IITB-FOSSEE WINTER INTERNSHIP 2025

MARKDOWN REPORT

THEME: **OPEN SOURCE HARDWARE**

TOPIC: **BUILD AND DEMONSTRATE ESP32 EMULATION FROM SCRATCH USING QEMU.**

SUBMITTED BY: SHRUT MAHENDRA PATIL & SIDDHI VIRAG LAD

GITHUB PROJECT LINK:

shrutmpatil/IITB_FOSSEE_Open-Source_Hardware

CONTENTS

1. INTRODUCTION 4
   A. AIM OF THE STUDY 4
   B. OBJECTIVES 4
   C. DELIVERABLES 4
   D. MINIMUM SYSTEM REQUIREMENTS 4
   E. PROJECT STRUCTURE 4
2. STEPS FOR INSTALLING OPERATING SYSTEM 5
   A. INSTALLING ON DUAL BOOT 5
   B. INSTALLING ON VIRTUAL MACHINE 6
3. INSTALLATIONS ON OS 8
   A. PRE-REQUISITES 8
   B. BUILD QEMU FOR ESP32 10
   C. INSTALL QEMU FOR ESP32 12
4. PROGRAM DEMONSTRATIONS 13
   A. LED BLINK PROJECT 13
   B. TEMPERATURE BASED ESP32 15
   C. MISCELLANEOUS 17
5. ISSUES ENCOUNTERED AND THEIR SOLUTIONS 18
   A. ENVIRONMENT SETUP FAILURE 18
   B. QEMU TOOL VERIFICATION FAILURE 18
6. REFERENCES 19

1. INTRODUCTION:

A. AIM OF THE STUDY:

The aim is to build a complete ESP32 emulation environment using QEMU and ESP-IDF, demonstrating LED blink and temperature reading applications for automated code evaluation.

B. OBJECTIVES:

- Set up a complete ESP32 emulation environment using QEMU and ESP-IDF on Linux/WSL
- Install and configure all necessary prerequisites including git, python3, cmake, and development tools.
- Build QEMU from Espressif's fork with xtensa-softmmu target for ESP32 support.
- Install and verify ESP-IDF SDK with compiler, libraries, and command-line tools.
- Create, compile, and run ESP32 projects using idf.py build tools.
- Demonstrate two working examples: LED blink simulation and temperature sensor reading.
- Document the complete process with screenshots, challenges, and application to Yaksh automated evaluation.

C. DELIVERABLES:

- **Functional QEMU-based ESP32 Emulator -** Complete local environment setup with working QEMU installation and ESP-IDF SDK configured.
- **LED Blink Application -** Working program that toggles GPIO pin and displays "LED ON/OFF" messages in QEMU console.
- **Temperature Reading Application -** Functional sensor simulation that generates and displays periodic temperature readings with threshold alerts.
- **Console Output Screenshots -** Captured images showing both programs successfully running in QEMU with visible output logs.
- **Markdown Documentation Report -** Comprehensive report.md containing system information, setup commands, challenges faced, solutions implemented, screenshots, and reflection on Yaksh integration.

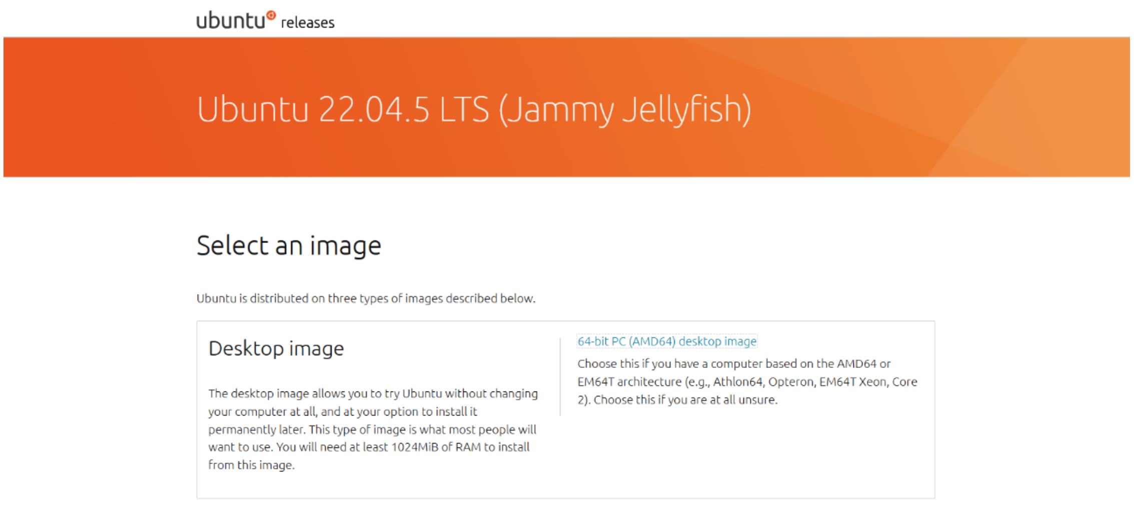
D. MINIMUM SYSTEM REQUIREMENTS:

1. Ubuntu 22.04 LTS Operating System
2. Minimum 4-8 GB RAM
3. 40-100 GB of Free Space

E. PROJECT STRUCTURE:

```
~/esp/
├── esp-idf/
├── blink_qemu/
│   └── main/
│       └── main.c
└── temp_sim_qemu/
    └── main/
        └── main.c
```

2. STEPS FOR INSTALLING OPERATING SYSTEM:


ubuntu releases

Ubuntu 22.04.5 LTS (Jammy Jellyfish)

Select an image

Ubuntu is distributed on three types of images described below.

Desktop image

The desktop image allows you to try Ubuntu without changing your computer at all, and at your option to install it permanently later. This type of image is what most people will want to use. You will need at least 1024MiB of RAM to install from this image.

64-bit PC (AMD64) desktop image

Choose this if you have a computer based on the AMD64 or EM64T architecture (e.g., Athlon64, Opteron, EM64T Xeon, Core 2). Choose this if you are at all unsure.

(Version considered for the installation - Official Website Image)

A. INSTALLING ON DUAL BOOT:

I. Download Ubuntu ISO

1. Open the official Ubuntu website.
2. Click Download → Ubuntu Desktop → Ubuntu 22.04 LTS.
3. Save the ISO file to your Windows system.

II. Download and Prepare Rufus

1. Download Rufus from its official website.
2. Connect your USB drive (8GB+).
3. Open Rufus as administrator.
4. Select your USB under Device.
5. Click Select and choose the Ubuntu 22.04 ISO.
6. Set Partition scheme: GPT and Target system: UEFI.
7. Keep File system as FAT32.
8. Click Start and wait for the USB to finish writing.

III. Prepare Windows for Dual Boot

1. Open Disk Management in Windows.
2. Right-click C: drive and select Shrink Volume.
3. Shrink and create at least 25GB unallocated space.
4. Open Control Panel → Power Options.
5. Disable Fast Startup in shutdown settings.
6. Restart and enter BIOS/UEFI.
7. Disable Secure Boot if necessary.

IV. Boot from USB

1. Restart the computer with USB inserted.
2. Press your boot key (e.g., HP: Esc/F9, Dell: F12, Lenovo: F12).

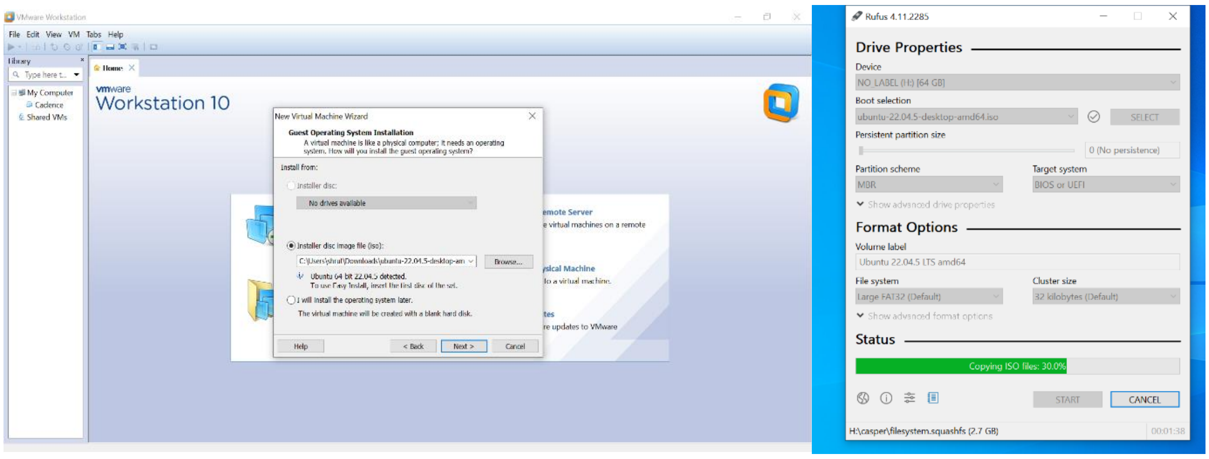
3. Select the USB drive from the boot menu.
4. Choose Try or Install Ubuntu.

V. Install Ubuntu

1. Click Install Ubuntu on the installer screen.
2. Choose language and keyboard layout.
3. Select Normal Installation.
4. Choose Install Ubuntu alongside Windows Boot Manager.
5. If not shown, choose Something Else and use the free space to create partitions.
6. Click Install Now and proceed.
7. Set your username, password, and location.
8. Wait for installation to finish.

VI. Final Setup

1. Restart the computer when prompted.
2. Remove the USB drive.
3. Choose between Ubuntu or Windows from the GRUB boot menu at startup.



New Virtual Machine Wizard

Guest Operating System Installation
A virtual machine is like a physical computer; it needs an operating system. How will you install the guest operating system?

Install from:
Installer disc: No drives available
Installer disc image file (iso): C:\Users\shruti\Downloads\ubuntu-22.04.5-desktop-am
Ubuntu 64 bit 22.04.5 detected.
To use Easy Install, insert the first disc of the set.
I will install the operating system later.
The virtual machine will be created with a blank hard disk.

Rufus 4.11.2285

Drive Properties
Device: NO_LABEL (H:) [64 GB]
Boot selection: ubuntu-22.04.5-desktop-amd64.iso
Persistent partition size: 0 (No persistence)
Partition scheme: MBR
Target system: BIOS or UEFI
Show advanced drive properties

Format Options
Volume label: Ubuntu 22.04.5 LTS amd64
File system: Large FAT32 (Default)
Cluster size: 32 kilobytes (Default)
Show advanced format options

Status
Copying ISO files: 30.0%
H:\casper\filesystem.squashfs (2.7 GB) 00:01:38

(Installation in Virtual Machine – VM Were and Creating a Bootable Drive from Rufus on the Windows Sub system))

B. INSTALLING ON VIRTUAL MACHINE:

I. Download Required Files

1. Open the official Ubuntu website.
2. Click Download → Ubuntu Desktop → Ubuntu 22.04 LTS.
3. Save the ISO file to your computer.
4. Visit the VMware website and download VMware Workstation Player (free for personal use).
5. Install VMware Workstation Player in Windows.

II. Create a New Virtual Machine

1. Open VMware Workstation Player.
2. Click Create a New Virtual Machine.
3. Select Installer disc image file (ISO).
4. Browse and select the downloaded Ubuntu ISO.
5. Click Next.

III. Configure VM Settings

1. Enter your Full Name, Username, and Password when asked.
2. Choose the VM name and installation location.
3. Set Disk size (recommended 25GB or more).
4. Choose Store virtual disk as a single file.
5. Click Customize Hardware (optional).
6. Increase RAM to 4GB or more if available.
7. Increase CPU cores to 2 or more if available.
8. Click Finish to create the VM.

IV. Start Ubuntu Installation

1. Click Play Virtual Machine in VMware.
2. Ubuntu installer will automatically start.
3. Choose Install Ubuntu.
4. Pick language and keyboard settings.
5. Select Normal Installation.
6. Enable Download updates while installing (optional).
7. Click Continue.

V. Complete Installation

1. Select Erase disk and install Ubuntu (only affects the virtual machine, not your real OS).
2. Click Install Now and confirm.
3. Select your time zone.
4. Wait for installation to complete.

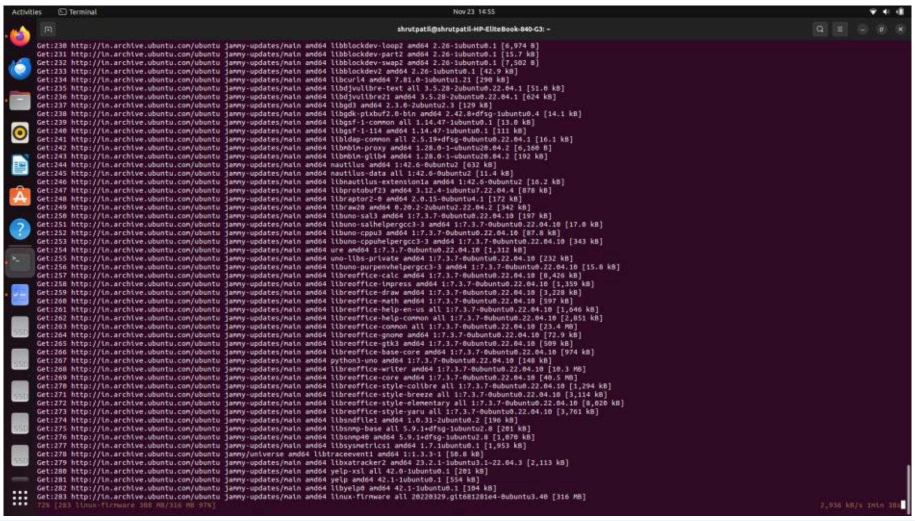
VI. Finish Setup

1. Click Restart Now when prompted.
2. Log in using the credentials you created.
3. Ubuntu 22.04 is now fully installed inside VMware.

3. INSTALLATIONS ON OS

A. PRE-REQUISITES:

```
sudo apt-get update
sudo apt-get upgrade -y

sudo apt-get install -y git wget flex bison gperf python3 python3-pip
python3-venv cmake ninja-build ccache libffi-dev libssl-dev dfu-util
libusb-1.0-0

sudo apt-get install -y libsdl2-dev libslirp-dev
```



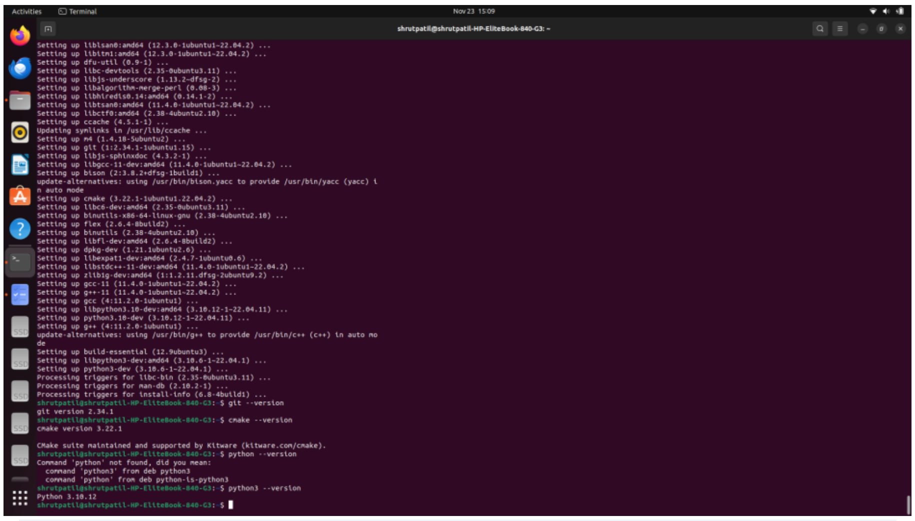
```
Get:230 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libblockdev-loop2 amd64 2.26-1ubuntu0.1 [6,974 B]
Get:231 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libblockdev-part2 amd64 2.26-1ubuntu0.1 [15.7 kB]
Get:232 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libblockdev-swap2 amd64 2.26-1ubuntu0.1 [7,502 B]
Get:233 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libblockdev2 amd64 2.26-1ubuntu0.1 [42.9 kB]
Get:234 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libcurl4 amd64 7.81.0-1ubuntu1.21 [290 kB]
Get:235 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libdjvulibre-text all 3.5.28-2ubuntu0.22.04.1 [51.0 kB]
Get:236 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libdjvulibre21 amd64 3.5.28-2ubuntu0.22.04.1 [624 kB]
Get:237 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgd3 amd64 2.3.0-2ubuntu2.3 [129 kB]
Get:238 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgdk-pixbuf2.0-bin amd64 2.42.8+dfsg-1ubuntu0.4 [14.1 kB]
Get:239 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgsf-1-common all 1.14.47-1ubuntu0.1 [13.0 kB]
Get:240 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libgsf-1-114 amd64 1.14.47-1ubuntu0.1 [111 kB]
Get:241 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libldap-common all 2.5.19+dfsg-0ubuntu0.22.04.1 [16.1 kB]
Get:242 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libmbim-proxy amd64 1.28.0-1~ubuntu20.04.2 [6,160 B]
Get:243 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libmbim-glib4 amd64 1.28.0-1~ubuntu20.04.2 [192 kB]
Get:244 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 nautilus amd64 1:42.6-0ubuntu2 [632 kB]
Get:245 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 nautilus-data all 1:42.6-0ubuntu2 [11.4 kB]
Get:246 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libnautilus-extension1a amd64 1:42.6-0ubuntu2 [16.2 kB]
Get:247 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libprotobuf23 amd64 3.12.4-1ubuntu7.22.04.4 [878 kB]
Get:248 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libraptor2-0 amd64 2.0.15-0ubuntu4.1 [172 kB]
Get:249 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libraw20 amd64 0.20.2-2ubuntu2.22.04.2 [342 kB]
Get:250 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libuno-sal3 amd64 1:7.3.7-0ubuntu0.22.04.10 [197 kB]
Get:251 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libuno-salhelpergcc3-3 amd64 1:7.3.7-0ubuntu0.22.04.10 [17.0 kB]
Get:252 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libuno-cppu3 amd64 1:7.3.7-0ubuntu0.22.04.10 [87.8 kB]
Get:253 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libuno-cppuhelpergcc3-3 amd64 1:7.3.7-0ubuntu0.22.04.10 [343 kB]
Get:254 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 ure amd64 1:7.3.7-0ubuntu0.22.04.10 [1,312 kB]
Get:255 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 uno-libs-private amd64 1:7.3.7-0ubuntu0.22.04.10 [232 kB]
Get:256 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libuno-purpenvhelpergcc3-3 amd64 1:7.3.7-0ubuntu0.22.04.10 [15.8 kB]
Get:257 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-calc amd64 1:7.3.7-0ubuntu0.22.04.10 [8,426 kB]
Get:258 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-impress amd64 1:7.3.7-0ubuntu0.22.04.10 [1,359 kB]
Get:259 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-draw amd64 1:7.3.7-0ubuntu0.22.04.10 [3,228 kB]
Get:260 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-math amd64 1:7.3.7-0ubuntu0.22.04.10 [597 kB]
Get:261 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-help-en-us all 1:7.3.7-0ubuntu0.22.04.10 [1,646 kB]
Get:262 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-help-common all 1:7.3.7-0ubuntu0.22.04.10 [2,851 kB]
Get:263 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-common all 1:7.3.7-0ubuntu0.22.04.10 [23.4 MB]
Get:264 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-gnome amd64 1:7.3.7-0ubuntu0.22.04.10 [72.9 kB]
Get:265 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-gtk3 amd64 1:7.3.7-0ubuntu0.22.04.10 [509 kB]
Get:266 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-base-core amd64 1:7.3.7-0ubuntu0.22.04.10 [974 kB]
Get:267 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 python3-uno amd64 1:7.3.7-0ubuntu0.22.04.10 [148 kB]
Get:268 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-writer amd64 1:7.3.7-0ubuntu0.22.04.10 [10.3 MB]
Get:269 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-core amd64 1:7.3.7-0ubuntu0.22.04.10 [40.5 MB]
Get:270 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-style-colibre all 1:7.3.7-0ubuntu0.22.04.10 [1,294 kB]
Get:271 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-style-breeze all 1:7.3.7-0ubuntu0.22.04.10 [3,114 kB]
Get:272 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-style-elementary all 1:7.3.7-0ubuntu0.22.04.10 [8,020 kB]
Get:273 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libreoffice-style-yaru all 1:7.3.7-0ubuntu0.22.04.10 [3,761 kB]
Get:274 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsndfile1 amd64 1.0.31-2ubuntu0.2 [196 kB]
Get:275 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsnmp-base all 5.9.1+dfsg-1ubuntu2.8 [201 kB]
Get:276 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsnmp40 amd64 5.9.1+dfsg-1ubuntu2.8 [1,070 kB]
Get:277 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libsysmetrics1 amd64 1.7.1ubuntu0.1 [1,953 kB]
Get:278 http://in.archive.ubuntu.com/ubuntu jammy/universe amd64 libtraceevent1 amd64 1:1.3.3-1 [50.8 kB]
Get:279 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libxatracker2 amd64 23.2.1-1ubuntu3.1~22.04.3 [2,113 kB]
Get:280 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 yelp-xsl all 42.0-1ubuntu0.1 [201 kB]
Get:281 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 yelp amd64 42.1-1ubuntu0.1 [554 kB]
Get:282 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 libyelp0 amd64 42.1-1ubuntu0.1 [104 kB]
Get:283 http://in.archive.ubuntu.com/ubuntu jammy-updates/main amd64 linux-firmware all 20220329.git681281e4-0ubuntu3.40 [316 MB]
72% [283 linux-firmware 308 MB/316 MB 97%]                                                    2,936 kB/s 1min 38s
```

(This are the commands used to update the initial operating system to latest level after that installing various frameworks like python, git, cmake, bison, etc)

`git --version (2.34.1)`

`Cmake --version (3.22.1)`

`Python3 --version (3.10.12)`

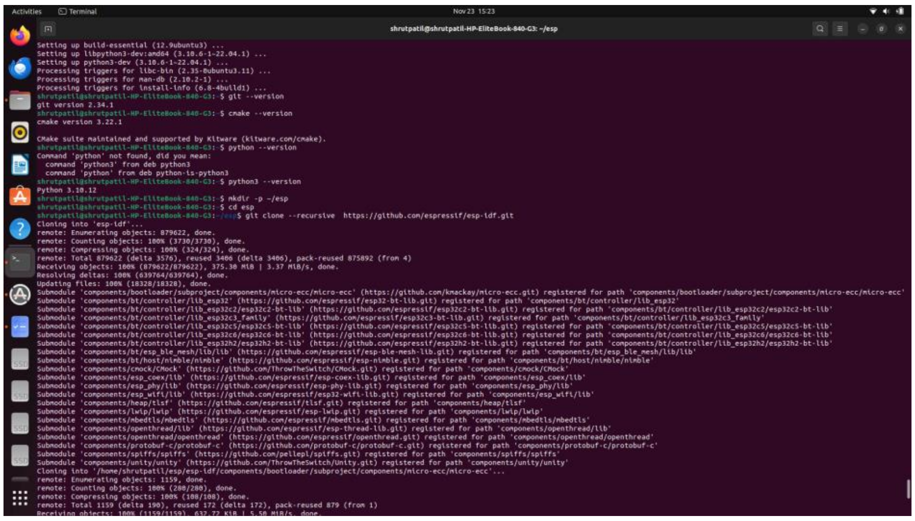


```
Setting up liblsan0:amd64 (12.3.0-1ubuntu1~22.04.2) ...
Setting up libitm1:amd64 (12.3.0-1ubuntu1~22.04.2) ...
Setting up dfu-util (0.9-1) ...
Setting up libc-devtools (2.35-0ubuntu3.11) ...
Setting up libjs-underscore (1.13.2~dfsg-2) ...
Setting up libalgorithm-merge-perl (0.08-3) ...
Setting up libhiredis0.14:amd64 (0.14.1-2) ...
Setting up libtsan0:amd64 (11.4.0-1ubuntu1~22.04.2) ...
Setting up libctf0:amd64 (2.38-4ubuntu2.10) ...
Setting up ccache (4.5.1-1) ...
Updating symlinks in /usr/lib/ccache ...
Setting up m4 (1.4.18-5ubuntu2) ...
Setting up git (1:2.34.1-1ubuntu1.15) ...
Setting up libjs-sphinxdoc (4.3.2-1) ...
Setting up libgcc-11-dev:amd64 (11.4.0-1ubuntu1~22.04.2) ...
Setting up bison (2:3.8.2+dfsg-1build1) ...
update-alternatives: using /usr/bin/bison.yacc to provide /usr/bin/yacc (yacc) i
n auto mode
Setting up cmake (3.22.1-1ubuntu1.22.04.2) ...
Setting up libc6-dev:amd64 (2.35-0ubuntu3.11) ...
Setting up binutils-x86-64-linux-gnu (2.38-4ubuntu2.10) ...
Setting up flex (2.6.4-8build2) ...
Setting up binutils (2.38-4ubuntu2.10) ...
Setting up libfl-dev:amd64 (2.6.4-8build2) ...
Setting up dpkg-dev (1.21.1ubuntu2.6) ...
Setting up libexpat1-dev:amd64 (2.4.7-1ubuntu0.6) ...
Setting up libstdc++-11-dev:amd64 (11.4.0-1ubuntu1~22.04.2) ...
Setting up zlib1g-dev:amd64 (1:1.2.11.dfsg-2ubuntu9.2) ...
Setting up gcc-11 (11.4.0-1ubuntu1~22.04.2) ...
Setting up g++-11 (11.4.0-1ubuntu1~22.04.2) ...
Setting up gcc (4:11.2.0-1ubuntu1) ...
Setting up libpython3.10-dev:amd64 (3.10.12-1~22.04.11) ...
Setting up python3.10-dev (3.10.12-1~22.04.11) ...
Setting up g++ (4:11.2.0-1ubuntu1) ...
update-alternatives: using /usr/bin/g++ to provide /usr/bin/c++ (c++) in auto mo
de
Setting up build-essential (12.9ubuntu3) ...
Setting up libpython3-dev:amd64 (3.10.6-1~22.04.1) ...
Setting up python3-dev (3.10.6-1~22.04.1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.11) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for install-info (6.8-4build1) ...
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ git --version
git version 2.34.1
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ cmake --version
cmake version 3.22.1

CMake suite maintained and supported by Kitware (kitware.com/cmake).
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ python --version
Command 'python' not found, did you mean:
  command 'python3' from deb python3
  command 'python' from deb python-is-python3
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ python3 --version
Python 3.10.12
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$
```

(Versions of the different frameworks installed ~ for clarifying their installations in the system registry

B. BUILD QEMU FOR ESP32:

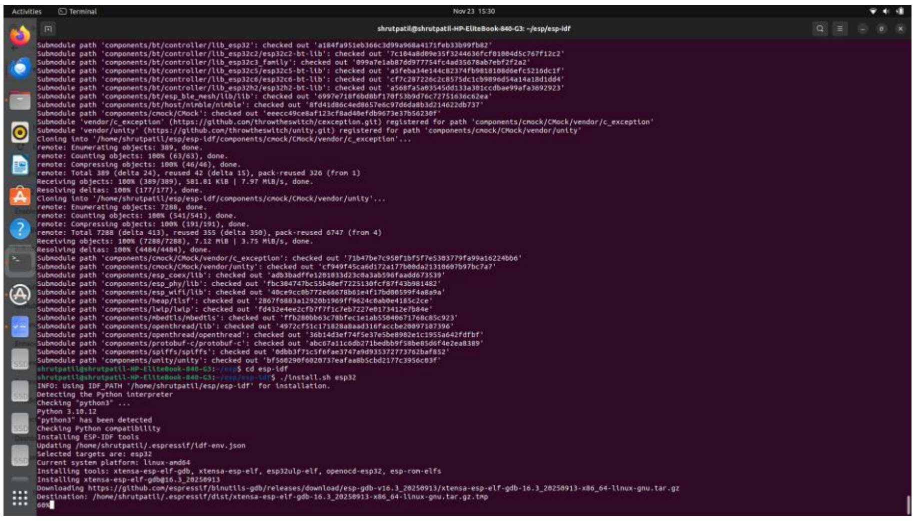
```
mkdir -p ~/esp32-qemu-project
cd ~/esp32-qemu-project
git clone https://github.com/espressif/qemu.git
```



```
shrutpatil@shrutpatil-HP-EliteBook-840-G3: ~/esp
Setting up build-essential (12.9ubuntu3) ...
Setting up libpython3-dev:amd64 (3.10.6-1~22.04.1) ...
Setting up python3-dev (3.10.6-1~22.04.1) ...
Processing triggers for libc-bin (2.35-0ubuntu3.11) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for install-info (6.8-4build1) ...
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ git --version
git version 2.34.1
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ cmake --version
cmake version 3.22.1

CMake suite maintained and supported by Kitware (kitware.com/cmake).
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ python --version
Command 'python' not found, did you mean:
  command 'python3' from deb python3
  command 'python' from deb python-is-python3
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ python3 --version
Python 3.10.12
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ mkdir -p ~/esp
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ cd esp
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp$ git clone --recursive  https://github.com/espressif/esp-idf.git
Cloning into 'esp-idf'...
remote: Enumerating objects: 879622, done.
remote: Counting objects: 100% (3730/3730), done.
remote: Compressing objects: 100% (324/324), done.
remote: Total 879622 (delta 3576), reused 3406 (delta 3406), pack-reused 875892 (from 4)
Receiving objects: 100% (879622/879622), 375.30 MiB | 3.37 MiB/s, done.
Resolving deltas: 100% (639764/639764), done.
Updating files: 100% (18328/18328), done.
Submodule 'components/bootloader/subproject/components/micro-ecc/micro-ecc' (https://github.com/kmackay/micro-ecc.git) registered for path 'components/bootloader/subproject/components/micro-ecc/micro-ecc'
Submodule 'components/bt/controller/lib_esp32' (https://github.com/espressif/esp32-bt-lib.git) registered for path 'components/bt/controller/lib_esp32'
Submodule 'components/bt/controller/lib_esp32c2/esp32c2-bt-lib' (https://github.com/espressif/esp32c2-bt-lib.git) registered for path 'components/bt/controller/lib_esp32c2/esp32c2-bt-lib'
Submodule 'components/bt/controller/lib_esp32c3_family' (https://github.com/espressif/esp32c3-bt-lib.git) registered for path 'components/bt/controller/lib_esp32c3_family'
Submodule 'components/bt/controller/lib_esp32c5/esp32c5-bt-lib' (https://github.com/espressif/esp32c5-bt-lib.git) registered for path 'components/bt/controller/lib_esp32c5/esp32c5-bt-lib'
Submodule 'components/bt/controller/lib_esp32c6/esp32c6-bt-lib' (https://github.com/espressif/esp32c6-bt-lib.git) registered for path 'components/bt/controller/lib_esp32c6/esp32c6-bt-lib'
Submodule 'components/bt/controller/lib_esp32h2/esp32h2-bt-lib' (https://github.com/espressif/esp32h2-bt-lib.git) registered for path 'components/bt/controller/lib_esp32h2/esp32h2-bt-lib'
Submodule 'components/bt/esp_ble_mesh/lib/lib' (https://github.com/espressif/esp-ble-mesh-lib.git) registered for path 'components/bt/esp_ble_mesh/lib/lib'
Submodule 'components/bt/host/nimble/nimble' (https://github.com/espressif/esp-nimble.git) registered for path 'components/bt/host/nimble/nimble'
Submodule 'components/cmock/CMock' (https://github.com/ThrowTheSwitch/CMock.git) registered for path 'components/cmock/CMock'
Submodule 'components/esp_coex/lib' (https://github.com/espressif/esp-coex-lib.git) registered for path 'components/esp_coex/lib'
Submodule 'components/esp_phy/lib' (https://github.com/espressif/esp-phy-lib.git) registered for path 'components/esp_phy/lib'
Submodule 'components/esp_wifi/lib' (https://github.com/espressif/esp32-wifi-lib.git) registered for path 'components/esp_wifi/lib'
Submodule 'components/heap/tlsf' (https://github.com/espressif/tlsf.git) registered for path 'components/heap/tlsf'
Submodule 'components/lwip/lwip' (https://github.com/espressif/esp-lwip.git) registered for path 'components/lwip/lwip'
Submodule 'components/mbedtls/mbedtls' (https://github.com/espressif/mbedtls.git) registered for path 'components/mbedtls/mbedtls'
Submodule 'components/openthread/lib' (https://github.com/espressif/esp-thread-lib.git) registered for path 'components/openthread/lib'
Submodule 'components/openthread/openthread' (https://github.com/espressif/openthread.git) registered for path 'components/openthread/openthread'
Submodule 'components/protobuf-c/protobuf-c' (https://github.com/protobuf-c/protobuf-c.git) registered for path 'components/protobuf-c/protobuf-c'
Submodule 'components/spiffs/spiffs' (https://github.com/pellepl/spiffs.git) registered for path 'components/spiffs/spiffs'
Submodule 'components/unity/unity' (https://github.com/ThrowTheSwitch/Unity.git) registered for path 'components/unity/unity'
Cloning into '/home/shrutpatil/esp/esp-idf/components/bootloader/subproject/components/micro-ecc/micro-ecc'...
remote: Enumerating objects: 1159, done.
remote: Counting objects: 100% (280/280), done.
remote: Compressing objects: 100% (108/108), done.
remote: Total 1159 (delta 190), reused 172 (delta 172), pack-reused 879 (from 1)
Receiving objects: 100% (1159/1159), 632.72 KiB | 5.50 MiB/s, done.
```

(Creating Directory of ESP-IDF & cloning ESP-IDF repository from GitHub with sub-modules)

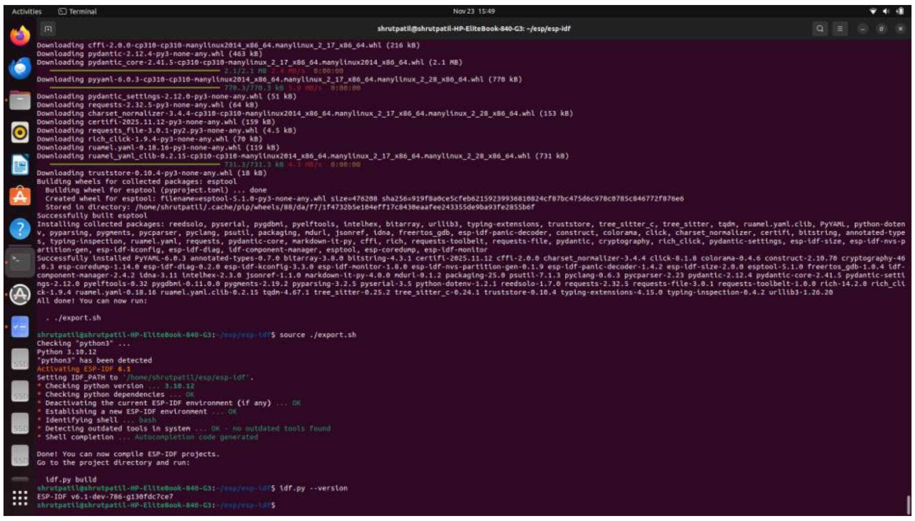
```
cd esp-idf
./install.sh esp32
```



```
shrutpatil@shrutpatil-HP-EliteBook-840-G3: ~/esp/esp-idf
Submodule path 'components/bt/controller/lib_esp32': checked out 'a184fa951eb366c3d99a968a4171feb33b99fb82'
Submodule path 'components/bt/controller/lib_esp32c2/esp32c2-bt-lib': checked out '7c104a8d09e35f3244636fcf01004d5c767f12c2'
Submodule path 'components/bt/controller/lib_esp32c3_family': checked out '099a7e1ab87dd977754fc4ad35678ab7ebf2f2a2'
Submodule path 'components/bt/controller/lib_esp32c5/esp32c5-bt-lib': checked out 'a5feba34e144c82374fb9818108d6efc5216dc1f'
Submodule path 'components/bt/controller/lib_esp32c6/esp32c6-bt-lib': checked out 'cf7c287226c2c8575dc1cb9896d54a14a18d1dd4'
Submodule path 'components/bt/controller/lib_esp32h2/esp32h2-bt-lib': checked out 'a568fa5a03545dd133a301ccdbae99afa3692923'
Submodule path 'components/bt/esp_ble_mesh/lib/lib': checked out '6997e718f6bd8bf170f53b9d76c72751636c62ea'
Submodule path 'components/bt/host/nimble/nimble': checked out '8fd41d86c4ed8657e6c97d6da8b3d214622db737'
Submodule path 'components/cmock/CMock': checked out 'eeecc49ce8af123cf8ad40efdb9673e37b56230f'
Submodule 'vendor/c_exception' (https://github.com/throwtheswitch/cexception.git) registered for path 'components/cmock/CMock/vendor/c_exception'
Submodule 'vendor/unity' (https://github.com/throwtheswitch/unity.git) registered for path 'components/cmock/CMock/vendor/unity'
Cloning into '/home/shrutpatil/esp/esp-idf/components/cmock/CMock/vendor/c_exception'...
remote: Enumerating objects: 389, done.
remote: Counting objects: 100% (63/63), done.
remote: Compressing objects: 100% (46/46), done.
remote: Total 389 (delta 24), reused 42 (delta 15), pack-reused 326 (from 1)
Receiving objects: 100% (389/389), 581.81 KiB | 7.97 MiB/s, done.
Resolving deltas: 100% (177/177), done.
Cloning into '/home/shrutpatil/esp/esp-idf/components/cmock/CMock/vendor/unity'...
remote: Enumerating objects: 7288, done.
remote: Counting objects: 100% (541/541), done.
remote: Compressing objects: 100% (191/191), done.
remote: Total 7288 (delta 413), reused 355 (delta 350), pack-reused 6747 (from 4)
Receiving objects: 100% (7288/7288), 7.12 MiB | 3.75 MiB/s, done.
Resolving deltas: 100% (4484/4484), done.
Submodule path 'components/cmock/CMock/vendor/c_exception': checked out '71b47be7c950f1bf5f7e5303779fa99a16224bb6'
Submodule path 'components/cmock/CMock/vendor/unity': checked out 'cf949f45ca6d172a177b00da21318607b97bc7a7'
Submodule path 'components/esp_coex/lib': checked out 'adb3badffe1201033d23c0a3ab596faadd673539'
Submodule path 'components/esp_phy/lib': checked out 'fbc304747bc55b40ef7225130fcf87f43b981482'
Submodule path 'components/esp_wifi/lib': checked out '40ce9cc0b772e66678b61e4f17bd00599f4a8a9a'
Submodule path 'components/heap/tlsf': checked out '2867f6883a12920b1969ff9624c0ab0e4185c2ce'
Submodule path 'components/lwip/lwip': checked out 'fd432e4ee2cfb7f7f1c7eb7227e0173412e7b84e'
Submodule path 'components/mbedtls/mbedtls': checked out 'ffb280bb63c78bfec1e1ab55040671768c85c923'
Submodule path 'components/openthread/lib': checked out '4972cf51c171828a8aad316faccbe20097107396'
Submodule path 'components/openthread/openthread': checked out '36b14d3ef74f5e37e5be8902e1c1955a642fdfbf'
Submodule path 'components/protobuf-c/protobuf-c': checked out 'abc67a11c6db271bedbb9f58be85d6f4e2ea8389'
Submodule path 'components/spiffs/spiffs': checked out '0dbb3f71c5f6fae3747a9d935372773762baf852'
Submodule path 'components/unity/unity': checked out 'bf560290f6020737eafaa8b5cbd2177c3956c03f'
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp$ cd esp-idf
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ ./install.sh esp32
INFO: Using IDF_PATH '/home/shrutpatil/esp/esp-idf' for installation.
Detecting the Python interpreter
Checking "python3" ...
Python 3.10.12
"python3" has been detected
Checking Python compatibility
Installing ESP-IDF tools
Updating /home/shrutpatil/.espressif/idf-env.json
Selected targets are: esp32
Current system platform: linux-amd64
Installing tools: xtensa-esp-elf-gdb, xtensa-esp-elf, esp32ulp-elf, openocd-esp32, esp-rom-elfs
Installing xtensa-esp-elf-gdb@16.3_20250913
Downloading https://github.com/espressif/binutils-gdb/releases/download/esp-gdb-v16.3_20250913/xtensa-esp-elf-gdb-16.3_20250913-x86_64-linux-gnu.tar.gz
Destination: /home/shrutpatil/.espressif/dist/xtensa-esp-elf-gdb-16.3_20250913-x86_64-linux-gnu.tar.gz.tmp
60%
```

(Installing Toolchain and dependencies - This script will download and install the required xtensa-esp32-elf toolchain and all Python packages.)

```
source ./export.sh
idf.py -version (ESP-IDF v6.1-dev-786-g130fdc7ce7)
```



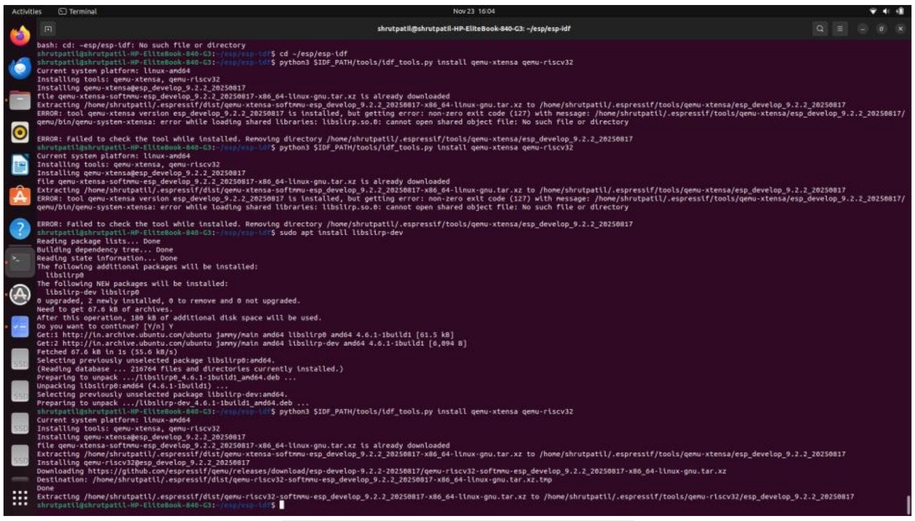
```
Downloading cffi-2.0.0-cp310-cp310-manylinux2014_x86_64.manylinux_2_17_x86_64.whl (216 kB)
Downloading pydantic-2.12.4-py3-none-any.whl (463 kB)
Downloading pydantic_core-2.41.5-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (2.1 MB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.1/2.1 MB 2.4 MB/s  0:00:00
Downloading pyyaml-6.0.3-cp310-cp310-manylinux2014_x86_64.manylinux_2_17_x86_64.manylinux_2_28_x86_64.whl (770 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 770.3/770.3 kB 5.9 MB/s  0:00:00
Downloading pydantic_settings-2.12.0-py3-none-any.whl (51 kB)
Downloading requests-2.32.5-py3-none-any.whl (64 kB)
Downloading charset_normalizer-3.4.4-cp310-cp310-manylinux2014_x86_64.manylinux_2_17_x86_64.manylinux_2_28_x86_64.whl (153 kB)
Downloading certifi-2025.11.12-py3-none-any.whl (159 kB)
Downloading requests_file-3.0.1-py2.py3-none-any.whl (4.5 kB)
Downloading rich_click-1.9.4-py3-none-any.whl (70 kB)
Downloading ruamel.yaml-0.18.16-py3-none-any.whl (119 kB)
Downloading ruamel_yaml_clib-0.2.15-cp310-cp310-manylinux2014_x86_64.manylinux_2_17_x86_64.manylinux_2_28_x86_64.whl (731 kB)
   ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 731.3/731.3 kB 4.3 MB/s  0:00:00
Downloading truststore-0.10.4-py3-none-any.whl (18 kB)
Building wheels for collected packages: esptool
  Building wheel for esptool (pyproject.toml) ... done
  Created wheel for esptool: filename=esptool-5.1.0-py3-none-any.whl size=476208 sha256=919f8a0ce5cfeb62159239936810824cf87bc475d6c970c0785c846772f876e6
  Stored in directory: /home/shrutpatil/.cache/pip/wheels/88/da/f7/1f4732b5e104eff17c8430eaafee243355de9ba93fe2855b6f
Successfully built esptool
Installing collected packages: reedsolo, pyserial, pygdbmi, pyelftools, intelhex, bitarray, urllib3, typing-extensions, truststore, tree_sitter_c, tree_sitter, tqdm, ruamel.yaml.clib, PyYAML, python-doten
v, pyparsing, pygments, pycparser, pyclang, psutil, packaging, mdurl, jsonref, idna, freertos_gdb, esp-idf-panic-decoder, construct, colorama, click, charset_normalizer, certifi, bitstring, annotated-type
s, typing-inspection, ruamel.yaml, requests, pydantic-core, markdown-it-py, cffi, rich, requests-toolbelt, requests-file, pydantic, cryptography, rich_click, pydantic-settings, esp-idf-size, esp-idf-nvs-p
artition-gen, esp-idf-kconfig, esp-idf-diag, idf-component-manager, esptool, esp-coredump, esp-idf-monitor
Successfully installed PyYAML-6.0.3 annotated-types-0.7.0 bitarray-3.8.0 bitstring-4.3.1 certifi-2025.11.12 cffi-2.0.0 charset_normalizer-3.4.4 click-8.1.8 colorama-0.4.6 construct-2.10.70 cryptography-46
.0.3 esp-coredump-1.14.0 esp-idf-diag-0.2.0 esp-idf-kconfig-3.3.0 esp-idf-monitor-1.8.0 esp-idf-nvs-partition-gen-0.1.9 esp-idf-panic-decoder-1.4.2 esp-idf-size-2.0.0 esptool-5.1.0 freertos_gdb-1.0.4 idf-
component-manager-2.4.2 idna-3.11 intelhex-2.3.0 jsonref-1.1.0 markdown-it-py-4.0.0 mdurl-0.1.2 packaging-25.0 psutil-7.1.3 pyclang-0.6.3 pycparser-2.23 pydantic-2.12.4 pydantic-core-2.41.5 pydantic-setti
ngs-2.12.0 pyelftools-0.32 pygdbmi-0.11.0.0 pygments-2.19.2 pyparsing-3.2.5 pyserial-3.5 python-dotenv-1.2.1 reedsolo-1.7.0 requests-2.32.5 requests-file-3.0.1 requests-toolbelt-1.0.0 rich-14.2.0 rich_cli
ck-1.9.4 ruamel.yaml-0.18.16 ruamel.yaml.clib-0.2.15 tqdm-4.67.1 tree_sitter-0.25.2 tree_sitter_c-0.24.1 truststore-0.10.4 typing-extensions-4.15.0 typing-inspection-0.4.2 urllib3-1.26.20
All done! You can now run:

  . ./export.sh

shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ source ./export.sh
Checking "python3" ...
Python 3.10.12
"python3" has been detected
Activating ESP-IDF 6.1
Setting IDF_PATH to '/home/shrutpatil/esp/esp-idf'.
* Checking python version ... 3.10.12
* Checking python dependencies ... OK
* Deactivating the current ESP-IDF environment (if any) ... OK
* Establishing a new ESP-IDF environment ... OK
* Identifying shell ... bash
* Detecting outdated tools in system ... OK - no outdated tools found
* Shell completion ... Autocompletion code generated

Done! You can now compile ESP-IDF projects.
Go to the project directory and run:

  idf.py build
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ idf.py --version
ESP-IDF v6.1-dev-786-g130fdc7ce7
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$
```

(Setting up the virtual environment and verifying the ESP-IDF version)

C. INSTALL QEMU FOR ESP32:

```
python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32
```

```
sudo apt install libslirp-dev
```



```
bash: cd: ~esp/esp-idf: No such file or directory
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ cd ~/esp/esp-idf
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32
Current system platform: linux-amd64
Installing tools: qemu-xtensa, qemu-riscv32
Installing qemu-xtensa@esp_develop_9.2.2_20250817
file qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz is already downloaded
Extracting /home/shrutpatil/.espressif/dist/qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz to /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817
ERROR: tool qemu-xtensa version esp_develop_9.2.2_20250817 is installed, but getting error: non-zero exit code (127) with message: /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817/
qemu/bin/qemu-system-xtensa: error while loading shared libraries: libslirp.so.0: cannot open shared object file: No such file or directory

ERROR: Failed to check the tool while installed. Removing directory /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32
Current system platform: linux-amd64
Installing tools: qemu-xtensa, qemu-riscv32
Installing qemu-xtensa@esp_develop_9.2.2_20250817
file qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz is already downloaded
Extracting /home/shrutpatil/.espressif/dist/qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz to /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817
ERROR: tool qemu-xtensa version esp_develop_9.2.2_20250817 is installed, but getting error: non-zero exit code (127) with message: /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817/
qemu/bin/qemu-system-xtensa: error while loading shared libraries: libslirp.so.0: cannot open shared object file: No such file or directory

ERROR: Failed to check the tool while installed. Removing directory /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ sudo apt install libslirp-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libslirp0
The following NEW packages will be installed:
  libslirp-dev libslirp0
0 upgraded, 2 newly installed, 0 to remove and 0 not upgraded.
Need to get 67.6 kB of archives.
After this operation, 180 kB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 http://in.archive.ubuntu.com/ubuntu jammy/main amd64 libslirp0 amd64 4.6.1-1build1 [61.5 kB]
Get:2 http://in.archive.ubuntu.com/ubuntu jammy/main amd64 libslirp-dev amd64 4.6.1-1build1 [6,094 B]
Fetched 67.6 kB in 1s (55.6 kB/s)
Selecting previously unselected package libslirp0:amd64.
(Reading database ... 216764 files and directories currently installed.)
Preparing to unpack .../libslirp0_4.6.1-1build1_amd64.deb ...
Unpacking libslirp0:amd64 (4.6.1-1build1) ...
Selecting previously unselected package libslirp-dev:amd64.
Preparing to unpack .../libslirp-dev_4.6.1-1build1_amd64.deb ...
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32
Current system platform: linux-amd64
Installing tools: qemu-xtensa, qemu-riscv32
Installing qemu-xtensa@esp_develop_9.2.2_20250817
file qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz is already downloaded
Extracting /home/shrutpatil/.espressif/dist/qemu-xtensa-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz to /home/shrutpatil/.espressif/tools/qemu-xtensa/esp_develop_9.2.2_20250817
Installing qemu-riscv32@esp_develop_9.2.2_20250817
Downloading https://github.com/espressif/qemu/releases/download/esp-develop-9.2.2-20250817/qemu-riscv32-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz
Destination: /home/shrutpatil/.espressif/dist/qemu-riscv32-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz.tmp
Done
Extracting /home/shrutpatil/.espressif/dist/qemu-riscv32-softmmu-esp_develop_9.2.2_20250817-x86_64-linux-gnu.tar.xz to /home/shrutpatil/.espressif/tools/qemu-riscv32/esp_develop_9.2.2_20250817
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$
```

(Installing QEMU using ESP-IDF Tools)

```
source ~/esp/esp-idf/export.sh
```

4. PROGRAM DEMONSTRATIONS

A. LED BLINK PROJECT:

```
cd ~/esp
```

```
idf.py create-project blink_qemu
```

```
cd blink_qemu
```

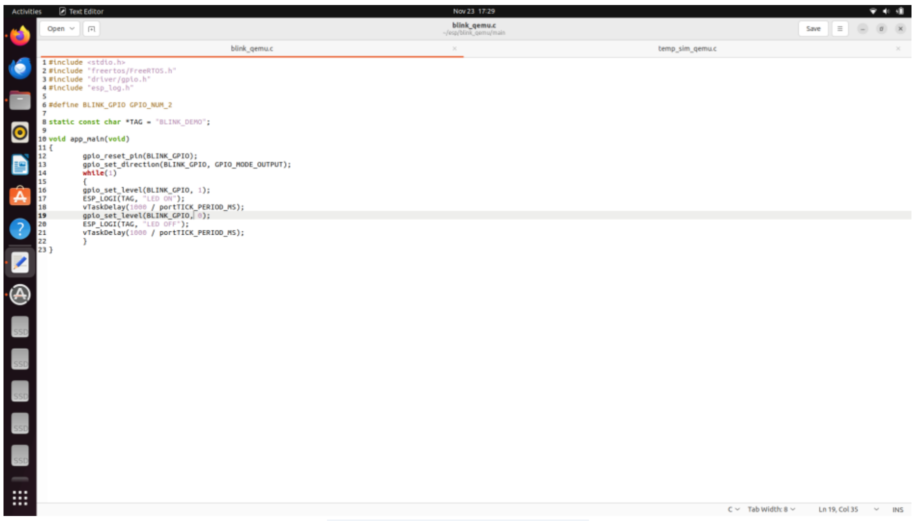
(Go to Home → esp → blink_qemu → main → blink_qemu.c and paste the following code)

```c
#include <stdio.h>
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "driver/gpio.h"
#include "esp_log.h"

#define BLINK_GPIO GPIO_NUM_2
static const char *TAG = "BLINK_DEMO";

void app_main(void)
{
    gpio_reset_pin(BLINK_GPIO);
    gpio_set_direction(BLINK_GPIO, GPIO_MODE_OUTPUT);

    while(1)
    {
        gpio_set_level(BLINK_GPIO, 1);
        ESP_LOGI(TAG, "LED ON");
        vTaskDelay(1000 / portTICK_PERIOD_MS);

        gpio_set_level(BLINK_GPIO, 0);
        ESP_LOGI(TAG, "LED OFF");
        vTaskDelay(1000 / portTICK_PERIOD_MS);
    }
}
```

```
idf.py set-target esp32
```

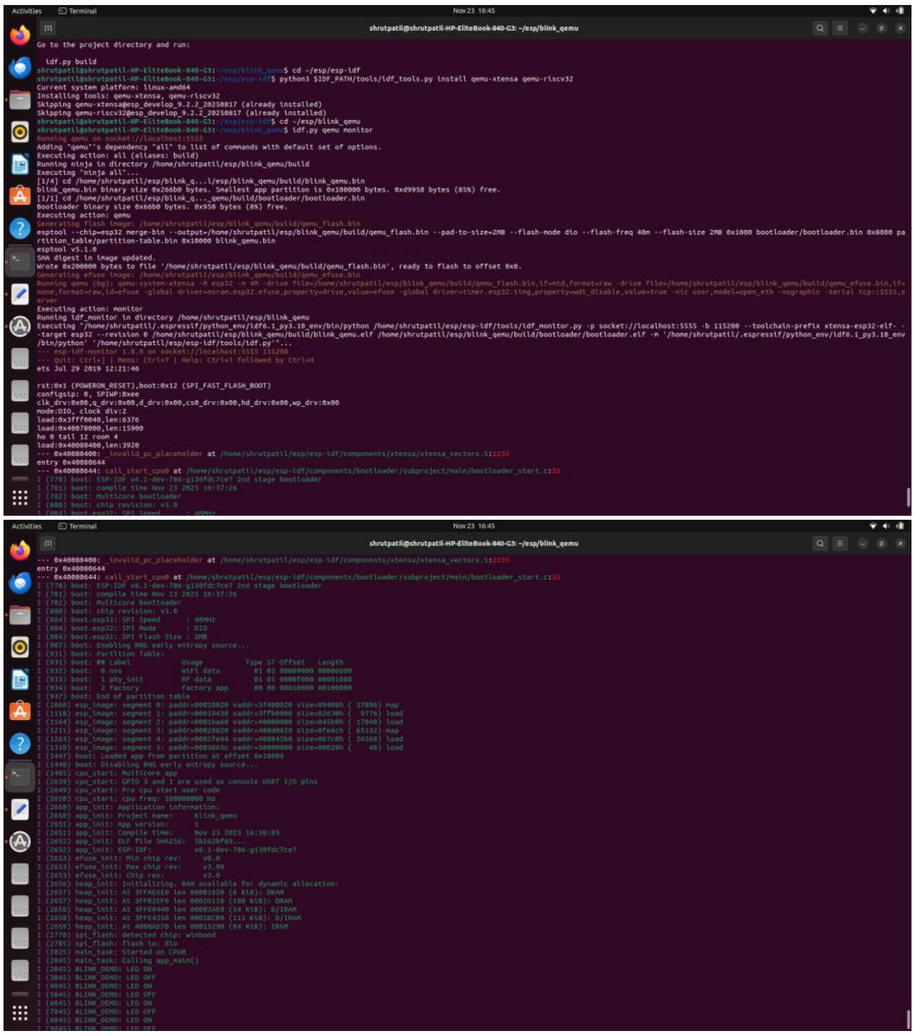
```
idf.py build
```

```
idf.py qemu monitor
```



```c
#include <stdio.h>
#include "freertos/FreeRTOS.h"
#include "driver/gpio.h"
#include "esp_log.h"

#define BLINK_GPIO GPIO_NUM_2

static const char *TAG = "BLINK_DEMO";

void app_main(void)
{
        gpio_reset_pin(BLINK_GPIO);
        gpio_set_direction(BLINK_GPIO, GPIO_MODE_OUTPUT);
        while(1)
        {
        gpio_set_level(BLINK_GPIO, 1);
        ESP_LOGI(TAG, "LED ON");
        vTaskDelay(1000 / portTICK_PERIOD_MS);
        gpio_set_level(BLINK_GPIO, 0);
        ESP_LOGI(TAG, "LED OFF");
        vTaskDelay(1000 / portTICK_PERIOD_MS);
        }
}
```

(Actual Code in blink_qemu.c)



```
Go to the project directory and run:

  idf.py build
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/blink_qemu$ cd ~/esp/esp-idf
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32
Current system platform: linux-amd64
Installing tools: qemu-xtensa, qemu-riscv32
Skipping qemu-xtensa@esp_develop_9.2.2_20250817 (already installed)
Skipping qemu-riscv32@esp_develop_9.2.2_20250817 (already installed)
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/esp-idf$ cd ~/esp/blink_qemu
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~/esp/blink_qemu$ idf.py qemu monitor
Running qemu on socket://localhost:5555
Adding "qemu"'s dependency "all" to list of commands with default set of options.
Executing action: all (aliases: build)
Running ninja in directory /home/shrutpatil/esp/blink_qemu/build
Executing "ninja all"...
[1/4] cd /home/shrutpatil/esp/blink_q...l/esp/blink_qemu/build/blink_qemu.bin
blink_qemu.bin binary size 0x266b0 bytes. Smallest app partition is 0x100000 bytes. 0xd9950 bytes (85%) free.
[1/1] cd /home/shrutpatil/esp/blink_q..._qemu/build/bootloader/bootloader.bin
Bootloader binary size 0x66b0 bytes. 0x950 bytes (8%) free.
Executing action: qemu
Generating flash image: /home/shrutpatil/esp/blink_qemu/build/qemu_flash.bin
esptool --chip=esp32 merge-bin --output=/home/shrutpatil/esp/blink_qemu/build/qemu_flash.bin --pad-to-size=2MB --flash-mode dio --flash-freq 40m --flash-size 2MB 0x1000 bootloader/bootloader.bin 0x8000 pa
rtition_table/partition-table.bin 0x10000 blink_qemu.bin
esptool v5.1.0
SHA digest in image updated.
Wrote 0x200000 bytes to file '/home/shrutpatil/esp/blink_qemu/build/qemu_flash.bin', ready to flash to offset 0x0.
Generating efuse image: /home/shrutpatil/esp/blink_qemu/build/qemu_efuse.bin
Running qemu (bg): qemu-system-xtensa -M esp32 -m 4M -drive file=/home/shrutpatil/esp/blink_qemu/build/qemu_flash.bin,if=mtd,format=raw -drive file=/home/shrutpatil/esp/blink_qemu/build/qemu_efuse.bin,if=
none,format=raw,id=efuse -global driver=nvram.esp32.efuse,property=drive,value=efuse -global driver=timer.esp32.timg,property=wdt_disable,value=true -nic user,model=open_eth -nographic -serial tcp::5555,s
erver
Executing action: monitor
Running idf_monitor in directory /home/shrutpatil/esp/blink_qemu
Executing "/home/shrutpatil/.espressif/python_env/idf6.1_py3.10_env/bin/python /home/shrutpatil/esp/esp-idf/tools/idf_monitor.py -p socket://localhost:5555 -b 115200 --toolchain-prefix xtensa-esp32-elf- -
-target esp32 --revision 0 /home/shrutpatil/esp/blink_qemu/build/blink_qemu.elf /home/shrutpatil/esp/blink_qemu/build/bootloader/bootloader.elf -m '/home/shrutpatil/.espressif/python_env/idf6.1_py3.10_env
/bin/python' '/home/shrutpatil/esp/esp-idf/tools/idf.py'"...
--- esp-idf-monitor 1.8.0 on socket://localhost:5555 115200
--- Quit: Ctrl+] | Menu: Ctrl+T | Help: Ctrl+T followed by Ctrl+H
ets Jul 29 2019 12:21:46

rst:0x1 (POWERON_RESET),boot:0x12 (SPI_FAST_FLASH_BOOT)
configsip: 0, SPIWP:0xee
clk_drv:0x00,q_drv:0x00,d_drv:0x00,cs0_drv:0x00,hd_drv:0x00,wp_drv:0x00
mode:DIO, clock div:2
load:0x3fff0040,len:6376
load:0x40078000,len:15900
ho 0 tail 12 room 4
load:0x40080400,len:3920
--- 0x40080400: _invalid_pc_placeholder at /home/shrutpatil/esp/esp-idf/components/xtensa/xtensa_vectors.S:2235
entry 0x40080644
--- 0x40080644: call_start_cpu0 at /home/shrutpatil/esp/esp-idf/components/bootloader/subproject/main/bootloader_start.c:25
I (778) boot: ESP-IDF v6.1-dev-786-g130fdc7ce7 2nd stage bootloader
I (781) boot: compile time Nov 23 2025 16:37:26
I (782) boot: Multicore bootloader
I (880) boot: chip revision: v3.0
I (884) boot.esp32: SPI Speed      : 40MHz
```

```
--- 0x40080400: _invalid_pc_placeholder at /home/shrutpatil/esp/esp-idf/components/xtensa/xtensa_vectors.S:2235
entry 0x40080644
--- 0x40080644: call_start_cpu0 at /home/shrutpatil/esp/esp-idf/components/bootloader/subproject/main/bootloader_start.c:25
I (778) boot: ESP-IDF v6.1-dev-786-g130fdc7ce7 2nd stage bootloader
I (781) boot: compile time Nov 23 2025 16:37:26
I (782) boot: Multicore bootloader
I (880) boot: chip revision: v3.0
I (884) boot.esp32: SPI Speed      : 40MHz
I (884) boot.esp32: SPI Mode       : DIO
I (884) boot.esp32: SPI Flash Size : 2MB
I (907) boot: Enabling RNG early entropy source...
I (931) boot: Partition Table:
I (931) boot: ## Label            Usage          Type ST Offset   Length
I (932) boot:  0 nvs              WiFi data        01 02 00009000 00006000
I (933) boot:  1 phy_init         RF data          01 01 0000f000 00001000
I (934) boot:  2 factory          factory app      00 00 00010000 00100000
I (947) boot: End of partition table
I (1060) esp_image: segment 0: paddr=00010020 vaddr=3f400020 size=09408h ( 37896) map
I (1118) esp_image: segment 1: paddr=00019430 vaddr=3ffb0000 size=02630h (  9776) load
I (1164) esp_image: segment 2: paddr=0001ba68 vaddr=40080000 size=045b0h ( 17840) load
I (1211) esp_image: segment 3: paddr=00020020 vaddr=400d0020 size=0fe6ch ( 65132) map
I (1263) esp_image: segment 4: paddr=0002fe94 vaddr=400845b0 size=067c8h ( 26568) load
I (1310) esp_image: segment 5: paddr=0003665c vaddr=50000000 size=00028h (    40) load
I (1447) boot: Loaded app from partition at offset 0x10000
I (1448) boot: Disabling RNG early entropy source...
I (1485) cpu_start: Multicore app
I (2639) cpu_start: GPIO 3 and 1 are used as console UART I/O pins
I (2649) cpu_start: Pro cpu start user code
I (2650) cpu_start: cpu freq: 160000000 Hz
I (2650) app_init: Application information:
I (2650) app_init: Project name:     blink_qemu
I (2651) app_init: App version:      1
I (2651) app_init: Compile time:     Nov 23 2025 16:38:03
I (2652) app_init: ELF file SHA256:  5b162bf69...
I (2652) app_init: ESP-IDF:          v6.1-dev-786-g130fdc7ce7
I (2653) efuse_init: Min chip rev:     v0.0
I (2653) efuse_init: Max chip rev:     v3.99
I (2653) efuse_init: Chip rev:         v3.0
I (2656) heap_init: Initializing. RAM available for dynamic allocation:
I (2657) heap_init: At 3FFAE6E0 len 00001920 (6 KiB): DRAM
I (2657) heap_init: At 3FFB2EF0 len 0002D110 (180 KiB): DRAM
I (2658) heap_init: At 3FFE0440 len 00003AE0 (14 KiB): D/IRAM
I (2658) heap_init: At 3FFE4350 len 0001BCB0 (111 KiB): D/IRAM
I (2659) heap_init: At 4008AD78 len 00015290 (84 KiB): IRAM
I (2770) spi_flash: detected chip: winbond
I (2785) spi_flash: flash io: dio
I (2825) main_task: Started on CPU0
I (2845) main_task: Calling app_main()
I (2845) BLINK_DEMO: LED ON
I (3845) BLINK_DEMO: LED OFF
I (4845) BLINK_DEMO: LED ON
I (5845) BLINK_DEMO: LED OFF
I (6845) BLINK_DEMO: LED ON
I (7845) BLINK_DEMO: LED OFF
I (8845) BLINK_DEMO: LED ON
I (9845) BLINK_DEMO: LED OFF
```

(Simulation Results)

B. TEMPERATURE BASED ESP32:

```
cd ~/esp
```

```
idf.py create-project temp_sim_qemu
```

```
cd temp_sim_qemu
```

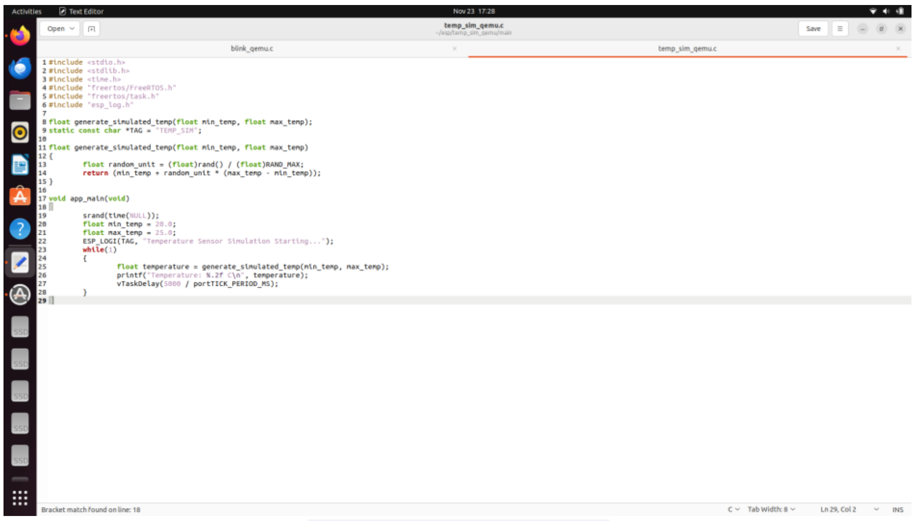
(Go to Home → esp → temp_sim_qemu → main → temp_sim_qemu.c and paste the following code)

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "esp_log.h"

float generate_simulated_temp(float min_temp, float max_temp);

static const char *TAG = "TEMP_SIM";

float generate_simulated_temp(float min_temp, float max_temp)
{
    float random_unit = (float)rand() / (float)RAND_MAX;
    return min_temp + random_unit * (max_temp - min_temp);
}

void app_main(void)
{
    srand(time(NULL));
    float min_temp = 20.0;
    float max_temp = 25.0;

    ESP_LOGI(TAG, "Temperature Sensor Simulation Starting...");

    while(1) {
        float temperature = generate_simulated_temp(min_temp,
max_temp);
        printf("Temperature: %.2f C\n", temperature);
        vTaskDelay(5000 / portTICK_PERIOD_MS);
    }
}
```

```
idf.py set-target esp32
```

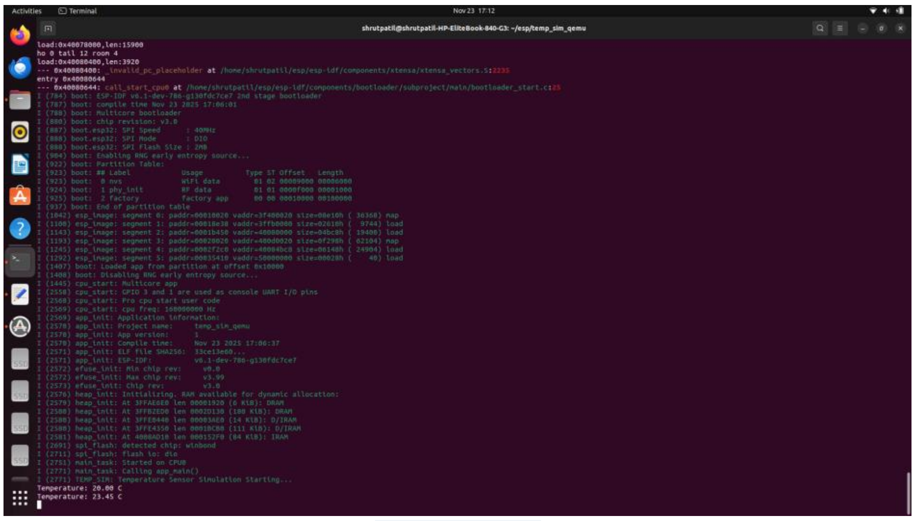
```
idf.py build
```

```
idf.py qemu monitor
```



```c
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include "freertos/FreeRTOS.h"
#include "freertos/task.h"
#include "esp_log.h"

float generate_simulated_temp(float min_temp, float max_temp);
static const char *TAG = "TEMP_SIM";

float generate_simulated_temp(float min_temp, float max_temp)
{
        float random_unit = (float)rand() / (float)RAND_MAX;
        return (min_temp + random_unit * (max_temp - min_temp));
}

void app_main(void)
{
        srand(time(NULL));
        float min_temp = 20.0;
        float max_temp = 25.0;
        ESP_LOGI(TAG, "Temperature Sensor Simulation Starting...");
        while(1)
        {
                float temperature = generate_simulated_temp(min_temp, max_temp);
                printf("Temperature: %.2f C\n", temperature);
                vTaskDelay(5000 / portTICK_PERIOD_MS);
        }
}
```

(Actual Code in temp_sim_qemu.c)



```
load:0x40078000,len:15900
ho 0 tail 12 room 4
load:0x40080400,len:3920
--- 0x40080400: _invalid_pc_placeholder at /home/shrutpatil/esp/esp-idf/components/xtensa/xtensa_vectors.S:2235
entry 0x40080644
--- 0x40080644: call_start_cpu0 at /home/shrutpatil/esp/esp-idf/components/bootloader/subproject/main/bootloader_start.c:25
I (784) boot: ESP-IDF v6.1-dev-786-g130fdc7ce7 2nd stage bootloader
I (787) boot: compile time Nov 23 2025 17:06:01
I (788) boot: Multicore bootloader
I (880) boot: chip revision: v3.0
I (887) boot.esp32: SPI Speed      : 40MHz
I (888) boot.esp32: SPI Mode       : DIO
I (888) boot.esp32: SPI Flash Size : 2MB
I (904) boot: Enabling RNG early entropy source...
I (922) boot: Partition Table:
I (923) boot: ## Label            Usage          Type ST Offset   Length
I (923) boot:  0 nvs              WiFi data        01 02 00009000 00006000
I (924) boot:  1 phy_init         RF data          01 01 0000f000 00001000
I (925) boot:  2 factory          factory app      00 00 00010000 00100000
I (937) boot: End of partition table
I (1042) esp_image: segment 0: paddr=00010020 vaddr=3f400020 size=08e10h ( 36368) map
I (1100) esp_image: segment 1: paddr=00018e38 vaddr=3ffb0000 size=02610h (  9744) load
I (1143) esp_image: segment 2: paddr=0001b450 vaddr=40080000 size=04bc8h ( 19400) load
I (1193) esp_image: segment 3: paddr=00020020 vaddr=400d0020 size=0f298h ( 62104) map
I (1245) esp_image: segment 4: paddr=0002f2c0 vaddr=40084bc8 size=06148h ( 24904) load
I (1292) esp_image: segment 5: paddr=00035410 vaddr=50000000 size=00028h (    40) load
I (1407) boot: Loaded app from partition at offset 0x10000
I (1408) boot: Disabling RNG early entropy source...
I (1445) cpu_start: Multicore app
I (2558) cpu_start: GPIO 3 and 1 are used as console UART I/O pins
I (2568) cpu_start: Pro cpu start user code
I (2569) cpu_start: cpu freq: 160000000 Hz
I (2569) app_init: Application information:
I (2570) app_init: Project name:     temp_sim_qemu
I (2570) app_init: App version:      1
I (2570) app_init: Compile time:     Nov 23 2025 17:06:37
I (2571) app_init: ELF file SHA256:  33ce13e60...
I (2571) app_init: ESP-IDF:          v6.1-dev-786-g130fdc7ce7
I (2572) efuse_init: Min chip rev:     v0.0
I (2572) efuse_init: Max chip rev:     v3.99
I (2573) efuse_init: Chip rev:         v3.0
I (2576) heap_init: Initializing. RAM available for dynamic allocation:
I (2579) heap_init: At 3FFAE6E0 len 00001920 (6 KiB): DRAM
I (2580) heap_init: At 3FFB2ED0 len 0002D130 (180 KiB): DRAM
I (2580) heap_init: At 3FFE0440 len 00003AE0 (14 KiB): D/IRAM
I (2580) heap_init: At 3FFE4350 len 0001BCB0 (111 KiB): D/IRAM
I (2581) heap_init: At 4008AD10 len 000152F0 (84 KiB): IRAM
I (2691) spi_flash: detected chip: winbond
I (2711) spi_flash: flash io: dio
I (2751) main_task: Started on CPU0
I (2771) main_task: Calling app_main()
I (2771) TEMP_SIM: Temperature Sensor Simulation Starting...
Temperature: 20.00 C
Temperature: 23.45 C
```

Activities
Terminal
Nov 23 17:12
shrutpatil@shrutpatil-HP-EliteBook-840-G3: ~/esp/temp_sim_qemu

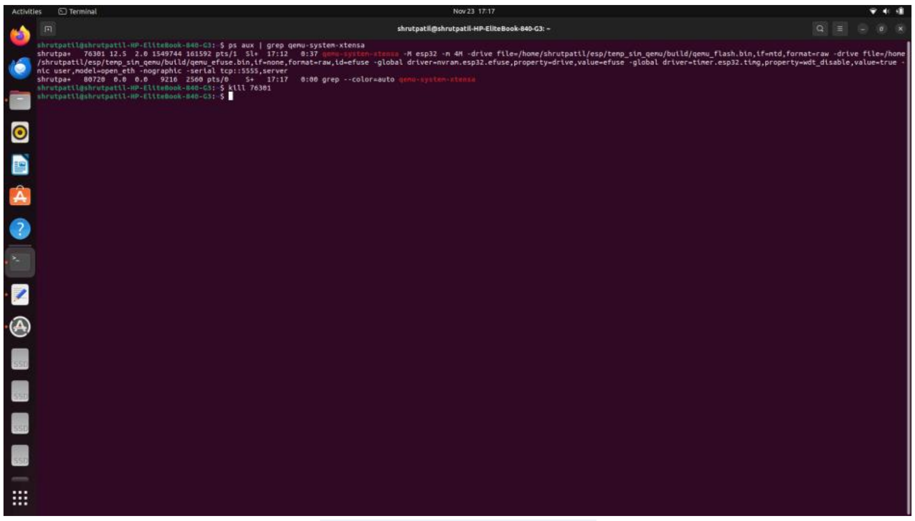
(Simulation Result)

C. MISCELLANEOUS:

To Stop the execution (Infinite loop):
Open New Terminal to the existing terminal and type the following command:

```
ps aux | grep qemu-system-xtensa
```

```
kill <Process ID>
```



```
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ ps aux | grep qemu-system-xtensa
shrutpa+   76301 12.5  2.0 1549744 161592 pts/1  Sl+  17:12   0:37 qemu-system-xtensa -M esp32 -m 4M -drive file=/home/shrutpatil/esp/temp_sim_qemu/build/qemu_flash.bin,if=mtd,format=raw -drive file=/home
/shrutpatil/esp/temp_sim_qemu/build/qemu_efuse.bin,if=none,format=raw,id=efuse -global driver=nvram.esp32.efuse,property=drive,value=efuse -global driver=timer.esp32.timg,property=wdt_disable,value=true -
nic user,model=open_eth -nographic -serial tcp::5555,server
shrutpa+   80720  0.0  0.0   9216  2560 pts/0    S+   17:17   0:00 grep --color=auto qemu-system-xtensa
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ kill 76301
shrutpatil@shrutpatil-HP-EliteBook-840-G3:~$ 
```

(Original Killing of the process)

5. ISSUES ENCOUNTERED AND THEIR SOLUTIONS

A. ENVIRONMENT SETUP FAILURE:

Error Message	Root Cause	Solution
idf.py: command not found	The necessary environment variables were not loaded into the current terminal session, or they were lost after a command.	**Source the environment:** `source ~/esp/esp-idf/export.sh`
error: Unable to import the rich module: No module named 'rich'. Please execute the install script.	Python virtual environment was not set up completely due to a missing Ubuntu package dependency.	**Install missing package and re-run install:** `sudo apt install python3-venv` then `./install.sh esp32`

B. QEMU TOOL VERIFICATION FAILURE:

Error Message	Root Cause	Solution
error while loading shared libraries: libSDL2-2.0.so.0: cannot open shared object file	The pre-built QEMU binary required the SDL2 system library, which was not installed.	**Install the dependency:** `sudo apt install libsdl2-dev`
error while loading shared libraries: libslirp.so.0: cannot open shared object file	The pre-built QEMU binary required the libslirp system library for networking, which was not installed.	**Install the dependency:** `sudo apt install libslirp-dev`
qemu-system-xtensa is not installed. Please install it...	QEMU failed verification due to previous missing shared library errors.	**Re-run tool install:** `python3 $IDF_PATH/tools/idf_tools.py install qemu-xtensa qemu-riscv32` (after fixing shared libraries).

6. REFERENCES

Sr. No.	Topic	Link
1	QEMU	https://www.qemu.org/docs/master/
2	Espressif QEMU Repo	https://github.com/espressif/qemu
3	ESP-IDF Get Started	https://docs.espressif.com/projects/espidf/en/latest/esp32/get-started/index.html
4	ESP-IDF GPIO Docs	https://docs.espressif.com/projects/espidf/en/latest/esp32/api-reference//gpio.html
5	Yaksh Platform	https://github.cperipheralsom/FOSSEE/online_test
6	Example ESP-IDF Projects	https://github.com/espressif/espidf/tree/master/examples/get-started