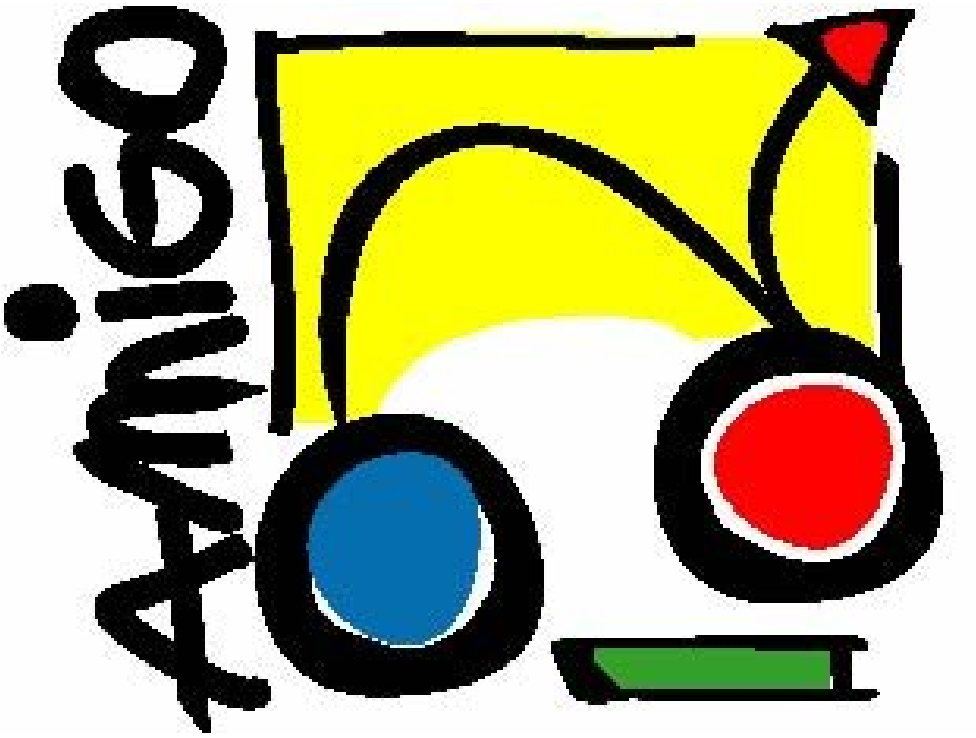

IST Amigo Project

Deliverable D2.3

Specification of the Amigo Abstract System Architecture

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Author(s)	:	Maddy Janse (ed., Philips), Fano Ramparany (FT), Basilis Kladis (Knowledge), Leo Rozendaal (Philips), Tom Broens (Telin), Henk Eertink (Telin)

Abstract

The abstract system architecture specification is presented as a point of reference for the overall Amigo system. It provides the basis for the design and implementation of core architectural elements that will be developed on other parts of the project. The dependencies between the different Intelligent User Services (IUS), between the IUS and the Amigo Base Middleware, and the IUS and the applications were presented.

Keyword list

Context-awareness, context-aggregation, context-prediction, user models, user profiles, user interface, user interaction, privacy, security, middleware, networked home system, ambient intelligence

Table of Contents

1 Introduction

The abstract system architecture specification serves as a point of reference for the overall Amigo system. It provides the basis for the design and implementation of core architectural elements that will be developed in other parts of the project, i.e., work package 3: Open Middleware for the Networked Home, and work package 4: Intelligent User Services. These architectural elements will be integrated in work packages 5, 6, and 7, the Home Care and Safety Environment, the Home Information and Entertainment Environment, and the Extended Home Environment respectively. They will be demonstrated and tested in applications in work package 8. The requirements for these architectural elements are derived from the user requirements that were generated in work package 1: User Requirements [1].

This report will focus on the specification of the abstract intelligent user service architecture. It complements the abstract middleware architecture that was specified in Amigo Deliverable D2.1 [2]. Together, Deliverables D2.1 and D2.3 specify the complete abstract system architecture. Figure 1.1 depicts the global system architecture, i.e., relative positions of middleware, intelligent user services, applications and the global architecture of the intelligent user services layer.

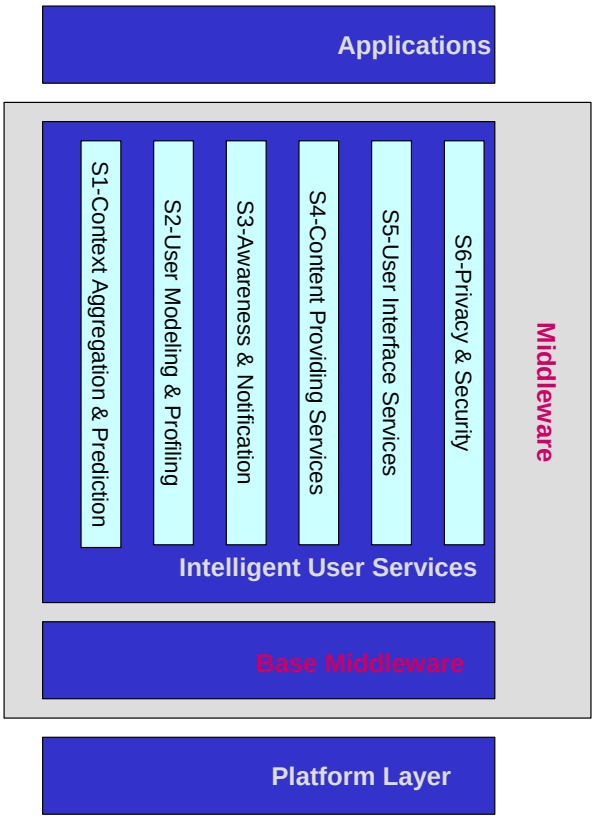

Figure 1.1: Amigo global system architecture

Within the first phase of the Amigo project five main topics for intelligent user services will be researched:

- Context Aggregation and Prediction (S1)
- User Modeling and Profiling (S2)
- Awareness and notification (S3)
- User Interface Services (S5)
- Security and privacy (S6)

The sixth topic, Context providing Services (S4) will be dealt with at the later phases of the Amigo project.

Context Aggregation and Prediction (S1) focuses on collecting, using and predicting context information. The goal is to provide the right information to enable the system to adapt as good as possible to the conditions of the physical context and the behavior of the persons and devices in it.

User Modeling and Profiling (S2) focuses on extracting user preferences from user actions or utterances. The goal is to adapt the system to these user preferences.

Awareness and Notification (S3) provides a mechanism that exploits information provided by different sources and presents this information in an appropriate fashion to different stakeholders; it also provides mechanisms that allow users to stay in touch with friends, and have a feeling of being connected with them.

User Interface Services (S5) handles the devices to present the contents, interaction modalities and explicit and implicit user interactions.

Security and Privacy (S6) focuses on ensuring personal privacy and security for the highly personalized Amigo system. This is a major challenge as it exploits the benefits of personalization. Sensitive personal information is being acquired from users, combined, processed and stored. While the middleware focuses on the technical foundation to warrant that secure data storage and privacy protection is possible, the Security and Privacy Intelligent User Service ensures the personal security and privacy protection.

This report starts with an overview of the requirements and the related scenario components that were derived from work package 1, Deliverable D1.2, [1]. After this overview, each of the intelligent user services will be discussed. The specification of the abstract intelligent user service architecture is an introduction to the work in work package 4, and will be further elaborated in Deliverable D4.1.

In summary, this report (Deliverable D2.3) reflects the intelligent user service architecture. It complements the middleware architecture document (Deliverable D2.1), it is an introduction to the report on specification and description of interfaces and services (Deliverable D4.1), and the detailed design of the amigo core middleware infrastructure (Deliverable D3.1).

2 Requirements for Intelligent User Services

While the investigation of requirements and attitudes of potential users is always important, it is especially relevant for these systems involving intelligent user services because the potential benefits are not for “free”. To effectively support people in their home environments, we have to provide the system with a certain amount of data about their behavior, or allow the system to collect these data by using different means. Given this situation, great care needs to be taken to build trusted platforms that perform exactly as they are expected to do, that protect our intimate data, and still allow easy access to it. Still, people might be hesitant to accept services that an intelligent home environment offers, if issues of control or privacy are involved.

Therefore, in order to succeed at defining, developing, and delivering useful services for future home environments we involved the potential users of those technologies right away from the beginning. Since the target end-user population for the intelligent user services comprises citizens from large urban and suburban areas in different parts of Europe, we conducted user studies not only in one country but exploited the situation of having project partners in several European countries. These studies resulted in lists of prioritized user requirements in Deliverable D1.2 from which technical requirements could be derived and worked out for the middleware architecture in Deliverable D2.1. The next step is to elaborate these requirements for the intelligent user services.

The intelligent user services in the Amigo project are:

- S1: Context Aggregation and Prediction (Task 4.1, Task 4.2)
- S2: User Modeling and Profiling (Task 4.4)
- S3: Awareness and Notification (Task 4.5)
- S4: Content Providing Services (N/A in the first 18 months of the project)
- S5: User Interface Services and Interaction Design (Task 4.8, Task 4.9)
- S6: Privacy and Security (Task 4.3)

In the following, for each of these services, the most appropriate user and technical requirements are summarized according to levels of priority as described in Deliverable D1.2. The associations between technical requirements and intelligent user services are the result of internal Amigo workshops. They were described in Deliverable D2.1.

S1: Context Aggregation and Prediction

One user requirement, unique to the context aggregation and prediction service and with high priority (priority 1) is: ‘The system must provide an added value to existing systems for multiple users at the same time’. Additional high priority requirements for S1 are: ‘the system should take context/environment conditions into account and be aware at any time of the local situation’ and ‘the system should take implicit social rules of behavior into account’.

From this and related user requirements, the following technical requirements can be derived:

- The Amigo system should be a distributed multi-user system, that;
- supports profiles of user groups (communities)
- provides personalization and customization
- assesses situations

Further main and crucial technical requirements that relate to S1 are: easy plug-in of sensors for capturing data, aggregation of sensor raw data to meaningful attributes (e.g., location) and abstractions such as “user looks at device or is to the left of the device” need to be supported. This implies that the system should serve more than one user at the same time, execute services, capture, use and store data and content on different devices, independent of the actual location of the user interaction device. The system should have the ability to adapt the behavior of the different devices to user preferences and the conditions of context and environment, including investigating different solutions for managing and storing the collected data, e.g., in (central) servers or in personal (storage) devices that users are carrying with them.

S2: User Modeling and Profiling

A top priority (priority 0) user requirement for the User Modeling and Profiling service is: ‘the system should enable individual settings and preferences’. Another high priority user requirement (priority 2) for this service is: ‘the system should provide concurrently the appropriate information to the right persons for the appropriate occasion at the right location. From these and related user requirements the following technical requirement can be derived:

- The Amigo system should be a system that can be personalized and customized such that it;
- can assign individual settings and preferences for users in a multiple user environment
- can adapt to different user profiles
- can adapt to privacy preferences
- can assess and adapt to the context in which it is used
- can adapt to the interaction between user profiles and context of use
- can track and keep track of the location and movement of users

In addition and unique for this service but dependent of the application domain is the user requirement: ‘the system should be energy-saving’. The technical requirement that can be derived from this is:

- The Amigo system should account for energy consumption by;
- being aware of levels of usage and costs
- setting priorities for devices and services
- being aware of the context of use

S3: Awareness and Notification

Awareness and notification is a common aspect for many Amigo applications. The user requirements and hence, the technical requirements can be classified into two distinct groups, based on two definitions of the term awareness. These definitions are: a) A mechanism that exploits information provided by different sources either in the form of basic data coming in from sensors and user interaction or already aggregated at a higher level and b) Awareness systems are computer mediated communication systems that support two or more individuals to stay aware of the activities of the other, with minimal effort over prolonged periods of time.

With regard to definition a), the user requirement with the highest priority (2) is: 'the system should support having control over data and information for best performance'. This requirement refers to the need that people have for reducing the overload of information and the burden to search for it. From this and related user requirements the following technical requirement can be derived:

- The Amigo system should be a system that enables users to watch and receive their multimedia contents everywhere in the house regardless of where the source of this content is, on any device they choose for display, with acceptable quality and without distortions and interferences. This implies providing;
- context awareness (see also above)
- classification and distribution of data
- situation assessment
- quality of service

With regard to definition b), the major user requirement is: 'the system should support keeping in touch with groups of friends and maintaining the feeling of connectedness'. From this and related user requirements the following technical requirement can be derived:

- The Amigo system should be a system that enables users to stay in touch with groups/communities of other users and to maintain the feeling of connectedness without the need for being always available. It should take implicit social rules into account and it should support different communication moments of users in different usage contexts. The system should;
- be able to share user information
- be always available
- have a component-based user interface structure
- support service availability
- have location management
- have trust management

For requirements concerning context awareness, multi-user system and personalization and customization see above.

S4: Content Providing Services

The activities for these services will start in the second phase of the Amigo project. They will not be discussed in this report.

S5: User Interface Services and Interaction Design

The focus of this intelligent user service is to support interaction based on multiple smart artifacts with intuitive and natural interfaces that are multimodal. Usability and comprehension by end-users are crucial in order to create engaging and coherent experiences for users. The high priority requirements for this user service concern the control by the user over their data, the possibilities to communicate and play games with multiple people at the same time, and accounting for implicit social rules of behavior. These requirements are not unique for S5; they are shared among all user services. From these and related user requirements, the following technical requirements can be derived:

- The Amigo system should be a distributed, multi-user system, that;
- provides context awareness and assesses situations
- supports sharing of information between communities
- provides automatic community information
- ensures quality of service
- supports natural, intelligent, context-aware, multi-modal, dynamic, component-based human-machine interfaces

In addition for specific situations, like game playing by children, the system should

- enable parental monitoring
- encourage physical interaction

S6: Privacy and Security

At issue for this intelligent user service are the privacy implications of employing sensing technology for recording and monitoring the behavior of people, and storing and using these data for automatically selecting and adapting functionality and services to users. The understanding of users of these implications is due to unfamiliarity not reflected in the requirements that they generated. However, a major requirement identified by the users was:

The system should provide concurrently the appropriate information to the right persons for the appropriate occasion at different locations and at the right time. It should provide controllable access and respect individual preferences and authorities. The technical requirements derived from these and related user requirements are:

- The Amigo system should be a multi-user system that can be personalized and customized, such that it;
- generates and maintains privacy profiles
- enables user authentication
- tracks user behavior
- detects physical intrusions
- assesses situation conditions
- is context-aware

The abstract architecture specifications for the intelligent user services will be introduced in the following chapters. Figure 2.1 (example for S1) shows the interfaces and dependencies that will be considered as a starting point for the specification of the abstract intelligent user service architecture.

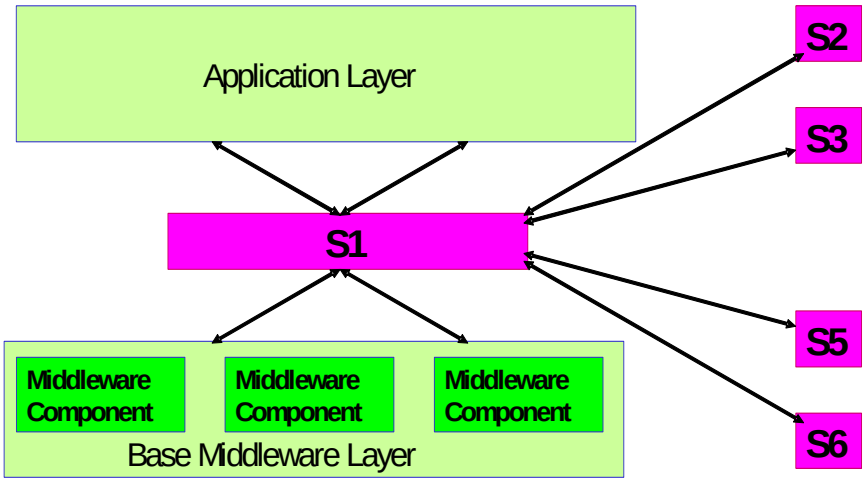

Figure 2.1 Example of Amigo intelligent user services and their interfaces and relationships.

3 Context Aggregation and Prediction (S1)

3.1 Introduction

To enable the development of context-aware services or applications two requirements are crucial. These requirements are:

- for the Amigo middleware architecture: the ability to use context information while looking up a service and
- for the Amigo application level services: the ability to exploit context information for its internal processing.

Context management is in this context a crucial component of the Context Aggregation and Prediction Service. It, addresses specific requirements with regard to handling real-time events, maintaining persistence for storing and retrieving data, and processing complex requests.

The context manager must have the capability to store and access context information in a consistent, yet flexible manner. In many cases, context data are received from heterogeneous sensors; it is desirable for the data to remain persistent. A persistence mechanism is any technology that can be used to permanently store objects for later update, retrieval, and/or deletion.

3.2 Architecture

The main functions of context management are to acquire rough data from sensors and other context information sources (UI interfaces, services, external or legacy context information sources), to aggregate and abstract these data into relevant context information, and make this information available to the Amigo intelligent user services and applications. Storing and exploiting context histories and activity patterns make it possible to predict future contexts. These functions are supported by a context management system.

Figure 3.1 shows the abstract overview of the Context Aggregation and Prediction service. Context Aggregation and Prediction service interfaces with most of the intelligent user services as well as with the upper application layer to provide information on context.

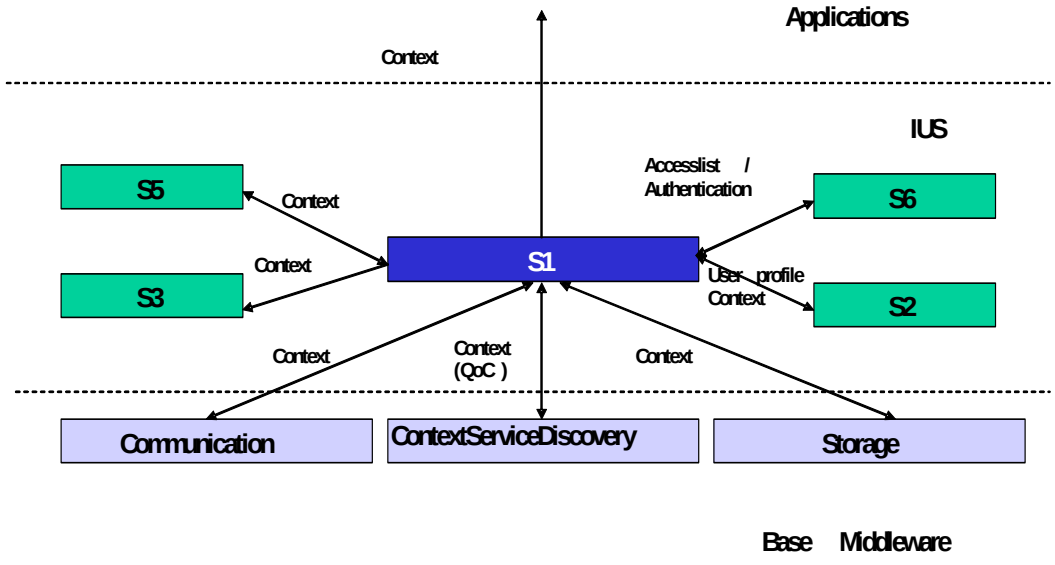

Figure 3.1: Context Aggregation and Prediction abstract overview
(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)

To enable context-dependent user models, contextual information is provided to S2: User Modeling and Profiling. Security related context information is exchanged with S6: Privacy and Security. S6 and S5 are also context information sources for S1.

To be context-aware and to adapt their behaviour to changing environments, services have to know what their context is. This context is a representation of the information about the world from the viewpoint of the service. This representation consists of a general context information ontology (meta-model) and instances that represent particular situations. Context is constructed from heterogeneous information provided by heterogeneous sensors that dynamically enter in the environment.

To communicate and reason about context, a Context Information Ontology is needed that can represent a wide variety of concepts. This Context Information Model describes the different categories of context, such as device context, user context and physical context. In addition, it should be able to represent context at different semantic levels, e.g., low level context information about current WiFi Access Points and higher level context information about the building in which someone is located.

Furthermore, the Context Information Model has to represent the Quality of Context and other characteristics of the context as described in Amigo Deliverable D2.1 [2], Buchholz03 [3]. Quality of Context (QoC) is related to qualitative characteristics of the context information. Examples of the quality characteristics are:

- accuracy of location, in meters or hundreds of meters
- creation time, i.e, at what time did the context sensor(s) produce the context information. Especially for context information that is subject to rapid changes, this is very important information
- reliability, e.g., if several context sources agree on the location of a person, the reliability is increased compared to contradicting context sources

3.3 Dependencies towards base middleware services

The context aggregation and prediction architectural element depends on the following base middleware services;

- persistent storage
- service discovery
- communication

Every AMIGO device and application may provide context information. This requires context service discovery support from the Amigo base middleware layer including;

- discovery of locally available context sources
- registration of context sources
- de-registration of context sources
- context-aware discovery of application services

Contextual data can be obtained from several sources: simple sensors, complex sensors or even devices and applications. Therefore, this context information can be acquired from multiple distributed and heterogeneous sources, which provide contextual data derived from sensors.

Communication support provided by the base middleware infrastructure makes it possible to connect context information sources (such as sensors) and context-aware services and enable the transfer of context information among them.

3.4 Discussion

The focus of this first presentation of the Context Aggregation and Prediction Service is very much on the context management function. In the follow-up, i.e., Amigo Deliverable D4.1 the collection, management and storage of basic sensor data will be addressed.

The context manager could be viewed as a mediator between entities, which provide context information (e.g. sensors) and entities, which consume context information (e.g. services). Context information is obtained from arbitrary Amigo devices and applications in the user's environment. Since a centralized context management service, i.e., a broker function between context information and context sources may not always be available, the context management architecture should support both centralized and peer-to-peer functionality. In a peer-to-peer configuration for example, context information is managed in a distributed way, such that sensor devices provide low-level context information and high-level context information is provided by the application services.

4 User Modeling and Profiling (S2)

4.1 Introduction

User Modeling and Profiling research looks for ways of enabling interfaces or applications to adapt to their users by constructing, maintaining, and exploiting user models, which are explicit representations of the properties of individual users. User modeling has been found to enhance the effectiveness and usability of services and interfaces in a wide variety of situations: it can be used to tailor information presentation to the user, to predict the user's future behavior, to help the user find relevant information, and to adapt interface features to the user.

User interface (UI) personalization can provide personalized user experience through the graphical UI components, modifying such aspects as colors, position of interface items, and font. Another example could be providing simplified voice UIs for young children or the elderly in the home. Different UI modalities can be activated to satisfy user needs.

In content personalization, typically the multimedia content (video, music, pictures, etc) is personalized to match the user preferences. For example, only the news about some particular topic (sport, culture, children, health, etc) according to user preferences is shown.

User preferences are usually dependent on the current situation (context). Thus combined information from user profiles and context providers (context-dependent user models) increases the degree of personalization and effectiveness of the system. An example scenario could be a music personalization for different occasion in the home (e.g. early morning wake-up, party, working atmosphere) or personalized TV news/movies programs based on people present in the room.

4.2 Architecture

The main functionality of the User Modeling and Profiling service is to provide on request accurate user profiles and preferences to other services and/or applications that require such information. To achieve this goal the User Modeling and Profiling service should be able to combine explicit and implicit user input with interaction and context history for constructing and keeping updated user profiles. Figure 4.1 illustrates the abstract overview of the User Modeling and Profiling service.

The User Modeling and Profiling service interfaces with most of the intelligent user services as well as with the upper application layer to provide information on user profiles. Namely a user profile is delivered on request to S1: Context Aggregation and Prediction Service, S3: Awareness and Notification Service and S5: User Interface Service. A service may request a specific attribute of user profile (i.e. preferable early morning wake-up music) or a full collection of user preferences for a particular situation (i.e. preferences for personalized GUI).

Contextual information (including both current context as well as context history) required for enabling context-depended user models is provided by S1: Context Aggregation and Prediction Service. Interaction status and history as well as explicit user statements about their preferences are delivered via S5: User Interface Service.

Finally, privacy and security information are required every time the User Modeling and Profiling Service has to deal with a request for user profile. This information is delivered via S6: Privacy and Security Service.

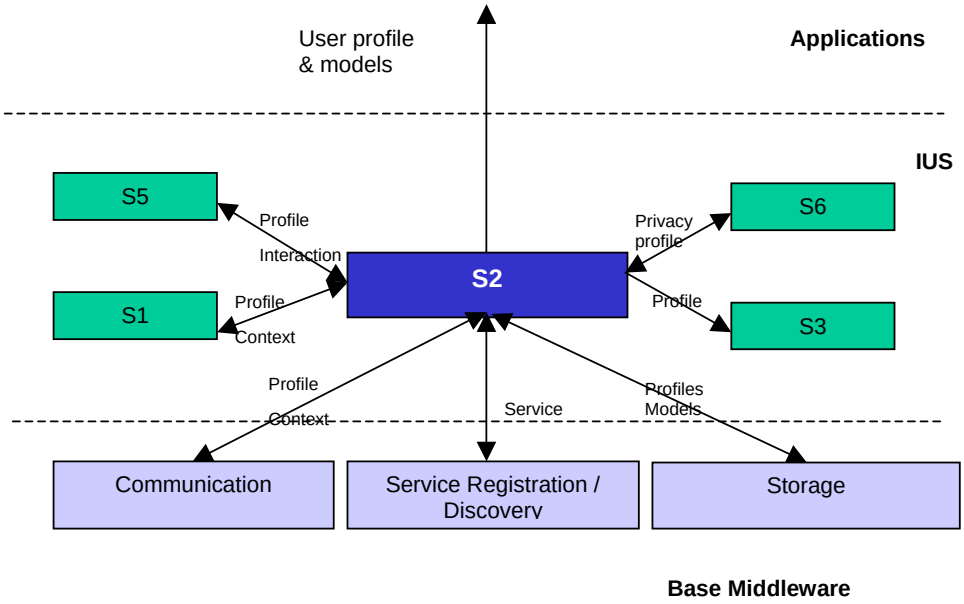

Figure 4.1: User Modeling & Profiling abstract overview. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

4.3 Dependencies towards base middleware services

The User Modeling and Profiling service depends on service registration and discovery mechanism in the base middleware layer for registering/deregistering itself and announcing its availability. The same mechanism will be used for discovering other available services, for example, to discover available context providers in order to request contextual information.

The service also depends on the underlying base middleware for unified communication and data exchange with other intelligent user services or application services.

Furthermore, another strong dependency towards the base middleware is storage and retrieval of user models and profile information as well as interaction logging. Although the format and the structure of user profiles as well as the required user models are topics to be addressed in the detailed specification and architecture of the User Modeling and Profiling Service, a persistence mechanism for storing and retrieving these data is required. This mechanism has to deal with centralized and/or decentralized storage of data as well as with data security aspects since user profile may contain sensitive personal information.

4.4 Discussion

In the more general arrangement of the Amigo scenarios, the User Modeling and Profiling Service will be involved in providing comprehensive models and the corresponding profile of every user, combining user interface aspects with contextual aspects of her/his personality.

Explicit sources of information as well as implicit techniques can be exploited in the acquisition of user models.

The explicit user-specific information can be requested by the Amigo services during the course of interaction (i.e., the system asks the user for information about him/her), or the user might set-up his/her user model by choosing among various options. In some occasions the user may provide his/her preferences and interests by filling questionnaires during the enrolment procedure. Implicit techniques infer user preferences from direct user feedback or by analyzing user-system interaction over a longer period.

The other major aspect of user modeling is how the user models, once they are built, are used to guide the performance of the rest of the system. If both, compiling a user model and using that model effectively, can be dealt with successfully, the Amigo system should be able to significantly improve the level of service it provides to the user.

5 Awareness and Notification (S3)

5.1 Introduction

Awareness systems are defined as computer-mediated communication systems that support two or more individuals to stay aware of the activities of the other, with minimal effort over prolonged periods of time. The Awareness and Notification Service provides a mechanism that exploits information provided by different sources and presents this information in an appropriate fashion to different stakeholders. These mechanisms allow users to stay in touch with friends and have the feeling of being connected with them.

The main idea for the Awareness and Notification Service is to use the processed context information together with user information and to present this information to other users and/or stakeholders, to notify them, depending on the type of application, about important information. Main issues to address are then: where is/are the user(s), what is their behavior, how can we display that information, to what extent can it be disclosed, and to whom?

5.2 Architecture

Two different situations can be distinguished for the Awareness and Notification Service. First, the service functions directly between two or more individuals. Second the service functions with another stakeholder as intermediate. The former case could be viewed as a simplified version of the latter case.

Figure 5.1 shows the abstract overview of the Awareness and Notification Service.

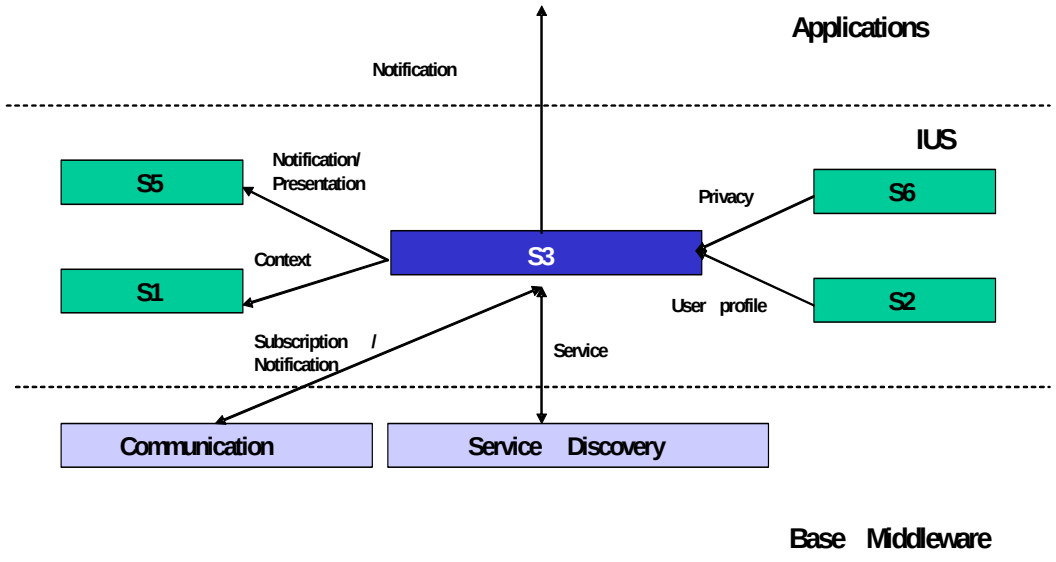

Figure 5.1: Awareness and Notification abstract overview. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

The Awareness and Notification Service interfaces with most of the intelligent services as well as with the upper application layer to provide information about notifications. Awareness and notification uses guidelines on privacy and security provided by S6: Security and privacy, and it incorporates information about user profiles and preferences provided by S2: User Modeling and Profiling. The Awareness and Notification Service provides input to S5: User interface service and to S1: Context aggregation and prediction.

A background activity of the Awareness and Notification Service is the monitoring of context information and the reacting upon relevant changes to this information. This behavior enables application services to access context information in an asynchronous way.

Be it explicit (upon an explicit setting of presence information from the user) or implicit (from automated recognition of presence status of the users from sensors measurements), this status change should be notified to interested parties so that they stay aware of the user status.

The definition of specification languages to define context subscription characterization, context query expression and context query answer is a topic for research in the Awareness project [4].

5.3 Dependencies towards base middleware services

The Awareness and Notification Service depends on the underlying base middleware for discovery of possible sensors and event management. It depends on service registration and discovery mechanism in the base middleware layer for registration/deregistration and for announcing availability. This mechanism will also be used for discovering the availability of other intelligent user services. The service also depends on the underlying base middleware for unified communication and data exchange with other intelligent user services or application services.

5.4 Discussion

The awareness system builds upon notification mechanisms. We suggest developing context changes notification mechanisms and using these mechanisms to build awareness systems. First and foremost finding a proper balance between changes in the environment, i.e., the evolving context, the demands with regards to security and privacy, and how this balance affects which information will be used for notification and to whom is at issue.

6 User Interface Services (S5)

6.1 Introduction

One important target of the Amigo project is to develop an interaction framework that combines natural and flexible end-user interfaces and communicates intelligently via several modalities or even with multilingual capabilities, enabling the user to handle the overall home easily and by using the most appropriate and convenient interaction mode each time. User Interface Services handle input/output interaction devices as well as interaction modalities and cope with explicit as well as implicit user interactions. The dialogue component of the Amigo platform shall take into account semantic considerations by proposing new standard semantic representation formats; multimodal fusion will further be based on this representation. The user interfaces designed for Amigo shall support dynamic adaptation to the context/devices and natural user interactions through multimodal (speech, 2D and 3D gestures) user inputs.

6.2 Architecture

In general, Amigo User Interface Services are identified as one of the six intelligent services that comprise the Intelligent User Services layer (Figure 6.1). As part of this layer, the User Interface Services will interact with all other services of the same layer, namely the Context Aggregation and Prediction, the User Modeling and Profiling, the Awareness and Notification, and the Security and Privacy Service.

In particular, User Interface Services will be one of the context information sources providing rough contextual data to the S1 service. At the same time S5 is also a context consumer: aggregated and interpreted context information is required (delivered from S1) for user interfaces to be adapted dynamically to context changes.

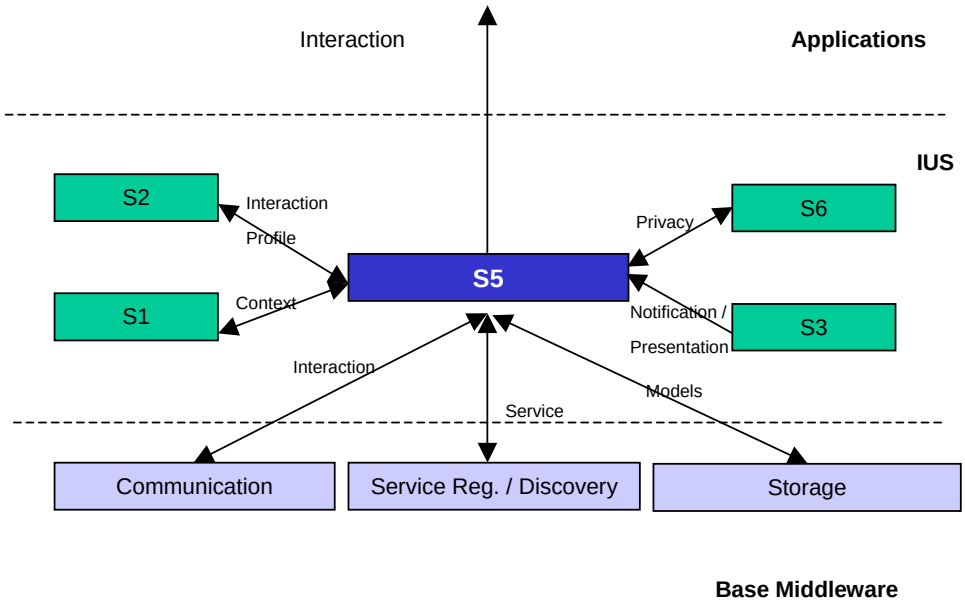

Figure 6.1: User Interface Service abstract overview. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

As regards S2, the User Interface Services require user profile and models for being adaptable to the specific user and for interacting in a convenient and personalized way. Interaction information collected via user interfaces is posted to S2; this information will be used for further personalization and customization of the system.

S3: Awareness and Notification Service delivers to S5 processed context information combined with user information to be presented to other users and/or stakeholders or to notify them –depending on the type of application – about important information.

The entire interaction as well as the particular use of specific information stored in user profiles will be governed by privacy and security settings and rules delivered from S6: Privacy and Security Service. The User Interface Services will provide the appropriate interaction to mediate the privacy and security information to and from the users.

Three different interaction modes will be explicitly made available to applications in the Amigo system, namely the speech modality, the 2D and the 3D gestures recognition. Other modes such as various tangible, physical or also GUI modes will be facilitated to integrate at an application level. The User Interface Service will, for instance, not directly provide a general purpose GUI toolkit, but will support applications e.g. by providing information about the appropriateness of rendering an interface on one device or another. A multimodal dialogue manager will combine explicit information coming from modality servers as well as implicit user interaction data detected by sensors to produce an abstract semantic representation of user input. This semantic representation will then be delivered to the application layer, where applications/application services will use user interface capabilities for establishing a communication between the system and the users.

6.3 Dependencies towards base middleware services

The User Interface Services will make use of basic middleware capabilities for fulfilling certain tasks, which are common among most of the intelligent user services. Service registration / de-registration will be used for announcing service availability, while service discovery will be used to discover available services with which User Interface Services can collaborate (i.e. available User Modeling and Profiling service for requesting user profile).

A common communication mechanism is also required either for information exchanges internally, between the S5 components (i.e. between different modality servers and the multimodal manager), or between the User Interface Services and other intelligent services. Furthermore, information about the devices and users currently present as well as their relationships and characteristics need to be available from the middleware layers.

Storage of information could also be considered as a dependency towards the base middleware. User Interface Services depends on various stored information, related to the service functionality: for example speech interface uses a number of acoustic, grammar and language models for performing speech recognition and understanding, gesture interface on the other hand depends on trained gesture library for performing gesture recognition, etc. It is under investigation in subsequent work packages whether all these models and libraries will be stored in a central storage area and a global storage/retrieval mechanism will be used, or whether they will be stored locally (i.e. by each modality server) thus reducing the effect of a central storage system failure.

6.4 Discussion

In this chapter, the abstract architecture of the intelligent User Interface Services was presented. The main goal of User Interface Services is to develop a multimodal interaction framework that will be user-friendly and user-adaptable, will better support dynamic adaptation to the context/devices and will further support more natural implicit and explicit user interactions using multiple modalities, such as natural language and gestures. Also the main dependences towards the base middleware and other Amigo intelligent services were identified in terms of information flow between these services and layers. The detailed infrastructure of interface components, their interaction mechanisms as well as the detailed description of interface capabilities will be elaborated and documented in Deliverable D4.1.

7 Security and Privacy (S6)

7.1 Introduction

The Security and Privacy Intelligent User Service focuses on ensuring personal privacy and security for the highly personalized Amigo system. This is a major challenge as it exploits the benefits of personalization while sensitive personal information is being acquired from users, combined, processed and stored. Whereas the base middleware focuses on the technical foundation to warrant that secure data storage and privacy protection is possible, the security and privacy intelligent user service ensures that this is also perceived and trusted by the users.

Personalized services rely for their operation on appropriate and sufficient information of the user. This information may include the identity of the user, usage of the system or service, preferences and dislikes, and actual time and dates of usage. Information might be collected by explicit means, i.e., input is consciously given by the user, or by implicit means, i.e., input is acquired without explicit intervention of the user. This might imply that the system continuously records sensitive and private information about users and makes inferences and predictions about their behavior based on personal information. Crucial then for personalized systems and services is building and maintaining the trust relation with their users.

Most existing work has concerned the study of trust towards online vendors and services with respect to handling personal data [5], [6], [7]. Less is known on how to ensure privacy protection in an ambient intelligence environment [8]. Designing for privacy and personal security/safety right from the beginning is a basic concern of the Amigo project. As a consequence, this task will in first instance produce guidelines for developing and integrating privacy enhancing features in the different services.

7.2 Architecture

Since the focus of this task is primarily on providing guidelines to the other intelligent user services in the Amigo project, its role is far from independent. Figure 7.1 provides a global structure for these relationships.

To provide security and privacy, relevant context information and appropriate prediction about changes in context is needed from S1, Context Aggregation and Prediction. Personal information about the user is used to adapt the environment towards the user's needs and desires. The User Modeling and Profiling Service (S2) provides this information. The Security and Privacy Service provides its information to the Awareness and Notification Service (S3), which processes this information together with context information and user information. User Interface Services (S5) provides the appropriate interaction to mediate the information to and from the users. A distinction will be made between the implicit and explicit user interactions.

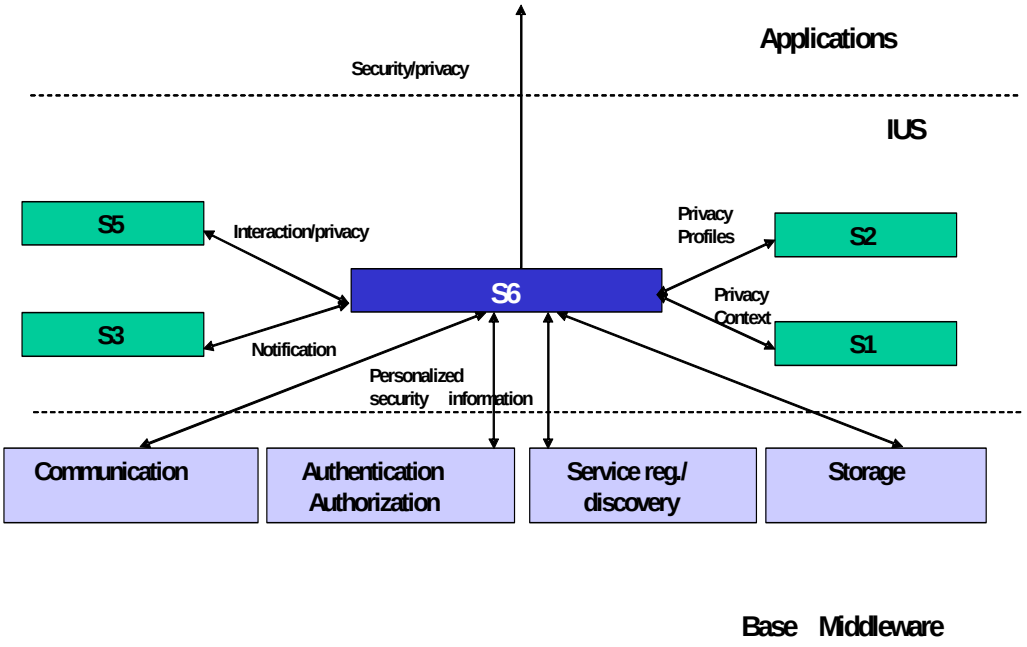

Figure 7.1: Privacy and Security abstract overview. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

7.3 Dependencies towards base middleware services

The Security and Privacy Service will make use of base middleware services for fulfilling tasks, which are common among most of the intelligent user services. Service registration and deregistration will be used for announcing service availability, while service discovery will be used to discover available services with which security and privacy collaborates.

The Security and Privacy Service depends on the underlying base middleware for authentication and authorization services as well as storage services for personalized security information.

The service also depends on the underlying base middleware for unified communication and data exchange with other intelligent user services or application services.

7.4 Discussion

In this chapter, the abstract architecture of the Security and Privacy Service was presented. The main goal of the Security and Privacy Service is to develop a framework in which the personal privacy of people can be dealt with in such away that users can and will trust that the system protects their privacy and adapt to conditions imposed by changes in the contexts. These privacy and security aspects have to be considered at different levels, i.e., data level, communication level, and interface level. For each of these levels different types of requirements exist. They will be elaborated and documented in Deliverable D4.1.

8 Conclusions

The abstract architecture descriptions for the Intelligent User Services (IUS) that were presented in the previous chapters reveal complex semantic relationships and dependencies between the different Intelligent User Services. These dependencies will be further explored and resolved in Amigo deliverable D4.1.

The egocentric perspective that was chosen to describe the abstract architecture of the IUS shows several common denominators. First, with regard to the dependencies between the IUS, three different abstract groups evolve. That is, the interfaces between Context Aggregation and Prediction (S1), User Modeling and Profiling (S2), and Awareness and Notification (S3) are mainly concerned with the exchange of information about context awareness and user models and profiles. The interface between Privacy and Security (S6) and S1, S2 and S3 exchanges information about context awareness, awareness notification, user profiles, and user privacy information. The interface between User Interaction Services (S5) and S1, S2 and S3 exchanges information about context awareness, awareness notification, user profiles, and explicit and implicit user interactions. The interface between S5 and S6 concerns the exchange of information about explicit and implicit user interactions and user privacy profiles. Figure 8.1 depicts these interfaces at a very global level and summarizes partly the Figures 3.1, 4.1, 5.1, 6.1 and 7.1.

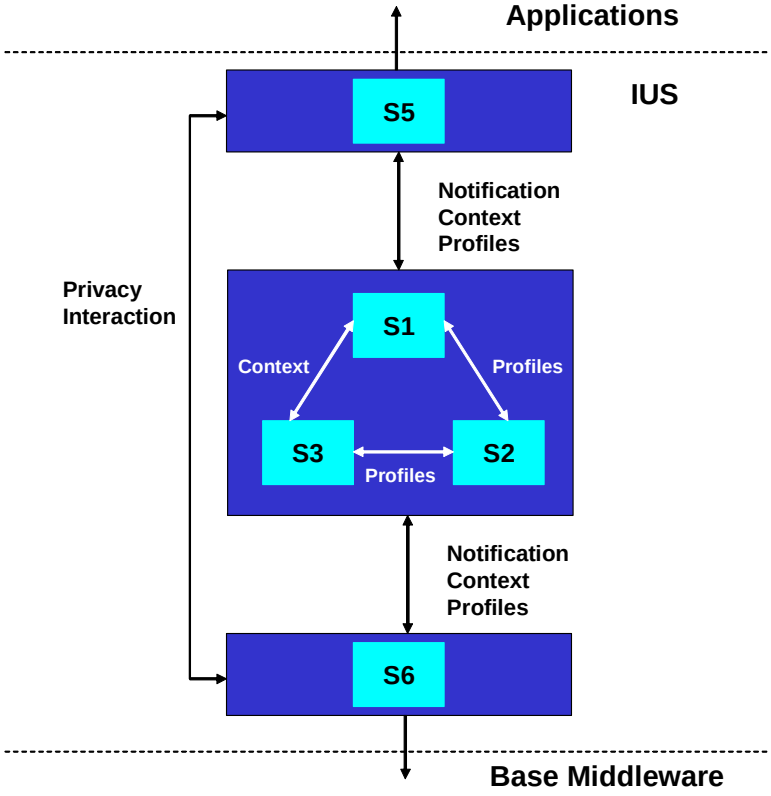

Figure 8.1: Interfaces between Intelligent User Services – abstract overview. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

Furthermore, all IUS depend on service registration and discovery mechanism in the base middleware layer for (de) registration and announcing their availability and for discovering the availability of other services. All IUS require unified communication and data exchange with other intelligent user services or application services through the base middleware. Another dependency for all IUS towards the base middleware concerns storage and retrieval, for example, profile information, interaction logging, context histories, user interaction models, personalized privacy and security profiles. S6 also depends on authentication and authorization mechanism in the base middleware layer. Figure 8.2 depicts these dependencies at a global level.

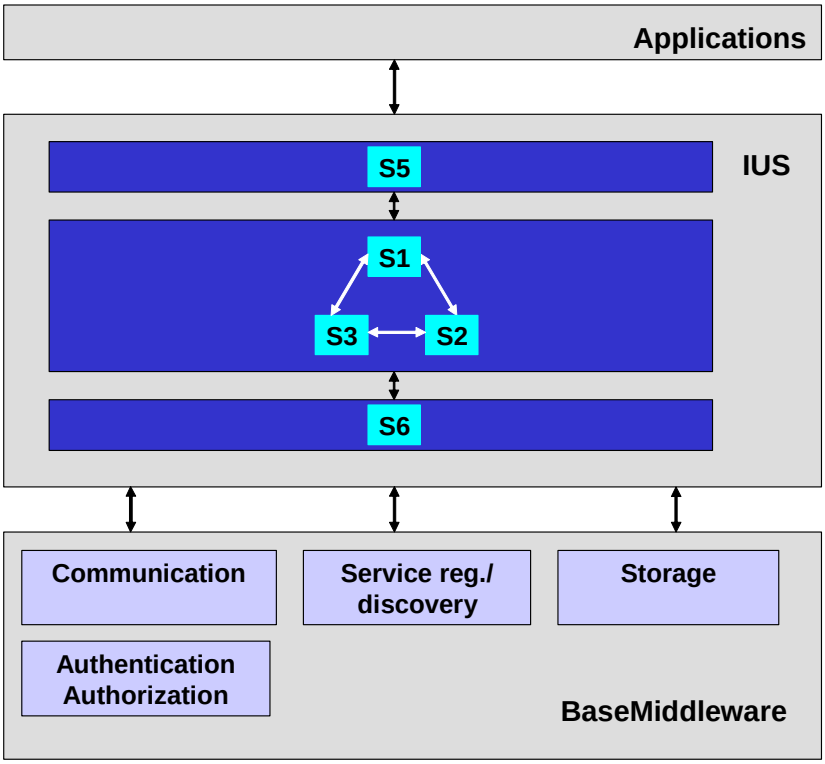

Figure 8.2: Interfaces between the IUS and the Base Middleware. *(S1: Context Aggregation and Prediction; S2: User Modeling and Profiling; S3: Awareness and Notification; S5: User Interface Services and Interaction Design; S6: Privacy and Security)*

Figures 8.1 and 8.2 reflect the results of working meetings among the Amigo project team members. They started from the general architecture diagrams depicted in the Amigo Description of work (DOW). A major difference constitutes the dependency of the IUS on base middleware modules for communication and storage. These modules had not been identified in the original global architecture. Service discovery was already a component in the 'DOW' architecture, but the registration and de-registration of the different IUS was not. Furthermore, the special role of S6 and the distinction between a component in the Middleware (Authentication and Authorization) and a component in the IUS dealing with personalized profiles was made explicit.

The functionality of the interfaces between the IUS and between the IUS and the Base Middleware and Application layers will be detailed in Amigo Deliverables D3.1 and D4.1.

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