# Learning GRID

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**In this Issue:**



## Editorial

Welcome to this second issue of the Learning GRID Newsletter, the newsletter of the Learning Grid Special Interest Group (SIG) of the Kaleidoscope Network of Excellence.

At the beginning, this newsletter had to be biannual: the first issue was in July, next issue had to be delivered in January 2005. Conversely, we decided to increase the number of yearly issues from two to four (two new issues in March and October) hoping to arise the interest in the research aspects faced in this SIG.

Before presenting this issue, I briefly report on some news in our SIG.

Recently, the new version of the Learning Grid SIG Portal was finalised and published at the following URL: http://kaleidoscope.grid.free.fr. The portal includes, in the "publication" section, all past releases of this newsletter. The portal adopts the new graphics of Kaleidoscope (we will upgrade also the Newsletter starting from the next issue) and is open to any suggestion for improvement.

The end of 2004 is coming. At this time, the SIG Steering Committee is planning activities of the next year. This is time for anyone interested in the Learning GRID world (virtually anyone is reading this newsletter) to propose ideas for new activities. Kaleidoscope gives us also the possibility to incorporate new members. Is your organization interested to join? If yes you must specify your experience in the Learning Grid domain and outline what will be your contribution to our current activities. For more details, please refer to the portal or send an e-mail to gridsig@crmpa.it.

We are now organising the first Learning Grid SIG Workshop. It will held in the Amalfi Coast (Italy) in March 2005. More details and the final call for paper will be available soon in the SIG portal.

After this brief list of news, we can now start talking about the content of this issue.

The featured article of this newsletter comes from the Learning Grid of Excellence Working Group (LeGE-WG) project, recently concluded successfully, and presents a vision about the use of GRID in e-learning.

LeGE-WG project aims were very similar to those of our SIG. It was in fact purposed to facilitate the establishment of a European Learning Grid Infrastructure by supporting the systematic exchange of information and by creating opportunities for close collaboration between the different actors in the formative process. Given this similarity, their achievements (here summarised) are considered of paramount importance for our activities.

Another important theme of this issue is the section related to the Learning Grid Scenarios aiming to present case of use of Grid technologies in e-Learning activities. The scenarios developed by the SIG members are presented.

The usual "research project focus" section presents the GRASP project aiming at the definition of an architecture for GRID Service Provision. In the "technology watch" section, instead, we will present IMS Learning Design and the WSRF specifications.

Enjoy your read.

**Pierluigi Ritrovato**
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# A Vision about the Learning GRID

***The Learning Grid of Excellence Working Group (LeGE-WG) project aimed to achieve an in-depth understanding of the fundamental issues underpinning the application of GRID computing for e-Learning. The purpose of this article is to summarise achievements of this project that ended in July 2004.***

### Introduction

The Learning Grid of Excellence Working Group (LeGE-WG) is a Thematic Network project funded by the European Commission in the frame of the IST fifth framework programme. LeGE-WG aims to facilitate the establishment of a European Learning Grid Infrastructure by supporting the systematic exchange of information and by creating opportunities for close collaboration between the different actors in the formative process.

The Working Group has been funded by the EC for an initial 2 years and brings together actors with complementary interests in Grid computing and e-Learning from technology-oriented disciplines, pedagogy, government or regulating bodies and of course students. It therefore provides an interdisciplinary consortium of experts and promotes close interaction between the communities associated with them, so as:

- to achieve an in-depth understanding of the fundamental issues underpinning the application of GRID computing for e-Learning,
- to cultivate the necessary common background for addressing the challenges associated with the establishment of a European Learning Grid Infrastructure,
- to establish a solid baseline for full exploitation of the EU-US Cooperation initiative on Science and Technology for e-Learning.

Furthermore, the Working Group aims to accelerate the emergence of a Learning Grid Infrastructure by supporting knowledge and technology transfer in multiple directions:

- technological innovation which will instigate the evolution of pedagogical models,
- feedback from students and educators which will serve to focus this technological innovation,
- the necessary regulatory frameworks to support this joint evolution will be brought about.

The project ended in July 2004. In the follow is given an overview of the vision about the Learning GRID elaborated by the project's participants.

### The Context

The main driver behind eLearning, and indeed conventional education as well, is the Knowledge Economy, with its emphasis on *globalization* – as work and hence workers are outsourced to distant locations; *knowledge intensity* – where 70% of developed world workers are information workers; *connectivity* – as e-commerce enhances cost savings, efficiencies and market reach; and *ICT infrastructures*. Add in the drive for *inclusivity* (avoiding the Digital Divide) and *employability* that most governments promote, and the need for “anytime, anywhere” learning becomes clear. eLearning is the way to deliver this. The general increase in (broadband) access to learning possibilities still represents one of the major changes that will affect the potential for integration of ICT in learning scenarios, and fulfilling the vision of lifelong learning. Unfortunately, the current “technology push” typified in most European and national eLearning initiatives, using ever more advanced technology to package and deliver information to effectively passive learners, is unlikely to achieve this. There needs to be a fundamental shift from such applicative projects to “learner driver” systems targeting experiential, contextualized and personalized development of the learner’s knowledge.

### New learning paradigm

For many of last years the teaching and learning practices have been based mainly on the information transfer paradigm. This focuses on content, and on the key authoritative figure of the teacher that provides information. Teachers’ efforts have been mainly devoted to find the best way for presenting content in order to transmit information to learners. Unfortunately the current generation of “e-Learning solutions”, which has arisen in response to political pressure, has adopted the rather narrow pedagogic paradigm of “information transfer”, which features the teacher as someone who selects particular pieces of information and makes them available to students on the Web. This approach very conveniently gives the surface impression that C&IT is being put to good use. However, there is no evidence that this approach to technology enhanced learning is in anyway effective. It has been adopted simply because it is an easy way to use the Web's basic facilities – material is selected and organised by the teacher on a web site, and students then browse and download it. Failures, such as massive drop out rates, are usually explained by a lack of staff awareness in the use of the Web, rather than critical reflection on the limits of this approach. Furthermore, it is not even clear that it has achieved reduced costs.

In our vision research should move towards the realisation of a paradigm shift that focuses on the learner and the new forms of learning. In our vision the learner has an active and central role in the learning process. Learning activities are aimed at facilitating the construction of knowledge and skills in the learner, instead of the memorisation of information. In fact, according to the recent cognitive theories, the learning process can be effective using an approach which considers in a unitary way some fundamental characters of learning as active, situated and collaborative learning. Keeping the learner at the centre of the new learning processes personalisation and individualisation became relevant aspects to be supported by technologies through the creation of the right context. Individualisation is related to the didactical process adopted allowing diversifying the path for guarantee the acquisition of basic competences according to specific didactical objectives. Personalisation means the possibility to reach specific didactical objectives fully exploiting the learners' intellective capabilities and competences and giving certain freedom in the choice of contents and approaches (playing with several simulations) in order to facilitate the creation of specific skills and knowledge. Personalisation and individualisation should happen at different level (contents, didactical models, pedagogical approaches) and should take into account the contents (the knowledge to be transferred during the process), the learner skill and preferences, the didactical objectives.

*Service orientation*

This new vision has two strong implications: teaching and learning moves toward the form of service and hence the technology must support this implication; teaching and learning process will push the creation of virtual communities where find heterogeneous resources (contents, tutoring, searching for learners for sharing experiences, etc.) virtualised as services. Technologies must be selected according to these implications. This the reason because we suggest to look at service oriented technologies for the realisation of widely distributed environments.

An open distributed service model is based on the concept of service that, in our context, is a kind of predefined combination of processes yielding some result (the goal of the service) from distributed, heterogeneous, asynchronously communicating and available resources. A service has access to some distributed heterogeneous resources and assuming the communication language is known to each resource, it performs a series of operations (queries of information, requests of computation, controls, redirection, etc.) by interacting with these resources.

The basic difference between a service and a product, we believe, is in the "truly" conversational, dynamic nature of services. In order to clarify the difference, the following are some consideration regarding products and services [16]:

- product is developed by the producer with a clearly predefined goal for the potential consumer, a service is offered within a service domain – or competence area, yet the consumer-specific objectives have to be defined during the initial conversations between the provider and the consumer of the service;
- a product is supposed to be in correspondence with a well established and a clearly identified need; a service often anticipates to the customer combinations of needs that were not clearly recognised as such by him/her before;
- a product is most often designed and prototypically developed once, produced many times; the value added by a product increases with the number of copies effectively distributed; a service must be conceived, designed, developed and distributed once for all, as it is custom made for a specific customer with specific needs; the value added by a service increases proportionally with the customer's satisfaction that entails an indirect publicity for the service producer and generates new customers ready to invest more resources in order to have similar services;
- a product's evolution is slow, as it requires modifications in the conception, design and development; shortly, a revision of the whole life cycle. A service evolves naturally as it is a combination of basic services and products on the fly as a consequence of a service definition and tuning during the conversations with a customer;
- a product is often chosen as a solution for an established need, even when the customer

does not really "trust" the producer's performance (e.g.: even if I dislike cars and prefer a car-less city centre, I need one for very practical reasons, and I choose the cheapest one because I plan to use it as little as possible); a service requires trust by the customer on the producer (e.g.: I do not go to a dentist or a lawyer unless I believe (s)he is trustable).

According to the needs of real applications, we can try to classify services in:

- "stateless services": these are represented as pure functions. The advantage of easy composition of purely functional services comes at the cost that they can hardly represent state;
- "conversational services": these are the most generic stateful services. Hard to be realized within a distributed and asynchronous context, heavy to be supported and maintained, they however maintain their fundamental interest for the most advanced applications. We believe that higher level services such as those emerging from semantically rich domains will require this model to co-exist with the other ones.

*Grid services*

Recently, Grid community efforts are related to the definition of a base framework for an Open Grid Service Architecture [3]: the Web Service Resource Framework (WSRF) [4].

Starting from experience gained from the definition of the Open Grid Service Infrastructure (O-GSI) [8], WSRF proposes an evolution of the Grid Service, which can be classified as a "conversational service", towards "stateless service acting upon a stateful resource".

WSRF proposal is involved also in defining service and its needs, and the proposed definition is a middle way between pure stateless services and stateful conversational ones, thus allowing a simple way to compose services without loosing the advantages of state management.

The next generation of Grid solutions will increasingly adopt the *service-oriented model* for exploiting commodity technologies. Its goal is to enable as well as facilitate the transformation of *Information* into *Knowledge*, by humans as well as – progressively – by software agents, providing the electronic underpinning for a global society in business, government, research, science, education and entertainment (*semantic aspects*) We refer to these efforts as the "Semantic Grid".

The Semantic Grid brings together Grid and Semantic technologies.

Semantic and Knowledge technologies are mainly focused on giving a well defined meaning to resources, services and information dispersed on the Web [5], they provides tools for knowledge representation and management, annotation of data and resources, semantic discovery of services and resources, automatic composition of services and inference over metadata and ontologies.

Current technologies, based on industrial standards and initiatives (e.g. UDDI [7], BPEL4WS [6]), allow composition of services with an a priori knowledge of services meaning and processes between services.

In contrast, Semantic Web and Knowledge technologies provides an expressive and semantically enriched description of services, by the use of ontology description languages as OWL-S [1], and allows for automatic selection, location and composition of services in order to achieve the required objectives.

According to this vision the new research direction should look at the creation of a semantic GRID for human learning: The Learning GRID.

The Learning Grid is a semantically enriched Grid that, bringing together the features of Grid and Semantic technologies, represents our solution for creation of the future learning scenarios.

It is based on the OGSA model, so it inherits all the features of that architecture. Two aspects, in particular, are important:

- the *openness* of the architecture, where open means extensibility, vendor neutrality, and commitment to a community standardization process;
- the *service orientation* and *virtualization*, where the first is related to definition of service interfaces and the identification of protocols that can be used to invoke a particular interface, and the second is related to the encapsulation behind a common interface of diverse implementation, so everything (tools, resources, scientific instruments, activities, etc…) in this environment is a service.

In our opinion, the Learning Grid is an ideal environment providing support during all the phases of a Learning Design.

*Scaling*

Grid technology can enable both advanced support for distributed activities and the necessary functionalities in a collaborative learning experience, and crucially, it can scale to handle large numbers of participants and actions/events and large quantities of data and processing in a cost effective manner. In addition to providing access to large facilities, it is possible to add a P2P architecture to a Grid infrastructure so as, on the one hand, to improve even more the Grid potential of robustness and resource availability and on the other hand, to allow participants to include computers at home, schools and businesses, and to scale to several millions of concurrent participants. The inherent decentralization of P2P systems provides interesting social benefits that a Learning Grid could fully take advantage of, such as not to depend on exclusive information, decision capacity, or central control as well as to support auto-organized groups, spontaneous groups and so on.

### Learning Documents

Authoring tools for production of learning scenarios can rely on knowledge-based decision making systems that can suggest what should be the best pedagogical models and/or activities for the learning scenario also on the basis of knowledge (e.g. starting skills, personal profiles, etc…) about the actors of the scenario. Furthermore, experts can also exploit the collaborative features of the Grid to cooperate in order to model the scenario. In this way, the Learning Grid supports analysis, modeling and development phases of Learning Design documents.

Even if this represents a good approach, collaborative and knowledge based, for modeling and definition, it is in the Delivery phase that the Learning Grid infrastructure shows its potentialities. The goal of this phase is the understanding of the Learning Design document and the execution of its content in order:

- to reproduce the didactical experience for the learner, and
- to supply to the teacher the capability to support the didactical experience.

The Learning Design document, describing the phases (in IMS-LD terminology, the plays) of a learning scenario, is parsed by an engine that is able to understand and execute the different acts and activities of a play. In order to execute the Learning Design document, we have to bind each activity with an environment that is a set of resources and services able to execute the activity. We can say that each activity points to an environment and, obviously, each environment has some requirements based on the pedagogical model adopted and learner preferences.

### Resources

To find inside the Grid the resources and services that best match the requirements of an environment, we rely upon OWL-S ontologies to index the core elements of the infrastructure. OWL-S provides three types of knowledge about a service: the *profile* that describes what the service does, the *model* that describes how a service works and the *grounding* that describes how a service can be accessed [10]. If a resource is virtualized through a service, its description can be semantically enriched by the use of OWL-S and this feature can be used to compare the requirements on a service against its description to find the service that best satisfy the requirements.

Indexing services and resources of a Grid can be used:

- by the Grid itself, in order to “know” its infrastructure and to provide machine understandable information about its resources and services,
- by knowledge tools, services or agents inside the Grid, in order to perform an automatic discovery of services matching demand’s requirements vs supply’s offers.

In this way, the Learning Grid uses its knowledge to bind the learner preferences and the pedagogical model against tools, resources and activities available on the Grid., in other words to provide the best environments for the IMS-LD activities.

In some conflict cases, where more than one appropriate resource is found, knowledge based support system can help in the selection.

### Learning scenarios

To support interactions among the actors involved in a scenario, trusted collaboration groups can be dynamically created where learners and teachers can join and resign the scenario. These collaboration groups are created when in a play there are acts containing shared activities among actors with different roles. Groups can share the same environment and rely upon collaborative features of the Grid to allow communication, either in a synchronous or asynchronous mode, among actors running the shared activity. In this way, actors can reach the objectives of the shared activity exchanging knowledge and experiences.

The Learning Grid makes available a learning scenario with all its “implicit knowledge” (pedagogical model of the scenario, learning goals of the scenario, resources and activities involved, etc…) as a building block for creation of more complex and interactive learning experiences composed by different scenarios.

A learning scenario, once produced and virtualized as a "Human Learning Service", can be indexed and stored in a knowledge base, thus becoming a shared unit of knowledge reusable in other contexts.

### Learning Context

During this shift from content to context of learning, it is crucial that the learner is provided with sufficient support. Most of the above discussion focussed on the learner and the learner support provided during the Delivery phase.

Typically, learners first encountering e-Learning welcome the benefits (added-value) of standardised, comparable support services and learning processes (interactivity, virtual communities, learner support, clear and credible information for decision-making, learner feedback and transparent certification). However, the current high drop-out rates (over 80% in some cases) cannot be blamed totally on inadequate, "information transfer"-oriented tools and methodologies which frustrate the learner. While the importance of the social and collaborative aspects of learning has been highlighted above, it must be remembered that many learners will still prefer tutor-lead education and training, in spite of the current trend towards learner managed learning (and in fact learner managed learning requires even more skill on the part of the tutor setting up the learning environment and providing the underlying resources). This implies that tutors must be considered and supported almost as much as the learners themselves. Tutor support ranges from tools to filter and manage the knowledge and experiences provided to the learner, to tools to monitor and assess learner performance. Tutors are also key in evaluating quality of learning resources and the wider relevance of the material being studied.

With increasing experience the learners focus widens to include those service components which facilitate learning itself. Validation of learning outcomes then becomes more important (accredited transferable qualifications, support for individuals integrating acquired competences into their everyday work).

The more quality and standardisation of approaches succeed in 'inner areas' (like content, technical platforms, basic interaction and feedback, certification standards), the more the scope and quality of 'sandwich services' will highlight the competitive advantages of e-Learning. At this phase, tutors become less central to the learning process, and collaborative learning can take off.

This process of de-institutionalisation in the acquisition of skills and competencies, (only partly driven by e-Learning), emphasises the role of each individual learner in collecting and integrating all their own competencies, regardless of source, into a personal portfolio.

The more Lifelong Learning spreads the acquisition of skills and competencies over different educational institutions, educational sectors, regions and nations, through formal/non-formal and informal learning processes, the more important becomes the transferability of the underlying accreditation as well as the embedding needed to successfully deliver those competencies in changing environments.

Many aspects of e-Learning (increased transparency, de-institutionalisation, standards, self-documentation, capacity of technology supported learning, use of products and services in a wide range of different educational/learning settings etc.) suggest its strategic role in improving transferability as a key element, leading to a better coordinated learner-oriented framework of Lifelong Learning provision, whilst providing for economies of scale.

### Integration of language technologies into e-learning Grid infrastructure.

Language technologies is a matter of great relevance to small language communities for sharing experience/expertise and learning materials also. Despite the rapid development of IT, multilingual computer-based technologies do not exist for many small languages. For example, in spite of the availability of Internet access, more than 65% of Lithuanian population are barred from the e-content of the Internet, due to the lack of English skills. Thus, particular groups of inhabitants with lower education level, residents of rural areas, elderly people, etc. are in danger to be cut off from the development. Recent online translation service provides text and web page translation from English to and from main EU languages only. Because software packages rather than human translators create these translations, absolute accuracy might be an issue. But if they are used to share a general understanding of the material, they can be an effective support system for learning and communication.

For learning and understanding purposes when sharing information there is no need to have a high accuracy language translators, a flexible set of language application tools like taggers, parsers, lexicons, etc. integrated into e-learning service infrastructure may help considerably. We suppose that the problem of multilingual dissemination of eLearning materials will still remain in the next 5-10 years. So, the development of multilingual communication services and the language application tools implementation as *services* will be particularly important for the expanded EU.

**Economic factors**

Of course, eLearning does not occur in a vacuum. As stated at the beginning of this section, there is a strong commercial need driving the uptake of lifelong learning, and eLearning as a means of achieving it. The use of Grid for providing eLearning is considered promising. The policy for the adoption of any new technologies should also consider cost minimisation and maximise return on investment (ROI) in all levels: from administration to the delivery of learning. In the latter case, new services should be designed in way that:

- fully utilise existing resources,
- can be expanded in order to support a large number of users while minimising costs,
- they ensure flexibility and are able to respond to the rapidly evolving global market,
- increase the power of core resources without creating the need for investing in additional hardware or hosting infrastructures,
- support expansion policies.

Another socio-economic driver that has a significant influence on eLearning is Intellectual Property Rights. Intellectual Property (IP) is increasingly seen as a valuable commodity, but it is the combination with other IP that generates added-value for the end-users. To protect their IP and ensure a decent ROI, owners increasingly want to control their information, even after it has been passed on to others. Grid technologies, in particular the high speed/high capacity networks, allow end-users to access and use IP without that IP having to leave the owners IT environment (and hence control). In addition, the tools used to control and manage the Grid infrastructure (security policy enforcement, certificates, etc.) can be used to protect data and processes from copyright and patent infringements.

The increasingly evident entrance of Universities into the e-Learning market in the role of providers is leading to the emergence of new business models in Higher Education. e-Universities are starting to appear, mainly resulting from partnerships and consortia of already existing institutions willing to keep their dominant position on the market by responding to the changing needs of demand and technological innovation challenges. The provision of on-line courses is further reinforcing the process of internationalisation of higher education and, at the same time, strongly impacting on the shift of learning provision from a regional to a global perspective. One corollary of this economic viewpoint is a focus on quality of courses and materials. The most likely approach to quality turns out to be reliance on reputation of publisher, use of brokers or consultants to advise, rating against published criteria of what constitutes quality materials, accrediting the producing organisation, public sector authority prescribes products which can be purchased.

**Summary**

We conclude emphasizing how our vision of the Learning Grid presents some of the properties described in [9] and is projected towards the Next Generation Grids:

- *it is open and standard based* – our vision is based on widely adopted standards and specifications,
- *it is person centric* – our Grid manages knowledge in order to satisfy learner requirements and preferences also on the basis of what the Grid know about the learner. Also the goal of the learning scenarios is person centric: they try to stimulate group of persons to acquire knowledge in many different fields,
- *it is transparent, easy to use and program*– an expert wishing to produce a learning scenario has only to learn how to use an authoring tool. He hasn't to know tools and resources of the Grid: the Grid itself, by the use of its knowledge, suggests the appropriate core elements available in the Grid. Furthermore, the adoption of expressive languages, as the OWL-S, could be a success factor from a programming viewpoint,
- *it is scalable* – our mechanism for indexing resources integrated with Grid tools for resource management allows for an easy and transparent joining and resigning of "nodes" in the Grid. Furthermore, indexing the resources brings the Grid to have some knowledge about its infrastructure, thus simplifying monitoring and self management of the infrastructure,
- *it is pervasive and ubiquitous* – our vision is based on the anytime-anywhere-anyhow paradigm inherited from the Grid (in some

way, it is part of the Grid paradigm). But, from our viewpoint, the term "ubiquitous" is referred, more generally, to the ability to support multiple diverse pedagogical models and to automatically adapt them in different contexts. Furthermore, the Learning Grid allows creation of pervasive learning scenarios: an actor is immersed in all the aspects of a learning process that takes care also of cultural and social context,

- *it is secure* – even if not clearly emphasized in this disseration, the Learning Grid has to address many security aspects from both technical and legal viewpoints (trust, confidentiality, security, etc.).

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## Learning GRID Scenarios

***One of the aims of our SIG is to define scenarios of use of a Learning GRID. This section of the newsletter will present collected scenarios.***

**First scenario:** Parallel Computing Cooperative Learning

This document presents a learning scenario for a course on parallel algorithms which requires students to have an active role, eliciting the discovery and construction of knowledge. An insight on concepts and practical issues in parallel processing can only be gained through experimentation using a real environment. Clusters of computers have constituted an appropriate platform for cost-effective parallel computing in general and for teaching in particular. The grid introduces a new platform that can be exploited for teaching parallel processing, taking advantage of the new characteristic it presents.

The learning scenario exploits collaborative methods of learning (such as peer learning and tutoring, reciprocal teaching, project or problem-based learning) in a grid environment.

### Overall Scenario Description

The scenario is focused on teaching a programming course on parallel algorithms. In the first instance, a single institution running such a course is considered. To provide for availability, the institution in which the course is run, provides a fixed set of resources (a dedicated cluster), permanently providing the services for the application. Apart from these resources, students and instructors' machines could also offer their storage and computational facilities. The collaboration among several institutions could be considered as a natural extension of this scenario, not only to share hardware resources but also to extend the collaborative learning experience.

As a consequence of the three aforementioned situations, the scenario supports a multi-structure platform in hardware and software. The system could be used as a cluster, as a network of computers (geographically constrained) and as a full-fledged grid in the case of collaboration among several institutions. This multi-structure encourages a broad learning experience, which includes issues from programming considering communication details to use the networked resources transparently and seamlessly as one supercomputer.

Each student executes a program which constitutes a peer in a peer-to-peer network for a computing sharing application. All the running peers constitute a federating system. This platform is available at any time, allowing students access to the documents and the computational power in the context of a lecture as well as in other contexts (from the library, from home).

The platform could support different programming languages. The user of the platform (student) can submit source code, compiled code, and/or a specification of a parallel algorithm.

This platform for distributed computing serves for executing and debugging parallel programs.

Different group projects are given to the students. For instance, given the specifications of several tasks and a dependency graph among them, different students can be assigned the programming of each of the tasks to be executed on the platform.

The following functionalities are necessary for this learning scenario:

1. commands for submitting jobs specifying the requirements for the resources (a node with a particular architecture, a node with a particular compiler installed, etc.)
2. monitoring of submitted jobs
3. monitoring of all the connected peers, allowing a tutor to visualize the activities of individual students and/or groups of students
4. file-sharing facilities to support the distribution of training materials; students might also provide documents to share (some solution, summaries of the subject, etc); and they may share code
5. the shared material may be qualified by the users (tutors can rate different solutions, summaries made by the students)
6. restriction to sharing facilitates in exam period
7. gathering results (answers to exercises, solutions, reports)
8. the platform has to allow the tutors to assess group goals as well as to measure individual progress; this could be implemented with an accountability system
9. collection of statistics related to student participation in the network, results, etc.

Functionalities 1 and 2 are already provided by existing execution environments in the grid. The other ones have to be implemented for this particular application.

### New pedagogical models exploitable in the described scenario

The described scenario encourages active and collaborative pedagogical models.

It is active because the learner is the principal actor of the process, being able to select different levels of abstraction in the use of the system. In a lower level, the student chooses the programming language to use, the communication method to use, establishing the requirements for the execution of the parallel algorithm, etc. At a higher level, the student can concentrate in problem stated in more abstract terms, neglecting the details that are managed by the system. Another aspect that makes the students proactive actors of the system is that they have increased opportunities to conduct independent work in a real platform and they can assess their own performance.

The creation of the knowledge is a collaborative process which evolves through the interactions with colleagues, tutors, instruments, sharing documents, discussions, code.

The system provides ubiquity and accessibility because the educational resources can be accessed all the time. This fact promotes a multi-context learning experience.

The simultaneous participation of students is encouraged by the federated system because the computational power is increased as more users join.

### Kind of services, features, tools, needed to support the scenario

As it was mentioned in Section 2, new services have to be provided to support the described scenario.

These new services combine grid with peer-to-peer computing features. Every user participating in the system not only uses resources but also offers his/her resources (including documents, code and computational power). Accountability of user activities is very important for students/groups to assess their own performance as well as to be evaluated.

**Business benefit / driver / need of the scenario**

The main benefit of this scenario is the experience gained by students when programming in a real distributed environment where they can select the level of abstraction to solve a particular problem. In this way, students gain knowledge of advantages and difficulties of parallel computing through experimentation in different contexts.

Another important and broader advantage of this scenario is the provision of a service for operational assessment of collaborative work environments such as file sharing and load distribution of services, which is of practical benefit, for example, in peer-to-peer contexts.

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**Second scenario:** A Collaborative Research Environment

Research is defined as original investigation undertaken in order to gain knowledge and understanding of a particular subject. The research process includes sourcing information about the area of research, analysing that information and producing new knowledge leading to new or substantially improved insights. Collaboration among individuals and/or research groups constitutes a key element in the research process.

The scenario presented in this document focuses on learning at the postgraduate level, supporting the process of finding and sharing information and promoting collaboration among research students, supervisors, and research groups. The system proposed by this scenario contributes to the research process in general.

Web technologies permitted the development of projects such as CiteSeer, based on autonomous citation indexing[4]. CiteSeer[3] is a digital library which organises scientific literature, allowing flexible searching and citation statistics.

This documents proposes a new scenario in which grid technologies are used to extend the digital library with new forms of collaborative activities, not realizable with previous tools, and constituting a collaborative research environment.

The resources that could be shared in the environment are, apart from papers (journal articles, conference articles, thesis, technical reports, preprints), formal or informal comments, reviews, summaries, meeting memorandums, presentations (which may include voice comments), videos, images, graphics, code. The same information may be provided in different file formats.

In addition, it is proposed that the environment would contain project, code and bibliographies management tools, facilities to develop forums, video conferencing, chatting as well as to perform statistics over the stored data.

A virtual organization (VO) is defined as a coordinated group of individuals and/or institutions that cooperate by sharing resources, according to predefined policies, to achieve a common goal. In the context of the collaborative research environment, different VOs are specified such as: a research student and their supervisor(s), a research group, several research groups possibly belonging to different institutions, the largest possible VO including all the research groups participating in the environment (this is the scope reached by systems like CiteSeer).

Each user of the environment can personalise the different facilities provided. For instance, considering a project definition the view of a research student will differ from the view of the group director.

The group director could define a project identifying tasks, their relationships, time estimation and participants. A student could have write access to his/her tasks and read access (or not) to others tasks. Any user could define a code repository, categorise papers, comments and reviews and give access to other users to this information. The user also defines the resources to share (or not) within a particular VO and could ask for comments about them to the rest of the members of the VO.

A user can subscribe to services which will inform him/her about addition of documents of a particular subject, by a particular author or set of authors, published in a particular journal or other options that can be customised.

The user could provide different criteria for searching resources. For instance, a user can identified equivalence among words or phrases (e.g. grid computing, e-science and metacomputing could be defined as equivalent by a particular user). The system could suggest equivalence classes of keywords to the user.

Personalisation options could be specified at individual level or VO level.

The access to the environment could be done through a grid portal, which is a web-based application that provides personalisation, single sign-on, content aggregation from different sources and hosts the presentation layer of information services.

### New pedagogical models exploitable in the described scenario

The scenario promotes the paradigm shift from learning based on information transfer to ubiquitous, collaborative, experiential, contextualised and personalised learning[1].

Previous digital libraries like CiteSeer provided a repository of information, without the possibility to personalise the use of the system, include new types of documents, categorise or share the information in different ways. The collaborative research environment is user-centred and allows the research student to learn with some hints (classification of documents) provided by his/her supervisor(s) at the first instance, other people in the research group, and most importantly, by himself/herself. Thus, this scenario fosters the transition from content-oriented learning solutions to a user-centred collaborative model.

### Kind of services, features, tools, needed to support the scenario

The scenario involves the collaboration among different research groups that may belong to different institutions geographically dispersed around the world, possibly including a large number of researchers.

Thus, a large-scale geographically distributed infrastructure composed of heterogeneous networked resources owned and shared by multiple administrative organizations is needed, i.e. a grid environment is necessary to provide this kind of scenario.

The information is scattered over the storage resources available. A basic service that the grid has to provide for the implementation of the scenario is efficient search of distributed resources. Some replication policy has to be used to provide high availability. Performance is also an important factor.

This is related to the scalability of the system. Systems like CiteSeer sometimes exhibit problems of unavailability or degraded performance.

The personalised interface, depending on the user and the context, could be done through the use of grid portals.

A publish/subscribe service has to be provided.

Consideration and management of the metadata for the stored information is fundamental.

### Business benefit / driver / need of the scenario

This scenario constitutes a new and useful way of supporting research activities, allowing to easily organise and access all sorts of documentation/information involved in the research process, and to assess individual and group progress. This system fosters the visibility and dissemination of information among VOs.

All the material stored could also be useful for development of teaching material.

The target users are in particular research students because the environment facilitates the insertion in the research world, but researchers in general could take advantage of this kind of scenario.

The expected impact on the learning world of this collaborative research environment is important because it is known that collaborative learning enhances critical thinking[2], a key instrument of the research activities.

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### Third scenario: A distance programming course based on practice

let's take the case of an institution that offers to students a course on introductory programming on line. This course adopts an extremely active pedagogy. Students are learning by doing. Each concept (elementary syntax, class and objects instantiation, methods and parameters, etc...) are presented to students with some explanations, but mainly with many exercises that are program pieces that students have to complete, or correct and run. Students do not have to download any programming environment. When they want to do an exercise, they click on it. The programming exercise appears in an editor window. When they are ready with the changes, they hit a submit button. The learning system itself takes care of the compilation and, if possible, of the execution of the program without any human action. After compilation and after execution, students are notified, with possible explanations, of the result. All students answers, time, error messages etc... are stored in a database.

**New pedagogical models exploitable in the described scenario**

This scenario goes away from the traditional 'information transfer' approach. What is required is the active participation of students.

Further, students do not have to download any compiler nor any programming environment. The platform takes care of that. They need only to concentrate on the principles of programming. They receive immediate feedback on their work. The learning platform analyses their answers and delivers right away the result and, possibly, an error message, also in case where the program compiles but does not produce the expected answer. Storing all interactions in the database makes it is possible to produce some detailed reporting (individual student view, class view, exercises view, errors view etc...), which makes it easier for teachers/tutors to monitor the class and the learning material.

**Kind of services, features, tools to support the scenario**

If many students hit the submit button at the same time, then the server will be overloaded. What is needed is a GRID system able to dispatch the work on unused CPU. Also, the database can become very large. A distributed database could be necessary.

**Business benefit / driver / need of the scenario**

The main benefit of this scenario is for students to learn programming not primarily by receiving information but by practicing a lot at their own place, at their own pace. We would like to implement this scenario in our Engineering School for students coming in with good skills in Math, Mechanics etc.. but with too little knowledge in Computer Science. Presently, these students are behind. The distance course would allow them to begin their studies with more confidence and to be more successful. For computer science teachers, it will make the standard of students more homogeneous, thus make the face to face teaching easier.

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**Forth scenario:** Collaborative lab

The GRID concept tries to take benefit of the interconnection capabilities of computer systems by providing an extra layer of abstraction coordinating distributed data and processing.

We could try to apply this approach in pedagogical situations where students and teachers are working with interconnected personal computers to improve the communication level and coherency within the group. E.g. physical or virtual labs of (possibly) numerous students, working individually or in groups, under the supervision of teachers or tutors.

Actually, a missing feature of computer-aided learning in labs (possibly web-based virtual labs) is the lack of visibility of students activities to the group and to the teachers. Contrast this situation with one-to-one training, or small-group gestural training, where one can benefit from a view of the others' activity.

The traditional situation is the following: the lab is a collection of isolated individuals each pulling their own material and exercises from a dumb pedagogical server, and deploying an activity invisible to the tutors. Usually informal mails and forums are the only groupware metaphors used by students to break this isolation.

We could imagine richer distributed system metaphors enabling teachers:

1. to visualize the activity of students and groups in the lab (who is working on which part of the training material, with whom, getting which results...),
2. to distribute training materials and tasks to people and groups, that could not be esily done on a server system,
3. to actively gather the results of students works (answers, solutions, reports)
4. to navigate through these results, and make them visible to the group, if needed.

Part of these same facilities could be made accessible to students.

### New pedagogical models exploitable in the described scenario

Assisted (personal and group) learning activities in labs.

### Kind of services, features, tools to support the scenario

Such a scenario suppose to break with the traditional server-centred e-learning models, in favour of a more distributed grid-like system providing some visibility of distributed users, data and processes (to be investigated further).

### Business benefit / driver / need of the scenario

We would like to implement such a scenario in our Engineering School for computer science training, making teaching in the lab more user-friendly and efficient. Indeed, a better view of student's activity would allow tutors to be aware of extremes (students left behind and students well ahead) and adjust their pedagogy accordingly. It would also make easier to conduct collaborative projects.

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### Fifth Scenario: *Using GRID computing for processing and analysing information from on-line collaborative learning teams*

The information collected regarding online collaborative learning requires classifying, structuring and processing. The aim is to process this information in order to extract, reveal and provide students and tutors with valuable knowledge, awareness and feedback in order to successfully perform the collaborative learning activity. However, the large amount of information generated during online group activity may be time-consuming to process and, hence, can hinder the real-time delivery of the information.

In this scenario we propose to use a Grid-based paradigm to effectively process and present the information regarding group activity gathered in the log files under a collaborative environment. The computational power of the Grid makes it possible to process a huge amount of event information, compute statistical results and present them, when needed, to the members of the online group and the tutors, who are geographically distributed.

### Introduction

Computer Supported Collaborative Learning (CSCL) applications are characterized by a high degree of user-user and user-system interaction and hence generate a huge amount of information usually maintained in the form of event information. In order to make this information useful to the group activity, it must be appropriately collected, classified and structured for later automatic processing by computers as part of a process of embedding information and knowledge into CSCL applications.

The aim is to extract essential knowledge about the collaboration and to make it available to users as awareness and feedback. The lack of sufficient computational resources is the main obstacle to processing data log files in real time and in real situations this processing tends to be done later, which as it takes place after the completion of the learning activity has less impact on it. With the emerging Grid technology such a handicap can be overcome by using its computational power.

In this scenario we propose a Grid-based approach for processing group activity log files in order to make the processed information available to the group members in an efficient manner, to compute statistical results and to present the results to the group members and tutors, who are in different locations, as a means of facilitating the group activity, decision making, task accomplishment, and assessment of the progress of the group etc.

The starting point could be the definition of an appropriate structure for the log files designed as a part of a more generic platform for supporting CSCL applications. The purpose is to define the structure of event information to be stored in order to permit the structuring of the event information in log files of different degrees of granularity. Then, it is necessary to understand how to use Grid computing paradigm for processing the log files resulting in a database ready to be used for statistical computations.

### The Structure of Group Activity Log Files

The classification of information in CSCL environments is made by distinguishing three generic group activity parameters: task performance, group functioning and scaffolding making up a hierarchy of events. Furthermore, in a collaborative learning experience, the group activity is driven by the actions of the participants on the collaborative learning resources, which are aggregated to the user events to form another taxonomy in which we can differentiate, at a high level of abstraction, between active, passive and support user actions.

In order to prepare the event information for efficient Grid processing, as soon as we classified and turned it into persistent data, we must store it in the system as log files of group activity. Next, we should predefine two generic types of log files according to the two basic criteria, time and workspace, that characterize group collaboration. These log files will represent as great a degree of granularity as possible regarding both criteria. During data processing it will be possible to concatenate several log files so as to obtain the appropriate degree of granularity thus making it possible for a distributed system to efficiently parallelize the data processing according to the characteristics of the computational resources.

### Using Grid infrastructure for Processing Log Files

In the context of online collaborative learning, Grid computing has been used to support the real-time requirements imposed by human perceptual capabilities as well as the wide range of many different interactions that can take place as one of the most challenging issues of collaborative computing support [1], [2].

Grid computing offers high-throughput and data-intensive computing, which greatly facilitate the process of embedding information and knowledge into CSCL applications making it very suitable for the purposes of our approach [3]. The structure of log files as well as the possibility of having different degrees of granularity makes it possible to implement our approach in a Grid computing environment which is inherently parallel, distributed, heterogeneous and dynamic, both in terms of the resources involved and their performance.

As described in the previous section, our event log files can be partitioned in chunks of arbitrary size and be processed in parallel with almost no dependencies between the processing tasks. The grid will allow us to easily, dynamically and securely aggregate machines to work on the problem in parallel. We expect a dramatic speed-up that will allow us to present part of the statistical results even in real time.

The Architecture of the Application can be made up of three parts:

1. the Collaborative Learning Application (in charge of maintaining the log files and storing them in specified locations);
2. the Grid Processing Application (in charge of processing log files);
3. the application that uses the resulting information in the databases to compute statistical results and present them to the final user.

Regarding the implementation of the Grid Processing Application we consider two possibilities:

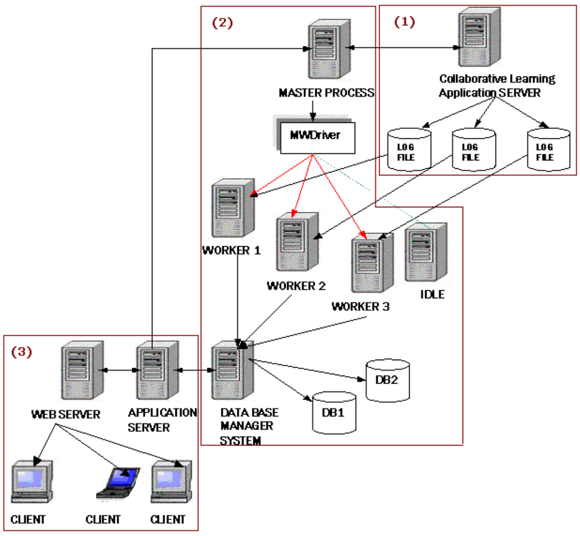
a. one that imposes no burden in terms of software prerequisites on the grid computing nodes except for a common native runtime environment (i.e. Linux);

b. one that reuses the legacy Java code we are actually using to sequentially process our event log files.

Option (b) requires a JVM to be available on the nodes or the ability to be able to deploy it, while option (a) forces us to write new code for processing event log files that natively executes on the target grid environment. On the other hand, option (a) allows us to more easily and dynamically aggregate any grid node to our application, while option (b) may require some software predeployment before a node can be aggregated.

All in all option (b) seems more appealing to us because it is more platform independent and better exemplifies the benefits of grid enabling an inherently parallel legacy sequential application without any or minimal source code modification. Furthermore, the (b) approach permits a clearer and direct performance comparison between the sequential and the distributed versions.

We exemplify the architecture of the application through the Master-Worker (MW) paradigm widely used for developing parallel applications (see next figure).




In the MW model there are two distinct types of processors: master and workers. The master processor performs the control and coordination and assigns tasks to the workers. The workers typically perform most of the computational work. The MW model has proved to be efficient in developing applications using different degrees of granularity of parallelism and is particularly useful when the communication load between the master and workers is low.

The master is in charge of generating new tasks for distributing them to the workers while the workers run in a simple cycle: receiving the message describing the task from the master, processing the task according to a specified routine and sending the result back to the master.

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## Research Project Focus: GRASP – Grid based Application Service Provision

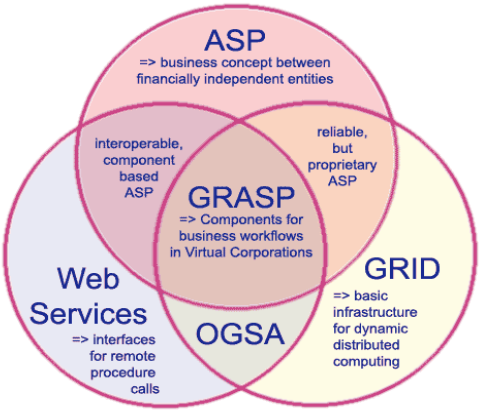
***The GRASP project aims at studying, designing, developing and validating a new GRID-based system infrastructure for achieving innovative business interaction models based on the pattern of Application Service Provision and Virtual Organisations. To validate project results in real business scenarios, the project includes a test-bed on e-Learning.***

The GRASP project aims at studying, designing, developing and validating a new advanced system infrastructure for achieving innovative business interaction models based on the pattern of Application Service Provision (ASP) and Virtual Organisations.

The infrastructure is based on GRID technologies, in particular on the emerging service oriented vision of grid architectures (defined in the frame of Open Grid Service Architecture Working Group of Global Grid Forum), combined with commodity technologies (such as Microsoft .NET, Web Services, XML, SOAP, etc.) and COTS (such as UDDI directory, MS BizTalk server, etc.).

The GRASP middleware, taking advantages from these technologies, is able to provide a high level of scalability, reliability and security, advanced accounting functionality, quality of service and resource management representing the technological vanguard currently available.

The GRASP project constitutes a first step towards the achievement of an advanced vision of Application Service Provision, thanks to the adoption on innovative solutions from both a technological and business point of view. This vision is realised through the provision of innovative and advanced services for supporting collaborative business oriented Virtual Organisations. The figure below shows the integration role of GRASP with respect to the three concepts: ASP, Grid, and Web Services.




**Project Objectives**

In summary the main objectives of the GRASP project are described below.

- To design, implement and validate a layered **architecture**, which constitutes the base of the GRASP infrastructure, using GRID technologies. The platform is based on the Grid Service concept (the building block of an OGSA compliant architecture) and includes at the bottom level an Open Grid Service Infrastructure (OGSI) compliant framework to enable the implementation of Grid Services supporting the basilar port type introduced and specified in the OGSI specification document version 1.0.

  On top of this level a number of fundamental middleware GRID services are provided, which simplify the integration of distributed resources and increase the efficiency of applications such as advanced instantiation and location, distributed accounting and QoS monitoring, fine-grained pricing, basilar security and grid service orchestration mechanisms.

- To analyse and evaluate **interoperability** issues between GRID middleware, Commodity Technologies and COTS such as Microsoft .NET and web services, MS UDDI directory services, MS BizTalk and MS application centre. Furthermore, to evaluate available OGSI framework for Microsoft .NET platform and the possibility to integrate into our Grid environment the emerging extensions for Web Services (e.g. WS-Security, BPEL4WS, etc.).

- To design and evaluate two **ASP business models** that fully exploit the GRID technologies "federated" and "Many-to-many" ASP models:

  – A *federated model*: this model foresees a network of ASPs. In this scenario, there are two distinct parts: the provider of applications (a network of ASPs) and the clients. The provider is not a single entity but is constituted by many actors that federate their resources in order to provide services to their clients. The federated model provides more powerful capabilities and is able to serve business intensive, heavy load applications with improved efficiency.

  – *Many-to-many model*: this paradigm is the evolution of the one-to-many model (the classic ASP model, where there is one provider and many clients).

    It permits the integration and collaboration of provider and user resources. The clients are able to make available their resources in order to receive an income. A many-to-many model is actually a P2P (Peer two Peer) relationship where sharing of resource is highly controlled and clearly defined in terms of which and how resources are shared and used.

- To **test** project results in real business scenarios, by defining and running two test beds, one in the medical attention management field and one in the learning field.

- To define methodologies and techniques in order to **make existing applications GRID aware**. This awareness constitutes the identification of Service Oriented GRID characteristics and the issues related to migrate towards a Grid Service based environment, in particular respect to the evaluation of interactions with the middleware grid service that allows the management of a Grid based Virtual Organisation and their effects on the application behaviour.

**Overview of the GRASP Architecture**

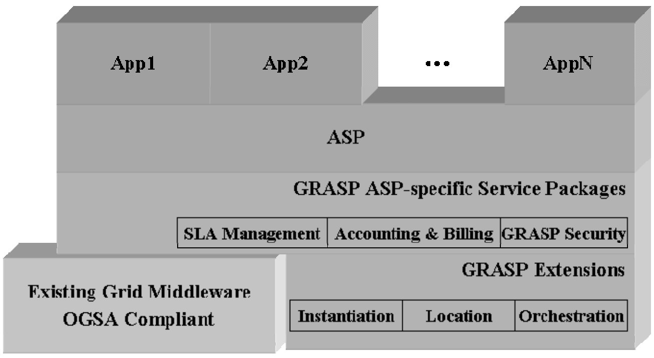
One of the key architectural elements of GRASP is the distinction between the Application Service delivered to a client and the component Grid services that are used to implement this.

The component Grid services are provided on demand by 3rd party Service Providers running Virtual Hosting Environments (VHE), which of course may consist of many individual hosts actually running the services. From a management perspective each VHE uses a Gateway server as front-end being responsible for creation and management of the Grid services within it, though from an operational perspective can be used.

This architecture enables the VHE manager to control the operation of and access to their services as necessary in a fully commercial environment while still exploiting the power of the underlying Grid technology (including direct P2P communication between services) to actually deliver the overall Application Service. The basic business functionality that Application and Service Provider require is built into the Grasp Framework, simplifying the job of building Grid-based Application Services.

The figure below shows the GRASP high level architecture. Building on top of existing OGSA compliant middleware (in the GRASP prototype implementation this is OGSI.NET) the key functionality of Location, Instantiation and Orchestration of Grid Services is extended to handle the Gateway concept:

- *Instantiator*: selects the an appropriate host – subject to QoS and other relevant pre-set criteria – and invokes the appropriate OGSI Factory (-ies) , initiates SLA monitoring and Accounting & Billing services; interacts with the security manager service that is responsible for securing the group of GRASP services executing an Application Service.
- *Locator*: pre-filter results for those Virtual Hosting Environments that can meet a specified QoS/SLA and returns the endpoint for the Instantiator (in the Gateway) not the factory as for OGSI;
- *Orchestration*: orchestrates potentially mobile Grid services, via Gateways; must allow for P2P communication between orchestrated Grid services.




On top of this extension, further business functionality is provided as part of the GRASP Framework including:

- *SLA Management:* SLA (template) used in selection of VHE and Host; monitoring of service to ensure compliance; mapping of monitored data to SLA concepts;
- *Accounting & Billing:* collection of raw performance/resource data (shared with SLA monitoring); merging different costings and applying pricing algorithms;
- *Security:* securing complete Application Service (multiple component Grid Services on multiple VHEs); handling securely life-time and addition and expulsion of component

### A GRASP-based e-Learning Scenario

An E-Learning System usually consists of a Learning Management System (LMS) which takes care of administering the courses and their assessments, some tools to produce and package the content, some community / group working functionality and perhaps a library and a certification / testing service.

This functionality could be naturally decomposed into separate components that are offered by different commercial providers using interoperable Grid/Web service interfaces, as shown below.

In a typical GRASP scenario, one can imagine a multiplicity of such services. Then a user agent undertaking the role of a content creator provides learning content which is checked by the Content Tool for compliance to the appropriate standards and it is then offered as an application service.

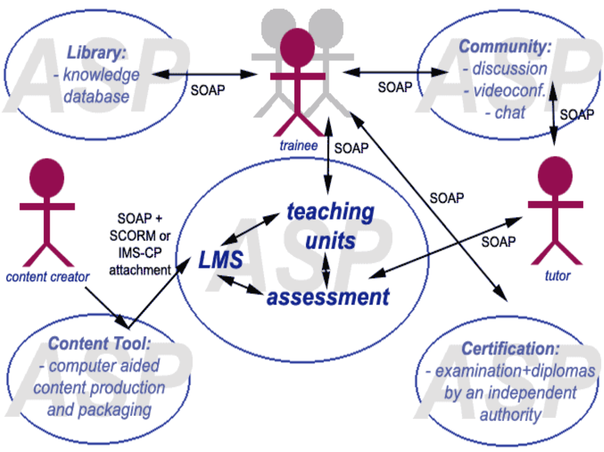
The Content Tool also publishes and registers the provision of this application service with a number of e-Learning content portals. A user agent undertaking the role of a trainee can then discover ASP such as Libraries (offering a knowledge base service) and Community services (such as videoconferencing) involving interaction with another user agent undertaking the role of a tutor.

The trainee can also select specific teaching units via the LMS service which discovers and bundles appropriate content services into teaching units while involving the tutor agent for course assessments. The trainee may also wish to obtain a certificate for this course. The latter can be provided by an independent authority which monitors the quality of the learning material and tutoring at hand.

In an instance of this scenario, a specific trainee may discover a LMS offered by company X which will then create on-demand transient instances of teaching unit, LMS and, when necessary, assessment service instances. The latter will try to locate and involve available tutor while the LMS service instance will contact appropriate Content providers requiring specific content packages.

Content provision is also implemented by the on-demand creation of transient service instances which will collaborate with the requesting LMS service instance. Certification also involves the creation of service instances for validating the credentials of each ASP involved (requesting cross-certification or additional recommendations from monitoring or reputation systems when appropriate) and then for producing a certificate or for rejecting the request.

All these service instances will consume shared computation and data resources through out their lifetime. These resources are reserved on-demand by the ASP generating each service instance, only to be released after the end of the operating life of the service instance.




## References

[1] Project Web Site: http://eu-grasp.net.

# Technology Watch

***This section presents Technologies, Specifications and Standards related to the e-Learning GRID world. A brief description will be given together with a set of references to "must read" articles and documents.***

## IMS Learning Design

IMS Learning Design is a specification for the description of pedagogies in online learning. Rather than attempting to capture the specifics of many pedagogies, it does this by providing a generic and flexible language. This language is designed to enable many different pedagogies to be expressed. The approach has the advantage over alternatives in that only one set of learning design and runtime tools then need to be implemented in order to support the desired wide range of pedagogies.

IMS Learning Design relies on a number of elements. These include: **roles** that people perform (who does what); **activities** (what they do); and **environments**, which include where they do them (services) and what they do them with (learning objects). The overall scenario or design is described within the **method** element, which contains **play**, **act**, and **role-parts** elements, and is analogous to a theatrical play. A learning design may be based around the achievement of specified **learning objectives** by learners; it may also define **prerequisites**. As well as allowing an entire design to be shared or reused, IMS Learning Design allows these elements to be reused in other learning designs.

By using IMS Learning Design it is possible to:

- describe and implement learning activities based on different pedagogies, including group work and collaborative learning;
- coordinate multiple learners and multiple roles within a multi-learner model, or, alternatively, support single learner activities;
- coordinate the use of learning content with collaborative services;
- support multiple delivery models, including mixed-mode learning;

IMS Learning Design also enables:

- transfer of learning designs between systems;
- reuse of learning designs and materials;
- reuse of parts of a learning design, e.g. individual activities or roles;
- internationalisation, accessibility, tracking, reporting, and performance analysis, through the use of properties for people, roles and learning designs.

More info about IMS Learning Design can be forum on the IMS site (see [1], [2] and [3]).

A first prototype of an open source editor for Learning Design is available as one of the results of the **Reload** Project [4]. An open source engine named **Coppercore** for the execution of IMS Learning Design packages is also available from the Open University of Nederland [5].

## References

[1] IMS Learning Design Information Model at http://www.imsglobal.org/learningdesign

[2] IMS Learning Design Information Binding at http://www.imsglobal.org/learningdesign

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## Web Service Resource Framework

The new trend of Grid technologies is represented by the migration towards a model built on concepts and technologies that are inherited from Grid and Web Services communities. From the merging of these two technologies, the new concept of "Grid Service", that is a stateful and (potentially) transient Web Service, has emerged and has been formalized with the introduction of the Open Grid Services Architecture (OGSA) [1]. OGSA defines the semantics of Grid Service instance, such as, how it is created, how it is named, how its lifetime is determined. OGSA does not place any requirements on implementation aspects and it relies upon a Service Oriented Infrastructure.

The Open Grid Services Infrastructure specification version 1.0 (OGSI) [3], proposed by the Global Grid Forum (GGF) [5] as infrastructure for the OGSA and released in July 2003, defines a set of conventions and extensions on the use of Web Service Definition Language (WSDL) and XML Schema to enable stateful Web Services. It defines approaches for creating, naming, and managing the lifetime of instances of services; for declaring and inspecting service state data; for asynchronous notification of service state change; for representing and managing collections of service instances; and for common handling of service invocation faults. At the core of OGSI is a Grid Service [1], a Web Service that conforms to a set of conventions for such purposes as service lifetime management, inspection, and notification of service state changes. OGSI also introduces standard factory and registration interfaces for creating and discovering Grid services, and a base fault type.

In order to provide a narrow integration with the Web Services standards and tools, to follow recent Web Service Architecture evolution and to answer to some critical questions summarized in [2], the Grid community proposed a refactoring and evolution of OGSI aimed at exploiting new Web Services standards, specifically WS-Addressing [6], and at evolving OGSI based on early implementation and application experiences.

The Web Service Resource Framework (WSRF) [4] is a set of specifications for Web Services allowing the programmer to declare and implement the association between a Web Service and one or more stateful resources. They describe the means by which a view of the state of the resource is defined and associated with a Web Services description, forming the overall type definition of a *WS-Resource*.

A WS-Resource is defined as the composition of a Web Service and a stateful resource that is:

- expressed as an association of an XML document with defined type with a Web Services portType, and
- addressed and accessed according to the *implied resource pattern*, a conventional use of WS-Addressing endpoint references.

WSRF [7] is concerned primarily with the creation, addressing, inspection, and lifetime management of stateful resources. The framework provides the means to express state as stateful resources and codifies the relationship between Web Services and stateful resources in terms of the implied resource pattern.

Based upon the construct of WS-Resource, WSRF defines a set of five technical specifications that define the normative description of the WS-Resource approach in terms of specific Web Services message exchanges and related XML definitions. These specifications address how:

- a WS-Resource can be destroyed, either synchronously with respect to a destroy request or through a mechanism offering time-based (scheduled) destruction, and specified resource properties (WS-ResourceProperties, [8]) may be used to inspect and monitor the lifetime of a WS-Resource (WSResourceLifetime, [9]);
- the type definition of a WS-Resource can be composed from the interface description of a Web Service and an XML resource properties document, and the WS-Resource's state can be queried and modified via Web services message exchanges (WS-ResourceProperties, [8]);
- a Web Service endpoint reference (WS-Addressing) can be renewed in the event the addressing or policy information contained within it becomes invalid or stale (WS-RenewableReferences);
- heterogeneous by-reference collections of Web Services can be defined, whether or not the services are WS-Resources (WS-ServiceGroups, [10]);

- fault reporting can be made more standardized through use of an XML Schema type for base faults and rules for how this base fault type is used and extended by Web Services (WS-BaseFaults, [11]).

A separate family of specifications, called WS-Notification [14], defines a general, topic based Web service system for publish and subscribe interactions that build on the WS-Resource framework.

The WSRF and WS-Notification currently are under the standardization process of the OASIS but some implementations of the specifications are available, for instance [12] and [13], and the next release of the Globus Toolkit (GT4) will be based upon WSRF.

### References

[1] I. Foster et al. "The Physiology of the Grid" 2002

[2] I. Foster, S. Tuecke, J. Frey et al. "From Open Grid Service Infrastructure to WS-Resource Framework: Refactoring and Evolution" V1.0, 2004

[3] I. Foster, S. Tuecke, J. Frey et al. "Open Grid Service Infrastructure (OGSI)" V1.0 2003

[4] Foster I, Frey J., Tuecke S. et al.: "The WS-Resource Framework", 2004

[5] http://www.ggf.org/

[6] WS-Addressing specifications available at: http://www-106.ibm.com/developerworks/webservices/library/ws-add/

[7] I. Foster et al. "Modeling Stateful Resources with Web Services", 2004

[8] WS-ResourceProperties specifications available at: http://docs.oasis-open.org/wsrf/2004/06/wsrf-WS-ResourceProperties-1.2-draft-04.pdf

[9] WS-ResourceLifetime specifications available at: http://docs.oasis-open.org/wsrf/2004/06/wsrf-WS-ResourceLifetime-1.2-draft-03.pdf

[10] WS-ServiceGroup specifications available at: http://docs.oasis-open.org/wsrf/2004/06/wsrf-WS-ServiceGroup-1.2-draft-02.pdf

[11] WS-BaseFault specifications available at: http://docs.oasis-open.org/wsrf/2004/06/wsrf-WS-BaseFaults-1.2-draft-02.pdf

[12] http://www-unix.globus.org/toolkit/docs/development/wsrf/3.9.1/index.html

[13]http://www.cs.virginia.edu/~gsw2c/wsrf.net

[14] WS-Notification specifications available at: http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=wsn

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## News

***By Angelo Gaeta***

### ADL Releases Important SCORM 2004 2nd Edition Addendum

The ADL Technical Team has released the SCORM 2004 2nd Edition Addendum document. This addendum describes all of the reported issues identified by implementers of SCORM 2004 2nd Edition since its release on July 22, 2004. SCORM implementers are urged to review this document immediately to understand the corrections, changes and clarifications described and how these may affect current SCORM 2004 vendor implementations. The information in this addendum supersedes referenced information in the SCORM 2004 2nd Edition documentation suite. The SCORM 2004 Conformance Requirements document is also being updated to reflect the changes described in this addendum and will be made available for download during the first half of October 2004. This addendum is considered part of the SCORM 2004 document suite and may be downloaded from the SCORM Downloads section.

In conjunction with these changes, the SCORM 2004 Conformance Test Suite Version 1.3.1 and SCORM 2004 Sample Run-Time Environment (RTE) Version 1.3.1 are also being updated to track to the changes incurred from this addendum and to address issues identified by the ADL Community. These will also be available for download during the first half of October 2004. The updated SCORM 2004 Conformance Test Suite and SCORM 2004 Sample RTE will then be at Version 1.3.2.

ADL will release updated versions of the SCORM 2004 2nd Edition Addendum to capture and resolve issues that might arise in the future. As more implementations are created, the rate of these releases is expected to drop, as has been the case in past. SCORM implementers should review the latest version of this document on an ongoing basis. The SCORM 2004 2nd Edition documentation suite and its addendum define the most current technical requirements for SCORM conformance.

### TELCERT Schema Profiling Tool Documentation and Source Code

TELCERT is a European 6th Framework project which draws together the IMS specifications, the IMS Application Profile Guidelines and the state-of-the-art in UML systems specification and testing. The project is implementing a range of tools that will support users in profiling the specifications to meet their needs. These tools, the associated design documentation and open source code are destined to be made available via the IMS web site so that they can be accessed by as broad a community as possible.

The project is also piloting the development of a test system that can be used to test implementations against these profiles.

Tools and documents are available at: http://www.imsproject.org/telcert.cfm

## Next Appointments

| When | What | Where |
|---|---|---|
| 17th December 2004 | **2nd IST Workshop on Metadata Management in Grid and P2P Systems (MMGPS):Models, Services and Architectures**<br>The MMGPS'04 workshop aims to identify recent technological advances and open research challenges regarding metadata management in novel applications requiring peer-to-peer information management in a distributed or Grid setting. In P2P systems, a number of autonomous servers (peers) share their computing resources, data and services. Grid systems also aim to allow sharing of computing resources, data and services among dynamic collections of servers. Thus, Grid and P2P systems face similar challenges, and there have been several workshops during 2003/4 aiming to bring together researchers from both communities in order to share and develop common solutions. | Senate House, University of London |
| February 7 - 11, 2005 | **GlobusWORLD 2005**<br>GlobusWORLD is the premier Grid conference featuring the Globus Toolkit®. If you want to learn about the Grid, go straight to the source -- only GlobusWORLD is organized by designers and developers of the toolkit that is central to virtually every major Grid deployment worldwide | Boston, Massachusetts |
| 4-6 May 2005 | **CF '05 2005 ACM International Conference on Computing Frontiers**<br>The increasing needs of present and future computation-intensive applications have stimulated research in new and innovative approaches to the design and implementation of high-performance computing systems. This challenging boundary between state of the art and innovation constitutes the computing frontiers, which needs to push forward and provide the computational support required for the advancement of all science domains and applications. This conference will focus on a wide spectrum of advanced technologies and radically new solutions and is designed to foster communication between the various scientific areas and disciplines involved. | Ischia, Italy |
| 9 - 12 May 2005 | **CCGrid '05 - Cluster Computing and Grid 2005**<br>Commodity-based clusters and Grid computing technologies are rapidly developing, and are key components in the emergence of a novel service-based fabric for high capability computing. Cluster-powered Grids not only provide access to cost-effective problem-solving power, but also promise to enable a more collaborative approach to the use of distributed resources, and new economic products and services. CCGrid2005, sponsored by the IEEE Computer Society (final approval pending), is designed to bring together international leaders who are pioneering researchers, developers, and users of clusters, networks, and Grid architectures and applications. The symposium will also serve as a forum to present the latest work, and highlight related activities from around the world | Cardiff, UK |

| When | What | Where |
|---|---|---|
| May 9 - 12, 2005 | **CLAG '05 - The Second International Workshop on Collaborative and Learning Applications of Grid Technology and Grid Education**<br>Education and collaboration are now emerging as very important application fields of grid technologies. On the one hand, the grid may also enable access to large amounts of heterogeneous resources that can be employed for educational purposes. Examples include remote laboratories, 3D virtual environments and educational services. Thus, the use of grid computing could provide significant benefits for education at different levels: K-12, high school, university, skill training and learning for life. On the other hand, there is an increasing interest in developing new tools and applications in order to support collaboration between users within a grid context. Distributed high quality visualization, distributed grid workflow management, and enhance group and presence management and visualization contribute to realize Grid-based collaboratories. Such collaboratories are being developed for the scientific community, but in the near future they will be adapted for collaborative work or collaborative learning purposes, as it has happened to other technologies developed by the scientific community. Complementary to these is the desire to create a forum for the discussion of innovative and exemplary materials and approaches to education about the grid and emerging grid technologies and standards | Cardiff, UK |
| May 9-12, 2005 | **SIGAW: Semantic Infrastructure for Grid Computing Applications Workshop**<br>This workshop is designed to take a snapshot of promising research on semantic systems in the context of Grid computing and track emerging do-able solutions for developing a semantic infrastructure. Languages, tools and technologies are already available, in particular those borrowed from the Semantic Web community, the Digital Library community, and the Semantic Grid. However, much remains to be done. For instance, a semantic infrastructure leveraging common denominators between grid applications and architectures is needed. Additionally, semantic systems must easily adapt to tailor customized solutions for individual applications. Some lightweight versions must be available to facilitate customization and integration in existing environments (for instance problem-solving environments). Other systems need to scale to the volumes and diversity of the data. As successful prototypes move towards deployment provisions for maintenance will have to be made. The workshop is seeking papers presenting innovative research, design, and lessons learned with an emphasis on scientific applications | Cardiff, UK |