

Raspberry Pi APRS Tracker

Version 1.6 – November 2019

The Linux version of Dire Wolf can be used as a tracker by enabling an optional feature to access GPS data. This is not enabled by default because most systems probably won't have the necessary files installed.

This document is targeted specifically for the Raspberry Pi. Other than the details about the serial port, everything else should be applicable to other Linux systems.

First install Dire Wolf as detailed in the other Raspberry Pi APRS document and make sure it is working properly before enabling this additional feature.

Step 1: Install the GPS support software.

There are three parts to this:

- **gpsd** daemon which communicates with the GPS receiver. **libgps20** should also be selected automatically.

```
sudo apt-get install gpsd
```

- Test programs.

```
sudo apt-get install gpsd-clients python-gps
```

- Other files for application development. (e.g. /usr/include/gps.h)

```
sudo apt-get install libgps-dev
```

Step 2: Connect GPS receiver.

There are different ways to attach a GPS receiver.

- The easy way is to use one with a USB interface. Plug it in and it should show up with a device name like /dev/ttyACM0. You can see that it is working by simply typing:

```
cat /dev/ttyACM0
```

This one was dirt cheap and very sensitive. It will pick up signals indoors where other GPS receivers won't. It is advertised as also being capable of receiving GLONASS satellites but I spent a considerable amount of time with the configuration software and couldn't enable GLONASS reception.

VK-172 <http://www.amazon.com/gp/product/B00NWEEWW8/>

- A GPS module with a 3.3 volt logic level interface can be connected directly to the Raspberry Pi's UART. Additional configuration steps must be taken to disable console output to the serial port. In this case, the device name is /dev/ttyAMA0.

(The Raspberry Pi model 3 uses the UART for Bluetooth. It is possible to remap the UART to different I/O pins. At the time this is being updated, the details are not yet clear.)

Complete instructions can be found here:

<http://learn.adafruit.com/adafruit-ultimate-gps-on-the-raspberry-pi/introduction>

When using the UART, be sure to edit two files as described in the reference above.

- **/boot/cmdline.txt** -- change from:

```
dwc_otg.lpm_enable=0 console=ttyAMA0,115200 console=tty1  
root=/dev/mmcblk0p2 rootfstype=ext4 elevator=deadline rootwait
```

to: *(remove part in red above mentioning ttyAMA0)*

```
dwc_otg.lpm_enable=0 console=tty1 root=/dev/mmcblk0p2 rootfstype=ext4  
elevator=deadline rootwait
```

- **/etc/inittab** -- change from:

```
#Spawn a getty on Raspberry Pi serial line  
T0:23:respawn:/sbin/getty -L ttyAMA0 115200 vt100
```

to: *(comment out one line)*

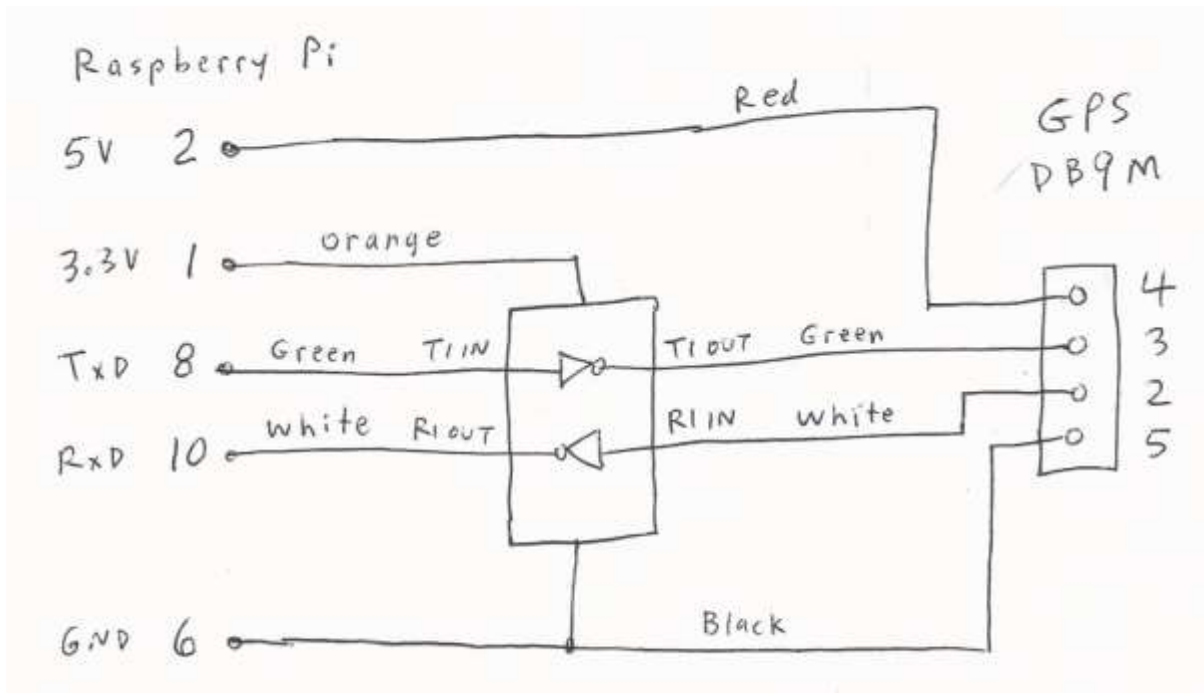
```
#Spawn a getty on Raspberry Pi serial line  
#T0:23:respawn:/sbin/getty -L ttyAMA0 115200 vt100
```

- RS-232 interface

This is similar to the previous step except you need to add a logic level to RS-232 level converter.

WARNING: Do not attempt to connect a GPS receiver with RS-232 voltage levels directly to the Raspberry Pi GPIO pins. It will probably destroy your Raspberry Pi. An RS-232 to 3.3v logic converter, must be used.

The SparkFun MAX3232 Breakout BOB-11189, <https://www.sparkfun.com/products/11189>, can be wired as shown below.



5 volts, to power the GPS, is supplied through pin 4. This is the same convention commonly used by other trackers such as OpenTrack and Tiny Trak4 so the same GPS receiver should be interchangeable between them.

It is also possible to obtain the RS-232 level converter and connector preassembled as a single unit. Something like the NKC Electronics 0609456348584 http://www.amazon.com/dp/B0088SNIOQ/ref=dra_a_cs_ss_hn_it_P1250_1000 looks like it would be suitable but I haven't actually tried it. Just be sure it has a male connector, is wired as DTE, and the level converter chip is capable of 3.3 volt operation. I'd like to hear from anyone who tried this specific item.

Reboot the system. (Type "sudo reboot.")

Start up the gpsd daemon with the appropriate device name:

```
sudo killall gpsd
sudo gpsd /dev/ttyACM0 -F /var/run/gpsd.sock
or
sudo killall gpsd
sudo gpsd /dev/ttyAMA0 -F /var/run/gpsd.sock
```

For testing you can run either "cgps -s" (text only) or "xgps" (with graphical display of satellite positions). Be sure that you are correctly receiving your location from the satellites.

Note that the GPS antenna is directional and should be oriented so that it sees up and to the sides. If in doubt, observe the results from "cgps -s" or "xgps" and note the signal strength when pointed in different directions. Those with a built in magnet are intended to be on a horizontal surface such as the roof of a car. Which way to point little USB sticks might not be as obvious.

If you run into problems, this troubleshooting information might be helpful.
<http://catb.org/gpsd/troubleshooting.html>

Step 3: Configure for automatic start up on reboot.

Wheezy and Jessie

This worked on Wheezy and Jessie versions of Raspbian but doesn't seem to work anymore for Stretch.

The one thing left out of the instructions from Ada Fruit is automatic start up on reboot. Run this command and answer the questions:

```
sudo dpkg-reconfigure gpsd
```

Use "-n" when it asks for options.

Stretch and Buster

Manually edit /etc/default/gpsd so that it contains the following:

```
START_DAEMON="true"  
USBAUTO="true"  
DEVICES="/dev/ttyACM0"  
GPSD_OPTIONS="-n"
```

Type:

```
sudo systemctl restart gpsd
```

Step 4: Optionally set clock from GPS receiver.

The RPi does not have a battery powered real time clock. When it is powered up, it doesn't know the current time and date. This is usually obtained from an NTP server over the network. A mobile tracking device probably won't have reliable Internet access. The system time can be set from your GPS receiver.

Edit /etc/ntp.conf and add lines like this:

```
server 127.127.28.0 4  
fudge 127.127.28.0 time1 0.340 refid GPS  
  
server 127.127.28.1 prefer  
fudge 127.127.28.1 refid GPS1
```

The fudge factor is to compensate for latency of communication over a slow serial port. The number above seems about right for a 4800 baud serial port. For the USB model, around 0.050 is good.

Restart the ntp daemon:

```
sudo /etc/init.d/ntp restart
```

After waiting a little while, you can tell if it is working by using the “**ntpq -p**” command. When obtaining time from Internet NTP servers, you will see something resembling this:

```
remote          refid          st t when poll reach  delay  offset  jitter
=====
*tock.usshc.com .GPS.          1 u  46  64  377  47.884  18.724  64.903
+estatico.iloves 216.129.104.26 3 u  41  64  377  94.824  18.614  66.610
+79.132.237.6.st 193.190.230.65 2 u  10  64  377  117.697 17.355  50.584
+sisdb01.muskego 173.255.240.184 3 u   7  64  377  44.962  19.065  35.800
```

The lines with * and + at the beginning indicate time sources considered to be good.

When obtaining time from your GPS, it will look more like this:

```
remote          refid          st t when poll reach  delay  offset  jitter
=====
+96.44.142.5    18.26.4.105    2 u  46  64  17  69.485  -0.346  61.541
+ec2-54-235-96-1 152.2.133.53  2 u  43  64  17  27.297  4.169  32.766
*lithium.constan 128.4.1.1      2 u  46  64  17  16.853  -1.192  24.474
-50.7.0.66      128.138.141.172 2 u  42  64  17  39.321  5.043  0.575
*SHM(0)         .GPS.          0 l  43  64  377  0.000  2.589  4.256
SHM(1)         .GPS1.         0 l   -  64  0  0.000  0.000  0.000
```

Notice how the line with SHM(0) .GPS. has * in front of it.

More detailed information can be found here: <http://www.satsignal.eu/ntp/Raspberry-Pi-NTP.html>

Step 5: Rebuild Dire Wolf with support for GPSD.

The build procedure will notice that the required files are present and Dire Wolf will be configured with support for GPSD.

```
cd ~
git clone https://www.github.com/wb2osz/direwolf
cd direwolf
mkdir build && cd build
cmake ..
make -j4
sudo make install
```

Step 6: Configure beaconing.

IMPORTANT: First you must modify your configuration file to obtain the location from **gpsd**. Add a line like this:

```
GPSD
```

The TBEACON configuration command is much like PBEACON and OBEACON except it takes the location, altitude, speed, and direction from the GPS receiver.

```
TBEACON EVERY=4 SYMBOL=horse
```

If you want to transmit the altitude, add "alt=1". In this case, it does not mean the altitude is 1. It just means to include the altitude from the GPS receiver.

```
TBEACON EVERY=4 SYMBOL=horse alt=1
```

If you will be listening to your radio, while riding around, you might want to advertise your operating frequency. This is the proper way to do it. Some APRS-enabled radios have a TUNE or QSY button which will switch to the frequency in the selected position report if in the proper format.

```
TBEACON EVERY=4 SYMBOL=horse FREQ=146.955 OFFSET=-0.600 TONE=74.4
```

DO NOT put the information in a free form comment. A human would understand it but APRS-enabled radios and other applications will not recognize it.

```
TBEACON EVERY=4 SYMBOL=horse comment="Listening 146.955 (-) PL 74.4"
```

WRONG!!! DO NOT put frequency in a free form comment.

That example will transmit at a set interval, every 4 minutes. It might be too infrequent for a vehicle moving quickly. It might generate too many redundant transmissions for something sitting still. SmartBeaconing™ can be used to adjust the timing based on speed and changes in direction. It's the same technique used by Kenwood, Yaesu/Standard, and in many other tracker applications. A configuration option like this will override any fixed interval in specified in TBEACON.

```
SMARTBEACONING 60 2:00 5 15:00 0:15 30 255
```

What do the numbers mean?

- For speeds above 60 MPH, a beacon will be sent every 2 minutes.
- For speeds below 5 MPH, a beacon will be sent every 15 minutes.
- For speeds in between, a rate proportionally in between will be used.

Additional beacons will be sent more frequently when direction changes significantly.

- Send no more frequently than 15 seconds apart.
- Send if direction has changed more than 30 degrees at high speed.
- Requires sharper turns at lower speeds.

More details can be found in these references or just Google for APRS SmartBeaconing to find many discussions and recommendations.

<http://www.hamhud.net/hh2/smartbeacon.html>

<http://info.aprs.net/index.php?title=SmartBeaconing>

Troubleshooting

1. Build errors.

If you see compiling or linking errors, mentioning missing **gps.h** or **libgps**, you didn't install the GPS software in Step 1.

2. Missing or erratic GPS data.

Try running "cgps -s" (text output) or "xgps" to look at GPS data.

Use direwolf "-d gg" command line option to observe information coming from GPS.

3. Unexpected tracker beacon behavior.

Use "-d t" option on direwolf command for tracker position debugging information.

Use "-d tt" option to include SmartBeaconing details.

Use "-d ttt" option, along with the logging option, to send tracker beacon transmissions to the log file with fake channel 999.

You could test the behavior of the SmartBeaconing algorithm, without actually transmitting over the radio, by logging to a file, converting log file with log2gpx, and displaying it on a map.