

# **mwptools**

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**Mission Planner, GCS, Log replay for inav**

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*(c) Jonathan Hudson 2014-2022*

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## 1.1 Overview

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Sweet dreams and flying machines<sup>1</sup>

[mwp](#) (originally "multi-wii planner") is a mission planner, ground control station and flight logger for MSP (Multiwii Serial Protocol) compatible flight controller firmware ([INAV](#) and Multiwii at least).

From its MultiWii origins mwp has evolved to support navigation capabilities in [INAV](#).

[INAV](#) is now the main development target, however MultiWii mission planning and ground control remains a supported function.

### 1.1.1 Features

- **Mission Planner** : Supports all [INAV](#) and MultiWii mission planning functions, including all INAV extensions.
- **Ground Control Station** : (Near) real time ground control monitoring, using a wide range of [telemetry](#) options. Audio status reports.
- **Monitoring and warning** of other airspace users (INAV radar, manned aviation ADS-B)
- **Flight log replay** (Blackbox, OTX/ETX logs, BulletGCSS)
- **Embedded video** (live and replay)
- **Support** functions
  - [INAV Safehome editor](#)
  - [Automatic mission shape](#) generation, block moves, animated mission preview.
  - [Terrain Analysis](#) with WP mission rewrite to safe elevation margins
  - Favourite sites editor
  - KML/KMZ static overlays

### Supported Protocols

[mwp](#) supports the following [telemetry protocols](#) :

- MSP (MultiWii Serial Protocol)
- LTM (Lightweight Telemetry)
- MAVLink (INAV subset)
- Smartport (direct / via inverter / or from Multi-protocol Module)
- Crossfire (CRSF)
- Flysky AA (via Multi-protocol Module)
- [BulletGCSS MQTT](#)

### Monitoring

[mwp](#) also supports the [real-time display of adjacent aircraft](#) using:

- [INAV-radar](#) (INAV UAS)
- dump1090 / SBS-1 Basestation (SDR ADS-B), streaming TCP, for general aviation
- MAVlink Traffic Report (e.g. general aviation, typically ADS-B via a device such as uAvionix PingRX)

## Log replay formats

[mwp](#) supports [replay](#) of:

- mwp log files (logged by mwp/GCS)
- Blackbox logs
- OpenTX and EdgeTX CSV (sdcard) logs
- BulletGCSS logs
- Ardupilot (.bin) log

Log replay requires tools from the [flightlog2x](#) project.

## 1.1.2 Platforms and OS

The tools are designed to be portable and as far as possible platform and architecture agnostic. The suite is developed on Arch Linux and is tested on Debian (Bullseye, Sid), Ubuntu (latest and most recent LTS), Fedora (current) and FreeBSD (current release). [mwp](#) also runs on MS Windows; Windows 11 / WSL-g is almost on feature parity with Linux / FreeBSD. Other (older) OS are unsupported, but may work (i.e. Debian 10 is used for the "release" builds).

## 1.1.3 Build and installation

Build and installation is described in the following sections:

- [Generic build and installation](#) Linux, FreeBSD, Windows / WSL
  - Windows additional information ([Win11](#), [Win10](#) and [earlier](#))

### Installation Tutorial

Somewhat [outdated](#), if you follow this, please note that some of is much simplified by the later [Generic build and installation](#) article.

[Watch on Vimeo](#)

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1. James Taylor, Fire and Rain. Full line is 'sweet dreams and flying machines in pieces on the ground', you may skip the final part. ↪

## 1.2 Running mwp

### 1.2.1 Video Tutorials

There is an [slightly outdated video](#) that describes dock usage and some post-install actions:

[Watch on Vimeo](#)

**i Update**

- More useful than I remember!
- The dock is now installed populated.
- WP editor switch is enabled by default
- There is now a graphical "favourite places" editor
- The build system is no longer `make`

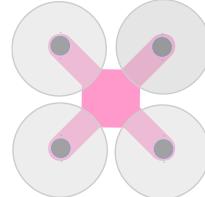
Apart from that, it's quite informative.

### Tutorial Playlist

All the developer's tutorial videos are in a [YouTube playlist](#).

### 1.2.2 Graphical User Interface

Once you've [built and / or installed mwp](#).



The install process installs an desktop icon and `mwp.desktop` application file

The `desktop` file tells the window manager where to find `mwp` and on modern desktop environments (e.g. Gnome Shell, xfce, kde), `mwp` will be added to the system application menu and / or 'finder'.

- It is also possible to run `mwp` from a terminal, passing additional [options](#) if required.
- Such [options can be added to a configuration file](#) for persistence or use from the graphical icon.

### Display Managers

`mwp` uses a library, `libchamplain` to draw maps and mission symbols; unfortunately, this does not integrate consistently with the various generations of open source display managers (ironically, it works without problems in WSL-G). Please check the following before raising Github issues:

- On **Wayland** : Wayland is the latest open source display manager. On some older graphics cards (i.e. more than c. 5 years old), it may fail to 'pick' waypoint symbols when there are more than c. 40 symbols in a mission. In order to mitigate this, the default setting in `mwp` is to use a fallback implementation known as **XWayland**. Use of **Wayland** (vice XWayland) for newer graphics cards may be forced by setting `GDK_BACKEND=wayland` in [~/.config/mwp/cmdopts](#) or the environment.
- On **Xlib** : Sometimes (rarely), you may load a mission and the WPs cannot be 'picked' and the map is unresponsive to mouse control. The work-around is to move the mouse off the map and back on again (or scroll the map with the keyboard, CTRL-arrow-keys).

Any technical solutions to either of these irritations would be most welcome.

### 1.2.3 Command line options

`mwp`'s command line options may be displayed with the `--help` option:

```
mwp --help
Usage:
  mwp [OPTION...]

Help Options:
  -h, --help           Show help options
  --help-all          Show all help options
  --help-gapplication Show GApplication options
  --help-gtk           Show GTK Options

Application Options:
  -m, --mission=file-name    Mission file
  -s, --serial-device=device_name Serial device
  -d, --device=device-name   Serial device
  -f, --flight-controller=fc-name mw!mwnav|bf|cf
  -c, --connect            connect to first device (does not set auto flag)
  -a, --auto-connect        auto-connect to first device (sets auto flag)
  -N, --no-poll             don't poll for nav info
  -T, --no-trail            don't display GPS trail
  -r, --raw-log             log raw serial data to file
  --ignore-sizing          ignore minimum size constraint
  --full-screen            open full screen
  --ignore-rotation         legacy unused
  --dont-maximise          don't maximise the window
  --force-mag               force mag for vehicle direction
  --force-nav                force nav capable
  -l, --layout              Layout name
  -t, --force-type=type-code_no Model type
  -4, --force4               Force ipv4
  -3, --ignore-3dr          Ignore 3DR RSSI info
  -H, --centre-on-home      Centre on home
  --debug-flags             Debug flags (mask)
  -p, --replay-mwp=file-name replay mwp log file
  -b, --replay-bbox=file-name replay bbox log file
  --centre=position         Centre position
  --offline                 force offline proxy mode
  -S, --n-points=N          Number of points shown in GPS trail
  -M, --mod-points=N        Modulo points to show in GPS trail
  --rings=number,interval   Range rings (number, interval(m)), e.g. --rings 10,20
  --voice-command=command string External speech command
  -v, --version              show version
  --build-id                show build id
  --really-really-run-as-root no reason to ever use this
  --forward-to-device-name  forward telemetry to
  --radar-device=device-name dedicated inav radar device
  --perma-warn              info dialogues never time out
  --fsmenu                  use a menu bar in full screen (vice a menu button)
  -k, --kmlfile=file-name   KML file
  --relaxed-msp             don't check MSP direction flag
  --display=DISPLAY          X display to use
```

### Bash completion

`mwp` installation also installs a 'bash completion' script (and also a `blackbox_decode` completion script). Note this is only available after you log in, so on first install, it's only available after the *next* login.

This facilitates automatic command completion, so you don't have to remember all the options or be always typing `mwp --help`.

Typing `mwp` and then `<TAB>` will first display the option lead `--`; then a subsequent `<TAB><TAB>` will display all the options. If one then typed `ra<TAB><TAB>`, it would complete to:

```
$ mwp --ra
--radar-device --raw-log
```

Further entry (e.g. `d`) would complete the command (`--radar-device`).

### Adding options to a running mwp

Certain options, like `--replay-bbox`, `--mission` allow you to add a file to a running `mwp`. So if `mwp` was running, either from the command line or Desktop Environment icon, then (for example):

```
mwp --mission file-i-forgot.mission
```

would load the mission `file-i-forgot.mission` into the running `mwp` rather than starting a new instance.

### Drag and Drop

You can *drag and drop* relevant files onto the `mwp` map:

- Blackbox Logs
- Mission Files
- KML Overlays

### Clean and unclean exits

If you exit `mwp` from the **Quit** menu (or Control-Q key shortcut), then the current dock layout will be saved; if you close `mwp` from the Window Manager `close` title bar button, or CLI `kill` command, the layout is not saved; this is a feature.

## 1.3 User interface

### 1.3.1 Main Window



The mwp main window and the main user interface elements are:

1. **Menu bar.** The menu options are described later.
2. **Map and Mission** settings
3. **Communications and telemetry** settings
4. **Map window**
5. **Dock Bar**
6. **Dock Items (Docklets)**
7. **Mouse location** (user preference units, cursor or map centre location)
8. **Flight controller** information
9. **Sensor status and flight timer**

In the sections that follow, there will be a brief summary of each part; more detail will then be provided in subsequent sections.

### 1.3.2 Menu Bar (1)

The following tables summarise the available menu options. Where usage is not obvious, operation will be described later on.

**File Menu**

Item	Usage
Open Mission	Offers a dialog to <a href="#">open a mission file</a>
Append Mission file	<a href="#">Appends a mission</a> to the current mission set (creates a multi-mission element)
Save Mission	Saves the mission to the current mission file, overwriting any extant content
Save Mission As	Saves the mission to a user selected file. For a <a href="#">multi-mission</a> the user can choose not to save specified mission segments.
Download Mission from FC	<a href="#">Downs a (multi-) mission</a> from the flight controller
Upload Mission to FC > Upload Active Mission	<a href="#">Uploads the current mission segment</a> to the flight controller
Upload Mission to FC > Upload All Missions	<a href="#">Uploads all mission segments</a> to the flight controller
Restore Mission from EEPROM	Restores the EEPROM stored mission from the flight controller
Save Mission to EEPROM	Saves the current mission segment(s) to the flight controller. The current active mission segment (in a multi-mission) is set as the active mission in the FC
Replay mwp log	Replay a mwp (JSON) log file
Load mwp log	Loads a mwp (JSON) log file (i.e, as fast as practical, ignoring timings)
Replay blackbox log	Replays a Blackbox log file
Load blackbox log	Loads a Blackbox log file (i.e, as fast as practical, ignoring timings)
Replay OTX log	Replays an OpenTX / EdgeTX CSV log file. (Also BulletGCSS and ArduPilot logs where available)
Load OTX log	Loads an OpenTX / EdgeTX CSV log file. (Also BulletGCSS and ArduPilot logs where available)
Stop Replay	Stops a running replay
Static Overlay > Load	Loads a static KML format overlay file
Static Overlay > Remove	Removes a loaded KML file from the display
Safe Homes	Invokes the <a href="#">INAV safe-home editor</a>
Quit	Cleanly quits the application, saving the display layout

**Edit Menu**

Item	Usage
Preferences	Displays the <a href="#">preferences</a> dialogue
Multi Mission Manager	Display the multi-mission dialogue to remove segments from a multi-mission
CLI serial terminal	Displays the <a href="#">INAV</a> CLI using the current connection
Nav Config	(Legacy MW) MW Nav Configuration
Get FC Mission Info	Display the mission status from a connected FC
Seed current map	Shows a dialogue to seed the map cache for offline (field) use
Reboot FC	Reboots a connected flight controller
Audio Test	Reads out the <a href="#">mwp</a> version number as an audio test

**View Menu**

Item	Usage
Zoom to Mission	Zooms the map to the currently loaded mission
Set location as default	Sets the current location as the default (startup) location
Centre on position ...	Shows the "Centre on Position" selector and "favourite places" editor"
Map Source	Displays a dialogue with information on the selected map source
GPS Statistics	Displays FC GPS status (rate, packets, errors, timeouts, HDOP/EPV/EPH)
Mission Editor	Adds the Mission Editor (tabular view) to the dock (default)
MW Nav Status	Adds the (legacy MW) Nav Status docklet to the dock
GPS Status	Adds the (legacy MW) GPS Status docklet to the dock
Radio Status	Adds the radio status docklet to the dock (default)
Battery Monitor	Adds the Battery Status docklet to the dock (default)
Telemetry Status	Adds the Telemetry Status docklet to the dock
Artificial Horizon	Adds the Artificial Horizon docklet to the dock (default)
Direction View	Adds the Direction View (mag v. GPS) docklet to the dock
Flight View	Adds the Flight View docklet to the dock (default)
Vario View	Adds the Vario docklet to the dock
Radar View	Displays the <a href="#">Radar (inav radar / ADS-B) view</a>
Flight Statistics	Display the flight statistic dialogue (also automatic on disarm)
Layout Manager > Save	Saves the current dock layout
Layout Manager > Restore	Restores a saved dock layout
Video Stream	Opens the (live) video stream window
GCS Location	Displays the indicative <a href="#">GCS location icon</a>

**Help Menu**

Item	Usage
Shortcut keys list	Displays the short cut keys list
About	Displays version, author and copyright information

**1.3.3 Map and Mission Settings (2)**

A number of different map providers are available. [mwp](#) offers the mapping library (`libchamplain`) defaults, Bing Maps (Bing Proxy) using a bespoke [mwp](#) API key, and [user defined options](#), for example [anonymous maps](#).

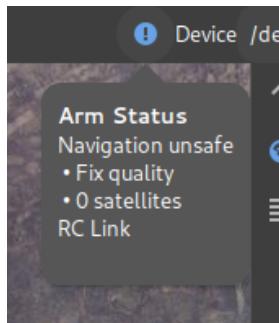
The zoom level may be selected from the control here, or by zooming the map with the mouse wheel.

The [+Edit WPs](#) button enables mission edit mode (click on the map to create a WP, drag to move, right mouse button for properties). Graphical WP editing may be augmented by the table orientated [mission table view](#), which allows additional control (altitude, speed, special functions, for example [fly-by-home](#) waypoints).

The "Active Mission" drop down supports [INAV 4.0+ multi-mission](#). There is also a [multi-mission manager](#) under the [Edit](#) menu.

### 1.3.4 Communications and telemetry settings (3)

There is a (blue "!" in the example) 'navigation safe' status icon. If this icon is shown (i.e. navigation is *unsafe*, then clicking on the item will provide more information:



The **Device** drop-down offers detected and pre-set (**Preferences**) devices for the FC / telemetry port. The device syntax is described the [Device and Protocol definition](#) chapter.

The **Protocol Selection** drop-down (showing **Auto** in the reference image) allows the user to provide a hint as to communication protocols available on **Device**. These are further described in the [Device and Protocol definition](#) article.

The **Connect / Disconnect** button connects / disconnects the displayed device.

The **auto** button causes [mwp](#) to automatically attempt to connect to the nominated device.

### 1.3.5 Map Area (4)

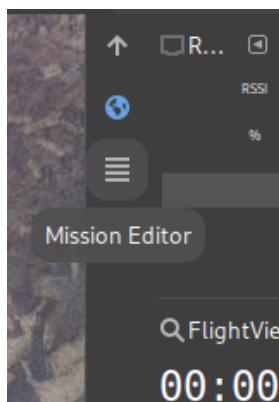
The map area displays the currently selected map at the desired zoom level. The map may be managed using familiar controls (drag, scroll wheel etc).

#### **i** Graphics Requirement

The map API used by [mwp](#) requires OpenGL / 3D accelerated graphics. Performance with software rendering is likely to be disappointing and CPU intensive.

### 1.3.6 Dock Bar (5)

The **Dock Bar** contains essentially minimised **Docklets**, selected from the **View** menu. In the illustration, these are the **Vario** view, **Telemetry** statistics, and **Mission Editor**. Hovering the mouse over the icon will reveal its function:



### 1.3.7 Docklets (6)

**Docklets** are display items that can be docked, iconised, hidden or displayed in floating windows. See [Dock Management](#). In the **main window screen shot** (left to right, top to bottom) we have:

- Radio status (RSSI or LQ)
- Artificial horizon
- Direction Status (Heading (Position Estimator/Compass v. GPS)). Useful to diagnose mag EMF interference on multi-rotors).
- Flight View. General geo-spatial information.
- Battery status. Current usage is also shown when available.

### 1.3.8 Location (7)

The location (of the mouse pointer), [user setting pos-is-centre](#) for either mouse pointer or map centre, and display format ([Preferences](#)).

### 1.3.9 FC Information (8)

Displays the firmware, version and build with API information, profile and flight mode.

### 1.3.10 Sensors and flight status (9)

- Follow : [user setting auto-follow](#). whether the map always displays the aircraft icon (requires GPS).
- In View : Scrolls the map to keep the aircraft in view; otherwise the map is centred on the aircraft (requires GPS).
- Logger : Generate mwp logs (JSON format).
- Audio : [user setting audio-on-arm](#). Whether to "speak" status information.

The green / red bars show gyro / acc / baro / mag / gps / sonar sensor status. If a required sensor fails, a map annotation will be displayed, together with an audible alarm.



## 1.4 Dock Concepts and Usage

### 1.4.1 Dock Overview

The **dock**, items 5 and 6 in the main window guide provides an area for optional widgets.



This [slightly outdated video](#) that describes dock usage probably better than written words can do.

[Watch on Vimeo](#)

#### i Current Status

- The dock is now installed populated.
- WP editor switch is enabled by default
- There is now a graphical "favourite places" editor
- The build system is no longer make

## 1.4.2 Dock Usage

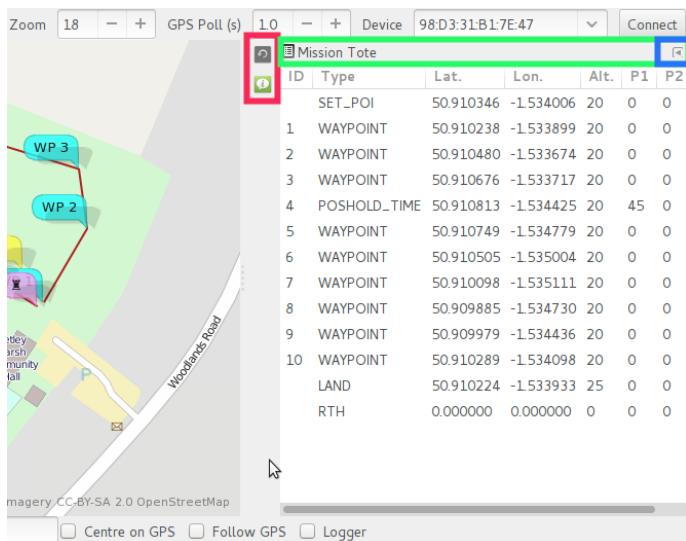
**mwp** uses the GNOME Docking Library (`gdl`) to provide a dock capability. Items in the dock may be hidden, iconified or torn off into a separate window (that may then be returned to the dock). This section explains how to use `gdl` in **mwp**. There is also an [ancient short \(silent\) video](#) illustrating the following dock actions.

- Load a mission into the mission tote
- Load the Nav Status into the dock bar
- Click the Nav Status icon to view nav status in the dock
- Move the Nav status view into a window
- Drag the Nav Status window back into the dock, selecting one of dock locations offered
- Minimise the Nav Status back to the dock bar (the little arrow)
- Reopen the Nav Status into the dock
- Hide the Nav Status
- Restore the Nav Status as a dock icon
- Reopen Nav Status in the dock.

### ⚠️ Caveat updates

If a **mwp** software update expands the dock by adding new dock items, any previously saved dock layouts are invalidated, and you will have to manually recreate them. Fortunately, this is a rare occurrence.

The main dock controls are shown below:



>This is an old image from c. 2015.

- Highlight in **red** : the dock icons. Clicking on these will restore the window (either to the dock, or as a separate window)
- Highlight in **green** : the dock item bar. Where multiple items are in the dock, the tab icon may be dragged to reposition the docked window. It also has a pop-up menu, that allows the item to be completely hidden (but recoverable from the View menu), and
- Highlight in **blue** : a iconify widget that will add the item to dock icon bar (the red highlighted area).

If the item bar icon (left-most in the green area) is dragged from the dock, the item will appear as a separate window. The detached window may be added back to the dock by dragging the window's "item bar" back into the dock, or added back to the dock icon bar using the iconify button (the left facing arrow to the right of the window's "item bar"). If the detached window is closed, then it becomes hidden, and may be reattached to the dock (as an iconified dock item) from the View menu.

### Wayland Display API

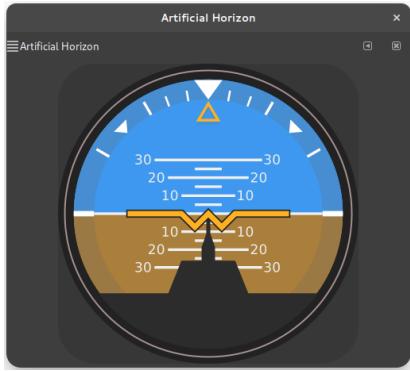
When docklets are dragged around to reposition then, an "target" landing area is shown on the dock area. Unfortunately, the some older versions of the "modern" **Wayland** display manager breaks this in a way that only the upstream maintainers can fix. The workaround is to temporarily force X11 mode:

```
# In a terminal
$ GDK_BACKEND=x11 mwp
# Drag dock items around
$ mwp # items moved, Wayland again
```

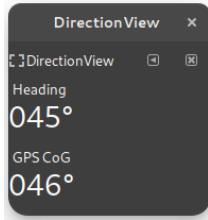
## 1.4.3 Dock Items (Dockets)

The following items are provided.

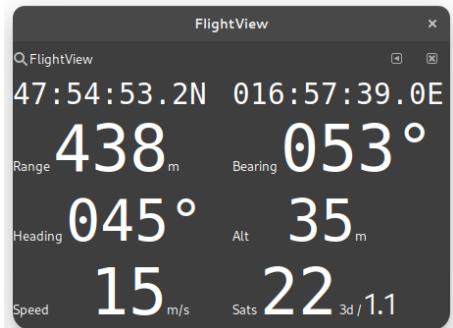
### Artificial Horizon



### Direction View



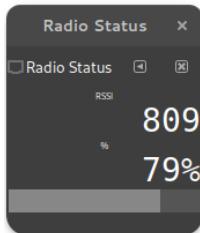
### Flight View



### Mission Editor

ID	Type	Lat	Lon	Alt	Spd	R/A	FBH	
1	WAYPOINT	54:07:28.6N	004:43:55.5W	241	12.0	0	1	<input type="radio"/>
2	WAYPOINT	54:07:30.1N	004:43:48.3W	182	12.0	0	1	<input checked="" type="radio"/>
3	WAYPOINT	54:07:44.8N	004:43:45.9W	340	12.0	0	1	<input type="radio"/>
4	WAYPOINT	54:07:55.4N	004:43:52.0W	292	12.0	0	1	<input type="radio"/>
5	WAYPOINT	54:08:00.2N	004:43:20.6W	413	12.0	0	1	<input type="radio"/>
6	WAYPOINT	54:08:14.2N	004:43:11.0W	451	12.0	0	1	<input type="radio"/>
7	WAYPOINT	54:08:41.4N	004:42:43.6W	338	12.0	0	1	<input type="radio"/>
8	WAYPOINT	54:08:46.7N	004:42:17.7W	260	12.0	0	1	<input type="radio"/>
9	WAYPOINT	54:08:59.1N	004:41:41.8W	276	12.0	0	1	<input type="radio"/>
10	WAYPOINT	54:09:08.5N	004:40:20.4W	459	12.0	0	1	<input type="radio"/>
11	WAYPOINT	54:08:58.1N	004:40:00.5W	500	12.0	0	1	<input type="radio"/>
12	WAYPOINT	54:08:35.7N	004:40:41.5W	327	12.0	0	1	<input type="radio"/>
13	JUMP	00:00:00.0N	000:00:00.0E	0	7	1	0	
14	WAYPOINT	54:07:35.5N	004:43:18.7W	411	12.0	0	1	<input type="radio"/>
15	WAYPOINT	54:07:31.1N	004:43:38.7W	45	0.0	0	0	<input type="radio"/>
RTH		00:00:00.0N	000:00:00.0E	0	0	0	0	

### Radio Status

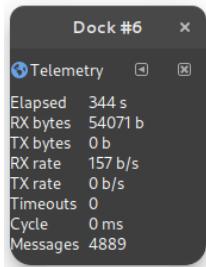
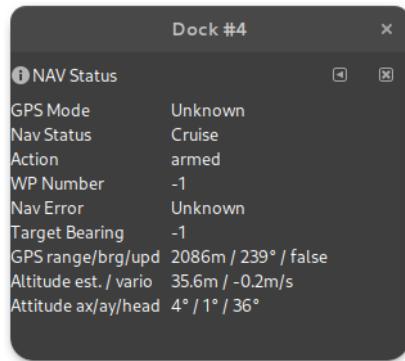


### Battery Monitor



### Vario View



**Telemetry View****MW Nav Status****MW GPS Status**

## 1.5 Mission Editor

### 1.5.1 Overview

Another [slightly outdated video](#), generic mission editing.

[Watch on Vimeo](#)

**i Current situation**

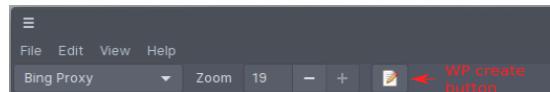
- INAV now supports 120 waypoints
- INAV now supports `SET_POI` and other multiwii waypoint types.
- Delete from the map popup context menu behaves as it does in the tabular editor; it removes the RTH state.

Please also refer to the following chapters that provide specific information for advanced INAV capability topics:

- [INAV multi-missions](#)
- [INAV fly-by-home](#)

### 1.5.2 Map Features

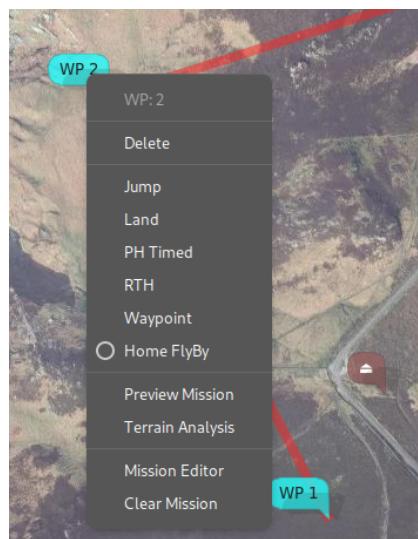
Missions are edited on the map by enabling mission edit mode:



This will:

- Display a notional home location (brown icon)
- Allow new WPs to be created by clicking on the map
- Provide a context popup menu by right click on a WP icon

The context menu depends on the type of the current WP, for example:



The use of more advanced functions, for example setting parameter values, moving multiple WP, mission preview etc. requires the tabular mission editor

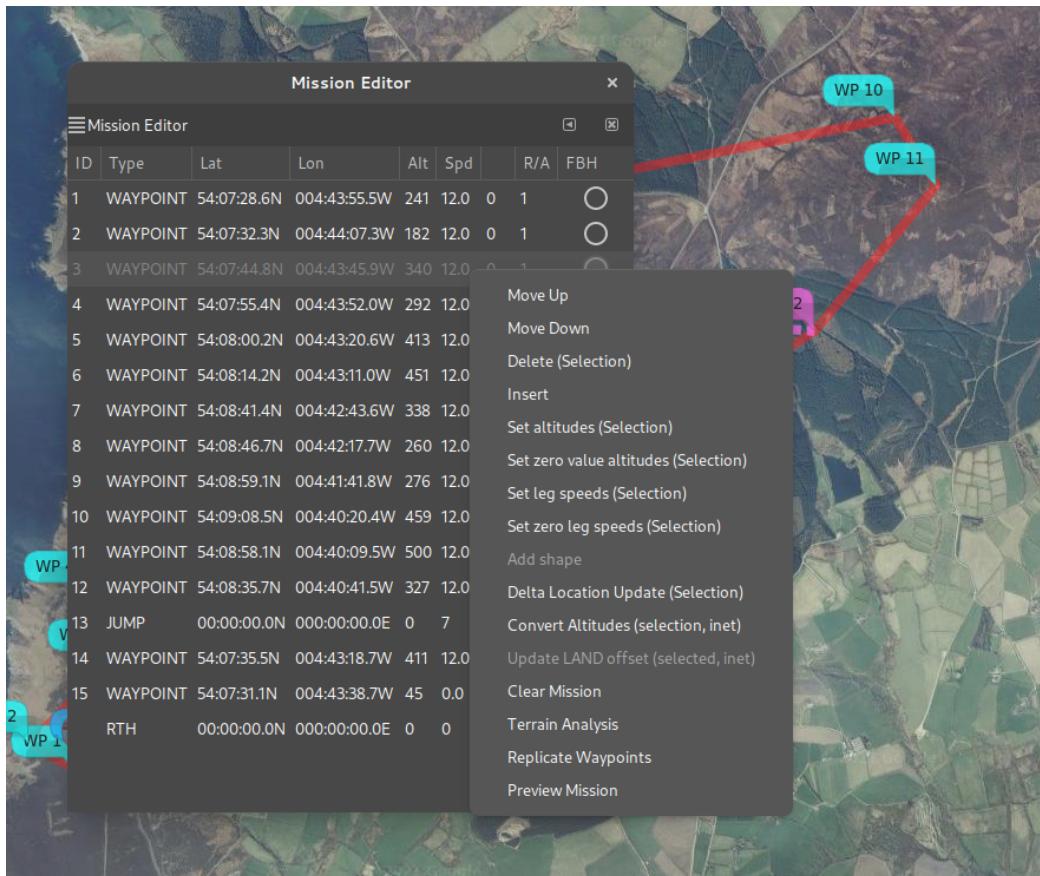
### 1.5.3 Mission Editor

The mission editor may be invoked from the [dock](#) or from a WP context menu.

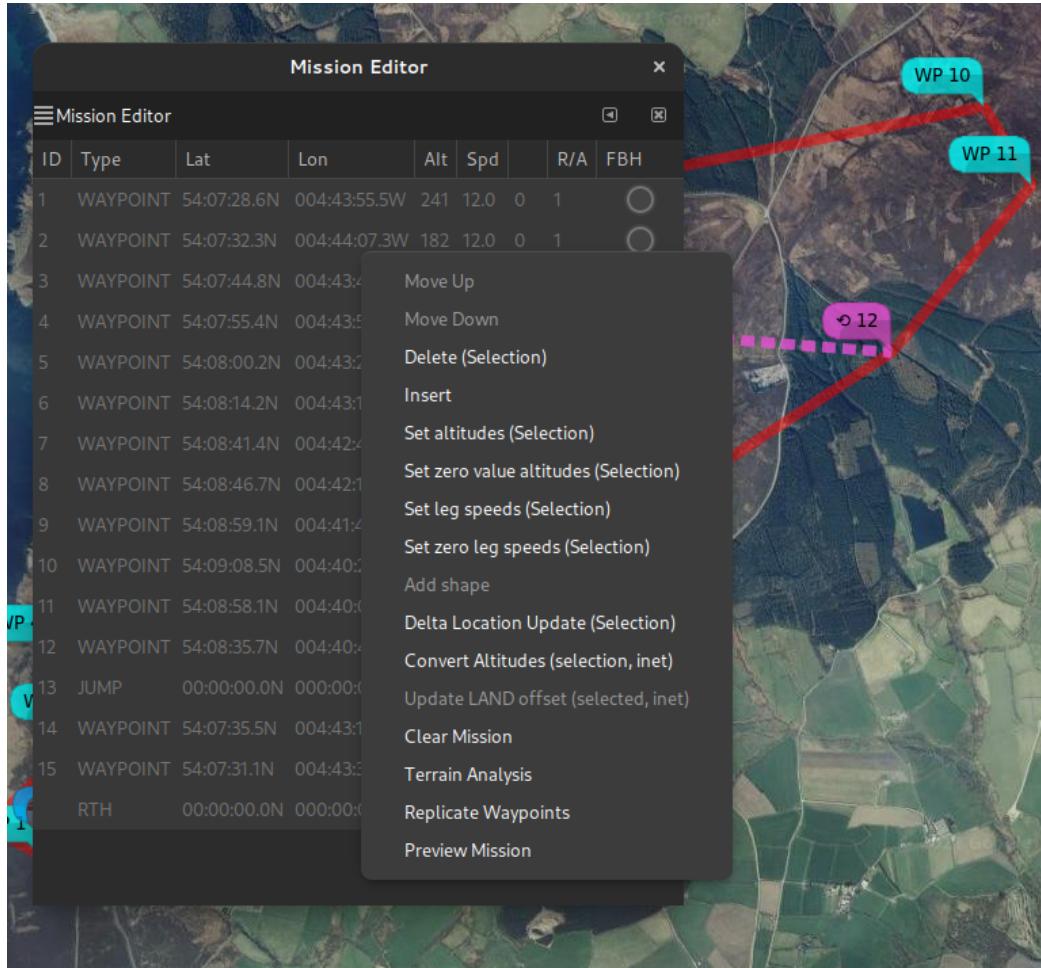
It provides the following functions:

- Create, delete, modify, reorder waypoints.
- Inline editing of parameters
- Context sensitive column titles for parameter editing
- Bulk updates (altitudes, speeds, position offsets)
- Automated path (polygon around a shape) generation.
- [Terrain Analysis](#), automated altitude correction.

There is a right mouse context menu, the availability of items depending on whether zero, one or multiple items are selected.



*Single selection context menu*



Multiple selection context menu

### Common Operations

Many of the operations described below are shown in the videos, which probably provide a clearer explanation than any textual description could.

## EDITING

Way points can be edited Mission Editor. When a row is selected, the column headers will change to indicate the data fields appropriate to the point type (in particular the “parameters” P1,P2,P3 whose interpretation is dependent on the point type).

- Position. The position of a way point may be changed by dragging the way point icon on the map or editing in the list.
- Order. The order of way points may be changed by either:
  - Using the “Move Up” and “Move Down” entries from the mission pop-up menu; or
  - Dragging the list item to the desired position. In order to drag, the entry must be ‘grabbed’ on the ID column. In that screen-shot (below), way point 7 is being dropped between way points 3 and 4.
  - At the end of the drop, the list and markers on the map will be re-ordered.

ID	Type	Lat	Lon	Alt	
	SET_POI	50:48:20.2N	001:29:40.2W	20	
1	WAYPOINT	50:48:18.1N	001:29:37.4W	20	
2	WAYPOINT	50:48:18.5N	001:29:41.3W	20	
3	WAYPOINT	50:48:19.9N	001:29:44.3W	20	
4	WAYPOINT	50:48:20.3N	001:29:36.8W	20	
5	WAYPOINT	50:48:22.0N	001:29:40.4W	20	
6	WAYPOINT	50:48:21.5N	001:29:38.9W	20	
7	WAYPOINT	50:48:20.3N	001:29:36.8W	20	
8	WAYPOINT	50:48:19.7N	001:29:35.8W	20	
9	WAYPOINT	50:48:18.7N	001:29:35.6W	20	
	LAND	50:48:18.1N	001:29:36.8W	20	

- Type. The way point type may be selected from a drop down menu embedded in the “Type” column of the list:

ID	Type	Lat	Lon	Alt	
	SET_POI	50:48:20.2N	001:29:40.2W	20	0 0 0
1	POINT	50:48:18.1N	001:29:37.4W	20	0 0 0
2	WAYPOINT	18.5N	001:29:41.3W	20	0 0 0
3	POS HOLD_UNLIM	19.9N	001:29:44.3W	20	0 0 0
4	POS HOLD_UNLIM	21.4N	001:29:43.3W	20	0 0 0
5	POS HOLD_TIME	22.0N	001:29:40.4W	20	0 0 0
6	RTH	21.5N	001:29:38.9W	20	0 0 0
7	SET_POI	20.3N	001:29:36.8W	20	0 0 0
8	JUMP	19.7N	001:29:35.8W	20	0 0 0
9	SET_HEAD	18.7N	001:29:35.6W	20	0 0 0
	LAND	18.1N	001:29:36.8W	20	0 0 0

Once the type has been changed, default parameters for that way point type or action will be set. The type may also be set by a right mouse button click on the map symbol.

- Altitude. New points are created with the default altitude (from the “Preferences”). Some basic validation is performed
- Parameters P1, P2 and P3. The parameters P1,P2 and P3 are integer values that have a meaning specific to the way-point type or action. For example, for action type of JUMP, P1 is the point to which to jump, and P2 is the number of repeats. This usage is documented in the [INAV wiki](#).
- Delete. The delete action will delete the selected (highlighted) way point(s). If no way point is selected, this option has no affect.

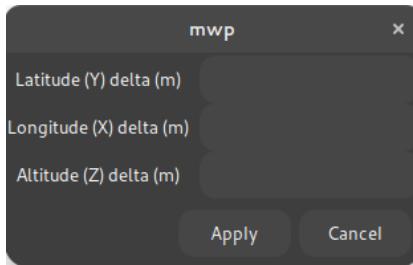
**ADD SHAPE**

If a SET POI point is added to the mission, (there may also be other extant way-points), this option will display a dialogue to enter the number of points in a shape, the radial distance (from the SET POI to each point), an offset angle and the direction of rotation. i.e this defines a polygon around the POI.

- The offset is relative to North. If you wanted the lines to be horizontal / vertical, specify an offset of 45° for a square.
- Shape points are appended to any extant mission points, and the shape tool may be invoked multiple times, for example to create 'concentric' circles.
- The `SET_POI` point may be deleted, unless you really want `SET_POI` functionality.

**LOCATION UPDATES**

Bulk location updates may be applied to selected waypoints.



If an item if left black (or 0), then no adjustment is applied to that axis. Offsets are in metres, regardless of the user's preference distance unit.

**SPEED AND ALTITUDE UPDATES**

Bulk speed and altitude updates may be applied to selected waypoints.

**CONVERT ALTITUDES**

From INAV 3.0, INAV supports both relative and AMSL altitudes. This, and the `mwp` features for managing this, are described [in a separate chapter](#)

**REPLICATE WAYPOINTS**

This item facilitates the cloning of waypoints. Since INAV now supports the JUMP waypoint type, this option is less useful than it was previously.

**PREVIEW MISSION**

"[Flies](#)" an aircraft icon around the mission; this may be useful for predicting the behaviour of multiple embedded JUMPs.

**CLEAR MISSION**

The Clear Mission option clears the mission. There is no confirmation, so be sure you really want to do this.

**1.5.4 Advanced WP types / Video Tutorials****JUMP, POSHOLD TIMED, LAND**

[Video example](#) setting up JUMP, POSHOLD TIMED and LAND waypoints.

[Watch on Youtube](#)

**SET\_POI, SET\_HEAD as mission elements**

[Video example](#) SET\_POI and SET\_HEAD (real mission usage).

[Youtube video](#)

### Mission Preview

[Video example](#) of preview for a complex (multiple jumps, timed POSHOLD) mission (preview from the first video).

[Watch on Youtube](#)

## 1.6 Ground Control Station Features

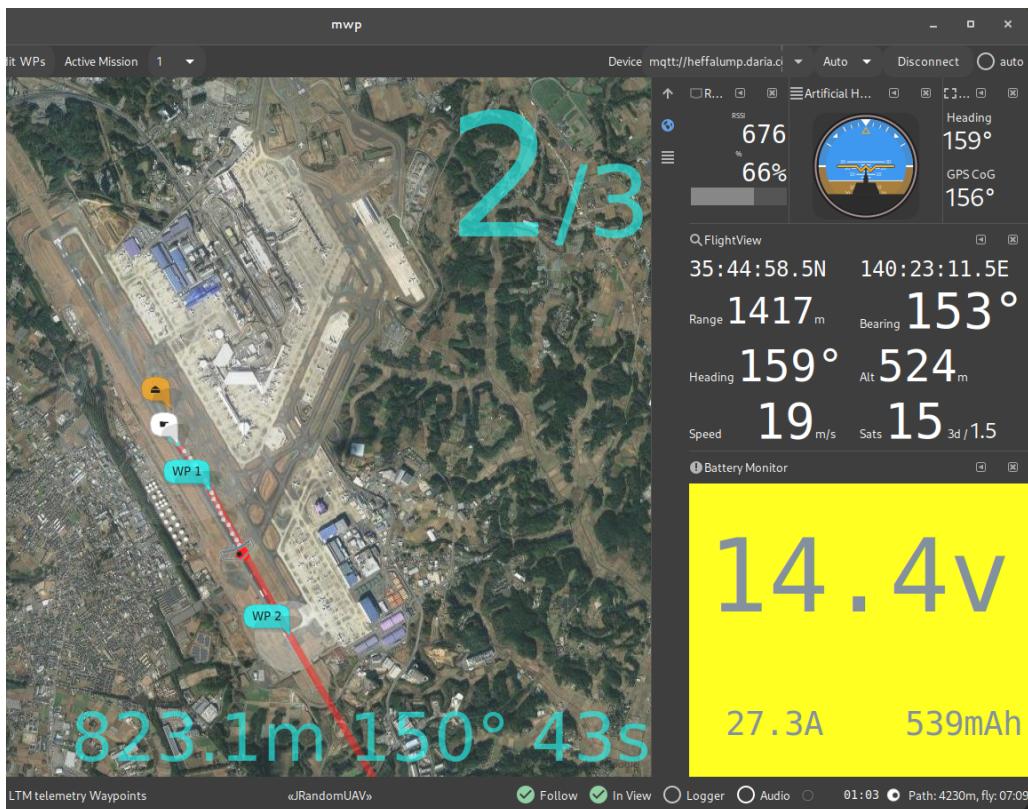
### 1.6.1 GCS Usage

#### Basic functionality

- Real time tracking of vehicle via [telemetry](#)
- Audio status reports
- OSD style WP information
- [Radar view](#) of other aircraft
- In picture [video feed display](#).

#### OSD information

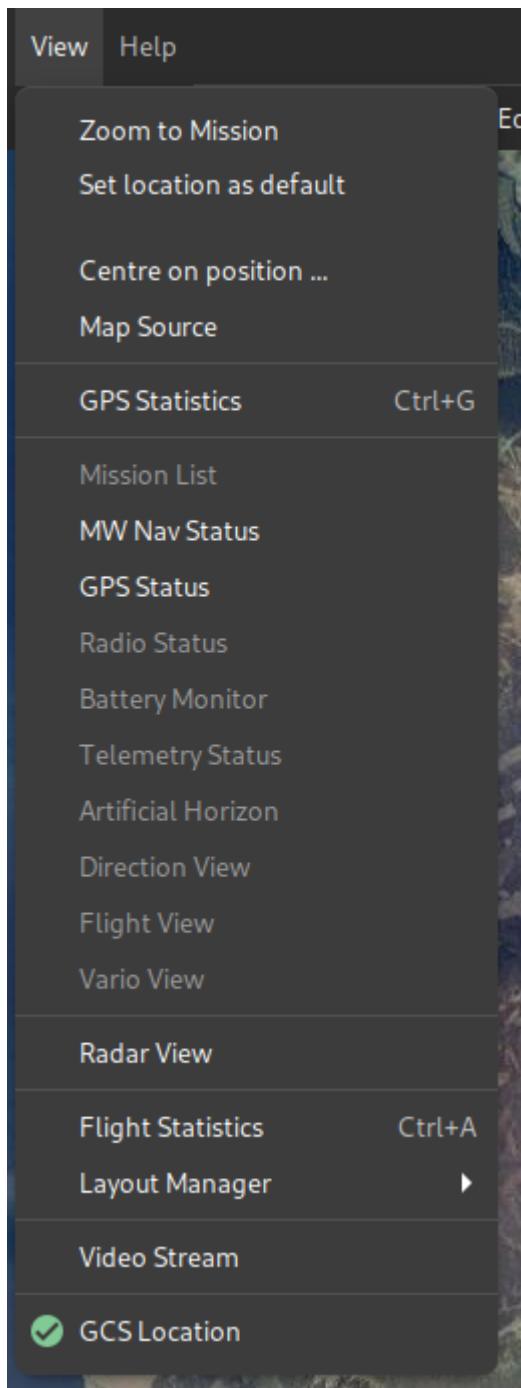
When flying waypoints, if the mission is also loaded into [mwp](#), [mwp](#) can display some limited OSD information.



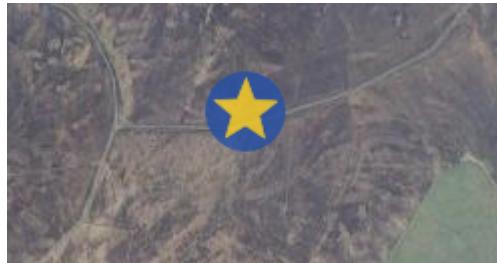
Various settings (colour, items displayed etc.) are defined by [settings](#).

#### GCS Location Icon

A icon representing the "somewhat static" GCS location can be activated from the **View/GCS Location** menu option:



By default, it will display a tasteful gold star which one may drag around. It has little purpose other than showing some user specified location (but see [below](#)).

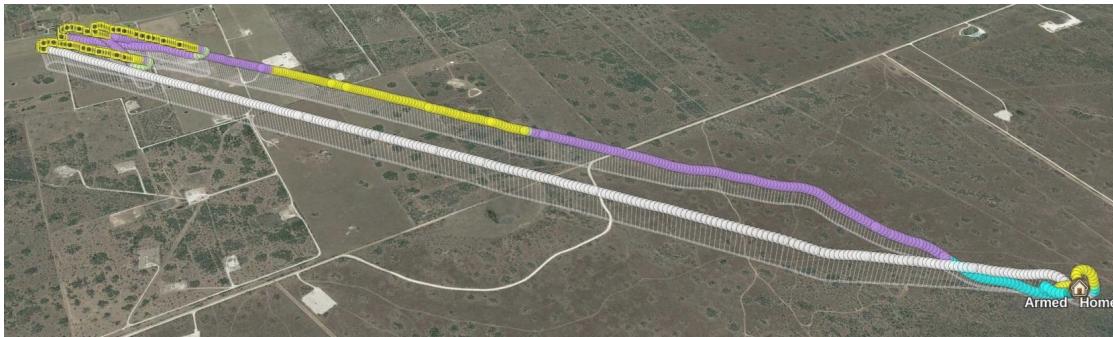


If you don't like the icon, you can override it by creating your own icon.

- If `gpsd` is detected (on `localhost`), then the position will be driven by `gpsd`, as long as it has a 3D fix.
- The one usage is when `inav-radar` is active; if the GCS icon is enabled (either by manual location or driven by `gpsd`), then rather than being a passive 'GCS' node, `mwp` will masquerade as an 'INAV' node and advertise the GCS (icon) location to other nodes. This implies that you have sufficient LoRa slots to support this node usage.

## 1.7 Replay Tools

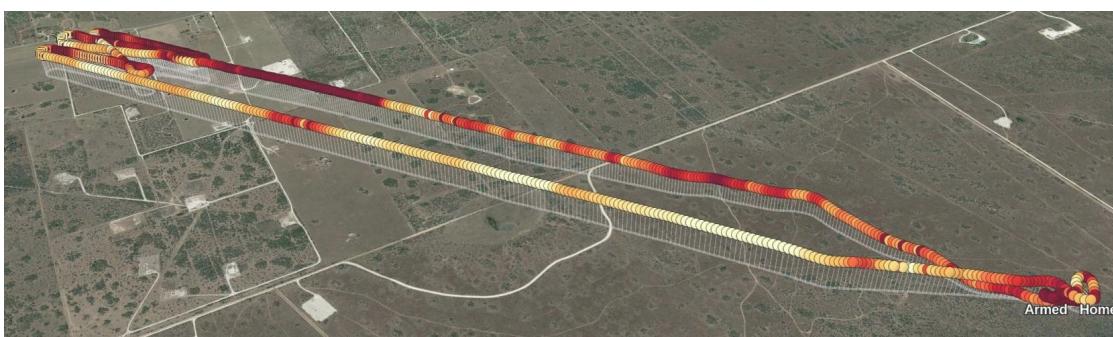
in order to replay log files, [mwp](#) has a number of external dependencies, in particular the [flightlog2x fl2ltm](#) tool provided by the [bbl2kml](#) repository. As well as providing replay tools for [mwp](#), you also get the facility to generate attractive animated KML / KMZ files for visualisation in [google-earth](#).



*Flight mode view*



*RSSI view*



*Efficiency view*

### Analysis

The RSSI view shows why the aircraft is playing "failsafe ping-pong" at the right extreme of flight

Binary packages are provided for many popular platforms.

### 1.7.1 Blackbox replay

In order to replay blackbox logs, you additionally need [inav blackbox tools](#), specifically `blackbox_decode`). Binary packages are provided for many popular platforms. The minimum required version is 0.4.4, the latest release is recommended.

### 1.7.2 OpenTX / EdgeTX logs (Smartport)

OpenTX enables the storage of Smartport telemetry logs on a transmitter's SD-Card. These logs contain all the (Frsky) telemetry information transmitted from the flight controller.

[mwp](#) can replay these logs, in a similar manner to the replay of Blackbox or mwp logs, albeit with less detail and typically at lower data rates.

- Enable Frsky telemetry on the FC
- Enable telemetry logging on the TX
- Post flight, transfer the log from the LOGS directory of the SD card to your computer
- Replay the log using the Replay OTX Log (or Load OTX Log for a "fast-forward" rendering)
- Limited support is available of TX logs from Ardupilot.

No addition software requirements.

### 1.7.3 BulletGCSS Logs

Requires that [mwp](#) is built with [MQTT support](#).

No addition software requirements.

### 1.7.4 Ardupilot logs

Requires Ardupilot's [mavlogdump.py](#) and [dependencies](#).

### 1.7.5 mwp JSON logs

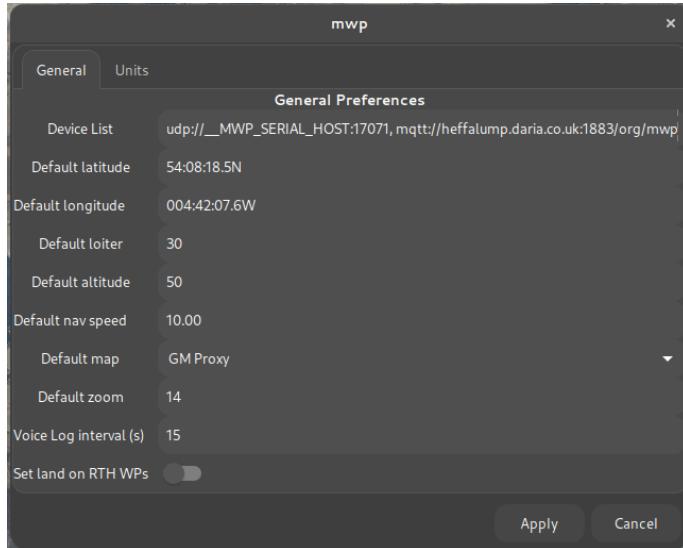
No addition requirements.

## 1.8 Miscellaneous UI Elements

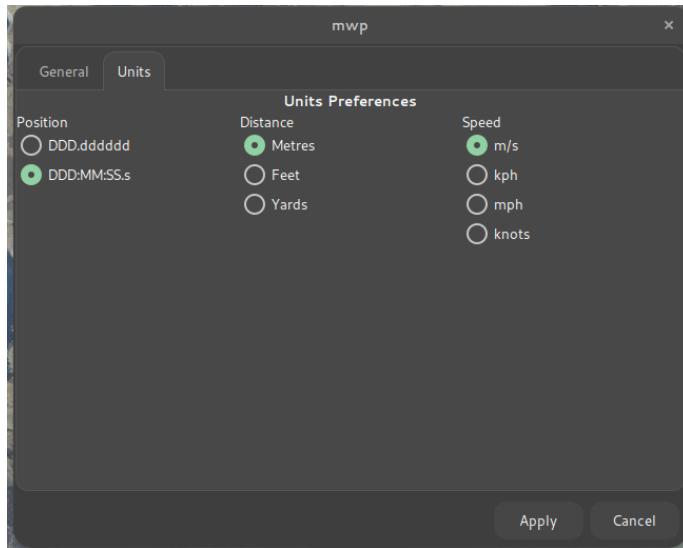
### 1.8.1 Preferences

The "Edit > Preferences" menu provides a UI for some `gsetting` / `dconf` [settings](#). The settings here are applied immediately if 'Apply' is clicked.

#### General Preferences



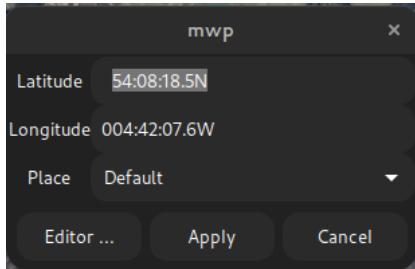
#### Units Preferences



Unit preferences should be instantly reflected in the UI when 'Apply' is clicked.

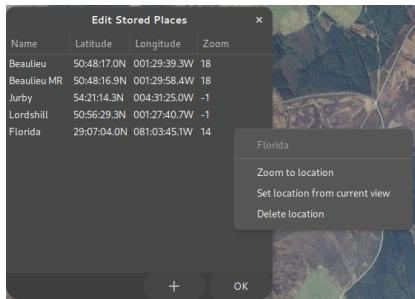
#### Favourite Places

mwp maintains a list of favourite places, from "View > Centre on Location" menu item.



The "Place" combo menu holds all places defined in `~/.config/mwp/places` (see the [configuration reference](#)).

For convenience, clicking the 'Editor ...' button will load the "Places Editor".



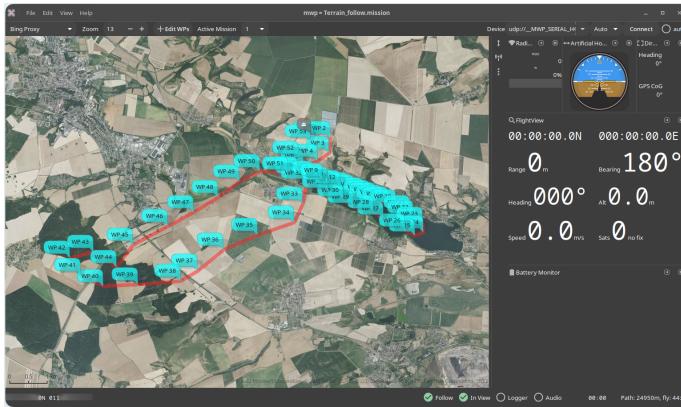
- New items are added with the + button.
- Locations can be edited in place
- The context (right mouse button) menu:
  - Zoom to location : Zooms to the place
  - Set location from current view : Sets the location to the centre of the current map view
  - Delete location : Deletes the location without question.
- **OK** Saves the locations to `~/.config/mwp/places`
- Closing using the window manager X icon closes without saving.

## 1.9 Terrain Avoidance Quick Guide

There's already quite a long article on [mwp's terrain analysis tool](#); this is a quick summary of how to use it in three easy steps.

### 1.9.1 1. Load your mission

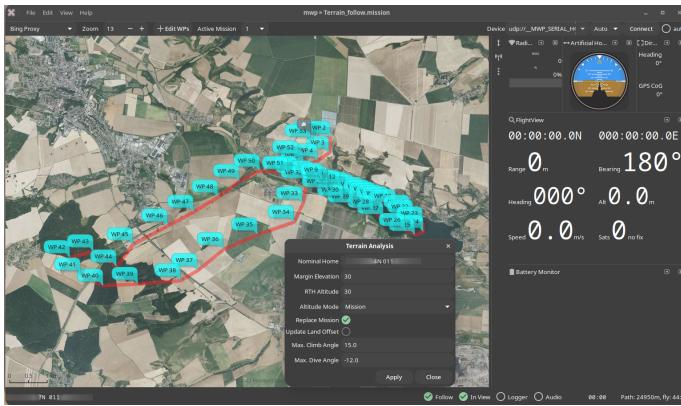
First load (or create) the mission in mwp. Here, the pilot chooses to take a cruise around the lake and adjacent country side. The brown / grey icon at the top of the mission is the planned home location. At first glance, the terrain looks quite benign.



### 1.9.2 2. Set your avoidance parameters

By right clicking on any waypoint, we can select **Terrain Analysis**. As this will use Bing Maps, we need to have an internet connection. We set the analysis parameters:

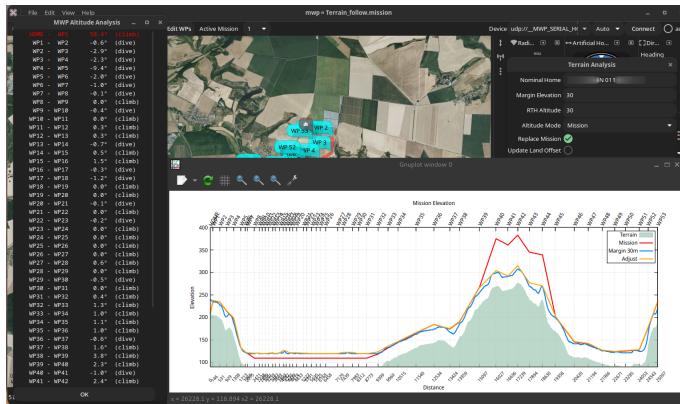
- Home is taken from the planned home location
- The pilot elects for 30m clearance above terrain
- Uses the same altitude definition (Relative / Absolute) as is set in the extant mission
- Replace the mission altitudes with the altitudes generated from the analysis
- Highlight any extreme climb / dive angles



On clicking **Apply**, the analysis will run.

### 1.9.3 3. Review the output

The output is displayed as a chart of the terrain (green), the original mission (red), the avoidance margin (blue, 30m in this example), and the adjusted mission (orange). There is also a Climb / Dive analysis.



There are a few places that could benefit from further manual adjustment, but in general it looks pretty good.

- We could eliminate the unnecessary small dips at WP37, WP41 and WP43
- It is unlikely we'll try the extreme climb from HOME to WP1; the mission will probably be invoked some distance from home.

So it looks good. Or does it?

#### 1.9.4 Terrain may not be the only hazard

The terrain analysis is only as good as the terrain data. If we zoom in closely, or look at a difference map source (e.g. OpenTopo), or examine the route in 3D (Google Earth) via [flightlog2kml](#) / [mission2kml](#), maybe from [fl2xui](#) we can see another hazard. Between WP36-WP37 and WP47-WP48 there are high voltage overhead transmission lines. Hitting these, or at WP48, the tower would be sub-optimal.



A replan seems like a good idea, at least adding significant altitude on these legs of the mission.

## 1.10 Mission Elevation

### 1.10.1 Overview

Prior to INAV 3.0, mission altitudes are relative to the HOME (arming) location, which is not part of a mission definition. As a result, the pilot has to ensure by some other means that the mission will clear any raised elevations on the mission path. For INAV 3.0, missions may be either [relative to home or absolute](#) (above a [datum, see below](#)).

**mwp** includes a `mwp-plot-elevations` tool that performs mission and terrain analysis. Prior to 2021-05-03, this was provided by a ruby script in `mwp-tools/samples`; since 2021-05-03 there is a Go program (in `mwp-tools/mwp-plot-elevations`) which is an enhanced version, and supports [INAV 3.0 absolute altitude](#) missions. If you're running an older version of **mwp**, or you haven't installed the Go compiler, you can use the older, less functional ruby version, but the Go version is recommended as:

- It supports INAV 3.0 absolute altitude waypoints
- It can update LAND waypoints to offset the difference between the home ground elevation and the LAND WP ground elevation.
- It's much faster
- Its usage is compatible with the deprecated ruby version.
- Bug fixes and improvements

Both the ruby application and the Go application are platform independent and can be used without **mwp** for mission terrain analysis.

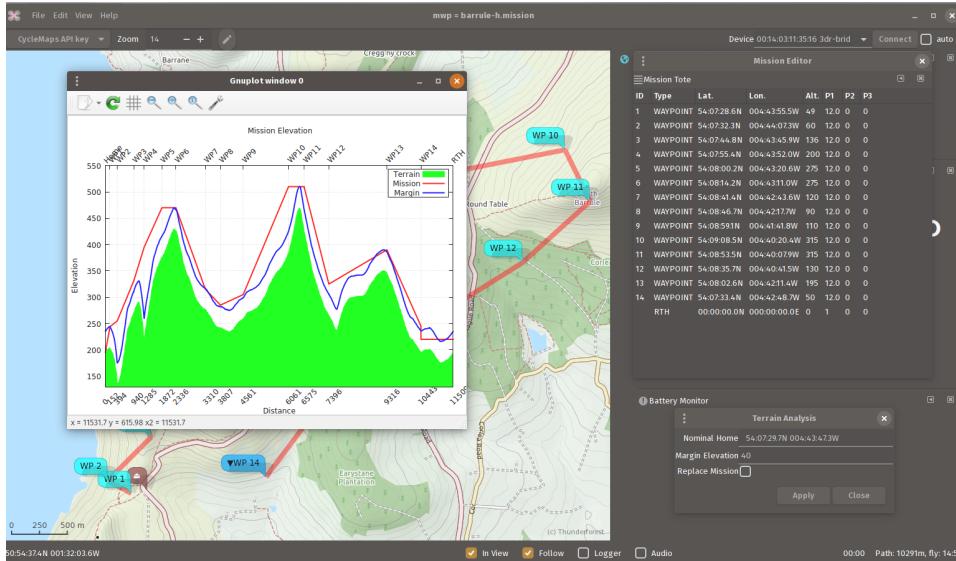
#### Obsolescence Note

Prior to 2021-05, the ruby version was installed as `mwp-plot-elevations.rb`; now it's installed as plain `mwp-plot-elevations` in order that the superior Go version is a drop-in replacement.

`mwp-plot-elevations` can rewrite the mission file with new elevations to provide a specified ground clearance.

### 1.10.2 Video Tutorial & UI integration

From 2018-12-06, `mwp-plot-elevations` is integrated into the `mwp` application.



There is a [video tutorial](#).

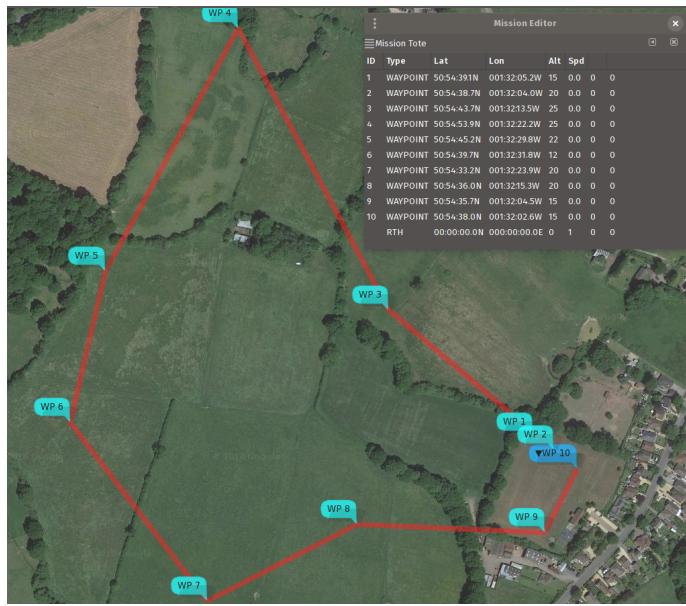
### Obsolescence Note

The video uses the older ruby application, but that doesn't really affect *basic* functionality.

[Watch on Youtube](#)

## 1.10.3 Sample output

Given the mission shown below:



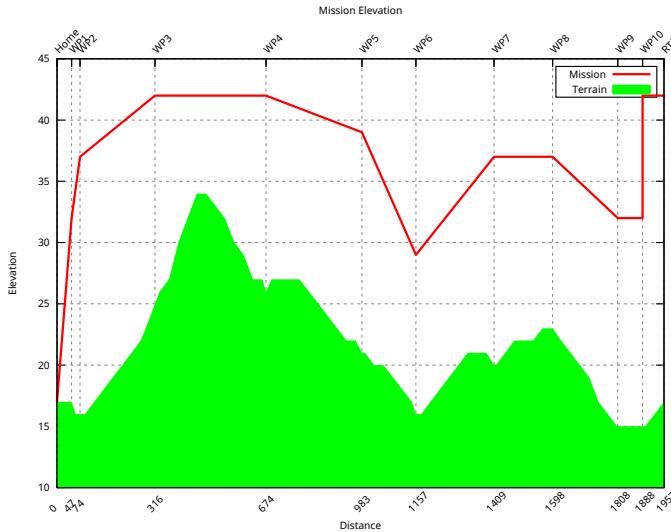
and knowing that the land rises to the north and west, we can check that we do indeed have adequate clearance with the planned route and elevations:

```
# for decimal '.' locales
$ mwp-plot-elevations --home 50.9104826,-1.5350745 --plotfile profile.svg west_field.mission
# for decimal ',' locales
$ mwp-plot-elevations --home "50,9104826 -1,5350745" --plotfile profile.svg west_field.mission
```

where:

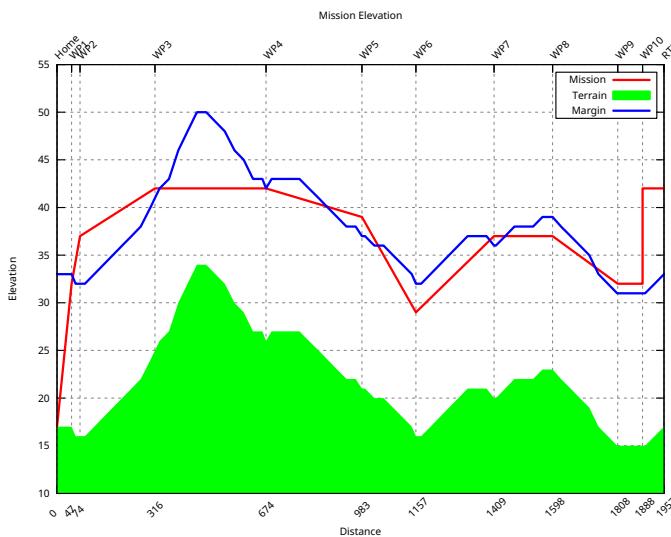
- `west_field.mission` is the MW-XML mission file (via `mwp`, INAV configurator, [ezgui, mission planner for INAV] or `imupload`)
- the `--home lat,lon` option defines the home position (which may also be set by the environment variable `MWP_HOME`), the command line having preference. Note that for modern `mwp` generated mission files, this information is provided in the mission file.
- The graphical output is `profile.svg`, via the `--plotfile` option.

The result from this command is an SVG file, which can be displayed with common image tools (`eog`, ImageMagick `display` et al). It can also be converted to a raster image using e.g. `rsvg-convert`); a sample is shown below:



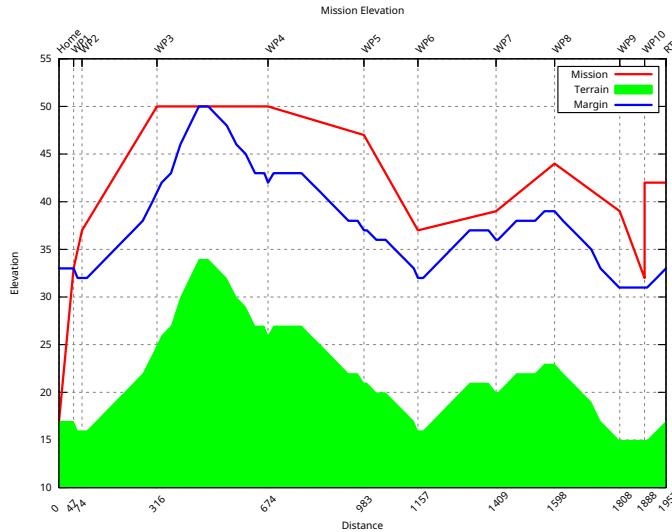
The red line represents the planned mission altitudes (which are defined relative to the estimated home location), and the green area represents the terrain. As we can see, we clear the hill (and other terrain), but cannot guarantee that we have LOS to lowest point of the mission, or that we're clear of the trees.

We can also specify a "clearance" option, in the image below this was set to 16m. Where the blue line is above the red line, one should review that the mission elevations are adequate.



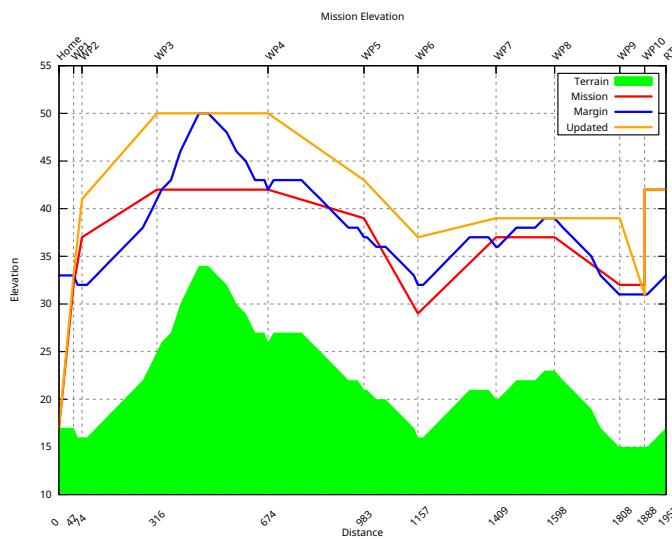
#### 1.10.4 Creating a new mission file

It is also possible (see command line options below) to write out a new mission that takes into account the clearance (`margin` parameter). If we then plot this new mission file, we can see that we are at least `margin` (in this example 16m) distance clear of the terrain.



Note that the original mission elevations are still taken into account. We can also ignore these, so we end up the absolute clearance distance above the terrain.

```
$ mwp-plot-elevations nm_west_field.mission --output /tmp/p1.mission --no-mission-alts
```



## 1.10.5 Dependencies

The `mwp-plot-elevations` has NO dependency on `mwp` or Linux / FreeBSD, it can just as easily be run on MacOS or MS Windows. It does however has some dependencies:

### Go version

- Go compiler (1.13 or later)

### Ruby version

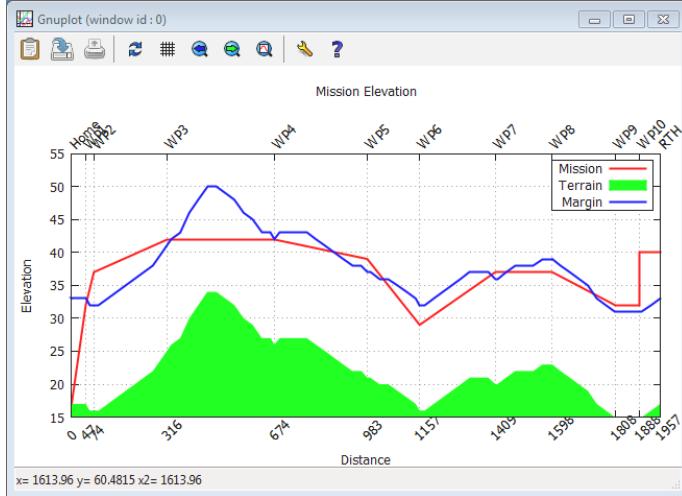
- ruby (2.0 or later)
- ruby 'gems' (libraries)
  - nokogiri
- gnuplot

`gnuplot` is easily provided (by your distro or from a binary download), and the `nokogiri` dependency is also easily satisfied by either the distro or Ruby's `gem` command:

```
$ apt install ruby-nokogiri
### or ###
> gem install nokogiri
## mwp Windows / Cygwin
$ cyg-apt install ruby-nokogiri
```

Using the package manager is recommended for non-proprietary operating systems.

On all operating systems, the terrain graph is also plotted interactively, regardless of whether the `-p` (save SVG plot) option has been specified. The following shows the UI on Windows (it's pretty much the same on other OS).



## 1.10.6 Caveats

- 3rd party terrain data is not guaranteed, either as to its absolute accuracy, nor to its coverage.
- Terrain data does not take into account other obstacles (trees, buildings, power lines etc).
- The tool does not faithfully model the vehicle motion. As multi-rotor and fixed-wing have different climb behaviours, this would be quite complex.
- RTH altitude has to be specified if you wish to model it, and assumes 'AT LEAST' behaviour.

## 1.10.7 Datum

Digital elevation services can use the WGS84 Ellipsoid or "sea level"; survey maps typically use AMSL (Above Mean Sea Level); GPS can report either or both of WGS Ellipsoid and above MSL (mean sea level). The "sea level" used by Bing Elevations is computed from a magnetic anomaly / gravity database and may not be the same as the AMSL "sea level" used by the survey. **Caveat User.**

- `mwp` currently uses Bing "Sea level" to obtain elevations. The user should apply a suitable margin.
- [INAV](#) firmware uses the GPS' AMSL value, so [INAV](#) and `mwp` are consistent on this.
- The INAV configurator uses Bing's Ellipsoid values (by default, it can be changed).

Due to the granularity of the AMSL grid used by GPS and the gravity based Bing Sea Level, there may be a significant difference between AMSL, "sea level", WGS84 Ellipsoid and Survey heights, for example, for a test point of 54.149461 -4.669315 (summit of South Barrule, Isle of Man):

- Google Earth : 470m
- Ordnance Survey (OS) Map (official survey): 483m
- Bing Ellipsoid (Configurator): 526m
- Bing "Sea Level" (`mwp`): 470m

## 1.10.8 So who's right?

Many years ago, I took a GPS up South Barrule.



It reads 485m, this pretty much agrees with the OS (Survey) height (AMSL). So the real issue is with the DEM available online (either Bing or Google). The 'sea-level' height DEM reports **for this location** is c. 13m below Ordnance Survey AMSL value whilst the WGS84 ellipsoid value is 43m above the OS AMSL value.

## 1.10.9 Command line help and options

```
$ mwp-plot-elevations --help
-dump
  Dump internal data, exit
-force-alt int
  Force Altitude Mode (-1=from mission, 0=Relative, 1=Absolute (default -1)
-home string
  home as DD.dddd,DDD.dddd
-keep
  Keep intermediate plt files
-margin int
  Clearance margin (m)
-no-graph
  No interactive plot
-no-mission-alts
  Ignore extant mission altitudes
-output string
  Revised mission file
-rth-alt int
  RTH altitude (m)
-svg string
  SVG graph file
-upland
  Update landing elevation offset
```

Note that Go considers `-foo` and `--foo` to be equivalent. The ruby script requires the `--` notation.

## 1.10.10 Configuration File

As well as specifying options such as home location, clearance margin and RTH altitude on the command line (or as an environment variable), some or all of these options may be set in a configuration file.

`mwp-plot-elevations` looks for options in one of the following (in order) `./.elev-plot.rc` (i.e. current directory), `$HOME/.config/mwp/elev-plot`, and `$HOME/.elev-plot.rc`. The configuration file is a simple text file containing `key=value` pairs. Blank lines and lines beginning with `#` are ignored; the following example illustrates the recognised keys. Note that `$HOME/.config/mwp/elev-plot` is the preferred location, as this is also used by `mwp` to populate its graphical dialogue to launch the analysis tool.

```
# settings for mwp-plot-elevations
margin = 16
home = 50.910476,-1.535038
# for ',' locales
# home = 50,910476 -1,535038
rth-alt=25
# 'sanity' is the home -> WP1 distance check; default if not set here is 100m
sanity = 200
```

### 1.10.11 Usage Examples

```
# Interactive plot, using the above configuration file:  
$ mwp-plot-elevations nm_west_field.mission  
  
# Interactive plot. save SVG file  
$ mwp-plot-elevations --plotfile /tmp/mission.svg nm_west_field.mission  
  
# Interactive plot. save SVG file, rewrite mission file  
$ mwp-plot-elevations --plotfile /tmp/mission.svg --output new_west_field.mission nm_west_field.mission  
  
# Interactive plot. save SVG file, rewrite mission file, override clearance margin (20m)  
$ mwp-plot-elevationsb --plotfile /tmp/mission.svg --outout new_west_field.mission --margin 20 nm_west_field.mission  
  
# Interactive plot. save SVG file, rewrite mission file,  
# override clearance margin (20m), reduce RTH altitude (22m)  
$ mwp-plot-elevations --plotfile /tmp/mission.svg --output new_west_field.mission --margin 20 --rth-alt 22 nm_west_field.mission
```

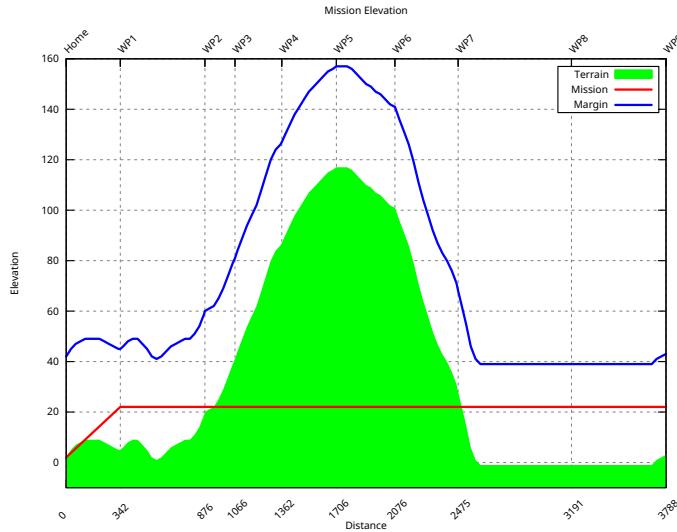
Another contrived example ... create a mission in Google Earth (tied to ground), save as KMZ, convert to MWXML mission file with [imupload](#) (0 altitude). Use `mwp-plot-elevations.rb` to calculate a safe mission.

#### KMZ planned in Google Earth



#### Conversion tools

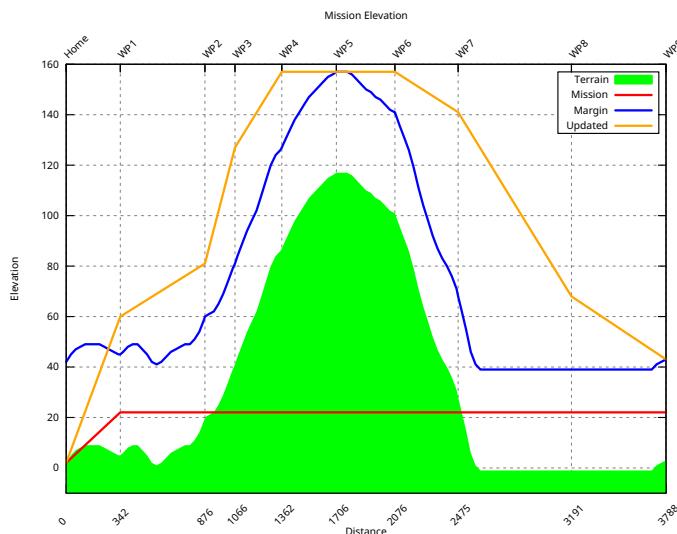
```
# convert the saved KMZ file to a MWXML mission file  
$ imupload convert /tmp/IOM.kmz /tmp/perwick.mission  
  
# Verify the elevations and clearance with plot-elevations.rb  
$ mwp-plot-elevations.rb -h 54.068826,-4.735472 -m 40 /tmp/perwick.mission
```



Looks OK (well, apart from the flying through the hill, due to implead's default altitude of 20m).

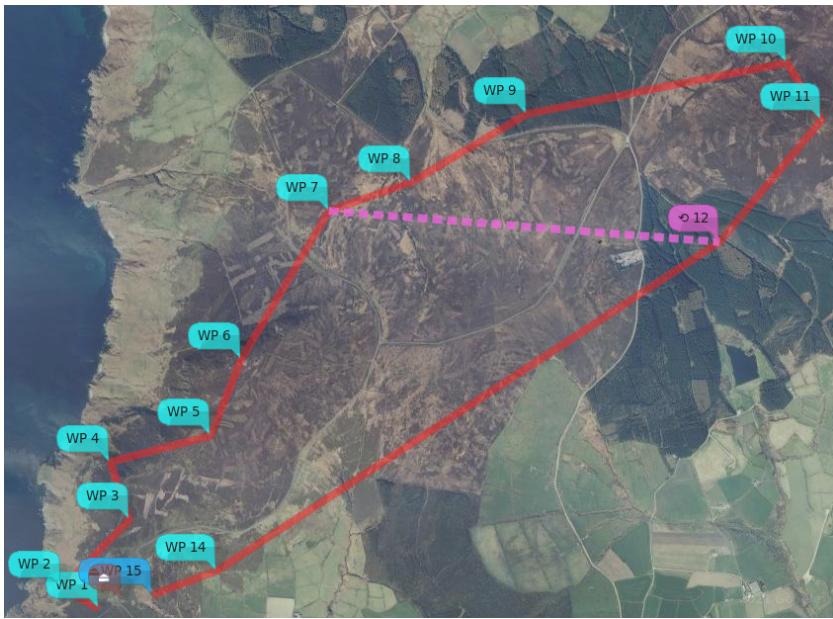
If we specify that a new mission file be generated ( `--output` ), the updated mission is also plotted, and we can see that this clears the hill.

```
mwp-plot-elevations --home 54.068826,-4.735472 --margin 40 --output /tmp/perwick-ok.mission /tmp/perwick.mission
```



It's not yet perfect, we could be more aggressive in reaching just the clearance altitude, but we clear the hill!.

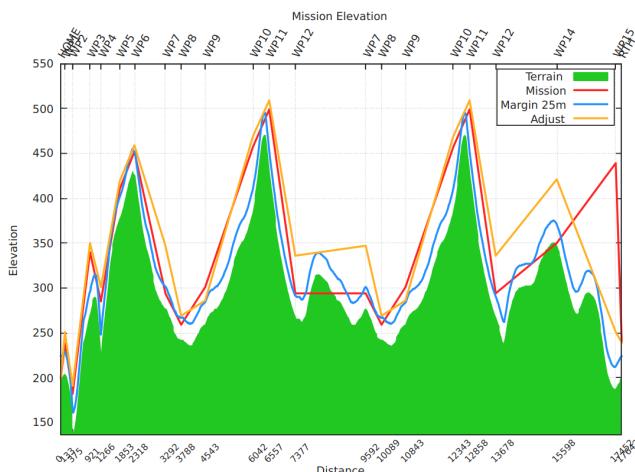
### 1.10.12 Climb and Dive Angle Report



*Mission used for climb /dive example*

As of 2021-06, it's also possible to get climb and dive angles for the calculated mission. Before I added the WP12 => WP7 jump in the mission shown below, it was almost OK; below the desired clearance in a couple of places and just failing to clear the hill at WP15. After adding the JUMP, it hits the terrain pretty conclusively between WP12 and WP7. The modified mission is interesting, as it has to adjust the WPs within the JUMP for the worst case (so the WP7, the second pass is definitive).

The final result:



We also get a climb / dive report, currently to STDOUT and \$TMP/mwpmission-angles.txt (tab separated for easy analysis).

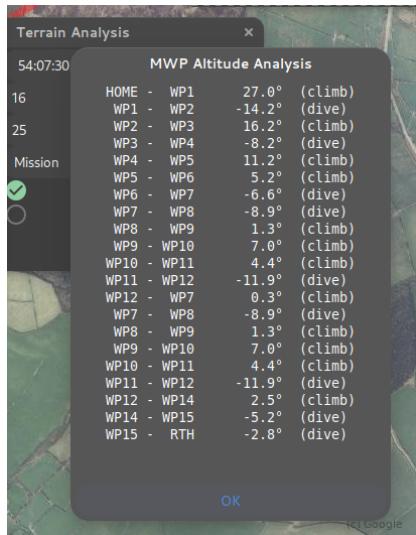
```
$ mwp-plot-elevations --margin 25 -no-mission-alts --output /tmp/n.mission \
--home 54.125205, -4.730322 -rth-alt 40 mwp/missions/IoM/barrule-jump.mission
HOME - WP1 21.3° (climb)
WP1 - WP2 -13.9° (dive)
WP2 - WP3 16.2° (climb)
WP3 - WP4 -8.1° (dive)
WP4 - WP5 11.4° (climb)
WP5 - WP6 4.9° (climb)
WP6 - WP7 -6.6° (dive)
WP7 - WP8 -8.9° (dive)
WP8 - WP9 1.3° (climb)
WP9 - WP10 7.0° (climb)
WP10 - WP11 4.4° (climb)
WP11 - WP12 -11.9° (dive)
```

```

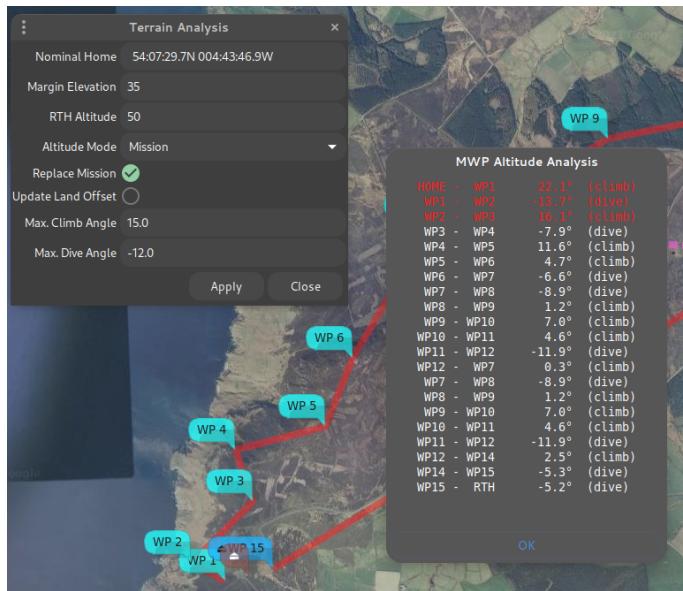
WP12 - WP7  0.3° (climb)
WP7 - WP8  -8.9° (dive)
WP8 - WP9  1.3° (climb)
WP9 - WP10  7.0° (climb)
WP10 - WP11  4.4° (climb)
WP11 - WP12 -11.9° (dive)
WP12 - WP14  2.5° (climb)
WP14 - WP15  -5.2° (dive)
WP15 - RTH  -3.6° (dive)

```

If you run **mwp-plot-elevations** via **mwp**, the information is presented in a separate window.

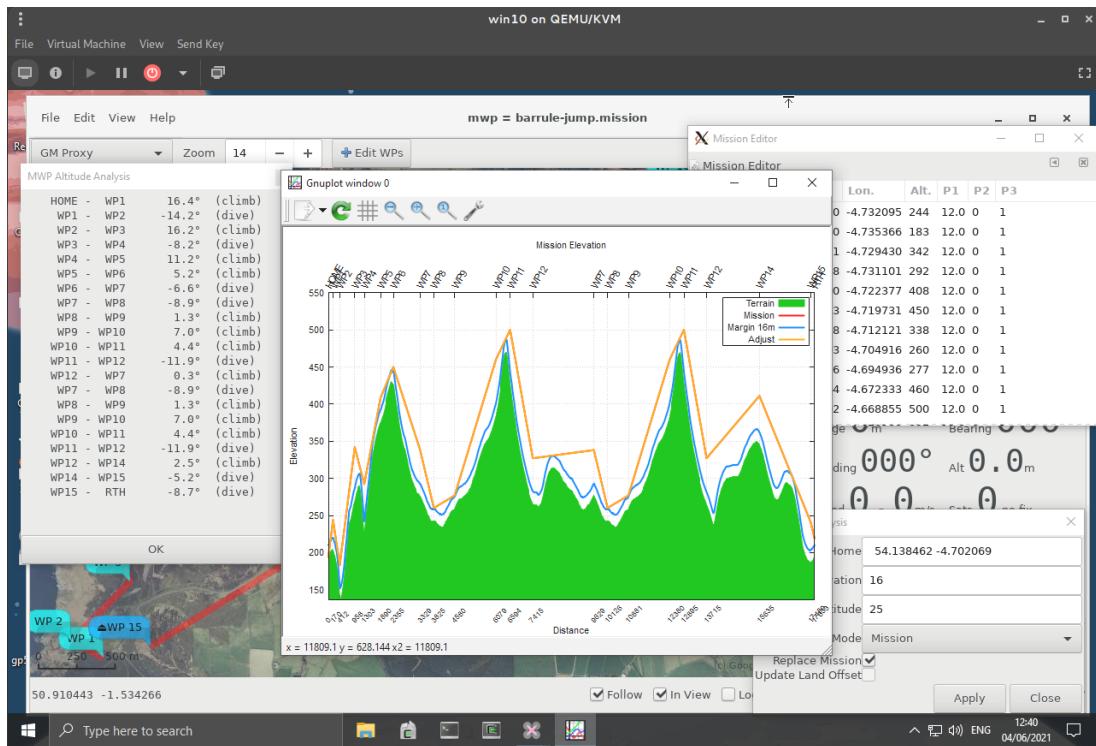


**mwp** can also highlight any legs that exceed user-defined (not 0) climb and dive angle limits. However, it's up to you to work out the best solution.



The steep hill and valley at the start are just too much here; best to reroute.

### 1.10.13 Finally ....



For Window 10 / Cygwin, you probably need to have the Windows gnuplot , vice the Cygwin version.

## 1.11 "Serial" device support

---

mwp supports a number of different data transports for "serial" protocols:

- Wired serial devices (USB TTL (VCP) etc.)
- Bluetooth
- IP (UDP and TCP)
- "Special" (e.g. BulletGCSS via the MQTT protocol).

Each of these requires a specific device name and *may* require a protocol selection.

### 1.11.1 Serial devices

Serial devices are defined by the operating system device node name and optionally include an embedded baud rate, for example:

```
# Linux, USB serial
/dev/ttyACM0
# Linux, USB serial with baud rate
/dev/ttyUSB0@57600
# Linux, RFCOM Bluetooth
/dev/rfcomm1

# FreeBSD
/dev/cuaU0
```

### 1.11.2 Bluetooth

Bluetooth may be specified by either an `rfcomm` device node (`/dev/rfcommX` on Linux, `/dev/ttypX` pseudo-terminal abstraction on FreeBSD) or by the device address (`BD_ADDR`, Linux and FreeBSD only):

```
# BT RFCOMM device node (Linux)
/dev/rfcomm1
/dev/rfcomm1@57600
# RFCOMM / SPP (FreeBSD)
/dev/ttyp6
# BT device address (note here baud rate is immaterial)
35:53:17:04:07:27
```

### Serial permissions

It is necessary for the user to have read / write permission on serial devices. The installation guide provides [instructions](#).

### 1.11.3 IP protocols (UDP and TCP)

mwp uses a pseudo-URL format for TCP and UDP connections `udp://host:port` and `tcp://host:port` (where `host` is either a hostname or an IP address as required).

Typically on one side of the connection you'll provide a hostname /IP and on the other you won't (as it can get the peer address from the first data packet).

Assuming the required UDP port is 43210

if mwp is the "listener" (doesn't need, *a priori*, to know the address of peer), set the "Device" to:

```
udp://:43210
```

i.e. the host part is empty.

If the remote device / application is the listener, and we know its IP address; in the following example "192.168.42.17", set the "Device" to:

```
udp://192.168.42.17:43210
```

Note that for TCP, mwp only supports the latter form (it expects to be the TCP client).

#### 1.11.4 Special Cases

##### UDP devices required defined local and remote port numbers

Some UDP devices (typically ESP8266 transparent serial) require that the port number is specified for both local and remote addresses; often the same port number at both ends. `udp://local_host:local_port/remote_host:remote_port` or `udp://remotehost:remote_port/?bind=port`. The following have the same effect.

```
udp://:14014/esp-air:14014
# both sides use port 14014, remote (FC) is esp-air, blank local name is understood as INADDR_ANY
udp://esp-air:14014/?bind=14014
```

##### MQTT / BulletGCSS

See the [mwp's MQTT support](#) article for a detailed description of the URI format:

```
mqtt://[:user[:pass]@]broker[:port]/topic[?cafile=file]
```

##### WSL UDP bridge

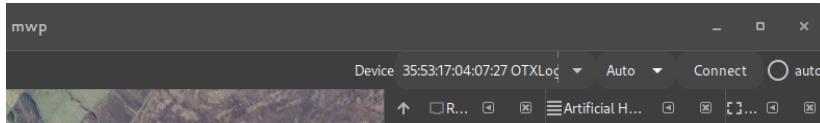
As WSL does not directly support USB serial connections, mwp provides a bespoke serial / UDP bridge using the pseudo-device name `udp://__MWP_SERIAL_HOST:17071`. See the [WSL article](#) for more detail.

#### 1.11.5 Multi Protocol selection

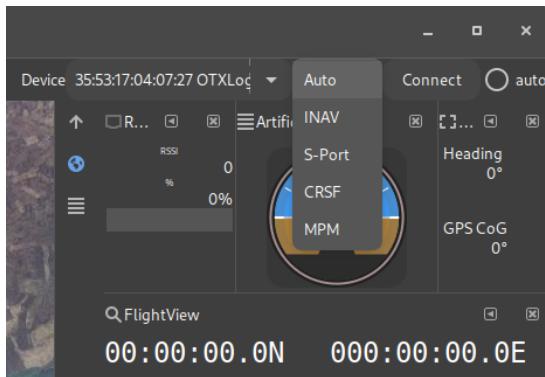
##### Overview

From 4.317.587 (2021-11-21), mwp does away with some of the weirdness around serial protocols (e.g. having to separately specify `--smartport` in order to use S-Port telemetry).

Instead, there is now a protocol drop-down that allows the user to select the in-use serial protocol.



Offering:



**Usage**

Item	Usage
Auto	Auto-detects the protocol from the serial data stream. Note that MPM cannot (yet) be auto-detected reliably, and must be explicitly selected).
INAV	INAV protocols, MSP, LTM and MAVLink. Legacy behaviours
S-Port	Smartport telemetry, previously required <code>--smartport</code> options. Expects a non-inverted stream
CRSF	Crossfire Telemetry.
MPM	Multi-Protocol-Module telemetry. The output from an EdgeTX / OpenTX radio with a multi-protocol module, FrSky Smartport or Flysky 'AA' via the EdgeTX / OpenTX "Telem Mirror" function. Prior to EdgeTX 2.7, this cannot be reliably auto-detected, and should be explicitly selected; with EdgeTX 2.7 and later, auto-detection is possible and reliable.

## NOTES

- For [radar functions](#) (INAV-radar, ADSB), it is necessary to set the `--radar-device= option`. Leave the protocol selector at 'Auto'.
- For telemetry forwarding, it is necessary to set the `--forward-to= option`. Leave the protocol selector at 'Auto'.
- For FlySky MPM telemetry, the INAV CLI setting `set ibus_telemetry_type = 0` is required; any other `ibus_telemetry_type` value will not work.

## AUTO-DETECTION

- INAV (MSP, LTM, MAVLink) auto-detection should be reliable (legacy function).
- S-Port and CRSF may be less reliably detected.
- MPM is hard to auto-detected. From EdgeTX 2.7, MPM auto-detection works reliably.
- It is recommended that for S-Port, CRSF and MPM, the desired protocol is set explicitly (not left at "Auto").

## 1.12 mwp Configuration

---

### 1.12.1 Overview

**mwp** stores configuration in a number of places, to some degree at the developer's whim, but also in accordance with the data item's volatility.

- Command line options
- Configuration Files
- dconf / gsettings

Each type is further discussed below.

### 1.12.2 Command line options

Command line options provide a 'per instantiation' means to control **mwp** behaviour; the current set of command line options may be viewed by running **mwp** from the command line with the single option `--help`:

```
$ mwp --help
```

Where it is required to give permanence to command line options, they can be added to the configuration file `$HOME/.config/mwp/cmdopts`, which is described in more detail in the following section.

#### Debug flags

The `--debug-flags` option takes a numeric value defines areas where additional debug information may be output.

Value	Usage
1	Waypoints
2	Startup
4	MSP
8	ADHOC
16	RADAR
32	LOG REPLAY
64	SERIAL
128	VIDEO
256	GCS Location

Values may be added together (so 511 means all).

### 1.12.3 Configuration Files

**mwp** configuration files are stored in a standard directory `$HOME/.config/mwp`. This directory is created on first invocation if it does not exist. The following files may be found there:

#### 1.12.4 cmdopts

The file `cmdopts` contains command line options that the user wishes to apply permanently (and conveniently when run from a launcher icon rather than the command line).

The file contains CLI options exactly as would be issued from the terminal. Options may be on separate lines, and blank lines and line prefixed with a hash '#' are ignored. For example:

In addition to options ( -- ), the file may also contain environment variables e.g. FOO=BAR .

```
# Default options for mwp
--rings 50,20
"--voice-command "spd-say -t female2 -e"
"--debug-flags=2
--dont-maximise
#-S 8192
# set the anonymous tile file.
MWP_BLACK_TILE=/home/jrh/.config/mwp/mars.png
```

So here the only current, valid options are --rings 50,20 --dont-maximise , and the environment variable MWP\_BLACK\_TILE is set (for anonymous maps).

The environment is set before any GTK / UI calls are made.

mwp (and other applications) can have a problem with OpenGL and the Wayland compositor. Typically this is manifest by being unable to pick mission WP icons for large (>40 point) missions.

On non-WSL platforms, mwp forces XWayland over Wayland to mitigate this. You can force Wayland / XWayland by setting the GDK\_BACKEND variable in cmdopts (or the environment). This will override mwp's default behaviour.

```
# set XWayland
GDK_BACKEND=x11
# set Wayland
GDK_BACKEND=wayland
```

## 1.12.5 .layout

.layout contains the current arrangement of Dock items. You are advised not to manually edit this file (or other named, alternate layout files).

## 1.12.6 sources.json

sources.json facilitates adding non-standard map sources to mwp. See the [anonymous maps](#) section and comments in the source files in the qproxy directory.

Here is an example `mwp tools/src/samples/sources.json` ;(you need your own free API key for the Thunderforest examples):

Note that the mapping library used by mwp (libchamplain) replaces the standard TMS notation for coordinates {z}/{x}/{y} with # in place of the brackets #Z#/#X#/#Y#, and the variables are capitalised.

```
{
  "sources" : [
    {
      "id": "OCM",
      "name": "CycleMaps API key",
      "license": "(c) Thunderforest",
      "license_uri": "http://thunderforest.com/",
      "min_zoom": 0,
      "max_zoom": 19,
      "tile_size": 256,
      "projection": "MERCATOR",
      "comment": "You need your own (free) hobbist key from https://www.thunderforest.com/",
      "uri_format": "https://a.tile.thunderforest.com/cycle/#Z#/#X#/#Y#.png?apikey=0000000000000000000000000000000000000000000000000000000000000000"
    },
    {
      "id": "Landscape",
      "name": "Landscape API key",
      "license": "(c) Thunderforest",
      "license_uri": "http://thunderforest.com/",
      "min_zoom": 0,
      "max_zoom": 19,
      "tile_size": 256,
      "projection": "MERCATOR",
      "comment": "You need your own (free) hobbist key from https://www.thunderforest.com/",
      "uri_format": "https://a.tile.thunderforest.com/landscape/#Z#/#X#/#Y#.png?apikey=0000000000000000000000000000000000000000000000000000000000000000"
    },
    {
      "id": "OpenTopo",
      "name": "OpenTopo TMS",
      "license": "(c) OSM",
      "license_uri": "http://opentopodata.org/OSM_TMS.html"
    }
  ]
}
```

```

"license_uri": "http://www.openstreetmap.org/copyright",
"min_zoom": 0,
"max_zoom": 19,
"tile_size": 256,
"projection": "MERCATOR",
"uri_format": "https://a.tile.opentopomap.org/#Z#/X#/Y#.png"
},
{
"id": "Black",
"name": "Black Tiles",
"license": "(c) jh",
"license_uri": "http://daria.co.uk/",
"min_zoom": 0,
"max_zoom": 20,
"tile_size": 256,
"projection": "MERCATOR",
"spawn": "bproxy"
}
]
}

```

See also [anonymous maps](#) to customise the "black tile". The `spawn` stanza uses a proxy for non-TMS formats (see `mwptools/src/qproxy` for some examples).

## 1.12.7 vcol.css

`vol.css` contains alternate CSS themeing for the battery voltage dock item that may work better on dark desktop themes. An example file is provided as `mwp/vcol.css` which can be copied into `.config/mwp/`.

## 1.12.8 places

The `places` (`~/.config/mwp/places`) file is a delimited (CSV) file that defines a list of "shortcut" home locations used by the "View / Centre on Position ..." menu item. It consists of a Name, Latitude, Longitude and optionally zoom level, separated by a `TAB`, `|`, `:` or `;`. Note that positions may be localised in the file and thus `.` is no longer recognised as a field separator.

Example `places`

```
# mwp places name,lat,lon [,zoom]
Beaulieu|50.8047104|-1.4942621|17
Jurby:54.353974:-4.523600:-1
```

The user may maintain these files manually if used, or use the [graphic places editor](#).

## 1.12.9 Dconf / gsettings

The underlying infrastructure used by `mwp` has a facility for storing configuration items in a registry like store. This is used extensively by `mwp`. The items can be viewed and modified using a number of tools:

- `mwp` preference dialogue (for a small subset of the items)
- The `dconf-editor` graphical settings editor
- The command line `gsettings` tool

For `gsettings` and `dconf-editor`, the name-space is `org.mwptools.planner`, so to view the list of items:

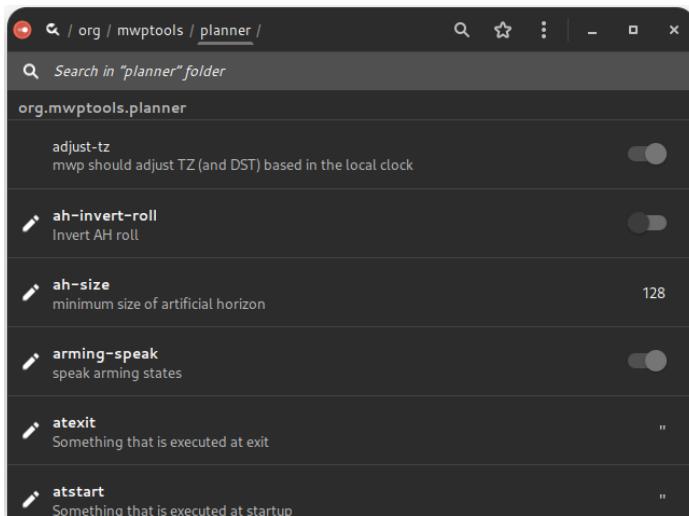
```
$ gsettings list-recursively org.mwptools.planner
```

and to list then get / set a single item:

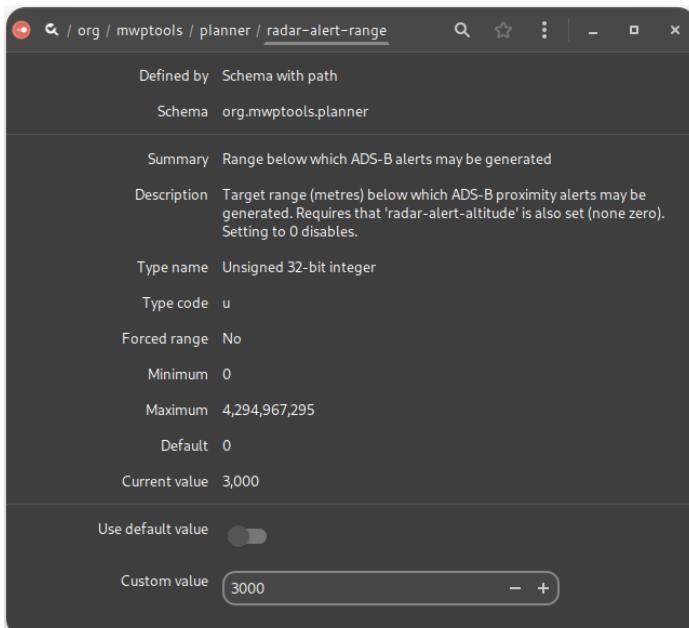
```
$ gsettings get org.mwptools.planner log-save-path
...
$ gsettings set org.mwptools.planner log-save-path ~/flight-logs/
```

### DCONF-EDITOR

This *may* not be installed by default, but should be available via the OS package manager / software centre.



Initial dconf-editor showing all mwp settings



dconf-editor; editing a setting

**List of mwp settings**

**List of mwp settings**

Name	Summary	Description	Default
adjust-tz	Adjust FC's TZ (and DST)	mwp should adjust FC's TZ (and DST) based on the local clock	true
ah-invert-roll	Invert AH roll	Set to true to invert roll in the AH (so it becomes an attitude indicator)	false
ah-size	minimum size of artificial horizon	(private setting)	32
arming-speak	speak arming states	whether to reporting arming state by audio	false
atexit	Something that is executed at exit	e.g. gsettings set org.gnome.settings-daemon.plugins.power idle-dim true. See also manage-power (and consider setting manage-power to true instead).	""
atstart	Something that is executed at startup	e.g. gsettings set org.gnome.settings-daemon.plugins.power idle-dim false. See also manage-power (and consider setting to true).	""
audio-bearing-is-reciprocal	Announce bearing as reciprocal	Whether the audio bearing is the reciprocal (i.e. bearing from home to machine, rather than from machine to home)	false
audio-on-arm	start audio on arm	start audio on arm (and stop on disarm)	true
auto-follow	set auto-follow	set auto-follow on start	true
auto-restore-mission	Whether to automatically import a mission in FC memory to MWP	If the FC holds a valid mission in memory, and there is no mission loaded into MWP, this setting controls whether MWP automatically downloads the mission.	false
auto-wp-edit	Whether direct WP editing is available	If true, the user can edit / create waypoints directly by clicking on the map, if false, it is necessary to toggle the WP Edit button to enable editing.	false
baudrate	Baud rate	Serial baud rate	115200
blackbox-decode	Name of the blackbox_decode application	Name of the blackbox_decode application (in case there are separate for iNav and betaflight)	"blackbox_decode"
centre-on	centre map on GPS	centre map on GPS as needed	true
checkswitches	check switches	check switches (an ancient JH sanity check)	false
compat-version	mw-nav compat version	Default mw-nav compat version in XML files. mwp doesn't care, older (MW) applications might.	"42.0"
dbox-is-horizontal	Geometry of the DirectionView box	If true, uses a horizontal organisation, rather than vertical	false
default-altitude	Default altitude	Default Altitude for mission (m)	20
default-latitude	Default Latitude	Default Latitude when no GPS	50.909528
default-layout	Default layout name	Default layout name. If not set, .layout is used.	""
default-loiter	Default Loiter time	Default Loiter time	30
default-longitude	Default Longitude	Default Longitude when no GPS	-1.532936

Name	Summary	Description	Default
default-map	Default Map	Default map key	""
default-nav-speed	Default Nav speed	Default Nav speed (m/s). For calculating durations only.	2.5
default-zoom	Default Map zoom	Default map zoom	15
delta-minspeed	Minimum speed for elapsed distance updates	Minimum speed for elapsed distance updates (m/s). Default is zero, which means the elapsed distance is always updated; larger values will take out hover / jitter movements.	0.0
device-names	Device names	A list of device names to be added to those that can be auto-discovered	[]
display-distance	Distance units	0=metres, 1=feet, 2=yards	0
display-dms	Position display	Show positions as dd:mm:ss rather than decimal degrees	false
display-speed	Speed units	0=metres/sec, 1=kilometres/hour, 2=miles/hour, 3=knots	0
dump-unknown	dump unknown	dump unknown message payload (debug aid)	false
espeak-voice	Default espeak voice	Default espeak voice (see espeak documentation)	"en"
fctype	Force fc type	Forces fc type (mw,mwnav,bf,cf)	"auto"
fixedfont	Use a fixed font for Flight View	Use a fixed font for Flight View	true
flash-warn	Flash storage warning	If a dataflash is configured for black box, and this key is non-zero, a warning is generated if the data flash is greater than "flash-warn" percent full.	0
flite-voice-file	Default flite voice file	Default flite voice file (full path, *.flitevox), see flite documentation)	""
font-fv	flight view font scaling	Scales the flight view widget. Smaller screens may need a lower value	12
forward	Types of message to forward	Types of message to forward (none, LTM, minLTM, minMAV, all)	"minLTM"
geouser	User account on geonames.org	A user account to query geonames.org for blackbox log timezone info. A default account of 'mwptools' is provided; however users are requested to create their own account.	"mwptools"
gpsd-host	gpsd provider	Provider for GCS location via gpsd. Default is "localhost", can be set to other host name or IP address. Setting blank ("") disables.	"localhost"
gpsintvl	gps sanity time (m/s)	gps sanity time (m/s), check for current fix	2000
heartbeat	Something that runs every minute	e.g. xscreensaver-command -deactivate . See also <code>manage-power</code> (and consider setting to <code>manage-power</code> to <code>true</code> ).	""
ignore-nm	Ignore Network Manager	Set to true to always ignore NM status (may slow down startup)	false
kml-path	Directory for KML overlays	Directory for KML overlays, default = current directory	""
led	GPS LED colour	GPS LED colour as well known string or #RRGGBB	"#60ff00"

Name	Summary	Description	Default
load-safehome	Load default set of safehomes	Set to file[,Y]. File defines a set of safehome lines (CLI format), optionally followed by a comma and Y. If the definition includes ",Y", then the safehome locations will be displayed.	""
log-on-arm	start logging on arm	start logging on arm (and stop on disarm)	false
log-path	Directory for replay log files	Directory for log files (for replay), default = current directory	""
log-save-path	Directory for storing log files	Directory for log files (for save), default = current directory	""
mag-sanity	Enable mag sanity checking	mwp offers a primitive mag sanity checker that compares compass heading with GPS course over the ground using LTM (only). There are various hard-coded constraints (speed > 3m/s, certain flight modes) and two configurable parameters that should be set here in order to enable this check. The parameters are angular difference (°) and duration (s). The author finds a settings of 45,3 (i.e. 45° over 3 seconds) works OK, detecting real instances (a momentarily breaking cable) and not reporting false positives.	""
manage-power	manage power and screen	whether to manage idle and screen saver	false
map-sources	Additional Map sources	JSON file defining additional map sources	""
mavph	RC settings for Mav PH	RC settings for Mav PH (chanid:minval:maxval)	""
mavrth	RC settings for Mav RTH	RC settings for Mav RTH (chanid:minval:maxval)	""
max-climb-angle	Maximum climb angle highlight for terrain analysis	If non-zero, any climb angles exceeding the specified value will be highlighted in Terrain Analysis Climb / Dive report. Note that the absolute value is taken as a positive (climb) angle	0.0
max-dive-angle	Maximum dive angle highlight for terrain analysis	If non-zero, any dive angles exceeding the specified value will be highlighted in Terrain Analysis Climb / Dive report. Note that the absolute value is taken as a negative (dive) angle	0.0
max-home-delta	home position delta (m)	Maximum variation of home position without verbal alert	2.5
max-radar-slots	Maximum number of aircraft	Maximum number of aircraft reported by iNav-radar	4
max-wps	Maximum number of WP supported	Maximum number of WP supported	120
media-player	Media player for alerts	Blank means internal gstreamer, "false" or "none" means no beeps.	""
misc-icon-size	Miscellaneous icon size	Size for miscellaneous icons (radar, GCS location) in pixels. -1 means the image's natural size (no scaling).	32
mission-file-type	Preferred mission file type	m for XML (.mission), j for json (change at your peril)	"m"

Name	Summary	Description	Default
mission-meta-tag	use meta vice mwp in mission file	If true, the legacy 'mwp' tag is named 'meta'	false
mission-path	Directory for mission files	Directory for mission files, default = current directory	""
osd-mode	Data items overlaid on the map	0 = none, 1 = current WP/Max WP, 2 = next WP distance and course. This is a mask, so 3 means both OSD items.	3
poll-timeout	Poll messages timeout (ms)	Timeout in milliseconds for telemetry poll messages. Note that timer loop has a resolution of 100ms.	900
pos-is-centre	Determines position label content	Whether the position label is the centre or pointer location	true
pwdw-p	internal parameter	(private setting)	72
radar-alert-altitude	Altitude below which ADS-B alerts may be generated	Target altitude (metres) below which ADS-B proximity alerts may be generated. Requires that 'radar-alert-range' is also set (non-zero). Setting to 0 disables. Note that ADS-B altitudes are AMSL (or geoid).	0
radar-alert-range	Range below which ADS-B alerts may be generated	Target range (metres) below which ADS-B proximity alerts may be generated. Requires that 'radar-alert-altitude' is also set (non-zero). Setting to 0 disables.	0
radar-list-max-altitude	Maximum altitude for targets to show in the radar list view	Maximum altitude (metres) to include targets in the radar list view. Targets higher than this value will show only in the map view. This is mainly for ADS-B receivers where there is no need for high altitude targets to be shown. Setting to 0 disables. Note that ADS-B altitudes are AMSL (or geoid).	0
require-telemetry	Whether to warn the operator if telemetry is disabled in iNav	if set, and telemetry is disabled, a non-timeout dialogue is displayed	false
rings-colour	range rings colour	range rings colour as well known string or #RRGGBBAA	"#fffff20"
rth-autoland	Set land on RTH waypoints	Automatically assert land on RTH waypoints	false
say-bearing	Whether audio report includes bearing	Whether audio report includes bearing	true
set-head-is-b0rken	set head bearing as reciprocal	Whether the set head bearing is the reciprocal (i.e. ancient bug in mw nav)	false
show-sticks	Whether to show sticks in log replay	If "yes", stick position is shown during log replay, if "no", never shown. If "decorated", then shown in a decorated window (for window managers can't cope with undecorated windows), e.g. WSL, Cygwin	"yes"
smartport-fuel-unit	User selected fuel type	Units label for smartport fuel (none, %, mAh, mWh)	"none"
speak-amps	When to speak amps/hr used	none, live-n, all-n n=1,2,4 : n = how often spoken (modulus basically)	"none"
speak-interval	Interval between voice prompts	Interval between voice prompts, 0 disables	15

Name	Summary	Description	Default
speech-api	API for speech synthesis	espeak, speechd, flite. Only change this if you know you have the required development files at build time	"espeak"
speechd-voice	Default speechd voice	Default speechd voice (see speechd documentation)	"male1"
stats-timeout	timeout for flight statistics display (s)	Timeout before the flight statistics popup automatically closes. A value of 0 means no timeout.	30
tote-float-p	Do Mission tote float	(private setting)	true
uc-mission-tags	Upper case mission XML tags	If true, MISSION, VERSION and MISSIONITEM tags are upper case (for interoperability with legacy Android applications)	false
uilang	Language Handling	"en" do everything as English (UI numeric decimal points, voice), "ev" do voice as English (so say 'point' for decimals even when shown as 'comma')	""
use-legacy-centre-on	If true, uses legacy centre-on	If true, uses legacy centre-on mode rather than the new "In View" mode.	false
vlevels	Voltage levels	Semi-colon(;) separated list of <i>cell</i> voltages values for transition between voltage label colours	""
wp-dist-size	Font size (points) for OSD WP distance display	Font size (points) for OSD WP distance display	56.0
wp-spotlight	Style for the 'next waypoint' highlight	Defines RGBA colour for 'next way point' highlight	"#fffffff60"
wp-text-style	Style of text used for next WP display	Defines the way the WP numbers are displayed. Font, size and RGBA description (or well known name, with alpha)	"Sans 144/#ff000080"
zone-detect	Application to return timezone from location	If supplied, the application will be used to return the timezone (in preference to geonames.org). The application should take latitude and longitude as parameters. See samples/tzget.sh	""

## 1.12.10 Settings precedence and user updates

**mwp** installs a number of icon files in `$prefix/share/mwp/pixmaps`. The user can override these by creating an eponymous file in the user configuration directory, `~/.config/mwp/pixmaps/`. Such user configurations are never over-written on upgrade.

For example, to replace a **mwp** specific icon; i.e. replace the GCS Location icon (`$prefix/share/mwp/pixmaps/gcs.svg`) with a user defined file `~/.config/mwp/pixmaps/gcs.svg`.

While the file name must be consistent, the format does not have to be; the replacement could be a PNG, rather than SVG; we're not MSDOS and file "extensions" are an advisory illusion.

### Example

e.g. replace the inav-radar icon.

```
mkdir -p ~/config/mwp/pixmaps
# copy the preview image
cp ~/local/share/mwp/pixmaps/preview.png ~/config/mwp/pixmaps/
# (optionally) resize it to 32x32 pixels
mogrify -resize 80% ~/config/mwp/pixmaps/preview.png
# and rename it, mwp doesn't care about the 'extension', this is not MSDOS:)
mv ~/config/mwp/pixmaps/preview.png ~/config/mwp/pixmaps/inav-radar.svg
# and verify ... perfect
```

```
file ~/.config/mwp/pixmaps/inav-radar.svg
/home/jrh/.config/mwp/pixmaps/inav-radar.svg: PNG image data, 32 x 32, 8-bit/color RGBA, non-interlaced
```

Note also that the resize step is no longer required, as `mwp` scales the icon according to the `misc-icon-size` setting.

## 1.12.11 Environment variables

`mwp` recognises the following application specific environment variables

Name	Usage
<code>CFG_UGLY_XML</code>	Generate ugly multi-mission XML, so as not to confuse the inav configurator
<code>MWP_ARGS</code>	Extra command line arguments
<code>MWP_BLACK_TILE</code>	Specify a black tile to be used by the Black Tiles map proxy
<code>MWP_IGNORE_SATS</code>	Consider LTM positions valid even with low satellite count
<code>MWP_LOG_DIR</code>	Location of console logs (\$HOME if undefined)
<code>MWP_PLAYBIN</code>	The gstreamer playbin for video. By default, mwp uses <code>playbin</code> , <code>playbin3</code> is an experimental (gstreamer_) alternative
<code>MWP_POS_OFFSET</code>	The fake position offset "delta-lat,delta-lon"
<code>MWP_PREF_DEVICE</code>	The serial device (from the preferences set) to display as default
<code>MWP_PRINT_RAW</code>	If defined, output hex bytes from serial I/O
<code>MWP_SERIAL_HOST</code>	The host for the magic <code>udp://__MWP_SERIAL_HOST</code> name (default undefined)
<code>MWP_TIME_FMT</code>	The time format for log output; by default "%FT%T%z", any GLib2 DateTime (strftime-like) format may be used; "%T.%f" works well on modern GLib.

## 1.12.12 Mime types for common file formats

`mwp` adds XDG mime types for certain file types handled by `mwp`.

Data Source	Mime Type	File Manager	DnD
Multiwii Mission (XML)	application/vnd.mw.mission	Yes <a href="#">1</a>	Yes <a href="#">2</a>
Blackbox log	application/vnd.blackbox.log	Yes	Yes
Mwp telemetry log	application/vnd.mwp.log	Yes	Yes
Multiwii mission (mwp JSON)	application/vnd.mwp.json.mission	Yes	Yes
OTX telemetry log	application/vnd.otx.telemetry.log	No	Yes

### Notes:

1. The file manager (at least Nautilus / Gnome) will offer `mwp` as the default application to open the file.
2. DnD. The file can be dropped onto the `mwp` map and will be opened. The file may also be provided on the `mwp` command line without `--` option; e.g. `mwp --mission demo.mission` and `mwp demo.mission` will behave in the same way.

## 1.13 mwp and INAV safehome

One of the great features of [INAV](#) 2.6 was the `safehome` capability. The user can define a set of up to eight locations, and if any of these is within 200m (configurable up to 650m in [INAV](#) 2.7), then that is used as the home location for RTH (and RTH failsafe).

### 1.13.1 INAV setting

`safehome` is set in [INAV](#) using the CLI, here's an example:

```
# safehome
safehome 0 1 508047750 -14948970
safehome 1 1 509102384 -15344850
safehome 2 1 509390336 -14613540
safehome 3 1 509149619 -15337365
safehome 4 0 508054891 -14961431
safehome 5 0 543545392 -45219430
safehome 6 0 540954148 -47328458
safehome 7 0 0 0
```

As you see, it's not too user friendly; the parameters are

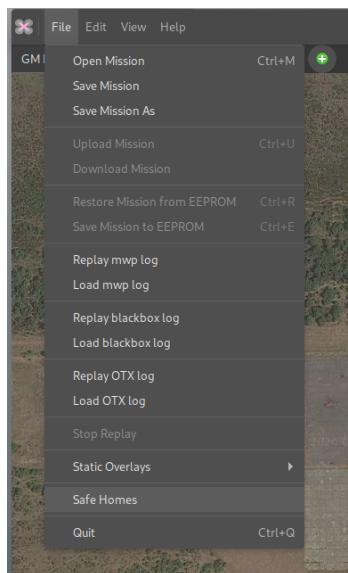
- Index (0 - 7)
- Status (0 = don't use, 1 = can use)
- Latitude as degrees \* 10,000,000 (i.e. 7 decimal places)
- Longitude as degrees \* 10,000,000 (i.e. 7 decimal places)

It can be error prone to get locations into the correct format, particularly when a common source (Google Maps) only provides 6 decimal places of precision.

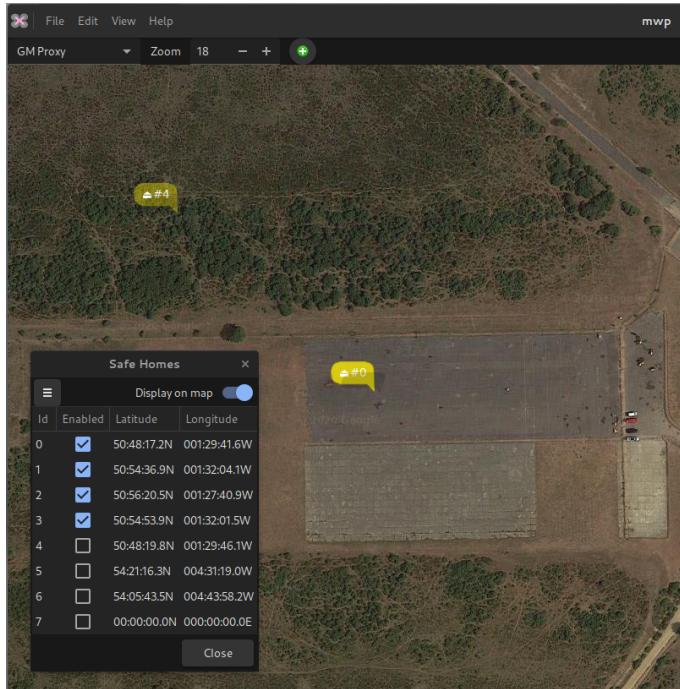
### 1.13.2 mwp solution

#### Graphical User Interface

`mwp` now offers a `Safe Homes` menu option:



This will launch the `Safe Home` window:



From here it is possible to:

- Load safehomes from a file in CLI format. A CLI diff or dump can be used.
- Save safehomes to a file in CLI format. If a CLI diff or dump is selected, then only the safehomes stanza is changed; other information in the diff / dump is preserved.
- Display safehomes on the map. Active safehomes are displayed with greater opacity than inactive locations.
- Change the status (active, inactive). If a previously unused item is enabled, an icon is placed on the centre of the map for positioning.
- Clear (unset) one or all safehomes.

Note that editing functions are only available when the `Safe Homes` window is active; if the windows is dismissed with icons displayed, then the icons remain on the map, but are not editable.

#### Display safehomes at startup

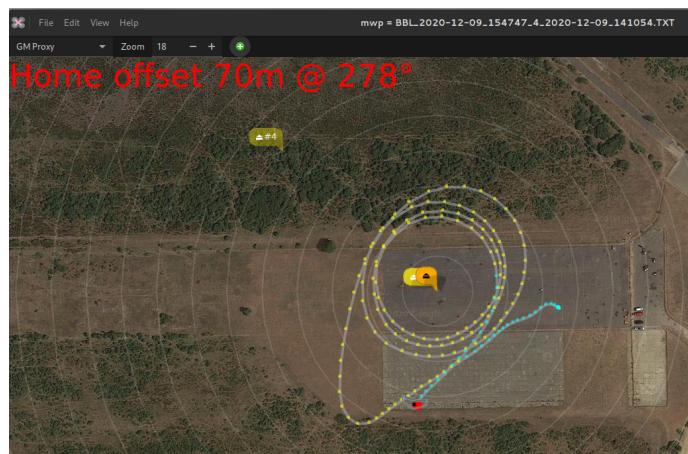
It also is possible to set a `gsettings` key to define a file of safehomes to load at startup, and optionally display (readonly) icons.

```
gsettings set org.mwptools.planner load-safehome ~/.config/mwp/safehome.txt,y
```

This sets the default safehomes file to `~/.config/mwp/safehome.txt` and the appended `,y` means display the icons on the map.

#### Example

The image below shows a blackbox replay. Note that the flight home location (brown icon) is coincident with the pale orange safehome icon.



## 1.14 Radar View

---

`mwp` supports the display of "radar" contacts. This provides a view of adjacent aircraft obtained from a number of sources:

- **INAV-radar.** INAV radar works in conjunction with [INAV](#) flight controllers to broadcast the location of UAS fitted with an ESP32 LoRa module. `mwp` can listen to one of these modems in ground station mode to display the positions of the rest of the 'swarm' (up to 4 UAS); [technical / MSP details](#).
- **Full size aircraft** reported by the MAVLink 'Traffic Report' message. An example is the [uAvionix PingRX](#), a compact device that receives ADS-B location data from full sized aircraft and publishes the locations as MAVLink. For a ground based installation, this device has around a 40Km detection radius. [MAVLink ICD](#).
- **Full size aircraft** reported using the [SBS-1 Basestation streaming TCP protocol](#). This can be generated by the open source [dump1090](#) application with a SDR receiver, as well as commercial products.
- Proximity alerts (visual and audible) for manned (ADS-B / SBS-1) aircraft, based on planned or actual home location.

### 1.14.1 mwp Configuration

`mwp` can receive the 'radar' data over one or two connections, either or both may be active, and `mwp` can receive and display 'own vehicle' telemetry (MSP, LTM or Smartpost), 'INAV-radar' and 'MAVlink Traffic' data simultaneously. Radar data may be received over:

- The main serial port device (see [caveat](#) for INAV-radar) or
- device(s) defined by the `radar-device` CLI or configuration parameter (MAVLink Traffic, INAV-radar)

The `radar-device` option is defined by the standard `mwp` naming scheme:

- A serial device node, with optional baud rate, e.g.:
  - `/dev/ttyACM0`, `/dev/ttyUSB4@567600`, `/dev/rfcomm3`
  - Serial defaults to 115200 baud, but may be set in the device name (@baudrate)
- A Bluetooth address (for BT bridges)
  - `00:0B:0D:87:13:A2`
- A UDP address, e.g. for simulation, recording replays or serial multiplexer (INAV, mavlink).
  - `udp://:30001` local UDP listener.
- A SBS-1 source, defined by a special URI:
  - `sbs://[[host][:port]]` Host and port are optional, defaulting to `localhost` and `30003`. So the minimal "URI" is `sbs://`.

The specific (not shared with the main serial port) radar device(s) may be defined on the command line, or in the static command options file (`~/.config/mwp/cmdopts`):

- `mwp --radar-device udp://:30001`
- `$ cat ~/.config/mwp/cmdopts`

```
# Default options for mwp
# using udev rule to associate a specific USB-TTL adaptor to a name
--radar-device=/dev/pingRX@57600
```

Multiple devices may be defined, e.g.

- As separate options, `--radar-device=/dev/pingRX@57600 --radar-device= /dev/inavradar@115200`
- As a comma separated list: `--radar-device=/dev/pingRX@57600,/dev/inavradar@115200`

Any bespoke `radar-device` is started automatically on startup (or when it shows up). It is not managed via the serial `Connect` button.

## 1.14.2 Using the main serial port

The main serial port may be used for MavLink Traffic without any further configuration. For INAV-radar, to use the main MSP port for INAV-radar (vice using `--radar-device`), it is still necessary to add a command option to `mwp`; it needs to told to relax the default inbound MSP direction check.

This is enabled as

```
mwp --relaxed-msp
```

which should be 'mainly harmless' for normal operations. It's entirely acceptable to put this in `~/config/mwp/cmdopts` to make it the default, as the protocol check dilution is slight.

## 1.14.3 Settings

The following `dconf` setting affect the radar function:

Setting	Usage
<code>radar-list-max-altitude</code>	Maximum altitude (metres) to show targets in the radar list view; targets higher than this value will show only in the map view. Setting to 0 disables. Note that ADS-B altitudes are AMSL (or geoid) and SBS-1 altitudes are "Flight Level" (standard atmosphere).
<code>radar-alert-altitude</code>	Target altitude (metres) below which ADS-B / SBS-1 proximity alerts may be generated. Requires that 'radar-alert-range' is also set (none zero). Setting to 0 disables. Note that the above altitude datum.
<code>radar-alert-range</code>	Target range (metres) below which ADS-B / SBS-1 proximity alerts may be generated. Requires that 'radar-alert-altitude' is also set (none zero). Setting to 0 disables.

Note that proximity alerts require that both the `radar-alert-altitude` and `radar-alert-range` values are set, and that there is a planned or actual home location.

## 1.14.4 Usage

Once the radar interface is open, radar tracks are displayed on the map and in a list available from the "View -> Radar View" menu option.

- The list view is sort-able on the `Id`, `Status`, `Last` (time) and `Range` columns.
- The map visualisation may be toggled by the `Hide Tracks` (`Show Tracks`) button.
- List and map views are updated in (near) real time.
- Preference for display units are used for positions, altitude and speed.

### Name

Type	Usage
INAV-radar	Node Id (typically 'A' - 'D')
Traffic Report	Callsign if reported, otherwise [ICAO number]
SBS-1	Callsign if reported, otherwise [Mode S hexadecimal code]

**Status**

Radar contacts have one of the following status values:

<b>Status</b>	<b>Explanation</b>
Undefined	Not shown in list or on the map
Stale	The last contact was more than 120s previous. Displayed in the list and shown on the map with reduced intensity or an INAV-radar node has 'lost' status
Armed	An active INAV-radar contact
ADS-B	A live MAVLink Traffic report
SBS	SBS-1 report
Hidden	A MAVLink Traffic /SBS-1 contact is between 5 and 10 minutes old. It remains in the list but is not displayed in the map. MAVLink Traffic Report / SBS-1 tracks are removed from the list (and internal storage) after 10 minutes inactivity. INAV-radar ground station. Stale / 'Lost' INAV-radar contacts do not expire, as they may relate to a lost model.

The number displayed after the status text is:

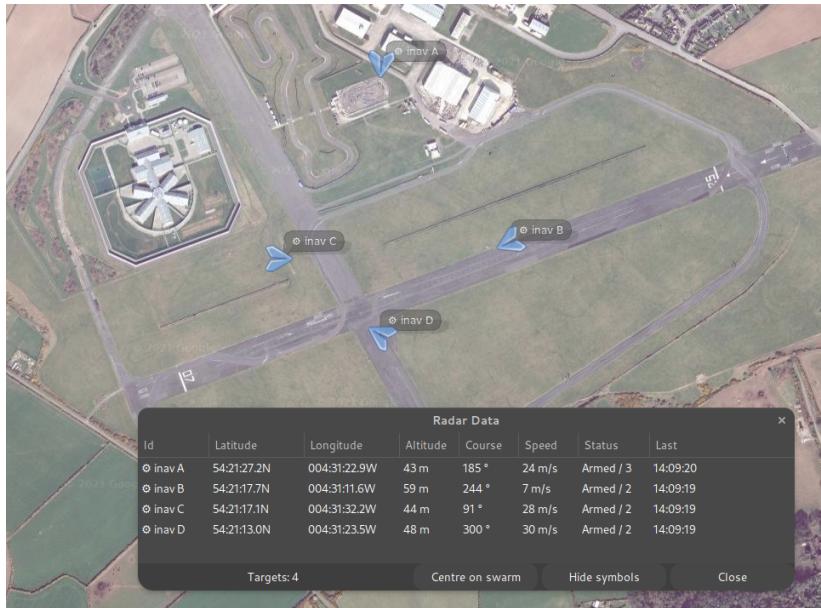
<b>Type</b>	<b>Usage</b>
INAV-radar	The link quality
Traffic Report	Time since last communication in seconds
SBS-1	Always 0

**1.14.5 Examples**

- Proximity Alerts
- Live and stale aircraft
- Aircraft tooltip
- Mission Plan
- List view



### Simulated INAV radar view



### 1.14.6 Simulators

There are simulators for both INAV-radar and MAVLink 'Traffic Report' (e.g. uAvionix PingRX) in the `mwp-tools/src/samples/radar` directory.

There is a replay tool for SBS-1 logs `mwp-tools/src/samples/sbs-test/sbs-player.rb`.

### 1.14.7 Changing the Radar Symbols

Any map symbol used by `mwp` can be changed by the user; in the image above, the INAV radar node symbol has been changed from the default stylised INAV multirotor to a smaller version of the mission replay "paper plane" symbol as described in [creating your own icon](#).

### 1.14.8 Protocol documentation

#### MAVLink 'Traffic Report' (e.g. uAvionix PingRX)

The MAVLink implementation is [comprehensively documented](#) by the vendor.

#### INAV radar

The following is required by a device wishing to act as a ground node (it either masquerades as an INAV FC, or declares itself a GCS)

- Receive and respond to the following MSP data requests:
  - `MSP_FC_VARIANT` (responding as `INAV` or (from 2021/05/06) `GCS` for generic ground control stations).
  - `MSP_FC_VERSION` (in `INAV` and `GCS` modes)
  - `MSP_NAME` (in `INAV` and `GCS` modes)
  - `MSP_STATUS` (in `INAV` mode)
  - `MSP_ANALOG` (in `INAV` mode)
  - `MSP_BOXIDS` (in `INAV` mode)
  - `MSP_RAW_GPS` (in `INAV` mode)
- Receive unsolicited
  - `MSP2_COMMON_SET_RADAR_POS`

Note that the device firmware assumes that MSP buffer sizes are "as specification"; exceeding the expected message buffer size may crash the device (mea culpa).

In `GCS` mode, the node is passive; it does not use a LoRa slot and does not attempt to broadcast a location. In `INAV` mode, the node takes up a LoRa slot and is expected to reply to the additional MSP queries.

`mwp`'s behaviour is defined by the [GCS Location](#)

- If the [GCS Location](#) is defined (when the radar device is initialised, then `mwp` will respond as `INAV` and return the [GCS Location](#), which may be driven by `gpsd` if required.
- Otherwise, `mwp` will respond as a passive `GCS`.

#### SBS-1

[Protocol description](#).

## 1.15 Playing Video in mwp

---

**mwp** provides support for live and replay video.

- In ground station mode, in order to repeat the FPV feed to the mwp screen, presumably for the enjoyment of spectators;
- During Blackbox replay, to show the FPV recorded video during the replay.

### 1.15.1 Dependencies and platform requirements

The video replay capability requires:

- Arch Linux `sudo pacman -S gstreamer1-plugins-base`
- Debian and derivatives `sudo apt install libgstreamer-plugins-base1.0-dev`
- Fedora `sudo dnf install gstreamer1-plugins-base gstreamer1-plugins-base-devel`
- Other distro -- consult the package manager

And, if not installed:

- Arch Linux `gst-plugins-good`
- Debian and derivatives `gstreamer1.0-plugins-good`
- Fedora `gstreamer1-plugins-good`
- Other distro -- consult the package manager

#### i One off actions

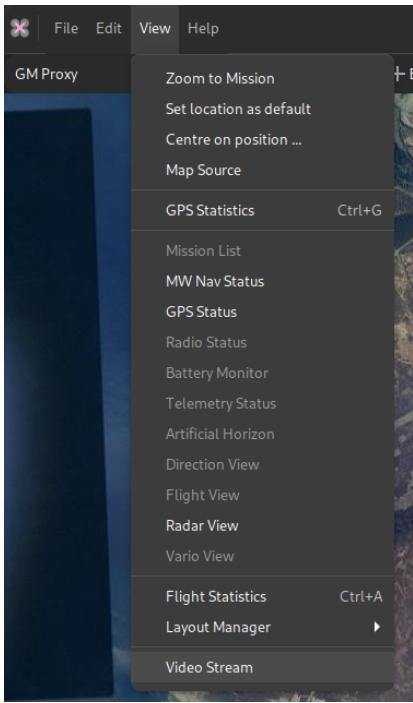
These are documented for new installs (and provided by the '[easy](#)' script).

#### i FreeBSD

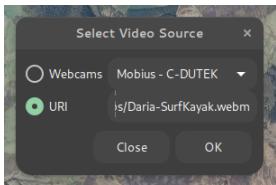
Strictly, **mwp** requires `gstreamer1.0-plugins-gtk` which *should* be included in `gstreamer1.0-plugins-good`; on FreeBSD it is necessary to install `gstreamer1-plugins-gtk` explicitly.

### 1.15.2 Live stream mode (GCS)

There is now a **Video Stream** option under the view menu.



Selecting this option opens the source selection dialogue. Camera devices offering a "video4linux" interface (i.e most webcams) will be auto-detected. There is also the option to enter a URI, which could be a `http` / `https`, `rtsp` or other standard streaming protocol, or even a file.

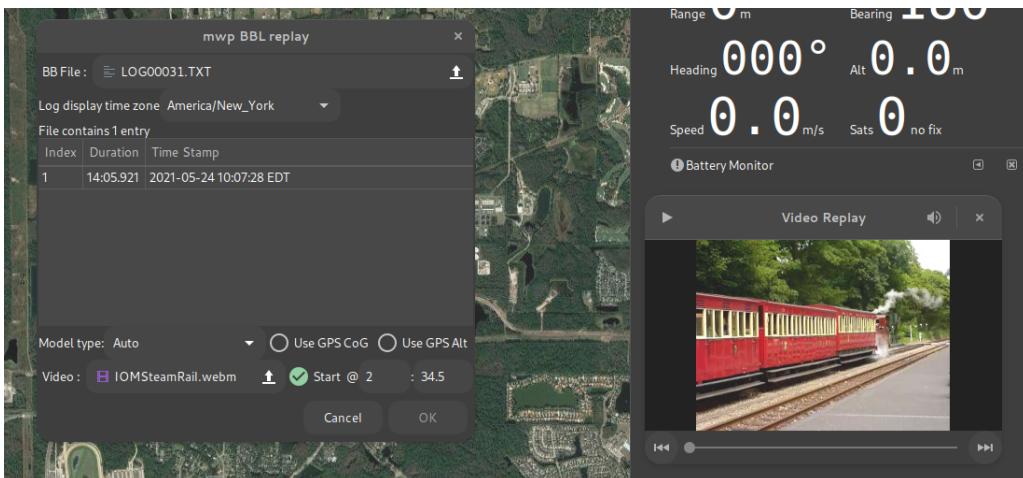


The selected source will then play in a separate window. This window will remain above the mwp application and can be resized, minimised and moved.

In stream mode, there are minimal video controls; a play/pause button and volume control. Note the volume is that of the video, the overall volume is controlled by the system volume control.

### 1.15.3 Blackbox replay mode (BBL replay)

The Blackbox log chooser also offers a video replay option.



Here the user can select a media file and start options, i.e. whether and when to start the video replay with respect to the start of the BB log replay.

- In order for mwp to start the replay, the **Start** check-button must be selected. If it is:
- The user can enter an optional time (minutes : seconds) that defines when the video starts relative to the start of the BB log:
  - No time is entered, or the time is 0:00 : The video starts at the start of the BBL replay.
  - The time is positive (e.g. 2:34.5 (two minutes, 34.5 seconds), as the example: Here the video would start when BB log starts, at an offset 2:34.5 into the video (i.e. the pilot started FPV recording 2m 34.5s before arming the aircraft).
  - If the time is negative (including "-0" minutes), then the start of the video is delayed by that amount; so -0:57 would delay the start of the video by 57 seconds relative to the start of BB log replay.
  - Pausing the replay will pause the video, and vice-versa.

When playing a file (vice a stream), the player gains a progress bar (which can be used to position the stream and "beginning" and "end" buttons.

#### 1.15.4 Issues / Workarounds

If your camera does not work the `gstreamer` utilities, it is unlikely to work with `mwp`, as it uses `gstreamer` APIs for camera access.

You can easily test this using `gst-launch-1.0` which will closely emulate the way `mwp` works:

```
gst-launch-1.0 playbin uri=v4l2:///dev/video0
```

Where `/dev/video0` is the camera device node.

##### Fail example and resolution

A camera (an old Mobius) works on some computers and not others, including, annoyingly, the main `mwp` development box. The issue was an old USB2.0 (extension) hub that didn't provide enough bandwidth; so there was just a black screen shown.

Fixed by setting uvcvideo quirk 640: `UVC_QUIRK_FIX_BANDWIDTH` (0x80, 128) `UVC_QUIRK_RESTRICT_FRAME_RATE` (0x200, 512)

##### TEST FIX

```
sudo rmmod uvcvideo
sudo modprobe uvcvideo quirks=640
```

Now there is a proper picture, rather than a black screen.

##### PERMANENT SOLUTION

Add a file e.g. `/etc/modprobe.d/v4l2.conf` containing the line:

```
options uvcvideo quirks=640
```

or to any other `.conf` file under `/etc/modprobe.d/`

##### Helper tools

There are a couple of tools under `mwp-tools/src/samples/gst-video/`. These are not built / installed by default but may be built if required to enable diagnostics.

```
cd mwp-tools/src/samples/gst-video
make
```

```
# optionally, install to ~/.local/bin  
make install
```

- `gst-devmon` provides the same video device monitoring as employed by `mwp`. It should report the insertion and removal of camera devices, together with their attributes.
- `gst-video-player` provides the same video replay capability as `mwp`
  - Camera stream : `gst-video-player v4l2:///dev/video0` . Assuming the camera, as reported by `gst-devmon` is `/dev/video0`.
  - File: `gst-video-player somefile.mp4`
  - Web stream `gst-video-player https://www.freedesktop.org/software/gstreamer-sdk/data/media/sintel_trailer-480p.webm`

## 1.15.5 Other OS

- FreeBSD. FreeBSD offers a video4linux emulation that works with `mwp`. Cameras are not auto-detected but will be recognised if plugged in before `mwp` is invoked. In any case, the URI `v4l2:///dev/video0` (for example) can be used in streaming mode if required.
- Windows 11/ WSLG: No support for cameras, probably works with files / URLs.

## 1.16 Fly By Home Waypoints

---

### 1.16.1 Introduction

For INAV 4.0, there is a "FlyBy Home" (FBH) waypoint modifier.

This will set waypoints of types WAYPOINT, POSHOLD\_TIME and LAND to execute at the arming home location (any safehome is ignored).

The flight controller applies FBH behaviour to waypoints having one (or both) of the following characteristics:

- The latitude and longitude are 0
- The mission item `flag` field is set to 0x48 (72 decimal, 'H')

In this case, the waypoint position is determined at run time (when the WP is actually used) and is set to the arming location. Note that the arming location must be set with a valid GPS fix.

As the waypoint location is determined during execution, it is not stored; so downloading a completed mission will return the original locations, not the locations used during the mission.

`mwp` will perform the following checks when importing WAYPOINT, POSHOLD\_TIME and LAND points:

- If the latitude and longitude are 0, then the flag is set to 0x48
- If the flag is set to 0x48 and latitude and longitude are 0, the latitude and longitude are set to the mission file home (which may also be 0)

This will ensure, as far as possible, that when such a mission is exported, it is safe on earlier INAV firmware. Note that this excludes using exactly 0,0 as an actual waypoint location (but 0.00001,0.00001 would be OK); in practical terms this is only likely to affect 007 villains.

### 1.16.2 Implications for a graphical mission planner

INAV (and `mwp`) do not require a planned homed location, so providing graphical support for waypoints whose location is indeterminate prior to mission execution is an interesting challenge. `mwp` incorporates a number of new features to support FBH.

- The concept of a planned home location is embedded in the planning function. The planned home location is indicated by a brown icon.
- The planned home location is stored as metadata in the XML mission files.
- The `flag` attribute has been added the XML mission file schema.

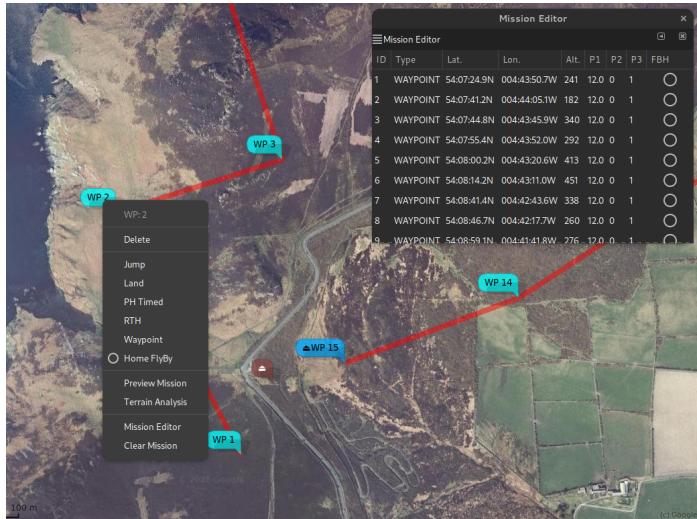
The practical results being:

- A common mission file format continues to be used by `mwp` and the INAV configurator planner; maintaining mission file interoperability between the two applications.
- The planned home is recorded and may be used for subsequent re-planning of a mission.
- FBH waypoints have a position (the planned home) and the `flag` set. This means they will behave predictably when uploaded to older firmware.

### 1.16.3 Usage in `mwp`

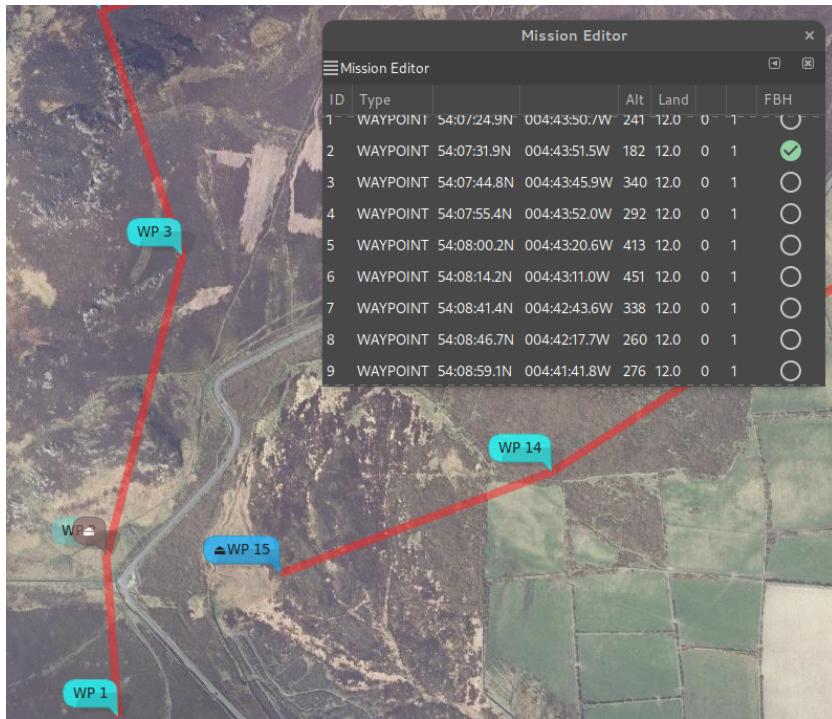
A waypoint may be set to FBH (or have FBH removed) from either the right mouse popup or the mission editor.

In the first image, no FBH waypoints have been set. We can see the planned home (the brown icon, which was read from the extant mission file), and the popup menu and mission editor. Note: the popup entry has since been renamed 'Fly By Home' for consistency.



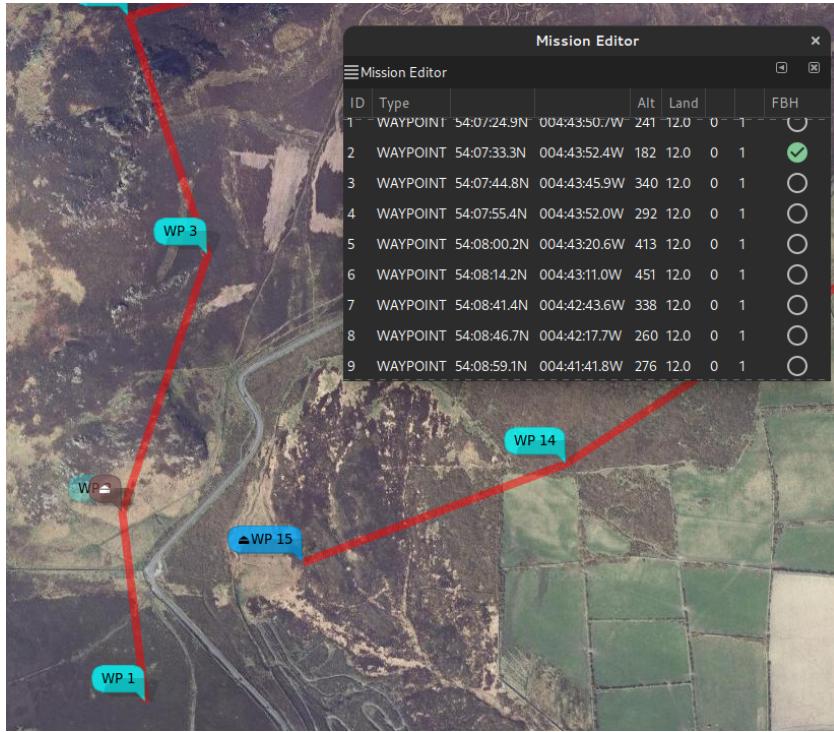
1. Initial state, no FBH

In the second image, WP2 has been made a FBH WP; we can see that it is now attached the home icon (and slightly faded). The home icon can be dragged, the attached FBH waypoint is no longer independently dragable.



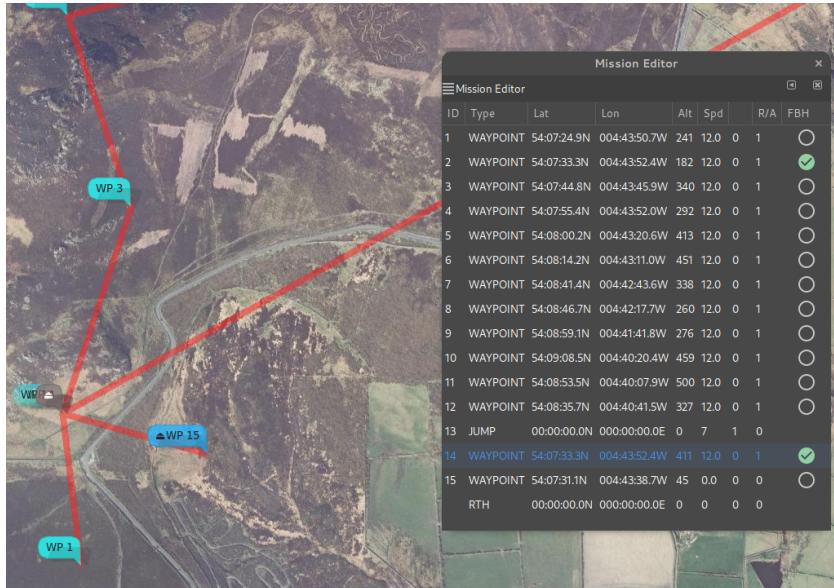
2. WP2 set as FBH

In the third image, the planned home has been moved slightly north, WP2 has moved with it.



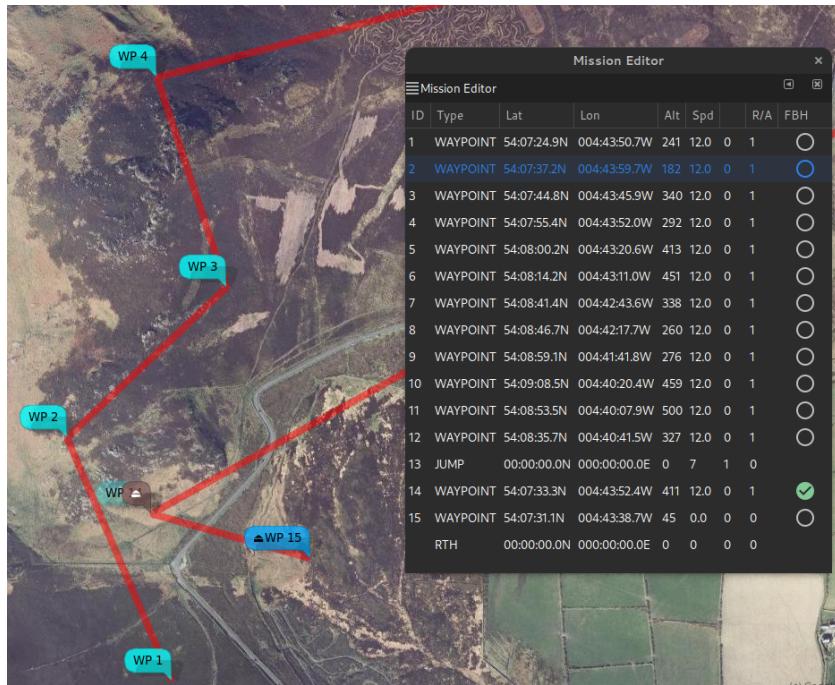
3. Home moved, WP2 moved as FBH

In the forth image, a second waypoint (WP14) has been set as FBH; it is also now locked to the planned home location.



4. Add WP14 as FBH

In the fifth image, the FBH attribute as been cleared on WP2; it has been independently dragged to a new location.



5. Remove FBH from WP2

## 1.16.4 mwp Ground Control Station and Replay modes

If a mission is loaded when mwp is used as ground control station or for log replay, and the mission contains FBH waypoints, then the mission will be redrawn with the actual home location when the home location is established.

## 1.17 Anonymous Maps

**mwp** provides a pseudo-map proxy that just gives you a black map (or user specified tile). This may be useful for a number of use-cases:

- privacy
- general obstinacy
- clarity of display

### 1.17.1 Building

This proxy is not build by default, it is necessary to build, install and configure the proxy manually.

```
cd mwptools/qproxy
make bproxy
# copy bproxy somewhere on the PATH
cp bproxy ~/.local/bin/
# or
sudo cp bproxy /usr/local/bin
# or
sudo cp bproxy /usr/bin
```

### 1.17.2 Configuration

That was the easy bit! Now it is necessary to tell **mwp** where to find the proxy. This involves a setting and a configuration file.

First of all, ensure that the `map-sources` setting is enabled:

```
$ gsettings get org.mwptools.planner map-sources
'sources.json'
# here this set to a file sources.json (in ~/.config/mwp/)
```

if this is not set, then set it:

```
$ gsettings set org.mwptools.planner map-sources 'sources.json'
```

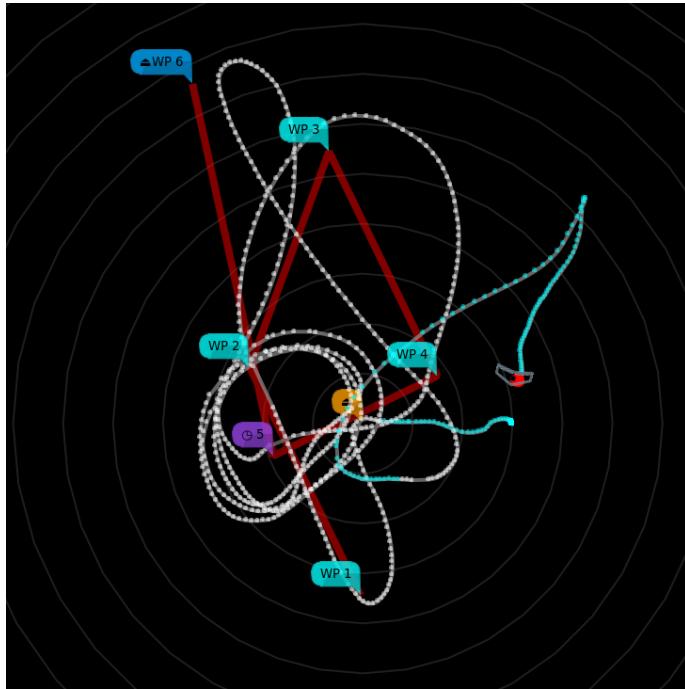
Now we need to edit the file `~/.config/mwp/sources.json`, there is a sample file in `mwptools/samples/sources.json`. your file needs a stanza like:

```
{
  "id": "Black",
  "name": "Black Tiles",
  "license": "(c) jh",
  "license_uri": "http://daria.co.uk/",
  "min_zoom": 0,
  "max_zoom": 20,
  "tile_size": 256,
  "projection": "MERCATOR",
  "spawn" : "bproxy",
}
```

So a minimal `~/.config/mwp/sources.json` looks like:

```
{
  "sources" : [
    {
      "id": "Black",
      "name": "Black Tiles",
      "license": "(c) jh",
      "license_uri": "http://daria.co.uk/",
      "min_zoom": 0,
      "max_zoom": 20,
      "tile_size": 256,
      "projection": "MERCATOR",
      "spawn" : "bproxy",
    }
  ]
}
```

On starting **mwp** you should see a new map option "Black Tiles".



### 1.17.3 Custom Tile

It's also possible to have a custom tile (which does not have to be black). The tile **must** be:

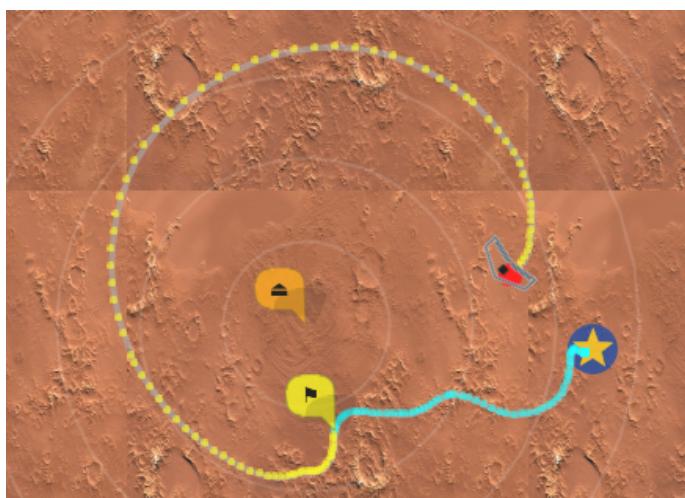
- 256x256 pixels
- PNG

The full path is provided in the environment variable `MWP_BLACK_TILE`, e.g.

```
# put this in e.g. ~/.bashrc to make it permanent
export MWP_BLACK_TILE=~/.config/mwp/mytile.png
```

The environment variable may instead be added to [~/.config/mwp/cmdopts](#).

For example:



## 2.1 Build / install mwp (Generic)

### 2.1.1 Overview

If you just want to install [mwp](#) on a Debian /derivative (includin WSL), x64\_64, then you can install the binary `.deb` package from the [Release Area](#).

Otherwise, if you're using a different (not Debian based) distribution, just curious about building mwptools, you want to explore other tools and scripts in the repository or you're using a different architecture (ia32, Arm7, aarch64, riscV, ppc etc.), then you can build from source.

For Arch Linux, you can install using the AUR package `mwp-tools-git`

The **mwp-tools** suite is built using the `meson` and `ninja` toolchain. For most users these will be automatically provided by a `build-essentials` type of package transparently to the user.

Prior to late May 2021, the build system used a convoluted `Makefile`.

For Debian and derivatives there is a simple "one stop" installation script, as well as a x86\_64 "Release" `.deb` archive.

### 2.1.2 Rationale

In its early days, `make` was a suitable build tool. As **mwp-tools** has gained in features and functionality, this has become un-maintainable. The migration to `meson` and `ninja` solves this problem and allows the project structure to be rationalised.

### 2.1.3 Usage

#### Migration (for old Make based installs)

If you're updating an old Makefile based install, please ensure your extant mwptools instance does not have untracked files:

```
git clean -fd -fx
git pull
```

#### First time

Set up the `meson` build system from the top level:

```
meson build --buildtype=release --strip [--prefix $HOME/.local]
```

- For a user / non-system install, set `--prefix $HOME/.local`
  - This will install the binaries in `$HOME/.local/bin`, which should be added to `$PATH` as required.
- For a Linux system wide install, set `--prefix /usr`
  - For FreeBSD (\*BSD), for a system-wide install, don't set `--prefix` as the default (`/usr/local`) is suitable

Unless you need a multi-user setup, a local install is preferable, as you don't need `sudo` to install, and you'll not risk messing up build permissions.

- If you're using a really old OS (e.g. Debian 10), you may also need `export XDG_DATA_DIRS=/usr/share:$HOME/.local/share` for a local install.

#### Easy first-time install on Debian and derivatives

- Download the [first time build script](#)

- Make it executable `chmod +x deb-install.sh`
- Run it `./deb-install.sh -y`
- Note that the script may ask for a password to install system packages
- The resulting executables are in `~/.local/bin`. Ensure this exists on `$PATH`
- If you get messages like `Removing /home/$USER/.config/mwp/.layout.xml 0 and Failed to save layout, remains in /tmp/.mwp.xxxxxx.xml` you also need `export XDG_DATA_DIRS=$XDG_DATA_DIRS:$HOME/.local/share`. This is rare and should not occur on supported platforms.

## Build and update

```
cd build
# for a local install (and cygwin)
ninja install
# for system install
ninja && sudo ninja install
```

## Accessing the serial port

The user needs to have read / write permissions on the serial port in order to communicate with a flight controller. This is done by adding the user to a group:

- Arch Linux: `sudo usermod -aG uucp $USER`
- Debian / Fedora (and derivatives): `sudo usermod -aG dialout $USER`
- FreeBSD: `sudo pw group mod dialer -m $USER`
- Windows/WSL: Not needed, no serial pass-through. Use the `ser2udp` bridge instead.

## Legacy

For now, some of the legacy `Makefiles` remain, and can be used similar to before, e.g.:

```
cd mwptools/src/mwp
make && sudo make install
```

At some stage, more of the Makefiles will be removed (or just rot into uselessness).

## 2.1.4 Files built / installed

### Default

Application	Usage
<code>mwp</code>	Mission planner, GCS, log replay etc.
<code>mwp-area-planner</code>	Survey planner
<code>mwp-plot-elevations</code> 1	Mission elevation / terrain analysis
<code>qproxy</code>	Proxy for certain commercial TMS
<code>cliterm</code>	Interact with the CLI
<code>fc-get</code> , <code>fc-set</code> 2	Backup / restore CLI diff
<code>inav_states.rb</code>	Summarise BBL state changes, also installed <code>inav_states_data.rb</code>
<code>fcflash</code>	FC flashing tool, requires <code>dfu-util</code> and / or <code>stmflash32</code>
<code>flashgo</code>	Tools to examine, download logs and erase from dataflash

### Notes:

1. This may either be the new Go executable or the legacy, less functional Ruby script.
2. `fc-set` is a hard link to `fc-get`

### Optional

These are only built by explicit target name; they will be installed if built.

```
# one of more of the following targets
ninja bproxy ublox-geo ublox-cli
sudo ninja install
```

Application	Usage
bproxy	Black tile map proxy, for those anonymous needs
ublox-cli	Ublox GPS tool
ublox-geo	Graphical Ublox GPS tool

### Troubleshooting and Hints

#### MIGRATE FROM A SYSTEM INSTALL TO A USER INSTALL

```
cd build
sudo ninja uninstall
meson --reconfigure --prefix=$HOME/.local
ninja install
```

#### FIXING BUILD PERMISSIONS

If you install to system locations, it is possible that `sudo ninja install` will write as `root` to some of the install files, and they become non-writable to the normal user.

- In the `build` directory, run `sudo chown -R $USER .`
- Consider migrating to a local install

### Help!!!!

#### YOU'VE INSTALLED A NEW VERSION BUT YOU STILL GET THE OLD ONE!

If you used the `deb-install.sh` script, then it installed everything into `$HOME/.local/bin` (and other folders under `~/.local`). This is nice because:

- mwp does not pollute the system directories;
- you don't need `sudo` to install it.

Linux (like most other OS) has the concept of a `PATH`, a list of places where it looks for executable files. You can see this from a terminal:

```
## a colon separated list
echo $PATH
```

So check that `$HOME/.local/bin` is on `$PATH`; preferably near the front.

If it is, then the problem may be that the older mwp also exists elsewhere on the PATH, and the system will not re-evaluate the possible chain of locations if it previously found the file it wants.

So, maybe you have an old install. You didn't remove it (alas); so the system thinks that mwp is `/usr/bin/mwp`; in fact it's now `$HOME/.local/bin/mwp`

If `$HOME/.local/bin` is on the PATH before `/usr/bin`, then you have two choices:

```
# reset the path search
hash -r
# mwp, where art thou? Hopefully now is ~/.local/bin
which mwp
# From **this terminal** executing mwp will run the location reported by `which mwp`
```

or

Log out, log in. The PATH will be re-evaluated.

If `$HOME/.local/bin` is not on PATH, then it needs to be added to a login file (`.profile`, `.bashrc`, `.bash_profile` etc.). Modern distros do this for you, however if you've updated an older install you may have to add it yourself.

```
# set PATH so it includes user's private bin if it exists
if [ -d "$HOME/bin" ] ; then
    PATH="$HOME/bin:$PATH"
fi

# set PATH so it includes user's private bin if it exists
if [ -d "$HOME/.local/bin" ] ; then
    PATH="$HOME/.local/bin:$PATH"
fi
```

If an older (perhaps Makefile generated) mwp exists; then you should remove all evidence of an earlier system install.

```
find /usr -iname \*mwp\*
```

review the list and as root, delete the old files. Do similar for blackbox-decode.

If you're content with the list, then (*caveat emptor*):

```
sudo find /usr -iname \*mwp\* -delete
```

You'll still have to remove non-empty directories manually.

"NINJA: ERROR: LOADING 'BUILD.NINJA': NO SUCH FILE OR DIRECTORY

Something, or persons unknown has removed this file.

```
cd mwptools
meson setup --reconfigure build --prefix ~/.local
cd build
ninja install
```

ERROR: DEPENDENCY "?????" NOT FOUND, TRIED PKGCONFIG

[mwp](#) requires a new dependency. This will be documented in the wiki [Recent Changes](#) document.

- Install the newly required dependencies
- Rerun your build

## Supporting data files

File	Target	Usage
src/common/mwp_icon.svg	\$prefix/share/icons/hicolor/scalable/apps/	Desktop icon
src/mwp/org.mwptools.planner.gschema.xml	\$prefix/share/glib-2.0/schemas/	Settings schema
src/mwp/vcols.css	\$prefix/share/mwp/	Colours used by battery widget
src/mwp/default.layout	\$prefix/share/mwp/	Default dock layout
src/mwp/beep-sound.ogg	\$prefix/share/mwp/	Alert sound
src/mwp/bleet.ogg	\$prefix/share/mwp/	Alert sound
src/mwp/menubar.ui	\$prefix/share/mwp/	Menu definition
src/mwp/mwp.ui	\$prefix/share/mwp/	UI definition
src/mwp/orange.ogg	\$prefix/share/mwp/	Alert sound
src/mwp/sat_alert.ogg	\$prefix/share/mwp/	Alert sound
src/mwp/mwp.desktop	\$prefix/share/applications/	Desktop launcher
src/mwp/mwp_complete.sh	\$prefix/share/bash-completion/completions/	bash completion for mwp
src/mwp/pixmaps	\$prefix/share/mwp/pixmaps/	UI Icons
src/mwp/blackbox_decode_complete.sh	\$prefix/share/bash-completion/completions/	bash completion for blackbox-decode
src/samples/area-tool/mwp_area_icon.svg	\$prefix/share/icons/hicolor/scalable/apps/	Desktop icon
src/samples/area-tool/mwp-area-planner.desktop	\$prefix/share/applications/	Desktop launcher
docs/mwptools.pdf	\$prefix/share/doc/mwp/	(Obsolete) manual
docs/debian-ubuntu-dependencies.txt	\$prefix/share/doc/mwp/	Debian / Ubuntu dependencies
docs/fedora.txt	\$prefix/share/doc/mwp/	Fedora dependencies

## 2.2 Windows 11 / WSL-G

---

### 2.2.1 Intro

As a result of user interest in running [mwp](#) on Windows 11 / WSL-G, here's an experiment to see if it's possible. By a Windows neophyte, so if I can install mwp on WSL, anyone can.

There is also an excellent [you-tube video tutorial](#) from Marc Hoffmann (in English and German).

[Watch on Youtube](#)

### 2.2.2 Environment

Tested with Windows 11 VM hosted on Arch Linux by the developer.

### 2.2.3 WSL Installation

- Installed default Ubuntu
- Note that serial ports remain *difficult* (workarounds described below)

#### Windows / WSL Pre-requisites

None other than the serial port issue, Wayland (GUI) and sound just work. The serial port problem can be mitigated by a "serial to IP" solution; mwptools provides [ser2udp](#) for this purpose or using [usbipd](#) / [usbip](#)

### 2.2.4 mwp Installation

Use one of the following:

#### (a) Install the current release from GitHub.

- Download the `.deb` file
- `cd` to where ever you saved the `.deb` file
- In the WSL terminal `sudo apt install mwptools_x.y.z_amd64.deb`

Example: using `curl` to download ...

```
$ curl -LO https://github.com/stronnag/mwptools/releases/download/x.y.z/mwptools_x.y.z_amd64.deb
$ sudo apt install ./mwptools_x.y.z_amd64.deb
```

Where `x.y.z` represents the build tag.

#### (B) UNIFIED FIRST-TIME BUILD SCRIPT (BUILD AND INSTALL FROM SOURCE)

For the initial installation, there is a unified / simplified install / build / install script: [Instructions](#)

This installs mwptools and blackbox-tools-inav to `$HOME/.local/bin`.

#### (C) TRADITIONAL BUILD PROCESS (BUILD AND INSTALL FROM SOURCE)

If you want more control over build options.

If `git` is not pre-installed in WSL, then it will be necessary to install it.

```
sudo apt update && sudo apt upgrade
sudo apt install git
```

Note: `/etc/sudoers` (via `visudo`) was edited to allow the WSL user to run commands as root without asking for a password.

Then it was just a case of cloning the mwp repository and following mwp's instructions (`mwp-tools/docs/debian-ubuntu-dependencies.txt`), to install the dependencies, this is available as an executable script thusly:

```
sudo mwp-tools/docs/debinstall.sh -y # "-y" bypasses interactive query / responses
```

Then build and install mwp and optionally the blackbox tools (as `mwp-tools/docs/debian-ubuntu-dependencies.txt`). [Build documentation](#).

For the optimal blackbox replay, install the [flightlog2x](#) tools, either from the GitHub release or build from source in Linux/WSL.

## 2.2.5 Running mwp

Compared to Win10/WSL or Cygwin, there is no longer any need to mess around the `DISPLAY` or `udev` settings. No 3rd party X-server, Windows 11 / WSL-G handles all the GUI.

### One off changes

- WSL installs a very cut down icon theme that does not provide the all the system / standard icons used by mwp. Fix this by:

```
sudo apt install adwaita-icon-theme-full
```

- If you wish to replay blackbox / OTX / BulletGCSS logs, it may be necessary to have an IPv6 definition of `localhost`; WSL's `/etc/hosts` does not provide this:

```
# updated in /etc/hosts for ipv6
::1   localhost ip6-localhost ip6-loopback
```

Note: This was caused by an unnecessary assumption in `flightlog2x`'s `f12ltm` which is corrected in `flightlog2x` release (> 0.11.0), so you might not need it anymore.

- Then tell WSL to please not break your `hosts` file again

```
### Add the following entry to /etc/wsl.conf:
[network]
generateHosts = false
```

- Due font differences, it may be necessary to reduce the font scaling in the mwp 'Flight View' docklet.

```
gsettings set org.mwp-tools.planner font-fv 10
# if you still have resizing problems, try 9 ....
```

Then you are ready to run mwp.

```
mwp
```

### Serial devices

In order to use a serial device, it is necessary to run a "serial to IP" bridge on the Windows side. There are two solutions to this, both involve some effort on both the Windows and Linux sides.

- `udnip`, a long-standing Linux feature that has recently been introduced to Windows
- Standalone "serial-to-IP" bridge, such as mwp's `ser2udp` tool. This application will need to be white-listed in the Windows firewall.

### udnip

See this [Microsoft developer blog article](#) for installation / usage information.

### Standalone Bridge

There are a number of existing solutions that may work; **mwp** provides a simple, dedicated `ser2udp` tool that works well, and once set up is transparent in usage.

## Installing mwp's ser2udp

Either:

- Download the compiled Zip file from the current [mwp release area](#) (on Windows); or
- Build on the **Linux/WSL side**:

```

• cd mwptools/src/samples/s2n
• make ser2udp.exe
• copy ser2udp.exe to the dark-Windows side

```

On the Windows side:

- Use the Windows firewall settings to allow `ser2udp.exe` to accept UDP traffic.
- Run `ser2udp.exe`; it will autodetect your serial port. By default this listens on UDP port 17071, you can change this by supplying a second parameter, e.g., to use port 34567. In this case, either define the serial port or use `auto` (auto-detect).

```

> ser2udp.exe auto :34567
## or just let ser2udp autodetect
> ser2udp.exe
External address: fe80::1439:d6de:efcb:97e1%eth0
External address: 172.29.32.1

```

The colon is required to define an alternative port.

- `ser2udp` will survive removal of USB devices and attempt to re-connect (e.g. if the FC is rebooted).
- `ser2udp` will *only* attempt to automatically acquire STM32 USB devices (0483:5740 vid:pid)
- You need to terminate `ser2udp` when you're done with it (e.g. to use the INAV configurator in Windows).

## USING SER2UDP IN MWP

- On the Linux side, we need to know the IP address (or have a hostname for) the Windows WSL endpoint. Fortunately this happens to be Linux's default gateway, so we can handle it fairly transparently.

It is easily automated by using the magic `__MWP_SERIAL_HOST` name in the serial device.

```

mwp -d udp://__MWP_SERIAL_HOST:17071
# recognised by other tools as well ...
cliterm udp://__MWP_SERIAL_HOST:17071

```

`__MWP_SERIAL_HOST` is resolved as:

- If an environment variable `$MWP_SERIAL_HOST` exists, it is used; else
- The default gateway (which on WSL is the Windows host IP) is used; else
- It will fail, as the literal name is unlikely to exist as a resolvable host name (not even a RFC legal host name).

Thus:

- For WSL and `ser2udp`, in mwp [preferences](#), set the serial device to `udp://__MWP_SERIAL_HOST:17071`
- Or in the shell, for some other scenario, `export MWP_SERIAL_HOST=foobox.org` in the event that you have a valid use case

## Launch ser2udp and MWP in one go

- Create a new `txt` file in the same folder where `ser2udp.exe` is located and copy the following lines into that file:

```

@echo off
echo Launching MWP Mission Planner
start wslg.exe -d Ubuntu mwp
echo Waiting for WSL System to boot up
timeout 5
echo Launching Serial to UDP Tool
start "Serial2UDP" cmd /c ser2udp.exe -verbose 1
exit

```

- rename the file with any name and change the extension to .cmd
- Create a shortcut anywhere on your PC or in `C:\Users\<username>\AppData\Roaming\Microsoft\Windows\Start Menu\Programs` to pin it to your Start Menu
- Replace the shortcut symbol with the MWP icon [from here](#)

#### BATch file considerations

- The `timeout` value may need changing (or not be needed at all). YMMV.
- Consider adding the `/min` to `cmd` to minimise the `ser2udp` window on startup.

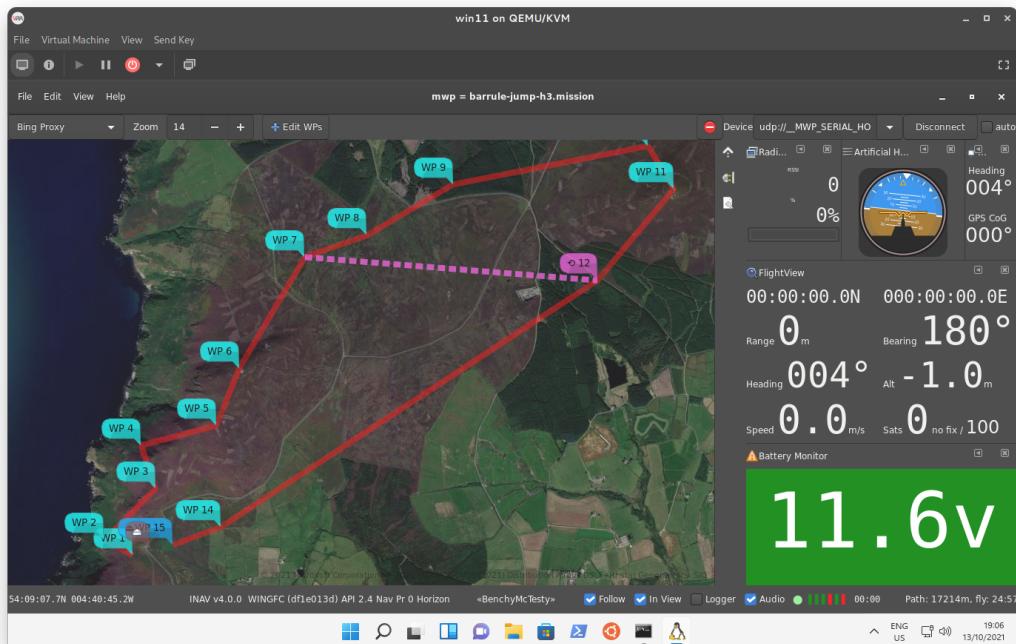
#### 2.2.6 Other packages for additional functionality.

- To replay blackbox logs, you need
  - [INAV blackbox tools](#), mandatory
  - [flightlog2x / bbl2kml](#). Provides a much better blackbox replayer than the default shipped with mwp (and you can generate really pretty Google Earth files from blackbox / opentxt / bulletgcss logs).
- Terrain Analysis
  - Gnuplot. Check the installer script that it's enabled.

#### 2.2.7 Summary

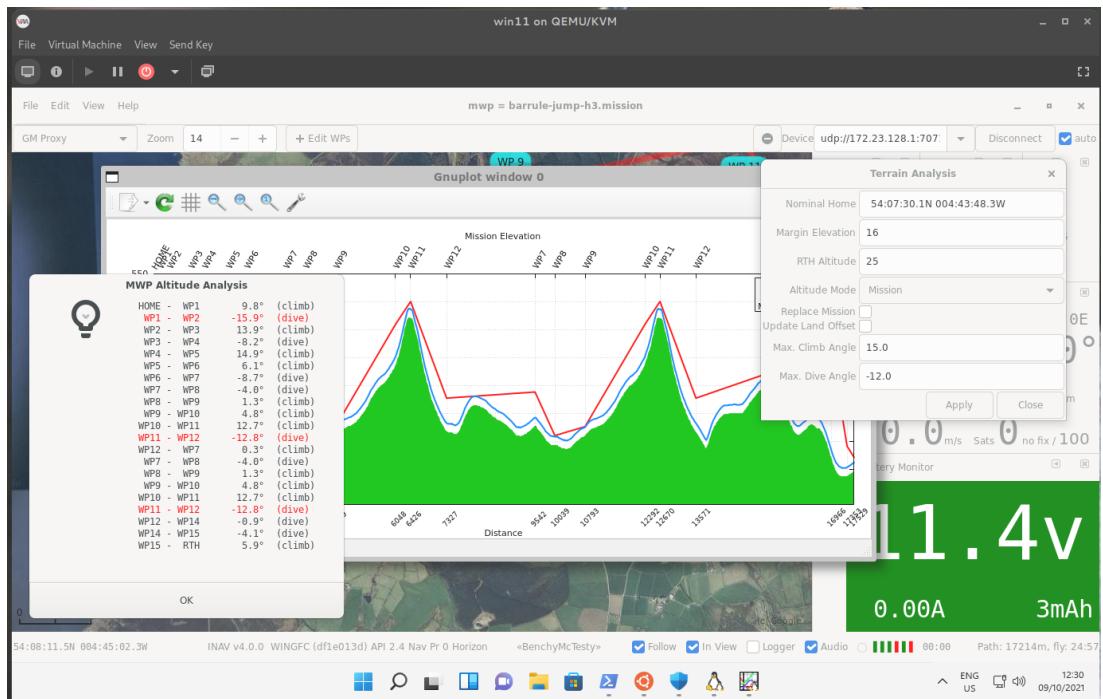
- Much, much better than the prior WSL instances, pity about the difficulty in using serial ports (still). Overall, the seamless WSL-g experience is impressive.

#### Connection via ser2udp bridge

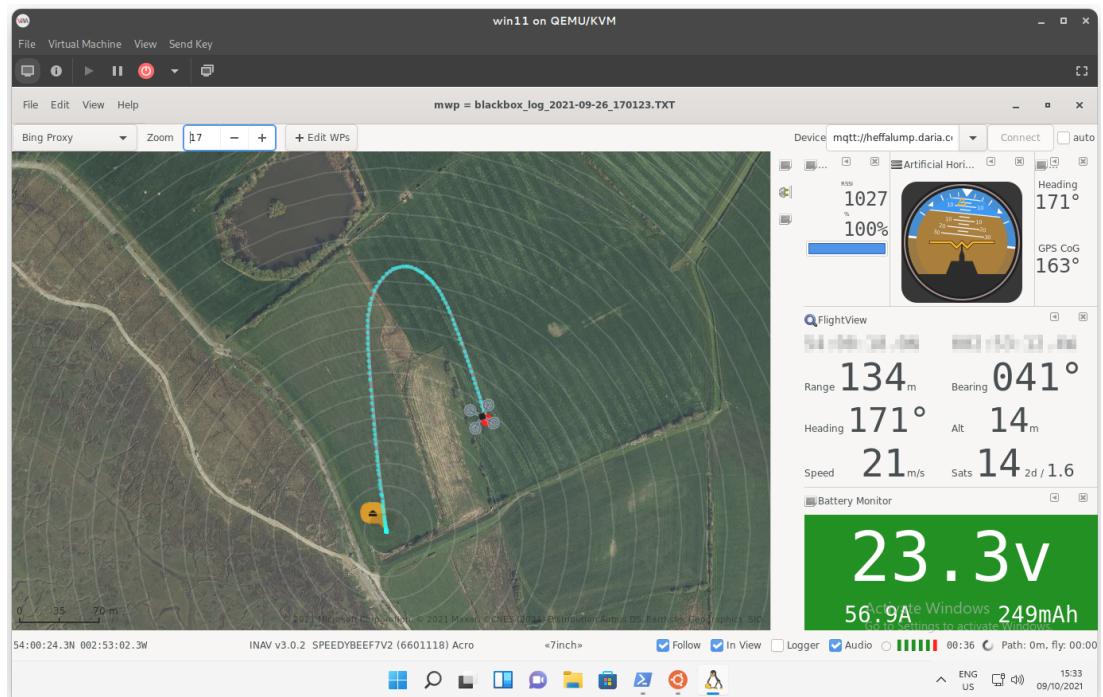


Dark theme, correct system icons installed, connected to FC via ser2udp .

## Terrain / elevation analysis



## Blackbox replay



**Good enough!**

The user's compass seems good enough for navigation functions (top right widget comparing GPS CoG v. compass heading).

---

### 3.1 Power and screen management

There are a number of ways of managing the screen (inhibit screen saver etc.)

- Use an external screen-saver manager such as [caffeine](#)
- Use the legacy [mwp](#) settings options, for example:

```
org.mwptools.planner atexit 'gsettings set org.gnome.settings-daemon.plugins.power idle-dim true'  
org.mwptools.planner atstart 'gsettings set org.gnome.settings-daemon.plugins.power idle-dim false'
```

- Allow [mwp](#) to manage screen and power settings, controlled by a setting:

```
gsettings set org.mwptools.planner manage-power true
```

In the first two cases, the setting is somewhat coarse, either requiring the user to click on something and applying to the whole [mwp](#) session.

The final case applies only when [mwp](#) is receiving push telemetry (LTM, Mavlink, MQTT). Inhibiting IDLE and SUSPEND is performed using the GTK inhibit() API and will thus work with most window managers.

## 3.2 INAV 4.0 Multi-Mission Support

---

### 3.2.1 Overview

In INAV 4.0, the FC supports "multi-missions", that is allowing the user to upload and store multiple missions.

The mission to be executed may be set when the mission set is uploaded, or selected by OSD command (or stick command).

### 3.2.2 mwp support

The means by which this function is provided by the FC is a little inconvenient (for the planner) but expedient; it's hard to see how else it could have been implemented.

In general and in summary, the functionality allows multiple missions to exist in a single "mission file" and either one or all of those mission can be uploaded to the FC.

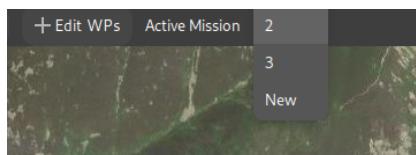
When a "multi-mission" set is downloaded from the FC, [mwp](#) will set the active mission to that set as active in the FC.

When a "multi-mission" set is uploaded to the FC, mwp will set the active FC mission to its active mission.

### 3.2.3 mwp changes

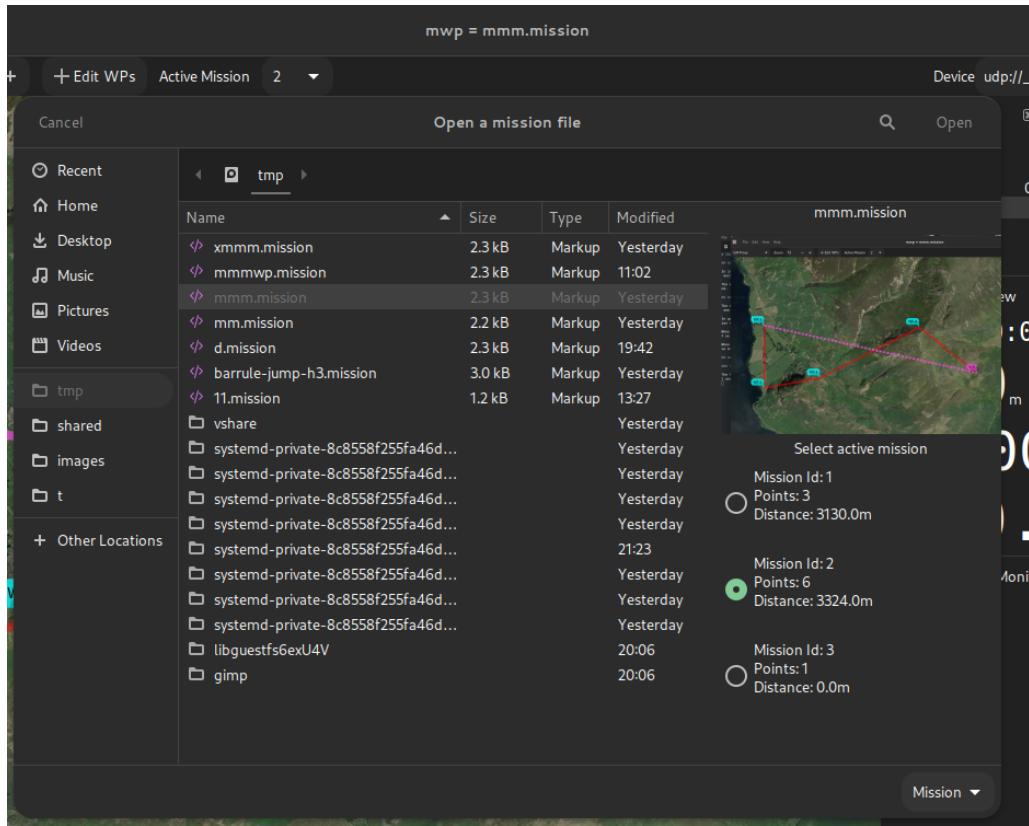
#### Top Bar

The top bar now includes an "Active Mission" item. This always has mission 1 (the legacy mission) and offers "New", allowing multiple missions to be maintained in one mwp session.



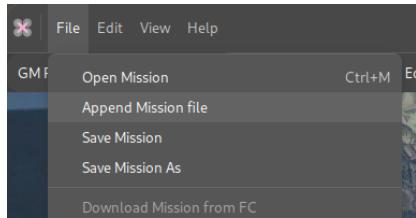
#### Open Mission file

The file open dialog has a preview pane that displays the missions in a multi-mission file. The user can select the mission to be the active mission.



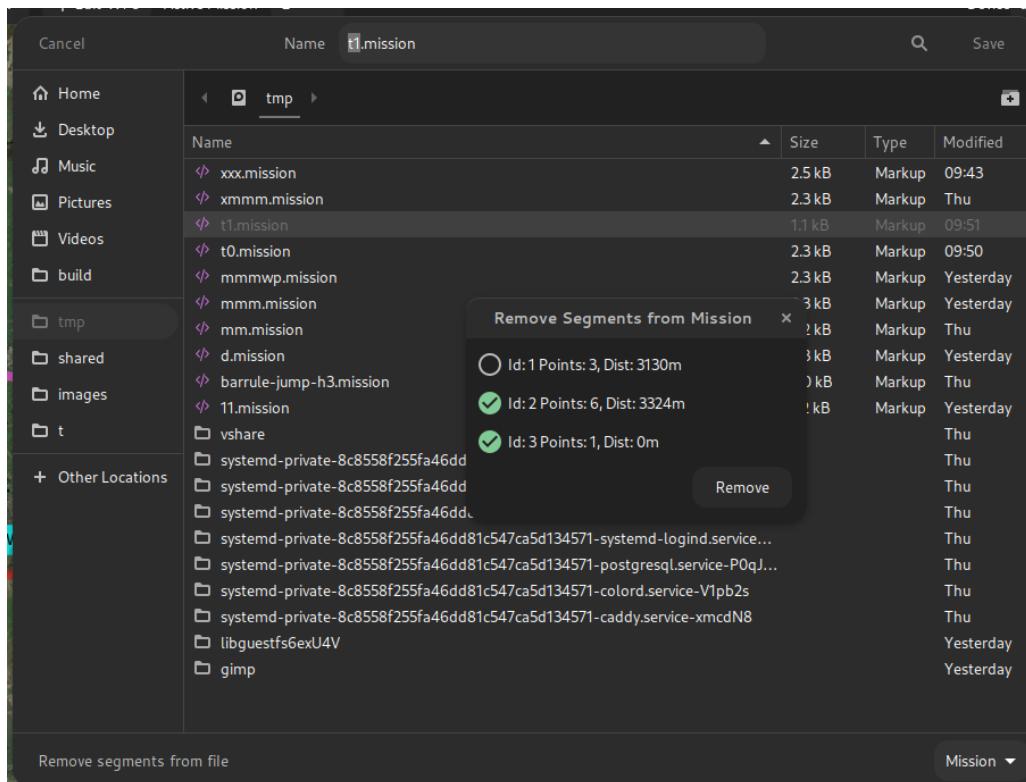
## Append Mission File

It is now possible to append an existing mission file (which may hold multiple missions) into a multi-mission set. This uses same dialog as [Open Mission File](#).



## Save As Mission file

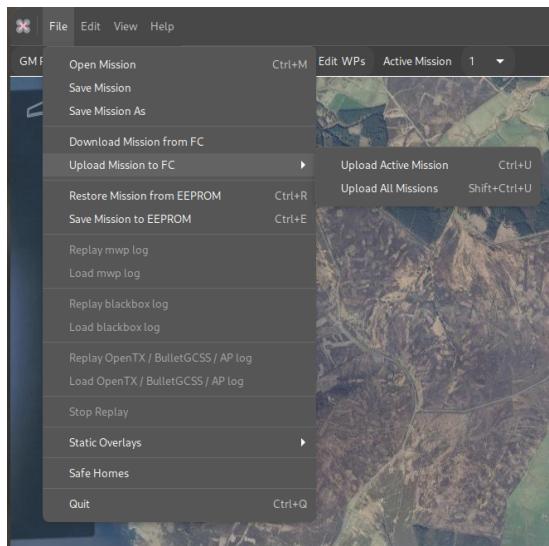
The file "Save as" dialog has an option to exclude specific segments from a multi-mission (via the **Remove Segments from file** button in the following image). Note that "Save" will always save all mission segments.



In this case, only segment 1 of the multi-mission would be saved.

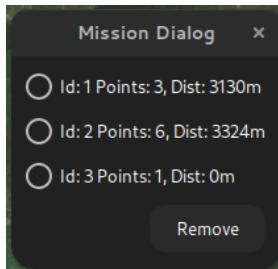
### 3.2.4 Upload / Download Menu Options

The menu options reflect the new capability to upload all or the active mission. The "Save to EEPROM" option may also change to this pattern in future.



#### Multi-Mission Manager

The **Edit** menu has a **Multi Mission Manager** option. This allows the user to delete one or more missions from a multi-mission scenario.



### 3.2.5 FC Limits

INAV 4.0 limits the total number of waypoints to 120 and the number of mission segments within a multi-mission scenario to 9.

**mwp** will allow the user to exceed these limits while creating / editing multi-mission scenarios, but enforces the limits for upload. So it would be possible to open / append files containing a total of (for example) 11 mission segments and 150 WPs. It would be necessary to reduce the mission set to the FC limits before it could be uploaded.

### 3.2.6 Legacy

mwp still supports prior FC firmware, including MW. It is a bug if this is not the case. However, the user needs to be aware of the capabilities of the FC firmware.

### 3.2.7 Caveats

- This is all quite novel and has required some significant changes in **mwp**; however it appears quite stable.
- By default, **mwp** writes mission files in "reset / per segment metadata" style.
- Multi-mission files may be written in the (IMO) ugly / confusing "sequential" style required by the configurator if the environment variable CFG\_UGLY\_XML is set (to any value). See the [schema definition](#) for details. mwp can read either style.

### 3.2.8 Example XML multi-mission file

```
<?xml version="1.0" encoding="utf-8"?>
<mission>
<!--mw planner 0.01-->
<version value="42"/></version>
<mwp save-date="2021-11-11T07:22:43+0000" zoom="14" cx="-3.2627249" cy="54.5710168" home-x="-3.2989342" home-y="54.5707123" generator="mwp
(mwptools)"><details><distance units="m" value="3130"/></distance><nav-speed units="m/s" value="10"/></nav-speed><fly-time units="s" value="319"/></fly-
time><loiter-time units="s" value="0"/></loiter-time></details></mwp>
<missionitem no="1" action="WAYPOINT" lat="54.5722109" lon="-3.2869291" alt="660" parameter1="0" parameter2="0" parameters="0" flag="0"/></missionitem>
<missionitem no="2" action="WAYPOINT" lat="54.5708178" lon="-3.2642698" alt="755" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="3" action="WAYPOINT" lat="54.5698227" lon="-3.2385206" alt="513" parameter1="0" parameter2="0" parameter3="0" flag="165"/></missionitem>
<mwp save-date="2021-11-11T07:22:43+0000" zoom="15" cx="-3.2778311" cy="54.5568837" home-x="-3.2983737" home-y="54.5622331" generator="mwp
(mwptools)"><details><distance units="m" value="9029"/></distance><nav-speed units="m/s" value="10"/></nav-speed><fly-time units="s" value="929"/></fly-
time><loiter-time units="s" value="0"/></loiter-time></details></mwp>
<missionitem no="1" action="WAYPOINT" lat="54.5599696" lon="-3.2958555" alt="236" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="2" action="WAYPOINT" lat="54.5537978" lon="-3.2958555" alt="136" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="3" action="WAYPOINT" lat="54.5547933" lon="-3.2864141" alt="238" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="4" action="WAYPOINT" lat="54.5597705" lon="-3.2695913" alt="570" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="5" action="WAYPOINT" lat="54.5552910" lon="-3.2598066" alt="502" parameter1="0" parameter2="0" parameter3="0" flag="0"/></missionitem>
<missionitem no="6" action="JUMP" lat="0.0000000" lon="0.0000000" alt="0" parameter1="1" parameter2="1" parameter3="0" flag="165"/></missionitem>
<mwp save-date="2021-11-11T07:22:43+0000" zoom="20" cx="-3.2501935" cy="54.5714148" generator="mwp (mwptools)"><details><distance units="m" value="0"/></distance></details></mwp>
<missionitem no="1" action="WAYPOINT" lat="54.5714148" lon="-3.2501935" alt="50" parameter1="0" parameter2="0" parameter3="0" flag="165"/></missionitem>
</mission>
```

[Download sample mission](#)

## 3.3 BulletGCSS Telemetry

### 3.3.1 mwp requirements

[mwp](#) works with the web-based Ground Control Station [BulletGCSS](#) MQTT protocol, tested with both a `fl2mqtt` simulation and a recorded live session.

The MQTT component is build if either `paho-mqtt` or `mosquitto` libraries are detected; `paho-mqtt` is preferred.

```
## Arch ##
yay -S paho-mqtt-c-git ## or you favourite AUR helper
# or #
sudo pacman -S mosquitto

## Debian and derivatives ##
### Debian testing / Ubuntu 20.10 + for paho ####
sudo apt install libpaho-mqtt-dev
# or #
sudo apt install libmosquitto-dev

## Fedora ##
dnf install paho-c-devel
# or #
dnf install mosquitto-devel

## FreeBSD ##
## paho-mqtt
# Clone github repo and build from source. Configure with cmake -DPAHO_WITH_SSL=true ..
git clone https://github.com/eclipse/paho.mqtt.c.git
cd paho.mqtt.c
mkdir build
cd build
cmake -DPAHO_WITH_SSL=true ..
make && sudo make install

# or #
sudo pkg install mosquitto
```

If you have both `paho-mqtt` and `mosquitto` installed, then `paho-mqtt` is preferred.

### 3.3.2 Usage

Once [mwp](#) is built with a MQTT library, you can use an MQTT URL as a device name, for example for the demo that runs every other hour (00:00, 02:00 .. 22:00) UTC on `broker.emqx.io` with topic `org/mwptools/mqtt/otxplayer`, the mqtt URI for [mwp](#) would be:

```
mqtt://broker.emqx.io/org/mwptools/mqtt/otxplayer
```

Or in general:

```
mqtt://[user[:pass]@]broker[:port]/topic[?cafile=file]
```

Note:

- port is the mqtt port (typically and by default 1883), not the websocket port.
- if you want to use TLS, then the port will be different, often 8883, and you might need to provide the broker's CA file.
- As [mwp](#) uses a pseudo-URL for the broker,topic etc, the topic should comply with rules for a URL rather than the more relaxed MQTT topic specification. This is a feature.

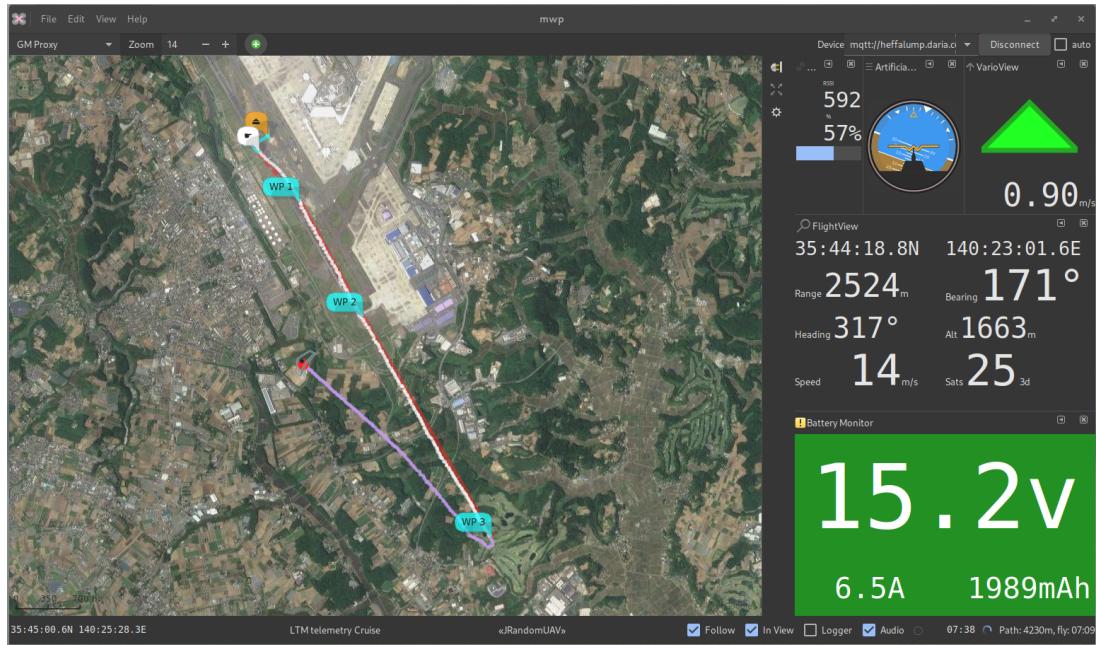
The scheme part (`mqtt://`) in the example is interpreted as:

- `ws://` - Websocket (vice TCP socket), ensure the websocket port is also specified, requires 'paho-mqtt' as the provider.
- `wss://` - Encrypted websocket, ensure the TLS websocket port is also specified. TLS validation is performed using the operating system. Not supported by `mosquitto`; requires `paho-mqtt` 1.39 or later.
- `mqtts://, ssl://` - Secure (TLS) TCP connection. Ensure the TLS port is specified. TLS validation is performed using the operating system, unless `cafile` is provided.
- `mqtt://` - TCP connection. If `?cafile=file` is specified, then that is used for TLS validation (and the TLS port should be specified).

MQTT looks like an incredibly elegant solution to long range telemetry.

More information on the [BulletGCSS website](#) and [BulletGCSS wiki](#)

See also [fl2mqtt](#), a tool to replay Blackbox and OpenTx logs as MQTT and [BulletGCSS mosquito hosting guide](#) for hosting your own MQTT broker.



## 3.4 mwp and INAV 3.0 Mission Updates

---

### 3.4.1 Overview

INAV 3.0 adds a couple of changes to INAV mission planning:

- Absolute WP altitudes
- Land WP ground elevation setting

#### Absolute WP altitudes

For Multiwii and INAV prior to 3.0, waypoint altitudes were always relative to the arming location. If you always fly in a flat area, or always arm at the same point, this wasn't really an issue; you could always use [mwp's terrain analysis](#) to check that you'd clear any obstructions.

However, if you armed some (vertical) distance from the arming point assumed when the plan was created, the absolute, (AMSL) elevation of the WP would differ by the ground difference between the assumed arming point at planning time and the actual arming point at take off. In the worst case (arming at an 'zero' absolute elevation well below the 'assumed at planning time' location), this could result in automated flight into terrain, which is generally undesirable.

Absolute mission altitudes addresses this issue, as the AMSL elevation of the WP is fixed and does not depend on arming location.

#### Land WP ground elevation setting

A similar issue existed prior to INAV 3.0 for the LAND WP; the initial implementation assumed that the LAND WP site ground elevation was at approximately the same ground elevation as the arming location. INAV computes landing behaviour based on relative altitude from home; if the actual LAND site was lower than home, then the descent would be slow; if it was higher, then slowdown might not occur and there would be a hard landing (for MR). For FW the final approach and motor-off would be sub-optimal.

The required land elevation uses the `P2` WP parameter, **in metres**.

- If LAND is a relative altitude WP, then this is the altitude difference between the assumed home and the LAND location.
- If LAND is an absolute altitude WP, then this is the absolute (AMSL) altitude of the LAND location.

### 3.4.2 mwp support for 3.0 features

---

**mwp** supports the new feature in the Mission Editor and Terrain Analysis.

#### Mission Editor

The mission editor gains two new context message options:

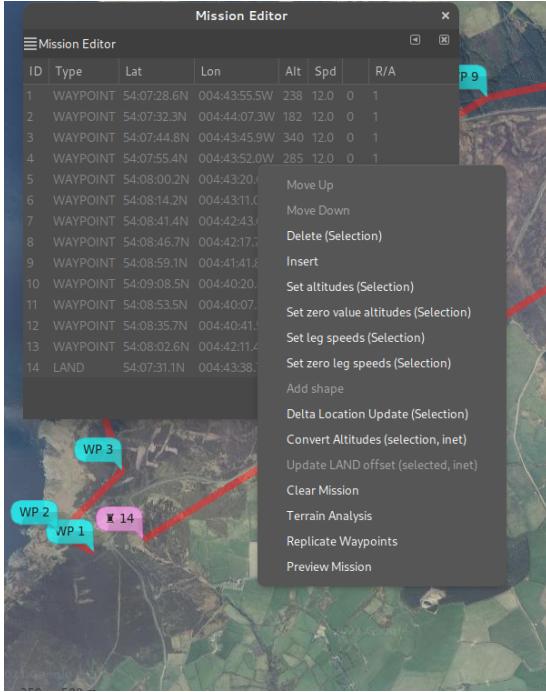
- Convert Altitudes (selection, inet)
- Update LAND offset (selected, inet)

The text in parentheses indicating that a selection of point and an internet (`inet`) connection is potentially needed.

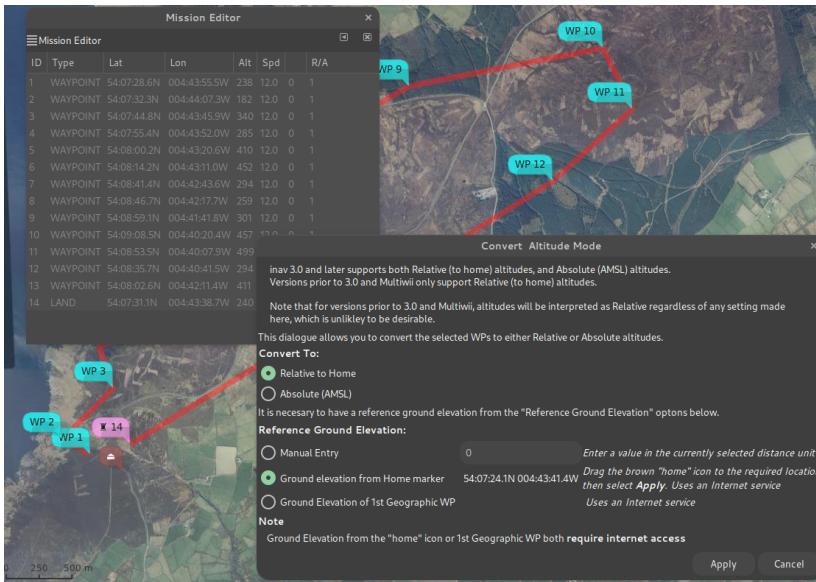
- Internet connectivity is needed in order to perform conversion between absolute and relative modes, unless manual entry of the home elevation is chosen.
- Internet connectivity is needed for automatic LAND elevation adjustment, as mwp needs to know the LAND site ground elevation.
- However, the values can all be edited manually if necessary:

In the image below:

- The R/A column indicates the altitude mode (**Relative to home**, **Absolute**). These are shown as the raw `P3` value, where `0` = Relative (default) and `1` means absolute (AMSL). A mission can contain a mixture of relative and absolute values.
- "Convert Altitudes ..." is enabled, because geospatial WPs are selected.
- "Update LAND offset ..." is not enabled; it requires a single LAND WP to be selected.



When "Convert Altitudes ..." is invoked, the user is presented with the following:

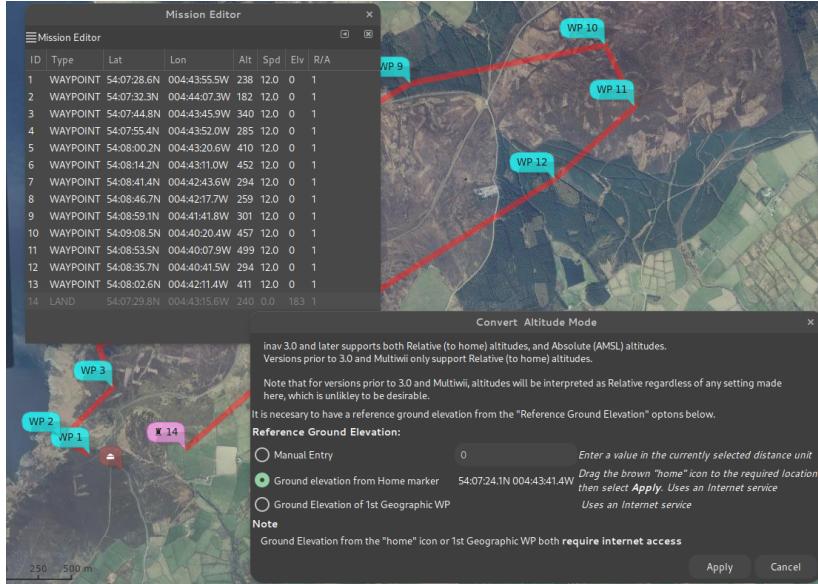


- The user can select to convert the selected WPs to either Relative or Absolute. Only geospatial WPs are converted, and if the WP is already of the selected mode, it will be ignored.
- The user can select the reference home altitude by:
  - Entering a manual value, does not require an internet connection.
  - Dragging the brown "home" icon to the required position
  - Using the position of the 1st geographic WP, which does not have to be in the conversion selection.

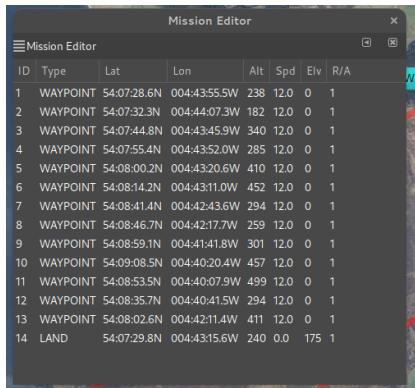
If "Apply" is clicked, the conversion proceeds, downloading elevation data from the internet as required. Cancel closes the dialogue and clears the selection from the Mission Editor.

When "Update LAND offset ..." is invoked, the user is presented with a similar dialogue, without the Altitude Mode selection, as that's implicit from the selected waypoint.

In the image below, WP14 has been moved down the valley:



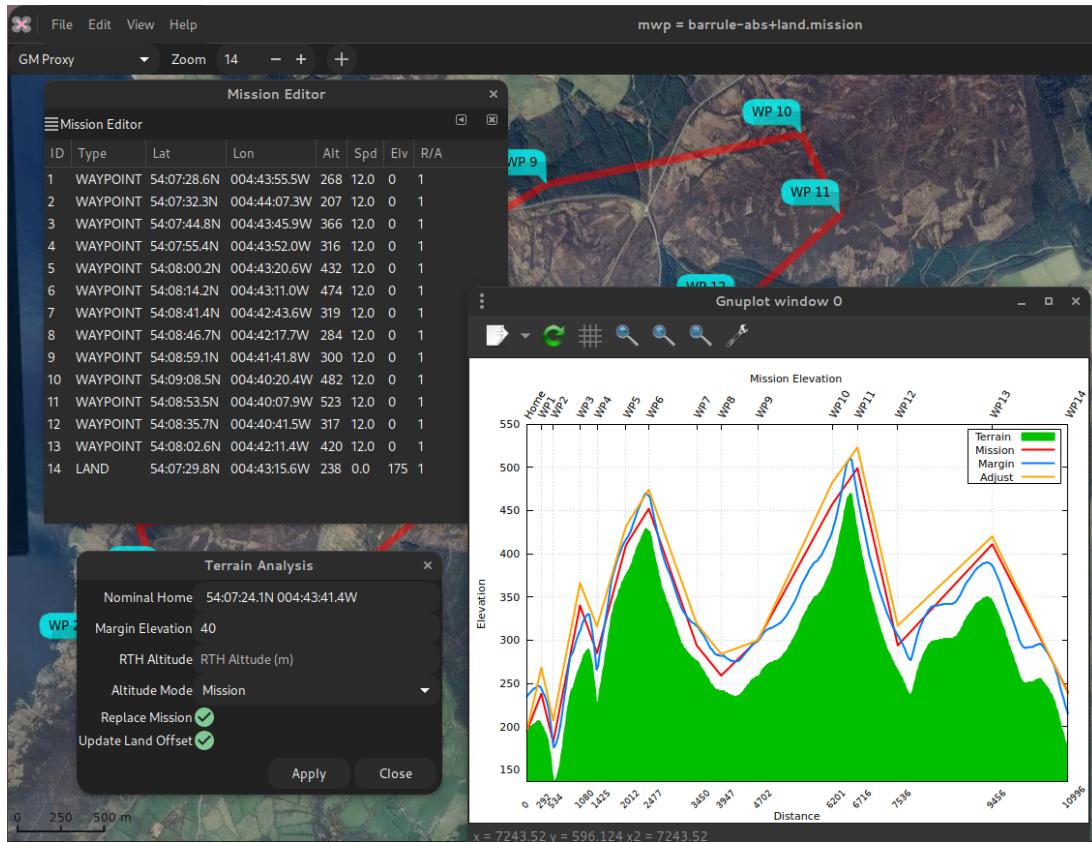
When this is applied, the WP14 value (parameter 2, "Elv" in the cell headers), should decrease, which it does, from 183m to 175m (AMSL).



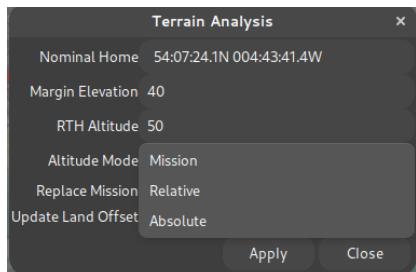
## Terrain Analysis

[mwp's terrain analysis](#) function has been upgraded to handle INAV 3.0 features (Relative / Absolute Elevations, Land Ground Elevation). If you're using the older (ruby) terrain analysis tool, you won't see the new features. The [mwp terrain analysis article](#) also describes the new analysis tool.

In the image below, the dialogue has been enhanced to allow selection of the altitude mode and adjustment of LAND elevation. The orange graph line shows the generated mission with a 40m clearance of all obstacles.



The user can select the following altitude modes:



- Mission - use the altitude mode from the mission
- Relative to home
- Absolute (AMSL).

### 3.4.3 Attribute editing

Of course, it's not necessary to use the new dialogues to set or change the new INAV 3.0 features.

- The `parameter3` value sets the altitude mode 0 = relative to home (legacy default), 1 = Absolute.
- The `altitude` value is interpreted according to `parameter3`
- For a LAND WP `parameter2` defines the LAND WP ground elevation; if `parameter3` is 0, then it's relative to home, if `parameter3` is 1, then it's absolute (AMSL).

### 3.4.4 Further reading

The [INAV wiki](#) describes WP mission parameters in some detail.

Discussion of the meaning of "sea level". It's confusing.

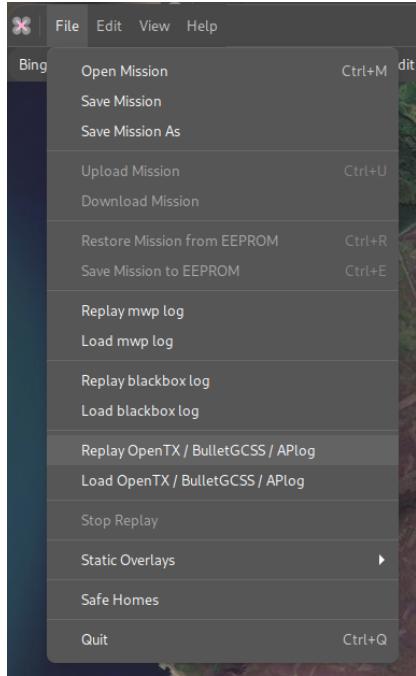
## 3.5 Ardupilot log replay

### 3.5.1 Requirements

It is possible to replay Ardupilot logs in the same way as one can replay blackbox, OpenTX / EdgeTX and BulletGCCS logs. This also requires [flightlog2x tools](#) 0.11.0 or more recent.

- It is necessary to install an Ardupilot tool to decode the logs [mavlogdump.py](#).

As the author does not have any (useful) AP logs, contributions are welcome.



## 3.6 Flite Text to Speech

---

### 3.6.1 Overview

mwp can use the `flite` text to speech engine (as well as `espeak` or `speech-dispatcher`). Flite is enabled if:

- You have the flite development files installed

Flite is available at run-time if:

- The flite version is 2.0 or later.

Unfortunately, it is non-trivial to detect the flite version at build time.

Flite provides reasonable quality voices with low overhead, including some female voices.

### 3.6.2 Configuration

---

Flite is configured using two `gsettings` keys:

Key	Usage
<code>speech-api</code>	Defines the speech API to be used, one of <code>none</code> , <code>espeak</code> , <code>speechd</code> or <code>flite</code>
<code>flite-voice</code>	The voice file to be used. If not specified, the internal <code>slt</code> (female) voice is used. The value takes the absolute path name to a voice file, optionally followed by a <code>,</code> and a floating point speed factor (see below)

```
$ gsettings set org.mwptools.planner speech-api flite
$ gsettings set org.mwptools.planner flite-voice-file /home/jrh/.config/mwp/cmu_us_clb.flitevox,0.9
```

### 3.6.3 Discussion

---

#### Voice Files

flite can use external voice files that provide better quality than the built-in voices. Your distro may provide these voice files in an optional package, or you can download from <http://www.festvox.org>, e.g. for flite 2.1 <http://www.festvox.org/flite/packed/flite-2.1/voices/> (replace 2.1 with 2.0 etc., not all the 2.1 voices may exist for 2.0). The following script will bulk download the non-Indic voices; you can test them out with the `flite` application, or mwp's `ftest` application).

```
#!/bin/bash

BASE=http://www.festvox.org/flite/packed/flite-2.1/voices

for V in cmu_us_aew.flitevox cmu_us_ahw.flitevox cmu_us_aup.flitevox \
    cmu_us_awb.flitevox cmu_us_axb.flitevox cmu_us_bdl.flitevox \
    cmu_us_clb.flitevox cmu_us_eey.flitevox cmu_us_fem.flitevox \
    cmu_us_gka.flitevox cmu_us_jmk.flitevox cmu_us_ksp.flitevox \
    cmu_us_ljm.flitevox cmu_us_lnh.flitevox cmu_us_rms.flitevox \
    cmu_us_rxr.flitevox cmu_us_slp.flitevox cmu_us_slt.flitevox
do
    wget -P . $BASE/$V
done
```

#### Replay Speed

The default replay speed for some flite voices is rather slow. The optional rate setting in the `gsettings flite-voice-file` key may be used to increase the rate.

### 3.6.4 Test

`mwp-tools/samples/flite` provides a test programme for assessing flite voices.

```
$ cd mwp-tools/samples/flite
$ make
$ ./ftest < mwp.txt # speak mwp like phrases using default voice
$ ./ftest cmu_us_clb.flitevox,0.9 < mwp.txt # speak mwp like phrases using external voice file, with relative rate (0.9)
```

Note: this test programme will work with flite 1.x; though you can only use the default 'kal' voice (you cannot load 'better' voices).

## 3.7 DBus API

---

### 3.7.1 Introduction

[mwp](#) provides a Dbus API to permit remote control or monitoring of mwp by third party applications.

Dbus is a common Linux API for inter-process communications, and can be used from most programming languages. [mwptools/samples](#) provides examples in `python`, `ruby` and `bash`.

It is intended that the `ruby` examples cover the majority of the API and provide canonical examples of usage.

As this is a developer topic, please raise GitHub issues if clarification is needed or you have a use case that would benefit from extending the API.

Please also note that the definitive definition of the DBus API is provided by DBus inspection.

### 3.7.2 DBus object and interface

The mwp Dbus API exists on the session bus when mwp is running.

- Object Path: `/org/mwptools/mwp`
- Interface: `"org.mwptools.mwp"`

### 3.7.3 Flight Status and geo-location information

A set of APIs is provided for synchronous and asynchronous (signals, event by event) notification of vehicle status and location. A use case might be to drive an antenna tracker.

#### Flight status and geo-location methods

##### GETSTATE NAMES

Returns human-readable names for the FC 'state' returned by `GetState`, as an array of strings. The size of the array is the return value.

```
int GetStateNames(out string[] states_names)

<method name="GetStateNames">
  <arg type="as" name="names" direction="out"/>
  <arg type="i" name="result" direction="out"/>
</method>
```

##### GETSTATE

Returns the FC 'state'. 0 if unarmed. Human-readable state names are provided by `GetStateNames()`.

```
int GetState()

<method name="GetState">
  <arg type="i" name="result" direction="out"/>
</method>
```

##### GETHOME

Returns the home location as latitude (WGS84 decimal degrees), longitude (WGS84 decimal degrees) and relative altitude (metres, which should always be 0).

```
void GetHome(out double latitude, out double longitude, out int32 altitude)

<method name="GetHome">
  <arg type="d" name="latitude" direction="out"/>
  <arg type="d" name="longitude" direction="out"/>
  <arg type="i" name="altitude" direction="out"/>
</method>
```

**GETLOCATION**

Returns the vehicle location as latitude (WGS84 decimal degrees), longitude (WGS84 decimal degrees) and relative altitude (metres).

```
void GetLocation(out double latitude, out double longitude, out int32 altitude)

<method name="GetLocation">
  <arg type="d" name="latitude" direction="out"/>
  <arg type="d" name="longitude" direction="out"/>
  <arg type="i" name="altitude" direction="out"/>
</method>
```

**GETSATS**

Returns the number of satellites and the fix type (0=nofix, 1=undefined, 2=2D fix, 3=3D fix).

```
void GetSats(out uint8 number_satellites, uint8 fix_type)

<method name="GetSats">
  <arg type="y" name="nsats" direction="out"/>
  <arg type="y" name="fix" direction="out"/>
</method>
```

**GETVELOCITY**

Returns the vehicle speed (m/s) and course (degrees), GPS provided.

```
void GetVelocity(out uint32 speed, out uint32 course)

<method name="GetVelocity">
  <arg type="u" name="speed" direction="out"/>
  <arg type="u" name="course" direction="out"/>
</method>
```

**GETPOLARCOORDINATES**

Returns the vehicle location as polar coordinates relative the home position: Range (m), Bearing (degrees) **from home to vehicle**, azimuth (elevation angle, degrees).

```
void GetPolarCoordinates(out uint32 range, out uint32 direction, out uint32 azimuth)

<method name="GetPolarCoordinates">
  <arg type="u" name="range" direction="out"/>
  <arg type="u" name="direction" direction="out"/>
  <arg type="u" name="azimuth" direction="out"/>
</method>
```

**GETWAYPOINTNUMBER**

Returns the next WP number (en-route to) or -1 if not flying WPs.

```
int GetWaypointNumber()

<method name="GetWaypointNumber">
  <arg type="i" name="result" direction="out"/>
</method>
```

**Flight status and geo-location signals**

A number of signals (asynchronous event by event notifications) are issued for changes in state and location. This avoids applications having to poll for changes. In general, the data returned is that for the eponymous Get\* methods.

All location signals may be rate limited by the `DbusPosInterval` property in order to avoid excessive DBus traffic.

**HOMECHANGED**

Notifies that the home position has changed.

```
signal void HomeChanged (double latitude, double longitude, int altitude)

<signal name="HomeChanged">
  <arg type="d" name="latitude"/>
  <arg type="d" name="longitude"/>
  <arg type="i" name="altitude"/>
</signal>
```

**LOCATIONCHANGED**

Notifies that the vehicle position has changed (geographic coordinates).

```
signal void location_changed (double latitude, double longitude, int altitude)

<signal name="LocationChanged">
  <arg type="d" name="latitude"/>
  <arg type="d" name="longitude"/>
  <arg type="i" name="altitude"/>
</signal>
```

**POLARCHANGED**

Notifies that the vehicle position has changed relative to home (polar coordinates).

```
signal void polar_changed(uint32 range, uint32 direction, uint32 azimuth)

<signal name="PolarChanged">
  <arg type="u" name="range"/>
  <arg type="u" name="direction"/>
  <arg type="u" name="azimuth"/>
</signal>
```

**VELOCITYCHANGED**

Notifies that the vehicle velocity (course or speed) has changed.

```
signal void velocity_changed(uint32 speed, uint32 course)

<signal name="VelocityChanged">
  <arg type="u" name="speed"/>
  <arg type="u" name="course"/>
</signal>
```

**STATECHANGED**

Notifies that the vehicle 'state' has changed.

```
signal void StateChanged(int32 state)

<signal name="StateChanged">
  <arg type="i" name="state"/>
</signal>
```

**SATSCHEANGED**

Notifies that the satellite status has changed.

```
signal void SatsChanged(uint8 nsats, uint8 fix)

<signal name="SatsChanged">
  <arg type="y" name="nsats"/>
  <arg type="y" name="fix"/>
</signal>
```

**WAYPOINTCHANGED**

Notifies that the current WP number has changed.

```
signal void WaypointChanged(int32 wp)

<signal name="WaypointChanged">
  <arg type="i" name="wp"/>
</signal>
```

**Application Status****QUIT**

The `quit` signal is issued when mwp exits, allowing a dependent application to close down gracefully or take action to wait for the bus to reappear.

```
quit()
```

```
<signal name="Quit">
</signal>
```

### 3.7.4 Properties

#### **DbusPosInterval**

```
uint dbus_pos_interval
```

Defines rate limiting for all position related signals. The value represents the minimum update interval in 0.1s intervals.

- 0 disables rate limiting
- 2 is the default, and matches the best LTM rate of 5Hz
- a large value (e.g. 999999, greater than a realistic flight time), would effectively disable event by event positional updates.

### 3.7.5 Serial Port and Mission management

A set of APIs is provided for remote serial port and mission management.

### 3.7.6 Serial Ports

#### **GetDevices**

The `GetDevices` API returns a list of the serial devices known to the `mwp` instance, as an array of strings.

```
void GetDevices(out string[]device_names)

<method name="GetDevices">
  <arg type="as" name="devices" direction="out"/>
</method>
```

#### **ConnectionStatus**

The `ConnectionStatus` API returns a boolean status as to whether `mwp` is connected to a serial device, and if connected, the name of the device.

```
bool ConnectionStatus(out string device_name)

<method name="ConnectionStatus">
  <arg type="s" name="device" direction="out"/>
  <arg type="b" name="result" direction="out"/>
</method>
```

#### **ConnectDevice**

The `ConnectDevice` API attempts connection to the given device, and returns the status of the operation (`true` => connected).

```
bool ConnectDevice(string device_name)

<method name="ConnectDevice">
  <arg type="s" name="device" direction="in"/>
  <arg type="b" name="result" direction="out"/>
</method>
```

### 3.7.7 Mission Management

Somewhat inconsistent set of mission management APIs. Note these are not yet multi-mission aware.

#### **ClearMission**

Clears the current mission from `mwp`.

```
void ClearMission()
```

```
<method name="ClearMission">
</method>
```

### SetMission

Opens a mission in mwp from an XML or JSON document, returns the number of mission points.

```
int SetMission(string mission)

<method name="SetMission">
  <arg type="s" name="mission" direction="in"/>
  <arg type="u" name="result" direction="out"/>
</method>
```

### LoadMission

Opens a mission in mwp from an mission file, returns the number of mission points.

```
int LoadMission(string filename)

<method name="LoadMission">
  <arg type="s" name="filename" direction="in"/>
  <arg type="u" name="result" direction="out"/>
</method>
```

### UploadMission

Loads the current mwp mission into the flight controller, optionally saving to it EEPROM. Returns the number of mission points.

```
int UploadMission(bool to_eeprom)

<method name="UploadMission">
  <arg type="b" name="to_eeprom" direction="in"/>
  <arg type="i" name="result" direction="out"/>
</method>
```

## 3.7.8 Examples

- samples/mwp-dbus-test.sh
- samples/mwp-dbus.rb
- samples/mwp-dbus.py
- samples/mwp-dbus-loc.rb
- samples/mwp-dbus-loc.py
- samples/mwp-dbus-to-gpx.rb

## 3.7.9 Introspection

Not withstanding the state of the documentation, it is possible introspect the API. Note that mwp must be running for the API to exist. The document returned by DBus introspection **is** the definitive definition of the API.

```
# Note samples/mwp-dbus-loc.rb also provides introspection.
$ samples/mwp-dbus-test.sh introspect
<!DOCTYPE node PUBLIC "-//freedesktop//DTD D-BUS Object Introspection 1.0//EN"
  "http://www.freedesktop.org/standards/dbus/1.0/introspect.dtd">
<!-- GDBus 2.60.3 -->
<node>
  <interface name="org.freedesktop.DBus.Properties">
    <method name="Get">
      <arg type="s" name="interface_name" direction="in"/>
      <arg type="s" name="property_name" direction="in"/>
      <arg type="v" name="value" direction="out"/>
    </method>
    <method name=" GetAll ">
      <arg type="s" name="interface_name" direction="in"/>
      <arg type="a{sv}" name="properties" direction="out"/>
    </method>
    <method name="Set">
      <arg type="s" name="interface_name" direction="in"/>
      <arg type="s" name="property_name" direction="in"/>
    </method>
```

```

<arg type="v" name="value" direction="in"/>
</method>
<signal name="PropertiesChanged">
  <arg type="s" name="interface_name"/>
  <arg type="a{sv}" name="changed_properties"/>
  <arg type="as" name="invalidated_properties"/>
</signal>
</interface>
<interface name="org.freedesktop.DBus.Introspectable">
  <method name="Introspect">
    <arg type="s" name="xml_data" direction="out"/>
  </method>
</interface>
<interface name="org.freedesktop.DBus.Peer">
  <method name="Ping"/>
  <method name="GetMachineId">
    <arg type="s" name="machine_uuid" direction="out"/>
  </method>
</interface>
<interface name="org.mwptools.mwp">
  <method name="GetStateNames">
    <arg type="as" name="names" direction="out"/>
    <arg type="i" name="result" direction="out"/>
  </method>
  <method name="GetVelocity">
    <arg type="u" name="speed" direction="out"/>
    <arg type="u" name="course" direction="out"/>
  </method>
  <method name="GetPolarCoordinates">
    <arg type="u" name="range" direction="out"/>
    <arg type="u" name="direction" direction="out"/>
    <arg type="u" name="azimuth" direction="out"/>
  </method>
  <method name="GetHome">
    <arg type="d" name="latitude" direction="out"/>
    <arg type="d" name="longitude" direction="out"/>
    <arg type="d" name="altitude" direction="out"/>
  </method>
  <method name="GetLocation">
    <arg type="d" name="latitude" direction="out"/>
    <arg type="d" name="longitude" direction="out"/>
    <arg type="d" name="altitude" direction="out"/>
  </method>
  <method name="GetState">
    <arg type="i" name="result" direction="out"/>
  </method>
  <method name="GetSats">
    <arg type="y" name="nsats" direction="out"/>
    <arg type="y" name="fix" direction="out"/>
  </method>
  <method name="SetMission">
    <arg type="s" name="mission" direction="in"/>
    <arg type="u" name="result" direction="out"/>
  </method>
  <method name="LoadMission">
    <arg type="s" name="filename" direction="in"/>
    <arg type="u" name="result" direction="out"/>
  </method>
  <method name="ClearMission">
  </method>
  <method name="GetDevices">
    <arg type="as" name="devices" direction="out"/>
  </method>
  <method name="UploadMission">
    <arg type="b" name="to_eeprom" direction="in"/>
    <arg type="i" name="result" direction="out"/>
  </method>
  <method name="ConnectionStatus">
    <arg type="s" name="device" direction="in"/>
    <arg type="b" name="result" direction="out"/>
  </method>
  <method name="ConnectDevice">
    <arg type="s" name="device" direction="in"/>
    <arg type="b" name="result" direction="out"/>
  </method>
  <signal name="HomeChanged">
    <arg type="d" name="latitude"/>
    <arg type="d" name="longitude"/>
    <arg type="i" name="altitude"/>
  </signal>
  <signal name="LocationChanged">
    <arg type="d" name="latitude"/>
    <arg type="d" name="longitude"/>
    <arg type="i" name="altitude"/>
  </signal>
  <signal name="PolarChanged">
    <arg type="u" name="range"/>
    <arg type="u" name="direction"/>
    <arg type="u" name="azimuth"/>
  </signal>
  <signal name="VelocityChanged">
    <arg type="u" name="speed"/>
    <arg type="u" name="course"/>
  </signal>

```

```
<signal name="StateChanged">
  <arg type="i" name="state"/>
</signal>
<signal name="SatsChanged">
  <arg type="y" name="nsats"/>
  <arg type="y" name="fix"/>
</signal>
<signal name="Quit">
</signal>
<property type="u" name="DbusPosInterval" access="readwrite"/>
</interface>
</node>
```

## 3.8 Troubleshooting and Support

---

### 3.8.1 Troubleshooting

- Check the [release note on the wiki](#) for new dependencies.
- Please ensure you've completed all the steps in the [installation guide](#).
- Please read the [Help](#) section in the [installation guide](#)
- There are a couple of articles on (rare) serial issues on the wiki:
  - [Serial USB Checklist](#)
  - [Serial USB Rarely asked questions](#)

### 3.8.2 Support

---

#### First steps

There is a "rolling release" [release note on the wiki](#). Please check that your issue is not due to a new dependency or requirement since your previous installation.

#### How, where

- GitHub issues preferred
- RCG, INAV discord and telegram
  - Most likely you will be requested to raise a GitHub issue for non-trivial cases.

#### Supported OS

- Arch Linux
- Debian Stable and later (`testing`, `sid`)
- Ubuntu latest and latest LTS (prior release where latest is also LTS).
- Fedora latest
- FreeBSD latest `RELEASE`

#### Supported infrastructure

- Native hardware (x64\_x86, ia32, aarch64).
- Non-proprietary video driver.
- qemu/kvm virtualised instances.
- Little endian (big endian never tested).

#### Information requirements

Where relevant, please include `mwp`'s console log, from your home directory, `mwp_stderr_YYYY-MM-DD.txt`, e.g. `$HOME/mwp_stderr_2021-12-28.txt`. Please do not delete any information from this file; the contents are there for a purpose, or paste the terminal output into a file (or copy/paste into the issue). The terminal output may include information from system components that are not the `mwp` log (e.g. GDK / GTK / Wayland messages).

#### Unsupported

- Anything else!

Problem reports on non-supported platforms will not be dismissed without *some* consideration, however it's unlikely that too much time be expended on such environments unless the problem can also be demonstrated on a supported platform.

#### Wayland / XLib

Different outcomes (including crash / not crash) may be experienced using different display environments.

mwp (and other applications) can have a problem with OpenGL and the Wayland compositor. Typically this is manifest by being unable to pick mission WP icons for large (>40 point) missions.

On non-WSL platforms, mwp forces XWayland over Wayland to mitigate this. You can force Wayland / XWayland by setting the `GDK_BACKEND` variable in `cmdopts` (or the environment). This will override mwp's default behaviour.

```
# set XWayland
GDK_BACKEND=x11
# set Wayland
GDK_BACKEND=wayland
```

If that improves matters, add the setting to [the configuration file](#).

## 3.9 mwp miscellaneous tools

### 3.9.1 Overview

The [mwp](#) suite contains numerous simple command line tools developed since 2015 in order to aid development of INAV, development of [mwp](#) and diagnosing numerous (often 3rd party) problems, more so in the early days.

This chapter describes a few of the command line tools that are provided by mwptools. Note that not all these tools are built or installed by default; it may be necessary to enter a source directory and invoke `make` in situ, or copy a script to a directory on the `$PATH`.

### 3.9.2 fc-get, fc-set

`fc-get` and `fc-set` are tools to manage CLI settings:

- `fc-get` : Dump cli `diff` settings to a file that can be replayed by `fc-set`
- `fc-set` : Replay a file of cli settings to the FC. Once the settings have been saved, a backup is made of the original file; the settings are then read from the FC and the original file updated.

```
$ fc-set --help
Usage:
  fc-set [OPTION?] - fc diff manager

Help Options:
  -h, --help      Show help options

Application Options:
  -b, --baud      baud rate
  -d, --device    device
  -n, --no-back   no backup
```

NOTE: `fc-get` and `fc-set` are essentially the same program, the function is defined by the name.

The tools auto-detect the plugging of an FC.

```
$ fc-get /tmp/dodo-test.txt
12:16:04 No device given ... watching
12:16:04 Opening /dev/ttyUSB0
12:16:04 Establishing CLI
12:16:05 Starting "diff all"
12:16:06 Exiting
12:16:06 Rebooting
```

Then, maybe after flashing the FC to a new version:

```
$ fc-set /tmp/dodo-test.txt
12:16:56 No device given ... watching
12:16:56 Opening /dev/ttyUSB0
12:16:56 Starting restore
12:16:56 Establishing CLI
12:16:58 [██████████] 100%
12:16:58 Rebooting
12:17:01 Establishing CLI
12:17:03 Starting "diff all"
12:17:03 Exiting
12:17:03 Rebooting
```

And now we have a settings backup ...

```
$ ls -l /tmp/dodo*
-rw-r----- 1 jrh jrh 2115 Mar 28 12:17 /tmp/dodo-test.txt
-rw-r----- 1 jrh jrh 2115 Mar 28 12:16 /tmp/dodo-test.txt.2018-03-28T12.17.01
```

### 3.9.3 flash.sh, fcflash

`fcflash` is a script to flash inav images to a flight controller using the command line. It requires that `stm32flash` and `dfu-util` are installed on your computer. Optionally, it requires GCC `objcopy` to convert hex files to binary for DFU operation.

- DFU mode requires `dfu-util`
- USB serial mode requires `stm32flash`

`fcflash` decides which tool to use depending on the detected device node (which can be overridden)

- `/dev/ttyACMx` => DFU
- `/dev/ttyUSBx` => USB serial

Note: `fcflash` is the installed file, in the repository it's `src/samples/flash.sh`.

#### Operation

`fcflash` performs the following tasks

- Auto-detects the serial port (unless `rescue` is specified, and the FC is set to DFU via hardware (switch, pads))
- Sets the serial port to a sane mode
- Sets the FC to bootloader mode (unless 'rescue' is specified).
- If necessary, converts the `hex` image to a `bin` image (for DFU)
- Flashes the firmware.

#### Options

`fcflash` parses a set of options given on the command line. Normally, only the path to the hex file is required and everything else will be detected (device, flashing mode).

- `rescue` : Assumed the FC is already in bootloader mode, requires a device name
- `/dev/*` : The name of the serial device, required for `rescue`, typically `/dev/ttyACM0`
- `erase` : Performs full chip erase
- `[123456789]*` : Digits, representing a baud rate. `115200` is assumed by default.

A file name (an inav hex file) is also required.

### 3.9.4 Examples

#### Flash image, DFU, auto-detect

```
fcflash inav_5.0.0_MATEKF405.hex
```

#### Flash image, USB serial (/dev/ttyUSB0), auto-detect

For my broken FC (USB connector unreliable).

```
# as above, /dev/ttyUSB0 is autodetected
fcflash inav_5.0.0_MATEKF405.hex

# force device (and USB serial mode)
fcflash /dev/ttyUSB0 inav_5.0.0_MATEKF405.hex
```

#### Flash image, rescue mode (hardware boot button), full flash erase

```
fcflash rescue erase /dev/ttyACM0 inav_5.0.0_MATEKF405.hex
```

The no specific ordering of the command line options is required.

In summary, the command:

```
fcflash inav_5.0.0_WINGFC.hex
```

results in

- The hex is converted to a temporary Intel binary format file, as required by `dfu-util`.
- The FC is put into bootloader mode
- `dfu-util` is invoked as:

```
dfu-util -d 0483:df11 --alt 0 -s 0x08000000:force:leave -D inav_5.0.0_WINGFC.bin
```

- The firmware is flashed and the FC reboots
- The temporary bin file is removed

see also [msp-tool](#) for another tool to simplify command line FC flashing.

### 3.9.5 flashgo

`flashgo` is a tool to download blackbox logs from on-board flash. If you're doing this on a VCP board, it will download much faster than the apparent baud rate indicates. If you're using a non-VCP board (i.e. F3 or earlier), then consider using `flash_dump.rb` which can temporarily alter the baudrate to achieve faster rates using CLI (vice MSP) commands.

`flashgo` is a replacement for the earlier `flashdl` tool.

```
$ flashgo --help
Usage of flashgo [options] [device]
-dir string
    output directory ($(pwd) if not specified)
-erase
    erase after download
-file string
    output file, auto-generated (bb1_YYYY-MM-DD_hhmmss.TXT) if not specified
-info
    show flash info and exit
-only-erase
    erase only and exit
-test
    download whole flash regardless of used state
device is the FC serial device, which may be auto-detected
```

### Usage Examples

#### CHECK FLASH USAGE

```
$ flashgo -info
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 0 / 2097152 (0%)
```

#### TEST MODE (DOWNLOAD WHOLE FLASH)

```
$ flashgo -test
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Entering test mode for 2097152b
Data flash 2097152 / 2097152 (100%)
Downloading to bbl_2022-05-22_113211.TXT
[██████████] 2.0MB/2.0MB 100% 0s
2097152 bytes in 40.2s, 52218.4 bytes/s
```

#### CHECK FLASH INFO

```
$ flashgo -info
Using /dev/ttyACM0
Unexpected MSP 108 (0x6c)
Firmware: INAV
```

```
Version: 5.0.0
Data flash 27674 / 2097152 (1%)
```

#### DOWNLOAD TO AUTO-GENERATED FILE NAME

```
$ flashgo
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 27674 / 2097152 (1%)
Downloading to bbl_2022-05-22_114044.TXT
[====] 27.0KB/27.0KB 100% 0s
27674 bytes in 0.5s, 50838.4 bytes/s
```

#### ERASE THE FLASH (ONLY, NO DOWNLOAD)

```
$ flashgo -only-erase
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Erase in progress ...
Completed
```

#### CHECK FLASH INFO

```
$ flashgo -info
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 46893 / 2097152 (2%)
```

#### DOWNLOAD TO NOMINATED FILE NAME

```
$ flashgo -file bbl_TEST.txt
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 46893 / 2097152 (2%)
Downloading to bbl_TEST.txt
[====] 45.8KB/45.8KB 100% 0s
46893 bytes in 0.9s, 52290.6 bytes/s
```

#### DOWNLOAD TO NOMINATED FILE AND DIRECTORY

```
$ flashgo -file bbl_TEST.txt -dir /tmp/
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 46893 / 2097152 (2%)
Downloading to /tmp/bbl_TEST.txt
[====] 45.8KB/45.8KB 100% 0s
46893 bytes in 0.9s, 52298.0 bytes/s
```

#### DOWNLOAD TO AUTO-GENERATED FILE NAME AND NOMINATED DIRECTORY, THEN ERASE FLASH

```
$ flashgo -dir /tmp/ -erase
Using /dev/ttyACM0
Firmware: INAV
Version: 5.0.0
Data flash 46893 / 2097152 (2%)
Downloading to /tmp/bbl_2022-05-22_114515.TXT
[====] 45.8KB/45.8KB 100% 0s
46893 bytes in 0.9s, 52291.9 bytes/s
Erase in progress ...
Completed
```

Note that in every case, the FC device node is auto-detected.

Note also that the download speed is approximately 5 times greater than one would expect from the nominal baud rate (115200 ≈ 10800 bytes/sec).

### 3.9.6 flash\_dump.rb

`flash_dump.rb` is another tool for downloading blackbox logs from on-board flash. Whereas `flashgo` uses MSP, `flash_dump.rb` uses CLI commands and is thus rather more fragile and requires that the FC firmware is compiled with `#define USE_FLASH_TOOLS` (**which is not the default**).

- It allows the temporary use of higher baud rates on USB (e.g. 921600).
- If it fails, you may have to reset the baud rate via the CLI, if the configurator is unable to connect > 115200 baud.

```
$ flash_dump.rb --help

flash_dump.rb [options] file
Download bb from flash
-S, --serial-device=DEV
-E, --erase
-E, --erase-only
-O, --output=FILE
-B, --baud=RATE
-B, --super-baud=RATE
-?, --help           Show this message
```

Unlike `flashdl` which auto-detects serial ports, `flash_dump.rb` tries `/dev/ttyUSB0` and `/dev/ttyACM0`, or the device given with `-d`. The "super baud" rate must be specified to use a faster rate than the FC default:

```
$ flash_dump.rb -B 921600
/dev/ttyUSB0
Changing baud rate to 921600
Found "serial 0 1 115200 38400 115200 115200"
setting serial 0 1 921600 38400 115200 115200
Reopened at 921600
Size = 1638400
read 1638400 / 1638400 100%   0s
Got 1638400 bytes in 18.8s 87268.8 b/s
Exiting
```

After the download has completed, the serial port is reset to the previously configured baud rate (typically 115200). Note the very high speed of the download, 87268 bytes /sec; this is almost 9 times faster than the standard baud (and 9x the speed of using the configurator with a USB board).

Should the download fail and the board serial speed is not reset automatically, it will be necessary to manually reset UART1, possibly using `cliterm`.

So, had the above failed, it could be rescued by pasting in the "Found" line above:

```
$ cliterm -b 921600
open /dev/ttyUSB0

Entering CLI Mode, type 'exit' to return, or 'help'

# serial 0 1 115200 38400 115200 115200

# save
Saving
Rebooting
```

### 3.9.7 cliterm

`cliterm` is a simple terminal program for interacting with the INAV CLI. Unlike alternative tools (`picocom`, `minicom` etc.), it will auto-detect the FC serial device, uses 115200 as the baud rate and, by default, automatically enters the CLI. In INAV 5.0 and later, it will set `cli_delay` in case you've compiled the firmware with GCC 11.

```
$ cliterm --help
Usage:
  cliterm [OPTION?] - cli tool

Help Options:
  -h, --help           Show help options

Application Options:
  -b, --baud=115200    baud rate
  -d, --device         device
  -n, --noinit=false  noinit
  -m, --msc=false      msc mode
  -g, --gpsspass=false gpsspassthrough
  -p, --gpsspass=false gpsspassthrough
```

```
-f, --file           file
--eolmode=[cr,lf,crlf,crcrlf]   eol mode
```

- With `-g`, `-p`, the FC is put into GPS passthrough mode, in order to use tools like `ublox-cli` or `u-center` (sic).
- `-m`, `--msc` causes the FC to reboot in MSC (USB Mass Storage) mode.

The options `-n` (don't enter CLI automatically) and `-m` may be useful when accessing other devices (for example a 3DR radio, HC-12 radio or ESP8266) in command mode.

`cliterm` understands Ctrl-D as "quit CLI without saving". You should quit `cliterm` with Ctrl-C, having first exited the CLI in the FC (`save`, `exit`, Ctrl-D). Or after `save`, `exit`, `cliterm` will exit when the FC is rebooted, by seeing the tear-down of the USB device node.

### 3.9.8 Blackbox analysis and diagnostics

`mwptools` has always included tools to simplify blackbox analysis. It seems to the author that it's often much easier to pre-process the output of `INAV blackbox_decode` into a smaller dataset that addresses the specific problem rather than try and make sense of the mass of data in a blackbox log.

There are a few basic prerequisites for doing this analysis using the `mwp` scripts:

- You have a recent version of INAV's `blackbox_decode`
- You have a `ruby` interpreter installed
- You don't mind "getting your hands dirty" on the command line
- If you want pretty graphs, have `gnuplot` installed; it's also possible to generate graphs ("charts") from spreadsheet applications (LibreOffice Calc, MS Excel).

#### Worked example

A user reported serious toilet-bowling / fly away on a large cine-octa with expensive VTX RF gear and camera gimbal. Two blackbox logs were provided, one with the RF and gimbal disabled, the other with them enabled (when the problem appears).

The logs were processed with the `mwptools/src/bbox-replay/parse_bb_compass.rb`. This script:

- Decodes the log, down-sampling to 0.1s intervals (or user provided interval)
- Extracts the GPS heading and the compass heading (via INAV's position estimator), the relevant blackbox fields being `GPS_ground_course` and `attitude[2]/10`.
- Generates a calculated heading from adjacent GPS locations.
- Generates a simplified CSV containing the down-sampled lines and required data only (including throttle and navigation state)
- Generates a SVG graph.

#### SCRIPT USAGE

You need to run this from a shell (Linux / MacOS /FreeBSD terminal, Windows powershell or cmd). `blackbox_decode` and (optionally) `gnuplot` need to be on the `PATH`.

```
$ ./parse_bb_compass.rb --help
parse_bb_compass.rb [options] [file]
  --list-states
  --plot              Generate SVG graph (requires 'gnuplot')
  --thr              Include throttle value in output
  -o, --output=FILE  CSV Output (default stdout)
  -i, --index=IDX    BBL index (default 1)
  -t, --min-throttle=THRATTLE  Min Throttle for comparison (1000)
  -s, --states=a,b,c Nav states to consider [all]
  -d, --delta=SECS   Down sample interval (default 0.1s)
  -?, --help          Show this message
```

## Results from the analysis

First, the good log (no VTX-RF or gimbal enabled):

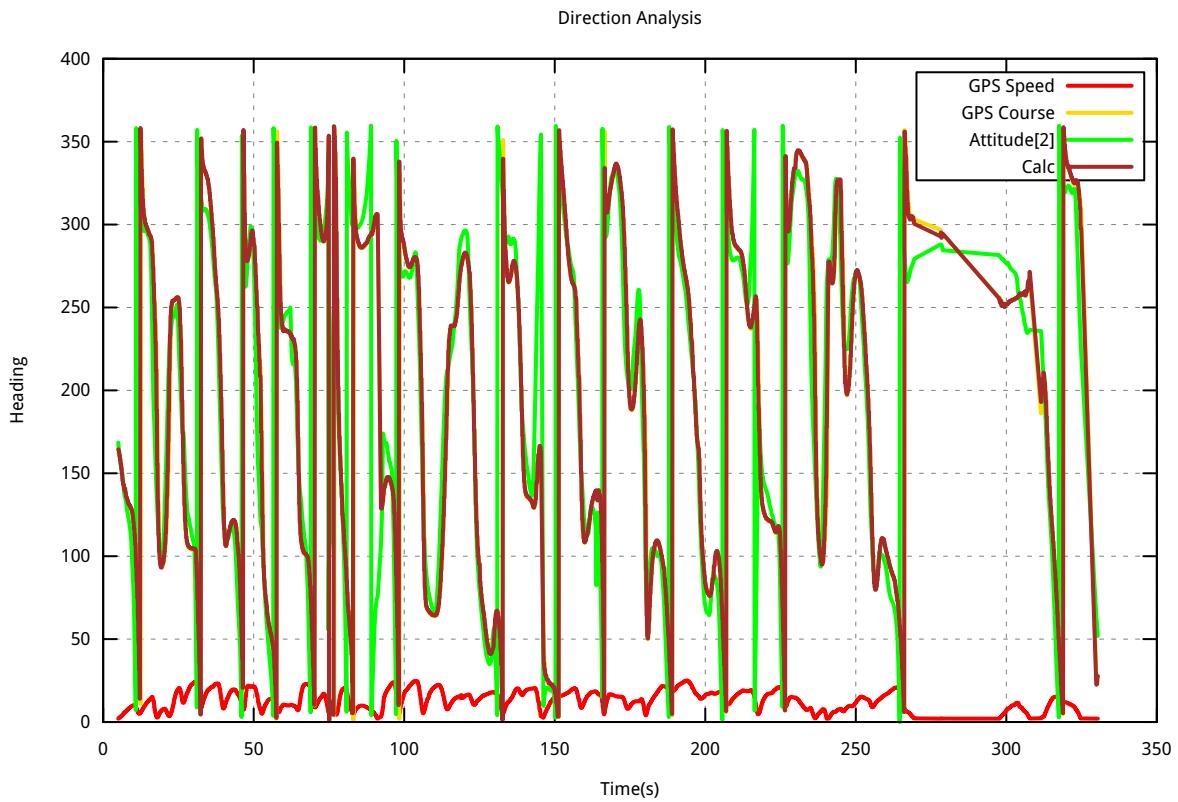
```
./parse_bb_compass.rb --plot /tmp/LOG00001.TXT
INAV 4.1.0, states from 2.7.0
Log 1 of 1, start 00:49.654, end 06:33.615, duration 05:43.961

Statistics
Looptime      506 avg       14.9 std dev (2.9%)
I frames     21061 128.0 bytes avg  2696240 bytes total
P frames    315692  81.6 bytes avg 25753176 bytes total
H frames      164 10.0 bytes avg   1640 bytes total
G frames     1865 21.6 bytes avg  40300 bytes total
E frames        1  6.0 bytes avg     6 bytes total
S frames     4066 40.0 bytes avg 162637 bytes total
Frames     336753 84.5 bytes avg 28449416 bytes total
Data rate  979Hz 83359 bytes/s    833600 baud

29 frames failed to decode, rendering 181 loop iterations unreadable. 2897 iterations are missing in total (1466ms, 0.43%)
339649 loop iterations weren't logged because of your blackbox_rate settings (171980ms, 50.00%)

Graph in /tmp/LOG00001.TXT.csv.svg
```

We see some information, mainly the summary from `blackbox_decode` and notification of the resulting graph file.

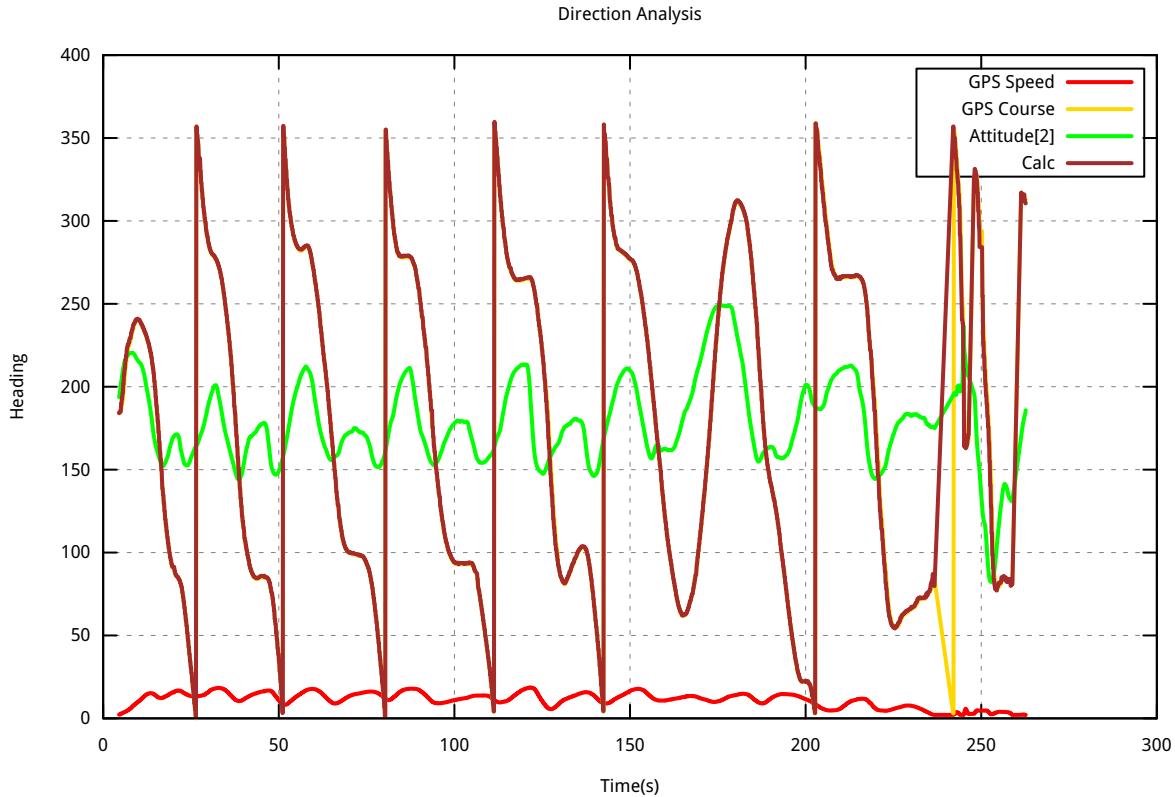


Looks OK, there's a few deviations between the GPS and position estimator, possibly a result of hard Acro mode manoeuvres.

Let's now look at the log with the VTX-RF and gimbal enabled:

```
./parse_bb_compass.rb --plot /tmp/LOG00008.TXT
...
Graph in /tmp/LOG00001.TXT.csv.svg
```

Note the difference



Something in generating enough interference to cause the heading / position estimator `attitude[2]` to essentially flat-line.

So now we have concrete evidence of the problem, the next steps would be for the pilot to repeat the exercise enabling just one of the suspect devices to identify the actual cause of the problem and then rectify it:

- Somehow isolate the device
- Replace the device with a better shielded substitute
- Move the GPS / compass further away (might not be so easy)

#### Similar tools

PH unstable altitude is often caused by excessive vibrations or inadequately protected (open cell foam) barometer. `mwp-tools/src/bbox-replay/inav_gps_alt.rb` will generate a similar graph of baro v. GPS v. position estimator elevations.

- GPS and baro correlate, position estimator is off, most likely vibrations
- GPS and baro don't correlate. Probably lack of baro protection (or GPS interference from VTX).

## 3.10 Licence and Alternative Tools

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[GPL v3](#) or later. (c) Jonathan Hudson and contributors.

## 3.11 Alternative Tools

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In addition to [mwp](#), the following [INAV](#) mission planners (and GCS in some cases) exist, in various states of usefulness, at least:

- [INAV Configurator \(for inav 2.x\)](#), limited planning support
- [INAV Configurator \(for inav 3.x and later\)](#), supports almost all current WP types. Development branch / [Preview builds](#) are also available; current and previews may be augmented with [implode](#) to upload missions to 2.x firmware.
- [Drone Helper](#) (Windows 10)
- [Ezgui, MissionPlanner for INAV](#) (Android) Unsupported, obsolete. May not work with either contemporary Android or INAV firmware.
- [Mobile Flight](#) (IOS) Unsupported, obsolete. May not work with either contemporary IOS or INAV firmware.
- [Apmplanner2](#) with [implode](#). Ardupilot planner, missions can be uploaded to INAV using [implode](#).
- [qgroundcontrol](#) with [implode](#). Ardupilot planner, missions can be uploaded to INAV using [implode](#).
- [Side-Pilot](#) with [implode](#) (untested). Ardupilot mission planner and telemetry viewer for IOS.

The following alternatives exist for [mwp-area-planner](#) :

- iforce2d's [online planner](#)
- [qgroundcontrol](#) with [implode](#). Generic surveys and corridor plans are supported. [Example images](#).