

---

# **Enroute Flight Navigation**

**Stefan Kebekus**

**Aug 03, 2021**



## Getting started

1	Think before you fly	3
2	Installation and setup	5
3	Before your first flight	7
4	Connect your traffic receiver	11
5	Connect your flight simulator	15
6	Make a donation	21
7	Map Data	23
8	Platform notes	27
I	Appendix	29
9	Software license	31
10	Third party software and data	43
11	Technical Notes	49





**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](https://akaflieg-freiburg.de/)<sup>1</sup>, 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 near-weekly updates and cover large parts of the world.

**Enroute Flight Navigation** includes flight weather data downloaded from the [NOAA - Aviation Weather Center](https://www.aviationweather.gov/)<sup>2</sup>.

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.

---

<sup>1</sup> <https://akaflieg-freiburg.de/>

<sup>2</sup> <https://www.aviationweather.gov/>

## **Enroute Flight Navigation**

---

# 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<sup>3</sup>

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.

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

## 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.

## 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.

## 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 exempt 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<sup>4</sup>](#) for more information.

## 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.

---

<sup>4</sup> <https://dontkillmyapp.com>

## Installation and setup

### 2.1 App installation

**Installation on Android devices** **Enroute Flight Navigation** is available as an Android App in the [Google Play Store](#)<sup>5</sup>.

An unofficial version of the app is also available at [F-Droid](#)<sup>6</sup>. While the author of **Enroute Flight Navigation** endorses publication at F-Droid, he has not tested this unofficial app for quality.

**Installation on Linux desktop machines** **Enroute Flight Navigation** is available for free download at [flathub.org](#)<sup>7</sup> and [snapcraft.io](#)<sup>8</sup>. Most likely you will 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.

### 2.2 Map download

**Enroute Flight Navigation** cannot be used without geographic maps. Two types of maps need to be installed for every region where you fly.

- Aeronautical maps. These contain airspaces, airfields and navaids. Some maps also contain reporting points, airfield traffic circuits and control zone entry/exit routes.
- Base maps. These contain geographic data, such as rivers, roads, railroads and land use.

Follow these steps to install the maps that you need.

- Open the Menu by touching the menu button in the upper right side of the screen. The button is marked with the symbol ‘≡’.
- Choose the menu item *Library*, then *Maps*. The map management page will then open.
- On the map management page, click or tap on the desired maps. The maps will be downloaded and installed on your device.

<sup>5</sup> [https://play.google.com/store/apps/details?id=de.akaflieg\\_freiburg.enroute](https://play.google.com/store/apps/details?id=de.akaflieg_freiburg.enroute)

<sup>6</sup> [https://f-droid.org/de/packages/de.akaflieg\\_freiburg.enroute/](https://f-droid.org/de/packages/de.akaflieg_freiburg.enroute/)

<sup>7</sup> [https://flathub.org/apps/details/de.akaflieg\\_freiburg.enroute](https://flathub.org/apps/details/de.akaflieg_freiburg.enroute)

<sup>8</sup> <https://snapcraft.io/enroute-flight-navigation>

Please download only those maps that you will actually need. The infrastructure and bandwidth for map downloads is kindly sponsored by the University of Freiburg, under the assumption that the cost stays within reasonable limits. You will also find that the app performs much better if it does not have to process many megabytes of map data.

---

**Note:** Do not forget that you need aeronautical maps **and** base maps for the desired area of flight. The base maps are large. Make sure that you have a good internet connection before you download maps. It might be inadvisable to download base maps via the mobile phone network.

---

### 2.3 Done.

Once the map download has finished, **Enroute Flight Navigation** will process the map data and update the map display after a minute or so. Tap or click on the arrow symbol ‘←’ or use the Android ‘Back’ button to leave the map page and return to the main screen.

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 any play with the app. Continue with the next section and take it for your first flight.

# 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.

### 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.

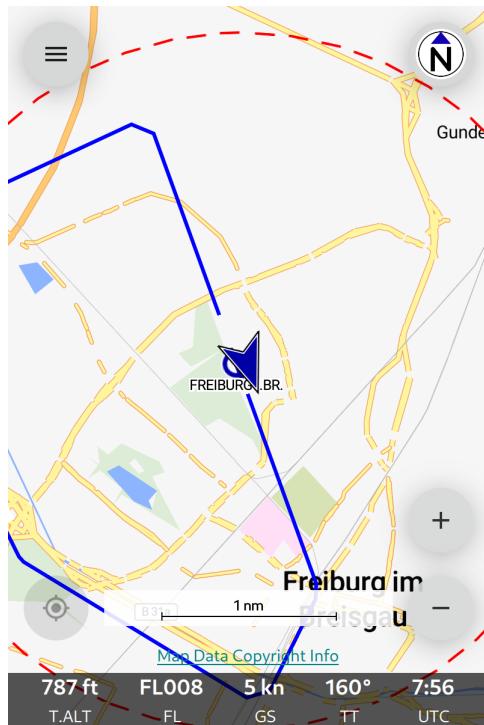


Fig. 1: Moving map display on the ground

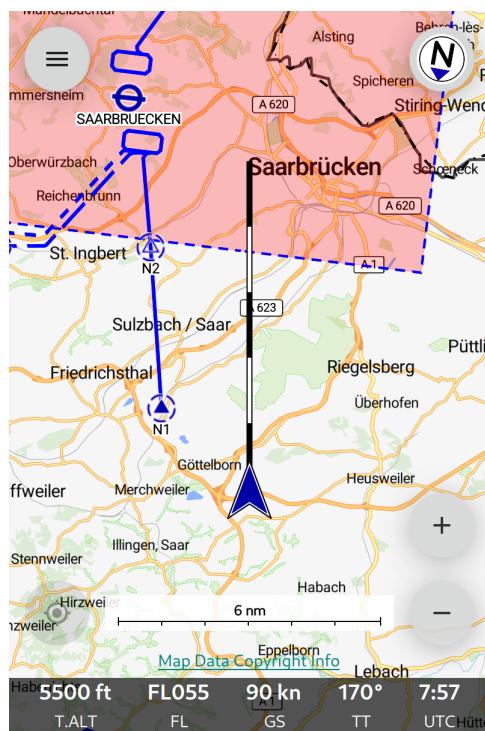


Fig. 2: Moving map display in flight

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.

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.**

## 3.2 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
Ⓐ N	Switch between display modes <b>north up</b> and <b>track up</b> .
○	Center map about own position.
+	Zoom in
-	Zoom out

## 3.3 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. 3: Information about EDFE airport

## **3.4 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*.

## Connect your traffic receiver

In order to display nearby traffic on the moving map, **Enroute Flight Navigation** can connect to your aircraft's traffic receiver (typically a FLARM device).

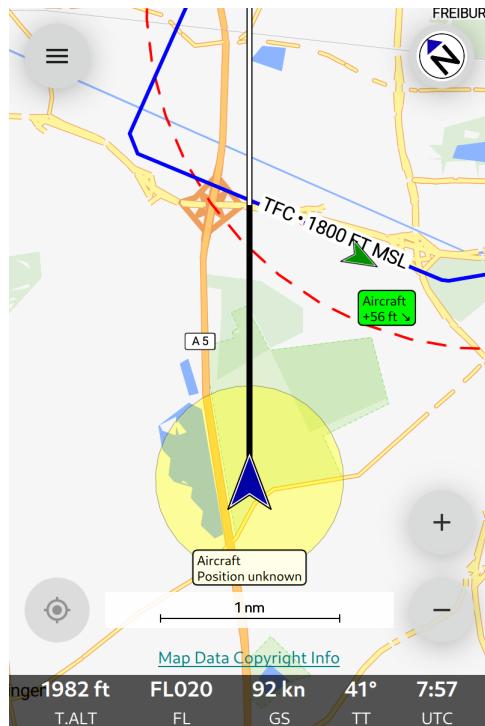


Fig. 1: Approaching EDTF with traffic

The figure *Approaching EDTF with traffic* shows what to expect. The figure shows two traffic factors.

- 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.

## 4.1 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<sup>9</sup> by Air Avionics<sup>10</sup> with software version 5.

Users reported success with the following traffic receivers.

- PilotAware Rosetta<sup>11</sup>
- SkyEcho2<sup>12</sup>
- Stratux devices<sup>13</sup>
- TTGO T-Beam devices<sup>14</sup>

**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 “Technincal Notes” in the appendix for more details.

---

## 4.2 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. This is currently **not** supported. Set up your device so that no additional password is required.

<sup>9</sup> [http://www.air-avionics.com/?page\\_id=253](http://www.air-avionics.com/?page_id=253)

<sup>10</sup> <http://www.air-avionics.com/>

<sup>11</sup> <https://www.pilotaware.com/rosetta/>

<sup>12</sup> <https://uavionix.com/products/skyecho/>

<sup>13</sup> <http://stratux.me/>

<sup>14</sup> <https://www.amazon.de/TTGO-T-Beam-915Mhz-Wireless-Bluetooth/dp/B07SFVQ3Z8>

## 4.3 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.

### 4.3.1 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.

### 4.3.2 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.

## 4.4 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.



# 5

## Connect your flight simulator

**Enroute Flight Navigation** can connect to flight simulator software. The app has been tested with the following programs.

- X-Plane 11<sup>15</sup>

Users have reported success with the following programs.

- Microsoft Flight Simulator (2020)<sup>16</sup>
- X-Plane 10<sup>17</sup>

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.

---

### 5.1 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.

- 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”

---

<sup>15</sup> <https://www.x-plane.com/>

<sup>16</sup> <https://www.flightsimulator.com/>

<sup>17</sup> <https://www.x-plane.com/>

## 5.2 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.

### 5.2.1 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.

- [XMapsy Essential](#)<sup>18</sup> (commercial, inexpensive, does not provide barometric altitude data).
- [XMapsy V3](#)<sup>19</sup> (commercial, more expensive, provides barometric altitude data).

---

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

---

**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.

**XMapsy V3** If you use XMapsy V3, set the “Message-Format” to “ADS-B/GDL90” and the “Preferred Technology” to SIMCONNECT. 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.

### 5.2.2 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”.

---

<sup>18</sup> <http://xmapsy.com/>

<sup>19</sup> <http://xmapsy.com/>

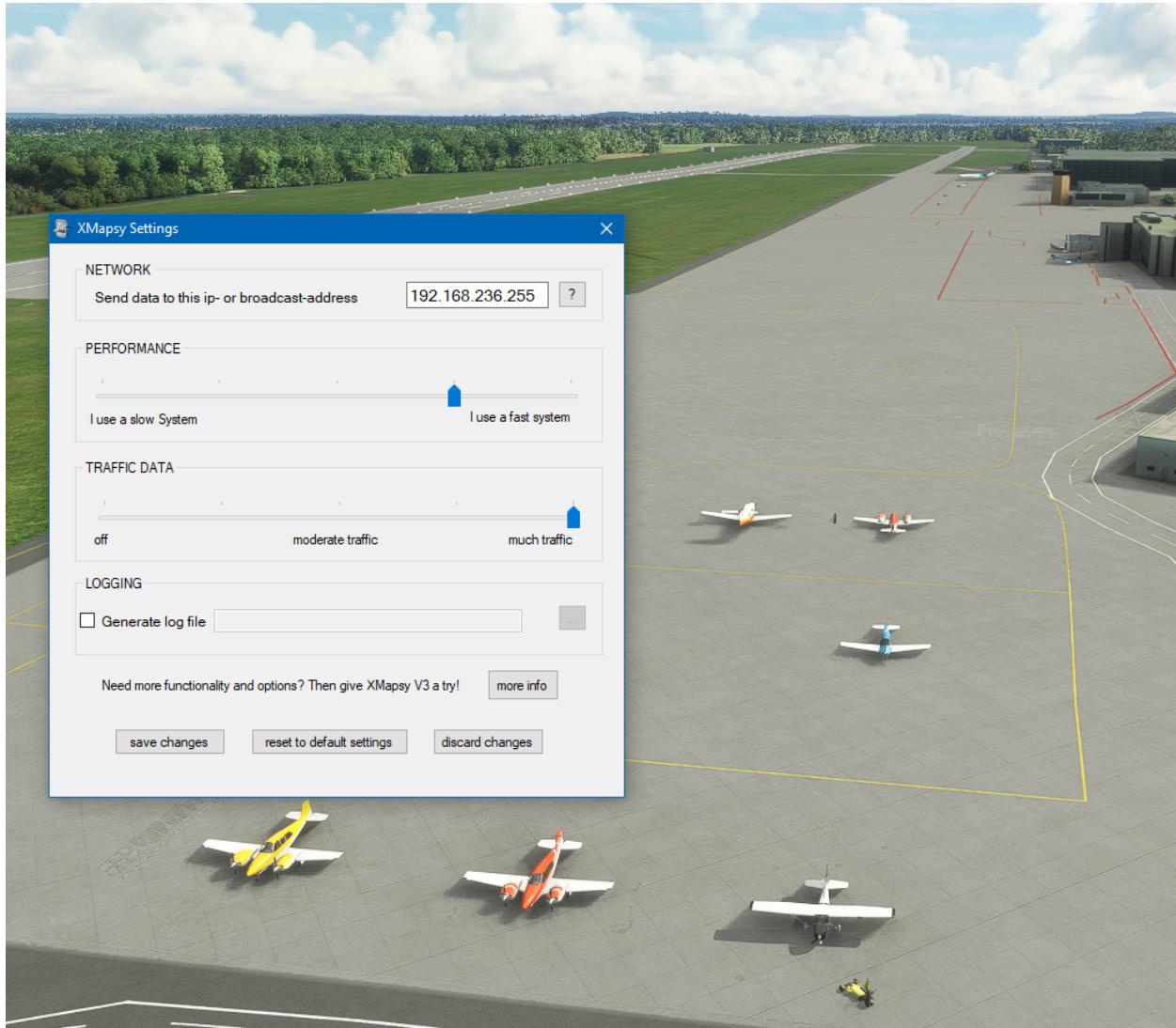


Fig. 1: XMapsy Essential settings

## Enroute Flight Navigation

---

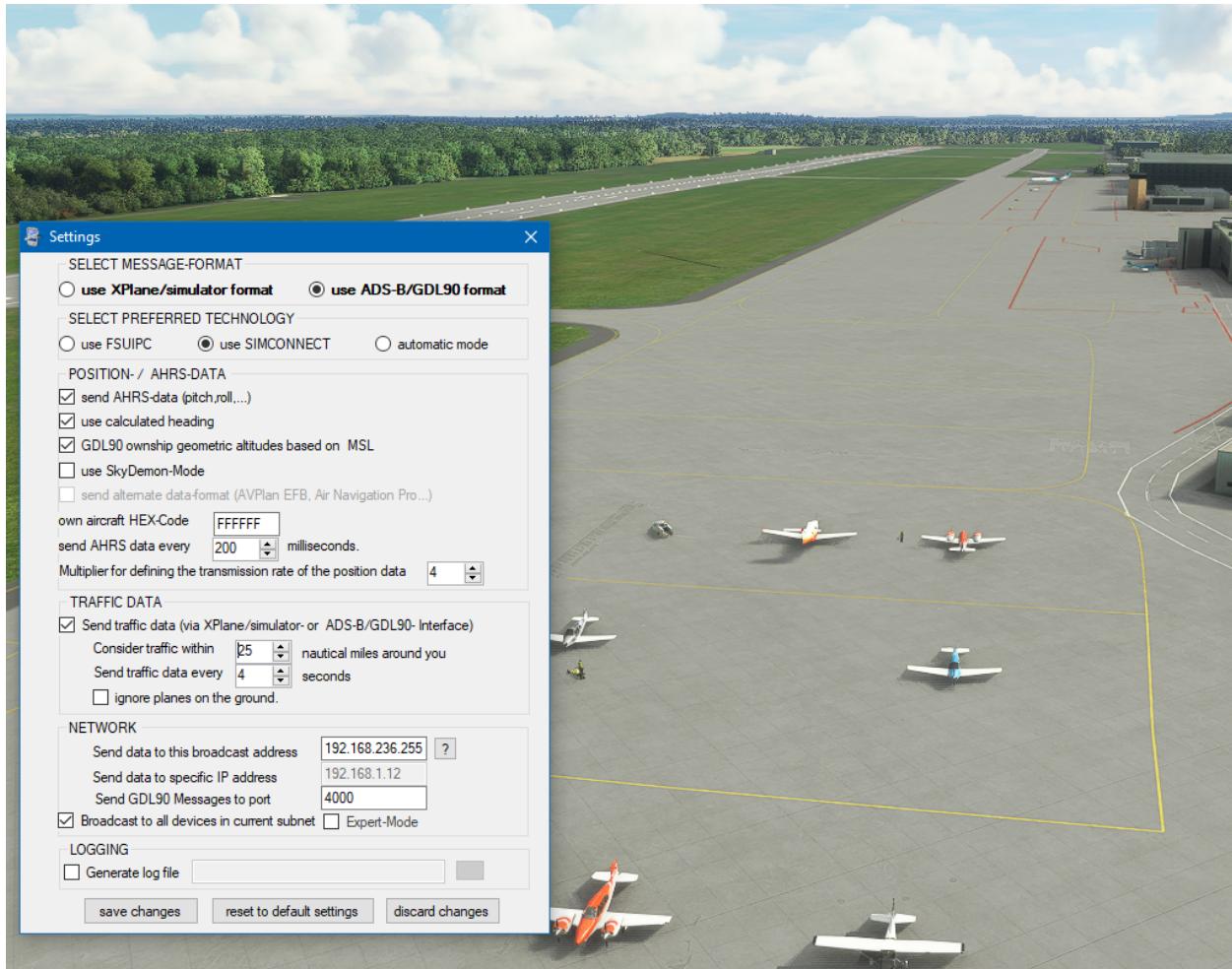
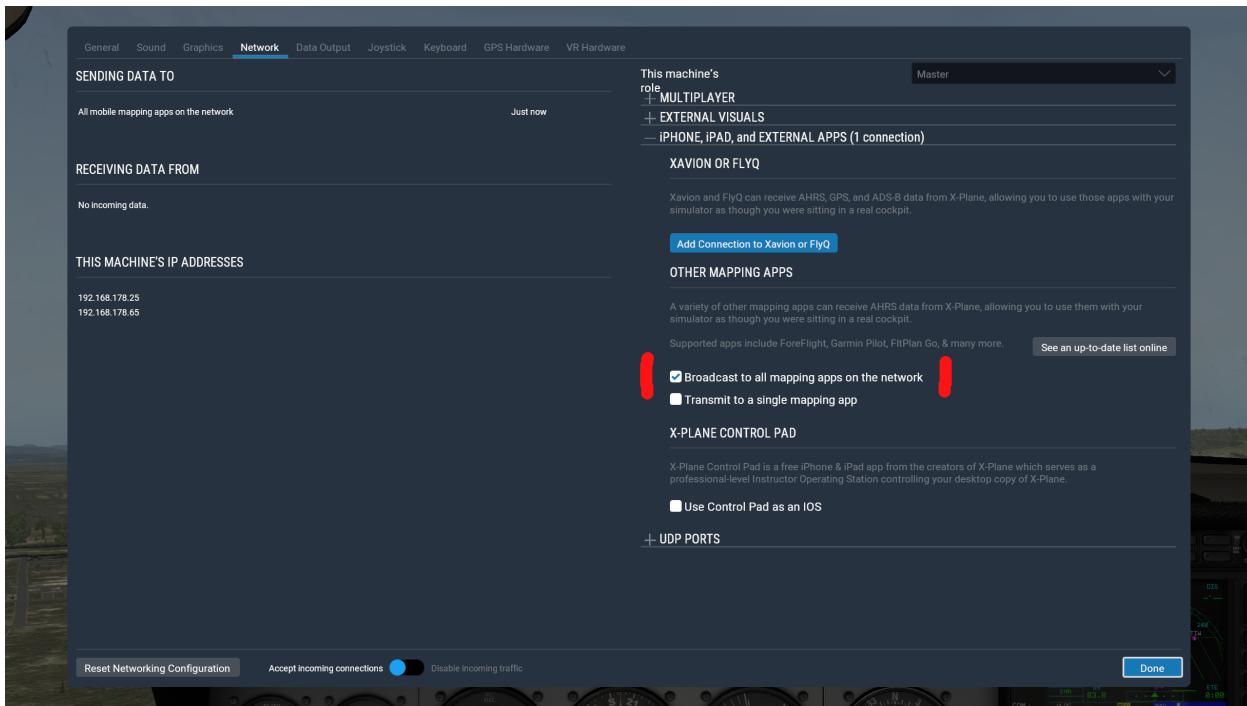


Fig. 2: XMapsy V3 settings

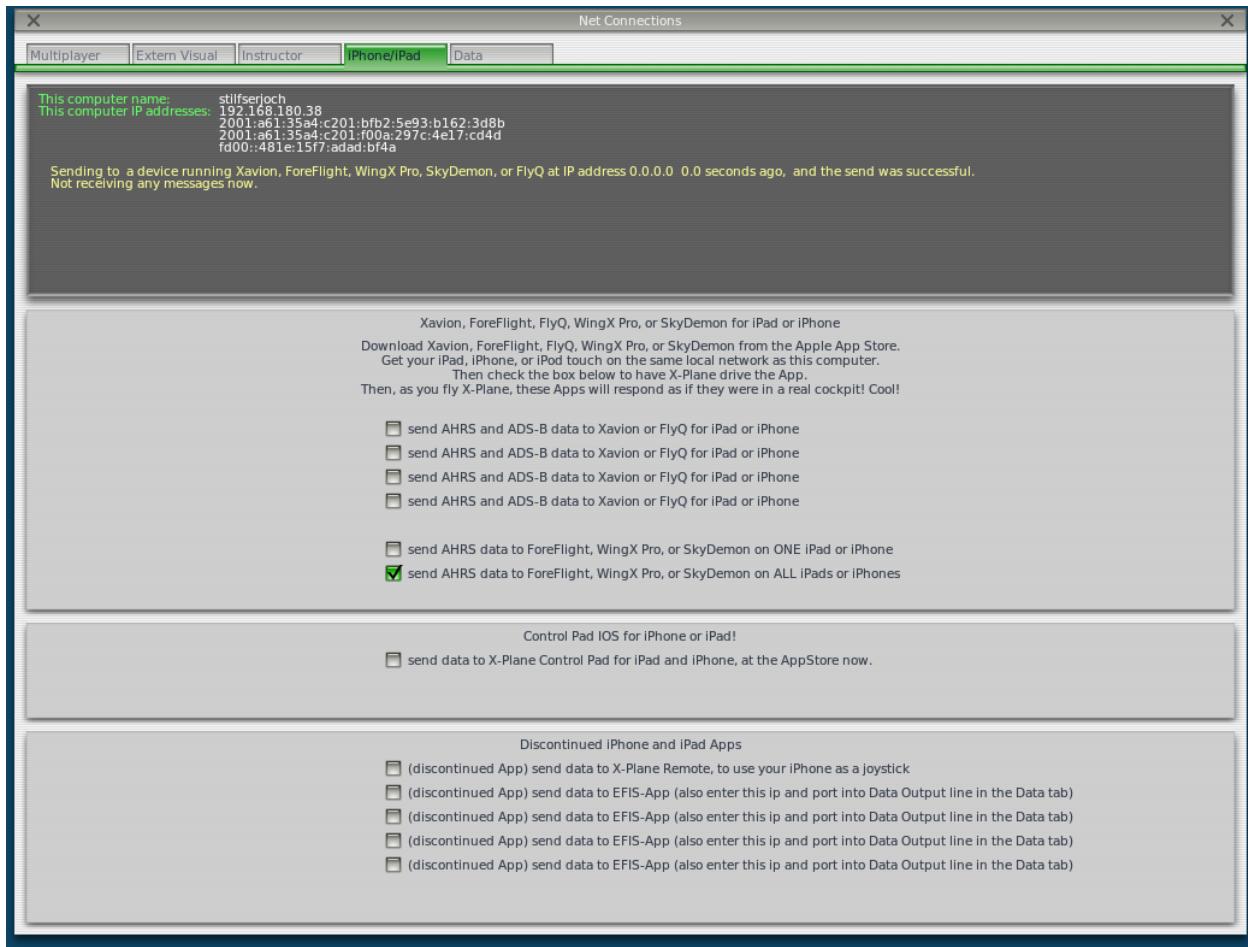


### 5.2.3 X-Plane 10

Follow the explanation on [this page<sup>20</sup>](#), which explains how to connect X-Plane 10 to the commercial app ForeFlight. In short: Open the “Settings” window and click “Internet Options”. There, go to the “iPhone/iPod” tab and turn on the “ForeFlight” option. Please be sure to disable output of data on tab “Data”.

<sup>20</sup> <https://www.x-plane.com/2012/08/foreflight-charts-supported-in-x-plane-10-10-beta-9/>

## Enroute Flight Navigation



### 5.2.4 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.

## 5.3 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.

# 6

## Make a donation

**Enroute Flight Navigation** is a non-commercial project of Akaflieg Freiburg<sup>21</sup> and the University of Freiburg<sup>22</sup>. 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.

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

<sup>21</sup> <https://akaflieg-freiburg.de/>

<sup>22</sup> <https://uni-freiburg.de/en/>



# 7

## Map Data

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

### 7.1 Base maps

Our base maps are edited versions of maps kindly provided by [Klokan Technologies<sup>23</sup>](https://www.klokantech.com/) through the [OpenMapTiles<sup>24</sup>](https://openmaptiles.org/) project.

### 7.2 Aeronautical maps

#### 7.2.1 Update policy

Our aeronautical maps are updated once a week.

#### 7.2.2 Data origin

The aeronautical maps are compiled from databases provided by the [openAIP<sup>25</sup>](http://openaip.net) and the [open flightmaps<sup>26</sup>](https://www.openflightmaps.org/) projects. While openAIP covers most of the world, the open flightmaps cover fewer countries but contain more detailed information.

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

<sup>23</sup> <https://www.klokantech.com/>

<sup>24</sup> <https://openmaptiles.org/>

<sup>25</sup> <http://openaip.net>

<sup>26</sup> <https://www.openflightmaps.org/>

### 7.2.3 List of maps

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

- Class 1 maps are compiled from [openAIP<sup>27</sup>](http://openaip.net) and [open flightmaps<sup>28</sup>](https://www.openflightmaps.org/) data. These maps contain complete information about airspaces, airfields and navaids. In addition, the maps contain (mandatory) reporting points. Some of our tier 1 maps also show traffic circuits and flight procedures for control zones.
- Class 2 maps are compiled from [openAIP<sup>29</sup>](http://openaip.net) 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	Namibia	Class 1
Africa	South Africa	Class 1
Asia	Japan	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	Greece	Class 1
Europe	Hungary	Class 1
Europe	Iceland	Class 2
Europe	Ireland	Class 2
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	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

continues on next page

---

<sup>27</sup> <http://openaip.net>

<sup>28</sup> <https://www.openflightmaps.org/>

<sup>29</sup> <http://openaip.net>

Table 1 – continued from previous page

Continent	Country	Class
Europe	Switzerland	Class 1
Europe	United Kingdom	Class 2
North America	Canada	Class 2
North America	United States	Class 2
South America	Argentina	Class 2
South America	Brazil	Class 2, NavAids missing



# 8

## Platform notes

### 8.1 Android

#### 8.1.1 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.

#### 8.1.2 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.

#### 8.1.3 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.

### 8.2 Linux desktop

#### 8.2.1 File import by drag-and-drop

It is possible to import files by dragging and dropping them 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

### 8.2.2 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 followin 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.
-s	Run simulator and generate screenshots for manual

# **Part I**

# **Appendix**



## Software license

The program **Enroute Flight Navigation** is licensed under the [GNU General Public License V3<sup>30</sup>](#) or, at your choice, any later version of this license.

### GNU GENERAL PUBLIC LICENSE

Version 3, 29 June 2007

Copyright © 2007 Free Software Foundation, Inc. <<https://fsf.org/>>

Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

#### Preamble

The GNU General Public License is a free, copyleft license for software and other kinds of works.

The licenses for most software and other practical works are designed to take away your freedom to share and change the works. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change all versions of a program--to make sure it remains free software for all its users. We, the Free Software Foundation, use the GNU General Public License for most of our software; it applies also to any other work released this way by its authors. You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for them if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs, and that you know you can do these things.

To protect your rights, we need to prevent others from denying you these rights or asking you to surrender the rights. Therefore, you have certain responsibilities if you distribute copies of the software, or if you modify

(continues on next page)

<sup>30</sup> <https://www.gnu.org/licenses/gpl-3.0-standalone.html>

(continued from previous page)

it: responsibilities to respect the freedom of others.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must pass on to the recipients the same freedoms that you received. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

Developers that use the GNU GPL protect your rights with two steps: (1) assert copyright on the software, and (2) offer you this License giving you legal permission to copy, distribute and/or modify it.

For the developers' and authors' protection, the GPL clearly explains that there is no warranty for this free software. For both users' and authors' sake, the GPL requires that modified versions be marked as changed, so that their problems will not be attributed erroneously to authors of previous versions.

Some devices are designed to deny users access to install or run modified versions of the software inside them, although the manufacturer can do so. This is fundamentally incompatible with the aim of protecting users' freedom to change the software. The systematic pattern of such abuse occurs in the area of products for individuals to use, which is precisely where it is most unacceptable. Therefore, we have designed this version of the GPL to prohibit the practice for those products. If such problems arise substantially in other domains, we stand ready to extend this provision to those domains in future versions of the GPL, as needed to protect the freedom of users.

Finally, every program is threatened constantly by software patents. States should not allow patents to restrict development and use of software on general-purpose computers, but in those that do, we wish to avoid the special danger that patents applied to a free program could make it effectively proprietary. To prevent this, the GPL assures that patents cannot be used to render the program non-free.

The precise terms and conditions for copying, distribution and modification follow.

### TERMS AND CONDITIONS

#### 0. Definitions.

“This License” refers to version 3 of the GNU General Public License.

“Copyright” also means copyright-like laws that apply to other kinds of works, such as semiconductor masks.

“The Program” refers to any copyrightable work licensed under this License. Each licensee is addressed as “you”. “Licensees” and “recipients” may be individuals or organizations.

To “modify” a work means to copy from or adapt all or part of the work in a

(continues on next page)

(continued from previous page)

fashion requiring copyright permission, other than the making of an exact copy. The resulting work is called a "modified version" of the earlier work or a work "based on" the earlier work.

A "covered work" means either the unmodified Program or a work based on the Program.

To "propagate" a work means to do anything with it that, without permission, would make you directly or secondarily liable for infringement under applicable copyright law, except executing it on a computer or modifying a private copy. Propagation includes copying, distribution (with or without modification), making available to the public, and in some countries other activities as well.

To "convey" a work means any kind of propagation that enables other parties to make or receive copies. Mere interaction with a user through a computer network, with no transfer of a copy, is not conveying.

An interactive user interface displays "Appropriate Legal Notices" to the extent that it includes a convenient and prominently visible feature that (1) displays an appropriate copyright notice, and (2) tells the user that there is no warranty for the work (except to the extent that warranties are provided), that licensees may convey the work under this License, and how to view a copy of this License. If the interface presents a list of user commands or options, such as a menu, a prominent item in the list meets this criterion.

#### 1. Source Code.

The "source code" for a work means the preferred form of the work for making modifications to it. "Object code" means any non-source form of a work.

A "Standard Interface" means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

The "System Libraries" of an executable work include anything, other than the work as a whole, that (a) is included in the normal form of packaging a Major Component, but which is not part of that Major Component, and (b) serves only to enable use of the work with that Major Component, or to implement a Standard Interface for which an implementation is available to the public in source code form. A "Major Component", in this context, means a major essential component (kernel, window system, and so on) of the specific operating system (if any) on which the executable work runs, or a compiler used to produce the work, or an object code interpreter used to run it.

The "Corresponding Source" for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work's System Libraries, or

(continues on next page)

(continued from previous page)

general-purpose tools or generally available free programs which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

The Corresponding Source need not include anything that users can regenerate automatically from other parts of the Corresponding Source.

The Corresponding Source for a work in source code form is that same work.

### 2. Basic Permissions.

All rights granted under this License are granted for the term of copyright on the Program, and are irrevocable provided the stated conditions are met. This License explicitly affirms your unlimited permission to run the unmodified Program. The output from running a covered work is covered by this License only if the output, given its content, constitutes a covered work. This License acknowledges your rights of fair use or other equivalent, as provided by copyright law.

You may make, run and propagate covered works that you do not convey, without conditions so long as your license otherwise remains in force. You may convey covered works to others for the sole purpose of having them make modifications exclusively for you, or provide you with facilities for running those works, provided that you comply with the terms of this License in conveying all material for which you do not control copyright. Those thus making or running the covered works for you must do so exclusively on your behalf, under your direction and control, on terms that prohibit them from making any copies of your copyrighted material outside their relationship with you.

Conveying under any other circumstances is permitted solely under the conditions stated below. Sublicensing is not allowed; section 10 makes it unnecessary.

### 3. Protecting Users' Legal Rights From Anti-Circumvention Law.

No covered work shall be deemed part of an effective technological measure under any applicable law fulfilling obligations under article 11 of the WIPO copyright treaty adopted on 20 December 1996, or similar laws prohibiting or restricting circumvention of such measures.

When you convey a covered work, you waive any legal power to forbid circumvention of technological measures to the extent such circumvention is effected by exercising rights under this License with respect to the covered work, and you disclaim any intention to limit operation or modification of the work as a means of enforcing, against the work's users, your or third parties' legal rights to forbid circumvention of technological measures.

(continues on next page)

(continued from previous page)

**4. Conveying Verbatim Copies.**

You may convey verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice; keep intact all notices stating that this License and any non-permissive terms added in accord with section 7 apply to the code; keep intact all notices of the absence of any warranty; and give all recipients a copy of this License along with the Program.

You may charge any price or no price for each copy that you convey, and you may offer support or warranty protection for a fee.

**5. Conveying Modified Source Versions.**

You may convey a work based on the Program, or the modifications to produce it from the Program, in the form of source code under the terms of section 4, provided that you also meet all of these conditions:

- a) The work must carry prominent notices stating that you modified it, and giving a relevant date.
- b) The work must carry prominent notices stating that it is released under this License and any conditions added under section 7. This requirement modifies the requirement in section 4 to "keep intact all notices".
- c) You must license the entire work, as a whole, under this License to anyone who comes into possession of a copy. This License will therefore apply, along with any applicable section 7 additional terms, to the whole of the work, and all its parts, regardless of how they are packaged. This License gives no permission to license the work in any other way, but it does not invalidate such permission if you have separately received it.
- d) If the work has interactive user interfaces, each must display Appropriate Legal Notices; however, if the Program has interactive interfaces that do not display Appropriate Legal Notices, your work need not make them do so.

A compilation of a covered work with other separate and independent works, which are not by their nature extensions of the covered work, and which are not combined with it such as to form a larger program, in or on a volume of a storage or distribution medium, is called an "aggregate" if the compilation and its resulting copyright are not used to limit the access or legal rights of the compilation's users beyond what the individual works permit. Inclusion of a covered work in an aggregate does not cause this License to apply to the other parts of the aggregate.

**6. Conveying Non-Source Forms.**

You may convey a covered work in object code form under the terms of sections 4 and 5, provided that you also convey the machine-readable Corresponding Source under the terms of this License, in one of these ways:

(continues on next page)

(continued from previous page)

- a) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by the Corresponding Source fixed on a durable physical medium customarily used for software interchange.
- b) Convey the object code in, or embodied in, a physical product (including a physical distribution medium), accompanied by a written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.
- c) Convey individual copies of the object code with a copy of the written offer to provide the Corresponding Source. This alternative is allowed only occasionally and noncommercially, and only if you received the object code with such an offer, in accord with subsection 6b.
- d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.
- e) Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

A separable portion of the object code, whose source code is excluded from the Corresponding Source as a System Library, need not be included in conveying the object code work.

A “User Product” is either (1) a “consumer product”, which means any tangible personal property which is normally used for personal, family, or household purposes, or (2) anything designed or sold for incorporation into a dwelling. In determining whether a product is a consumer product, doubtful cases shall be resolved in favor of coverage. For a particular product received by a particular user, “normally used” refers to a typical or common use of that class of product, regardless of the status of the particular user or of the way in which the particular user actually uses, or expects or is expected to use, the product. A product is a consumer product regardless

(continues on next page)

(continued from previous page)

of whether the product has substantial commercial, industrial or non-consumer uses, unless such uses represent the only significant mode of use of the product.

“Installation Information” for a User Product means any methods, procedures, authorization keys, or other information required to install and execute modified versions of a covered work in that User Product from a modified version of its Corresponding Source. The information must suffice to ensure that the continued functioning of the modified object code is in no case prevented or interfered with solely because modification has been made.

If you convey an object code work under this section in, or with, or specifically for use in, a User Product, and the conveying occurs as part of a transaction in which the right of possession and use of the User Product is transferred to the recipient in perpetuity or for a fixed term (regardless of how the transaction is characterized), the Corresponding Source conveyed under this section must be accompanied by the Installation Information. But this requirement does not apply if neither you nor any third party retains the ability to install modified object code on the User Product (for example, the work has been installed in ROM).

The requirement to provide Installation Information does not include a requirement to continue to provide support service, warranty, or updates for a work that has been modified or installed by the recipient, or for the User Product in which it has been modified or installed. Access to a network may be denied when the modification itself materially and adversely affects the operation of the network or violates the rules and protocols for communication across the network.

Corresponding Source conveyed, and Installation Information provided, in accord with this section must be in a format that is publicly documented (and with an implementation available to the public in source code form), and must require no special password or key for unpacking, reading or copying.

## 7. Additional Terms.

“Additional permissions” are terms that supplement the terms of this License by making exceptions from one or more of its conditions. Additional permissions that are applicable to the entire Program shall be treated as though they were included in this License, to the extent that they are valid under applicable law. If additional permissions apply only to part of the Program, that part may be used separately under those permissions, but the entire Program remains governed by this License without regard to the additional permissions.

When you convey a copy of a covered work, you may at your option remove any additional permissions from that copy, or from any part of it. (Additional permissions may be written to require their own removal in certain cases when you modify the work.) You may place additional permissions on material, added by you to a covered work, for which you have or can give appropriate copyright permission.

(continues on next page)

(continued from previous page)

Notwithstanding any other provision of this License, for material you add to a covered work, you may (if authorized by the copyright holders of that material) supplement the terms of this License with terms:

- a) Disclaiming warranty or limiting liability differently from the terms of sections 15 and 16 of this License; or
- b) Requiring preservation of specified reasonable legal notices or author attributions in that material or in the Appropriate Legal Notices displayed by works containing it; or
- c) Prohibiting misrepresentation of the origin of that material, or requiring that modified versions of such material be marked in reasonable ways as different from the original version; or
- d) Limiting the use for publicity purposes of names of licensors or authors of the material; or
- e) Declining to grant rights under trademark law for use of some trade names, trademarks, or service marks; or
- f) Requiring indemnification of licensors and authors of that material by anyone who conveys the material (or modified versions of it) with contractual assumptions of liability to the recipient, for any liability that these contractual assumptions directly impose on those licensors and authors.

All other non-permissive additional terms are considered “further restrictions” within the meaning of section 10. If the Program as you received it, or any part of it, contains a notice stating that it is governed by this License along with a term that is a further restriction, you may remove that term. If a license document contains a further restriction but permits relicensing or conveying under this License, you may add to a covered work material governed by the terms of that license document, provided that the further restriction does not survive such relicensing or conveying.

If you add terms to a covered work in accord with this section, you must place, in the relevant source files, a statement of the additional terms that apply to those files, or a notice indicating where to find the applicable terms.

Additional terms, permissive or non-permissive, may be stated in the form of a separately written license, or stated as exceptions; the above requirements apply either way.

### 8. Termination.

You may not propagate or modify a covered work except as expressly provided under this License. Any attempt otherwise to propagate or modify it is void, and will automatically terminate your rights under this License

(continues on next page)

(continued from previous page)

(including any patent licenses granted under the third paragraph of section 11).

However, if you cease all violation of this License, then your license from a particular copyright holder is reinstated (a) provisionally, unless and until the copyright holder explicitly and finally terminates your license, and (b) permanently, if the copyright holder fails to notify you of the violation by some reasonable means prior to 60 days after the cessation.

Moreover, your license from a particular copyright holder is reinstated permanently if the copyright holder notifies you of the violation by some reasonable means, this is the first time you have received notice of violation of this License (for any work) from that copyright holder, and you cure the violation prior to 30 days after your receipt of the notice.

Termination of your rights under this section does not terminate the licenses of parties who have received copies or rights from you under this License. If your rights have been terminated and not permanently reinstated, you do not qualify to receive new licenses for the same material under section 10.

9. Acceptance Not Required for Having Copies.

You are not required to accept this License in order to receive or run a copy of the Program. Ancillary propagation of a covered work occurring solely as a consequence of using peer-to-peer transmission to receive a copy likewise does not require acceptance. However, nothing other than this License grants you permission to propagate or modify any covered work. These actions infringe copyright if you do not accept this License. Therefore, by modifying or propagating a covered work, you indicate your acceptance of this License to do so.

10. Automatic Licensing of Downstream Recipients.

Each time you convey a covered work, the recipient automatically receives a license from the original licensors, to run, modify and propagate that work, subject to this License. You are not responsible for enforcing compliance by third parties with this license.

An “entity transaction” is a transaction transferring control of an organization, or substantially all assets of one, or subdividing an organization, or merging organizations. If propagation of a covered work results from an entity transaction, each party to that transaction who receives a copy of the work also receives whatever licenses to the work the party's predecessor in interest had or could give under the previous paragraph, plus a right to possession of the Corresponding Source of the work from the predecessor in interest, if the predecessor has it or can get it with reasonable efforts.

You may not impose any further restrictions on the exercise of the rights granted or affirmed under this License. For example, you may not impose a license fee, royalty, or other charge for exercise of rights granted under

(continues on next page)

(continued from previous page)

this License, and you may not initiate litigation (including a cross-claim or counterclaim in a lawsuit) alleging that any patent claim is infringed by making, using, selling, offering for sale, or importing the Program or any portion of it.

### 11. Patents.

A “contributor” is a copyright holder who authorizes use under this License of the Program or a work on which the Program is based. The work thus licensed is called the contributor's “contributor version”.

A contributor's “essential patent claims” are all patent claims owned or controlled by the contributor, whether already acquired or hereafter acquired, that would be infringed by some manner, permitted by this License, of making, using, or selling its contributor version, but do not include claims that would be infringed only as a consequence of further modification of the contributor version. For purposes of this definition, “control” includes the right to grant patent sublicenses in a manner consistent with the requirements of this License.

Each contributor grants you a non-exclusive, worldwide, royalty-free patent license under the contributor's essential patent claims, to make, use, sell, offer for sale, import and otherwise run, modify and propagate the contents of its contributor version.

In the following three paragraphs, a “patent license” is any express agreement or commitment, however denominated, not to enforce a patent (such as an express permission to practice a patent or covenant not to sue for patent infringement). To “grant” such a patent license to a party means to make such an agreement or commitment not to enforce a patent against the party.

If you convey a covered work, knowingly relying on a patent license, and the Corresponding Source of the work is not available for anyone to copy, free of charge and under the terms of this License, through a publicly available network server or other readily accessible means, then you must either (1) cause the Corresponding Source to be so available, or (2) arrange to deprive yourself of the benefit of the patent license for this particular work, or (3) arrange, in a manner consistent with the requirements of this License, to extend the patent license to downstream recipients. “Knowingly relying” means you have actual knowledge that, but for the patent license, your conveying the covered work in a country, or your recipient's use of the covered work in a country, would infringe one or more identifiable patents in that country that you have reason to believe are valid.

If, pursuant to or in connection with a single transaction or arrangement, you convey, or propagate by procuring conveyance of, a covered work, and grant a patent license to some of the parties receiving the covered work authorizing them to use, propagate, modify or convey a specific copy of the covered work, then the patent license you grant is automatically extended to all recipients of the covered work and works based on it.

(continues on next page)

(continued from previous page)

A patent license is “discriminatory” if it does not include within the scope of its coverage, prohibits the exercise of, or is conditioned on the non-exercise of one or more of the rights that are specifically granted under this License. You may not convey a covered work if you are a party to an arrangement with a third party that is in the business of distributing software, under which you make payment to the third party based on the extent of your activity of conveying the work, and under which the third party grants, to any of the parties who would receive the covered work from you, a discriminatory patent license (a) in connection with copies of the covered work conveyed by you (or copies made from those copies), or (b) primarily for and in connection with specific products or compilations that contain the covered work, unless you entered into that arrangement, or that patent license was granted, prior to 28 March 2007.

Nothing in this License shall be construed as excluding or limiting any implied license or other defenses to infringement that may otherwise be available to you under applicable patent law.

12. No Surrender of Others' Freedom.

If conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot convey a covered work so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not convey it at all. For example, if you agree to terms that obligate you to collect a royalty for further conveying from those to whom you convey the Program, the only way you could satisfy both those terms and this License would be to refrain entirely from conveying the Program.

13. Use with the GNU Affero General Public License.

Notwithstanding any other provision of this License, you have permission to link or combine any covered work with a work licensed under version 3 of the GNU Affero General Public License into a single combined work, and to convey the resulting work. The terms of this License will continue to apply to the part which is the covered work, but the special requirements of the GNU Affero General Public License, section 13, concerning interaction through a network will apply to the combination as such.

14. Revised Versions of this License.

The Free Software Foundation may publish revised and/or new versions of the GNU General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies that a certain numbered version of the GNU General Public License “or any later version” applies to it, you have the option of following the terms and conditions either of that numbered version or of any later version

(continues on next page)

(continued from previous page)

published by the Free Software Foundation. If the Program does not specify a version number of the GNU General Public License, you may choose any version ever published by the Free Software Foundation.

If the Program specifies that a proxy can decide which future versions of the GNU General Public License can be used, that proxy's public statement of acceptance of a version permanently authorizes you to choose that version for the Program.

Later license versions may give you additional or different permissions. However, no additional obligations are imposed on any author or copyright holder as a result of your choosing to follow a later version.

### 15. Disclaimer of Warranty.

THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

### 16. Limitation of Liability.

IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MODIFIES AND/OR CONVEYS THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

### 17. Interpretation of Sections 15 and 16.

If the disclaimer of warranty and limitation of liability provided above cannot be given local legal effect according to their terms, reviewing courts shall apply local law that most closely approximates an absolute waiver of all civil liability in connection with the Program, unless a warranty or assumption of liability accompanies a copy of the Program in return for a fee.

# 10

## Third party software and data

**Enroute Flight Navigation** builds on a large number of open-source software components and on open-source data.

### 10.1 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<sup>31</sup>, published under a CC-BY 4.0 design license<sup>32</sup>.
- The aviation maps contain data from openAIP<sup>33</sup>, licensed under a CC BY-NC-SA license<sup>34</sup>.
- The aviation maps contain data from open flightmaps<sup>35</sup>, licensed under the OFMA General Users' License<sup>36</sup>.

### 10.2 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<sup>37</sup>. BSD 3-Clause “New” or “Revised” License.
- ANGLE Library<sup>38</sup>. BSD 3-clause “New” or “Revised” License.
- ANGLE: Array Bounds Clammer for WebKit. BSD 2-clause “Simplified” License.
- ANGLE: Khronos Headers. MIT License.
- ANGLE: Murmurhash. Public Domain.
- ANGLE: Systeminfo. BSD 2-clause “Simplified” License.
- ANGLE: trace\_event. BSD 3-clause “New” or “Revised” License.

<sup>31</sup> <https://github.com/openmaptiles/openmaptiles>

<sup>32</sup> <https://github.com/openmaptiles/openmaptiles/blob/master/LICENSE.md>

<sup>33</sup> <http://www.openaip.net>

<sup>34</sup> <https://creativecommons.org/licenses/by-nc-sa/3.0/>

<sup>35</sup> <https://www.openflightmaps.org/>

<sup>36</sup> <https://www.openflightmaps.org/live/downloads/20150306-LCN.pdf>

<sup>37</sup> <https://github.com/adobe-type-tools/agl-aglfn>

<sup>38</sup> <http://angleproject.org/>

- Anti-aliasing rasterizer from FreeType 2<sup>39</sup>. Freetype Project License or GNU General Public License v2.0 only.
- Bitstream Vera Font<sup>40</sup>. Bitstream Vera Font License.
- Boost<sup>41</sup>. Boost Software License 1.0.
- Clip2Tri Polygon Triangulation Library<sup>42</sup>. MIT License.
- Clipper Polygon Clipping Library<sup>43</sup>. Boost Software License 1.0.
- Cocoa Platform Plugin. BSD 3-clause “New” or “Revised” License.
- CSS Color Parser<sup>44</sup>. MIT License.
- cURL Parse Date<sup>45</sup>. MIT License.
- Cycle. MIT License.
- Data Compression Library (zlib)<sup>46</sup>. zlib License.
- DejaVu Fonts<sup>47</sup>. Bitstream Vera Font License.
- Earcut<sup>48</sup>. ISC License.
- Earcut Polygon Triangulation Library<sup>49</sup>. ISC License.
- Earth Gravitational Model<sup>50</sup>. Public Domain.
- Easing Equations by Robert Penner<sup>51</sup>. BSD 3-clause “New” or “Revised” License.
- Efficient Binary-Decimal and Decimal-Binary Conversion Routines for IEEE Doubles<sup>52</sup>. BSD 3-clause “New” or “Revised” License.
- fontawesome<sup>53</sup>. SIL Open Font Licence 1.1.
- forkfd. MIT License.
- FreeBSD strtoll and strtoull<sup>54</sup>. BSD 3-clause “New” or “Revised” License.
- Freetype 2<sup>55</sup>. Freetype Project License or GNU General Public License v2.0 only.
- Freetype 2 - Bitmap Distribution Format (BDF) support<sup>56</sup>. MIT License.
- Freetype 2 - Portable Compiled Format (PCF) support<sup>57</sup>. MIT License.
- Freetype 2 - zlib<sup>58</sup>. zlib License.
- geojson-cpp<sup>59</sup>. ISC License.

---

<sup>39</sup> <http://www.freetype.org>

<sup>40</sup> <https://www.gnome.org/fonts/>

<sup>41</sup> <http://www.boost.org>

<sup>42</sup> <https://github.com/raptor/clip2tri>

<sup>43</sup> <http://www.angusj.com/delphi/clipper.php>

<sup>44</sup> <https://github.com/kkaefer/css-color-parser-cpp>

<sup>45</sup> <https://curl.haxx.se>

<sup>46</sup> <http://zlib.net/>

<sup>47</sup> <https://dejavu-fonts.github.io/>

<sup>48</sup> <https://github.com/mapbox/earcut.hpp>

<sup>49</sup> <https://github.com/mapbox/earcut.hpp>

<sup>50</sup> <https://earth-info.nga.mil>

<sup>51</sup> <http://robertpenner.com/easing/>

<sup>52</sup> <https://github.com/google/double-conversion>

<sup>53</sup> <https://github.com/FortAwesome/Font-Awesome>

<sup>54</sup> <https://github.com/freebsd/freebsd/>

<sup>55</sup> <http://www.freetype.org>

<sup>56</sup> <http://www.freetype.org>

<sup>57</sup> <http://www.freetype.org>

<sup>58</sup> <http://www.freetype.org>

<sup>59</sup> <https://github.com/mapbox/geojson-cpp>

- [geojson-vt-cpp<sup>60</sup>](https://github.com/mapbox/geojson-vt-cpp). ISC License.
- [geometry.hpp<sup>61</sup>](https://github.com/mapbox/geometry.hpp). ISC License.
- [geosimplify-js polyline simplification library<sup>62</sup>](https://github.com/mapbox/geosimplify-js). geosimplify-js License.
- [Google Fonts<sup>63</sup>](https://fonts.google.com). Apache 2 License.
- [Google Material Icon Font<sup>64</sup>](https://material.io/resources/icons/). Apache Licence 2.0.
- [Gradle wrapper<sup>65</sup>](https://gradle.org). Apache License 2.0.
- [Guidelines Support Library<sup>66</sup>](https://github.com/microsoft/GSL). MIT License.
- [HarfBuzz](https://harfbuzz.org). MIT License.
- [HarfBuzz-NG<sup>67</sup>](https://github.com/google/harfbuzz-nginx). MIT License.
- [IAccessible2 IDL Specification<sup>68</sup>](https://www.linuxfoundation.org/zh/wiki/Accessibility/iaccessible2/). BSD 3-clause “New” or “Revised” License.
- [JavaScriptCore Macro Assembler<sup>69</sup>](https://trac.webkit.org/wiki/JavaScriptCore). BSD 2-clause “Simplified” License.
- [jQuery<sup>70</sup>](https://jquery.com). MIT License.
- [KDAB’s helper class for single-instance policy applications<sup>71</sup>](https://github.com/KDAB/KDSingleApplication). MIT License.
- [kdbush.hpp<sup>72</sup>](https://github.com/mourner/kdbush.hpp). ISC License.
- [libdbus-1 headers<sup>73</sup>](https://github.com/freedesktop/dbus). Academic Free License v2.1, or GNU General Public License v2.0 or later.
- [LibJPEG-turbo<sup>74</sup>](https://libjpeg-turbo.virtualgl.org). Independent JPEG Group License.
- [LibPNG<sup>75</sup>](https://www.libpng.org/pub/png/libpng.html). libpng License and PNG Reference Library version 2.
- [Linux Performance Events<sup>76</sup>](https://www.kernel.org/doc/Documentation/PerformanceEvents). GNU General Public License v2.0 only with Linux Syscall Note.
- [lunr.js<sup>77</sup>](https://lunr.js). MIT License.
- [Mapbox GL Native<sup>78</sup>](https://github.com/mapbox/mapbox-gl-native). BSD 2-clause “Simplified” License and zlib License.
- [Material Design Icons<sup>79</sup>](https://github.com/google/material-design-icons). Apache License.
- [Material Sphinx Theme<sup>80</sup>](https://github.com/bashtage/sphinx-material/). MIT License.
- MD4. Public Domain.
- [MD4C<sup>81</sup>](https://github.com/mity/md4c). MIT License.

<sup>60</sup> <https://github.com/mapbox/geojson-vt-cpp>

<sup>61</sup> <https://github.com/mapbox/geometry.hpp>

<sup>62</sup> <https://github.com/mapbox/geosimplify-js>

<sup>63</sup> <https://fonts.google.com>

<sup>64</sup> <https://material.io/resources/icons/>

<sup>65</sup> <https://gradle.org>

<sup>66</sup> <https://github.com/microsoft/GSL>

<sup>67</sup> <https://harfbuzz.org>

<sup>68</sup> <https://www.linuxfoundation.org/zh/wiki/Accessibility/iaccessible2/>

<sup>69</sup> <https://trac.webkit.org/wiki/JavaScriptCore>

<sup>70</sup> <https://github.com/jquery/jquery>

<sup>71</sup> <https://github.com/KDAB/KDSingleApplication>

<sup>72</sup> <https://github.com/mourner/kdbush.hpp>

<sup>73</sup> <https://www.freedesktop.org/wiki/Software/dbus/>

<sup>74</sup> <http://libjpeg-turbo.virtualgl.org/>

<sup>75</sup> <http://www.libpng.org/pub/png/libpng.html>

<sup>76</sup> <https://www.kernel.org>

<sup>77</sup> <https://github.com/olivermn/lunr.js>

<sup>78</sup> <https://github.com/mapbox/mapbox-gl-native>

<sup>79</sup> <https://github.com/google/material-design-icons>

<sup>80</sup> <https://github.com/bashtage/sphinx-material/>

<sup>81</sup> <https://github.com/mity/md4c>

- MD5. Public Domain.
- [Metaf library<sup>82</sup>](https://github.com/nnaumenko/metaf). MIT License.
- Native Style for Android. Apache License 2.0.
- [nunicode<sup>83</sup>](https://bitbucket.org/alekseyt/nunicode.git). MIT License.
- [OpenGL ES 2 Headers<sup>84</sup>](https://www.khronos.org/). MIT License.
- [OpenGL Headers<sup>85</sup>](https://www.khronos.org/). MIT License.
- [openSSL library<sup>86</sup>](https://github.com/openssl/openssl). Apache 2 License.
- [Optional<sup>87</sup>](https://github.com/akrzemi1/Optional). Boost Software License 1.0.
- [OSM Liberty<sup>88</sup>](https://github.com/maputnik/osm-liberty). BSD License.
- [PCRE2<sup>89</sup>](http://www.pcre.org/). BSD 3-clause “New” or “Revised” License.
- [PCRE2 - Stack-less Just-In-Time Compiler<sup>90</sup>](https://github.com/rapidjson/rapidjson). BSD 2-clause “Simplified” License.
- [Pixman<sup>91</sup>](https://github.com/Pixman/pixman). MIT License.
- [Poly2Tri Polygon Triangulation Library<sup>92</sup>](https://code.google.com/p/poly2tri/). BSD 3-clause “New” or “Revised” License.
- [polylabel<sup>93</sup>](https://github.com/mapbox/polylabel). ISC License.
- [protozero<sup>94</sup>](https://github.com/protocolbuffers/protobuf). BSD 2-clause “Simplified” License.
- [QEventDispatcher on macOS](https://github.com/KDAB/QEventDispatcher). BSD 3-clause “New” or “Revised” License.
- [QHttpEngine<sup>95</sup>](https://github.com/KDAB/QHttpEngine). MIT License.
- [Qt Toolkit, Libraries and Modules<sup>96</sup>](https://github.com/qt/qtbase). GNU General Public License v3.0.
- [RapidJSON<sup>97</sup>](https://github.com/RapidJSON/rapidjson). MIT License.
- [Secure Hash Algorithm SHA-1<sup>98</sup>](https://github.com/SecureHashAlgorithm/sha1). Public Domain.
- [Secure Hash Algorithm SHA-3 - brg\\_endian](https://github.com/SecureHashAlgorithm/sha3). BSD 2-clause “Simplified” License.
- [Secure Hash Algorithm SHA-3 - Keccak](https://github.com/SecureHashAlgorithm/sha3). Creative Commons Zero v1.0 Universal.
- [Secure Hash Algorithms SHA-384 and SHA-512](https://github.com/SecureHashAlgorithm/sha3). BSD 3-clause “New” or “Revised” License.
- [Shadow values from Angular Material<sup>99</sup>](https://github.com/angular/material2). MIT License.
- [shelf-pack-cpp<sup>100</sup>](https://github.com/mapbox/shelf-pack). ISC License.

---

<sup>82</sup> <https://github.com/nnaumenko/metaf>

<sup>83</sup> <https://bitbucket.org/alekseyt/nunicode.git>

<sup>84</sup> <https://www.khronos.org/>

<sup>85</sup> <https://www.khronos.org/>

<sup>86</sup> <https://www.openssl.org>

<sup>87</sup> <https://github.com/akrzemi1/Optional>

<sup>88</sup> <https://github.com/maputnik/osm-liberty>

<sup>89</sup> <http://www.pcre.org/>

<sup>90</sup> <http://www.pcre.org/>

<sup>91</sup> <http://www.pixman.org/>

<sup>92</sup> <http://code.google.com/p/poly2tri/>

<sup>93</sup> <https://github.com/mapbox/polylabel>

<sup>94</sup> <https://github.com/mapbox/protozero>

<sup>95</sup> <https://github.com/nitroshare/qhttpengine>

<sup>96</sup> <https://qt.io>

<sup>97</sup> <http://rapidjson.org>

<sup>98</sup> <http://www.dominik-reichl.de/projects/csha1/>

<sup>99</sup> <https://angularjs.org/>

<sup>100</sup> <https://github.com/mapbox/shelf-pack>

- Smooth Scaling Algorithm. BSD 2-clause “Simplified” License and Imlib2 License.
- [SQLite<sup>101</sup>](https://www.sqlite.org/). Public Domain.
- sRGB color profile icc file<sup>102</sup>. International Color Consortium License.
- [Sunset library<sup>103</sup>](https://github.com/buelowp/sunset). GNU General Public License v2.0.
- [supercluster.hpp<sup>104</sup>](https://github.com/mapbox/supercluster.hpp). ISC License.
- [Tango Icons<sup>105</sup>](https://tango.freedesktop.org/Tango/Desktop_Project). Public Domain.
- [Tango Weather Icon Pack by Darkobra<sup>106</sup>](https://tango.freedesktop.org/Tango/Desktop_Project). Public Domain.
- [tao\\_tuple<sup>107</sup>](https://github.com/taocpp/tao_tuple). MIT License.
- Text Codec: EUC-JP. BSD 2-clause “Simplified” License.
- Text Codec: EUC-KR. BSD 2-clause “Simplified” License.
- Text Codec: GBK. BSD 2-clause “Simplified” License.
- Text Codec: ISO 2022-JP (JIS). BSD 2-clause “Simplified” License.
- Text Codec: Shift-JIS. BSD 2-clause “Simplified” License.
- Text Codec: TSCII. BSD 2-clause “Simplified” License.
- Text Codecs: Big5, Big5-HKSCS. BSD 2-clause “Simplified” License.
- [The Public Suffix List<sup>108</sup>](https://publicsuffix.org/). Mozilla Public License 2.0.
- [TinyCBOR<sup>109</sup>](https://github.com/intel/tinycbor). MIT License.
- [underscore<sup>110</sup>](https://github.com/jashkenas/underscore). MIT License.
- [Unicode Character Database \(UCD\)<sup>111</sup>](https://www.unicode.org/ucd/). Unicode License Agreement - Data Files and Software (2016).
- [Unicode Common Locale Data Repository \(CLDR\)<sup>112</sup>](https://www.unicode.org/cldr/). Unicode License Agreement - Data Files and Software (2016).
- [unique\\_resource<sup>113</sup>](https://github.com/okdshin/unique_resource). Boost Software License 1.0.
- [Valgrind<sup>114</sup>](https://valgrind.org/). BSD 4-clause “Original” or “Old” License.
- [variant<sup>115</sup>](https://github.com/mapbox/variant). BSD 3-clause “New” or “Revised” License.
- [Vector Tile Library<sup>116</sup>](https://github.com/mapbox/vector-tile). ISC License.
- [Vulkan API Registry<sup>117</sup>](https://www.khronos.org/vulkan). MIT License.

---

<sup>101</sup> <https://www.sqlite.org/>

<sup>102</sup> <http://www.color.org/>

<sup>103</sup> <https://github.com/buelowp/sunset>

<sup>104</sup> <https://github.com/mapbox/supercluster.hpp>

<sup>105</sup> [http://tango.freedesktop.org/Tango/Desktop\\_Project](https://tango.freedesktop.org/Tango/Desktop_Project)

<sup>106</sup> <https://www.deviantart.com/darkobra/art/Tango-Weather-Icon-Pack-98024429>

<sup>107</sup> <https://github.com/taocpp/>

<sup>108</sup> <http://publicsuffix.org/>

<sup>109</sup> <https://github.com/intel/tinycbor>

<sup>110</sup> <https://github.com/jashkenas/underscore>

<sup>111</sup> <https://www.unicode.org/ucd/>

<sup>112</sup> <http://cldr.unicode.org/>

<sup>113</sup> [https://github.com/okdshin/unique\\_resource](https://github.com/okdshin/unique_resource)

<sup>114</sup> <http://valgrind.org/>

<sup>115</sup> <https://github.com/mapbox/variant>

<sup>116</sup> <https://github.com/mapbox/vector-tile>

<sup>117</sup> <https://www.khronos.org/>

- Vulkan Memory Allocator<sup>118</sup>. MIT License.
- Wagyu Geometry Processing Library<sup>119</sup>. MIT License.
- WebGradients<sup>120</sup>. MIT License.
- Wintab API. LCS-Telegraphics License.
- X Server helper<sup>121</sup>. X11 License and Historical Permission Notice and Disclaimer.
- XCB-XInput<sup>122</sup>. MIT License.
- XSVG. Historical Permission Notice and Disclaimer - sell variant.

---

<sup>118</sup> <https://github.com/GPUOpen-LibrariesAndSDKs/VulkanMemoryAllocator>

<sup>119</sup> <https://github.com/mapbox/wagyu>

<sup>120</sup> <https://webgradients.com/>

<sup>121</sup> <https://www.x.org/>

<sup>122</sup> <https://xcb.freedesktop.org/>

# 11

## Technical Notes

### 11.1 Traffic Receiver

#### 11.1.1 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)<sup>123</sup>, Version 7.13, as published by FLARM Technology Ltd.<sup>124</sup>.
- Datagrams in GDL90 format must conform to the GDL 90 Data Interface Specification<sup>125</sup>.
- Datagrams in XGPS format must conform to the format specified on the ForeFlight Web site<sup>126</sup>.

<sup>123</sup> <https://flarm.com/support/manuals-documents/>

<sup>124</sup> <https://flarm.com/>

<sup>125</sup> [https://www.faa.gov/nextgen/programs/adsb/archival/media/gdl90\\_public\\_icd\\_reva.pdf](https://www.faa.gov/nextgen/programs/adsb/archival/media/gdl90_public_icd_reva.pdf)

<sup>126</sup> <https://www.foreflight.com/support/network-gps/>

### 11.1.2 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.

- Stratux devices generate a ring of eight virtual targets around the own position. These targets are named “Mode S”.
- Air Avionics 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.

### 11.1.3 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.