Cloud Messaging to Instantly Reach Students During Learning

Xheni Melo
Department of Computer Science, Faculty of Natural Sciences, University of Tirana
Blv. Zogu I, Tirana, Albania
E-mail: xheni.melo@fshn.edu.al

Alba Como
Department of Computer Science, Faculty of Natural Sciences, University of Tirana
Blv. Zogu I, Tirana, Albania
E-mail: alba.como@fshn.edu.al

Ilia Ninka
Department of Computer Science, Faculty of Natural Sciences, University of Tirana
Blv. Zogu I, Tirana, Albania
E-mail: ilia.ninka@fshn.edu.al

Abstract
Interacting and communicating is an important aspect of creating better relationships and cooperation where participants exchange experiences with each other, know each other and their needs better, contributing in creating a more productive environment where everyone benefits. Communication and interaction is highly important in teaching and learning process. Even though face to face communication is very effective, sometimes it becomes very difficult to achieve, especially when we have to contact and communicate with many people at the same time like in a teacher-student relationship. In this regard technology can help to facilitate the process. Taking in consideration that in the recent years mobile devices usage has experienced an exponential growth, they are becoming the perfect tool to reach users and directly contact them, personally or even in groups, anytime and everywhere.
This paper focuses on the potentials of push notifications and study Google Cloud Messaging, its architecture components, their interactions and the main advantages that makes this technology an appropriate solution for supporting massage transfer to mobile users. We introduce a specific implementation that uses GCM to transfer questions with possible answers, from teachers to multiple students and test the connection performance. This implementation can be used also for other types of teacher-student communication and also student to student communication.

Keywords: Mobile Learning, Google Cloud Messaging, Push Notification, Real Time Communication

1. Introduction

Creating a direct link of communication with the end users and exchange information in real time with them, especially with many of them at the same time, is a very important aspect because it can contribute in creating a better and more productive relationship and more satisfied users. In this paper we give a possible solution using Google Cloud Messaging, a solution that supports message transfer from teachers to students in real time using mobile devices. The paper is organized as following; First, we focused on the importance of creating a direct contact and communication with the end user in general and between teachers and students in a more specific context, through technology and specifically through mobile devices. Then, we study the possibility that mobile devices offer through notifications, to directly access a specific user or a group of users at the same time. We consider Google Cloud Messaging(GCM) as a possible solution to manage the process of sending and receiving messages to and from mobile apps. We study GCM architecture, its components and the way they interact with each other. We highlight the main advantages of this technology that influenced in choosing GCM for message transfer in the learning environment. After that, we present a specific implementation of GCM technology that supports delivering questions with possible answers from teachers to multiple students at the same time and taking back the results. We study the performance of message delivering and at the end give our conclusions.

2. Importance of direct contact and communication

Direct contact and communication is the key to success [1]. We can clearly say this in different contexts and situations like customer relationship, business success, group projects and also in learning and teaching. With direct communication we can know each other better, exchange our experiences and produce a more effective cooperation and as a result, work in a more productive environment.

In the learning process, teacher-student contact and communication is essential. Teaching and learning wouldn't be effective without direct interaction [2,3]. Teachers wouldn't understand if they are valuable to students and also wouldn't know students' needs. On the other hand students wouldn't perfectly understand what they listen and wouldn't find a space to express what they learn and what they need.

Face to face contact and communication is of course very effective and no one can negate it. But we can say that it requires a lot of time and effort, especially when you have to communicate with a lot of people and this is exactly the case of teaching and learning. In this regard, information technology offers new ways to facilitate this process. We can say for certain that technology helps to connect with each other [4].

With the life getting busier every day, people are more and more on the go, trying to get from one place to another and spend less time in front of a computer in a fixed location. In this situation the usage of mobile devices and especially phones has experienced a very fast growth in the last few years [5]. In this regard, mobile devices offer access every time and everywhere with the mobile user making them the perfect way to reach users and directly contact them, personally or even in groups. Because users have their mobile devices always with them, we can have a faster response and feedback. This can lead to more generated and stored data that can help to facilitate processes like knowing better the end user, offering better services, etc.

3. Notifications to increase engagement

Notifications can be a very useful tool in creating a direct link of communication with a mobile user. They can easily be used as an effective way to give access and focus to new important information.

"Notification is the only communication channel specifically designed for mobile apps. It enables advertisers, publishers and developers to increase mobile users' engagement with their app. [6]"

With a notification you grab instantly the attention of a user. Authors in [7] collected notifications' information through a smartphone logging application in 15 mobile phone users for a week and found that mobile users had to deal with approximately 63.5 notifications per day. Whether the phone was in silent mode or not, users constantly check their phones and as a result see and access notifications within minutes. In the same topic, results from [8] show that the time between seeing and clicking the notification is very short. If a user clicks on a notification, this happens in less than 30 seconds.

Authors in [9] conducted another data collection from automated smartphone logging. They collected 10372 notifications and 474 questionnaire responses on notification perception from 20 mobile users. Results from this research show that the seen time (the time between notification arrival and user seeing it) varies from 3 minutes and 21 seconds to approximately 7 minutes, depending on whether the device is in silent mode or not, with or without vibration or sound. On the other hand the decision time (the time between seeing and clicking) varies approximately from 3 seconds to 12 seconds. Even though, authors of these research emphasize the fact that the response time of a notification by the user is influenced by many factor including notification presentation, the relationship with the sender, context of the user and the complexity of the task with which the user is engaged.

In regard of these results, we can say that notifications can give a big contribution to increase the attention of a mobile user to access a specific application.

They can give the opportunity to reach users personally or in groups of several users at the same time. With a notification they have the perception of being personally contacted and feel more important.

In other cases they can feel a part of a group and this is very important in a social perspective. This is the reason why mobile users give a higher priority to social notification like messengers or other social interaction applications. Authors in [8] collected notification information from more than 40,000 users and categorized them in 14 categories. After analyzing the data they concluded that notifications from messenger applications are more important than notifications form all other categories. [7] collected also opinions of mobile users about their notifications and their perceptions, and found a positive attitude toward social notifications and an increased feeling of being connected with others.

Taking the above studies in consideration, we can say that in the learning process context, notifications can contribute on directing the attention of students toward learning content, increasing in this way their behavioral engagement. Notifications also can make students feel identified and appreciated at the same time part of a group in cases when notifications are from group participants. As a result, using

notifications can increase their emotional engagement toward learning [10].

4. Google Cloud Messaging Architecture

"Google Cloud Messaging (GCM) is a free service that enables developers to send messages between servers and client apps. This includes downstream messages from servers to client apps, and upstream messages from client apps to servers. [11]"

The GCM service handles all aspects of storing, queueing of messages and delivery to and from the client app.

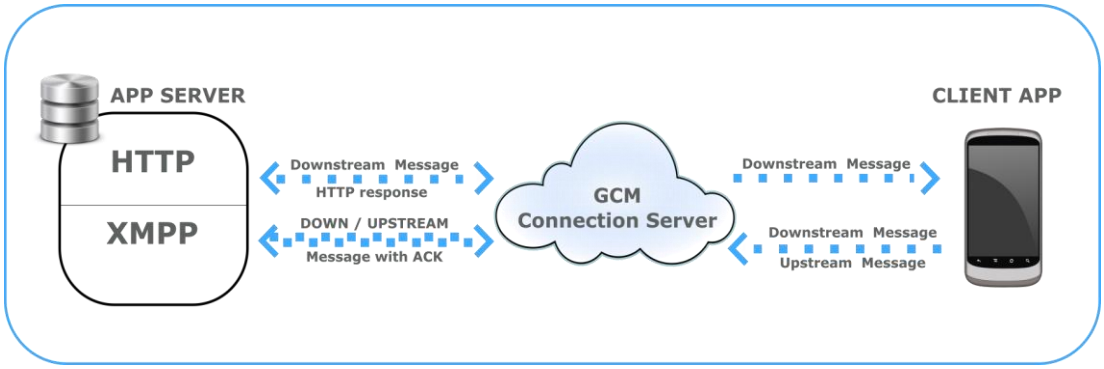

Figure 1. Components of GCM Architecture

4.1 Main components of the architecture

The main components of a GCM architecture are:

- GCM Connection Server

These servers are totally managed by Google and are responsible for managing message interchange between the App Server and Client Server. They can support downstream messages from App server to one or multiple client apps and from 2013 they support also upstream messages in the opposite direction from the client app to the app server.

- App Server

They can use HTTP or XMPP protocol to communicate with GCM servers. If they use HTTP they can only send downstream messages to client apps. On the other hand, if XMPP is used, the App Server can send downstream messages to client apps and receive upstream messages at the same time using the same connection. “The Extensible Messaging and Presence Protocol (XMPP) is an open technology for real-timecommunication, using the Extensible Markup Language (XML) as the base format for exchanging information. In essence, XMPP provides a way to send small pieces of XML from one entity to another in close to real time [12]”. As a result is an appropriate protocol to use for real time communications.

- Client app.

GCM service supports Android, iOS and Chrome client apps. Client apps must register with GCM service and receive a unique registration token that identifies the app from GCM servers and also App Servers.

4.2 Advantages of using Google Cloud Messaging

- It is a completely free service offered by Google and can support as many connections to the GCM as is needed.
- GCM supports push notifications to client apps. Using these kind of notifications is a very good practice in reducing network traffic and mobile device battery life because we avoid traffic from a big number of mobile devices that send requests for new data to the same server in the same time.
- GCM can send the same push notification to Android apps, iOS apps and Chrome

- The client app does not have to be active at the moment when the message is sent. The push notification mechanism awakes the client app automatically.

- Even when the mobile device is offline and doesn't have access to internet connection, messages sent toward them are not lost. They are saved in the cloud and sent when the mobile device is online again. These messages are stored in the cloud for approximately 4 weeks.

- Supports sending messages to multiple users at the same time. Using GCM we can send broadcast messages and also individual messages but we have to initiate the delivery from our app server.

- Possibility to use the same connection to send downstream messages from server to device and upstream messages from device to server for a better performance and low battery consumption.

- GCM servers are maintained by Google and as a result offer a very reliable way to manage our messages.

5. Usage of GCM in learning environment

Taking in consideration all the advantages of Google Cloud Messaging, we have implemented a module of our mobile learning application that uses this technology to instantly reach students in the classroom or outside it. The objective is to use this implementation for sending students a question with many possible answers and take back their responses in real time. Google Cloud Messaging makes this implementation possible because GCM supports communication in real time, downstream and upstream messages, and very importantly, GCM supports sending messages to many users at the same time, because we want to reach all the students in the class at the same time.

The client app in our implementation is an Android app. Every mobile device that will run our Android app has to register with GCM service in order to communicate with GCM servers. This registration in our application is done the first time our app runs on the device. As a result of the registration, every device receives a registration id that is sent to the app server from the Android app. The app server is implemented in a web server and stores information, including the registration IDs of android devices, in a MySQL database.

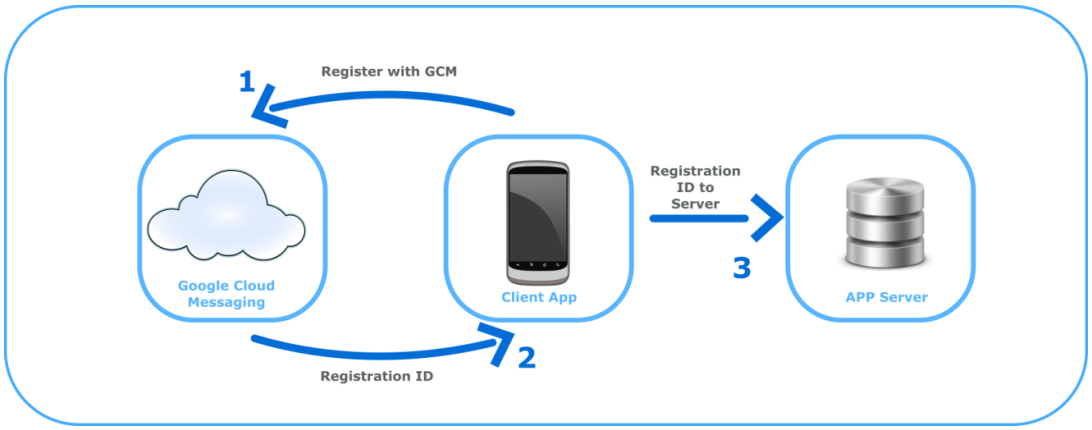

Figure 2. Client registration scheme

Our app server uses php scripts to communicate with the GCM connection server. These scripts include the API key generated after registering in Google Services Console and enabling GCM service. This key is necessary to identify our app server with GCM Connection server. We have developed a web interface from which the teacher enters the question and possible answers and sends it to GCM Connection server. Before sending teacher input, we package the information to be sent in json format.

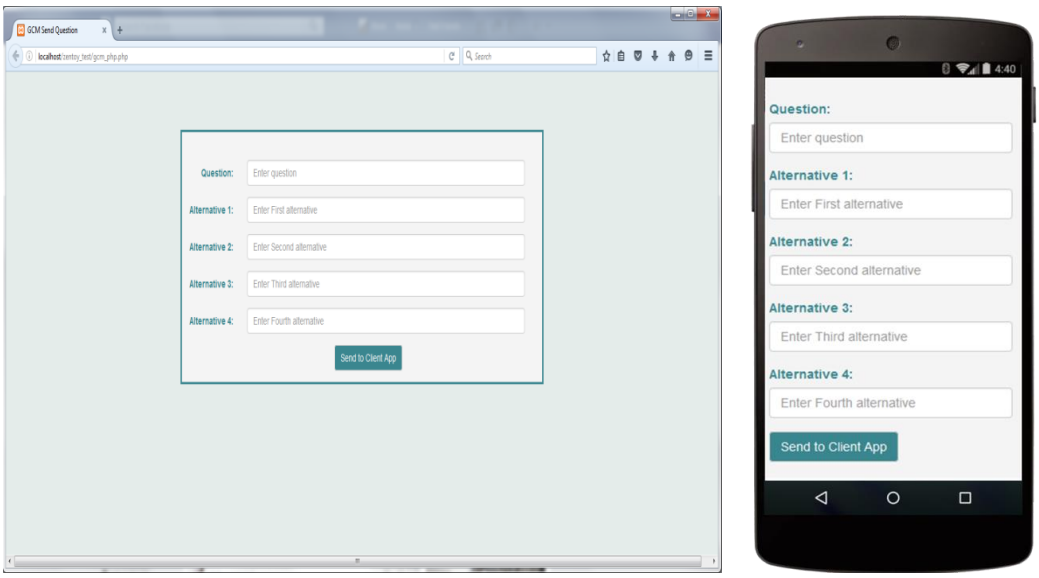

Figure 3. Web interface to send questions from the app server to Android client app
The first picture is from desktop browser and the second is from mobile

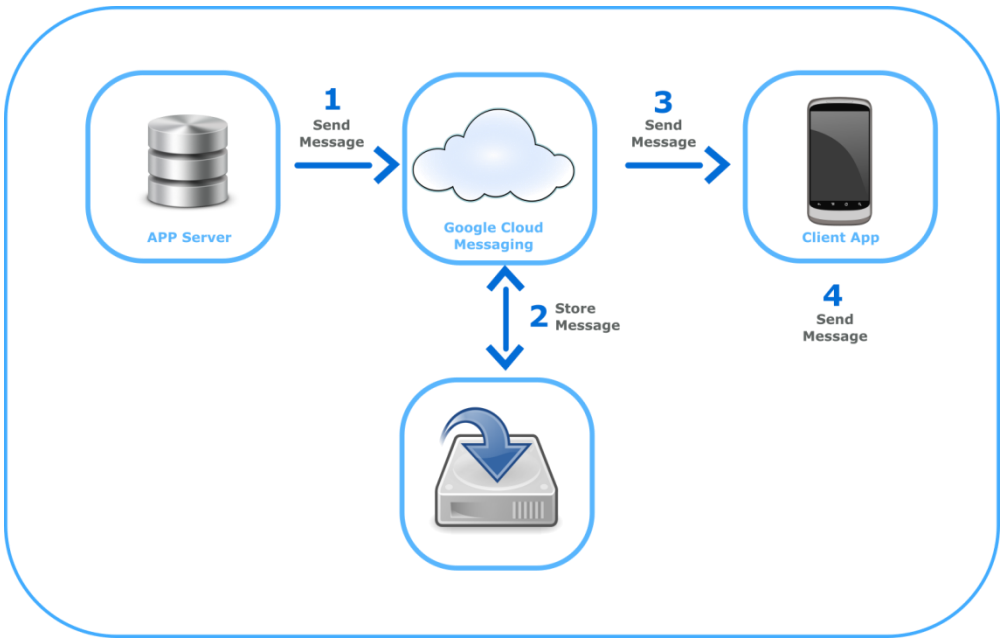

Figure 4. Push notification scheme

As can be seen in the scheme messages sent from our app server to GCM connection server are directly forwarded to the client app that have the specific registration id, for all registration ids saved in MySQL server database.

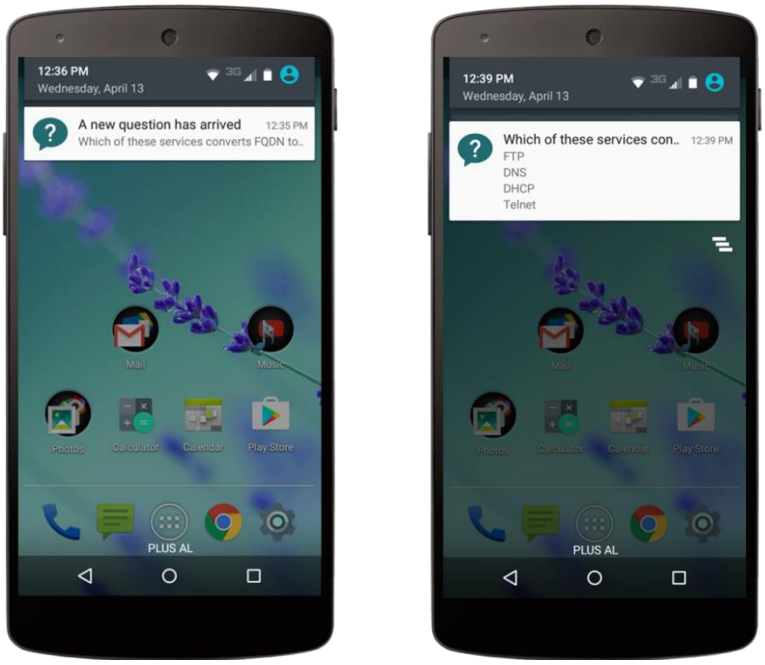

Figure 5. Message arrival in Android client app as a notification with the question and possible answers

We tested the performance of message delivery toward ten Android devices with different versions of Android operating system, at the same time. In average messages arrived in 1.7 seconds when the device is online. When the device is offline messages normally take a little more time to arrive after the device returns to online mode, approximately 14 seconds. Of course delivery time is influenced by the internet connection quality because delivery in wireless connections is faster than in poor cellular data connections but the difference is not very significant. These results clearly show that GCM service is appropriate to use in mobile message delivering.

6. Conclusions

In this paper we focused on the importance of creating a direct contact and communication with the end user in general and between teachers and students in a more specific context, through technology and specifically through mobile devices. We studied the importance of mobile push notifications, to directly access a student or a group of students at the same time. We considered (GCM) as a practical solution to manage the process of sending and receiving messages to and from mobile apps. After highlighting GCM advantages in mobile message delivery, we presented a practical, hands-on implementation of GCM technology that supports delivering questions with answer options from teachers to multiple students at the same time and tested the real time performance of GCM technology demonstrating that it can be an appropriate solution also for other similar communications.

References

[1] Hovland, I. (2005). Successful Communication - A Toolkit for Researchers and Civil Society Organizations, Overseas Development Institute's Research and Policy in Development (RAPID) report.

[2] Liberante, L., (2012). The importance of teacher–student relationships, as explored through the lens of the NSW Quality Teaching Model, Journal of Student Engagement Education matters, 2-9.

[3] Morreale, SH.P, Osborn, M.M, & Pearson, J.C, (2000), Why Communication is Important: A Rationale for Centrality of the Study of Communication, Journal of the Association for Communication Administration.

[4] Dutta, S., & Bilbao-Osorio, B., (2012). The Global Information Technology Report 2012 - Living in a Hyperconnected World, Insight Report, World Economic Forum, Geneva.

[5] Kemp, S.,(January 2016) “Digital in 2016 - We Are Social’s compendium of global digital, social, and mobile data, trends and statistics”, We Are Social.

[6] Pailler, L, Batista, F., & Borde, Ch., (2015) Push notifications, user manual 2015, The Mobile Marketing Association France's Guidelines.

[7] Pielot, M., Church, K., & Oliviera, R., (2014). An In-Situ Study of Mobile Phone Notifications, MobileHCI '14 Proceedings of the 16th international conference on Human-computer interaction with mobile devices & services, 233-242

[8] Shirazi, A. S. et al.(2014). Large-Scale Assessment of Mobile Notifications, CHI '14 Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 3055-3064.

[9] Mehrotra, A. et al (2016). My Phone and Me: Understanding People’s Receptivity to Mobile Notifications, In Proceedings of CHI 2016: The ACM SIGCHI Conference on Human Factors in Computing Systems.

[10] Melo, XH, (2016). Mobile devices in support of learning theories in higher education. in Proceedings of ICTAE, Split 2016.

[11] Google Developers, Cloud Messaging (2016) [Online] Available: https://developers.google.com/cloud-messaging/ (April 4, 2016)

[12] Saint-Andre, P., Smith, K., & Tronçon, R. (2009). XMPP: The Definitive Guide. Building Real-Time Applications with Jabber Technologies, O’Reilly 2009