S103 REFERENCE GUIDE

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Contents

Nothing is perfect, so it is possible that there are still some errors in this document. If you find a potential error, please email Mr Nicola Roberto ZEMA (nicola.zema@lisn.upsaclay.fr) under the heading:

Disclaimer
`S103 -- Documentation.`

1 Introduction

Welcome to S103.

1.1 Work organization

The students will work in trinomes.

- Multiple trinomes are arranged in TD groups.
- Each group will have a reference teacher.
- Each group will have a group responsible.
  - The group responsible needs to be "elected". By the end of the S.A.E. all groups should deliver a written report of what they have done.
    In absence of a report by the end of the S.A.E. the mark "0" could be applied to the group components.
    If you finish the project before the end of the semester, that's it. It is not necessary to come to the IUT but you will have to notify the teacher that you have completed the project and the teacher will have to verify that you did it.

1.2 Teachers

The teachers involved in S103 **for 2023** will be:

- Nicola Zema
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- Xavier Lacour
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2 Materials given to each group

For the S.A.E. each and every group will use:

- 1 Raspberry Pi 400
- 1 SD card
- 1 an SD card reader/adapter
- 1 Ethernet-to-USB adapter
- 1 UTP Patch (short Ethernet cable)

- 1 HDMI-to-USBc cable (to connect the Raspberry to a monitor)
- 1 USBa-to-USBc cable (to power the Raspberry)

  The students will keep **ONLY** the SD Card they were given and **LEAVE** the other equipment as it is.

  The materials need to be checked before and after each S.A.E. session by each student group **AND** the teacher. Eventual malfunctioning has to be reported as for any other in the computing infrastructure of the Orsay IUT.

2.1 Halls

Each SAE session will be in a hall at the IUT.

For half of the sessions a teacher will be with each group, for the other half the students have to work autonomously.

All groups will cycle between:

- Hall I 224-226
- Hall I 225-227

All the halls are in "RESEAUX" mode.


A note

2.2 Material Localization

You are allowed to keep with each group only the SD card with the saved work.

The rest of the material has to be left in the halls.

2.3 Internet and Proxy

It is supposed that the main helping hand for any SysOp is, as of 2022, the biggest manual of it all: **Internet**.

- The students are supposed and encouraged to use the information available on the Internet to complete their objective (install and configure an `Apache Server` on a Raspberry Pi 400).

  In fact, being able to read manuals available on the Internet and find out how to do things on-the-fly is one of the most important "competences" that a SysOp need to have.

  The students will be left to find out by themselves how to "do things" by scavenging developer's forums and social platform.

  As of 2022 it is not even necessary to "ask" questions to people about the task of installing an apache server on a Raspberry Pi. The information is all already there.

3 Objectives

The final objective of this S.A.E. is to install an **Apache Server** and configure it on a *bare metal* Raspberry PI 400 and document all the steps necessary to reproduce the process.

By being able to install and configure the apache server on a Raspberry Pi 400, starting from an empty SD card, validates that *the student* is able to "set up and configure a digital work station".

3.1 Sub-objectives

1. Install an Operating System on the Raspberry
2. Install an Apache Server on the Raspberry
3. Configure a website on the Raspberry
4. Configure multiple websites on the Raspberry
    - One website for each component of the student trinome
    - All the websites should be accessible on the same server by **Virtual Hosting** *in port mode*.
    - **OPTIONAL**: put a simple password authentication on the website.
    - **TO HAVE AN HIGH MARK**: put TLS on the website.

3.1.1 Evaluation Conditions

- The verification is to be done starting from a not powered on Raspberry.
    - this means that the server should be configured to start by itself when the raspberry is powered on.

3.2 What is an Apache Server?

The Apache HTTP Server (*pæti* -PATCH-ee) is a free and open-source cross-platform web server software, released under the terms of Apache License 2.0. Apache is developed and maintained by an open community of developers under the auspices of the Apache Software Foundation.

Apache is a Web Server. A web server is computer software and underlying hardware that accepts requests via HTTP (the network protocol created to distribute web content) or its secure variant HTTPS. A user agent, commonly a web browser or web crawler, initiates communication by making a request for a web page or other resource using HTTP, and the server responds with the content of that resource or an error message. A web server can also accept and store resources sent from the user agent if configured to do so.

Apache supports a variety of features, many implemented as compiled modules which extend the core functionality. These can range from authentication schemes to supporting server-side programming languages such as Perl, Python, Tcl and PHP. Popular authentication modules include `mod_access`, `mod_auth`, `mod_digest`, and `mod_auth_digest`, the successor to `mod_digest`. A sample of other features include *Secure Sockets Layer* and *Transport Layer Security* support (`mod_ssl`), a proxy module (`mod_proxy`), a URL rewriting module (`mod_rewrite`), custom log files (`mod_log_config`), and filtering support (`mod_include` and `mod_ext_filter`).

Popular compression methods on Apache include the external extension module, `mod_gzip`, implemented to help with reduction of the size (weight) of web pages served over HTTP. ModSecurity is an open source intrusion detection and prevention engine for Web applications. Apache logs can be analyzed through a Web browser using free scripts, such as AWStats/W3Perl or Visitors.

Virtual hosting allows one Apache installation to serve many different websites. For example, one computer with one Apache installation could simultaneously serve `example.com`, `example.org`, `test47.test-server.example.edu`, etc.

Apache features configurable error messages, DBMS-based authentication databases, content negotiation and supports several graphical user interfaces (GUIs).

3.3 What is Virtual Hosting?

Virtual hosting is a method for hosting multiple domain names (with separate handling of each name) on a single server (or pool of servers). This allows one server to share its resources, such as memory and processor cycles, without requiring all services provided to use the same host name. The term virtual hosting is usually used in reference to web servers but the principles do carry over to other Internet services.

One widely used application is shared web hosting. The price for shared web hosting is lower than for a dedicated web server because many customers can be hosted on a single server. It is also very common for a single entity to want to use multiple names on the same machine so that the names can reflect services offered rather than where those services happen to be hosted.

There are two main types of virtual hosting, name-based and IP-based. Name-based virtual hosting uses the host name presented by the client. This saves IP addresses and the associated administrative overhead but the protocol being served must supply the host name at an appropriate point. In particular, there are significant difficulties using name-based virtual hosting with SSL/TLS. IP-based virtual hosting uses a separate IP address for each host name, and it can be performed with any protocol but requires a dedicated IP address per domain name served. Port-based virtual hosting is also possible in principle but is rarely used in practice because it is unfriendly to users.

Name-based and IP-based virtual hosting can be combined: a server may have multiple IP addresses and serve multiple names on some or all of those IP addresses. This technique can be useful when using SSL/TLS with wildcard certificates. For example, if a server operator had two certificates, one for *.example.com and one for *.example.net, the operator could serve foo.example.com and bar.example.com off the same IP address but would need a separate IP address for baz.example.net.

3.4 What to do?

To **validate** the installation of Apache it is required that each group create the web server and display a simple web page.

It is **recommended** to use the HTML leftovers of other courses, i.e. the website you students have done for the HTML course.

However, to run an Apache server on a Raspberry, it is necessary that an Operating System (OS) is also running on the latter.

- A raspberry and supporting material will be given to each group.
- The raspberry itself does not contain any software or OS at all.
- Before installing the Apache server, the students need to install and configure an operating system for their Raspberry.
    - Even the SD card that will be given to each group will be empty. The students will need to "flash" it with an image of the operating system.

3.4.1 Choice of Operating System

The Pedagogical Equipe suggest to focus on two possibilities for an operating system:

Raspberry Pi OS Recommended option for anyone. Copious documentation available on the internet.

Arch Linux ARM Recommended for these that have already some experience with installing operating systems **and** *want a challenge*.

4 Expected Results

Each group needs to install first Raspberry Pi OS and then `Apache Server` on its Raspberry Pi 400

4.1 Translation to practical evaluation

In order to be evaluated, each group needs to:

1. Produce the proof that they have installed `Apache Server` on their Raspberry
   - The proof will be a working `Apache Server` software installation
   - The teacher will verify that the program is working by verifying that the server correctly display the web page of choice.
   - The web page of choice should be a simple website
   - Each component of the trinome/binome should have a dedicated website, managed on the same server using **Virtual Hosting** *in port mode*.
2. Document the process
   - Deliver a written report about the installation process.
   - **In absence of a report deliverance by the end of the S.A.E. the mark "0" could be applied to the group components**.
   - Deliver it inside the moodle activity.
3. Verify that each student inside each group has grasped the basic competences envisioned by the SAE by responding to a QCM.

4.2 The Report

The report is to be given as a 5-pages *maximum* **PDF** Document. Write it using your favorite document editor and then export it to PDF.

AVOID THE USE OF SCREENSHOT AND INSTEAD LEARN HOW TO IMPORT SYNTAX-HIGHLIGHTED-CODE IN YOUR DOCUMENT

- You can find a template for the report here.
  - https://www.lri.fr/~zema/S103/reportemplatev3.ott

4.2.1 English part

Originally the report was 15-pages with 5 pages in english (total: `20`).

However, since there is not enough time to correct all your reports in the time frame that starts the day before your last session (19 January) and the last day of the semester (20 january), the 5-pages report has to be done **entirely in English**.

4.3 The QCM

Coming Soon.

A warning

It will be in English

A note

It will be on Moodle

A note

5 Material

5.1 Raspberry Pi

Raspberry Pi (/paɪ/) is a series of small single-board computers (SBCs) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. The Raspberry Pi project originally leaned towards the promotion of teaching basic computer science in schools and in developing countries. The original model became more popular than anticipated, selling outside its target market for uses such as robotics. It is widely used in many areas, such as for weather monitoring, because of its low cost, modularity, and open design. It is typically used by computer and electronic hobbyists, due to its adoption of HDMI and USB devices. After the release of the second board type, the Raspberry Pi Foundation set up a new entity, named Raspberry Pi Trading, and installed Eben Upton as CEO, with the responsibility of developing technology. The Foundation was rededicated as an educational charity for promoting the teaching of basic computer science in schools and developing countries.

As of May 2021, more than forty million Raspberry boards have been sold. Most Pis are made in a Sony factory in Pencoed, Wales, while others are made in China and Japan.

There are three series of Raspberry Pi, and several generations of each have been released. Raspberry Pi SBCs feature a Broadcom system on a chip (SoC) with an integrated ARM-compatible central processing unit (CPU) and on-chip graphics processing unit (GPU), while Raspberry Pi Pico has a RP2040 system on chip with an integrated ARM-compatible central processing unit (CPU).

5.1.1 Model Reference Table

Raspberry Pi 400 is a Raspberry Pi 4 with integrated hardware.

In Table 1 it is possible to find a list of recent Raspberry Pi models.

5.1.2 Raspberry Pi 400

Raspberry Pi 400 (Figure 1) was released in November 2020. It features a custom board that is derived from the existing Raspberry Pi 4, specifically remodeled with a keyboard attached (Figure 2). The case was derived from that of the Raspberry Pi Keyboard. A robust cooling solution (i.e. a broad metal plate) similar to the one found in Commodore 64 allows the Raspberry Pi 400's Broadcom BCM2711C0 processor to be clocked at 1.8 GHz, which is slightly higher than the Raspberry Pi 4 it's based on. The keyboard-computer features 4 GB of LPDDR4 RAM.

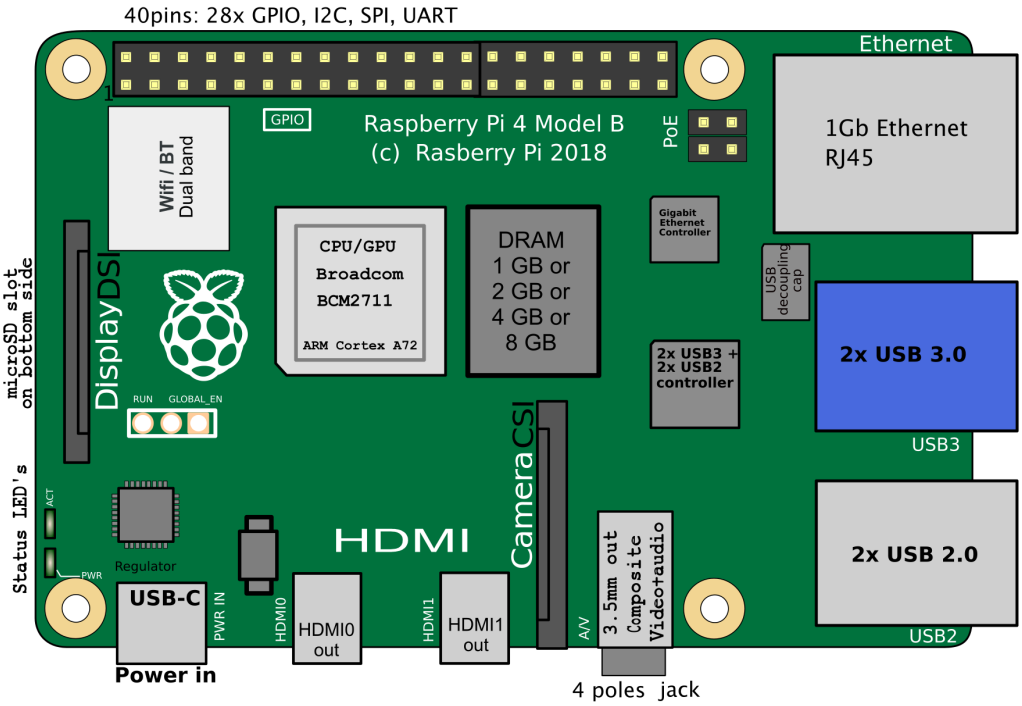

Figure 1: Raspberry Pi Card

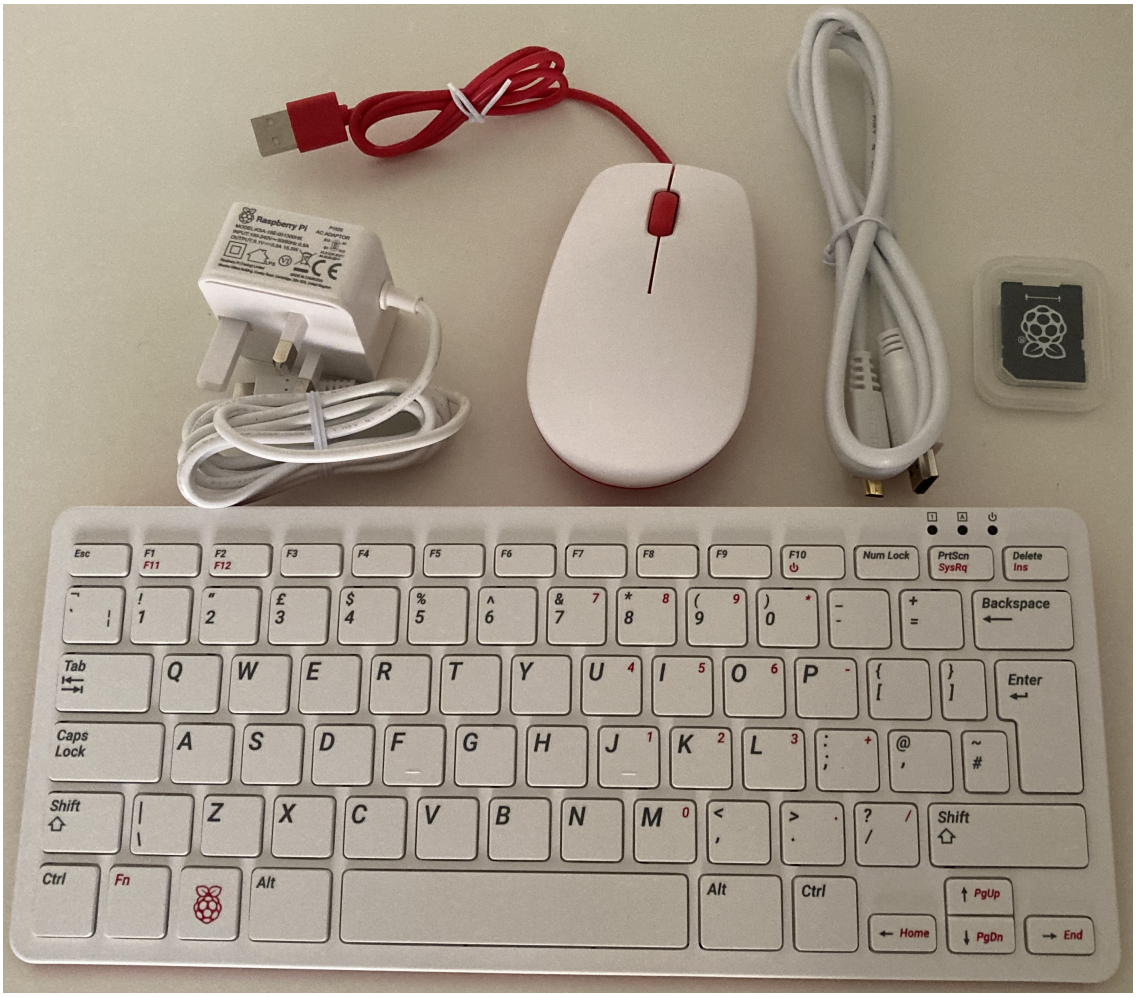

Figure 2: Raspberry Pi 400

5.2 Operating Systems

The Raspberry Pi Foundation provides Raspberry Pi OS (formerly called Raspberry Pi OS), a Debian-based (32-bit) Linux distribution for download, as well as third-party Ubuntu, Windows 10 IoT Core, RISC OS, LibreELEC (specialized media centre distribution) and specialized distributions for the Kodi media center and classroom management. It promotes Python and Scratch as the main programming languages, with support for many other languages. The default firmware is closed source, while unofficial open source is available. Many other operating systems can also run on the Raspberry Pi. The formally verified microkernel seL4 is also supported. There are several ways of installing multiple operating systems on one SD card.

5.2.1 Raspberry Pi OS

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012.

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Openbox stacking window manager, along with a unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica and a version of Minecraft called Minecraft: Pi Edition, as well as a lightweight version of the Chromium web browser.

1. Description: Raspberry Pi OS looks similar to many common desktops, such as macOS, Microsoft Windows, and is most similar to LXDE. The menu bar is positioned at the top and contains an application menu and shortcuts to Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock.

   Packages can be installed via APT, the Recommended Software app, and by using the Add/Remove Software tool, a GUI wrapper for APT.

   PCManFM is a file browser allowing quick access to all areas of the computer, and was redesigned in the first Raspberry Pi OS Buster release (2019-06-20).

   Raspberry Pi OS originally used Epiphany as the web browser, but switched to Chromium with the launch of its redesigned desktop.

   Raspberry Pi OS comes with many beginner IDEs, such as Thonny Python IDE, Mu Editor, and Greenfoot. It also ships with educational software like Scratch and Bookshelf.

2. References:

   Official Web site https://www.raspberrypi.com/software/operating-systems/

   Direct link to download page https://www.raspberrypi.com/software/

   Basic Usage https://www.raspberrypi.com/documentation/computers/os.html

   General Documentation https://www.raspberrypi.com/documentation/

5.2.2 Arch Linux ARM

For those who wants a challenge it is possible to choose to install Arch Linux for ARM instead of Raspberry Pi OS.

The support for Raspberry Pi 400 has not yet tested. Use Arch Linux ARM at your own risk.

A warning

Arch Linux ARM is a distribution of Linux for ARM computers. It provides targeted kernel and software support for soft-float ARMv5te, hard-float ARMv6 and ARMv7, and ARMv8 AArch64 instruction sets on a variety of consumer devices and development platforms. Raspberry Pi 3 is a ARMv8. Up to October 2021, Raspberry Pi 400 was not supported by the AArch64 kernel but now, with kernel 5.15, it should work out of the box. Our collaboration with Arch Linux brings users the best platform, the newest packages, and installation support.

Kevin Mihelich is currently Arch Linux ARM's primary developer. Arch Linux ARM is community-developed, with software development and user support provided fully by volunteer effort and donations. Also, unlike other community-supported operating systems such as Ubuntu, Arch Linux ARM has a relatively small user base, making user participation in development especially important.

Arch Linux ARM has a rolling release cycle, i.e. new software is packaged as it is released. This "bleeding edge" release cycle of small, frequent package updates differs from release cycles of Linux distributions such as Debian, which focus on large, scheduled releases of packages proven to be stable.

Arch Linux ARM can run on any device that supports ARMv5te, ARMv6h, ARMv7 or ARMv8 instruction sets. However, support can be limited in some cases. For example, although the Raspberry Pi 4B offers the 64-bit ARMv8 instruction set, on this processor Arch Linux ARM uses 32-bit ARMv7 as the 4B is not yet fully supported by the Linux kernel, however an experimental ARMv8 version is provided, although full hardware support is not guaranteed.

Up to October 2021, Raspberry Pi 400 was not supported by the AArch64 kernel but now, with kernel 5.15, it should work out of the box.

A note

5.3 References Raspberry Pi

Physical Installation Guide https://www.raspberrypi.com/documentation/computers/getting-started.html

Processors List https://www.raspberrypi.com/documentation/computers/processors.html

6 Physical Installation

In order to make the Raspberry Pi power up and get an internet connection, it is necessary to attach it to a power supply and to an Ethernet Cable.

To start up, you cannot connect the Raspberry Pi **directly** to the power grid and network. You need to attach it first to a IUT computer, authenticated via a username/password pair.

You, as a group, were given an USB cable, a USB network adapter and a short Ethernet cable. You need to:

- Power up the PC you use as a group and select GNU/Linux Debian at the boot menu.
- Login to the machine
- Attach the USB network adapter to a free USB port on the fixed PC
- Attach the two ends of the network cable one to the network adapter and one to the Raspberry Pi
- Attach the HDMI cable to the monitor
- **Switch the monitor to display the external input**
- Attach the USB power supply between the Raspberry Pi and the fixed PC. If you did not install any Operating System on the Raspberry, you should not see anything on the screen. Otherwise, if the SD Card contains an operating system, then the Raspberry Pi should power up and load.

6.1 Things to take into account for the IUT PCs

To start up and connect the Raspberry Pi to the internet, you need to connect it **first** to a IUT PC and then use it.

There are, however, some quirks to take into account while operating the raspberry as you don't connect directly to the internet but through the IUT infrastructure.

There is a set of automatic scripts put in place by the pedagogical team of S103 that will automatically fire up when a network adapter for the Raspberry Pi is detected.

For the moment, you only take into account the following.

6.1.1 Software for flashing the SD card

In all the guides it is written that you need a specific software that needs to be run with privilege escalation for flashing the SD card: `imager` or `rpi-imager`

In the IUT PCs we provide you with an already installed version.

You need to run it via `sudo`.

The root password will **not** be asked for.

You will be asked your own password.

6.2 Things to take into account on the Raspberry Pi

6.2.1 General Internet Connection

After connecting the cable there will be no internet connection.

There is a set of internal scripts, not accessible by non-root users, that enable internet connection in the raspberry and these scripts are linked to the command that opens the internet connection in the salle.

6.2.2 NTP

The Rasberry Pi does not have a BIOS battery so the clock will probably be out of synch.

Normally, there is a NTP server running on the Raspberry but, as there will be no internet immediately, it will not be possible for the Raspberry to get the correct time from outside.

For this reason, some advanced services, like HTTPS, **COULD** not work out-of-the-box, if the difference between the current time and the last time saved on the Raspberry is too large.

To fix this, you need to check up and set up the time manually on your Raspberry at each start up.

6.3 Raspberry Pi OS

To install Raspberry Pi OS on a raspberry, it is necessary to follow the guide here

- https://www.raspberrypi.com/documentation/computers/getting-started.html and using the material given by the teacher:
  - Raspberry Pi 400
  - SD Card
  - Adapter
  - HDMI cable
  - Network Adapter + Cable

7 Installing Apache Server

Please follow the instructions in the link.

8 Copyright Notice

This guide uses material from the Wikipedia articles

- Raspberry Pi which is released under the Creative Commons Attribution-Share-Alike License 3.0.

Table 1: Raspberry Pi models as of 2021.

Family	Model	SoC	Memory	Form Factor	Ethernet	Wireless	GPIO	Released	Discontinued
Raspberry Pi	B	BCM2835	256 MB	Standard[a]	Yes	No	26-pin	2012	Yes
	A				No			2013	No
	B+		512 MB		Yes		40-pin	2014	No
	A+			Compact[b]	No			2014	No
Raspberry Pi 2	B	BCM2836/7	1 GB	Standard[a]	Yes	No		2015	No
Raspberry Pi Zero	Zero	BCM2835	512 MB	Ultra-Compact[c]	No	No		2015	No
	W/WH					Yes		2017	No
	2 W	BCM2710A1				Yes		2021	No
Raspberry Pi 3	B	BCM2837A0/B0	1 GB	Standard[a]	Yes	Yes		2016	No
	A+	BCM2837B0	512 MB	Compact[b]	No	Yes (dual band)		2018	No
	B+		1 GB	Standard[a]	Yes (Gigabit Ethernet)			2018	No
Raspberry Pi 4	B	BCM2711	1 GB	Standard[a]	Yes (Gigabit Ethernet)	Yes (dual band)		2019	March 2020
			2 GB						No
			4 GB						
			8 GB					2020	
	400		4 GB	Keyboard					
Raspberry Pi Pico	N/A	RP2040	264 KB	Pico (21 mm × 51 mm)	No	No	26-pin	2021	?