Preparing RPi

Completion: Required
Submission: None

In this tutorial, your Raspberry Pi (RPi) needs to end up being connected to a wireless network accessible via VNC (a remote terminal). The RPi can be directly connected to your laptop so that you can use laptop's screen keyboard and mouse to work on the RPi through VNVC. If your laptop does not have an Ethernet RJ45, you may need to get a USB-Ethernet (RJ45) adapter. *There are six RPi-friendly workstations available in BSETB 1.508 which you may use to setup your RPi*.

==

***If the RPI that you are getting is already cloned by the CS department with a working OS*, you simply need to do the steps (a through h) given below. Otherwise, skip to Section I to complete all the sections I through VI. In any case, you are required to be familiar with the whole tutorial (Sections I through VI) for learning purposes:**

a) Use the following URL to download RealVNC viewer on your laptop:
https://www.realvnc.com/download/viewer

b) Connect RPi's wired Ethernet port (RJ45 connector) to your laptop's wired Ethernet port using a network cable. *{You may need a USB-Ethernet (RJ45) adapter if your laptop does not have an Ethernet (RJ45) network port.}*

c) The cloned RPi's wired network port already has an IP address of 192.168.1.3. Assign 192.168.1.2 to the wired network port (refer to Section IV Part 1) of your laptop.

d) The VNC server is already available on the cloned RPi and is listening on 192.168.1.3. Open VNC viewer on your laptop and enter 192.168.1.3 in the viewer to connect to the RPi. In the authentication dialog box enter "*pi*" as the username and "*hello*" as the password.

e) Refer to Section VI for adjusting the resolution of RPi's remote screen. This is important to do, otherwise, you may not see the whole screen when using nano editor to modify the required file in the following step for connecting to Eduroam.

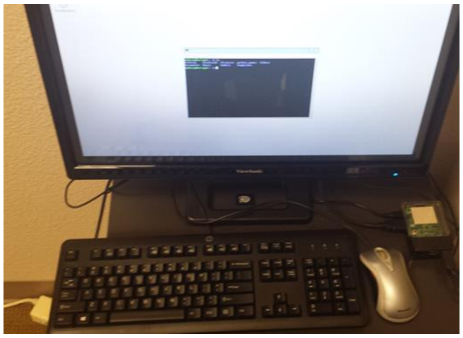
f) Refer to Section V for connecting to Eduroam.

g) Refer to Section VI for securing your RPi.

h) Refer to Section VI for "Security, Connectivity and Other Topics" which may resolve issues that you may encounter.

==

I. Installing Raspbian OS



1) Press ***SHIFT*** key during the boot process when prompted to do so.

2) NOOBS (*New Out Of the Box Software*) will show Raspbian OS. An icon to select keyboard will appear at the bottom of the screen. Select "us" keyboard (the default is "uk" keyboard). Press ***w*** to connect to an appropriate network; for example, eduroam if on campus.

3) After connecting to a network, available OS options will be listed. If RPi is not connected to the network while installing an OS, the installation will not be proper. Select ***Raspbian [Recommended]*** and click on ***install*** and ***confirm***. Click ***ok*** when done.

4) Change to US Keyboard (if not done earlier):

a) Access Raspbian terminal

b) Execute "***sudo nano /etc/default/keyboard***" to edit the keyboard configuration file. Change ***XKBLAYOUT*** to "***us***" and then execute "***sudo reboot***" to reboot for the new configuration to take effect.

II. Installing VNC

1) VNC (*Virtual Network Computing*) is a graphical terminal that makes the remote system being accessed more real on the local machine. After ***Raspbian*** has been installed, type the following on a terminal:

```
#sudo apt-get update                                          ;to update RaspberryPi
#sudo apt-get install realvnc-vnc-server realvnc-vnc-viewer   ;to install VNC if it is not part of pixel
```

2) Enable VNC by accessing ***menu→preferences→Raspberry Pi Configuration→ Interfaces*** and enabling VNC option. One can also execute "***sudo raspi-config***" to enable VNC. If VNC option is not displayed, the OS was not properly installed.

3) VNC icon should appear on the task bar (top right side of the screen). Click on it. The dialog box should show the VNC server running, and which interfaces (identified by IP Addresses) it is listening on.

III. Automating VNC Server Startup at Bootup

1) Type the following on a terminal:

```
#cd /home/pi/.config                 ;access the relevant directory
#mkdir autostart                     ;create autostart directory
#cd autostart                        ;access autostart directory
#nano realvnc.desktop                ;Use nano editor to create realvnc.desktop

        [Desktop Entry]
        Type = Application
        Name=RealVNC
        Exec=vncserver-x11:1
        StartupNotify=false          ;CTRL-X followed by Y to save
#ifconfig                            ;make note of the RaspberryPi's IP address
```

IV. Accessing RaspberryPi from another Computer Using VNC

1) Give IP addresses to RPi and your laptop within the same subnet. For example,

Laptop's wired IP address*: 192.168.1.2
255.255.255.0 (netmask)

*In a computer running a Windows OS, access ***Control Panel* → *Network and Sharing Center* → *Change Adapter Settings*** where the correct wired network adapter needs to be selected and its properties accessed to assign it a static IP address of 192.168.1.2.

RPi wired IP address**: 192.168.1.3
255.255.255.0 (netmask)

Edit */etc/dhcpcd.conf*** file to make sure that the following lines exist (insert if these lines don't exist) for eth0 (RJ45) interface (the commented-out lines are for your reference in case you want to specify a gateway and/or name servers:

```
interface eth0
static ip_address=192.168.1.3/24
#static routers=192.168.1.1
#static domain_name_servers=192.168.1.1
```

Leave everything else (such as *static routers=* field) blank. Do "***sudo service networking restart***" for the changes take effect.

Use ***ping*** utility on your laptop and RPi to ping the laptop from RPi and vice versa to make sure that they can see each other. (you may not be able to ping from RPi to your laptop due to firewall).

2) Click on the VNC icon. The dialog box should show the VNC server listening on 192.168.1.3. If it is not, try disabling & enabling VNC (***menu* →*preferences* →*Raspberry Pi Configuration* → *Interfaces***).

3) Use the following URL to download RealVNC viewer on your laptop:

https://www.realvnc.com/download/viewer

4) Open the downloaded viewer (on your laptop) and enter the RaspberryPi's IP Address (192.168.1.3) to access it. Enter the username as "***pi***" (your username in RPi) and password as "***raspberry***" (default password of user "***pi***"). You can change the password of the user "***pi***" by executing "***sudo passwd pi***").

V. Connecting to Eduroam

1) If Eduroam icon is grayed out, the credentials may be incorrect. You may want to enter your credentials in ***identity*** and ***password*** fields (within quotes) of ***wpa_supplicant.conf*** file to access Eduroam. The file may look as follows:

```
ctrl_interface=DIR=/var/run/wpa_supplicant GROUP=netdev
update_config=1
network={
        ssid="eduroam"
        key_mgmt=WPA-EAP
        identity="john.doe@utrgv.edu"
        password="Becareful_I_am_going_to_appear_in_Plain_Text_So_Secure_Your_Pi"
}
```

Access RPi's terminal and enter "***sudo nano /etc/wpa_supplicant/wpa_supplicant.conf***" command to modify the above file with your Eduroam credentials. After saving the modified file *(CTRL-X followed by Y to save)*, enter "***sudo reboot***" for changes to take effect. Eduroam should be available from RPi, and one should be able to browse via RPi.

VI. Security, Connectivity and Other Topics

1) Corrupted VNC key: If private key of VNC gets corrupted, remove the corrupted key and generate a new one by doing the following:

-Disable VNC (***menu➔ preferences➔ Raspberry Pi Configuration➔ Interfaces***)
-***sudo rm /root/.vnc/private.key***
-Enable VNC (***menu➔preferences➔Raspberry Pi Configuration➔ Interfaces***).

2) Graceful shutdown: To avoid corrupting data, do a graceful shutdown before disconnecting power (rather disconnecting power before properly shutting down):

#sudo shutdown –h 0   ;Shutdown or Halt in 0 minutes

3) Setting Resolution: Access ***menu➔ preferences➔ Raspberry Pi Configuration➔ System*** and click on ***Set Resolution*** option to set the resolution.

4) Securing RPi:

a) Access ***menu➔ preferences➔ Raspberry Pi Configuration➔ System*** and uncheck ***Auto Login: As current user*** option to disable auto login. Run "***sudo passwd root***" to add password to root account. Run "***sudo passwd pi***" to change user pi's password. Run "***sudo reboot***" to get login screen.

b) Run "***sudo apt-get install xscreensaver***" to install screen saver. Once installed, run "***sudo reboot***" for changes to take effect. Access ***menu➔ preferences➔ Screensaver*** and enable ***Lock Screen After*** with the desired time in minutes. This is the delay in locking the screen after screen blanks and screensaver starts.

5) Formatting and Installing NOOBS on an SD Card:

a) Download SD Card Formatter on your laptop/desktop from https://sdcard.org; e.g. SDCardFormatterv5_WinEN.zip. Run the "*SD Card Formatter*" to format the SD card.

b) Download NOOBS (e.g. NOOBS_v3_2_1) from https://www.raspberrypi.org/downloads/noobs/.

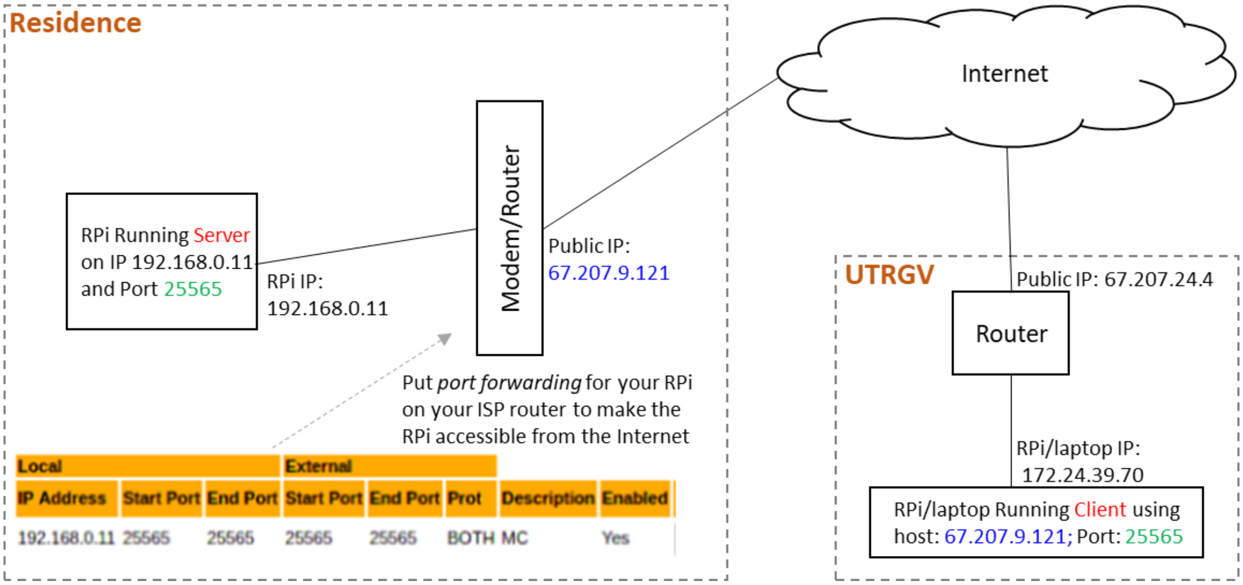
c) Select and drag all the folders and files under NOOBS (e.g. NOOBS_v2_8_1) onto the formatted SD card.

6) Eduroam Issues with new OS:

The new image (OS) of the RPi is having problems with its version of supplicant which may be causing WiFi connectivity issues. Consider reverting to an older image. Older images can be found in the following repository:
https://downloads.raspberrypi.org/raspbian/images

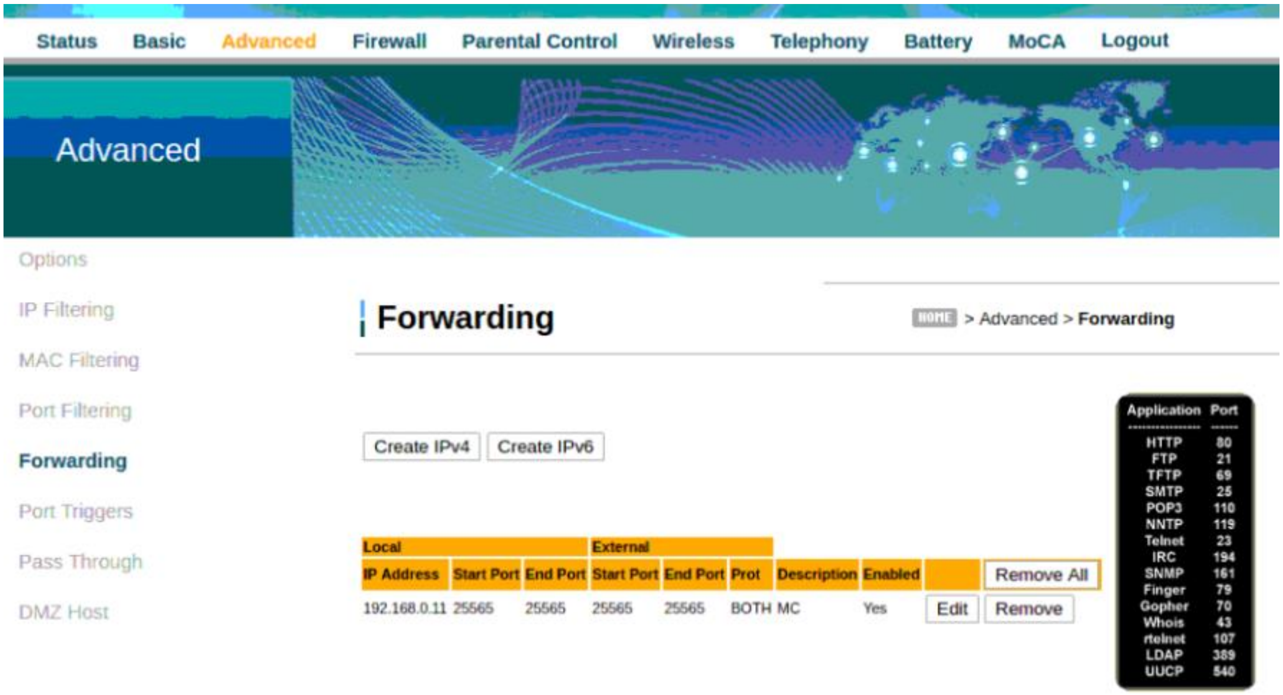
One can execute "uname -a" on the Linux Terminal to find the version of OS on the RPi. The most stable image with (no WiFi or ADC issues) is:
Linux raspberrypi 4.9.35-v7+ #1014 SMP
This version can be downloaded from:
https://downloads.raspberrypi.org/raspbian/images/raspbian-2017-07-05/

7) Connecting to RPi (at home) from a laptop (or from another RPi) at another location:


Residence
RPi Running Server on IP 192.168.0.11 and Port 25565
RPi IP: 192.168.0.11
Modem/Router
Public IP: 67.207.9.121
Put *port forwarding* for your RPi on your ISP router to make the RPi accessible from the Internet
Internet
UTRGV
Public IP: 67.207.24.4
Router
RPi/laptop IP: 172.24.39.70
RPi/laptop Running Client using host: 67.207.9.121; Port: 25565

Local			External				
IP Address	Start Port	End Port	Start Port	End Port	Prot	Description	Enabled
192.168.0.11	25565	25565	25565	25565	BOTH	MC	Yes

For putting port forwarding on your home router, below is an example based on a Ubee Cable Modem/Router:



Local			External				
IP Address	Start Port	End Port	Start Port	End Port	Prot	Description	Enabled
192.168.0.11	25565	25565	25565	25565	BOTH	MC	Yes

Application	Port
HTTP	80
FTP	21
TFTP	69
SMTP	25
POP3	110
NNTP	119
Telnet	23
IRC	194
SNMP	161
Finger	79
Gopher	70
Whois	43
rtelnet	107
LDAP	389
UUCP	540

8) Editors

The default editors on RPi are ***vi*** and ***nano***. However, it is recommended that ***vim*** is downloaded for use as an editor since it provides additional features including auto-indentation and matching-parentheses.

```
$sudo apt-get  install vim
```

9) Installing WiringPi Library

Your current OS image may already come with wiringPi library. This module enables one to conveniently interface sensors/actuators with RPi through GPIO. First check if wiringPi is already installed by executing the following command:

```
$gpio -v
```

If it is already installed, the response is going to include gpio version etc., for example:

```
gpio version: 2.44
Copyright (c) 2012-2017 Gordon Henderson
This is free software with ABSOLUTELY NO WARRANTY.
For details type: gpio -warranty

Raspberry Pi Details:
  Type: Pi 3, Revision: 02, Memory: 1024MB, Maker: Embest
  * Device tree is enabled.
  *--> Raspberry Pi 3 Model B Rev 1.2
  * This Raspberry Pi supports user-level GPIO access.
```

If wiringPi is not already installed, install wiringPi Library using the instructions below:

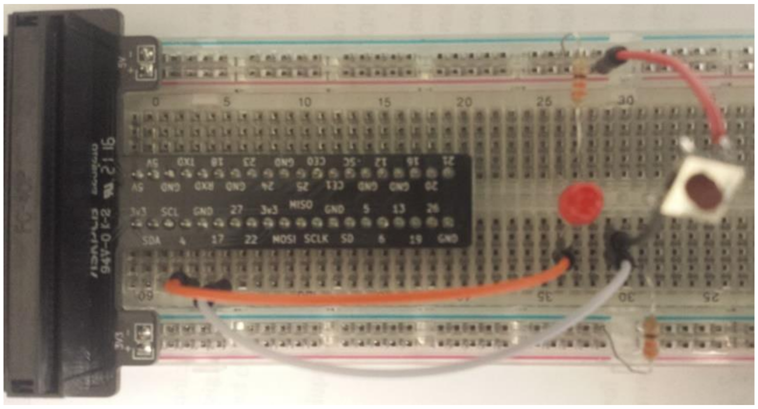
```
$sudo apt-get update && sudo apt-get upgrade
$sudo apt-get install git git-core

 $git clone git://git.drogon.net/wiringPi
$cd wiringPi
$./build
```

If the *above method is unsuccessful in installing wiringPi*, then download the *tar file* from https://github.com/WiringPi/WiringPi and follow the instructions provided under PLAN B of the website given below:

http://wiringpi.com/download-and-install/

To test the basic GPIO functionality, connect an LED (through a current-limiting resistor) on BCM Pin #4 and a switch to BCM Pin #17 (with Pin #17 grounded through a current-limiting resistor so that the pin is digitally 0 when the switch is OFF/Open). Below is a snapshot to show how the connectivity may be accomplished:



Below are the Linux level commands that one can use to do GPIO related functions from RPi's Linux terminal:

#	Command/Instruction	Description
1	$gpio -g mode 4 output	Set BCM Pin #4 as output (**-g for BCM** & **-1 for physical** pin #)
2	$gpio -g write 4 1	Set BCM Pin #4 to 1 (LED should power on)
3	$gpio -g write 4 0	Set BCM Pin #4 to 0 (LED should power off)
4	$gpio -g mode 17 input	Set BCM Pin #17 as input
5	$gpio -g read 17	Read the value from Pin #17

Attempt the following:

```
#cd wiringPi
#gpio -g  mode 4 output          @Set BCM Pin #4 as output (-g for BCM & -1 for physical pin #)
#gpio -g  write 4 1                      @Set BCM Pin #4 to 1 (LED should power on)
#gpio -g  write 4 0                      @Set BCM Pin #4 to 0 (LED should power off)

#gpio -g  mode 17 input          @Set BCM Pin #17 as input
#gpio -g  read 17        @Do not press the switch (Or do not connect the switch wire to 5VDC)
0                                        @ (should return 0 since switch is not ON)
#gpio -g  read 17        @Press the switch (Or, connect the switch wire to 5VDC)
1                                        @ (should return 1 since switch is pressed)
```

Below is a C program (compiled with *gcc -o p1 p1.c -l wiringPi*) for your reference:

```
//This program powers on/off the LED connected to BCM Pin #4 (physical Pin #7) and reads the position
//of the switch connected to BCM Pin #17 (physical Pin #11)

        #include <stdio.h>
        #include <stdlib.h>
        #include <unistd.h>
        #include <wiringPi.h>

        int main()
        { int n;
         if(wiringPiSetupGpio() == -1)
                 {printf("Problem... "); exit(1);}    //setup wiring per BCM
         pinMode(4,1);                                        //set BCM Pin #4 as output
         pinMode(17,0);                               //set BCM Pin #17 as input

         digitalWrite(4,1);                           //sets BCM Pin #4 to 1 (LED ON)
         sleep(1);
         digitalWrite(4,0);                           //sets BCM Pin #4 to 0  (LED OFF)

         n=digitalRead(17);                           //read BCM Pin #17
         if(n) printf("Switch connected to BCM Pin #17 is ON\n");
         else printf("Switch connected to BCM Pin #17 is OFF\n");
}
```

Below is a Python program for your reference:

```
#!/usr/bin/python
#The following Python program turns LED (connected to BCM Pin #4) ON and then OFF, and
#also provides the status of the switch on BCM Pin #17
import RPi.GPIO as GPIO                             #import GPIO library
import time
GPIO.setmode(GPIO.BCM)                              #set the pins according to BCM scheme
GPIO.setup(4,GPIO.OUT)                              #configure BCM Pin #4 as OUTPUT
GPIO.setup(17,GPIO.IN)                                        #configure BCM Pin #17 as INPUT
print "Powering LED ON... BCM pin 4"
GPIO.output(4,GPIO.HIGH)                            #set BCM Pin #4 to 1
time.sleep(2)                                                 #wait
print "Powering LED OFF... BCM pin 4"
GPIO.output(4,GPIO.LOW)                             #set BCM Pin #4 to 0
sw=GPIO.input(17)                                   #read the status of BCM Pin #17
if sw==1: print "Switch is ON... BCM pin 17"
else: print "Switch is OFF... BCM pin 17"
GPIO.cleanup()                                                #set BCM pins to default for next time
```

10) Installing MySQL

➢ Access RPi’s terminal and enter the following command to install MySQL:

```
#sudo apt-get install mysql-server
```

➢ Enter the command below to access MySQL. Press enter when prompted for a password:

```
#sudo mysql –u root -p
```

➢ Enter the commands below in MySQL environment to create the user ‘user’ with ‘pass’ as password (*the username and password are needed when writing SQL-embedded programs in another language such as Python*):

```
>create user  'user'@'localhost'  identified by 'pass';
>grant all privileges on *.*  to  'user'@'localhost';
>flush privileges;
>quit;
```

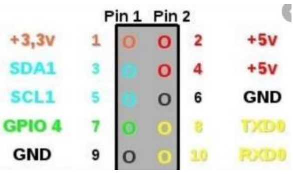
➢ Enter the command below to access MySQL as user ‘user’ and enter the password when prompted to do so:

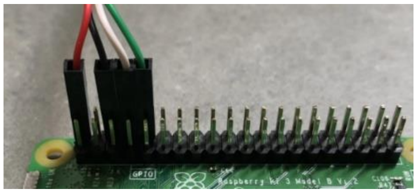
```
#mysql –u user -p
```

11) Serial Interface (headless)... Work In Progress (WIP)... Do not attempt this section ... *included for your reference only*

a) One needs a USB-TTL cable which has built-in electronics to convert between voltage levels to provide a serial connection at 115200, 8, N, 1, NoFlowControl. From RPi's perspective, the cable has four wires (Green:RX from remote, White:TX to remote, Black:GND, and RED:+5V). If the RPi is being powered using its own power supply, leave the RED wire needs to be left unconnected.

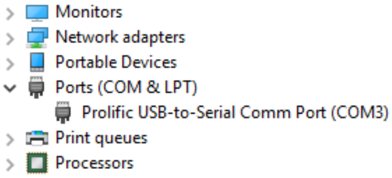
The RPi side will look as follows, after connecting the cable to GPIO pins:





b) RPi needs to be configured to *disable* for "*login shell to be accessible over serial*" and *enable* the use of "*Serial Port Hardware*." This can be done using *raspi-config* (*Interfacing Options* → *Serial*). RPi needs to be rebooted.

c) On Windows side, the cable's USB-end needs to be plugged into a USB socket. Under Device Manager, the corresponding serial generated should show up, e.g. COM3. If device appears as "unknown", one download drivers from *prolific.com*.



Monitors
Network adapters
Portable Devices
Ports (COM & LPT)
Prolific USB-to-Serial Comm Port (COM3)
Print queues
Processors

One can download and use ***putty*** as a terminal emulator (https://putty.org/). The serial interface should be configured as COM3, 115200, 8, No Parity, No FlowControl (under *Connection* → *Serial*); Terminal-Type string to ***putty*** and terminal speeds to *115200,115200* (under *Connection* → *Data*). One can save the current session under a profile, say ***rpi***, so that one does not have to repeat settings each time.