Building and installing a PilotAware ATOM Station to detect and re-transmit glider and Mode-S MLAT locations and provide Virtual RADAR SERVER July 2021.

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Introduction

There are many reasons to install an ATOM Ground station.

I. In doing so you will be helping the General Aviation Communities (Foot-launched, Gliding, Microlights and Powered Aircraft) in the UK and Europe to improve the interoperability of the various Electronic Conspicuity systems available today. These are ADSB, FLARM, PilotAware, Mode- S and ADSB.

II. By installing an ATOM Ground station at your location (Club or House) you will be contributing to the ground network that will assist the interoperability between systems by up-linking situational awareness data to PilotAware equipped aircraft.

III. Installing an ATOM Ground station will provide you or your club with a comprehensive Virtual RADAR Server that will show all aircraft detected in your neighbourhood and beyond. This will include aircraft transmitting PilotAware, Flarm, ADSB (1090MHz) and Mode-S using MLAT. No other ground station provides this amount of information.

IV. You will be provided with real time METARS for your club members to see before flight

V. You will provide real time METARS in flight to anyone who has an inexpensive PilotAware installed in their aircraft.

VI. Its great fun and also inexpensive to build yourself.

However, we don't expect you to do it all alone. At suitable locations PilotAware will provide you with the electronics (Raspberry Pi, Radio Bridge SD card software and case) free of charge for the ATOM ground based station. You will provide the rest, as described in this document, which you can do for less than £230-300 depending on your location and the installation.

A PilotAware Ground based station will provide about a 30-60Km area of coverage to help aviation safety around your site. It will also provide you with a Virtual RADAR feed that will allow your monitor screen or TV to see all aircraft, ADSB, FLARM, PilotAware around the site in real time and also Mode-S with a nominal MLAT delay of up to 10 seconds.

To improve range and fidelity all stations are connected to other local stations using the PilotAware Neighbour Service to increase range and functionality.

For more information please see the following videos on You Tube

https://www.youtube.com/watch?v=A8TtscFCRKo&t=0s

https://www.youtube.com/watch?v=J1imxhjG8ds&t=0s

https://www.youtube.com/watch?v=wCjRKH3F_Wo&t=0s

https://www.youtube.com/watch?v=me12z7oLhI4&t=0s

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If you are already a contributor to the OGN via the gliding community, then it is even easier and cheaper. You will already have half the system and at selected sites we will provide the rest of the equipment for free. Send us a request to ogn@pilotaware.com .

Using the ATOM GRID Station.

The ATOM GRID Network provides information from possibly more Electronic Conspicuity types of transmission than any other single source in the UK and parts of Europe. Its aim is to provide the best Situational Awareness tool for the GA community at the lowest possible cost for entertainment, search and rescue activities and to test the real time in-flight operational fidelity of all types of Electronic Conspicuity .

The ATOM GRID network is very innovative and continues to be a game changer for situational awareness of GA aircraft, it is however not approved by the UK Civil Aviation Authority or any other authority and therefore should not be used for air traffic control or air traffic management.

This is made clear in the following document issued by the UK Civil Aviation Authority.

https://www.caa.co.uk/Commercial-industry/Airspace/Communication-navigation-and-surveillance/Display-and-use-of-surveillance-data-from-unapproved-systems/?fbclid=IwAR2ihjoDpLkJedp_9XQQy-54vBTze0QSVQsFthjFPINwAizGcsd_ChnNfIY

In compliance with this, PilotAware ATOM GRID software is provided free of charge on the understanding that, in using it, the data provided will not be used for Air Traffic Managment or Air Traffic Control in any form by anyone at any time.

Interested in installing an ATOM GRID station? Let's go.

Issue History

Significant additional features have been added to the original concept of the OGN-R rebroadcast station. These include;

- increased server capability
- full data encryption on the GRID
- secure datalink access to all sites
- a centralised suite of Network Management and diagnostic tools.
- fully automated same day software update for all connected sites.
- smart data sharing using PilotAware Neighbour.
- increased range and increased functionality.

The new integrated network has been renamed **PilotAware ATOM-GRID**.

(ATOM)   Air Traffic Observation Domain and Management
(GRID)   Ground Relay Infrastructure Domain

ATOM is the Ground Station and GRID is the network.

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ATOM-GRID Uplink

Thank you for considering to help expand the Ground Network to provide additional safety for powered aircraft and gliders alike by up-linking FLARM and Mode-S equipped aircraft co-ordinates to PilotAware equipped aircraft and forwarding information for safety and Search And Rescue activities.

To help you with the costs of upgrading or installing a new ATOM-GRID uplink, PilotAware will, whilst stocks last, provide a Raspberry Pi 2B computer, PilotAware Radio Bridge and Case FREE OF CHARGE. This is available to supporters who want to increase the ATOM-GRID network both in the UK and mainland Europe. In addition, if required, PilotAware will load and configure the software to make it even easier for you. If you want to know more contact us at mailto:OGN@pilotaware.com and apply for your free stuff.

Installing and maintaining an ATOM-GRID Ground Station does not require a high level of technical knowledge. ATOM_GRID is a technical innovation but the highly technical parts do not need to be understood by the installer or host. These step by step instructions are provided to help you through the installation. Help is available on line and on the phone.

What you need to do

1. Determine what parts are needed
2. Get your free stuff and any other at cost parts from PilotAware
3. Make up the coaxial cables
4. Connect the parts together
5. Configure the software
6. Switch on and connect to the GRID
7. Test the station to ensure
   a. You are receiving METARS
   b. You are receiving Flarm Data
   c. You are receiving 1090 data
   d. You are receiving and transmitting PilotAware data
   e. You are receiving and contributing MLAT data
   f. The VRS is configured to your needs.
8. All is done using step by step instructions and help is available on line and on the phone.
9. Or get us to do it for you.

What Parts are Required

1. A Raspberry Pi Single Board Computer (Pi2B or 3B)   Provided Free of Charge
2. A PilotAware Radio Bridge   Provided Free of Charge
3. A Case   Provided Free of Charge
4. Software   Provided Free of Charge
5. An 8G SD Memory Card (with the software loaded)   Provided Free of Charge
6. An RTLSDR software defined Radio tuned to pick up FLARM signals
7. An RTLSDR software defined Radio for Mode-S and ADSB data collection.
8. A Raspberry Pi Mains- to 5.2V 2.1A power supply. (Or power over ethernet (20W))
9. An Ethernet cable to connect to your existing router.

10. Coaxial cable (HDF400 recommended), to connect the antennas to the electronics.
11. Pigtails to connect the coaxial cable to the RTL-SDR's.
12. Antenna mounts to support the antennas
13. 3 External antennas as follows

1. The PilotAware Antenna. This is used to **transmit and receive data** to aircraft fitted with PilotAware units operating at **869.5MHz**. The PilotAware antenna is connected to the PilotAware Radio Bridge and Raspberry Pi via a co-axial cable and a pigtail with an SMA connector.

2. The Flarm Antenna. This **receives** signals that are transmitted from FLARM, OGN Tracker or Fanet+ equipped gliders and aircraft. The feed from the FLARM 868Mhz antenna, is connected to the Raspberry Pi via a software defined receiver (SDR). This can be inserted in any of the USB slots but by convention is located in the top left hand USB slot on the raspberry Pi unit with the Ethernet socket to the left. The location chosen is then configured in the set up as described later on.

3. The 1090MHz Antenna† A third 1090MHz **receive only** antenna is also used for the ATOM-GRID installation. This antenna collects 1090MHz transmitted data i.e. ADSB and Mode-S transmissions for use by 360RADAR to contribute to their network and provide Mode-S data for use in PilotAware Mode-S/3D reception. The feed from the 1090MHz Antenna, is connected to the Raspberry Pi via a software defined receiver (SDR). This can be inserted in any of the USB slots but by convention is located in the bottom right hand USB slot on the raspberry Pi unit with the Ethernet socket to the left. The location chosen is then configured in the set up as described later in this document.

All data collected can additionally be used to provide a feed for a local Virtual RADAR Screen (VRS) which will show local PilotAware, FLARM, ADSB traffic in real time and Mode-S traffic with a few seconds MLAT delay. This is a useful feature at your club site or café to show all local aircraft.The VRS can be accessed remotely using an encrypted password protected link.

*Note using the latest software the location of the 2 RTLSDRs can be chosen to be located in any slot at the configuration stage. This is because some RTLSDR's are larger than others and this allows easier mechanical fitment. However the slot used must be chosen in the configuration. It is very easy to do this.

†Note. An external 1090MHz antenna or an internal 1090MHz antenna can be used as convenient. (external fitment is best but the 1090MHz signal is very strong so an internal antenna may work at your location if necessary).

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Here is a screenshot of the 3 antennas that can be supplied at cost.
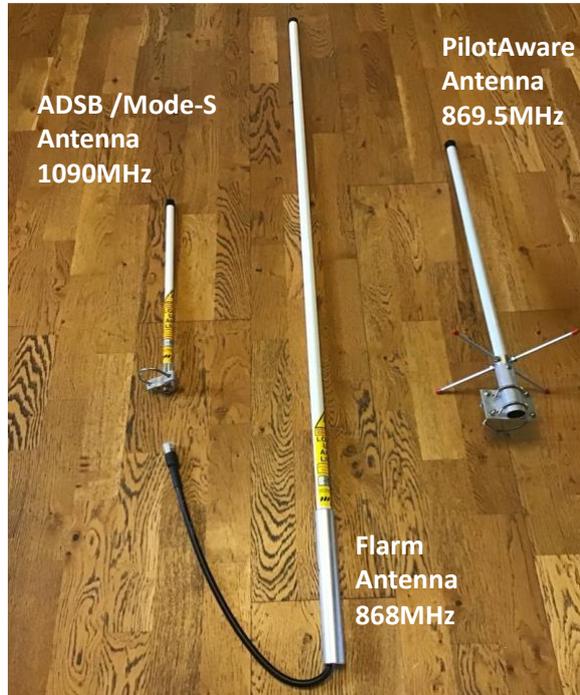
A list of equipment and suppliers is available at the end of this document any queries
mailto:OGN@pilotaware.com.
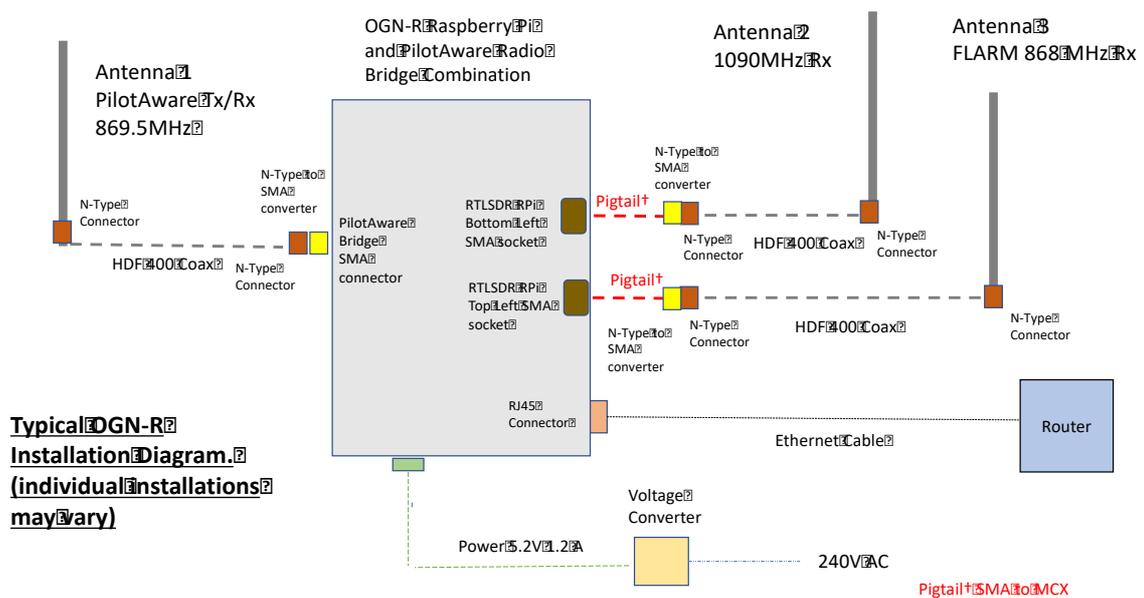
Installation High Level Diagram

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The above diagram is provided as a normalised visualisation of the hardware installation which can be modified for your specific installation. Active power over ethernet (PoE) is now the popular choice for powering the unit.

Installation

The installation consists of

1. Selecting a dry location for the electronics with access to 240V and Internet. †
1. Installing the external antennas at a suitable location as high as possible.
2. Making up and running low loss coaxial cable from the antennas to the electronics.
3. Connecting the parts together
4. Configuring the software for the specific site.
5. Power up and test.

Location for the Electronics

- The location for the electronics should be as close to the antennas as practically possible. The co-axial cable run should be as short as possible. However when using high grade low loss HDF 400 or RG8 co-axial cable up to 10M is OK.. *Note up to 16 metres has been shown to work using the recommended HDF 400 coaxial cable.*
- Active 48V power over ethernet (PoE) is recommended to power most installations as this gives flexibility in the distance from the router and mains from the ATOM electronics.
- With PoE an ethernet cable is required to connect the PoE injector to the Raspberry pi (for power and data) and a second ethernet cable is required to connect the router to the PoE injector (data).
- Alternatively a traditional Raspberry Pi mains to 5.2v 1.2A dc/dc converter can be used with a single ethernet cable to the router for the data.

Location for the antennas

- The antennas should be positioned vertically and as high as possible avoiding obstacles that would get in the way of transmission and reception, such as walls and chimneys. The antennas should be a minimum 30cm apart. The further away the better. Only the PilotAware antenna is transmitting. (It transmits at 869.5MHz and will not affect or be affected by or affect VHF voice transmissions)
- **Each and every installation will be bespoke**. A wide variety of antenna mounts are commercially available from Screw fix, Tool Station and other suppliers in the UK. A list of typical mounts is supplied at the end of these instructions.
- The recommended antennas are all supplied with Female N-Type connectors.

Typical Antenna Array Construction.

The following screenshot shows a typical antenna array with all three antennas supported by a single pole. Alternatively 3 individual poles can be used.

The parts for making up this, and where to get them, are described in the addendum at the end of this document.

Making up the Co-Axial Cables

- For maximum efficiency HDF 400 (double shielded low loss coaxial cable) or equivalent and N-Type connectors should be used for all antennas. Although a smaller cable like RG8X or LM240 can be used for short reaches up to 5 metres if necessary.
- HDF400 cable is fairly thick and will require a suitable Crimp tool to make off the connectors. If you are just doing the one installation, it may be cheaper to have these cables made up commercially. A crimp tool is about £15 from WiFi Antennas Ltd or other suppliers. The centre conductor pins must be soldered not crimped.
- The Male N-type connector on the Co-Axial cable should be offered to the Female N-Type connector on the antenna and the connectors screwed firmly together. The joint should be weather-proofed using self-amalgamating tape.
- This should be repeated for the second and third cables.
- The Co-Axial cables should then be dressed to the location of the electronics which should be as close as practically possible. (Take care that you know which cable goes to which antenna by labelling the loose ends.)
- A suitable short pigtail is usually required to connect the N-type connector to the chosen RTL-SDR dongle. This will either be a male SMA or Mcx connector depending on the RTLSDR chosen.
- Female N-Type to SMA pigtails are useful as they can then be used as bulkhead connectors on the side(s) of a larger enclosure for a more professional installation. *Note this will then require male N-type connectors on each end of the main HDF cables.*

Connecting the Electronics

A good tip is to mount the electronic onto a small wall board or box to secure the units without putting stress onto the components or cables. The cables can then be secured with cleats. The electronics are connected to the following interfaces. (*The following diagram is typically only and will vary between installations*)

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The diagram below is representative only. Your installation may change depending on the RTL-SDR's and connector types used. The following instructions therefore will not be the same for all installations.

1. Pigtails are required to convert the N-Type connectors on the co-axial cable to the SMA or Mcx connectors of the RTL-SDR dongles. This will be bespoke to your installation. In this example a N-type to SMA converter and a SMA to Mcx pigtail is used .
2. The coaxial cable connected to the P3i Antenna (shown on the left) is connected firmly to the SMA connector on the PilotAware Bridge. A pigtail can also be used here for flexibility.
3. The Coaxial cable connected to the **FLARM Antenna** is connected to the RTL-SDR in the top left hand USB slot. An SMA to mcx pigtail is used in this diagram. For an optimal installation an RTLSDR with a Temperature Controlled Oscillator (TCO) is recommended.
4. The Coaxial cable connected to the **1090MHz Antenna** is connected to the RTL-SDR in the bottom left hand USB slot. An SMA to mcx pigtail is used in this diagram. It is not necessary to have an RTLSDR with a TCO unless the optimum installation is required.
5. The Ethernet cable is connected to the Ethernet port of the Raspberry Pi, with the other end connected to a free port on the local router
6. The Raspberry Pi power supply is connected to the mains supply.
7. DO NOT AT THIS POINT TURN THE POWER ON.
8. Make sure that the complete set up is located firmly and that there is no bending moments causing pressure on any of the components.
9. Cable cleats and other fixtures should be used to affect a neat installation or the equipment installed in a suitable enclosure.
10. The hardware is now set up.

The Diagram below is representative of one installation only and can be implemented in many ways when you do it at your site.
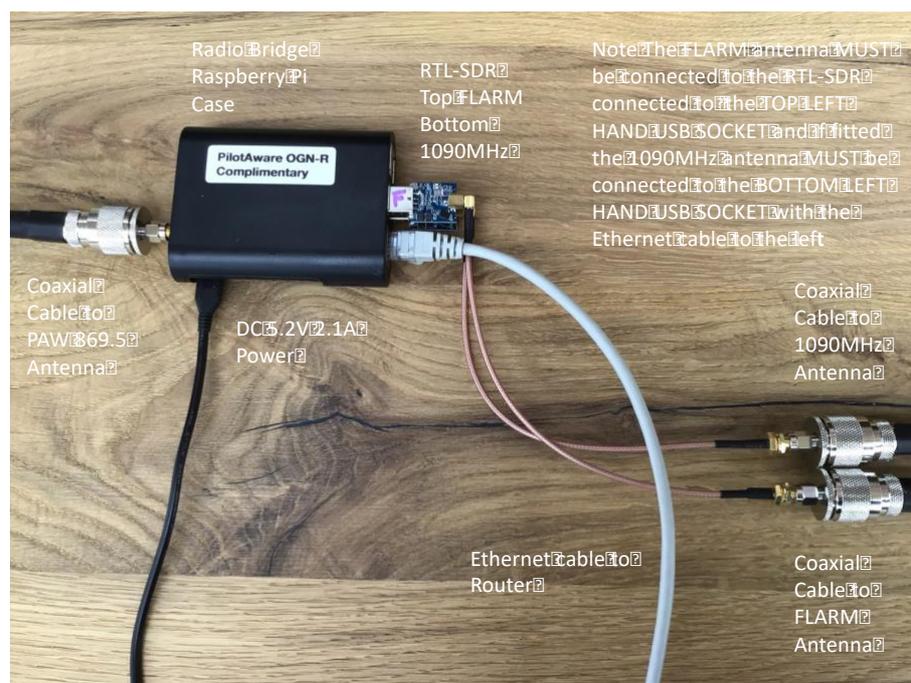
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†Note the previous picture uses low power RTLSDR dongles as these fit the available space. If the RTL-SDR's are larger they can be configured to be inserted in other USB sots in the configuration program described later. If necessary external aluminium enclosures provided with the dongles should be removed. Many high quality installations are installed in a bespoke enclosure. An example of the equipment installed in an inexpensive box from Screwfix is shown below. This uses PoE, female N-type bulkhead connectors and an ethernet passthrough connector to make a very neat job.

Locating and Naming your Site
Before downloading and configuring the ATOM-GRID software, specific information is required about your site. These are:

1. The Location
2. The Name

Location Information
You will need to have the unique location information for your station to hand.
This information can be obtained by going to
htthttps://pilotaware.com/product/rosetta/p://schellenberg.nl/ogn/index-latlon.html on your computer.

When the program opens, (usually at a location in Europe) drag the red marker to the position of your installation and you will be given the latitude, longitude and the height AMSL in metres and Geoidsepar. Only use the 6 digits following the decimal point for the latitude and longitude and remember that the longitude **will be –ve. West of Greenwich**. Make a note of these values for use in configuring the software for your specific location. A matrix is provided for this on the next page. The Geoid Sphere will be automatically calculated in the latest software so you don't need to input this.

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The receiver location app will look something like this. (although since google maps went commercial it will be darker). You will also have to use your smartphone to get the **height of the antennas** above sea level in metres. Do this by getting the ground level and adding the height to the antennas.
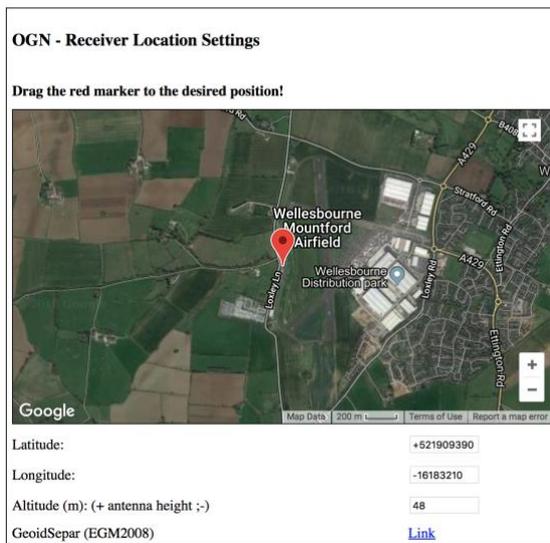
Station Name

In essence please keep your station name to a maximum of 7 characters. If it is an airfield it is conventional to give its ICAO code such as EGBW for the example of Wellesbourne. When you have configured your software, this name will then be automatically prefixed with PW ie PWEGBW**. (YOU DO NOT NEED TO START YOUR SITE NAME WITH PW)**

You can record your unique configuration here.

Item Required	Description	Record Here
Host Name	Don't change this unless you are competent	OGNPAW
Station Name	See naming Rules above	
New Password	A new station password can be input to replace the generic one. Note if you forget the password it CANNOT be retrieved.	
Latitude	6 digits following the decimal point.	
Longitude	6 digits following the decimal point.	
Altitude	Metres AMSL	
Geoidsepar	Metres using EMG 64	This is now calculated automatically.

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Downloading and installing ATOM-GRID Software.

To make the installation as easy as possible new software has been produced that steps you through the installation process.

1. If we haven't provided it with the free stuff you can Download the latest disk image for the combined OGN/PAW software from this URL

http://pilotaware.lode.co.uk/downloads/OGN/PilotAware-OGN.latest.zip

2. This will download a zip file with a name similar to ***PilotAware-OGN.20201118*** into the downloads folder of your computer. The numbers after the '.' Indicate the version date. In this case 18th November 2020.
3. Place all ***the individual unzipped contents of this file (not the folder)*** into the formatted Micro SD Card. This will require the use of an SD card holder to fit the Micro SD card into the SD slot on your computer. One of these is provided with every Rosetta unit.
4. **The root** of the SD card should contain the following folders
   - defaults
   - os
   - overlays
   and many other files (21 in total).
5. When you have downloaded all the files, eject the card from your computer and load the SD card into the UNPOWERED Raspberry Pi. Power up and leave for about 20 minutes to allow the files to unpack and self-configure.
6. There will be a permanent red light (Power) and a flashing green light (Disc access) on the raspberry pi as this operation is proceeding. DO NOT INTERUPT THE POWER SUPPLY WHILST IT IS UNPACKING AS THIS WILL CORRUPT THE SOFTWARE.
7. If of interest, you can watch the unpacking progress by attaching a TV or a monitor to the Pi via an HDMI cable. When it has finished the prompt, 'pi' will be seen. The software has now downloaded and unpacked successfully.

Configuring the Software for your Specific Location.

Logging in

1. PilotAware ATOM GRID software has been developed so that you can run a command shell from within a web browser. (Google Chrome Safari or Firefox is recommended) When connected (either by WiFi or wired) onto the same network as the ATOM GRID Unit, navigate to **http://ognpaw.local (Note this is NOT https://).** You will probably get a prompt to say that this site is insecure - ignore this and continue to the address. (*Not all routers will recognise ognpaw.local as they do not resolve the allocated IP address to the default host name which is ognpaw.local. If this in this case you will have to revert to using the allocated IP address as shown in the next paragraph*) .

2. To get the actual IPv4 address allocated to the ATOM GRID unit you may have to use an advanced menu on your router that is password protected. See your local router instructions.

For example, a UK SKY network routers generic log in is '**admin**' and the password is '**sky'.** Others will differ. Then choose Maintenance followed by Attached Devices. For example, if the IPv4 address allocated for your unit with the default hostname 'ognpaw' is 192.168.0.200 then use this. The allocated IPv4 address will vary from router to router.

Alternatively use ip scanning software such as **Angry IP Scanner** which will list the IP addresses allocated to all devices connect to your computer.

Angry IP Scanner
Version: 3.5.3

*Also, please note if the router is powered down it **may** allocate a different IP address. This is called dynamic IP allocation. This can be overcome by giving the OGN-R a fixed IP address. How this is done varies between router makes and is not done in the PilotAware software.*

Configuring your Individual ATOM GRID unit.

When you have accessed your ATOM Grid Unit using **ognpaw.local** or the IP address (no extension) you will see the Home Page which looks something like this but with a temporary station name (unset) and no traffic.

| Home | Metar | Radar | Login |

Version 20200128 : Date 2020-02-12 21:17:52 (19ms) : Station PWWilmcot
P3I(data)=56222 MLAT=Connected Internet=Connected

ICAO	Reg	Type	Age	Amb(RND/ACT)	GS(KN)	Dist(KM)	Alt(FT)	Uplink
4CAAD8	EI-FAT	---Ar	-	-	164	8.9	7650(Q)	-
40755F	40755F	---Al	-	-	133	33.0	1625(Q)	-
406A50	G-FBJK	---Ar	-	-	177	42.1	3425(Q)	-
40755A	40755A	---Ar	-	-	113	46.5	1950(Q)	-
4CAFD6	-	--M-1	3	0.30/0.19 NM	232	48.2	4750(Q)	-
ACB4E4	N918FD	---Ar	-	-	212	67.7	8050(Q)	-
401153	G-JECY	---Ar	-	-	290	69.9	11000(Q)	-
4070A8	G-DHKE	---Ar	-	-	177	87.9	4175(Q)	-
406250	G-EUYI	---Ar	-	-	299	95.9	9775(Q)	-

Click the **Login** Box on the top line. You will get the log in prompt. Your responses are shown in red below. Notes are shown in blue. Things that can go wrong are shown in Orange

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login: **pi (enter)** *(Ensure this is pi NOT PI or Pi)*

password: **12345678 (Enter)** # This is the default Password. It is recommended to change it during the configuration. *(Note the password will not appear in the command line as you are typing it.)*

You will then be given this screen with options to choose from.

```
#######################################################
##                 PilotAware ATOM Menu             ##
#######################################################
1) Configure
2) Update-Beta
3) Quit
Please enter your choice: ^[{
```

To run the config program type in 1

You may see something like the following:

(21:26:34) FILESYS : Mount RW
Stopping Services
Do not plug in or remove any SDR dongles whilst this configuration script is running.
It is strongly advised to have the SDR's plugged in and then reboot the Pi before running this configuration script.
Found 2 SDR's:
WARNING: device 0 with serial number: 1090 cannot be found
Most likely the serial number has been altered and the Pi not rebooted before running this script.
Reboot required
If any of the SDR's are plugged into a powered USB hub then the hub will also need to be powered down at the same time.
Rebooting in 10 seconds
Please rerun config afterwards

If so the system will reboot so log back on using ognpaw.local or the allocated IP address and go back to

login: **pi (Enter)**

password: **12345678 (Enter)**

```
#######################################################
##                 PilotAware ATOM Menu             ##
#######################################################
1) Configure
2) Update-Beta
3) Quit
Please enter your choice: ^[{
```

Choose **1**

You should then see something like this

(21:32:48) FILESYS   : Mount RW
Stopping Services
Do not plug in or remove any SDR dongles whilst this configuration script is running.
It is strongly advised to have the SDR's plugged in and then reboot the Pi before running this configuration script.

Found 2 SDR's:
   USB Port Top Left   : USB hub or powered USB extension cable detected -> SDR detected ID=1 currently allocated to OGN/FLA
RM reception on 868Mhz
   USB Port Bottom Right : SDR detected ID=0 currently allocated to ADS-B reception on 1090Mhz
   USB Port Top Right   : no SDR detected
   USB Port Bottom Left : no SDR detected
One SDR is currently configured for OGN and the other is configured for ADS-B reception.
Do you wish to change the SDR(s) configuration [y/N]:

Type in **N (Enter)**

If the allocations are wrong then choose Y and change the allocation. By convention the Flarm RTLSDR is positioned in the top left USB slot (with the ethernet socket to its left) and should be connected to the Flarm antenna and have the ID 1. The ADSB RTLSDR is at the bottom right and should have the allocation 0.

If the RTL-SDR's are not detected this will because they are not seated correctly in the USB sockets on the Raspberry Pi single board computer. They may have moved in transit so push them securely in. Or they are faulty.

Do you want to change the ADSB Antenna Gain value () [y/N]:

*This is for future use and can be ignored by typing N or just carriage return. If you know the gain of the antenna then put it in. All **ADSB** antennas supplied by PilotAWare are +7dBi (white fibreglass outer fibreglass shell with yellow look up and live sticker 50-60 cm in length). Examples of antennas are shown below*

Do you want to change the FLARM Antenna Gain value () [y/N]:

*This is for future use and can be ignored by typing N or just carriage return. If you know the gain of the antenna then put it in. 1.7M **FLARM** antennas supplied by PilotAWare are +9dBi. If you have used the 60mm shorter version these are 7dB (white fibreglass outer fibreglass shell with yellow look up and live sticker 50-60 cm in length). Examples of antennas are shown below*

Do you want to change the PAW Antenna Gain value () [y/N]:

*This is for future use and can be ignored by typing N or just carriage return. If you know the gain of the antenna then put it in. **PAW** antennas (869.5Mhz) supplied by PilotAWare are generally grey 80cm antenna with a four rod ground plane. These are +5dBi. If you have*

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used the 60mm shorter version these are 7dB (white fibreglass outer fibreglass shell with yellow look up and live sticker 50-60 cm in length). Examples of antennas are shown below
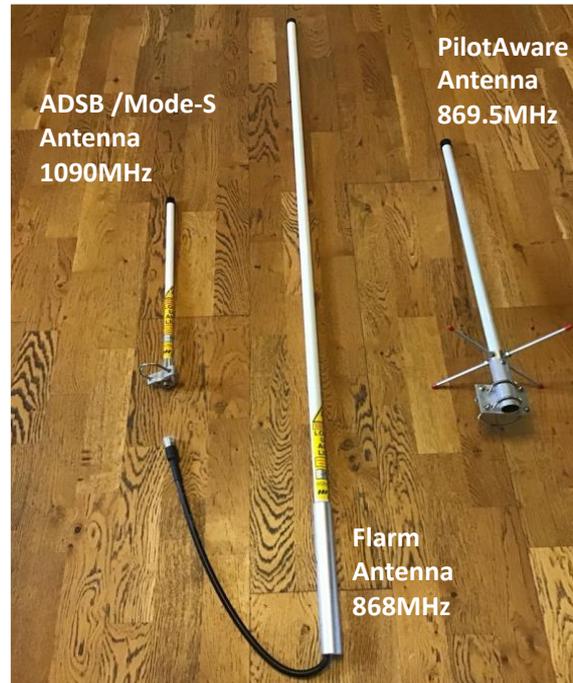
Do you want to set a Password (recommended first time) [y/N]:

*It is recommended that you type in a new password rather than the default 12345678. Choose something that has 8 characters and numbers upper and lower case. PLEASE MAKE A NOTE OF THIS PASSWORD AS IT **CANNOT BE RETREIVED.***

*Type in **Y** followed by your new **PASSWORD (Enter).***

Do you want to change the Station Name (Setup0n) [y/N]:
*Type in **Y** followed by your **Station Name** (7 Characters max) (Enter)*

Do you want to change the Station Latitude (DD.ddddd) [y/N]:
*Type in **Y** followed by your station **Latitude** in Decimal. (Enter)*

Do you want to change the Station Longitude (-1.75833) [y/N]:
*Type in **Y** followed by your station **Longitude** in Decimal. (Enter)*

Do you want to change the Station Altitude AMSL in Metres (77) [y/N]:
*Type in **Y** followed by your station **Altitude** in Metres. (Enter) This is the height of the antennas above Mean Sea level not the height above the ground!*

 ** Altitude GEOID has been calculated from LAT/LONG as GG **

Do you want to change the email address for the station maintainer (keithvinning@gmail.com) [y/N]:

The altitude GEOID is an automatic calculation you need do nothing.

Maintainer email address

*Type in **Y** and change the station maintainer from JohnDoe@Gmail.com to your **email address. (Enter)***

Do you want to setup WiFi wlan0 [y/N]:

If you are using a Pi3 with built in WiFi you will be given the option to set up WiFi. This is not available when using a Pi2. If you want to use WiFi rather than a wired connection and you are technically competent, you can do this by following the instructions.

Testing --ppm=0 --gain=0

The program will now self-test the FLARM antenna by logging onto several local GSM stations. This will allow the program to set a frequency offset to tune the antenna. The receive gain will step through from 0dB to 50dB after which you will see a message similar to the following but with your configuration set. The gain receiving the highest number of stations will be chosen. This is not always 50dB

You will then see a resume of your configuration

```
######################### Summary #########################
Station Name is             : Your Station Name
Station APRS Server is       : aprs.glidernet.org:14580
Station Latitude is          : Your Station Latitude
Station Longitude is         : Your Station Longitude
Station Altitude AMSL  [M] is  : Your station altitude
Station Altitude GEOID [M] is  : Your Station GEOID
Station SDR PPM is           : Your Station Flarm Offset
Station SDR Gain is          : Your Station Flarm Antenna Gain
Station SDR Freq Centre is     :Your Station Centre Frequency
######################### Summary #########################
```

Starting Services

The station will now log into the OGN and the ATOM GRID servers and you will get

(21:54:20) FILESYS   : Mount RO
pi@ognpaw:~/rtlsdr-ogn $

If you do not get this message after about 20 minutes check that the connection to the router is secure and that you have access to the internet.

The configuration is now done and the PilotAware servers will get a message to connect you to the secure grid. This has to be authenticated manually to ensure that you are a genuine site so may take some time as the email address is not manned 24/7. Any issues contact ogn@pilotaware.com.

To get back to the home page type the IP address into the command line with no extension. (make sure that an extension has not been cashed if it appears delete it) This extension may be 4200 just delete it to get back to the home page.

Testing the Installation

Your station will next appear on the Open Glider Network App the URL of which is shown here. This may take up to 20 minutes to appear.

https://ognrange.glidernet.org/#,max,lastweek,52.12902_6.85676,,#000000ff:#000000ff,circles;

It will also show in the list of sites available here

https://www.dropbox.com/s/0n5emkw4nm85sw1/ogn-r.txt?dl=0

It may take some time to register but not longer than 20 minutes.

Check PilotAware transmission to and from the ATOM-GRID Ground Station.

To check that the ATOM GRID ground station is working, power up a PilotAware unit outside and in the immediate location. Ensure that you have configured the PilotAware Unit to show ground stations. This is done on the Rosetta configure page.

Once the Rosetta has booted up;

1. The number of ground stations in view will be shown in the top right hand of the Rosetta RADAR Screen. This will normally be 1.
2. The ground station will be shown as an ICON in the centre of the RADAR screen. (You must have selected show ground stations on your PilotAware Rosetta to see this).
3. The OGN-R station will appear in the list in the Rosetta Traffic Page
4. The PilotAware with ICAO number, Altitude and Distance will be recorded on the ATOM GRID Virtual RADAR Screen. In the diagram below it is shown a MLAT-TEST but it will show whatever the flight ID of your PilotAware unit has been set to.

Building and installing a PilotAware ATOM Station to detect and re-transmit glider and Mode-S MLAT locations and provide Virtual RADAR SERVER July 2021.

The ATOM table shown below is similar to what you will see on the ATOM GRID Home Page.

Home	Metar	Radar	Login

Version 20200128 : Date 2020-02-13 09:08:13 (71ms) : Station PWWilmcot
P3I(data)=23 MLAT=Connected Internet=Connected

ICAO	Reg	Type	Age	Amb(RND/ACT)	GS(KN)	Dist(KM)	Alt(FT)	Uplink
F1267D	MLAT-TEST	-P--l	-	-	0	0.0	209(G)	-
3C661A	D-AIPZ	---Al	-	-	265	16.6	6700(Q)	-
3C66B8	D-AIUX	---Al	-	-	294	34.1	11650(Q)	-
406F9A	G-PRPE	---Al	-	-	245	43.4	11550(Q)	-
A6869C	N52AG	---Ar	-	-	9	45.6	750(Q)	-
AC9837	N910RW	---Ar	-	-	163	65.7	5600(Q)	-
43C8DE	ZM504	---Ar	-	-	74	89.5	1925(Q)	-
3C5433	D-AEAS	---Ar	-	-	207	99.5	6350(Q)	-
4CA9BB	-	---Ar	-	-	239	99.7	10725(Q)	-

At the top of the page is the menu to gain access to the other pages.

METAR shows the data for airfields limited to 150Kms away.
RADAR accesses the ATOM Virtual RADAR Page.
Login takes you to the software shell to configure the software and run diagnostic programmes.

The following data is shown below the Menu.

Version 20200128 . This is the software version currently running. New versions will be downloaded automatically via the internet.
Date and Time. Current Date and Time including server response time.
Station. The Station name allocated. In this example it is PWWilmcot.
**P3I Data.** The number of PilotAware packets received today.
MLAT. 'Connected' means receiving MLAT data.
Internet. 'Connected' means connected to the internet.

Line 1 of the matrix shows the test PilotAware unit being received by the ground station showing that it is receiving data from PilotAware units. Designated as a PilotAware (P) being picked up locally (l). The altitude shown is the height above sea level and it is GPS (G) derived data.

On the PilotAware Rosetta RADAR screen the ground station will be shown as active in the top right hand banner and also in the centre close to the test Rosetta.

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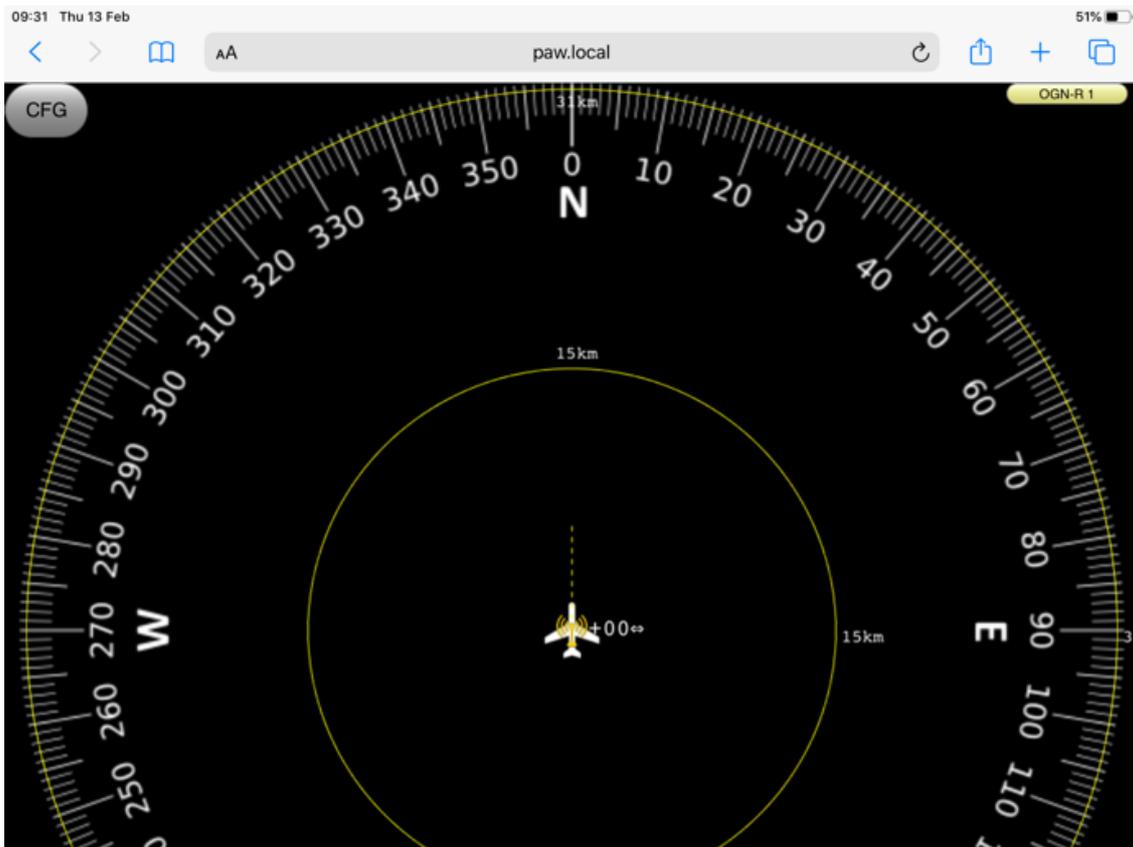
Check Reception from The ATOM GRID Ground Station.

1090MHz Reception.

To check whether you are receiving 1090 signals through the 1090MHZ antenna and RTLSDR receiver log in from the home page

login: **pi (Enter)**

password: **12345678 (Enter)** *You may have changed the password*

pi@ognpaw: $ **nc localhost 30003 (Enter)** *This is exercising port 30003*

You should see a scrolling screen of data something like

pi@ognpaw:~ **$** nc localhost 30003
MSG,8,1,1,43EA47,1,2020/11/25,18:13:43.549,2020/11/25,18:13:43.604,,,,,,,,,,,,,0
MSG,3,1,1,39CE41,1,2020/11/25,18:13:43.550,2020/11/25,18:13:43.606,,23350,,,52.33328,-1.45993,,,,,,0
MSG,8,1,1,43EA47,1,2020/11/25,18:13:43.554,2020/11/25,18:13:43.608,,,,,,,,,,,,,,0

MSG,4,1,1,39CE41,1,2020/11/25,18:13:43.558,2020/11/25,18:13:43.609,,,316,179,,,2560,,,,,0
MSG,8,1,1,43EA47,1,2020/11/25,18:13:43.560,2020/11/25,18:13:43.610,,,,,,,,,,,,,0
MSG,8,1,1,43EA47,1,2020/11/25,18:13:43.566,2020/11/25,18:13:43.612,,,,,,,,,,,,,0
MSG,7,1,1,4041E7,1,2020/11/25,18:13:43.574,2020/11/25,18:13:43.614,,3500,,,,,,,,,
MSG,8,1,1,43EA47,1,2020/11/25,18:13:43.577,2020/11/25,18:13:43.615,,,,,,,,,,,,,0

This can b stopped by typing in Control and C which will return you to the prompt

MSG,3,1,1,5083A3,1,2020/11/25,18:15:56.327,2020/11/25,18:15:56.374,,6725,,,52.27397,-1.58297,,,,,,0
^C
pi@ognpaw:~ $

Flarm Reception.

If the Flarm antenna tested correctly during the Config then the Flarm antenna will have been shown to be working OK. Further proof and confidence will be obtained as gliders are detected as the station gathers data and reports this to the various sites.

The Full Set of Traffic Receptions

The ATOM GRID ground station will pick up transmissions from aircraft equipped with any of the following Electronic Conspicuity transmissions.

1. PilotAware
2. FLARM
3. ADSB-out (1090MHz)
4. Mode-S (1090MHz)†

† For the Mode S transmissions to work there must be sufficient local 360 RADAR MLAT stations in the area. There are over 1300 installed in the UK. Installation of more inexpensive 360 RADAR receivers around your site (10Kms) will improve the MLAT availability and see aircraft at lower levels. Contact 360RADAR.
https://signup.360radar.co.uk

Building and installing a PilotAware ATOM Station to detect and re-transmit glider and Mode-S MLAT locations and provide Virtual RADAR SERVER July 2021.

ATOM GRID Home Page

Here is an example of the ATOM Grid Home Page in operation.

| Home | Metar | Radar | Login |

Version 20200128 : Date 2020-02-13 10:26:57 (70ms) : Station PWWilmcot
P3I(data)=5510 MLAT=Connected Internet=Connected

ICAO	Reg	Type	Age	Amb(RND/ACT)	GS(KN)	Dist(KM)	Alt(FT)	Uplink
F1267D	MLAT-TEST	-P--l	-		0	0.0	206(G)	-
405B19	G-MOOV	---Al	-		0	0.0	850(Q)	-
F33567	UNDEF	-P--l	-		0	0.0	236(G)	-
404E81	G-RVJW	-P--l	-		1	0.1	196(G)	-
4CAF94	4CAF94	---Al	-		245	18.8	5350(Q)	-
4070E7	G-JZHT	---Ar	-		190	22.4	2475(Q)	-
43C6F9	ZZ336	---Ar	-		274	39.4	10200(Q)	-
407962	-	--M-l	2	0.10/0.06 NM	102	40.6	3025(Q)	-
404708	G-TRNG	--M-l	6	0.30/0.15 NM	88	50.9	3600(Q)	-
406FA3	G-FICH	---Ar	-	-	92	68.3	2100(Q)	-
43C8E6	ZM512	---Ar	-	-	61	75.7	5150(Q)	-
DD0A1A	-	O---r	-	-	60	75.8	4324(G)	-
40263E	G-BMJD	---Ar	-	-	48	76.0	1600(Q)	-
403BF5	G-BWXT	O---r	-	-	105	78.4	1476(G)	-
43C8ED	43C8ED	---Ar	-	-	84	79.7	1925(Q)	-
DD092F	-	O---r	-	-	84	79.8	1217(G)	-
43C8E8	ZM514	---Ar	-	-	109	81.4	1900(Q)	-
402723	G-BMTJ	-P--r	-	-	72	82.9	1420(G)	-
400EE4	G-BYVG	O---r	-	-	114	85.9	2552(G)	-
400ED0	G-BYUL	O---r	-	-	103	87.9	2562(G)	-
43C8DE	ZM504	---Ar	-	-	72	89.4	1700(Q)	-
43C8F5	43C8F5	---Ar	-	-	73	90.2	1900(Q)	-
400EE5	G-BYVH	O--Ar	-	-	69	90.9	7395(G)	-
4CC27E	TF-ISP	---Ar	-	-	275	94.3	9000(Q)	-
4071B9	G-PRPH	---Ar	-	-	175	95.9	10000(Q)	-
400ED1	G-BYUM	O---r	-	-	90	97.6	4425(G)	-
A8D3B4	N668UA	---Ar	-	-	280	100.6	10975(Q)	-

Column 1 shows the ICAO code of the received aircraft
Column 2 shows the Registration of the received aircraft
Column 3 shows the type of transmission being received

Key

O = FLARM
P = PilotAware
M = MLAT i.e. Mode-S
A = ADSB from a transponder (DF17)
a = ADSB from a transceiver such as CAP 1391 (DF18)
l shows that the reception is local i.e. being picked up by this ATOM GRID station
r shows that the reception is being sent from another local ATOM GRID station

Please check that you are receiving PilotAware transmissions, Flarm transmissions and ADSB transmissions within 30 Km.

MLAT derived traffic will only be detected when the MLAT feed is available. This is done automatically when you have been security checked and admitted to the ATOM GRID network. This may initially take an hour or so.

Other Columns in the Home Page

Column 4 shows the age of the received transmission useful for MLAT data
Column 5 shows the ambiguity of the MLAT data useful for MLAT data
Column 6 shows the distance of the received aircraft from the ground station
Column 7 shows the altitude of the received aircraft. G (GPS) Q (BARO)

Rebroadcast

When a FLARM target is detected its latitude and longitude will be re-broadcast.
When an MLAT target is detected then its latitude and longitude will be rebroadcast

Re-broadcasts will only happen if there is a PilotAware unit in the area to pick it up. This
minimises the amount of bandwidth used. If there is no one there to receive transmissions
we will not send them.

Column 9 shows you the detail of the PilotAware equipped aircraft that is enabling and
requesting the uplink.

Please note as the ATOM is primarily for GA aircraft use, the altitude reported on the home
page is limited to 12000 ft ie FL120. This filter declutters the commercial air traffic operating
above this height which is of no interest to the home page. The Virtual Radar screen is
however given information on aircraft at all heights and its display can be configured for
convenience.

ATOM GRID RADAR.

The PilotAware ATOM Unit also provides a ground based RADAR system that can be used for Situational Awareness if allowed by your National Aviation Authority. It is currently an unapproved system in the UK and cannot be used for Air Traffic Control or Management.

The ATOM Unit provides the input to software such as the open source software VRS. Virtual RADAR Server. This is not PilotAware software and is used by graceful permission.

To access the Virtual RADAR Server screen, use a browser equipped computer logged onto the same LAN (wired or WIFI) and type in the allocated IP address. This will be something like 192.168.0.14.

If your browser supports it you can just type in the ognpaw.local. Multiple computers can access the ATOM Unit simultaneously thus providing a café monitor if required.

Select RADAR from the top menu and after about 30 seconds you will see something like the following.
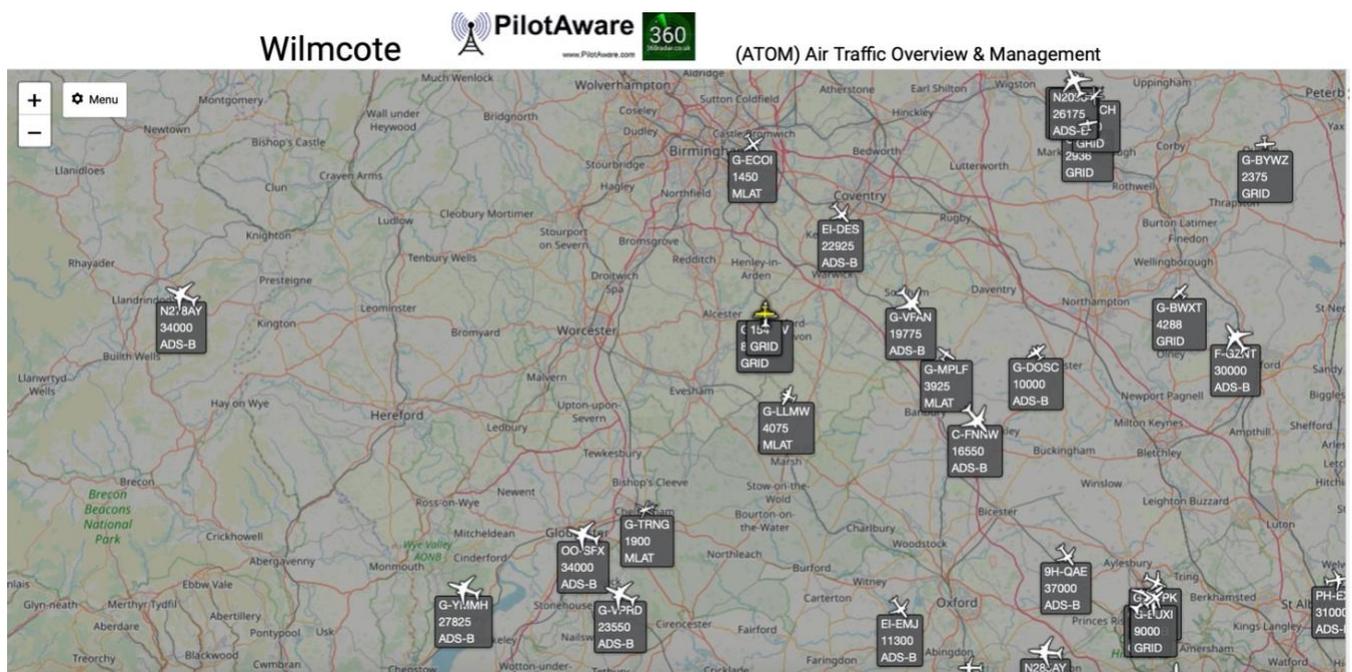
ATOM GRID Radar, will give you real time data (negligible delay) of all PilotAware, FLARM and ADSB equipped aircraft in your region. This will be typically 30-60Km for PilotAware and FLARM equipped aircraft and 100Km for transponders transmitting ADSB depending on the height of the target aircraft. CAP1391 transmitter will be typically 30KM like Flarm and PilotAware depending on airframe obscuration.

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In addition, Mode-S aircraft that are being interrogated by Secondary Surveillance Radar (SSR) will also be shown on the screen with the normal limitations of multilateration (MLAT).

These limitations are

(i) The target Mode-S aircraft must be interrogated by Primary RADAR. This may not happen below 600ft.
(ii) There will be a delay of between 1 and 10 seconds for the MLAT trace to be refreshed.
(iii) There will be a persistence of about 12 seconds from the last MLAT signal received.

Configuring Virtual RADAR Server

At the top left corner of the VRS screen, there is a menu which when activated allows configuration of the screen. The menu has several options.

It is not intended to go through each menu here as they are self-explanatory. However, at the high level they are:

General This allows the user to configure the centre of the map on your current or other location and chose the units for the heights speeds etc.

Map Allows the user to apply distance rings choose colours etc

Aircraft This allows a multitude of parameters to be set for the target aircraft detected.

List This allows the aircraft list to be configured

Filters The filters page allows the user to generate a range of filters for customising the display. Full operating instructions are available at

http://www.virtualradarserver.co.uk

Please remember as good as the ATOM GRID VRS is this must not be used for air traffic management, control or guidance.

Before MLAT traffic will appear on the VRS Screen this facility has to be unlocked by 360RADAR. To get this unlocked please request this in an email to ogn@pilotaware.com.

Summary

The correctly installed PilotAware ATOM GRID network will rebroadcast all locally captured Flarm equipped gliders to PilotAware equipped aircraft. When there are sufficient ATOM stations installed and connected to the GRID then each station will rebroadcast positions to

other nearby stations via the internet increasing the reach. This includes ADSB, FLARM, PilotAware and MLAT traffic.

Addendum

Parts Required to build an ATOM-GRID uplink

The parts below have been used successfully.

Part	Supplier
Raspberry Pi 2B	Provided free of Charge by PilotAware as long as stocks are available.
P3i Radio Bridge	Provided free of Charge by PilotAware as long as stocks are available.
Case	Provided free of Charge by PilotAware as long as stocks are available.
RTLSDR 2 required (1) for FLARM (2) for 1090	These are available from https://www.amazon.co.uk/Nooelec-NESDR-SMArt-SDR-R820T2-Based/dp/B01HA642SW/ref=sr_1_2?crid=I9MZD3SVNOHB&keywords=nooelec+sdr+dongle&qid=1569836681&sprefix=Nooelec%2Caps%2C141&sr=8-2 Please note that you will have to remove the aluminium enclosures for both of these to fit into the Pi this is OK. Other RTL-SDR's are available however you **MUST** choose one that uses the RTL2832U & R820T2 chipsets.
Pigtail. You can choose to use a pigtail to connect between the Co-Ax cable and the RTL-SDR. Make sure the end connections are correct for the RT:SDR you have chosen	https://www.amazon.co.uk/Bewinner-Connection-Military-Applications-Antennas-default/dp/B07PGPYY6R/ref=sr_1_fkmr0_2?keywords=Ntype+to+SMA+pigtail+RG316&qid=1569837131&sr=8-2-fkmr0 Note if you want to put your unit into an enclosure the a pigtail with a female N-type bulkhead connector is useful. This will however need Male N Type connectors on each end of the main coaxial cable. https://www.ebay.co.uk/itm/N-female-bulkhead-jack-D-cut-to-SMA-male-plug-RG316-pigtail-Coaxial-Coax-Cable/173974368764?ssPageName=STRK%3AMEBIDX%3AIT&_trksid=p2057872.m2749.l2649
CoAx Cable	https://www.wifi-antennas.co.uk/hdf400-coaxial-cable-per-metre
N-Type Connector Male	https://www.wifi-antennas.co.uk/n-type-male-crimp-connector-hdf400
N-Type Connector Female	https://www.wifi-antennas.co.uk/n-type-female-crimp-connector-hdf400
N-type Male to SMA	https://www.wifi-antennas.co.uk/sma-male-to-n-type-male-adaptor
HDF 400 Crimp tool	https://www.wifi-antennas.co.uk/ratchet-crimp-tool-rg58-clf200-hdf400
SD Card	https://www.amazon.co.uk/SanDisk-MicroSDHC-Memory-Label-Change/dp/B001D0ROGO/ref=asc_df_B001D0ROGO/?tag=googshopuk-21&linkCode=df0&hvadid=309924738384&hvpos=1o1&hvnetw=g&hvrand=455651977643598

	2955&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1007082&hvtargid=pla-309497947842&psc=1
RPi Charger	https://www.amazon.co.uk/Raspberry-Pi-Power-adapter-UK/dp/B01CCR5P8U/ref=sr_1_5?s=computers&ie=UTF8&qid=1533245620&sr=1-5&keywords=Raspberry+Pi+charger
PoE Injector as an alternative to the RPI Charger	https://www.amazon.co.uk/Regun-POE-Power-Adapter-regulatory-British/dp/B08C31KVQC/ref=sr_1_12_sspa?dchild=1&keywords=POE+Injector&qid=1606329964&sr=8-12-spons&psc=1&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExSTZYMjcyVEM4M09RJmVuY3J5cHRlZElkPUEwNzQwMTMxMlhSRzFPRzVaWTVORyZlbmNyeXB0ZWRBZElkPUEwMjg5ODEwNkU2S0c1UkdRMlNHJndpZGdldE5hbWU9c3BfbXRmJmFjdGlvbj1jbGlja1JlZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==
PoE Splitter as an alternative to the RPI Charger	https://www.amazon.co.uk/DSLRKIT-Active-Splitter-Ethernet-Raspberry/dp/B01H37XQP8/ref=sxts_sxwds-bia-wc-p13n1_0?cv_ct_cx=Poe+splitter&dchild=1&keywords=Poe+splitter&pd_rd_i=B01H37XQP8&pd_rd_r=86a8eaa3-2fb8-402b-bda4-b3b69bd1283a&pd_rd_w=YfLeT&pd_rd_wg=Q7jdb&pf_rd_p=2dd2e810-929c-4688-a622-8bf5cd31314f&pf_rd_r=F20MHPGSFD1GZW8N9KDT&psc=1&qid=1601020321&sr=1-1-ac3a866f-801f-44fe-9e94-bb9a271cf6b8
Ethernet cable	https://www.amazon.co.uk/CSL-Ethernet-Gigabit-1000Mbit-compatible/dp/B00J3UYNII/ref=sr_1_6?s=computers&ie=UTF8&qid=1533245968&sr=1-6&keywords=Ethernet+cable
FLARM Antenna	ogn@pilotaware.com or https://fjhuahong.manufacturer.globalsources.com/si/6008806990472/pdtl/Omni-antenna/1130137384/868MHz-9dBi-omni-base-antenna-fiberglass-antenna-N.htm
PilotAware Antenna	ogn@pilotaware.com or https://fjhuahong.manufacturer.globalsources.com/si/6008806990472/pdtl/Omni-antenna/1130172675/868MHz-7-dBi-Omni-Antenna-fiberglasss-antenna-N-F.htm
1090Mhz antenna	ogn@pilotaware.com or https://fjhuahong.manufacturer.globalsources.com/si/6008806990472/pdtl/Omni-antenna/1130172675/1090MHz-7-dBi-Omni-Antenna-fiberglasss-antenna-N-F.htm

Parts for The 3 Antenna Array Support

The parts required for building the 3 Antenna Array described earlier are:

1 10 ft 1.5" pole

https://www.toolstation.com/tv-aerial-satellite-dish-pole/p81967

2 pole mounts

https://www.toolstation.com/tv-aerial-fixing-kit/p69098

1 1"cross member cut to size.

https://www.toolstation.com/tv-aerial-satellite-dish-pole/p64731

2 antenna brackets

https://www.ebay.co.uk/itm/2-Shelly-Pole-Mast-Clamp-Bracket-8-Nut-Aerial-Bolt-Universal-Steel-Extension-TV-/371342052139?hash=item5675b60b2b

With these you can produce the 3 antenna array below this. (use the remainder of the 1 inch aluminium to produce the small vertical stub on the right hand side for the 1090 antenna). The PilotAware antenna is on the left and the Flarm antenna is in the centre.

Building and installing a PilotAware ATOM Station to detect and re-transmit glider and Mode-S MLAT locations and provide Virtual RADAR SERVER July 2021.

Other Useful Hardware

.

https://www.toolstation.com/shop/Electrical/d190/TV+%26+Satellite/sd3084/TV+Aerial+%26+SatelliteDish+Pole/p39913

https://www.toolstation.com/shop/p69098

https://www.wifi-antennas.co.uk/antenna-wall-mount-kit-with-z-bend-stand-off.html

https://www.screwfix.com/p/labgear-29924lab-3m-aerial-mast/32094

If you need further information ogn@pilotaware.com

End of Document