Developing Application Programming Interface (API) for Student Academic Activity Monitoring using Firebase Cloud Messaging (FCM)

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Abstract. Information about the progress of a student lecture is very important to know by parents. Generally, universities already have information systems that contain the data of lecturing process, but many of the information is not accessible by parents. Therefore, an application is needed to monitor student lecture activity that can be accessed directly by parents, so that when there is a change in student lecture activity, parents can directly know it. But to create such an application requires an Application Programming Interface (API) that will facilitate the application to be able to interact with existing information systems and can send notification to parent. Delivery of notification to parents will use Firebase Cloud Messaging (FCM) which will quickly notify parents without making the university cost. The API will be built using web protocol (http/https) and will act as an additional system that will run in conjunction with the ongoing academic information system.

1. Introduction
Learn in a collage is one of parent's wishes for his children. With learn at a college, parents expect their children to get a good education. In fact, sometimes parents do not know the lecture process information conducted by their children. Often parents who are out of control of their lectures. So often the parents come to college to ask everything about their children’s lectures. Sometimes the process is late because parents only knows the information of his child's lecture activities when approaching the final semesters. Information normally required by parents is the information of the current semester, the grade per semester, finance, and class attendance [1-3].

Several universities have made efforts to report student lecture information through several systems such as through websites, email, post service and SMS (Short Message Service). But there is a possibility at some point parents forget to check email or website that informs the information about their children lecturing progress. With SMS and post service, parent can be informed about their children information, but it comes with cost to the university [4-6].

Therefore, we need a monitoring application that can be used by parents to monitor their lecture activities. The application is recommended to be built based on Android as global market share of Android in the second quarter of 2017 reached 87.7% [7-9]. But for security reasons, an application (especially a mobile application) is not recommended to access the database of an information system directly. Therefore, we need an intermediary medium that will bridge the communication between the applications with the database in an information system. That's where an Application Programming
Interface (API) is used. With API anyone can now develop their own applications using the data stored in the academic information system [10].

The API must be able to access the database of the current academic information system and should be able to send notification to the smartphone of registered student's parents. To overcome these problems, there is a technology that can be used that can directly display the information to the destination and also does not cost [1] i.e. cloud messaging technology. One of the existing cloud messaging providers is Firebase Cloud Messaging (FCM) which formerly called as Google Cloud Messaging (GCM).

Therefore, this research will focus on how the build API that can be used by student activity monitoring application that will be able to access database of ongoing academic information system and will use Cloud Messaging service as a medium of information delivery to notify parent about their children collage activity.

2. Methods

Application programming interface (API) is a set of procedures, functions, protocols and rules. It specifies how different software components or packages should interact with each other. API is like an intermediate between two people who interact with each other using completely different languages. [8].

The API should have ability to access academic database and send notification to student’s parent. A notification is a message that pops up on the user's device. Notifications can be triggered locally by an open application, or they can be "pushed" from the server to the user even when the app is not running. They allow your users to opt-in to timely updates and allow you to effectively re-engage users with customized content [1].

Firebase Cloud Messaging (FCM) is a cross-platform messaging solution that lets you reliably deliver messages at no cost [2], and it has no quotas. GCM/FCM is performed via cellular network or Wi-Fi, the cost of PNS is almost zero [7]. FCM is the default push messaging solution for the Android platform [5]. With FCM, application developer can send notification to FCM supported application easily. In the term of responsiveness, GCM/FCM has a better result (quicker) than SMS.

Firebase Cloud Messaging is designed to provide connection to your devices via messages and notifications. It’s intended to be reliable, with 98% of messages delivered to connected devices in 500ms or less, as well as massively scalable, with an infrastructure that delivers over a trillion messages each week [3].

Every device that have application supported with FCM will have a Registration Id that represent a unique device. Registration Id sometime called as token. An application developer can use HTTP API protocol to send notification (in JSON format) to target device with their token. For one request, FCM allow up to 1000 token. Sample of FCM Request Notification Format can be seen at Figure 1.

```
{
  "to" : "Registration Id",
  "notification" : {
    "body" : "Content of Notification",
    "title" : "Title of Notification"
  }
}
```

Figure 1. FCM Request Notification Format.

FCM/GCM message delivery is unpredictable, namely having a reliable connection to Google’s GCM servers on the client device does not guarantee a timely message arrival (GCM does not indicate any time guarantee in its documentation [12]) but GCM delivers the push messages to a big portion of the subscribers in a reasonable timeframe (in 10 seconds) [11] [12]. That's why FCM / GCM is still feasible to serve as a medium for delivering messages / notifications.
3. Results and Discussion

3.1. Current System Analysis
University has an academic information system that is used in every academic activity. Students use the information system to check grades, choose the courses to be followed, check the finances, see the class schedules and also see class attendance. The information system is an internet-based application so it can be viewed anytime and anywhere as long as there is internet connection.

3.2. The Proposed System
Based on the existing problems, university require a system that can notify parents when there is a change of academic data of students that will immediately notify via smart phone device with push notification method.

The architecture of proposed system can be seen at Figure 2.

![Figure 2. The Architecture of proposed system.](image)

The proposed system (named Parent Notification System) consist of 3 parts that are:

3.2.1. Notification Database. Notification Database is used for storing data that related to notification, that are parent information, the relationship between parent and student, and notification queue. This database get data from academic information system or parent’ smartphone via Notification API.

3.2.2. Notification Application Programming Interface (API). Notification API is used as interface from other system (academic information system and parent’ smartphone application) to notification database. Academic information system can send notification data via this API. The API will convert that data (such as student id become parent’s token_fcm) and save it to notification queue table.

3.2.3. Notification Queue Agent. Notification Queue Agent will become as a service worker. This Agent will process notification queue in database. This agent is needed because Firebase Cloud Messaging has 1000 registrant ids as a limit when sending notification request. So, the agent can search unsent notification from notification queue and if the notification has more than 1000 registrant ids, agent will split it to 1000 registrant ids for every notification request.

3.3. Software Requirement Specification (SRS)
To accomplish the purpose of this system, the service that will be build consist of 2 services, that is services for other application (such as Academic System Information) to send notification to notification queue and services for client-side application (parent application).

Service that will be built for other application is only service that allow other application to send. This service will be used by other application to send notification to parent. This service need 3 data which are token_app (token_app is token to identify the application that send notification), title of notification, body of notification and the list of student id. This service will find parent’s token_fcm
according to student id list and send the notification to notification queue. The rest process will be done by Notification Queue Agent.

And the services for client-side application (parent application) consist of 10 services that are:

3.3.1. **Parent Registration.** This service will be used to register parent to gain access to system. To register a parent, service need 2 data (phone number and parent’s name). Then the service will create random password for the parent. Generated password will be sent using regular SMS (Short Message Services).

3.3.2. **Parents Login.** This service will be used to authentication of parent. Parent will send 3 data to the service, which is phone number, password and the registrant_id (automatically taken from phone). The service will check to database. If the data has been authenticated then the service will send parent data to the client (parent’s app).

3.3.3. **Find Students.** This service is used to find students that related with parent phone number. This service need token of parent’s registrant_id (called token_fcm). The service will find students information from Academic Database that has the same phone number in student’s parent contact.

3.3.4. **Add Student.** This service will add student information (from service Find Student) to parent’s student list. This service need 2 data which is parent’s token_fcm and student’s token (called token_mhs).

3.3.5. **Get Student List.** This service is used to get student information list related to a parent. This service need 1 data which is token_fcm. The service will find student data that is related to the parent’s token_fcm.

3.3.6. **Get Student Info.** This service is used to get detailed information about the student. This service need token_fcm of parent and token_mhs from students. The service will find student information from Academic Database.

3.3.7. **Get Class Schedule.** This service is used to get information about student’s class schedules. These services need 2 data which is token_fcm and token_mhs. The service will find student’s class schedules from Academic Database.

3.3.8. **Get Attendance List.** This service is used to get information about student’s class attendance. This service need 2 data which is token_fcm and token_mhs. The service will search student’s class attendance from Academic Database.

3.3.9. **Get Grade List.** This service is used to get grade information. This service need 2 data which is token_fcm and token_mhs. The service will search grades and courses from Academic Database.

3.3.10. **Get Tuition Fee List.** This service is used to get information about tuition free that have been paid by students. This service also need 2 data which is token_fcm and token_mhs. The service will tuition fee information from Academic Database.

3.4. **Database Design**
Database schema for the notification system can be seen on Figure 3.
Database for notification system consist of 5 tables, that is:

- **Parent**, used to store parent information (phone number, name, password, active status)
- **Student-Token**, used to store token belong to students (student_id, token)
- **Parent-Student**, used to store parent and student relationship information (parent_id, student_id).
- **Notification**, used to store notification information than will be sent (notification_id, title, content)
- **Notification Queue**, used to store notification queue that will be sent by Notification Queue Agent.

### 3.5. Procedural Design

Parent notification system can accept a lot of notification request from other application. But Firebase Cloud Messaging has a limitation that is only allowed 1000 registration id for 1 request. Therefore, the service worker (Notification Queue Agent) should have a specific procedure to match that limitation. The flowchart of procedure that will be used for Notification Queue Agent can be seen at Figure 4.
4. Conclusions
The use of cloud notification makes the delivery of information can be done quickly with almost no cost (when the internet connection is not counted) although notification is not timely received. Implementation of cloud notification in an academic information system can produce a good outcome, where a parent can get the latest information about their children's lecture activities directly through their smartphone.

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