BeaconBox

While reading the article “Radio and Maps – Mapping Raio” by Georg Wiessala in the October 2024 issue of Practical Wireless, my attention was drawn to the picture of the MFJ-890 Beacon Monitor. This device displays the activity of HF beacons within the NCDXF/IARU International Beacon Project. To do this it synchronises with a time signal and then lights up small LEDs on a map as and when they become active on the chosen frequency. The user then listens of the chosen frequency to see in beacons can be heard to gain an idea of current HF propagation. The whole device is just 6.75” x 5.25” so it’s quite a compact device.

This got me thinking. Instead of going looking for beacons that you may be able to hear why can’t we have the beacons come to you? The Reverse Beacon Network may just be the answer.

The Revers Beacon Network is “a network of stations listening to the bands and reporting what stations they hear, when and how well”. I’ve made use of data from the Reverse Beacon Network before with the RBNSpyBox project published in the July 2019 issue of Practical Wireless. Along with an interactive web interface the Reverse Beacon Network also provides terse data via telnet. This data contains one line for each spot and typically looks like:

DX de G4ZFE-#: 21150.0 CS3B CW 15 dB 20 WPM NCDXF B 1441Z

From this we can determine that G4ZFE spotted CS3B on 21.150Mhz at 14:41 UTC with an SNR of 15db. So, if we are in the UK, we could look out for similar reports for beacons in the NCDXF/IARU network spotted by G callsigns and from that determine current HF conditions.

So how can this data best be displayed? The obvious answer is on a map. When it comes to Amateur Radio and maps the most famous map of all must be the “YAESU THE RADIO AMATUUR’s WORLD MAP” – See Fig 1. Yaesu give these away with all their HF offerings, I can’t imagine how many are out there, and I’d guess that there are many still in their original boxes having never been used. Can we give these maps a new lease of life? Can we turn them into something informative, interactive, and fun?

Fig 1

A map of the world

Description automatically generated

Other suitable World maps are available. The RSGB sell one and one of the popular high street book shops tend to sell cheap World maps too.

The map will need lights, one for each of the NCDXF/IARU beacons. The NCDXF website provides grid square locations for all 18 of their beacons so accurately locating the lights should not be an issue. They also need to be quite large and bright. I chose to use 8mm WS2812D RGB LEDs. These devices can be wired in series and form a chain of individually addressable LEDs. Each LED can represent an RGB colour. Unfortunately, each LED requires a 75-ohm resistor and 100nf capacitor and mounting these behind the map initially proved fiddly. To make life easier I designed a small PCB to host the resistor, capacitor, and LED and this sits behind the map and held in place by matching LED holder mounted in the board holding the map. See Fig 2 and Fig 3.

Fig 2 and Fig 3

A green circuit board with a light

Description automatically generated

A close-up of a green circuit board

Description automatically generated

There is also a small frequency display PCB that indicated active ???????????????????

To process the data, I chose the ESP32-WROOM-32. This device has built in Wi-Fi and more than enough processing power to process the Reverse Beacon Network data. It can be programmed using C++ via the Arduino IDE.

A small PCB was designed to hold the ESP32 along with a Mode button.

What does the software do? Obviously, the software needs to process the Reverse Beacon Network data but before it can do that it needs to be configured, it needs to know which Wi-Fi network to connect to, which callsign to accept as valid spotters, etc. To support configuration the software provides a simple web interface containing configuration pages and live data pages.

Beyond that I chose three modes of operation. Beacons Heard mode, Beacons Active mode, and Beacons in Daylight mode. The modes can be selected via a small tactile button on the frequency board, or via the Web interface.

In Beacons Heard mode the display cycles through each of the beacon’s frequencies and illuminates on the map the LED associated with each beacon that has been heard in the last 5 minutes – this duration is configurable via the Web interface.

The Beacons Active mode is a simple emulation of the MFJ-890 Beacon Monitor and shows you which beacons are currently transmitting on which frequency.

The Beacons in Daylight mode does just that, it shows which beacons are currently in daylight. This might be useful if chasing grey line propagation.

On to of these modes sits an animation mode. This provides a way to cycle the BeaconBox through the modes on a time basis. Again, this is configured via the Web interface.

Starting the build

The build starts with a frame for the map. The map is quite large, and the frame must be deep enough to accommodate the LED PCBs that protrude slightly on the back. I failed to find a commercial offering, so I ended up building one myself. For the base I chose 9 mm MDF, and I then used some narrow timber strips to form a frame. The 9 mm MDF may seem be too heavy for the job, but I had some ‘in stock’ so 9 mm it was. Extra timber strips were used on the back to provide space for the LED PCBs.

The next task was to drill the holes. Using the grid square locations on the NCDXF website and a good eye I used a bradawl, pushing it though the map and into the MDF to mark the position of each beacon. Accuracy isn’t a big problem but having the beacons vaguely correct is a good thing and will add to the aesthetics. The holes were cut with a 13 mm flat wood drill bit making sure there was a scrap piece of week behind it to stop the MDF blowing out.

I decided to locate the frequency display PCB along the bottom of the map, towards the righthand side, where it didn’t cover up anything important on the.

The next problem was what to do with the controller PCB. It could be mounted in a box of its own – BeaconBox – but I chose to locate it on the reverse side of the frame. To aid this four mounting holes were drilled bottom right and PCB standoffs bolted in. See Fig 4. You’ll also notice that I labelled each of the holes with the callsign of the associated beacon. These help identify the holes and associated LEDs should anything go wrong!

Fig 4

*A green circuit board with a black chip

Description automatically generated*

Once I was happy all the holes were drilled it was time to mount the map in the frame. The map is large and contact adhesive may not have provided enough to adjust the position of the map as I might require so I chose good, old fashioned, wallpaper paste. Before pasting the map home, I lined the frame with some sheets of A4 printer paper.

Sadly, my wallpapering skills let me down. When sticking the map down I applied paste to the board and then laid the map on top. The map quickly soaked up water from the glue, expanded, and wrinkled! Some of the wrinkles came out when it dried, and some did not. Reading around the internet it seems as though I should have pasted the map, not the board, and let it stand for a minute or two before laying on the board.

References:

<https://www.ncdxf.org/beacon/>

https://www.reversebeacon.net/