# **Software Requisites:**

In this document, the requirements and steps to install EdgeEmu Server and Client on a system are mentioned. In addition to the requirements and installation guidelines of the EdgeEmu, the steps for installing the Android SDK command line tool and creating AVDs are explained.

The following requirements should be provided to be able to install the EdgeEmu components (Client and Server).

* Java SE Development Kit 20 ([download](https://www.oracle.com/java/technologies/javase/jdk20-archive-downloads.html));

Please do not forget to set the JAVA\_HOME environment variable ([Link](https://www3.ntu.edu.sg/home/ehchua/programming/howto/Environment_Variables.html#zz-2.2) to how to set environment variable).

* Apache Tomcat Server v9 ([download](https://tomcat.apache.org/download-90.cgi)); \*
* Localhost network ports available for EdgeEmu-Cli: 8081; \*
* Local network ports available for EdgeEmuServer: 7000, (8085\*\* and 8095\*\*);
* Most up-to-date Android SDK command line tools ([download](https://developer.android.com/studio?gclid=CjwKCAjwrpOiBhBVEiwA_473dASLL9IAfVl1UZ6B83QVVutn3v8Lx_bUxo_j2M_458WC-X5MGXY_jhoCD1wQAvD_BwE&gclsrc=aw.ds)).

\* This is only needed if the user intends to use the EdgeEmu GUI (this is required to evaluate the reusability claim).

\*\* These ports can be user configured by accessing the file config/communicationports.txt on the EdgeEmuServer folder (not recommended).

## **1.1 Installing Android SDK command line tools:**

Please go to the Android developers [link](https://developer.android.com/studio?gclid=CjwKCAjwrpOiBhBVEiwA_473dASLL9IAfVl1UZ6B83QVVutn3v8Lx_bUxo_j2M_458WC-X5MGXY_jhoCD1wQAvD_BwE&gclsrc=aw.ds) and scroll down to the "Command line tools only" section. Download the related package and follow the steps below according to your OS.

* **Mac and Linux Operating Systems**

After downloading the package follow the steps below to install the package.

1. Please move the downloaded file to the home folder of your system. First, we need to create a directory to store the Android SDK, so open a terminal window and follow the steps:

~ $ mkdir android

~ $ cd android

1. Then we need to move and unzip the tools in the android directory we just created. Please note that the name of the file should be replaced according to your download file name. So, please replace "commandlinetools-mac-6858069\_latest.zip" with the correct name in the following commands.

~/android $ mv ~/commandlinetools-mac-6858069\_latest.zip ./

~/android $ unzip commandlinetools-mac-6858069\_latest.zip

~/android $ rm commandlinetools-mac-6858069\_latest.zip

1. After unzipping the content, you will get a directory named cmdline-tools. Please run the following steps in the android directory in the terminal:

$ cd cmdline-tools

$ mkdir tools

$ mv -i \* tools

The last command will probably give you a warning, but you don’t need the worry about that.

1. Now before we can add tools to path we have to add $ANDROID\_HOME to the path, to do that just open the .zshrc, .profile, or .bash\_profile (depending on your terminal) in your preferred terminal file editor (nano or vim) and add the following code at the end of the file:

export ANDROID\_HOME=$HOME/android

export PATH=$ANDROID\_HOME/cmdline-tools/tools/bin/:$PATH

export PATH=$ANDROID\_HOME/emulator/:$PATH

export PATH=$ANDROID\_HOME/platform-tools/:$PATH

1. After adding the code, please save the file, close the terminal window, and open a new terminal window. After you have opened a new terminal window just type the following command and hit return/enter.

$ sdkmanager --list

If the progress bar and then the list of packages are shown, your tools have been set up successfully.

1. The basic packages you need to install are as follows.

$ sdkmanager --install "platform-tools"

$ sdkmanager --install "platforms;android-30"

$ sdkmanager --install "build-tools;30.0.3"

$ sdkmanager --install "emulator"

$ sdkmanager --install "system-images;android-30;google\_apis;x86\_64"

If you got any error during running the above commands, please try to type the commands instead of copying them. Please note that if your CPU is not Intel, you need to install arm-based system images (in the last command, the system image should be replaced with an arm-based system image from the output of the "sdkmanager --list" command).

* **Windows Operating System**

After downloading the command line tools zip file, follow the steps below to install it. These steps are based on the tutorial available in this [link](https://android.tutorials24x7.com/blog/how-to-install-android-sdk-tools-on-windows).

1. Please create the directory "android" at your preferred location and extract the content of the downloaded SDK Tools zip to this directory. The result will be a new folder called cmdline-tools in the android directory. Please create a new folder called "latest" in the android\cmdline-tools directory and move all files in cmdline-tools to the latest folder.

1. Search for the Environment Variables in the Windows search field. Choose "Edit the system environment variables". The System Properties window will be opened (Advanced tab). Click the Environment Variables button in this window. Create a new variable by clicking the New button.

Set the Variable Name field to ANDROID\_HOME and Variable Value to the android directory created by us in the first step. Similarly, also configure the environment variable ANDROID\_SDK\_ROOT and ANDROID\_SDK\_PATH to the android directory. Also, make sure that the JAVA\_HOME environment variable is set to the JDK installation directory.

1. In the first step, we downloaded and extracted the Command Line tool to the android directory. This tool provides several command-line utilities which we need to run by going to the appropriate directory having the executable files. We can make these commands available at the system level without going to these directories by adding \ …\android\cmdline-tools\latest, …\android\cmdline-tools\latest\bin, to the system path. To this end, please select Path from the User variables list in the Environment Variables window and click the edit button. Add the following path to the list by clicking the New button (please fill … with the path to the android directory you have created in the first step) …\android\cmdline-tools, …\android\cmdline-tools\latest, …\android\cmdline-tools\latest\bin, …\android\platform-tools, …\android\emulator. Make sure that these executables do not break other commands having the same name before adding these paths to the PATH environment variable.

4. After setting the Path variable, open a new cmd prompt. Run the following command.

> sdkmanager --list

If the progress bar and then the list of packages are shown, your tools have been set up successfully.

5. The basic packages you need to install are as follows.

> sdkmanager --install "platform-tools"

> sdkmanager --install "platforms;android-30"

> sdkmanager --install "build-tools;30.0.3"

> sdkmanager --install "emulator"

> sdkmanager --install "system-images;android-30;google\_apis;x86\_64"

If you got any error during running the above commands, please try to type the commands instead of copying them.

1. Please run the following commands.

> adb kill-server

> adb start-server

## **1.2. Create AVDs**

To be able to run the test scripts for networks with at most two nodes (small setup), we need to create two AVDs. To generate all the results shown in the figures in the paper, we need to create 10 AVDs. By repeating the following commands, we can create more AVDs.

* $ avdmanager create avd -n emu1 -k "system-images;android-30;google\_apis;x86\_64"
* $ avdmanager create avd -n emu2 -k "system-images;android-30;google\_apis;x86\_64"

Please note that "emu1" and "emu2" are the names of the AVDs that we are creating. You could replace these names with any arbitrary name. In order to check if the emulators work, please run the "emulator @emu1" command on the terminal\cmd. If the emulator starts successfully, shut it down and continue to the installing EdgeEmu Server section. Otherwise, please look up the error reported by Android.

# **Installing the EdgeEmu Server component**

1. Copy the EdgeEmuServer folder to a path that you wish to install the EdgeEmu Server. Set the following environmental variables ([Link](https://www3.ntu.edu.sg/home/ehchua/programming/howto/Environment_Variables.html#zz-2.2) to how to set environment variables):

* EDGEEMU\_SERVER\_PATH="path to EdgeEmuServer folder"
* ANDROID\_SDK\_PATH="path to android sdk"

1. Please insert the IP address of the network interface connected to the internet (your local network IP address) to the localnetwork.txt file in the config folder in the EdgeEmuServer folder (.../EdgeEmuServer/config/ localnetwork.txt).

You could use this [link](https://www.avg.com/en/signal/find-ip-address) to find out how to check your IP address on Mac and Windows. Please use this [link](https://www.ionos.com/digitalguide/hosting/technical-matters/get-linux-ip-address/) to find your IP address on Linux.

1. This step is required only for Mac and Linux OS. Please make all the .sh files in ".../EdgeEmuServer/config/serverscripts" and ".../EdgeEmuServer" folders executable using the "chmod +x \*.sh" command.
2. Please open a command line window (cmd for Windows and terminal for Mac and Linux) and go to the EdgeEmuServer directory/folder using the cd command. Run the server by using the following command:

* In Linux or Mac OS - run the script EdgeEmuServer.sh

(using the "./EdgeEmuServer.sh" command)

* In Windows - run the batch file EdgeEmuServer.bat

1. If everything goes well the following output is expected:

EdgeEmu Server ONLINE on network 192.168.1.X:

Working Directory = …/EdgeEmu Server

EDGEEMU\_PLATFORM = mac

ANDROID\_SDK\_PATH = …/Library/Android/sdk

Type "help" or "h" for the full command list

EdgeEmu Server is now up and ready; now let’s install EdgeEmu Client.

# **Installing the EdgeEmu Client component**

1. Copy the EdgeEmu-Cli folder to a path that you wish to install the EdgeEmu Client. Set the following environmental variables:

* EDGEEMU\_CLI\_PATH="path to EdgeEmu-Cli folder"
* TOMCAT\_PATH="…/apache-tomcat-9.0.34" (This variable is optional and is only needed if the user intends on using EdgeEmu GUI)

1. Set the EdgeEmuServer(s) network(s):

For EdgeEmu-Cli to connect with the EdgeEmuServer(s) first we need to indicate to EdgeEmu-Cli where each EdgeEmuServer is running. To do this we need to provide the network IP of each machine running EdgeEmuServer.

* Please open the text file at …/EdgeEmu-Cli/config/networks.txt

Here we could type each EdgeEmuServer network and the client port we wish the EdgeEmu-Cli to connect to (In this tutorial the required IP address is the same IP address we obtained in the second step in installing the EdgeEmu Server), ex: 192.168.0.101:8085

1. Run the EdgeEmu-Cli:

* In Linux or Mac OS - run the script EdgeEmuCli.sh
* In Windows - run the batch file EdgeEmuCli.bat

1. If everything goes well, UI options will be shown. Please, choose 1 to continue with the command line interface.

Please note that to use the second option (i.e., Google Map UI) you have to get Google Map API [Key](https://developers.google.com/maps/documentation/javascript/get-api-key). After getting the key, please add it to the apikey.txt file. This file is located in the "EdgeEmu-Cli/ui/EdgeEmuUI/" directory. You can use this key for free for up to 90 days, for more usage there is a need for payment. The OpenStreetMap API (the third option) is free. However, you have to get a key for [OpenRoutService](https://openrouteservice.org/) API (which has a free version) and add it to the apikey\_OpenRouteService.txt file in "EdgeEmu-Cli/ui/EdgeEmuUI\_OpenStreetMap/" directory.

Now, you are ready for the execution of the tool. To this end, please follow the steps explained in the Execution section of the ReadMe file. To make the process easier for you, the script files are also included in the Distribution folder. As a result, you do not need to turn the EdgeEmuClient VM on if you decide to install the EdgeEmu Client on your local machine as well.