

My First Babble App Tutorial

Mosaic Networks

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My First Babble App Tutorial

This article is a walkthrough of the process of building your first Android App using the `babble-android` library. We are working towards the Sample App included in the `babble-android` library¹.

Babble

Babble enables multiple computers to behave as one. It uses Peer to Peer (P2P) networking and a consensus algorithm to guarantee that a group of connected computers process the same commands in the same order; a technique known as state-machine replication. This makes for secure systems that can tolerate arbitrary failures, including malicious behaviour.

We use an adaptation of the Hashgraph consensus algorithm, invented by Leemon Baird. Hashgraph is best described in the white-paper and its accompanying document. The original algorithm is protected by patents in the USA. Therefore, anyone intending to use this software in the USA should obtain a license from the patent holders.

Hashgraph is based on the intuitive idea that gossiping about gossip itself yields enough information to compute a consensus ordering of events. It attains the theoretical limit of tolerating up to one-third of faulty nodes without compromising on speed. For those familiar with the jargon, it is a leaderless, asynchronous BFT consensus algorithm.

Babble projects the output of the consensus algorithm onto a linear blockchain which is more suitable for representing an ordered list of transactions and facilitates the creation of light-clients. For information about this projection please refer to documentation pages.

This blockchain mapping is also instrumental in two important features that were alluded to in Baird's paper, but not implemented:

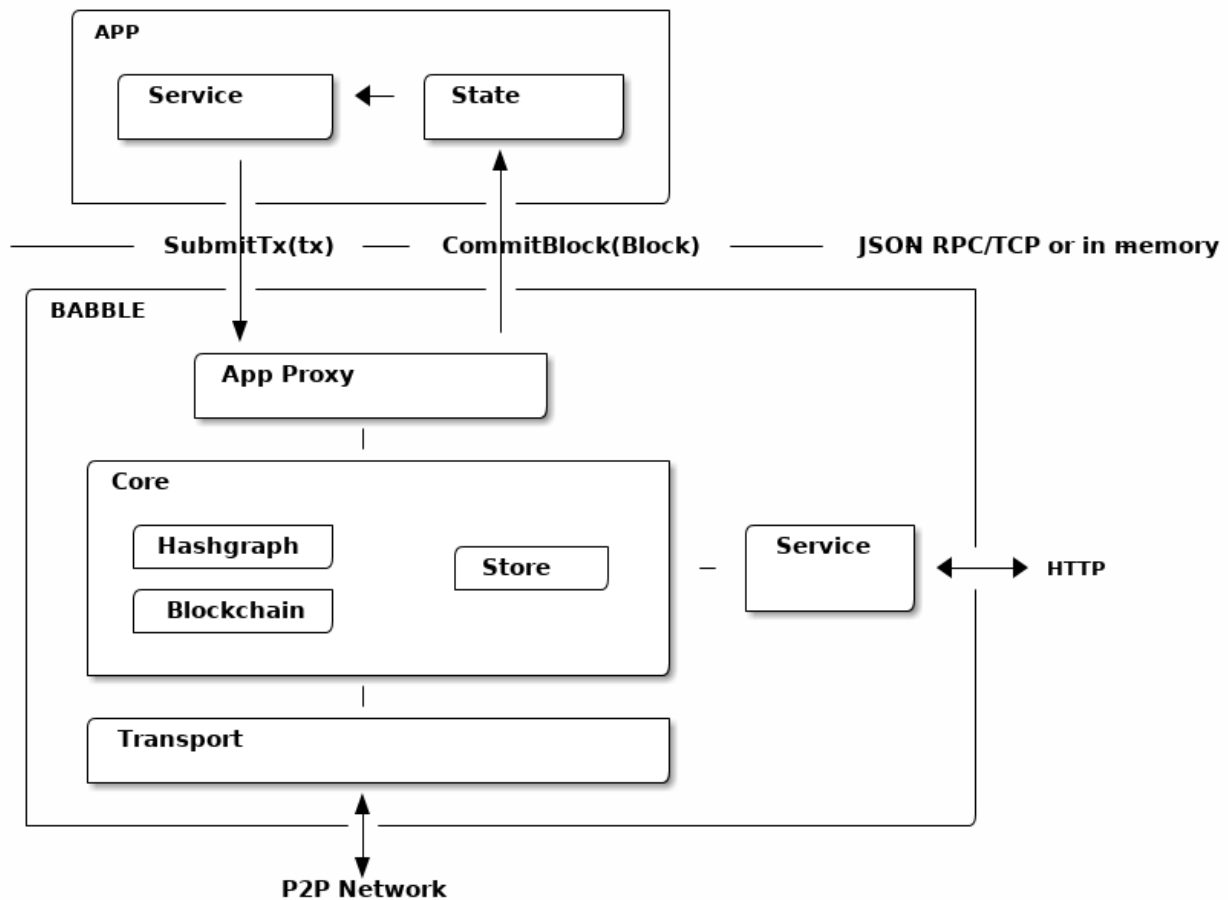
- A fast-sync protocol which enables nodes to join a cluster without having to download the entire history of gossip.
- A dynamic membership protocol, which enables peers to join or leave a cluster on demand.

Design

Babble is designed to integrate with applications written in any programming language.

¹The sample app is part of the `babble-android` library and is available from the GitHub repo

Overview



Almost any software application can be modelled in terms of a *service* and a *state*. The *service* is responsible for processing commands (ex. user input), while the *state* is responsible for manipulating and storing the data (eg. database). Usually, when commands need to update the data, the *service* will invoke the *state* directly. In a distributed application, however, commands (referred to as *transactions* in this context), must be broadcast to all replicas and consistently ordered before being applied to the *state*. This ensures that all replicas process the same commands in the same order. Hence, the *service* no longer communicates directly with the *state* (except for read-only requests), but forwards commands to a *transaction ordering system* which takes care of broadcasting and ordering the transactions across all replicas before feeding them back to the application's *state*.

Babble is an ordering system that plugs into any application thanks to a very simple interface. It uses a consensus algorithm, to replicate and order the transactions, and a blockchain to represent the resulting list. A blockchain is a linear data structure composed of batches of transactions, hashed and signed together, easily allowing to verify any transaction. So, instead of applying commands directly to the *state*, Babble applications must forward the commands to Babble and let them be processed asynchronously by the consensus system before receiving them back, in blocks, ready to be applied to the *state*.

Note that it is left to the application layer to filter out bad transactions before relaying them

from clients to the consensus engine. Unlike other middleware designed to sit in front of the application (like Apache or Tendermint), the user-facing API is app-specific, and Babble just takes care of managing the consensus “under the hood”. This filtering partially addresses spam from anonymous clients, but doesn’t protect against malicious nodes spamming the network; that is a potential enhancement on the roadmap.

API

Babble communicates with the App through an **AppProxy** interface, which has two implementations:

- **SocketProxy**: A **SocketProxy** connects to an App via TCP sockets. It enables the application to run in a separate process or machine, and to be written in any programming language.
- **InmemProxy** : An **InmemProxy** uses native callback handlers to integrate Babble as a regular Go dependency.

The **AppProxy** interface exposes three methods for Babble to call the App:

- **CommitBlock(Block) (CommitResponse, error)**: Commits a block to the application and returns the resulting state-hash, with accepted internal transactions.
- **GetSnapshot(int) ([]byte, error)**: Gets the application snapshot corresponding to a particular block index.
- **Restore([]byte) error**: Restores the App state from a snapshot.

Reciprocally, **AppProxy** relays transactions from the App to Babble via a native Go channel - **SubmitCh** - which ties into the application differently depending on the type of proxy (**Socket** or **Inmem**).

Babble asynchronously processes transactions and eventually feeds them back to the App, in consensus order and bundled into blocks, with a **CommitBlock** call. Transactions are just raw bytes and Babble does not need to know what they represent. Therefore, encoding and decoding transactions is done by the App.

Prerequisites

We will assume that you have installed Android Studio, an Android SDK with API version 29 and Android NDK. Android API 29 (10.0 / Q) is assumed, if use a previous version the create activity items in these instructions will use AppCompatActivity instead of androidx², leading to incompatibilities with the pasted source code. The babble node itself is compatible with AppCompatActivity, but converting the sample to use AppCompatActivity is beyond the scope of this article.

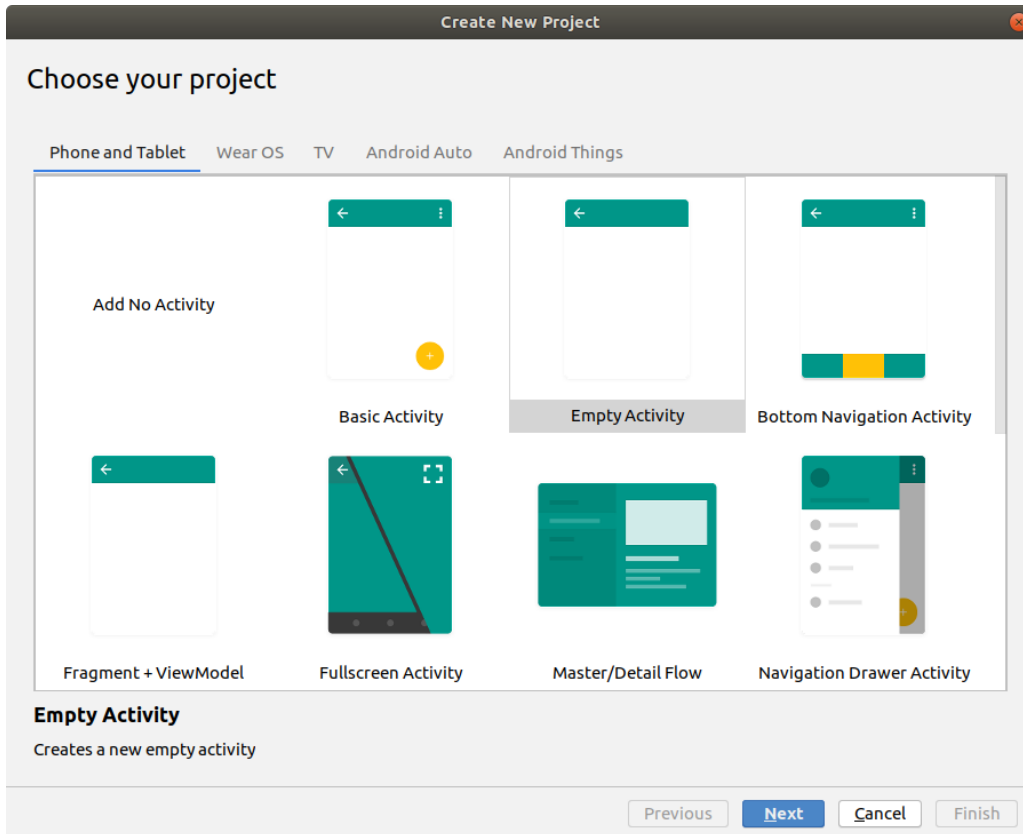
This tutorial is going to assume deployment to a physical Android device. Thus you will need an Android device (minimum API version 19³) with the developer options turned on, debugging enabled, and a suitable USB cable. You could use the android emulator, but that is beyond the scope of this article.

²You can read more about androidx here: <https://android-developers.googleblog.com/2018/05/hello-world-androidx.html>

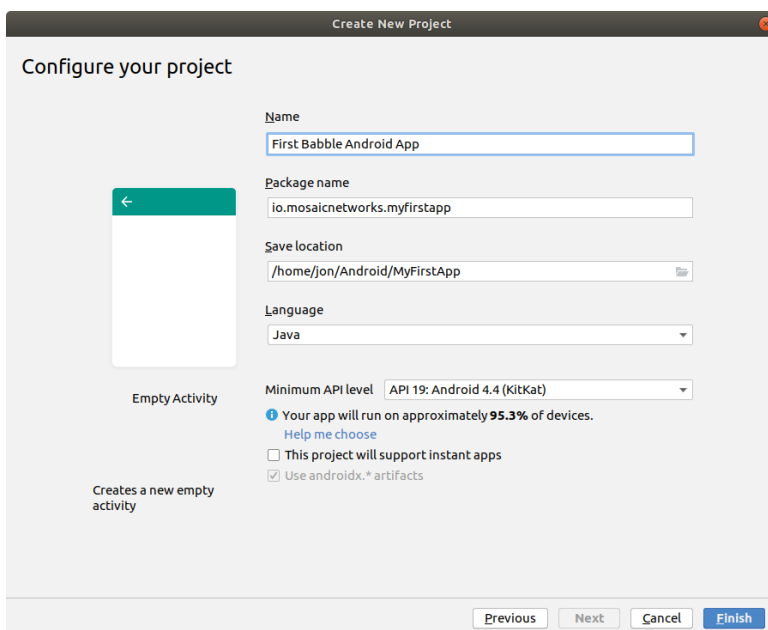
³API version 19 is Android 4.4 (KitKat). In May 3.8% of devices were using version 18 or lower. Android 4.4 was released in 2013. Whilst it would be possible to code support for earlier versions, the existing code uses Android features introduced in Android 4.4.

Our First Minimal App

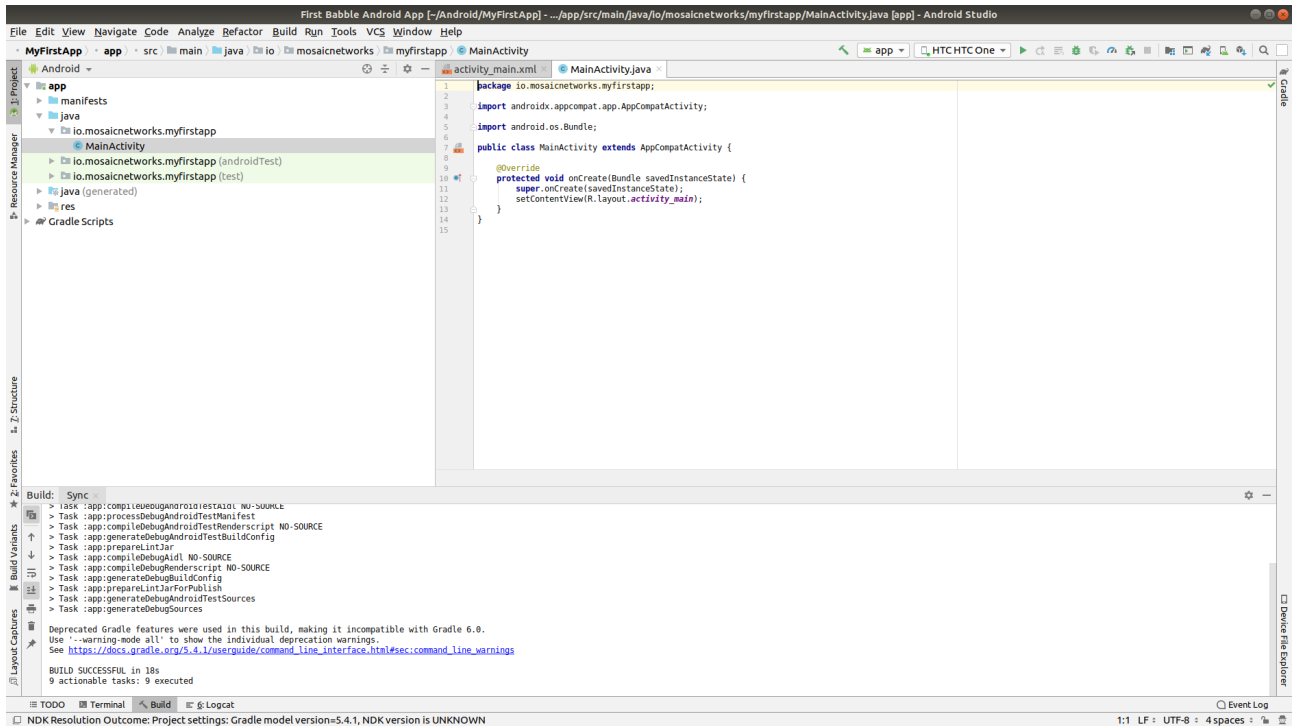
First up we will create a minimal app to test our environment and prove that we have loaded the `babble-android` library correctly. Fire up Android Studio and select `File/New Project`. You are asked to choose a project template.



Choose *Empty Activity* from the *Phone and Tablet* tab, and click Next.



The options here should be self-explanatory. We would recommend not using spaces in the Package Name or the Save Location. Do not set the Minimum API Level below 19. Click Finish.



Android Studio will open, and after expanding some of the menus it will look something like above.

N.B. the screen will change a few seconds after opening when the initial gradle scripts complete. The status bar at the bottom of the window should tell you this is happening.

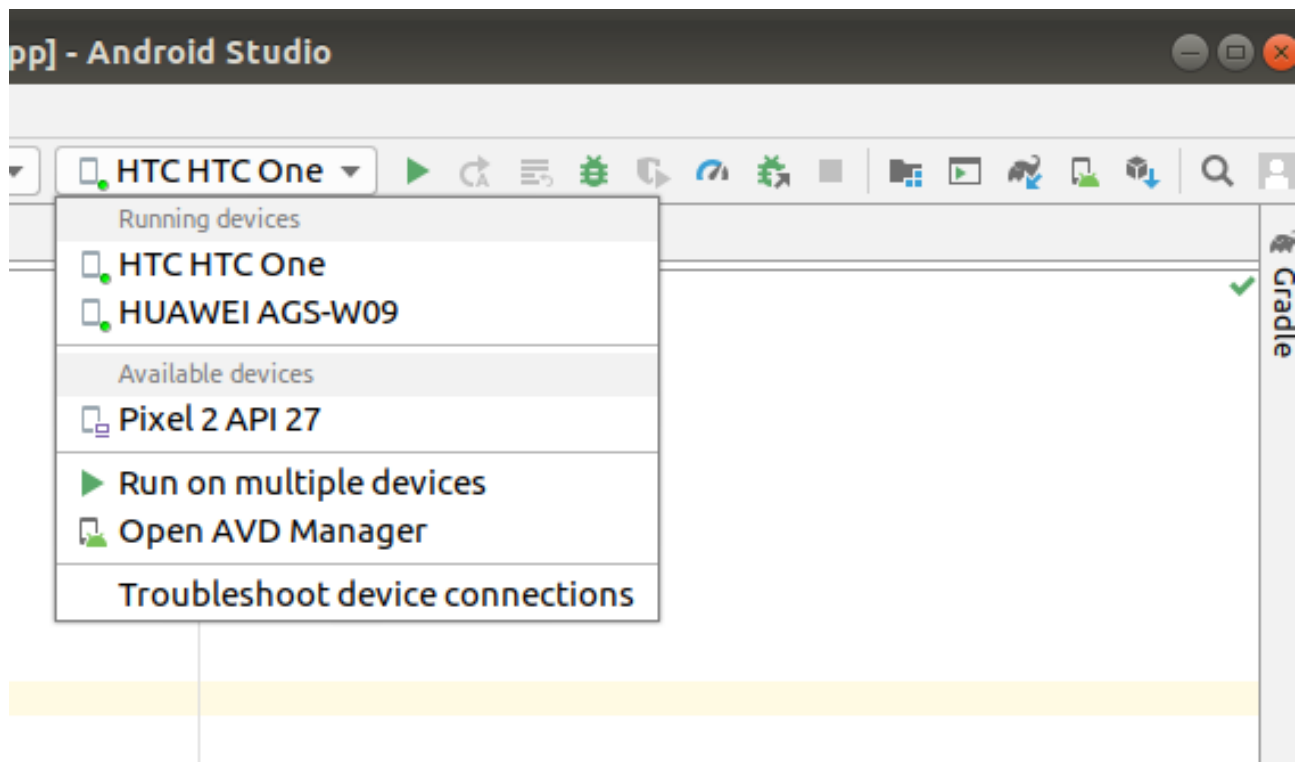
Running the App

Connect your android device to your computer via a USB cable. First we will test that the Android Debug Bridge (**adb**) can see the device.

```
jon@hpjon:~/Android/MyFirstApp$ adb devices
List of devices attached
4JPNU18709118621    device
jon@hpjon:~/Android/MyFirstApp$
```

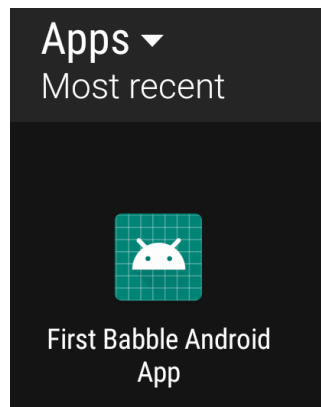
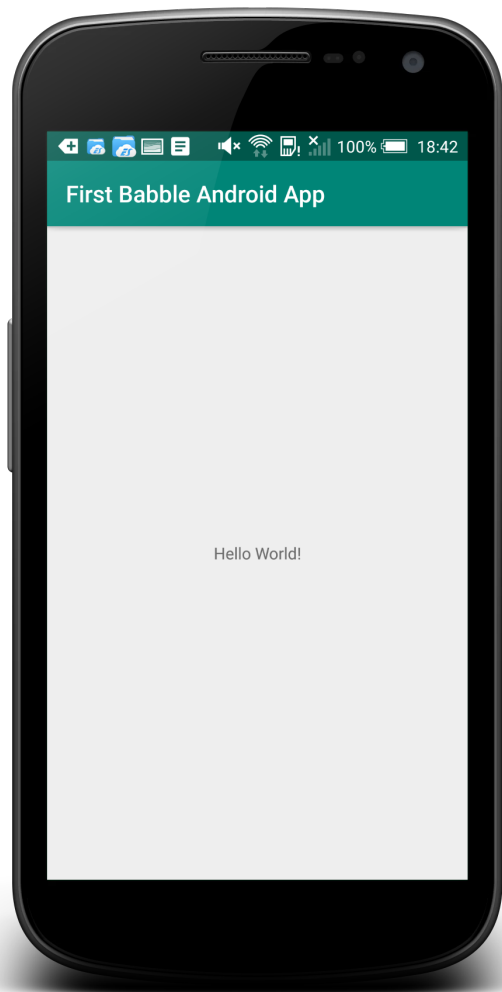
The command `adb kill-server` will reset this connection.

If you can see a device listed, go back to Android Studio. and in the top right is a target device dropdown. Select your device from the list.



If you cannot find your device in the list, the `Troubleshoot device connections` option on that menu should help.

Then press that little green triangle to the right of the dropdown device menu. Gradle then builds the app, which is then installed onto the physical android device that you selected. The whole process took about 20 seconds on my laptop (feel free to buy me a quicker one).



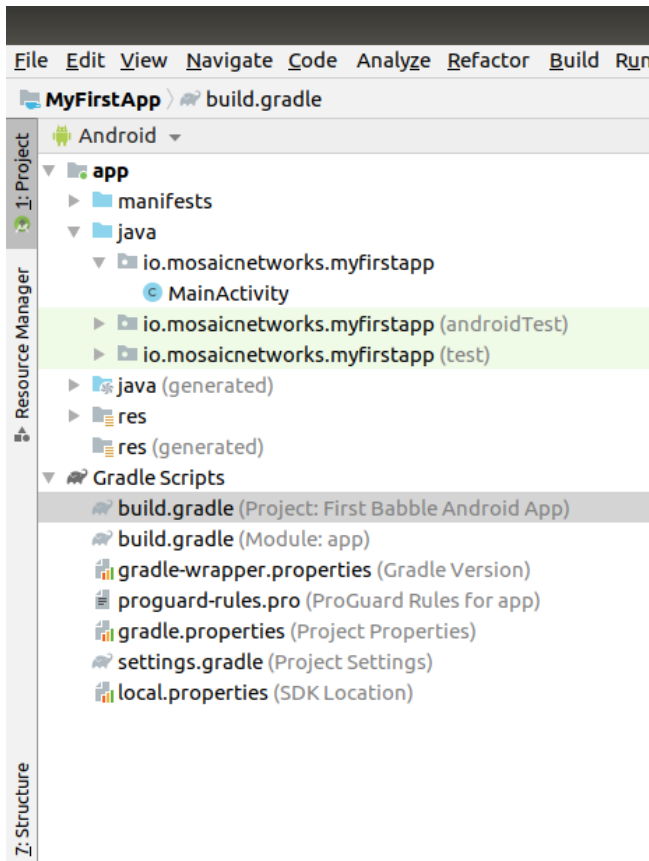
If you look on the device, you should find the app installed, as on the right above. Congratulations, you have an app. Now onto Babble...

Our First Babble App

We will now integrate the `babble-android` library into our skeleton app. We will use it to generate a key pair – just to prove that we have a working library instance.

Integrating the Babble-Android Library

The library is hosted **jcenter**. To make it available, we need to amend some gradle scripts.



In Android Studio, double click on the Project `build.gradle` as highlighted in the screenshot above.

We then add the 3 line `maven` instruction as below:

```
allprojects {
    repositories {
        google()
        jcenter()
        maven {
            url 'https://dl.bintray.com/mosaicnetworks/maven'
        }
    }
}
```

Which leaves the entire file looking like this:

```
// Top-level build file where you can add configuration options common to all
// sub-projects/modules.
```

```
buildscript {
    repositories {
        google()
        jcenter()
    }
    dependencies {
        classpath 'com.android.tools.build:gradle:3.5.2'

        // NOTE: Do not place your application dependencies here; they belong
        // in the individual module build.gradle files
    }
}

allprojects {
    repositories {
        google()
        jcenter()
        maven {
            url 'https://dl.bintray.com/mosaicnetworks/maven'
        }
    }
}

task clean(type: Delete) {
    delete rootProject.buildDir
}
```

Next we need to amend the app build.gradle (it is below the Project build.gradle in the screenshot above. We add an implementation line to the bottom dependencies section.

```
implementation 'io.mosaicnetworks:babble:0.1.0'
```

This leaves us with this full file:

```
apply plugin: 'com.android.application'

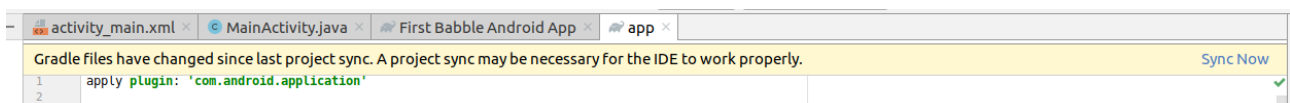
android {
    compileSdkVersion 29
    buildToolsVersion "29.0.2"
    defaultConfig {
        applicationId "io.mosaicnetworks.myfirstapp"
        minSdkVersion 19
        targetSdkVersion 29
    }
}
```

```

    versionCode 1
    versionName "1.0"
    testInstrumentationRunner "androidx.test.runner.AndroidJUnitRunner"
}
buildTypes {
    release {
        minifyEnabled false
        proguardFiles getDefaultProguardFile('proguard-android-optimize.txt'),
            'proguard-rules.pro'
    }
}
}

dependencies {
    implementation fileTree(dir: 'libs', include: ['*.jar'])
    implementation 'io.mosaicnetworks:babble:0.1.0'
    implementation 'androidx.appcompat:appcompat:1.1.0'
    implementation 'androidx.constraintlayout:constraintlayout:1.1.3'
    testImplementation 'junit:junit:4.12'
    androidTestImplementation 'androidx.test.ext:junit:1.1.1'
    androidTestImplementation 'androidx.test.espresso:espresso-core:3.2.0'
}

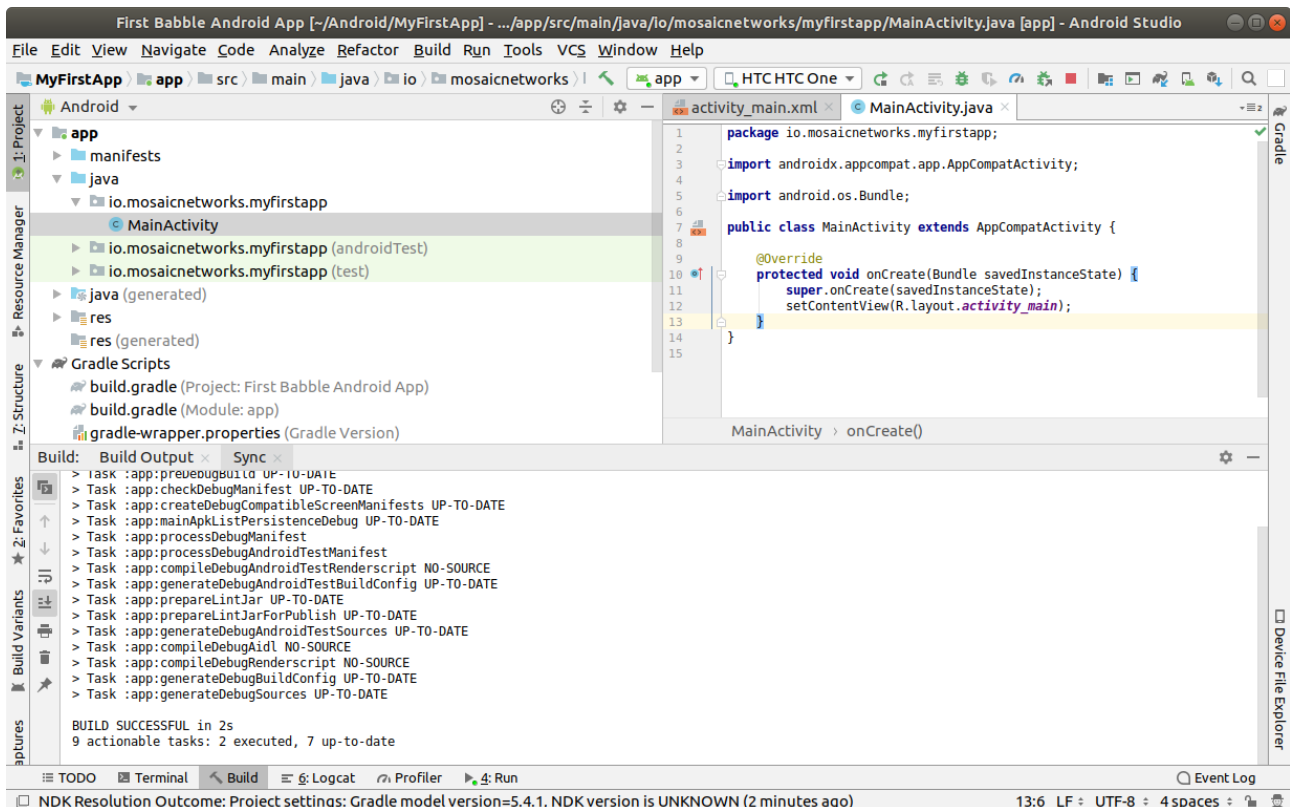
```



When you get a message like the above, click the **Sync Now** link on the right of the message.

Using the Library

The library should now be included in the project. So let's use it! Open `MainActivity.java` as below:



Add the lines below underneath the last import statement. The lines will appear greyed out, as the import is not yet used. As well as babble we are importing the Log package to write to the Android logs.

```

import io.mosaicnetworks.babble.node.KeyPair;
import android.util.Log;

```

Add the following lines as the last line of the onCreate function

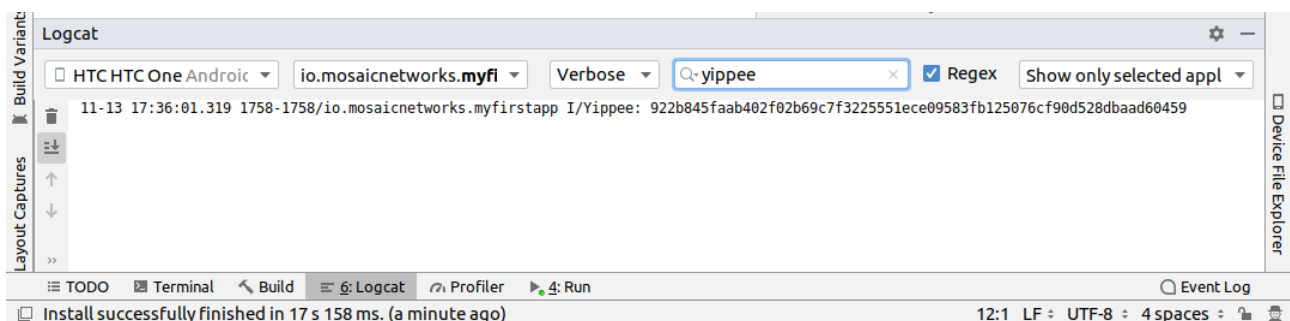
```

KeyPair kp = new KeyPair();
Log.i("Yippee",kp.privateKey);

```

This code generates a key pair and writes the private code to the logs.

Save all the files and run your app.



The app looks exactly as per the previous iteration, so let's take a look under the hood. Press logcat, as highlighted in gray in the screenshot above. Then type yippee in the search box at the top of that window to filter the logs. You should have a freshly generated private key in

there.

This project at this stage is available from github from here ⁴

The downloadable version of the project has mosaic network icons, rather than the default android ones. You can customise the icons using Android Studio Image Asset Studio.⁵

⁴This code is the stage1 branch at <https://github.com/mosaicnetworks/babble-android-tutorial/tree/stage1>

⁵Android Studio Image Asset Studio is described here: <https://developer.android.com/studio/write/image-asset-studio>

Our First Babble Blockchain

Now we have access to the babble library from within our app, the next stage is to start a babble network. We will start with a single node. But before we can start babble we need to add some UI elements to allow us to interact with our babble node.

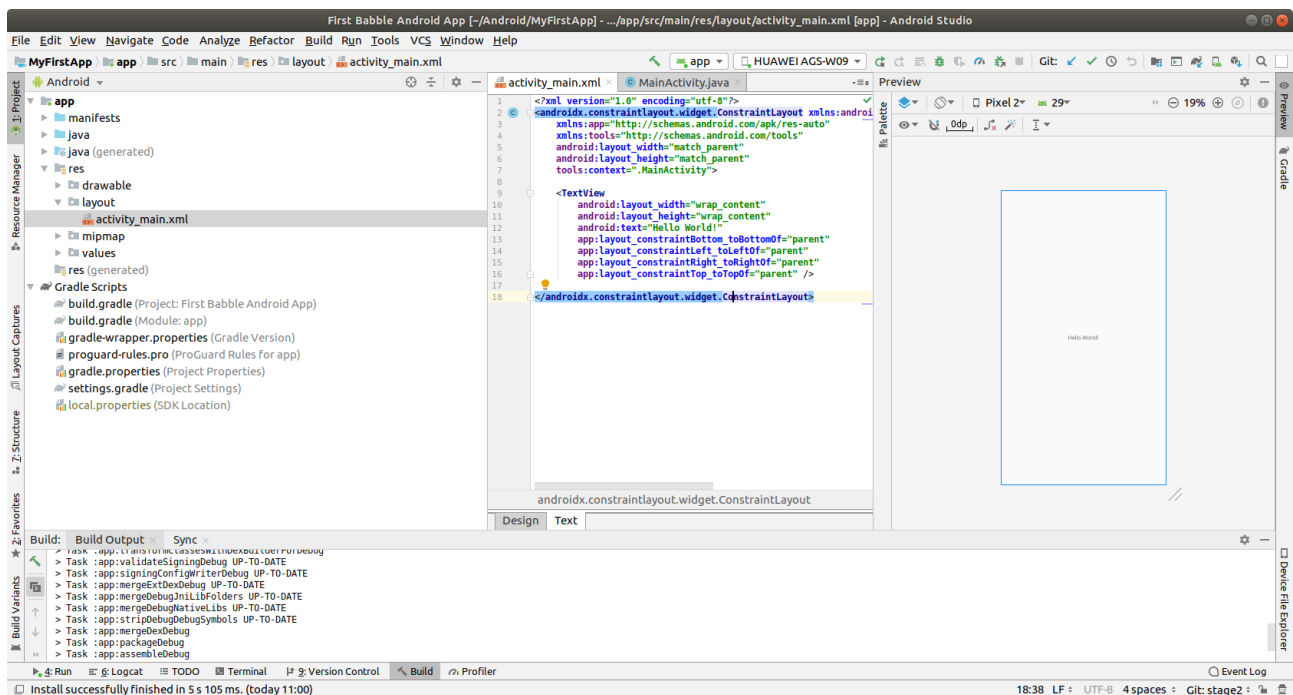
Currently our application launches the activity `MainActivity` which calls the key pair generation code in it's `onCreate` method.

In the Sample App ⁶ that we are working towards, the `MainActivity` Screen presents the user with a choice of “**New**” or “**Join**”. **New** starts a new babble network with your device as the sole peer. **Join** lets you specify the address of an existing network, pull down the configuration for that network and request to join it.

As **New** is standalone functionality, and **Join** requires **New** be implemented to function, we will implement **New** first.

Main Activity

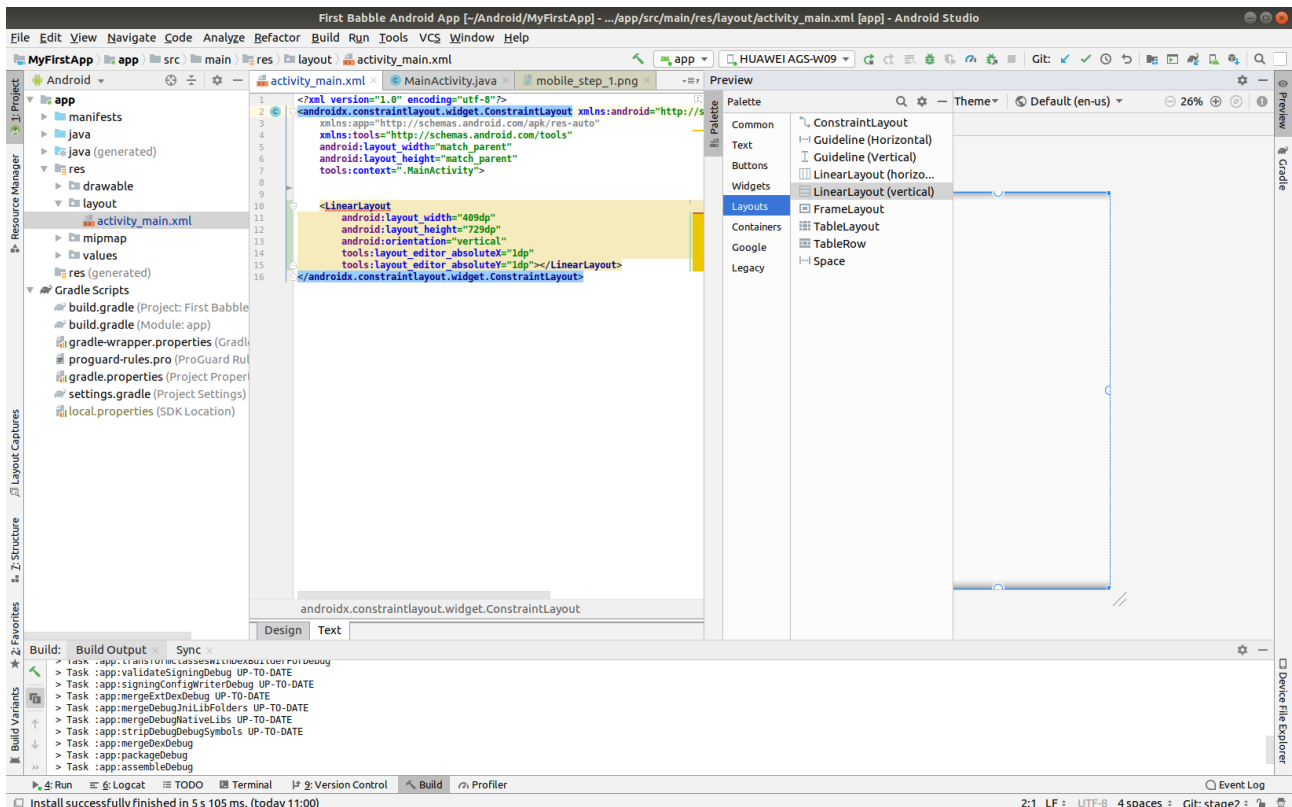
First up we will amend `MainActivity.java`. In the Android view it's layout should be under `app/res/layout/activity_main.xml`. Double click on that file to open the XML layout file. It may also show a Preview:



Delete the `TextView` tag. We have passed beyond the “Hello World!” stage.

In the preview window. Click on **Palette** / **Layouts** / **LinearLayout** (vertical) and drag it onto the preview window.

⁶The sample app is part of the `babble-android` library and is available from the GitHub repo



We will then set some properties for the LinearLayout. Amend it to look like this:

```
<LinearLayout
    android:layout_width="0dp"
    android:layout_height="wrap_content"
    android:layout_marginStart="8dp"
    android:layout_marginLeft="8dp"
    android:layout_marginTop="8dp"
    android:layout_marginEnd="8dp"
    android:layout_marginRight="8dp"
    android:layout_marginBottom="8dp"
    android:orientation="vertical"
    app:layout_constraintBottom_toBottomOf="parent"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toTopOf="parent">

</LinearLayout>
```

The principal effect of these changes are to set a margin so the buttons will not reach to the edge of the screen. Next we add a button by adding the following code between the opening and closing LinearLayout tags.

```
<Button
    android:id="@+id/button3"
    android:layout_width="match_parent"
```

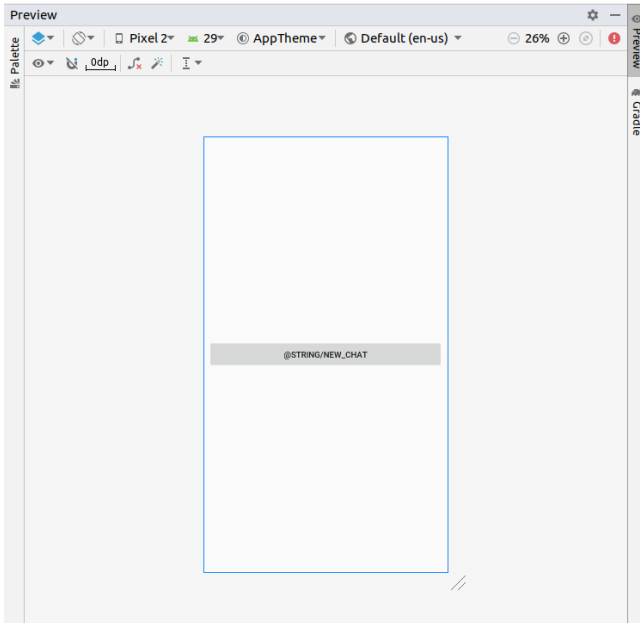


```

        android:layout_height="wrap_content"
        android:onClick="newChat"
        android:text="@string/new_chat" />

```

Note that the `onClick` method is marked as an error as we have not created it yet, as is the caption. The preview should look as below:



Update the `strings.xml` file found under `app/res/values/strings.xml` adding the line:

```

<string name="new_chat">New</string>

```

to give:

```

<resources>
    <string name="app_name">First Babble Android App</string>
    <string name="new_chat">New</string>
</resources>

```

Save the file, and if you navigate back to the `MainActivity` preview, the text `New` should now appear on the button.

Open `MainActivity.java` (the java code, not the XML).

Add the following code to the `MainActivity` class, under the `onCreate` method:

```

    // called when the user presses the new chat button
    public void newChat(View view) {
        Log.i("Ki", "newChat Called");
    }

```

Add the line below as the first line of the class, we will use this later to identified log messages from our app. :

```

public class MainActivity extends AppCompatActivity {

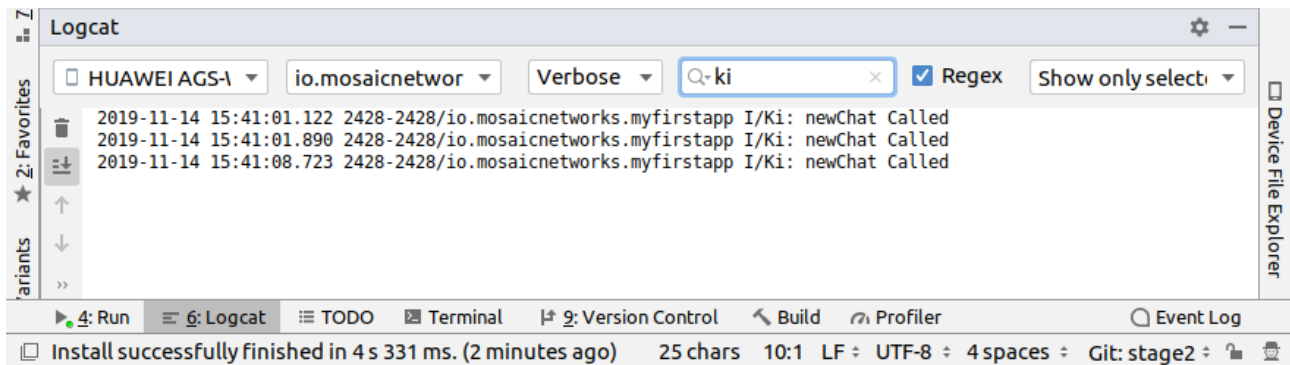
```

```
public static final String TAG = "FIRST-BABBLE-APP";
```

If the IDE does not add the line below, add it manually:

```
import android.view.View;
```

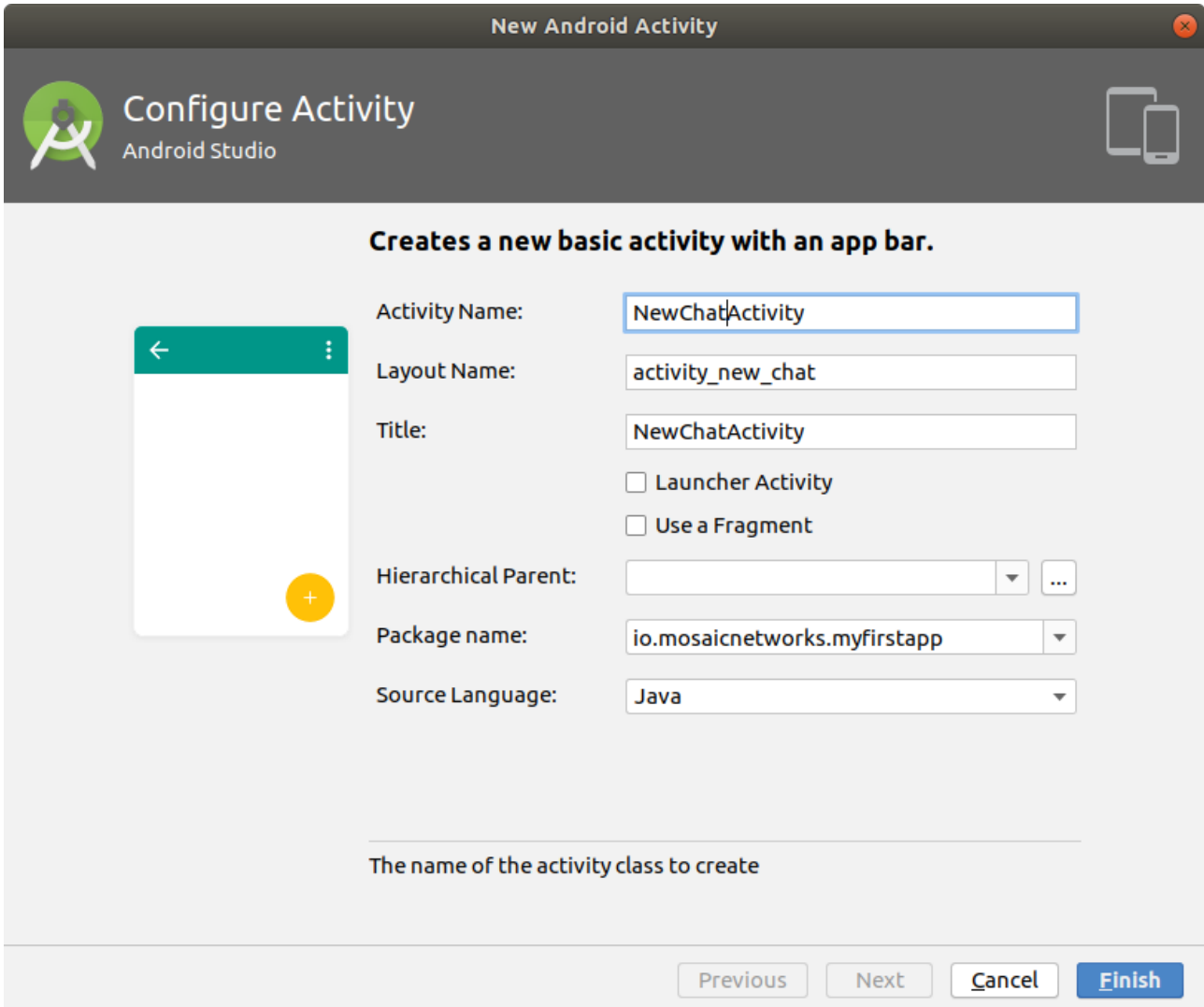
The project should now build successfully. So build and run it. If you search for Ki in the logcat window — exactly as you searched for Yippee before you should find results like below (if you have pressed the New button a few times...).



New Chat Activity

When we press the New button, we want to open a new screen where we can set some Chat Options. So lets create NewChatActivity.

Right click on MainActivity under the java tree. Select **New > Activity > Basic Activity** and enter the details as below:



New Android Activity

Configure Activity
Android Studio

Creates a new basic activity with an app bar.

Activity Name:

Layout Name:

Title:

☐ Launcher Activity

☐ Use a Fragment

Hierarchical Parent: ...

Package name:

Source Language:

The name of the activity class to create

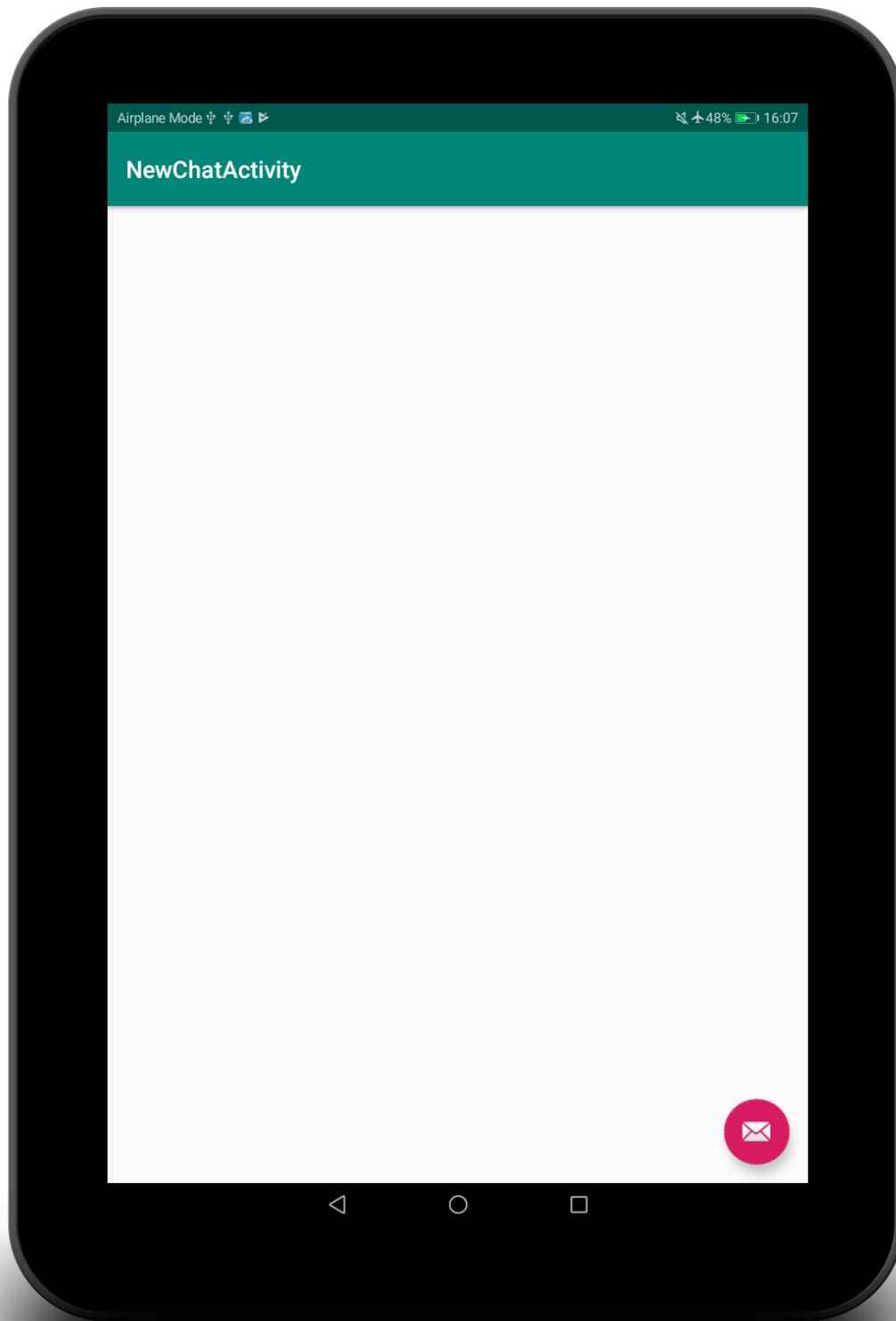
Edit MainActivity.java and amend the newChat function to read as follows:

```
// called when the user presses the new chat button
public void newChat(View view) {
    Log.i("Ki","newChat Called");
    Intent intent = new Intent(this, NewChatActivity.class);
    startActivity(intent);
}
```

If the IDE does not add the line below, add it manually:

```
import android.content.Intent;
```

This change means pressing the button opens the NewChat Activity. The app will compile and run at this point. After pressing the button, you should get a screen that looks like this:



Update `res/values/strings.xml` to set the `title_activity_new_chat` to “New Chat”

```
<resources>
  <string name="app_name">First Babble Android App</string>
```

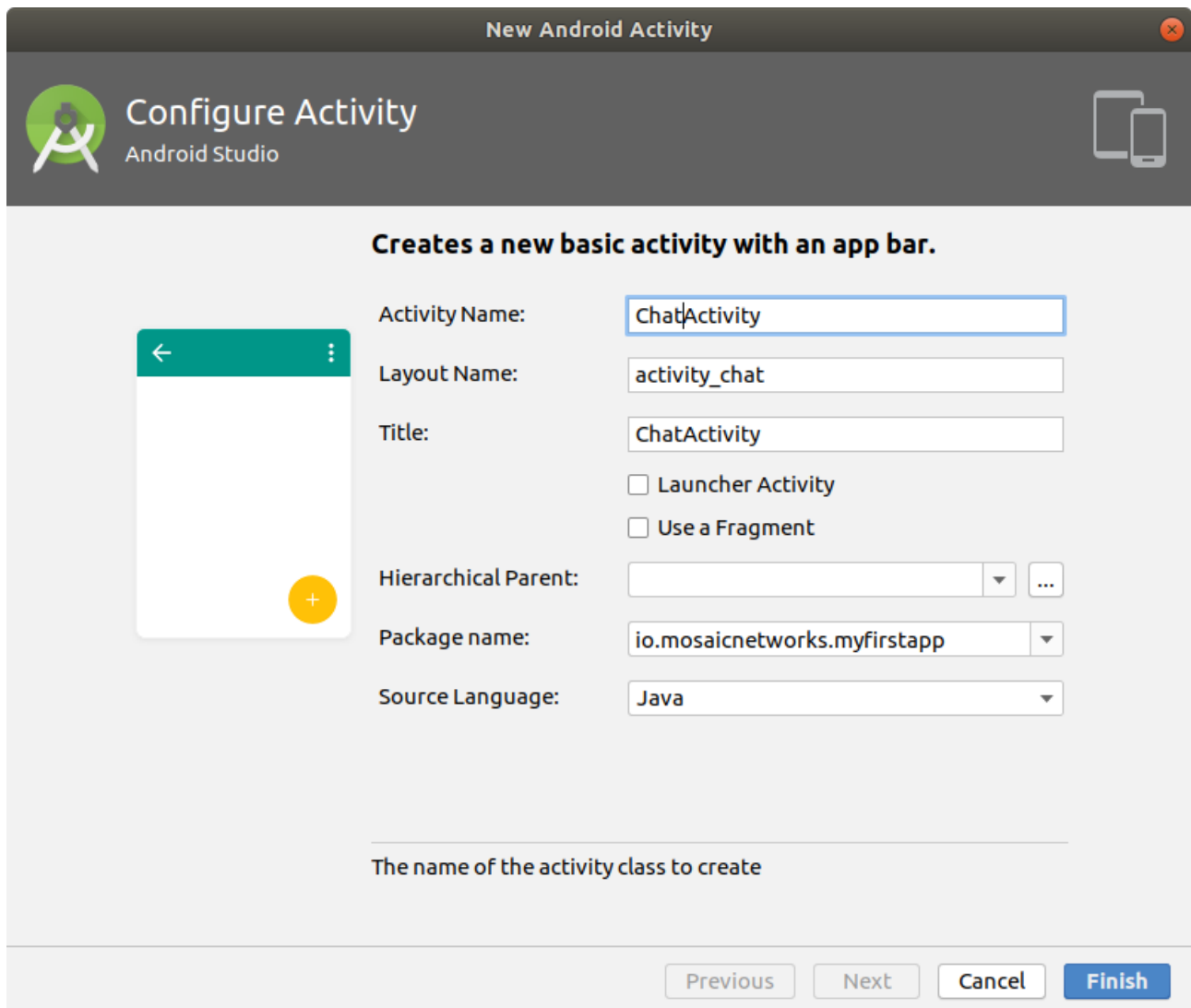
```

    <string name="new_chat">New</string>
    <string name="title_activity_new_chat">New Chat</string>
</resources>

```

New Chat Activity Layout

Create new `BasicActivity` activity `ChatActivity` as per the `NewChatActivity` above, using the values below:



Creates a new basic activity with an app bar.

Activity Name:

Layout Name:

Title:

☐ Launcher Activity

☐ Use a Fragment

Hierarchical Parent: ▼ ...

Package name: ▼

Source Language: ▼

The name of the activity class to create

Previous Next Cancel Finish

In `activity_new_chat.xml` replace the whole file with the following code:

```

<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"

```

```

tools:context=".NewChatActivity">

<LinearLayout
    android:layout_width="0dp"
    android:layout_height="wrap_content"
    android:layout_marginStart="8dp"
    android:layout_marginLeft="8dp"
    android:layout_marginTop="8dp"
    android:layout_marginEnd="8dp"
    android:layout_marginRight="8dp"
    android:layout_marginBottom="8dp"
    android:orientation="vertical"
    app:layout_constraintBottom_toBottomOf="parent"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toTopOf="parent">

    <EditText
        android:id="@+id/editText"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:ems="10"
        android:hint="@string/moniker"
        android:inputType="textPersonName" />

    <Button
        android:id="@+id/button"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:onClick="startChat"
        android:text="@string/start" />
</LinearLayout>

</androidx.constraintlayout.widget.ConstraintLayout>

```

This adds an edit box to set the moniker for this node and a button to actually start the Chat. You can delete `content_new_chat.xml` from the `res/layout` folder now as we have just removed the reference to it.

In `NewChatActivity.java` replace the whole file with the code below:

```

package io.mosaicnetworks.myfirstapp;

import android.content.Intent;
import android.os.Bundle;

```

```

import androidx.annotation.StringRes;
import androidx.appcompat.app.AlertDialog;
import androidx.appcompat.app.AppCompatActivity;

import android.view.View;
import android.widget.EditText;

import java.util.ArrayList;

import io.mosaicnetworks.babble.discovery.Peer;

public class NewChatActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_new_chat);
    }

    // called when the user presses the start chat button
    public void startChat(View view) {
        //get moniker
        EditText editText = findViewById(R.id.editText);
        String moniker = editText.getText().toString();
        if (moniker.isEmpty()) {
            displayOkAlertDialog(R.string.no_moniker_alert_title,
                                R.string.no_moniker_alert_message);
            return;
        }

        MessagingService messagingService = MessagingService.getInstance();
        try {
            messagingService.configureNew(moniker, Utils.getIPAddr(this));
        } catch (IllegalStateException ex) {
            //we tried to reconfigure before a leave completed
            displayOkAlertDialog(R.string.babble_busy_title,
                                R.string.babble_busy_message);
            return;
        }

        messagingService.start();
        Intent intent = new Intent(this, ChatActivity.class);
        intent.putExtra("MONIKER", moniker);
    }
}

```

```

        startActivity(intent);
    }

    private void displayOkAlertDialog(@StringRes int titleId,
                                     @StringRes int messageId) {
        AlertDialog alertDialog = new AlertDialog.Builder(this)
            .setTitle(titleId)
            .setMessage(messageId)
            .setNeutralButton(R.string.ok_button, null)
            .create();
        alertDialog.show();
    }
}

```

StateObserver.java

Copy the code below into a new file: StateObserver.java in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

public interface StateObserver {

    void onStateChanged(Message message);
}

```

This class provides an event handler for use in the MessagingService we are about to create...

BabbleState.java

Copy the source below into place in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

import com.google.gson.JsonSyntaxException;

import java.nio.charset.Charset;
import java.nio.charset.StandardCharsets;
import java.security.MessageDigest;
import java.security.NoSuchAlgorithmException;

import io.mosaicnetworks.babble.node.TxConsumer;

public final class BabbleState implements TxConsumer {

    private static final MessageDigest mSha256Digest;

```



```

private StateObserver mObserver;
private byte[] mStateHash = "geneseis-state".getBytes();

static {
    try {
        mSha256Digest = MessageDigest.getInstance("SHA-256");
    } catch (NoSuchAlgorithmException ex) {
        // Every implementation of the Java platform is required to
        // support the SHA-256 MessageDigest algorithm, so we
        // shouldn't get here!
        throw new RuntimeException(ex);
    }
}

public BabbleState(StateObserver observer) {
    mObserver = observer;
}

@Override
public byte[] onReceiveTransactions(byte[][] transactions) {
    for (byte[] rawTx:transactions) {
        String tx = new String(rawTx, StandardCharsets.UTF_8);

        BabbleTx babbleTx;
        try {
            babbleTx = BabbleTx.fromJson(tx);
        } catch (JsonSyntaxException ex) {
            //skip any malformed transactions
            continue;
        }

        mObserver.onStateChanged(Message.fromBabbleTx(babbleTx));
        updateStateHash(tx);
    }

    return mStateHash;
}

private void updateStateHash(String tx) {
    mStateHash = hashFromTwoHashes(mStateHash, hash(tx));
}

private static byte[] hash(String tx) {
    return mSha256Digest.digest(tx.getBytes(Charset.forName("UTF-8")));
}

```

```

        private static byte[] hashFromTwoHashes(byte[] a, byte[] b) {
            byte[] tempHash = new byte[a.length + b.length];
            System.arraycopy(a, 0, tempHash, 0, a.length);
            System.arraycopy(b, 0, tempHash, 0, b.length);
            return mSha256Digest.digest(tempHash);
        }
    }
}

```

BabbleTx.java

Copy the source below into place in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

import com.google.gson.Gson;
import com.google.gson.annotations.SerializedName;

public class BabbleTx {

    private final static Gson gson = new Gson();

    @SerializedName("from")
    public final String from;

    @SerializedName("text")
    public final String text;

    public BabbleTx(String from, String text) {
        this.from = from;
        this.text = text;
    }

    public static BabbleTx fromJson(String txJson) {
        return gson.fromJson(txJson, BabbleTx.class);
    }

    public byte[] toBytes() {
        return gson.toJson(this).getBytes();
    }
}

```

Message.java

Copy the source below into place in the same folder as MainActivity.java:

```
package io.mosaicnetworks.myfirstapp;

import com.stfalcon.chatkit.commons.models.IMessage;
import com.stfalcon.chatkit.commons.models.IUser;

import java.util.Date;

public final class Message implements IMessage {

    public final static class Author implements IUser {

        private final String mName;

        public Author(String name) {
            mName = name;
        }

        @Override
        public String getId() {
            return mName;
        }

        @Override
        public String getName() {
            return mName;
        }

        @Override
        public String getAvatar() {
            return null;
        }
    }

    private final String mText;
    private final String mAuthor;
    private final Date mDate;

    public Message(String text, String author) {
        mText = text;
        mAuthor = author;
        mDate = new Date();
    }
}
```

```

public static Message fromBabbleTx(BabbleTx babbleTx) {
    return new Message(babbleTx.text, babbleTx.from);
}

public BabbleTx toBabbleTx() {
    return new BabbleTx(mAuthor, mText);
}

@Override
public String getId() {
    return mAuthor;
}

@Override
public String getText() {
    return mText;
}

@Override
public Author getUser() {
    return new Author(mAuthor);
}

@Override
public Date getCreatedAt() {
    return mDate;
}
}

```

You will note the section below introduces an external dependency:

```

import com.stfalcon.chatkit.commons.models.IMessage;
import com.stfalcon.chatkit.commons.models.IUser;

```

Add the lines below to the app build.gradle file dependencies section, and click Sync Now on the pop up bar:

```

implementation 'com.google.code.gson:gson:2.8.5'
implementation 'com.github.stfalcon:chatkit:0.3.3'

```

MessageObserver.java

Copy the source below into place in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

public interface MessageObserver {

```

```

        void onMessageReceived(Message message);
    }

```

Utils.java

Copy the source below into place in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

import android.content.Context;
import android.net.wifi.WifiManager;
import android.text.format.Formatter;
import android.util.Log;

import static android.content.Context.WIFI_SERVICE;

public class Utils {

    public static String getIPAddr(Context context) {
        WifiManager wm = (WifiManager)
            context.getSystemService(WIFI_SERVICE);
        String ip =
            Formatter.formatIpAddress(wm.getConnectionInfo().getIpAddress());
        Log.d("getIPAddr", "Got IP address: " + ip);
        return ip;
    }
}

```

MessagingService.java

Copy the source below into place in the same folder as MainActivity.java:

```

package io.mosaicnetworks.myfirstapp;

import java.io.IOException;
import java.util.ArrayList;
import java.util.List;

import io.mosaicnetworks.babble.discovery.HttpPeerDiscoveryServer;
import io.mosaicnetworks.babble.discovery.Peer;
import io.mosaicnetworks.babble.node.BabbleConfig;
import io.mosaicnetworks.babble.node.BabbleNode;
import io.mosaicnetworks.babble.node.KeyPair;
import io.mosaicnetworks.babble.node.LeaveResponseListener;

public class MessagingService {

```

```

public enum State {
    UNCONFIGURED,
    CONFIGURED,
    RUNNING,
    RUNNING_WITH_DISCOVERY
}

private static MessagingService instance;
private List<MessageObserver> mObservers = new ArrayList<>();
private BabbleState mBabbleState;
private BabbleNode mBabbleNode;
private HttpPeerDiscoveryServer mHttpPeerDiscoveryServer;
private KeyPair mKeyPair = new KeyPair();
private static final int BABBLING_PORT = 6666;
public static final int DISCOVERY_PORT = 8988;
private State mState = State.UNCONFIGURED;

public static MessagingService getInstance() {
    if (instance==null) {
        instance = new MessagingService();
    }
    return instance;
}

public void configureNew(String moniker, String inetAddress) {
    List<Peer> genesisPeers = new ArrayList<>();
    List<Peer> currentPeers = genesisPeers;
    genesisPeers.add(new Peer(mKeyPair.publicKey, inetAddress +
        ":" + BABBLING_PORT, moniker));

    configure(genesisPeers, currentPeers, moniker, inetAddress);
}

public void configureJoin(List<Peer> genesisPeers, List<Peer> currentPeers,
    String moniker, String inetAddress) {
    configure(genesisPeers, currentPeers, moniker, inetAddress);
}

private void configure(List<Peer> genesisPeers, List<Peer> currentPeers,
    String moniker, String inetAddress) {

    if (mState==State.RUNNING || mState==State.RUNNING_WITH_DISCOVERY) {
        throw new IllegalStateException(
            "Cannot configure while the service is running");
    }
}

```

```

    }

    mBabbleState = new BabbleState(new StateObserver() {
        @Override
        public void onStateChanged(Message message) {
            notifyObservers(message);
        }
    });

    try {
        mBabbleNode = BabbleNode.createWithConfig(genesisPeers, currentPeers,
            mKeyPair.privateKey, inetAddress,
            BABBLING_PORT, moniker, mBabbleState,
            new BabbleConfig.Builder().logLevel(
                BabbleConfig.LogLevel.DEBUG).build());
        mState = State.CONFIGURED;
    } catch (IllegalArgumentException ex) {
        //The reassignment of mState and mBabbleNode has failed, so leave them as before
        //TODO: need to catch port in use exception (IOException) and throw others
        throw new RuntimeException(ex);
    }

    mHttpPeerDiscoveryServer = new HttpPeerDiscoveryServer(inetAddress,
        DISCOVERY_PORT, mBabbleNode);
}

public void start() {
    if (mState==State.UNCONFIGURED || mState==State.RUNNING ||
        mState==State.RUNNING_WITH_DISCOVERY) {
        throw new IllegalStateException(
            "Cannot start an unconfigured or running service");
    }

    mBabbleNode.run();
    mState=State.RUNNING;

    try {
        mHttpPeerDiscoveryServer.start();
        mState=State.RUNNING_WITH_DISCOVERY;
    } catch (IOException ex) {
        //Probably the port is in use, we'll continue without the discovery service
    }
}

public void stop() {
    if (!(mState==State.RUNNING || mState==State.RUNNING_WITH_DISCOVERY)) {

```

```

        throw new IllegalStateException(
            "Cannot stop a service which isn't running");
    }

    mHttpPeerDiscoveryServer.stop();
    mHttpPeerDiscoveryServer=null;

    mBabbleNode.leave(new LeaveResponseListener() {
        @Override
        public void onSuccess() {
            mBabbleNode=null;
            mState = State.UNCONFIGURED;
        }
    });
}

public void submitMessage(Message message) {
    if (!(mState==State.RUNNING || mState==State.RUNNING_WITH_DISCOVERY)) {
        throw new IllegalStateException(
            "Cannot submit when the service isn't running");
    }
    mBabbleNode.submitTx(message.toBabbleTx().toBytes());
}

public State getState() {
    return mState;
}

public void registerObserver(MessageObserver messageObserver) {
    if (!mObservers.contains(messageObserver)) {
        mObservers.add(messageObserver);
    }
}

public void removeObserver(MessageObserver messageObserver) {
    mObservers.remove(messageObserver);
}

private void notifyObservers(Message message) {
    for (MessageObserver observer: mObservers) {
        observer.onMessageReceived(message);
    }
}
}

```


strings.xml

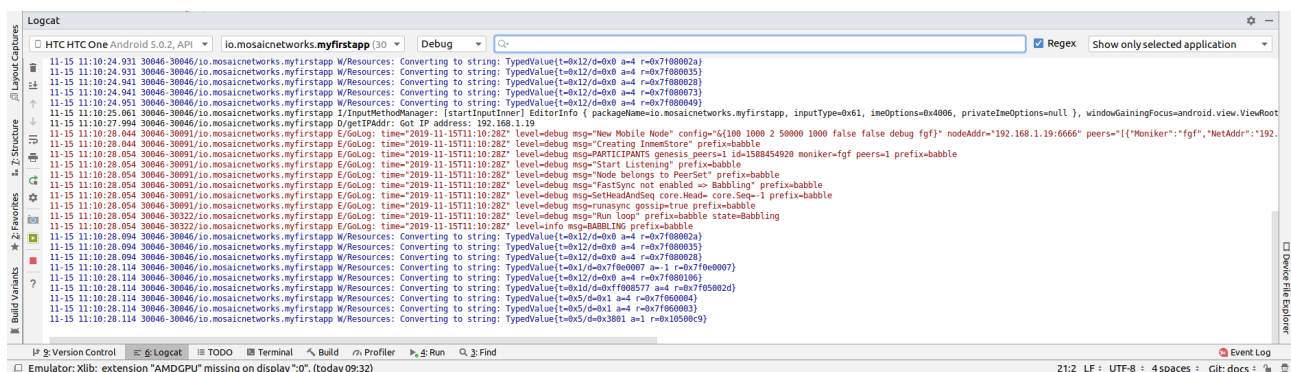
We need to add the following to `res/values/strings.xml` as they are used in the code changes above.

```
<string name="moniker">Moniker</string>
<string name="start">Start</string>
<string name="no_moniker_alert_title">No moniker</string>
<string name="no_moniker_alert_message">Please enter a moniker!</string>
<string name="ok_button">OK</string>
<string name="babble_busy_title">Babble node busy</string>
<string name="babble_busy_message">Please try again in a few seconds!</string>
```

Running Babble

And finally after all of that cut and paste, we have a working instance of babble — albeit with at least one major drawback — it has no UI and no way to access it.

If you start the app through Android Studio, and look at the logcat output (filtered to just our app), after pressing the New button, entering a Moniker and pressing the Join button, you should see something like below:



Some Explanations

We have just added a lot of code, which is all co-dependent. Now we have a babble invocation in place, we can pause to explain what just happened there.

Within the `NewChatActivity.java` button click handler the contents of the edit box are processed into `mMoniker` and the function `joinChat()` is called.

Within `joinChat()` are the 2 key lines:

```
messagingService.configureNew(moniker, Utils.getIPAddr(this));
...
messagingService.start();
```

They invoke the singleton instance of the `MessagingService` class. The `MessagingService` class is a simplified version of the code from the sample app included in the babble-android repo.

At a high level, it configures, then starts a babble node.

Delving a little deeper, the `configureNew` method is a wrapper for a `configure` method that takes a peers list, the moniker and IP for this node. In our New Node use case, the peers list will always be empty.

This project at this stage is available from github from here ⁷

Interacting with Babble

The next stage is to make Babble usable. To do that we need to work on the `ChatActivity` so it sends and receives messages from Babble.

First up we need a UI. We are going to use ChatKit rather than reinvent the wheel.

build.gradle (app)

We need to add this library to the app `build.gradle` file by adding the following line:

```
implementation 'com.github.stfalcon:chatkit:0.3.3'
```

activity_chat.xml

We can then add the layout to `res/layout/activity_chat.xml` — replace all the contents with the code below:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="@color/white"
    tools:context=".ChatActivity">

    <com.stfalcon.chatkit.messages.MessagesList
        android:id="@+id/messagesList"
        android:layout_width="match_parent"
        android:layout_height="match_parent"
        android:layout_above="@+id/input"/>
```

⁷This code is the stage2 branch at <https://github.com/mosaicnetworks/babble-android-tutorial/tree/stage2>

```

<View
    android:layout_width="match_parent"
    android:layout_height="1dp"
    android:layout_above="@+id/input"
    android:layout_marginLeft="16dp"
    android:layout_marginRight="16dp"
    android:background="@color/gray_light"/>

    <com.stfalcon.chatkit.messages.MessageInput
        android:id="@+id/input"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_alignParentBottom="true"
        app:inputHint="@string/hint_enter_a_message"
        app:showAttachmentButton="true"/>

```

</RelativeLayout>

The layout here is a fairly standard chat layout a message entry section at the bottom of the screen and a message display above it.

colors.xml

We need to add the following to `res/values/colors.xml` as it is used in the code changes above.

```

<color name="gray_light">#e8e8e8</color>

```

ChatActivity.java

Replace all of the file `ChatActivity.java` with the code below:

```

package io.mosaicnetworks.myfirstapp;

import android.os.Bundle;
import androidx.appcompat.app.AppCompatActivity;
import android.content.Intent;
import android.widget.Toast;
import com.stfalcon.chatkit.messages.MessageInput;
import com.stfalcon.chatkit.messages.MessagesList;
import com.stfalcon.chatkit.messages.MessagesListAdapter;

public class ChatActivity extends AppCompatActivity implements MessageObserver {

    private MessagesListAdapter<Message> mAdapter;

```

```

private String mMoniker;
private final MessagingService mMessagingService =
    MessagingService.getInstance();

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_chat);

    Intent intent = getIntent();
    mMoniker = intent.getStringExtra("MONIKER");

    initialiseAdapter();
    mMessagingService.registerObserver(this);

    if (mMessagingService.getState() !=
        MessagingService.State.RUNNING_WITH_DISCOVERY) {
        Toast.makeText(this, "Unable to advertise peers",
            Toast.LENGTH_LONG).show();
    }
}

private void initialiseAdapter() {
    MessagesList mMessagesList = findViewById(R.id.messagesList);

    mAdapter = new MessagesListAdapter<>(mMoniker, null);
    mMessagesList.setAdapter(mAdapter);

    MessageInput input = findViewById(R.id.input);

    input.setInputListener(new MessageInput.InputListener() {
        @Override
        public boolean onSubmit(CharSequence input) {
            mMessagingService.submitMessage(
                new Message(input.toString(), mMoniker));
            return true;
        }
    });
}

@Override
public void onMessageReceived(final Message message) {
    runOnUiThread(new Runnable() {
        @Override
        public void run() {
            mAdapter.addToStart(message, true);
        }
    });
}

```

```

        }
    });
};

@Override
public void onBackPressed() {
    mMessagingService.stop();
    super.onBackPressed();
}

@Override
protected void onDestroy() {
    mMessagingService.removeObserver(this);

    super.onDestroy();
}
}

```

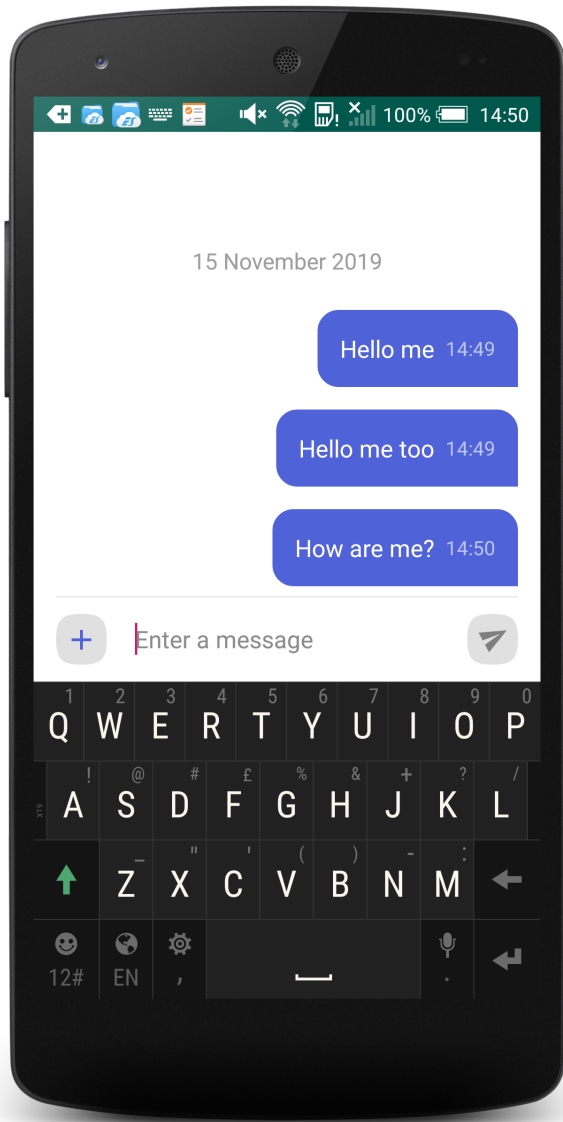
strings.xml

We need to add the following to `res/values/strings.xml` as they are used in the code changes above.

```
<string name="hint_enter_a_message">Enter a message</string>
```

Build, Run and Test

Build your app and run it. You should now be able to start a chat with yourself and send messages to yourself as below:



This project at this stage is available from github from here ⁸

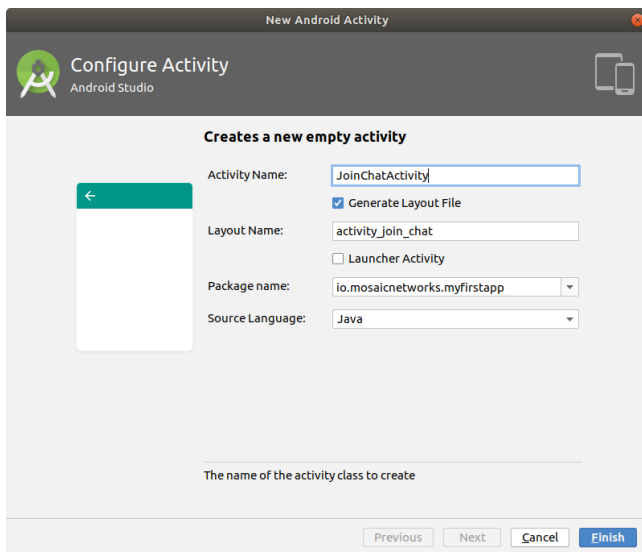
⁸This code is the stage3 branch at <https://github.com/mosaicnetworks/babble-android-tutorial/tree/stage3>

Joining

Thus far, we have been dealing with a single node, which kind of misses the whole point of having a blockchain. So this section remedies this. We will add a new button the MainActivity to Join an existing blockchain. This will require discovering the network - we will just enter an IP address for the moment - although more complex schemes would be used in a production environment.

Create Join Chat Activity

We create a new Activity: `JoinChatActivity` using the wizard at **File > New > Activity > Empty Activity**. Enter the name `JoinChatActivity` and the rest autocompletes.



activity_join_chat.xml

First we set the layout in `res/layout/activity_join_chat.xml`. Overwrite all the contents of the file.

```
<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".JoinChatActivity">

    <LinearLayout
        android:layout_width="0dp"
        android:layout_height="wrap_content"
```

```

    android:layout_marginStart="8dp"
    android:layout_marginLeft="8dp"
    android:layout_marginTop="8dp"
    android:layout_marginEnd="8dp"
    android:layout_marginRight="8dp"
    android:layout_marginBottom="8dp"
    android:orientation="vertical"
    app:layout_constraintBottom_toBottomOf="parent"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toTopOf="parent">

```

```

<EditText
    android:id="@+id/editMoniker"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:ems="10"
    android:hint="@string/moniker"
    android:inputType="textPersonName" />

```

```

<EditText
    android:id="@+id/editHost"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:ems="10"
    android:hint="@string/host"
    android:inputType="textUri" />

```

```

<Button
    android:id="@+id/buttonJoin"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:onClick="joinChat"
    android:text="@string/join" />

```

```

</LinearLayout>

```

```

</androidx.constraintlayout.widget.ConstraintLayout>

```

This defines a screen where the user can enter a moniker, exactly as per the `NewChatActivity`. In contrast the `NewChatActivity`, there is an additional field to enter the address (IP/hostname) of an existing node on the network.

strings.xml

We need to add the following to `res/values/strings.xml` as they are used in the code changes below.


```

<string name="invalid_hostname_alert_title"
    >Invalid hostname</string>
<string name="invalid_hostname_alert_message"
    >Please enter a valid hostname!</string>
<string name="no_hostname_alert_title">No hostname</string>
<string name="no_hostname_alert_message"
    >Please enter a hostname!</string>
<string name="peers_error_alert_title"
    >Unable to retrieve peers list</string>
<string name="peers_json_error_alert_message"
    >Did not receive a valid response from the host</string>
<string name="peers_connection_error_alert_message">Failed to connect to host</string>
<string name="peers_timeout_error_alert_message"
    >Timed out waiting for host</string>
<string name="peers_unknown_error_alert_message"
    >Unknown error</string>
<string name="loading_title">Please wait...</string>
<string name="loading_message"
    >Fetching peers list from host</string>
<string name="join">Join</string>
<string name="host">Hostname</string>

```

JoinChatActivity.java

Now we need to add the Java source to JoinChatActivity.java overwriting the code that is already there.

```

package io.mosaicnetworks.myfirstapp;

import androidx.appcompat.app.AlertDialog;
import androidx.appcompat.app.AppCompatActivity;

import android.app.ProgressDialog;
import android.content.DialogInterface;
import android.content.Intent;
import android.os.Bundle;
import android.view.View;
import android.widget.EditText;

import androidx.annotation.StringRes;

import java.util.List;

import io.mosaicnetworks.babble.discovery.HttpPeerDiscoveryRequest;
import io.mosaicnetworks.babble.discovery.Peer;
import io.mosaicnetworks.babble.discovery.ResponseListener;

```

```

public class JoinChatActivity extends AppCompatActivity
    implements ResponseListener {

    private ProgressDialog mLoadingDialog;
    private String mMoniker;
    private HttpPeerDiscoveryRequest mHttpGenesisPeerDiscoveryRequest;
    private HttpPeerDiscoveryRequest mHttpCurrentPeerDiscoveryRequest;
    private List<Peer> mGenesisPeers;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_join_chat);
        initLoadingDialog();
    }

    // called when the user presses the join chat button
    public void joinChat(View view) {
        //get moniker
        EditText editText = findViewById(R.id.editMoniker);
        mMoniker = editText.getText().toString();
        if (mMoniker.isEmpty()) {
            displayOkAlertDialog(R.string.no_moniker_alert_title,
                                R.string.no_moniker_alert_message);
            return;
        }

        //get peer IP address
        EditText editIP = findViewById(R.id.editHost);
        final String peerIP = editIP.getText().toString();
        if (peerIP.isEmpty()) {
            displayOkAlertDialog(R.string.no_hostname_alert_title,
                                R.string.no_hostname_alert_message);
            return;
        }

        getPeers(peerIP);
    }

    private void getPeers(final String peerIP) {
        try {
            mHttpGenesisPeerDiscoveryRequest =
            HttpPeerDiscoveryRequest.createGenesisPeersRequest(
                peerIP,
                MessagingService.DISCOVERY_PORT,

```

```

new ResponseListener() {
    @Override
    public void onReceivePeers(List<Peer> genesisPeers) {
        mGenesisPeers = genesisPeers;

        mHttpCurrentPeerDiscoveryRequest =
            HttpPeerDiscoveryRequest.createCurrentPeersRequest(
                peerIP,
                MessagingService.DISCOVERY_PORT,
                JoinChatActivity.this,
                JoinChatActivity.this);

        mHttpCurrentPeerDiscoveryRequest.send();
    }

    @Override
    public void onFailure(Error error) {
        JoinChatActivity.this.onFailure(error);
    }
}, this);
} catch (IllegalArgumentException ex) {
    displayOkAlertDialog(
        R.string.invalid_hostname_alert_title,
        R.string.invalid_hostname_alert_message);
    return;
}

mLoadingDialog.show();
mHttpGenesisPeerDiscoveryRequest.send();
}

@Override
public void onReceivePeers(List<Peer> currentPeers) {
    MessagingService messagingService = MessagingService.getInstance();

    try {
        messagingService.configureJoin(mGenesisPeers, currentPeers,
            mMoniker, Utils.getIPAddr(this));
    } catch (IllegalStateException ex) {
        //we tried to reconfigure before a leave completed
        mLoadingDialog.dismiss();
        displayOkAlertDialog(R.string.babble_busy_title,
            R.string.babble_busy_message);
        return;
    }
}

```

```

        mLoadingDialog.dismiss();
        messagingService.start();
        Intent intent = new Intent(JoinChatActivity.this,
            ChatActivity.class);
        intent.putExtra("MONIKER", mMoniker);
        startActivity(intent);
    }

    @Override
    public void onFailure(io.mosaicnetworks.babble.discovery.ResponseListener.Error error) {
        mLoadingDialog.dismiss();
        int messageId;
        switch (error) {
            case INVALID_JSON:
                messageId = R.string.peers_json_error_alert_message;
                break;
            case CONNECTION_ERROR:
                messageId = R.string.peers_connection_error_alert_message;
                break;
            case TIMEOUT:
                messageId = R.string.peers_timeout_error_alert_message;
                break;
            default:
                messageId = R.string.peers_unknown_error_alert_message;
        }
        displayOkAlertDialog(R.string.peers_error_alert_title, messageId);
    }

    private void initLoadingDialog() {
        mLoadingDialog = new ProgressDialog(this);
        mLoadingDialog.setProgressStyle(ProgressDialog.STYLE_SPINNER);
        mLoadingDialog.setTitle(R.string.loading_title);
        mLoadingDialog.setMessage(getString(R.string.loading_message));
        mLoadingDialog.setIndeterminate(true);
        mLoadingDialog.setCanceledOnTouchOutside(false);
        mLoadingDialog.setCancelable(true);
        mLoadingDialog.setOnCancelListener(new DialogInterface.OnCancelListener(){
            @Override
            public void onCancel(DialogInterface dialog){
                cancelRequets();
            }
        });
    }

    private void displayOkAlertDialog(@StringRes int titleId,
        @StringRes int messageId) {

```

```

        AlertDialog alertDialog = new AlertDialog.Builder(this)
            .setTitle(titleId)
            .setMessage(messageId)
            .setNeutralButton(R.string.ok_button, null)
            .create();
        alertDialog.show();
    }

    private void cancelRequets() {
        if (mHttpCurrentPeerDiscoveryRequest!=null) {
            mHttpCurrentPeerDiscoveryRequest.cancel();
        }

        if (mHttpGenesisPeerDiscoveryRequest!=null) {
            mHttpGenesisPeerDiscoveryRequest.cancel();
        }
    }

    @Override
    protected void onDestroy() {
        cancelRequets();
        super.onDestroy();
    }
}

```

There is a lot going in that code, so we will break it down into easier pieces. The `JoinChatActivity` is more complicated because it has to negotiate with another node and play nicely with it rather than just having the freedom to do its own thing that a `NewChatActivity` has. To join a network, our joining node needs to know the address of a node on the existing network. It then also needs the current peer set - so it know who to ask about the hashgraph history, and the genesis peer set (simply the peerset at the time that the network was instantiated). In a more complex example than this one, we would also need an initial state. By defining the initial state as blank, this app has circumvented that need, but in a more complex system utilising babble as a consensus engine, it would be required. Thus, `monetd`⁹ also requires a `genesis.json` file with a POA smart contract and initial Tenom assignments.

```

@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_join_chat);
    initLoadingDialog();
}

```

⁹Monetd is the daemon component of the **Monet Toolchain**; a distributed smart-contract platform based on EVM-Lite and Babble.

The **Monet Toolchain** underpins the MONET Hub, but it is also available for use in other projects. You can read more about MONET in the whitepaper.

The `onCreate` event sets up the UI and initialises a Dialog for later use.

```
public void joinChat(View view) {
```

JoinChat is involved on pressing the Join button. This sanity checks the user input and then calls:

```
getPeers(peerIP);
```

`getPeers` requests both peers lists from the node specified by the user. If successful, the function below is invoked:

```
public void onReceivePeers(List<Peer> currentPeers) {
```

Which contains the following lines. It uses the information retrieved from the existing node to configure the `messagingService`. The invocation is then exactly as per the `NewChatActivity` where the `messagingService` starts a babble node, and then invokes a `ChatActivity`.

```
messagingService.configureJoin(mGenesisPeers,  
    currentPeers, mMoniker, Utils.getIPAddr(this));
```

```
...
```

```
messagingService.start();  
Intent intent = new Intent(JoinChatActivity.this, ChatActivity.class);  
intent.putExtra("MONIKER", mMoniker);  
startActivity(intent);
```

activity__main.xml

We amend `res/layout/activity_main.xml` to add a Join Button (the `newChat` button tag was already in the file):

```
<Button  
    android:id="@+id/button3"  
    android:layout_width="match_parent"  
    android:layout_height="wrap_content"  
    android:onClick="newChat"  
    android:text="@string/new_chat" />  
  
<Button  
    android:id="@+id/button4"  
    android:layout_width="match_parent"  
    android:layout_height="wrap_content"  
    android:onClick="joinChat"  
    android:text="@string/join" />
```

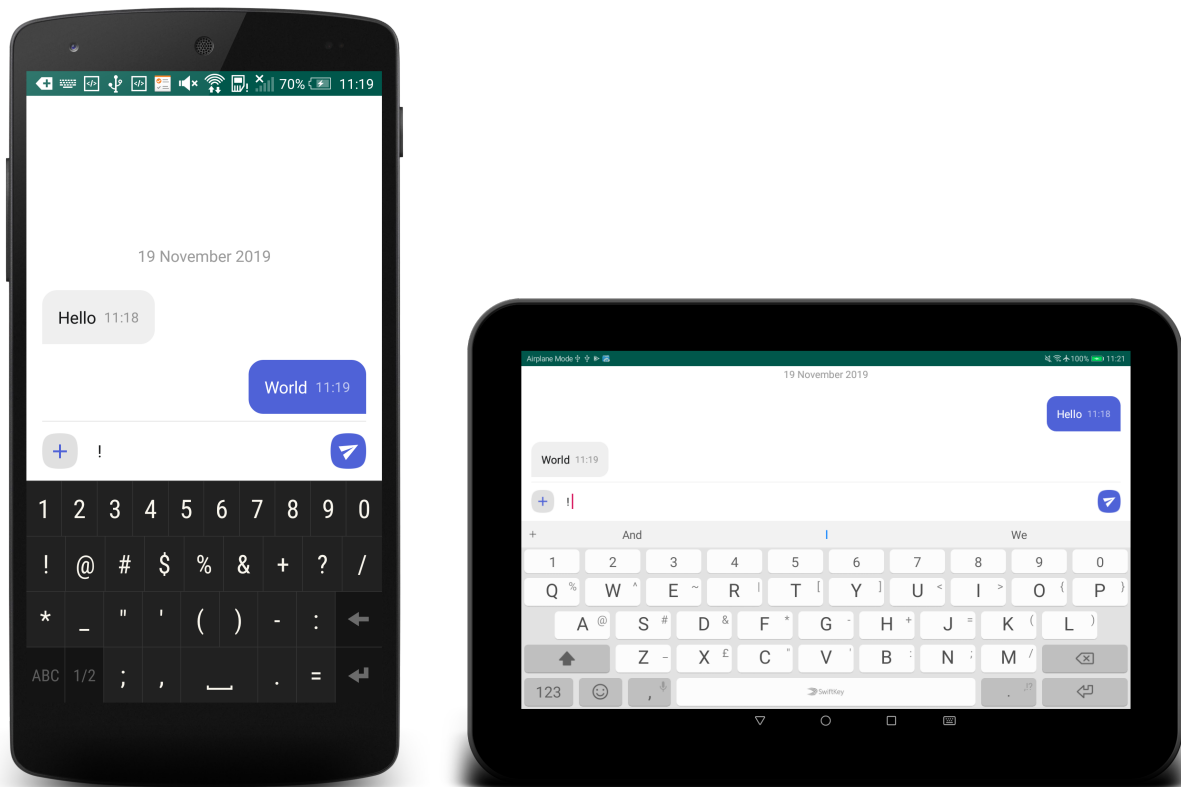
MainActivity.java

Having added the Join button, we add the click handler to invoke the JoinChatActivity on clicking.

```
// called when the user presses the join chat button
public void joinChat(View view) {
    Intent intent = new Intent(this, JoinChatActivity.class);
    startActivity(intent);
}
```

Build, Run and Test

Build your app and run it on 2 devices. You should now be able to start a chat on one and join with the other:



This project at this stage is available from github from here ¹⁰

¹⁰This code is the stage4 branch at <https://github.com/mosaicnetworks/babble-android-tutorial/tree/stage4>