Enroute Flight Navigation

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Contents

1 Introduction

Enroute Flight Navigation is a free flight navigation app for Android and other devices. Designed to be simple, functional and elegant, it takes the stress out of your next flight. The program has been written by flight enthusiasts, as a project of Akaflieg Freiburg[1], a flight club based in Freiburg, Germany.

Enroute Flight Navigation features a moving map, similar in style to the official ICAO maps. Your current position and your flight path for the next five minutes are marked, and so is your intended flight route. A double tap on the display gives you all the information about airspaces, airfields and navaids – complete with frequencies, codes, elevations and runway information.

The free aeronautical maps can be downloaded for offline use. In addition to airspaces, airfields and navaids, selected maps also show traffic circuits as well as flight procedures for control zones. The maps receive daily updates and cover large parts of the world.

Enroute Flight Navigation includes flight weather data downloaded from the NOAA - Aviation Weather Center[2].

While **Enroute Flight Navigation** is no substitute for full-featured flight planning software, it allows you to quickly and easily compute distances, courses and headings, and gives you an estimate for flight time and fuel consumption. If the weather turns bad, the app will show you the closest airfields for landing, complete with distances, directions, runway information and frequencies.

This manual describes program version 2.23.0.

[1] https://akaflieg-freiburg.de/
[2] https://www.aviationweather.gov/

2 Getting Started

2.1 Think before you fly

Enroute Flight Navigation is a free software product that has been published in the hope that it might be useful as an aid to prudent navigation. It comes with no guarantees. It may not work as expected. Data shown to you might be wrong. Your hardware may fail.

This app is no substitute for proper flight preparation or good pilotage. Any information **must always** be validated using an official navigation and airspace data source.

> **Warning:** Always use official flight navigation data for flight preparation and navigate by officially authorized means. The use of non-certified navigation devices and software like **Enroute Flight Navigation** as a primary source of navigation may cause accidents leading to loss of lives.

We do not believe that the use of **Enroute Flight Navigation** fulfills the requirement of the EU Regulation No 923/2012:SERA.2010[3]

> Before beginning a flight, the pilot-in-command of an aircraft shall become familiar with all available information appropriate to the intended operation.

To put it simply: relying on **Enroute Flight Navigation** as a primary means of navigation is most likely illegal in your jurisdiction. It is most certainly stupid and potentially suicidal.

2.1.1 Software limitations

Enroute Flight Navigation is not an officially approved flight navigation software. It is not officially approved or certified in any way. The software comes with no guarantee and might contain bugs.

[3] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:281:0001:0066:EN:PDF

2.1.2 Navigational data and aviation data

Navigational– and aviation data, including airspace and airfield information, are provided "as is" and without any guarantee, official validation, certification or warranty. The data does not come from official sources. It might be incomplete, outdated or otherwise incorrect.

2.1.3 Operating system limitations

We expect that most users will run the software on mobile phones or tablet computers running the Android operating system. Android is not officially approved or certified for aviation. While we expect that the app will run fine for the vast majority of Android users, please keep the following in mind.

- The Android operating system can decide at any time to terminate **Enroute Flight Navigation** or to slow it down to clear resources for other apps.
- Other apps might interfere with the operation of **Enroute Flight Navigation**.
- Many hardware vendors, most notably One Plus, Huawei and Samsung equip their phone with "battery saving apps" that randomly kill long-running processes. These apps cannot be uninstalled by the users, do not comply with Android standards and are often extremely buggy. At times, users can manually excempt apps from "battery saving mode", but the settings are usually lost on system updates. Google's own "Pixel" and "Nexus" devices do not have these problems. See the website Don't kill my app[4] for more information.

2.1.4 Hardware limitations

Enroute Flight Navigation runs on a variety of hardware platforms, but we expect that most users will run the software on mobile phones, tablet computers and comparable consumer electronic devices that are not certified to meet aviation standards. Keep the following in mind.

- Your device might not be designed to operate continuously for extended periods of time, in particular if the display is on.
- Your device can overheat. Batteries can catch fire.
- Battery capacity is limited. Even if your device is connected to power via a USB cable, the display and/or CPU might use more energy than USB can deliver.

2.2 Installation and setup

2.2.1 App installation

Installation on Android devices
Enroute Flight Navigation is available as an Android App in the Google Play Store[5].

Installation on iOS devices
Enroute Flight Navigation has been ported to iOS and is available for public beta testing. Download a public beta version of the app for iOS on Apple TestFlight[6].

[4] https://dontkillmyapp.com
[5] https://play.google.com/store/apps/details?id=de.akaflieg_freiburg.enroute
[6] https://apps.apple.com/de/app/testflight/id899247664

Installation on Linux desktop machines

Enroute Flight Navigation is available for free download at flathub.org[7]. Depending on your Linux distribution, you might also find the app in the software management application on your computer.

After installation, start the app. Depending on the platform, you might need to grant the necessary permissions. You will be asked to accept the terms and conditions.

Enroute Flight Navigation cannot be used without geographic maps. As the last step in the installation, the app will suggest downloading maps that are relevant for your current location. Once the map download has finished, **Enroute Flight Navigation** will process the map data and update the map display after a minute or so.

2.2.2 Set aircraft specifics

We recommend that you tell **Enroute Flight Navigation** a little about your aircraft before you fly.

- Open the Menu by touching the menu button in the upper right side of the screen.
- Choose the menu item *Aircraft*. The aircraft page will then open.

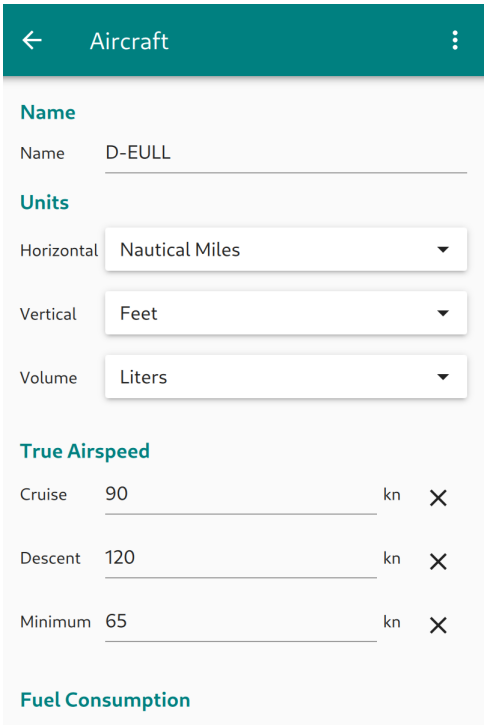


Fig. 1: Aircraft specifics

Please fill in the relevant data. While not every data item is used in the present version of **Enroute Flight Navigation**, we expect that future versions of the app will use all the data that is requested on this page.

Tap or click on the arrow symbol '←' or use the Android 'Back' button to leave the map page and return to the main screen.

[7] https://flathub.org/apps/details/de.akaflieg_freiburg.enroute

2.2.3 Done.

You are now ready to go. There are many things that you could set up at this stage, but we recommend that you simply look around and play with the app. Continue with the next section and take it for your first flight.

2.3 Before your first flight

Now you are ready for the first use of **Enroute Flight Navigation**. General operation is very intuitive. Still, we recommend that you take a minute to make yourself familiar with the moving map display and with the basic controls before you take the app on its first flight. The section *Main Page and Moving Map* covers the moving map in more detail.

2.3.1 The moving map

After startup, the app will show a moving map, similar in style to the standard ICAO maps that most pilots are used to. You can use the standard gestures to zoom and pan the map to your liking. The figures *Moving map display on the ground* and *Moving map display in flight* shows how the map will typically look.

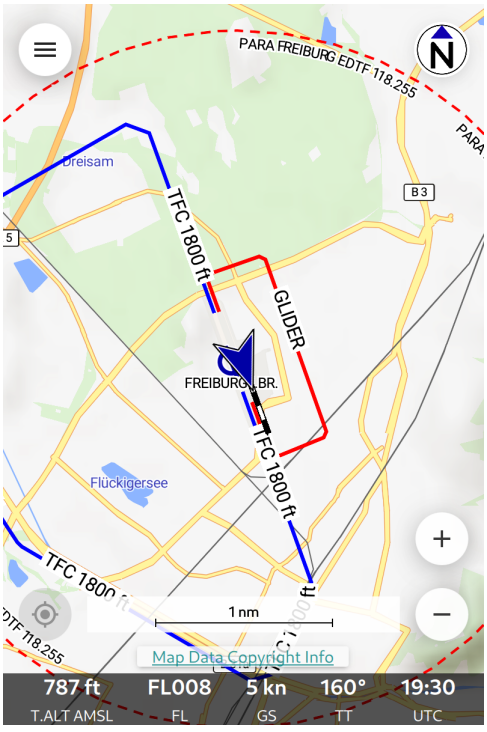


Fig. 2: Moving map display on the ground

Initially, your own position is shown as a blue circle (or gray if the system has not yet acquired a valid position). Once you are moving, your own position is shown as a blue arrow shape. The flight path vector shows the projected track for the next five minutes, sized so that each of the black and white segments corresponds to one minute.

Note: When you start the app for the first time, you will probably see a bright red aircraft symbol in the lower left corner of the map. This symbol indicates that the app is not connected to the traffic data receiver of your aircraft, so that traffic will not be shown on the moving map.

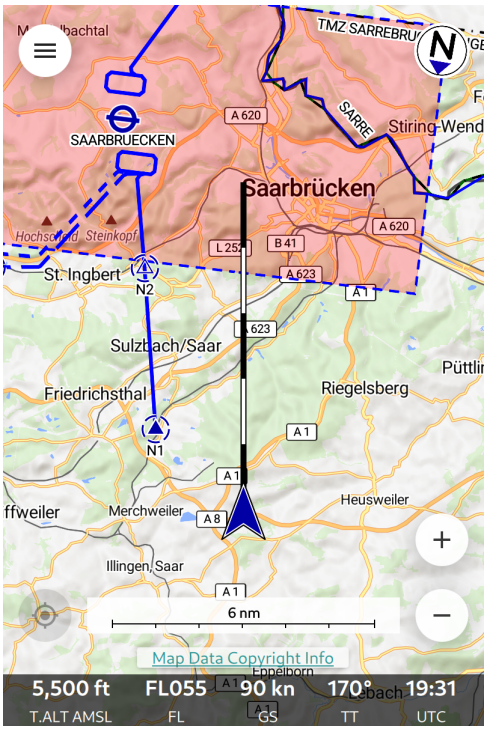


Fig. 3: Moving map display in flight

Fig. 4: Projected flight path for the next five minutes

Once you are familiar with the app, please have a look at the Section *Sense and avoid* of this manual.

2.3.2 The Navigation Bar

The bottom of the display shows a little panel with the following information.

Code	Meaning
T.TALT	True altitude (=geometric altitude) above sea level.
FL	Flight level.
GS	Ground speed.
TT	True track.
UTC	Current time.

The flight level is only available if your device is connected to a traffic receiver (such as a PowerFLARM device) that reports the pressure altitude. Flight level and current time are hidden if the display is not wide enough.

Warning: Vertical airspace boundaries are defined by pressure altitudes (with respect to QNH or standard pressure). Depending on temperature and air density, the pressure altitude will differ from the true altitude that is shown by the app. **Never use true altitude to judge vertical distances to airspaces.**

2.3.3 Interactive controls

In addition to the pan and pinch gestures, you can use the following buttons to control the app.

Symbol	Function
	Open main menu
	Switch between display modes **north up** and **track up**.
	Center map about own position.
	Zoom in
	Zoom out
	This control is shown when the app is not connected to a traffic data receiver. A click opens the traffic receiver status page.

2.3.4 Information about airspaces, airfields and other facilities

Double tap or tap-and-hold anywhere in the map to obtain information about the airspace situation at that point. If you double tap or tap-and-hold on an airfield, navaid or reporting point, detailed information about the facility will be shown. The figure *Information about EDFE airport* shows how this will typically look.

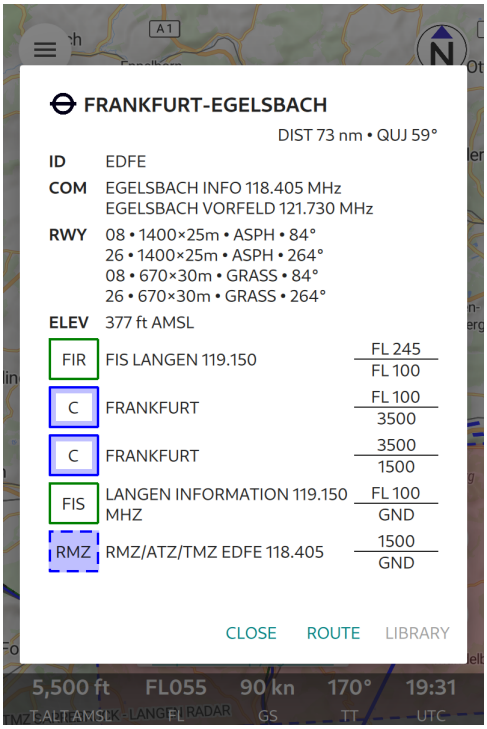


Fig. 5: Information about EDFE airport

2.3.5 Go flying!

Enroute Flight Navigation is designed to be simple. We think that you are now ready to take the app on its first flight. There are of course many more things that you can do. Play with the app and have a look at the next section *Further Steps*.

3 Further Steps

3.1 Sense and avoid

Midair collisions are a major reason for loss of lives in general aviation. Collisions often happen near airfields or in the traffic circuit. In order to enhance security, **Enroute Flight Navigation** can connect to your aircraft's traffic receiver (typically a FLARM device) and display nearby traffic on the moving map.

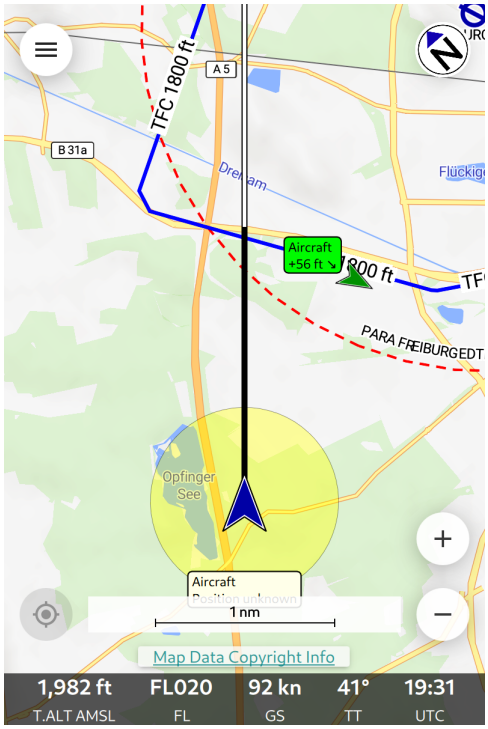


Fig. 1: Approaching EDTF with traffic

The figure *Approaching EDTF with traffic* shows what to expect. The figure shows two traffic factors. The section *Main Page and Moving Map* covers the traffic display in detail.

- There is one aircraft in the downwind section of the traffic circuit. The traffic has approximately the same altitude as the own aircraft and is sinking. The green color indicates "no alarm".

- There is one aircraft nearby whose precise position is unknown to the traffic receiver; this is often the case with traffic that has only a Mode-S transponder. The traffic is most likely found within the yellow circle. The yellow color indicates that the traffic might be close enough to be dangerous.

Note: To show only relevant traffic, **Enroute Flight Navigation** will display traffic factors only if the vertical distance is less than 1.500m and the horizontal distance less than 20nm.

Warning: **Enroute Flight Navigation** shows traffic on the moving map, but does not issue traffic warnings. The app contains no collision avoidance algorithms. Color coding of traffic according to relevance works best with FLARM devices.

3.1.1 Compatibility

Enroute Flight Navigation should work with all modern, standard-compliant traffic receivers. The author has tested the app with the following receivers.

- AT-1 AIR Traffic[8] by Air Avionics[9].
- PowerFLARM Core[10] by FLARM Technology Ltd[11], and AIR Connect[12] WiFi Adaptor by Air Avionics[13].

Users reported success with the following traffic receivers.

- PilotAware Rosetta[14]
- SkyEcho2[15] – but see the Section *Known issues with SkyEcho devices*
- Stratux devices[16]
- TTGO T-Beam devices[17]

Note: Most traffic data receivers can only handle one concurrent connection. If more devices connect, this might lead to frequent loss of connection or loss of data. To be on the safe side, it might be useful to ask your passengers to disable Wi-Fi on their phone before boarding.

Note: For best results, use FLARM compatible devices. If your traffic receiver supports FLARM/NMEA as well as GDL90 output, always use FLARM/NMEA. The GDL90 protocol has a number of shortcomings that **Enroute Flight Navigation** cannot always work around. See the Section *Known issues with GDL90* for more details.

[8] http://www.air-avionics.com/?page_id=253
[9] http://www.air-avionics.com/
[10] https://flarm.com/flarm-product/powerflarm-core-pure/
[11] https://flarm.com/
[12] https://www.air-avionics.com/?page_id=401
[13] http://www.air-avionics.com/
[14] https://www.pilotaware.com/rosetta/
[15] https://uavionix.com/products/skyecho/
[16] http://stratux.me/
[17] https://www.amazon.de/TTGO-T-Beam-915Mhz-Wireless-Bluetooth/dp/B07SFVQ3Z8

3.1.2 Before you connect

Before you try to connect this app to your traffic receiver, make sure that the following conditions are met.

- Your traffic receiver has an integrated Wi-Fi interface that acts as a wireless access point. Bluetooth devices are currently not supported.
- You know the network name (=SSID) of the Wi-Fi network deployed by your traffic receiver. If the network is encrypted, you also need to know the Wi-Fi password.
- Some devices require an additional password in order to access traffic data. If this is the case, you will need to know this password.

3.1.3 Connect to the traffic receiver

It takes two steps to connect **Enroute Flight Navigation** to the traffic receiver for the first time. Once things are set up properly, your device should automatically detect the traffic receiver's Wi-Fi network, enter the network and connect to the traffic data stream whenever you go flying.

Step 1: Enter the traffic receiver's Wi-Fi network

- Make sure that the traffic receiver has power and is switched on. In a typical aircraft installation, the traffic receiver is connected to the 'Avionics' switch and will automatically switch on. You may need to wait a minute before the Wi-Fi comes online and is visible to your device.
- Enter the Wi-Fi network deployed by your traffic receiver. This is usually done in the "Wi-Fi Settings" of your device. Enter the Wi-Fi password if required. Some devices will issue a warning that the Wi-Fi is not connected to the internet. In this case, you might need to confirm that you wish to enter the Wi-Fi network.

Most operating systems will offer to remember the connection, so that your device will automatically connect to this Wi-Fi in the future. We recommend using this option.

Step 2: Connect to the traffic data stream

Open the main menu and navigate to the "Information" menu.

- If the entry "Traffic Receiver" is highlighted in green, then **Enroute Flight Navigation** has already found the traffic receiver in the network and has connected to it. Congratulations, you are done!
- If the entry "Traffic Receiver" is not highlighted in green, then select the entry. The "Traffic Receiver Status" page will open. The page explains the connection status in detail, and explains how to establish a connection manually.

3.1.4 Flarmnet data

Enroute Flight Navigation is able to use the database from Flarmnet.org[18] to identify aircraft and to show the aircraft registration in the moving map display. The process does not require user interaction: once the app connects to a FLARM device and receives traffic information, the Flarmnet database will automatically be downloaded and updated with every map update. If desired, the database can also be downloaded manually on the page "Maps and Data" (open the main menu and go to "Library/Maps and Data").

[18] https://www.flarmnet.org/flarmnet/

3.1.5 Troubleshooting

The app cannot connect to the traffic data stream.

- Check that your device is connected to the Wi-Fi network deployed by your traffic receiver.

The connection breaks down after a few seconds.

Most traffic receivers cannot serve more than one client and abort connections at random if more than one device tries to access.

- Make sure that there no second device connected to the traffic receiver's Wi-Fi network. The other device might well be in your friend's pocket!
- Make sure that there is no other app trying to connect to the traffic receiver's data stream.
- Many traffic receivers offer "configuration panels" that can be accessed via a web browser. Close all web browsers.

3.2 Find nearby waypoints

If the weather turns bad, **Enroute Flight Navigation** can help you find the best place to land. Open the main menu and choose the item "Nearby waypoints". You will be presented with a list of the closest aerodromes, together with distances and directions. Click on any item to open a dialog with detailed information, including lists of runways and communications frequencies. The dialog has a button "Direct" the replaces the current route with a route that brings you directly to the aerodrome.

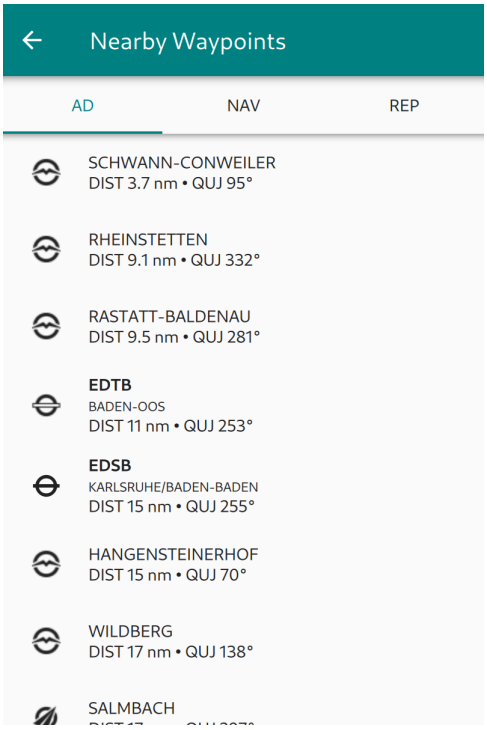


Fig. 2: List of airfields close to the current position

Apart from aerodromes, there are additional tabs that list nearby navaids and reporting points.

3.3 Check Weather

Enroute Flight Navigation can show METAR reports and TAF forecasts from nearby airfields along your route. The data is updated frequently, provided that an internet connection is available. To check weather, open the main menu and choose the item "Weather". The weather information comes from the "Aviation Weather Center", a website of the US government. When you open the page for the first time, **Enroute Flight Navigation** asks for your permission to access that site.

> **Warning:** The weather information shown by **Enroute Flight Navigation** might be outdated or otherwise wrong. Assessment of meteorological flight conditions has to be done via an officially approved source of flight weather.

As soon as weather information has been downloaded, the page will look like this.

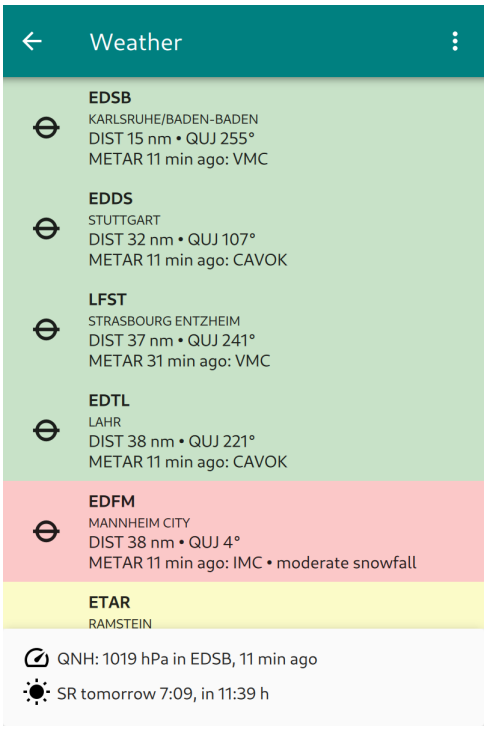


Fig. 3: Weather information

The page body displays a list of stations that are within 85nm around your current position or your intended flight route. As you can see in the picture, the following information is shown.

- ICAO identifier for Station and Airport name
- Distance and QUJ
- METAR summary

The entries are classified and colored according to the "aviation flight categories" typically used in the United States. The coding scheme is explained in the table below. Note that this color coding might be different from the scheme typically used in your country. Green color does certainly **not** imply that it is advisable (or legal) to fly.

Category	Color	Ceiling		Visibility
low IFR	Red	<500 feet AGL	or	<1 mile
IFR	Red	500 – 1,000 feet AGL	or	1 – 3 miles
marginal VFR	Yellow	1,000 – 3,000 feet AGL	or	3 – 5 miles
VFR	Green	>3,000 feet AGL	and	> 5 miles
no data	White	–	–	–

Touch any item in the list to open dialog window with more details. The dialog window will look like this.

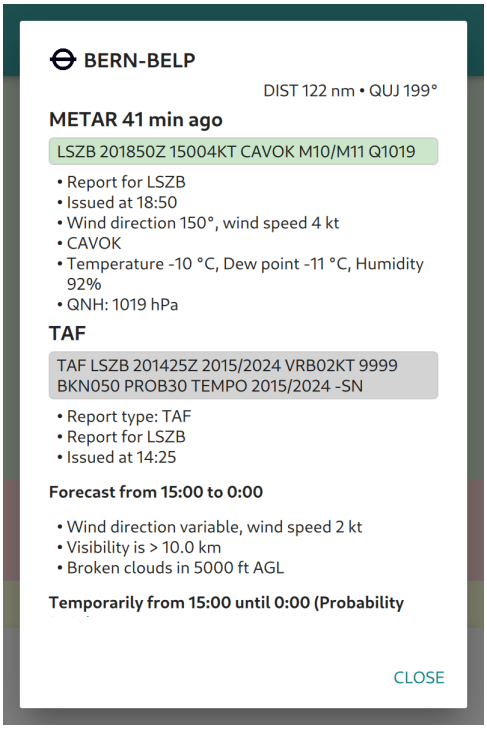


Fig. 4: Detailed Weather Dialog

As you can see in the picture, the weather dialog shows the following information.

1. Station data including bearing and distance
2. METAR text (if available)
3. Decoded and translated METAR text
4. TAF text (if available)
5. Decoded and translated TAF text

Depending on screen size, you might have to scroll down in order to read the full weather forecast.

3.3.1 Page footer

The footer of the page shows the following data.

- QNH of the closest airfield, as well as location and time of the report
- Time of next sunset or sunrise at current location
- Remaining time until sunset

3.3.2 Three-dot menu

The three-dot menu at the top right of the page allows to do the following.

- Check for updates of METAR and TAF data
- Disallow the internet connection to the “Aviation Weather Center” in case of privacy concerns

3.4 Plan a Flight

3.4.1 What to expect

Enroute Flight Navigation offers essential flight planning functionality: you can display the route on the moving map and compute travel time and fuel consumption estimates. The following image shows the Flight Route Window in a typical situation.

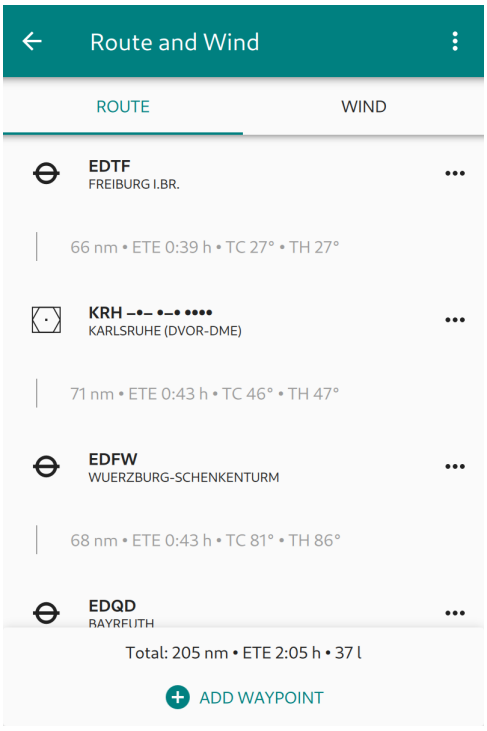


Fig. 5: Flight route window, route set

As soon as you are flying and following the route, the moving map will show additional items that help you navigate.

- The moving map shows the intended flight as a magenta line.

- The map shows the path from the current position to the next waypoint as a thin red line.
- An infobox shows distance, ETE, and ETA for the flight to the next and the final waypoint.

The following image shows a typical situation.

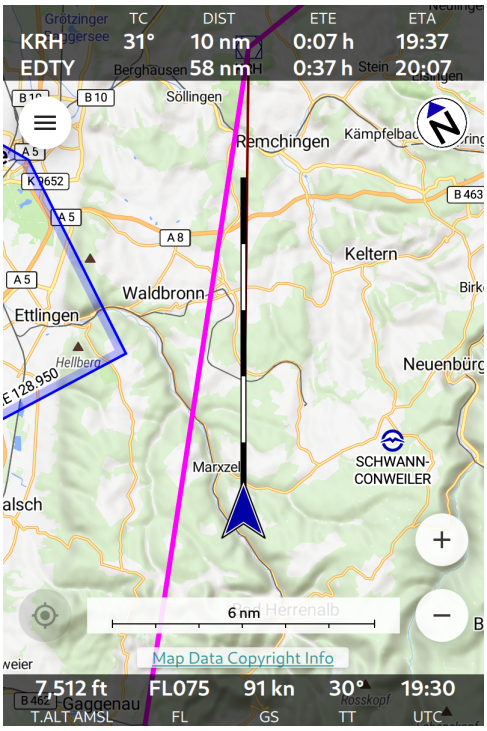


Fig. 6: Moving map when following a flight route

Note: **Enroute Flight Navigation** shows the info box only when airborne, closer than three nautical miles to the intended route and further than three nautical miles from your destination.

3.4.2 Set up a route

This chapter will take you through the necessary steps to set up a route.

Step 1: Set aircraft characteristics

To compute travel time, **Enroute Flight Navigation** needs to know the cruise speed of your aircraft. If you have followed this manual, you have entered this piece of data after you downloaded the aviation map. If not, then please check the section *Set aircraft specifics* again.

Step 2: Specify wind

Enroute Flight Navigation also needs to know about the wind. If you are not on the page "Route and Wind," open the main menu and choose the item "Route and Wind." Select the tab "Wind" and enter an estimate for wind direction and speed that you expect to encounter during your flight.

Step 3: Specify waypoints

Enroute Flight Navigation needs to know where you want to go. There are several ways to specify the waypoints in your route.

- Enter waypoints by name
- Select waypoints in the moving map
- Import a route from the route library
- Import a GPX file from another program

Most users will enter the waypoints manually. Still, we explain all four methods in some detail.

Option 1: Enter waypoints by name

If you are not on the "Route and Wind" page, open the main menu and choose the item "Route and Wind." On the page, select the "Route" tab. The page will initially look like this:

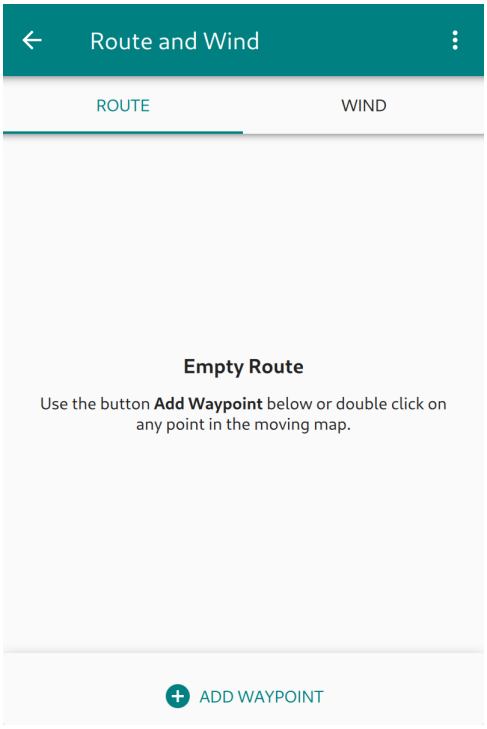


Fig. 7: Flight route window, no route set

A tap on the field "Add Waypoint" at the bottom of the page will open a dialog window showing a long list with all waypoints from all aviation maps you have installed. Enter a few letters of the waypoint name ("Freiburg") or ICAO code ("EDTF") to narrow the list down. Once the desired waypoint becomes visible, a click will add it to the route.

Click on the field "Add Waypoint" again to enter more waypoints.

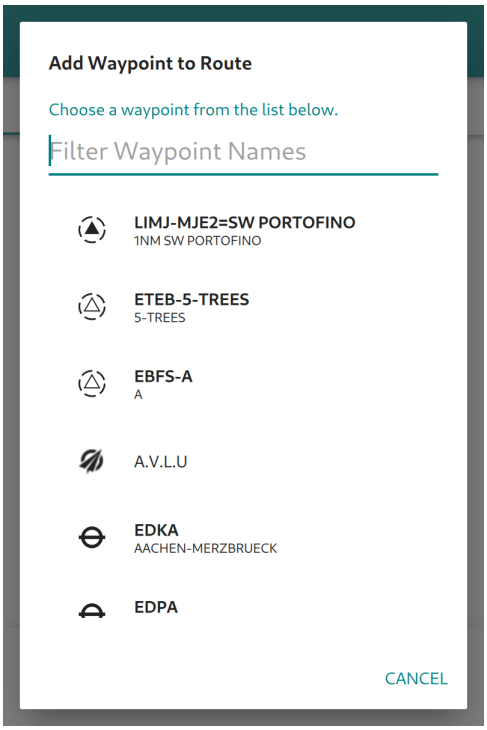


Fig. 8: Enter waypoints by name

Option 2: Select waypoints in the moving map

It is possible to add waypoints directly from the moving map. Double-tap or tap-and-hold on any point of the moving map. The waypoint description dialog will open.

- Tap on the "Plus" sign to append the waypoint to the current route.
- Tap on "Direct to" to discard the current route and to add the current position and the given waypoint to your path.
- If the waypoint is already present in your route, you can tap on the "Minus" sign to remove it.

Option 3: Import a route from the library

Section *Optional: Save route for future use* will show how to save a route to the library for future use. If you have already saved a route to the library, go to the open the main menu and choose the item "Library/Routes." The route library page will open. Choose a route by tapping on the respective item in the list.

Option 4: Import a GPX file from another program

To prepare your flight, you might want to use full-featured flight preparation software or online services, such as FL95[19]. Most (if not all) programs allow exporting the route in GPX format. Transfer the GPX file to your device (using Bluetooth file transfer, Google Drive, sending yourself an e-mail, or any other communication channel).

- On Android devices, it suffices to open the file. Depending on the transfer mode, you can open the file after the Bluetooth transfer, in the Google Drive App, or perhaps in the e-mail client. **Enroute Flight Navigation** will automatically open and import the route. If more than one program on your device can handle GPX files, the system will ask you which program to use.
- On the Linux desktop, drag-and-drop the GPX file to the **Enroute Flight Navigation** window.

[19] https://fl95.de

Step 4: Edit the route if necessary

It might be necessary to edit the route. If you are not on the "Route and Wind" page, open the main menu and choose the item "Route and Wind." On the page, select the "Route" tab.

Global functions

The three-dot-menu in the upper right corner of the screen allows reversing the route or deleting it entirely.

Waypoint-specific functions

The three-dot-menu to the right of each waypoint allows one to delete a specific waypoint or move it up and down in the list. You can edit waypoints that do not refer to pre-set airfields, navaids, or reporting points. Tap on the pencil symbol to open a dialog that allows you to set a name and edit the coordinates.

3.4.3 Optional: Save route for future use

Once you are happy with the route, you might want to save it for future use. If you are not on the "Route and Wind" page, open the main menu and choose the item "Route and Wind." On the page, select the "Route" tab. The three-dot-menu in the upper right corner of the screen allows saving the route to the library.

3.4.4 Optional: Export and share the route

Enroute Flight Navigation can write the route to a file, which can then be transferred to other devices, or opened with other apps. **Enroute Flight Navigation** is able to write files in GeoJSON and GPX format. While GPX is understood by most programs, GeoJSON is the preferred format for sharing data between several instances of **Enroute Flight Navigation**.

- On Android devices, choose the item "Share…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.
- On the Linux desktop, choose the item "Export…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.

3.4.5 Optional: Open the route in another app

It is possible to open the route in another app. Choose the item "Open in other app…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.

3.5 Manage a waypoint library

3.5.1 What to expect

Enroute Flight Navigation allows you to build a small library of waypoints that can be used in flight routes and shared with others. For the typical user, the library might contain a list of touristic landmarks ("Hohenzollern Castle"), or perhaps a list of emergency landing fields. The waypoints from the library are shown in the moving map.

Note: The waypoint library has been designed with small libraries in mind. If you import files containing thousands of waypoints, you might find that the moving map of **Enroute Flight Navigation** slows down considerably.

3.5.2 Add waypoints to the library

To add a waypoint to the library, tap-and-hold onto the moving map, so that the waypoint description dialog opens. In that dialog, click on "Library/Add…" Before saving, it is possible to assign a name and to edit the coordinates of the waypoint.

Note: To avoid data duplication, it is not possible to add airfields, navaids or reporting points to the waypoint library. If you tap-and-hold onto an airfield, you will find that the Item "Library" is disabled in the waypoint description dialog.

3.5.3 View the waypoint library

To open the waypoint library, go to the main menu and choose the item "Library/Waypoints."

3.5.4 Import waypoints

Enroute Flight Navigation is able to import waypoints from files in CUP, GeoJSON or GPX format.

- On Android devices, transfer the file to your device and open it there. Depending on the transfer mode, you can open the file after the Bluetooth transfer, in the Google Drive App, or perhaps in the e-mail client.
- On the Linux desktop, drag-and-drop the file to the **Enroute Flight Navigation** window. Alternatively, open the waypoint library by choosing "Library/Waypoints" from the main menu, and choose the item "Import" from the three-dot menu at the top right of the screen.

3.5.5 Export and share the waypoint library

Enroute Flight Navigation is can write the waypoint library to a file, which can then be transferred to other devices, or opened with other apps. **Enroute Flight Navigation** is able to write files in GeoJSON and GPX format. While GPX is understood by most programs, GeoJSON is the preferred format for sharing data between several instances of **Enroute Flight Navigation**.

To start, open the waypoint library by choosing "Library/Waypoints" from the main menu.

- On Android devices, choose the item "Share…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.
- On the Linux desktop, choose the item "Export…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.

3.5.6 Open the waypoint library in another app

It is possible to open the waypoint library in another app. To start, open the waypoint library by choosing "Library/Waypoints" from the main menu. Once the main library page is open, choose the item "Open in other app…" from the three-dot menu at the top right of the screen, and choose the appropriate file type from the submenu.

3.6 Connect your flight simulator

Enroute Flight Navigation can connect to flight simulator software. When setup correctly, position and traffic information is sent from the flight simulator via WiFi to the device that runs **Enroute Flight Navigation**.

The author has tested **Enroute Flight Navigation** with the following flight simulator programs.

- *FlightGear*
- *X-Plane 11* for desktop computers

Users have reported success with the following programs.

- *Aerofly FS*, Version 2 and 4 for desktop computers
- *MS Flight Simulator*
- X-Plane, Versions 10, 11 and 12 for desktop computers

Please contact us if you are aware of other programs that also work.

Note: **Enroute Flight Navigation** treats flight simulators as traffic receivers. To see the connection status, open the main menu and navigate to the "Information" menu.

3.6.1 Before you connect

This manual assumes a typical home setup, where both the computer that runs the flight simulator and the device that runs **Enroute Flight Navigation** are connected to a Wi-Fi network deployed by a home router. Make sure that the following conditions are met.

- Open the "Settings" page in the main menu and tap on the entry "Primary position data source" and select the "Traffic data receiver" as the main source. **As long as the built-in satnav receiver is selected, all position information provided by your flight simulator is ignored.**
- The computer that runs the flight simulator and the device that runs **Enroute Flight Navigation** are connected to the same Wi-Fi network. Some routers deploy two networks, often called "main network" and a "guest network".
- Make sure that the router allows data transfer between the devices in the Wi-Fi network. Some routers have "security settings" that disallow data transfer between the devices in the "guest network"

3.6.2 Set up your flight simulator

Your flight simulation software needs to broadcast position and traffic information over the Wi-Fi network. Once this is done, there is no further setup required. As soon as the flight simulator starts to broadcast information over the Wi-Fi network, the moving map of **Enroute Flight Navigation** will adjust accordingly. To end the connection to the flight simulator, simply leave the flight simulator's Wi-Fi network.

Aerofly FS

Aerofly works well with **Enroute Flight Navigation** if the program is set to broadcast flight information via the network. Open the menu "Miscellaneous settings", activate the option "Broadcast flight info to IP address" and enter the correct „Broadcast IP address". The figure *Aerofly Miscellaneous settings* and shows the settings that work for one of our users.

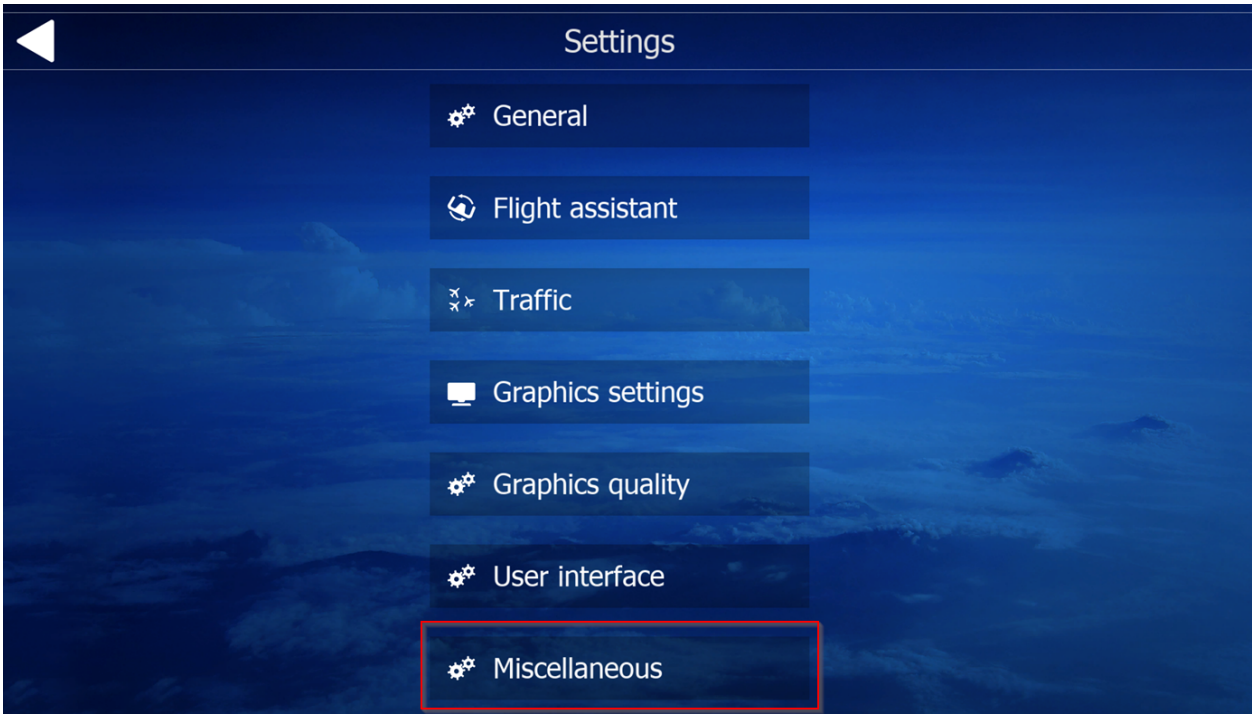


Fig. 9: Aerofly settings

FlightGear

FlightGear works well, even though position information is only broadcast when the simulated aircraft is moving. The following two parameters in the text field of the settings dialog need to be set:

```
--generic=socket,out,1,255.255.255.255,49002,udp,foreflight-xgps
--httpd=8080
```

The figure *FlightGear settings* shows settings window.

MS Flight Simulator

In order to communicate with other programs, the MS Flight Simulator requires additional software. Users reported that **Enroute Flight Navigation** works well with the following EFB-connector programs.

- fs2ff[20] (free, open source)
- XMapsy Essential[21] (commercial, inexpensive, does not provide barometric altitude data).
- XMapsy V3[22] (commercial, more expensive, provides barometric altitude data).

[20] https://github.com/astenlund/fs2ff
[21] http://xmapsy.com/
[22] http://xmapsy.com/

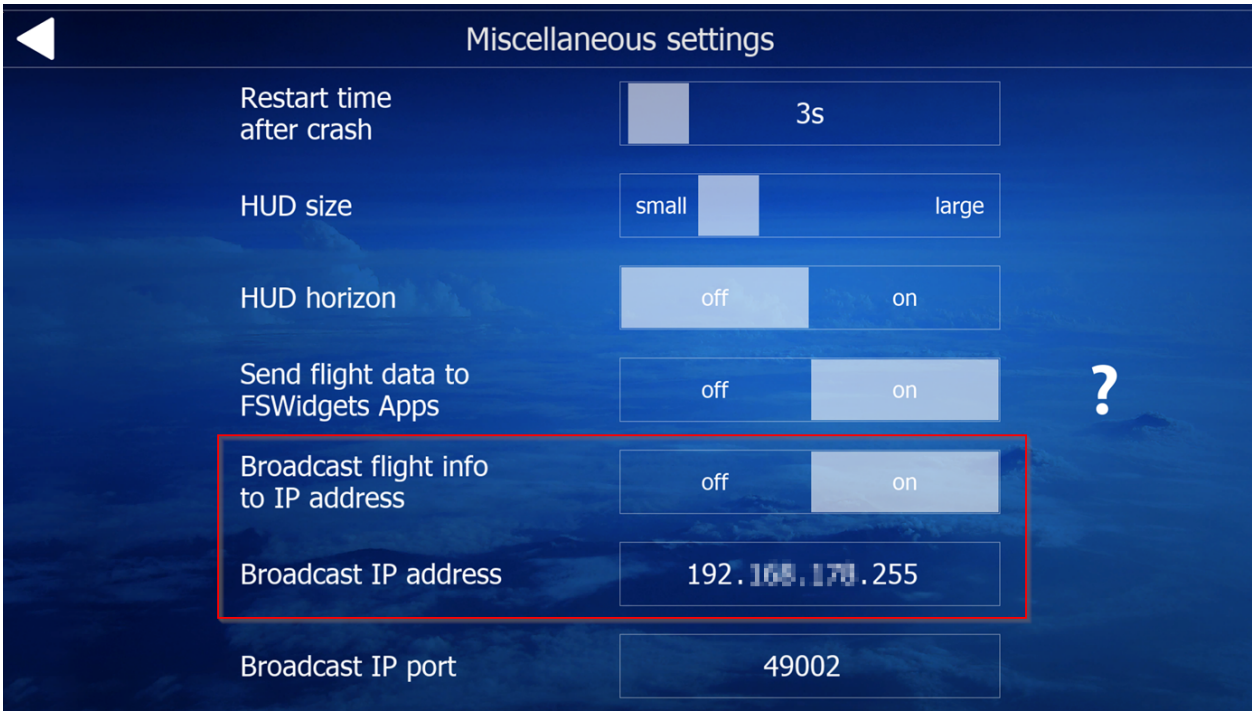


Fig. 10: Aerofly Miscellaneous settings

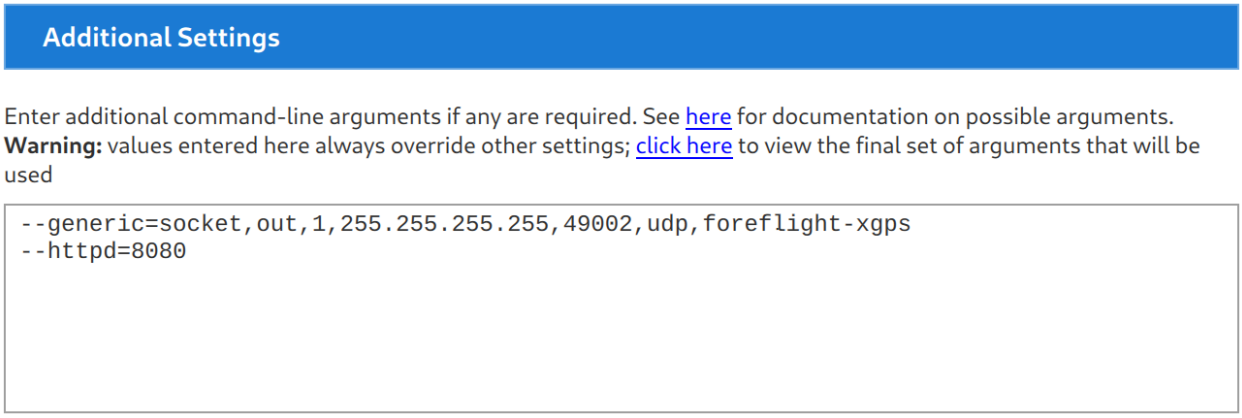


Fig. 11: FlightGear settings

The web site of the commerical EFB program ForeFlight[23] lists additional EFB-connector programs that might also work.

Note: In MSFS2020 cold and dark mode, traffic in the air will not been shown. You have to power on the avionics!

Note: At the time of writing (04Aug21), the MS Flight Simulator reports only traffic that has a tail number. This is likely due to a bug in the MS Flight Simulator software.

fs2ff

The program fs2ff[24] does not require any complicated installation or setup, just download and run. The latest release of fs2ff can be downloaded here[25]. Detailed instruction are found here[26]. The figure *fs2ff settings* shows extremely simple settings window.

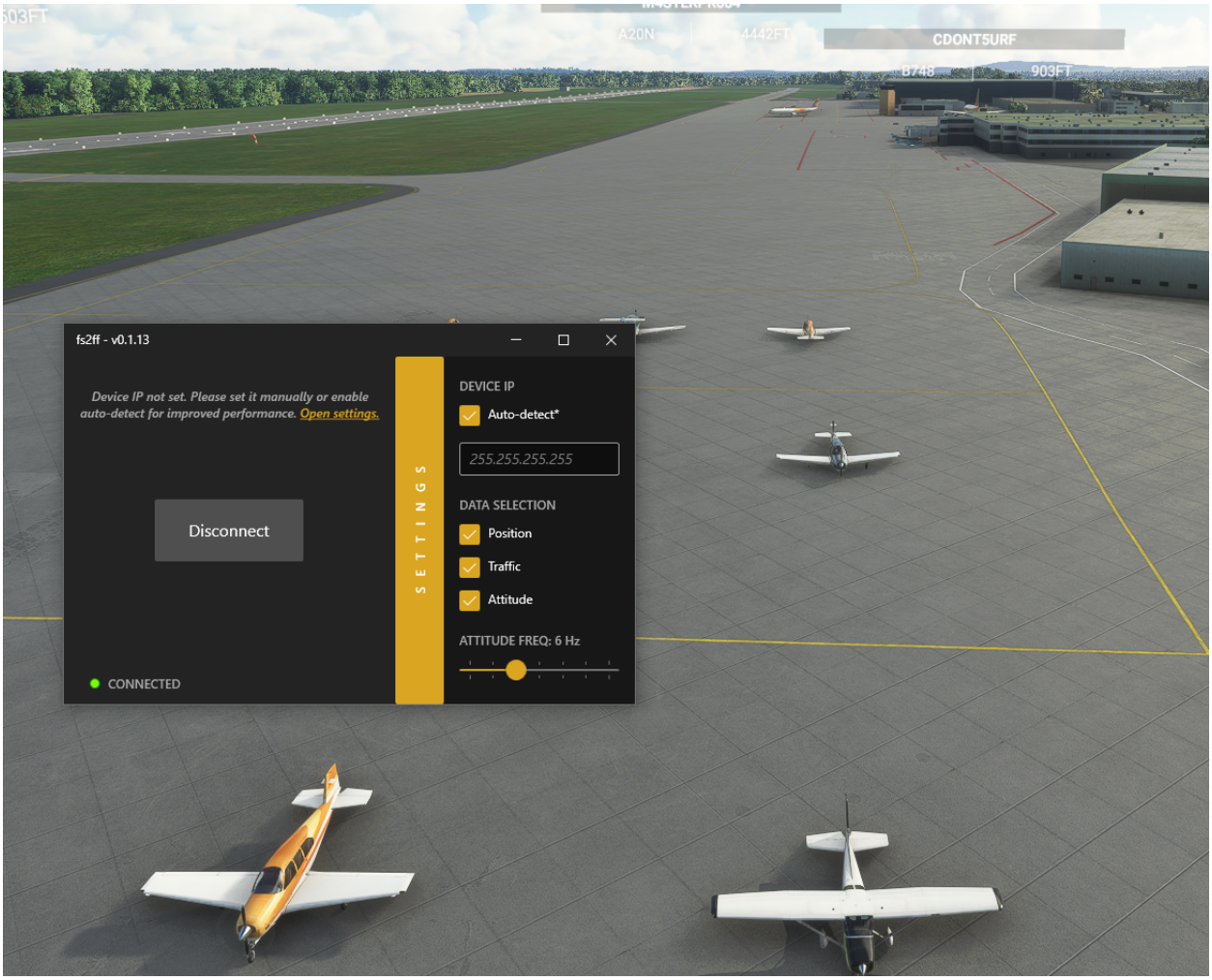


Fig. 12: fs2ff settings

[23] https://foreflight.com/support/support-center/category/about-foreflight-mobile/204115275
[24] https://github.com/astenlund/fs2ff
[25] https://github.com/astenlund/fs2ff/releases/latest
[26] https://github.com/astenlund/fs2ff#fs2ff-flight-simulator-to-foreflight

XMapsy Essential

If you use XMapsy Essential, you need not to setup anything. Just start Xmapsy Essential and start MSFS2020. The broadcast address will be setup automatically. The figure *XMapsy Essential settings* shows the settings.

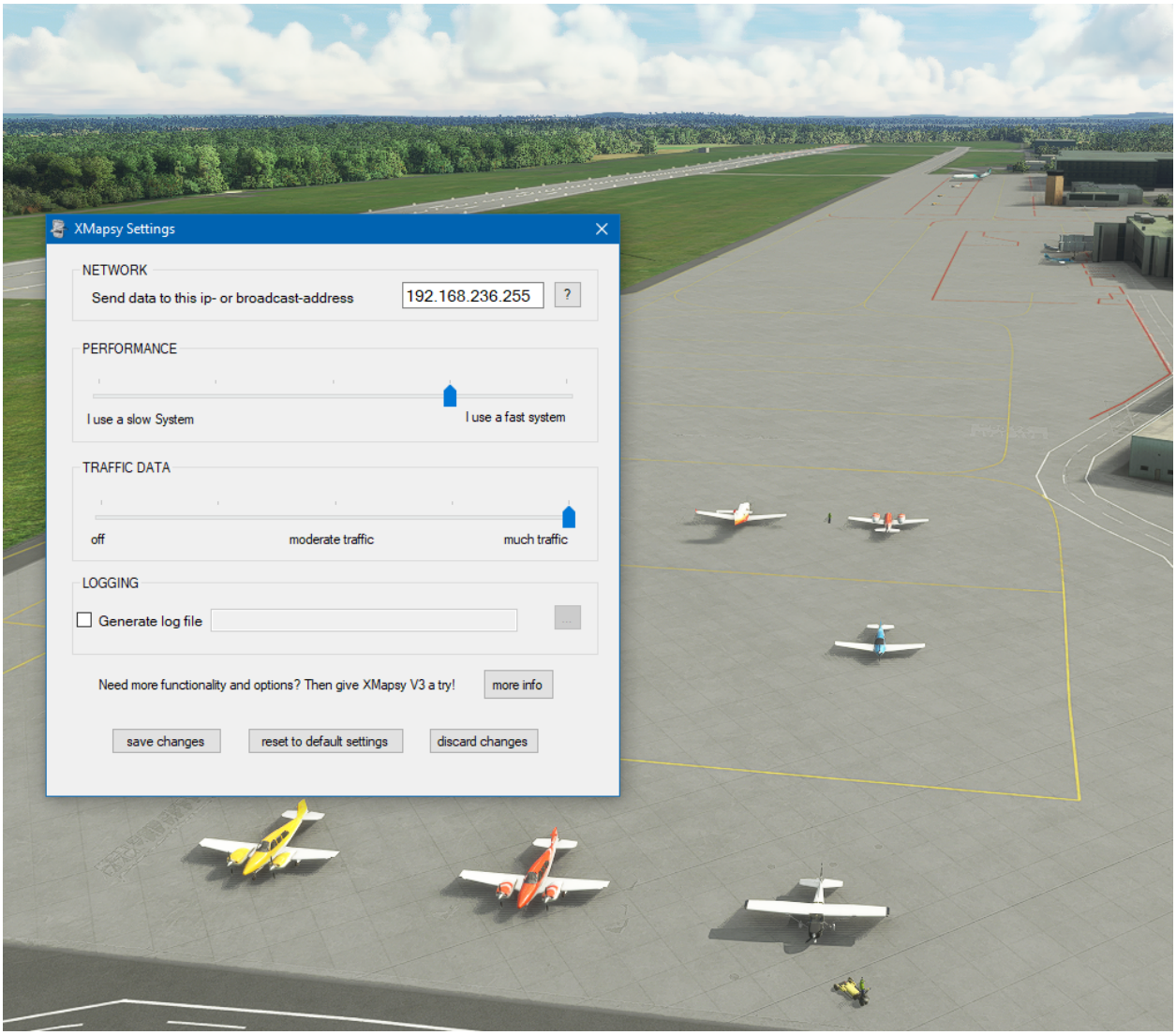


Fig. 13: XMapsy Essential settings

XMapsy V3

If you use XMapsy V3, set the "Message-Format" to "ADS-B/GDL90" and the "Preferred Technology" to SIM-CONNECT. To receive the correct altitude, be sure to check the box "GDL90 ownship geometric altitudes based on MSL". The figure *XMapsy V3 settings* shows verified XMapsy V3 settings for proper work with MSFS2020. The Broadcast address will be determined by Xmapsy and should not be touched except you have extended network configuration experience.

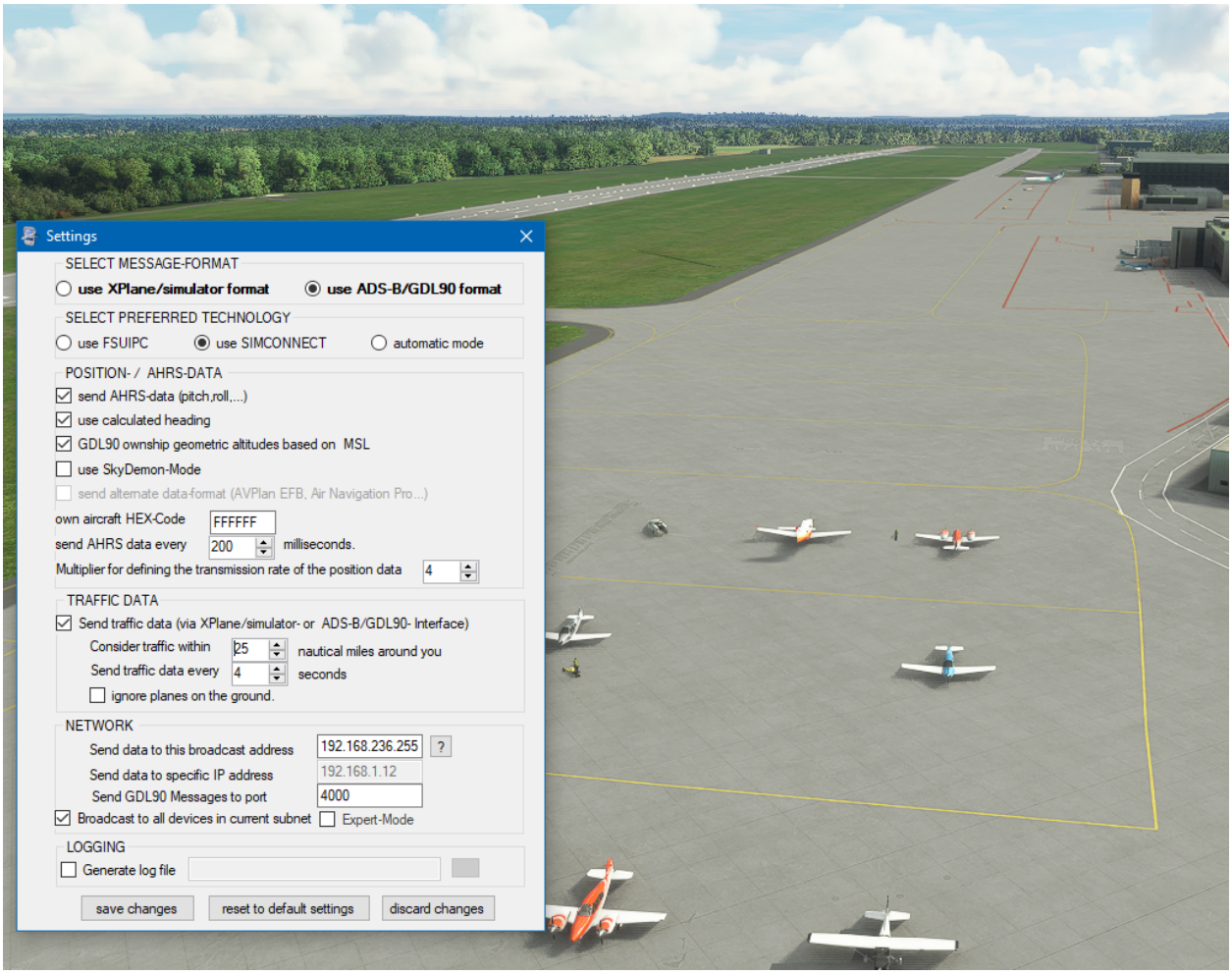
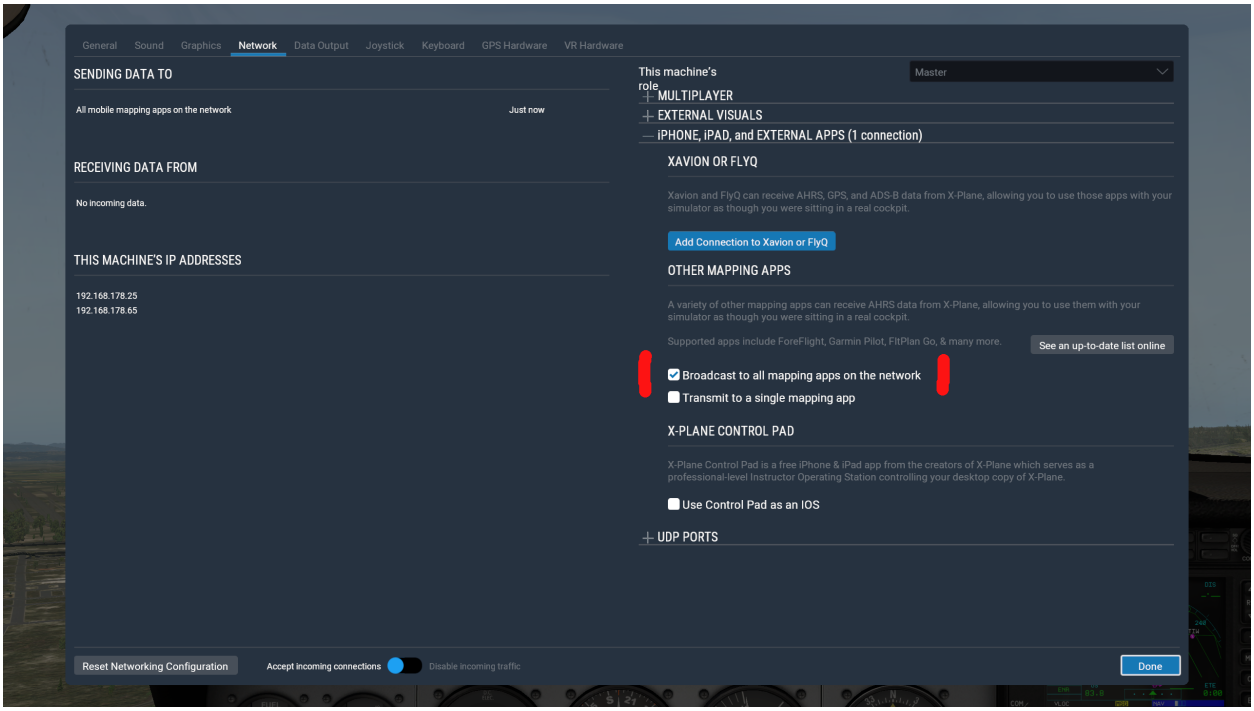


Fig. 14: XMapsy V3 settings

X-Plane 11

Open the "Settings" window and choose the "Network" tab. Locate the settings group "This machine's role" on the right-hand side of the tab. Open the section "iPHONE, iPAD, and EXTERNAL APPS" and select the item "Broadcast to all mapping apps on the network" under the headline "OTHER MAPPING APPS".



Other programs

The flight simulator needs to be set up to send UDP datagrams in one of the standard formats "GDL90" or "XGPS" to ports 4000 or 49002. Given the choice, GDL90 is generally the preferred format.

3.6.3 Troubleshooting

Enroute Flight Navigation treats flight simulators as traffic receivers. To see the connection status, open the main menu and navigate to the "Information" menu. If the entry "Traffic Receiver" is highlighted in green, then **Enroute Flight Navigation** has already found the program in the network and has connected to it. If not, then select the entry. The "Traffic Receiver Status" page will open, which explains the connection status in more detail.

3.7 Make a donation

Enroute Flight Navigation is a non-commercial project of Akaflieg Freiburg[27] and the University of Freiburg[28]. The app has been written by flight enthusiasts in their spare time, as a service to the community. The developers do not take donations.

If you appreciate the app, please consider a donation to Akaflieg Freiburg, a tax-privileged, not-for-profit flight club of public utility in Freiburg, Germany.

[27] https://akaflieg-freiburg.de/
[28] https://uni-freiburg.de/en/

```
IBAN:    DE35 6809 0000 0027 6409 07
BIC:     GENODE61FR1
Bank:    Volksbank Freiburg
Message: Enroute Flight Navigation
```

4 Advanced Use

4.1 Use your own maps

Enroute Flight Navigation comes with a set of base maps that cover large parts of the world and are updated frequently. Still, there might be situations where a user would like to use their own base maps.

- Where available, some users might prefer to use official ICAO charts of their countries.
- Some users might prefer raster maps that follow a different style.
- Some users might prefer to install high-detail vector maps for particular regions of interest.

Enroute Flight Navigation is able to import MBTILES file containing raster or vector data. Vector data must follow the standard OpenMapTiles[29] schema. Vector maps are rendered in the same style that **Enroute Flight Navigation** uses for its own maps. It is possible to install vector maps along with the maps provided by **Enroute Flight Navigation**, in order to provide higher detail for particular regions of interest.

4.1.1 Import Maps

Import Maps on Android devices

If you are using an Android device, you need to transfer the MBTILES file to the device, and open it there. There are many ways to transfer files, but most users will likely do one of the following.

- Download the MBTILES file on the Android device with a web browser. The browser will then offer to open the file in **Enroute Flight Navigation**.
- Download the MBTILES file to a desktop computer, connect the device to the desktop computer via USB and then copy the file to the device. Afterwards, the file can be opened by a file management app on the Android device.

[29] https://github.com/openmaptiles/openmaptiles

Import Maps on Linux Desktop

If you are running **Enroute Flight Navigation** on a Linux Desktop machine, use the file manager to drag-and-drop the file into the main window of the app.

Note: MBTILES files are often extremely large. It is possible that your device becomes unresponsive for a few seconds while copying the file. Also, note that **Enroute Flight Navigation** will copy the file to its internal data directory. In order to save space, we recommend deleting the MBTILES file once it has been imported.

4.1.2 MBTILES Map Data Sources

We are aware of a few websites that offer vector or raster maps that can be used with **Enroute Flight Navigation**. Please let us know if you know of other map data sources!

- The website maptiler data[30] provides excellent vector maps that can be installed alongside the base maps provided by **Enroute Flight Navigation**, in order to provide high-detail maps for specific regions of interest.
- The website open flightmaps[31] provides excellent aviation maps in raster format for a variety of European countries, as well as South Africa and Namibia.

4.1.3 Raster Maps in GeoTIFF format

We are aware of websites that offer raster maps in GeoTIFF format. At present, **Enroute Flight Navigation** cannot handle GeoTIFF files, but there are tools that convert GeoTIFF to MBTILES.

- Official ICAO maps for Denmark are available from the danish AIM Naviair[32]
- Official ICAO maps for Spain are available from the Spanish Insignia Servicio de Información Aeronáutica[33]
- Official ICAO maps for Switzerland are available from the Swiss Federal Office of Topography swisstopo[34]
- Official VFR raster charts are available from the United States Federal Aviation Administration[35]

Users have successfully used the free tool QGIS[36] to convert GeoTIFF files to MBTILES, which can then be used with **Enroute Flight Navigation**.

Since QGIS is a powerful tool that is not always easy to use, one user has kindly provided the following short tutorial.

- Install QGIS on your desktop computer. On Fedora Linux, we found that the packages provided by the default software repository were outdated and lacked the necessary functionality. We followed the installations instructions on the QGIS website[37] to install a current and full-featured version of the program.
- Open QGIS. Create a new project and open the GeoTIFF file in QGIS by dragging-and-dropping the GeoTIFF file into the QGIS window. The content of the GeoTIFF file should become visible.
- Choose the menu item "Project/Properties…" to open the dialog window "Project Properties". There, set the coordinate reference system to EPSG:3857. To locate the reference system, use the text field "Filter" and search for EPSG:3857.

[30] https://data.maptiler.com/downloads/planet/
[31] https://www.openflightmaps.org/https://www.openflightmaps.org
[32] https://aim.naviair.dk/en/charts/
[33] https://aip.enaire.es/AIP/CartasInsigniaImpresas-es.html
[34] https://www.swisstopo.admin.ch/en/geodata/aero/icao.html
[35] https://www.faa.gov/air_traffic/flight_info/aeronav/digital_products/vfr/
[36] https://qgis.org/en/site
[37] https://qgis.org/en/site/forusers/download.html

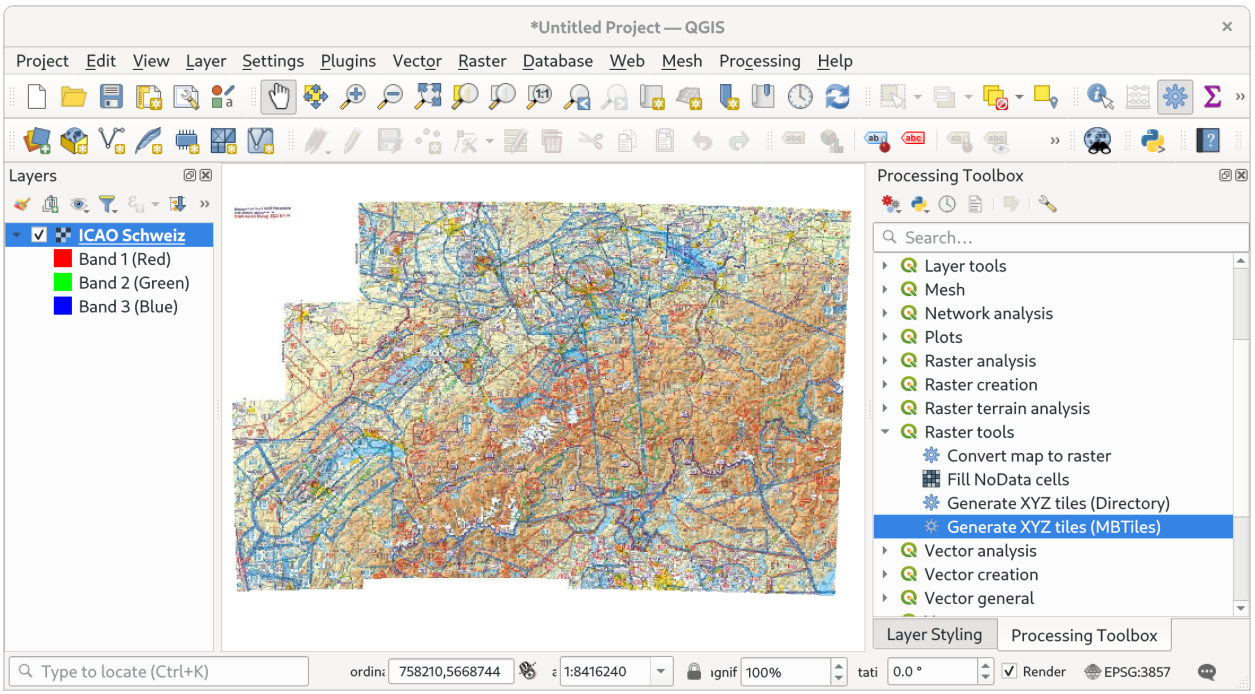


Fig. 1: QGIS Main Window

- Use the menu items under “View/Panels/…” to ensure that the panels “Layer” and “Layer Styling” are visible. Select the layer of your GeoTIFF file and in the “Layer” panel. Then, go to the “Layer Styling” panel and set “Resampling” to “Bilinear” for better image render quality.
- Use the menu items under “View/Panels/…” to ensure that the panel “Processing Toolbox” is visible. Inside the “Processing Toolbox”, double-click on “Raster Tools→Generate XYZ Tiles (MBTILES)”. The dialog “Generate XYZ Tiles (MBTILES)” will open. Fill the necessary parameters, as seen in the image below. We found the function “Draw on Map Canvas” useful to specify the map extent. Pay attention to the maximum zoom level, as the time and file size increase significantly after zoom level 12. Depending on the size of your GeoTIFF and on the number of zoom levels you use, it may take a while to generate the MBTILES file.

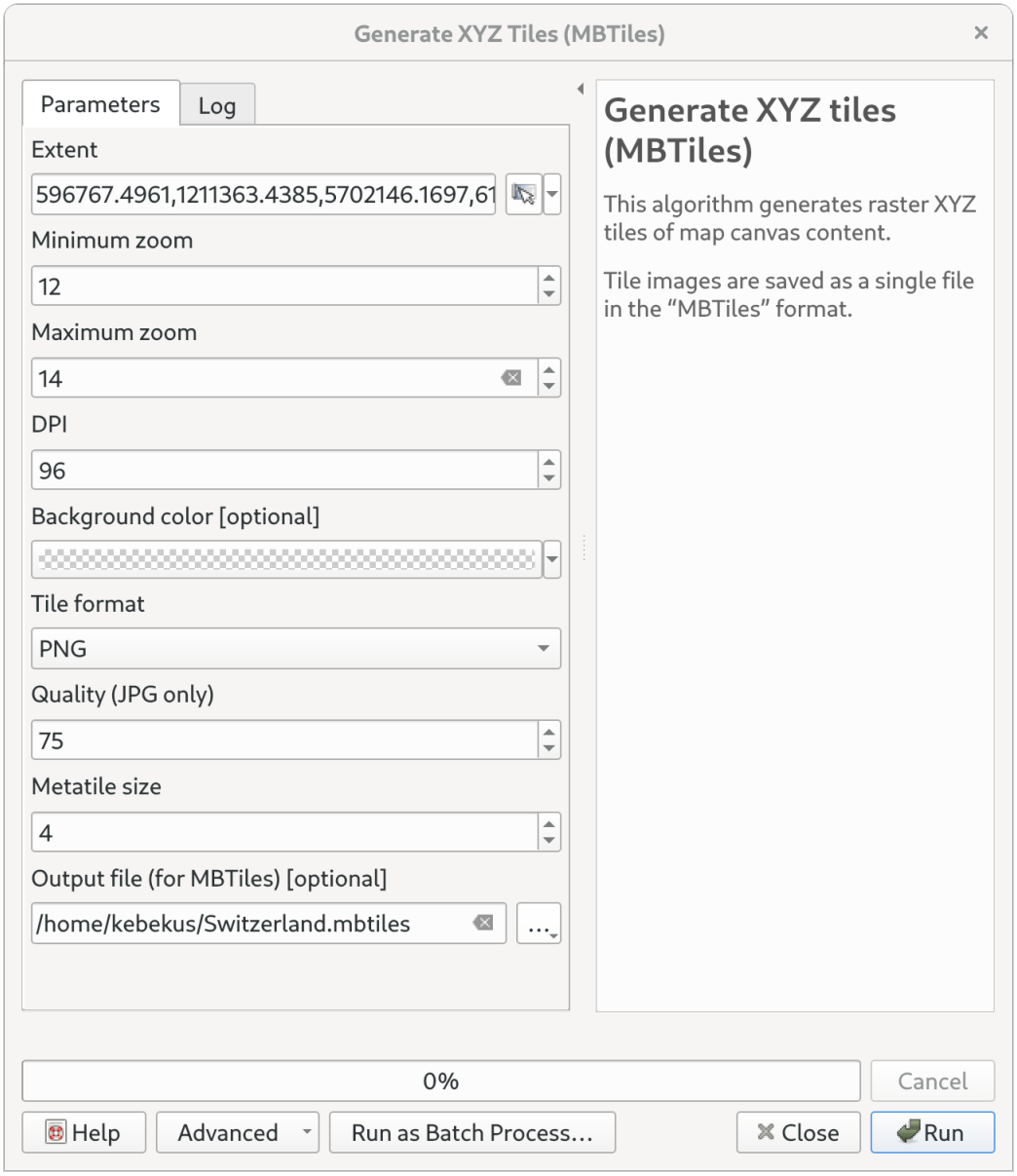


Fig. 2: QGIS Generate Tiles Dialog

5 Reference: Pages

5.1 Main Page and Moving Map

The main page is the page that you will use the most often. This is also the page that opens when you start the app. The following image shows the Main Page in a typical flight situation.

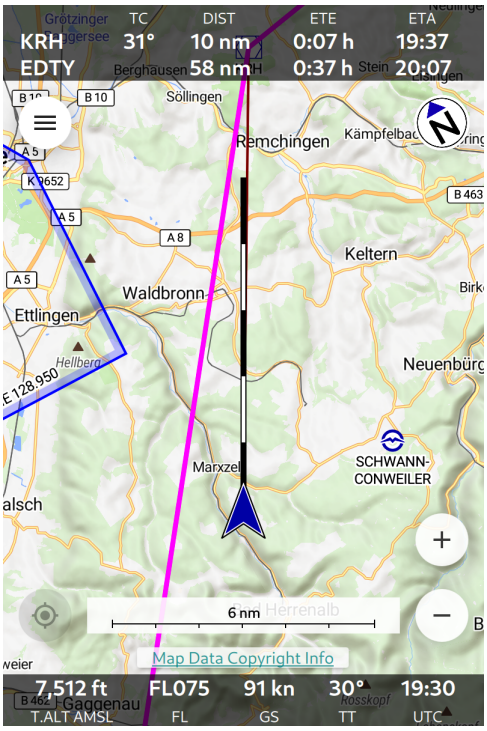


Fig. 1: The Main Page of **Enroute Flight Navigation**

- At the top of the screen, you see the *Route Information Bar* with information about the remaining flight route.
- The page body shows a moving map with your current position and a number of interactive controls.
- At the bottom, the *Navigation Bar* displays information about the current flight situation.

This manual uses the words “Bearing Mode” and “Autopan Mode” to describe two settings that govern the behavior of the map display.

Bearing Mode
: The moving map can operate in two “bearing modes”. In the mode “north up”, the map is rotated so that the north direction is up, as you would expect from a paper map. In the mode “track up”, the map is rotated according to your direction of movement, so that your flight direction is up.

Autopan Mode
: If the autopan mode is on, the map is automatically moved, so that the position you aircraft is near the center of the map display. If the autopan mode is off, the map is not moved and the position of your aircraft might not be visible on the map.

5.1.1 Route Information Bar

If you have defined a flight route following the steps outlined in the section *Plan a Flight*, then the top of the Main Page will show a tabular panel with one or two lines of information about the remaining route that you still have to fly. The first line of the table refers to the next waypoint, the second line to the final waypoint in your route.

Code	Meaning
—	Name of the waypoint.
TC	True course to the waypoint (only shown for course to next waypoint).
DIST	Distance to the waypoint.
ETE	Estimated Time Enroute to the waypoint.
ETA	Estimated Arrival Time at the waypoint, in UTC.

- The units for the distance are chosen according to the settings on the Aircraft Page.
- If the information cannot be computed (e.g. because the positions is unknown, or because you are flying too far away from the route), the panel shows a brief error message.
- Close to the final destination, the panel shows the words “Near destination.”

5.1.2 Interactive Controls

The page body shows the following interactive control buttons that can be used together with the standard gestures to operate the app.

Sym-bol	Function
	Opens main menu.
	Switches between modes **north up** and **track up**.
	Sets autopan mode to “on”.
	Zoom in.
	Zoom out.
	This control is shown when the app is not connected to a traffic data receiver. A click opens the traffic receiver status page.

5.1.3 Moving Map

The moving map shows a physical map with shaded terrain relief, overlaid with aviation data. At low zoom values, the map looks similar to the standard 1:50.000 ICAO maps. At higher zoom value, the map will also show traffic circuits and control zone procedures, as you would expect from an approach chart.

Note: Traffic circuits and control zone procedures are available for select countries only. See the section *Aeronautical maps* for more details.

The moving map shows the following additional items

- If you have set an *Airspace Altitude Limit* on the *Settings Page*, the map will show a little reminder at the top of the screen, with a text such as “Airspaces up to 9500 ft”.
- To give you a rough estimate for the horizontal distances, the map features a scale. Depending on screen orientation, the scale is shown at the bottom or at the left of the screen.
- At the very bottom of the screen, there is a copyright notice. Click on the notice to open a dialogue window with more detailed information.

Gesture Controls

The moving map can be controlled by standard gestures.

- **Mouse Wheel:** On desktop computers, the mouse wheel zooms in and out.
- **Pinch Gesture:** On touch-screen devices, the pinch gesture zooms in and out.
- **Pan Gesture:** On touch-screen devices, the pinch the pan gesture moves the map and sets the autopan mode to “off”.
- **Tap-and-hold Gesture:** Tap-and-hold anywhere in the map to open the waypoint description dialogue. This is the quickest way to obtain information about airfields, navaids, reporting points, terrain elevation and airspace. The figure *Information about EDFE airport* shows how this will typically look.
- **Double Tap Gesture:** The double tap gesture is equivalent to tap-and-hold.

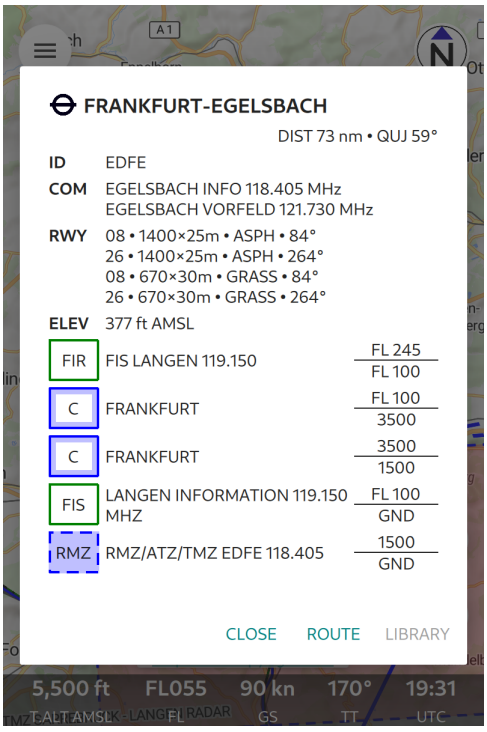


Fig. 2: Information about EDFE airport

Ownship Position

The ownship position is shown prominently in the moving map, using one of the following symbols.

Symbol	Function
	SatNav is not working. The symbol shows the last known position.
	SatNav is working, and the aircraft is not moving. The symbol shows the current position.
	SatNav is working, and the aircraft is not moving. The symbol shows the current position. The arrow shows the direction of movement.

As soon as you are flying, the app shows the projected flight path for the next five minutes. The flight path vector is sized so that each of the black and white segments corresponds to one minute.

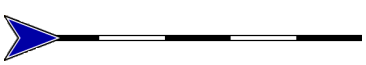


Fig. 3: Projected flight path for the next five minutes

Traffic Information

Enroute Flight Navigation can connect to your aircraft's traffic receiver (typically a FLARM device) and display nearby traffic on the moving map. The section *Sense and avoid* explains how to establish the connection. The figure *Approaching EDTF with traffic* shows a typical situation.

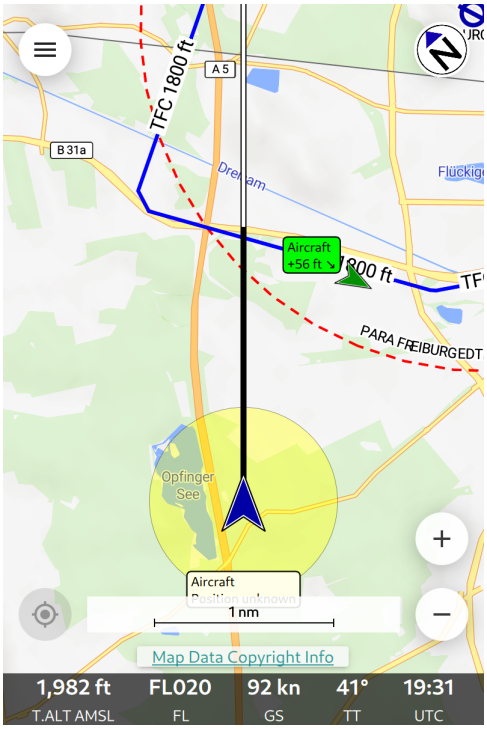


Fig. 4: Approaching EDTF with traffic

To show only relevant traffic, **Enroute Flight Navigation** will display traffic factors only if the vertical distance is less than 1.500m and the horizontal distance less than 20nm.

> **Warning:** **Enroute Flight Navigation** shows traffic on the moving map, but does not issue traffic warnings. The app contains no collision avoidance algorithms.

Color Coding

Enroute Flight Navigation uses colors to indicate the potential danger of the traffic. This works best when the app is connected to a FLARM device. In this setting, the colors have the following precise meaning.

Color	Meaning
Green	No alarm.
Yellow	Alarm level 1. Collision predicted in 13-18 seconds.
Red	Alarm level 2 or higher. Collision predicted in less than 13 seconds.

Traffic Factors

The moving map display two kinds of traffic.

- Traffic whose precise position is unknown to the traffic receiver; this is often the case with traffic that has only a Mode-S transponder. This kind of traffic is indicated in the moving map by a transparent circle around the ownship position. The traffic is likely to be found inside that circle.
- Traffic whose position is precisely known. This traffic is typically equipped with a FLARM or ADS-B transmitter. The symbols used to display this traffic in the moving map are explained below. If the traffic is known to be moving, its projected flight path is indicated with a black-and-white flight vector, similar to the symbol shown in the Figure *Projected flight path for the next five minutes* for the ownship flight vector.

Symbol	Function
	The traffic is not moving, or its movement is unknown. No alarm.
	The traffic is not moving, or its movement is unknown. Alarm level 1. Collision predicted in 13-18 seconds.
	The traffic is not moving, or its movement is unknown. Alarm level 2 or higher. Collision predicted in less than 13 seconds.
	The traffic is moving, the arrow shows the direction of movement. No alarm.
	The traffic is moving, the arrow shows the direction of movement. Alarm level 1. Collision predicted in 13-18 seconds.
	The traffic is moving, the arrow shows the direction of movement. Alarm level 2 or higher. Collision predicted in less than 13 seconds.

Traffic labelling

The traffic is labelled with the following pieces of information about the traffic, to the extent known.

- Traffic type. This is one of “Aircraft”, “Airship”, “Balloon”, “Copter”, “Drone”, “Glider”, “Hang Glider”, “Jet”, “Paraglider”, “Skydiver”, “Static Obstacle” and “Tow Plane”.
- The traffic callsign.
- The relative vertical distance, in the units for the distance chosen in the settings on the Aircraft Page. A positive value indicates that the traffic is above you.
- An arrow symbols pointing upwards, downwards or sideways indicates the vertical speed of the traffic.

Note: Traffic callsigns are shown only if the “FLARM Database” has been installed in the page “Map and Data Library”.

5.1.4 Navigation Bar

The bottom of the display shows a little panel with the following information.

Code	Meaning
T.ALT	True altitude (=geometric altitude).
FL	Flight level.
GS	Ground speed.
TT	True track.
UTC	Current time.

- Depending on the settings made in the *Settings Page*, the field T.ALT shows the altitude above sea level or the altitude above ground. This is indicated with the standard abbreviation "AMSL" or "AGL".
- The units for the altitude display are chosen according to the settings on the Aircraft Page.
- The flight level is only available if your device is connected to a traffic receiver (such as a PowerFLARM device) that reports the pressure altitude.
- The units for the ground speed display are chosen according to the settings on the Aircraft Page.
- Flight level and current time are hidden if the display is not wide enough.

Warning: Vertical airspace boundaries are defined by pressure altitudes (with respect to QNH or standard pressure). Depending on temperature and air density, the pressure altitude will differ from the true altitude that is shown by the app. **Never use true altitude to judge vertical distances to airspaces.**

5.2 Settings Page

Enroute Flight Navigation is designed to be simple. The number of user settings is deliberately small. To access the user settings, open the main menu and choose "Settings."

5.2.1 Moving Map

The settings grouped under "Moving Map" change the appearance of the map display.

Airspace Altitude Limit

If you never fly higher than 5.000ft, you will probably not be interested in airspaces that begin above FL100. **Enroute Flight Navigation** allows you to set an altitude limit to improve the readability of the moving map. Once set, the app will show only airspaces below that limit. Tap on the entry "Airspace Altitude Limit" to set or unset the altitude limit.

Once you set an altitude limit, the moving map will display a little warning ("Airspaces up to 9,500 ft") to remind you that the moving map does not show all airspaces. The app will automatically increase the limit when your aircraft approaches the altitude limit from below.

Warning: Airspace boundaries are often flight levels. The true altitude of a flight level depends on meteorological conditions (such as the temperature gradient) and is not known to **Enroute Flight Navigation**. When deciding which airspace to show, the app will use an approximation. The approximation might be off by 1,000ft or more in extreme weather. **Always leave an ample safety margin when setting an airspace altitude limit.**

Gliding Sectors

In regions with high glider traffic, local regulations often allow gliders to fly in airspaces that are otherwise difficult to access, such as control zones. The moving map displays these "Gliding Sectors" in bright yellow. If you are not flying a glider, the gliding sectors are probably not relevant. Hiding the gliding sectors might improve the readability of the moving map.

Hillshading

We have received a report from a user, who experienced issues with the hillshading graphics on a very old device, potentially because of buggy system libraries. If you experience problems, use this switch to disable the hillshading feature.

5.2.2 Navigation Bar

These settings apply to the Navigation Bar, shown at the bottom of the moving map screen.

Altimeter Mode

Use this settings item to chose if the altimeter shows height above ground level (AGL) or height above main sea level (AMSL).

Note: In order to compute height above ground, if terrain maps for your region must be installed. If terrain data is not available, the altimeter field of the navigation bar will display "–". If you are unsure if terrain data is available, open the main menu and go to "Library/Maps and Data" to check which maps are installed in your device.

5.2.3 User Interface

Large Fonts

Use this option to enlarge fonts for improved readability.

Night mode

The "Night Mode" of Enroute Flight Navigation is similar to the "Dark Mode" found in many other apps. We designed the night mode for pilots performing VFR flights by night, whose eyes have adapted to the darkness. Compared with other apps, you will find that the display is quite dark indeed.

Voice Notifications

Pilots should not be looking at their mobile devices for extended periods of time. Enroute Flight Navigation is therefore able to read notification texts in addition to showing them on the screen. Since we expect that not everybody likes this feature, this setting item allows switching voice notification on and off.

5.2.4 System

Primary Position Data Source

Enroute Flight Navigation can either use the built-in satnav receiver of your device or a connected traffic receiver as a primary position data source. This setting is essential if your device has reception problems or if you use **Enroute Flight Navigation** together with a flight simulator.

- You will most likely prefer the built-in satnav receiver for actual flight. The built-in receiver provides one position update per second on a typical Android system, while traffic receivers do not always provide timely position updates.
- If you use **Enroute Flight Navigation** together with a flight simulator, you **must** choose the traffic receiver as a primary position data source. Flight simulators broadcast position information of simulated aircraft via Wi-Fi, using the same protocol that a traffic data receiver would use in a real plane. As long as the built-in satnav receiver is selected, all position information provided by your flight simulator is ignored.

Note: Setting a traffic receiver as a primary position data source is safe even when the app is not connected to a traffic receiver. When no traffic receiver is connected, **Enroute Flight Navigation** will automatically fall back using the built-in satnav receiver of your device.

Ignore network security errors

This entry is visible if you have asked the app to download data via insecure internet connections after a secure connection attempt failed. Uncheck this item to revert to the standard policy, which enforces secure connections.

Clear password storage

This entry is visible if you have connected to a traffic data receiver that requires a password in addition to the Wi-Fi password and if you have asked the app to remember the password. Tap on this entry to clear the password storage.

5.2.5 Help

The items grouped under "Help" refer the user to this manual.

5.3 About Enroute Flight Navigation

The page **About Enroute Flight Navigation** shows basic information about the app and the system. To access the page, open the main menu and choose "Information/About Enroute Flight Navigation."

The page presents four tabs with information about the app, its authors, the software license, and the current system.

System information can be helpful to the developers **Enroute Flight Navigation**. The button "Share Info" at the bottom of the "System" Tab can be used to share the information with other apps, such as your e-mail program, and forward it to the developers.

6 Reference: Other

6.1 Map Data

Our maps available for offline use, so that the app does not require any internet connection in flight.

6.1.1 Base maps

Our base maps are generated from Open Streetmap[38] data.

6.1.2 Terrain maps

Our terrain maps are derived from the Terrain Tiles Open Dataset on Amazon AWS[39]. The underlying data sources are a mix of:

- 3DEP (formerly NED and NED Topobathy) in the United States, 10 meters outside of Alaska, 3 meter in select land and territorial water areas
- ArcticDEM strips of 5 meter mosaics across all of the land north of 60° latitude, including Alaska, Canada, Greenland, Iceland, Norway, Russia, and Sweden
- CDEM (Canadian Digital Elevation Model) in Canada, with variable spatial resolution (from 20-400 meters) depending on the latitude.
- data.gov.uk, 2 meters over most of the United Kingdom
- data.gv.at, 10 meters over Austria
- ETOPO1 for ocean bathymetry, 1 arc-minute resolution globally
- EUDEM in most of Europe at 30 meter resolution, including Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kosovo, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, and United Kingdom
- Geoscience Australia's DEM of Australia, 5 meters around coastal regions in South Australia, Victoria, and Northern Territory

[38] https://www.openstreetmap.org
[39] https://registry.opendata.aws/terrain-tiles/

- GMTED globally, coarser resolutions at 7.5”, 15”, and 30” in land areas
- INEGI’s continental relief in Mexico
- Kartverket’s Digital Terrain Model, 10 meters over Norway
- LINZ, 8 meters over New Zealand
- SRTM globally except high latitudes, 30 meters (90 meters nominal quality) in land areas

Attributions

- ArcticDEM terrain data DEM(s) were created from DigitalGlobe, Inc., imagery and funded under National Science Foundation awards 1043681, 1559691, and 1542736;
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- Canada terrain data contains information licensed under the Open Government Licence – Canada;
- Europe terrain data produced using Copernicus data and information funded by the European Union - EU-DEM layers;
- Global ETOPO1 terrain data U.S. National Oceanic and Atmospheric Administration
- Mexico terrain data source: INEGI, Continental relief, 2016;
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- United States 3DEP (formerly NED) and global GMTED2010 and SRTM terrain data courtesy of the U.S. Geological Survey.

6.1.3 Aeronautical maps

Update policy

Our aeronautical maps are updated once per day, provided that new data is available. Note, however, that we do not **guarantee** regular updates.

Data origin

The aeronautical maps are compiled from databases provided by the openAIP[40] and the open flightmaps[41] projects. While openAIP covers most of the world, the open flightmaps cover fewer countries but contain more detailed information.

[40] http://openaip.net
[41] https://www.openflightmaps.org/

Map Feature	Data Origin
Airfields	openAIP
Airspace: Nature Preserve Areas	open flightmaps
Airspace: all other	openAIP
Navaids	openAIP
Procedures (Traffic Circuits, ...)	open flightmaps
Reporting Points	open flightmaps

List of maps

For simplicity, our maps are divided in "Class 1" and "Class 2".

- Class 1 maps are compiled from openAIP[42] and open flightmaps[43] data. These maps contain complete information about airspaces, airfields and navaids. In addition, the maps contain (mandatory) reporting points. Some of our class 1 maps also show traffic circuits and flight procedures for control zones.
- Class 2 maps are compiled from openAIP[44] data only. They contain complete information about airspaces, airfields and navaids.

Below is a complete list of the maps that we offer.

Continent	Country	Class
Africa	Canary Islands	Class 1
Africa	Madagascar	Class 2
Africa	Namibia	Class 1
Africa	South Africa	Class 1
Asia	Bahrain	Class 2
Asia	Unit. Emirates	Class 2
Asia	Japan	Class 2
Asia	Qatar	Class 2
Australia Oceanica	Australia	Class 2
Australia Oceanica	New Zealand	Class 2
Europe	Austria	Class 1
Europe	Belgium	Class 1
Europe	Bulgaria	Class 1
Europe	Croatia	Class 1
Europe	Cyprus	Class 2
Europe	Czech Republic	Class 1
Europe	Denmark	Class 1
Europe	Estonia	Class 2
Europe	Finland	Class 1
Europe	France	Class 2
Europe	Germany	Class 1
Europe	Great Britain	Class 1
Europe	Greece	Class 1
Europe	Hungary	Class 1
Europe	Iceland	Class 2
Europe	Ireland	Class 2

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[42] http://openaip.net
[43] https://www.openflightmaps.org/
[44] http://openaip.net

Table 1 – continued from previous page

Continent	Country	Class
Europe	Italy	Class 1
Europe	Latvia	Class 2
Europe	Liechtenstein	Class 2
Europe	Lithuania	Class 2
Europe	Luxembourg	Class 2
Europe	Malta	Class 2
Europe	Netherlands	Class 1
Europe	North. Ireland	Class 1
Europe	Norway	Class 2
Europe	Poland	Class 1
Europe	Portugal	Class 2
Europe	Romania	Class 1
Europe	Serbia	Class 2
Europe	Slovakia	Class 1
Europe	Slowenia	Class 1
Europe	Spain	Class 2
Europe	Sweden	Class 1
Europe	Switzerland	Class 1
North America	Canada	Class 2
North America	United States	Class 2
South America	Argentina	Class 2
South America	Brazil	Class 2, NavAids missing
South America	Colombia	Class 2
South America	Falkland Is.	Class 2

6.2 Platform notes

6.2.1 Android

Network security problems

Like most other programs, **Enroute Flight Navigation** uses Transport Layer Security (TLS)[45] for secure communication with servers on the internet. The technology relies on digital certificates[46] that are built into the Android operating system and can only be updated by the device manufacturer through system security updates. Regretfully, manufacturers of Android devices are often not interested in after-sales support and provide updates only for a very short period of time, if at all.

If a device does not receive regular system updates, the certificates will expire after a while, and secure network connections are no longer possible. As covered in the media[47], many users of systems running Android 7.1 (or below) started to experience problems on 30. September 2021, when an important certificate expired.

When certificates expire, some apps will stop working. Other app authors prefer to hide the complexity of secure communication from their users and write apps that will silently revert to insecure communication. These apps appear to run as normal, but leave communication (and eventually the system) open to tampering and manipulation.

The author of **Enroute Flight Navigation** believes that pilots should be able to make an informed decision about the security of their systems. **Enroute Flight Navigation** will tell the user of any network security errors. Users can then

[45] https://en.wikipedia.org/wiki/Transport_Layer_Security
[46] https://en.wikipedia.org/wiki/Transport_Layer_Security#Digital_certificates
[47] https://techcrunch.com/2021/09/21/lets-encrypt-root-expiry

decide to do one of the following.

- Replace the device by a more recent model, preferably from one of the few manufacturers who offer long-time support for their products.
- Accept the risk of insecure communication and ignore network security errors in the future.

Note: The author, who is concerned about short-lived digital products, uses a Fairphone[48] personally. Fairphones are long-lasting, can be repaired easily and receive many years of security updates. Other brands might have similar offers.

Screen backlighting

Enroute Flight Navigation overrides the system settings of your device and ensures that the screen backlighting is always on. To save battery power, the screen can be switched off manually with the hardware "power button" of your device.

Screen locking

Enroute Flight Navigation stays on top of the lock screen of your device. It will therefore be shown immediately as soon as the screen is switched on. You can therefore use **Enroute Flight Navigation** without unlocking your device.

Wi-Fi locking

When running on Android, **Enroute Flight Navigation** acquires a Wi-Fi lock as soon as the app receives heartbeat messages from one of the channels where it listens for traffic receivers. The lock is released when the messages no longer arrive.

6.2.2 Linux desktop

File import by drag-and-drop

It is possible to import files by dragging and dropping then anywhere in the main window of **Enroute Flight Navigation**. The following file types are accepted.

Content	Format	File name
FLARM Test Data	Text	*.txt
Flight Route	GeoJSON	*.geojson
Flight Route	GPX	*.gpx

[48] https://www.fairphone.com

Command line

Rather than importing file by drag-and-drop, file names can also be given when starting **Enroute Flight Navigation** via the Unix command line. The following command line options are supported.

Option	Description
-h, –help	Displays help on commandline options.
–help-all	Displays help including Qt specific options.
-v, –version	Displays version information.
–sg	Run simulator and generate screenshots for Google Play
–sm	Run simulator and generate screenshots for the manual

6.3 Airspace Display

The display of airspace will generally follow the common ICAO symbology.

Note: The Airspace structure at an arbitrary point may be seen by double touching the point on the screen. This will select the point as a waypoint. The waypoint pop-up window shows the information on the waypoint including airspace structure. This technique is also helpful to view the data and vertical limits of special use airspace.

6.3.1 Restricted Airspace

Restricted airspace are surrounded by an intense red dashed line and a thick transparent red line inside the restricted area boundaries. When selecting a point inside the restricted area by double touching the screen the information to the related area is given with the waypoint pop-up window:

- Area Name
- Area altitude limits
- Area activation time

6.3.2 Controlled Airspace

All boundaries of controlled airspace are indicated by a solid blue line and a thick transparent blue line inside the airspace. When selecting a point inside the controlled airspace by double touching the screen the information to the related area is given with the waypoint pop-up window:

- Airspace designation
- Vertical Limits
- Other airspace at location

Note: Communication frequencies are shown in the pop-up window related to the station or aerodrome.

All controlled airspace (Class A – Class D) are shown in the same way even if different restrictions or ATC clearance requirements may be present.

6.3.3 Control Zone

The Control Zone of an airport is indicated by a dashed blue line filled in transparent red color. When selecting a point inside the Control Zone (CTR) by double touching the screen the CTR designation and vertical limit is given within the waypoint pop-up window.

Note: Communication frequencies are shown in the pop-up window related to the station or aerodrome.

6.3.4 Transponder Mandatory Zones

Transponder Mandatory Zones TMZ are indicated by a black dashed outline. When selecting a point inside the Transponder Mandatory Zone (TMZ) by double touching the screen the information to the related ares is given with the waypoint pop-up window:

- Area Name
- Area altitude limits
- Monitoring Frequency
- Mode 3 Squawk

6.3.5 Radio Mandatory Zone

Radio Mandatory Zones (RMZ) are indicated by a solid blue dashed outline and filled in transparent blue. When selecting a point inside the Radio Mandatory Zone (RMZ) by double touching the screen the information to the related area is given with the waypoint pop-up window:

- Area Name
- Area altitude limits
- Radio Frequency

6.3.6 Parachute Jumping Areas

Parachute Jumping Exercise areas (PJE) are indicated with a solid red dashed outline. When selecting a point inside the PJE by double touching the screen the information to the related area is given with the waypoint pop-up window:

- Area Name
- Area altitude limits
- Radio Frequency

6.3.7 Nature Reserve Areas

Nature Reserve Areas (NRA) are indicated with a solid green outline. When selecting a point inside the NRA by double touching the screen the information to the related area is given with the waypoint pop-up window:

- Area Name
- Area altitude limits

Caution: Check restrictions applicable for flying inside NRA when planning your flight. For example in Austria high fines are applicable when flying inside NRA.

6.3.8 Airfields

The symbology used to display airfields follows the ICAO rules. When selecting an airfield by double touching the screen the related Airfield Information is given in a pop-up window:

- Airfield Name and Identifier
- Radio Frequency including COM and Information frequencies
- Navaid frequencies
- Runway orientation, dimensions and surface
- Field elevation
- Data for associated airspace
- Approach and Departure Routes

Approach routes to airfields are shown as solid blue lines. The designation of the route is written along the paths. The associated reporting points are shown as blue triangles with a dashed circle and the reporting point designation. Approach Routes will be shown by a solid line and Departure Routes will be shown as dashed lines.

Note: Approach Routes will only be displayed when zooming into the area.

6.3.9 Traffic Pattern

Traffic pattern for motorized aircraft are shown as blue lines. Traffic circuits for gliders or Ultralight aircraft are shown as red lines. Entry and exit routes to traffic pattern are indicated by open ends of the pattern. The traffic circuit will show the traffic circuit altitude when the information is available.

Note: Traffic pattern will only be displayed when zooming into the area.

7 Appendix

7.1 Software license

The program **Enroute Flight Navigation** is licensed under the GNU General Public License V3[49] or, at your choice, any later version of this license.

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Version 3, 29 June 2007

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[49] https://www.gnu.org/licenses/gpl-3.0-standalone.html

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  specific operating system (if any) on which the executable work runs, or a
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   offer to provide the Corresponding Source. This alternative is allowed
   only occasionally and noncommercially, and only if you received the
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7.2 Third party software and data

Enroute Flight Navigation builds on numerours open-source software components and on open-source data.

7.2.1 Geographic maps

As a flight navigation program, **Enroute Flight Navigation** heavily relies on geographic map data. The geographic maps are not included in the program, but are downloaded at runtime. They are compiled from the following sources.

- The base maps are modified data from OpenMapTiles[50], published under a CC-BY 4.0 design license[51].
- The aviation maps contain data from openAIP[52], licensed under a CC BY-NC-SA license[53].
- The aviation maps contain data from open flightmaps[54], licensed under the OFMA General Users´ License[55].

7.2.2 Software and data included in the program

Depending on platform and configuration, the following components might be included in the installation of **Enroute Flight Navigation**.

- Adobe Glyph List For New Fonts[56]. BSD 3-Clause "New" or "Revised" License.
- Anti-aliasing rasterizer from FreeType 2[57]. Freetype Project License or GNU General Public License v2.0 only.
- Bitstream Vera Font. Bitstream Vera Font License.
- BLAKE2 (reference implementation)[58]. Creative Commons Zero v1.0 Universal or Apache License 2.0.
- Catch2[59]. Boost Software License 1.0.
- Clip2Tri Polygon Triangulation Library[60]. MIT License.
- Clipper Polygon Clipping Library[61]. Boost Software License 1.0.
- Cocoa Platform Plugin. BSD 3-clause "New" or "Revised" License.
- Cycle. MIT License.
- Data Compression Library (zlib)[62]. zlib License.
- DejaVu Fonts[63]. Bitstream Vera Font License.
- Earcut Polygon Triangulation Library[64]. ISC License.
- Earth Gravitational Model[65]. Public Domain.

[50] https://github.com/openmaptiles/openmaptiles
[51] https://github.com/openmaptiles/openmaptiles/blob/master/LICENSE.md
[52] http://www.openaip.net
[53] https://creativecommons.org/licenses/by-nc-sa/3.0/
[54] https://www.openflightmaps.org/
[55] https://www.openflightmaps.org/live/downloads/20150306-LCN.pdf
[56] https://github.com/adobe-type-tools/agl-aglfn
[57] http://www.freetype.org
[58] https://blake2.net/
[59] https://github.com/catchorg/Catch2
[60] https://github.com/raptor/clip2tri
[61] http://www.angusj.com/delphi/clipper.php
[62] https://zlib.net/
[63] https://dejavu-fonts.github.io/
[64] https://github.com/mapbox/earcut.hpp
[65] https://earth-info.nga.mil

- Easing Equations by Robert Penner[66]. BSD 3-clause "New" or "Revised" License.
- Efficient Binary-Decimal and Decimal-Binary Conversion Routines for IEEE Doubles[67]. BSD 3-clause "New" or "Revised" License.
- extra-cmake-modules[68]. BSD-3-Clause.
- fontawesome[69]. SIL Open Font Licence 1.1.
- forkfd. MIT License.
- Freetype 2[70]. Freetype Project License or GNU General Public License v2.0 only.
- Freetype 2 - Bitmap Distribution Format (BDF) support[71]. MIT License.
- Freetype 2 - Portable Compiled Format (PCF) support[72]. MIT License and MIT Open Group variant.
- Freetype 2 - zlib[73]. zlib License.
- geosimplify-js polyline simplification library[74]. geosimplify-js License.
- Google Fonts[75]. Apache 2 License.
- Google Material Icon Font[76]. Apache Licence 2.0.
- Gradle wrapper[77]. Apache License 2.0.
- Guidelines Support Library[78]. MIT License.
- HarfBuzz-NG[79]. MIT License.
- IAccessible2 IDL Specification[80]. BSD 3-clause "New" or "Revised" License.
- JavaScriptCore Macro Assembler[81]. BSD 2-clause "Simplified" License.
- jQuery[82]. MIT License.
- KDAB's helper class for single-instance policy applications[83]. MIT License.
- KWin[84]. BSD-3-Clause.
- libdus-1 headers[85]. Academic Free License v2.1, or GNU General Public License v2.0 or later.
- LibJPEG-turbo[86]. Independent JPEG Group License and BSD 3-Clause "New" or "Revised" License and zlib License.

[66] http://robertpenner.com/easing/
[67] https://github.com/google/double-conversion
[68] https://api.kde.org/ecm/
[69] https://github.com/FortAwesome/Font-Awesome
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[74] https://github.com/mapbox/geosimplify-js
[75] https://github.com/google/fonts
[76] https://fonts.google.com/icons
[77] https://gradle.org
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[82] https://github.com/jquery/jquery
[83] https://github.com/KDAB/KDSingleApplication
[84] https://www.kde.org/
[85] https://www.freedesktop.org/wiki/Software/dbus/
[86] http://libjpeg-turbo.virtualgl.org/

- LibPNG[87]. libpng License and PNG Reference Library version 2.
- libpsl - C library to handle the Public Suffix List[88]. BSD 3-clause “New” or “Revised” License.
- Linux Performance Events[89]. GNU General Public License v2.0 only with Linux Syscall Note.
- lunr.js[90]. MIT License.
- Material Design Icons[91]. Apache License.
- Material Sphinx Theme[92]. MIT License.
- MD4. Public Domain.
- MD4C[93]. MIT License.
- MD5. Public Domain.
- Metaf library[94]. MIT License.
- Native Style for Android. Apache License 2.0.
- OpenGL ES 2 Headers[95]. MIT License.
- OpenGL Headers[96]. MIT License.
- openSSL library[97]. Apache 2 License.
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- PCRE2 - Stack-less Just-In-Time Compiler[100]. BSD 2-clause “Simplified” License.
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- Poly2Tri Polygon Triangulation Library[102]. BSD 3-clause “New” or “Revised” License.
- QEventDispatcher on macOS. BSD 3-clause “New” or “Revised” License.
- QHttpEngine[103]. MIT License.
- Qt Toolkit, Libraries and Modules[104]. GNU General Public License v3.0.
- Secure Hash Algorithm SHA-1[105]. Public Domain.
- Secure Hash Algorithm SHA-3 - brg_endian. BSD 2-clause “Simplified” License.
- Secure Hash Algorithm SHA-3 - Keccak. Creative Commons Zero v1.0 Universal.

[87] http://www.libpng.org/pub/png/libpng.html
[88] https://github.com/rockdaboot/libpsl
[89] https://www.kernel.org
[90] https://github.com/olivernn/lunr.js
[91] https://github.com/google/material-design-icons
[92] https://github.com/bashtage/sphinx-material/
[93] https://github.com/mity/md4c
[94] https://github.com/nnaumenko/metaf
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[98] https://github.com/maputnik/osm-liberty
[99] http://www.pcre.org/
[100] http://www.pcre.org/
[101] http://www.pixman.org/
[102] https://github.com/greenm01/poly2tri
[103] https://github.com/nitroshare/qhttpengine
[104] https://qt.io
[105] http://www.dominik-reichl.de/projects/csha1/

- Secure Hash Algorithms SHA-384 and SHA-512. BSD 3-clause "New" or "Revised" License.
- Shadow values from Angular Material[106]. MIT License.
- SipHash Algorithm[107]. Creative Commons Zero v1.0 Universal.
- Smooth Scaling Algorithm. BSD 2-clause "Simplified" License and Imlib2 License.
- SQLite[108]. Public Domain.
- sRGB color profile icc file[109]. International Color Consortium License.
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- The Public Suffix List[112]. Mozilla Public License 2.0.
- TIFF Software Distribution (libtiff)[113]. libtiff License.
- TinyCBOR[114]. MIT License.
- underscore[115]. MIT License.
- Unicode Character Database (UCD)[116]. Unicode License Agreement - Data Files and Software (2016).
- Unicode Common Locale Data Repository (CLDR)[117]. Unicode License Agreement - Data Files and Software (2016).
- Valgrind[118]. BSD 4-clause "Original" or "Old" License.
- Vulkan API Registry[119]. Apache License 2.0 or MIT License.
- Vulkan Memory Allocator[120]. MIT License.
- WebGradients[121]. MIT License.
- WebP (libwebp)[122]. BSD 3-clause "New" or "Revised" License.
- Wintab API. LCS-Telegraphics License.
- X Server helper[123]. X11 License and Historical Permission Notice and Disclaimer.
- XCB-XInput[124]. MIT License.
- XSVG. Historical Permission Notice and Disclaimer - sell variant.

[106] https://angularjs.org/
[107] https://131002.net/siphash/
[108] https://www.sqlite.org/
[109] http://www.color.org/
[110] http://tango.freedesktop.org/Tango_Desktop_Project
[111] https://www.deviantart.com/darkobra/art/Tango-Weather-Icon-Pack-98024429
[112] http://publicsuffix.org/
[113] http://www.simplesystems.org/libtiff/
[114] https://github.com/intel/tinycbor
[115] https://github.com/jashkenas/underscore
[116] https://www.unicode.org/ucd/
[117] https://cldr.unicode.org/
[118] http://valgrind.org/
[119] https://www.khronos.org/
[120] https://github.com/GPUOpen-LibrariesAndSDKs/VulkanMemoryAllocator
[121] https://webgradients.com/
[122] https://developers.google.com/speed/webp/
[123] https://www.x.org/
[124] https://xcb.freedesktop.org/

7.3 Technical Notes

7.3.1 Traffic Data Receiver support

Communication

Enroute Flight Navigation expects that the traffic receiver deploys a WLAN network via Wi-Fi and publishes traffic data via that network. In order to support a wide range of devices, including flight simulators, the app listens to several network addresses simultaneously and understands a variety of protocols.

Enroute Flight Navigation watches the following data channels, in order of preference.

- A TCP connection to port 2000 at the IP addresses 192.168.1.1, where the app expects a stream of FLARM/NMEA sentences.
- A TCP connection to port 2000 at the IP addresses 192.168.10.1, where the app expects a stream of FLARM/NMEA sentences.
- A UDP connection to port 4000, where the app expects datagrams in GDL90 or XGPS format.
- A UDP connection to port 49002, where the app expects datagrams in GDL90 or XGPS format.

Enroute Flight Navigation expects traffic data in the following formats.

- FLARM/NMEA sentences must conform to the specification outlined in the document FTD-012 Data Port Interface Control Document (ICD)[125], Version 7.13, as published by FLARM Technology Ltd.[126].
- Datagrams in GDL90 format must conform to the GDL 90 Data Interface Specification[127].
- Datagrams in XGPS format must conform to the format specified on the ForeFlight Web site[128].

Known issues with GDL90

The GDL90 protocol has a number of shortcomings, and we recommend to use FLARM/NMEA whenever possible. We are aware of the following issues.

Altitude measurements
: According to the GDL90 Specification, the ownship geometric height is reported as height above WGS-84 ellipsoid. There are however many devices on the market that wrongly report height above main sea level. Different apps have different strategies to deal with these shortcomings.

  - **Enroute Flight Navigation** as well as the app Skydemon expect that traffic receivers comply with the GDL90 Specification.
  - ForeFlight has extended the GDL90 Specification so that traffic receivers can indicate if they comply with the specification or not.
  - Many other apps expect wrong GDL90 implementations and interpret the geometric height has height above main sea level.

MODE-S traffic
: Most traffic receivers see traffic equipped with MODE-S transponders and can give an estimate for the distance to the traffic. They are, however, unable to obtain the precise traffic position. Unlike FLARM/NMEA, the GDL90 Specification does not support traffic factors whose position is unknown. Different devices implement different workarounds.

[125] https://flarm.com/support/manuals-documents/
[126] https://flarm.com/
[127] https://www.faa.gov/nextgen/programs/adsb/archival/media/gdl90_public_icd_reva.pdf
[128] https://www.foreflight.com/support/network-gps/

- Stratux devices generate a ring of eight virtual targets around the own position. These targets are named "Mode S".
- Air Avioncs devices do the same, but only with one target.
- Other devices create a virtual target, either at the ownship position or at the north pole and abuse the field "Navigation Accuracy Category for Position" to give the approximate position to the target.

Enroute Flight Navigation has special provisions for handling targets called "Mode S", but users should expect that this workaround is not perfect.

ForeFlight Broadcast

Following the standards established by the app ForeFlight, **Enroute Flight Navigation** broadcasts a UDP message on port 63093 every 5 seconds while the app is running in the foreground. This message allows devices to discover Enroute's IP address, which can be used as the target of UDP unicast messages. This broadcast will be a JSON message, with at least these fields:

```
{
   "App":"Enroute Flight Navigation",
   "GDL90":{
      "port":4000
   }
}
```

The GDL90 "port" field is currently 4000, but might change in the future.

Known issues with SkyEcho devices

Enroute Flight Navigation works fine with SkyEcho devices. There are, however, several shortcomings that users should be aware of.

Unidirectional FLARM
: The SkyEcho can receive FLARM signals, but cannot send them. The SkyEcho device cannot be seen by other FLARM users. The author of **Enroute Flight Navigation** is not convinced that unidirectionl FLARM is a good idea.

FLARM Output
: uAvionix follows an unusual business model. The FLARM/NMEA output of the SkyEcho is encrypted. To read the FLARM data, all apps need to include commercial, closed-source decryption libraries that must be purchased by the app users. The author of **Enroute Flight Navigation** feels that this is incompatible with the idea of free, open source software.

  To communicate with SkyEcho devices, **Enroute Flight Navigation** will switch to the GDL90 protocol.

Alitmeter readings
: SkyEcho includes an integrated barometric altimeter, but does not have any access to static pressure. To estimate the barometric altitude, the SkyEcho correlates cabin pressure altitude to altitudes of nearby traffic. The author of **Enroute Flight Navigation** is not convinced that this method gives altimeter readings that are sufficiently realiable for aviation purposes.

7.4 Tips & Tricks

7.4.1 Display of recorded satnav tracks

We have been approached by users who recorded a flight and wished to show the recorded flight track in **Enroute Flight Navigation**, perhaps in order to confirm that they complied with all airspace restrictions. While **Enroute Flight Navigation** is able to import GPX tracks as a flight route, the program has been designed for flight planning purposes and is limited to tracks of no more than 100 data points. In comparison, typical GPS tracks contains thousands or tens of thousands data points.

One of our users suggested a solution using the mapping and navigation program Osmand[129], which is open source and available for a range of devices. We reproduce his suggestion below. Please let us know if you are aware of other good solutions!

Before you start

This text assumes that you have installed Osmand[130] on your device, that you have installed maps for your region, and that you know how to import and display a GPS track with Osmand[131]. In order to show aviation data, we are going to add the "open flightmaps" to Osmand[132] as a map overlay. These maps are very complete and well-designed, but cover only select European and African countries. Visit the OFM web site[133] to learn more.

Step 1: Install plugin

As a first step, ensure that the Osmand plugin "Online maps" is enabled. For this, open the main menu and choose "Plugins". The page "Plugins" will open where the plugin "Online maps" can be selected. Once done, return to the main page.

Step 2: Enable the map overlay

Open the main menu, choose "Configure map" and select "Overlay map…". Select the slider, which currently shows "Off". In the dialogue window, choose "OpenFlightMaps" and move the slider for "Overlay transparency" to the right.

Step 3: Enjoy

Finally, open your track of your last flight in Osmand. Look at the track and reassure yourself that you have respectfully circumnavigated all restricted airspaces!

7.5 Privacy policies

We do not process any personal data from you. Data that you enter into the app (including routes, waypoints, and aircraft specifics) is stored locally on your device, is not transmitted to us, and is not processed by us.

However, to ensure the functionality, the app must transmit following data to servers on the internet.

- The app regularly checks for updates and allows downloading maps and data from a server at the University of Freiburg[134] to your device. In order to provide this functionality, your device's IP address must be transmitted to the server. Knowledge of the IP address is necessary for the server to respond. However, the server does not store any personal data about you in its log files. In particular, it does not store the IP address of your device in its log files. We can assure this because the server is under our control.

[129] https://osmand.net/
[130] https://osmand.net/
[131] https://osmand.net/
[132] https://osmand.net/
[133] https://www.openflightmaps.org/
[134] https://cplx.vm.uni-freiburg.de/storage

- The app shows METARs and TAFs for airfields near your current location and near your currently planned route. It also shows METARs and TAFs for all waypoints that you open in the app. In order to provide this functionality, your current location, your currently planned route, waypoint coordinates, and your device's IP address must be transmitted to web services at the Aviation Weather Center[135]. Knowledge of the IP address is necessary for the web services to respond. The web services cannot read any other data from your device in the process. However, you must expect that your device's IP address will be stored together with the transmitted position data. The web services are operated by the US government and are beyond our control. Detailed information about these web services can be found at https://www.aviationweather.gov/dataserver.
- The app shows NOTAMs for places near your current location and near your currently planned route. It also shows NOTAMs for all waypoints that you open in the app. In order to provide this functionality, your current location, your currently planned route, waypoint coordinates, and your device's IP address must be transmitted to web services at the Federal Aviation Administration[136]. Knowledge of the IP address is necessary for the web services to respond. The web services cannot read any other data from your device in the process. However, you must expect that the IP address of your device will be stored together with the transmitted position data. The web services are operated by the US government and are beyond our control. Detailed information about these web services can be found at https://api.faa.gov/s.

7.5.1 Responsible

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[135] https://www.aviationweather.gov
[136] https://api.faa.gov