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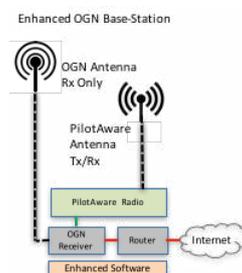
## Introduction

This paper shows how to add an 869.5MHz transceiver to an existing OGN (Open Glider Network) 868MHz receiver to re-transmit local glider positions for reception by PilotAware equipped aircraft in the vicinity local to the Antenna. This is done to improve safety by increasing situational awareness of gliders that are FLARM or OGN tracker equipped to the passing aircraft that are PilotAware equipped. Then PilotAware equipped powered aircraft will see gliders from the OGN.

The existing OGN receiver needs to be upgraded as follows: -

1. Upgrade the Computer to a Raspberry Pi 2B – if required
2. Add a PilotAware Radio Bridge.
3. Upgrade the SD Card to 8GB.
4. Upgrade the power supply to one capable of supplying 5.2V 2.1A minimum.
5. Add an 869.5MHz Antenna and Co-axial feed.

A schematic of the enhanced unit is shown below.



The following image shows an example of the finished antennas installed at Wellesbourne Mountford Aerodrome. The hardware can be tailored to your individual requirements. For example, the two antennas can be mounted separately to appear less intrusive. The hardware used to mount the two antennas will be bespoke to your individual local requirements. However, an example is shown at the end of this paper.

The requirement is that each antenna is mounted as high as possible away from local disturbances such as buildings and trees that will attenuate the signals. The OGN receiver is a high gain receiver but the PilotAware transmitter must use the approved antenna to meet the transmission regulations



### *The 869.5MHz Antenna.*

The 869.5MHz antenna is simply a PilotAware 869.5MHz end feed antenna positioned as high as possible at the existing OGN receiver station. The antenna should be connected to the PilotAware Radio Bridge using low loss co-axial cable kept as short as possible. RG8 (lowest loss but thicker) or RG8x cable has been shown to effective up to 10 metres in length. Similar to your existing installation, antennas should be positioned as high as possible but the hardware to do this will differ from site to site. 2<sup>nd</sup> hand scaffold poles make a good base for the antennas, if available, but the general rule is as high as possible with good sight of open sky.

SMA connectors are required at each end of the co-axial cable. The standard PilotAware end feed antenna has 3dB gain which has been shown to give a transmission radius of 30Km+. Higher gain antennas can be used to overcome the loss in the coaxial cable and connectors but not to exceed an overall 3dB.

**RG8X Cable** can be bought here <http://www.ebay.co.uk/itm/RG8X-Mini-8-32FT-10M-Low-Loss-Coaxial-Cable-/390775909213?epid=1869886484&hash=item5afc0f2b5d:g:qQ0AAOxy2HFSZ-iD>

Male and Female SMA connectors for RG8x cable can be bought here.

#### **SMA Male Connector**

<http://www.ebay.co.uk/itm/SMA-Male-plug-Male-pin-crimp-for-RG-8X-LMR240-RG8X-cable-RF-Connector-USA-/141070191561?hash=item20d8704bc9:g:jjAAAQxy2FZSP0HS>

#### **SMA Female Connector**

<http://www.ebay.co.uk/itm/SMA-Female-plug-Female-Pin-crimp-for-RG-8X-LMR240-RG8X-cable-RF-Connector-USA-/141070206914?hash=item20d87087c2:g:nMQAAOxymwBSP0cs>

How you physically support the antenna will be different at each site. A very simple antenna can be made by installing the end fed OGN antenna inside a 1 metre length of 25mm electrical conduit sealed at each. This can be connected directly to an aluminium pole or via a straight or cranked antenna mount. See the end of this paper.

### *Upgrading the Raspberry Pi Computer.*

A Raspberry Pi Computer, specification 2B is required with a PilotAware Radio Bridge attached. Power is supplied via a DC 5.2V power supply capable of delivering at least 2.1A. Connection to the internet is via an Ethernet cable of suitable length. Depending on which Pi case you have, it will have to be modified to accept the egress of the SMA connector on the PilotAware Bridge.

## Raspberry Pi Computer.

A Raspberry Pi 2B should be used as the Raspberry Pi B+ will be working too hard for reliable use. Raspberry Pi Computers can be sourced at the following website.

[http://cpc.farnell.com/raspberry-pi/raspberrypi-2-modb-1gb/sbc-raspberry-pi-2-model-b-1gb/dp/SC13794?mckv=s0CmGHHJZ\\_dc|pcrid/72935674577|kword||match||plid|&CMP=KNC-GUK-CPC-GEN-SHOPPING-RASPBERRYPI-Development Boards Evaluation Ki](http://cpc.farnell.com/raspberry-pi/raspberrypi-2-modb-1gb/sbc-raspberry-pi-2-model-b-1gb/dp/SC13794?mckv=s0CmGHHJZ_dc|pcrid/72935674577|kword||match||plid|&CMP=KNC-GUK-CPC-GEN-SHOPPING-RASPBERRYPI-Development Boards Evaluation Ki)

## 8GB SD Card

The memory for the system comes from an 8GB SD card and can be obtained from here.

<https://www.amazon.co.uk/Kingston-8GB-Micro-SD-HC/dp/B001CQT0X4>

## *PilotAware Radio Bridge and Antenna*

The PilotAware Radio Bridge has been designed to fit directly onto the Raspberry Pi unit and meets the relevant ETSI Standard EN 300 220-1 which is harmonised into OFCOM IR 2030 - UK Interface Requirements 2030 Licence Exempt Short Range Devices. PilotAware is providing the Radio Bridge unit and the 869.5MHz Antenna at a subsidised price and it is available by requesting them through an email to

[OGN@pilotaware.com](mailto:OGN@pilotaware.com).

## *Raspberry Pi Case*

Several Raspberry Pi cases are available an example is available here. The chosen case will need to be drilled to accept the PilotAware Bridge antenna egress.

[http://cpc.farnell.com/kksb/110218/metal-case-for-raspberry-pi-3/dp/SC14490?mckv=sUhPm3bzh\\_dc|pcrid/72935509697|kword||match||plid|&CMP=KNC-GUK-CPC-GEN-SHOPPING-KKSB-Enclosures 19in Cabinet Racks-SC14490](http://cpc.farnell.com/kksb/110218/metal-case-for-raspberry-pi-3/dp/SC14490?mckv=sUhPm3bzh_dc|pcrid/72935509697|kword||match||plid|&CMP=KNC-GUK-CPC-GEN-SHOPPING-KKSB-Enclosures 19in Cabinet Racks-SC14490)

## *Power Supply*

A 240V to 5.2V USB supply is required to supply 2.1A minimum.

<https://www.amazon.co.uk/Official-Power-Adapter-Raspberry-Pi/dp/B01CO1ELT8>

## *Software and Configuration*

Whilst many installers are very literate in all things Linux, C++ and networking, to make the installation as easy as possible for the average, new software has been produced that automates the installation process. If however, you have integrated your existing OGN station with other stuff and want more information on its structure email [pilotaware.ogn.com](mailto:pilotaware.ogn.com).

To install the new software, you will need to undertake a **full overwrite format** of the SD card if it has been used before. This will require an SD card holder to fit your PC or mac.

[https://www.amazon.co.uk/d/Computer-Memory-Card-Accessories/STOREINBOX-MicroSD-Adapter-Converter-Connector/B00S983AGG/ref=sr\\_1\\_1?ie=UTF8&qid=1498847719&sr=8-1&keywords=micro+sd+card+converter](https://www.amazon.co.uk/d/Computer-Memory-Card-Accessories/STOREINBOX-MicroSD-Adapter-Converter-Connector/B00S983AGG/ref=sr_1_1?ie=UTF8&qid=1498847719&sr=8-1&keywords=micro+sd+card+converter)

If you don't have SD formatter it can be downloaded here.

[https://www.sdcard.org/downloads/formatter\\_4/](https://www.sdcard.org/downloads/formatter_4/)

How to download the software will be found at.

<http://pilotaware.lode.co.uk/downloads/OGN/README.install>

Please read and follow the instructions. Connect the 2 antennas, the Ethernet cable to the raspberry Pi.

The Software will be downloaded to your download directory with a filename of PilotAware20170602 or similar, where <<20170602>> is the version dated 02<sup>nd</sup> June 2017.

Copy all the files under the top folder onto the SD card. There should be 19 files. Do not just download the high-level folder as the files need to be at the highest level in the directory. Eject the CD holder and CD card and put the CD card into the Raspberry Pi.

Power up the Raspberry Pi. The files will now be downloaded and the disk partitioned. This will take about 20 minutes to complete. If you want to see the progress you can connect a monitor or TV to the HDMI output of the Raspberry Pi.

## Shellinabox

The OGN\_R software has been developed so that this installation is as simple as possible and provides prompts for the installer to follow.

Before you start you will need to have the following unique information for your station to hand. This information can be obtained by going to <http://schellenberg.nl/ogn/index-latlon.html>

Drag the red marker to the desired position and you will be given the required latitude, longitude and the height AMSL in metres. Only use the 6 digits following the decimal point for the latitude and longitude and remember that in the UK the longitude may be negative west of Greenwich. To get the Geoidsepar click the link button and use the EMG84 value.

## Site Name

The Open Glider Network sensibly maintains a naming convention for all sites. Please see the rules at this link on the OGN website.

<http://wiki.glidernet.org/receiver-naming-convention>

You can record your unique configuration here for convenience and record.

Item Required	Description	Record here if required
Station Name	See naming Rules above	
New Password	A new station password is input to replace the generic one.	
Latitude	6 digits following the decimal point.	
Longitude	6 digits following the decimal point.	
Altitude	AMSL	
Geoidsepar	M	

How to connect to configure the program.

1. The most direct way to input the above data is to connect a monitor and keyboard to the Pi.
2. Alternatively, you can use a computer that is connected via a wired Ethernet connection to the router and find out the IP address allocated locally to your OGN-R unit which is wired to the same router.

This is usually done by typing in 192.168.0.1 and looking at the devices connected to your network. To get the actual address you may have to use an advanced menu that is password protected. See your local router

instructions. For example, a Sky network router generic is log in '**admin**' password '**sky**' then choose LAN IP Set Up.

For example, if the IP address allocated for ognpaw is 192.168.0.200 then connect via 192.168.0.200:**4200**.

The allocated address will vary from router to router.

3. Additionally, the software has been developed so that you can run a shell from within a web browser. Google Chrome or Firefox is recommended.

Connect on the same network as the Pi to `https://ognpaw.local:4200/`  
You may get a prompt to say that this is insecure - ignore this and continue

When connected, you will see the following prompts. Your response is the characters in red

```
login: pi
password: 12345678
pi@ognpaw: $ cd rtlcdr-ogn
pi@ognpaw: /rtlsdr-ogn $./PilotAware-OGN.config.sh
```

Now follow the instructions. You will be prompted to provide a new **Password** please do this so no one else can hack your system – they will. Record your password for posterity.

Provide a **Name** for your ground station (Currently this is set at Coventry. Replace it with in your name). You may have seen that OGN uplinks are prefixed with PW i.e. PWBidford. You do not need to prefix your name with PW this is done automatically.

The program will require you to input the Latitude, Longitude, Altitude, Height AMSL and Geoidsphere

Using the values gained previously and recorded above.  
Provide Station **Latitude** (change default value to the value of your station) Return  
Provide Station **Longitude** (change default value to the value of your station). Return  
Provide Station **Height AMSL** (change default value to the value of your station). Return  
Provide **Geoidsepar** (change default value to the value of your station) Return

The software will then install and calibrate the software defined radio receiver.  
This will take about 90 seconds and it will step through 0dB to 50dB  
Following this it will show Start Services. It is now up and running

```
##### Summary #####
Station Name is      : pawtest1
Station Latitude is  : 52.217521
Station Longitude is : -1.758672
Station Altitude AMSL [M] is : 69
Station Altitude GEOID [M] is : 50.5038
Station SDR PPM is   : 0
Station SDR Gain is  : 45
Station SDR Freq Centr is : 923.400
##### Summary #####
Starting Services
^[{
```

- If it cannot calibrate the antenna at all this usually means that there is no connection to the antenna.
- The calibration uses GSM signals so it cannot be calibrated in a cupboard.
- If it cannot start services, this may be that it cannot get through the router to the internet and hence to the OGN servers.

When connecting to the OGN servers via the internet it can take up to 10 minutes for the station to appear.

The ports can be opened for diagnostics and to check that the installation is working. Whilst connected to the same network as the pi using Chrome type in.

```
http://ognpaw.local:8080
http://ognpaw.local:8081
```

<http://ognpaw.local:8082>

Note that this starts http not https ☺

Alternatively using the wired connection as in 2 above

192.168.0.n:**8080**

192.168.0.n:**8081**

192.168.0.n:**8082** where n is specific to your network

You can then check progress by logging on to

The Open Glider Network at <http://ognrange.onglide.com>

Spot the Gliders at <http://live.glidernet.org>

On each site zoom into your local area and check your site progress.

For further help on upgrading an OGN receiver to an OGN 869.5 MHz Uplink please visit

[forum.pilotaware.com](http://forum.pilotaware.com)

## Addendum

### Example of how to make an L crank antenna.

How you fabricate your antenna will be bespoke to your installation however here is an example that has been used at a couple of installations where the original OGN antenna is mounted on a vertical pole.

## Instructions

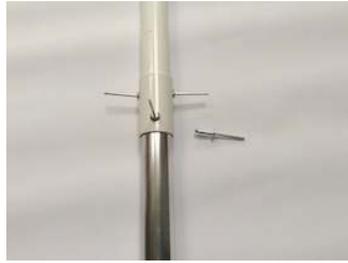
Using the components shown in the URL links inserted in the text.

1. Take an L Cranked antenna <http://www.screwfix.com/p/labgear-29935lab-tv-l-cranked-mast/21470> such that the shorter end is vertical and the longer end is horizontal with the shorter end pointing upwards.
2. Drill a 1 cm hole in the bottom of the aluminium tube approximately 10 cm from end of the long end of the cranked antenna. This is so the coaxial cable can be threaded through the inside of the aluminium tube and the plastic tubes.



3. Cut the white 25mm tubing <http://www.screwfix.com/p/tower-conduit-heavy-gauge-25mm-x-3m-length-white/2411p> to 150 cm. This will act as the outer sheath of the Antenna.
4. Cut the black 20mm <http://www.screwfix.com/p/tower-conduit-heavy-gauge-20mm-x-3m-length-black/7980p> tubing to 142 cm. This will act as an inner strengthener and locator for the P3I antenna
5. Push and glue the 25mm Tube <http://www.screwfix.com/p/conduit-couplings-25mm-white-pack-of-2/56704?requestid=218096> connector onto the short end of the cranked antenna making sure that it goes all the way on to the shoulder in the middle of the connector.
6. Push the 20mm black tubing hard (jam it) into the short end of the cranked antenna
7. Insert and glue the 25mm tube into the 25mm tube connector, making sure that it goes all the way on to the shoulder in the middle of the connector.
8. Use 2 rivets <https://www.amazon.co.uk/Am-Tech-Assorted-Rivets-100-Pieces/dp/B008CYPX3A> to connect the 2 tubes, 25mm connector and aluminium together and 2 rivets to connect the 2 tubes and

25mm tube connector together. This gives rigidity to the antenna. Drill the holes first but don't rivet until the co-axial cable has been inserted.



9. Gently feed the coaxial cable through the hole, drilled in step (2), making sure that any sharp edges of the hole do not strip the outer coaxial insulation. As it feeds through the short end, use a push me pull me action until about 30cm of coaxial cable can be seen through the end of the white 25mm outer tube. When the cable is through you can line up the holes and fix the rivets at the junction between the aluminium and plastic tubes. Make sure that the rivets go through the black and white tubes and the aluminium tube. The picture below shows the cable passing between the plastic and aluminium tubes before they are riveted together.



10. Connect the female SMA connector to the antenna end of the coaxial cable (check that there isn't a short between the inner and outer conductors) and attach the P3I antenna.
11. Wrap self-amalgamating tape <http://www.screwfix.com/p/self-amalgamating-rubber-tape-black-19mm-x-10m/87717?requestid=442978> just below the female coaxial connector to make a small cone shaped bung that will fit on top of the black tube. (this will correctly locate the antenna and ensure that it is vertical). At the top of the antenna fix some foam or another packing to keep the antenna vertical.



12. Gently push the antenna and cable back into the white tube until it locates into the top of the black tube. (gently pull the cable through the hole drilled in (2) as the antenna is pushed in).
13. Insert a plastic 25mm end cap <http://www.ebay.co.uk/itm/Round-End-Caps-Plastic-Blanking-Plugs-Steel-Alluminium-Tube-Inserts-White-> into the end of the outer white plastic antenna tubing.
14. Insert the long end of the cranked antenna mount into the bracket supplied and ensure that the antenna will be vertical when connected to the pole or roof. Tighten up the wingnuts.
15. For a better job replace the wing nuts with 'nyloc' nuts and then saw off the excessive bolt length.

16. To stop the aluminium tube from rotating fix a couple of rivets through the bright steel bracket and aluminium tube. Do this both sides for symmetry.



17. Finish off the bracket by tightly wrapping self-amalgamating tape around the steel bracket to weatherproof it.
18. Cut the coaxial cable to length, connect the male connector and check for continuity and low resistance of the central conductors, continuity and low resistance of the outer conductors, and open circuit between the outer and inner conductors.
19. Connect to the pole using the hose connectors <http://www.screwfix.com/p/t-mex-stainless-steel-worm-drive-hose-clips-40-80mm-10-pack/67161> packing the lower edge of the bracket, if required, to ensure that the antenna is vertical. (Bolts would be better if convenient)
20. Dress the connected bracket with self-amalgamating tape to make it waterproof, covering the mild steel, hose connectors and bracket so they don't rust. Use cable ties <http://www.screwfix.com/p/cable-ties-natural-300-x-4-5mm-pack-of-100/81146> to dress the coaxial cable to the pole.



If you have any questions on upgrading your OGN antenna to an OGN PilotAware Uplink, please contact [OGN@PilotAware.com](mailto:OGN@PilotAware.com) or for ongoing information please join and visit the forum at [forum.pilotaware.com](http://forum.pilotaware.com) and look on the OGN thread.