

# 1. PUBLISHABLE SUMMARY

## 1. Project fact

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|--------------------------------|---|
| <b>Project Acronym:</b>        | SM4ALL  |
| <b>Project Title:</b>          | Smart hoMes for ALL                                 |
| <b>Grant Agreement number:</b> | FP7-2008-IST-224332                                 |
| <b>Duration:</b>               | 36 months (September 1st, 2008 - August 31st, 2011) |
| <b>Budget (EU Funding):</b>    | 2.899.991 EURO                                      |

## 2. Consortium

| Organization  | Short Name | Country        | Site Leader  |
|---|------------|----------------|--|
| UNIVERSITÀ DEGLI STUDI DI ROMA<br>"LA SAPIENZA" - Coordinator | UNIROMA1   | Italy          | Roberto Baldoni (Project Manager)<br>[baldoni@dis.uniroma1.it]<br>Massimo Mecella (Technical Manager)<br>[mecella@dis.uniroma1.it] |
| TECHNISCHE UNIVERSITAET WIEN                                  | TUW        | Austria        | Schahram Dustdar<br>[dustdar@infosys.tuwien.ac.at]   |
| UNIVERSITY OF GROENINGEN                                      | RUG        | The Netherland | Marco Aiello<br>[m.aiello@rug.nl]  |
| KTH, ICT  | KTH        | Sweden         | Rassul Ayani<br>[ayani@kth.se]   |
| Swedish Defence Research Agency                               | FOI        | Sweden         | Marianela Garcia Lozano<br>[garcia@foi.se]   |
| Fondazione Santa Lucia, IRCCS                                 | FSL        | Italy          | Donatella Mattia<br>[d.mattia@hsantalucia.it]  |
| Thuiszorg Het Friese Land                                     | THFL       | The Netherland | Johanna Rinsma<br>[Johanna.Rinsma@thfl.nl]   |
| Telefónica Investigación y Desarrollo                         | TID        | Spain          | Vicente Cruz Medina<br>[vcruz@tid.es]  |
| Elsag Datamat   | ED         | Italy          | Paolo Pucci<br>[paolo.pucci@elsagdatamat.com]  |
| Guger Technologies OEG  | GTEC       | Austria        | Christoph Guger<br>[guger@gtec.at]   |

## 3. Objectives

The SM4All (Smart hoMes for All) project aims at studying and developing an innovative middleware platform for inter-working of smart embedded services in immersive and person-centric environments, through the use of composability and semantic techniques, in order to guarantee dynamicity, dependability and scalability, while preserving the privacy and security of the platform and its users. This is applied to the challenging scenario of private/home/building in presence of users with different abilities and needs (e.g., young able bodied, aged and disabled).

## 4. Research Activities

In order to support these complex objectives, the following topics were investigated in the context of the project:

- Software Architectural Frameworks
  - Service Oriented Architectures (SOAs)
  - Publish and Subscribe Architectures (PSAs)
- Middleware Technologies and Solutions for SOAs and PSAs
  - Self-adaptive Management of Available Services
  - Enactment of Composed Services: Service Orchestration
  - Client-tailored Service Composition and Domotic Ontologies
  - Dependability in Service Oriented Middleware

- Advanced Interfaces
  - Brain-Computer Interfaces (BCIs)
  - Touchscreen-based Interfaces
  - Remote-access Interfaces
- Domotics

## 5. Project Objectives and Major Achievements

The objectives reached from the beginning of the project (month 1 – month 36) have been:

- **Analysis of the State-of-the-Art and relevant techniques.** The analysis of the State-of-the-Art in the area relevant for the project has been run in order to:
  - Examine projects with special emphasis on their relation with SM4ALL
  - identify innovative aspects to previously run project and indicate what can be reused in the SM4ALL project
- **Identification of the user requirements.** A list of requirement was obtained with the Human-Centered Design methodology through interviews, probes and focus group: 46 people coming from 3 different countries and very different users of the consortium (THFL, FSL, TID) were involved. Moreover they were kept in the loop and have been the first to be exposed to the prototypes (preliminary and final) of SM4All groups to be representative for the interviews. More (visionary) technical requirements have been also added by the members of the consortium. The collected requirements have been classified as user and system requirements and as functional and non functional.
- **Showcases and Validation.** An important goal of the project is to bring the SM4ALL innovative system out in the real world. To this end, a test plan to be used for the entire testing process was defined in order to give plans and general directives for both testing and integration activities, in order to build up an integrated system which can show if and how SM4ALL requirements are met. In first instance in D7.0 and after in the D7.4a we formalized several showcases in order to emphasize the final SM4All architecture achieved in according to the outcome of the users requirements and the input received from all technical WPs. A detailed description of the results of the functional, user and integration testing was provided in D7.2b while the D7.3b is a user manual that provides an overview on the developed software and describes how it should be used by users and system administrators.
- **Design of the SM4ALL conceptual and technical architecture.** The SM4ALL architecture has been defined. Due to the different technologies employed by the devices that are expected within SM4ALL, the architecture relies on an abstracting communication layer represented by the UPnP standard. The SM4ALL system is constituted by a set of logical components arranged in three distinct layers:
  - **User layer** – devoted to the interaction with final users and administrators.
  - **Composition layer** responsible for receiving high level commands issued by users through the interface layer and fulfilling the corresponding complex goals by controlling the execution of lower level services offered by devices deployed within the SM4ALL architecture.
  - **Pervasive layer** - representing the physical layer of the SM4ALL architecture and the software components needed to abstract it - was designed to fulfill several requirements related to devices and their behavior in the system, which were extracted during the requirements process.
- **Prototyping of the components of the SM4ALL architecture.** The SM4ALL following layers were designed and prototyped:
  - **User layer.** The following components were developed:
    - User Interfaces components:
      - 2 prototypes of BCI available (at FSL and at GTEC)
      - 1 prototype of HTML user interface available at UNIROMA1
    - AAI component
  - **Composition layer.** The following components were developed:
    - Synthesis
    - Orchestration Engine
    - Repository
    - Rule maintenance engine
    - Context-awareness

- **Pervasive layer.** The following components were developed:
  - Discovery Controller
  - Discovery Module
  - Device Controller
  - BT Support
  - Communication Protocol Support
  - UPnP Support
  - Pervasive Controller
- **Solutions for dependability, scalability, dynamicity, security and privacy of the SM4ALL architecture.** The following objectives were reached:
  - Identification of a techniques to satisfy non functional requirements on the SM4ALL architecture
  - Final integration of these techniques in the SM4ALL components
  - Implementation of all the SM4ALL components:
- **Exploitation and dissemination activities.** During the project a huge amount of dissemination activities was performed by partners (documented in D8.1.d). A project exploitation plan was developed and updated. Dissemination work consisted of making the results of SM4All known to the wider research community and the public, to this end the Consortium has been active with:
  - publishing in top conferences and journals
  - making Demos at top conferences
  - dissemination of the SM4ALL project

Furthermore, the general public has been addressed with the creation of YouTube videos and with several appearance on newspapers, radio and TV broadcasts.

- **Co-operation with other projects.** The SM4ALL consortium made an important step towards the realization of smart domotic systems energy consumption oriented. The partners signed a co-operation agreement with the Taiwan's Industrial Technology Research Institute ITRI with the endorsement of the European Commission. The cooperation, that will last till August 2012, will bring to the project the valuable expertise of the Home Energy Management System group of ITRI. In particular, Energy efficiency, domotic devices, power measuring technologies and demand analysis solutions will be coupled with the research efforts on smart home middleware developed within SM4All. In this context, the researchers at ITRI will carry out the definition of a detailed energy consumption model based on the operation of smart appliances and embedded into the framework defined by the SM4ALL project and will set up a detailed showcase.

## 6. Impact

Final results of the SM4ALL Project will have the following profitable impacts:

**Industry competitiveness:** A successful SM4ALL project will provide a clear European answer to the problem of embedded platforms, an area in which there is increasing competition. Results from this project research will be disseminated widely, and play a large part in the global standards for a better performance of pervasive embedded domotic platforms. Specifically in BCI, g.tec developed a P300 and SSVEP based BCI system including active electrodes inside the EC project that can be offered now on the international market together with distribution partners. The technology is sold into more than 60 countries together with 20 distribution partners. Most important customers are Universities (including MIT, Stanford etc), industry (Nokia, General Electrics etc) and hospitals (Wadsworth Center, Riken Brain Science Institute etc.). In the context of SM4ALL's Pervasive Layer allows Telefónica to easily support and homogeneously manage devices implementing the different domotic standards that can be found at their customers' homes. This integration capability makes it possible for Telefónica to provide innovative domotic services without requiring the installation of a specific type of devices. This is beneficial for the customers since their already existing devices can be used and also provides Telefónica the freedom to select at any time the most convenient manufacturer to supply the devices that may be bundled with the offered services. Finally, ElsagDatamat, in the context of the SM4ALL Middleware Layer has developed a technology for event processing well suited to domotic environments. The technology was originally developed in the context of command and control system has opened thus a new marked segment.

**Social benefits:** Introducing a smart embedded services platform and BCI technologies to assist citizens such as aged and disabled ones is an ambitious target that can radically change the current approach to prevention. BCI

technology allows locked-in and ALS patients to communicate with their environment only by thoughts. This enables them to write text, but also to control the home environment. The innovation introduced by SM4All, and more specifically by the showcase based on domotic applications developed on SM4All platform, will result in a tremendous impact on the quality of life, not only for the users, who will gain a more natural and independent life style, but also for their families, that will find it easier to assist their loved ones in a more reliable and secure home environment. The simulation of the SM4All Smart home has been tested with users of a home care organization with positive results in terms of acceptability and usability. Most users look forward large scale availability of technologies such as those pioneered in SM4All.

Summarizing, several social entities will get benefit from SM4All, including:

- Citizens affected by motor disabilities and impairments: better quality of life, higher independency, higher safety, longer expected lifespan.
- Informal caregivers (relatives, friends): better quality of life, higher serenity.
- Healthcare institutions (hospitals, clinic centres): better use of human resources, better service, possibility of providing advanced treatments (re-education, rehabilitation), lower costs.

The results of the SM4ALL project allows SM4ALL industry partners (Telefónica, ElsasDatamat and Gtec) to design and implement services specially tailored to impaired and elderly citizens. The addition of such services to SM4ALL partners' portfolio of home solutions will be beneficial for this population who will have easy access to these otherwise difficult to obtain services.

### **Technological and Scientific benefits.**

Several technological advances have been mad thanks to the work around the SM4ALL project that is compliant with many standards from BCI accessibility (e.g., ISO 13407, ISO 9241-11), pervasive layer (e.g., [Bluetooth v1.1](#), IEEE 802.15.4/ZigBee, IEEE 802.11.x) to web services:

FThe Limbo tool allows developers to easily implement UPnP and Web Service interfaces for any device regardless of its native API in a simplified and semi-automatic fashion. In this sense, a cooperation with Hydra Project Open Source initiative is being done by introducing improvements in Limbo tool, called Service Compiler in Hydra, which will be available by April 2011.

A technology for event processing well suited to domotic environments has been developed. This technology adapts from command and control and shows its flexibility to get into other market segments. BCI technology developed in the context of the SM4ALL project has been made compliant to medical normative EN60601 to ensure patient safety.

Scientific benefits are amongst the most evident benefits. A new area of research, namely intelligent (smart) houses, has been shaped during the project. In addition to several scientific papers, a contract for writing a book with Springer has been recently signed. This book will include all SM4ALL scientific advances and will contribute to see smart houses as a nice interdisciplinary scientific challenge.

## **7. Project Logo**



## **8. Project Web Site**

The address of the SM4ALL project Web site is: <http://www.sm4all-project.eu>. The site consists of:

- a public area, mainly static, containing general information on the project and publicly available results (deliverables, software prototypes, demonstrations, etc.);
- a private area, with a Wiki, a simple content management system, mailing lists, etc. used as a collaborative tool by the Consortium itself during its day-to-day operations, and . Such an area is restricted in the access and protected.