D5.3: Context Aware Reminders

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Abstract

This deliverable details the context-aware reminders within the HERMES system. Their functionality is described, focussing on context awareness both in generating the reminders and in issuing them. Then the two applications regarding reminders are detailed, having to do with the indoor and the outdoor systems.
Table of Contents

1. INTRODUCTION ........................................................................................................................... 4

2. OVERVIEW OF THE FUNCTIONALITY ......................................................................................... 5
   2.1 REMINDER TRIGGERS ........................................................................................................... 5
       2.1.1 Time triggers ................................................................................................................ 5
       2.1.2 Location-aware triggers .............................................................................................. 5
       2.1.3 Person-aware triggers ................................................................................................. 6
   2.2 EVENTS GENERATION ............................................................................................................. 6
       2.2.1 Manual events ............................................................................................................. 6
       2.2.2 Automatic events based on speech understanding ..................................................... 6
       2.2.3 Automatic events based on context .......................................................................... 7
   2.3 ISSUING THE REMINDERS ................................................................................................... 7
       2.3.1 Person-aware .............................................................................................................. 7
       2.3.2 Location-aware .......................................................................................................... 8
       2.3.3 Modality .................................................................................................................... 8

3. ARCHITECTURE AND TECHNOLOGY COMPONENTS ............................................................... 9
   3.1 XML DATABASE ..................................................................................................................... 9
   3.2 PERSON TRACKING AND IDENTIFICATION ...................................................................... 10
   3.3 KNOWLEDGE BASE REASONING MODULE .................................................................... 10
   3.4 MOBILE DEVICE AND HOME SYSTEM INTERFACE ....................................................... 10

4. REMINDERS ON THE HOME SYSTEM ..................................................................................... 11
   4.1 TIME-BASED REMINDERS ................................................................................................. 11
   4.2 PERSON-BASED REMINDERS ............................................................................................. 11
   4.3 USER INTERFACE .................................................................................................................. 11
       4.3.1 Time-based Reminders ............................................................................................... 12
       4.3.2 Person-based Reminders ........................................................................................... 14
       4.3.3 Location-based Reminders ....................................................................................... 15
       4.3.4 Alerts ......................................................................................................................... 16
       4.3.5 Evaluation .................................................................................................................. 17

5. REMINDERS ON THE MOBILE DEVICE ................................................................................ 18
   5.1 TIME-BASED REMINDERS ................................................................................................. 18
   5.2 OUTDOOR LOCATION AWARENESS AS CONTEXT .......................................................... 19
   5.3 MOBILE USER INTERFACE ................................................................................................ 19
       5.3.1 Time-based Reminders ............................................................................................... 19
       5.3.2 Location-based Reminders ........................................................................................ 22
       5.3.3 Alerts ......................................................................................................................... 23

6. CONCLUSIONS .......................................................................................................................... 24

7. GLOSSARY .................................................................................................................................... 25
1. Introduction

Memory is the first mental ability of the elderly that suffers from decline. Memory plays the most central role in the HERMES project, both as regards its training to alleviate cognitive decline and its aid, to facilitate elderly life.

The reminder is the instrument of memory aid in the HERMES project. The HERMES reminders are not the traditional post-it notes or alarm clocks. They are automated, context-aware events that make the life of the main HERMES user easier.

Context-awareness has a triple role in HERMES reminders. It is used to post, trigger and deliver the reminder. As regards reminder posting, context-awareness facilitates the automatic entry of reminder events in the calendar of the elderly user. The HERMES reminder triggers are not just temporal: any situation (like the entry of a person in the user’s home, or the walk by the grocery shop) can trigger a reminder. Finally, the HERMES reminders are issued in a context-aware manner. This awareness ranges from simple ambient noise measurements to setup volume and illumination of the display, to observing privacy levels based on other people presence.

This deliverable is about the context-aware reminders. It is structured as follows:

- In chapter 2, the functionality of the reminders is detailed.
- Chapter 3 describes the HERMES architecture supporting this reminder functionality.
- Chapter 4 provides the step-by-step guide to the indoor reminders’ GUI.
- Chapter 5 details the outdoors reminders’ GUI on the mobile device.
- Finally, in chapter 6 the conclusions are drawn.
2. Overview of the Functionality

Context-aware reminders are delivered because a posted reminder gets triggered due to some event. The overview of the reminders’ functionality is illustrated in Figure 1, together with the rest of the involved HERMES subsystems. This chapter details the different means for posting, triggering and delivering reminders. It is the architecture of the rest of the HERMES subsystems that facilitates the reminders in the way detailed in chapter 3. The presented overview of the reminder functionality is then specialized in the indoor and outdoor applications detailed in the following two chapters 4 and 5.

![Figure 1](image-url)

Figure 1: Overview of the reminder functionality and the HERMES subsystems that facilitate it. The three coloured boxes over the arrow represent the three stages of the reminders, detailed in this chapter, while the communication between the light cyan boxes is detailed in chapter 3.

2.1 Reminder triggers

Traditionally reminders are triggered by time. Apart from time, other context-based triggers are made possible with HERMES. These are location-aware and person-aware triggers. All the triggers are issued by the sensing environments of the indoor and outdoor subsystems.

2.1.1 Time triggers

Time-based triggers are supported in HERMES, both the indoor and the outdoor sub-systems. They are associated with a calendar entry, i.e. an event entry in the Calendar. The list of such triggers is kept in the Calendar Events tool.

2.1.2 Location-aware triggers

Location-awareness is of paramount importance in the outdoor subsystem. There, it is obtained by the GPS in the mobile device. These triggers are related to notes attached by the user to specific favourite places. For details, see section Location-based Reminders 5.3.2. The list of such triggers is kept in the Locations tool.
2.1.3 Person-aware triggers

Person-aware triggers are utilized to provide “person-based reminders”, which are events that can be attached to specific people so that when they enter the room and their faces are detected, the reminder appears. Usually these reminders will be set by the main user in order to remind himself/herself of something related to a person. In order to avoid potential discomfort or embarrassment on the part of the user, context-based rules are in place to ensure that visitors are not exposed to the reminders without the user’s consent. The notification only appears in the simultaneous presence of the user and the person to which the reminder is attached, and when it appears, the contents of the reminder are hidden by default.

More infrequently reminders will be left for a particular person other than the main user, in order to remind the other person of something upon entrance. To this end it is possible to make reminders “public” so that the alert exposes the full reminder contents and is displayed even if the main user is absent. The list of such triggers is kept in the People tool. These cases of context-based reminder delivery are summarized in Table 1.

Table 1: Different context that triggers person-aware reminders.

<table>
<thead>
<tr>
<th>Origin</th>
<th>Delivery context</th>
<th>Recipient</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person-based reminder (default)</td>
<td>Main user present &amp; other person enters</td>
<td>Main user</td>
<td>When John comes, we should discuss football</td>
</tr>
<tr>
<td>Person-based reminder (public)</td>
<td>Other person enters</td>
<td>Other person</td>
<td>If John pops by, remind him to call his home</td>
</tr>
</tbody>
</table>

2.2 Events generation

The events in Calendar can be entered manually. Things like birthdays are entered for the user at installation time, while notes about people or places are left by the user at any time.

On the other hand, there are events that can be generated automatically, based on information from the text-to-speech module, or the context. Automatic event generation is not part of the final prototype, since many factors render it premature of user testing. It is on-going research between the partners though, and hence it is reported in sections 2.2.2 and 2.2.3.

2.2.1 Manual events

Most of the entries and notes left about people and places are generated manually. There are three cases of manual events:

- **Time events**: At installation, important dates like birthdays are entered in the system. Further time events are entered at usage.
- **Location events**: At usage, the main user enters favourite places and associates them with events using the GPS (Locations) application.
- **Person events**: At usage, the user can associate reminders with people.

2.2.2 Automatic events based on speech understanding

Speech transcription from the mobile device results in textual annotations. The captured information is converted into useful events and stored in a database, as described in D5.1. These annotations can be created on Calendar entries, to be associated with time triggers, or on location- or person-based reminders. In all cases, the spoken text is transcribed and the transcribed data entered into the event metadata for later viewing by the user on the home and mobile systems. The original audio content is also maintained and can be played back when viewing these events. Alternatively, speech can be recorded as a “conversation”, which when transcribed is automatically converted into a searchable event in the MyPast timeline on the home system. In this case a media-navigation interface similar to the one used for video media is
provided, using a waveform instead of a filmstrip for orientation, and including synchronized “subtitles” taken from the transcribed textual data. It is also a possible extension to use transcribed future dates to populate Calendar entries. In this way events can be automatically associated with time triggers. On the other hand, this would require logic and GUI extensions for user verification of the extracted spoken context, as well as an algorithm for the characterisation of the transcription as being the details for an appointment. All this functionality has not been finalised, and hence is not part of the final prototype.

2.2.3 Automatic events based on context

Within HERMES we have researched the possibility for automatic events’ generation based on context. We have identified two such types of events: those generated by observing repeating patterns of indoors activity and notes about people or places generated by loosely timed Calendar events. Unfortunately, there are some technological and practical limitations that are prohibiting the inclusion of such functionality in the final prototype, as discussed in the following paragraphs.

The way repetition is discovered in indoor activities is detailed in D4.5, chapter 4. On the other hand, loosely timed Calendar events are those that refer to a time interval, not a specific time instance. Such events can be related to people or activities. Since the derivation of such repetitive events requires weeks of system usage, the inclusion of this functionality in the prototype has not been made possible.

The Calendar entry “Grandson’s birthday” refers to the whole day and is used to generate a time-triggered reminder. It is a straightforward extension to link the Calendar event to a specific person in the system, and then automatically create a person-based reminder for the grandson that is activated when (if at all) the grandson is identified by the indoor sensing subsystem. On the other hand, this extension has not been completed due to the false positives in the face recognition system. The final version of the face recognizer is still under evaluation, while platform porting problems are encountered between Windows and Linux-based workstations.

The shopping list entry “Buy grocery” can be used to generate a note about a place, the grocery shop. This note can be used to augment the message generated to the user when he or she is close to that place (refer to section Location-based Reminders5.3.2). It is a straightforward extension to pass the data to the mobile locations application and automatically activate the relevant location-aware reminder. This extension requires that it is made possible to assign shopping categories to locations. Then, when a shopping item in the category “Food” becomes active, all locations in the category “Food” would have their reminders enabled.

2.3 Issuing the reminders

Although reminders are very important, the way they are issued to the main user can have implications. The user can be embarrassed if the reminders are openly given when particular people are present. Also, the best display mode can vary, depending on the activity.

2.3.1 Person-aware

As person-based reminders are presented on the home console, there is an extra risk that a reminder’s appearance could prove embarrassing to the user. In order to avoid embarrassment, these reminders are issued only when trusted people are present, where “trusted people” is defined to mean anyone who the user has saved in the system and is thereby recognized by the sensing environment. Additionally, there are two possible privacy settings for person reminders—private (default) and public—which change when and how reminders are presented. In the case of private reminders, the primary user must be present, in addition to the person with whom the reminder is associated, in order for an alert to be triggered. (Additionally, as mentioned, the alert will not be shown if any non-trusted people are present.) In this case the
alert is presented accompanied by a generic message and generic audio signal. The actual contents of the reminder—both text and voice notes—must be explicitly opened by the user by clicking on designated buttons. This ensures that the user’s privacy is not compromised.

In the case of public reminders, on the other hand, the user’s goal is to notify/remind someone else of something. Therefore it is displayed even in the absence of the primary user (although it still requires only trusted people to be present). Additionally, reminder text is shown and voice notes are played back automatically.

2.3.2 Location-aware

Based on the location of the main user, the best reminder issuing method and its intensity can be determined. Certainly this requires an integrated version of the 3D tracker that is not available as an on-line component.

Hence for person-aware notifications the system can exploit knowledge about the proximity of a person to the reminder-issuing terminal. Font sizes and/or sound volume can be adjusted accordingly.

2.3.3 Modality

Audio or visual reminders can be used, depending on indoor/outdoor operation, environment and location. For either of the two reminder issuing modalities, environmental sensing can help in the tuning of the issuing system: the sound volume or display brightness can be adjusted accordingly.

Regarding the audio issuing of reminders, a Text-To-Speech module has been developed for issuing voiced reminders from the PDA. It is ported to the Mobile 6 platform and is integrated with the Mobile Application. Both Spanish and German voices are provided to support both HERMES deployments.
3. Architecture and Technology Components

The following figure shows an overview of the system components responsible for issuing and updating reminders that are detailed further in this section.

![System architecture for reminders](image)

**Figure 2: System architecture for reminders.** The various methods for communication between modules are presented, along with a brief description of what information is exchanged. The solid lines denote that the modules are continuously connected over a LAN, while the dotted line marks the ad-hoc connection of the Mobile Device.

In order to enable reminders, the following components are utilized:

### 3.1 XML Database

This module stores the list of persons that the system has been trained to recognize. For each one, personal details such as name/surname and address may be stored, along with a sample picture of this person, as well as the file paths where the face training vectors are located. Furthermore, this is where the reminder description and if applicable the file path of the audio reminder are stored, along with the privacy preferences of each person. Finally this module, apart from serving as a communication overlay between the other components, also provides permanent data storage for the rest of the modules, as they access it on start-up to retrieve any pre-configured settings.
3.2 Person Tracking and Identification
This module is responsible for providing the required information for issuing person-aware reminders. A number of individual person trackers, matching the number of available cameras, provide information about the location and the ID of the visible persons from each camera. This information is generated for every new frame, leading to a rate of more than 10 messages/second. Thus direct communication with the KB Reasoning Module via TCP/IP was required to avoid the overhead of calling Web Services.

3.3 Knowledge Base Reasoning Module
This module receives location and ID information from the individual Person Tracking and Identification modules and aggregates that information in order to acquire knowledge about the people currently present in the room. If all targets are recognized as persons in the user’s friends list, they are considered trusted and issuing of reminders is enabled; on the other hand, if the tracked targets are not recognized, i.e. the confidence about their ID is low, no further processing takes place for that particular time instant and the system awaits for more accurate input. Each time a new person is detected and recognized, this module accesses the XML database and retrieves any reminders configured as enabled for that person, along with the corresponding settings regarding the type of the reminder (public or private). If the reminder is private, an additional check is performed whether the primary user is visible in the system, and only if this holds the reminder is triggered. To avoid re-issuing the same reminder, the XML Database information is updated to set that reminder as disabled and to handle the case when a target disappears briefly, for example due to an occlusion, no reminder is issued for the same person within a few seconds of the previous one.

3.4 Mobile Device and Home System Interface
These are the presentation modules, responsible for showing the reminders to the end user. The mobile device is only connected on an ad-hoc basis, as denoted by the dotted line in the above figure, at which time the calendar is synchronized along with time-based reminders. On the other hand, the Home System Interface polls as often as needed the XML Database to retrieve the time-based reminders. Furthermore, by using the BlazeDS framework that has been integrated as a component in the KB Reasoning Module, it receives the notifications required for the triggering of the context-based reminders.
4. Reminders on the Home System

The home system allows setting reminders for:

a) Time-based events
b) Person-based events

Location-based reminders created on the PDA can also be edited and enabled/disabled from the home system.

The created events can be synchronised with the mobile device, which in turn allows the user to browse/edit such events through the HERMES mobile application.

4.1 Time-based reminders

This kind of reminder is the most common one. It works just like a calendar, allowing the user to set events in the form of reminders at a specific date/time. Such events are linked to textual description and/or audio notes recorded by the user by leveraging the microphones in the home setup. These voice notes are then automatically transcribed. The subsequent synchronization of the device allows the mobile device to acquire the event details, including textual transcription but not the audio note itself.

The time-based alert itself occurs on the mobile device only; this avoids the problem of multiple simultaneous alerts on the home and mobile systems, while ensuring that the user is presented with the reminder regardless of their proximity to the home console. For further details on the presentation of these alerts on the mobile device, see section 5.3.3.

4.2 Person-based reminders

This kind of reminder is used primarily to remind the user of something in connection with a visitor, but may also be used to remind a visitor of something. As with the time-based reminders, person-based reminders may contain text and/or voice notes (which are automatically transcribed).

The alerting mechanism for person reminders is performed via a full-screen pop-up containing the textual and/or audio content of the reminder along with the name and picture of the relevant person. An audible alert is also emitted at a volume level adjusted for the user’s proximity to the system.

4.3 User interface

The user interface of the HERMES home apps have been redesigned and expanded to take usability feedback from the first trials into account, as well as to better mirror the capabilities present on the mobile device. Please see D5.1b for more details about the design of the revised GUI.

Below are some screenshots related the portions of the GUI related to reminders.
4.3.1 Time-based Reminders

From the Calendar the user is able to browse existing time-based appointments and add new ones. Above is the Calendar view as it appears when first opened. In order to create a new appointment the user taps the “Create new appointment” button on the lower right-hand side.

At this point a new appointment is shown in the list on the right-hand side corresponding to the date selected on the left-hand side. By default it is shown in its “expanded” form, which allows the user to enter details. Note that this same view is available for existing appointments by clicking the “Show details” button on any of them.
The user is enabled to:

- Set the date and time for the event by tapping on the button containing this information.
- Add a textual description for the appointment by tapping the text field,
- Record an audio note by tapping the “Record voice note” button
- Set the time for the alert so the user can be reminded before the appointment expires, by tapping the “Reminder…” button
- Undo the insertion of the new appointment (or delete an existing appointment as the case may be) using the “Delete appointment” button
When the user taps on the date and time button, an overlay appears that allows it to be adjusted. Numerous fields are displayed, each of which can be adjusted by pressing the +/- buttons adjacent to them. The fields are, in order: Day of month, month, year, hour, minute.

Similarly, overlays appear when the user taps the description field or the “Record voice note” button to add a description or voice note, respectively (see D5.1b for details). However it’s worth taking a look at the form that allows setting the alert time in advance:

![Figure 6 – Time-based reminders – Alert time setup](image)

The available options mirror those that are available on the mobile device (see section 5.3.1), allowing the user to precisely define the alert behaviour of the mobile device, even from the comfort of the home console.

### 4.3.2 Person-based Reminders

Person-based reminders are attached to specific people, and are triggered when they enter the room based on face detection. They are able to be set within the home system using the People browser:
For each person within the system, the user is able to:

- Change details of the person (name, birthdate) using the “Change Info” button
- Add a textual description and/or voice note for the person-based reminder, by using the “Change Reminder” and “Add Voice Note” buttons
- Enable/disable the reminder using the “Enable Reminder?” toggle buttons

Additionally, the user is able to view all conversations (videos) in which a person was present (links to MyPast). The person’s privacy can also be protected by tapping “NO” next to the question “Is it OK to videotape…?” This ensures that the person is not recorded by cameras in the future—as long as person is detected to be the room, the camera video feed will not be recorded.

### 4.3.3 Location-based Reminders

Although location-based reminders cannot be created on the home system due to the fact that this requires GPS data, they can be easily browsed and the reminders modified from the home system.
The user is enabled to:

- Set the name of the location using the “Change Name” button
- Add a textual description and/or voice note for the reminder that will be shown from the alert, by using the “Change Reminder” and “Add Voice Note” buttons
- Enable/disable the reminder using the “Enable Reminder?” toggle buttons

As with the time-based reminders, these functions mirror those available on the mobile device, allowing the user to adjust the behaviour of location-based alerts on the mobile device, from the comfort of the home console.

### 4.3.4 Alerts

The Alert popup appears when a person enters a room and the sensing environment recognizes their face. At this point a combination audio/visual alert fills the screen, as shown below:
For privacy purposes, by default the alert will not be shown unless both the user and the visiting person are present simultaneously. Also by default, the reminder text is hidden and a generic alert tone is played back—the actual text and voice note are only available by clicking on the relevant buttons as shown above. However, the system also supports the case that the user wants to remind the visitor of something (as opposed to just reminding themselves). In this case, the user can opt to change the reminder’s privacy settings to “public”, which enables the alert to be shown even when the user is not present, and which enables the display of the reminder text and playback of any voice note upon the initial triggering of the alert.

4.3.5 Evaluation

The reminder functionality in the context of both home and mobile devices was evaluated as part of the system evaluations. We found that the concept and utilization of these features was generally well accepted and perceived by users to be quite useful. Full details of the evaluation results can be found in the documentation of the system evaluation in D7.3.
5. Reminders on the Mobile Device

The mobile application allows setting reminders for:
   a) Time-based events
   b) Location-based events

The created events can be synchronised with the home-based workstation that in turn allows to browse/edit such events through the main HERMES application reflecting the HERMES Mobile GUI and functionalities.

It’s possible also to do the other way around: the user is enabled to create a time-based event through the home-based application and then synchronise it with the mobile application. Of course location-based events cannot be created from home since it’s meaningless but, instead, it’s possible to leverage on the mobile device to do that, in an outdoor context.

The alerting mechanism is performed by the device in the following way:
   • turn the display on (not seen if in bag)
   • vibrate (good if carried in pocket, but not if in a handbag or similar)
   • play an alarm sound

Initially we’ve added also the possibility to leverage on the text-to-speech (TTS) functionality instead of playing an alarm sound, but basing on the user trials we then considered starting TTS automatically not to be a good idea, because a) the user might not understand what is said (because volume is too low or the PDA is in a bag), b) he/she might get irritated by a voice speaking in his pocket and most importantly c) the user might be in a public place (quite possible when carrying the PDA) or some other place where he/she does not want everyone to hear his private appointment details.

5.1 Time-based reminders

This kind of reminder is the most common one. It works just like a calendar allowing the user to set events in the form of reminders at a specific date/time. Such events are linked to textual description and/or audio notes recorded by the user by leveraging on the mobile device’s built-in microphone. The subsequent synchronization of the device allows the home-based system to acquire the recordings (as well as the event details), process them and transcribe the audio note. The user is enabled to set the alert some time in advance before the actual event takes place, this could be useful in order to organize his/her daily activities accordingly or to avoid the alert in certain hours of the day (i.e.: late night).

Once issued the reminder it’s possible to accept and then clear the event or to snooze it. Again, basing on the user trials where the reminder screen with its many options confused the users, for snoozing/delaying we found two options:
   1. short time reminder: 1/10 of remaining time to appointment, rounded up to next “unit step” (see below). If less than 5 minutes: “remind at start of appointment”
   2. long time reminder: 1/2 of remaining time, rounded up to next unit step.

Unit step: instead of setting 1/10 and 1/2 exactly, the next reminder is based on the remaining time:
   • < 1 hour: round to next 5 minutes
   • < 3 hours: 15 min
   • < 24 hours: 1 hour
   • > 24 hours: 1 day
Example 1
The reminder is set 30 minutes in advance:
Short-time reminder: \( \frac{1}{10} \) of 30 = 3 minutes, rounded to 5 minutes
Long-time reminder: \( \frac{1}{2} \) of 30 = 15 minutes

Example 2
The reminder is set 2 hours in advance:
Short-time reminder: \( \frac{1}{10} \) of 120min = 12, rounded to 15 minutes
Long-time reminder: \( \frac{1}{2} \) of 120min = 1 hour.

5.2 Outdoor location awareness as context
The HERMES Mobile is part of the outdoor sensing environment for audio and location recording. With respect to reminders it provides the possibility to create a new event storing the current user location, as part of the outdoor context, leveraging on the GPS subsystem built in the project mobile device and integrated in the mobile application.
The idea is to help the user reminding a particular place so that the next time he/she will be around the chosen area (± 30m), HERMES will issue the alert.
The possibility to attach comments and/or audio notes is the same as the one described above for time-based reminders.
The following is an example of one possible workflow utilizing location reminders:

1. The user has in the past associated a location with the reminder “Buy groceries”. S/he also has a shopping list containing all food items that s/he normally buys. Currently all of the items are checked off, from the last time s/he went shopping.
2. The user notices there is no bread left in the kitchen.
3. The user goes into the Shopping List and unchecks “bread”.
4. The user goes into Locations, and enables the previously created reminder.
5. When the user walks by the grocery store, s/he is reminded to buy groceries. S/he walks into the store, opens the Shopping List and sees that s/he needs to buy bread. After putting the bread in the shopping cart, the user checks it off on the Shopping List.

5.3 Mobile user interface
The user interface of the HERMES Mobile app has been redesigned following revised usability indication. Please see D5.1b for more details about the design of the revised mobile GUI.
Below are some screenshots related the portions of the GUI about reminders.

5.3.1 Time-based Reminders
From the mobile calendar the user is enabled to browse existing time-based appointments and add new ones. Above is the typical calendar form. Once the user creates a new event he has the possibility to add some information about it.

The user is enabled to:
- Set the date and time for the event
- Add a textual description for the appointment or record an audio note
- Set the time for the alert so the user can be reminded before the appointment expires
- Undo the insertion of the new appointment and return back to the calendar using “Cancel”
- Save the new appointment into the system through the “Done” button
The Set Date and Time form provides:
- A first section that contains the selected date for the event comprised by three boxes: date, month and year.
- A second section that contains the time comprised by two boxes: hours and minutes.
- A Whole Day button that sets the appointment not for a selected time but for the whole day.

In the same way, from the form described in Figure 11, it’s possible to enter a description or record an audio note (see D5.1b for details). However it’s worth taking a look at the form that allows setting the alert time in advance:

![Figure 12 – Time-baser events – Set date and time](image)

![Figure 13 – Time-based events – Alert time setup](image)
5.3.2 Location-based Reminders

Similarly to time-based reminders, location-based reminders can be easily browsed/created through the following form:

![Location-based reminders example](image)

The creation of a location-based reminder is pretty straightforward:

![Reminder creation example](image)

- Set the name of the location
- Add a textual description for the reminder that will be shown from the alert
- Determine the current GPS position. (The button becomes green if the signal is taken correctly or yellow if not)
• Undo the insertion of the new location reminder and return back to the *Locations List* using “Cancel”
• Save the new location into the system through the “Done” button

5.3.3 Alerts
The Alert popup appears only when an event expires, it is used for both time-based and location-based reminders and it is prompted to the user with sound and vibrations feedback. If the user doesn’t choose to clear the reminder or snooze it, this form is prompted again each minute with the same feedback.

![Reminder](image)

Figure 16 – Alert

The user is enabled to:
• *Read out description* of the event (this button leverages on the Text-To-Speech engine)
• *Play voice note*, if present
• Clear the reminder.
• Postpone the reminder of 1/10 or 1/2 of the saved reminder time

For locations-based reminders this form is very similar but postpone buttons are replaced by a single button that allows the user to maintain the alert active for the next time he reaches the same geographic area.
6. Conclusions

This deliverable summarised the context-based reminders in HERMES. Starting with the overview of the functionality in chapter 2 and the account of the involved components of the HERMES system in chapter 3, the reminders are specialised in chapters 4 and 5. There, the two applications for indoors and outdoors reminders are presented. Note that chapter 2 presents the general ideas behind the context-aware reminders. Not all this functionality has been implemented in the two applications. The reason for this has to do with the robustness of the event extraction. This robustness depends on the algorithms, which are mature, but also on the available hardware. Especially indoors location awareness requires more cameras and consequently more computers to process the signals that the available two.
7. Glossary

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>ASR</td>
<td>Automatic Speech Recognition</td>
</tr>
<tr>
<td>BT</td>
<td>Blue Tooth</td>
</tr>
<tr>
<td>CTM</td>
<td>Close Talking Microphone</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communications</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
</tr>
<tr>
<td>SDK</td>
<td>Software Development Kit</td>
</tr>
<tr>
<td>SIR</td>
<td>Spoken Information Retrieval</td>
</tr>
<tr>
<td>SQL</td>
<td>Structured Query Language</td>
</tr>
<tr>
<td>TTS</td>
<td>Text-To-Speech Synthesis</td>
</tr>
<tr>
<td>VAD</td>
<td>Voice Activity Detection</td>
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<tr>
<td>XML</td>
<td>eXtensible Markup Language</td>
</tr>
<tr>
<td>KB</td>
<td>Knowledge Base</td>
</tr>
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