KNOWLEDGE SHARING IN A HIGHER EDUCATION CONTEXT: THE ROLE OF MOBILE AND GRID/P2P TECHNOLOGIES

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ABSTRACT
M-learning mainly addresses informal learning aiming at the creation of knowledge outside curricula or courses. In this paper we present an investigation into whether and how a formal structure like a university can promote and guide informal learning. A mobile infrastructure allows learners to overcome space/time difficulties and to enter in a virtual community in which individuals share some learning interests. Among the technical facilities required to fulfill such a vision, a special relevance is assumed by ubiquitous wireless networks to support wide area and local collaborative activities. In our view, a grid/peer-to-peer based infrastructure can be effectively built upon pervasive wireless networking to obtain an active knowledge sharing environment blending many heterogeneous services and the different end-user devices and goals.

KEYWORDS
Collaborative learning, knowledge sharing, Grid/P2P services, platforms for m-learning

1. INTRODUCTION
Mobile technologies have been so far primarily exploited to extend traditional e-learning scenarios in which learning material is organized by teachers and instructors while a Learning Manager System fits it to students on the basis of a curricular activity. Generally speaking, mobile technologies could facilitate anytime, anywhere e-learning, thus motivating a first definition of m-learning (mobile learning), i.e. learning using a mobile device (Trifonova et al. 2004).

The flexibility and portability of a PDA make it the preferred tool to people who have to combine work, studying, journeys and leisure time in a meaningful way. Many environments, like museums or hospitals rely on this fact to provide personnel and visitors with the right information at the right time. These “intelligent” environments offer the possibility to enter in contact with knowledge that depends on the context, that is to say, depending on the place and on the situation in which the learner is found. In this case the attention can be focused not on the technology but on the learner who becomes a “mobile” learner (Sharples eds, 2006).

While e-learning is best suited for curricular activities, m-learning mainly addresses informal learning aiming at creation of knowledge and skills’ acquisition outside curricula (Syvänen 2004).

Within mobile learning activities we can recognize both an individual use of a portable device as well as an interactive use of it. In the latter case mobile devices and wireless technologies are the way to exchange information, to perform a collaborative work, to discuss about a matter and to produce new relationships. This kind of informal learning is also the most popular way in which young people and students take advantage of these technologies. In the case of higher education such technologies should allow student interests to overcome the boundaries of curricular programs. In particular, each student would be able to personalise her/his knowledge by the study of a matter belonging to another curriculum or by deepening some subjects by means of additional learning material, research activity, exercises, seminars and so on.

A typical university campus includes several knowledge centres (specialized in some research areas), together with learning centres in which knowledge is transferred in a formal way, as well as other centres
where learners can study or organize their learning experiences. Students have to reach these centres to attend their education: this activity can be done and enriched by the use of communication network, mobile devices and useful services.

In this paper we try to investigate if and how a formal and well-defined structure like a university can promote and guide informal learning. In this context a mobile e-learning application can be seen as a mediating tool in the learning process. It allows learners to overtake space/time difficulties and to enter in a virtual community in which individuals share some learning oriented interests and speak the same language. Among the technical facilities required to fulfill such a vision, a special relevance is assumed by ubiquitous wireless networks, both as a commonly available infrastructure and as ad-hoc networks that can be autonomously activated by end-users, to support wide area and local collaborative activities. In our view, a grid/peer-to-peer(P2P) based infrastructure can be effectively built upon pervasive wireless networking to obtain this kind of active knowledge building and blending many heterogeneous services and the different end-user devices and goals.

2. A NEW LEARNING ENVIRONMENT FOR A UNIVERSITY CAMPUS

Our general aim is to investigate and experiment new forms of interaction among students, teachers, researchers and services manager, enabling time and space continuous higher education learning within and outside a university campus. This work will extend with new features a flexible university portal in which e-learning services can be used both by those with wired internet access and by those nomadic users with mobile devices (Bianchi et al., 2005). The research activity integrates the services offered by our university portal such as e-mail, newletters, electronic registration to courses and exams. Our school of engineering hosts experiments on a Learning Management Systems which can suggest the proper sequences of objects to build “ad-hoc” courses to the e-learner. This can be achieved by the use of a domain ontology and learning objects that are catalogued in the SCORM standard. Additionally, in order to provide teaching contents and auto-evaluation tests which are really usable on PDAs we have introduced a LMS able to recognize (and adapt to) student profiles and end-user devices.

Many students, particularly those spending a lot of time in daily journeys to/from the university sites, have shown a particular interest in those e-learning services which can potentially turn productive an otherwise useless and often boring time. In order to render more productive and interesting the time spent by students while at the university and while commuting, we need to integrate not only synchronous and asynchronous learning activities but also blend formal and informal education. By means of their mobile devices and thanks to the available networking facilities and set of e-services, students can make most of their time devoted to learning, both when accessing university structured resources and when directly exchanging knowledge built upon their own experience at the university.

As one of the main enabling technologies for scalable, seamless and secure distributed systems, Grid technology may enable new applications for education and collaborative learning. There are already examples of access to remote laboratories, 3D virtual environments, multimedia streaming, knowledge sharing among students in different organizations. The great number of relevant technologies, the use of heterogeneous devices and user terminals as well as the high variety of learning activities to be supported call for a service-oriented approach and the Open Grid Service Architecture (OGSA) is emerging as a de facto standard for building open, service-oriented learning opportunities. In our approach the service-oriented infrastructure underlies all communication tools used in the learning process and knowledge building. This means that the learner using limited capacity, portable wireless devices can enter in a virtual community of knowledge and yet fully take advantage of the available services. Thanks to service-orientation, generic clients and content adaptation, there is no need to download and store a large amount of data together with the corresponding applications: services can be provided in a transparent way to groups of heterogeneous terminal devices. Moreover, after browsing some indexing services, a learner can directly access the fragments of knowledge that belong to her/his interests and has the possibility to build and organize a personal knowledge base as well as a personal learning activity.

Critical issues of this infrastructure include how to guarantee a suitable quality of service to the end-user, how to ensure the up-to-dateness and the reliability of the didactic resources and how to manage a well-defined but flexible security policy. Additionally, the essential interoperability is to be achieved at two
different levels, namely at the lower level of media integration and data exchange facilitations and at the higher level of educational and semantic-based use of shared pieces of knowledge.

It is possible to identify two networked scenarios in which the process of sharing and building knowledge takes place. In the first one there is the presence of infrastructural static peers acting as service providers, while mobile peers, i.e. the learners, are mostly service invokers. In this context, it is possible to direct learners’ interests and to assist the learning process: for example the service managers can provide common ontologies and catalogued resources and guided services to subscribe new resources. The second kind of scenario refers to ad-hoc mobile networks of groups of students in which the university only makes available collaborative applications which once deployed to user terminals can be used by learners to share knowledge.

3. TECHNICAL ASPECTS OF A SERVICE-ORIENTED INFRASTRUCTURE FOR LEARNING ACTIVITIES

As e-learning applications are increasingly deployed, next generation learning community platforms will have to support more flexible and extensible environments in which portable devices equipped with wireless technologies become the main client platforms. For example, while multimedia sharing is rapidly becoming one of the most important Internet applications, several universities around the world have already deployed or are experimenting solutions enabling multimedia content distribution for teaching purposes. In (Amoretti, M. et al. 2006 a) our choices are described for the design of a service-based grid infrastructure for content searching and multimedia streaming for virtual organizations, which are transitory communities in which technology enables members to bridge gaps of space and time and allow for an effective knowledge sharing. The prototype of multimedia service manager is based on OGSA and it is endowed with a number of services allowing publishing and discovery of decentralized multimedia contents, Quality of service (QoS) management and support for user authentication and authorization.

In a typical Grid-based network services are hosted by fixed and always-on servers and only clients can be mobile on the network. Likewise, in our system the distributed nature and heterogeneity of the service infrastructure is completely hidden to the user: she/he submits a request through a common graphical interface and obtains a streaming session that depends on the user profile and the network status. Both quality of service and security management are handled by a conventional and centralized e-learning system. The learning resources available in the system are consistent since only teachers can introduce new instances which are classified with metadata that share a common language (formally expressible by defining a domain ontology) that the experts share (Amoretti, M. et al 2004). With the anytime, anywhere possibility of sharing different large distributed and possibly interactive repositories of learning resources, mobile users can personalise their learning activities and gain new skills in unused time for curricula activities. Moreover, an informal sharing of the common language used by experts in a matter can redefine the way in which learners achieve their knowledge. While it is evident that students enjoy attending informal learning by means of a portable device, it is more difficult to establish how the sharing of a more peculiar language in a expert domain could create more interested and active students.

In a more dynamic environment end-users can also become resource and/or service providers and Grid technologies could be integrated within a P2P network so as not to depend on centralized servers. In order to support a service-oriented P2P architecture for a decentralized learning environment we plan to extend our service sharing and content distribution system by taking advantage of JXTA P2P middleware and integrating OWL-S descriptions of Web Services (Amoretti, M. et al. 2006 b). The goal is the development of a robust and highly decentralized, knowledge-based hybrid Grid/P2P system where the extensibility is achieved by following SOARM (Service-Oriented Architecture Reference Model) rules in the definition of the functional and technical specifications of the system. The underlying core technology currently under development is based on the JXTA-SOAP component, whose purpose is to fill the gap between JXTA and Web Services, two technologies which may well complement each other. While Web Services have gained rapid acceptance as a design shift for the development of loosely coupled distributed applications, their effective deployment in many domains can be hindered by the requirement and rigidity of centralized UDDI registries. However, JXTA’s peer-to-peer underpinnings can provide scalable alternatives for Web Service discovery and communication, seamlessly working across wired and wireless networks with stationary and mobile peers (thanks to JXME, i.e. JXTA version for mobile devices). Currently, JXTA-SOAP allows to deploy, publish, discover and invoke Web Services in a network of JXTA peers.
The effective and secure information sharing we want to introduce in this service-oriented P2P infrastructure cannot be addressed by generic security mechanisms and semantic retrieval techniques. We need to define how a resource or service description should be published including information about its level of importance as well as about the owner and the intended users (authorization). The P2P infrastructure will incorporate a decentralized reputation management system allowing users to select service providers on the basis of other users’ experience and advise. Moreover, given the lack of a centralized and a priori common language, we are currently investigating a semantic discovery of service advertisements. The service search module still uses an algorithm proposed in (Navigli et al.) exploiting WordNet to create semantic graphs but appears too limited to build an effective support to knowledge sharing communities.

4. RELATED WORKS

Context mobile learning has been investigated in MOBIlearn, (Lonsdale et al. 2004). Context awareness is being explored not just as a way to deliver appropriate content but to enable appropriate actions and activities, including interactions with other learner in the same or similar contexts. Our research try to support this kind of interaction by offering to mobile learners an infrastructure to enter in a virtual community. The importance of wireless technologies in high education contexts has been investigated and tested at the University of Birmingham (Corlett et al. 2004). The focus of this research is the development of mobile, personal learning organiser, while our work focuses on the possibility to exchange and build knowledge in a collaborative learning.

In these last years a lot of work has been done about the role of technologies in informal and collaborative learning activities and most crucial factors of success have emerged. In (Allison et al. 2004) the concept of QoS in collaborative learning is introduced while security aspects are treated in (Lirong et al. 2005). A collaborative multimedia m-learning environment is shown in (Fiadhi et al. 2005) in which the attention is focused to how provide various type of multimedia information in a standard way. Also our infrastructure provide services to treat security and to guarantee the same QoS among different kind of multimedia and end-user devices.

In (Hsu-Yang et al. 2005) an adaptive mobile learning mechanism is presented and a grid capability of real-time interaction are showed, while our aim is to integrate different kinds of learning by using the flexible grid-based approach.

The success of web-based file-sharing services and the advantages of the P2P approach in building medium applications for interoperable learning object repositories are discussed in (Terneier et al. 2005). Probably, the most famous application is the open source project Edutella which is built on Sun Microsystems JXTA Framework (Nejdl et al. 2002). It is a semantic based application to exchange data and it tries to solve the lack of structured metadata in a P2P networks. Edutella technology is used to connect heterogeneous kinds of educational nodes in ELENA Project(Simon et al. 2003) which aims to provide personal learning assistants interacting with the connected peers in order to query for suitable learning services. Edutella project is a very interesting framework to use in the development of tools for virtual knowledge community.

5. CONCLUSIONS AND FUTURE WORK

In this work we discussed how recent mobile and Grid/P2P technologies can improve the anywhere, anytime learning experience of university students. In particular we reported our first steps in bridging learning activities and collaborative as well as multimedia applications over wireless networks. E-learning environments can increase both their efficiency and quality of service by exploiting grid based technologies together with adaptation to end-users’ devices. Our previous system provides a good accessibility to learning material which is organized in well-defined repositories but it does not take advantage of knowledge sharing among learners connected to a network. In order to extend it, a service-oriented P2P architecture for decentralized learning is under development where semantically annotated services and resources are offered by the infrastructure and also by the end users. We are currently defining how to manage its security and which semantic models are appropriate for knowledge sharing communities.
In order to guide further development, the first system prototype will be evaluated with some of our courses, e.g. database principles and technologies. This course is imparted both in a regular class and in an e-learning modality. The course requires the interaction of people with different skills and personal curricula: students, teachers and network administrators. Moreover, they interact with the system at different times and in different places thus they need to become a “virtual community”. Teachers put their learning material, i.e. lessons, slides, examples, on the e-learning platform together with a well-defined ontology, while authorized people, like specific students or administrators, can put seminars, tutorial, exercises, small applications on other peers of the infrastructure. These learning resources can be partially classified according to the language defined in the ontology domain and they allow students to learn and to share different aspects of the course domain.

From these experiences we aim at understanding whether students will appreciate the possibility to increase their knowledge by working with various forms of learning, whether the system will really improve their learning process and whether our model of decentralized service architecture is suitable to this context. We also plan to carry out tests and interviews to both regular and e-learning students in order to assess if they have acquired similar levels of property of language in the course domain, whereas monitoring forums or system accesses will help us to determine the level of appreciation and the difficulties encountered by end-users.

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