# User Interfaces for Older Adults

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**Abstract.** Needs and wishes regarding the interaction with ICT solutions change over time and vary between older adults. They depend on the user's physical and mental capabilities and preferences. Thus the user interface, which is considered critical to the success or failure of an ICT product or service, should be adaptable. AALuis provides an open middleware layer to guarantee accessible and usable user interfaces for Ambient Assisted Living services. The general idea is to foster a detachment of the user interface from the service and its functionality, respectively. Furthermore an input fusion and output fission regarding I/O modalities based on the user's preferences is striven for. At the heart of AALuis lays a dynamically adapted, personalized interaction between an older adult and the service, with various I/O devices. The first results of the project look promising to achieve flexibility in the creation and usage of interfaces. The chosen approach allows further developments expanding the functionalities and improving the generated user interfaces.

**Keywords:** Ambient Assisted Living Services, Human-Computer Interaction, User Interface, Framework, Automatic Adaptation.

## 1 Introduction

Needs and wishes regarding the interaction with ICT solutions change over time and vary between older adults. They depend on the users physical and mental capabilities and preferences, but are age independent. Thus the user interface (UI), which is considered critical to the success or failure of an ICT product or service [1], should be adaptable. Older adults appreciate being treated respectfully and having a freedom of choice [2], which can be achieved by the presented solution.

In recent years, there has been an increasing amount of research going on focusing on the user interface and thus on the presentation of services for older

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adults. In the following some selected and relevant research projects and their approaches are described. GUIDE[1] has focused on a novel adaptive accessibility framework and a characterization of individual users for creating accessible TV applications [3]. MyUI[2] has addressed the provision of individualized user interfaces which are accessible to a broad range of users by the collection of information about the user during the interaction and updating the user profile accordingly [4]. The VOMS Cluster[3] aims to provide input to the standardization of user models and finally targets at helping designers and developers to maximize the level of usability and accessibility of products and services by providing appropriate user models [5].

The project AALuis focuses on solutions within the Ambient Assisted Living (AAL) domain and provides an open middleware layer that allows to generate accessible and usable user interfaces for different types of services [6]. The general idea is to foster a detachment of the user interface from the service and its functionality, respectively. Furthermore an input fusion and output fission regarding input and output (I/O) modalities based on the user's preferences is striven for. At the heart of the AALuis project lays a dynamically adapted, personalized interaction between an older adult and any kind of service, with different types of I/O devices, such as smart phones, tablets, TVs or PCs. To achieve this, the AALuis middleware layer controls the user interaction by dynamically adapting the transformation process from an abstract task description to a user interface. The transformation process even allows to generate splitted UIs to be displayed on multiple I/O devices to optimize output (e.g. on a large TV screen) and input (e.g. using a tablet for controlling the service displayed on the TV). This feature is not yet implemented, but is a possible extension for future releases. I/O device interfacing is realized via UPnP which allows on-the-fly and automatic integration or removal of I/O devices even when the service is still running.

The first integrated prototype is finalized and the newly developed AAL services and the automatically generated UIs will be tested in lab trials in the next months with older adults. The achievements of the first development iteration are described in the following. First of all the main objectives of the project are highlighted, followed by a description of the methodology used to achieve these. User involvement is an important aspect of the project and thus addressed in the next section. Finally first results and a conclusion based thereupon are presented.

## 2 Objective

The main objective of the development is to achieve flexibility in the creation and usage of interfaces, which can adapt to changes in capabilities and preferences of the user. This covers the perspective of technical (service developers and service providers) as well as of non-technical (end-users, namely assisted

[1] http://www.guide-project.eu/
[2] http://www.myui.eu/
[3] http://www.veritas-project.eu/vums/

persons and (in)formal caregivers) users. To address the former the project aims to create a tool for the generation of suitable and adaptable user interfaces to support service developers. The goal is to keep the additional development effort within narrow bounds to ensure that service developers can focus on service development and do not need to focus on the user interface. To address the requirements of the final end-users of AAL solutions, the older adults, the project aims to provide mechanisms for the automatic selection and adaption of user interfaces for different I/O devices, I/O modalities and individual settings and methods for an adaptation based on context information, such as user (profile and preferences), environment (environmental data, e.g. sensor data) and device (capabilities) context.

## 3 Technological Methodology

In the following the most important methodologies used for the realization of the AALuis prototype to achieve the above mentioned objectives are described.

### 3.1 Task Execution and Transformation Process

The layer is designed in a flexible way using OSGi. It delivers a transformation chain from the service description to a final user interface, presented on a single or split on multiple I/O devices [7][8] (see figure 1). The service description is delivered as XML artifacts, i.e. a task model based on the ConcurTaskTrees Notation [9][10][11], a binding description for call-backs containing the mapping from task actions to methods, content documents and the choice of template (at the moment there is just one template to be chosen, but this will be expanded in the future). This approach facilitates service integration and discovery and allows as well the usage of web services as of OSGi component based services. Thus the detachment of user interface from service development can be realized.

The information from the service description is transformed to an abstract UI (AUI) description, which is modality and device independent. The AUI is further enriched by utilizing context information to create concrete UI (CUI) descriptions, which are modality and device specific. The transformation to CUI descriptions follows these steps: (1) find I/O channels: find all device and modality combinations the current interaction should include, (2) derive the list of CUI descriptions to be created, (3) convert media according to appropriate modalities where necessary and (4) find and apply the transformation steps for each CUI. The final step is the creation of renderable UIs (RUIs), which can be displayed by the specific I/O devices, by applying predefined or customized templates. The RUIs are provided by the AALuis layer via UPnP to the I/O devices to be rendered. At the moment the RUIs are HTML5 documents as they provide most flexibility and availability to cover many requirements raised in the early phase of the project. Further iterations foresee additional renderable content, e.g. video and audio streams for dedicated devices.

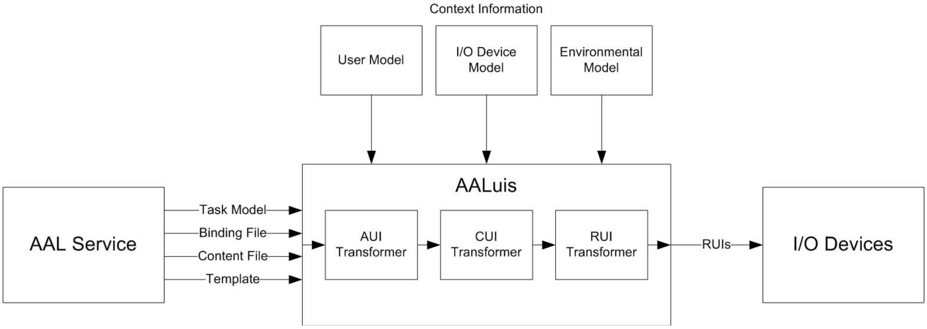
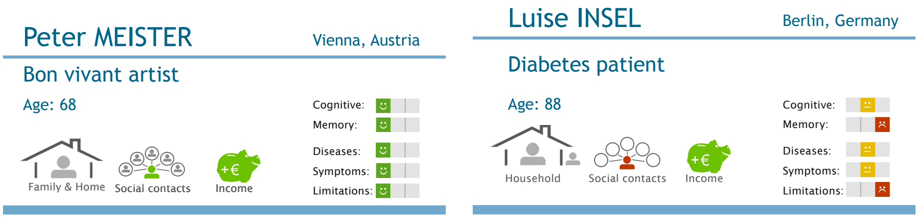



**Fig. 1.** The AALuis transformation process

## 3.2 Context Information Models

The context information models used in the transformation process are: The user, the device and the environment context information model. The user model comprises capabilities and preferences of the user. The idea is to create certain predefined profiles based on CURE-Elderly-Personas, which are fictitious persons synthetically generated from average traits mixed across countries [12][13]. These personas cover aspects like 'About & family', 'Health status', 'Social status' and 'Technology Usage', which are used to derive implications for the UI and I/O devices. Snippets of two exemplary personas can be seen in figure 2a and 2b.

The profiles based on the personas can be either directly used or adapted to special needs and wishes. In a first approach these profiles are defined in real-time exchangeable configuration files, whereas the user model will be enhanced in the second development cycle by using outcomes of the previously mentioned projects. So far the user profile model from MyUI [19] has been deployed in an adapted way. The profiles of the personas depicted in figure 2 differ for example in the user profile variable 'visualAcuity'. This difference has an affect on the font size and the contrast of the graphical user interface in the current implementation (see section 5).




(a) Peter Meister (b) Luise Insel

**Fig. 2.** Two example snippets from CURE-Elderly-Personas used for the first prototype [20][13]

The I/O device model reflects the capabilities, e.g. supported I/O modalities, of all registered devices. The environmental model contains information about the user's environment. This includes the actual living space as well as natural phenomena surrounding the user and thus allows adaptations based on factors such as surrounding light and noise. Based on the aggregated context the I/O device(s), the I/O modalitie(s) and the characteristics of the user interface are derived.

### 3.3 User Interface

A commonly known and used technology for storing and describing user interfaces is the XML language (e.g. [14][15][16][17][18]). It can be adopted to support a wide variety of use cases. Since it is one of the aims of the project to deliver UIs to many devices, a web-based solution is considered to be most suitable. Thus we combine the power of XML with the widespread availability of web browsers.

Looking at the projects time frame, HTML5 seems to be most promising as UI language of choice, instead of proprietary solutions like Adobe Flash, Microsoft Silver Light, Mozilla XUL technology, and others. The AALuis middleware thus has to provide the following documents (or a subset of them) for a user interface: (1) HTML5 markup holding the content to be displayed (as far as possible using HTML5), (2) additional content documents to be displayed (e.g. images, video streams), (3) CSS code defining the look, (4) JavaScript code defining the dynamic behavior, thus running the UI and providing the feel and finally (5) configuration meta data.

It is possible to generate multiple RUIs in the transformation process. This allows splitting up the UI, which means e.g. output on a large I/O device such as the TV and input via a portable device such as a convenient tablet. This approach offers additional flexibility for controlling and using the services. In the course of the project this concept will be evaluated to see if splitting the UI is accepted by older adults or if it leads to confusion.

### 3.4 I/O Device Interfacing

On the user interaction side the UPnP device manager tracks available UPnP devices. When they enter the network and conform to a specified AALuis UPnP profile, they are automatically integrated into the AALuis framework. The UPnP device manager analyses the device descriptions and translates them into an AALuis specific abstraction. This abstraction, in the form of OSGi services, enables other components of the framework to communicate with the I/O devices. E.g. the dialog management uses it for issuing rendering commands and the transformation process for device context accumulation.

## 4 User Involvement

The targeted users, as well older adults as technical stakeholders, are involved in the whole development process to ensure on the one hand the usability of the generated UIs and on the other hand the technical usefulness and applicability of the AALuis layer. In a first stage the stakeholder requirements were gathered by means of online surveys targeting at service and UI developers and providers and by means of cultural probes and focus groups covering the needs and wishes of the older adults. These results are already promising, have been valuable input for the first development cycle and underline the need for adaptable solutions which can be realized by the AALuis layer.

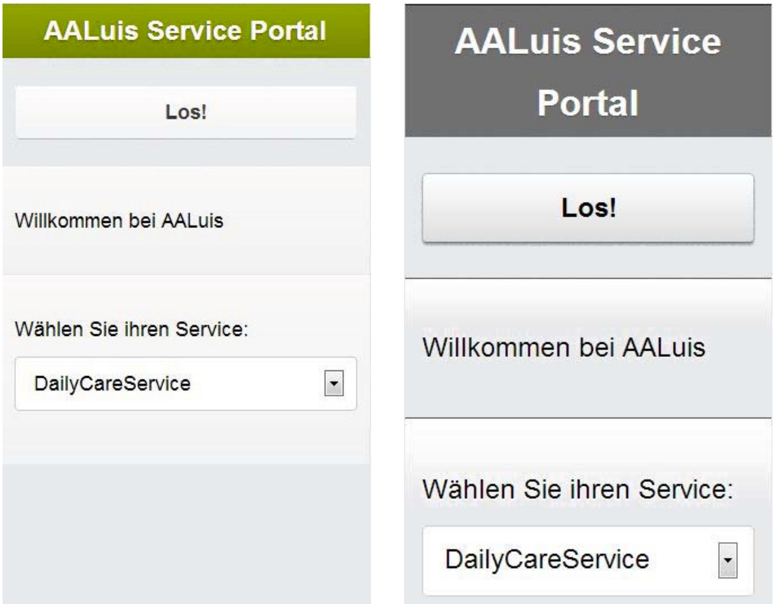
Based on the first project results first formative usability tests with older adults have been performed using mock-ups. The method used for these evaluations was a task-based empirical investigation. A pre- and a post-interview were conducted to cover users expectations (before the test) and to understand their experience (after the test). The usability was evaluated via the System Usability Scale (SUS) [21]. The results are important input for the advancement of the presented results.

In further consequence the services and user interfaces will be evaluated in lab and field trials to gather feedback in real life scenarios. In the lab trials the same methods as used for the formative usability tests plus eye tracking to get insights (via heat-maps) of how the users gaze behaves on the UI will be used. For the field trials a method mix of qualitative and quantitative measures will be applied. This will cover pre- and post-interviews to investigate expectations and experiences, weekly telephone-interviews and usage of the services (frequency and duration of usage of different functionalities) will be logged to compare the insights from the interviews to the usage.

## 5 Results

The open middleware layer is OSGi based and structured in a flexible way to ensure simple extension in the course of the project and beyond as an open source project. Furthermore it can be combined with already existing (AAL) middlewares and platforms, since it can be integrated in a straight forward way due to its clear interfaces. The biggest advantage of the presented solution is the fact that service developers can use it even though the services are not running in the same framework (e.g. web services) by providing the service description as XML artifacts.

The first prototype is finalized and will be tested in trials, whereas the results will be valuable input for the second development cycle. First results of the transformation process based on the profiles for the two personas (figure 2a and 2b) and the differences between the two RUI render results are shown in figure 3. One of the two presented profiles (figure 2b) uses both accessibility options of higher contrast and larger font based on her visual acuity. The two profiles result in different interfaces catered to the requirements of each of the personas. Further accessibility options will be available in the next development phase.




**(a)** Normal contrast and normal font **(b)** Higher contrast and larger font

**Fig. 3.** Two RUI displayed on mobile device for Peter Meister (3a) and Luise Insel (3b)

## 6 Conclusion

The first results of the project look promising and the chosen approach allows further developments expanding the functionalities and improving the generated user interfaces. They have shown that the outcomes are auspicious to achieve flexibility in the creation and usage of interfaces, which can adapt to changes in capabilities and preferences of the user. In the following some aspects for further improvements based on the insights from the first development iteration are presented.

So far the generated UIs are fairly simple, but it is an aim to create richer UIs in several ways. Due to the flexible architecture it is possible to integrate additional output modalities. Alternative output can be achieved by adapting the transformation process in two ways: First, by addition of a media converter, secondly by adding the modality to the whole chain from service content descriptions, over task execution to the transformation process. The latter option means for example to add a service providing video streaming. This would require a new modality, thus adding to the service content description, specialized task execution for videos and new templates for video streaming on different devices. An additional modality planned for the second prototype will be an Avatar that represents the service to the user as a virtual personification [22]. Furthermore the CTTs of the services shall be enriched by semantic information to be provided by the service developer if desired. This allows to add further information to the task model, which at the moment provides just minimal information, and thus falcilitates enriching the UI.

Another aim for the second development cycle is an enhancement of the context information for the transformation process. There are already a couple of considerations how to realize this enhancement. Firstly, the context information model from universAAL[4], which acts as a reference AAL middleware, can be integrated by means of mapping the ontologies. Secondly, the user model can be enhanced by following and integrating the outcomes by the VOMS cluster and other international research activities.

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