
Basic Configuration of a Raspberry Pi

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1 INTRODUCTION

This document describes the steps to set up a Raspberry Pi with a basic configuration which can then be used for different purposes.

This procedure will detail the steps for:

- Create a Bootable Media
- Basic Configuration
- Network Access
- Routing
- Miscellaneous

Throughout this document, the following convention will be used:

Commands:

```
$ command
```

File contents:

```
4 This is line 4 of the file
5 This is line 5
```

The line number might not match the actual line number in the file.

2 REQUIREMENTS

The following will be required for this procedure:

- Raspberry Pi OS Lite
Access [L1] and download the Raspberry Pi OS Lite *zip* file. The zip file contains an *img* file used to create the bootable media on the Micro SD Card.
- Rufus (portable)
Available [L2] it will be used to create the bootable Micro SD Card. It is not mandatory to use this software. On the Raspberry Pi website, there is a *Raspberry Pi Imager* which must be installed.
- microSD Card^{1,2}
- Monitor with HDMI connection
- USB keyboard
- Computer running Windows³ and with a microSD card slot².

¹ Minimum 4 GB; Recommended 16 GB.

² Depending on the card reader available, it might be needed a microSD adapter to allow the microSD card to be used on a full-sized SD slot.

³ A computer running Linux will also be suitable. In this case, check the section Error! Reference source not found..

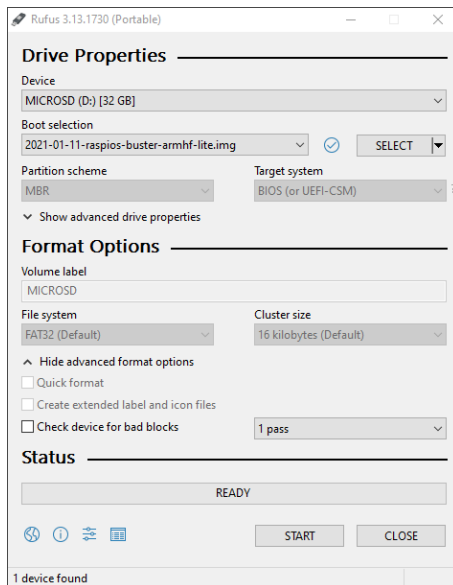
3 CREATE A BOOTABLE MEDIA

It is assumed that the Rufus software was already downloaded, and the Operating System image file was extracted from the downloaded zip file.

Insert the microSD card in the computer's slot.

Start Rufus by double-clicking on the executable.

Ensure that the Device Combobox has the microSD card.



Press SELECT and then browse for the *img* file of the Operating System.

Press START. A warning message will be shown. Press OK to proceed.

Once finished, the Progress Bar will show READY.

Press CLOSE.

On Windows Explorer, right-click on the drive associated with the microSD Card and select Eject.

Remove the microSD card from the slot. The microSD card is ready to be used on the Raspberry Pi.

4 BASIC CONFIGURATION

This section describes the steps for different configurations.

4.1 Root password

By default, the root has no password assigned. For security reasons, it is suggested to leave it this way.

However, the root's password can be changed using the following command:

```
$ sudo passwd
```

4.2 New User

Not allowing root to log in will require someone to find the user's username with superuser rights. For this to be effective, a new user should be created (the 'pi' user is broadly known).

The following commands should be used to create a new user. For convenience, the username will be 'username' which should be replaced by the actual username.

```
$ sudo useradd -m username -c "f_name l_name"
$ sudo passwd username
```

If a user already exists with superuser rights, then the following commands can be skipped. The following commands will add the new user created above to the super users, a.k.a. *sudoers*.

```
$ sudo usermod -aG sudo username
```

It is now required to delete the default user ('pi') and its home directory.

```
$ sudo userdel pi
$ rm -fr /home/pi
```

Details of the newly created user can be checked by reading the contents of the `passwd` file

```
$ cat /etc/passwd
```

4.3 Hostname

The hostname can be configured in two ways.

One option is to use the `raspi-config` (Raspberry PI Configuration Tool).

```
$ sudo raspi-config
```

After, select **1 System Options** and then **S4 Hostname**. Once the new hostname is entered, and after selection **Finish** to exit the configuration tool, it will be prompted to reboot, which should be accepted.

The other option is to edit the `/etc/hostname` file directly.

```
$ sudo vi /etc/hostname
```

The current hostname can be verified using the following command:

```
$ hostname
```

Using the options mentioned above will only change the `/etc/hostname` file. However, the hostname is also used in the file `/etc/dhcpd.conf` which should be updated accordingly. This is done by editing the line 8 of the file `/etc/dhcpd.conf`.

```
7 # Inform the DHCP server of our hostname for DDNS.
8 myhostname
```

Further down in the file, the hostname must be added to the `interface eth0` section. This is so that the hostname could be sent when the DHCP request is issued. After edited, the file should look like this:

```
43 # Example static IP configuration:
44 interface eth0
45 hostname myhostname
```

5 NETWORK ACCESS

This section covers different network configurations for both wired and wireless connections. For each, both static IP address and dynamic IP address (DHCP) scenarios will be considered.

The configurations outlined below will involve editing the configuration file `/etc/dhcpd.conf`. For that reason, it is convenient to keep a safe copy of it. For that, use the following command:

```
$ sudo cp /etc/dhcpd.conf /etc/dhcpd.conf.sav
```

To apply changes made to the configuration file, reboot⁴ using the following command:

```
$ sudo reboot
```

5.1 Wired

5.1.1 Dynamic IP Address

By default, the IP address is dynamically assigned by the DHCP server. Nothing needs changing the `/etc/dhcpd.conf` file.

If a static address is in place, as described in the next section, to enable dynamic addressing, just comment those lines in the configuration file.

5.1.2 Static IP Address

The following lines must exist (uncommented) in the configuration file to define a static IP address

```
46 static ip_address=192.168.0.100/24
47 static routers=192.168.0.1
48 static domain_name_servers=192.168.0.1
```

In the excerpt above, the IP address is defined in the first line alongside the netmask 255.255.255.0⁵.

The gateway is defined in the second line. The name server in the last line.

5.2 Wireless

To connect to a wireless network, run `raspi-config`. Select **1 System Options** and then **S1 Wireless LAN**. The first time, it will be asked to select the country.

After, enter the SSID and, when prompted, the password.

Exit `raspi-config` with rebooting. After rebooting, wireless access to the network should be active.

To turn Wi-Fi off and on, use the following commands respectively:

```
$ sudo ifconfig wlan0 down
$ sudo ifconfig wlan0 up
```

To remove the SSID from the know networks, edit the file `/etc/wpa_supplicant/wpa_supplicant.conf` and remove the lines shown below.

```
5 network={
6     ssid="SSID"
7     psk="password"
8 }
```

After rebooting, the `wlan0` interface will be available but not connected.

6 ROUTING

6.1 Wired – Wireless Router

This section details the steps to configure the Raspberry Pi as a wireless access point. It is assumed that a wired connection is active (see Section **Wired**) with internet connectivity.

⁴ [Improvement required] Apply the changes without rebooting.

⁵ Defined by the value 24; for more information see [L4].

The steps presented in this section summarise the steps presented in Section **Wireless access point** in [L3].

6.1.1 Install Software

Start by installing the packages `hostapd` and `dnsmasq`, which are required to manage the access point and network (DNS and DHCP), respectively.

```
$ sudo apt install hostapd
$ sudo apt install dnsmasq
```

Enable the wireless access point service and set it to start at boot time.

```
$ sudo systemctl unmask hostapd
$ sudo systemctl enable hostapd
```

Install `netfilter-persistent` and its plugin `iptables-persistent`.

The following helps by saving firewall rules and restoring them when the Raspberry Pi boots.

```
$ sudo DEBIAN_FRONTEND=noninteractive apt install -y netfilter-persistent iptables-persistent
```

6.1.2 Set up the network router

To configure the Access Point (static) IP address edit the file `/etc/dhcpd.conf` with the following contents:

```
64 interface wlan0
65 static ip_address=192.168.5.1/24
66 nohook wpa_supplicant
```

6.1.3 Enable routing and IP masquerading

To enable routing, i.e., to allow traffic to flow from one network to the other in the Raspberry Pi, create a file `/etc/sysctl.d/routed-ap.conf` with the following contents:

```
1 # https://www.raspberrypi.org/documentation/configuration/wireless/access-point-routed.md
2 # Enable IPv4 routing
3 net.ipv4.ip_forward=1
```

To allow traffic between clients on this foreign wireless network and the internet without changing the main router's configuration, the Raspberry Pi can substitute the IP address of wireless clients with its own IP address on the LAN using a "masquerade" firewall rule.

- The main router will see all outgoing traffic from wireless clients as coming from the Raspberry Pi, allowing communication with the internet.
- The Raspberry Pi will receive all incoming traffic, substitute the IP addresses back, and forward traffic to the original wireless client.

This process is configured by adding a single firewall rule:

```
$ sudo iptables -t nat -A POSTROUTING -o eth0 -j MASQUERADE
```

Next, just save the rule⁶.

```
$ sudo netfilter-persistent save
```

6.1.4 Configure the DHCP and DNS services for the wireless network

Save the default configuration file with the following command:

```
$ sudo mv /etc/dnsmasq.conf /etc/dnsmasq.conf.sav
```

⁶ Filtering rules are saved to the directory `/etc/iptables/`.

Then, edit (create) the file `/etc/dnsmasq.conf` with the following contents:

```
1 interface=wlan0 # Listening interface
2 dhcp-range=192.168.5.2,192.168.5.20,255.255.255.0,24h
3                # Pool of IP addresses served via DHCP
4 domain=wlan    # Local wireless DNS domain
5 address=/gw.wlan/192.168.5.1
6                # Alias for this router
```

The list of DHCP leases can be found in the file `/var/lib/misc/dnsmasq.leases`.

6.1.5 Ensure wireless operation

```
sudo rfkill unblock wlan
```

6.1.6 Configure the access point software

Create the file `/etc/hostapd/hostapd.conf` with the following contents:

```
1 country_code=GB
2 interface=wlan0
3 ssid=NameOfNetwork
4 hw_mode=g
5 channel=7
6 macaddr_acl=0
7 auth_algs=1
8 ignore_broadcast_ssid=0
9 wpa=2
10 wpa_passphrase=ThisIsThePassword
11 wpa_key_mgmt=WPA-PSK
12 wpa_pairwise=TKIP
13 rsn_pairwise=CCMP
```

The value `hw_mode`⁷ is set according to the band to be used as per the following:

- a = IEEE 802.11a (5 GHz)
- b = IEEE 802.11b (2.4 GHz)
- g = IEEE 802.11g (2.4 GHz)

The configuration is now completed. Reboot.

6.2 Wireless – Wired Router

Setup Wireless Network Access

See Section **Wireless**.

6.2.1 Install Software

Start by installing the packages `dnsmasq` required to manage the network (DNS and DHCP).

```
$ sudo apt install dnsmasq
```

Install `netfilter-persistent` and its plugin `iptables-persistent`.

The following helps by saving firewall rules and restoring them when the Raspberry Pi boots.

```
$ sudo DEBIAN_FRONTEND=noninteractive apt install -y netfilter-persistent iptables-persistent
```

⁷ Note that when changing the `hw_mode`, you may need to also change the channel – see [L5].

6.2.2 Set up the network router

To configure the IP address of the wired connection, edit the file `/etc/dhcpd.conf` with the following contents:

```
44 interface eth0
45 static ip_address=192.168.4.2/24
```

6.2.3 Set up wireless access

See Section **Wireless**.

6.2.4 Enable routing and IP masquerading

To enable routing, i.e., to allow traffic to flow from one network to the other in the Raspberry Pi, create a file `/etc/sysctl.d/routed-ap.conf` with the following contents:

```
1 # https://www.raspberrypi.org/documentation/configuration/wireless/access-point-routed.md
2 # Enable IPv4 routing
3 net.ipv4.ip_forward=1
```

Add the following single firewall rule and save it:

```
$ sudo iptables -t nat -A POSTROUTING -o wlan0 -j MASQUERADE
$ sudo netfilter-persistent save
```

6.2.5 Configure the DHCP and DNS services for the wireless network

Save the default configuration file with the following command:

```
$ sudo mv /etc/dnsmasq.conf /etc/dnsmasq.conf.sav
```

Then, edit (create) the file `/etc/dnsmasq.conf` with the following contents:

```
1 interface=eth0 # Listening interface
2 dhcp-range=192.168.4.64,192.168.4.95,255.255.255.0,24h
3                # Pool of IP addresses served via DHCP
4 domain=lan     # Local wireless DNS domain
5 address=/gw.lan/192.168.4.2
5                # Alias for this router
```

7 MISCELLANEOUS

7.1 SSH Access

SSH is disabled by default.

To enable an SSH connection, the SSH Server has to be enabled. Before enabling the SSH server ensure that no default users and passwords are in place, and existing users have strong passwords.

The simplest way to enable the SSH Server is to use `raspi-config` as follows:

```
$ sudo raspi-config
```

After, select 3 **Interface Options** and then P2 **SSH**. Then select **Yes**.

7.2 Splash Screen

The package `rpdp-lym-splash` is required to configure a custom splash screen. To install the package, execute the following command

```
$ sudo apt install rpd-lym-splash
```

The run `raspi-config`. Select **1 System Options** and then **S7 Slash Screen**. It will be prompted if you like to show the splash screen at boot. Select **Yes**.

With no further configuration, the default Raspberry welcome splash screen shown below will be shown.

The image has 1024 x 768 pixels at 72 ppi.



The default image can be located at `/usr/share/plymouth/themes/pix` with the name `splash.png`. The easiest way (not ideal) is to rename that file and copy to that location a new file with the name `splash.png`.

7.3 Mount a removable USB media

To use a removable USB media device, one needs to know the device assigned to the USB device and a mounting point to mount that device.

Insert the USB device, and to check the device name, type the following command:

```
$ lsblk -f
```

The USB device should be presented under `sda` (`sda1`, for example) – that is the device.

Now, to create the mounting point, one needs to create a directory. For convenience, a `/mnt` directory already exists, and it will be used for this purpose. To create the mounting point, use the following command:

```
$ sudo mkdir /mnt/usb
```

Now, to mount the device using the mounting point created, use the following command:

```
$ sudo mount /dev/sda1 /mnt/usb
```

For this point on, the USB is accessible to read and write⁸.

Before removing the USB device, it needs to be unmounted. For that, use the following command:

```
$ sudo umount /dev/sda1
```

7.4 Update Linux Distro

To update the Linux, run the following commands

```
$ sudo apt update
$ sudo apt -y upgrade
$ sudo apt autoremove
```

8 USEFUL LINKS

[L1] Operating System (disk images)
<https://www.raspberrypi.org/software/operating-systems/>

⁸ Only the root has write access.

- [L2] Rufus
<https://rufus.ie/>
- [L3] Configuration Guides
<https://www.raspberrypi.org/documentation/configuration/>
- [L4] Classless Inter-Domain Routing - Wikipedia
https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing#Subnet_masks
- [L5] List of WLAN channels - Wikipedia
https://en.wikipedia.org/wiki/List_of_WLAN_channels

NOTES:

www.hardpath.co.uk

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