

European Unified Approach for Accessible Lifelong Learning

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European Unified Approach for Accessible Lifelong Learning (EU4ALL) is an Integrated Project funded by the European Commission. The aim of EU4ALL is to improve the efficiency and efficacy of the Life Long Learning paradigm removing the access barriers that people with functional diversity usually face. Since technology is playing an increasing role in mediating this learning, this project research on the procedures and architectures to introduce the needed support to offer life long learning services for all. At aDeNu Research Group we focus mainly on developing a flexible, open, standard-based architecture to support the life long learning paradigm and providing universal access to e-Learning by applying user modelling and machine learning techniques to produce adaptive interfaces that cope with the needs for all.

Keywords Accessible services; Open architectures; Life long Learning; Standards; Adaptation; Special Needs; Higher education; Adaptive interfaces; User Modelling; Machine Learning.

1. Introduction

European Unified Approach for Accessible Lifelong Learning (EU4ALL¹) is an Integrated Project funded by the European Commission (IST-2005-034778) started in October 2006 and with an expected duration of 48 months. Thirteen partners make up the Project Consortium, led by ATOS Origin as Project Coordinator and the Spanish National University for Distance Education (UNED) as Scientific Coordinator. The aim of EU4ALL is to improve the efficiency and efficacy of the Life Long Learning paradigm removing the access barriers that people with functional diversity usually face [1]. This approach has been identified in EU4ALL as Accessible Lifelong Learning (ALL) and is based on the following three strategies:

1. The technology that mediates lifelong learning does so accommodating the diversity of ways people interact with technology and the content and services it delivers.
2. This technology is used to bring support services to disabled learners.
3. Support services and technical infrastructure is provided to enable teaching, technical and administrative staff of educational institutions to offer their teaching and services in a way that is accessible to disabled learners.

These strategies will be developed by defining a standards-based framework that facilitates the integration of the approach with a wide range of eLearning systems. More specifically the goals of EU4ALL project are the following:

- Design the open service-oriented architecture.
- Develop the software infrastructure for the services (including content, support and access services).
- Provide technical standards/specifications for the applications integrated with current and emerging eLearning standards.
- Validate the results in two large-scale higher education settings, namely UNED (Spanish National University for Distance Education) and OUUK (Open University of United Kingdom).

Furthermore, in EU4ALL the use of accessible ePortfolios is a research issue, which intends to build up evidence of learning in different contexts, following the IMS ePortfolio Specification.

¹ <http://www.eu4all-project.eu/>

Two broad user groups benefit from the EU4ALL project: 1) end-users (adult learners with visual, hearing, physical or cognitive impairments; teachers and tutors), and 2) system users (providers of eLearning systems, contents and services).

In this paper, we focus on the research works to be carried out by aDeNu Research Group at UNED. First we clarify the meaning of the term services in the context of the open oriented services architecture. Second, we outline of the architecture framework to be designed and later implemented at different existing developments. Third, we describe how we are going to manage the adaptation to the users' needs by applying user modelling and machine learning techniques within adaptive interfaces. Finally, we end up with some conclusions.

2. Open oriented service architecture

One of the objectives of the project is to define practical specifications and implement in terms of standards an open and extensible architecture of services for ALL, which is prepared both to assist learners and support service providers. The term 'services' is very tricky since it has very different meanings in different contexts. For this reason, first we comment on the different understanding for this term and specify the meaning in the open oriented service architecture context. Next, we provide technical details on the architecture.

2.1 Clarification for the services terminology

According to the Wikipedia², the term service can refer from a non-material equivalent of a good to a function within a systems' environment. In EU4ALL project we clearly differentiate the meaning of the term services from 1) the functionality, 2) the technical development and 3) the structure point of views.

From the *user level* (functionality) it can be distinguished two different types of services:

- **Services for systems users** (on the demand side): such as assistance for exam preparation, pedagogical guidelines to create/teach materials, assistance for mentoring, supporting the use of assistive technology, psychological guidelines for technology mediated learning.
- **Services for adult learners with special needs** (on the supply side): such as plug in users' assistive technology; content adapted to learners needs; management of learners' ePortfolio; technical, pedagogical and psychological assistance; working in a learning environment (e.g. reading materials, taking notes, discussions, group activities, supplementary practice, assessment activities, research skills, complex problem solving, contextual searching, written communication, resource management).

From the *technical development* point of view, these end-services (consultancy and support) are considered together with the technical services that support them in the following categorisation:

- **End-user services** (eService Platform)
 - *Consultancy services* for professionals (how to prepare materials) which refers to support in terms of pedagogical and psychological guidance.
 - *Support services* to disabled students (how to use and cope with the assistive technology and special needs) which refers to universal access by considering modelling and personalization techniques, content transformation based on metadata and support via ePortfolios.
- **Technical services** (tools to support the interaction between user and technology)
 - *Core-services* (essential technical features) such as interaction, adaptation, tracking, learning design instantiation, collaboration, search, management, auditing.
 - *Middleware and Networking services*, in terms of connectivity, interoperability, multi-processing, web services.

² [http://en.wikipedia.org/wiki/Service_\(disambiguation\)](http://en.wikipedia.org/wiki/Service_(disambiguation))

This classification avoids ambiguities in the context of the current web services approach by distinguishing between 'services' to the users (to provide the end-user services) and 'services' from one entity to another to build the final service to the user (the core-services).

The next figure shows the service layers defined in EU4ALL. These layers follow the classification in end-user and technical services described above.

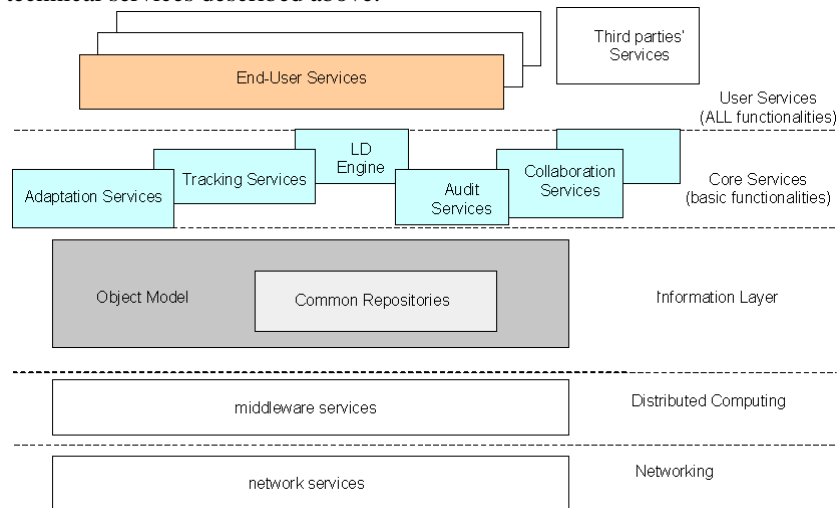


Fig. 1 EU4ALL service layers. From the technical development point of view, the different layers differentiate the end-user services (consultancy and support) from the technical services (core, middleware and networking).

Finally, the *service structure* deals with the architecture and specifications. The initial approach for the architecture framework is described in the next subsection, open and accessible service architecture.

2.2 Open and Accessible service architecture

The main purpose of EU4ALL project is to develop a service architecture to support the life long learning paradigm for ALL. The objective of this architecture is twofold, i) technology flexibility and ii) user centred.

The first objective deals with providing open services that allow the interoperability with existing third party services. Moreover, it has to be extensible so new functionality can be easily integrated if appropriate. Finally, it has to be based on standards so reusability at all levels (development, contents, user profiles, etc.) is achieved.

Regarding the second objective, it has to be centred on the user, considering the different roles users may take, such as learner, teacher and administrative staff. This means that the services provided by the architecture have to take into account the user preferences and special needs and follow pedagogical and psychological procedures. Therefore, the behaviour of the system has to adapt to these requirements and provided a personalized response to each user, which implies interface adaptation, contents personalization and service discovery (i.e. right service at the right moment).

The architecture will support the full life cycle of adaptation for service provision, which covers the following phases: design, publication, use and auditing [2]. The management of this cycle will be focused on individual users' needs, which are diverse and change over time. To cope with these issues, an approach based on standards for combining design and runtime adaptations will be developed considering related work performed in the aLFanet project (IST-2001-33288) [3].

In EU4ALL architecture, the management of service adaptation will consist on a loop of continuous interactions, where the following phases are identified (see Fig. 2):

- **Design:** provides the logic for the pre-design adaptations and provides the hooks and information upon which the runtime adaptation bases its reasoning. The services are to be defined in terms of IMS-LD[4] (extended if needed to fulfil the requirements).
- **Publication:** includes the storage and management of data to be retrieved by the different components. The usage of standards (e.g. IMS³ family) guarantee the required interoperability.
- **Use:** focuses on the environment while running the service. It deals with the delivery of contents taking into account the learning design specifications, the user profile and the accessibility requirements by properly adapting the user interface and by producing dynamic and contextual recommendations.
- **Auditing:** closes the cycle and provides reports on the actual use of services.

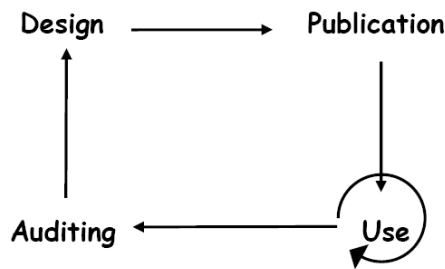


Fig. 2. *Full life cycle of service adaptation.* The service provision in EU4ALL covers the design, publication, use and feedback phases. The management is focused on individual users' needs, which are diverse and change over time.

The EU4ALL architecture will support an effective way to integrate existing and new components, providing an open and extensible framework and, at the time, allowing focusing the development efforts in the adaptation subjects. After a state of the art analysis regarding technological infrastructures, open services architectures, accessibility and community building systems, the design of the general architecture will be done. This design will provide the module decomposition, the data model definition and the detailed interface for the different components. This will be the architecture of the framework where the different services will be integrated.

3. Adaptation to User Needs

EU4ALL adaptations to the final user put a big emphasis on properly modifying the user interface and the content according to the particular disability of each user, the pedagogical and psychological procedures, the context in which the user is accessing the information and the device used for that purpose. Moreover, the basic idea behind EU4ALL is that content provision is based on standards and focused on users' needs which, in turn, are managed in terms of user models. For this reason, both the structure and the process to access contents is described via standard-based learning design specifications where alternative roles and activities are organised to let the user follow the adapted learning path. Not only content accessibility guidelines (i.e. WAI) are taken into account, but the instructional design is used to guarantee that the pre-defined adaptations take into account the accessibility requirements for the different types of users' needs. In turn, to guide users' interactions, personal assistants will monitor users' behaviours over time and identify troublesome (i.e. lack of knowledge) and promising situations (i.e. high interest), and perform remediation or support actions. In other words, taking into account already pre-defined adaptations, unexpected situations may arise at runtime and the system will provide data mining and machine learning techniques to cope with the different types of unexpected situations.

Since automated responses to the accessibility needs of individual students are to be made, the system requires information about each individual (including records on their needs, preferences, learning styles,

³ <http://www.imsglobal.org/>

etc.). To this, an effective way of modelling the user in terms of their access requirements is required, and there already exist specifications and standards to facilitate the definition of these models [5, 7].

In more detail, the following actions are considered within the scope of EU4ALL project:

- Define the interaction preferences in terms of IMS-AccLIP
- Track, extract and learn user profiles from interaction data, combining the different needs and considering the evolution on time
- Take devices and context-awareness into account
- Implement recommending systems to provide support at runtime (in a pedagogical scenario)
- Provide support to pedagogical and psychological guidelines defined by experts
- Prepare reports on the interactions to adjust the service

From the technological point of view, 3 modules will be developed to cope with these specifications:

- **Adaptive Module:** adapts the response to the individual user needs (in IMS-AccLIP)
- **Pedagogical Module:** assures contents and activities are delivered following the most appropriate pedagogical and psychological guidelines (defined in IMS-LD)
- **Tracking Module:** monitors learning experience and provides feedback (to learners, service providers, course authors)

We would like to remark that adaptation is not something that can be plugged in a particular content or service, but it requires considering the full life cycle of adaptation, as described in previous section.

4. Validation

This project has been designed as a continuous iterative process where several cycles of prototype development and validations are defined. All cycles are led by the end-users requirements which are exhaustively analysed along the whole length of the project. These requirements are the inputs for the service prototypes to be developed as well as for the functional validations done afterwards. The prototypes are validated at different levels: accessibility, stand-alone functionality, technical integration in the architecture and end-user functionality. Moreover, user evaluations (in terms of satisfaction surveys, observational studies of interaction and semi-structured interviews) and expert validations (covering accessibility, usability and technical validation against guidelines, standards and specifications) are organised at a large scale in two European mega universities (UNED and OUUK) plus several smaller scale evaluations exercises at other partner institutions. A support centre co-ordinated by EADTU will also supply user evaluation input for international benchmarking.

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