

AMBIENT LEARNING – AMBIENT; MULTIMODAL AND CONTEXT-SENSITIVE LIFELONG LEARNING

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ABSTRACT

The objective of the AMBIENT LEARNING project is to provide a pragmatic, easy-to-use eLearning service, which allows any time, anywhere and anyhow access to personalised, high quality learning content. AMBIENT LEARNING is an eLearning web-service, which allows to use "any content", from articles out of magazines, internet articles up to SCORM (Shareable Content Object Reference Model) based eLearning solutions and deliver it to the user based on the user context (time-, location-, device-dependent) at any time and any how. The service is based on stable and mature technology and offers ambient, multi-modal, multilingual, personalised and context-sensitive access to learning at work, at home, at a training institution or on the move. The service will be demonstrated around five European regions (Italy, Germany, Greece, UK and Ireland). This project is at market validation stage and is partially funded by the eTEN Programme designed to help the deployment of telecommunication networks based services (e-services) with a trans-European dimension.

Distinguishing Services of the System

- Multimodal Broadband Access allows the user access to eLearning objects any time, anywhere and anyhow. The AMBIENT LEARNING system supports broadband network access: with LAN, WLAN, GPRS, UMTS, Bluetooth, Satellite etc. The content is available based on the context as Wen-Document, as (mobile) Flash, as WAP (2.0), as read-out text (voice-XML and TTS), as interactive learning object (e.g. SCORM-based), etc.
- Context Management allows delivering the eLearning services in an individualised and flexible way, e. g. Profile, Role, Schedule (Calendar), Tasks, Working Content, Interest, Existing Know-how, Time, Place, Available Device etc.
- Content Integration allows integrating existing knowledge catalogues and eLearning resources. The benefit is to effectively 're-purpose' and target content, ending the costly cycle of recreating content for a particular need, audience, or distribution device, and to protect investments in already existing eLearning objects.
- Multilingual Access allows the user to define the language in which we wishes to receive the eLearning content.
- Interoperability allows to work with other systems or products without special effort on the part of the customer either by adhering to published interface standards or by making use of a "broker" of services.

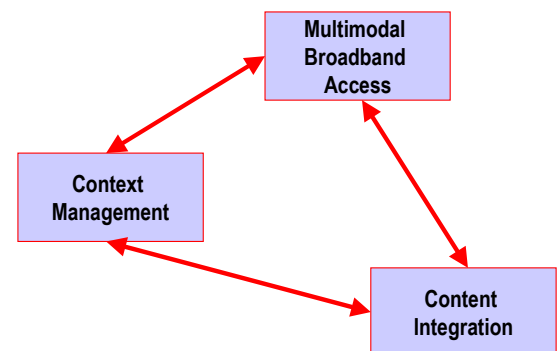
AMBIENT LEARNING Objectives

A survey commissioned by the European Directorate General Education and Culture, called "Lifelong learning: a citizen's view" identified the main obstacles to lifelong learning: **time and money**. "Although European citizens recognise the personal and social benefits of learning, they underline that lack of time due to job and family commitments is an important obstacle. In general, money represents a major obstacle: half of the respondents said that they would pay nothing under any circumstances. Nevertheless, it is interesting to note that people are ready to make a financial contribution if they judge the benefit to be an exclusively personal one. **Individualised and flexible learning options could be effective incentives**. People mention diverse incentives, but most common are flexible working hours (21%), **individualised programmes of study and personal choice of methods of study** (20% each). This suggests that implementing lifelong learning effectively must find ways to enable people to combine activities in ways that **suit them practically and personally**".

Exactly at the above identified obstacles starts the AMBIENT LEARNING project. **The objective of the project is to provide a pragmatic, easy-to-use eLearning service, which allows any time, any where and any how access to personalised, high quality learning content. The AMBIENT LEARNING service is based on stable and mature technology and offers ambient, multimodal, personalised and context-sensitive access to learning at work, at home, at a training institution or on the move. The main purpose of the project is the market validation of the AMBIENT LEARNING service by demonstrating the various services in four European (Italy, Germany, Greece, UK/Ireland) regions and therefore preparing the ground for successful market deployment.**

The main distinguishing features of the AMBIENT LEARNING services to other eLearning approaches are the following:

- **Multimodal Broadband Access** which allows the user access to eLearning objects any time, any where and any how.
Explanation: The user can use the eLearning system via different existing broadband networks (e.g. LAN at the office, WLAN at a specific hotspot, GPRS/UMTS on the move) employing the most suitable modality (interactive learning objects on the Office-PC, text-to-speech read-out while driving in the car, mobile PDF while sitting in the train etc.).
- **Context Management** enables the provision of eLearning objects based on the context of the user.
Explanation: The context of the user includes factors like schedule, tasks, personal profile, know-how and interests etc. Based on the context; learning content, which suits the user perfectly can be delivered according to the context using the above mentioned multimodal broadband access.
- **Content Integration** allows access to existing knowledge catalogues and eLearning resources.
The system can integrate already existing eLearning objects and other high-quality content. Within the project the resources of Press-Catalogue are included, which embraces the content of some 20.000 European scientific and professional magazines. Especially for the training of busy and experienced people this approach is suitable



AMBIENT LEARNING Services

The goal of AMBIENT LEARNING is to support the deployment of a lifelong learning service of common interest, which allows learning at any time, any how and on any device. Lifelong learning is seen as encompassing all purposeful learning activity, whether formal or informal, undertaken on an ongoing basis with the aim of improving knowledge, skills and competence.

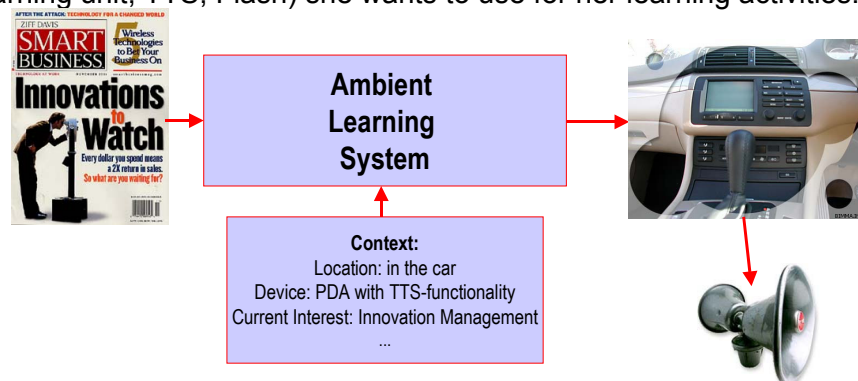
AMBIENT LEARNING is an elearning web-service which allows to use “any content” (from articles out of magazines, internet articles up to SCORM (Shareable Content Object Reference Model) based eLearning solutions) and deliver it to the user based on the user context (time-, location-, device-dependent) at any time and any how.

In order to gain a better understanding of the proposed services three use cases with examples are described.

Examples of AMBIENT LEARNING services

Use Case 1: An empirical study identified that busy professionals lack time for vocational training. Moreover the busy professionals prefer articles out of scientific or professional magazines as their main source for vocational training. Exactly this problem is addressed within the first application example of the AMBIENT LEARNING project.

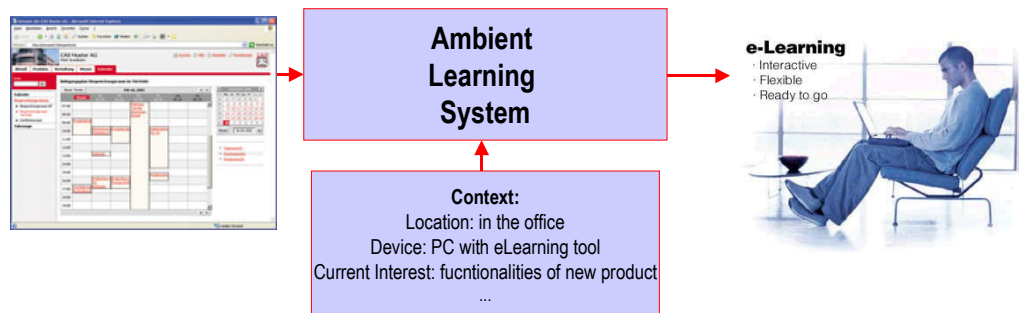
Example 1: Mrs. Taylor is a partner in a consulting company, which is specialised in high-technology consulting. Due to her busy schedule and her attempt to achieve a good work-life and private-life balance, and because of her private assignment to assure a good upbringing of her children, she lacks time for vocational training. The AMBIENT LEARNING service allows her to structure and define her personal training needs. Based on her context (a situation like driving with her car to a customer) and her personal interest the learning content is downloaded from a scientific magazine database to her mobile device and is read to her with a TTS engine (text-to-speech) while she drives to her customer. The AMBIENT LEARNING service allows Mrs. Taylor to actively train and improve her knowledge in a concurrent approach, which does not negatively affect her daily schedule. If she has a free evening she can study from home using a secure broadband access to the AMBIENT LEARNING service and choose ad hoc which type of media (e.g.: SCORM-based interactive learning unit, PDF, WWW-based learning unit, TTS, Flash) she wants to use for her learning activities.



Use Case 2: Innovative software based solutions and applications are not widely deployed in European SMEs. This is mainly due to the digital illiteracy and lack of financial resources to employ consultants, which could tailor the software applications to the specific needs of the SMEs. The second example tackles this issue.

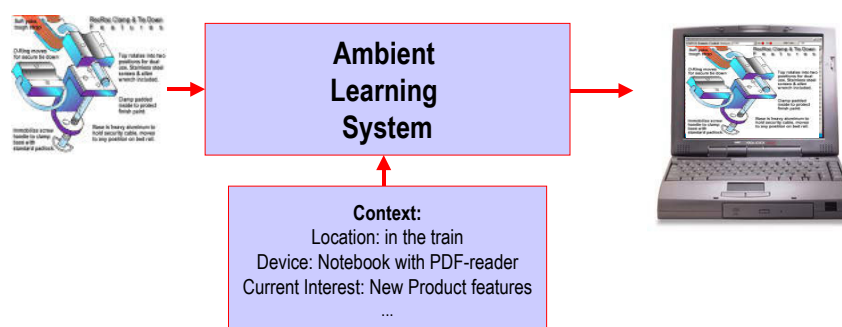
Example 2: Mr. Frey is a trainer for a small software house and instructs customers how to install, adapt and use innovative information management solutions. Due to lack of qualified

consultants, his employer is not able to deploy the useful information management solution to the European market. The AMBIENT LEARNING service allows to deliver an interactive learning unit to potential customers, where the functionalities of the information management solution are explained. An integrated assessment tool allows for interactive testing of the customers know-how and suggests context-based in-depth training or repetition of specific areas.



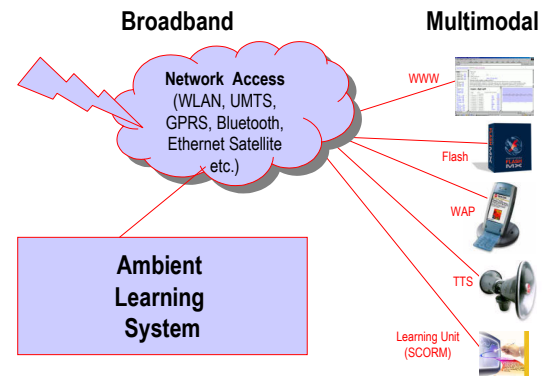
Use Case 3: Service employees which are mainly on external duty, have often no time and possibility to participate in standard training activities or state-of-the-art eLearning applications due to their different and often changing environments (different devices, different communication networks etc.). The AMBIENT LEARNING allows context-based access to important learning units, like new functionalities or services.

Example 3: Mr. Fernando is a travelling salesman for a mechanical engineering company. His company is able to implement innovations quite quickly into the machines. Therefore Mr. Fernando can always offer highly innovative products, which are described in technical specifications. Du to his extensive travelling with different means of transportation he needs to learn about the new functionalities of the machines using different modalities. If he is travelling by train the technical specification is downloaded from the Intranet as a PDF-document to his Notebook. During the train-ride he has the chance to read the specification. If he is travelling by plane, the technical specification is converted to mobile flash and he can access the learning content on his PDA, while he is flying to the customer. If he is on his way by car, he is informed about the main new features via TTS (text-to-speech).



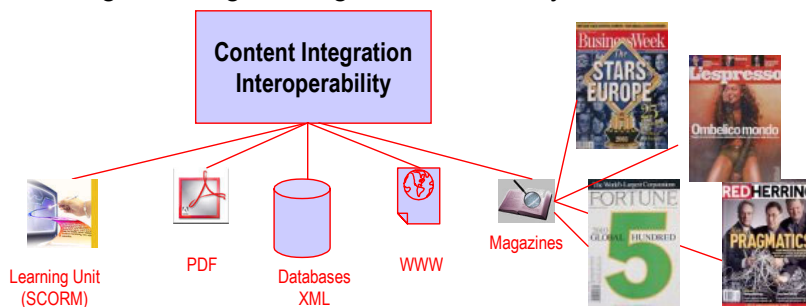
Distinguishing Services of the AMBIENT LEARNING system

Multimodal Broadband Access allows the user access to eLearning objects any time, any where and any how. The AMBIENT LEARNING system supports broadband network access: with LAN, WLAN, GPRS, UMTS, Bluetooth, Satellite etc. The content is available based on the context as Wen-Document, as (mobile) Flash, as WAP (2.0), as read-out text (voice-XML and TTS), as interactive learning object (e.g. SCORM-based etc.) etc.



Context Management allows to deliver the eLearning services in an individualised and flexible way. There is a long list of context dimensions which are taken into account, some of them are: Profile, Role, Schedule (Calendar), Tasks, Working Content, Interest, Existing Know-how, Time, Place, Available Device, Preferences, Network Access and many more. Based on the context the learning content, which suits the user perfectly can be delivered context-specific taking into account the various context dimensions.

Generic **Content Integration** allows to integrate existing knowledge catalogues and eLearning resources. The ability to leverage existing content is a critical component of eLearning. Reusing existing content not only accelerates these eLearning initiatives, but also



improves overall quality. The benefit is to effectively repurpose and target content, ending the costly cycle of recreating content for a particular need, audience, or distribution device, and to protect investments in already existing eLearning objects.

For the pilot usage the content of some 20.000 European scientific and professional magazines out of the Press-Catalogue¹ (www.pressekatlog.de) is integrated.

Moreover it assures interoperability. Interoperability is the ability of a system or a product to work with other systems or products without special effort on the part of the customer. The AMBIENT LEARNING system achieves interoperability with eLearning content either by adhering to published interface standards or by making use of a "broker" of services that can convert one product's interface into another product's interface on the fly.

¹ Pressekatlog.de is the main OEM web-service for Amazon in the magazine/newspaper area in Europe, e.g. <http://www.amazon.de/zeitschriften>

OVERALL SYSTEM ARCHITECTURE

The AMBIENT LEARNING system is a eLearning platform that delivers context-based and personalised learning, assessment and testing, and built-in asynchronous collaboration. The AMBIENT LEARNING LMS provides complete Catalogue and Management functionality. The ability to list any online learning, event and any content type (electronic Books, SCORM-based learning objects, databases etc.) enables a one stop shop for all learning in the organisation.

The AMBIENT LEARNING system is based on a service-oriented architecture (SOA). An SOA is an architecture that has special properties. It is an architecture made up of components and interconnections that stress interoperability and location transparency. Services and service-oriented architectures are about designing and building systems using heterogeneous network addressable software components. The software architecture of the AMBIENT LEARNING system consists of the large-grained structures of the software. It describes the components of the system and how those components interact at a high level. The interactions between components are called connectors. The configuration of components and connectors provide both a structural and a behavioral view of the system.

The component concept of the AMBIENT LEARNING system allows us a better way of managing the dependencies in the large system. A component is a smaller group of objects working together to provide a system function. The method of component-based development has allowed to create more complex, higher quality systems faster than ever before because we have a better way of managing complexities and dependencies within a software system. A service-oriented architecture is one that has a robust service layer. The services in the service layer have the ability to be invoked over a network. The technologies used to invoke the interface of the services stress interoperability. The services in the service layer also stress location transparency so they may be discovered and used dynamically.

The services in the business logic layer of the AMBIENT LEARNING system have the ability to be invoked over a network. The technologies used to invoke the interface of the services stress interoperability. The services in the service layer also stress location transparently so they can be discovered and used dynamically. The AMBIENT LEARNING system allows to be invocable across a network. The payload format is the format of the data that is transmitted from a client to the AMBIENT LEARNING service for method invocation, the request data must contain both the service that the client wishes to invoke as well as the arguments for the method. Extensible Markup Language (XML) is the most popular format used for the data exchange. It is a text-based format that uses tags to delimit data elements in an XML document. The interoperability is based on the ability of the AMBIENT LEARNING service to be invoked by any potential client of the service. Potential clients via the Internet or via a mobile network are able to invoke the service using more than one protocol type at a time by using adapters (API/Access/Display Engine).

Since location transparency is a property of the AMBIENT LEARNING service, code mobility is possible. The lookup and dynamic binding to a service means that the client does not care where the service is located. Therefore, the AMBIENT LEARNING service is flexible to move services to different machines, or to move a service to an external provider. The creation of a service layer within the AMBIENT LEARNING systems means by definition that there is an additional network interface that can be used by multiple applications.

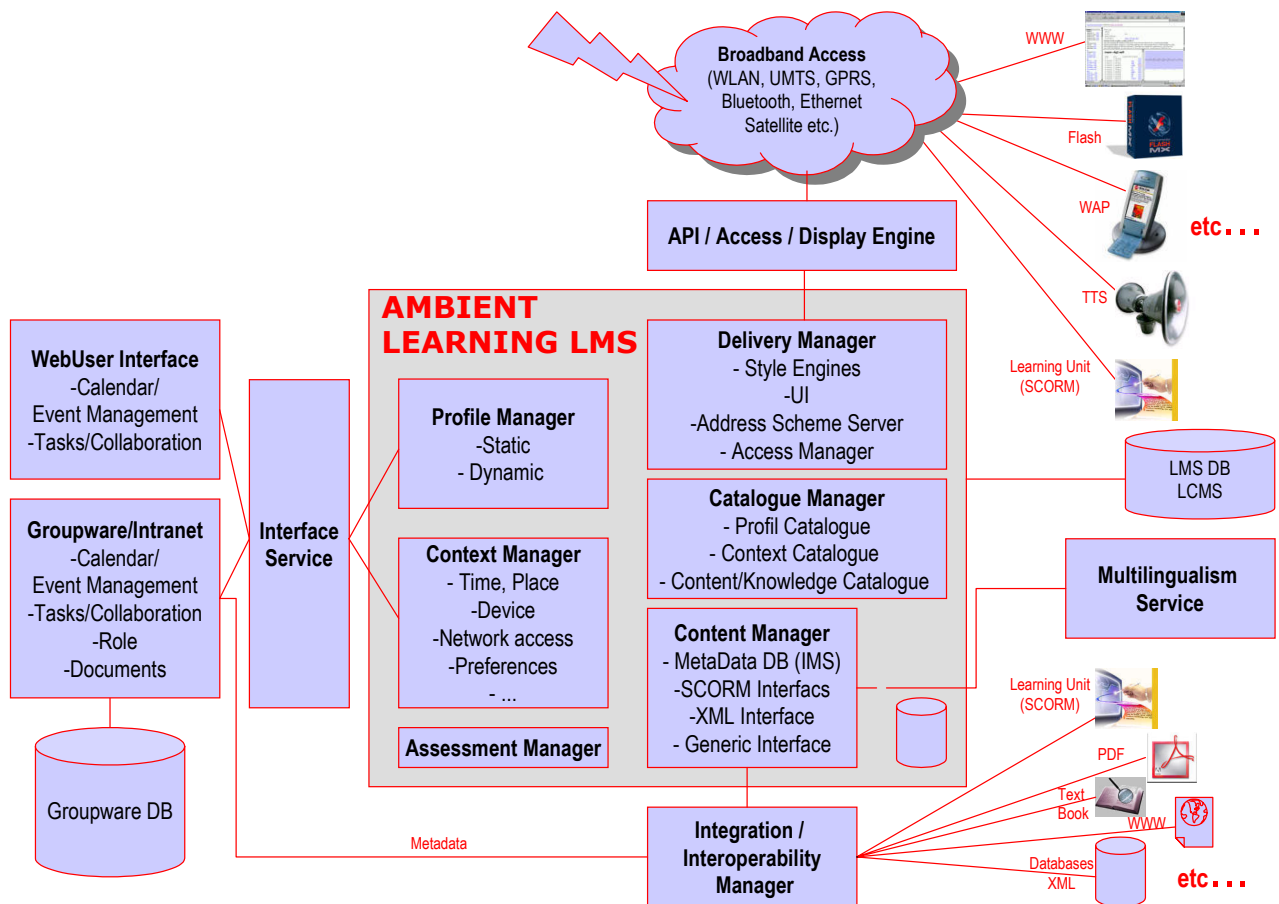
The AMBIENT LEARNING system has an own security mechanism, the service will therefore have multi-level authentication at both the client level and at the service level. As crucial network-communication takes place between different clients, clients and the service provider and within the providers facilities a major key is to make this communication as safe and secure as possible. Safeguarding communications can be done by existent off-the-shelf solutions, but ensuring good system security must be done at several levels simultaneously.

Not only communication links or data-exchange protocols have to accomplish the mentioned security properties. The software itself has to be reviewed carefully according to these objectives. Finally and most importantly end-users have to learn the correct and careful handling of sensible data.

Therefore there are three issues which are tackled within the AMBIENT LEARNING system:

- Confidentiality: For communication within the networks (e.g. company LANs or the Internet) state-of-the-art encryption mechanisms are used.
- Integrity: Appropriate counteractive measures have to be taken to prevent an attacker to actively alter the communication data changing important details or even the whole meaning.
- Authenticity and Non-Repudiation: Digital signatures and certificates can help with the task to make sure what person is responsible for the action. Also sending data to a communication peer must not be deniable.

The AMBIENT LEARNING system is a powerful web-service based training platform that enables easy conversion of existing content, rapid deployment to the web, and manages everything from the most basic level of Learning Objects to the highest level of organisational competency. The following figure illustrates the technical architecture of the system.



TECHNOLOGY USED

Multimodal Broadband Access (API, Access, Display Engine and Delivery Manager)

To maximise cost-effectiveness and to reach the widest possible user base, the architecture of the AMBIENT LEARNING platform is based on a powerful central server with multiple 'thin' clients. This provides an excellent level of security

for the customer organisations. In addition, it allows end-users a wide choice of low-cost client terminals. This component allows the user access to the eLearning content any time, any where and any how. project. The users can access the AMBIENT LEARNING web services through a peer-to-peer arrangement over various networks (broadband access like DSL, UMTS, WLAN, GPRS etc) employing the most suitable modality (interactive learning objects on the Office-PC, text-to-speech read-out while driving in the car, mobile PDF while sitting in the train etc.).

The transport type is the protocol that is used to transfer data from your client to your service. A Web server uses Hypertext Transfer Protocol (HTTP) to transfer data. HTTP is also used with Web Services to transfer service requests. The benefit of HTTP is that requests to a service are not blocked by company firewalls. A request that is transferred via HTTP is the most interoperable of all protocols because of the firewall issue. However, there are a huge number of transport types that can be used for service invocation. The attributes of the service you are building will determine the most appropriate transport type. The Learning Management Service is responsible for the delivery and management of the learning content. The Learning Management Service is distinguished from a typical 'LMS' by its flexible support for multiple pedagogic models through static and adaptive Reusable Learning Object sequences. It is, in effect, a neutral delivery and tracking tool which will 'play' whatever content is fed into it (from the LCMS or from any third party provider) so long as it conforms to standard XML protocols.

Content Management and Interoperability

Content Integration allows access to existing knowledge catalogues and eLearning resources. It enables fast conversion of existing content and powerful course assembly. It is possible to quickly and easily create Learning Objects-based courses and integrated testing using content that can come in the form of Word, text, SCORM-conformant content and any HTML documents. The system can integrate already existing eLearning objects and other high-quality content. Within the project the resources and existing content of Press-Catalogue (pressekatalog.de) are included, which embraces the content of some 20.000 European scientific and professional magazines.

The Learning Content Management Service uses a workflow-driven approach. Learning Objects are discovered and assembled using a meta-data language allowing flexible course usage. The learning material can be imported from other Content Systems using IMS interoperability standards and similarly exported to the Learning Management Service for learning delivery.

Context and Profile Management

As far as possible, an eLearning platform must adapt the services and the service delivery according to the needs and situation of the user. This component enables the provision of eLearning objects based on the context of the user. The context of the user includes factors like schedule, tasks, personal profile, previous experience, available device and interests etc. It allows personalised and context based usage. Personalization is the process of tailoring pages to individual users' characteristics or preferences. It is a means of meeting the users' needs more effectively and efficiently, making interactions faster and easier and, consequently, increasing users satisfaction and the likelihood of increasing the eLearning activities. Based on the context and the profile, the learning content, which suits the user perfectly can be delivered context-specific using the best suitable multimodal broadband access.

All services in the framework delegate the task of managing users and groups to the central services Context and Profile Management. This Management Service provides the backbone for the user authentication and authorisation for all services in the framework. All services have access to a single schedule management system controlling both synchronous and asynchronous messages between the services and the users. Examples include reminder messages to chase the progress of a student application for enrolment, a student for an assignment, or a tutor for responses to student queries and so on. User calendar functionality is also supplied by the Schedule Management Service.

Interface Service

The AMBIENT LEARNING system can be tailored to every organisations/end-users guidelines and can easily integrate with existing legacy-systems like Groupware-Systems (genesisWorld, Lotus Notes etc.), Intranet-Systems (teamWorks, LCDS etc., ERP-Systems (Sage KHK, Navision, SAP etc.) or other Web-Services (GMX, freeOffice etc.)

The Interface Service provides a generic XML-based connector which is needed to integrate the AMBIENT LEARNING system with aöreday existing business systems such SAP etc..

Through this integration, state of the art eLearning can become an intrinsic part of every business process.

The AMBIENT LEARNING Reference Architecture is the abstraction of common facilities from the typical 'LMS only' model. This is demonstrated in the use of a central collaboration environment being made available to all users of the platform. This environment is the backbone of the all-pervasive feedback mechanism allowing users to collaborate on any of the services available in the Reference Architecture and have their comments directed to the appropriate resource owner.

Assessment Manager

Both formative and summative assessment is provided through a collection of tools available to tutors to assess learners' progress against their learning objectives. The tools support the following assessment types:

- Individual Feedback and feedback aggregation (see Amazon feedback mechanisms)
- Multiple Choice Questions
- Multiple Right Answer
- Short Answer
- True/False
- Group Work
- Secure assignment handling
- Support for accreditation processes.

Catalogue Manager and Databases

The Catalogue Manager includes complete catalogues of all AMBIENT LEARNING services/components. This is a necessary basis for scalability and performance. Moreover the repositories contain libraries of digital resources for constructing learning material. Resources are discovered through an open search interface and made available to both the Learning Content Management Service for sequence definition of courses and the Learning Management Service for delivery. Reusable Learning Objects are represented using a metadata language for mark-up of digital media including descriptions, specifications and usage guidelines.

Multilingualism Service

The Multilingualism Service will be integrated into the AMBIENT LEARNING system to include multilinguality in an elearning environment: Users can request elearning material via the AMBIENT LEARNING system and will be notified which material is available in which languages. The following aspects are relevant:

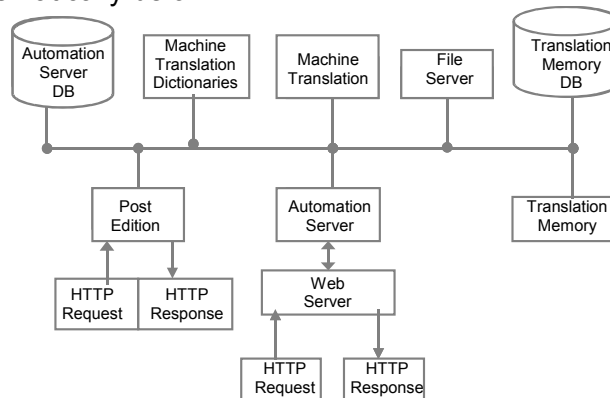
1. Multilingual keyword search: In order to be able to return information about materials available in other languages.
2. Translation workflow and output quality.

- User receives raw translated document within a couple of minutes
- User orders documents that need translating, these will be machine translated, routed to the human post-editing services and returned in good quality. The revised language strings will be saved in the translation memory. The next time the same document is requested in the same target language, the translated version will be immediately available. It will be validated in the pilot test involving users whether machine translated output of a machine translation system customised to the terminology of the relevant domain envisaged as a target learning environment will be acceptable as a basis for eLearning.

At the technical level, the communicator itself comprises three components:

- A *translation memory* populated with the localised software, bilingual versions of documentation, online help, and frequently asked questions;
- An interface to a *machine translation* program (e.g. SYSTRAN) including a custom dictionary holding key terms relevant to a given customer;
- An *automation server* responsible for workflow management, which routes messages through the translation modules and an optional post-editing service.

Together, these function as a 'black box', with input and output in XML format, this architecture is shown schematically below:



In principle, the system can handle any language combination, limited only by the capabilities of the machine translation (MT) software available; between them, the existing MT systems cover all the major European languages, and increasing numbers of non-European languages also.

Once the pilot system is set up, it is relatively easy to add further languages, with the automation server ensuring that each incoming message is directed to the appropriate MT module within the translation environment. A single help desk can then support users in many different countries at little additional cost. This forms an excellent basis for European-wide deployment of the AMBIENT LEARNING service.

INTEROPERABILITY

Interoperability is the ability of a system or a product to work with other systems or products without special effort on the part of the customer. Interoperability becomes a quality of increasing importance for information technology products as the concept that "The network is the computer" becomes a reality. Products achieve interoperability with other products using either or both of two approaches, either by adhering to published interface standards or by making use of a "broker" of services that can convert one product's interface into another product's interface on the fly. The AMBIENT LEARNING system uses both approaches.

eLearning Interoperability

Existing Learning Objects (either off-the-shelf or specifically developed) based on the SCORM-standard are integrated on the fly. SCORM (Shareable Content Object Reference Model) is an XML-based framework used to define and access information about learning objects so they can be easily shared among different learning management systems (LMSs). The SCORM specifications, which are distributed through the Advanced Distributed Learning (ADL) Initiative Network, define an XML-based means of representing course structures, an application programming interface (API), a content-to-LMS data model, a content launch specification, and a specification for metadata records for all components of a system. The ADL specification group's next challenge is to motivate vendors to comply with SCORM specifications.

The interoperability issues taken into account within the AMBIENT LEARNING project are based on the output from the following organisations.

- *IEEE | Learning Technology Standards Committee*
- *AICC | The Aviation Industry CBT Committee*

The AICC is an international association of technology-based training professionals formed to standardize instructional material for aircraft manufacturers and buyers.

- *IMS | Instructional Management System Global Learning Consortium*

The IMS Global Learning Consortium is comprised of members from educational, commercial, and government organisations.

- *Cedefop | Centre Européen pour le Développement de la Formation Professionnelle*

The Cedefop is an European agency that helps policy-makers and practitioners of the European Commission, the Member States and social partner organisations across Europe make informed choices about vocational training policy.

ACTUAL PROJECT STATUS

Use case and service definition is the process of collecting, organizing, maintaining, analyzing, and presenting data that enables activities to achieve the best value acquisition of the AmbientLearning service to meet the needs of potential end-users. It is a continuous process designed to gather data on needs, capabilities, and the business practices associated with them. It explains the phased validation approach, which is based on an iterative process, then it provides the user manual for the regional system and service providers and finally it delivers the basic questionnaire for the specific end-user evaluation. This questionnaire will be updated and adapted based on the first feedback by the end users.