Mobile Web Services for Collaborative Learning

Mohamed Amine Chatti, Satish Srirama, David Kensche, Yiwei Cao
RWTH Aachen University, Informatik V (Information Systems)
{chatti,srirama,kensche,cao}@cs.rwth-aachen.de

Abstract

Since learning nowadays is conceptualized as a social system within communities of practice, the best way to learn is with others, in groups. In the past few years, there has been an increasing focus on social software applications as a result of the rapid development of new web technologies. Furthermore, mobile and ubiquitous technologies have provided capabilities for more sophisticated open social systems, where mobile knowledge sharing is the norm. In this paper, we explore the use of these concepts for learning and present a smart phone driven mobile Web Services architecture for collaborative learning.

1. Introduction

Most e-learning content today is delivered via centralized learning management systems that do very little to encourage the learner to communicate with peers and share knowledge. However, learning is conceptualized as a social system within communities of practice [1]. Therefore, a learning system should include a collaborative learning environment that encourages knowledge sharing, facilitates socialization, and supports collaborative learning. In the past few years, research on social software applications has expanded as a result of the development of new web technologies. Additionally, advances in mobile and ubiquitous technologies have opened the door for new learning forms, in which learners are no longer put under constraints of specific time and place. Based on these emerging technologies, we believe that the term e-learning, which describes learning resources or activities, delivered or enabled by means of electronic technology, is going away and the terms such as *me- learning*, *we- learning*, *m-learning* and *u-learning* will become a mainstream. *Me-learning* is the vision that will provide personalized learning experiences to every person everyday [2]. *We-learning* refers to a culture where knowledge sharing is the norm. Mobile learning or *m-learning* is learning supported by mobile devices and intelligent user interfaces [3]. Ubiquitous learning or *u-learning* is learning that is not constrained to a physical space or specific time.

In this paper, we stress the importance of collaboration, community building, knowledge sharing, and social networking for learning. Section 2 explores the shift from e-learning to we-learning and points to the potential use of social software in collaborative learning environments. Section 3 focuses on mobile and ubiquitous learning to enhance collaborative learning activities. Section 4 highlights a mobile Web Services architecture for mobile learning with scenarios. Finally, Section 5 gives a summary.

2. From e-learning to we-learning

Learning is leaving the training classroom and becoming an indispensable ingredient of living and working in our society [4]. Hodgins defines learning as a knowledge and social skill that has to be learned and continuously improved. It is one of the new basic skills of the future [5]. Siemens presents learning as a network-forming process which is the act of encoding, connecting and organizing specialized nodes to facilitate information, and knowledge flow [6]. Wenger views learning as a social system within communities of practice which are groups of people sharing a concern or a passion for something they do and learn how to do it better as they interact regularly [1]. Despite the social aspects of learning, most e-learning content today is designed, authored and delivered via centralized learning management systems (LMS) such as WebCT, Blackboard or Moodle as static-packaged online courses and modules. Learning is more than authoring, and delivering static learning content from centralized learning repositories. It is more about linking people to people instead of to content for supporting collaborative learning. Rather than a top- down knowledge push approach, learning

has to occur within a socially open context which supports various forms of interaction, such as discussing, commenting, or co-creating of learning resources and best practices among community members (e.g. novice learners, or experts). This means a move away from e-learning to we-learning, a culture based on collaboration, which fosters knowledge sharing and network building.

Educational learning environments must place a significant value on collaboration and integration of new applications to connect people to share ideas, create new forms of dynamic learning content, and learn from each other. This class of applications is commonly called social software.

2.1. Social software

Over the past few years, the Web was shifting from being a medium, in which information was transmitted and consumed, into being a platform, in which content is created, shared, remixed, repurposed, and passed along [7]. We are entering a new phase of Web evolution: The read-write Web, a new generation of user-centric, open, dynamic Web, with sharing, collaboration, collective intelligence and distributed content in the foreground. Social software has emerged as a major component of this movement [10].

Social software can be defined as a tool to augment human's social and collaborative abilities, enabling social connections, information interchange, and a system of people, practices, and values in a particular local environment [8]. Social software supports conversational interaction, social feedback, or social networks [9]. Below we provide a brief outline of characteristics of certain social software technologies.

A wiki is a collaborative Web site which can be constantly edited by anyone, thereby building a shared knowledge repository. Wikipedia is such a good example of social software to enable collaborative content creation and social interaction.

Another form of Web publishing is blogging. Technorati was tracking the rapidly increasing number of over 44.5 million blogs as of June 2006 [31]. In contrast to wikis, where anyone can add and edit items, a blog is edited by one individual or a small number of persons. An enhancement of blogs is Webfeeds, e.g. RSS and Atom feeds. Webfeeds are also a new mode of communication that allows blog-authors to syndicate their posts to subscribed readers. The features and technologies used in blogs (e.g. comments, trackbacks, blogrolls) make them a communication medium and an example of social software in action. Commenting on blog posts enables the interaction between blog-authors and readers. New readers can join discussions by commenting or writing a post on their own blog with a reference to the blog post that they want to comment on. Trackbacks detect these references and establish a distributed discussion across blogs. Consequently, a social network of people with similar practices or interests can be created and enlarged by blogrolls. Trackbacks and blogrolls are also a measure of the reputation of a blog-author, as an interesting blog post will be frequently cited and often listed in the blogrolls.

Other popular examples of social software are media sharing and social tagging. Today, Web users are sharing information such as ideas, hobbies, files, or bookmarks. They are using tags to organize their own digital collections, categorize the content of others. Tagging can be defined as user-driven, freeform labeling of content and is implemented on most popular social sites such as on Flickr, del.icio.us, and 43 things. This collaborative, bottom-up classification has been referred to "folksonomy", a combination of "folks" and "taxonomy" meaning a non-hierarchical vocabulary created as a natural result of user-added metadata [11] which is a good example of collective intelligence at work. Thus, media sharing and social tagging foster community building as users organize, share information, and find people with the same interests.

2.2. Mobile social software

In addition, mobile technologies have facilitated social applications such as mobile publishing, listening, and sharing of diverse resources. Mobile technologies enable various social software applications on mobile settings. New variants of blogs are gaining more popularity everyday. For examples, photoblogs (phlogs) have photographs as primary content and mobile blogs (moblogs) offer users possibilities to post content (e.g. pictures, video and text) from a mobile device to their blogs. Following up moblogs, "podcasting" is becoming a mainstream. The term is a combination of the two words iPod and broadcasting and refers to audio files recorded by individuals and then distributed via Webfeeds. A variant of podcasting, called "vodcasting" ("video-on-demand), offers videos for streaming and download. All these can be viewed as variants of mobile social software.

2.3. Social software for learning

Learning is participation in a social process, not only an individual knowledge acquisition. Learning occurs through this process where individual knowledge, goals, and intentions are changed through socio-cultural practice [14]. Thus, similar to the Web, learning has to take a new direction, more open, dynamic and learner-centric. Standalone learning resources should be replaced by shared collaborative learning environments that foster socialization and network building. Here, we briefly explore the potential benefits of new online social software in collaborative learning environments. Wikis facilitate collaboration, offering a simple tool for asynchronous collaborative learning content creation, organization, and peer editing. Blogs can be used as personal knowledge management tools to organize and exchange learners' knowledge, online knowledge publishing systems to support learning communities in designing, creating, and posting up-to-date learning objects, communication medium to enable learners to discuss learning resources with peers, and distributed learning object repositories for learners to search for learning resources. Learners can receive notification of up-to-date learning content via Webfeeds. Social tagging can be used to categorize learning resources in a collaborative way. Learners can find learners with same interests or subscribe to tags and receive content labeled with that tag via Webfeeds. In learning settings, podcasting and vodcasting can provide new channels for material review, feedback to learners and enable instructors to review training, or supplementary content [15].

3. From e- to m- and u-learning

Learning is mobile in terms of space, i.e. it happens at the workplace, at home, and at places of leisure. It is mobile between different areas of life, i.e. it may be related to work demands, self-improvement, or leisure. And it is mobile in terms of time, i.e. it happens at different time periods, on working days or on weekends [13]. M-learning is learning supported by mobile devices and intelligent user interfaces [3]. Compared to the prior generation a few years ago, storage capacity and screen size of mobile devices as well as transfer speed of wireless connections have significantly increased. Equipped with mobile devices, learners can conduct learning activities at anytime anywhere. U-learning is learning that is not constrained to a physical space or specific time and learning that is supported by communication with embedded computing elements in the environment on every move of the learner.

Our shared belief is that in the future mobile phones will be a powerful learning tool integrated in the learning process. Meanwhile, mobile phones are used to communicate, take pictures and video clips, send e-mails, texts and graphics, browse the Web, play games and download programs. Students learn English or study math and to access university lectures on mobile phones [12]. In learning settings, they can be used as communication, content input/output, computing devices, and educational mobile Web Service providers. In the next section, we present a mobile phone-driven Web Services architecture for mobile learning and discuss the potential use scenarios.

4. Mobile Web Services architecture for collaborative learning

Software has traditionally been released as a product. Software as a Service (SaaS) is the next generation of software. Traditional, standalone software will be replaced by open Web Services that can be accessed online or reused and combined to create new applications. Popular examples are Amazon.com, eBay, Google, Yahoo!, which provide a series of interesting APIs and Web Services accessible to the outside world. In the technology enhanced learning arena, more and more softwares are being provided as a service and Web sites offering free hosting services are increasingly being used. For example, the hosted LMS service nuvvo. The modular Service-Oriented Architecture (SOA) and the more lightweight approach Web-Oriented Architecture (WOA) are increasingly being adopted in Web applications to access third-party microcontent via SOAP, XML-RPC and other lightweight technologies such as RSS, XML/HTTP, and REST. The accessed microcontent can be remixed and multiple modular Web applications dynamically assembled to create mashups. These concepts can also be applied in mobile learning settings. Mobile social software that foster community building in learning environments and collaborative learning applications (e.g. applications for collaborative learning resource creation and annotation or applications for learning media sharing) can be delivered as services via mobile phones. To achieve this, we have developed a mobile Web Service provider for smart phones: The "Mobile Host".

Mobile Host was developed based on SOA. SOA describes a new component model which relates distributed components, called services, to each other by means of formally defined interfaces [16]. In doing so, SOA provides loose coupling of services that cleanly encapsulate their functionality. Usually, SOA

is implemented by means of Web Services which enable application-to-application communication over the Internet. Web Services are self-contained, modular applications with their public interfaces described using Web Services Description Language (WSDL). They provide access to software components through standard Web technologies and protocols like SOAP and HTTP. A service provider develops and deploys the service and publishes its description and access details (WSDL) with the UDDI registry. Any potential client, who queries the UDDI, gets the service description and accesses the service using SOAP. [17]

Component-orientation is not new and a SOA can also be implemented with e.g. the Common Object Request Broker Architecture (CORBA) and Corba IDL (Interface Definition Language). But using Web Services for SOA provides certain advantages over other technologies. Web Services are based on a set of still evolving, though well-defined W3C standards that allow much more than defining interfaces.

Furthermore, all Web Services standards are based on XML. Consequently, Web Services encapsulate functional units in a way that is independent of the actual implementation, platform and programming language used. That makes Web Services a perfect fit for settings involving many peers such as m-learning and u-learning environments that may contain a multitude of different smart phones and other mobile devices based on different hardware and heterogeneous software prerequisites. Implementing such a system as a SOA by means of a set of well-defined Web Services, provides the necessary encapsulation, loose coupling, and flexibility of new hosts entering or leaving the system at runtime. Here we will discuss the architecture and performance analysis of the Mobile Host.

4.1. Mobile Web Service provisioning

As high end mobile phones and all-ip broadband based mobile networks are fast creeping into the current market, the increase in usage of mobile data services is quite evident. Also processing power and device capabilities of mobile phones have increased drastically, enabling better applications in different domains. These developments lead to the usage of mobile terminals as Web Service clients. Mobile Web Service clients lead to many opportunities to mobile operators, wireless equipment vendors, third-party application developers, and end users.

Now to check the feasibility of having a Web Service provider on mobile phones, a lightweight mobile Web Service provider (Mobile Host) was developed for smart phones. Figure 1 shows the basic mobile Web Services framework with Web Services being provided from the Mobile Host. The Mobile Host has been developed as a Web Service handler built on top of a normal Web server. The SOAP based Web Service requests sent by HTTP tunneling are diverted and handled by the Web Service handler.

The Mobile Host was developed in PersonalJava on a SonyEricsson P800 Smart Phone. Open source kSOAP2 was used for creating and handling the SOAP messages at the Mobile Host. kSOAP2 thin enough to be used for resource-constrained devices and provides a SOAP parser with special type mapping and marshalling mechanisms. The footprint of our fully functional Mobile Host prototype is only 130 KB. [18]

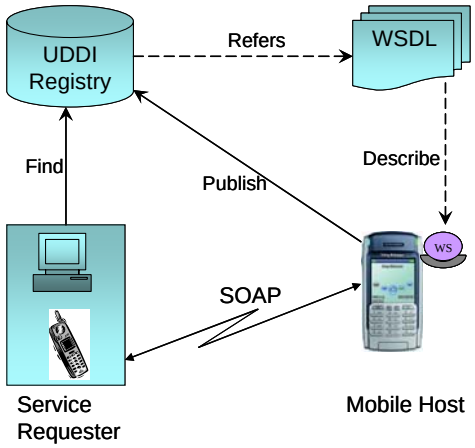

Figure 1. Mobile Web Services framework

4.2. Performance analysis

The developed Mobile Host was extensively tested for performance issues like the memory load, server-processing load etc. For this evaluation, a simple request-response scenario was started, in which a standalone client program based on Axis accessed the Mobile Host deployed on P800 as a Web Service requester. The client calls for different services deployed on the Mobile Host and the performance of the Mobile Host was observed while it is processing the Web Service request. The evaluation considered services like mobile photo album service, which allows the Web Service client to browse the pictures taken by the mobile, the location data provisioning service, which provides the exact location information of the mobile terminal using a GPS device.

In terms of performance of the Mobile Host, the key question was whether a reasonable number of clients could be supported with an overhead that would not prevent the mobile user from using smart phone in the

normal fashion (usual phone functions). This study was also required since it would define the limit for the number of concurrent participants in the collaborative m-learning environments. Concurrent requests were generated for the services deployed on the Mobile Host, simulating multiple clients. The results of this regression analysis are very encouraging. The Mobile Host has successfully handled up to 8 concurrent accesses for reasonable service like location data provisioning service with response size of around 2kb. Figure 2 shows the time delays of different activities at the Mobile Host, for the fastest of 10 concurrent Web Service requests for this service.

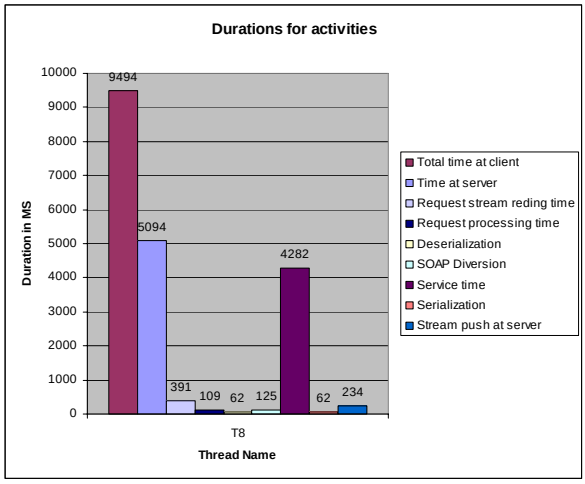

Figure 2. Delays for the location data provisioning service in GPRS environment

The evaluation showed that service delivery as well as service administration can be done with rational ergonomic quality by normal mobile phone users. The performance of Mobile Host is directly proportional to achievable higher data transmission rates. [18]

4.3. Mobile Host scenarios for m-learning

The Mobile Host provides a large scope for many applications in the m-learning domain. As the Mobile Host, the mobile terminal can provide information like pictures, audios, videos, tags, documents, location details, and learning services. It is also possible to deliver mobile social software as services. Many m-learning application scenarios can be envisioned, e.g. a mobile learning media sharing service. In this, learners can share audio or video lecture recordings or go for the field study and take the pictures of the location. Peers can then browse through the pictures taken, add tags, and give their suggestions or comments.

Another scenario can be a mobile expertise finder service. In collaborative learning environments, learners are always looking for reliable access to learning resources, persons who share the same interests, and experts with the required know-how that can help achieving better results. The Mobile Host can maintain a repository of domains and experts and provide an expertise finder service that automates the process of identifying experts inside or outside the learning environment. Any potential client can then call the service wirelessly and find the person to contact.

5. Conclusion

In this paper, we stressed the importance of collaboration, community building, knowledge sharing, and social networking for learning, highlighted the integration of new web concepts and social software in the learning process, explored the use of mobile and ubiquitous technologies to enhance collaborative learning activities and presented the details of a smart phone driven Web Services approach for mobile learning. Mobile Host, the prototype of a Web Service provider, demonstrates the technical feasibility of our approach in terms of resource consumption, standard compliance, and performance.

Acknowledgements:

This work is supported in part by the EU Network of Excellence PROLEARN (http://www.prolearn.eu) and the Research Cluster Ultra High-Speed Mobile Information and Communication (UMIC) (http://www.umic.rwth-aachen.de/).

6. References

[1] E., Wenger, *Communities of practice: Learning, meaning and identity*, Cambridge University Press, Cambridge, UK.
[2] H.W. Hodgins, Grand Challenges for Learning Objects, *Presentation at Learntec*, Karlsruhe, Germany, 2005.
[3] S., Sharma, F., Kitchens, Web Services Architecture for M-Learning, Electronic, *Journal on e-Learning*, 2(1), 2004.
[4] R., Watkins, Preparing E-Learners for Online Success, *Learning Circuits, Article*, 2006.
[5] H. W., Hodgins, Into the Future. *Learnativity Vision Paper*, 2006.
[6] G., Siemens, Connectivism: Learning as Network-Creation, *Learning Circuits Article*, 2006.
[7] S., Downes, E-learning 2.0, *ACM eLearn Magazine, Article*, 2006.
[8] T., Coates, My working definition of social software, *Plasticbag.org, Blog*, May 26, 2006, from http://www.plasticbag.org/archives/2003/05/my_working_definition_of_social_software.shtml
[9] E., Kaplan, E., We-Learning: Social Software and E-Learning, *Learning Circuits, Article*, 2005.

[10] B., Alexander, *EDUCAUSE Review*, 41(2): 32–44 2006.
[11] E., Kroski, The Hive Mind: Folksonomies and User-Based Tagging, *Infotangle, Blog*, 2005, from http://infotangle.blogsome.com/2005/12/07/
[12] M. Prensky, What Can You Learn from a Cell Phone? Almost Anything! *Innovate, Online Journal*, 5(1), 2005.
[13] G.N., Vavoula, M. Sharples, KLeOS: A personal, mobile, Knowledge and Learning Organisation System. *In Proc. WMTE 2002*, pp 152-156, Aug 29-30, Vaxjo, Sweden.
[14] J., Lave, E., Wenger, *Situated Learning. Legitimate peripheral participation*, Univ. of Cambridge Press.
[15] E., Kaplan, Trend: Podcasting in Academic and Corporate Learning. *Learning Circuits, Article*, 2005.
[16] T. Erl: *Service-Oriented Architecture. Concepts, Technology, and Design*, Prentice Hall, 2005.
[17] K. Gottschalk, S. Graham, Introduction to Web Services Architecture, *IBM Systems J.* 41(2): 178-198, 2002.
[18] S. Srirama, M. Jarke, W. Prinz: Mobile Host: A feasibility analysis of mobile Web Service Provisioning, *Proc. UMICS 2006, @ CAiSE'06*, pp. 942-953, 2006.