Integrating Various Cloud Computing Services in a Collaborative Geo-referenced Learning Scenario

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Abstract: Some of the main characteristics of Cloud Computing are reliability, scalability and ubiquity. This makes it especially suitable to support large groups on learning activities that require computer support in various settings, in and outside the classroom. In this work, we first analyze the use of Google Maps for supporting a learning activity in an urban environment, concluding that some important features are missing. We then propose an approach for taking advantage of cloud computing services for learning activities by integrating different services in a new application.. A general architecture explaining this approach and a design for such an application as example are finally presented.

1 INTRODUCTION

Cloud computing, in all its modalities, is increasingly being used to support collaborative learning activities, especially for those involving large groups (Antunes et al., 2011), since scalability is one of the most prominent characteristic of it.

According to (Tan and Kim, 2011), the benefits of using cloud computing to support learning are following: cost saving, flexible IT management, and accessible IT Resources and Services, because the services they provide are accessible from any device connected to the internet like desktop PCs, laptops, tablets and smartphones.

On the other side, they point to some risks: *reliability*, because vendors of cloud services will never provide 100% reliability; *control*, since the services reside and are controlled by the vendor; *security* and *privacy* because the lack of control also may lead to the risk of security or privacy breaches; Organizational Learning, because users of cloud services (students and teachers) might need to learn a new way to interact with the software. Moreover, in (Masud and Huan, 2011) authors say that public clouds may offer low-cost services, but in return they may not provide needed assurances of security for those services. They also refer to the need that Software-as-a-Service (SaaS) has to be customized to meet the needs of various customers. However, providers cannot afford to develop and maintain a version of application for each individual customer.

This work first presents an experience in which a well known cloud service, namely Google Maps, was used "as it is" in order to support students of a pre-graduate university course about business and TI, in which they had to propose, discuss and rank ideas in which IT could be used in certain parts of the city in order to solve problems or improve citizens' daily life. A questionnaire was applied to the students in order to find out in which degree did the software meet the needs for performing the requested collaborative learning activity. Analyzing the answers we found that they appreciated many of the functionalities provided by the site.

However, they also pointed out to some important drawbacks, such as the lack of private workspace, security problems, delayed synchronisation and the basic mechanisms for supporting decision making: a public discussion space and a mechanism to rank the solutions/ideas they generated during this work. Based on these results, we present here a new development, which uses services from the cloud as building blocks for developing an own application customized to meet the needs of the particular leaning scenario involving

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a large group with the minimum effort, programming only the “glue code” to integrate these blocks and implement the missing functionalities. The development has the following characteristics:

- It uses de cloud computing services from Goggle Maps in order to show maps and associate specific data objects to certain geographical locations, which represents the ideas proposed by the students.
- It uses the cloud computing services from Twitter in order to implement students’ participation to Rank ideas.
- It uses Facebook Authentication services to register and keep track of what students contribute to the discussion.
- Implements freehand writing and sketching over the maps.
- Implements on-time synchronism on the objects which are created/modified on the map (sketches, location marks, photos, comments, ideas ranking)
- Stores the important data in an own server using a XML format.

In this way we also address some of the problems related to control and security inherent to cloud services mentioned before. This approach has many ideas in common with the one presented in (Jansen et al., 2012), in which cloud services such as Twitter, Facebook, even SMS and e-mail are used as data input channel for various learning applications. One of the main ideas we share is from the software engineering point of view, which considers that cloud services may be integrated into a new application in order to reuse available, well implemented and scalable functionalities.

2 RELATED WORK AND DEFINITIONS

According to (Sultan, 2010), cloud computing is an emerging computing paradigm which promises to provide opportunities for delivering a variety of computing services and that educational organizations are already taking advantage of the benefits.

According to (Alabbadi, 2011), cloud computing will significantly impact the educational and learning environment. They propose the use of cloud computing in the educational and learning arena, to be called “Education and Learning as a Service” (ELaaS).

Some studies explored specific cases where Google Document, Google Presentation, and Google Maps are used to facilitate collaboration in learning contexts. In (O'Broin and Raftery, 2011) authors explored how Google Docs overcome some limitations in project-based learning. They report that work with project-based learning has limitations related to students’ difficulty to collaborate on artifacts outside the class, and that it is problematic for the teacher both to monitor the progress of the project, and to assess the individual contribution of each student. Authors say these limitations are partly overcome by Google Docs, because: (1) it enables students in different locations to work simultaneously but independently on the same artifact; and (2) teachers can be included as observers on each project group and thus track the development of the work. However, students also identified some limitations of simultaneous editing of Google Docs: if two or more students edit text in the same region of a document, one of the students will receive a message informing the student that his/her text has been discarded, spontaneous deletions of text, and confusion caused by the auto-save feature.

Cloud computing for learning environments has different groups of stakeholders, with different information needs (Masud and Huang, 2011): students rely on IT for communication and information searching; teachers pervasively utilize IT to deliver individual or collaborative task (e.g. using Google Docs, Google Maps, etc.), lectures, manage course materials, and provide speedy feedbacks to students; administrators use IT-based information systems to manage registration, human resource, and accounting. A case study methodology was applied, in order to investigate the use of Google Docs as a free cloud computing based product (Masud and Huang, 2011). The results obtained indicate that MBA students held positive impact on perceived usefulness and satisfaction about using Google Docs. In (Kumar, 2009) authors report that undergraduates students found that Google Docs helped them to complete large amounts of work online by allowing them all to work on a document without need to meet all at the same time.

In (Chu and Kennedy, 2011), Chu and Kennedy describe an experience about using MediaWiki and Google Docs at undergraduate level as online collaboration tools for co-constructing knowledge in group project work. Students used MediaWiki for project during a knowledge management course and Google Docs for completing a final year project. Results indicated that some of the students had positive experiences using the tools for online collaboration in the group projects. According to this report, MediaWiki and Google Docs gave teachers the facility to closely monitor student progress, and provide feedback to assist in the effective management of the report-writing process. Thomas (Thomas, 2011) also explores the potential of cloud computing in an educational setting using Google Docs.

Fluke reports a pilot study on the use of Google Maps to provide virtual field trips as a component of a wholly online graduate course on the history of astronomy (Fluke, 2008). The Astronomical Tourist Web site (ATsite) is an example of how Web 2.0 applications (mash-ups) can be used to build new online learning environments. The use of Google Maps was used to support virtual field trips. It helped to clarify and strengthen the connection between the places and people involved. Students could share their experiences visiting locations, personalizing the learning experience. By encouraging students to seek out locations active learning was undertaken.

From the literature review, we can conclude that free cloud services offered by various providers have been used to support learning activities. Most cases report that the cloud service was used “as it is”, except for (Fluke, 2008) and (Jansen et al., 2012), in which APIs of different cloud services were used in order to create a new application. In this work, we intend to systematize this approach in order to develop learning applications combining various services offered by the cloud and integrating them in a new learning application.

3 EVALUATING GOOGLE MAPS “AS IS”

As seen from (Fluke, 2008), learning can benefit from making use of the services provided by Google Maps, especially those in which the knowledge to be acquired is related to information with a strong association to a geographic place. Other examples are described in (Otaga et al., 2006) and (Zurita and Baloian, 2012). In our case, we decided to first make an experiment in order to have some insight about the suitability of Google Maps to support certain collaborative learning activity involving a large group of students.

We used the same methodology, experiment design and applied a similar questionnaires in the work reported in (Antunes et al., 2011). However, the results were analyzed for a different purpose: this time the focus was to find out which functionalities were missing or not properly supported to accomplish the task.

The experiment involved students from an undergraduate course undertaking a collaborative design assignment to identify problems and/or opportunities in a urban area and propose innovative solutions based on information technology. They were asked to accomplish the assignment using Google Maps. This assignment was given during the second semester of 2012. The sample consisted of 46 students, 28 male; average age 22.3, taking an undergraduate course on Computer Science, in the eight semester of Information and Management Control Engineering, at Universidad de Chile. It is expected that students at the end of the course are able to: (a) detect problems and identify opportunities in an organization, that may be supported through IT; (b) manage an IT strategy that can introduce competitive advantages into an organization; (c) design IT solutions; and (d) develop communication and teamwork skills. These students were good users of computing technology because 35% use notebooks or tablets in classes and most have smartphones, all use PC at home. They regularly use popular desktop software; and use social media tools like Twitter, Facebook and MSN.

The task was performed collaboratively outside regular classes. All students were part of a single team. The teacher explained the task in the classroom, recommending the students to observe an area and identify problems, opportunities and ideas that may be addressed using IT, which should be geo-referenced in Google Maps. Each student should deliver at least two ideas. Students were also asked to discuss and give their opinions on the classmates’ ideas and collaboratively choose the ten best by mutual agreement. Students had one week to perform the task. No instruction regarding the type of hardware to be used or the coordination mechanism to select the best ideas was given. They were just told they should use Google Maps. Consensus rules, task awareness and coordination mechanisms had to be established by the students themselves.

Following the instructions, students performed the task accordingly. Most pictures were taken with mobile phones and uploaded in Google Maps later. The resulting documentation of the activities done with Google Maps may be seen in Figure 1.

The students filled in questionnaire with three questions: (Q1): “did you feel information overload during the task?”, (Q2) “how easy was the software itself to use”, and(Q3) “how easy to use was the collaboration support?” Students were asked not

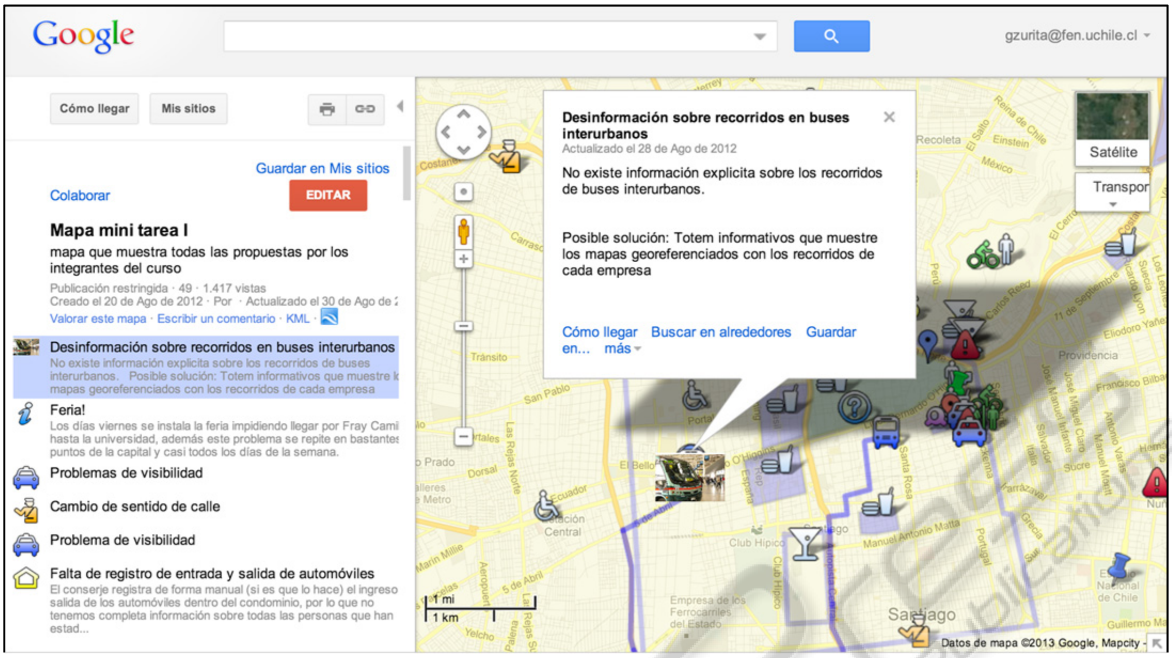

Figure 1: A Google map collaboratively geo-referenced by the students. On the left side, the list of problems, ideas and comments are shown. Geo-references are displayed as icons on the map representing the location for these ideas.

Table 1: the positive and negative comments associated with the Q1.

Q1: Did you feel information overload during the task ?			
Positive comments		**Negative comments**	
2	Everyone was available on the computer screen	19	Too many ideas and comments shown at the same time
1	Work was performed orderly	6	Some contributions were duplicated
1	History of ideas was easy to follow	2	Considerable flow of ideas and feedback
		6	Relation between ideas and comments difficult to establish
		7	Related ideas are shown apart from each other
		2	Too many objects shown in the same window at the same time
		2	Some comments were simply forgotten

Table 2: the positive and negative comments associated with the Q2.

Q2: how easy was the software itself to use?			
Positive comments		**Negative comments**	
10	Easy to understand	8	Proximate comments are difficult to discern
3	Immediate visualization of new comments	6	Cannot see who deleted comments
2	Reference of ideas in geographical context	7	Lacks coordination support
2	Using of colors	6	Mapping and chatting unrelated
2	Using of text and pictures	2	Slow
1	Use of icons	2	No private working space
1	Easy access to ideas	1	Had to improvise in order to collaborate
1	Searching	1	Difficult to merge comments, ideas
		1	Communication is not primarily focus

only to give a quantitative answer but also mention positive and negative aspects of the software related to the question. The results are shown in Tables 1, 2, and 3.

The comments to Q1 indicate that the flow of ideas was very high, making it difficult to follow and easy to forget. Also, the number of repeated ideas was considered high. Very few comments were given on the positive side. The most relevant observation was that the participants liked having all information visible on the computer screen.

Comments to Q2 reveal several technical issues contributing to the perceived low usability. The most frequently cited one is a usability problem related with uploading photos. Two other ones concern difficulties discerning comments when their locations are very proximate, and lack of information regarding who deleted others' comments.

Within the collection of negative factors, we also find references to more conceptual problems regarding the task organization. In particular, the participants pointed out a disparity between mapping and commenting ideas, the fact that communication is not the primary focus of Google Maps, and the need to improvise collaboration strategies, since the tool does not offer clear support in that area.

Table 3 reveals a large set of negative and positive factors regarding collaboration support, although with clear emphasis on the negative side. Within the negative factors, two of them were very preeminent: the group had to develop a coordination mechanism (using Google Docs) since the tool does not provide a native solution; and the problem that any participant may modify or delete comments without control or rollback. Within the positive factors, the most significant ones were the support for sharing ideas, obtaining and giving immediate feedback about the ideas, and asynchronous interactions. Students also mentioned that besides having to devise an alternative scheme to collaborate they also had to designate a facilitator.

Table 3: the positive and negative comments associated with the Q3.

Q3: how easy to use was the collaboration support?			
Positive comments		**Negative comments**	
4	Shared view of ideas	14	Group had to develop alternatives for coordinating group work
1	Easies problem understanding	12	Users can edit others' contributions
1	Facilitates view of task progress	7	Tool inadequate for discussion support
2	Permits asynchronous interaction	1	Difficult to converge
1	Easies time management	1	Asymmetric participation
1	Uses colors	1	Lack of chat tool
		1	Lacks awareness mechanisms

4 PROPOSAL FOR AN INTEGRATED APPLICATION

In (Tan and Kim, 2011) authors state that the match between the attributes of a particular technology and the characteristics of the tasks to be supported by this technology is one of the critical success factors in IT adoption and implementation. Based on the comments given by the students about the missing functionalities we propose in this chapter (1) a general architecture for developing applications to support learning activities for large groups integrating cloud services; (2) a new application based on this architecture, which implements most of the functionalities that were considered important but were not provided by Google Map "as is".

4.1 A General Architecture

The starting point for our proposal is the SOA approach for software development and the conceptual basis elaborated in (Jansen et al., 2012), essentially an architecture that takes advantage of the already existing "cloud services" for collecting inputs and in this way achieves an improved "accessibility" of the overall system. Our approach here goes one step further by proposing that various cloud services could be used not only for facilitating data input in a convenient way but also for other functionalities. In the particular case of systems for situated, location-dependent learning activities based on geo-collaboration we see at least the following additional functionalities to be integrated using available cloud services:

- Maps: Maps are an important element for many applications supporting field trips. Today they can be downloaded from various sources: Google Maps and Open Layer offer 2D maps, Google Earth offers 3D maps. They offer APIs in order to download and manipulate maps.
- Authentication: Many learning activities require identifying the student who generates learning material or performs an activity. Google's or Facebook's authenticator may be used to incorporate this functionality in a new application.
- Discussion board: Social networks like Twitter or Facebook, as well as other Cloud Services may be used to implement the input text for these facilities.
- Synchronization: Real time synchronization of data is frequently necessary. Cloud Services like Google App engine, Microsoft Window Azure or Amazon's Elastic Compute Cloud could be interesting platforms to be considered for implementing this part of the system.
- Data storage: For this, there are many possibilities which offer APIs to store data in varied formats: Amazon S3, Apple iCloud for Cloud storage service, Dropbox for files, Google Storage , KIT Video API among many others.

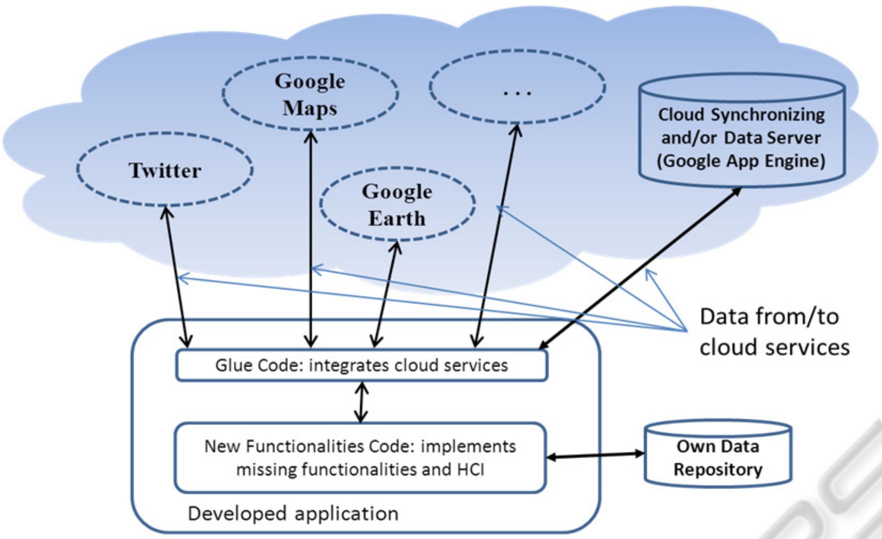

Figure 2: The picture shows the logical general schema of the proposed architecture.

Figure 2 shows a logical schema of the proposed general architecture for supporting geo-collaborative learning activities with key functionalities provided through cloud services. The new application has a "glue–code" component implementing the communication with the cloud services through their APIs by sending and receiving data and/or invoking functions. This part also interacts with the code that has been developed in order to implement additional functionalities not provided by the cloud services, including the user interface. This part of the code may also in some cases implement functionalities for data storage in an own server or repository in the case that available Cloud Services may not match the requirements needed. This can, for example, be due to the data format, or because the data to storage may be sensitive (priovacy). In order to guarantee a maximum portability of the developed applications, our approach proposes to develop the applications using HTML5 and JavaScriptas a common deniominator between a variety of platforms, including desktop PCs running Windows or Unix, tablets and smartphones running Android as well as iPads running iOS. With its new features, HTML5 is capable of implementing rich interactive applications running on a browser (Baloian et al., 2011).

4.2 A Reference Architecture

According to the students' comments, some of the problems were related to the lack of coordination and awareness mechanisms. For this reason, it was difficult to keep track of the work process. To overcome this problem, we first propose that students should be individualized in order to associate their contribution to their login name and establish an authorship property for these contributions. This may be accomplished by the authoring services in Facebook, since Facebook also provides the functionalities for implementing discussion boards with non-anonymous contributions.

Another coordination problem was the lack of a mechanism allowing to rank the ideas and suggestions. For this we propose to integrate the like/dislike of twitter, since is a well know mechanism and it is easy to integrate. Facebook offers a similar functionality. We select Google Maps in order to integrate the maps because of the simplicity of the tasks that need to be accomplished. Google maps also provide api services: routes, distances, elevations, geocoding and places. Thus the "glue code" implements the conversation with Facebook, Twitter and Google Maps through their APIs and renders the graphical elements received from the services. Additional code has to be developed in order to implement private and public workspaces as well as switching between them and passing data from the private to the public workspace. Due to the characteristics of the data generated by the system and related privacy issues, it is not possible to use an external cloud service for sorage, so a specific dedicated server has to be used. For the same reason, it is also impossible to implement the synchronization of data for the public workspace with an external service. This will be implemented using a mechanism developed earlier by the authors which allows easy synchronization of

Figure 3: Mock-up of the interface for the proposed application.

applications developed in HTML5 called "couple objects" [15].

5 CONCLUSIONS

Some of the main advantages that authors have mentioned about Cloud Computing are scalability, ubiquity, and reliability. These characteristics match the requirements of many learning scenarios, especially those in which students have to perform learning activities across various setting, inside and outside the classroom, collaboratively and individually working on generating and analyzing data, using different kind of computing devices supporting this work. This work proposes the use of cloud computing for learning in a different way as reported by the literature: instead of using services as they are offered we propose to combine them in a new application which can be tailored to meet the requirement of a specific learning activity taking advantage of the characteristics of cloud computing and getting rid of at least some of its drawbacks.

We first analyzed the potential of using a popular cloud computing service to support a collaborative learning activity with a large group of students, understanding large by more than 20 individuals. Although Google Maps was able to provide a number of functionalities required to accomplish the task, it was clear that student missed other functionalities which would have helped a lot. This leads us to the idea that cloud services could be combined and integrated in a new application tailored especially for the learning requirements saving considerable development efforts. We present this idea as architecture for developing applications using this approach. Based in this, we present a preliminary design for an application which matches the requirements for this learning activity including the missing ones. The feasibility of this approach has been already proved by previous applications implementing this approach to some extent (Jansen et al., 2012); (Baloian et al., 2011).

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