

# AIS Reception

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# 1 What is AIS?

AIS is an international tracking system for ships. Messages can contain position, speed, course, name, destination, status, dimensions, and many other types of information.

## 1.1 How is it sent over the radio?

AIS uses VHF FM Marine Radio channels:

- 87B 161.975 MHz
- 88B 162.025 MHz

The radios use 25 kHz channel spacing with a peak deviation of  $\pm 5$  kHz. AIS uses HDLC over 9600 bps GMSK. It is very much like our ham radio 9600 bps G3RUH style transmission.

Located about 50 km from the ocean, I'm able to hear a few ships with an ordinary 2 meter ham transceiver and a vertical antenna on the roof.

## 1.2 AIS NMEA Sentences

AIS receivers produce NMEA style sentences which are sent to other devices. These are much like the sentences you see from a GPS receiver. Instead of starting with something like \$GPRMC, it starts with !AIVDM instead. A typical sentence might look like:

```
!AIVDM,1,1,,A,15N4cJ`000rrjq@H@0i2hbuN0LOU,0*31
```

- The talker and sentence type.
- A couple fields we don't care about here.
- A bit vector represented as a printable character for each group of 6 bits.
- A checksum at the end.

## 2 Connecting to Radio

This will not work with the audio from your receiver's speaker!!! Don't waste your time trying.

For proper decoding, about 5kHz of audio bandwidth is required. Like 9600 bps AX.25, this will not work with the speaker connection because the audio processing stages distort the signal too much.

You need to get the audio signal from the FM discriminator before the de-emphasis and other audio processing make it useless for this purpose.

### 2.1 Traditional Radios

Some Ham Radio VHF transceivers have a special connector for use with external modems. The big 3 Japanese manufacturers (Kenwood, Icom, Yaesu) all standardized on the same 6 pin round mini-DIN connector. Radios with the 6 pin round connector provide this signal. Some Alinco models have the same signals available but the connector is physically different.

The connector is often labeled "data" but it is really audio for an external modem. There are two receive audio signals:

- Narrow bandwidth good for 1200 bps packet, SSTV, etc.
- Wide audio bandwidth, reasonably flat out to 5 kHz, good for 9600 bps.

You need to use the latter. The other distorts the signal too much to be usable.

### 2.2 Software Defined Radio (SDR)

Software Defined Radios can also be used. The Dire Wolf User Guide has details on usage with popular software such as

- Gqrx
- rtl\_fm
- SDR#
- Gnu Radio

The one thing you must remember is the audio bandwidth. It must be fairly flat out to 5kHz. Be sure that an de-emphasis or other audio filtering is disabled.

### 3 Selecting AIS mode

There are two different ways to select a modem.

- For the first, or only, radio channel, the “-B” (upper case B) command line option can be used to specify the speed.
- In a multiple radio setup, you would need to use the MODEM command in the configuration file.

A suitable modem is selected for the given speed. This defaults to 1200 AFSK but other values, such as 9600 G3RUH style, are possible when using APRS/Packet Radio. AIS also uses 9600 bps so a special case was added. Instead of a number, the characters “AIS” are used.

Example:

```
direwolf -B AIS -r 48000 -T "%H:%M:%S"
```

- "-B" sets the speed. 9600 is for ham radio AX.25 G3RUH. A special case was added for AIS.
- "-r" sets the audio sample rate. 44100 is the default. I found that 48000 can provide a slight benefit for 9600 bps.
- "-T" adds a time stamp.

If all goes well, you should see some lines similar to this:

```
[0.3 08:51:47] AIS>APDW16:{DA!AIVDM,1,1,,A,15N4cJ`000rrjq@H@0i2hbuN0L0U,0*31
```

Let's break this down:

- [0.3 08:51:47]

Receiving channel and timestamp.

- AIS>APDW16:

The ship identifier won't fit in the source address field so “AIS” is there to indicate the origin. The destination field indicates the software doing the reception.

- {DA

An information part beginning with “{” indicates user defined data. D and A indicate Dire Wolf and AIS.

- !AIVDM,1,1,,A,15N4cJ`000rrjq@H@0i2hbuN0L0U,0\*31

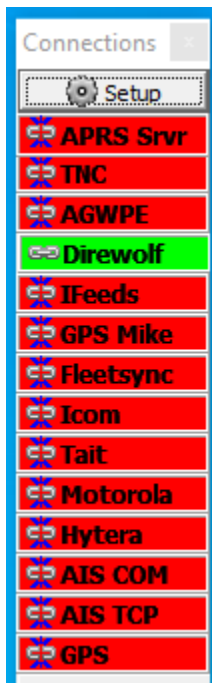
This is what you would get out of a normal AIS receiver. It is similar to the NMEA sentences from a GPS receiver.

## 4 Using with Mapping Applications

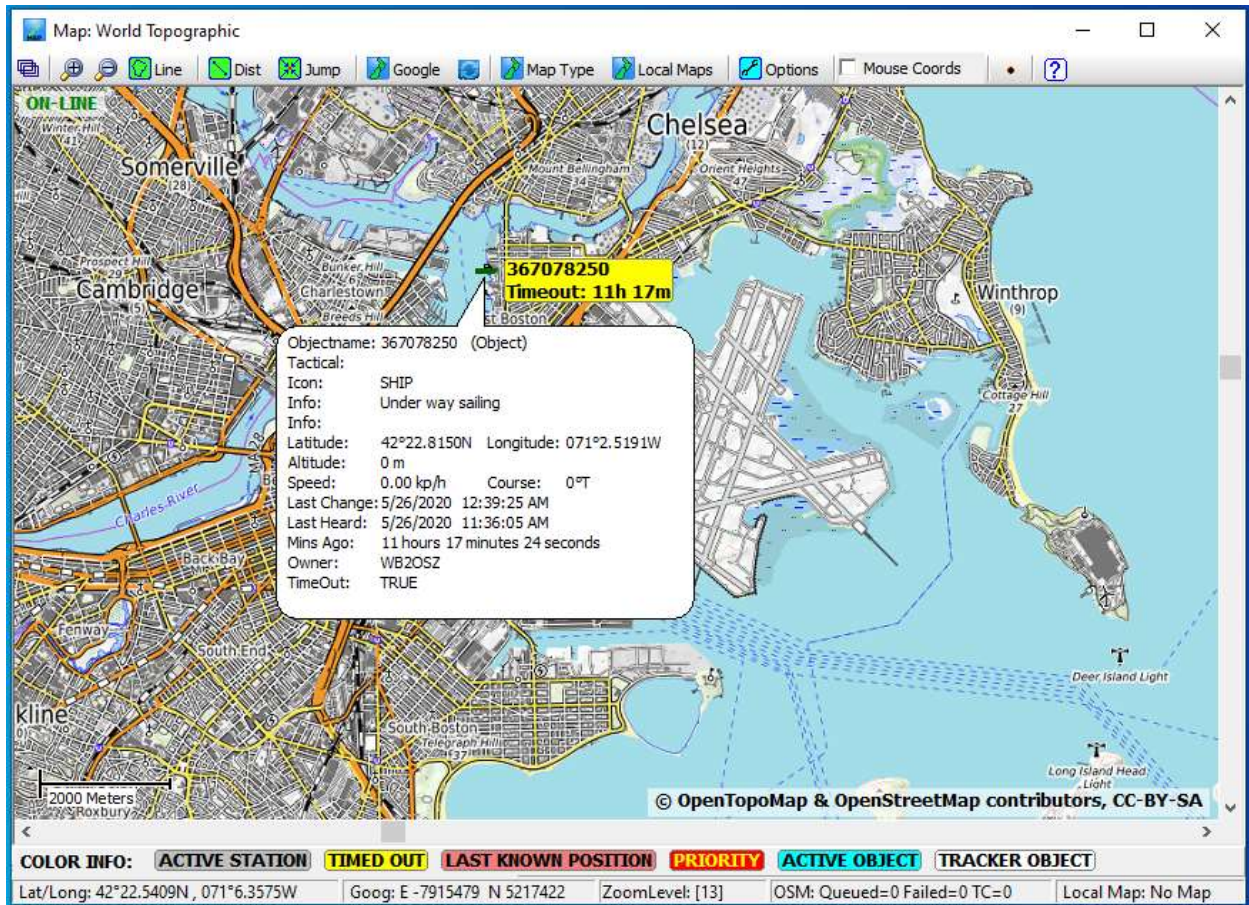
Dire Wolf generates NMEA sentences like those from a normal AIS receiver. Looking at them is not much fun for most people. You probably want to feed this information into some sort of mapping application.

### 4.1 SARTrack

The Connections panel has a special button for connecting to the Dire Wolf TNC.



SARTrack recognizes the APRS information fields starting with “{DA” and knows how to decode the AIS sentences.



Move your mouse pointer over a ship to see more details.

APRS and AIS can be viewed on a single map without any special configuration required.

## 4.2 Most other APRS Applications

At the time this is being written, I'm not aware of any other APRS applications that know how to decode the AIS sentences. For applications, such as APRSISCE/32, YAAC, PinPoint APRS, Xastir, etc. Dire Wolf can translate AIS positions into normal APRS Object Reports.

Simply add the "-A" (upper case A) option to the direwolf command line. Example:

```
direwolf -B AIS -r 48000 -T "%H:%M:%S" -A
```

- "-A" causes AIS position reports to be converted to APRS Object Reports.

With this method less detailed information will be available because other types of AIS messages will not be converted.

Applications can connect to the Dire Wolf TNC in a variety of ways. Modern applications allow connection to a TNC over the network. The TNC and application(s) using it can be on different computers.

- AGW network protocol, default TCP port 8000.
- Network KISS, default TCP port 8001.

For older applications, that only know how to talk to a hardware TNC over a serial port, the Linux version provides a "pseudo terminal" which is a virtual serial port with a KISS TNC on the other side.

Windows does not have similar functionality built in so it takes a little more effort to do the same thing. The User Guide describes the use of "comocom" to create a pair of virtual serial ports, connected to each other with a "null modem" cable.

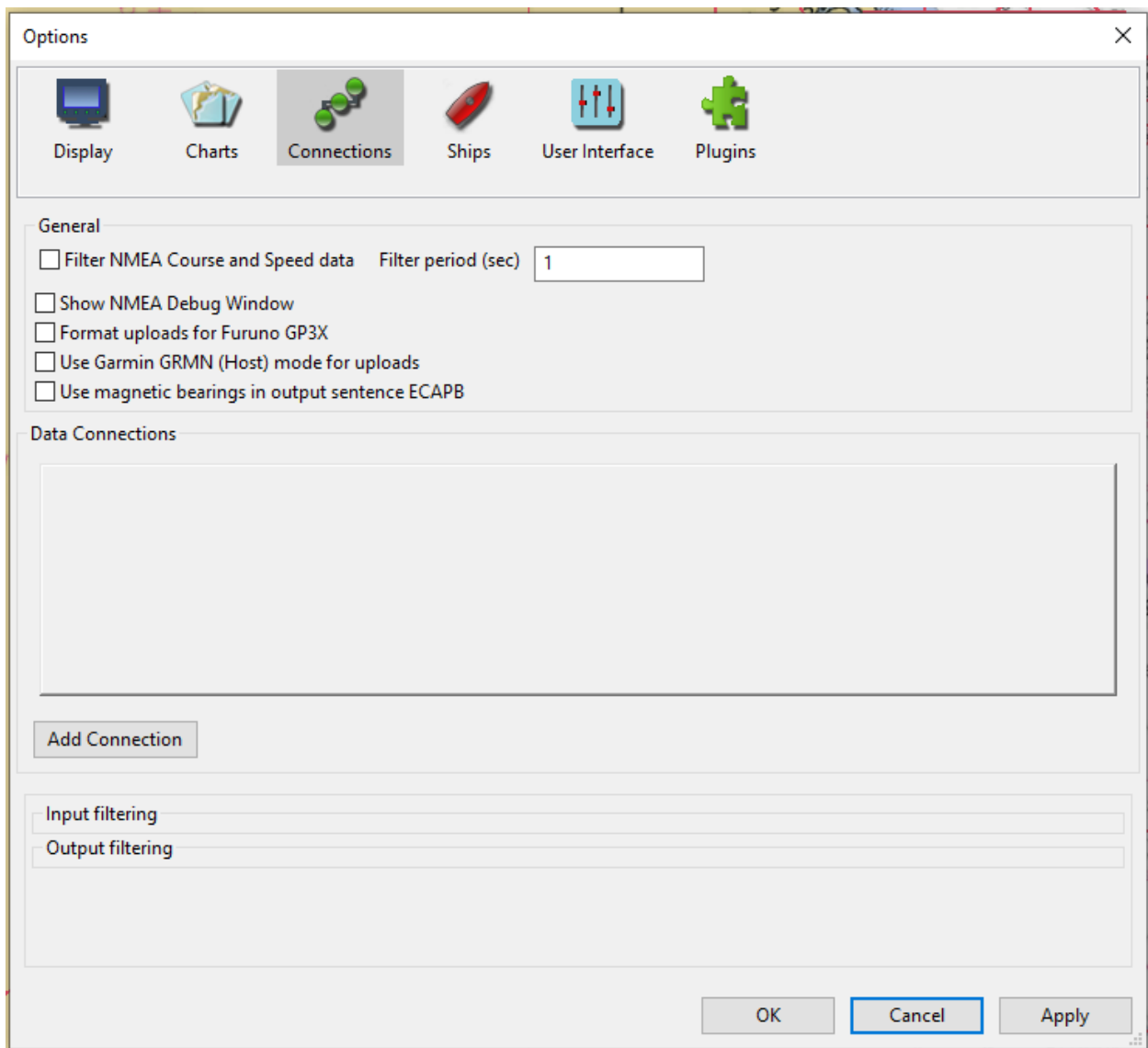
## 4.3 OpenCPN

Open Chart Plotter Navigation (OpenCPN) is designed specifically for use on a boat. Naturally, it knows how to decode AIS sentences but it doesn't know anything about packet radio TNCs or APRS or KISS protocols. We need to communicate with it in a different way.

Install OpenCPN, then download and install some charts, as detailed here:

<https://opencpn.org>

Select Options > Connections, then click "Add Connection" in the lower pane:





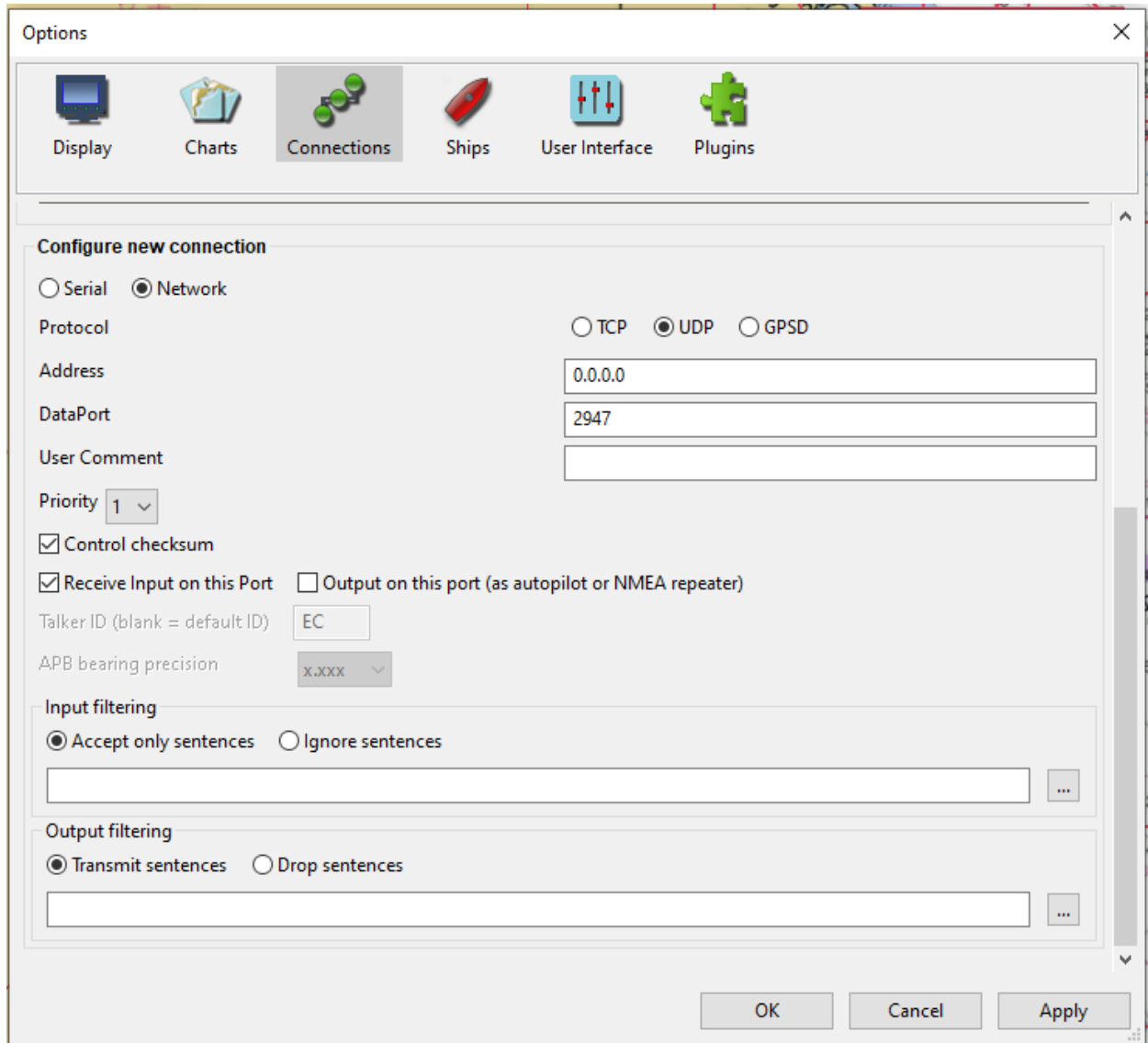
Select:

- Network
- UDP

Address does not matter so it can be left as 0.0.0.0.

Make note of the dataport number because we will need this later. 2947 appeared as the default so we will use that here.

Ensure that “Receive Input on this Port” is checked.



Click OK.

Edit the `direwolf.conf` configuration file and add a line, similar to one of these depending on whether you want to use a specific IP address or a hostname where **OpenCPN** is running. Use the same UDP port number from the OpenCPN connections.

```
WAYPOINT 192.168.12.34:2947 A
```

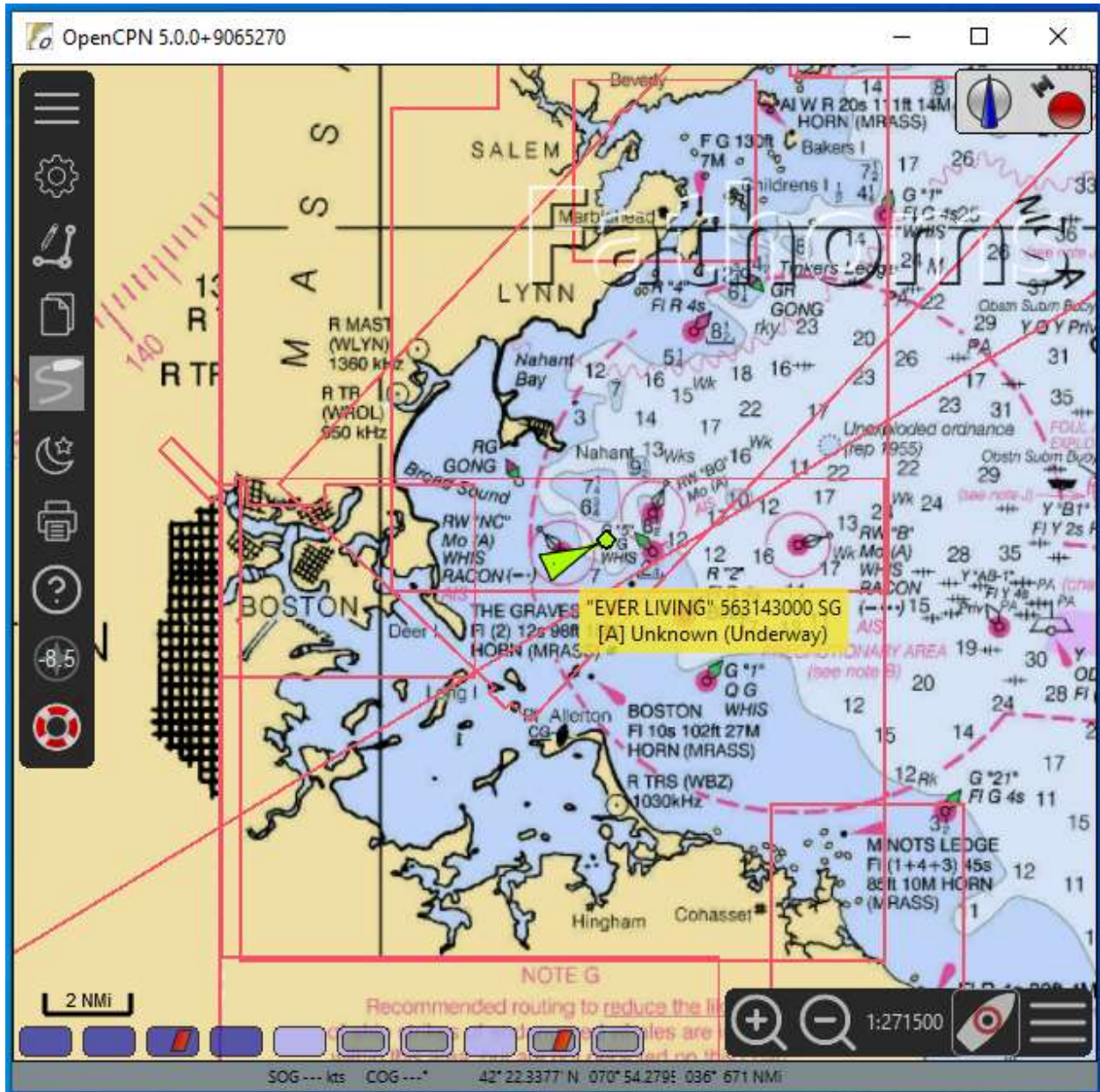
```
WAYPOINT localhost:2947 A
```

The “A” at the end is very important. It means that AIS NMEA sentences should be sent.

Run `direwolf` in the usual way, with the “-B AIS” command line option.

```
direwolf -B AIS -r 48000 -T "%H:%M:%S"
```

Here we see a ship represented by a green triangle. Mousing over the icon will produce details.



Right click on the icon and pick “Target List...” to get a list of ships.

Trk	Name	C ▲	MMSI	Class	Type	Nav Status	Brg	Range	CoG	SoG
'	EVER LIVING		563143000	A	Unknown	Underway	-	-	066	12.9

Target info  
Center view  
Create WPT  
Hide All Tracks  
Show All Tracks  
Toggle track  
Copy MMSI  
 AutoSort  
Limit range: NM  
9999  
Target Count  
1  
Close

As mentioned earlier, I’m about 50 km from the coast and this doesn’t seem to be a very good radio day with only one ship currently displayed.

My current location is not known to the application so I had to supply a very large Limit Range to see anything listed here.

## 4.4 Display APRS on OpenCPN

I happened to stumble across something interesting under Options > Ships > AIS Targets.

Treat WPL sentences as APRS position reports

It seems there is a limited ability to display information, from APRS, by the use of \$GPWPL waypoint location sentences. Waypoints are meant to be stationary points, along a route, so it's a bit of a kludge to repurpose them for multiple types of moving objects.

Some Kenwood transceivers, the Dire Wolf software TNC, and perhaps others, can translate received APRS Positions and Objects into NMEA sentences for display on GPS receivers and other mapping applications.

The sentences available are:

- \$GPWPL - NMEA generic with only location and name.
- \$PGRMW - Garmin, adds altitude, symbol, and comment to previously named waypoint.
- \$PMGNWPL - Magellan, more complete for stationary objects.
- \$PKWDWPL - Kenwood with APRS style symbol but missing comment.

Any combination of these can be generated by adding corresponding letters to the WAYPOINT command in the Dire Wolf configuration file.

Sentence	Origin	Config file option	Name	Location	Altitude	Speed & Course	Symbol	Comment
\$GPWPL	APRS	N	✓	✓				
\$PGRMW	APRS	G	✓	*	✓		✓	✓
\$PMGNWPL	APRS	M	✓	✓	✓		✓	✓
\$PKWDWPL	APRS	K	✓	✓	✓	✓	✓	
!AIVDM	AIS	A	✓	✓	✓	✓	✓	✓

\* = \$PGRMW adds additional attributes to a waypoint with same name.

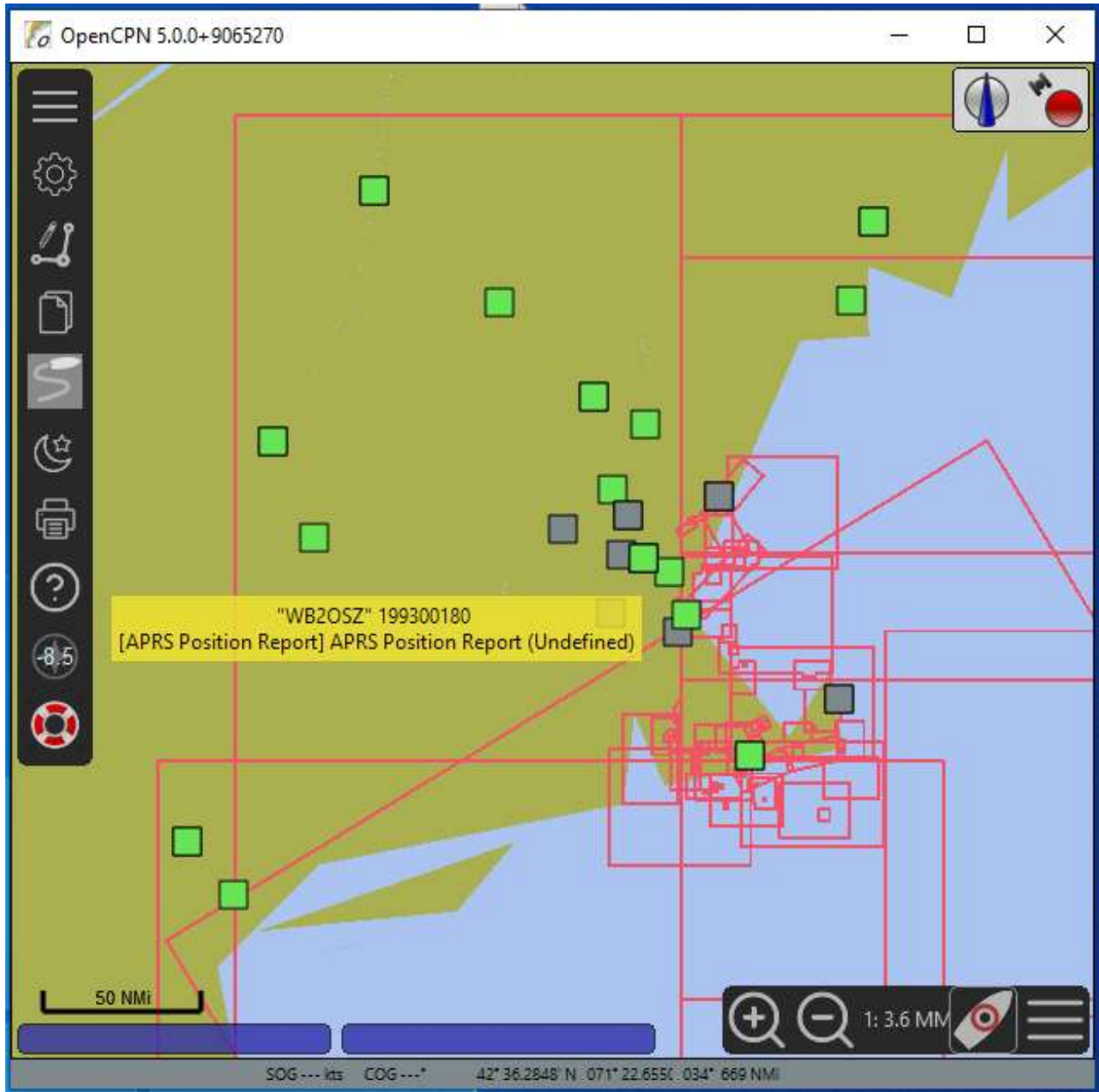
Example, when receiving APRS:

```
WAYPOINT localhost:2947 N
```

This will send a \$GPWPL sentence each time an APRS Position or Object Report is received.

The feature works but it is not very satisfying when looking at APRS stations on land. The maps (“charts”) are designed for navigating near the coast and don’t have inland features.

All of the stations show up as a square because \$GPWPL does not have provision for a symbol. (\$PKWDWPL would have been a much better choice!) Names are displayed when the mouse pointer hovers over the icon.



NMEA Debug Window

```

22:14:21 (UDP:0.0.0.0:2947) $GPWPL,4214.7900,N,07106.1000,W,K1ZBT-7*79<0x0D> <0x0A>
22:14:22 (UDP:0.0.0.0:2947) $GPWPL,4214.7900,N,07106.1000,W,K1ZBT-7*79<0x0D> <0x0A>
22:14:52 (UDP:0.0.0.0:2947) $GPWPL,4258.9900,N,07135.2900,W,UNCAN*0E<0x0D> <0x0A>
22:14:56 (UDP:0.0.0.0:2947) $GPWPL,4238.2300,N,07310.1000,W,K1FFK*60<0x0D> <0x0A>
22:14:57 (UDP:0.0.0.0:2947) $GPWPL,4238.2300,N,07310.1000,W,K1FFK*60<0x0D> <0x0A>
22:15:07 (UDP:0.0.0.0:2947) $GPWPL,4312.9800,N,07354.3600,W,K2DLL-2*7E<0x0D> <0x0A>
22:15:16 (UDP:0.0.0.0:2947) $GPWPL,4418.5200,N,06945.3100,W,KQ1L*3C<0x0D> <0x0A>
22:15:59 (UDP:0.0.0.0:2947) $GPWPL,4220.7400,N,07134.0400,W,W1MRA*63<0x0D> <0x0A>

```

AIS target list

Trk	Name	C	M...	▲	Class	Type	Nav Status
'	KA1MTM-13		199300001		APRS	APRS Po...	Undefined
'	N1MJL		199300008		APRS	APRS Po...	Undefined
'	W1MRA		199300009		APRS	APRS Po...	Undefined
'	K1RK-1		199300129		APRS	APRS Po...	Undefined
'	KB1DDC		199300147		APRS	APRS Po...	Undefined
'	WB2OSZ		199300180		APRS	APRS Po...	Undefined
'	ALOY-10		199301238		APRS	APRS Po...	Undefined
'	K1RTA-1		199301299		APRS	APRS Po...	Undefined
'	K2DLL-2		199301300		APRS	APRS Po...	Undefined
'	N3LLO-3		199301301		APRS	APRS Po...	Undefined
'	K1ZBT-7		199301305		APRS	APRS Po...	Undefined
'	W1WRA-9		199301407		APRS	APRS Po...	Undefined
'	N2JNT-10		199313038		APRS	APRS Po...	Undefined
'	W2VER-15		199314043		APRS	APRS Po...	Undefined
'	WB2OSZ-5		199318503		APRS	APRS Po...	Undefined
'	N5PZ		199384190		APRS	APRS Po...	Undefined

Target info

Center view

Create WPT

Hide All Tracks

Show All Tracks

Toggle track

Copy MMSI

AutoSort

Limit range: NM

700

Target Count

16

Close