Seamless interoperation of digital home services

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The seamless integration of devices and computation will soon become part of our daily lives. Sensors, actuators, wireless networks and terminal devices powered by intelligent computation will blend into future environments in which people will live. The convergence of indoor network-enabled multimedia electronics and business services has progressed to a level sufficient to justify proliferation of such capabilities, not only in large business environments, but also in small business and residential situations. The future communications networks require anywhere and anytime connectivity and will seamlessly assist the user with advanced functionalities that fit her/his preferences, the current location and context or various device capabilities.

However, current domestic systems with their overabundant selection of various incompatible standards and features are restricting ubiquitous access to many available digital services, while services and devices do not offer the interoperability that would cover the whole small office/home office (SOHO) context. To fulfil the dream of interoperable and accessible services and devices, ANSO has realised that it needs to overcome two main technological constraints and barriers of interoperability and modularity to provide a novel seamless services chain of home automation, multimedia and communications services in the digital home environment.
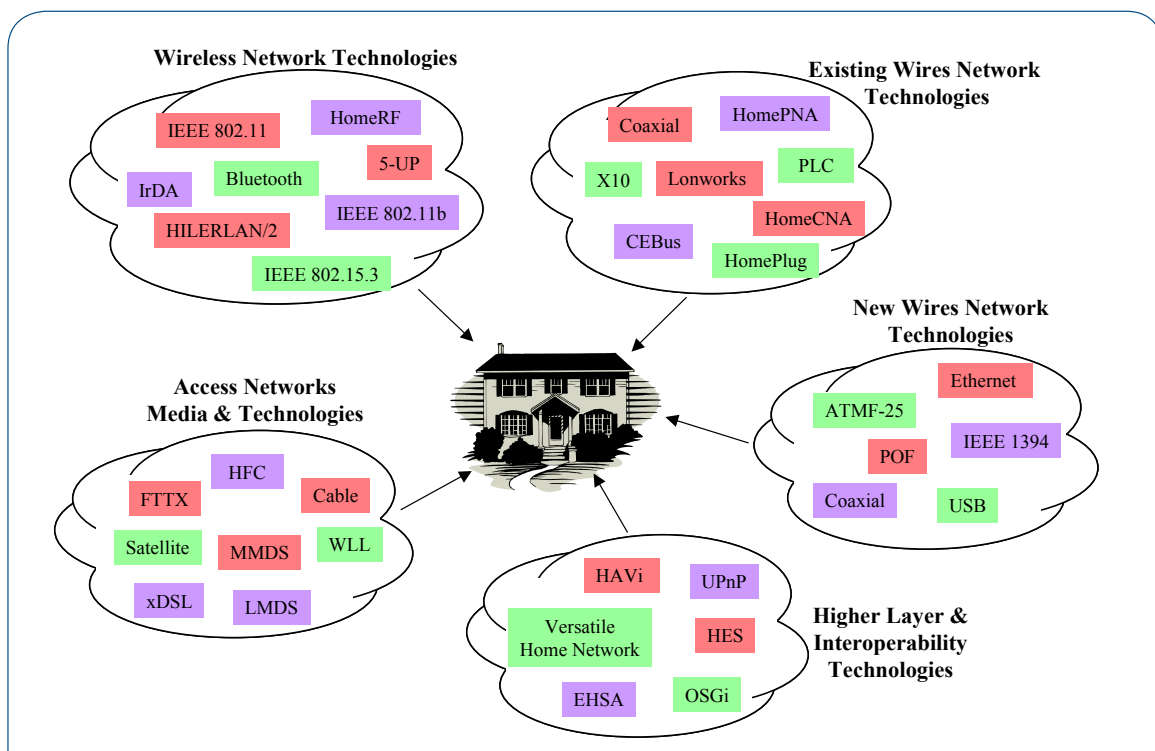

Figure 1. Home environment with a broad selection of non-interoperable technologies

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The results of this project will enable universal access to multimedia, home control and communications services, including a full range of automation, computing and entertainment products. This allows more citizens to access digital services, and gives them a greater freedom of choice when mixing and matching services and appliances to suit specific needs. ANSO thus encourages social cohesion by enabling the housebound and those currently excluded through the 'digital divide' to participate in high quality digital services. Hence, through a range of service offerings, ANSO permits network operators, content providers and appliance manufacturers to consider new business models and deliver sustainable, high quality services to the home. In addition, ANSO enhances domestic security by facilitating greater safety in the home through a low-cost infrastructure for monitoring applications. Examples include assisted living for the disabled or housebound, low-cost home surveillance for security and fire prevention through wireless integration with domestic appliances such as heaters and ovens.

The combination of the above aspects will support the detailed design and implementation of an appropriate platform-independent software solution for a future home environment. Using this, a seamless interoperability of multimedia, control and communications services will be enabled. In general, the software solution will be the central point for the realisation of such functionalities in a heterogeneous networking environment.

Determining consumer needs

To ensure it meets real world needs and requirements, the project initially studied and evaluated market and end-user needs by conducting a public survey and interviews of technical people. It showed the market clearly moving towards the networked home environment, which is required to provide open access to Internet services and to services in heterogeneous home networks. Consumers expect support for home automation, communications, entertainment and all services required throughout the home environment. Key consumer issues included security, and ease of use and integration.

Interoperability and modularity

On the basis of the consumer and technical requirements and goals, the main technological constraints addressed were the interoperability and modularity of services for the digital home environment. This led to the design and development of a common ANSO distributed middleware (ADM) offering interoperability of traditionally isolated and non-interacting services in modular fashion. The issue of interoperability was solved by providing a common ADM middleware layer based on message communication, using state-of-the-art plug-n-play and service-oriented computing technologies. Furthermore, the modularity was introduced by a novel service and component models and architecture providing a uniform solution extending from mobile terminals up to servers.

In more detail, the solution includes
- A novel extendable ADM service framework providing interoperability of multiple service-oriented software technologies extending the existing OSGi bundle model;
- Novel component models enabling easy development and deployment of modular and behaviourally-adaptive service components extending the OSGi bundle model;
- Introduction of distributed capabilities to the OSGi ecosystem; and
- Completion of the device profile for web services (DPWS) ecosystem and its extension to dynamic service-oriented architecture.

As a result, this middleware solution addresses the problem area in the digital home environment, enabling services and applications to interoperate there. Implemented and tested main applications and application areas for the interoperable ADM platform include:

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Home gateways and other related devices and applications:
- Home-automation applications such as security, remote control and management,
- Assisted living for disabled or elderly people, and
- Home networking;

Communications applications:
- Voice over Internet (VOIP), and
- Chat; and

Multimedia applications and devices:
- Video-on-demand services,
- Set-top boxes and services, and
- Context-aware Internet applications.

Figure 2. Interoperable seamless services chain enabled by the ANSO distributed middleware (ADM)
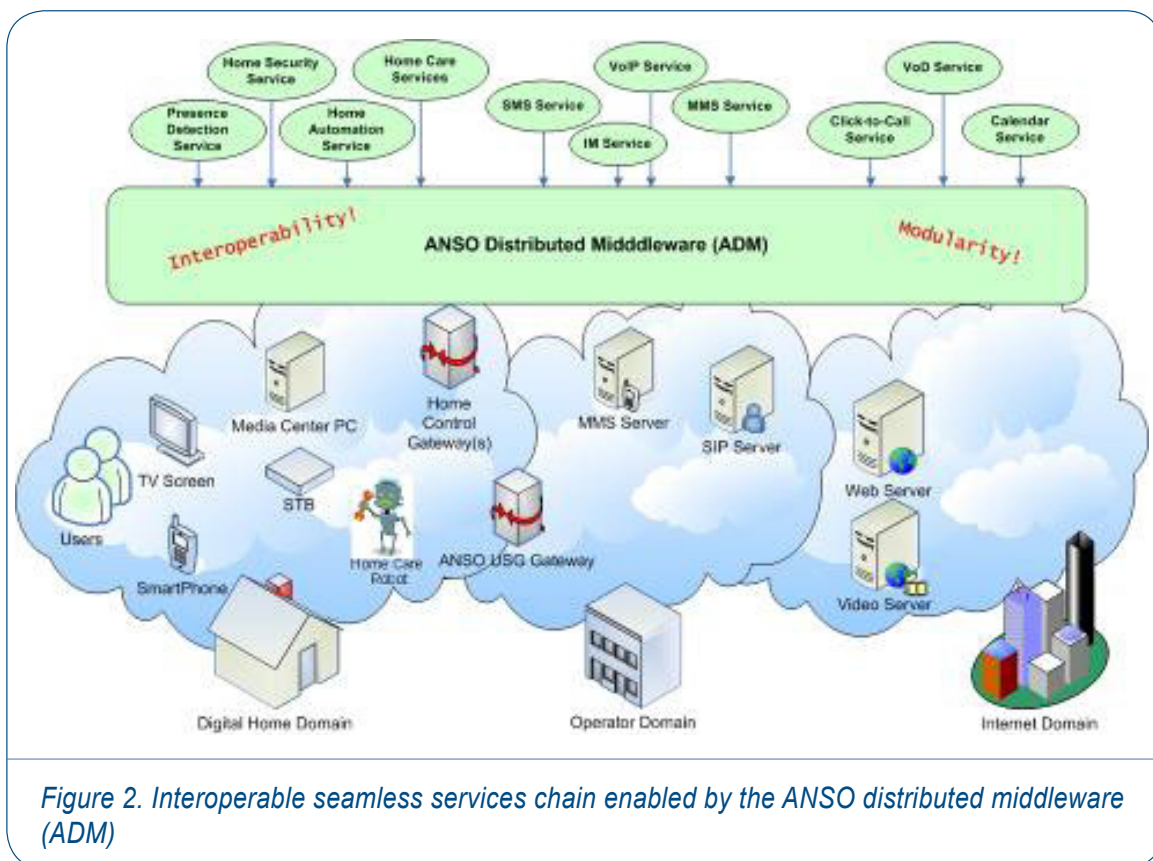
In addition to the actual middleware platform, one of the results – part of the ADM providing access and interoperability for the home domain – is the OSGi DPWS base driver that provides a bridge combining the Web Services and OSGi standards. The basis of the driver is the DPWS stack – a result of the ITEA SODA project that has been used further in this project. The ANSO result – the infrastructure surrounding the base driver – hides the complexity involved in the distribution and heterogeneity from the developers and provides integration into the OSGi context and ADM solution. This part has been contributed to and accepted by the OSGi standardisation body as a part of the OSGi plug-n-play technologies.
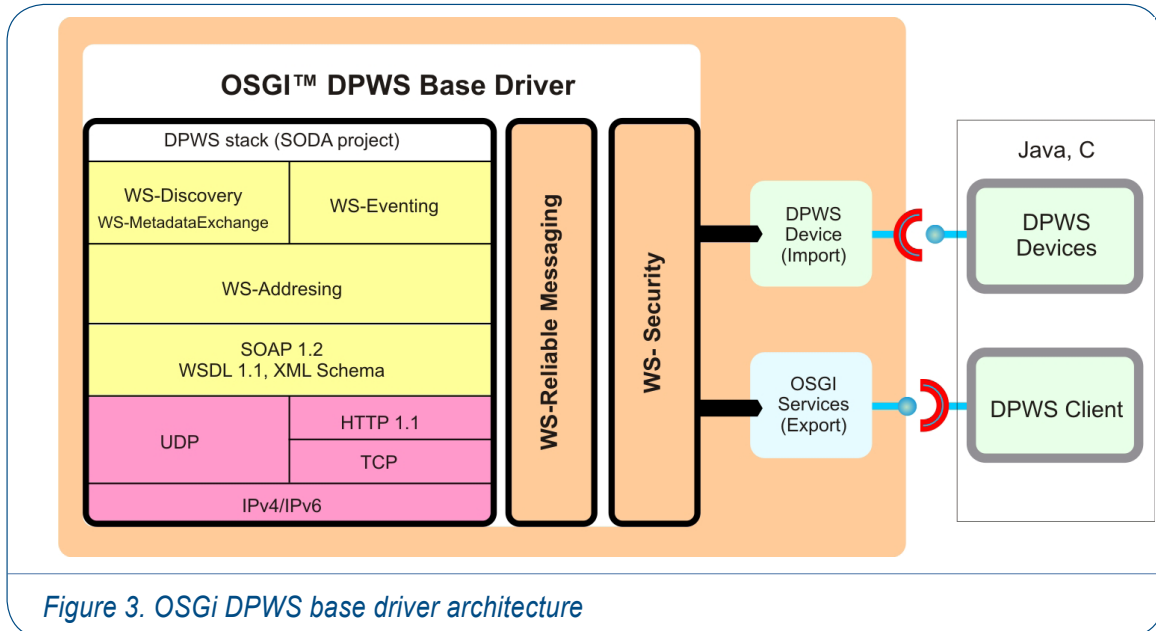
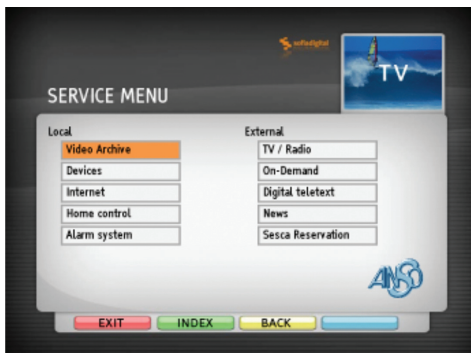Figure 3. OSGi DPWS base driver architecture

Figure 4. The control of connected devices at home using a DVB-MHP-enabled set-top box

Figure 5. Home control user interface on the MHP-enabled TV

Further contributions to standards have been through influence on Digital Video Broadcasting Multimedia Home Platform (DVB-MHP) standardisation to allow local MHP services on the home network in MHP version 1.2, where the television is used to supply the actual user interfaces.

Another very interesting part investigated during the course of the project was an automatic home assistance provided by a robotic companion for incapacitated home occupants. Synthetic Autonomous Majorduomo (SAM) is a companion robot designed for prototyping assistance and service functions. The robot is composed of a mobile platform on top of which a manipulator arm is mounted. The mobile robot is equipped with a laser range-finder sensor to provide autonomous navigation and security functionalities. The arm holds a gripper used for object manipulation and low-cost cameras are set on the gripper to give a video feedback to the operator. These cameras are also used to provide visual servoing grasping function. The robot companion is able to interact with the home environment using the developed ANSO middleware; it controls and communicates with the environment to help it in its tasks – e.g. controlling home lights for better lighting conditions for its imaging systems. Using

patented technologies, the user is easily able to designate what he/she wants the robot to fetch just by clicking the object in the image.
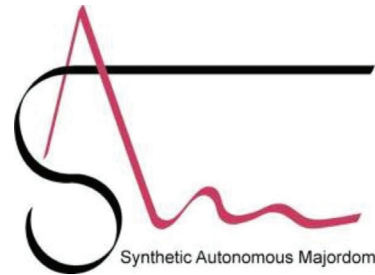

Figure 6. Home-assistance robot in action, fetching an item for the disabled home occupant

With no doubt, home networking will play the most important role in pervasive computing research as the home is the place where people invest much money, energy and time. Multimedia and entertainment markets, mobile subscribers and broadband markets are three key business factors to foster home network research. Market research shows that an increasing number of consumers are interested in sharing music, pictures and videos among digital electronics, personal computers (PCs) and mobile devices. One deployment target for project results providing interoperability and modularity for home digital services and applications will be residential gateways and central units providing accessibility to the services. Residential gateway demand alone has been forecast to rise to well over 15 million units worldwide in 2008.

The work carried out is having a major impact on market plans for all the partners as the demonstration integration is a first field trial for coexistence with other vendor solutions. The trials are also a first approach to real life situations in a controlled environment, similar to the one that the final commercial solutions will cover. The focus areas for the demonstration have been home automation, communications and entertainment services, which are line with the market potential of residential gateways.

ANSO has targeted a very fast growing market and there will be three levels of revenue generation in ANSO emerging model and project exploitation:

- Service providers, who will sell premium services over the network;
- Network operators, who will evolve from today's Internet service providers (ISPs), telecommunications operators and cable/satellite operators; and
- Appliance manufacturers and digital home service developers, who will market the various new forms of interoperable end-user products through online and retail stores, as is currently the case.