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

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ABSTRACT

M-learning mainly regards informal learning aiming at creation of knowledge outside curricula or courses. In this paper we try to investigate if and how a formal structure like a university can promote and guide informal learning. A mobile infrastructure allows learners to overtake 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 this kind of active knowledge sharing and amalgamating 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 tools to people who have to combine work, studying, journeys and leisure time in a meaningful way. Many environments, like museum 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 that becomes a "mobile" learner (Sharples eds, 2006). While e-learning is best suited for curricular activities, m-learning mainly regards 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 high education such technologies should allow student interests to overtake (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 amalgamating 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).

Many students, particularly those spending a lot of time in daily journeys to/from the university sites, have shown a particularly 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 provider, 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

While e-learning applications are increasly deployed, next generation learning community platforms will support more flexible and extensible environments in which portable devices and wireless technologies applications are the fundamental elements.

As multimedia content distribution is rapidly becoming one of the most important network applications, several universities around the world have already deployed or are experimenting solutions for multimedia content distribution. In (Amoretti, M. et al. 2006 a) our choices are described for the design of a service-based infrastructure for content distribution and multimedia streaming for virtual organizations, which are transitory communities in which technology enables members to bridge gaps of space and time and reach an effective sharing knowledge. 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 are mobile on the net. 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 guaranteed by the system in a mostly quite traditional way of a centralized e-learning system. The learning resources 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 like to attend informal learning by the use 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 not relying 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 based on the JXTA middleware and 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 guaranteed by following SOARM (Service-Oriented Architecture Reference Model) rules in the definition of the functional and technical specifications of the system.

Features like scalability, high availability and effective information sharing we want to introduce in this service-oriented P2P infrastructure cannot be addressed by traditional 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 trust or importance and about the owner and the intended users (authorization). Moreover there is not a centralized and apriori 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.) that use WordNet to create semantic graphs but appears too limited to build an effective support to knowledge sharing communities.

4. RELATED WORKS

The use of wireless technologies and of a mobile learning organiser in high education contexts has been tested at the University of Birmingham (Corlett et al. 2004), while contextual mobile learning, including interactions with other learner, has been investigated in MOBIlearn Project (Lonsdale et al. 2004).

In (Hsu-Yang et al. 2005) an adaptative mobile learning mechanism is presented and a grid capability of real-time interaction are showed, while (Fiaidhi et al. 2005) reports how to provide various type of multimedia information in a standard way in a collaborative m-learning envinronment.

The explosion 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 structurized metadata in a P2P networks. Edutella technology is used to connect heterogeneous kinds of educational nodes in ELENA Project(Simon et al. 2003).

5. CONCLUSIONS

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 and 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.

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