

## Change History:

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2013/06/28	1.1	fractals	Purpose added
2013/06/28	1.2	fractals	Document Conventions added
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2013/06/28	1.6	fractals	Overall Architecture added
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2013/06/28	3.3	fractals	Logical View added
2013/06/28	3.4	fractals	Development View added
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2013/06/28	3.6	fractals	Policies added
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2013/06/30	4.3	fractals	System Description updated
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2013/06/30	4.8	fractals	Scalability updated
2013/06/30	4.9	fractals	Modifiability updated
2013/06/30	5.0	fractals	Security updated
2013/06/30	5.1	fractals	Performance updated
2013/06/30	5.2	fractals	Usability updated
2013/06/30	5.3	fractals	Integrability updated
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2013/08/22	7.0	fractals	Project Scope updated
2013/08/22	7.1	fractals	References updated
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2013/08/22	7.3	fractals	Overall Architecture updated
2013/08/22	7.4	fractals	Architectural Pattern updated
2013/08/22	7.5	fractals	Architectural Strategies/Tactics updated
2013/08/22	7.6	fractals	Reliability updated
2013/08/22	7.7	fractals	Scalability updated
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2013/08/22	8.0	fractals	Performance updated
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2013/08/22	8.2	fractals	Integrability updated
2013/08/22	8.3	fractals	Maintainability/Flexibility updated
2013/08/22	8.4	fractals	Constraints updated
2013/08/22	8.5	fractals	Reference Architecture updated
2013/08/23	8.6	fractals	Technology and Framework Selection updated
2013/08/23	8.7	fractals	Build Tools updated
2013/08/23	8.8	fractals	Details of the Subsystem updated
2013/08/23	8.9	fractals	Scenarios Diagrams updated
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2013/08/24	9.3	fractals	Overall Architecture updated
2013/08/24	9.4	fractals	Reliability updated
2013/08/24	9.5	fractals	Modifiability updated
2013/08/24	9.6	fractals	Integrability updated
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2013/08/24	10.3	fractals	Login Use Case: Services Contract Added
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2013/08/24	10.6	fractals	Messaging Use Case added
2013/08/24	10.7	fractals	Messaging Use Case: Services Contract added
2013/08/24	10.8	fractals	Messaging Use Case: Functional Requirements added
2013/08/24	10.9	fractals	Messaging Use Case: Activity Diagram added
2013/08/24	11.0	fractals	View Contact List Use Case Added
2013/08/24	11.1	fractals	View Contact List Use Case: Services Contracts added
2013/08/24	11.2	fractals	View Contact List Use Case: Functional Requirements Added
2013/08/24	11.3	fractals	View Contact List Use Case: Activity Diagram added
2013/08/24	11.4	fractals	Exit Use Case added
2013/08/24	11.5	fractals	Exit Use Case: Services Contracts added
2013/08/24	11.6	fractals	Exit Use Case: Functional Requirements added
2013/08/24	11.7	fractals	Exit Use Case: Activity Diagram added
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2013/08/24	12.1	fractals	Policies updated
2013/08/24	12.2	fractals	Document Conventions updated
2013/08/24	12.3	fractals	Technology and Framework updated
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2013/10/11	15.3	Michelle Peens	System Description: Login Updated
2013/10/11	15.4	Michelle Peens	System Description: Updated
2013/10/11	15.5	Michelle Peens	Added Activity Diagrams
2013/10/12	15.6	Janine Venter	System Description Updated
2013/10/12	15.7	Janine Venter	System Description: Support for LaTeX and MimeTeX Libraries Updated
2013/10/12	15.8	Janine Venter	System Description: Messaging Updated
2013/10/12	15.9	Janine Venter	System Description: Login Updated
2013/10/13	16.0	Janine Venter	Diagram: Logout added
2013/10/13	16.1	Janine Venter	Functional Requirements: Logout Updated
2013/10/23	16.2	Janine Venter	Added all Services Contracts

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# 1. Introduction

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## 1.1 Purpose

The purpose of this document is to provide our client with a high level overview of the architecture specification including architectural strategies or tactics and patterns that will form a basis for the development of the LaTeX Chat Application. The overall outline of these concepts and how they are implemented will provide our team with a means to achieve the given set of requirements as previously agreed upon in the Requirements and Design document. This document is also meant to describe the architecture requirements needed to achieve our final goal.

## 1.2 Document Conventions

- Document Formatting: LaTeX
- UML Diagrams: Diagram Designer, Visual Paradigm

## 1.3 Project Scope

The aim of the project is to develop an open source android XMPP chat client which supports the embedded LaTeX base equations which are rendered as images. LaTeX based equations will be rendered on the handset to produce mathematical equations. Our system will also provide the ability to view, edit and correct equations before sending. The application will provide a similar functionality to yaxim. Exchange of images and mathematical expressions will be possible through our software solution. The TeXchat application will have the ability to show a preview of the entered text send the equation as LaTeX code and then render it on the receiving end on the client handset.

## 1.4 References

- Mr. Will van Heerden.
- MSDN Authors. Chapter 3: Architectural Patterns and Styles.  
[Online] Available at: <http://msdn.microsoft.com/en-us/library/ee658117.aspx>  
[Accessed 21 June 2013].
- Android Authors, 2013. Android NDK.  
[Online] Available at: <http://developer.android.com/tools/sdk/ndk/index.html>  
[Accessed 18 August 2013].

## 2. System Description

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The goal of our software application is to provide a chat service that will allow users to exchange normal text messages and send mathematical equations displayed in a rendered image format. The application is intended to provide a service to users that require the ability and support for a chat client that allows them to communicate more efficiently and effortlessly in a scientific, and mathematical context. It will provide a more usable mobile version of a Latex chat application.

### **Support for LaTeX and MimeTeX Libraries**

The application makes use of a Latex based library (MimeTeX) for the rendering of equations as images on the mobile device. For this reason we have implemented the support for the MimeTeX library, through the use of the Android NDK (Native Development Kit), which allows us to embed the native C/C++ code of the MimeTeX library, in the source code. The NDK acts as a bridge between the C/C++ code and Java code. The library is compiled through Eclipse using a special makefile that sets the correct compiler flags to indicate that it is in math mode and not text mode. The compiler flags represent different capabilities of the MimeTeX library, in this case we set it to math mode to support the mathematical LaTeX equations.

### **Messaging**

The purpose of this application is for messaging to be possible between multiple clients on the server. The application now supports this feature as well as allowing a user to send both plain text messages and Latex based equations, which are rendered on the client side and displayed as an inline images. The rendering of the Latex based equations on the client side is provided through the use of the MimeTeX library. The messages sent between the various clients on the server is stored statically through making use of a client side SQLite database, which also provides the functionality for the retrieval of messages.

Unsent messages, such as messages sent while the user was offline, is stored on the server and as soon as the client is online these messages are fetched and displayed on the user's handset. The server uses a queue to store these messages.

### **Login**

The application allows a user to log in using an appropriate username and password combination. A user is authenticated by logging into the server. If a username and password combination is invalid the server will automatically hinder the user from logging in. Our user authentication component is implemented by the functionality provided by the server. The user is informed by the application that his/her attempt to log in was unsuccessful.

### **Register**

The application allows someone to register to the TexChat service as a new user. Through the user registration form the user provides the necessary information and selects a username and password combination that is later used to authenticate the user on the server. After a user is successfully registered, he can immediately log in and start using the messaging functionality provided.

### 3.Overall Architecture

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The architectural framework chosen for the application will be based on the Model View Controller(MVC) architecture in combination with the Client-Server architecture. The Operating System on which the system will be developed is Windows using Eclipse as the development tool, with Android development capabilities and the programming languages are Java, XML and as a native Java language, C and C++. The MimeTeX libraries were developed using C/C++.

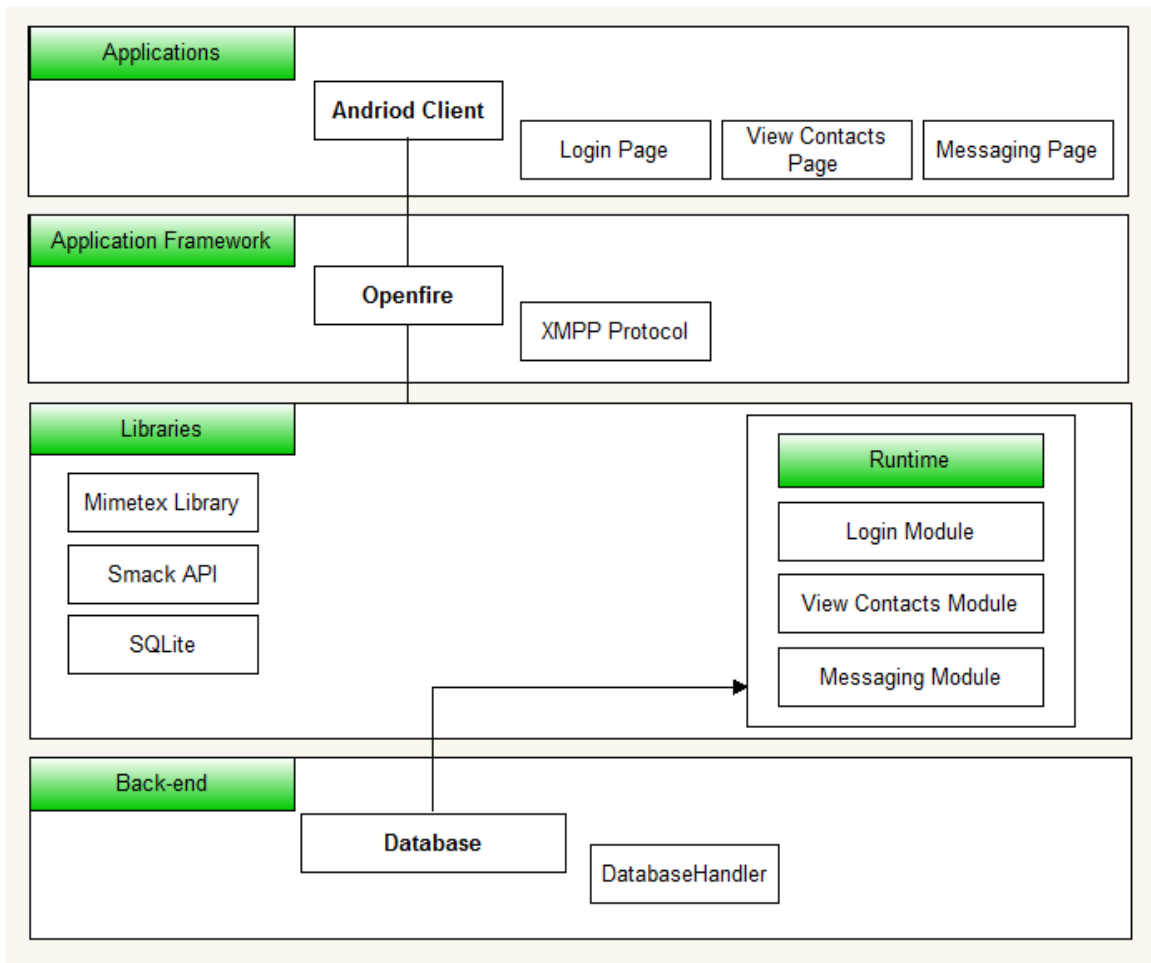
The MVC reference architecture will allow us to separate the view (the user interface of the Android application itself), controller (the actual coding that will handle the LaTeX rendering and the message sending and connection of clients to the server) and the model (the database that will be found on the server given to us).

The Client-Server architecture will be present when it comes to the actual connection of the clients to the server. This is where a lot of contention will be present. The Client-Server architecture will be encapsulated inside the MVC architecture.

#### 3.1 Architectural Pattern

As mentioned previously our system will be using the MVC reference architecture, and follow a client server approach. This method will allow us to separate presentation specifics from the overall control, as well as provide the support of multiple clients. The high level architecture for our application will be the Android Application Component Architecture. The layered high level view is depicted below, outlining the applications, application framework, libraries, runtime and relevant back end components. The overall structure of the model is depicted below:





[Figure 1] Overall Architecture

### Application Layer

This layer provides the client interface to the application.

### Application Framework

This layer outlines the server used (Openfire) and provides the connection between the clients. Moreover the protocols through which the communication is achieved is also specified.

### Libraries

These libraries are used within the various modules of the application. (MimeTeX, SQLite, Smack)

### Runtime mModules

The modules that make up the application. Each module is integrated into the application. (Login, View Contacts, Messaging, Render MimeTeX)

### Back-End

This layer contains the functionality that the user is unaware of while using the application and includes at this point only the database for storing data relevant to a user while interacting and communication with other users. (Database).

### 3.2 Architectural Strategies/Tactics

#### Reliability

The technology and framework we will be using, such as, Openfire, will provide a very reliable server for hosting our clients. It is already implemented with multiple backup servers, and we will build our application using that. This component, provided by the server itself, is included in the current release for this iteration.

We will also add a component dedicated to ensuring that messages do deliver after a client has sent it, and report an error if it failed. This will use methods such as heartbeat or ping. This will make the chat more reliable in ensuring that communication lines remain available. This component is not included in the current release of the application, and will be added during the next iteration phases of the software solution.

We will implement a backup database component to ensure that data relating to clients and messages remain reliable and available while the application is running. This component needs to ensure that a fail-over database remains available. The component has been implemented, and will be expanded on in later iterations of the application during development.

#### Scalability

The application at this phase of development will support only one client chat, thus it is able to support the two users that are participating in the chat. The provided server and database will allow for more than two users, but this kind of support for multiple clients will only be expected on the next release of the software.

We also need to consider the available size for the SQLite database on the client side (on the device itself), to ensure that data such as client information and chat history doesn't grow too large for the space available. This is where a database cleanup from the client side will be made available in the next release.

This may happen with previous chat histories that a user may want to retrieve or view at a later stage. Our tactic to ensure that this memory usage doesn't grow too large will be a component to periodically delete the earliest  $n$  (some integer value greater than 0) message entries that have been in the database for long periods of time. This will remove stale data that will take up unnecessary space. At this point of development the only database functionality included, is the retrieval of all message information ordered by date and time, thus the deletion of message will be included at a later phase of development.

#### Modifiability

The agile methodology that we are following throughout this project (RUP) will assume changes in the requirements and the design will have to be modifiable to compensate for these future changes.

For instance we will need the system to eventually be able to support more than the initial amount of users (which at this point in time is two), thus supporting multiple clients participating in separate chat instances. In this release of the application we will only be supporting the one chat instance between two users, but the system's design at this point is relatively modifiable, and support for multiple chat instances may be easily implemented. Integrating and developing the system to support more than two clients will be relatively easy, especially if an online server such as Jabber.org is used (in this case we are using a local server and will later upgrade to an online server) If the online server is used it will also solve the scalability issue of supporting more than two concurrent users.

Users may want other features such as changing background colours to suite their profile or their personal preference to the display of the chat client. Thus the application has to be modifiable to later include such user specific features and also extra options and features. This component may only be expected in a later version of the design. The current iteration phase will only display necessary

information, and not provide any additional design and presentation semantics.

### **Security**

One of the nice-to-have features will be that Messages sent via the chat application will be encrypted when sent and decrypted when received. This will make them secure and unobtainable by outside sources. This will also provide privacy between two users when using the application. We will provide a component or function to provide the encryption and decryption mechanics in a later phase of the development. (This has not yet been implemented)

### **Performance**

Messages need to be delivered within reasonable time therefore we will add a component to avoid contention on the network between the various clients. The performance of the application will also be tested with more and more active users, exchanging messages concurrently. Analysis for this component will be done during the testing phases of our development process, and thus will not be provided in this current version of the application. The performance of the rendering of the MimeTeX (mathematical) equations will not be a problem because it is rendered on the device itself and not on a server. As long as the device has an operating system later than or including from Android 2.2, with the underlying hardware supported by 2.2.

### **Usability**

Our final goal for this project is to develop an application that is intuitive and easy to use. Therefore we need our design to be as simple as possible while still providing the needed or required functionality as provided by our client. This version of the project is not as user friendly as we intend for the final product to be. At this point it works on a basic Android device.

User friendliness will be analyzed once the core functionality, as requested by our client, has been included, and user testing will be done at a later stage of development.

- The application should be intuitive.
- It should be easy to use.
- The design should be simple.
- It should be able to work on the most basic Android device.

### **Integrability**

The application is currently being developed using Eclipse as the development tool, which has Android development capabilities. Thus the core programming languages are Java and XML. For our application to support the Mimetex library we have in this release started implementing components for the integration of C and C++ languages as native development languages in our application. For this integrability requirement we have used the Android NDK (Native Development Kit).

### **Maintainability/Flexibility**

Using a set of coding standards will allow us to reuse code and increase efficiency and reducing redundancy. This will make our source code easy to read and modify if needed by parties that aim to develop the project further. This standard has been implemented from the initial phases of development and will remain consistent throughout the development process.

The application will have a low maintainability factor regarding the server since the server that is used is an open source server, and will provide all the maintenance needed.

Additional maintenance will have to be done on the client side, namely on the android application itself. These maintenance components will include database deletion for messages that have been in the database for too long periods of time. This database maintenance component will be implemented in later iterations and aims to increase performance on the client side. The client will also get the

option to delete an entire chat with another client (This will also be implemented in the next iteration.)

Documentation for the application will also be provided as a hard copy. We also intend to include a user manual document within the application itself, to provide the user of the device with additional help and needed information while using the application. This will aim to increase user satisfaction and overall usability for the application. This component will only be implemented at a later stage of development, and thus not included in this version of the application.

Unit testing will be done during the iterations of the releases and summaries of these will also be provided with the final project in the end.

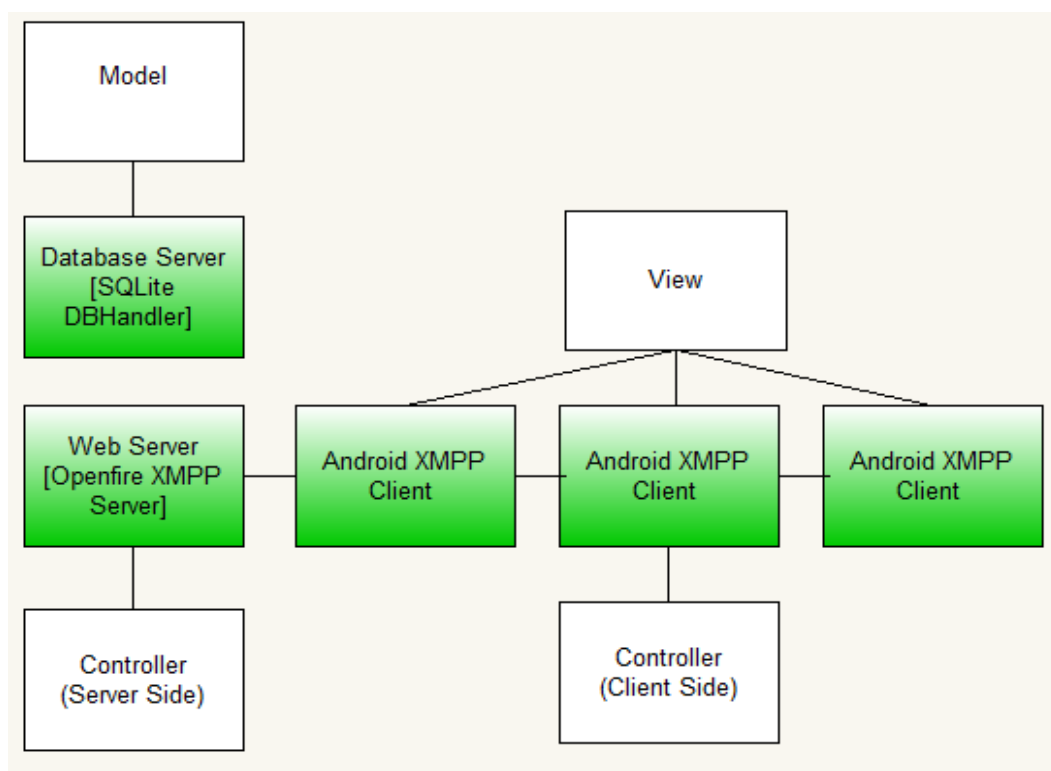
### Constraints

The constraints of the physical device might be an issue, designing the application in such a manner that it is still intuitive and user friendly with regard to issues such as a person being able to see the rendered image clearly even if their device has a small or limited screen display.

Another issue will be whether the libraries such as the Mimetex library will be reliable enough for the application's needs will be analysed in the next iteration of development.

### 3.3 Reference Architecture

Our reference architecture will be the Model View Controller (MVC) architecture. It is a well known architecture that has proven to solve known web application problems, and will allow us to incorporate concepts of separating the representation of the data from a user's ( or android client's) interaction with it. This way we can keep the data safe from the client aspect of our system, and only provide it with the allowed functions or methods to alter, view or retrieve the data as required by the user, via the control mechanism.



[Figure 2] Model-View-Controller and Client-Server Architectural Model

### **3.4 Technology and Framework Selection**

- Android SDK, NDK
- Technology: Java, XML, C
- Frameworks: Android Application Component Architecture

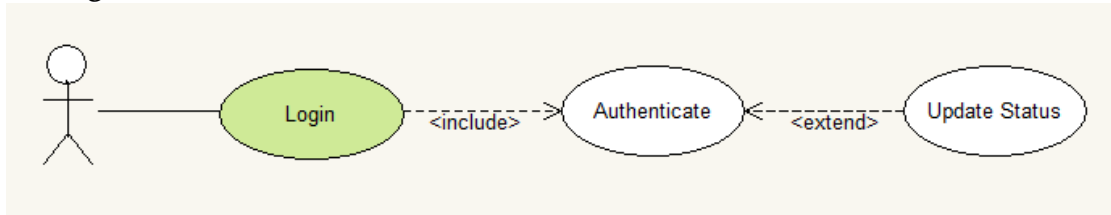
### **3.5 Build Tools**

- We will be using Eclipse IDE and Android SDK software to build the Android Application, as well as the NDK software.
- We will be using the Android ADT plugin to test the application.
- The application will then be distributed at a final stage on Google PlayStore and SourceForge.

## 4. System Diagrams

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### 4.1 Login Use Case



[Figure 2]Login Use Case

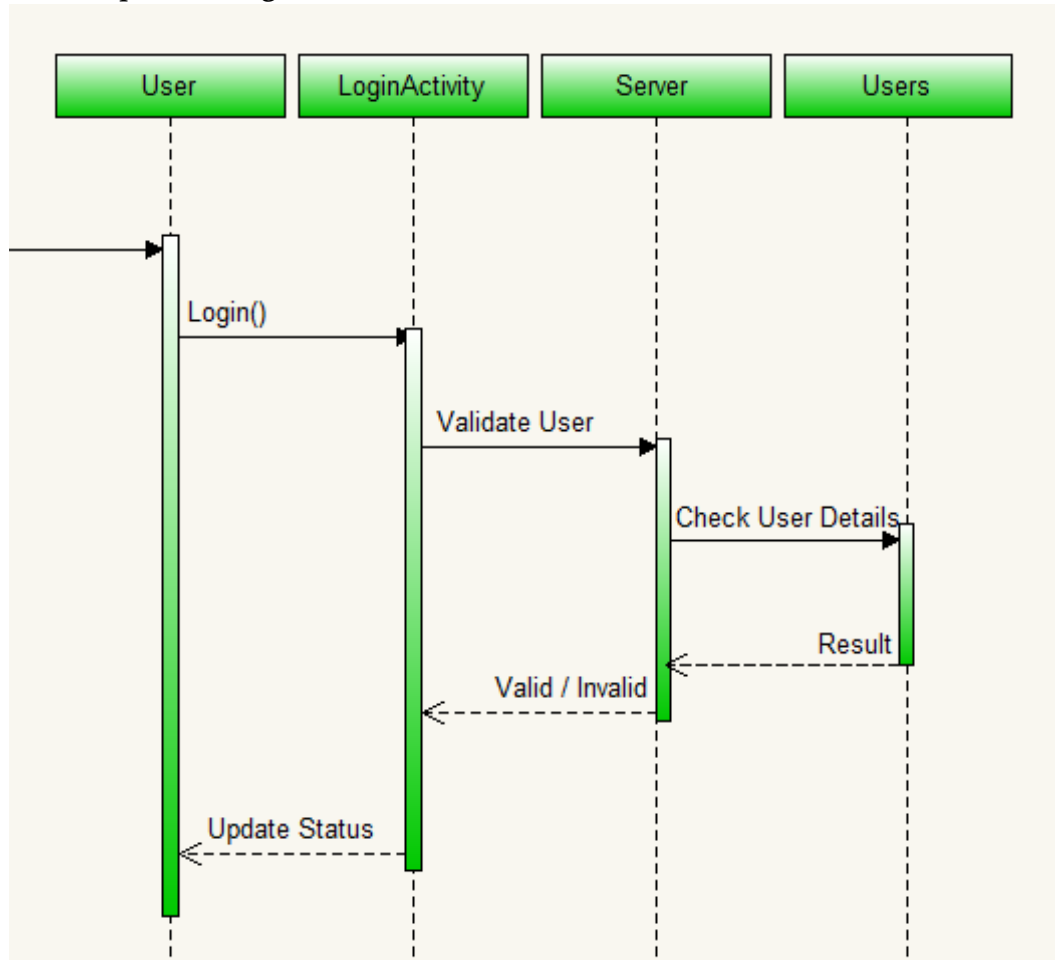
#### 4.1.1 Services Contract

To be added.

#### 4.1.2 Functional Requirements

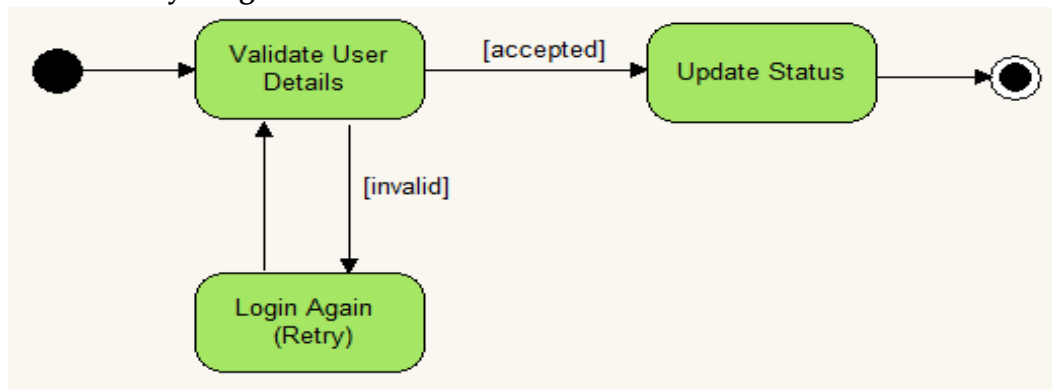
- A secure login
- Log in with username, password combination.
- Authentication is server side.
- Status stored in server database.
- Option to remember username and passwod (stored locally on device then)

#### 4.1.3 Sequence Diagram



[Figure 3]Login Sequence Diagram

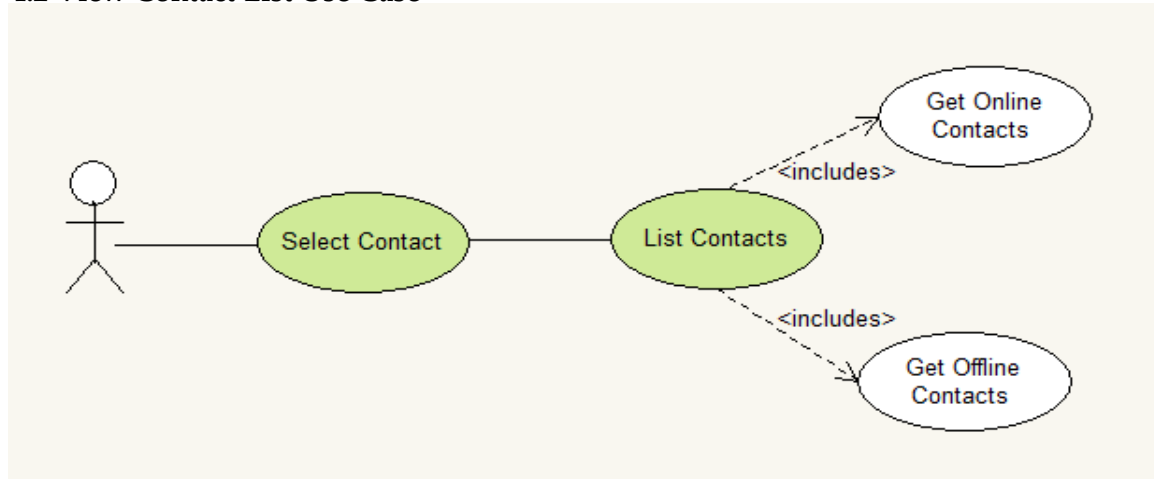
#### 4.1.4 Activity Diagram



[Figure 3]Login Activity Diagram



## 4.2 View Contact List Use Case



[Figure 4]View Contact List Use Case

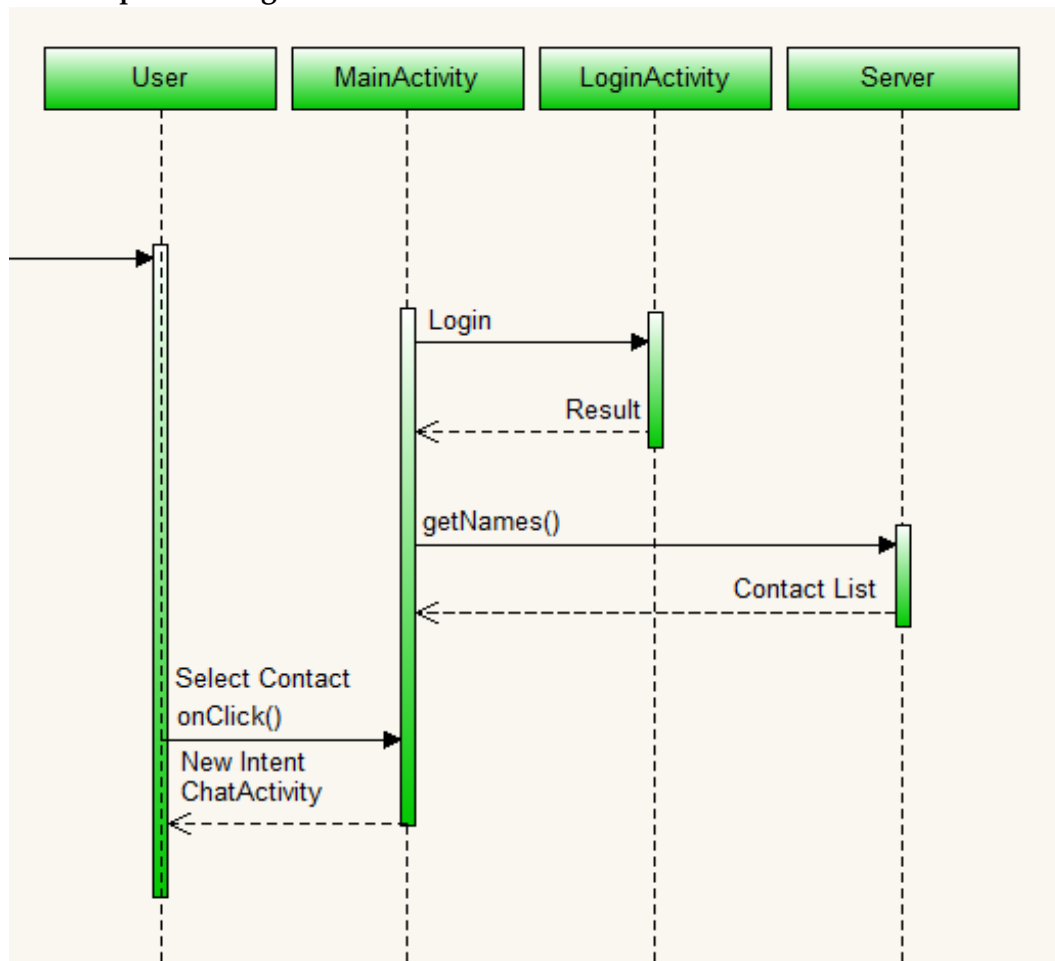
### 4.2.1 Services Contract

To be added.

### 4.2.2 Functional Requirements

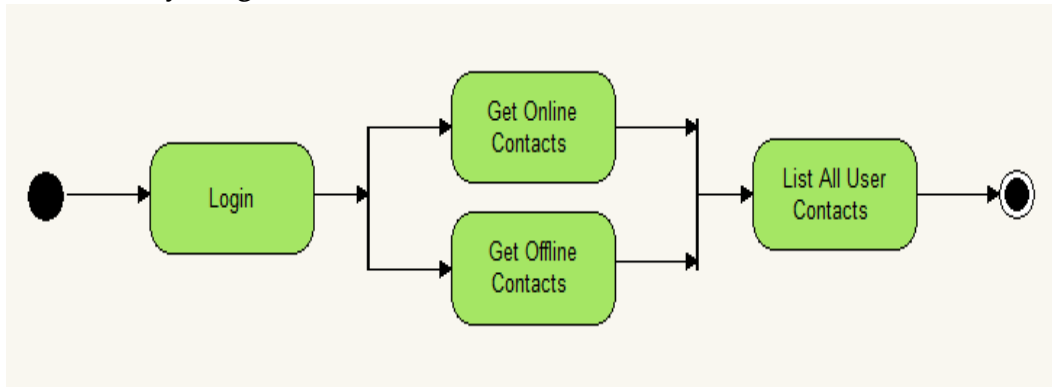
- View a contact's status.
- Click on contact to open a chat with the chosen contact.
- All contacts are shown, online and offline.
- Gets the previous messages from the database, they can also be viewed.

### 4.2.3 Sequence Diagram



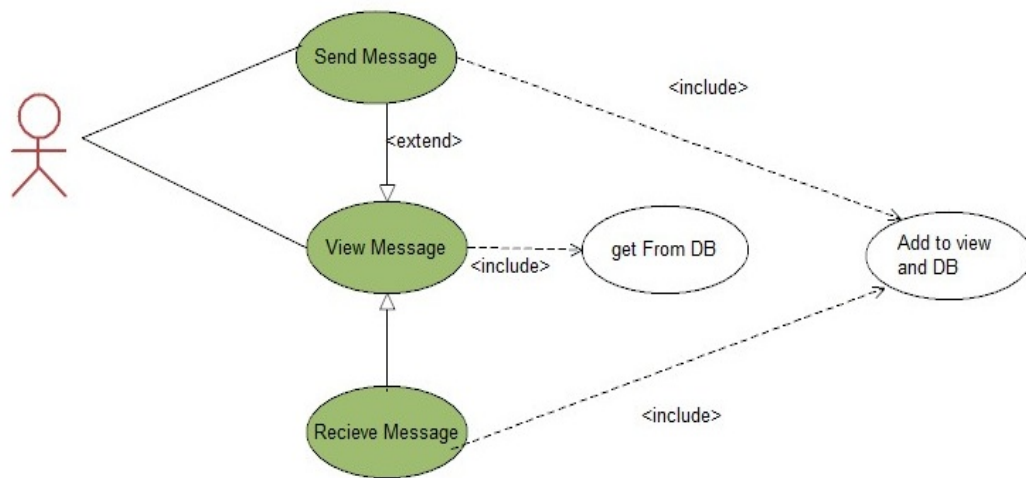
[Figure 5]View Contact List Sequence Diagram

#### 4.2.4 Activity Diagram



[Figure 5]View Contact List Activity Diagram

### 4.3 Messaging Use Case



[Figure 6]Messaging Use Case

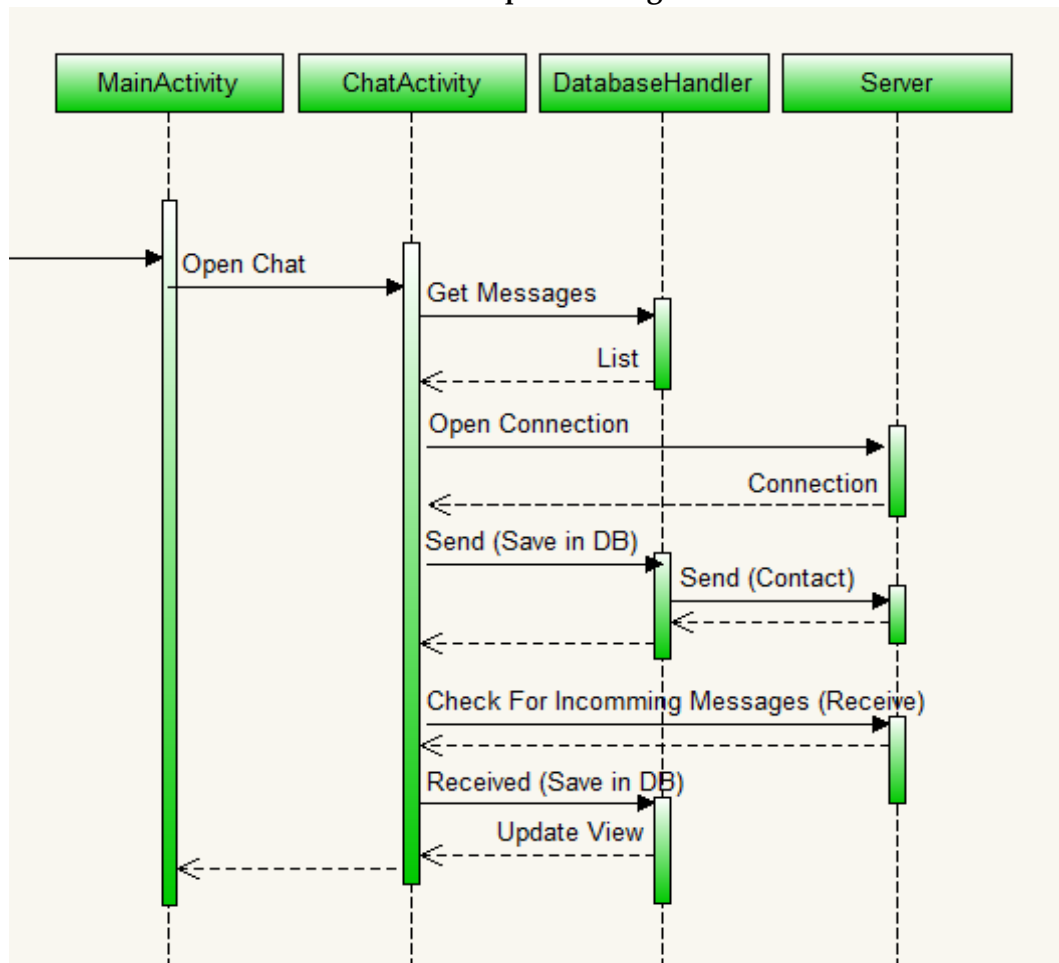
#### 4.3.1 Services Contract

To be added.

#### 4.3.2 Functional Requirements

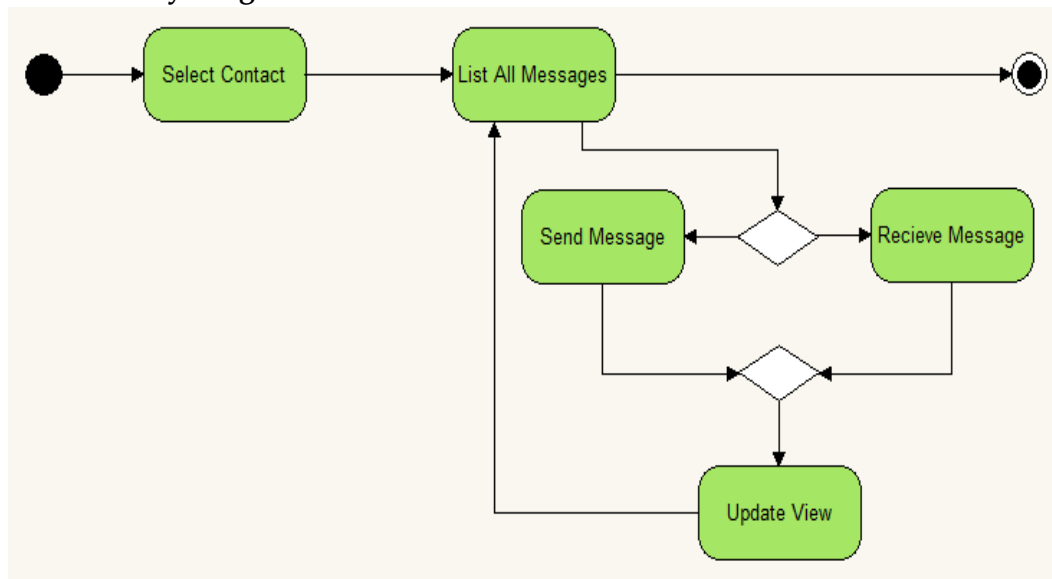
- You can view previous messages.
- Send a new messages. New message is stored in the db.
- Offline and online messages are received instantly.

### 4.3.3 Sequence Diagram



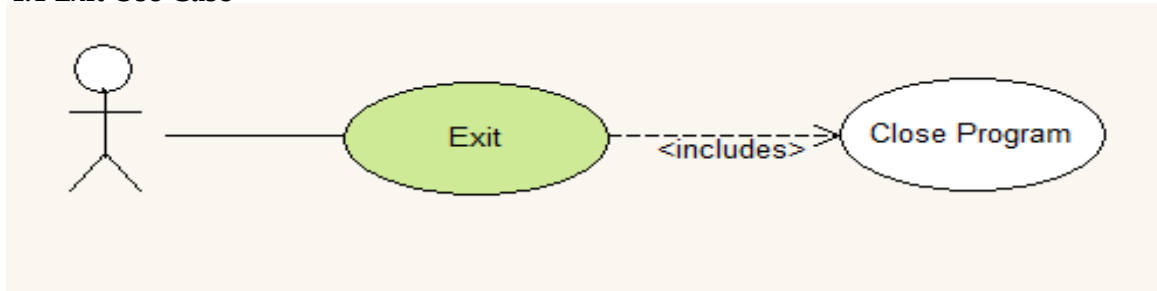
[Figure 7]Messaging Sequence Diagram

#### 4.3.4 Activity Diagram



[Figure 7]Messaging Activity Diagram

#### 4.4 Exit Use Case



[Figure 8]Exit Use Case

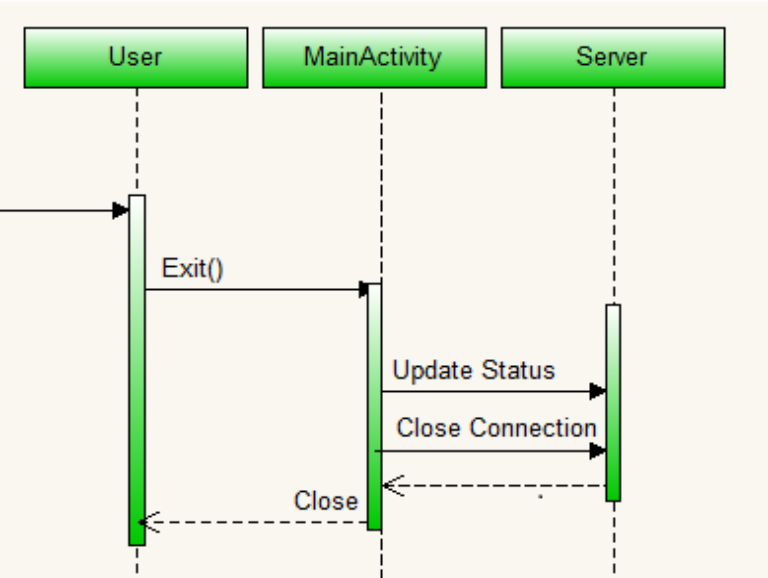
##### 4.4.1 Services Contract

To be added.

##### 4.4.2 Functional Requirements

- Ends the application on the device.

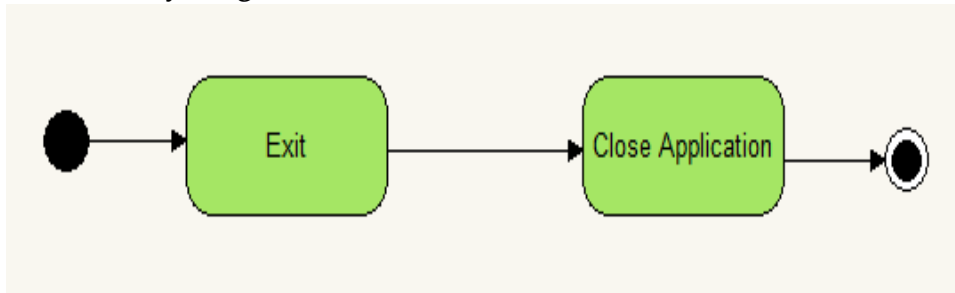
4.4.3 Sequence Diagram



[Figure 9]Exit Sequence Diagram

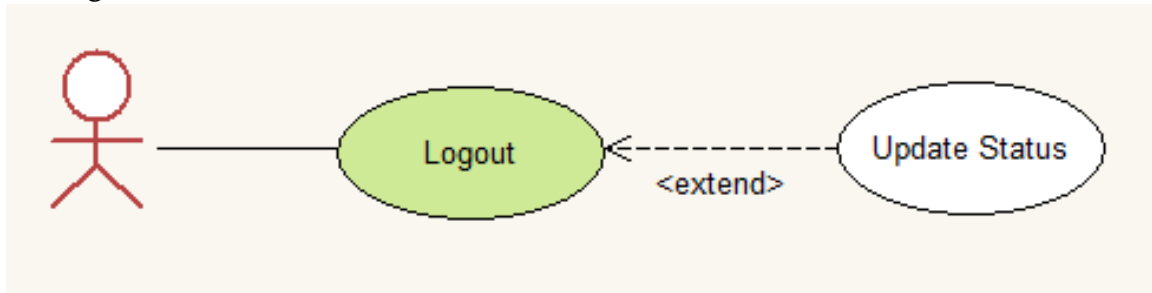


#### 4.4.4 Activity Diagram



[Figure 9]Exit Activity Diagram

## 4.5 Logout Use Case



[Figure 8]Logout Use Case

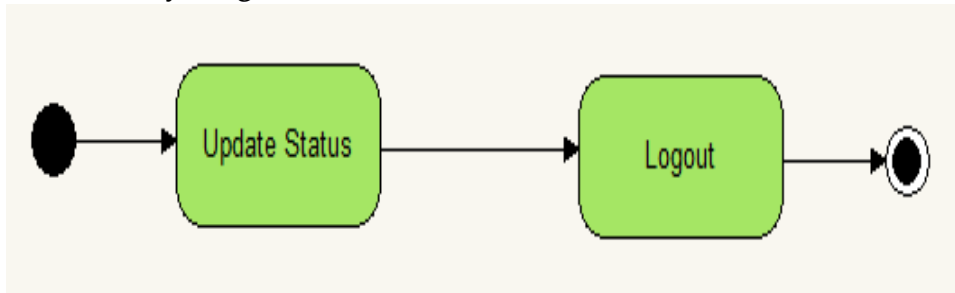
### 4.5.1 Services Contract

To be added.

### 4.5.2 Functional Requirements

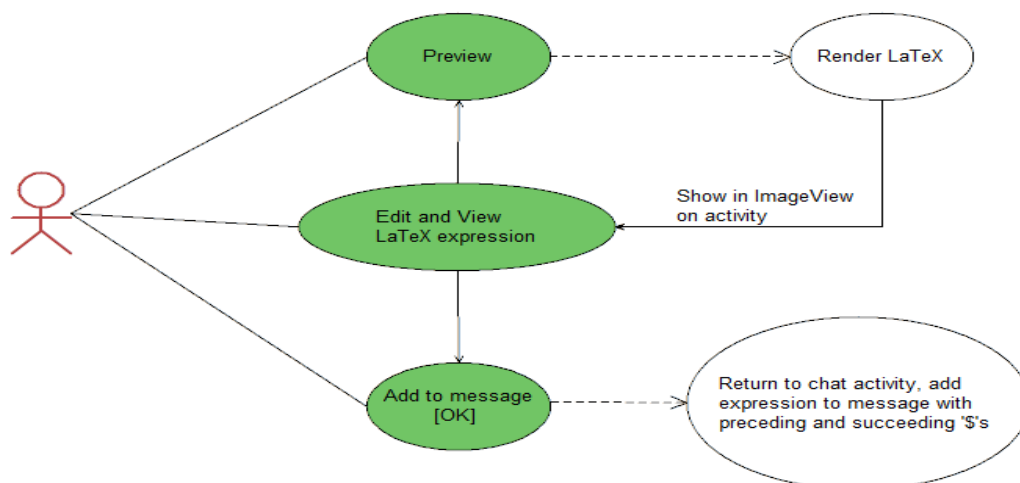
- Logs the user out of the application.

### 4.5.3 Activity Diagram



[Figure 9]Exit Activity Diagram

## 4.6 MimeTeX Use Case



[Figure 10]MimeTeX Use Case

### 4.6.1 Services Contract

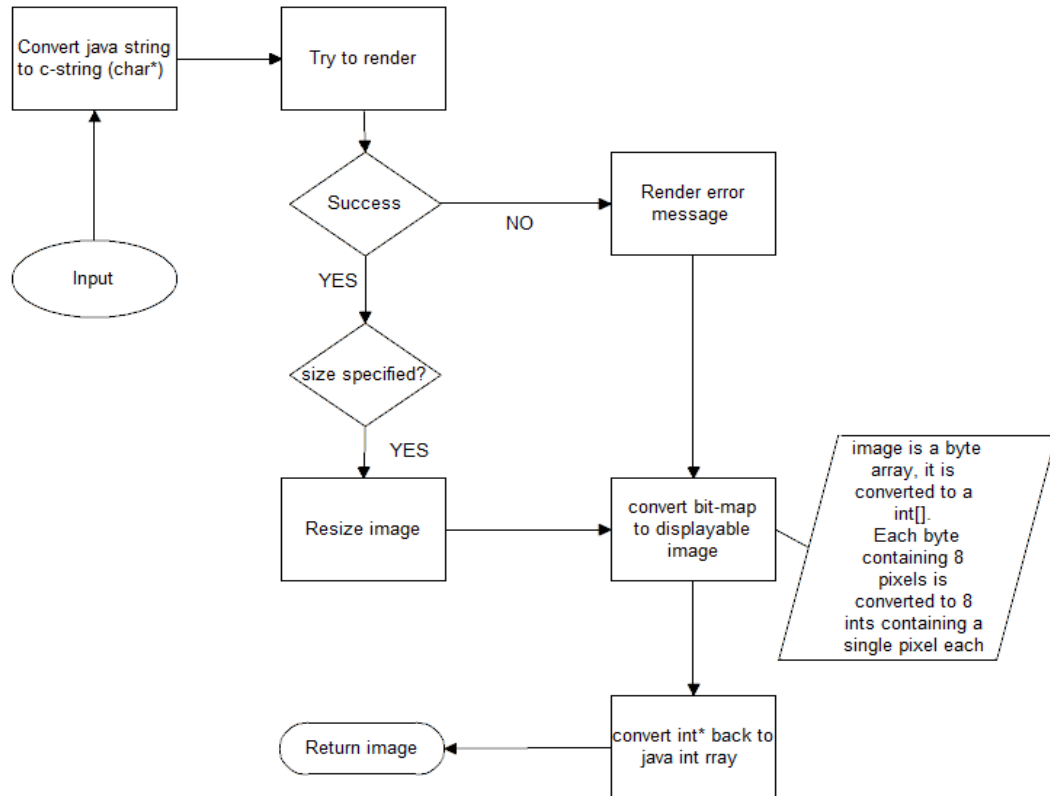
To be added.

### 4.6.2 Functional Requirements

- Render LaTeX equations.
- Allows for preview of equations

#### 4.6.3 Activity Diagram

##### TexChat Mimetex interface



[Figure 11]MimeTeX Activity Diagram

## 5. Policies

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- Following Google's coding standards for the different languages used.
- Using Google's coding conventions.
- Software Development Methodology: Agile - RUP.
- Development will be mainly done using Java and XML and the Eclipse IDE, SDK, ADT and the NDK.
- The Android API will be used as a guideline and the API functions will be incorporated in the application.

## 6. Open Issues

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- Styling
- Usability
- Testing and Integration Testing

## 7. Glossary

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- SDK - Software Development Kit
- NDK - Native Development Kit
- ADT - Android Development Toolkit plugin
- IDE - Integrated Development Environment
- RUP - Rational Unified Process
- XML - eXtensible Markup Language
- Agile - Development methodology
- MVC - Model View Controller
- UML - Unified Modelling Language
- API - Application Programming Interface
- MimeTex - LaTeX library ported to Android