Beginning Raspberry Pi Class – The Basics

Session 9 – Set up the Raspberry Pi – V2

This session will acquaint you with how to set up a Raspberry Pi and get started using it. Although the Raspberry Pi Model 5 has been announced, it is just starting to ship and you may have new-product issues. For our uses in Amateur Radio, a Raspberry Pi Model 4 is best.

Also, there is a new version of the Raspberry Pi OS, Bookworm, and I would hold off using it for a while until the kinks are worked out. (Bookworm is required for the Raspberry Pi 5.) We will use Buster.

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BILL OF MATERIALS

- Computer: Windows, Mac, or Linux
- For VNC, you can also use a tablet or smartphone.
- Raspberry Pi 4 Model B starter kit including
  - Raspberry Pi 4 Model B 2GB 4GB or 8GB
  - Power supply, 5v, 3 amps
  - MicroHDMI to HDMI adapter cable
  - MicroSD card, at least 16 GB. Choose one size and type of card and stick to it, such as Sandisk Ultra 32GB, which is what I use.
  - Optional: case, fan, heatsinks
  - You can either buy a starter kit or the individual components.
  - To find a vendor with Raspberry Pi in stock, visit https://rpilocator.com/

- Either [HDMI Monitor, keyboard, mouse] or
  computer. I will have a monitor, keyboard, mouse available at the workshop.
- USB to MicroSD card reader
- A second MicroSD card for backup
- Optional: USB GPS. This is useful for applications such as HamClock and APRS.
  - For example, VK-162 USB GPS Dongle - Remote Mount USB - External GPS Navigation Dongle ($16-18 on Amazon).
  - There are GPS devices available as "dongles" that plug right into a USB port such as the HiLetgo VK172 G-Mouse USB GPS/GLONASS USB GPS Receiver ($12 on Amazon) For a Pi4, this causes interference with the GPS mounted right at the USB port and your GPS will not work reliably.
  - I purchased a GlobalSat BU-353S4 USB GPS Receiver several years ago when it was inexpensive ($30 on Amazon). It has gotten more expensive ($80 on Amazon but less expensive elsewhere such as Newegg, around $50) but it is the best GPS unit I have found.
  - The VK-162 is less expensive and will work although it might not find a fix as fast or as reliably. I could get a good signal inside the window on the GlobalSat but I had to put the VK-162 outside the window.
- A TNC (Terminal Node Controller) or audio interface for your radio. See WINLINK section for information on Winlink hardware requirements.

MAKE A MICRO-SD CARD WITH THE RASPBERRY PI OS

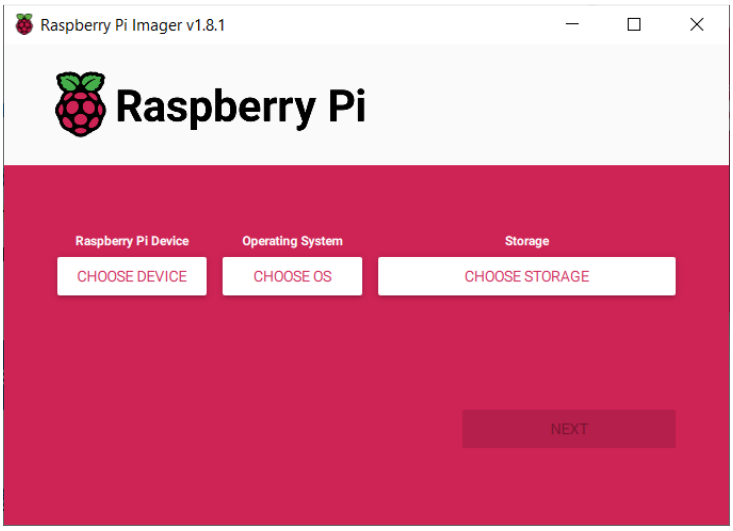
Insert the MicroSD card into the computer (if your computer has a slot for it) or into the USB to MicroSD card reader and then into the computer.

Use the Raspberry Pi Imager software, available at:

https://www.raspberrypi.org/downloads/

Click on the link for your operating system. Save the "imager.exe" file (for Windows, or whatever file is needed for your operating system), install it, and then execute it.

In the Raspberry Pi Imager window



Click on “CHOOSE DEVICE” and select your Raspberry Pi model. In this case, I chose Raspberry Pi 4.

Click on “CHOOSE OS” and select “RASPBERRY PI OS (LEGACY)” Use legacy (Bullseye) as it is more stable than the newest version (Bookworm). These names refer to the release of the Debian version of Linux. This is the 32 bit version.

There is also a 64 bit version available, but not all applications work on that version. This will not diminish our use of the Pi as our applications are small enough that they really don’t need 64-bit capability. I am working to get the issues resolved and will inform you when I feel it is safe to use the 64-bit version as well as the 32-bit version.

Click on “CHOOSE SD CARD” and select your SD card. Be sure to select the right drive.

In the next window “Use OS Customization” “Would you like to apply OS customization settings?” select “EDIT SETTINGS.”

Under GENERAL:

Select a Hostname which makes it easier to determine which Pi you are accessing. I used “AA6BD”. Use something unique for you such as your callsign.

Set a username and password. This document will assume you entered “pi” as the username. Enter a password and REMEMBER it as there is no way to recover it if you forget.

Select “Configure Wireless LAN” so that you can access your Pi using a Network Connection from your laptop to your Pi. (The alternative is to use a hard wire to connect to your LAN.) If you use this, you won’t need to connect a monitor-keyboard-mouse directly to the Pi. Enter your SSID and network password, and select wireless LAN country of “US”.

Set locale settings of Time Zone “America/New_York” and Keyboard layout “US.”

Under SERVICES:

Enable SSH and Use Password Authentication.

Under OPTIONS:

Select “Eject Media when finished”

Click “SAVE.”

Click “YES.”

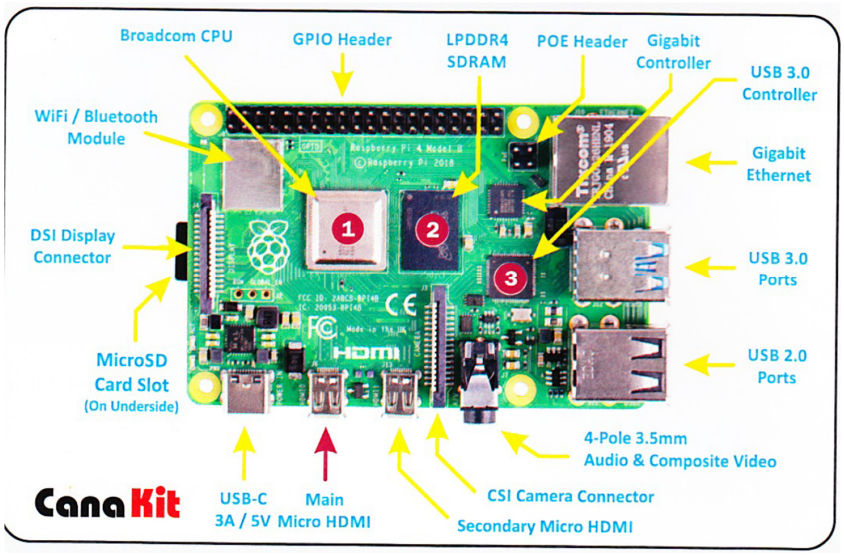
In the Warning window, click “YES.”

W- A- I- T for the card image to be written to the SD card.

If you have a problem with the Raspberry Pi Imager, an alternate way to write an SD card is to use Balena Etcher.

WALK AROUND THE PI

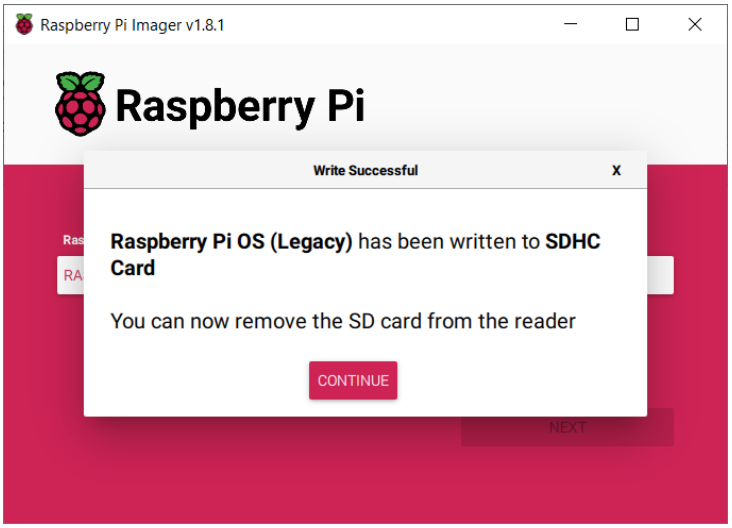
While we are waiting, let’s walk around the Raspberry Pi 4 Model B. If you have an earlier or later model, it’s the same except for a few differences I will point out as we go.



Starting with the Ethernet connector and moving clockwise:

- Ethernet port
- 2- USB 3 ports – blue insert
- 2- USB 2 ports – black insert
- (earlier models: all ports are USB 2, and USB and Ethernet ports are reversed)
- Audio port (hidden on Raspberry Pi 5)
- Camera port
- MicroHDMI 1 port
- MicroHDMI 0 port
- (earlier models: only one full size HDMI port)
- USB C power port (earlier models: MicroUSB power port)
- Display port
- Under the Display Port is the MicroSD card slot. The MicroSD card is your file storage for your Raspberry Pi. The MicroSD card is inserted with the gold fingers UP.
- 40 pin GPIO pins
- Pi 5 has some new features, including an on-off switch, ~~and~~ a realtime clock and a PCIe bus~~.~~

When you see “Raspberry Pi OS has been written to SD card”



Click “Continue” and close Raspberry Pi Imager. Remove the SD card from your computer.

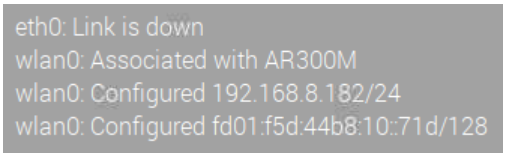
Linux Command Notes: All commands in Linux are case-sensitive. For example, “SSH” is NOT the same as “ssh” or “Ssh”
I will show commands that you type into a Terminal window preceded with a $. Your system shows the $. DO NOT repeat the $.

CONNECT TO YOUR PI

Steps 1 and 2 direct you how to use your Raspberry Pi with either an external HDMI monitor, etc. (step 1) or how to use your computer system for purposes of display and control (step 2).

1. If you have a monitor, keyboard, and mouse available, then this is a way to get started.
    a. Materials needed:
        i. HDMI Monitor (could be your television with an HDMI port)
        ii. HDMI Adapter if needed
            1. HDMI to micro-HDMI Cable
        iii. Keyboard (USB or wireless)
        iv. Mouse (USB or wireless)
        v. Optional: USB plug (dongle) for wireless keyboard and mouse

b. Plug the HDMI cable into the monitor and into the HDMI 0 port, next to the power port (Pi 4 or 5).
c. Plug the keyboard and mouse, or wireless dongle, into USB ports.
d. If you have a USB GPS, plug it into a USB port.
e. Insert the microSD card into the Raspberry Pi. The gold contacts go in closest to the Pi.
f. Insert the power cord and turn on the power.
g. The Pi will now boot for initial use. It may restart several times.
h. Hover the mouse over the WiFi Network icon in the upper right of the Pi screen and you will see the Pi IP address displayed. Look for "wlan0: Configured 192.168.8.182/24" for example.
Your Pi IP address in this example is 192.168.8.182.



If your monitor does not display the full screen, open a command window and type "ifconfig" and look for your IP address under "wlan0"
You might also record your MAC address to make it easier to find your Pi on a network. For example, mine is d8:3a:dd:28:49:76

h. On your Pi, select Start
h.i. > Preferences > Raspberry Pi Configuration.
i.j. Click Interfaces
j.k. Enable VNC
k.l. Click OK.
l.m. Now you can continue below starting with "You can now use VNC to access the GUI interface for your Pi."

2. Use your computer as the display and controller for your Raspberry Pi
   a. Materials needed:
      i. Computer with
         1. SSH program, built in to most systems
         2. VNC Client program
      ii. Internet network, wired or wireless
         1. Know the SSID and password if you are using your wireless network.
         2. Recall the "hostname" you entered for your Pi. Or determine the IP address of your Pi. If you cannot determine one of these, you will need to start with a monitor, keyboard, and mouse.
   b. Install the VNC Viewer program on your computer:

https://www.realvnc.com/en/connect/download/viewer/
If you have not used RealVNC before, you will need to create an account there.

c. If you have not already started your Pi as in step 1 above:
    a. Insert the SD card into your Raspberry Pi.
    b. Insert the Ethernet cable if you are connecting via wire.
    c. Insert the power cord and turn on the power.
    d. The Raspberry Pi (Pi) will now boot for initial use.

d. Run your SSH program, and provide the hostname or IP address.
On Windows 10, open a command window by pressing the Windows Start key and typing "cmd", and then type
`$ ssh pi@<hostname>.local`

When you setup your Pi Image, you provided a hostname. You can often reach your Pi using this. For example, I used "AA6BD" for my hostname so I can reach my pi by entering
`$ ssh pi@AA6BD.local`

When I did this, ssh responded
"The authenticity of host 'AA6BD.local (192.164.8.16)' can't be established"
This showed me that I was ready to connect to my Pi and also provided my IP address. I replied Yes that I wanted to continue.

If the above method of addressing your Pi does not work, then you can use its IP address.
`$ ssh pi@<IP address>`

where "pi" is the username you entered.
for example,
`$ ssh pi@192.168.8.180`
Type `yes` when asked to continue connection.

e. If you need your IP address and have a Windows laptop, the easiest way to find your IP address is to use
http://www.nirsoft.net/utils/wireless_network_watcher.html
to display the addresses on your network.
Look for the device associated with Raspberry Pi Foundation or the device name raspberrypi. Newer Pi's may show a blank device name. I start Wireless Network Watcher before I power on my Pi so that I can see it as it connects to the network. Look for new entries at the bottom of the listing.
You might use your router browser interface to show the IP addresses. You can browse to the IP address of your router, which might be something like

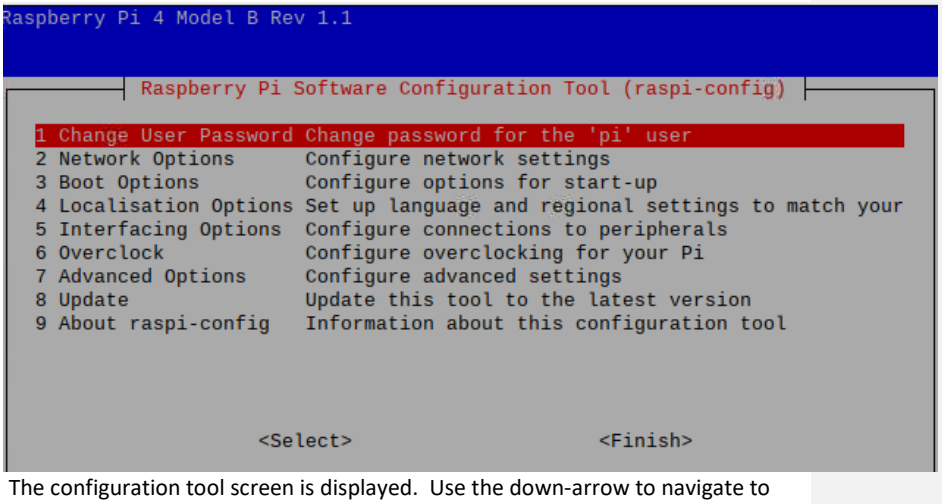
http://192.168.1.254 (AT&T modem) or http://192.168.0.1. If you can view your network interface properties, use the address for IPV4 DNS Server.

On your **Mac**, choose Apple menu > System Preferences, then click Network. In the list at the left, select the network connection service you want to use (such as Wi-Fi or Ethernet), then click Advanced. Click **DNS**, then click the Add button at the bottom of the **DNS Servers** list.

On Linux, open a command window and type the command
$ grep "nameserver" /etc/resolv.conf
or you can install and use a program like NMap and
$ sudo nmap –sn 192.168.8.0/24

On Android, use Network Analyzer which provides similar functionality to Windows Wireless Network Watcher.

f. When asked for the password, type the password you entered.
The password is not echoed to your screen.
g. After the command prompt, type
`$ sudo raspi-config`
h. The exact appearance of raspi-config varies with the release so just look for the right options.

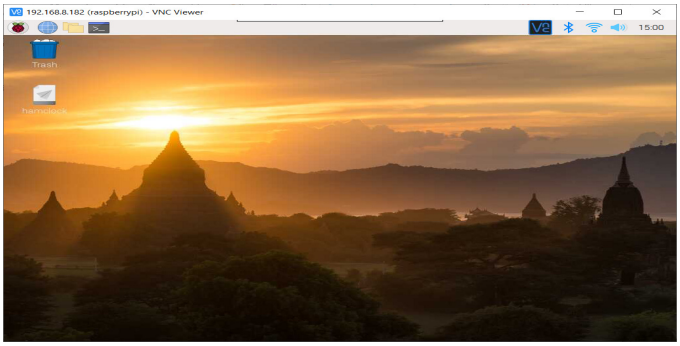


i. The configuration tool screen is displayed. Use the down-arrow to navigate to
`Interface Options`
and press `Enter`
j. Use the down-arrow to navigate to

VNC
and press `Enter`

k. Use the TAB key to select <Yes> and press Enter, then press Enter again to select <Ok>
l. If you are connecting via VNC, use the down-arrow to navigate to
`Display Options`
Use the down-arrow to navigate to
`VNC Resolution`
Use the down-arrow to navigate to
`1920x1080`
You can use a different resolution if you desire as long as your screen is at least as large as what you select. Do not enter a resolution larger than your computer screen.
Tab to <Ok> and press enter, then press Enter
m. Use the TAB key to navigate to `<Finish>` then press Enter
n. When you see:
`Would you like to reboot now?`
Select `<Yes>` and press Enter

o. **You can now use VNC to access the GUI interface for your Pi.**
Start your VNC program that you installed above in 2.b. You will need to create a free RealVNC account to use this program.
In the address bar, enter the hostname or IP address of your Pi and press Enter. You must be on the same WiFI network as your Pi. The username is as you entered it (pi) and the password is as you entered it.
p. If you see "VNC Server not recognized" click "Continue"
q. In the Authentication window, enter Username and password then click OK. I also check "save password" to make the next use easier.
r. You should now see the Raspberry Pi desktop window.



I have found that my current router changes the IP address it assigns to my Pi regularly so be aware that you may need to find a new IP address occasionally. If you use a hostname, it will not change.

UPDATE SOFTWARE

It is good to update your software regularly. You can use this: 
"Update Software" will take time so you can skip it for now and do it later. If you skipped it, or you get an error message while checking for updates, open a terminal window by clicking on this icon  in the upper left, and type:

```
$ sudo apt-get update
$ sudo apt-get full-upgrade
```

If asked "Do you want to continue", type y and press enter.

OR to also update the Pi eeprom:

```
$ sudo apt update && sudo apt full-upgrade -y && sudo rpi-eeprom-update -d -a
```

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Linux does not automatically update, so you will need to enter these commands whenever you want to update, which is good to do before you install any new programs.

73Linux will run an update every time that you install any additional programs, ensuring that you have the latest operating system software. This means that there will be a delay while this happens, and updates can be released multiple times per day.
I recommend that you back up your SD Card before installing new programs so you can recover from any unknown issues. See below for how to back up.

You have set up your Pi and are ready to use it.
Explore the Start menu to see what is available.
"Start" is the first icon at the top of the screen that looks like 
which is the Raspberry Pi Logo.

See https://www.raspberrypi.org/documentation/linux/ to learn more about Linux and its command language. Help is also available once you have your Pi set up using Start > Help > Help

SHUT DOWN SAFELY

CAUTION: It is very possible that during your times using your Pi, you will find that your microSD card has become damaged and needs to be restored, especially if you don't shut off power properly. The next step explains the proper method of removing power from your Pi. Please follow this procedure carefully to avoid damage to the microSD card.

To power off your Pi, select Start > Shutdown > Shutdown.

Your Pi will now go through its shutdown procedure. **W-A-I-T** for the green light to flicker, then flash on and off about 8 times, then go out. The exact number of flashes varies by Pi model. It is now safe to remove power to your Pi.

To start it again, just restore power to your Pi. Reconnect your VNC if needed and you are ready to go.

Note that you can add a pushbutton switch connected to the GPIO pins to provide a shutdown switch. See https://forums.raspberrypi.com/viewtopic.php?t=217442

1. Prepare a pushbutton switch with female connectors.

2. `$ sudo mousepad /boot/config.txt`
3. At the end of this file, add
   `dtoverlay=gpio-shutdown`
4. Ctrl-s and Ctrl-q to save the file and quit mousepad
5. Shutdown your pi and install the pushbutton switch between pins 5 and 6.
6. Reboot.
7. When you push the switch, the Pi will shutdown.
8. When you push the switch again, the Pi will restart.
9. There is an alternate command if you need to use pin 5 for another purpose, such as I2C:
   `dtoverlay=gpio-shutdown,gpio_pin=26`
   which will now use GPIO pin 26 (physical pin 37). Or pick another pin as desired.
10. However, this will not support restart.

BACK UP YOUR PI

To protect your work against a corrupted microSD card, regularly back up your microSD card. One way to do this is to insert your second microSD card into your USB microSD card reader and insert it into a USB port on your Pi. Select Start > Accessories > SD Card Copier and make a copy of your SD card. You should repeat this BEFORE you make significant changes to your Pi.

To restore your backup, insert the backup SD card into the Pi, and re-do the copy, then use the copy you just made so you preserve your backup.

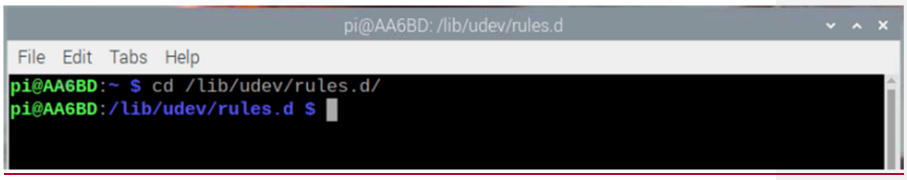
Alternately use “dd” and “pishrink” on a Linux computer to make smaller image copies to your laptop. If the Linux computer were your Pi, you would need to add an external hard drive to provide sufficient capacity.

See more detailed information on this at
https://www.tomshardware.com/how-to/back-up-raspberry-pi-as-disk-image

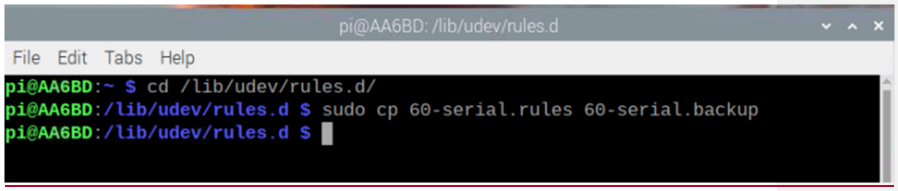
SET UP FOR HAM RADIO APPLICATIONS

There are several packages of software available that combine ham radio applications to more easily install them on a Pi. I recommend Build-a-Pi (BAP). 73 Linux is the next evolution of Build a Pi. Not only does 73 Linux support Raspberry Pi but it also supports x86_64 Debian based systems.

1. This would be a good time to back up your Pi before you install more software.
2. If you have a USB device connected, there is a bug in the current release of PI OS that needs to be patched before you can connect your USB GPS or any other USB device.
   a. Go to folder /lib/udev/rules.d/
      ```
      $ cd /lib/udev/rules.d/
      ```

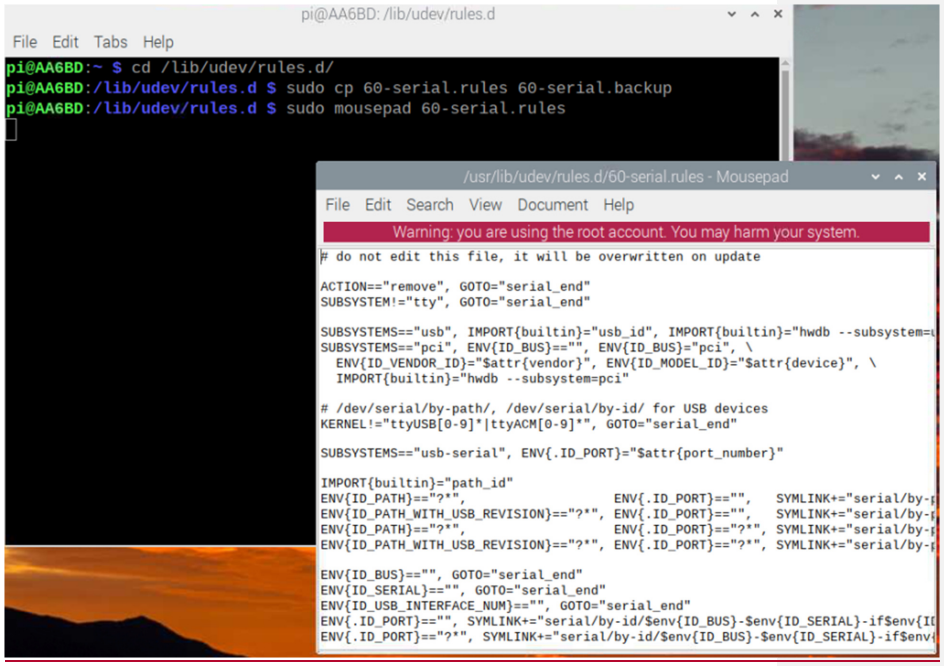


   b. Make a backup of the File "60-serial.rules"
      ```
      $ sudo cp 60-serial.rules 60-serial.backup
      ```



c. Edit the File 60-serial.rules

```
$ sudo mousepad 60-serial.rules
```



d. Replace the whole content of this File with the content from
https://github.com/systemd/systemd/blob/main/rules.d/60-serial.rules

i. Open the web page using the pi browser
Click Start > Internet > Chromium Web Browser

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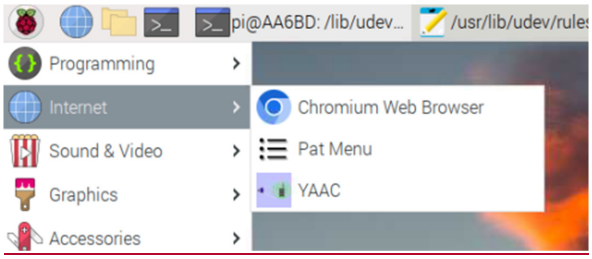

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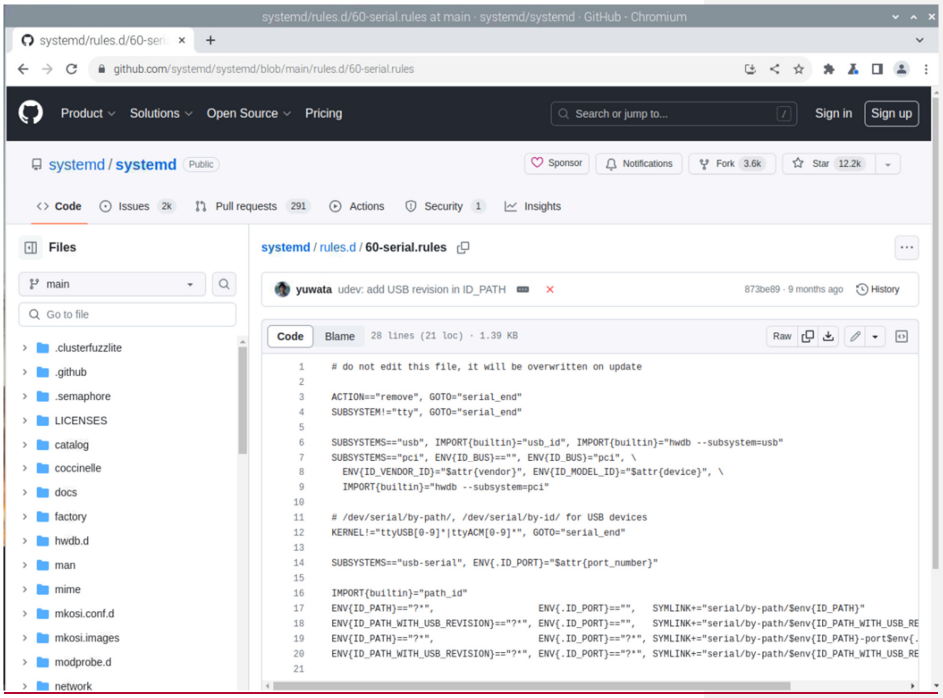
Navigate to https://github.com/systemd/systemd/blob/main/rules.d/60-serial.rules



ii. Click on this icon:  at the right of the window

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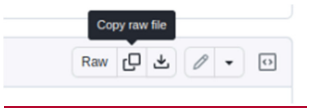
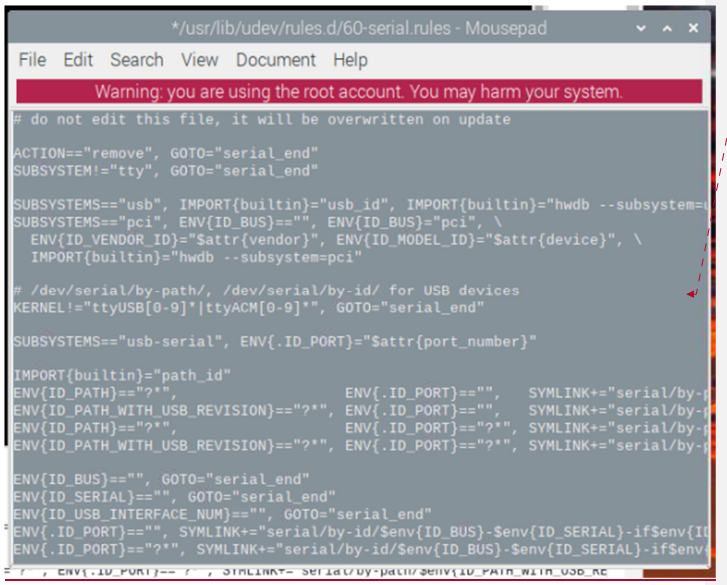


to copy the file to your copy buffer.

iii. In the 60-serial.rules editing window, click ctrl-a (to select all of the code in the window)



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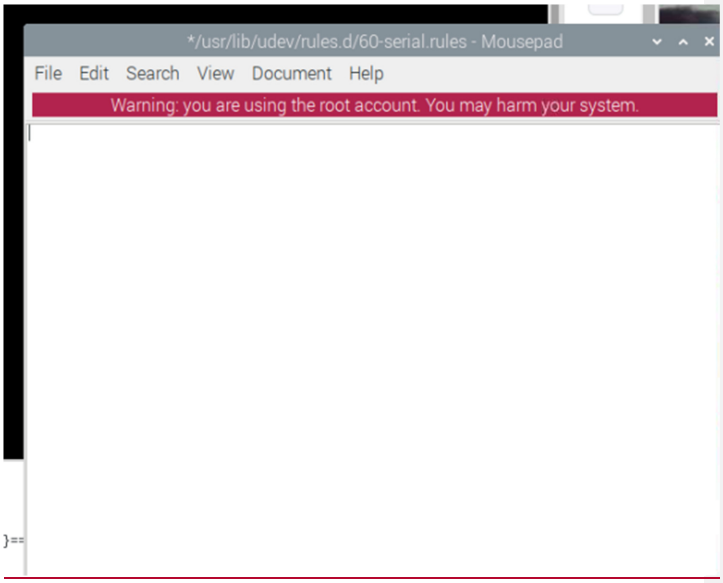
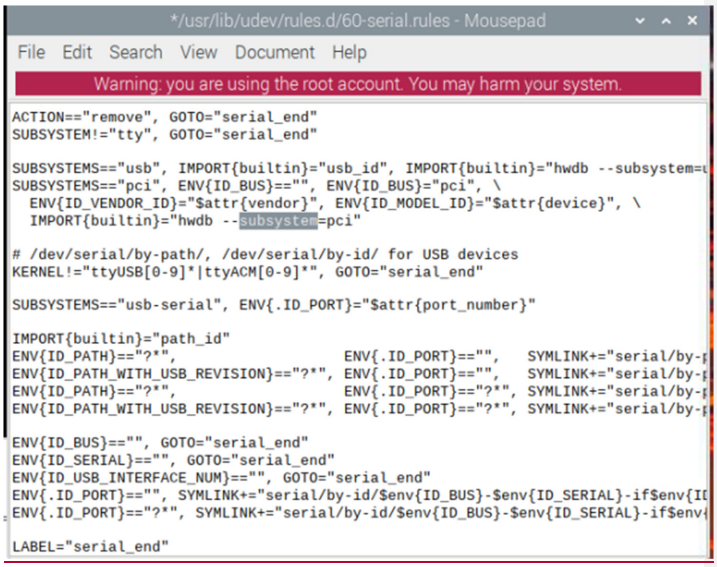
The click the “delete” key (so you can see that the contents are deleted)

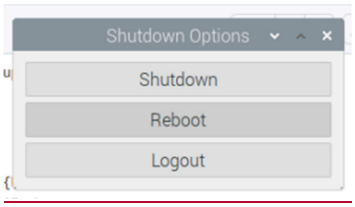


and ctrl-v (paste command) to replace the file contents with the contents from the web site.

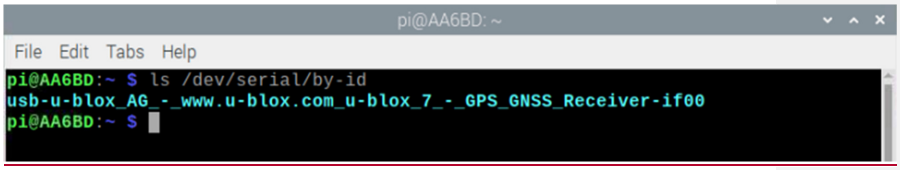


~~d.~~

e. Save File and quit the editor (press ctrl-s and then ctrl-q)
f. Reboot the Pi: Press Start > Shutdown and in this popup window, press Reboot.



g. To see that your patch was successful, open a Terminal window and enter
`$ ls /dev/serial/by-id`



You should see something like:
`usb-Prolific_Technology_Inc._USB-Serial_Controller_D-if00-port0`

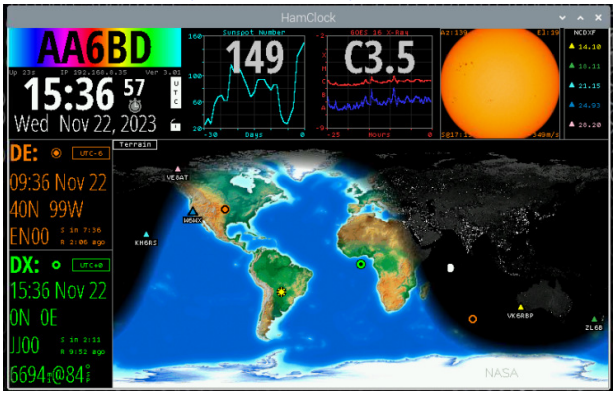
h. Reboot your Pi
i. From https://groups.io/g/KM4ACK-Pi/topic/bap_3_3_2_gpsupdate_not/99095766?p=Created%2C%2C%2C20%2C1%2C20%2C0&jump=1

3. Browse to https://github.com/km4ack/73Linux
4. Follow instructions under "Install."
5. The command to use is

```
$ git clone https://github.com/km4ack/73Linux.git $HOME/73Linux &&
bash $HOME/73Linux/73.sh
```

entered on one line. This can be easily copied from the github site with one click.
6. Follow the on-screen instructions to install this package.
7. Note that 73Linux will update your system so be prepared for this delay.
8. For your initial use, I suggest selecting
   a. GPS
   b. GPSUPDATE
   c. CONKY
   d. HAMCLOCK

9. Reboot when this is requested.
10. Once the installation completes, you will see a new menu item: Hamradio. You will also see a "Conky" display on the right side of the screen showing many operational items.
11. Check your GPS if you have connected one.
    a. In a terminal window, type
       `$ cgps`
       You will see a window showing the satellites that you are seeing with your GPS.
    b. You can also type
       `$ xgps`
       to see a graphic representation of the satellites your GPS is seeing.
    c. Once your GPS connects, you will see your gridsquare at the top of the right side in the Conky display.
    d. This capability uses "gpsd" a "daemon" application that makes your GPS data available to any program that can reach your Pi locally. It was installed when you selected GPS to be installed via 73Linux. The connection between the GPS and Conky can be a little unstable so you will not always see the Gridsquare displayed on Conky.
    e. You can use
       `$ gpsupdate`
       to manage the connection to your GPS.
12. Select Start > Hamradio > Hamclock. Complete the setup window. In the first setup window, enter your callsign. If you do not have a GPS connected, enter your lat-lon. If you do have a GPS connected, click "use gpsd" and it will change to Yes. Then click Done. You will see a display of items interesting to us hams. You can configure the display, see documentation at https://www.clearskyinstitute.com/ham/HamClock/



13. Hamclock includes a web interface so you can see it on other computers on your LAN. Browse to http://<pi address>:8081/live.html
    For example, http://192.168.234.89:8081/live.html
~~13.~~14. To install additional applications on your Pi, select Start > Hamradio > 73Linux > 73Linux.

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When you do so, you can see what applications have been installed, and if updates are available. To install an update, put a check before that app as you run 73Linux.

~~14.~~15. I have had occasional problem installing apps using 73Linux usually due to connectivity issues. If you have problems, you can try to reinstall an app or if that doesn't repair things, you can start over. You DID make a backup before installing new software, right?

SUPPORT

Support for Build-a-Pi and 73Linux is provided in the groups.io system. To join, browse to https://groups.io/groups and search for "KM4ACK-Pi." If you don't already have a login at groups.io, create one. Join KM4ACK-Pi and browse or search through the messages. I use it often.

Issue reporting and feature request is provided at https://github.com/km4ack/73Linux/issues

There is useful documentation at https://github.com/km4ack/pi-build including descriptions of many of the programs included in BAP and 73Linux.

Also useful are the many YouTube videos by KM4ACK. I have subscribed to his channel and regularly view them.

CONKY

The display that overlays on the right side of the screen is Conky. It is customizable and there have been many changes made by users.

There is an app "setconky" that provides for changes in the size of the Conky display which is useful if you change the screen resolution. I often use 1280x720 while in VNC so that the size of the characters is larger. I need the "medium" size Conky display so it all fits on the screen.

There is a bug in the currently distributed version of setconky which I have patched (I am a real beginner in exploring BASH scripts). To patch it:

1. `$ mousepad bin/conky/setconky`
2. Find the line
   `CPU=$(lscpu | grep Architecture | grep arm)`
3. Change to
   `CPU=$(lscpu | grep Architecture | grep aarch64)`
4. Key Ctrl-S and Ctl-Q

You can now choose 7inchscreen, small, medium, or large Conky displays.

To run setconky, go to Start > Preferences > Conky-Prefs

WINLINK

We will explore installing and running Winlink on the Pi. In case you are not familiar, Winlink is an application that allows you to send and receive email using RF. It was originally developed for sailors so they could stay in touch while out on the seas. It now has widespread use in the ham community especially for emergency communications.

You can see more about Winlink at https://winlink.org/

If you don't already have a Winlink account, you will need one. In https://winlink.org/user see "How to get an account." You can use this installation of Pat to get your account.

The Winlink client supported on the Pi is "Pat." Actually Pat is a cross-platform Winlink client so you could also use it on Windows or Mac.

To install the software needed for Winlink, select Start > Hamradio > 73Linux > 73Linux.

Select "Start Scan"

Enter your call sign and select "Continue."

Select
ARDOP
ARDOPGUI
DIREWOLF
AX25
PAT
PAT-MENU

Click "Next."

Enter your Six Character Grid Square and Winlink Password.

If you don't already have a Winlink account, leave the Winlink Password blank.

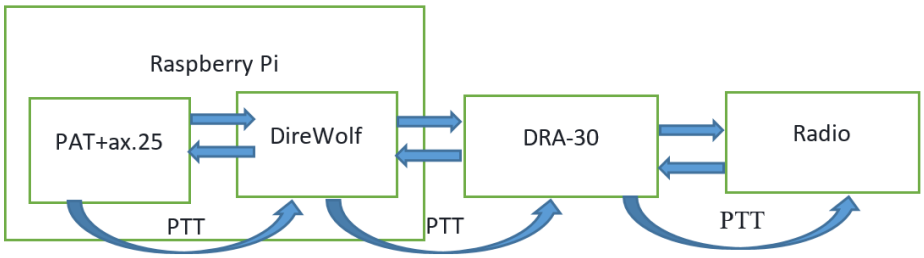
Click "Install/Update Selected."

73Linux will download and install your selected applications. Select "Reboot" when requested.

You will now see in Conky that "PAT is ACTIVE" meaning that the PAT program has been started. Now we can proceed to send and receive emails.

First, we must deal with the hardware requirements. On the Pi, PAT can format the messages to and from Winlink, but the Pi can only send a digital signal that must be converted to an analog signal that can be sent by a radio. There are many ways to address this. Traditionally, there is a device called a "Terminal Node Controller" or TNC that connects the Pi to your radio. The term TNC is not quite accurate as it used to refer to a computer-like device that connected a keyboard to a radio, but the term is often used more broadly. A TNC can be as simple as an audio interface between the Pi and radio. Today, most TNCs are called KISS TNCs as they leave the processing to the Pi and convert the signals to audio that can be transmitted or received on the radio. A TNC can be hardware or software based with an audio sound card to be the connector. Some radios today have a sound card built in so you can connect your computer to your radio with nothing else required.

For this example, we will use the following: The Pi will run PAT to format the email messages, and pass them to a software TNC called Direwolf. Direwolf will pass the signals to an audio interface, a Masters Communications DRA-30 which will be connected to the data connector on a radio, an IC-7100. The protocol used is AX.25 which is a packet protocol also used for Winlink, APRS, and other packet applications.



Other TNCs are Signalink sound card modem, Mobilinkd, Digirig, PACTOR, Rigblaster, TNC-Pi, TNC-Pi9k6, and home-built interfaces such as the one demonstrated by Dale N5EIA.

For VHF, software modems include Packet and VARA FM.

For HF, software modems include ARDOP and VARA HF.

VARA can be installed on a Pi but it is a little finicky.

Direwolf must be configured for your soundcard.

a) You may need to configure Direwolf for your sound card. In my case, here is what is needed for DRA-30 support:

   i) Determine where your soundcard is listed on the Pi:
   `$ arecord -l` (that is a "lima" not a "one")
   Note the Card number and device number. For example,
   `Card 3: Device [USB PnP Sound Device]. Device 0: USB Audio [USB Audio]`
   My card is at 3,0

   ii) Edit direwolf.conf to support the soundcard. For example,
   `$ mousepad direwolf.conf`
   (Mousepad is a text editor that is easy to use, as it is a WYSIWIG editor similar to Notepad on Windows.)

   Build-a-Pi will set this:
   `ADEVICE plughw:3,0`

   Uncomment: (remove the leading #)
   `PTT CM108`
   This provides Push To Talk (PTT) via the soundcard GPIO line which the DRA cards support.

   If you are using a Signalink, then no PTT line is needed, as the Signalink generates the PTT.

   If you have a different soundcard, you will need a different PTT command.
   For example, for a USB Sound Card, I uncommented the PTT line so it was:

```
PTT GPIO 25
```

I also uncommented the DCD line so it was:

```
DCD GPIO 13
```

Read documents at https://github.com/wb2osz/direwolf for Direwolf instructions and the many capabilities of Direwolf.

Save and close the editor:

```
Ctrl-s
Ctrl-q
```

To send an email via PAT Winlink:

1. Select Start > Hamradio > Pat Menu
2. Click Start/Stop Modem
3. Click Start Packet Modem
4. You will see "DIREWOLF ACTIVE" and "KISSATTACH ACTIVE" go green in Conky.
5. You will see a window "The PACKET modem has started." Click OK.
6. A browser window will open. If asked to allow notifications, select "ALLOW."
7. PAT is running in this browser window. You will see menu items at the top, messages in the middle, and in the black area at the bottom, system status messages.
8. If this is your first time using Winlink and you don't yet have an account, see below "I WANT TO USE WINLINK…" and then come back here to complete the connect by radio.
9. To compose and send a message:
    i. Select "Action" > "Compose"
    ii. Compose your message
    iii. Click "Post"
10. To connect via 2M FM radio to send and receive messages:
    i. Select "Action" > "Connect"
    ii. Select transport "AX.25"
    iii. Enter the callsign of the gateway as the target, for example, AK4ZX-12
    iv. (A Gateway is a radio station that connects your RF radio to the Internet Winlink servers.)
    v. Tune your radio to the gateway frequency, for example, 145.050
    vi. Click "Connect"
    vii. You will see status in the bottom black part of the window and any messages in your inbox
11. To connect to Winlink via telnet, using just the Internet,
    a. Select Action > Connect
    b. In the dropdown (select alias), select "telnet"
12. You can create aliases to make it easier to connect to different gateways. For example, to create an alias for AA6BD-10 and AK4ZX-12, run

```
$ pat configure
```

and change the connect_aliases section to

```
 "connect_aliases": {
   "telnet": "telnet://{mycall}:CMSTelnet@cms.winlink.org:8772/wl2k",
  “AA6BD-10”: “ax25:///AA6BD-10”,
   "AK4ZX-12": "ax25:///AK4ZX-12"
```

Using “pat configure” invokes the Nano editor so you will need to learn how it works. Basically, use the arrow keys to position the cursor where you want to make changes, make your changes, and type “Ctrl-x”, “y”, and hit “return”.

After you make any changes using “pat configure”, you must restart your Pi for the changes to take effect.
While you are in the Pat Configure file, look around to see what else is there.

I WANT TO USE WINLINK. HOW DO I GET AN ACCOUNT?

From the https://winlink.org/user website:

Winlink accounts are created with a client program such as PAT.

If you use a different program from Winlink Express: (such as PAT)

a) Follow the program's help or instructions to configure it for your callsign and use. In PAT, we already did this above.
b) Connect with the Winlink system (send a message via Telnet [the Internet]) to create your account:
c) In the PAT Mailbox window, select Action > Connect
d) In the “Connect to remote node” window, select alias “Telnet” and click “Connect”
e) *Do not use a password on your first connection.* Your radio email address is *YOURCALL*@winlink.org. A message containing your password will be sent to your account. Retrieve it with a second connection. After retrieving your password, secure login will now be enforced by the CMS, so *be sure to set your password in your client program.*
f) For PAT, open a Terminal session and type

```
$ pat configure
```

This uses the Nano editor, so be sure to see how to use it.
Edit the second line, “secure login password”: “”
and put your password between the “”
then type

```
Ctrl-X
y
enter
```

To recover your password and log into your account on Winlink.org:

i) At any time, use the recovery form at Winlink.org [My Account] to have a password re-sent to your account or password recovery address. Retrieve it using the appropriate program.
ii) *Use your callsign as your username*, and password to log in at Winlink.org. You can change your password once you're logged in.
iii) *Be sure to edit your account settings at Winlink.org and **set a password recovery address!***

BACK TO CONKY

Some times, when you install a program, you "break" another one. In this case, I have found that when I installed Pat, then Conky ran into an address conflict. This was due to both programs wanting to use the same "port" to display using a browser.

To fix this, change the port that Pat uses:

1. Start > Hamradio > Pat Menu
2. Click Settings/Config
3. Click Current Config Settings
4. Change Pat Port from 8080 to 5000.
5. Click Update.
6. Click Main Menu.
7. Open a Terminal window.
8. `$ pat configure`
9. In the line
   "http addr": "127.0.0.1:8080"
   Change "8080" to "5000"
10. Type Ctrl-o, Hit enter, and Ctrl-x
11. Reboot

You can now run both Hamclock and Pat at the same time.

How did I learn this? By searching messages in https://groups.io/g/KM4ACK-Pi

Troubleshooting tip: I have had some programs fail to start. I often can repair this problem by reinstalling the program.

EXPLORE YOUR PI

Take some time to explore what software is available on your Pi. Click through some of the menu items under the Pi Start menu. See what applications are available in 73Linux. Let me know what you want to explore next.

- APRS – I recommend YAAC as an APRS client
  APRS can be used for tracking location, messaging, texting via RF, telemetry
- HOTSPOT provides a WiFi hotspot that you can use to connect your Pi to a tablet, phone, or laptop in the field when no other WiFi is available.
- FLDIGI is a modem program for most of the digital modes used by radio amateurs today: CW, PSK, MFSK, RTTY, Hell, DominoEX, Olivia, and Throb are all supported. It can help calibrate a sound card to a time signal and do frequency measurement tests.
- WSJT-X weak signal digital mode software such as FT8 and FT4

- JS8CALL weak signal digital mode software for enhanced messaging
- QSSTV slow scan TV
- LinBPQ packet software includes the capability to host APRS digipeaters or Winlink Gateways or packet bulletin boards
- Many utility programs such as loggers and various lookup tools

Other programs of interest might include

- APRS digipeater can be built using several software programs
- Transmitting using a Pi for FM or WSPR
- GNUradio.
- Allstar node
- MMDVM hotspot for DMR, YSF, and DStar

Other sources of Raspberry Pi apps include:

- https://www.raspberryconnect.com/raspbian-packages/39-raspbian-hamradio
- https://www.dxzone.com/catalog/Technical_Reference/Raspberry_Pi/

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WHAT'S NEXT

After reviewing this information, decide what capabilities you want to implement in a Raspberry Pi. For example, I use them for:

- My LED Christmas Tree (not ham radio, but fun)
- Winlink through DRA-30 and (IC-7100 or FTM-300)
- WSPR transmitter to test where my antenna reaches through TAPR WWOT on 40M and 20M
- MMDVM hotspot for YSF
- LinBPQ/PiGate RMS for 2M Winlink Gateway
- In progress: Allstar node
- In progress: packet nodes using NanoTNC

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Here is something unusual you can do with your Raspberry Pi and APRS: Use APRS to send a message from one radio to another and use that message to control another radio, such as turn it on and off. Check this out: https://www.youtube.com/watch?v=F8EmZNcbKT0

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Other possibilities include fldigi and NBEMS

- And turning these sessions more toward exploring data digital modes, using Pi as a platform but not limiting it to Pi

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