Conjoint PERSONA – SOPRANO Workshop[1]

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Abstract. Being both EU-IST integrated projects in the field of AAL, PERSONA and SOPRANO organized a conjoint workshop on the occasion of the AmI-07 conference in order for the researchers of the projects to exchange insights of the approaches to the key field challenges, the achievements so far in each of the projects, and possible synergies in the future. Here, we summarize the exchanged info and the workshop results. The paper gives a good overview of the two projects and their status by the end of October 2007.

Keywords: EU-IST integrated project, ambient intelligence, assisted living, use cases and scenarios, architectural design, technological approach

1 Introduction

This EU Project Workshop has been a conjoint activity of the EU-IST integrated projects (FP6, IST-2006-6.2.2 Ambient Assisted Living (AAL) in the Ageing Society) PERSONA (Contract No. 045459) and SOPRANO (Contract No. 045212), both started in January 2007 with the goal to realize an Ambient Intelligence (AmI) solution for assisting elderly people throughout the life.

The project PERSONA aims at advancing the paradigm of Ambient Intelligence through the harmonisation of Ambient Assisted Living (AAL) technologies and concepts for the development of sustainable and affordable solutions for the social inclusion and independent living of senior citizens, integrated in a common semantic

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framework. PERSONA is developing a scalable open standard technological platform for building and hosting a broad range of AAL services, demonstrating and testing the concept in real life implementations, assessing their social impact, and establishing the initial business strategy for future deployment of the proposed technologies and services. Aiming at proposing an AAL system reference architecture, the PERSONA technical platform is exploiting and incorporating a broad range of relevant technologies, such as micro- and nano-electronics, embedded and distributed (bio)sensors / systems, communication and network technologies, energy control technologies, human-machine interfaces, and intelligent software tools for decision support.

The project SOPRANO aims to design and develop innovative, context-aware, smart services with natural and comfortable interfaces for older people with the goal to extend the time, in which they can live independently and autonomously in their homes. SOPRANO seeks to extend today's RTD methods by integrating design-for-all paradigms: from requirements, iterative prototyping and usability tests. Research is expected to strongly advance global knowledge in semantic IT, RFID location, remote diagnostics, radar and integration architectures. A new AAL architecture is to support pro-active assistance based on situational analysis fed by user input and local monitoring. Responses are to follow agreed rules and seamless access provided to external professionals. Safety and security is strongly enhanced with adherence to stringent reliability standards. Multiple modalities and dialogue adaptations to cognitive ageing help meet special accessibility and usability needs.

The workshop was organized as an exchange platform for researchers and scientists of SOPRANO and PERSONA to meet and discuss topics, such as:

- Ambient Intelligence use cases that destine the requirements for future technology research
- Ambient Intelligence technologies that will be applied with respect to the projects' application set
- Ambient Assisted Living architectures that enable the communication and cooperation of the identified devices and applications
- Field trial approaches for validation and enhancement of technology outcomes.

Furthermore, this workshop was expected to facilitate the establishment of communication and cooperation between the SOPRANO and PERSONA project members. Members of the two projects' advisory boards along with work package and task leaders and other selected project members were invited to participate. The following is a kind of report summarizing the presented material and the workshop results.

2 Summary of PERSONA Presentations

2.1 PERSONA Overview

PERSONA aims at advancing the paradigm of Ambient Intelligence through the harmonisation of Ambient Assisted Living (AAL) technologies and concepts for the

development of sustainable and affordable solutions for the social inclusion and independent living of Senior Citizens, integrated in a common semantic framework.

It will develop a scalable open standard technological platform on which a broad range of AAL Services can be deployed, to demonstrate and test the concept in real life implementations, assessing their social impact and establishing an initial business strategy for future deployment of the proposed technologies and services.

To meet its objectives, the project is faced with the following challenges:

- To find solutions and develop AAL Services for social inclusion, for support in daily life activities, for early risk detection, for personal protection from health and environmental risks, for support in mobility.
- To develop a technological platform that allows the seamless and natural access to those services indicated above.
- To create psychologically pleasant and easy-to-use integrated solutions.
- To demonstrate that the solutions found are affordable and sustainable for all the actors and stakeholders involved: elderly citizens, welfare systems, service providers in the AAL market.

The PERSONA technological platform will exploit and incorporate a broad range of relevant technologies which are developed and integrated in the project: AAL system reference architecture, micro- and nano-electronics, embedded systems (e.g. as in smart textiles), Human Machine Interfaces (display technologies, natural language communication), Communication (e.g. body area network, wireless sensor networks), software, web & network technologies (e.g. tele-services), biosensors (to measure physiological data), embedded and distributed sensors (to observe activity patterns, nutrition, gait, sleep), energy generation and control technologies (energy harvesting), and intelligent software tools for decision support.

An important measure of success for the project will come from the outcome of the evaluation and validation in extensive test-beds and trials in Spain, Italy, and Denmark.

Over a time frame of 42 months, PERSONA will be developed through a Consortium, led by VODAFONE. This consortium will bring together a group of leading organisations from all over Europe, contributing to the project with all the technological, scientific, sociological and business expertise required.

2.2 PERSONA User Experience Vision

As stated in the project mission, PERSONA is devoted to empower people to feel included, secure, protected and supported, by development of Ambient Assisted Living products and services for the achievement of more autonomy and quality in their lives.

People that will benefit for these AAL services are seniors that need any kind of assistance and help to continue living in their home, with an acceptable level of autonomy and do want to preserve the freedom of making their own decisions in all relative of their life.

In consequence, to succeed in this mission we need:

- To understand users' desires, needs, motivations and contexts

- To understand business, technical, and domain requirements and constraints
- To translate this knowledge in AAL services whose form, content and behaviour is useful, usable, and desirable as well as economically viable and technically feasible.

However, there are many obstacles we should overcome in our way to successfully implement such services. In the context of ICT projects, where carrying user-driven innovation is always a challenge, we need to define specific procedures to involve end-users in all the stages of development; but it could happen that our end-users can't comprehend the future technology. On the other hand, technology-oriented researchers can be very far from reality.

In order to put all these pieces together for them to work efficiently, PERSONA project adopted the strategy of defining an Activity Line specifically devoted to take care of the PERSONA's vision regarding user experience within the development process. The objectives are:

- To involve in an active way end-users & stakeholders in the different phases of the project to gain insights to understand:
  - Why people would embrace a particular AAL service
  - What these services should be about
  - Who are involved as stakeholder in these services
  - Where in the context of people's daily life they access these services
  - How do they interact with these services
- To set up pilot sites to gather continuous feedback from users. three sites have been defined:
  - Odense municipality (Denmark)
  - Comunità Montana delle Valli del Taro e del Ceno (Italy)
  - Valencia region (Spain)
- To develop common methodology for assessment and evaluation activities
- To organize the Group of External Experts & Users, that will address the interactions of PERSONA members with users, experts and stakeholders

2.3 PERSONA Requirements Collection

As AAL services are innovative in nature, standard user requirement collection methods are not enough and need to be complemented with new user experience methodologies that enable continuous end-user insights and feedback along the project. Consequently, in every phase of the project, iterative user experience loops will be integrated taking different users and stakeholders into account.

According to the analysis made in advance on the services of high potential impact for independent living of senior citizen, four categories of AAL Services have been identified as starting point for user requirement gathering:

- Social integration: services in this category aim at alleviating loneliness & isolation by empowering social contact and sharing of vital experiences

– Daily activities: services in this category aim at improving independence at home by supporting the realization of daily activities
– Safety & protection: services in this category aim at creating safe environment by detecting risk situation occurrence and taking care of them
– Mobility: services in this category aim at supporting life outside home by providing contextualized information and guidance.

PERSONA space	Body	Home	Neighbourhood	Village
User need	Support for personal care, physiological activities, self administration	Support for Instrumental ADL mainly housekeeping	Support for shopping and remainders of appointments. Planning social activities	Very similar to Neighbourhood
Issues	• Personal Care • Personal Hygiene • Comfort in dressing • Sleep period supervision	• Cooking assistance • Support for running a house	• Shopping in the supermarket • Remainder tool • Social activities/events agenda	
AAL services	• Caregiver support • Weather Info • safety services • Health services	• Cooking assistance service (recipes, shopping lists, meal storage list) • Shopping list/shopping (e-commerce) • Housekeeping service (cleaning, ironing, washing)	• E-commerce services • Leisure activities services • Agenda coordinator service	

Fig. 1. Example of AAL Service matrix for Daily Activities category

During the first iteration, each PERSONA AAL Service category was considered as a "context of use" and following aspects were defined and discussed in detail to compose a matrix related to the four spaces where the services could be provided (body, house, neighbourhood and village):

– User needs: define the main goal of senior citizens in each of the spaces and for all the categories of services.
– Issues that needs to be taken into account to cover user needs
– AAL Services: formalize how to address the issues to support the end-users in achieving their goals.

The next step was to illustrate each AAL Service by means of the definition of Scenarios ("A day in the life of…" tool). These scenarios describe how an end-user interacts with an AAL Service in a context of use. As a result, 16 promising use scenarios were produced as the first description of user requirements, combining our hypothesis based on our experiences in the field as well as real situations of elderly from the pilot sites which have been discussed and analysed in expert workshops.

The second iteration consisted of an enrichment process of the scenarios formerly defined. It started with prioritization of the current 16 scenarios according to its technical relevance and end-user interest. Eight scenarios were selected for improvement, technical requirements were included in the definition and functionalities that cover user-needs were described together with detailed interaction flows between systems, devices and end-users.

The result has been used as base to develop mock-ups to be validated by end user collectives to provide feedback of user experience to the AAL service specification. This evaluation will be done in the first six month of 2008.

2.4 PERSONA Technological Goals, Approach, and Achievements

The technological goal of the PERSONA project is to develop a scalable open standard platform for AAL based on a reference architecture for AmI systems comprising

- a self-organizing middleware,
- a framework supporting context-awareness,
- service-orientation (discovery, composition, provision, and orchestration),
- multimedia integration and content adaptation, and
- integration of embedded sensors and actuators.

As the number of research projects and industrial labs dedicated to AmI systems is constantly increasing, PERSONA decided to be a pioneer in identifying reusable results in the areas of architecture and middleware and chose an appropriate methodology for this purpose (see Fig. 2).

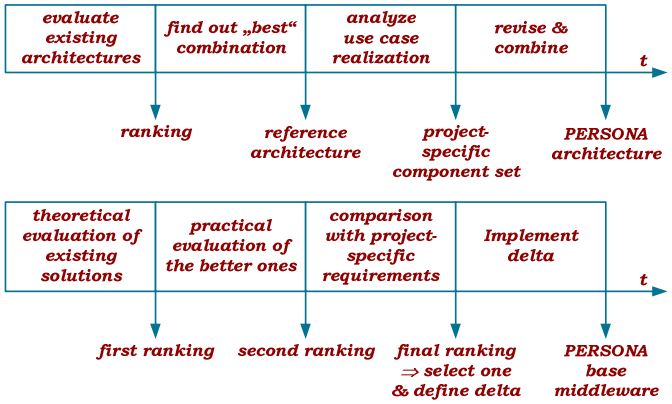

Fig. 2. Methodology for reusing solutions for architecture (above) and middleware (below) fulfilling PERSONA requirements

Starting with an abstract view on the physical architecture of AmI environments as a dynamic ensemble of networked nodes (see Fig. 3) and based on an understanding of *middleware* as the gluing software facilitating the integration of, and the collaboration among the nodes comprising an AmI system (cf. [4]), we gathered over 30 R&D projects with promising solutions in these two fields. After two quick iterations for filtering out those with comparatively less significant outcomes, this list was reduced to six: Oxygen (launched by MIT in 1999, still continuing), EMBASSI (1999–2003, a German national “seminal” research project), DynAMITE (2003–06, a German

national research project), RUNES (2004–07, EU-IST project), AMIGO (2004–08, EU-IST project), and ASK-IT (2004–08, EU-IST project).

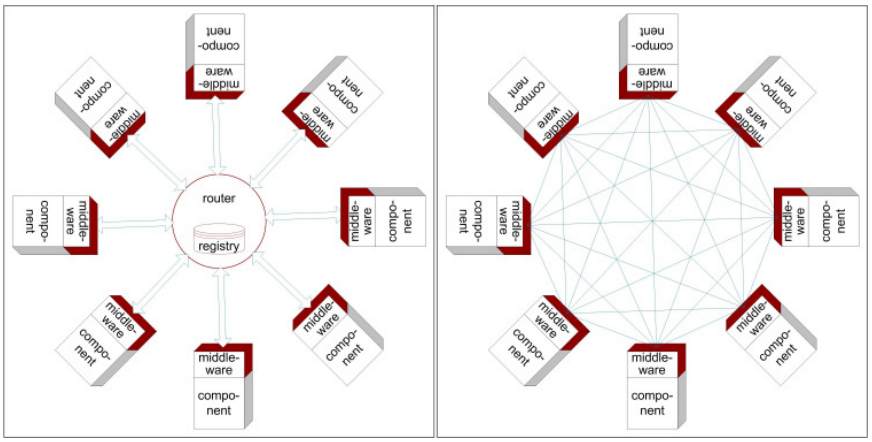

Fig. 3. An abstract view on the physical architecture in AmI environments as a dynamic ensemble of networked nodes, whether structured (left) or ad-hoc / peer-to-peer (right)

To guarantee a purposeful evaluation of the competing solutions, we defined a set of criteria for each of the two fields. In the field of architectural design, these were:

- Consideration of functional elements that facilitate the explicit, hybrid and multi-channel interaction of the users with the system, support context-awareness in all layers of the system and adaptability in the presentation layers, and hide the complexity of utilizing services from the users accessing them (cf. the concept of service brokerage in [7, 8]). Other integral functional elements could support QoS-awareness, identity management and privacy-awareness, among others.
- Regarding the domain-specific integrable components, guaranteeing a high-level of flexibility in the distribution of functionality and facilitating the integration of arbitrary numbers of sensors, actuators, control units, appliances, and applications into the system.
- Regarding the design techniques, the most important characteristic of an architecture is its modularity, because it leads to better distribution and extensibility of the system, higher maintainability / dependability, and greater possibility for reusing existing and composing new functionality.

The evaluation criteria for middleware comprised:

- Mechanisms supporting ad-hoc networking and self-organization of the components based on automatic service discovery and binding resp. service composition, on one hand, and aggregation of low-level events to deduce more high-level events, on the other hand.
- Supporting different communication paradigms, such as events, calls, streams, and transactions.

– At the technical level, stability and diagnosis, efficiency and performance, completeness versus complexity of the API, and level of dependency on platform and network layers.

Our studies showed that a combination of the data-flow-based approach of EMBASSI [2] and the service oriented approach of AMIGO [1] could lead to an optimized solution for AmI systems. Based on this conclusion, we worked out the architecture shown in Fig. 4.

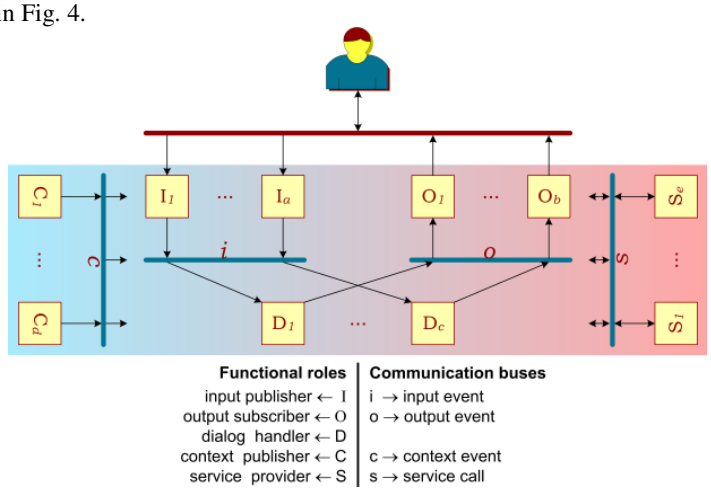

Fig. 4. The derived logical architecture for the PERSONA system

The architecture models the basic data flow in AmI systems: The explicit user input through *input publishers* and the contextual / situational events posted by *context publishers* trigger dialogs that will finally terminate with explicit system output through *output subscribers* and / or changes in the environment performed by service providers. The *dialog handlers* (formally equivalent to simultaneously playing the role of input resp. context subscriber, output publisher, and service client) are therefore responsible for the behavior of the whole system. All functionality not leading to context, input, or output events or their direct processing is abstracted as *service*, which is equivalent to the AMIGO approach; the way how this separation is considered relies however on the EMBASSI approach.

Fig. 4 defines furthermore the communication buses which reflect the loose connections needed in a dynamic environment and represent, in a modular way, the need for interface / ontology definitions, protocol specifications for communication, and strategies for "dispatching incoming messages" to an appropriate (set of) receiver(s). The horizontal arrows attached to the vertical buses symbolize the availability of services and context in the whole system, independent from any layering. For example, the input and output layers may access the s-bus for utilizing transformation services, such as ASR or TTS and the dialog handling layer accesses the s-bus, mainly for procurement of application services to the user.

The buses are realized by a middleware that must be integrated into each component, whether a (standard[2] or an application-specific) software component or a physical component, such as a sensor, an actuator, an appliance, or a device. (see also Fig. 3). Each such node may be so simple that it plays only one of the above mentioned functional roles and hence registers to only one bus or so complex with several functional roles that it must register to several buses each with different roles. Through the cooperation of different instances of the middleware, local pieces of the same bus will find each other and so will be able to cooperate with each other based on strategies specific to each bus so that the distribution of functionality in different nodes will remain hidden from the view point of the bus members.

The base software realizing the middleware is implemented as a set of OSGi bundles (see Fig. 5). It is formed from three APIs: (1) the abstract connection layer (ACL) realizes the ad-hoc networking within the ensemble with, by now, three concrete implementations using Remote-OSGi[3], UPnP, and Bluetooth, (2) the Sodapop [2] layer realizes the basic concepts of the bus structure and peer-to-peer communication between instances of the middleware, and (3) the last layer realizes the concrete PERSONA set of communication buses, each with an appropriate ontology, protocol, and strategy[4], and provides the open interface of the whole middleware to the application layer.

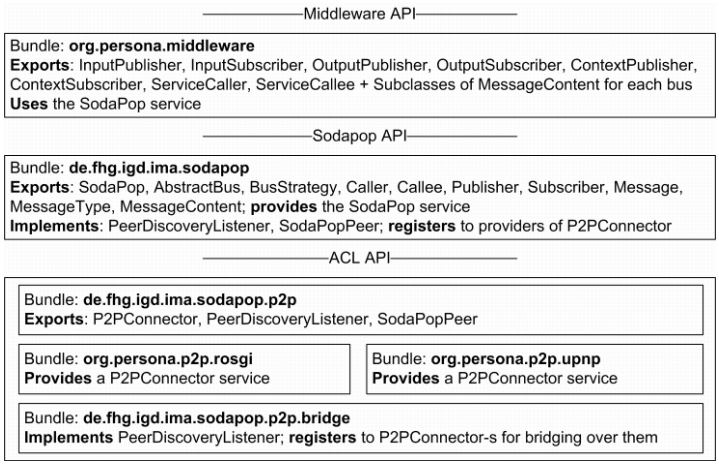

Fig. 5. The set of OSGi bundles realizing the PERSONA middlewar

[2] PERSONA has identified six standard components that are currently under discussion for providing their specifications: a rule-based context reasoner, a dialog manager as the default dialog handler, a service orchestrator for managing and performing composite services, a profiling component, a privacy-aware identity and security manager, and an AAL space gateway.

[3] http://r-osgi.sourceforge.net/

[4] The specification of these ontologies, protocols, and strategies is almost finalized; however, discussing them here would go far beyond the scope of this report.

3 Summary of SOPRANO Presentations

3.1 SOPRANO Overview

"Service-oriented Programmable Smart Environments for Older Europeans" (SOPRANO) is an Integrated Project in the European Commission's 6th Framework Programme. SOPRANO's aim is to enable older Europeans to lead a more independent life in their familiar environment. As an approach, SOPRANO will develop a next generation of smart homes based on ambient intelligence. Very important is the positive mindset of the project: the resulting system will not only act in problematic (e.g. fall, burglary) or emergency cases (e.g. health problems, fire) but will focus with the same attention on improving the quality of everyday life of elderly people.

Research within SOPRANO focuses on three pillars:

- to design the next generation of systems for ambient assisted living in Europe: highly innovative context-aware, smart home environment services with natural and comfortable interfaces for older people at an affordable cost, meeting requirements of users, of family carers and Europe's over-stretched care providers so as to significantly extend the time during which elderly people can live independently in their preferred environment;
- to set up large-scale, visible demonstrations of innovative AAL systems showing their viability in European markets - markets both for care provision and smart-home comfort;
- to adapt and extend state-of-the-art Experience & Application Research (E&AR) methods, integrating design-for-all components and providing innovative tools to create a new, consistently user-centred design methodology. Design-for-all is incorporated both to combat stigma and to reap economies of scale. These and design decisions informed by cost-benefit analysis in the project will help ensure SOPRANO solutions are cost effective.

A key feature of the methodology will be the frequent, active and strong involvement of older users throughout the entire R&D process, using scenarios, prototypes, test environments and implementations in real home settings, culminating in large-scale validation and demonstration of the innovative service-oriented smart living environments in real life settings with 600 users across four countries.

The SOPRANO environment will assist users in carrying out daily activities, monitor key vital signs and user activity - to detect situations calling for pro-active assistance- and provide strongly enhanced safety and security at home - not least by observing the most stringent of Europe's social alarm reliability standards. Through rule-based local monitoring and integration of external service provision, users will have the most effective access to social, medical and emergency services imaginable.

The technical core of the system in each house will be the SOPRANO Ambient Middleware (SAM), which receives the user commands and sensor inputs, enriches them semantically and triggers appropriate reactions via actuators in the house. SOPRANO adopts a novel ontology-centred design approach for this component in order to get an intelligently acting, but also deterministic and economically scalable module.

First prototypes of SORPANO houses based on SAM are expected in June 2008. The evaluation of the developed concepts is also planned in this year, both in a large-scale field trial in 300 homes with restricted functionality and a fully-functional trial in dedicated smart home laboratory environments.

The SOPRANO consortium of enterprises, public bodies and (university) research institutes comprises of 25 partners from 7 European countries, namely Greece, Germany, UK, Netherlands, Spain, Slovenia and Ireland, having expertise in:

- systems integration, software architecture, voice recognition, sensing systems, semantic ICT and a range of other technology domains;
- human factors, gerontology, user needs analysis and evaluation;
- social care of older people
- telecare and assistive technologies.

The project started in January 2007 and will last 40 months.

3.2 The need for Ambient Assisted Living

Over the last decade, considerable RTD efforts have been pursued by the European Commission, national governments and relevant industries to provide an adequate technology response to these challenges. In terms of technology uses, the so called "independent living" or "assisted living" domain today comprises a heterogeneous field of applications ranging from quite simple devices such as intelligent medication dispensers to complex systems such as networked homes and interactive services. Some are relatively mature and some are still under development.

When it comes to more complex systems in particular, the potential ICT generally holds in relation to independent living – e.g. in terms of quality of life for care recipients – are very likely to be not enough for the sustained success of ICT enabled social and medical support services.

Experiences from previous research suggest for instance that organisational, cultural and other non-technological issues come into the play if ICTs are to be successfully introduced into day-today practice. But also in relation to the technology itself, up to now all too often simplistic assumptions have been made in relation to the needs and aspiration of those who's independence is ultimately to be supported in one way or another, and of those who provide assistance to them as well. There is for instance some evidence that many older people, despite being in need of some help, are wary of giving outsiders intimate insight into and access to their homes. It seems very likely that they would accept technology based help more readily if they had more say in what information is sent out, to whom and under what circumstances. Also, the complexity and novelty of many systems and devices that have been developed during recent years seem to threaten many older people with exclusion from their uses.

At the same time, recent research suggests that a large segment of the growing number of older people in Europe can be offered ICT enabled support services which considerably improve their quality of life, provided usability of ICT systems can be equally improved. The opportunity to do so is given by recent developments in ambient intelligence and new abilities of software systems to communicate with users in something approaching natural human to human interaction. Against this

background, SOPRANO aims at taking a leap forward in the way users can interact with and take charge of their living environment and in the way professional care personnel can support them when called on to do so. In that sense, the SOPRANO system is not to act as a traditional "smart home", passively receiving user commands, nor as pure "remote care", monitoring user activity to alert outside staff to a need for action. Instead, SOPRANO shall act as an informed, friendly agent, taking orders, giving advice or reminders and ready to help, and get help, when needed.

3.3 Use Case Development and Participatory Requirements Engineering

Home technologies must be designed having the needs of older people in mind if these are ultimately to be successful in supporting their independence. Therefore, an extensive program of user-related research has been implemented during the first year of the overall project.

Work started with the conduction of an extensive literature review. Here the focus was on gaining a better understanding of physical and other changes that tend to come with the process of human ageing and their potential impacts on a person's experience of life in old age. This preparatory exercise was to lay the ground for the identification of key challenges to independent living, with a view to identifying options for the provision of an adequate technological response to these.

Further to this, a repository of generic situations potentially threatening older peoples' independence or quality of life was compiled on the basis of the knowledge gained from the literature, and on the basis of feedback received from those project partners who have experiences in providing support services to older people.

The next step in requirements elicitation focused on involving potential users of the SOPRANO system in order to gather their feedback on a) key challenges to independence/quality of life and b) initial ideas on how technology could be harnessed to better cope with these challenges. To this end a qualitative methodological approach was adopted, involving both focus groups and individual interviews. The "situations inventory" compiled earlier in the project was used for triggering responses and stimulating lively discussions at the part of the participants. Overall, 14 dedicated focus groups (with more than 90 end users) were conducted with older people, informal carers and care professionals in the UK, the Netherlands, Spain and Germany. Individual interviews with older people took place in Germany, Spain and the Netherlands.

Key themes that emerged from these activities for further consideration in the SOPRANO design process included both technical and non-include aspects. Amongst others, these include the issues:

- ***Social isolation/loneliness***: Perhaps one of the biggest problems mentioned at the part of the users concerns social isolation resulting in many negative outcomes such as loneliness, depression or the feeling of being cut-off. An aspect motioned in this context as well concerns the feeling of boredom which seems to be related with a feeling of being socially excluded in many cases.
- ***Safety and Security***: Another challenge that was frequently mentioned concerns the desire for safety and security. Important issues that were highlighted in this

context include for example falls, disorientation, control of household equipment or receiving help in the case of emergency.

- ***Forgetfulness***: Forgetfulness seems to be a challenge to independence for many and concerns for example taking medication or finding objects in the house. Particular issues that were mentioned around taking medication are multi facetted and relate to forgetting to take the correct medicine at the right time and to find the medicine in the house, but also to undesired side effects when taking different kinds of medicine. Also, some people seem to have problems in handling or managing their appointments or a normal calendar.
- ***Keeping healthy and active***: Challenges were also reported in relation to keeping healthy and active in later life, e.g. when it comes to physical and mental activity and exercise, good nutrition, good routines (such as sleep patterns) and, again adherence to appropriate medications. Some people reported difficulties in adhering to specific regimes that have been determined by health professionals, including rehabilitation programmes.
- ***Community participation/contribution to local communities***: During a UK focus group there was a strong emphasis on the desire to participate in local government activities and informal and semi-formal support networks. While this seems a somewhat unique view, this outcome points into the direction that community participation and contribution to local communities should not be underestimated.
- ***Accessing information/keeping up to date***: Keeping up to date seems to be a crucial issue for many as well. Here, access to local news or the possibility to read newspapers were emphasised, as was the need to find tradesmen to do little jobs around the home, such decorating, cleaning, repairs, etc.
- ***Getting access to shops and services***: People often seem to have difficulty getting out of the house for shopping banking pensions, etc. These kinds of services and support are usually outside the remit of local authorities so that the person in need to support has to manage getting such things done on his/her own, or is dependent on others or voluntary organisations.
- ***Checking up on care provision***: Local authorities can be purchasers and/or direct providers of care at home. As care is provided in the community within the person's own home, it seems not always easy to ensure that the right amount and right quality of care is delivered.
- ***Mobility inside and outside the home***: Keeping mobile outside the home was mentioned as a problem area as well. This concerns on the one hand being able to walk as long as possible and the use of public transport on the other hand. Mobility restrictions were reported especially common in winter and evenings.

The hitherto sketched work with older people, informal carers and care professionals revealed a set of key challenges to older peoples' independence and quality of life where some kind of technology-based response was seen as having great potential to provide practical help.

A set of use cases were developed to effectively capture functional requirements on the technical SOPRANO system by describing interactions between one or more users and the system itself. These scenarios not only reflect functionalities of the technical system under design but also the processes, actions and interaction of 'components' of the overall socio-technical system.

3.4 Ontology-Centered Design and Architecture

The technical core of the project is the SORPANO Ambient Middleware (SAM) [3], which will be installed in each of the houses and provides its intelligence by receiving user commands and inputs from sensors, enriching them semantically and providing appropriate reactions via actuators in the house. Planned are sensors for e.g. smoke, temperature, door status, location of the user by radar or RFID, her health status and so on. Planned actuators are speech synthesizers, digital TVs with avatars, device regulators (for switching devices on/off or modifying their behaviour), emergency calls to a central and more. Additionally the more static context of the house and the user shall be taken into considerations when performing concrete actions.

As SAM is supposed to be an integrating component in an open service infrastructure, a novel design approach was chosen for it to ensure semantic coherence: the *ontology-centred design* methodology, in which the ontology (i.e. the formal specification of a shared data model and vocabulary) is considered as a mediating artefact in the design discourse [5]. As a practical consequence, the ontology (see Fig. 6) was developed as a as the first step in order to serve as the basis for the subsequent design decisions - as opposed to other ontology-based approaches. The ontology is used as a blueprint for the internal data structures of the components, a guideline for the communication between components by helping to define interfaces and exchanged data structures as well as a communication vehicle between the technical system and the typically non-technical user.

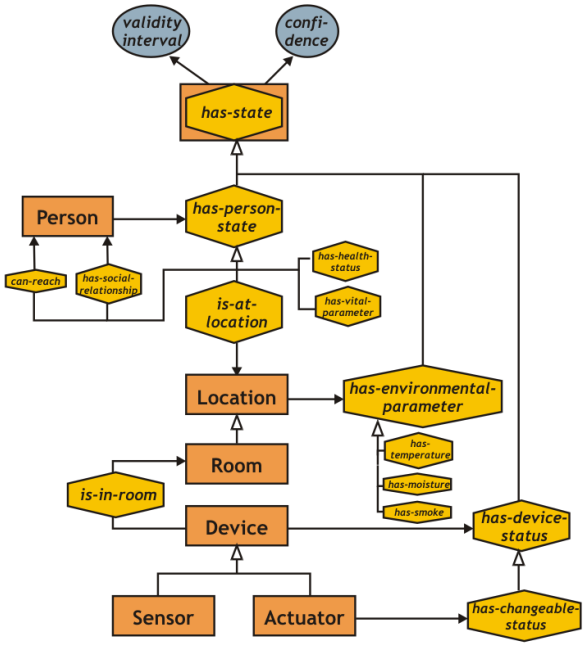

Fig. 6. Core concepts and properties of the SOPRANO context ontology (in an extended ER notation from [6])

From the architectural point of view (see Fig. 7), the ontology is used in the following ways: The contract with sensor components specifies that they provide basically state update messages (e.g. temperature is 23 degrees, fridge door is open) to the context manager (which is responsible for providing a consistent and up-to-date view on the current context, abstracting low-level sensor information into higher-level status information). This can be done via push mechanisms (the sensors sends state information to the context manager) or pull mechanisms (the context manager can query the sensor). The context manager updates the global context with this information and possibly aggregates it to other state information.

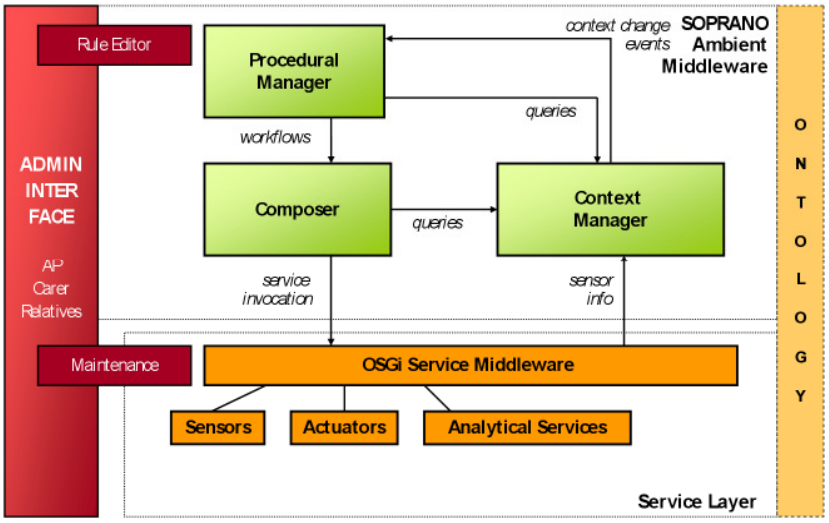

Fig. 7. Service-Oriented Architecture of SOPRANO

The Procedural Manager (responsible for context-aware system responses) registers with the Context Manager for changes to the state (e.g. AP has fallen, temperature in kitchen has fallen from medium to low, AP has not left apartment for more than 24 hours). Based on these context changes, the procedural manager can select predefined workflows whose basic building blocks are made up of goals as desirable target states (e.g. *neighbour informed*, if not possible or no reaction after 15 minutes: *relatives informed*, if not possible *service centre informed*). Based on these abstract target states, the Composer selects appropriate services described according to the state changes they can achieve.

This state-centric core of the SOPRANO ontology can be expressed in a subset of OWL Lite and thus allows for efficient implementation on top of relational databases. Subcomponents, though, might benefit from representing additional background knowledge in the ontology, e.g., for context aggregation.

4 Summary and Outlook

The workshop has brought together stakeholder representatives from the two projects and has provided an opportunity to exchange experiences made so far in relation to both requirements elicitation and system design.

Representatives from both projects agreed that successful research in the AAL field should have a strong involvement of users during the whole RTD process, and that a multi-disciplinary approach also involving experts from various disciplines is necessary. The workshop has also clearly identified that a number of research issues will need to be addressed to fully exploit the long term potential of AAL.

The two projects have used different approaches to elicit requirements but they have identified a very similar set of services useful to support independent living. This fact was acknowledged very positively by both of the projects.

One of the differences that have emerged is that PERSONA has an additional focus on mobility support whereas SOPRANO more concentrates on supporting older people in the house. However, since technical components under development will be conceived and designed as part of a socio-technical system, SOPRANO also considers mobility components, although with a less strong focus than PERSONA. This difference is also reflected in the technological solutions adopted where the SOPRANO middleware is a centralized solution and the PERSONA middleware is a peer-to-peer architecture. Nevertheless, both SOPRANO and PERSONA middleware are based on the OSGi gateway architecture.

SOPRANO will initiate early field trials in 2008. It will be very interesting for PERSONA to further exchange experiences for the preparation of the PERSONA trials that will start in the middle of 2009.

In order to further promote experience exchange between the two projects, it was suggested to:

- organize regular meetings in order to stay up-to-date with the respective progress,
- organize an exchange of expertise to evaluate the respective platform and services,
- consider the production of a joint public study on the user needs, and
- consider the definition of a joint public reference architecture for the middleware.

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