

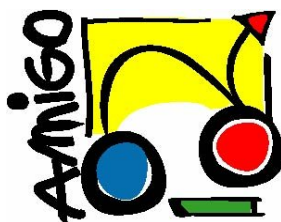
FRAMEWORK PROGRAMME (FP) 6  
 INFORMATION SOCIETY TECHNOLOGIES (IST)  
 Open development platforms for software and services.



IST-2004-004182 Amigo

# Amigo

## Ambient Intelligence for the networked home environment



# Amigo Final Report

<b>Project Coordinator</b>	Maddy D.Janse Philips Research Laboratories Eindhoven (NL)		
<b>Start date Project</b>	1 September 2004	<b>Duration</b>	42 months
<b>Version</b>	3.0		
<b>Status</b>	Final		
<b>Date of issue</b>	10 September 2008		
<b>Filename</b>	Amigo_Final Report version-3		

## 0 DOCUMENT INFO

### 0.1 AUTHORS

Author	Company	e-mail
Maddy D. Janse	Philips	Maddy.janse@philips.com

### 0.2 DOCUMENT HISTORY

Date	Version	Editor	Change	Status
26/06/2008	Version-1	Maddy D. Janse	Draft	
10/09/2008	Final	Maddy D. Janse		

### 0.3 DOCUMENT KEYDATA

Keywords	IST-2004-004182 – Amigo, Amigo Final Report- Project month 1 to 42
Editor Address data	Maddy D. Janse Connected Consumer Solutions (CCS) Sector Digital Lifestyle Technology Tel.:+31 40 2749540 Mobile: +31 651981862 E-mail: maddy.janse@philips.com
Delivery Date	September2008

### 0.4 DISTRIBUTION LIST

Date	Issue	E- mailer
03/07/08	Report to consortium	Al_amigo_all@natlab.research.philips.com
03/07/08	Report to project officer and reviewers	
10/09/08	Report to project officer	

© Amigo Consortium

# Table of Contents

<b>Executive Summary</b> .....	<b>5</b>
<b>1 The Challenge</b> .....	<b>8</b>
<b>2 Addressing the Challenge: The Amigo Proposition</b> .....	<b>9</b>
<b>3 Who Can Benefit from Amigo</b> .....	<b>11</b>
<b>4 Highlights of Achievements</b> .....	<b>12</b>
4.1 Amigo open, flexible and modular middleware platform for the networked home .....	12
4.1.1 Amigo interoperability and programming frameworks .....	12
4.1.2 Amigo user-centric services .....	12
4.2 Amigo suite of applications .....	13
4.3 Amigo modular training program for industrial and post-graduate learners .....	13
4.4 The Amigo usability work .....	13
<b>5 Results</b> .....	<b>15</b>
5.1 Amigo Architecture .....	15
5.1.1 Amigo Base Middleware .....	15
5.1.2 Amigo Interoperability Framework .....	17
5.1.3 Amigo Programming and Deployment framework .....	18
5.1.4 Amigo Intelligent User Services .....	19
5.2 Amigo modular training program .....	23
5.2.1 Seminar modules .....	23
5.2.2 Training modules .....	24
5.2.3 Self-learning material .....	24
5.3 Amigo user-centred development approach .....	24
<b>6 The Amigo Applications</b> .....	<b>27</b>
<b>7 Availability of Results</b> .....	<b>30</b>
7.1 The Amigo open source software repository and its related documentation .....	30
7.2 Amigo deliverables .....	31
<b>8 Potential Impact of the Results</b> .....	<b>33</b>
<b>9 Lessons Learned During the Project</b> .....	<b>35</b>
<b>10 Partners</b> .....	<b>38</b>
<b>11 Contacts</b> .....	<b>41</b>

## List of Abbreviations

.NET	Microsoft .NET Framework – Windows developer platform
ANS	Awareness and Notification Service
API	Application Programming Interface
BDF	Fagor Domotic Bus
CE	Consumer Electronics
CE-HTML	Consumer Electronics - Hypertext Mockup Language
CHES	Community sharing Services
CMS	Context Management Service
DLNA	Digital Living Network Alliance
ECA	Event Condition Act
EIB	European Installation Bus
GUI	Graphical User Interface
HTTP	Hypertext transfer Protocol
JVM	Java Virtual Machine
MSN	Microsoft Network
OS	Open Source
OSGi	Open Service Gateway initiative
OWL	Web Ontology Language
PAD	Personal Amigo device
PDA	Personal Digital Assistant
PPS	Privacy and Personal Security
QoS	Quality of Service
RDF	Resource Description Framework
RMI	Remote Method Invocation
RPC	Remote Procedure Call
SAInt	Seamless audio interface
SD	Secure Digital
SI	Semantic Interoperability
SLP	Service Location Protocol
SME	Small Medium Enterprise
SOA	Service Oriented Architecture
SOAP	Simple Object Access protocol
SPARQL	SPARQL Protocol and RDF Query Language
UI	User Interface
UIS	User Interface Service
UMPS	User Modelling and Profiling Service
UPnP	Universal Plug and Play
WS	Web Services
WS-Discovery	Web Services Discovery

## Executive Summary

### Scope

Today's average household consists of several electronic systems such as televisions, refrigerators, personal computers, personal digital assistants and music systems. All these devices operate independently from each other. In the vision of the networked home environment, these devices can communicate with each other in an intelligent manner. In such a futuristic home, for example, the refrigerator may communicate with the TV to warn the viewer that the door has been left open. Another example is that the ambient lighting might change automatically for movie watching. Several challenges have been hampering development in intelligent networked home environments, such as lack of interoperability between different manufacturers' equipment and the lack of compelling user services.

Amigo provides a platform and building blocks for technologically advanced home environments. This platform gets all networkable devices and services in the home to communicate with each other (Figure 1). It overcomes interoperability issues by using a service-oriented architecture, Web services and protocols such as Universal Plug and Play (UPnP). Semantic interoperability is ensured through ontology definitions that enable a common understanding between the interacting devices.

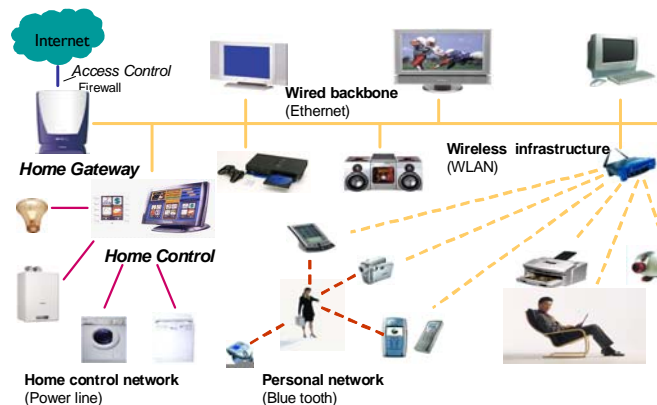


Figure 1: Amigo networked home environment

### Advances

The Amigo architecture contains a base middleware layer, an intelligent user services layer, Amigo-aware applications, and a programming and deployment framework. The middleware layer and the user services layer provide the functionalities needed for a networked environment and an ambient in-home network, respectively. Amigo-aware applications and services form the top-layer of the architecture, and the programming and deployment framework allows developers to create applications and services (Figure 2). The interoperable middleware operates across different application domains and across different homes and environments. This flexibility of the architecture ensures that the system can grow, as and when new devices and applications are added. Furthermore, the Amigo software is open source, which encourages further development of the system.

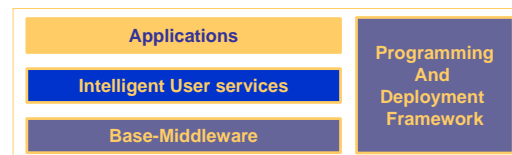


Figure 2: Amigo Architecture

The Amigo service-oriented architecture enables the development of software as services that are delivered and consumed on demand. Existing protocols for discovery and communication are supported in an interoperable way. This allows programmers to select the protocol of their choice while they can still access the functionality of services that are using different methods.

A suite of applications on top of the Amigo platform shows the potential for end-users and the benefits of the architecture for application developers. These include a comfort management system that maintains environmental conditions adapted to user profiles, different zones in the home, and the time of the day. Another example is a health management system that offers people in-home health monitoring and coaching. Using a personal device - a mobile - in somebody else's home network for using the services in one's own home is another possibility.

Amigo applications show the move ahead towards realization of a future where homes adapt to user behaviour. For example, doors are locked when someone leaves, and relatives or emergency services are contacted when someone is ill. The applications also allow sharing of information and experiences in an extended home environment, thereby enabling the use of tele-presence applications to communicate and interact socially (Figure 3). These applications use standard protocols that are widely used, such as WiFi, Ethernet, and UPnP. Most of the applications are web-based, that is, any device with a web browser can connect to the Amigo network and users can easily interact with the home devices.



*Figure 3: The Extended Home Environment applications provide end-users with services that enable them to share activities and experiences in an easy and personalized way. For example, parents who are on a business trip can still share daily activities with their children at home, tell them their bedtime stories, watch TV together, look at pictures or play a game with them. That is, they can share their presence independent of location and devices, for example, using TV with PC, TV with TV, or mobile with TV*

### Positioning in global context

Separate islands of Internet, mobile, CE broadcast and home automation that don't work together, currently exist next to each other. These proprietary vertical implementations are easy to market, but inhibit a wider acceptance by consumers as complex installation, operation, service and maintenance problems are induced. Installation of separate products is quite easy, but installation of networked products is hard. The Amigo project made a significant progress towards providing interoperability over devices, networks and services and making the installation easier for users. Amigo achieved this by means of automatic device and service discovery, and by creating flexibility and sustainability for a gradual roll-out and incremental building up of customized home networks. This infrastructure and the open source software enable the development and flexible implementation of a wide variety of innovative services, applications and products for the digital home. Current proprietary systems can not provide this.

### Contribution to standardization and interoperability issues

First of all, Amigo shows standards in action. The focus is on Open Source development, which supports open standards and promotes interoperability and interaction between systems. The components of the Amigo Service Oriented Architecture support, amongst others, Universal Plug and Play (UPnP) and Web Services, and are available for both Java (OSGi) and .NET. The Digital Living Network Alliance standard is used to achieve multimedia interoperability in the base middleware. Results from Amigo are incorporated in a draft proposal for a Web-based protocol and framework for Remote User Interface on UPnP (Web4CE) and remote display of User Interface for third party devices. This enables a wide range of UI capabilities for TVs, mobile phones and portable devices.

### Target users / sectors in business and society

The main target users are designers and developers of services and applications and third-party developers in: 1) telecommunication, multimedia, informatics and consumer electronics convergence, 2) home automation and security, such as energy suppliers, household appliances, security and surveillance enterprises or health and assistance service providers, and 3) Internet service providers and entertainment companies.

### **Overall benefits for business and society**

Application designers and developers can build applications very quickly by just using a subset of the Amigo platform, having the possibility to gradually extend the applications with the tools that they are most familiar with. This is particularly effective for building showcases, for customization, and for transfer of knowledge and technology to different businesses and domains. It also facilitates effective knowledge transfer to SMEs and technical training of young professionals for the digital home domain.

### **Achievements**

- Software framework and components, available as open source software, and supported by extensive tutorials and software developer's guides.
  - Interoperable middleware for integrating resources from CE, PC, mobile and home automation domains.
  - Building blocks for making applications context-aware, personalised, multi-modal and privacy-aware.
  - The .NET / OSGi programming framework to support developers to write their application or component software in a fast, easy and effective way; using their preferred programming language.
- Amigo suite of applications
- Amigo modular training program for industrial and post-graduate learners
- Amigo usability work on user needs and user requirements methodologies

### **Contact**

<http://www.hitech-projects.com/euprojects/amigo//index.htm>

<http://amigo.gforge.inria.fr/home/index.html>

<http://www.hitech-projects.com/euprojects/amigo/tutorials.htm>

# 1 The Challenge

The major challenges addressed by the Amigo project are:

- Developing a consistent interoperable framework for the networked home environment that can be extended across different homes and locations
- Demonstrating compelling and sensible end-user applications for different usage domains

Today's average household consists of several electronic systems such as televisions (TV), refrigerators, personal computers (PC), personal digital assistants (PDA) and music systems. All these devices operate independently from each other. In the vision of the networked home environment, these devices can communicate with each other in an intelligent manner. In such a futuristic home, the refrigerator may communicate with the TV to warn the viewer that the door has been left open. Another example is that the ambient lighting might change automatically for movie watching. Several challenges have been hampering development in intelligent networked home environment, such as lack of interoperability between different manufacturers' equipment and the lack of compelling user services.

Traditionally home automation, consumer electronics, mobile communications and personal computing were strictly separate domains all having their own industrial companies, with their own business plans, standardization efforts and form factors. By introducing the networked home, also called the connected home, this traditional separation of activities is no longer valid. In such a home, several pieces of equipment are connected by using the same infrastructure, the technology is completely integrated into the environment and people can freely and interactively use it. Living in such a connected environment is very difficult to perceive and imagine for users. Let alone that they can explicitly specify their requirements and express their appreciation for such an intelligent environment. Furthermore, these requirements will change and evolve over time as people are becoming more familiar with connected environments.

Figure 1 shows the Amigo envisioned networked home environment.

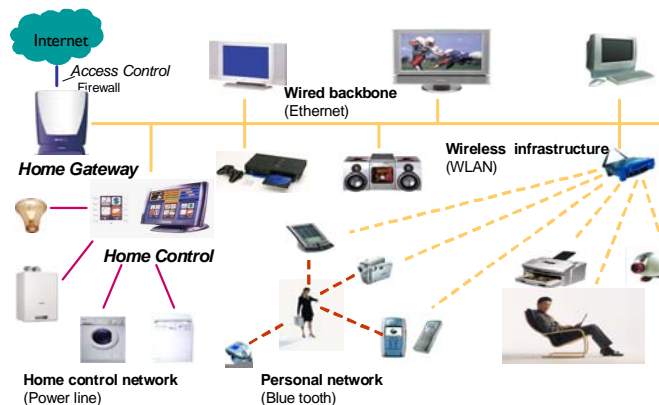


Figure 1: Amigo networked home environment

The Amigo project started in September 2004 and ended in February 2008. The full name of the project is: Ambient Intelligence in the Networked Home Environment. The project is a collaboration of 15 European companies, research institutes and universities, partly funded by the European Commission in the 6<sup>th</sup> Framework Programme (Integrated Project-IST-2004-004182). Philips Research is the project coordinator.



## 2 Addressing the Challenge: The Amigo Proposition

Home networking has already emerged in specific applications such as PC to PC communication and home entertainment systems, but its ability to really change people's lives is inhibited by the lack of interoperability between different manufacturer's equipment, complex installation procedures, and the scarcity of compelling user services.

The Amigo project addressed these challenges by:

- Developing middleware that dynamically integrates heterogeneous systems for achieving interoperability between services and devices.
- Adopting a user-centred development approach.
- Developing applications in different domains that show the potential for end-users and the benefits of the service oriented-middleware architecture for application developers.

The Amigo interoperable middleware dynamically integrates services and devices. For example, home appliances, such as, heating and lighting systems, washing machines and refrigerators, multimedia players and personal devices, like mobile phones and PDA's are connected in the home network to work in an interoperable way. This interoperability across different application domains can also be extended across different homes and locations. The Amigo architecture contains a base middleware layer, an intelligent user services layer, Amigo-aware applications, and a programming and deployment framework. The middleware layer and the user services layer provide the functionalities needed for a networked environment and an ambient in-home network, respectively. Amigo-aware applications and services form the top-layer of the architecture, and the programming and deployment framework allows developers to create applications and services (Figure 2). The interoperable middleware operates across different application domains and across different homes and environments. This flexibility of the architecture ensures that the system can grow, as and when new devices and applications are added. Furthermore, the Amigo software is open source, which encourages further development of the system.

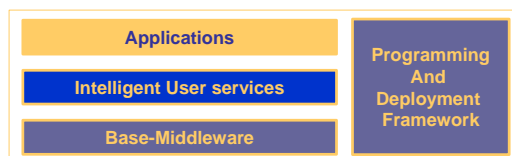


Figure 2: Amigo Architecture

Living in such a connected environment is very difficult to perceive and imagine for users, let alone, that they can explicitly specify their requirements and express their appreciation for such an intelligent environment. Furthermore, user requirements will change and evolve over time as people are becoming more familiar with connected environments. To facilitate working with the dynamics of such evolving user requirements a user-centred development approach was adopted. Central to this approach was the development of a usage scenario to present the potential functionalities and implementations to users and developers. (Ref. video of this scenario is on YouTube <http://www.youtube.com/watch?v=wey94w-pNVI>).

Amigo applications are developed for three different domains: "Home Care and Safety", "Home Information and Entertainment", and the "Extended Home Environment" – in which multiple homes are connected. Different applications have been developed for each of these domains. For example, a comfort management system that maintains environmental conditions that are adapted to user profiles, the different zones in the home and the time of day. Health management is another example of an integrated service that offers people in-home health monitoring and coaching. The integrated demonstrators for the Home Information and Entertainment domain use standard protocols that are widely used, like Wi-Fi, Ethernet or UPnP. Most of these applications are web-based, i.e., any device with a web browser can connect to the Amigo network and users can easily interact with the home devices. The Extended Home Environment applications provide end-users with services that enable them to share activities and experiences in an easy and personalized way. For example, parents who are on a business trip can still share daily activities with their children at home, tell them their bedtime

stories (Fig 3, Fig 4), watch TV together, look at pictures or play a game with them. That is, they can share their presence independent of location and devices, for example, using TV with PC, TV with TV, or mobile with TV. Using a personal device, for example a mobile, in somebody else's home network for using the services in one's own home is another possibility. Such a device enables users to access services which are operating in their own home from other domains, for example, a friend's home, cinema, or office. This computing device travels with the user and 'binds' a visited domain to a home domain (Fig. 5).

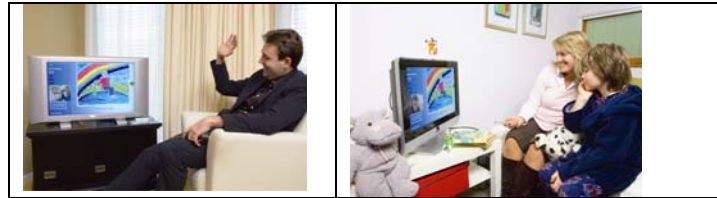


Fig 3 & Fig. 4: Shared story telling at two different locations

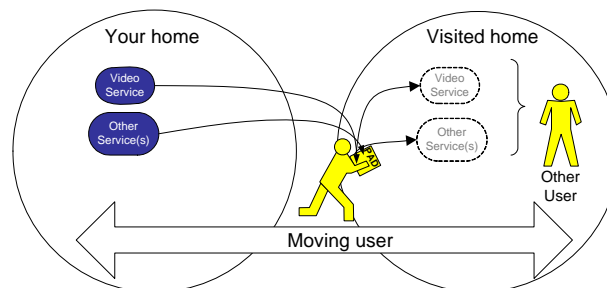


Figure 5: Using a personal device for accessing services in one's own home from another location.

### 3 Who Can Benefit from Amigo

The main target users of the Amigo software and applications are designers and developers of services and applications and third-party developers in: 1) telecommunication, multimedia, informatics and consumer electronics convergence, 2) home automation and security, such as energy suppliers, household appliances, security and surveillance enterprises or health and assistance service providers, and 3) Internet service providers and entertainment companies.

Several applications developed on the Amigo platform showcase the potential for end-users and the benefits of the architecture for application developers. These applications show application designers and developers, the advantages of using the Amigo software, of having the advantage to use the tools that they are most familiar with, of being able to build applications very quickly by just using a subset of the Amigo platform and by having the possibility to gradually extend the applications.

The Amigo project created a basis for interoperable, heterogeneous plug and play home networking over the CE, PC, mobile, and domotica domains. Application designers and developers in these domains aiming at interoperability and smooth environments for their customers benefit from using the Amigo software components. They can build their applications quickly and gradually extend them by exploiting the flexibility offered by the system. These benefits apply for application development by and for SME's and their customers, as well as for larger industrial organizations. The Amigo platform is very suitable to quickly build and show application possibilities to customers, to support the development of roadmaps and to customize for clients.

The architecture is such that it ensures flexibility of the system to grow, as and when new devices and applications are added. Yet another noteworthy aspect of Amigo software is that it is open source, which serves to encourage further development of the system.

Amigo provides a common framework for developers and manufacturers to give an impulse to the networked home: a networked home that ensures interoperability. This opens a path to the home's inside for different stakeholders. It is an opportunity for the development of a new generation of telecommunication services that gravitate around the home and that integrate service providers and operators and home networks in a trend that could be named "from the PC, to the TV to the laundry" These services can become accessible from external networks through the Amigo services. For example, the following would be possible from an external network:

- Controlling home appliances, consumer electronic devices and health devices.
- Accessing data at the home and receiving data from it: content, context, notifications, and user preferences.
- Remote deployment and configuration of components and services.

The Amigo technologies enable PC and Windows based mobile devices to interoperate with other mobile and consumer devices in the home by utilizing all the programmable devices in the home. New devices from the mobile and consumer domains can use interoperable devices and offer new, innovative services.

Major application domains for Amigo are, among others:

- Home automation, smart homes - new applications and services
- Digital home and advanced household systems
- Mobile services/content provision
- Consumer electronics and Lifestyle – resource-constrained networked devices, gateways, dynamic updating of software on remotely managed networked embedded devices, remote building of automation services,
- Health and wellbeing - ambient assistance services, elderly care
- Collaborative work and communication – sharing experiences, content, work

Designers and developers of applications and services in these domains can benefit by using the Amigo framework. How they can benefit from using Amigo components is described in the following paragraphs. Amigo provides developers with infrastructures and software mechanism which address real user needs.

## 4 Highlights of Achievements

To make home systems much more attractive for end-users, the benefits for the end-user of a combined home system must be evident. Most of the Amigo services use knowledge of the world around the device like the other devices in the system and the user. This is only possible in a networked system. Such new services for the end-user are, for example, using a display that is in the neighbourhood to display information instead of on a small PDA display, using the processing capabilities of the home server to do speech recognition and communicating the results back to the camera that has only small processing capabilities, i.e., combining user-related and context-related information.

The major achievements of the Amigo project are:

- Software framework and components, available as open source software, and supported by extensive tutorials and software developer's guides.
  - Interoperable middleware for integrating resources from CE, PC, mobile and home automation domains.
  - Building blocks for making applications context-aware, personalised, multi-modal and privacy-aware.
  - The .NET / OSGi programming framework to support developers to write their application or component software in a fast, easy and effective way.
- Amigo suite of applications
- Amigo modular training program for industrial and post-graduate learners
- Amigo usability work on user needs and user requirements methodologies

### 4.1 Amigo open, flexible and modular middleware platform for the networked home

Interoperable middleware for integrating resources from CE, PC, mobile and home automation domains offers interoperability and key middleware functions, such as, resource discovery and security. Easy and effective to use for application and service developers, integrated methodology ('how to') for employment, source code of components, developed service description vocabulary and language ontologies, user's and developer's guides for components and ontologies (JavaDoc and OWLDoc), and available as open source software.

#### 4.1.1 Amigo interoperability and programming frameworks.

The Amigo interoperability framework provides middleware-layer mechanisms that enable the integration of heterogeneous networked devices and services. The programming and development framework helps developers to program Amigo services or applications using amigo services without having to care about underlying protocols so as to reduce programming effort and enforce interoperability.

#### 4.1.2 Amigo user-centric services

The Amigo intelligent user services are the building blocks for making applications context-aware, personalised, multi-modal and privacy-aware. They broker between users and service providers, and provide context information, combine multiple sources of information and make pattern-based predictions. Information is tailored to user profiles and adapts to the user's situation and changes in the context. Extensive tutorials and software developer's guides are available for all components. The modules are available as open source software.

## 4.2 Amigo suite of applications

The demonstrators for Home Care & Safety, Home Information & Entertainment, and Extended Home Environment domain used the middleware components and intelligent user services to integrate different applications. Complete installation, configuration instructions and user guides are available for every application. A large number of applications was developed showing the variety and the breadth of what is possible with Amigo middleware platform and services. Developer's and user's guides for each application are available.

The Home Care & Safety demonstrator integrated the following applications:

- Comfortable environment for the HOME domain, in which appliances management, entrance management, and a comfort system were integrated,
- Wellness and health system for the CARE domain, in which a daily life cycle monitor, health management, and food management were integrated, and
- Safety and security system for the SAFETY domain, in which alarms management and a crisis response application were integrated.

The Home Information & Entertainment demonstrator integrated the following applications:

- Home information system, in which a home agenda, a monitoring manager and a personalized news application were integrated,
- Home entertainment system, in which a media manager core, privacy enforcement, parental control and a game were integrated.

The Extended Home environment integrated the following applications:

- Presence management and ambience sharing, in which presence awareness is provided for distributed interpersonal communication applications
- Feeling@, providing ambient communication and content sharing between home and workplace
- Activity sharing, a TV based community service
- Awareness globe, a social network device for initiating shared activities
- Personal Amigo device, enabling sharing intelligent services between homes
- Social radio, a music-based approach to emotional awareness mediation
- SAInt, a seamless audio interface for real-time audio communication and ambience sharing.

## 4.3 Amigo modular training program for industrial and post-graduate learners

Special training courses were developed to address industrial (especially SMEs) and post-graduate learners. Courses are organized in a modular way offering the opportunity to combine different modules according to the special needs of the target audience. Among Amigo specific topics, the courses also address key technologies on which the Amigo middleware is based.

Part of the courses addressed decision makers responsible for the development of new products and applications in the area of smart homes while others were aiming at software/hardware developers. To this end, not only lecture type presentations were developed but also a set of training modules where attendees get the opportunity to gather hands-on programming experience by developing some simple Amigo components.

## 4.4 The Amigo usability work

The Amigo project developed and adapted quantitative and qualitative methods to elicit user needs and requirements for the Amigo networked home system. These studies were conducted in different European countries. A field study was conducted to understand what people would want from a connected home and what their values and needs were. The outcomes provided specific findings on topics such as information, entertainment, communication, professional life and care & safety. The Amigo use scenario was developed to present the system concepts and its potential user benefits.

The scenario was adapted to incorporate the user feedback and served as a guiding mechanism throughout the overall project. By using complimentary methods confirming evidence with regard to perceived user goals and needs and the appreciation of the proposed Amigo solutions was obtained.

## 5 Results

### 5.1 Amigo Architecture

The Amigo service-oriented architecture enables the development of software as services that are delivered and consumed on demand. The benefit of this approach lies in the loose coupling of the software components that make up an application. Discovery mechanisms can be used for finding and selecting the functionality that a client is looking for. Existing protocols for discovery and communication are supported in an interoperable way. This allows programmers to select the protocol of their choice while they can still access the functionality of services that are using different methods. The components in the Amigo architecture can be divided into three main parts:

- The Base Middleware contains the functionality that is needed to facilitate a networked environment. It provides the semantics to communicate and discover available services and devices in the network, including the ones that are based on existing communication and discovery standards, such as UPNP, WS, or SLP. This implies that independence is accomplished for existing hardware and software, and new services can be discovered and composed. In addition, security mechanisms for authentication, authorisation, and encryption are provided.
- The Intelligent User Services contain the functionality that is needed to facilitate an ambient in-home network. They broker between users and services, and provide context information, combine multiple sources of information and make pattern-based predictions. Information is tailored to user profiles and adapts to the user's situation and changes in the context.
- The Programming and Deployment Framework contains modules that facilitate the development of Amigo-aware services in .NET or Java by providing support for interoperability, security and service description to service developers. Amigo supports and abstracts over several important protocols used for discovery and communication. Therefore, heterogeneous services can be integrated into the networked home independently of their underlying software and hardware technologies. Programmers can select the protocol of their choice while they can still access the functionality of services that are using different methods.

The software components can be structured as a set of core components which provide basic functionality and a set of additional components that provide supporting or advanced functionality. Furthermore, all software components are available as open source software.

#### 5.1.1 Amigo Base Middleware

The Amigo Base Middleware follows a modular approach, providing a rich variety of service-oriented components for an application developer to choose from. It provides a comprehensive and flexible middleware solution for the networked home, integrating the most important existing technologies in terms of service platforms, middleware protocols, and programming paradigms. Our goal has been to provide not yet another homogeneous middleware architecture, but to enable interoperability and integrate heterogeneous service platforms. A generalized use of semantics is applied to represent functional, non-functional and architectural features. Semantic technologies allow for automated reasoning on represented concepts, thus providing the basis for resolution of device and service heterogeneity, service discovery and composition, context-awareness, content discovery and distribution. Advanced mechanisms are integrated for ad hoc composition of heterogeneous home resources towards complex applications. The Amigo Base Middleware is available as open source software (<https://gforge.inria.fr/projects/amigo/>). It provides:

- a service- and content-oriented, semantics-, context- and QoS-aware, middleware platform for the development, deployment, configuration and run-time phases of the system's life-cycle,
- and support for integrating heterogeneous services and heterogeneous service platforms.

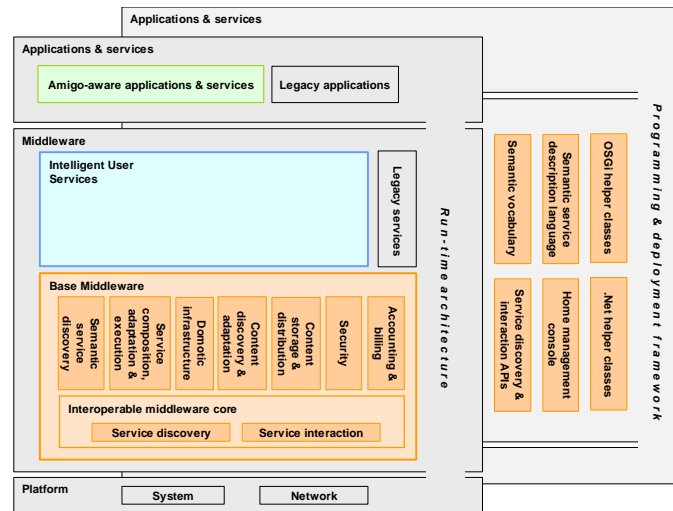


Fig.6: The Amigo Base Middleware architecture

An overview of the Amigo Base Middleware architecture, identifying its high-level building blocks, is depicted in Fig. 6. The programming & deployment framework supports, in an integrated way, diverse programming technologies (OSGi and .Net), service discovery and interaction protocols (Web Service-related and UPnP-related), and interaction schemes (RPC and event-based).

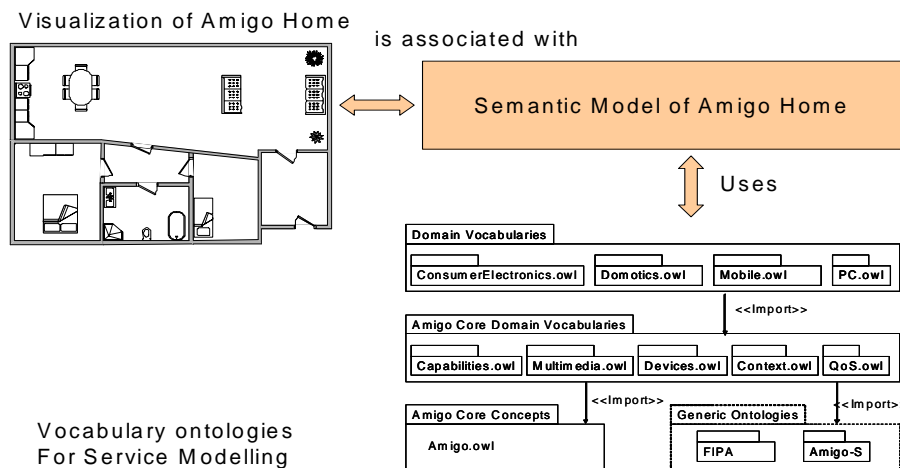


Fig.7: Semantic vocabulary

Service modelling is based on the definition of various ontologies for the abstract specification of generic and domain-specific services. They provide a common set of concepts and vocabularies that can interact with each other. A complete and integrated set of ontologies on service capabilities, QoS, context, device classes & properties and multimedia content describing different functional domains i.e. PC, mobile, CE, and home automation is available. Furthermore, the architecture of the vocabulary ontologies is based on modularization principles to support maintainability and future evolution of concepts. A visualization and modelling tool provides service developers with support on home semantic services modelling. The service description vocabulary ontologies and the visualization tool are depicted in Figure 7.

The Amigo networked home environment is dynamic – we do not know in advance which services will be available to an Amigo-aware application, nor their exact interfaces or behaviours. Thus, we rely on the discovery of services based on the semantics of the application's required capabilities. For this, both our “abstract” request (since we do not know in advance the services that we will finally employ) and the available provided services are semantically described. Our request is described in the form



of a task, which is an abstract workflow. Then, we carry out: semantic service discovery, filtering on QoS and context properties as required; service workflow composition if no single service satisfies our request but the composite usage of several services does; and adaptation of our “abstract expectation” to the available service(s). Finally, we execute the “adapted expectation” invoking the single or multiple composed services. Descriptions of services employ in combination the Amigo-S service description language and the semantic vocabulary. Figure 8 illustrates the different components for the integration of the semantic service description, discovery, composition, adaptation and execution.

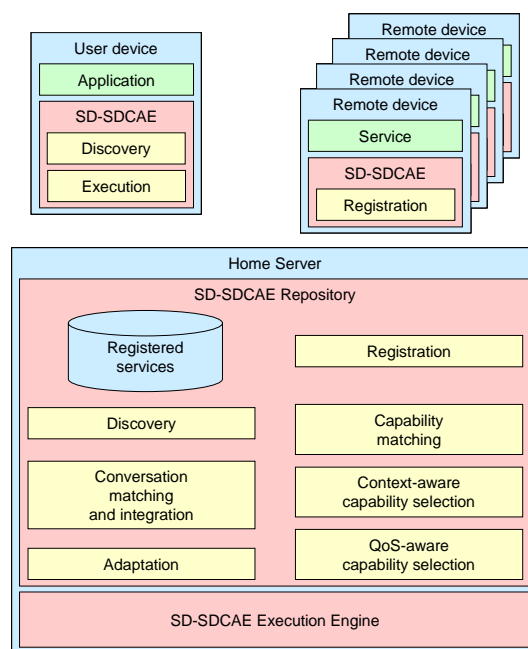


Fig.8: Semantic service description, discovery, composition, adaptation & execution

## 5.1.2 Amigo Interoperability Framework

The Amigo Interoperability Framework provides middleware-layer mechanisms that allow for integrating heterogeneous services in the networked home independently of their underlying software and hardware technologies. Integration is achieved by bridging between the service (discovery and interaction) protocols run by the various devices. Target networked services come from the four application domains of the Amigo home, i.e., from the Personal Computing (PC), Mobile Computing, Consumer Electronics (CE) and Home Automation domains. The middleware protocols being bridged include: a) service-oriented interaction protocols, such as those offered by Web Services (SOAP), UPnP (SOAP), and RMI-based infrastructures; and b) service discovery protocols such as SLP, UPnP and WS-Discovery. Additional middleware-related protocols being integrated embrace the control/command protocols from the Home Automation domain. The developed domotic infrastructure aims at enabling the integration of different device technologies (e.g., BDF - Fagor Domotic Bus, EIB - European Installation Bus), exposing them by means of standard service platforms (UPnP, Web Services), and isolating at the same time the service clients from the specific low-level device technologies. Control protocols for multimedia content distribution from the CE domain are also implicitly supported based on the bridging of service discovery and interaction protocols. A proof-of-concept prototype of the Amigo Interoperability Framework that integrates services from different domains is depicted in Fig.9.

The Amigo Interoperability Framework integrates a number of novel features. For example, SD and SI interoperability are supported transparently for concerned devices and services, as the interworking mechanisms intervene between the native middleware and the underlying network protocol stack. These mechanisms are flexible and extensible: they may be deployed on the client or service host or on an intermediate networked node; they may further be dynamically instantiated. To achieve independence of any platform or execution environment such as the JVM, C was employed as the programming language for these mechanisms. Furthermore, the Amigo solution was specifically

designed for open networked resource-constrained environments. Finally, the domotic infrastructure enables easy incorporation of other low-level bus or high-level service technologies. The Amigo solution to SD and SI interoperability ensures interworking between the most common SD (SLP, UPnP, and WS-Discovery) and SI (RMI, SOAP) protocols. The Amigo approach to the domotic infrastructure exposes heterogeneous domotic devices as UPnP or Web services. Both approaches as a whole enable integration of a large set of heterogeneous device and service technologies.

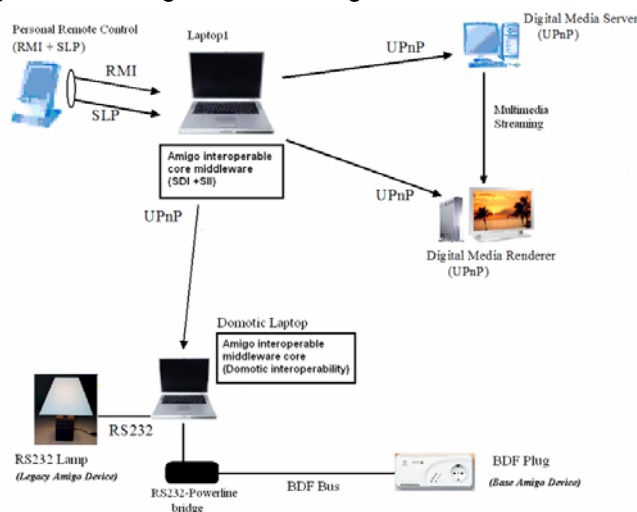


Fig. 9: Proof-of-concept prototype of the interoperability framework

### 5.1.3 Amigo Programming and Deployment framework

The Amigo Programming and Deployment framework helps developers program Amigo services without having to care about underlying protocols and thus reduce programming effort and enforce interoperability. Using this framework offers a number of advantages:

- Ease of programming, as protocol aspects are not dealt directly with
- Maintenance: possibility to correct problems at the core component level.
- Consistency: components developed by different partners using the same framework share common features. For example, all components that use the OSGi framework are available as OSGi bundles, and can be dynamically deployed from the bundle repository.

Hence the .NET / OSGi programming and deployment framework is an essential part of the Amigo Software. The goal of the framework is to support developers to write their application or component software in a short timeframe by relieving them of time consuming and complex tasks, such as protocol-specific details for remote communication and discovery. It enforces interoperability between different components by using an agreed set of networked protocols, i.e., WS-discovery for publishing and discovering Amigo services, HTTP/SOAP for remote method invocation, and WS-eventing for subscription to event sources. The OSGi framework (Java) and the .Net framework (C#) allow a Java or C# developer to:

- make a Java or C# object remotely available as an “Amigo Service”,
- publish an Amigo service through WS-discovery,
- discover Amigo services using WS-discovery,
- interact with discovered Amigo services.

A Java client may discover and interact with C#, .Net services, and vice versa. Applications/services developed using the .Net framework can be deployed on any platform providing the .Net or .Net Compact framework, which can be deployed on most PDAs or smart phones running Windows CE / XP. Applications/services developed using the OSGi framework can be deployed on any platform providing a compatible Java runtime.

The use of this framework is not mandatory, and developers may also package Amigo-aware services as independent applications that are to be deployed on a given system or hardware. Both kinds of

components will be able to interact within the same Amigo environment through SDP, communication protocols and interoperability methods. However, the use of the framework reduces programming efforts, eases reusability of components and enforces interoperability.

### 5.1.4 Amigo Intelligent User Services

The Intelligent User Services contain the functionality that is needed to facilitate an ambient in-house network. Figure 10 depicts the high level building blocks.

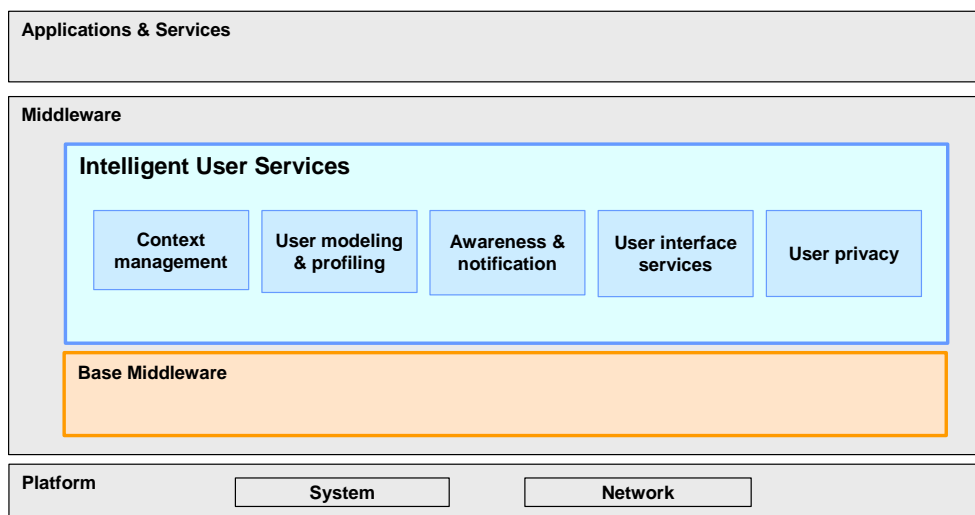


Figure 10: Amigo architecture

Besides their functionality, the Intelligent User Services broker between users and service providers, and provide context information, combine multiple sources of information and make pattern-based predictions. Information is tailored to user profiles and adapts to the user's situation and changes in the context.

#### 5.1.4.1 Amigo Context Management Service

The Amigo Context Management Service (CMS) provides timely and relevant context information to context aware applications and services. It deals with the collection of data for establishing context information and transforms them into appropriate formats that can be used for further processing. Context sources are, for example, basic sensor data on location, emotional states, environmental parameters, but also data on the presence of people (local and remote) that are derived from the existence of voices (speech detection and recognition front end) and acoustic scene analysis. This also includes detecting gestures of people and movements of objects. In all cases, it is necessary to recognize multiple users and multiple objects and being able to differentiate between them. CMS takes input from a range of different sources, transforms and aggregates them so that it can be used in a higher-level format by other services. Major challenges are finding the appropriate units of aggregation and the mechanism for dealing with missing data. Transformation mechanisms, context representation formalisms, and context ontologies are major components of the context management service, which together with semantic service descriptions allow inferring service parameters by reasoning from this context knowledge.

The most prominent advantage of the Amigo solution compared to existing context management infrastructure is its openness. This openness and interoperability is achieved by relying on standard technologies for:

- Binding applications to context sources: applications interact with context sources using the SOAP protocol which is a well established standard in the web service domain.
- Modelling context information: context information exchanged between context sources and context consumers are expressed in RDF. In our approach, pieces of context information are

considered as resources. The semantics of these resources is made explicit by relating them to an extensible context ontology expressed using OWL.

- Querying context information: context consumers use SPARQL for querying context sources on specific context information.
- Context interpretation is rule-based where rules are created by application developers; thus, context interpretation can be easily tailored to specific application needs.

Furthermore the CMS is an easy to extend and deploy infrastructure as it is implemented on top of the OSGi and .NET component based frameworks, making it easy for developers to integrate this framework in their applications and services to make them context-aware.

The CMS implements a distributed context management system. The context sources are designed as web services providing a standard context source interface. Compared to existing work, this Service Oriented Approach to designing a context management system is new and fits the dynamic nature of ambient intelligence environments or more generally pervasive computing environments, where objects and humans appear and disappear, and interact in a loosely and ad-hoc fashion.

The CMS architecture (Fig. 11) shows how physical sensors or any devices that could provide context information are encapsulated within an interface layer. For example, data processing systems such as a context history or dedicated context interpreters that abstract or aggregate context information can be integrated in this layer. The CMS infrastructure provides a directory service called Context broker which is aware of context sources that are actually available. Based on this information the context broker is able to connect consumers to context sources.

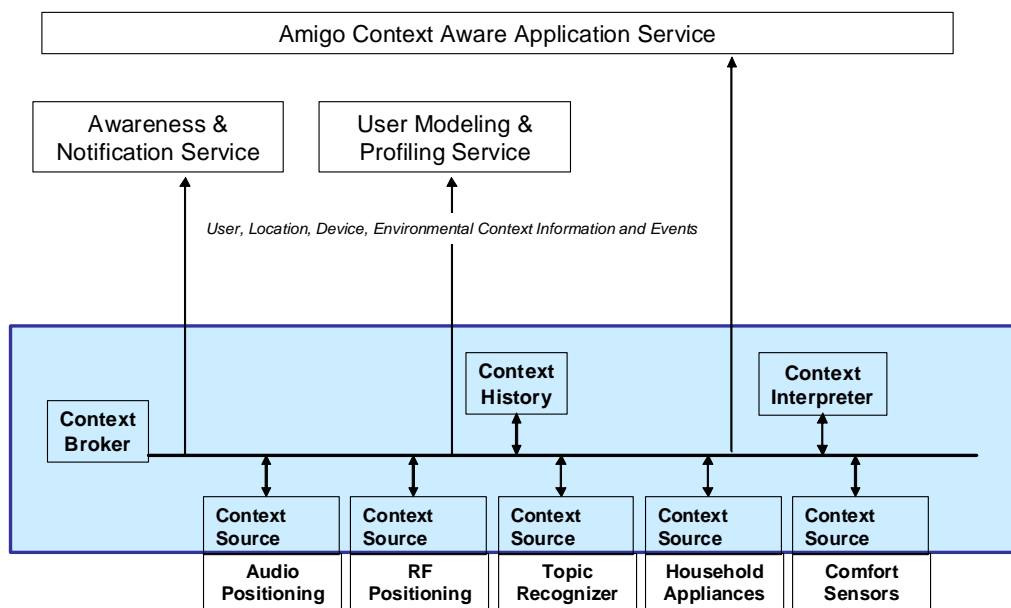


Figure 11: Context Management System architecture

#### 5.1.4.2 User Modelling and Profiling Service

The Amigo User Modelling and Profiling Service (UMPS) combine static and dynamic modelling of user preferences. Static modelling is based on use of stereotypes and explicit acquisition of context-dependent user preferences. Unobtrusive dynamic modelling of context-dependent user preferences, both for individual and multi-user environment, is based on learning context-dependent user preferences from interaction history. User profiles are initialized by using stereotypes avoiding the construction of user ontologies by the system. Users don't need to explicitly configure their profiles. The method adapts to family practices, learns preferences of multi-user environments fast and works well for heterogeneous groups of users.

### 5.1.4.3 Awareness and Notification Service

The Awareness and Notification Service (ANS) provides the basic functionality required to develop applications that allow applications and users to stay aware of any significant change in their environment with minimal effort. Changes that ANS is able to keep track of can be of various nature such as the activities or presence of remote people. The ANS rule language allows application developers to conveniently enhance their applications with reactive context-aware behaviour by using a scripting format. This relieves the developer from writing programming code inside his application to deal with notifications.

From the system perspective, ANS makes applications aware of context changes by notifying them. Applications do not have to take care about managing and monitoring context data. They only have to register monitoring rules that specify what changes in context should be notified to them. In our approach, changes in the environment are modelled using Event-Condition-Action (ECA) rules [5]. The service builds on top of the lower Amigo middleware. The lower middleware offers standardized and reliable functionality to publish ANS as an Amigo web service and enables communication with other user applications and user services. ANS uses the Amigo Context Management Service to access context data of the smart home and the User Modelling and Profile Service to access the preferences of the users (Fig.12).

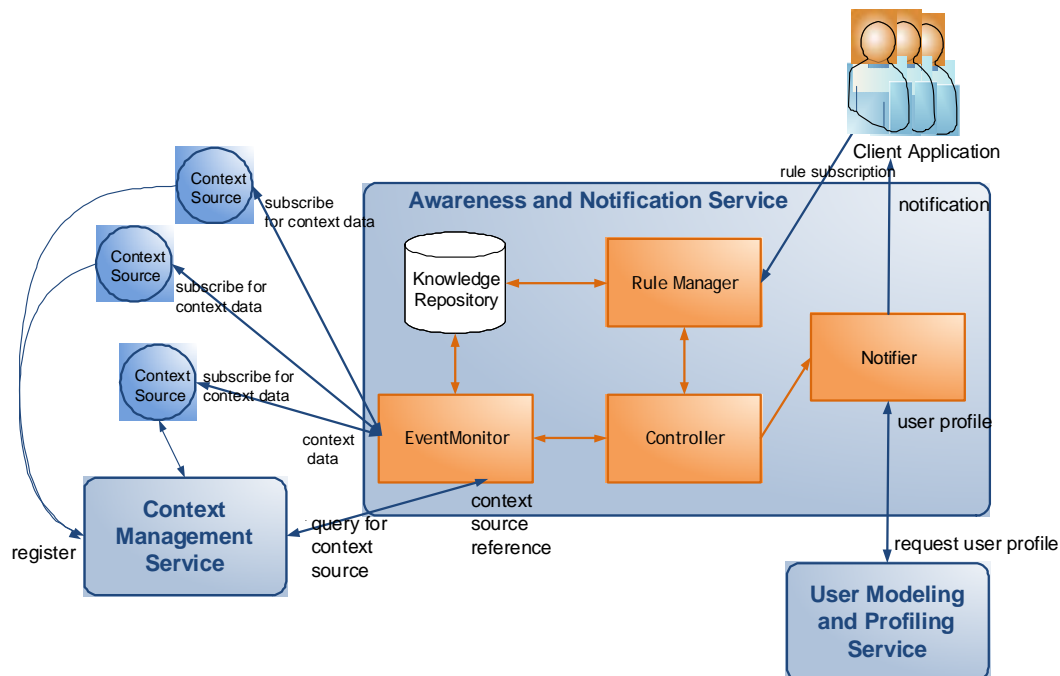


Figure 12: Awareness and Notification Service architecture

### 5.1.4.4 User Interface Service

The Amigo User Interface Service (UIS) handles the interaction devices to present the contents, manages multiple interaction modalities and their combination, and provides support for explicit and implicit user interactions. The UIS architecture provides flexibility and openness due to the Amigo service-oriented architecture and to the blackboard-based design of the dialogue manager. It is very easy to add new advanced interaction functionalities, such as a task manager for multi-user support, or an abstract UI model to decouple concrete UIs from generic UI descriptions at the application level. A set of interaction services is available, which include 2D and 3D gestures capture and interpretation, a generic GUI framework and advanced speech interactions with multiple microphones de-noising, flexible large vocabulary recognition, keyword spotting for implicit interaction, speaker adaptation, etc. Late fusion of all these modalities is based on standards that open the system to future modality add-ons, and that exploit semantic information for fusion.

As, ambient intelligence platforms exploit every potential interaction terminal available these devices have to be managed by the UIS and put at the disposal of the application controller. Furthermore, to

be at the service of everyone and to extend the range of potential users of the platform requires supporting different interaction modalities, such as natural speech, gestures and more traditional physical and virtual GUIs. Since, such a system runs everywhere permanently, this needs to be realized unobtrusively, i.e., without disturbing the users, except when they explicitly require it. Thus, both implicit and explicit interactions have to be smoothly integrated. The UIS is decomposed into three groups of functionalities (Fig. 13). The multimodal input service processes both user explicit and implicit inputs from different modalities.

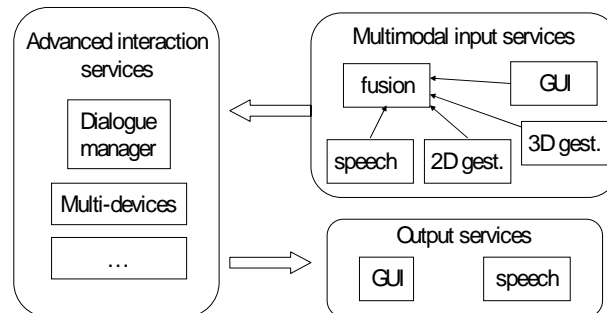


Figure 13: User Interface Service components

The Amigo Graphical User Interface (GUI) Service, for example, automatically generates graphical user interfaces to manage the complexity of networked-environments. The navigation structure and presentation can be adapted to the user's way of thinking and to the actual used interaction device. As the user interface is presented in a familiar way, users can operate an unknown environment efficiently without having to adapt to the logic of each environment. In contrast to other concepts, the personalization of menu structures can be applied to unknown services and environment configurations, because the logic of the menu structure is described, instead of integrating single appliances into a fixed menu structure. This offers the possibility to take operation strategies and presentations from one environment to another. Personal navigation structures can be appliance orientated like today's remote controls. Furthermore, the binding between devices and their functionalities can be broken to present a device-independent view of all the functionalities that are embedded in the environment.

#### 5.1.4.5 Community Sharing Services

The Amigo Community Sharing Services (CHESS) provides a generic mechanism to share web based applications between multiple clients. The basic principle of this mechanism is that it provides community based aspects to these applications, allowing sharing of information and experiences. Embedded within the Amigo network, this functionality enables users to share data and devices in their network with other users and organizes this sharing into a number of communities similar to the communities in Internet communication tools such as MSN, Jabber or Skype.

Multiple-user aspects and distributed applications for sharing information within and between different locations within the Amigo environment are possible. This includes remote presence and ambience sharing, thus linking spaces at different locations, the detection of multiple users in one and different locations. Note that there are different situations with regard to the distribution of applications: within the home, e.g., in different rooms of the same building, between different homes, and between the home and being outside the home in a mobile context. In all situations, users are able to operate their distributed devices and get in touch with each other's distributed services. CHESS provides the support for remote user interfaces and handles the gateways, the communities, the link to UIS, the service discovery and integration of the services. The standard that has been chosen for rendering of the user interfaces is CE-HTML. This format closely resembles HTML but is more specific to (thin client) CE equipment. It can be used by applications to create a GUI that can be displayed by various devices in an Amigo home; the input and output capabilities will then depend on the device (e.g. screen resolution, touch screen, remote control).

#### 5.1.4.6 Privacy and Personal Security (PPS)

Perceived privacy - how end-users perceive that a system affects their privacy - is one of the key aspects for user acceptance of ambient intelligent systems. It is also complex to handle. The Amigo

project takes an empirical approach to this problem, starting with exploratory, field and concept studies to acquire user input for design guidelines, followed by modelling and the development and implementation of an experimental platform for application tuning.

The user studies provided major observations on user behaviour with regard to handling perceived privacy:

- People use many diverse mechanisms to preserve their social privacy,
- People share their personal information only within a small community of relatives and friends,
- People need to perceive a clear benefit for information sharing,
- People control the level of detail of the information that is being shared, and they are consciously maintaining this control.

These results implied that, the type of information that is being shared, the level of detail at which it is shared, with whom it is shared, and whether it is shared between single individuals or groups of people are crucial variables to handle by an Amigo application. Design guidelines were derived from these data.

A privacy model was developed that consisted of the following four components:

- Services: to collect and provide contextual information about the environment.
- Applications: to provide access to contextual information.
- Control: to allow users to control the flow of data between components by setting their privacy preferences.
- User contacts: communicate with users; for example, family, friends, or any other pre-defined contact.

Different value combinations of the components create different context dependent settings. A sharing application by which two people at different locations can share content, context, location and presence, was chosen to implement this model.

## 5.2 Amigo modular training program

The main objective of the Amigo training program was to help bringing Amigo solutions the market. To this end, small and medium enterprises (SMEs) were selected as the main target group.

Courses were organized in a modular way. These courses also address the key technologies on which the Amigo middleware is based. This is required as SMEs are not necessarily familiar with modern software paradigms, e.g. ontologies. In addition to seminar content and lectures, training material has been developed that combines explanatory presentations with practical programming sessions in which participants have the opportunity to get in touch with the Amigo middleware. The material is provided in such a way that it can be used by people to get a quick practical introduction into the Amigo middleware. To this end appropriate self-training material has been developed and published on-line.

Seminar and training material has been developed for the following five major topics:

- Module A: New procedures and innovative approaches in multimedia and home automation integration
- Module B: Interoperability in managed home networks
- Module C: Interaction design
- Module D: Context awareness in Ambient Intelligent systems
- Module E: Addressing security and privacy issues in Ambient Intelligent systems

### 5.2.1 Seminar modules

The following six seminar modules have been developed:

- *Ambient Intelligence Environments*. After the presentation the audience knows the benefits of modern Ambient Intelligent home systems as well as the challenges that arise when building such systems. This lecture aims to provide the motivations for the Amigo approach and architecture.
- *Amigo Architecture*. After the presentation the audience knows the core elements of Amigo. They know the basic vocabulary that is used within Amigo in order to be able to follow additional detailed explanations of various Amigo components.
- *Context-Awareness Concepts and Principles: Introduction*. After the presentation the audience knows the benefits of context awareness as well as how this is established in the Amigo middleware solution.
- *Service Discovery for Context Aware Applications*. After the presentation attendees know how services within the Amigo environment are discovered and how context-aware service discovery is done.
- *Opportunities and Challenges of Speech Processing in a Networked Home*. The audience gains knowledge about the major components of a speech processing system as well as what can be achieved with speech processing. Further, it shows how to exploit the speech signal for physical user tracking.
- *Security and Privacy*. The lecture makes the audience sensitive to the security problems and shows the core techniques that are used to implement secure systems nowadays. The audience learns about the key approach that is used within Amigo to enable security.

## 5.2.2 Training modules

For the training sessions seven modules have been developed:

- *Using Amigo Web Services*: this training block introduces how to use the Amigo deployment framework.
- *Semantic Modelling for Ambient Intelligent environments*: this block gives a basic introduction into semantic modelling using ontologies.
- *Context Management Services*: explains how to use the CMS service and how to write context sources.
- *Awareness and Notification Service*: this block explains how an ANS client can be used to inject rules into ANS and to react on event generated by ANS.
- *User Modelling and Profiling Service*: during this block usage of the UMPS service is explained. The modelling tools as well as the API to UMPS are explained.
- *Security in Amigo*: during this part the Amigo security mechanisms are explained in order to secure communication channels in an Amigo network.
- *Multimedia*: this training block shows how to handle multimedia content in Amigo.

## 5.2.3 Self-learning material

Self-learning material has been generated to enable people to get into Amigo as fast as possible. This material contains both: a short introduction into the addressed topic and how it is solved in Amigo as well as a training part where programming assignments are presented to the reader and the solutions are explained in a step by step manner. In order to ease programming, appropriate sets of support files have been created which contain parts of the source code solutions and must be completed by the reader. Further, the complete solution to the problems is given as well. This self-learning material has been made available on the Amigo web-site for download. It provides the training material as well as the required Amigo software.

## 5.3 Amigo user-centred development approach

The Amigo project adopted a user-centred development process to obtain user requirements, to guide the system design process and to provide evaluation and user feedback throughout the



duration of the project. Since the Amigo system has to provide a complex platform that enables a wide range of functionalities and applications that have to benefit a large variety of users from varied backgrounds, the user requirements need to reflect this variety. Throughout the Amigo project a usage scenario is being used as the central representation to facilitate this process. This scenario serves to explain the overall vision and goals of the project; it envisions the use of a system that has not yet been constructed. The main topics in the scenario focus on the Amigo applications domains and comprise examples of the effect of the functionality of the Intelligent User Services. The user-centred research work consisted of a qualitative and quantitative evaluation of this scenario. Furthermore, an extensive field study was conducted in four European countries, France, Italy, Spain and the United Kingdom, to get insights into people's values, behaviour and attitudes in the context of everyday life: how they behave, interact and influence each other in the context of their home or an extension of it.

The user studies were composed of three complimentary parts. One part was dedicated to obtain the quantitative results and two parts were dedicated to obtain the qualitative results. For each part a methodology was designed, in which the Amigo application domains and the Intelligent User Services where the independent variables and user responses with regard to usefulness and appreciation ratings, listings of advantages and disadvantages, and feedback from focus groups were the dependent variables. The quantitative part – organized as a Gallery set-up – was conducted in exactly the same way at 6 different Amigo partner locations. The qualitative parts were conducted as focus group sessions and adapted to the partner sites. The participating sites were distributed over The Netherlands, Germany, France, Italy, and Spain.

The results from the qualitative studies were summarized and prioritized in 6 different classes of user needs, each comprising a set of user requirements. These user needs and requirements were fully supported by confirming evidence from the focus group reports. The 6 classes of user needs were, in order of user priority, to:

1. maintain control and responsibility for how their physical and social household is organized and kept
2. reduce the overload of information and the burden to search
3. reduce the load of housekeeping chores and to prevent all kinds of household accidents
4. have support for organizing their personal environment at home and between home and work
5. have support for organizing their home environment and ambiance
6. be supported with the care for others and for staying in touch with others.

Most pertinent user requirements were those, which we might call 'hygienic', such as, easy to use, nice looking, and no programming, no extra effort, affordable, functional. From the user's point of view, the functionality of an Amigo system could be distinguished in four categories. These categories concern: practical and improvement functions, and functionality that might affect social relations and social isolation.

*Practical functions:* addressing a recognized need or being quite handy to have. These functions were perceived as practical compared to current practices that people are used to. In this context, the home automation functions were well received in that they lead to an improvement of daily life and could reduce the tediousness of home care. The key user benefits concern everything that:

- Reduces malfunctioning and the time spent on domestic chores.
- Reduces risks for home accidents and calamities, i.e., a safe and healthy home environment.
- Integrates and links different devices.
- Improves home management.

*Improvement functions:* increasing pleasure by enlarging the possibilities for having access to information, entertainment and games. These functions were perceived as improvements to the environment and current practices that people are used to. In this context, people refer to the music that follows a person into various rooms or the ambiance that adapts to the environment for playing games or watching a movie. They expect that this brings more pleasure and enrichment to their leisure activities. The key benefits for the users are:

- New functionalities that provide new possibilities for using existing equipment.

- New possibilities for playing games.
- Broadcast that follows around the house.
- Making communication easier.

*Functions affecting social relations:* The relationships between the members of a household can be affected by, for example, the presence of cameras that monitor movements to provide context-aware services may invoke the feeling of being kept under surveillance. These functions need to obey and maintain social rules and conventions in order to be acceptable. The key user benefits are:

- Support for social and family activities in a context-aware fashion, while complying with social, privacy and politeness rules.
- Intelligent doorkeeper and safety control.

*Functions affecting social isolation, privacy and personal protection:* Consumers do not expect everything to be sanitized and automated. They are not looking for so much automation that this might result in the disappearance of even the slightest effort, nor for losing control when confronted with the mechanization of their daily life. This was perceived as a contradiction between the promise of an even more accessible and intelligent house and being forced to suppress their - "tactile" contacts with their environment, i.e., actions that are a way for marking one's territory and asserting oneself at home. As household data and information will be potentially exposed to the risks of intrusion, virus attacks and piracy, security and privacy protection are vital concerns. The centralization of several functions in a single system raised concerns with regard to potential malfunctioning of the system or the effect of, for example, power cuts. The key user benefits are:

- Perceived safety and protection against undesired intrusions.
- Partial automation of household activities
- Prioritization of set-up and possibilities for personalization

The user requirements resulted in an adaptation of the Amigo scenario. The scenario portrays a day in the life of a middleclass young family who uses an operational ambient intelligent system. It consists of 3 scenes which are representative for the three application domains of the Amigo project. The user requirements and the scenes in the scenario provided the input for the application development in the project. That is, the Amigo application scenarios (scenes) and the relevant user requirements for these scenarios were used throughout the project and adhered to by all application developers.

## 6 The Amigo Applications

The Amigo applications were developed for three different domains to demonstrate the potential for end-users and the benefits of the service oriented–middleware architecture for application developers. The objectives were twofold: 1) validating the Amigo middleware and the intelligent user services by integrating them in application prototypes and 2) exploring the scenarios and novel user interaction concepts for the application domains. The application development provided requirements for new services or middleware features and feedback on the use of Amigo software. This resulted in major improvements of the Amigo software quality. The three different domains for which the Amigo integrated demonstrators were developed are Home Care and Safety, Home Information and Entertainment, and the Extended Home Environment.

### 6.1.1.1 Home Care and Safety

The major aim of the Home Care and Safety demonstrator is to create applications for a comfortable, safe and secure home environment in which several household systems and devices, such as, the heating and air-conditioning system, domotic appliances, and sensor-monitored windows, doors and shutters are automated and controlled. Occupants are provided with a safe and secure environment in which calamities are detected, for example, gas and water leakage, intrusions, but also with advice for personal health and monitoring and coaching of personalized food and exercise patterns.

The prototype integrated different applications, for example, a personal health care centre, a daily life cycle manager, food and health management, technical alarms, appliances, and entrance management. The entire demonstrator was set up at the Ikerlan partner site in a newly built two bedroom apartment that also had a kitchen, bathroom and living room. This minimum infrastructure includes household appliances, furniture, medical measurement devices, video cameras and microphones to recognize people in the entry, sensors, user location devices, displays and so on. The apartment has been designed to show the demonstrator in the most *realistic way* to end-users for validation and user testing. The integrated demonstrator is shown on video [[http://www.hitech-projects.com/euprojects/amigo/videos/MASTER\\_con\\_TITULOS001\\_VP6\\_768K\\_Stream.swf](http://www.hitech-projects.com/euprojects/amigo/videos/MASTER_con_TITULOS001_VP6_768K_Stream.swf)]. Crucial to these applications is the dynamic adaptation to context information and the integration in a global home management system.

### 6.1.1.2 Home Information and Entertainment

The major aim of the Home Information and Entertainment demonstrator is to integrate home information and home entertainment environments by creating applications, seamlessly integrating and composing services, and providing users with easy discovery, access and interaction on any appropriate device wherever they are. The entire demonstrator was set up at the Telefonica I+D partner premises in a dedicated location with a complete network and user location infrastructure that simulated a networked home environment. The demonstrator has been equipped with a complete set of consumer electronics, legacy as well as Amigo aware devices. The prototypes integrate different applications (Amigo Box), for example, a home agenda, a monitoring manager and a personalized news recommendations service application for home information and a media manager, a context dependent personalization, and a privacy enforcement application for home entertainment. The demonstrator shows interoperability between different devices and services for content and information provisions in the home. The integrated demonstrator is shown on video [<http://www.hitech-projects.com/euprojects/amigo/videos/WP6%20-%20HIE%20Demonstrator.swf>].

The set of applications provides all that is needed for a digital home. Users don't have to buy new devices to connect to the Amigo Box. All the protocols are widely used standards such as, WiFi, Ethernet or UPnP. Most of the applications are web-based so any device with a web browser can connect to the Amigo Box and users can easily interact with their home devices.

### 6.1.1.3 Extended Home Environment

The major aim of the extended home environment demonstrators is to create applications that provide support for a shared feeling of presence through sharing ambience and activities of persons, between one's home and other distant environments, such as homes of friends, relatives, or the workplace. That is, to extend the home environment for both interpersonal communication and shared activities by using the generic Amigo platform (Middleware and Intelligent User Services). All the extended home applications focus on one of the two sub-domains, i.e., new forms of interpersonal communication and means for sharing activities with remote people.

The aim of the Palantir service, for example, is to indicate user status for ambient communication and activity sharing applications on the basis of contextual information relative to persons who are potentially involved. This service can also transfer events that are explicitly issued by users who are willing to enter in communication by using a particular application. Awareness and communication abilities are computed by the Palantir service according to context information and are sent to all registered Palantir GUIs, i.e., the implementation that shows presence of buddies as a patchwork of pictures with varying size and colour intensity. The more "aware" a buddy, the bigger his/her picture is. Buddy's communication abilities are reflected by the colour intensity of their pictures (Fig. 14, 15).

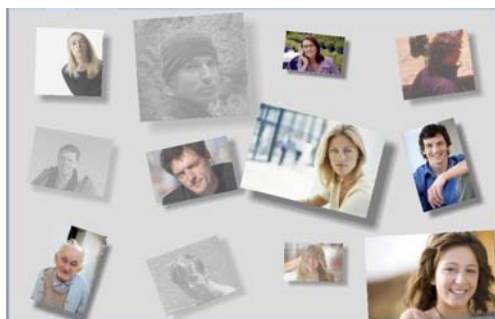


Fig. 14: The Palantir shows presence of buddies as a patchwork of pictures



Fig. 15: The Palantir ambience sharing supports a quasi-permanent communication link between remote people

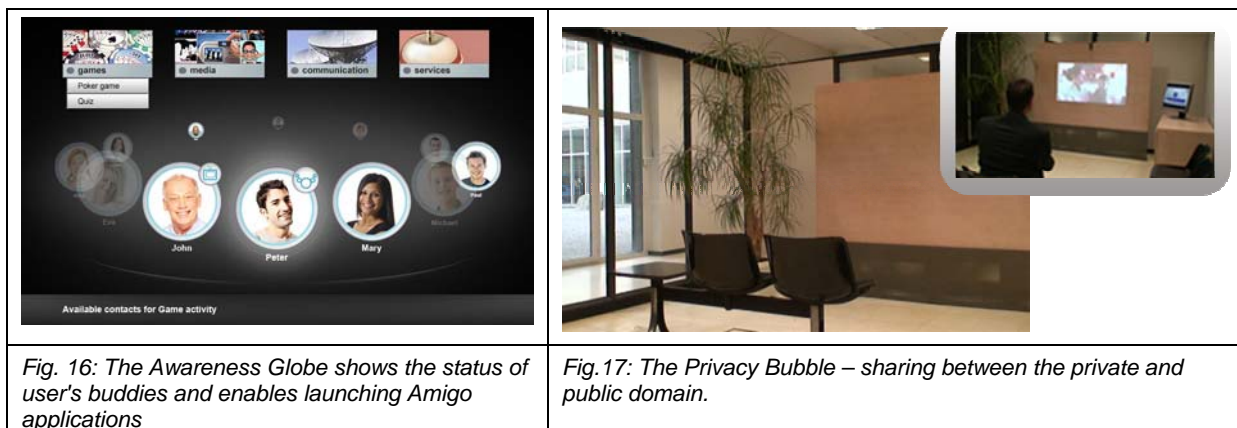
The Ambience Sharing application is a context-adaptive extension of traditional person to person visual communication services such as videoconference. It offers a quasi-permanent communication channel supporting smooth switching between different communication modes, covering a continuous spectrum between non-communication and full communication. The Ambience Sharing application adapts to activities and recedes into the background as much as possible. By using unobtrusive communication modes and implicit context-adaptive interaction it avoids the saturation of the users' attention and helps them to manage the range of services offered by ambient intelligence environments. This Amigo service implements also dynamic service composition for audiovisual communication. It is responsible for user location-driven video redirection and for interacting with the SAInt audio system and the Scheduler. The SAInt (Seamless audio Interface) audio system is a software building block for real-time audio communication and ambience sharing. It offers audio support and enables that the communication follows the user according to the information provided by the location management service and automatically adapts to the available hardware.

The Amigo "Activity Sharing" module lets users communicate with remote friends and family supporting the engagement in their social relations. Live audio and video is part of the interface on the normal TV and interaction takes place with a standard remote control. Status information (online / offline / busy) of online communities and community members is displayed on the screen. Users can select persons to communicate with and different activities to share, for example, shared photo browsing or playing a game. Furthermore, a tangible device, the Awareness Globe can show the status of user's buddies and allows launching Amigo applications (Fig. 16).

The Feeling@ application provides support for a shared feeling of presence between the home and the workplace. The interaction between the specified locations happens in different ways and modalities involving communication between parties, usage of a variety of devices and sharing of content. Direct communication is implemented as bidirectional audio-video conference between Home location and the Office, including the use of a Privacy Bubble. All communication is mediated by presence and availability concepts. Content sharing, again can be subdivided in direct user-conscious sending and receiving of data and indirect user-unaware synchronization of common

information. The former is addressed by media content sharing (images basically) displayed on video screens, while the latter involves work activity scheduling, shared and updated between different locations (Fig. 17).

The Personal Amigo Device (PAD) enables users to access services which are operating in their own home from other domains (e.g. a friend's home, cinema, and office). The PAD is a computing device that travels with the user and can 'bind' a visited domain to a home domain. It thereby tries to create a feeling of being at home even when the user is away!



All the demonstrator applications are context-aware; in particular they take into account user presence and user location in the environment. This form of context-awareness allows for dynamic adaptation to context changes and is a very good illustration of the power of the Amigo middleware. The service oriented architecture in which resource managers, arbitrating access to shared interaction resources, and application schedulers play a pivotal role. They offer a flexible solution while leveraging the Amigo middleware and services for dynamic context adaptation in distributed communication applications. The extended home applications have been installed and deployed at three locations: Philips' HomeLab, Ital Design's IDGLab, and France Telecom's VisionLab. The home information and entertainment applications have been installed at the Telefonica I+D premises. The home care and safety applications have been installed at the Ikerlan premises.

## 7 Availability of Results

### 7.1 The Amigo open source software repository and its related documentation

The Amigo Open Source Software Repository provides all the resources required to get started with developing new and exciting Amigo applications.

#### OSS Repository

The repository is based on the Gforge system (<http://gforge.org/>), and is available online at <https://gforge.inria.fr/projects/amigo/>. In the following, we will briefly tour through the various facilities the Amigo open source software repository provides.

#### The Amigo Project Summary Page

The Amigo project summary page, available at <https://gforge.inria.fr/projects/amigo/>, provides an overview of the Amigo software repository. This page lists all of the developers who are involved with the Amigo software, and provides contact details for them. Furthermore, the summary page lists announcements of the latest file releases of each of the Amigo software components.

#### The Amigo Downloads Page

The Amigo software, source code, API documentation, and user and developer guides can be downloaded from the Amigo software downloads page. It is located at [https://gforge.inria.fr/frs/?group\\_id=160](https://gforge.inria.fr/frs/?group_id=160). Here you find each of the downloads grouped by component, as well as tutorials and examples developed for the Amigo Challenge (<http://challenge.amigo-project.org>), and copies of the various licenses the Amigo software components are released under. Each component can be freely downloaded, and does not require registration. If you wish to monitor a component's releases, so that you are informed by e-mail when a new release of the component becomes available, simply click on the envelope icon "✉" beside the component name.

Package	Release & Notes	Filename	Size	DL	Arch	Type
<b>01 - Tutorials</b>						
Overview of the Amigo Open Source Software Repository						
Amigo_OSS_Overview.pdf			49 KB	8 Any		pdf
UMPS Tutorial 1.0						
UMPS-Tutorial.pdf			435 KB	52 Any		pdf
UMPS-Tutorial.zip			1.1 MB	18 Any		Source zip
Pentecost						
Pentecost-Tutorial.pdf			163 KB	104 Any		pdf
Pentecost-Tutorial.zip			11.24 MB	21.095		zip
VantagePoint						
VantagePoint_OSS_Tutorial.pdf			396 KB	55 Any		pdf
VP_OSSBundle.zip			8.31 MB	34 Any		zip
SD-SOCAE Tutorial 1.0.0						
SD-SOCAE-Examples-1.0.0-bin.zip			8 KB	104 Any		zip
SD-SOCAE-Examples-1.0.0-ecr.zip			20.7 MB	76 Any		Source zip
SD-SOCAE-Tutorial.pdf			618 KB	518 Any		pdf
ANS Tutorial 2.0						
ANS-Tutorial.pdf			248 KB	478 Any		pdf
ANS-Tutorial.zip			16.33 MB	86 Any		zip
Amigo Security Services Tutorial v2.0						
Amigo_Security_Services-Tutorial.pdf			471 KB	373 Any		pdf
Amigo_Security_Services-Tutorial.zip			15.25 MB	75 Any		zip
Web Services Tutorial 1.4						
Web_Services-Tutorial.pdf			912 KB	473 Any		pdf
Web_Services-Tutorial.zip			17.74 MB	153.095		Source zip
CMS Tutorial 1.0.0						
CMS-Tutorial.pdf			332 KB	396 Any		pdf
CMS-Tutorial.zip			37.64 MB	86 Any		Source zip

#### The Amigo Subversion Repository Page

If you wish to view the source code of the Amigo software, you can do so at the Amigo Subversion repository page, available at [https://gforge.inria.fr/scm/?group\\_id=160](https://gforge.inria.fr/scm/?group_id=160). From here you can view any revision of the Amigo software source code.

#### The Amigo Forums Page

The Amigo forums are the preferred channel for posting queries about the Amigo software. Several forums are available, and these are listed on the Amigo forums page at [https://gforge.inria.fr/forum/?group\\_id=160](https://gforge.inria.fr/forum/?group_id=160). There are five Amigo forums: amigo-mdw – where you can post questions about the Amigo middleware; amigo-ius – where you can post questions about Amigo Intelligent User Services; amigo-general – where you can post general questions about the Amigo project; as well as two forums created for the Amigo Challenge – amigo-challenge-general and amigo-challenge-technical which cater for Challenge entrants' general and technical questions about the Amigo software respectively. In these forums you will be able to find the latest announcements about the Amigo software, and share in other users' queries and their responses.

## 7.2 Amigo deliverables

The project deliverables that are downloadable from the project website are:

### User-centred development in Amigo:

Amigo D1.2 Report on user requirements, volume I: Summary

Amigo D1.2 Report on user requirements, volume II: State of the Art

Amigo D1.2 Report on user requirements, volume III: Quantitative and qualitative research scenario driven

### System architecture

Amigo D2.1 Specification of the abstract system architecture

Amigo D2.2 State of the art analysis including assessment of system architectures for ambient intelligence

Amigo D2.3 Specification of the Amigo abstract system architecture

### Amigo middleware

Amigo D3.1 Detailed design of the Amigo middleware core: Introduction

Amigo D3.1a Detailed design of the Amigo middleware core: Service modelling for Composability

Amigo D3.1b Detailed design of the Amigo middleware core: Service specification, Interoperable middleware core

Amigo D3.1c Detailed design of the Amigo middleware core: Middleware core security and privacy, Content distribution, Data storage

Amigo D3.2 Amigo middleware core: Prototype implementation & documentation

Amigo D3.3 Amigo middleware core enhanced: Prototype implementation & documentation

Amigo D3.4 Amigo overall middleware: First Prototype implementation & documentation

Amigo D3.5 Amigo overall middleware: Final prototype implementation & documentation

### Amigo intelligent user services

Amigo D4.1 Report on specification and description of interfaces and services

Amigo D4.3 First version of software services overview

Amigo D4.7 Intelligent User Services

1. Introduction
2. Context Management Service Software Developer's Guide
3. User Modelling and Profiling Service Software Developer's Guide
4. Awareness and Notification Service Software Developer's Guide
5. User Interface Service Software Developer's Guide
6. Community CE-HTML based Experience Sharing Service Software Developer's Guide
7. Intelligent User Services Privacy and Personal Security
8. Interaction Design & User-based Multiplelab Evaluation

### Amigo applications

Amigo D5.4 Prototype of Home Care and Safety application domain: Implementation and user guides

Amigo D6.4 Implementation of integrated functionalities for the Home Information and entertainment prototype: Implementation and user guides

Amigo D7.4 Ambient applications prototype for Extended Home Environment: Implementation and user guides

### **Evaluation and testing**

Amigo D8.1 Methodology and Test plan

Amigo D8.2 Verification of technical and functional aspects

Amigo D8.3 End user tests

### **Open source software**

Amigo D9.5 Web site for sharing open source software developed within Amigo

Amigo D9.5b Website for sharing the Amigo open source software

### **Modular training program:**

Amigo D10.2 Training activities

Amigo D10.3 Training Plan

Amigo D10.4 WP10 Training

### **Amigo project websites:**

<http://www.hitech-projects.com/euprojects/amigo//index.htm>

<http://amigo.gforge.inria.fr/home/index.html>

<http://www.hitech-projects.com/euprojects/amigo/tutorials.htm>



## 8 Potential Impact of the Results

Separate islands of Internet, mobile, CE broadcast and home automation that don't work together, currently exist next to each other. These proprietary vertical implementations are easy to market, but inhibit a wider acceptance by consumers as complex installation, operation, service and maintenance problems are induced. Installation of separate products is quite easy, but installation of networked products is hard. The Amigo project made a significant progress towards providing interoperability over devices, networks and services and making the installation easier for users. Amigo achieved this by means of automatic device and service discovery, and by creating flexibility and sustainability for a gradual roll-out and incremental building up of customized home networks. This infrastructure and the open source software enable the development and flexible implementation of a wide variety of innovative services, applications and products for the digital home. Current proprietary systems can not provide this.

An open middleware for the home network that may become a standard, whether it becomes de facto or through other standardisation channel, provides the common framework for developers and manufacturers to give an impulse to the networked home: a networked home that ensures interoperability. This opens a path to the home's inside for different stakeholders for new services and devices in the home. This interoperability between services and devices is an opportunity for the development of a new generation of telecommunication services gravitating around the home. These services can be accessible from external networks through the Amigo services, for example, controlling home appliances, consumer electronic devices and health devices from an external network, accessing data at the home and receiving data from it, or conducting remote deployment and configuration of components and services.

The Amigo technologies enable PC and Windows based mobile devices to interoperate with other mobile and consumer devices in the home, utilizing all programmable devices in the home, and to enable new devices from the mobile and consumer domain to use interoperable devices and offer new, innovative services. The main target users are designers and developers of services and applications and third-party developers in: 1) telecommunication, multimedia, informatics and consumer electronics convergence, 2) home automation and security, such as energy suppliers, household appliances, security and surveillance enterprises or health and assistance service providers, and 3) Internet service providers and entertainment companies.

Application designers and developers can build applications very quickly by just using a subset of the Amigo platform, having the possibility to gradually extend the applications with the tools that they are most familiar with. This is particularly effective for building showcases, for customization, and for transfer of knowledge and technology to different businesses and domains. It also facilitates effective knowledge transfer to SMEs and technical training of young professionals for the digital home domain.

Viable application domains for Amigo are, among others:

- Home automation, smart homes - new applications and services
- Digital home and advanced household systems
- Mobile services/content provision
- Consumer electronics and Lifestyle – resource-constrained networked devices, gateways, dynamic updating of software on remotely managed networked embedded devices, remote building of automation services,
- Health and wellbeing - ambient assistance services, elderly care
- Collaborative work and communication – sharing experiences, content, work

Regarding standardization, Amigo is a project that shows standards in action. The focus is on Open Source development, which supports open standards and promotes interoperability and interaction between systems. The components of the Amigo Service Oriented Architecture support Universal

Plug and Play, OSGi, and Web Services. The Digital Living Network Alliance standard is used to achieve multimedia interoperability in the base middleware. Results from Amigo are incorporated in a draft proposal for a Web-based protocol and framework for Remote User Interface on UPnP (Web4CE) and remote display of User Interface for third party devices. This enables a wide range of UI capabilities for TVs, mobile phones and portable devices.

## 9 Lessons Learned During the Project

Amigo is a large project and addresses a complex set of engineering problems. In addition, the run time of the project is longer than most internal consortium partner's projects, which ensures changing responsibilities for key people, re-adjustments of research focus, and trends in society. The lessons learned are summarized in the following list.

### 1. Team building and internal project communication

Maintaining and nurturing a 'team of Amigo's', composed of scientists, engineers, developers and designers from different cultural backgrounds, keeping the project objectives and ambitions at course, while countering the dynamics and challenges of our R&D work takes more than just management resources. This people factor and the complexity of making tacit project knowledge explicit and translating of expertise across multidisciplinary domains should never be underestimated in large complex projects like Amigo. For example, the Amigo project facilitated the turnover of nearly all work package leaders, i.e., the experts within the responsible organizations, and the change of activities from one group to another within one partner organization (namely from FhG IPSI which was dissolved to FhG SIT) without hampering the progress of the project. Key facilitators for this process were the communication channels in the project and the regular in-depth working meetings. The Amigo team was a TEAM in which everybody had a recognized role and acted as such.

### 2. Technical alignment within the project

Consistency of internal architectural relationships and alignments between the activities of the work packages should not be taken for granted. The Amigo project installed an architecture team to maintain conceptual consistency and technical alignment across work packages and to maintain the coherence of the middleware architecture when breaking it down to actual design decisions. The members of the architecture team were selected solely on their experience as software architects. They functioned as the technical conscience of the Amigo project. They identified and notified when problems occurred across work packages, acted on technical issues that crossed work packages and explained the architecture view within and outside the consortium. They helped individual contributors to the Amigo project to fit their work in the Amigo system and fostered cooperation between people and tasks to assure proper integration. The activities of the architecture team also involved restructuring and changing the duration of the relevant work packages and conducting explicitly enabling transfer workshops and meetings.

### 3. Adaptation to technical advancement

The Amigo project started in 2004 with the technologies and expectations of that time. Furthermore, the preparations for the project started in 2003. Technology has advanced enormously during these past five years. These technologies, for example sensor network technologies, could have been used differently in the project. Furthermore, the surge of Web 2.0 technologies that are often used for social networking application, just like many applications developed in Amigo are related to social networking. To stay up to speed with regard to such advances in technology and its applications, the project needs to be aware of the relevance of these developments for its activities and to adapt if appropriate and feasible. The Amigo application work packages started using such services as example to illustrate the adaptability and flexibility of the system. Other activities, not foreseen in the original proposal, were started, for example, the communication framework. Furthermore, the central role for the Context Management Service in the Intelligent User Services was made explicit for the middleware architecture. The choice of .NET Web interfaces was a risky decision 3 years ago. But, it is now very much at the forefront with regard to the devices' market of today, e.g., Apple iPhone and iPod touch with a complete Safari browser, TV with CE-HTML support, and even printers.

### 4. Adaptation to societal and end-user needs – sustainability and home automation

The original assumption of Amigo: the networked home as an important step towards Ambient Intelligence, can only be achieved if the benefits for the end-user of a networked home system are

attractive and evident, and services offer a surplus over what is offered by non-networked systems today. Most of these attractive services will use knowledge of the world around the device like the other devices in the system and the user. This is only possible in a networked system. The gathering and use of context and user information lead to the development of new services for the end-user that could enhance the attractiveness of the system for the end-user. For example: use a display that is in the neighbourhood to display information instead of on a small PDA display, use the processing capabilities of the home server to do speech recognition and communicating the results back to the camera that has only small processing capabilities in order to combine user-related and context-related information. For most consumers however, application of Amigo technologies and services as demonstrated in the project is still far away; why would a consumer talk to his/her washing machine, for instance? In home automation and domotica, people look more and more to Amigo-like results, not so much driven by the possible attractiveness of connected devices as above, but driven by e.g. energy consumption and sustainability concerns, and demographic changes, e.g. homes for the elderly. The Amigo project mainly adapted to these challenges by putting more emphasis in the dissemination activities on these applications that are particular relevant for these evolving consumer needs and showing how the Amigo interoperable middleware addresses these challenges.

#### 5. Dissemination of the open source software by means of a design competition

The Amigo Challenge has been organized as a design competition for students and the OSS communities. The major goal was to make the software available to a large community of young designers and developers. A website was set up and used to make all the software components, tutorials and developer's guides available. Forum sites and support for developers was made available. The challenge was announced and advertised, worldwide, via email, networks and professional organizations, and supported by the appropriate visuals. The project's website set-up for the Amigo challenge attracted over 9000 downloads of software and tutorials. However, the number of actual participants was extremely low, probably due to the fact that the prizes to be won were rather low. But, the effort was extremely useful for the project to ensure the usability and the completeness of all the software modules, documentation, developer's guides and tutorials and last but not least, to create a great amount of positive publicity for the Amigo project as a whole.

#### 6. Dissemination of the overall Amigo concepts and results

With regard to the overall dissemination of the project, the R&D expectations of 2003/2004 focusing on customer benefits of futuristic applications needed to be adjusted for the community of application development, emphasizing the modularity of the Amigo system and its flexibility in supporting the incremental development and integration of home automation applications. Both middleware and application elements appear to have different time to market. The influence and role of the existing infrastructures, i.e., including bricks and power lines, needs to be addressed and adapted for each potential stakeholder community. It should be noted that software production for the home, as Amigo propagates, is cutting edge with regard to current practice in the domain. The focus of the project with regard to dissemination has been on empowering the middleware for supporting interoperability and flexibility, and especially supporting the development of networked applications in an easy and dynamic fashion, thus, enabling all kinds of networked services that go beyond or integrate the current application demonstrators. Also, several of the elements of the original Amigo scenario were not very well appreciated by the target user groups. The user requirements have been accounted for in the Amigo applications and furthermore, when using the scenarios as a communication tool for dissemination, these elements could be varied and adapted to the stakeholder requirements.

#### 7. Take-up of technology is *not* about technology

The feedback given by the participants of the Amigo dedicated training program provided very useful feedback with regard to current practices, state of the art in the application domain and obstacles to take-up. That is, SMEs current technology is typically "years behind" of the Amigo approaches. They are looking for out-of-the-box solutions and are not convinced that Amigo will survive as a whole. But, they see elements of the application prototypes easily being taken up. This is not a matter of technology, but of market demands, trends, and politics, and of distribution and installation channels. However, Amigo was perceived by the SME community as setting the tone for demonstrating innovative concepts and ideas and as a source for innovative components and solutions.

#### 8. End-user acceptance and feedback

Most feedback of end-users was generated by means of the evaluation of the initial application scenarios and the final integrated prototypes. This feedback is not based on long-term usage in people's homes but on presenting and interacting with the prototypes. In general people liked the applications related to health and wellness, and home automation. However, whatever the feedback of the end-users, it is always dependent on how and to what extent they can trust the applications, how reliable, robust and trustworthy the system is perceived. It is important for users to have similar or universal interfaces for all the applications. Furthermore, the logging of user data, content, and context are extremely sensitive issues that need to be addressed for any subsequent implementation or follow-up research. End-users don't consider the different Amigo domains as separate domains. That is, for them interoperability is obvious and natural and it is much more important to maintain the overall comfort and social integrity of their home environment.

#### 9. Application developer acceptance and feedback

Building an Amigo service is fast, it takes about one day. Understanding the Amigo concepts takes longer, this takes several weeks. Application development is an easy task thanks to the availability of numerous attractive development and runtime features. The Amigo middleware is modular, flexible and open. Developers can employ one or more features, a variety of technologies and approaches, and they are not restricted in merging with non-Amigo technologies.

#### 10. Sharing ambience and activities

The concept of ambience and activity sharing that was exemplified in the Amigo extended home applications extends the traditional views of remote communication between people and between locations. The take-up of this concept in home applications will require heavy investment in devices and it is a long-term perspective, but it constitutes very suitable applications for the broadband home. Potential short term applications could aim at, for example, Informal communication in office environments, remote care, and remote assistance.

## 10 Partners

**Philips**, Royal Philips Electronics of the Netherlands is a global leader in healthcare, lifestyle and technology, delivering products, services and solutions through the brand promise of "sense and simplicity". Philips is the project coordinator of the Amigo project. Headquartered in the Netherlands, Philips employs approximately 121,700 employees in more than 60 countries worldwide. With sales of EUR 27.0 billion in 2006, the company is a market leader in medical diagnostic imaging and patient monitoring systems, energy efficient lighting solutions, personal care and home appliances, as well as consumer electronics. Philips Research has integrated experiences research into its innovation pipeline. "Our people-centric research involves understanding what people actually want from technology to improve their daily lives,"

**France Telecom** is number three mobile operator and number one provider of broadband internet services in Europe and one of the world leaders in providing telecommunication services to multinational companies. France Telecom serves more than 161 million customers in five continents (220 countries or territories) as of March 31, 2007, of which two thirds are Orange customers. In 2006, Orange became the Group's single brand for Internet, television and mobile services in the majority of countries where the company operates, and Orange Business Services the brand name for services offered to businesses worldwide. Orange Labs (formerly France Telecom R&D) now comprise all innovation activities of the France Telecom group, with 15 sites on 4 continents. Activities in ambient intelligence began at the Grenoble site around 1999, with a research agenda summarized by the phrase "communicating objects", a.k.a., "smart networked devices". As such, it encompassed both the evolution of interface devices for existing telecommunication services and emerging new services opened up by the networking of regular (non-IT) devices, now pursued in connection with a new line of business for M2M (machine to machine) services.

**Fagor** Electrodomesticos, the Spanish white goods multinational, is part of the Mondragon Co-operative Corporation (MCC). Fagor Electrodomesticos has a workforce of 4,500 people and manufacturing plants in four continents: Europe, South America, Asia and Africa. Fagor Electrodomesticos is divided in eight business divisions: refrigeration, washing and drying machines, cooking, dishwashers, heating, small electrical appliances, home systems and kitchen furniture. Therefore, Fagor Electrodomesticos can give a complete solution to the kitchen environment nowadays, including Home Automation services, and in the coming future with Ambient Intelligence (Aml) concepts.

The **Fraunhofer Institute Microelectronic Circuits and Systems (IMS)** is looking back on more than fifteen years of successful work chaired by Prof. Dr. Günter Zimmer. Due to a continuous process of scientific development and business growth the institute meanwhile plays a leading role in the field of applied research for microelectronic circuits and systems.

The **Fraunhofer (SIT)** in Darmstadt ([www.sit.fraunhofer.de](http://www.sit.fraunhofer.de)) is a specialist in IT security; SIT covers a wide spectrum of relevant technologies and topics. And because the digital world is rapidly converging, IT security questions additionally impact many other IT domains. Alongside purely security-related techniques such as biometrics, Internet security and electronic ID cards, therefore the Institute's sphere of work also embraces a variety of interdisciplinary technologies.

**Ikerlan** is a research centre which more than ten years ago together with Fagor started the development of a new concept of products in the Home Automation area. Ikerlan participates in the definition and implementation of the new Ambient Intelligent applications in other actuation fields at home: Entertainment environment; Communications outside home; And Security and comfort systems.

**INRIA** (National Institute for Research in Computer Science and Control) is a French public-sector scientific and technological institute operating under the dual authority of the Ministry of Research and

the Ministry of Industry. The research carried out at INRIA brings together experts from the fields of computer science and applied mathematics covering the following areas: Networks and Systems; Software Engineering and Symbolic Computing; Man-Machine Interaction; Image Processing, Data Management, Knowledge Systems; Simulation and Optimization of Complex Systems.

**Italdesign-Giugiaro**, established as Studi Industriali Realizzazione Prototipi in Turin, February 1968, is a concern operating in the development of projects within the automotive field. It can offer a complete program (from styling to assistance in pre-production stage) as well as smaller commissions which can be just as demanding as styling research, engineering of body subassemblies or building of prototypes. Having a good knowledge of the main software tools used in the design phases, Italdesign-Giugiaro can give a good support for the evaluation and benchmarking of the developed tools in terms of performances, user friendliness and applicability of the results in the daily business.

**SingularLogic S.A.** was established in 1988 by a group of post-graduate students from Patras Polytechnic University. Today, it is a member of the Logic Data Information Systems (LogicDIS) Group, one of the largest software and service providers in Greece. The company aims at developing and promoting Information Technologies and Communication systems in Greece.

**Microsoft** - The European Microsoft Innovation Center (EMIC) in Aachen (Germany) is a new R&D entity created by Microsoft to focus on collaborative research. This entity is growing to be 20 people strong in a year time and also has close collaborations with Microsoft's other Research and Development centres. EMIC is part of the Advanced Technology group reporting into the Chief Technology Officer of Microsoft Corporation. The group works directly with many of Microsoft's product and standards groups, giving it a clear and direct channel to disseminate and utilize the results of its research projects.

**Telematica Instituut** (as Telematica Research Centre founded in 1993) is a public/private funded research institute that performs applied research in the area of telecommunication and information technology and its applications. Its research focus is on mobility, middleware, service creation and service management, multimedia content engineering and distribution, e-commerce and human-computer interaction, in particular for in-home, Internet, and mobile environments. About 130FTE research capacity is available at Telematica Instituut. Projects are typically carried out together with industry on a bilateral basis, or within the scope of national or European research programmes.

**Institute of Communication and Computer Systems ICCS** has been established in 1989 to conduct research and development activity in the field of telecommunications systems and techniques, computer systems and their applications. ICCS is associated with the School of Electrical and Computer Engineering (SECE) of NTUA. ICCS has actively participated in both National and European community funded research programmes. ICCS has established research co-operations all over Europe. The Computer Network laboratory is now the biggest group in terms of staff and research activities. ICCS has a long tradition in the area of wireless communications. ICCS become an active member to the WWRF in two areas of major interest: context aware services and location based services.

**Telefónica I+D** is the part of Telefónica Group that develops new services for its clients using the latest technologies. Telefónica I+D intend to improve Telefónica Group's competitiveness through technologic innovation. This way, it can provide a better service and anticipate future user demands. Over the last few years, the line of work of Telefónica I+D has evolved to conform to the objective of becoming a services creation lab. This objective is driven by the emergence of interactive multimedia services which are increasingly becoming a major force in the telecommunications market.

The **University of Paderborn** calls itself "The University for the Information Society". Its strong position in computer science dates back to the initiative of Heinz Nixdorf, the famous German computer pioneer, who supported the foundation of a focal point in computer science and information engineering at the university in the 80ies. The cluster on speech processing of the Department of Communications Engineering (<http://www-nt.uni-paderborn.de/>) is concerned with hands-free speech

recognition and communication in adverse acoustical environments. Algorithms are developed for acoustic scene analysis (acoustic source localization, speaker tracking, etc.), speech enhancement (noise suppression, microphone array processing, and echo cancellation) and automatic speech recognition for various applications.

**VTT** Electronics is part of the Technical Research Centre of Finland (VTT, see [www.vtt.fi](http://www.vtt.fi)), which is one of the largest non-profit contract research organizations in Europe. The main technological subjects of VTT Electronics are telecommunication, embedded software, interactive systems and opto-electronics. Our services are used by electronics, telecommunications, process automation, mechanical engineering, instrumentation and software industries.



## 11 Contacts

Philips Electronics Nederland B.V.  
High Tech Campus 37 ( WY-3.010 )  
5656 AE Eindhoven, The Netherlands  
Contact: Maddy D. Janse (maddy.janse@philips.com)

France Telecom S.A.  
28 Chemin du Vieux Chêne  
BP 98, 38243 Meylan Cedex, France  
Contact: Gilles Privat (gilles.privat@francetelecom.com)

Fagor Electrodomésticos, S. Coop.  
Bº San Andrés, 18- Apartado 49  
20500 Arrasate (Gipuzkoa), Spain  
Contact: Imanol Lucas (imalucas@fagorelectrodomesticos.com)

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. Institut für  
Mikroelektronische Schaltungen und Systeme  
Finkenstraße 61  
47057 Duisburg, Germany  
Contact: Edwin Naroski (Edwin.Naroska@ims.fraunhofer.de)

Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. Fraunhofer-Institut für  
Sichere Informationstechnologie (SIT). (SIT replaces FhG IPSI)  
Rheinstraße 75  
D-64295 Darmstadt, Germany  
Contact: Thorsten Henkel (thorsten.henkel@sit.fraunhofer.de)

Ikerlan Sociedad Cooperativa  
P. Jose Mº de Arizmendiarieta n 2  
20500 Mondragon (Guipuzcoa), Spain  
Contact: Natividad Herrasti (NHerrasti@ikerlan.es)

Institut National De Recherche En Informatique Et En Automatique  
Paris-Rocquencourt  
Domaine de Voluceau - Rocquencourt - B.P. 105  
78153 Le Chesnay Cedex – France  
Contact: Nikolaos Georgantas (nikolaos.georgantas@inria.fr)

Italdesign – Giugiaro S.P.A.  
Via Achille Grandi 25  
10024 Moncalieri (Torino), Italy  
Contact: Luca Jozzo (luca.jozzo@italdesign.it)

SingularLogic S.A.

Al. Panagouli & Siniosoglou Str.  
142 34 Nea Ionia  
Athens, Greece  
Contact: Basilis Kladis (bkladis@knowledge-speech.gr)

Europaeisches Microsoft Innovations Center GMBH  
Ritterstraße 23,  
52072 Aachen, Germany  
Contact: Tim McGrath (tmcgrath@microsoft.com)

Stichting Telematica Instituut  
Brouwerijstraat 1  
7523 XC Enschede, Nederland  
Contact: Henk Eertink (henk.eertink@telin.nl)

Institute Of Communication And Computer Systems National TU of Athens  
9, Iroon. Polytechniou Str.,  
GR-157 73 Zografou - HELLAS  
Contact: Militiades E. Anagnostou (miltos@central.ntua.gr)

Telefónica Investigación y Desarrollo Sociedad Anónima Unipersonal  
Parque Tecnológico Walqa  
Edificio 1  
Carretera Zaragoza 330, Km 566  
22197 Cuarte (Huesca), España  
Contact: Jose Maria Miranda (jmmr@tid.es)

Universitaet Paderborn  
Dept. of Communications Engineering  
University of Paderborn  
D-33095 Paderborn, Germany  
Contact: Reinhold Häb-Umbach (haeb@nt.uni-paderborn.de)

VTT Technical Research Centre of Finland  
Kaitoväylä 1  
PL 1100 90571 Oulu, Finland  
Contact: Julia Kantorovitch (Julia.Kantorovitch@vtt.fi)

Project website: <http://www.hitech-projects.com/euprojects/amigo//index.htm>