CHIP - Connected Home Over IP

This lab procedure walks through the steps to build CHIP Lock-app project using EFR32 SLWRB4170A. The first part reviews how to setup the environment using Virtual Machine running Ubuntu 20.04 LTS on Windows 10 machine. The second part shows how to create Lock-app example and flash on to SLWRB4170A. The final part introduces how to establish the connection with OTBR and use Chip-tool to control the device.

*As of 5/11/2021 Project Connected Home over IP is now Matter. Learn more about Matter.

KEY POINTS

- Setup CHIP environment on WSL2
- Build Lock-app project for BRD4170A
- Flash firmware on BRD4170A
- Establish communication with OTBR
- Use chip-tool to control the device

1 Prerequisites

For this lab you will need the following:

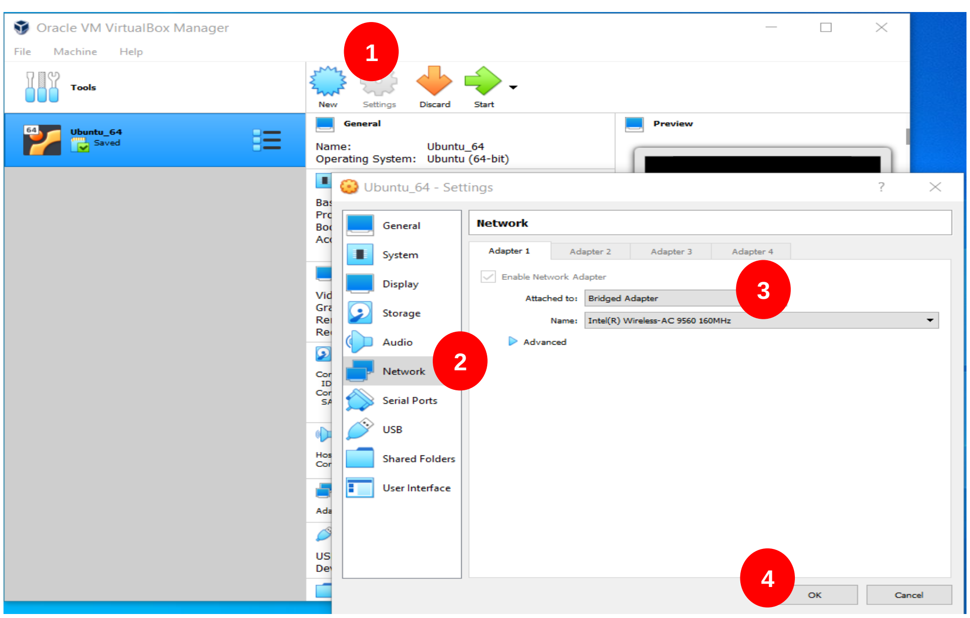
- Software Requirement:
    1. Studio 5 with Gecko SDK 3.0.0 or later installed on Windows 10
    2. VirtualBox (with **Ubuntu 20.04 LTS**) installed on Windows 10
        - VirtualBox: https://www.virtualbox.org/
        - Ubuntu **20.04.x** LTS: https://ubuntu.com/download/desktop
    3. Latest Raspberry Pi OS.
        - For more instructions visit: https://www.raspberrypi.org/documentation/installation/noobs.md
    4. Gecko SDK v2.7 downloaded in Linux (Ubuntu) VM
        - Download from https://github.com/SiliconLabs/sdk_support
    5. Tera Term: https://ttssh2.osdn.jp/index.html.en
    6. J-Link RTT Viewer: https://www.segger.com/downloads/jlink/
    7. SSH Client (Putty or Similar) : https://www.putty.org/

    Note: WSL2 or Native Linux or Mac machine can also be used to build this CHIP Project but WSL2 has limitations as described in ***section 5.4***. To install WSL2 visit: https://docs.microsoft.com/en-us/windows/wsl/install-win10

- Hardware Requirements:
    1. SLWSTK6000B Wireless Starter Kit main board + BRD4170A for CHIP device
    2. SLWSTK6000B Wireless Starter Kit main board + BRD4170A for RCP Device
    3. Raspberry Pi 3B+/4 for Open Thread Border Router
    4. Two Micro-USB to USB Type-A cables for Kit

1.1 Prepare Network setting for VirtualBox

Assuming Ubuntu is installed on VM in Windows 10. Before running the VM, we need to configure networking setting and change network adapter to Bridge mode.

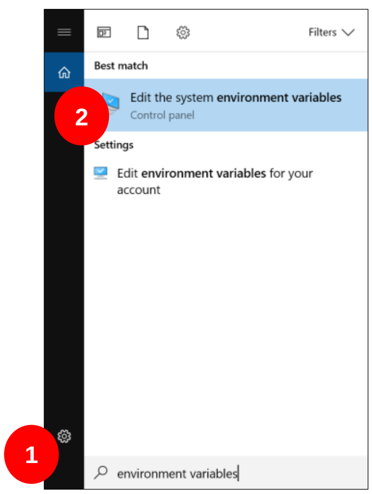


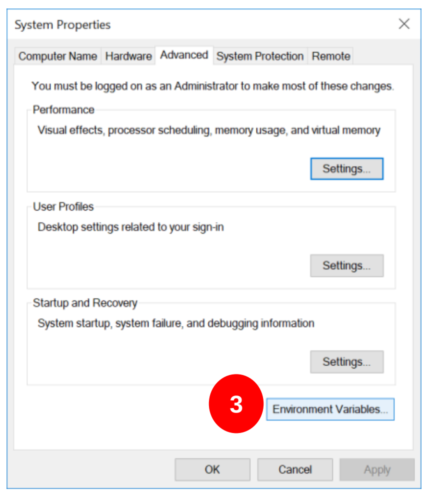
1. Open the VirtualBox and click on '**Settings**' of your Linux VM.
2. Click on '**Network'** and Select the '**Adapter 1**' tab.
3. Make sure **'Bridge Adapter'** is selected in the '**Attached to:**' box.
4. Click OK.

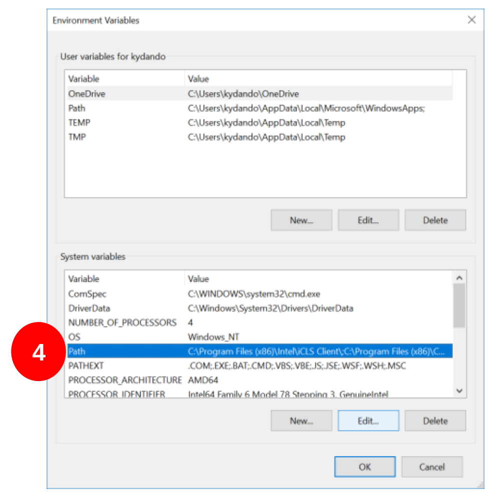
1.2 Prepare Windows 10 OS to run Simplicity Commander (optional)

For simplicity's sake add the path of Simplicity Commander (*C:\SiliconLabs\SimplicityStudio\v5\developer\adapter_packs\commander*) to the *path* environment variable in your OS, so that the *commander*.exe can be called from any directory as well as from Linux terminal.

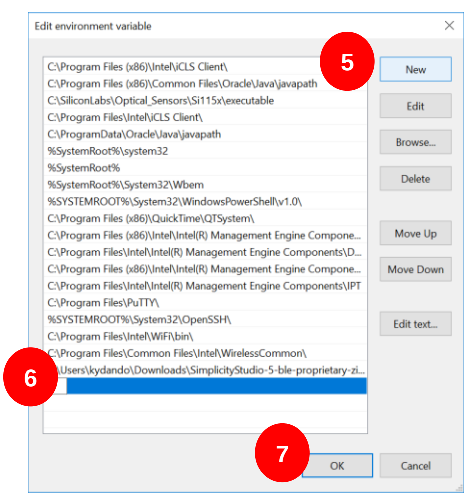
1. Use Search bar in Windows 10 to locate "**Environment Variables**" menu.
2. Select "**Edit the system environment variables**".







3. Select **"Environment Variables**" in the System Properties window.
4. Select "**Path**" under System Variables. Click "**Edit…"**



5. Click "**New**".
6. *Verify this is the valid path for your installation.* ***C:\SiliconLabs\SimplicityStudio\v5\developer\adapter_packs\commander***
7. Most default installations will have this path. It will be different if you modified the installation folder for Simplicity Studio.
8. Paste the verified location of Simplicity Commander

9. Click “**OK**” to accept addition to path and return to Environment Variables window
10. Under System variables Click “**New**”
11. Under Variable name enter “**PATH_GCCARM**”
12. Under Variable value enter “***C:\SiliconLabs\SimplicityStudio\v5\developer\toolchains\gnu_arm\7.2_2017q4***”
13. Click “**OK**” to accept new variable.
14. Under System variable Click “**New**”
15. Under Variable name enter “**PATH_SCMD**”
16. Under Variable value enter “C:\SiliconLabs\SimplicityStudio\v5\developer\adapter_packs\commander” (VERIFIED IN STEP 5)
17. Click “**OK**” to accept new variable.
18. Click “**OK**” 3 times to close the open windows
19. Computer will need to be restarted for new PATH variable to be updated

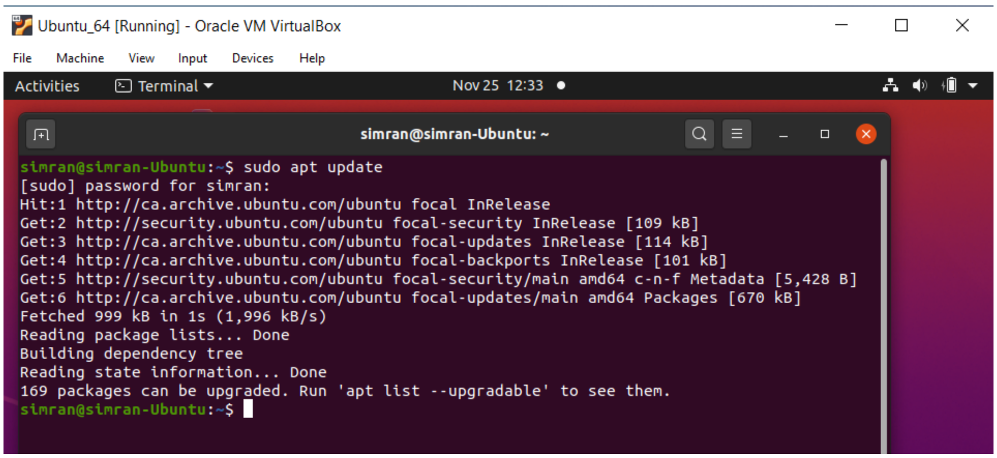
1.3 Prepare Linux packages

Note: *Following instructions can also work on WSL2 (Windows 10), Native Linux or Mac machine*

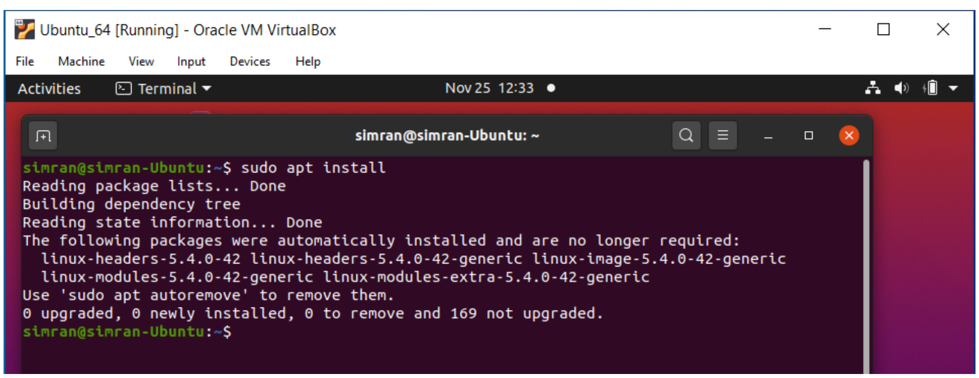
In Virtualbox, start **Ubuntu 20.04 VM** and open terminal window.

Update the latest packages by typing following commands in terminal window:

1 **sudo apt update**



2 **sudo apt install**



2 Build Preparation for CHIP

***Note**: Instructions provided in this **section 2** can be used to build Chip project on WSL2 (Windows 10), Native Linux or Mac machine)*

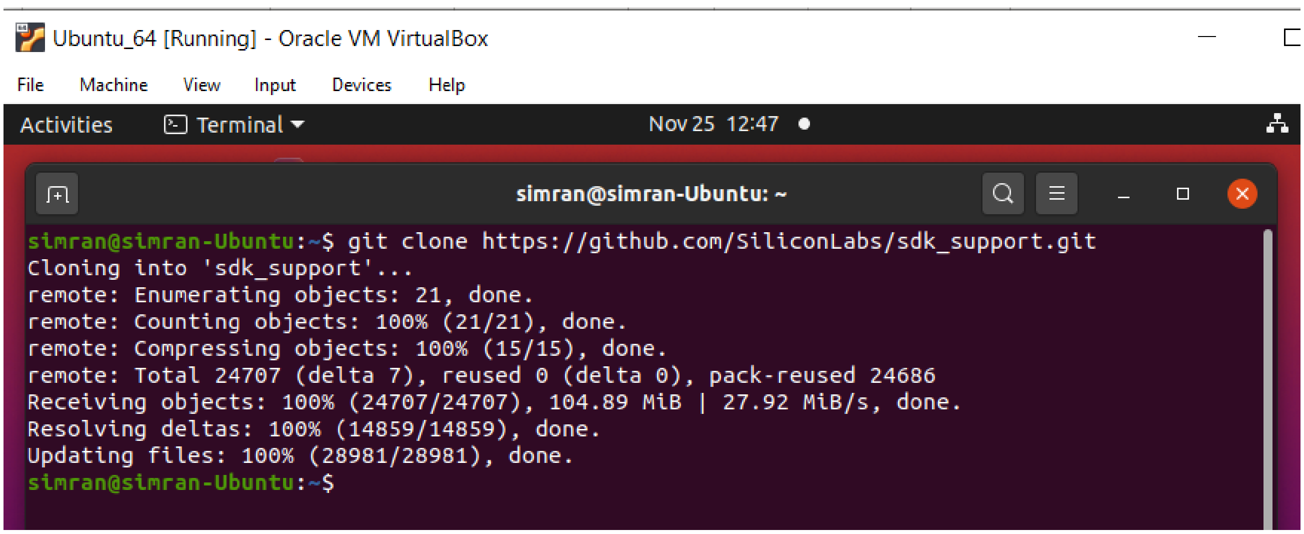
2.1 Prerequisites for CHIP project on Linux VM

The following section details how to set up environment for CHIP Project. All the current development on CHIP is available at https://github.com/project-chip/connectedhomeip

Check out the Code and SDK from GitHub.

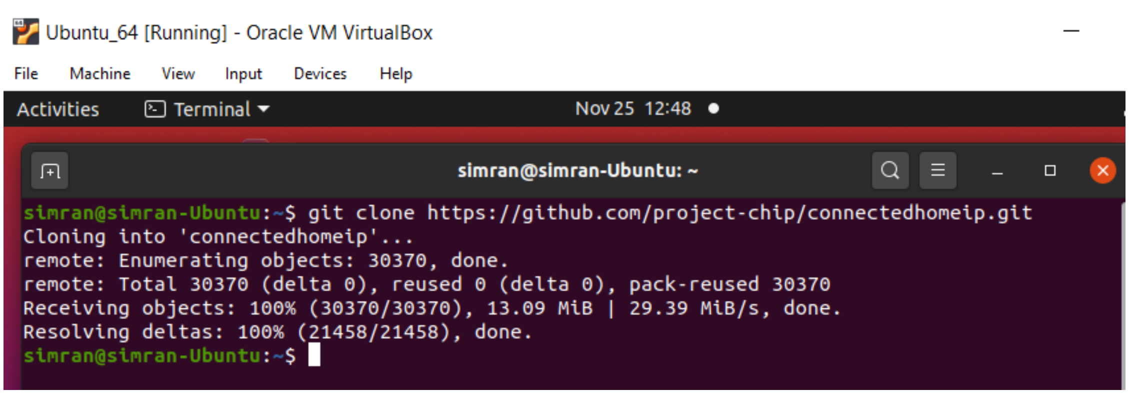
1. Open the Linux terminal from start menu.
2. Clone the Gecko SDK 2.7 from https://github.com/SiliconLabs/sdk_support

```
git clone https://github.com/SiliconLabs/sdk_support.git
```



3. Clone the repository. To check out the CHIP repository:

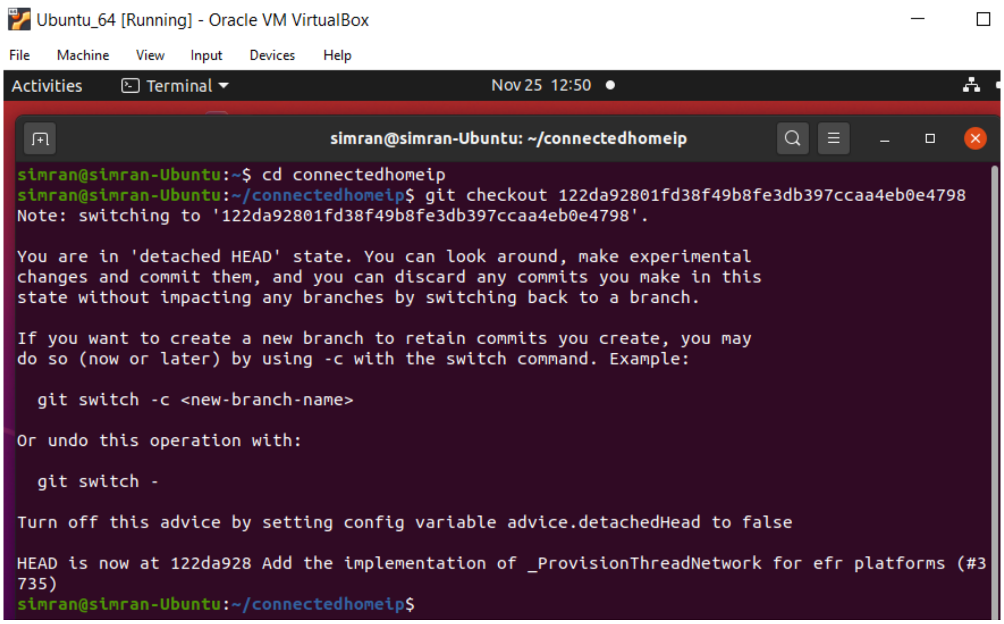
```
ls
```



4. Switch to '**connectedhomeip'** directory and checkout the commit `122da92801fd38f49b8fe3db397ccaa4eb0e4798`

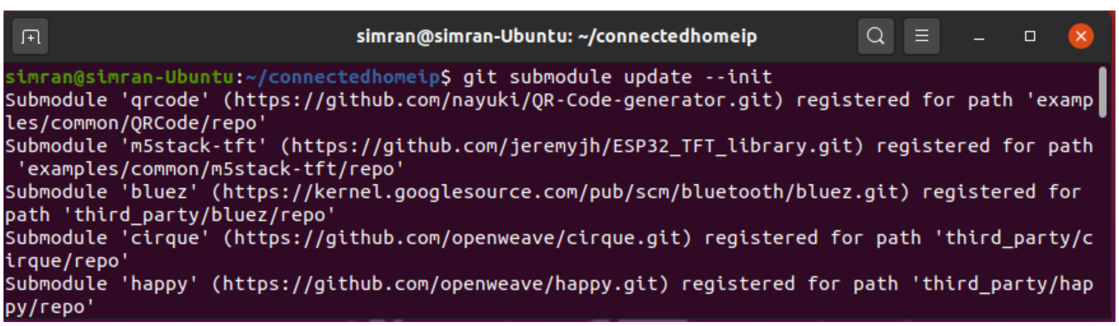
(At the time of this tutorial, following commit hash is tested. Latest commit on GitHub should work as well)

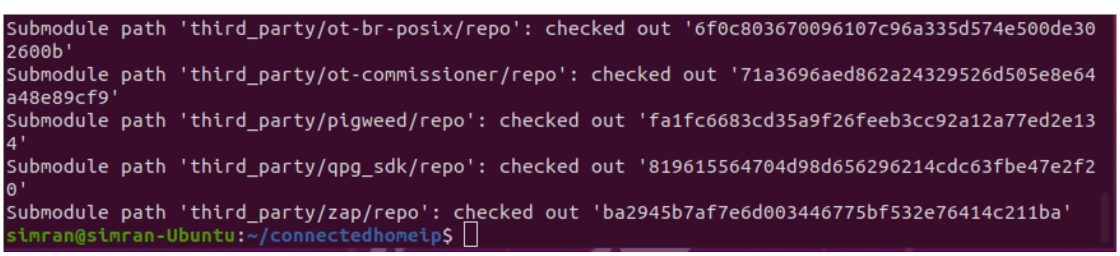
```
git checkout 122da92801fd38f49b8fe3db397ccaa4eb0e4798
```



5. If you already have a checkout, run the following command to sync submodules:

```
git submodule update --init
```





6. Install prerequisites on Linux required to CHIP project.

```
sudo apt-get install git gcc g++ python pkg-config libssl-dev libdbus-1-dev libglib2.0-dev libavahi-client-dev ninja-build python3-venv python3-dev unzip
```

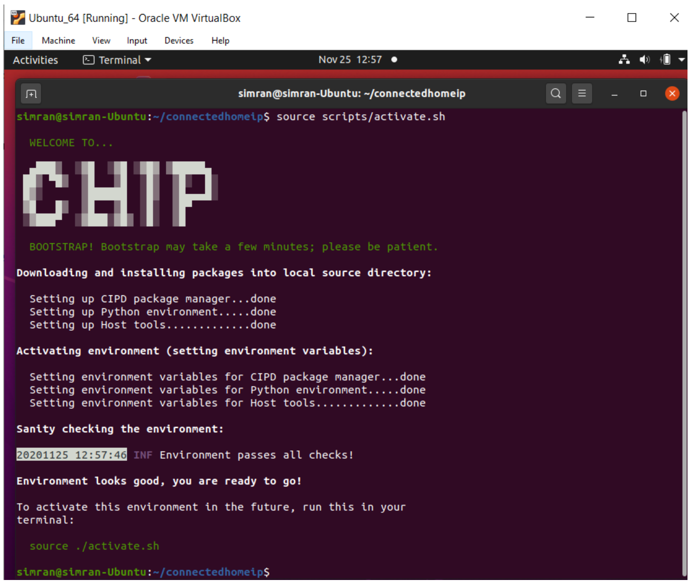
2.2 Prepare CHIP Environment and build the source and libraries

Build all sources, libraries, and tests for the host platform.

1. Activate the environment builds

```
source scripts/activate.sh
```

Before running any other build command, the environment setup script should be sourced at the top level. This script takes care of downloading GN, ninja, and setting up a Python environment with libraries used to build and test.



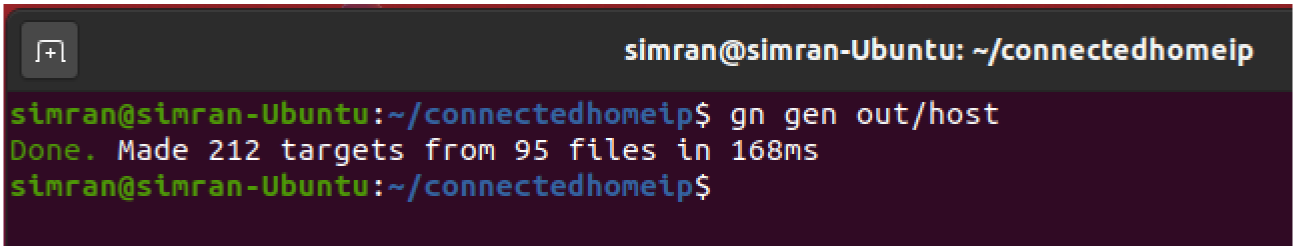
If this script says the environment is out of date, it can be updated by running:

```
source scripts/bootstrap.sh
```

This script re-creates the environment from scratch, which is expensive, so avoid running it unless the environment is out of date.

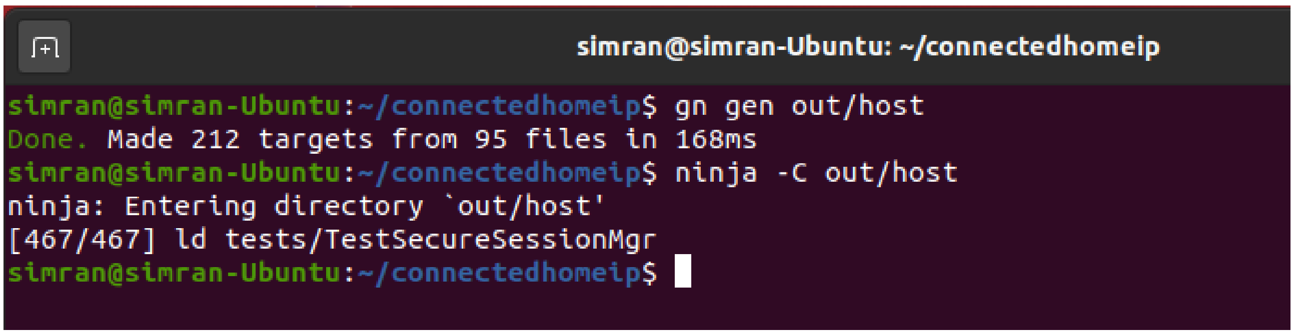
2. Make a build directory:

```
gn gen out/host
```



3. To build these files, pass the label with its path (but no leading “//”) to ninja:\

```
ninja -C out/host
```



The directory name **‘out/host’** can be any directory, although it's conventional to build within the out directory. This example uses host to emphasize that we're building for the host system. Different build directories can be used for different configurations, or a single directory can be used and reconfigured as necessary via gn args.

3 Creating EFR32 Lock-App

***Note**: Instructions provided in this **section 3** can be used to build Chip project on WSL2 (Windows 10), Native Linux or Mac machine)*

The EFR32 lock example provides a baseline demonstration of a door lock device, built using CHIP and the Silicon Labs gecko SDK. The example currently supports Open Thread.

The lock example is intended to serve both to explore the workings of CHIP as well as a template for creating real products based on the Silicon Labs platform.

3.1 Building the example

1. Switch to efr32 lock-app folder.

```
cd ~/connectedhomeip/examples/lock-app/efr32
```

2. Verify all the submodules are updated and synchronized.

```
git submodule update --init
```

3. Make sure to activate the environment. This will load gn and ninja for building further instructions.

```
source third_party/connectedhomeip/scripts/activate.sh
```

4. Setup the Gecko SDK 2.7 path. Refer to section 1.2 for downloading the Gecko SDK 2.7

export EFR32_SDK_ROOT=<path-to-silabs-sdk-v2.7>

```
export EFR32_SDK_ROOT=~/sdk_support
```

5. Set the board number used to build this example project.

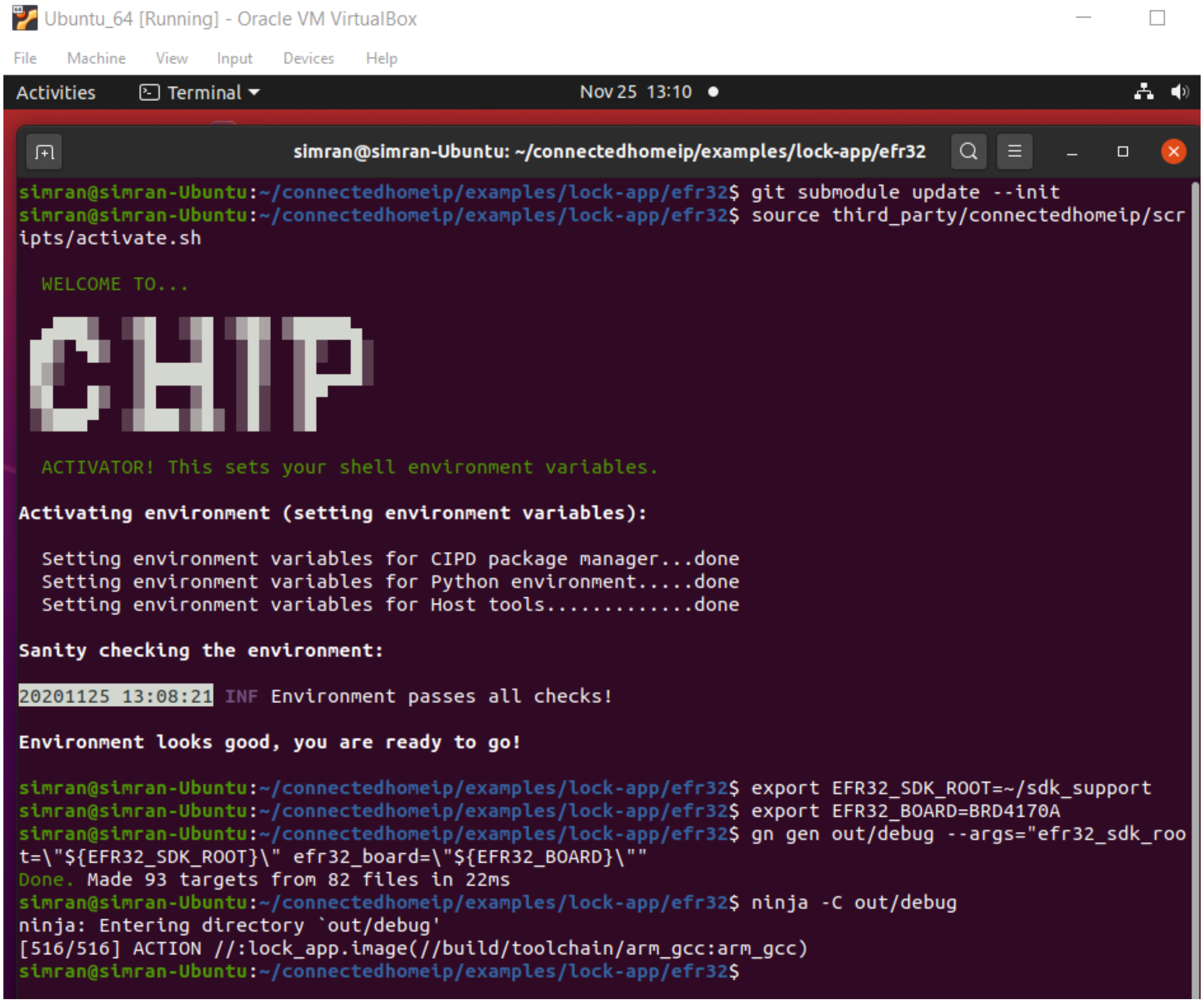
```
export EFR32_BOARD=BRD4170A
```

6. Now, setup the build directory before compiling the project. with GN, you can setup your own build directories with the settings you want. This lets you maintain as many different builds in parallel as you need.

```
gn gen out/debug --args="efr32_sdk_root=\"${EFR32_SDK_ROOT}\" efr32_board=\"${EFR32_BOARD}\""
```

7. To build the project, pass the label with its path to ninja

```
ninja -C out/debug
```



8. If you want to delete the generated the project files: (*not required for this lab*)

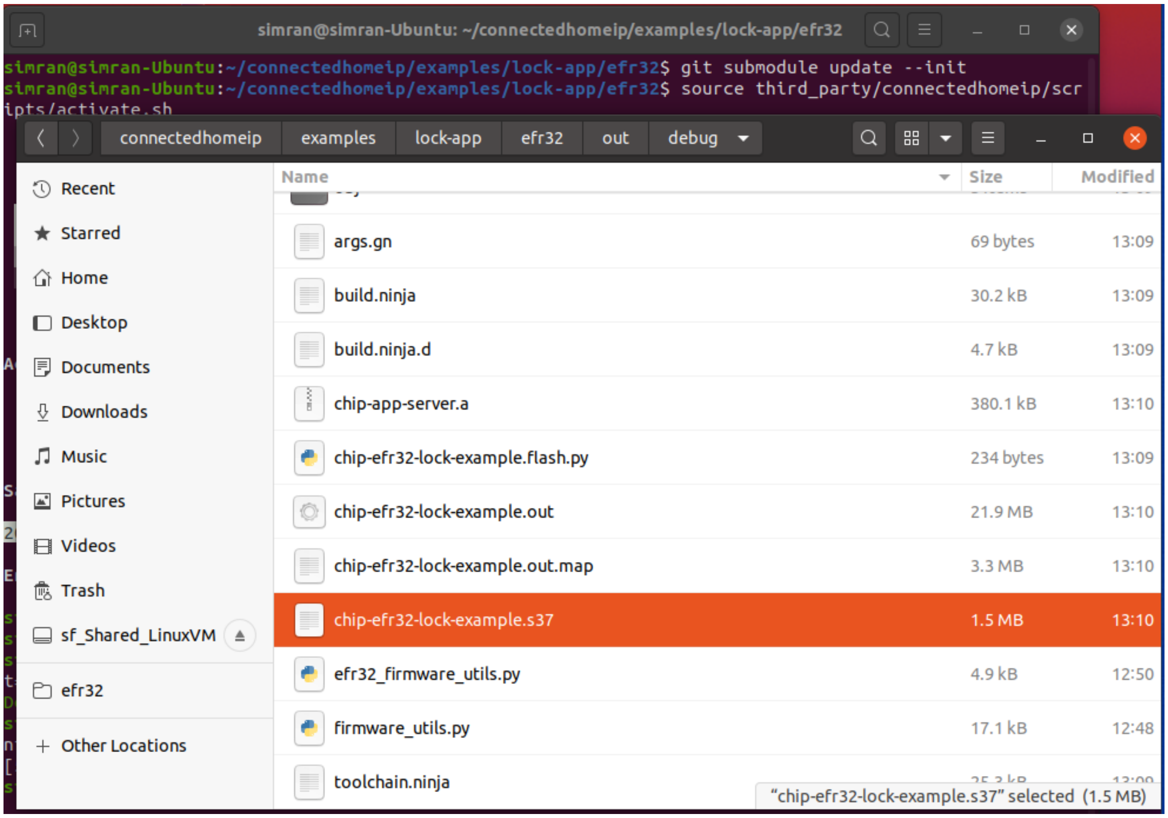
```
rm -rf out/
```

3.2 Flashing the Firmware

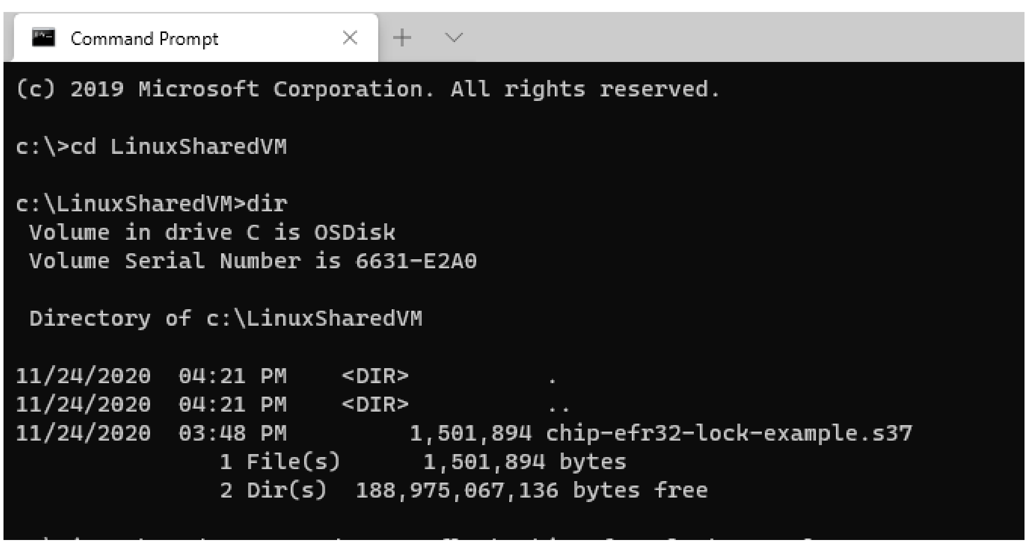
For this lab we will begin by programing the BRD4170A using the wired USB interface.

The generated files for 'Lock-app' project on Linux VM is typically be stored at:

\home\connectedhomeip\examples\lock-app\efr32\out\debug



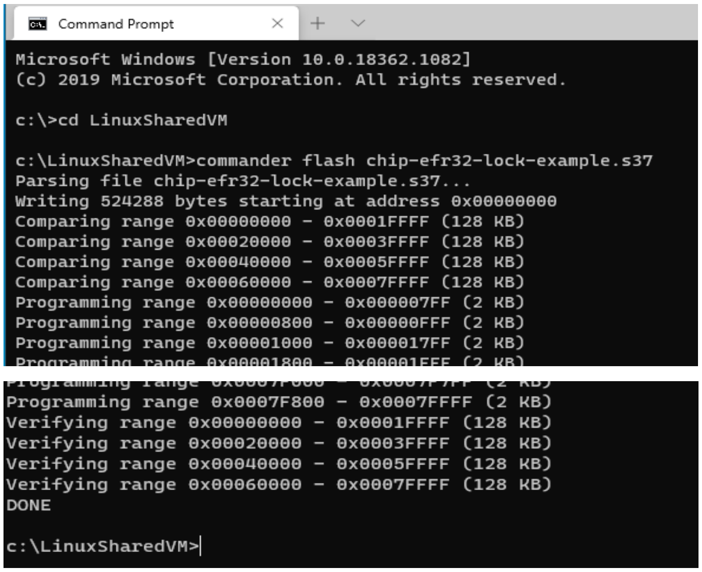
1. Copy the "**chip-efr32-lock-example.s37**" from …/out/debug folder from Linux VM to Windows 10 using shared folder.
2. Open Command prompt on Windows 10, make sure you are in directory where firmware file is copied in previous step.



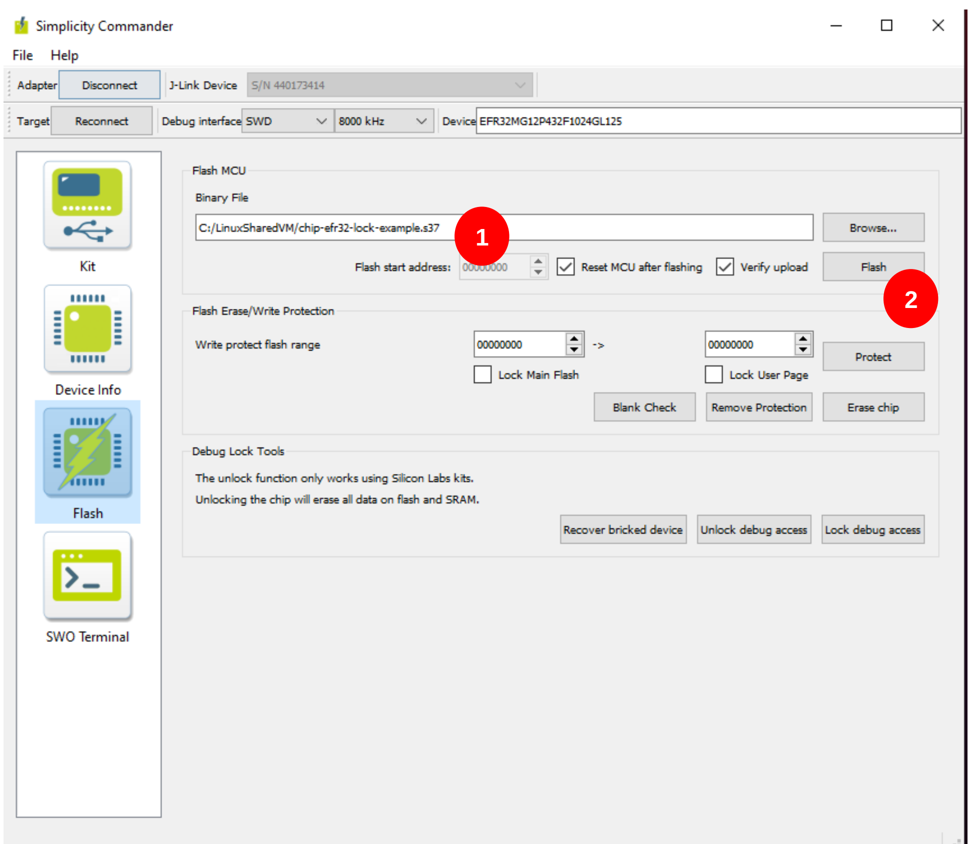
3. Before flashing the application firmware, verify whether the bootloader is flashed. Otherwise the application will not bootup.

4. Type the following command to flash the firmware to the BRD4170A:

```
commander.exe flash chip-efr32-lock-example.s37
```



Note: You can also manually launch GUI interface of commander.exe file from (C:\SiliconLabs\SimplicityStudio\v5\developer\adapter_packs\commander) and flash the file to the board

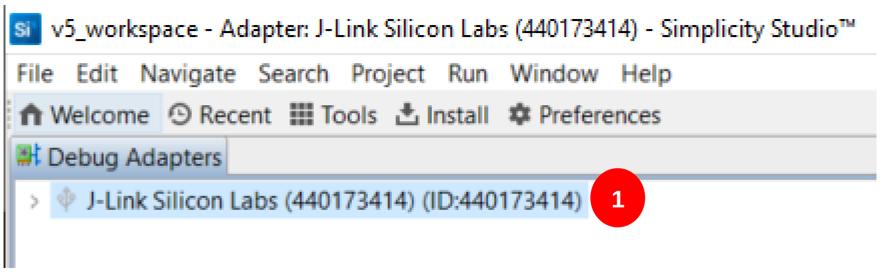


4 Preparing OTBR and RCP Device

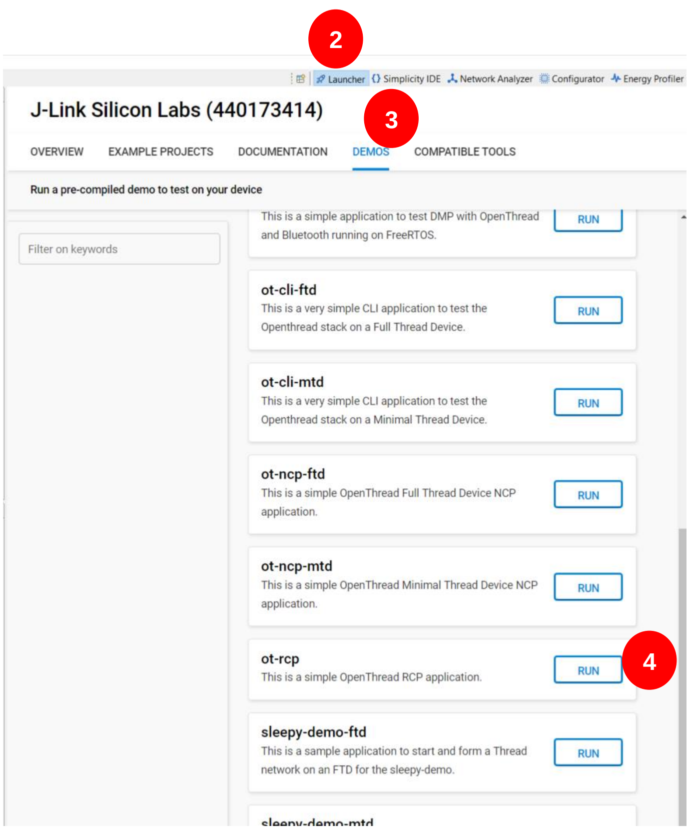
This section is not covered in this tutorial. So, we will only cover brief setup of RCP and Board Router. For in-depth detail on setting up Open Thread Boarder Router, you can refer to *AN1256: Using the Silicon Labs RCP with the Open Thread Border Router* https://www.silabs.com/documents/public/application-notes/an1256-using-sl-rcp-with-openthread-border-router.pdf

4.1 Preparing RCP Device

1. Once you have you WSTK kit with BRD4170A board connected via USB, Simplicity Studio 5 will detect the available adapters. Select the adapter by clicking over it.



2. Click on the '**Launcher'** tab on Simplicity Studio 5



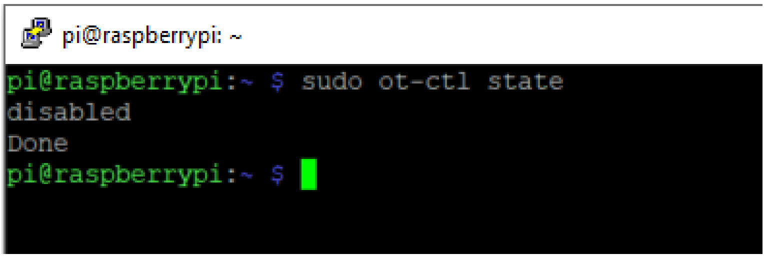
3. Click on 'Demo' tab to list all available pre-complied firmware for selected device.
4. Click 'RUN' on '**ot-rcp**' demo project. This will install the pre-built RCP image for selected board.
5. Now RCP device is ready to connect with OTBR running on Raspberry Pi.

4.2 Launching OTBR (Open Thread Boarder Router)

Assuming OTBR is already setup and running on Raspberry pi (refer to section 4 introduction for installing OTBR on Raspberry Pi). You can use SSH terminal like Putty. Open SSH terminal and login to Raspberry pi.

4.2.1 Check the status of OTBR by typing following command

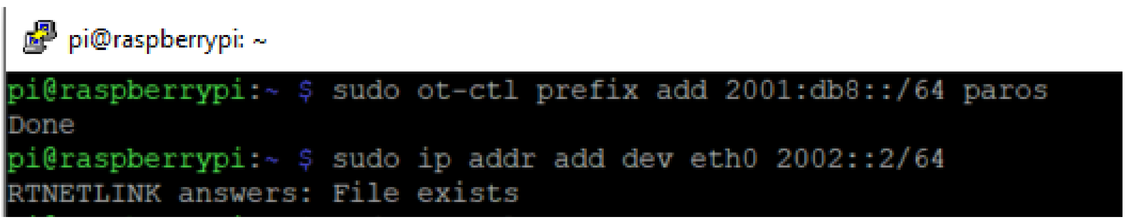
```
sudo ot-ctl state
```



4.2.2 OT-BR need to have a Global prefix configured. Type the following commands on RPI

```
sudo ot-ctl prefix add 2001:db8::/64 paros
```

```
sudo ip addr add dev <interface> 2002::2/64   // e.g. name of interface that Raspi
                                              // is connected to like eth0/wpan0/etc
```



4.2.3 Restart the OTBR, type the following command

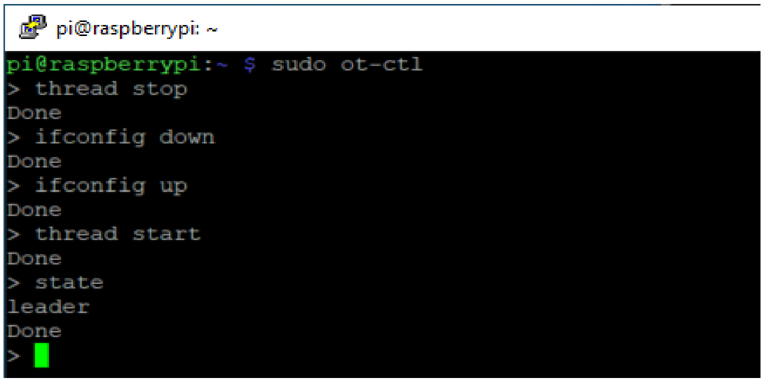
```
sudo ot-ctl state
```

```
> thread stop
```

```
> ifconfig down
```

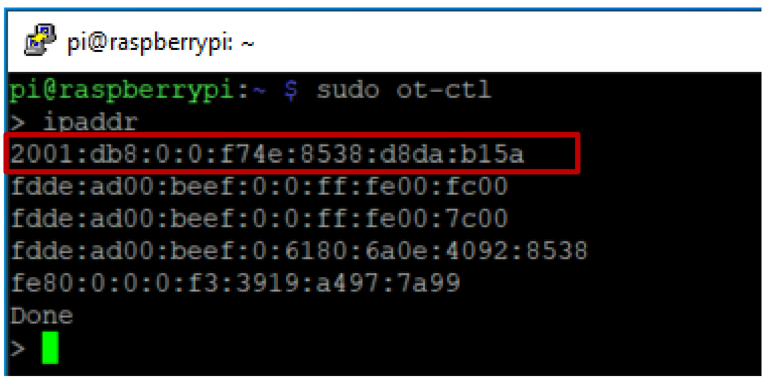
```
> ifconfig up
```

```
> thread start
```



4.2.4 Check the IP address of OTBR on Raspberry Pi to verify the changes.

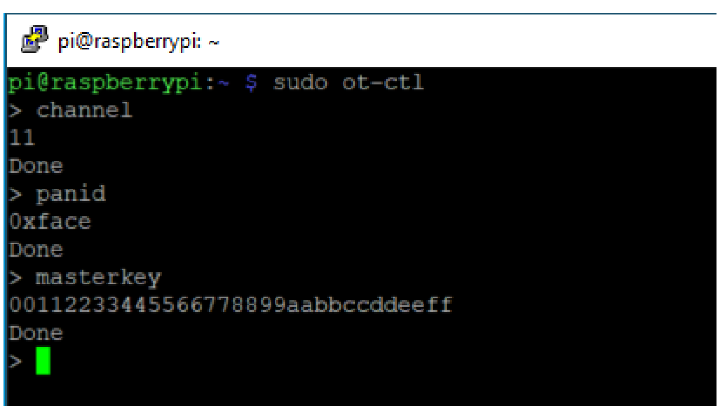
```
> ipaddr
```



4.2.5 Get the connection detail of OTBR. This is required for connecting child device with OTBR.

Type following commands:

```
> channel
> panid
> masterkey
```

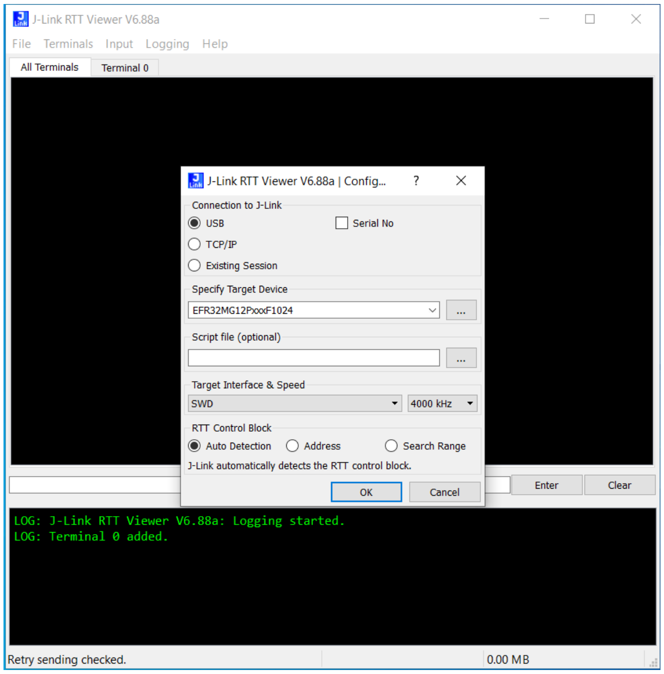


Take a note of these details and it will be used in [section 5.2.3](#) for connecting CHIP End-device.

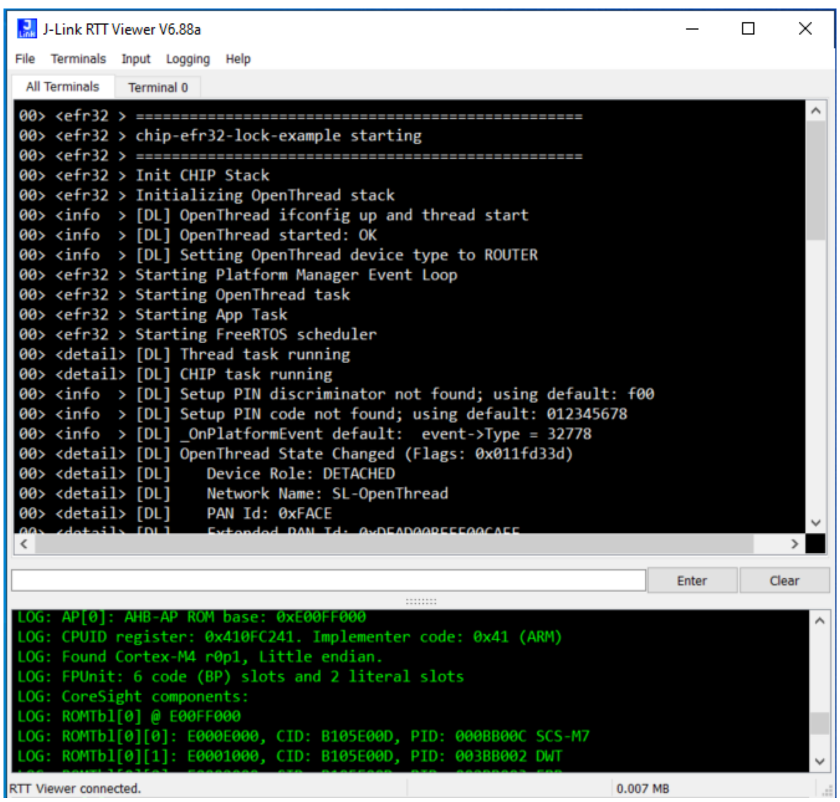
5 Running the CHIP End Device Demo

5.1 Startup the J-Link RTT Viewer

1. On Windows 10, connect CHIP End-device to J-Link RTT viewer, Press OK to connect.

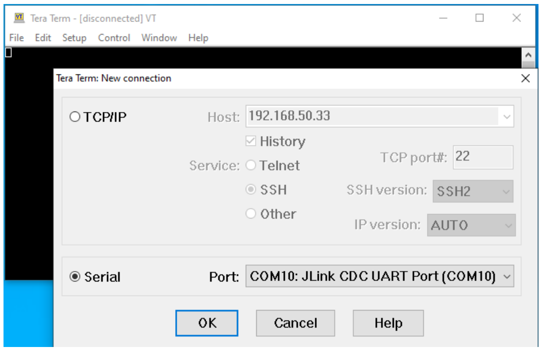


2. Press the reset button on WSTK kit and logs will be shown on J-Link RTT viewer when Chip End device restarts.



5.2 Open Tera Term serial terminal for CHIP End-device

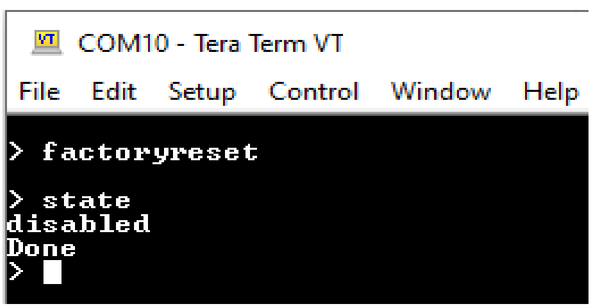
5.2.1 On Windows 10, Open Serial Terminal like Tera term and connect the end-device.



5.2.2 Verify the state of the device, type 'factoryreset' followed by 'state' on Tera-term console

```
factoryreset
```

```
state
```



5.2.3 Connect the CHIP end device to OTBR, connection detail can be obtained as explained in Section 4.2.5.

Type following commands:

```
dataset channel 11
```

```
dataset panid 0xface
```

```
dataset masterkey 00112233445566778899aabbccddeeff
```

```
dataset commit active
```

```
> dataset channel 11
Done
> dataset panid 0xface
Done
> dataset masterkey 00112233445566778899aabbccddeeff
Done
> dataset commit active
Done
> ifconfig up
Done
> thread start
Done
```

5.2.4 Check the IP address of CHIP end-device, it will have IPV6 address with "2001::db8" prefix

```
COM10 - Tera Term VT
File  Edit  Setup  Control  Window  Help
> ipaddr
fdde:ad00:beef:0:0:ff:fe00:8400
2001:db8:0:0:cf3d:172e:c2fb:ee2e
fe80:0:0:0:484d:e74f:47ef:f00
fdde:ad00:beef:0:be65:37a6:3abf:b7cc
Done
>
```

5.2.5 On raspberry pi, verify if OTBR have child device

```
pi@raspberrypi: ~
pi@raspberrypi:~ $ sudo ot-ctl
> child table
| ID  | RLOC16 | Timeout    | Age        | LQ In | C_VN |R|S|D|N| Extended MAC
  |
+-----+--------+------------+------------+-------+------+-+-+-+-+---------------
---+
|   2 | 0x7c02 |        240 |         29 |     3 |  206 |1|1|1|1| 4a4de74f47ef0f
00 |

Done
```

5.2.6 To verify, whether the device communication is successful send ping from raspberry pi to child device.

```
pi@raspberrypi: ~
pi@raspberrypi:~ $ sudo ot-ctl
> ping 2001:db8:0:0:cf3d:172e:c2fb:ee2e
Done
> 16 bytes from 2001:db8:0:0:cf3d:172e:c2fb:ee2e: icmp_seq=2 hlim=255 time=35ms
```

Now, CHIP end-device is successfully on thread network.

5.3 Building CHIP-TOOL in Linux VM

***Note**: Instruction provided in this **section 5.3** can be used to build Chip-tool on WSL2 (Windows 10), Native Linux or Mac machine) But WSL2 cannot act as client to send messages using chip-tool*

Chip-tool allow to send message over thread network to control CHIP END-DEVICE. Before using chip-tool, we must build binaries just like lock-app example.

On Virtual Machine, open Linux terminal, and switch to chip-tool directory under '**connectedhomeip**' directory.

```
cd examples/chip-tool
```

```
git submodule update --init
```

```
source third_party/connectedhomeip/scripts/activate.sh
```

```
gn gen out/debug
```

```
ninja -C out/debug
```

Now, generated binaries for chip-tool are under '***~/examples/chip-tool/out/debug'*** folder. Using chip-tool you can now control the lock status with on/off command. But before that we need to add ipv6 route in next step.

5.4 ADD IPV6 Route on Client Device

Client device is used to send messages to Chip End device. Linux VM or native Linux or Mac machine can be used as client device.

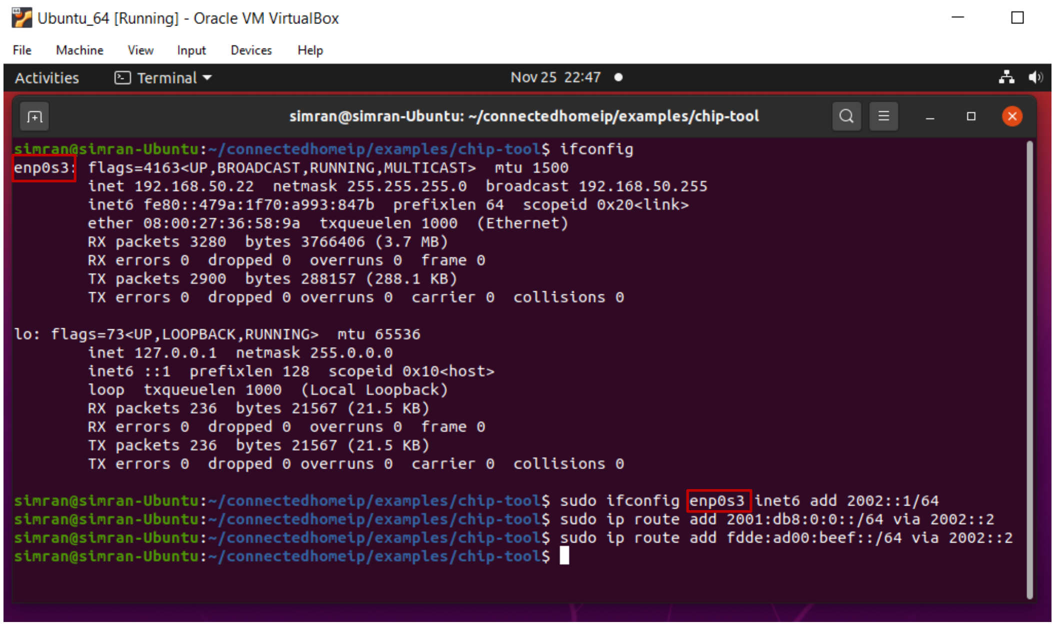
Note: WSL2 does not currently support IPV6 routing and cannot be act as client for sending messages using chip-tool.

- Type the following command on VM (Ubuntu) (or native Linux Ubuntu machine)

```
sudo ifconfig <interface> inet6 add 2002::1/64
```

```
sudo ip route add 2001:db8:0:0::/64 via 2002::2
```

```
sudo ip route add fdde:ad00:beef::/64 via 2002::2
```



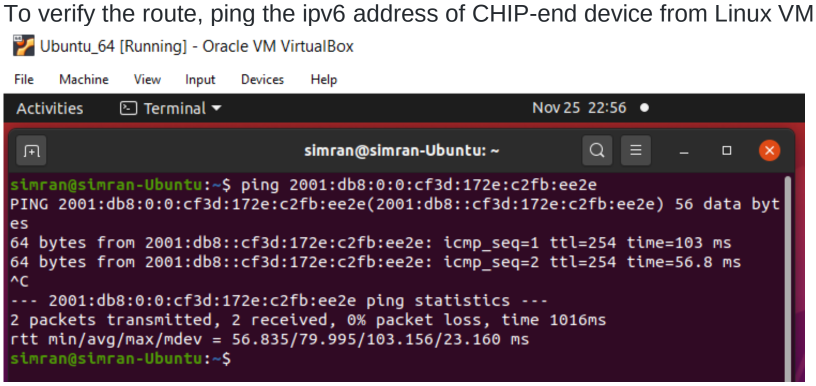
- **On Mac machine**, following commands can be used to add ipv6 routes

```
sudo ifconfig <interface> inet6 add 2002::1/64   //e.g enp0s3
```

```
sudo route add -inet6 2001:db8:0:0::/64 2002::2
```

```
sudo route add -inet6 fdde:ad00:beef::/64 2002::2
```

To verify the route, ping the ipv6 address of CHIP-end device from Linux VM



Note*: Chip-tool is currently working on Linux VM/ native Linux machine or Mac machine. WSL2 on Windows 10 does not fully support bridge network mode to run chip-tool via ivp6 route.*

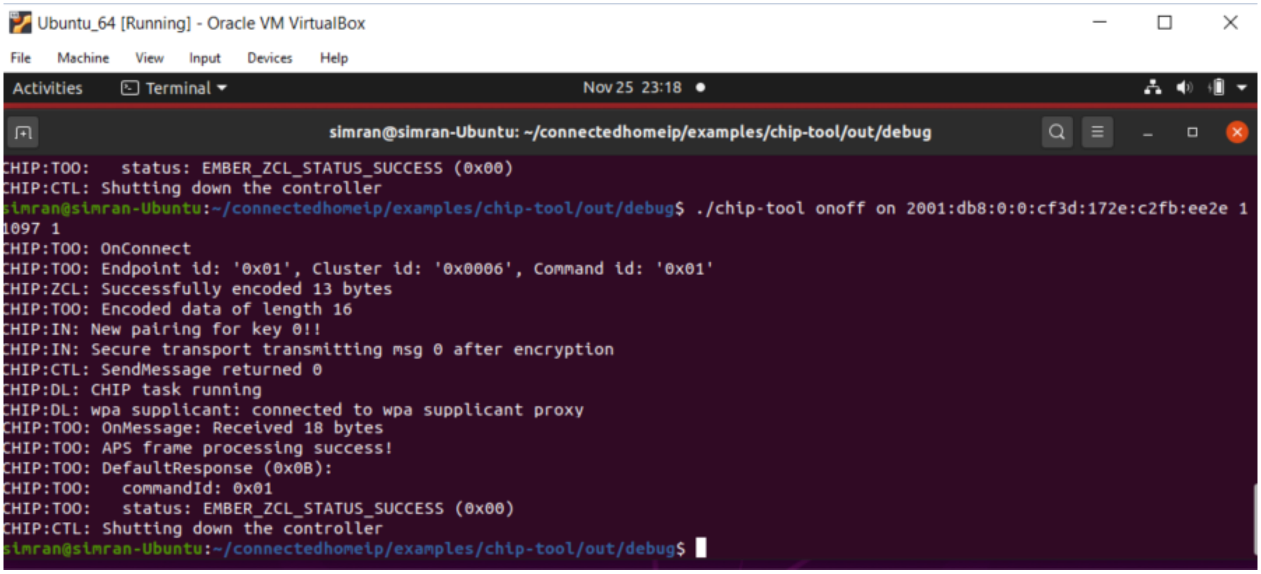
5.5 Send message using Chip-tool to End-Device

- *Currenlty, WSL2 cannot work as client to send messages using chip-tool*.

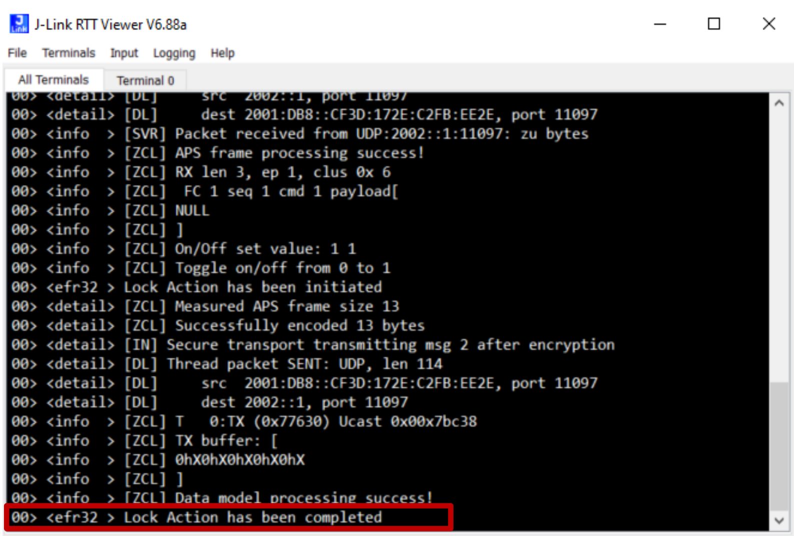
To use the Client to send a CHIP commands, run the built executable and pass it the target cluster name, the target command name, the IP address and port of the server to talk to as well as an endpoint id. The endpoint id must be between 1 and 240.

1. On VM, open Linux terminal window, make sure we are in the '***~/connectedhomeip/examples/chip-tool/out/debug'*** directory.
2. Using chip-tool, control the lock status with on/off command.

```
./chip-tool onoff on <ipv6 address of the node> 11097 1
```



On J-Link RTT Viewer connected on CHIP End-Device, you can verify the command is successfully executed. Also, on WSTK you can see Led is turned ON.



This complete the tutorial on building CHIP Lock-app. End device can establish communication with OTBR and able to send messages to CHIP end device via client running on Linux VM.