User Interfaces for AAL: How Can I Satisfy All Users? Benutzerschnittstellen im AAL: Wie kann ich allen Benutzern gerecht werden?

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Abstract

Research and industry have explored home control and smart environments and their potentials for years. Despite of the perceived success in the form of prototypical systems and show homes, there has been relatively little impact on the mainstream market and personal homes of the consumers. In this paper, we will look at the current market situation on remote user interfaces for the home environment. Hereby we will focus on four requirements that such user interfaces and their systems should meet: coherence, task-orientation, scalability and accessibility. We introduce two open standardization efforts that are currently underway and that have the potential to deliver a new generation of remote user interfaces to a broad customer base, while facilitating the desired characteristics. Finally, we describe our efforts in moving this technology to the market. Important steps include the creation of a European eco system for our technology.

Zusammenfassung

In Forschung und Industrie werden seit Jahren die Gebiete home control und intelligente Umgebungen sowie deren Potential untersucht. Trotz bemerkenswerter Erfolge in Form von Prototypen und show homes, sind die Auswirkungen auf den etablierten Markt und private Haushalte relativ gering. In diesem Papier werfen wir einen Blick auf die akutelle Marktsituation von Fernbedienungen (remote controls) im häuslichen Umfeld. Dabei fokussieren wir vier Anforderungen, die solche Systeme erfüllen sollten: Kohärenz, Aufgabenorientierung, Skalierbarkeit und Barrierefreiheit. Wir stellen zwei offene Industriestandards vor, die diese Anforderungen erfüllen und die das Potential besitzen, den Weg für eine neue Generation von Interaktionslösungen zu ebnen. Um diese Technologie auf dem Markt zu etablieren, streben wir die Schaffung eines Europäischen Ökosystems um diese Technologie an.

1 The digital home - state of the art

AAL systems in the home should integrate well with existing solutions and equipment for the digital home. It should be possible to extend existing digital solutions at home by specific components for AAL rather than having to buy and install a completely new system for AAL. As a person is coming to age and gradually needs increased support in AAL, their digital home system should be able to also evolve gradually to compensate for their additional needs.

Before looking at existing solutions and user interfaces for the digital home, we highlight four requirements for user interfaces that we believe are essential for acceptance by the users. This applies to all user interfaces at home, including AAL systems. Then we will look at the current market situation, and assess how well the current products suit these requirements.

1.1 User Interface Requirements

Coherence - A user interface should be coherent. This means that it should allow for seamless control across the appliances included into the user interface. This includes health-related appliances, consumer electronics devices, appliances in a household such as stoves and washing machines, also other systems that are part of a home such as lighting, heating, air conditioning and security, and software services, such as, calendar, video telephone etc. For example, the user might want to be reminded to take a specific medication while watching a movie. Or they would like to brighten up the lights while looking at the results of a recent blood pressure measurement. They should be able to do so with as little overhead for switching between the functionality of the blood pressure meter, and the lights.

Task Orientation - User interfaces should be task-oriented or task-based, in that they should expose what the user can do with an integrated set of devices rather than how this will be achieved. For example, the task “watch a movie” might involve the following steps: Switch on the DVR, switch on the TV and select the DVR as input source, switch on the receiver and select the DVR as input source, select a movie on the DVR, and start “play” on the DVR. Most users are not interested in seeing and controlling the individual steps of this task (except for selecting

the movie which is a parameter in this task).

Scalability - User interfaces should be scalable so that a user can have an initial, but functional, system with only a small number of devices. When subsequently adding devices and services to the home environment, the overall user interface should present additional tasks that are made possible by the new devices and services. Thus a home environment with many devices could incrementally evolve over years [8]. The user should not need a new controller for controlling a new device or service, and should not have to buy a new TV when transitioning to a different controller.

Accessibility - a user interface should be designed based on the universal design approach, i.e. it should be accessible to a wide range of users, including older people and people with disabilities. Alternatively, the user interface technology should support the replacement of a user interface by an alternate user interface which may be tailored to a specific user group. The accessibility requirement applies to any technology used developed for digital homes and in particular for AAL technology.

1.2 Categories of Current User Interfaces

A thorough market review is beyond the scope of this paper. Instead, we focus mainly on three types of systems for user interfaces in the digital home that are currently available on the market for home control, and how these types relate to the three requirements of coherence, task orientation, and scalability.

Infra-red remote controls - Traditional remote user interfaces are dedicated to one particular target. Infrared-based remote controls shipped with and bound to specific target devices are prevalent in today's homes. This results in a large number of remote controls in the digital home, a real usability problem with a growing number of target devices in the average home. Since infra-red remote controls communicate with the target devices in a one-way direction only, they do not provide access to the current status of a target device (i.e. there is an accessibility problem for people who cannot see or hear status information coming directly from the target device). Clearly, traditional infrared controls do not provide for user interfaces that are reasonably consistent, task oriented, scalable and accessible.

"Universal remote controls" are an improvement because they allow for controlling a set of devices with one controller only. This makes for more coherent user interfaces, and enables task-oriented features that span multiple devices. However, universal remote controls typically come with an increase on complexity, especially if user programming is required. This is not acceptable for AAL applications. Also, scalability is not guaranteed unless the user interface for the new device can be downloaded from the database of the universal remote control manufacturer.

Custom installation homes – In general, custom-made solutions for home control can be installed. These custom installation homes are equipped with integrated and sometimes task-oriented user interfaces for consumer electronics products and appliances at home. Custom-tailored control solutions can be accessible to users with disabilities and older users, although this requires a two-way communication with the target devices (e.g. by serial communication). The drawback of custom installation is that the design of custom-made user interfaces is a cumbersome process requiring special skills. It is not really scalable since every time a new device is added, the user interface needs to be revised manually.

Custom installation is becoming popular among people who can afford high-end home electronics, in particular in the United States. This is a niche market, offering products that are out of reach for AAL because of the expensiveness of the manual customization process that must be repeated for every home installation.

Media Centers – There are a number of TV-PC hybrid products on the market, offering the functionality of a PC on the screen of a TV. They are usually named "media centers". Microsoft's approach for controlling the home environment is the Windows Media Center [WMC], a special user interface for a TV screen facilitating remote control of the integrated entertainment system. WMC comes with an infra-red remote and software libraries for third parties to integrate their devices and user interfaces. There is also a free media center implementation available that is based on Linux [2].

Media centers integrate user interfaces for devices and functions of a multimedia computer, including a TV tuner, DVR, video on demand, radio, MP3 player, sound system and slide show. For example, one can instruct the DVR to record a program directly from the EPG listing. Usually, user interfaces for other home appliances such as lighting, heating and security, may be added by third parties. Thus AAL related devices and services could be easily integrated into an existing control system. For all devices, the user is in control through a TV screen and one remote. Accessibility issues are common for people with visual and physical disabilities for the following reasons: There is no assistive technology available that could magnify or voice-output the content of the TV screen, and the available remote controls impose problems for people who cannot see the small labels, or cannot hit the small buttons with their fingers.

Media centers are examples of coherent, mostly task-oriented and scalable user interfaces for the digital home, but currently with accessibility issues. Also, current media center products are constrained to the PC as controller platform, rendering graphical user interfaces only. They do not directly support remote user interfaces running on other platforms, possibly involving other modalities such as voice or gesture.

2 New User Interface Standards

We are proposing new standardized technology for creating user interfaces. This approach is developed with the needs of users, device manufacturers and third parties in mind. For the design, great care has been taken in order to support the characteristics of coherence, task orientation

and scalability. The Universal Remote Console (URC) framework is published under ISO/IEC 24752 and the CEA 2018

2.1 The Universal Remote Console framework

The Universal Remote Console (URC) framework is depicted in figure (Figure with the URC - attached to this page). The central part of the framework is a middelware denoted a Universal Control Hub (UCH) which specifies a "User Interface Socket" (or short "Socket") that functions as the contract between an appliance and the user interfaces. On one side of the UCH, controllers ("Universal Remote Consoles", short URCs) can connect to a Socket, using any kind of user interface that "plugs into the Socket". Controllers can look for and retrieve pluggable user interfaces (called "User Interface Implementation Descriptions", short "UIIDs") from "Resource Servers" on the Internet.

Whereas pluggable user interfaces are based on one or multiple User Interface Sockets, they are free to use any modality and user interaction mechanism they want. They can be provided by the manufacturer of a device, by the manufacturer of a particular controller, by companies that specialize in user interface design, or even by user groups.

The URC framework supports coherence of user interfaces in two ways:

1. Each device describes its "abstract user interface" in the same way, enabling the use of one controller for all devices.
2. Pluggable user interfaces can interact with multiple Sockets (and thus multiple devices). Therefore, a single user interface can interact with several devices at the same time.

Task orientation is supported to some degree, since the User Interface Socket is an abstraction of the control protocol that the device or service employs. In the next section, we describe how the i2home project is enhancing their implementation of the UCH in order to fully support this requirement.

Since every device exposes a User Interface Socket that any third party can design a pluggable user interface for, the URC framework enables scalability. Available pluggable user interfaces are maintained by globally available Resource Servers whose specification is part of the standard. Controllers can thus download suitable pluggable user interfaces from these Resource Servers which at the same time can function as a market place for, in principle, arbitrarily resources.

The URC framework is independent of any particular networking platform. For the home environment, the "Universal Control Hub" architecture [5][6] represents a solution for the URC framework to be implemented even if the controlled devices and controllers are not URC compatible. Instead of specifying the wire protocol between a controller and the controlled device, the framework is implemented on top of one or more existing networking platforms that provide the necessary functionality for device discovery, control and eventing.

An implementation of the Universal Control Hub architecture has been developed at the Trace R&D Center, University of Wisconsin-Madison, USA. A recent prototype demonstrates how a variety of mobile devices can be used to remotely control a UPnP-based entertainment system [6].

The Universal Control Hub is also being applied in the "i2home" project [4], a project funded by the European Research programme IST. The i2home consortium consists of organizations and companies from Germany, Sweden, the Czech Republic, Spain and Portugal (see also section "Towards a European Ecosystem").

Organizations interested in the promotion and implementation of the URC standards have formed the URC Consortium (URCC) that provides more information on current projects and tools [3].

2.2 Task-model Descriptions

As described above, it is a desirable feature of remote user interfaces to combine functions of different appliances. At the same time, it is advanteguos and desirable to hide the concrete implementation on how to reach a certain goal by exposing tasks in the user interfaces. In the i2home project, we are currently implementing and merging a task-model engine based on the CEA-2018 "Task-model Description"-standard with the Universal control hub. In this way, any user interface will be able to utilize task models. Particularly, a task model is implemented as a socket thus exposing to the user interfaces its functionalities in the same language as appliances or services do.

In CEA-2018, tasks models are hierarchical structures where more abstract tasks consist of subtasks that eventually can become so-called simple tasks. Atomic tasks can be "grounded" to actual device functions. The combination of task models and User Interface Sockets has several benefits:

1. The task layer on top of the Socket layer provides an explicit model for defining tasks for a particular combination of target functionalities. For example, a user may be presented with a list of possible tasks at any time, or the system may assist the user in performing a specific task step by step.
2. The User Interface Socket is used as a common model for any user interface, e.g., graphical or voice user interfaces and a task engine. Therefore, the user may either use the task engine to operate the devices, or a graphical/voice user interface, or both in any sequence. At any time, the current status of the devices will be reflected in both user interfaces.
3. The middle layer of User Interface Sockets represents a convenient grounding platform for task models. The grounding to the typically more complex operations of the device interface layer can be delegated to the User Interface Socket, which can use procedural code to map to the actual device operations.

3 Towards a European Ecosystem

Although the described ISO standard has been successfully ratified and published (in February 2008), this fact is by itself not enough to make sure that its many benefits come available eventually to the public - elderly people, other people with special needs and even the mainstream public – in practical terms, e.g. as stand-alone products or as embedded components. Rather, an intensive dissemination process has to be launched and put onto its way. As it happens in many cases, good and useful standards simply do not get into the market due to a lack of adequate and wide dissemination and promotion.

In i2home, our vision is the effective establishment of an **international ecosystem based on the URC standard**, with emphasis on its implementation in the European space, and that will live and grow after the project terminates. This vision is shared by our partners at the TRACE center in the United States who also develop efforts to promote the URC standard towards users, politics, industry and other stakeholders potentially interested in the standard, underlying concepts and technology and its concrete adoption and application. The common link, in this context, is the URC Consortium (www.myurc.org).

In Europe, some success of effective dissemination and transfer of URC technology has already been achieved, namely based on our **Starter and Extension Kits** (see figure 1) are already available or currently being prepared by i2home project partners DFKI, ATG, Meticube, VICOMTech, C-LAB and CTU.

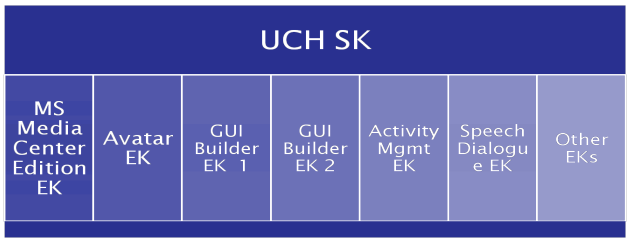

Figure 1: Starter Kits and Extension Kits made available by i2home

- The UCH Starter Kit has already been successfully adopted by sibling IST projects **MonAMI**, **VITAL**, **Easyline+** and **share-IT**.
- Collaboration with the Spanish national project **INREDIS**.
- Manifestation of interest from several German, Spanish, Portuguese and Czech SMEs.
- i2home partners Meticube and INGEMA successfully promoted the URC standard and technology in the scope of the AAL Programme: both institutions will participate in an already accepted project called **BEDMOND** (Behaviour Pattern Based Assistant for Early Detection and Management Of Neurodegenerative Diseases) where the UCH will play an important role as integrating middleware and facilitate the development and integration of accessible and usable, multimodal User Interfaces. The project will start in February 2009. The expected result in the BEDMOND project will be a near-to-product system.
- Meticube will start a Portuguese, nationally funded project called **i2Life**, for the development of a bio signal real time monitoring system. Again, the UCH acts as the main integration platform, enhanced by advanced logging, data evaluation and visualization and Business Intelligence functionalities, among others.

In i2home, we will continue to make all most of our results available to any interested third-party, free of charge for private or non-for-profit use, including R&TD. For selected elements (development tools, etc.) a special Non-Commercial License Agreement (NCLA) will be provided, starting in February 2009, according to the Exploitation Plan developed jointly by the project partners.

4 A Business Perspective

The i2home project collaborates very closely with external entities on the evaluation of business perspectives in the AAL / Independent Living / Home Automation & Control markets. In this context the IST project MonAMI (www.monami.info) deserves a special mention. In this 5-year IP project, the evaluation and development of business perspectives specifically tailored to the Ageing Population problem are intrinsically built-in.

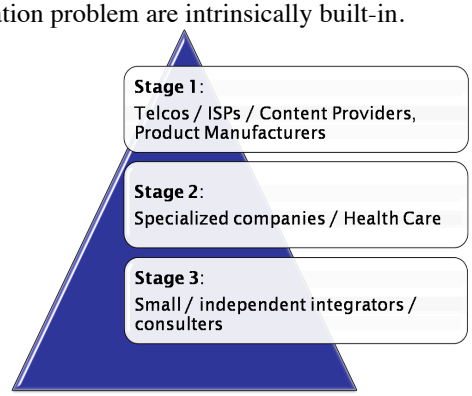

Figure 2: Exploitation stages in i2home

The market for healthcare products that support AAL and Independent Living is still a relatively small niche market. However, the European Monitoring & Control market for Healthcare will be a fast growing market within the next 12 years, with an average 9.6% growth rate per year (Enu, 2008).

In i2home, we will apply an exploitation strategy that is organized in three stages (see figure 2).

5 Conclusion and Outlook

We presented a new approach for the creation of user interfaces meeting four fundamental requirements necessary for successful realizations of the digital home particularly within the scope of AAL: coherence, task orientation, scalability and accessibility. Our horizontal technology, combining necessary ingrediences for a generic ac-

cessible usability framework based on open industry standards, is driven by the EU-funded project i2home [4] and has also been adopted by other domestically and/or European-funded projects.

We also indicated our plans for bringing this technology to the market and thus to the users, in particular, for persons with special needs. Short-range activities include a UCH starter kit which includes software, documentation allowing for a smooth jump-start. Next steps include support, tools and additional functionalities, such as, streaming. The standardized resource server will go online soon. Also, follow-up projects on their way which guarantees continuity within the next few years and further development based on new scenarios and real needs.

6 Acknowledgements

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7 Bibliography

[1] Enu, D. (2008). Monitoring and control: today's market, its evolution till 2020 and the impact of ICT on these. Paris: DECISION Etudes Conseil; ASPROM workshop.

[2] LinuxMCE (2008). http://linuxmce.com/

WMC (2008). Windows Media Center, http://www.microsoft.com/windows/products/winfamily/mediacenter/default.mspx

[3] URC Consortium. http://myurc.org/

[4] The i2home Project. http://www.i2home.org

[5] ISO/IEC FCD 24752. Information technology – User interfaces – Universal remote console – 5 parts. International Organization for Standardization (ISO), 2006. http://www.iso.org/iso/en/CombinedQueryResult.CombinedQueryResult?queryString=24752

[6] Zimmermann, G.; Vanderheiden, G.; Rich, C. (2006). Universal Control Hub & Task-Based User Interfaces. URC Consortium, 2006. http://myurc.org/publications/2006-Univ-Ctrl-Hub.php

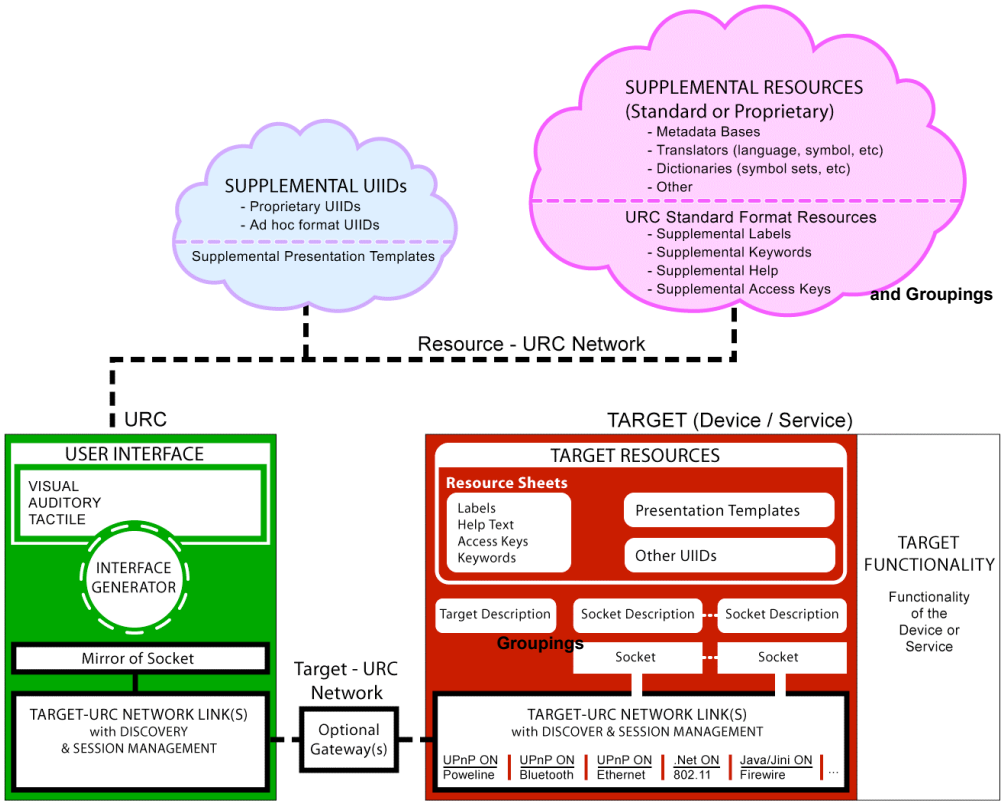

Figure 3: Conceptual structure and components of the URC framework. It illustrates both elements for which there are formats specified by the URC framework, and elements that can use these or other standard or proprietary formats. Technical details for each component are provided in ISO/IEC 24752-1:2008.