIA home icon. In this menu; a user can logout, edit settings or view help and about information.



Logging out

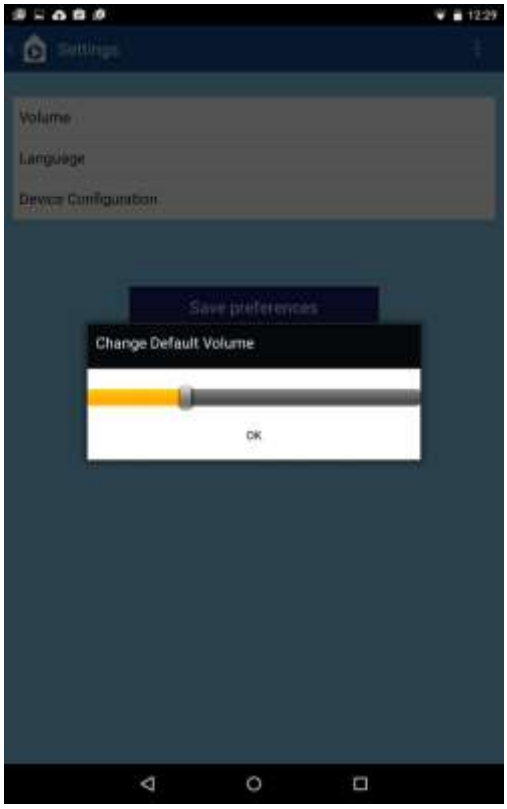
On clicking the Logout option the user is prompted to confirm that they wish to logout. On selecting Ok the user is logged out.



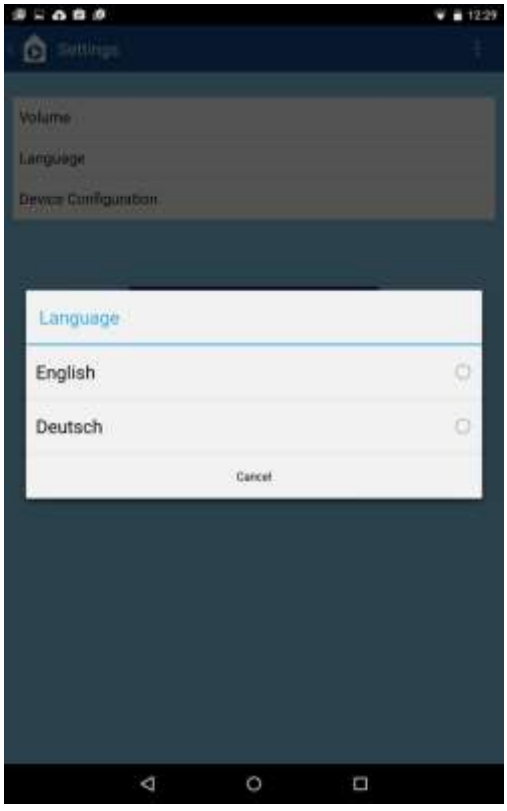
Changing settings

When the Settings option is selected, 3 options are presented; Volume, Language and Device configuration.

Selecting volume presents a slider for a user to change the default playback volume of the application. Changes can be made and committed by pressing ok.



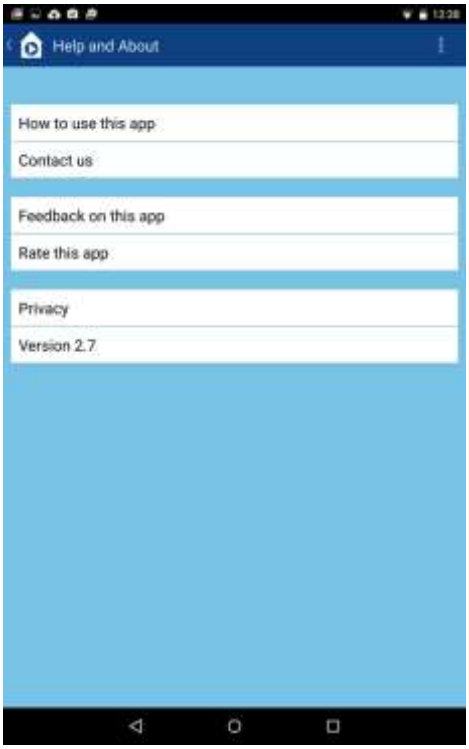
Selecting the language option allows a user to select between the interface languages, the options presented are English or Deutsch.

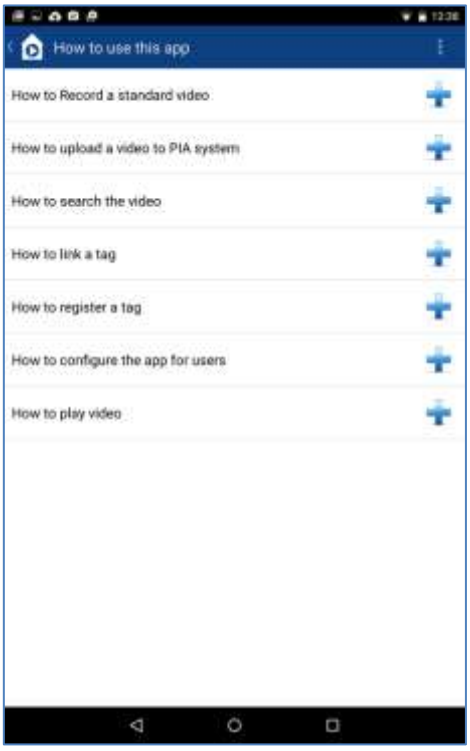


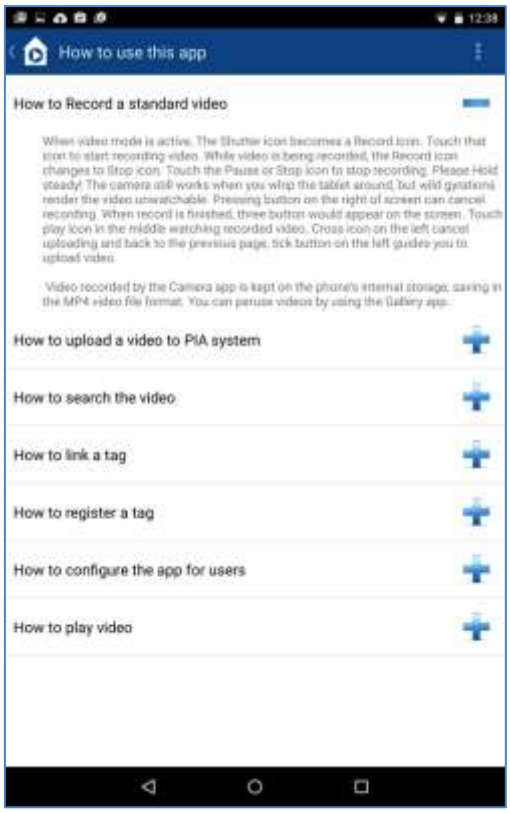
When device configuration is selected the primary user of the device can be specified, this is a list of users specified in the SmartTtracker component of the PIA cloud.

Viewing help

When the Help and about option is selected, an easily navigated interface is presented for a user to browse help topics or information about the app.

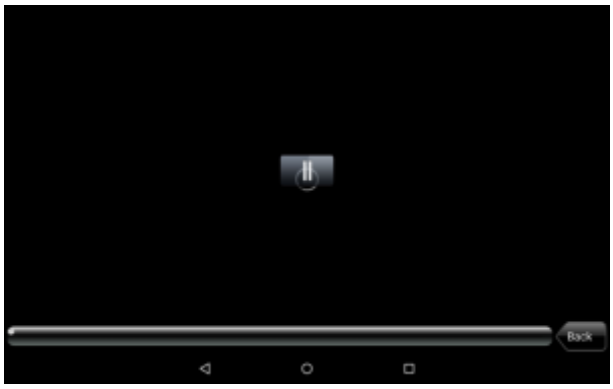






8.5 User guide – End user mode

To use the application as an end user the PIA application should already be installed on the device and the screen should be unlocked. Once the device is placed in appropriate proximity to a linked tag the appropriate video should be start downloading and playing.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