PROJECT PERIODIC REPORT

Version 0.3 – 30 June 2010

Reminder: In addition to its previous version 0.2, this report includes figures on used person efforts by the project partners in Chapter 6. Chapter 7 and overview on other costs of the project will be completed after submission of the partners' C forms and will be provided in final version of this report.

Grant Agreement number: 224621

Project acronym: AIM

Project title: "A novel architecture for modelling, virtualising and managing the energy consumption of household appliances"

Funding Scheme: Collaboration Project (CP) – Small of medium-scale focused research project (STREP)

Date of latest version of Annex I against which the assessment will be made: 16 March 2010

Periodic report: 1st ☐ 2nd ■ 3rd ☐ 4th ☐

Period covered: from 1 June 2009 to 31 May 2010

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1 Usually the contact person of the coordinator as specified in Art. 8.1. of the grant agreement

2 The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

1 PUBLISHABLE SUMMARY

AIM has as main objective the definition and implementation of a generalised technology for the management of the energy consumed in households, covering both active and standby appliances. In the specification of its technology AIM takes into consideration usability requirements from three major user groups; a) residential users, b) communication network and services operators, and c) energy generation utilities.

The **detailed objectives of the project** are:

- The design and implementation of logic for managing the energy consumption of home appliance intelligently, beyond the simple ON/OFF model.
- The design and implementation of a generic method for measuring the energy consumption of household appliances, adopting the appliance profiling concept.
- The interfacing of the energy consumption values of the household appliance types to the home network logic.
- The design and implementation of an energy resources virtualisation environment and appropriate semantics to enable users build up their own energy management applications.
- The designation and implementation of a generic energy management methodology addressing active as well as stand-by appliances.
- The design and implementation of energy management applications targeting the usability requirements of the three target user-groups; energy generation utilities, residential users and communication network operators.
- The enhancement of the ESTIA gateway architecture from a simple communication node to an energy-aware management system, with the addition of logic for autonomous energy monitoring and control.
- The evaluation of the AIM architecture through the involvement of real users.
- The validation of the functionality of the AIM arhcitecture through a number of evaluation experiments involving applications for three use-cases.
- The creation of impact on existing relevant energy saving and networking standards.

The core component of a new ICT energy management architecture designed by the project in its first yera is the AIM system logic, which is composed of three main elements (Figure 1): a) the Energy Management Device (EMD), providing physical access to the appliances over the home network, b) the home gateway, acting as service host or as service proxy in the case where the energy management service is hosted in the operator network, and c) the operator service platform, offering an alternative to the service host.

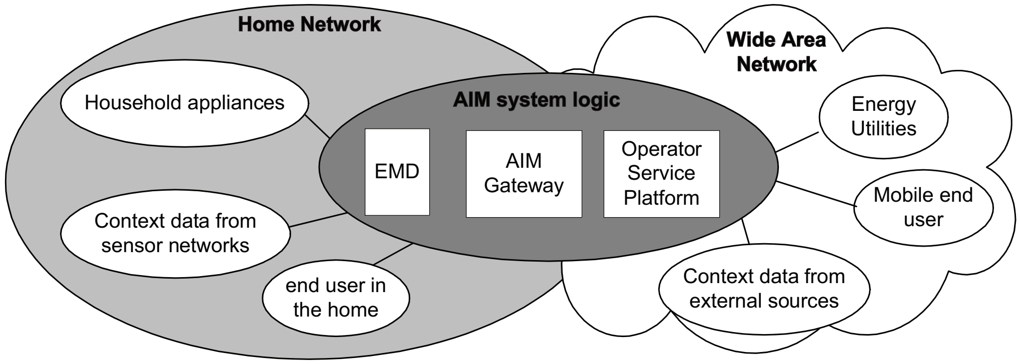

Figure 1: General architecture diagram

In the second year of its execution phase, AIM designed the final EMD version and realised its software management architecture, enabling accommodation of user applications. Based on it, the energy savings applications, developed for the three user groups, have been implemented. Furthermore, evaluation and validation of the AIM architecture and its components were carried out by implementation of the AIM components, including DVE, user's applications, and considered appliances, within two virtual laboratories and in three real households in Greece. These implementations have been used for estimation of energy savings achieved by application of AIM technology and related usability tests. With this, the technological phase of the project has been concluded with the performance evaluation of the resultant AIM energy management system.

Main innovation of the project is the cognitive way in which energy management is performed, whereby instead of using costly and hard-to-install smart metering devices energy measurement is performed on the basis of monitoring appliances status through the network. This way, using existing home communication interfaces (power line, wireless, etc), the home network is able to control appliance programs by swapping them with other less energy consuming. Association between appliance programs and the notion of energy consumption is possible thanks to the definition and exploitation of profiles for each appliance category, which maintain a relation between appliance programs and the consumed energy.

This new energy management concept provides three main functions:

- Energy monitoring and metering: appliances' current status is retrieved and consumed energy is measured cognitively using the corresponding appliance profile.
- Energy control: appliance programs are swapped with others less energy consuming or , so that the overall energy consumption figure of the home environment remains within user defined limits.
- Standby devices management: appliances set in standby mode are traced down and are switched off provided that certain conditions are met. For example, there is no user in the room where the appliance is located, etc.

The AIM project has applied its concept on three broad household appliance categories; a) white goods (refrigerators, kitchens, washing machines, and dishwashers), b) audiovisual equipment (TV, set-top-boxes) and c) home communication equipment (home routers, wireless hot spots, etc).

In accordance with the discussion presented above, it can be concluded that **all project objectives have been achieved** during the project life from June 2008 – May 2010.

Main innovations made by the project consortium in this period can be summarised as follows:

- Generic energy profiling of popular appliance types.
- Cognitive implementation of energy management on the basis of appliance user programmes.
- Elimination of energy consumed by standby devices.
- Realisation of generic energy management functions using the EMD (monitoring, control and standby devices management).
- Generic energy management implementation with ICT methods that can be implemented with off-the-shelf components.
- Integration of the AIM components with the communications network by using various kinds of interfaces, ensuring interaction with service platforms, with different appliances, and home gateway.
- Both solutions with the EMD integrated within the appliances or as stand-alone device/software to control appliances without in-built AIM functionalities (e.g. old appliance generation).
- Generic device virtualisation logic, available to be implemented on the top of home gateway architecture, enhancing the gateway to provide autonomous energy management functions and enabling implementation of related services and applications, including all necessary features, for the local users and/or by third parties (e.g. energy management service providers).
- Prototypes of energy management applications for local users, including usage of information collected by a sensor network, and mobile applications, to be offered by network or service providers, enabling remote energy management.

As mentioned above, in order to test and validate the overall AIM architecture and its individual components, the consortium performed a number of integration, usability, and energy savings experiments:

1) During December 2009, all individual components of the AIM architecture have been tested within stand-alone and interworking experiments, where specific tests on the communication interfaces modelled in D2.1 were carried out.

2) First successful integration test, which included all AIM components, was performed in February 2010 (in Grenoble, Figure 2) and was repeated by using enhanced and improved AIM components in May 2010 (in Milano), showing that the overall AIM architecture as well as it individual components operate as expected.

3) First usability testing carried out in Grenoble was focused on mobile application (remote interface) for the remote energy management of home appliances (designed to be offered by a service provider, e.g. a network operator), whereas second usability testing, organised in Milano was focused on the testing of the functionality of the local interface (DVE-Device Virtualisation Environment). Usability tests were performed with the help of people who were not involved in the AIM project representing different categories of potential users (different age, occupation, familiarity with the

technology, etc.). Tests showed that developed user interfaces and energy management applications are suitable for their wide usage requirements.

4) In order to estimate energy savings achieved by application of the AIM technology in real conditions, three households with their “real users” in Greece were chosen to perform related tests. AIM components were installed on conventional appliances (appliances which were already in use and do not include the AIM components), to show that the system is seamlessly applicable to every household, independently on the kind of appliances available. Thus, the AIM components have been used in households without need to procure any new appliances. Results achieved after using the AIM technology in the real households during May-June 2010 showed energy saving of more than 20%, when the system has been applied on audiovisual appliances, white goods and communication equipment. Energy saving can be far greater if the AIM technology is to be applied in other appliance categories, such as lighting and air conditioning systems.

Figure 2: Part of AIM installation in Grenoble during work in progress

Apart from current technological results, AIM has managed to create impact on the proceedings of the standardisation bodies working on energy saving applications. In particular, in its preliminary recommendations, the ITU Focus Group on the consolidation of ICT methods for mitigating climate change has recognised AIM as the most important worldwide research activity in the area, while the project itself has performed extensive contributions in all three ITU recommendations drafted so far. In addition, AIM has participated to three conferences, two exhibitions, provided several paper contributions to various conferences and provided several journal papers, two newspaper articles in Greece and Italy, and received one best paper award. Furthermore the project has pursued further system commercialisation toward the market by responding to the EC call on PSP a proposal for the massive AIM technology deployment in four large social household organisations.

Detailed information about current proceeding of the project, documents and partner information can be found on the **AIM project website** at www.ict-aim.eu.