To Dr. Young Park
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Date : May 8, 2023
Subject: CMPE 209 Team Project - Android Device Rooting Lab

Lab Setup

1. Download and install Virtualbox. Virtualbox can be downloaded from https://www.virtualbox.org/
2. Download pre-built Ubuntu 16.04 from https://seedsecuritylabs.org/labsetup.html.
3. Download the SEEDAndroid image file(.zip) from SEED lab course website. https://seedsecuritylabs.org/Labs_20.04/Mobile/
4. Create new virtual machines in Virtual Box. We need to create one VM for SEEDUbuntu 16.04 and another one for SEEDAndroid.
   User manual can be found from https://seedsecuritylabs.org/Labs_20.04/Mobile/

NOTE: For this lab, we have to increase the number of the processors in Android VM to two or more, otherwise, you might see kernel panic errors and it is very important to change the graphics controller in the display settings to VBoxVGA, otherwise, you will not be able to see Android UI.

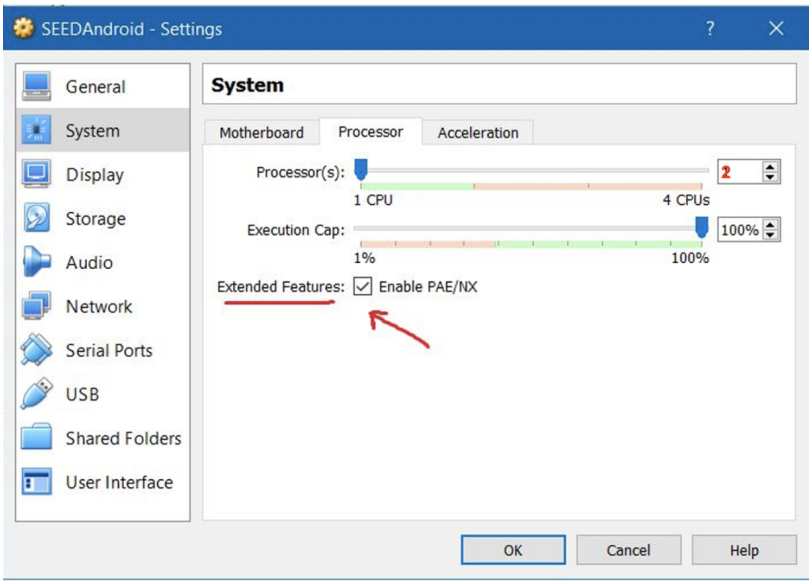


Figure 1: Android VM settings to configure CPU and PAE/NX

Lab Task 1: Build a simple OTA package

Before injecting a program into the Android OS

1. Boot up SEED Android VM, open an emulator app on the Home screen. Then, open a terminal window.
2. Navigate to the 'system' directory in the file system by typing the command "`cd /system`" in the terminal window.
3. Type the command `ls` to list all files in `/system` directory. Notice that it should not be a dummy.sh file in the /system directory.

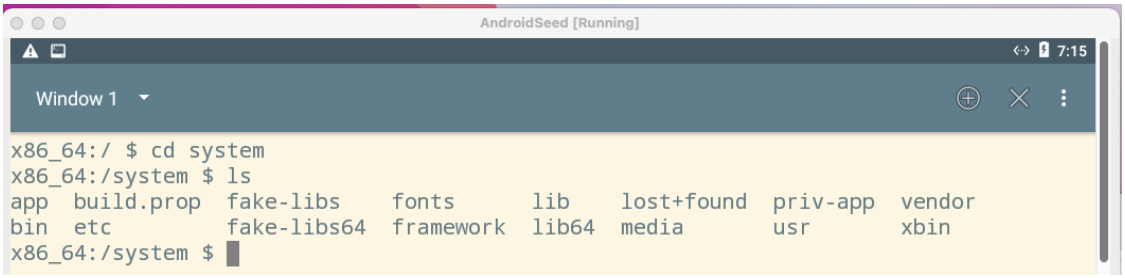


Figure 2: System directory before injecting a program into the Android OS

In this task, we are going to create a file called 'dummy.sh' in the '/system' folder of an Android device. However, this requires special permission (root privilege) because the '/system' folder cannot be modified by regular users. To achieve this, a command is used that places the word "hello" into the 'dummy' file. This command is stored in a script file called 'dummy.sh'.

To apply an OTA (Over-the-Air) update on an Android device, the update package file needs to be saved in the 'download' directory or the 'root' directory of the device's internal storage. In this case, we will save dummy.sh in `META-INF/com/google/android`.

The '`META-INF/com/google/android/update-binary`' binary is responsible for executing OTA updates on an Android device. When an OTA update is initiated, this binary is loaded by the recovery operating system and it subsequently executes the 'updater-script' file that is included in the update package."

Start building OTA package

1. In Ubuntu 16.04 SEED VM, create a folder called task1, then under task1, create a subfolder according to the OTA package structure, `META-INF/com/google/android/`.

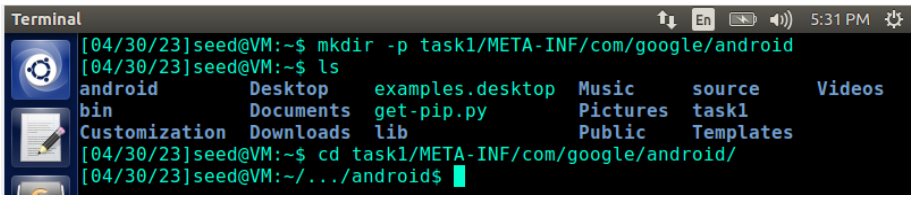


Figure 3: required folder structure, META-INF/com/google/android is created under task1 folder

2. Open a Terminal in SEEDUbuntu 16.04 and type '`gedit dummy.sh`'. Then, add '`echo hello > /system/dummy`' to `dummy.sh`, save and close the file. Finally, type the command '`cat dummy.sh`' to verify that the file contains the correct contents.

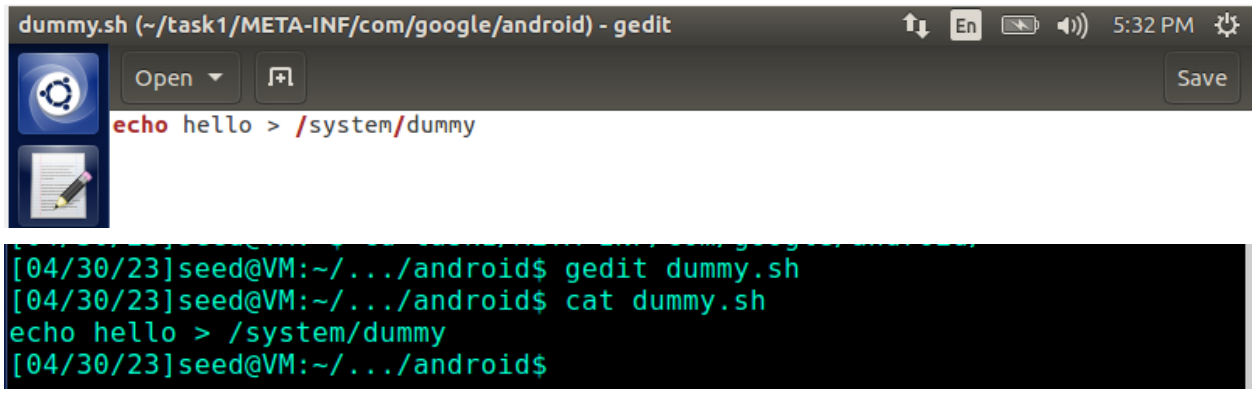


Figure 3: dummy.sh saved in task1/META-INF/com/google/android

Step 1. Write the update script

3. Create the update-binary file and save it in `task1/META-INF/com/google/android`, same directory as dummy.sh.

Figure 5: The contents of update-binary using gedit text editor

Line 1 - `cp dummy.sh /android/system/xbin` copies the file 'dummy.sh' to the '/android/system/xbin' directory on the Android device.

Line 2 - `chmod a+x /android/system/xbin/dummy.sh` sets the permissions on the 'dummy.sh' file to allow it to be executed. The 'chmod' command is short for 'change mode', and the 'a+x' argument specifies that all users should have execute permission on the file.

Line 3 - `sed -i "/return 0/i/system/xbin/dummy.sh" /android/system/etc/init.sh` modifies the 'init.sh' script on the Android device by inserting a line that references the 'dummy.sh' file. The 'sed' command is used for text manipulation, and the '-i' argument specifies that the changes should be made to the file in-place. The '/return 0/i' argument specifies that the line should be inserted before the line that contains

'return 0', and the '/system/xbin/dummy.sh' argument specifies the path to the 'dummy.sh' file. *This modification ensures that the 'dummy.sh' file is executed every time the device boots up.*

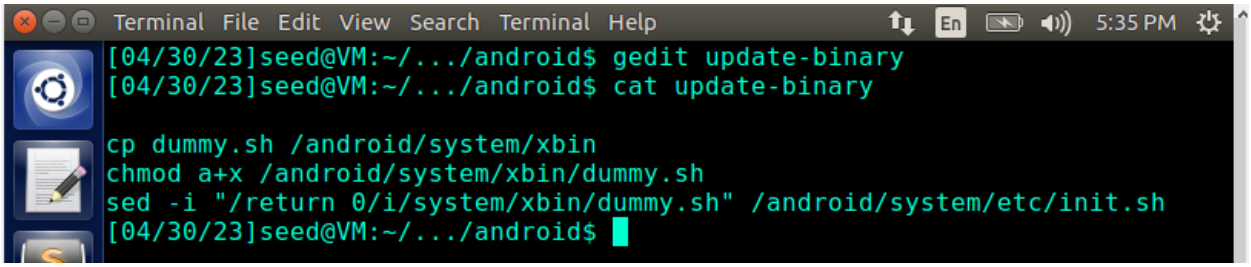


Figure 6: update-binary.sh saved in task1/META-INF/com/google/android

Step 2. Build the OTA package

4. Currently, we are in `task1/META-INF/com/google/android`. Since we are going to zip the folder and send it to an Android VM, we are going to change to the directory where task1 is saved in. In this case, task1 is saved in /home/seed. Then, we are going to use the zip command to zip task1 by typing `zip -r task1.zip task1`

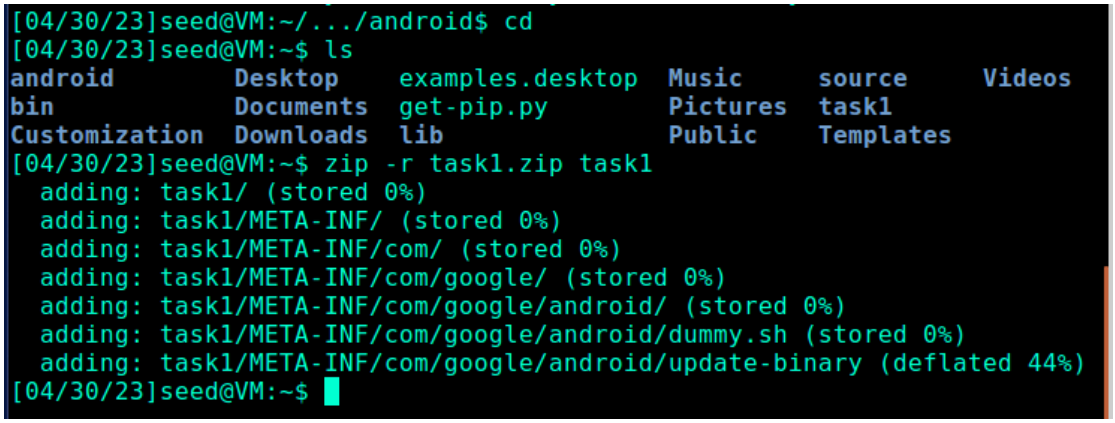


Figure 7: zipping task1 folder

5. After finishing zipping, let's verify whether task1 has been successfully zipped by typing the command ls.

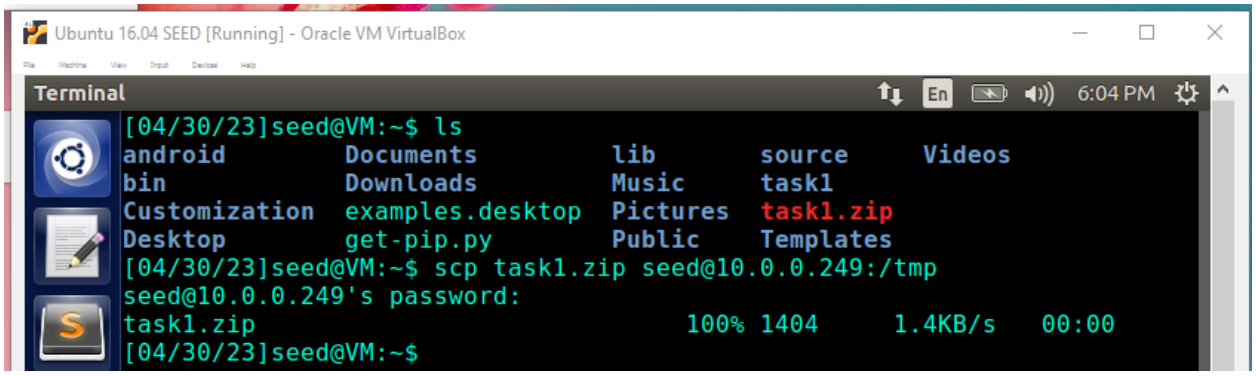


Figure 8: task1.zip

6. Still on Ubuntu 16.04, we will send the zip file to the android OS using scp command. To use the scp command to send a file, we need to locate the destination IP address of the android VM.
7. To locate the IP address of the AndroidSEED VM, login to Android recovery OS, then type `ifconfig` command to obtain the required IP address. Power off the Android VM if it is still running a normal mode, then restart the VM, and quickly hold down the shift key right before you see the Virtual box logo booting up the VM to enter the GNU mode and select Ubuntu so that we can enter into Android recovery mode.

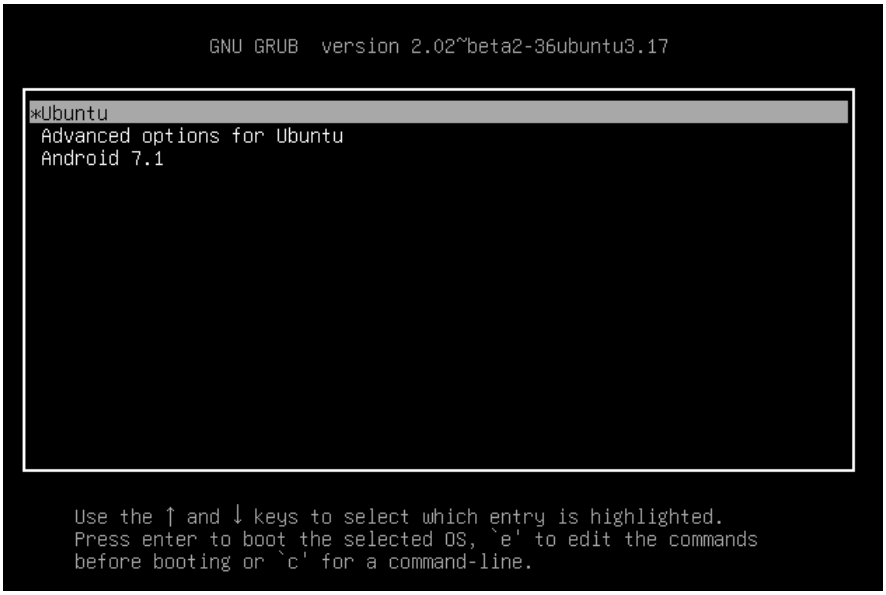


Figure 9: GNU mode used for Android Recovery Mode

8. When prompted for a recovery login, enter *"seed"* for the username and "*dees"* for the password.

Figure 10: Android Recovery Mode

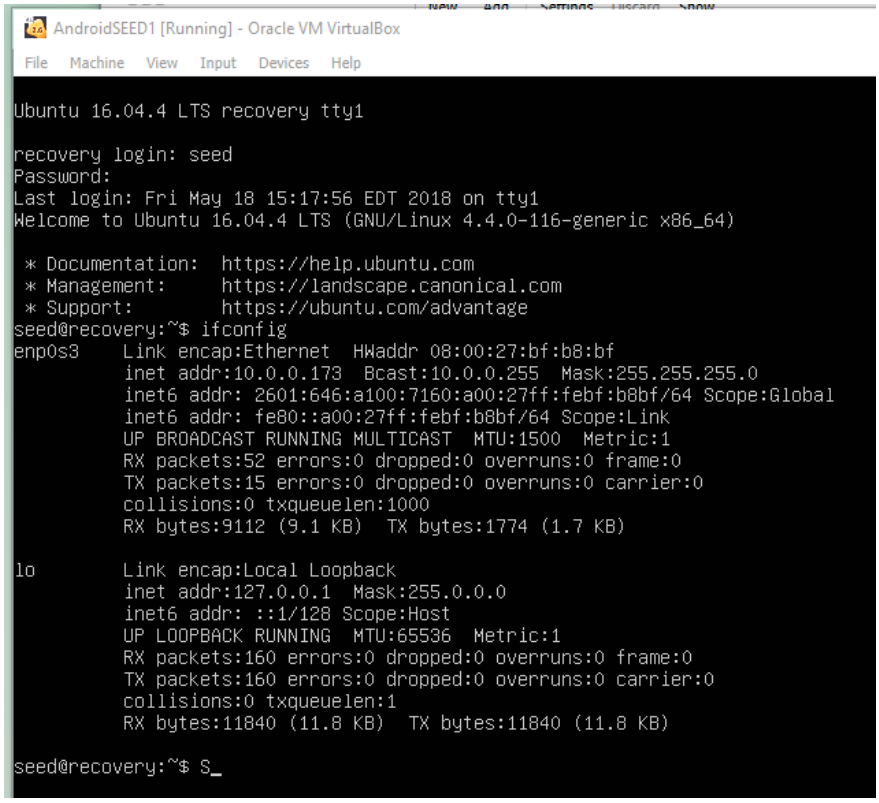
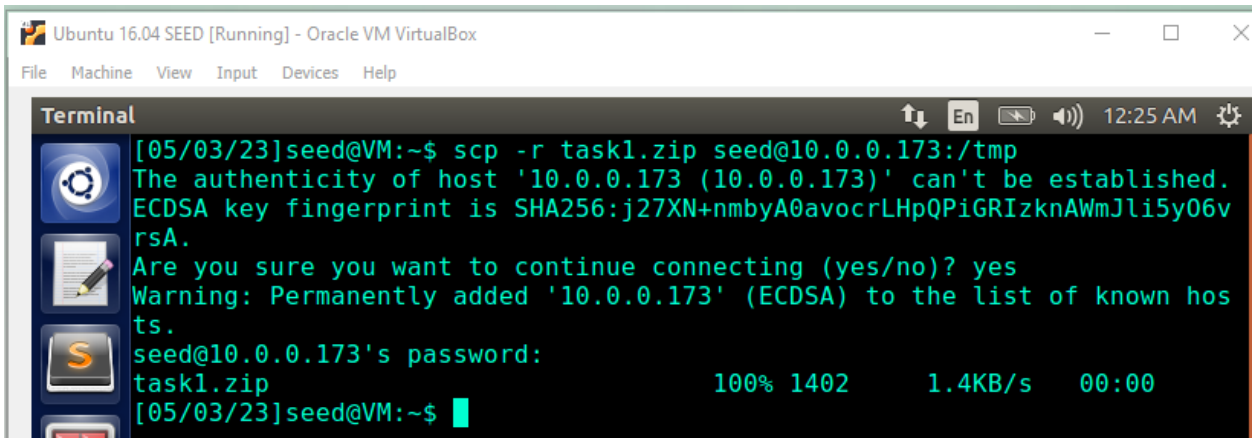


Figure 11: IP address obtained from the Android Recovery OS

9. In Ubuntu 16.04 SEED VM, type the command, `scp -r task1.zip seed@10.0.0.249:/tmp` to transfer task1.zip to the AndroidSEED VM placing it in /tmp folder.



10. Since we have the Android Reovery OS window opened, we can navigate to /tmp folder to verify that the Android Recovery OS has received task1.zip sent from another OS.

```
seed@recovery:~$ ls
seed@recovery:~$ cd /tmp
seed@recovery:/tmp$ ls -la
total 36
drwxrwxrwt  8 root root 4096 Apr 30 17:55 .
drwxr-xr-x 23 root root 4096 Mar 26  2018 ..
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .font-unix
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .ICE-unix
drwx------  3 root root 4096 Apr 30 17:52 systemd-private-85d218f63b664d319a24
imesyncd.service-2u1Mnc
-rw-rw-r--  1 seed seed 1404 Apr 30 17:55 task1.zip
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .Test-unix
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .X11-unix
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .XIM-unix
seed@recovery:/tmp$
```

Figure 12: task1.zip displayed in /tmp folder of Android VM

11. In AndroidSEED VM, type unzip task1.zip

```
-rw-rw-r--  1 seed seed 1404 Apr 30 17:55 task1.zip
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .Test-unix
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .X11-unix
drwxrwxrwt  2 root root 4096 Apr 30 17:52 .XIM-unix
seed@recovery:/tmp$ unzip task1.zip
Archive:  task1.zip
   creating: task1/
   creating: task1/META-INF/
   creating: task1/META-INF/com/
   creating: task1/META-INF/com/google/
   creating: task1/META-INF/com/google/android/
 extracting: task1/META-INF/com/google/android/dummy.sh
  inflating: task1/META-INF/com/google/android/update-binary
seed@recovery:/tmp$
```

Figure 13: unzipping task1.zip in /tmp folder of Android VM

Step 3. Run the OTA package

12. Task1.zip has been successfully unzipped. Change the directory to where we have dummy.sh and update-binary by typing the command, `cd /task1/META-INF/com/google/android`, then the command ls to list all files in that folder.

```
seed@recovery:/tmp/task1/META-INF/com/google/android$ ls
dummy.sh  update-binary
seed@recovery:/tmp/task1/META-INF/com/google/android$ chmod a+x update-binary
seed@recovery:/tmp/task1/META-INF/com/google/android$ sudo ./update-binary
seed@recovery:/tmp/task1/META-INF/com/google/android$ sudo reboot
```

Figure 14: The contents of task1, dummy.sh and update-binary

13. Execute update-binary script so that dummy.sh will be written in the /system folder. Then, reboot.

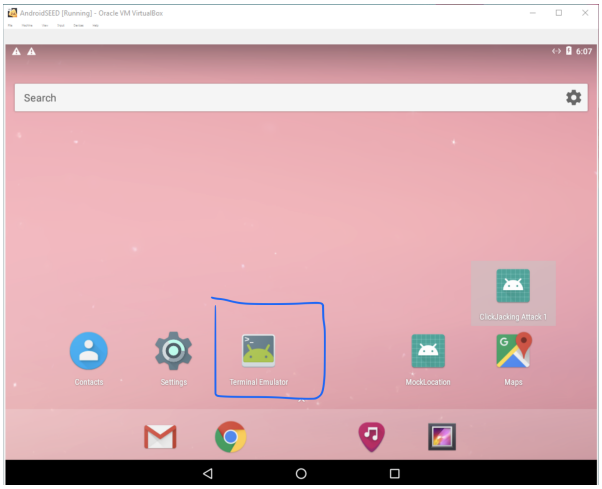


Figure 15: Android GUI mode - Terminal Emulator

14. To verify that we have successfully gained access to the root, login to Android VM, then open the Terminal Emulator and type `cd /system`.

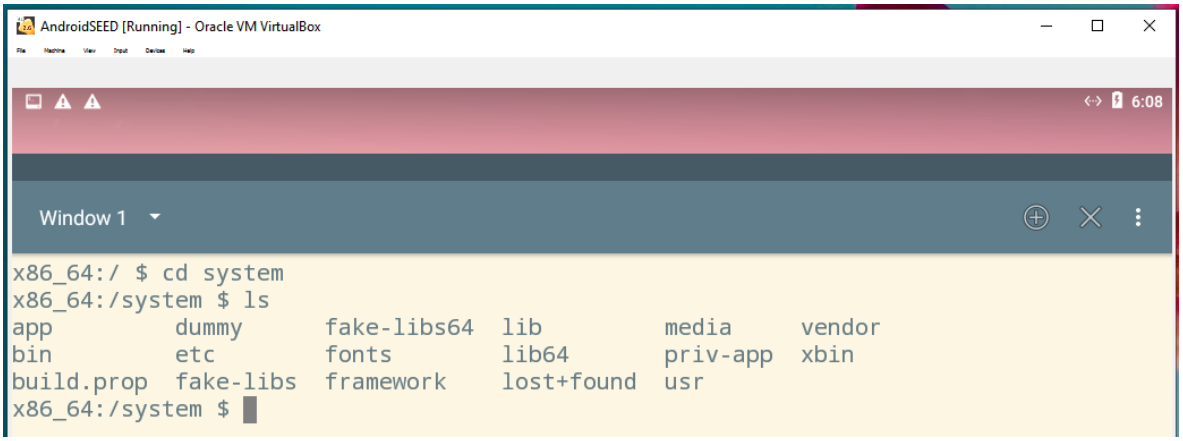


Figure 16: Android GUI mode - dummy file displayed in /system folder

In this lab, we successfully built a simple OTA package by creating and modifying files in the Android system. We started by creating a dummy file in the /system folder using root privilege, then added the content of dummy.sh using gedit in Terminal. We then created an update-binary file and saved it in task1/META-INF/com/google/android. After zipping the folder and sending it to an Android VM, we updated the recovery OS using the OTA package to gain root access. Overall, the lab was a success in demonstrating the process of building a simple OTA package.

Lab Task 2: Inject code via app_process

When the Android runtime initializes, it executes an application process named "app process" with root privileges. The purpose of this process is to start the Zygote daemon, which is responsible for launching applications. As a result, Zygote serves as the parent process for all application processes. Our objective is to alter the behavior of app process such that, in addition to starting the Zygote daemon, it also runs a custom program of our choosing. As in the previous task, we aim to demonstrate that we can execute our program with root privileges by placing a dummy file (dummy2) in the /system folder.

The code provided below serves as a wrapper for the original app process. To implement this wrapper, we will rename the original app process binary to "app process original" and then use "app process" as the name for our wrapper program. Within our wrapper code, we first write some data to the dummy file and then execute the original app process program.

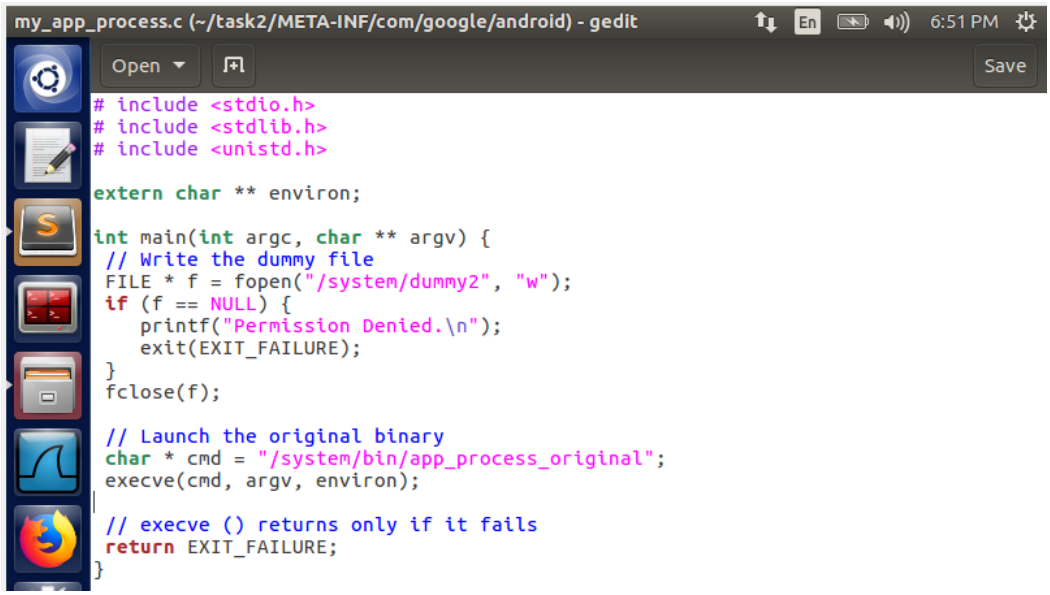


Figure 17: my_app_process.c

Code Explanation

LOCAL_PATH := $(call my-dir) sets a variable LOCAL_PATH to the current directory. The include $(CLEAR_VARS) command clears all variables defined previously by the Android.mk file.

The LOCAL_MODULE variable specifies the name of the module to be built, which in this case is my_app_process.

The LOCAL_SRC_FILES variable specifies the source files needed to build the module, which in this case is my_app_process.c.
The include $(BUILD_EXECUTABLE) command includes the rules for building an executable in the make system. This rule takes the values specified in LOCAL_MODULE and LOCAL_SRC_FILES and creates an executable file with the specified name

To create our wrapper program "app_process," we must use the Native Development Kit (NDK) to compile a standalone native program. It is crucial to note that we must perform this compilation process in our SEEDUbuntu virtual machine and not within the Recovery OS or Android OS, as neither of them has the necessary development environment to compile native code. Fortunately, we have installed the NDK in our SEEDUbuntu VM, which is a collection of tools that facilitate the compilation of C and C++ code for the Android OS.

Step 1. Compile the code.

1. Go to Android VM, boot into normal/GUI mode. Then, open the Teminal Emulator app.

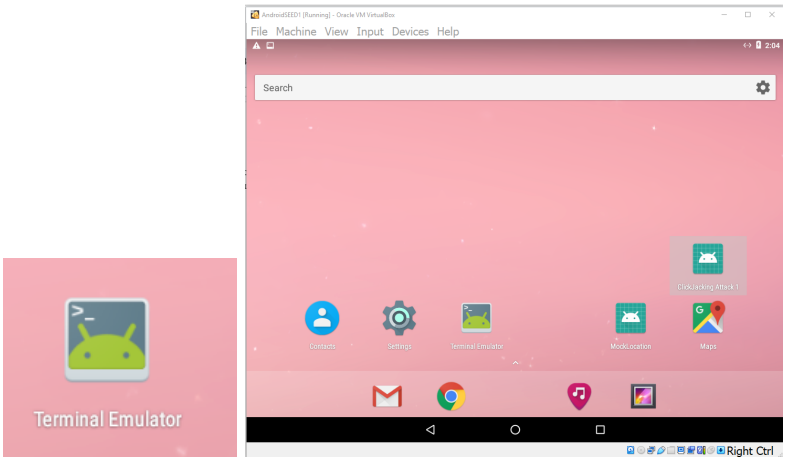


Figure 17: AndroidVM - Terminal Emulator

2. Before we begin rooting, let's verify that there is no dummy2.sh in the Android root or in the /system folder. To do this, type the command `cd /system` then `ls`. Notice that dummy2 is not there yet.

Figure 18: No dummy2.sh found in /system folder

3. Execute the following command in the terminal to create a folder with the required structure for Task 2, as provided in the SEED lab manual. This will enable us to zip the contents of the folder and transfer it to the Android Recovery OS at a later stage.
   `mkdir -p task2/META-INF/com/google/android`
4. To utilize the NDK, we must create two files, Application.mk and Android.mk, and store them in the same directory as our source code. To achieve this, we will create a new directory called "codes," and we will generate the Application.mk and Android.mk files within this directory.

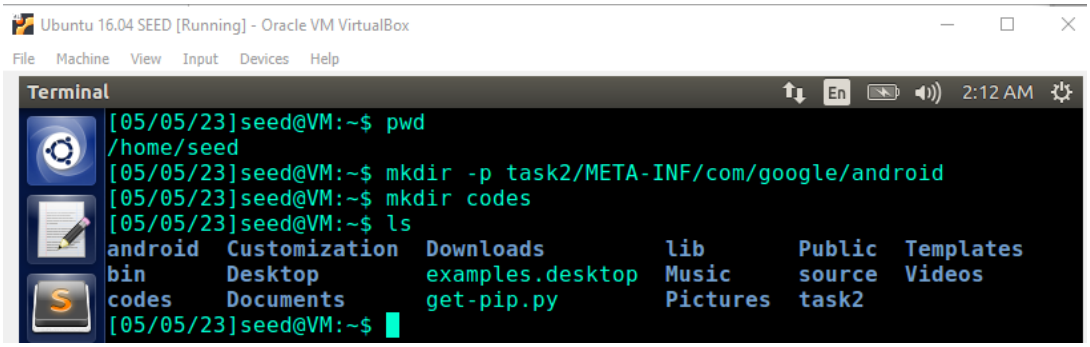


Figure 19: Creating required folders for task2

5. Type the command "gedit" in the terminal to create the file "my_app_process.c". The code for this file can be found in the Seed Lab manual.

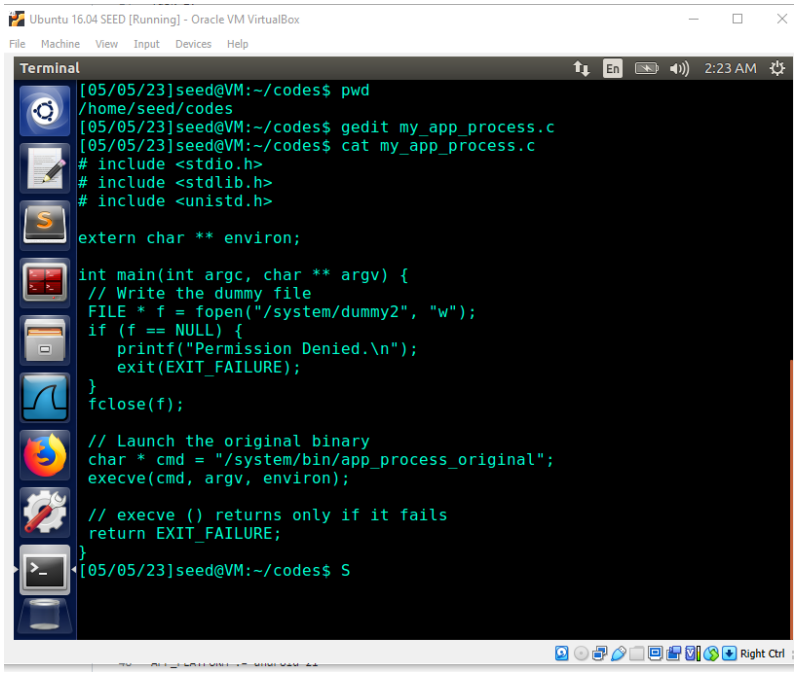


Figure 19: Creating my_app_process.c and save it in the codes folder

6. Type the command "gedit" in the terminal to create the file "Application.mk". The code for this file can be found in the Seed Lab manual.

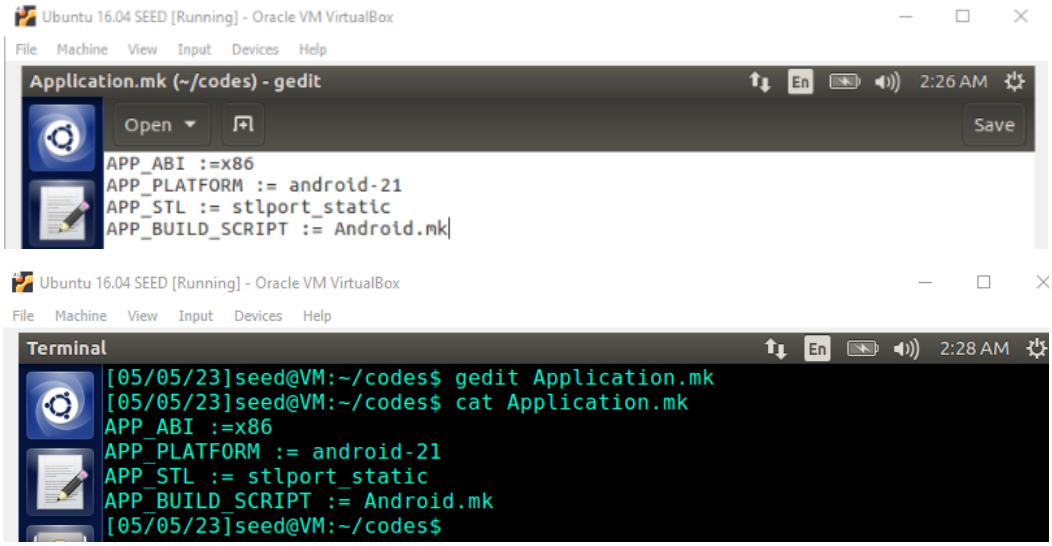


Figure 20: Application.mk

7. Type the command "gedit" in the terminal to create the file "Android.mk". The code for this file can be found in the Seed Lab manual.

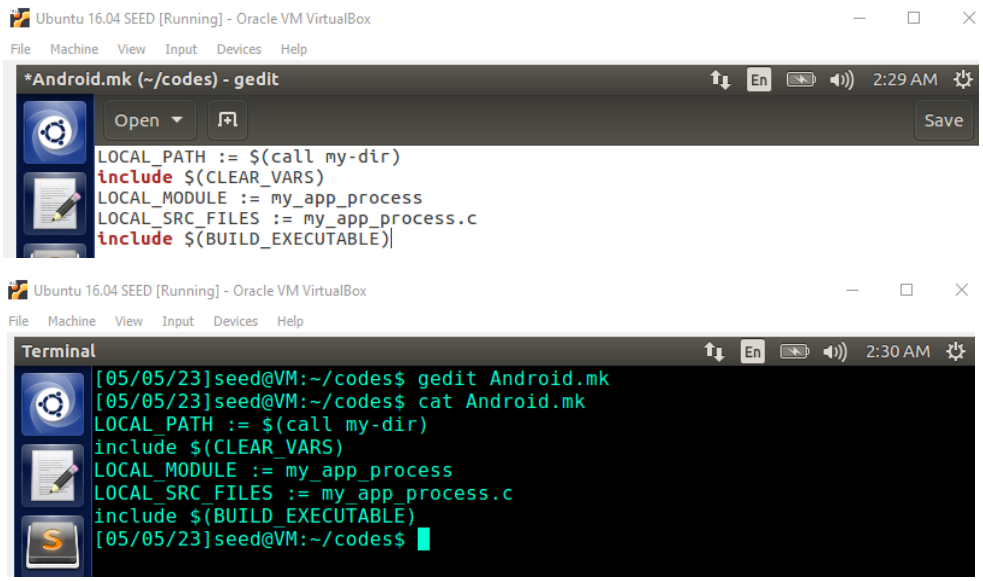


Figure 21: Android.mk

8. Execute the following commands within the source directory to compile our code. If the compilation process is successful, we will locate the binary file in the ./libs/x86 folder.

```
export NDK_PROJECT_PATH=.
ndk-build NDK_APPLICATION_MK=./Application.mk
```

9. Type the command "gedit" in the terminal to create the file "compile.sh". Add the above two lines into compile.sh.

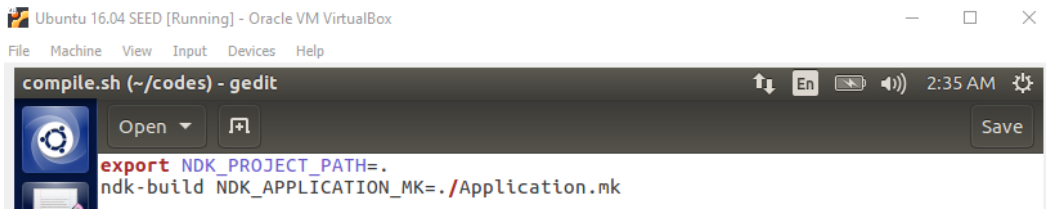


Figure 22: compile.sh

Explanation

The code export NDK_PROJECT_PATH=. sets an environment variable named NDK_PROJECT_PATH to the current directory. (i.e., the directory where this command is executed).

The NDK (Native Development Kit) is a set of tools that allow developers to write and compile native code (C/C++) for Android applications. The ndk-build command is used to build native code projects using the NDK.

The code ndk-build NDK_APPLICATION_MK=./Application.mk invokes the ndk-build command with an option -NDK_APPLICATION_MK specifying the path to the Application.mk file in the current directory (./). The Application.mk file is a makefile used by the NDK build system to specify build options for the project. This command builds the native code project using the options specified in the Application.mk file.

10. Use the command, `cat compile.sh` to display the contents of compile.sh to verify that the we have added the code correctly.

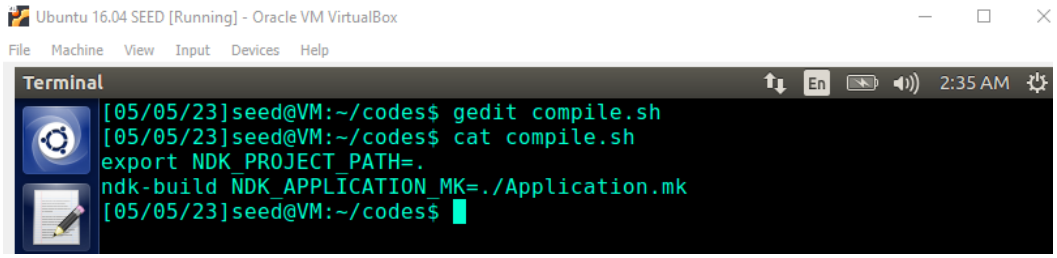


Figure 23: compile.sh

11. To enable us to run the file "compile.sh", we must add execute permissions. Type the command "`chmod a+x compile.sh`" to achieve this.

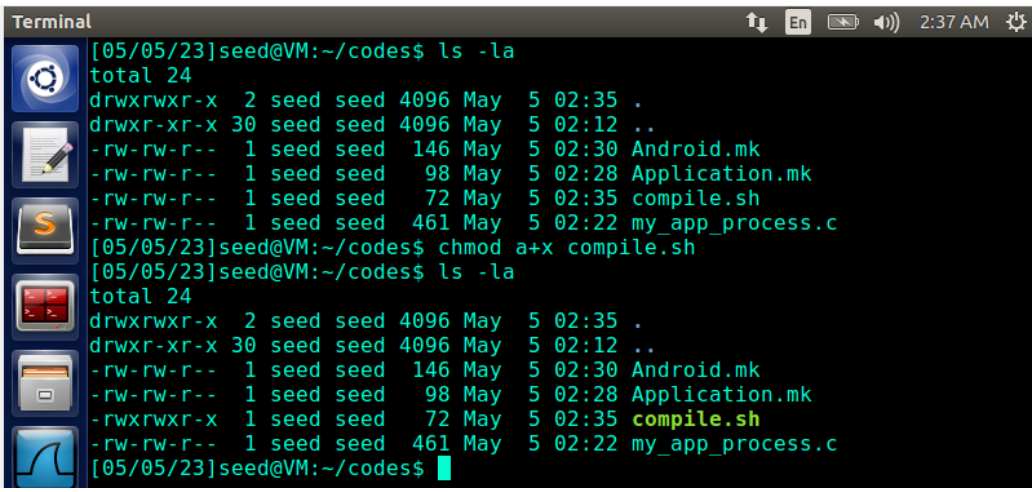


Figure 24: executable compile.sh

12. Compile compile.sh by typing ./compile.sh.

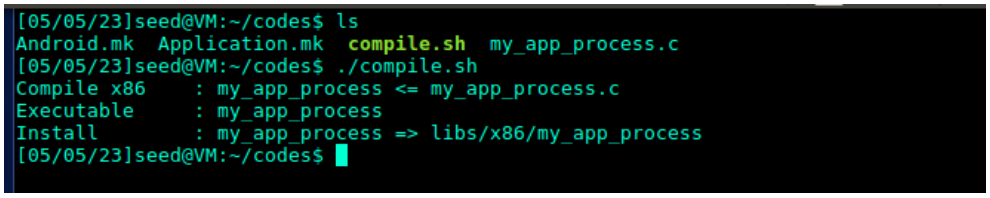


Figure 25: Compile compile.sh

```
[05/05/23]seed@VM:~/codes$ ls -la
total 32
drwxrwxr-x  4 seed seed 4096 May  5 02:50 .
drwxr-xr-x 30 seed seed 4096 May  5 02:12 ..
-rw-rw-r--  1 seed seed  146 May  5 02:30 Android.mk
-rw-rw-r--  1 seed seed   98 May  5 02:28 Application.mk
-rwxrwxr-x  1 seed seed   72 May  5 02:35 compile.sh
drwxrwxr-x  3 seed seed 4096 May  5 02:50 libs
-rw-rw-r--  1 seed seed  461 May  5 02:22 my_app_process.c
drwxrwxr-x  3 seed seed 4096 May  5 02:50 obj
[05/05/23]seed@VM:~/codes$
```

Figure 26: libs and obj generated from compile.sh

13. The compilation process was successful, and we can locate the resulting binary file in the ./libs/x86 folder. Type the command `cd /libs/x86` to locate my_app_process.

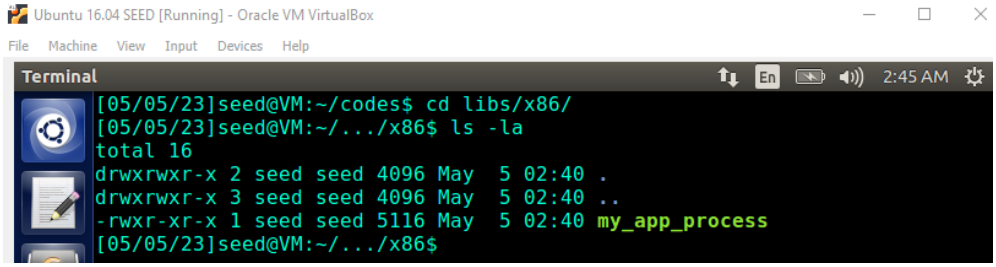


Figure 27: compiled binary code located in /libs/x86

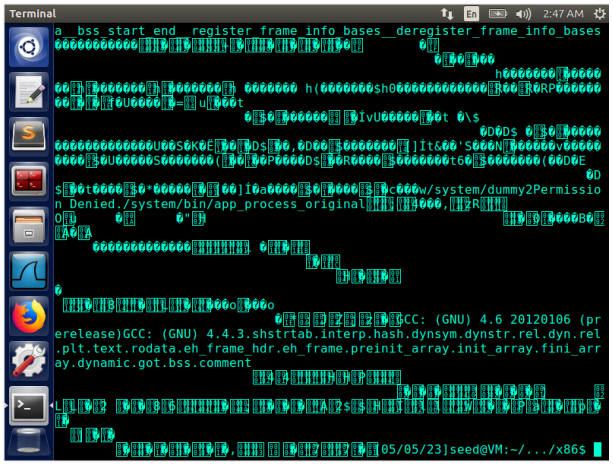


Figure 28: my_app_process, the compiled binary code

Step 2. Write the update script and build OTA package.

1. To proceed, we must copy our compiled binary code to the appropriate locationwithin the Android system, so will copy my_app_process to `Task2/META-INF/com/google/android`.

```
[05/05/23]seed@VM:~/.../x86$ mv my_app_process ~/task2/META-INF/com/google/android/
[05/05/23]seed@VM:~/.../x86$ cd ~/task2/META-INF/com/google/android/
[05/05/23]seed@VM:~/.../android$ ls -la
total 16
drwxrwxr-x 2 seed seed 4096 May  5 02:59 .
drwxrwxr-x 3 seed seed 4096 May  5 02:10 ..
-rwxr-xr-x 1 seed seed 5116 May  5 02:51 my_app_process
[05/05/23]seed@VM:~/.../android$ pwd
/home/seed/task2/META-INF/com/google/android
[05/05/23]seed@VM:~/.../android$ S
```

Figure 29: my_app_process copied to /task2/META-INF/com/google/android

2. We need to rename the original `app_process` binary to a new name, and then use our compiled code as the new `app_process`. The name of the original app process binary can either be app process32 or app process64 depending on the device's architecture. Since our Android VM is a 64-bit device, we will use the name "`app_process64`" for our new binary.
3. Type the command "gedit" in the terminal to create the file "update-binary" in the same directory as my_app_process. The code for this file can be found in the Seed Lab manual.

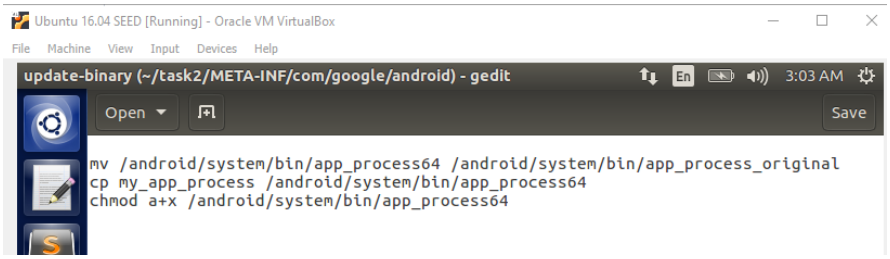


Figure 30: update_binary

4. Type the command `ls -la` to verify that we have `my_app_process`, the compiled binary file, not my_app_process.c file and update-binary in the same source folder, which is `task2/META-INF/com/google/android`.

```
[05/05/23]seed@VM:~/.../android$ cat update-binary

mv /android/system/bin/app_process64 /android/system/bin/app_process_ori
ginal
cp my_app_process /android/system/bin/app_process64
chmod a+x /android/system/bin/app_process64
[05/05/23]seed@VM:~/.../android$ ls -la
total 20
drwxrwxr-x 2 seed seed 4096 May  5 03:07 .
drwxrwxr-x 3 seed seed 4096 May  5 02:10 ..
-rwxr-xr-x 1 seed seed 5116 May  5 02:51 my_app_process
-rw-rw-r-- 1 seed seed  175 May  5 03:07 update-binary
[05/05/23]seed@VM:~/.../android$ pwd
/home/seed/task2/META-INF/com/google/android
[05/05/23]seed@VM:~/.../android$
```

Figure 31: my_app_process and update-binary in the same source folder

5. To enable us to run the file "update-binary", we must add execute permissions. Execute the command "`chmod a+x update-binary.sh`" to achieve this.

```
[05/05/23]seed@VM:~/.../android$ ls -la
total 20
drwxrwxr-x 2 seed seed 4096 May  5 03:07 .
drwxrwxr-x 3 seed seed 4096 May  5 02:10 ..
-rwxr-xr-x 1 seed seed 5116 May  5 02:51 my_app_process
-rw-rw-r-- 1 seed seed  175 May  5 03:07 update-binary
[05/05/23]seed@VM:~/.../android$ chmod a+x update-binary
[05/05/23]seed@VM:~/.../android$ ls -la
total 20
drwxrwxr-x 2 seed seed 4096 May  5 03:07 .
drwxrwxr-x 3 seed seed 4096 May  5 02:10 ..
-rwxr-xr-x 1 seed seed 5116 May  5 02:51 my_app_process
-rwxrwxr-x 1 seed seed  175 May  5 03:07 update-binary
[05/05/23]seed@VM:~/.../android$
```

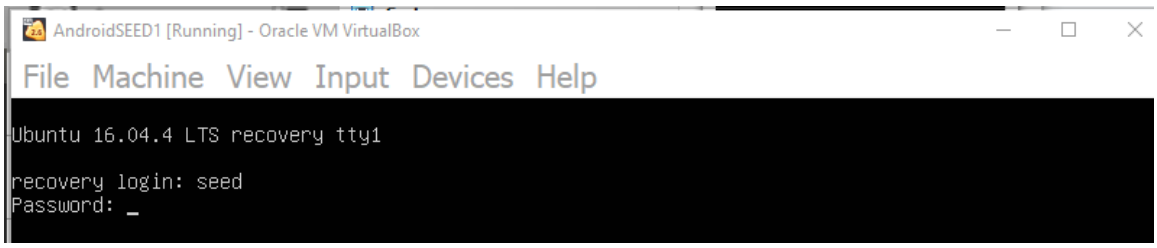
Figure 32: executable update-binary

6. Change the directory to `/home/seed`, then zip task2 folder by typing the command `zip -r task2.zip task2`.

```
[05/05/23]seed@VM:~/.../android$ cd /home/seed/
[05/05/23]seed@VM:~$ ls
android  Customization  Downloads         lib       Public  Templates
bin      Desktop        examples.desktop  Music     source  Videos
codes    Documents      get-pip.py        Pictures  task2
[05/05/23]seed@VM:~$ zip -r task2.zip task2
  adding: task2/ (stored 0%)
  adding: task2/META-INF/ (stored 0%)
  adding: task2/META-INF/com/ (stored 0%)
  adding: task2/META-INF/com/google/ (stored 0%)
  adding: task2/META-INF/com/google/android/ (stored 0%)
  adding: task2/META-INF/com/google/android/update-binary (deflated 58%)
  adding: task2/META-INF/com/google/android/my_app_process (deflated 72%)
[05/05/23]seed@VM:~$
```

Figure 33: zipping task2 folder

7. Upon successfully building the OTA package, we can deliver it to the recovery OS. In a real-world scenario, the recovery OS would automatically execute the package. However, since we are operating within a lab environment, we are using Ubuntu as our recovery OS. Ubuntu, however, does not possess the necessary recovery functionality. Therefore, we must emulate the recovery functionality ourselves by manually unpacking the OTApackage (using the unzip command).To deliver the zipped task2 folder, type the command `scp -r task2.zip seed@IPofrecoveryOS:\tmp`.
8. Login to Android Recovery OS by holding down the shift key before the system is booting up. Use the arrow up to select “Ubuntu”



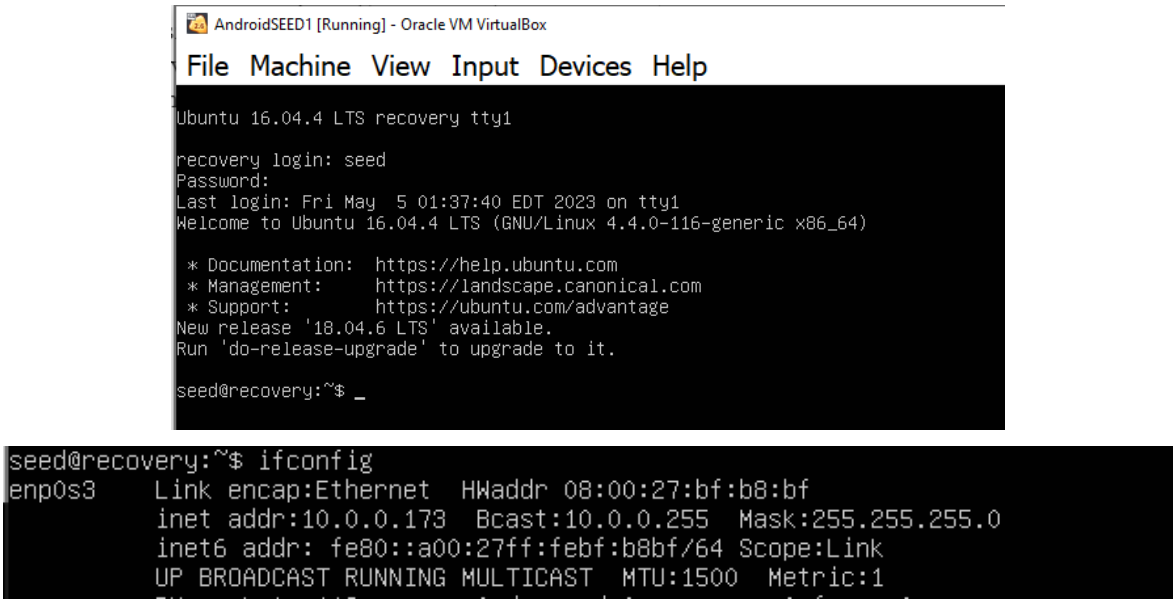


Figure 34: Login to Recovery OS to locate the IP adress

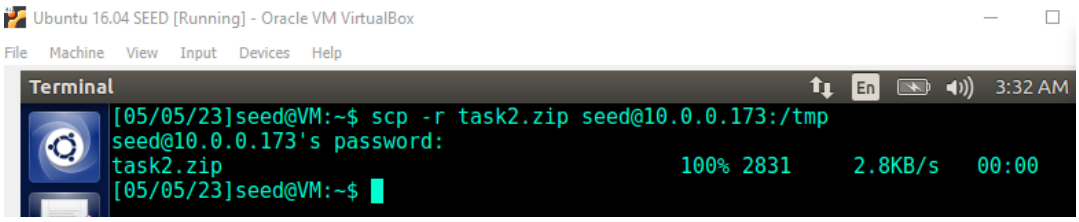


Figure 35: Deliver task2.zip to the Android recovery OS using its IP address

9. In Android VM, change the directory to /tmp and use the ls command to list the files.

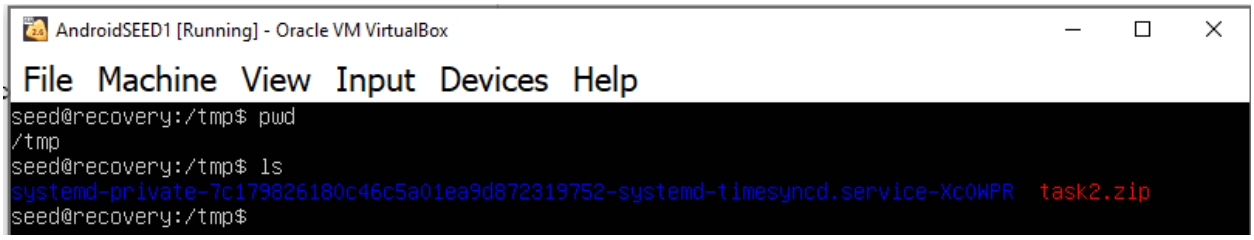


Figure 36: task2.zip in /tmp in Android Recovery

10. Unzip task2.zip in /tmp

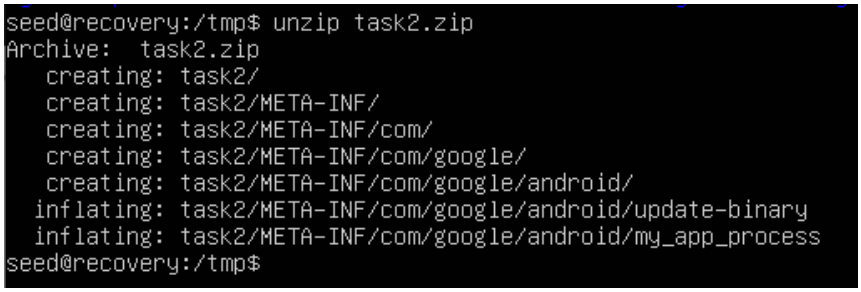


Figure 37: unzip task2.zip in /tmp in Android Recovery

11. Navigate to the directory META-INF/com/google/android and locate the update-binary file. Run the file, and if all of the steps were carried out accurately, the Android system should be updated. Subsequently, start the Android OS and verify whether the dummy2 file has been created within the /system directory.

Figure 38: ls command to display the files in `tmp/task2/META-INF/com/google/android`

Figure 39: compile update-binary, then reboot

In this lab, we successfully modified the `app_process` program in the Android OS. The `app_process` is executed by the Android runtime during bootstrapping and is responsible for launching the Zygote daemon, which in turn launches all applications. We achieved this by creating a standalone native program using NDK, compiling it and placing it in the appropriate folder structure, and executing it via the update-binary file to update the Android system. Upon booting up the Android OS, we verified that the dummy2 file had been created, thereby demonstrating the successful modification of the app process program.

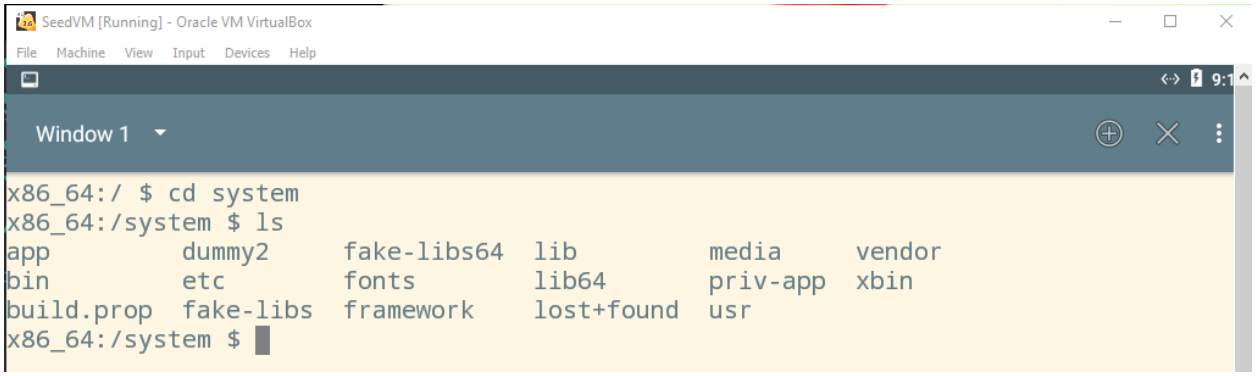


Figure 32: dummy2 created in the /system folder, demonstrating root privilege

Lab Task 3: Implement SimpleSU for Getting Root Shell

Another approach to gaining root access on an Android device is to start a root daemon during the booting process, and then use this daemon to help users get a root shell. This method is used by popular rooting OTA packages like SuperSU developed by Chainfire. In this task, we will write a similar daemon to understand how it helps users gain root access. The basic idea is that when a user wants to gain root access, they run a client program that sends a request to the root daemon. Upon receiving the request, the daemon starts a shell process and gives control of the process to the client, allowing the user to control the shell process. The challenging part of this approach is figuring out how to let the user control the shell process created by the daemon. According to The Official Document of Security Updates on Android 4.3, `setuid/setgid` programs have been removed from Android system files and support for filesystem capabilities has been added. This reduces the root attack surface and lowers the likelihood of potential security vulnerabilities.

To complete this task, download the file SimpleSU.zip from `https://seedsecuritylabs.org/Labs_20.04/Mobile/Android_Rooting/`

Files Needed

- SimpleSU.zip

1. Boot up SEED Android VM, open an emulator app on the Home screen. Then, open a terminal window.
2. Navigate to the 'system' directory in the file system by typing the command "`cd /system`" in the terminal window.
3. Type the command `ls` to list all files in `/system` directory. Notice that it should not be a mysfu file in the /system directory.

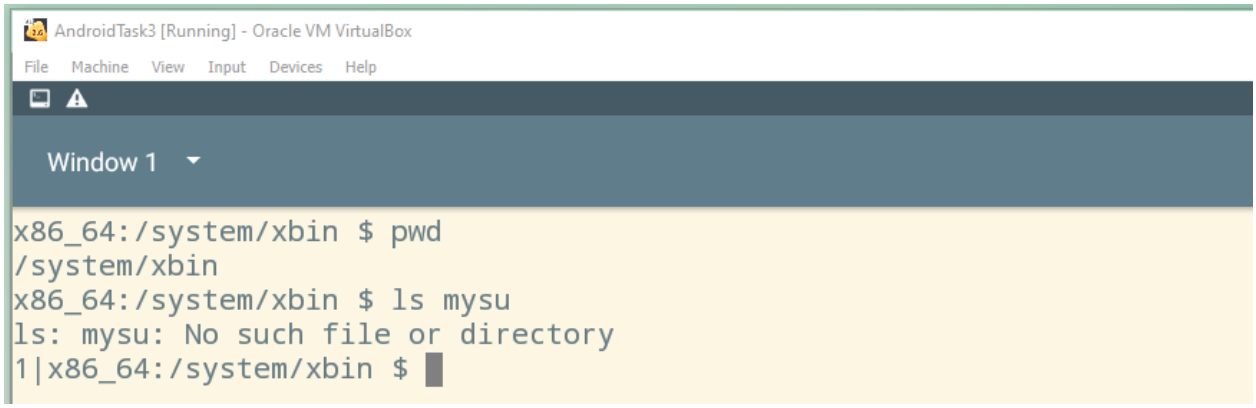


Figure 33: mysu is not found in the /system folder

4. In Ubuntu 16.04 SEED VM, create a folder called task3, then under task3, create a subfolder according to the OTA package structure, `META-INF/com/google/android/`

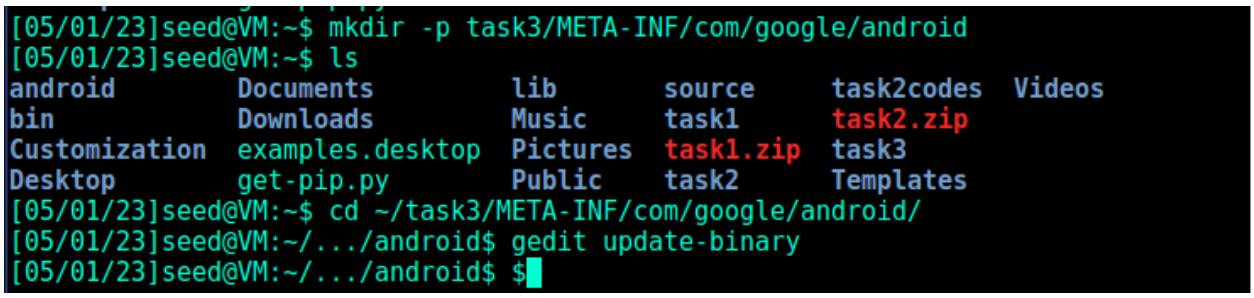


Figure 34: `META-INF/com/google/android/`

5. Type the command "gedit" in the terminal to create the file "update-binary". The code for this file can be found in the Seed Lab manual but we have to modify it. Refer to Figure 35.
6. To enable us to run the file "update-binary", we must add execute permissions. Type the command "`chmod a+x` update-binary" to achieve this.

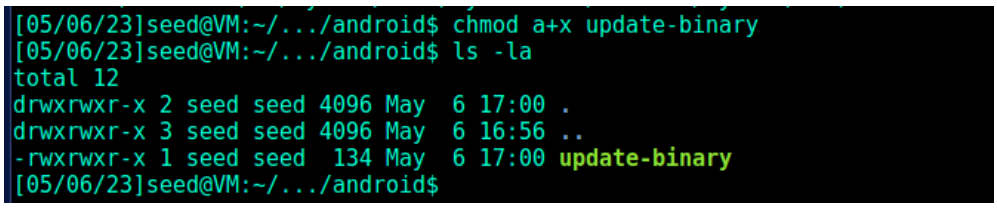


Figure 35: executable update-binary script

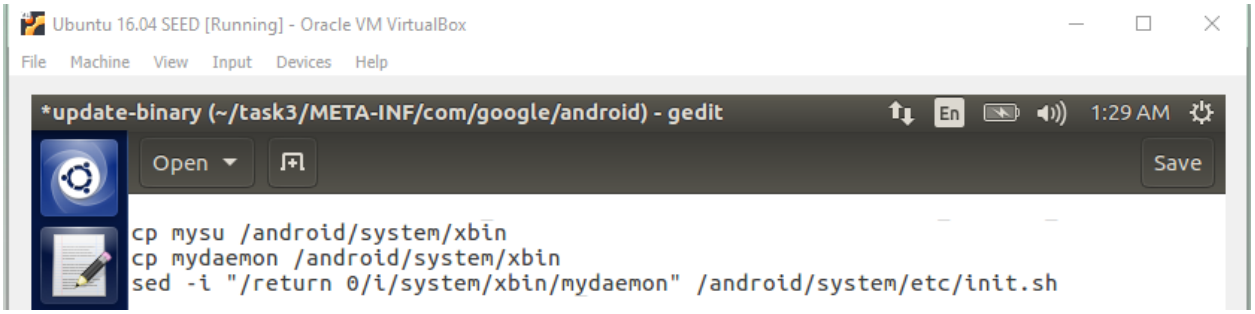


Figure 36: task3 - update-binary contents

7. Create a source code folder named task3codes, then unzip the file SimpleSU.zip from the /Downloads directorty to task3codes directory by typing the command, `unzip ~/Downloads/SimpleSu.zip`.

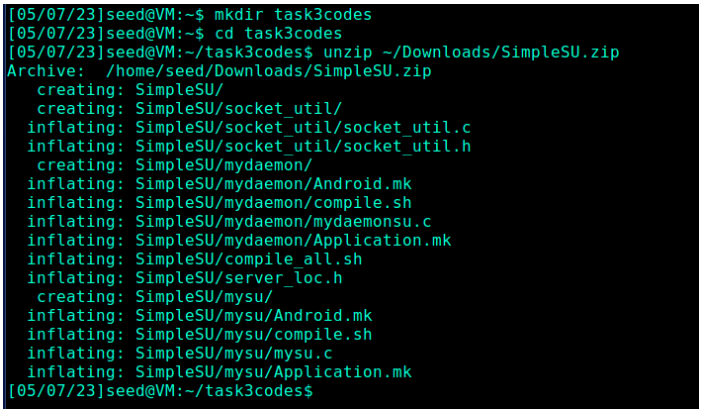


Figure 37: unzipping the source code, SimpleSU.zip

8. Change the current directly to SimpleSu by typing `cd SimpleSu`, then list all files in the SimpleSu folder by typing the command ls, then type the command `bash compile_all.sh` to execute all the listed commands in this script.

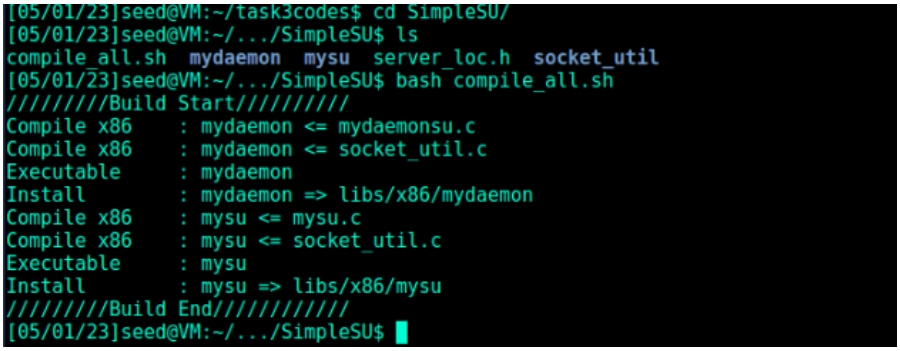


Figure 38: the output of bash compile_all.sh

9. List all the files after compiling compile_all.sh by typing the command, we need two output files from mydaemon and mysu.

```
[05/07/23]seed@VM:~/.../SimpleSU$ ls -la
total 28
drwxr-xr-x 5 seed seed 4096 May 22  2018 .
drwxrwxr-x 3 seed seed 4096 May  7 14:05 ..
-rw-r--r-- 1 seed seed  138 Mar 31  2016 compile_all.sh
drwxr-xr-x 4 seed seed 4096 May  7 14:34 mydaemon
drwxr-xr-x 4 seed seed 4096 May  7 14:34 mysu
-rw-r--r-- 1 seed seed  371 Mar 11  2016 server_loc.h
drwxr-xr-x 2 seed seed 4096 Mar 31  2016 socket_util
[05/07/23]seed@VM:~/.../SimpleSU$
```

Figure 38: the output of bash compile_all.sh

10. Change the current directory to mydaemon/libs/x86 and mysu/libs/x86 and copy mydaemon and mysu to task3/META-INF/com/google/android
Refer to Figure 39-40.

```
[05/07/23]seed@VM:~/.../SimpleSU$ cd mydaemon/libs/x86
[05/07/23]seed@VM:~/.../x86$ ls
mydaemon
[05/07/23]seed@VM:~/.../x86$ mv mydaemon ~/task3/META-INF/com/google/and
roid/
[05/07/23]seed@VM:~/.../x86$
```

Figure 39: copying mydaemon to the required directory, task3/META-INF/com/google/android

```
[05/07/23]seed@VM:~/.../x86$ cd ~/task3codes/SimpleSU/mysu/libs/x86
[05/07/23]seed@VM:~/.../x86$ ls
mysu
[05/07/23]seed@VM:~/.../x86$ mv mysu ~/task3/META-INF/com/google/android
/
[05/07/23]seed@VM:~/.../x86$
```

Figure 40: copying mysu to the required directory, task3/META-INF/com/google/android

11. Change the current directory to task3/META-INF/com/google/android to verify that we have the three OTA files needed for this task, mysu, mydaemon, and update-binary.

```
[05/07/23]seed@VM:~/.../x86$ cd ~/task3/META-INF/com/google/android/
[05/07/23]seed@VM:~/.../android$ ls
mydaemon  mysu  update-binary
[05/07/23]seed@VM:~/.../android$ ls -la
total 36
drwxrwxr-x 2 seed seed 4096 May  7 14:41 .
drwxrwxr-x 3 seed seed 4096 May  7 14:01 ..
-rwxr-xr-x 1 seed seed 9232 May  7 14:34 mydaemon
-rwxr-xr-x 1 seed seed 9232 May  7 14:34 mysu
-rwxrwxr-x 1 seed seed  133 May  7 14:01 update-binary
[05/07/23]seed@VM:~/.../android$
```

Figure 41: mydaemon, mysu, and update-binary in task3/META-INF/com/google/android

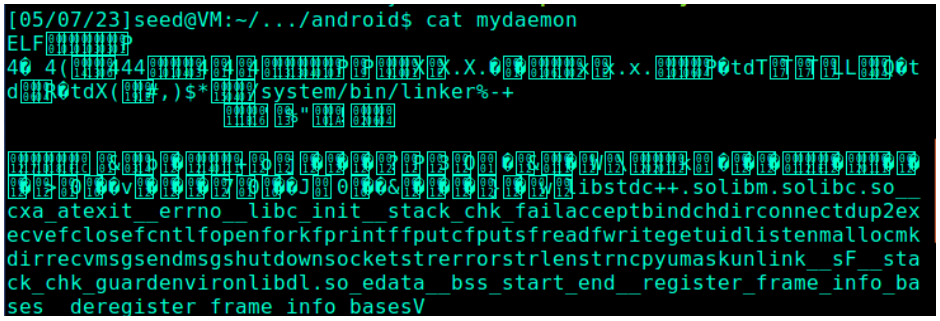


Figure 42: the contents of mydaemon when using the cat command to display

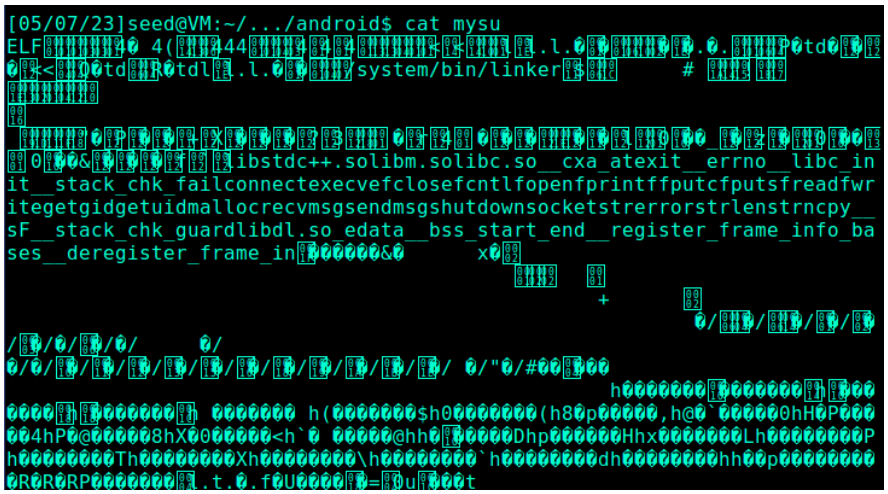


Figure 43: the contents of mysu when using the cat command to display

12. Change the current directory to where we save task3/META-INF/com/google/android so that we can zip the entire folder and transfer the code to the Android recovery OS. To do this, type the command, `cd /home/seed, then` use the ls command to verify that we are able to locate task3 folder.

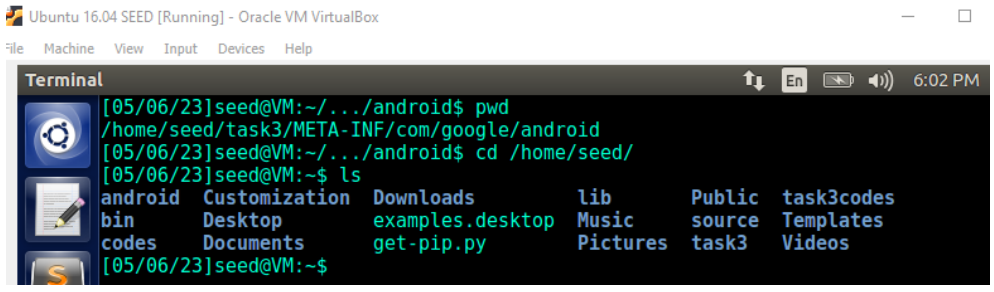


Figure 44: Getting ready to zip task3 folder, cd /home/seed

```
[05/07/23]seed@VM:~$ zip -r task3.zip task3
  adding: task3/ (stored 0%)
  adding: task3/META-INF/ (stored 0%)
  adding: task3/META-INF/com/ (stored 0%)
  adding: task3/META-INF/com/google/ (stored 0%)
  adding: task3/META-INF/com/google/android/ (stored 0%)
  adding: task3/META-INF/com/google/android/update-binary (deflated 41%)
  adding: task3/META-INF/com/google/android/mydaemon (deflated 60%)
  adding: task3/META-INF/com/google/android/mysu (deflated 66%)
[05/07/23]seed@VM:~$
```

Figure 45: Zipping task3 folder

13. We have successfully zip task3.zip in /home/seed, then we are going to transfer the task3.zip folder to the Android Recovery OS.

```
[05/07/23]seed@VM:~$ ls
android         Documents          lib       source      Templates
bin             Downloads          Music     task3       Videos
Customization   examples.desktop   Pictures  task3codes
Desktop         get-pip.py         Public    task3.zip
[05/07/23]seed@VM:~$
```

Figure 46: task3.zip

14. To locate the IP address of the AndroidSEED VM, login to Android recovery OS, then type `ifconfig` command to obtain the required IP address. Power off the Android VM if it is still running a normal mode, then restart the VM, and quickly hold down the shift key right before you see the Virtual box logo booting up the VM to enter the GNU mode and select Ubuntu so that we can enter into Android recovery mode.

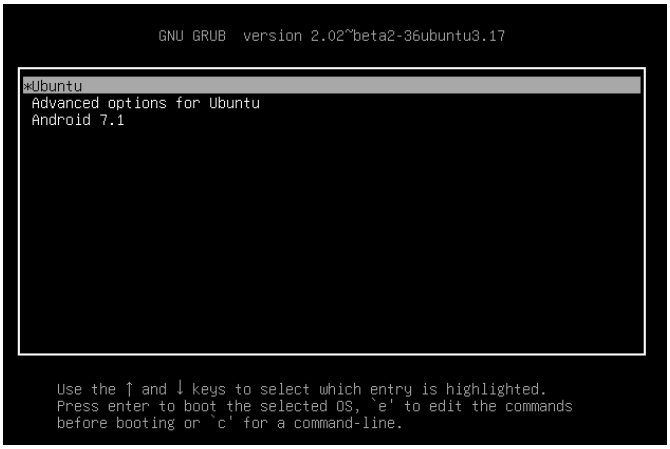


Figure 47: GNU mode used for Android Recovery Mode

15. When prompted for a recovery login, enter *"seed"* for the username and "*dees"* for the password.

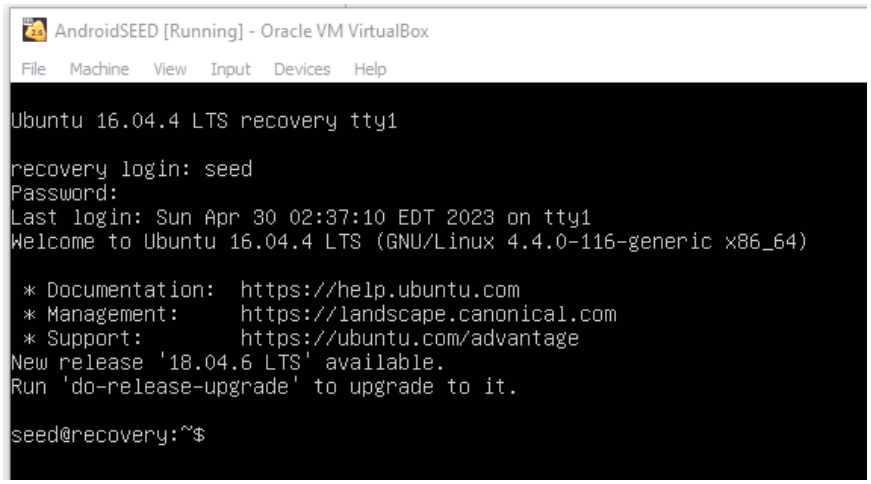


Figure 48: Android Recovery Mode

16. Type the command if config, and locate the IP address, in this case, it is 10.0.0.173.

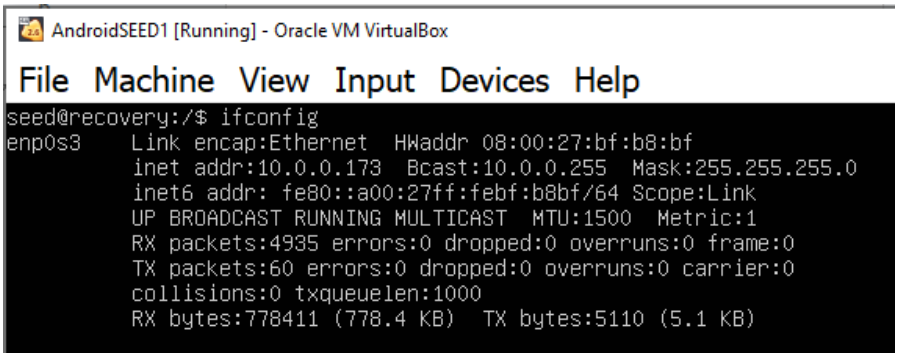


Figure 49: Locating the IP address of the AndroidSEED VM, 10.0.0.173.

17. Return to Ubuntu16.04 SEEDVM and type the command, `scp -r task3.zip seed@10.0.0.173:/tmp` to transfer task3.zip to the AndroidSEED VM.

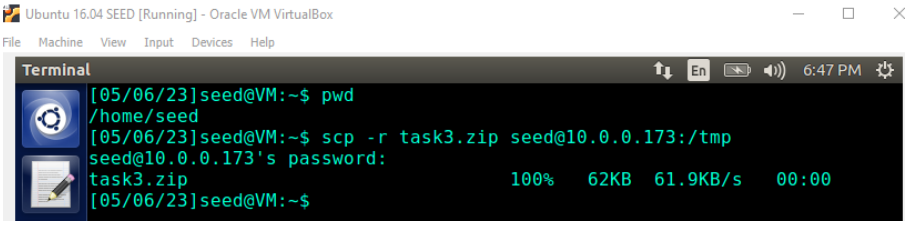


Figure 50: transferring task3.zip to the AndroidSEED VM

18. Switch to the AndroidSEED VM, then change the current directly to /tmp, then use the command ls to list all the files. Refer to Figure 50 - task3.zip has been successfully transferred to the AndroidSEED VM or the Android Recovery OS.

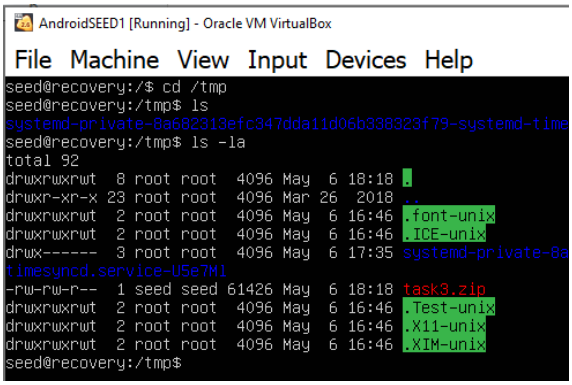


Figure 51: task3.zip in the /tmp folder in Android root

19. Unzip the task3.zip.

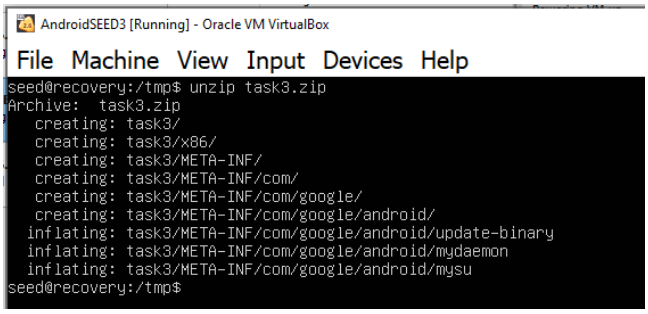


Figure 52: Unzipping task3.zip in the /tmp folder in Android root

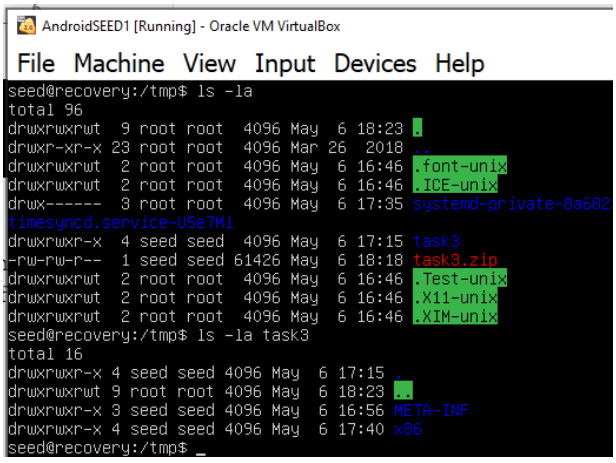


Figure 53: Unzipped task3.zip in the /tmp folder in Android root

20. Change the current directory to `/task3/META-INF/com/google/android` and type the command ls to list all files.

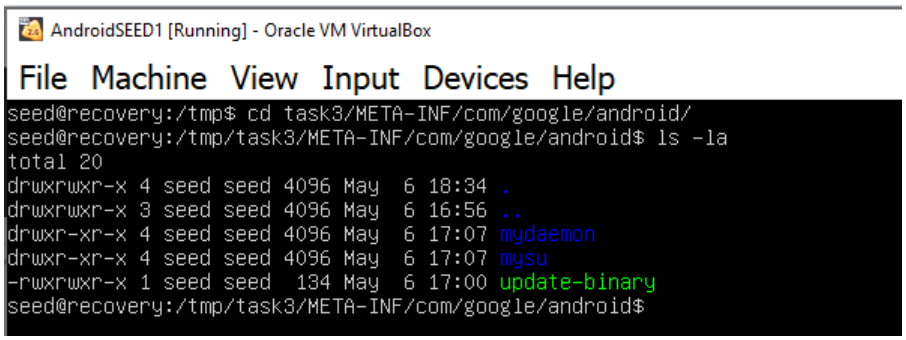


Figure 54: mydaemon, mysu, and update-binary in /task3/META-INF/com/google/android

21. Execute the command `sudo ./update-binary` then, enter the password “dees and `sudo reboot`.

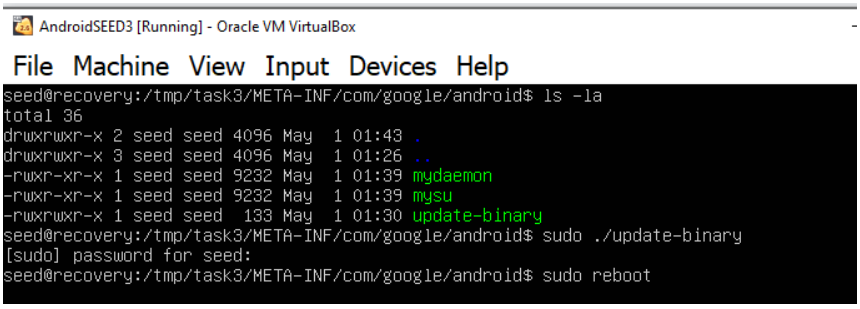


Figure 55: execute scripts in the file, update-binary

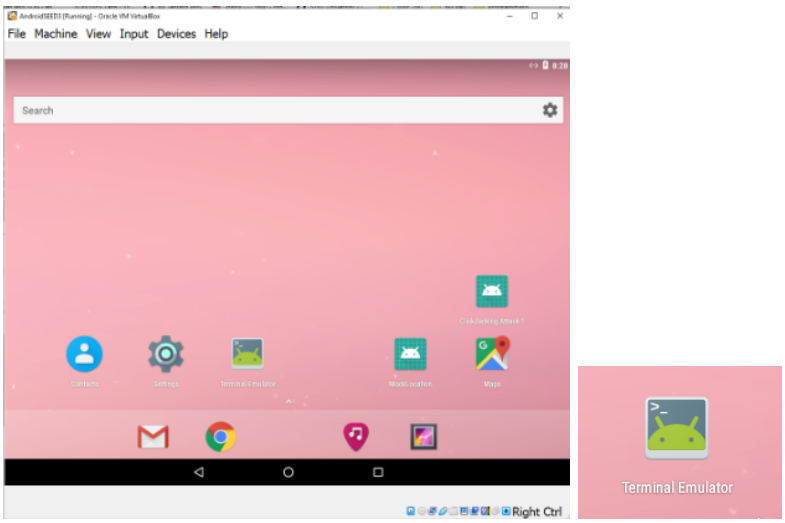


Figure 56: After executing sudo reboot, the VM is booting up intp Android GUI.

22. Open the Terminal Emulator app, and type cd system/xbin, then ls -la my* to display any files that start with my. Notice that mydaemon and mysu are listed below, refer to Figure

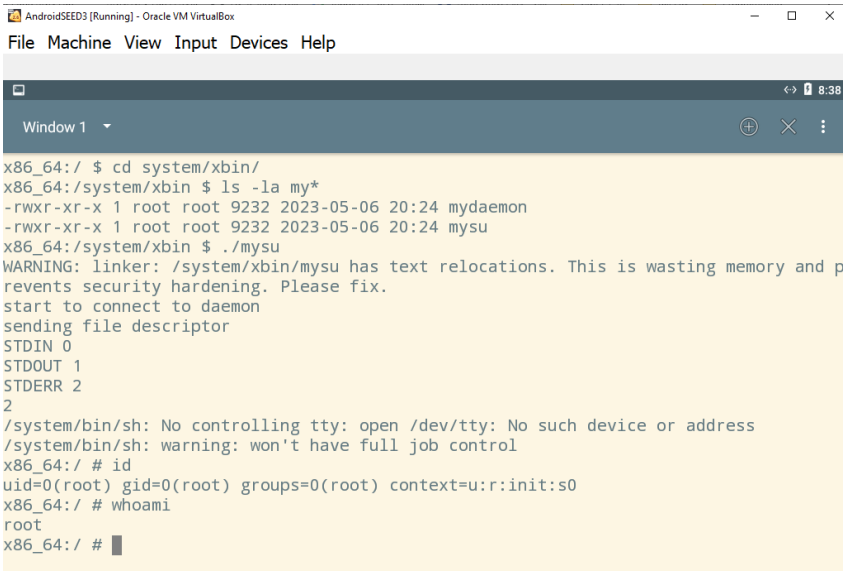


Figure 57: mysu and daemon in /system/xbin gaining root access

In task3, we were able to start a root daemon during the booting process, and then use this daemon to get a root shell. We achieve this by placing mysu and mydaemon in the root directory. To gain root privileges, we had to run a client program that sent a request to the root daemon, which then started a shell process and gave it to the client and finally, we have the root access.

There are several ways to defend against Android Rooting Device attacks:

1. Lock the bootloader
2. Keep the device's software up-to-date with the latest security
3. Disable USB debugging not allowing a device to connect to a computer and run commands on it.
4. Use strong passwords for unlocking the device to prevent unauthorize access to the device.
5. Avoid sideloading apps from unknown sources, only download apps from the official app