Ham Radio

Not just (for) old men
Matt Foster (m0puh.radio)

Ham radio in the UK has a reputation for basically being old men chatting in their sheds using thousands of pounds worth of equipment, or of using morse code. I think this is a shame because there's much more to it than that, and I wanted to spend a while explaining why the hobby might be of interest to engineers, by talking about a few things I've found interesting, and giving you a bit of background. I'll also talk a bit about how to get a license, and what you can do with one.

WARNING Low Coverage

This talk is a tiny snippet of a huge area, and I've ignored or don't know about thousand of things people spend countless hours on.

I'm always happy to take questions, so please fire away.

First off, to deal with the demographics – ham radio is absolutely mainly older men, and there are really two (or maybe three) main reasons for this.

Demographics

In the UK only 15% of license holders are under 45.

In the US only 15% of license holders are women.

1. Male: I think that there are lots of men with radio licenses for the the same reason that tech is skewed that way – it's a giant male clique. In the US only 15% of operators are women.
2. Older: In the UK, only 15% of license holders are under 45.

In my experience a load of people with radio licenses were refugees from changes to CB licensing in the early 80s, or they were license holders from before then – often people who worked in radio or broadcasting.

Back when they were licensed being able to chat on a radio with your mates was unique, which is totally unlike now, where it sometimes feels like it's almost impossible to escape endless chats.

I also saw a recent mastodon thread talking about how more women would get into radio if widows were encouraged to start using their husband's radio gear, which is certainly not going to help encourage many younger people.
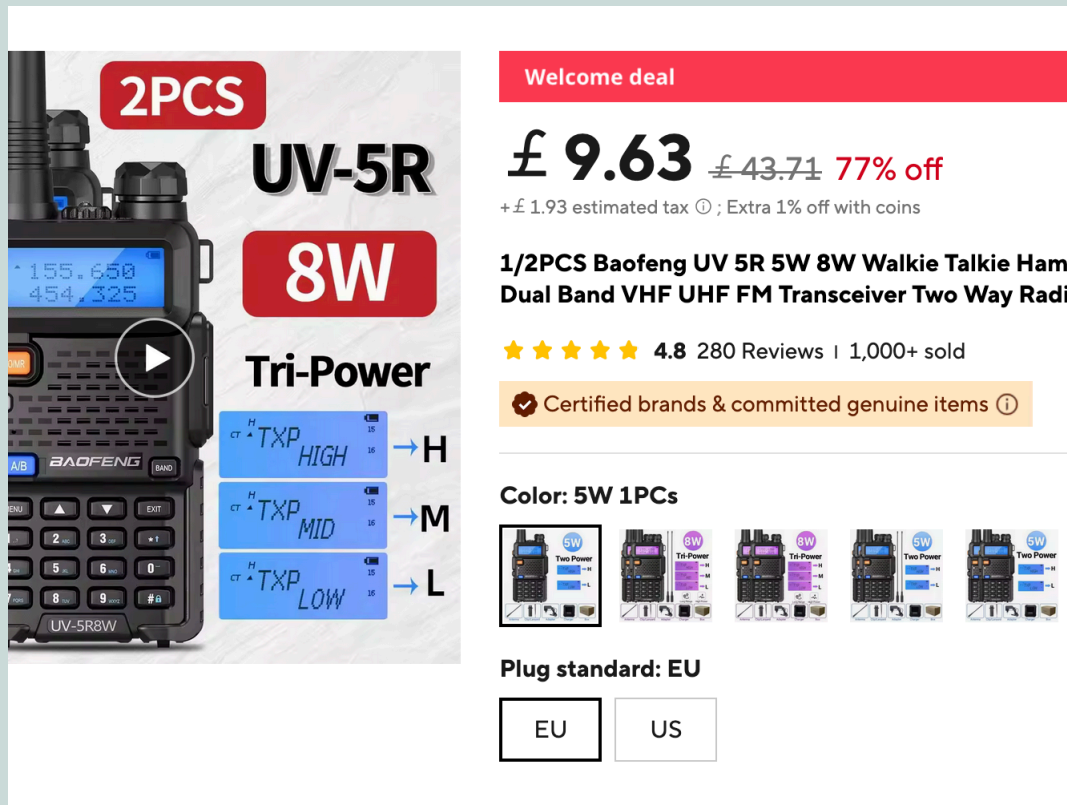
I don't have specific solutions for the demographic problems, aside from trying to explain some of the things I think younger people won't be put off by, so that's the plan here. Incidentally, I think people in the US do a way better job of outreach, with training at hacker conferences and a lot more interest, but radio in some other countries is much more useful than it is here, with emergency comms and coverage in large wilderness areas providing genuine utility we don't really need here.

The traditional view

So, the traditional view of a radio operator is an older man, sitting behind a desk of expensive gear with either a morse code key or an expensive microphone. And this is probably fairly accurate in many cases, but it's really the tip of the iceberg.

As you might expect you can buy extremely expensive radios, antennas, amplifiers, power supplies and everything, and some people do just that. A lot of people are happy to use off the shelf "appliances" and spend money at what they enjoy without doing anything else, but in my experience this represents a minority of people, and actually the hobby is really broad, and a lot of us don't operate like that at all because there's so much other stuff to do.

Also, in recent years, Chinese radio gear has really disrupted markets, so you will see and a lot of people are using relatively good kit that's super cheap.

So, before I start talking about other things, I will say that if you are interested in talking with mainly local friends, a Foundation license will get you the ability to use a radio like this, which will have a fairly limited range, but you can use on local repeaters to improve coverage.

In fact, for most people these days a foundation license is probably really all you need.

License background

100Khz	250GHz
2km	1mm
LF	Light

An amateur radio license gives you access to various chunks of the electromagnetic spectrum, ranging from about 100kHz in frequency to 250GHz. Or wavelengths from 2km to 1mm.

It also lets you communicate with satellites, and gear on spacecraft like the ISS. Other people bounce signals off the moon, meteor trails, rain, aircraft, the structure of the troposphere, and of course the ionosphere, which people are finding very exciting currently because of where we are in the sun's 11–ish year cycle.

The license allows you to build equipment to operate on these band, experiment pretty widely, and communicate. And there's a license to make sure you know what you're doing, primarily so that you don't interfere with other spectrum users (which is everyone and everything at this point). It also gives you a callsign which you can use to identify yourself, and which contains a bit of info on your location and license type.

So, as you can hopefully see, you don't just have to buy a radio and chat with other people and there's a lot of interesting things to mess with.

M0PUH

M = England

0 = Full license

PUH = Unique bit

My callsign is M0PUH. The M means I'm in England, or more strictly now in the UK. MW would be Wales, MM Scotland, and there are a few others. Other countries have different letters, like F for France, EA for Spain, etc.

0 means I have a full license, I start with 6 for foundation, then at intermediate you currently get the weird 2E0 prefix for England. As you might guess from a nerdy hobby, people collect contacts with call signs, and people send cards to one another to confirm contacts.

Finally, the unique part is either randomly allocated, or you can pick from what's left. I picked PUH because rad used to call me matt puh foster (see the wactus wiki page for part of the reason why).

License

– Foundation

– Intermediate

– Full

There are three levels of license, Foundation, Intermediate and Full, which build progressively to give you a decent understanding of what's required to build and operate radio gear safely and legally. This includes things like some electronics, how radios work and are designed, antennas, how to use test gear, and so on. Recent changes to licensing in the UK mean that for most people who want to mess about, just having a foundation license is probably enough.

Often, people who just want to chat find it annoying that you have to learn so much more than that, but a lot of people find it super interesting, because it means you can build things.

Building things

One thing that a lot of people do is build some or part of a system they can use to transmit. For example, I got hold of an old radio from my Dad, then built an antenna system in my garden by attaching a scaffolding pole to my house and hanging a huge wire as high as I could get it.

Then I used an antenna tuner I bought from a radio rally (basically a car boot sale) to connect the radio to the antenna system.

And then I got quite obsessed a data mode called FT8 which I talk about in a bit.

Kits
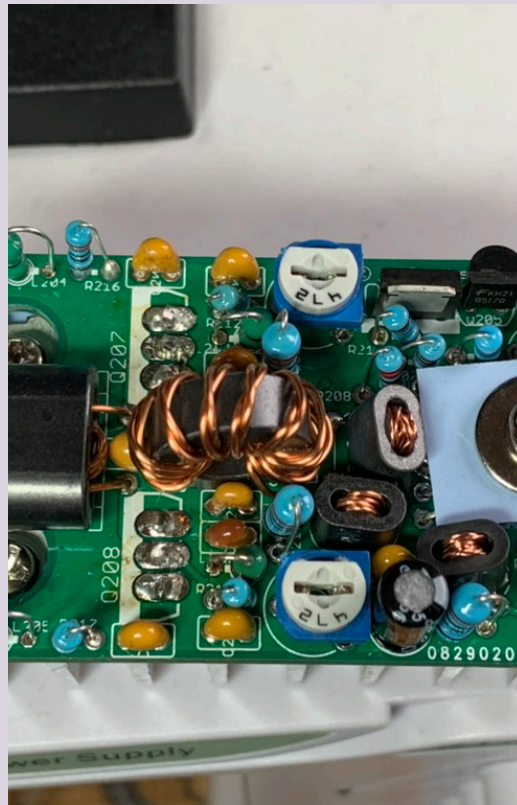
Other things people make include literally thousands of kits you can buy and build yourself, ranging from full radios, through to giant power amplifiers and dishes.

This is an amplifier from QRP labs, which is a shop run by a radio amateur that makes loads of fun kits, including super light weight trackers you could put in a balloon, and full radio systems you can build yourself and use to transmit and receive signals from across the world.

Scratch builds
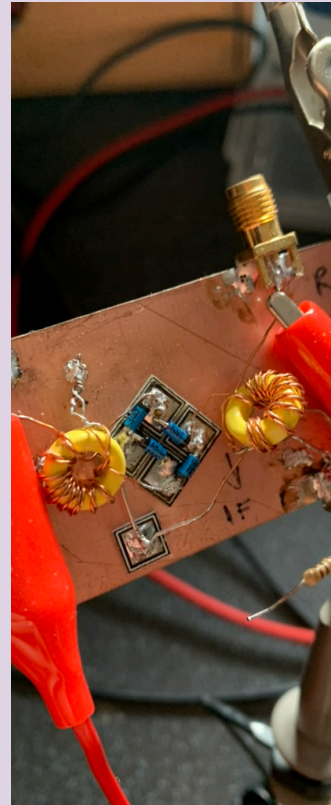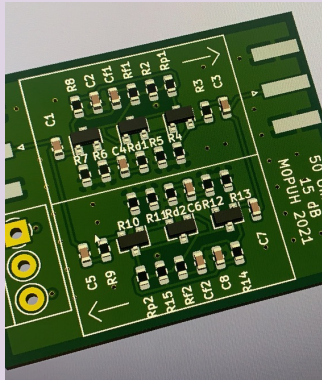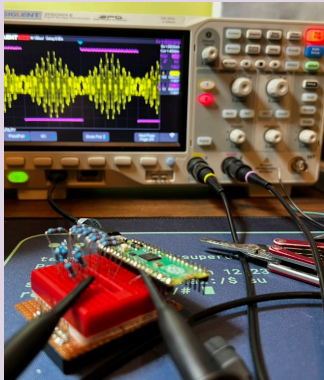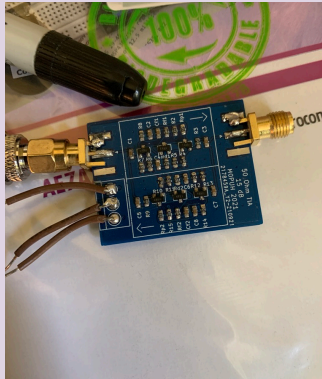
– Build on existing designs block by block

– No need to be an analog design engineer

  – Pick a block and build

    – e.g. I built a TIA but haven't done anything with it yet. Next up: mixer?

    Here are some examples of a few things I've built over the last few years, here there's a small amplifier I designed and built, a mixer, and me messing with a Pi Zero to synthesise some signals. Lots of people do things like this, and are eventually able to build radios from scratch, using their own designs. Essentially, you split things down into blocks (amplifiers, filters, mixers, audio, mixers, etc), work out what each block needs to do, and then tackle them one at a time. Some of the pics on this slide are my attempts at tackling blocks.
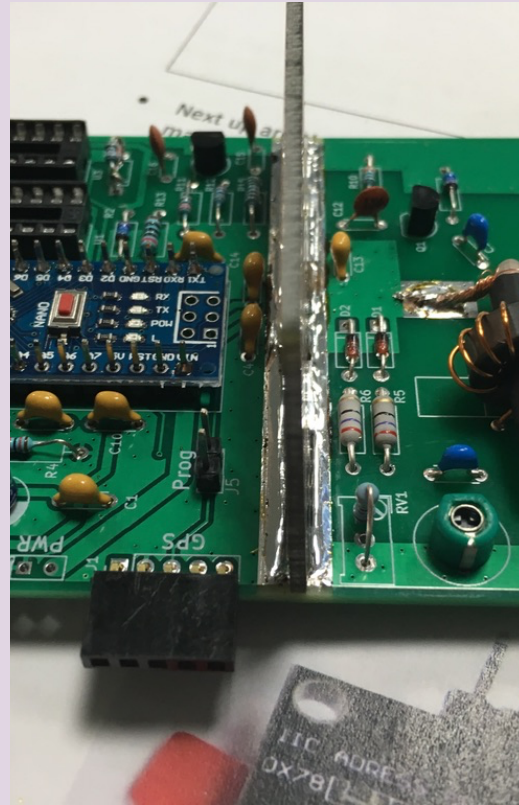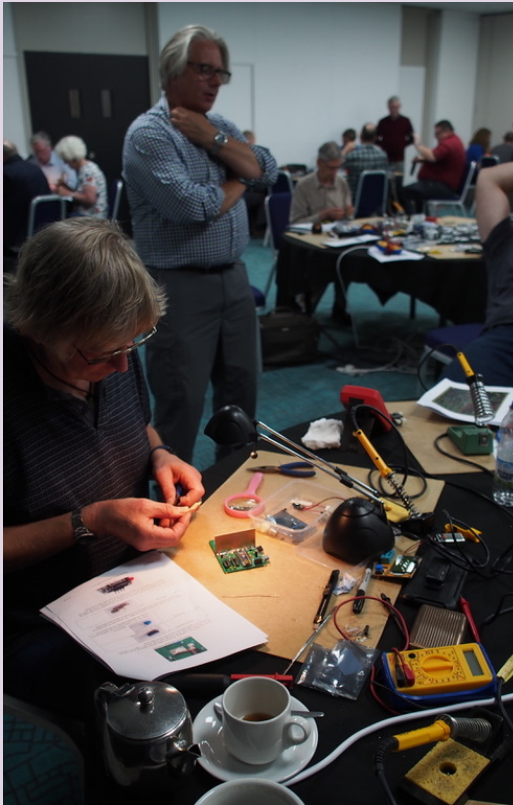
Buildathons can be a fun way to meet people, here's one I went to run by a national club. In these everyone builds the same kit then gets to test it and get help.
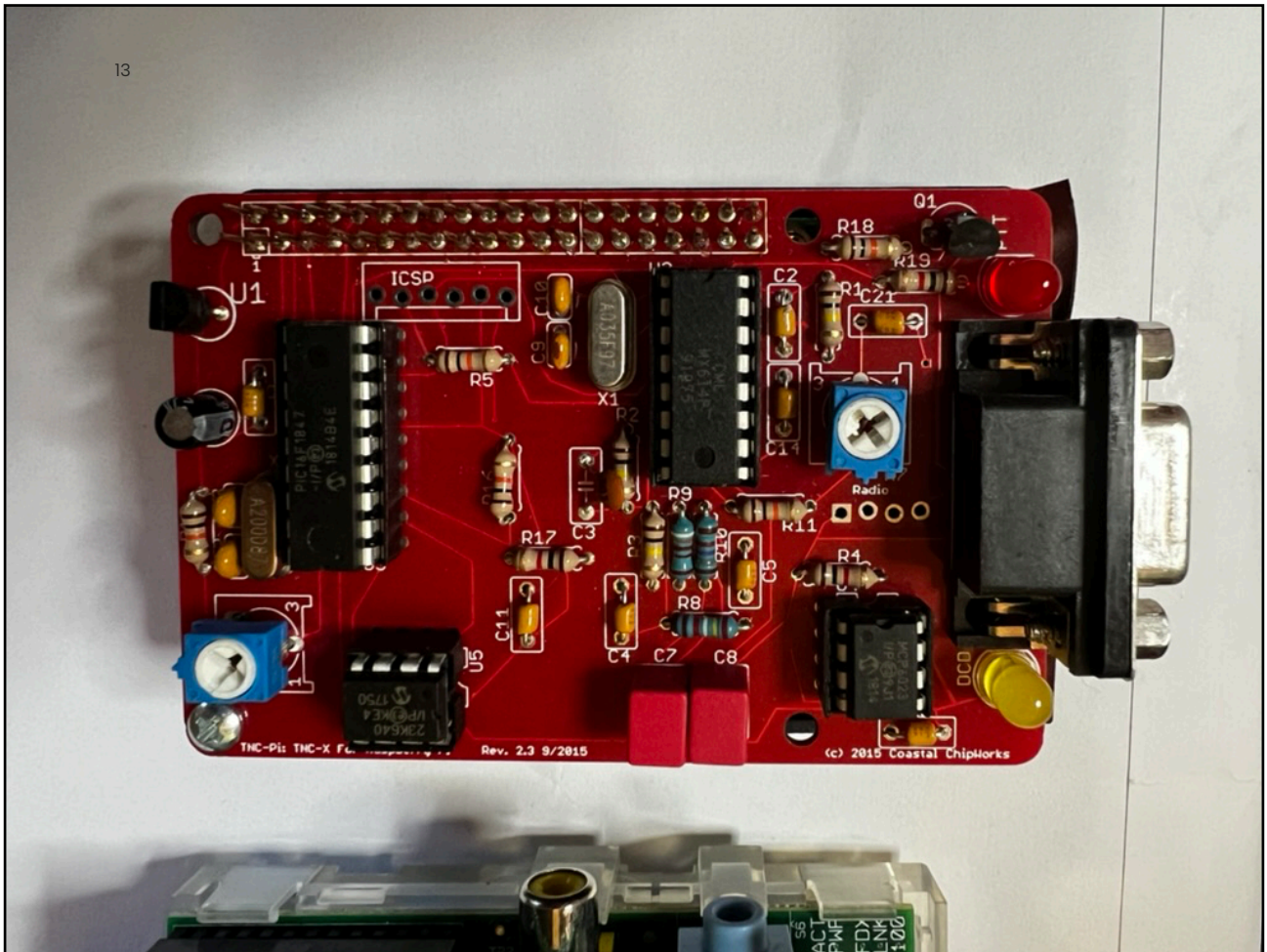
Raspberry pi hats have made building complex gear way easier, by giving access to decent hardware as well as allowing people to build useful UIs. I've built a few different hats over the last few years, ranging from test gear to things like this, which is a modem called a TNC, for use with packet radio modes like APRS (more on that in a bit).

Of course, things have to move past the build stage at some point, and you should probably use what you've built or bought.

Options for doing this without actually speaking are pretty numerous, thanks to *data modes*.

The screenshot shows a program called WSJT–X, which was up and coming when I got my license in 2017 but quickly became one of the most used data modes.

This is a modern digital communication mode which lets you easily transmit low power signals which can be received around the world.

It sounds pretty weird, but with this mode you don't really talk, so much as make semi automated contacts. It actually takes a bit of skill to do it successfully.

There are literally hundreds of data modes, including some which have been around since the 1920s (RTTY) and others which are still being developed now. Moderns modes tend to require less power, as they use modern encoding techniques (like FT–8) and there's a lot of decent software you can use to play with them.

But as well as digital data modes there are also analog modes, like SSTV (slow scan TV) – here's an image I received a few years back.

As well as analogue images, like this, people do experiment with digital TV, including terrestrially, and with drones and satellites. In fact there's a Qatari geostationary satellite called ES'HAIL which has an amateur payload people can use for a load of different things, and I've seen a few talks on people modifying satellite TV gear for transmitting and receiving using this.

Radio Networks
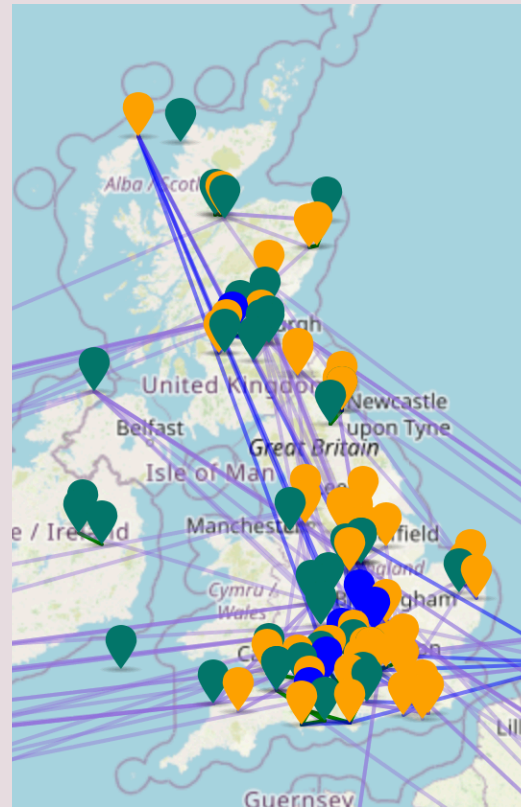
I've already mentioned data modes, but since the early days of the internet people have been building networks with radio. In the late 70s, when ARPANET was being built there was a radio version called PRNET, which used a protocol called AX.25. This has been used since then, with varying levels of popularity (I think it peaked in the 80s), and it allows people to run radio based BBSes, and TCP/IP networks.

In fact, during the early days of the net, the ham radio community managed to get whole of an entire class A block of IP addresses – 44. 44net makes chunks of addresses available to licensed amateurs all over the world and you can use it for basically anything. A few years ago, ARDC, who runs 44net sold a block of 44net and now use it to provide grants for interesting tech and radio projects.

Ham radio workbench 229 has a great intro to this, and the modern ham has some great posts on this.
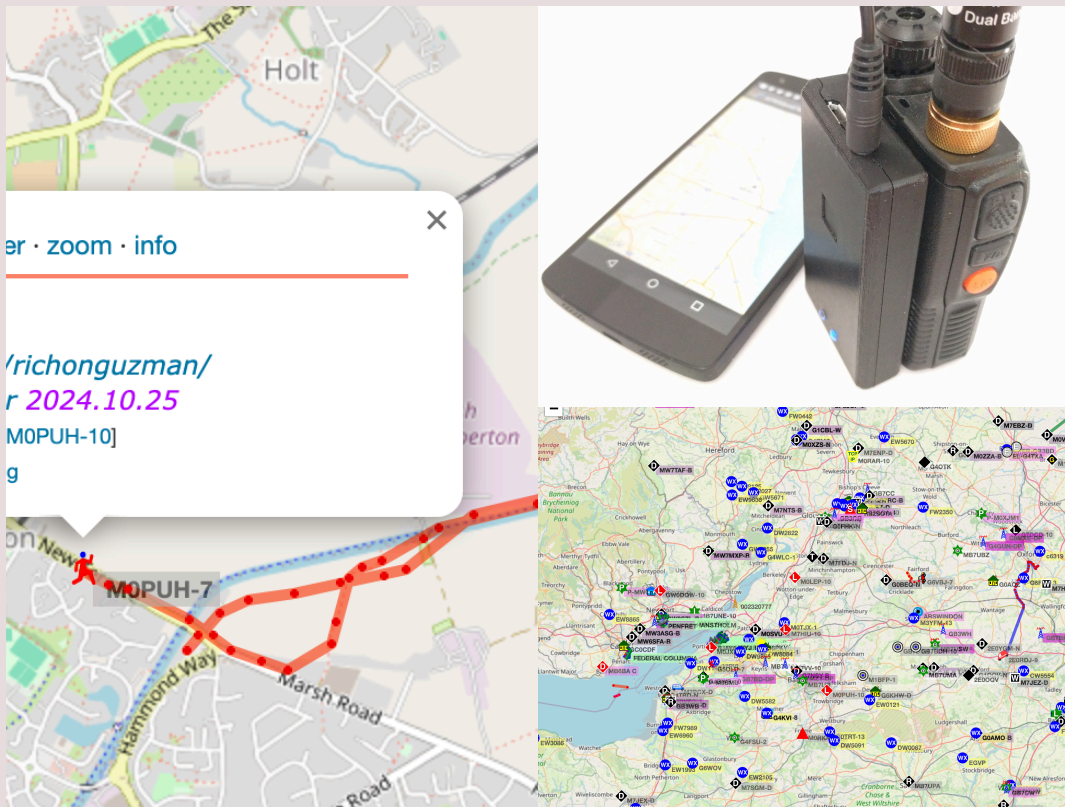
These days, when people talk about packet radio they almost always mean APRS. APRS is widely used for telemetry, and supported by a load of radios, phone apps and projects.

This system works by people running receivers called iGates which listen on a specific frequency for APRS packets and then send them to the net, or rebroadcast them to other receivers.

The transmitters are either built into radios, small trackers you can buy or build, or things that connect to a phone using an audio cable or bluetooth and then use a cheap walkie talkie to transmit.
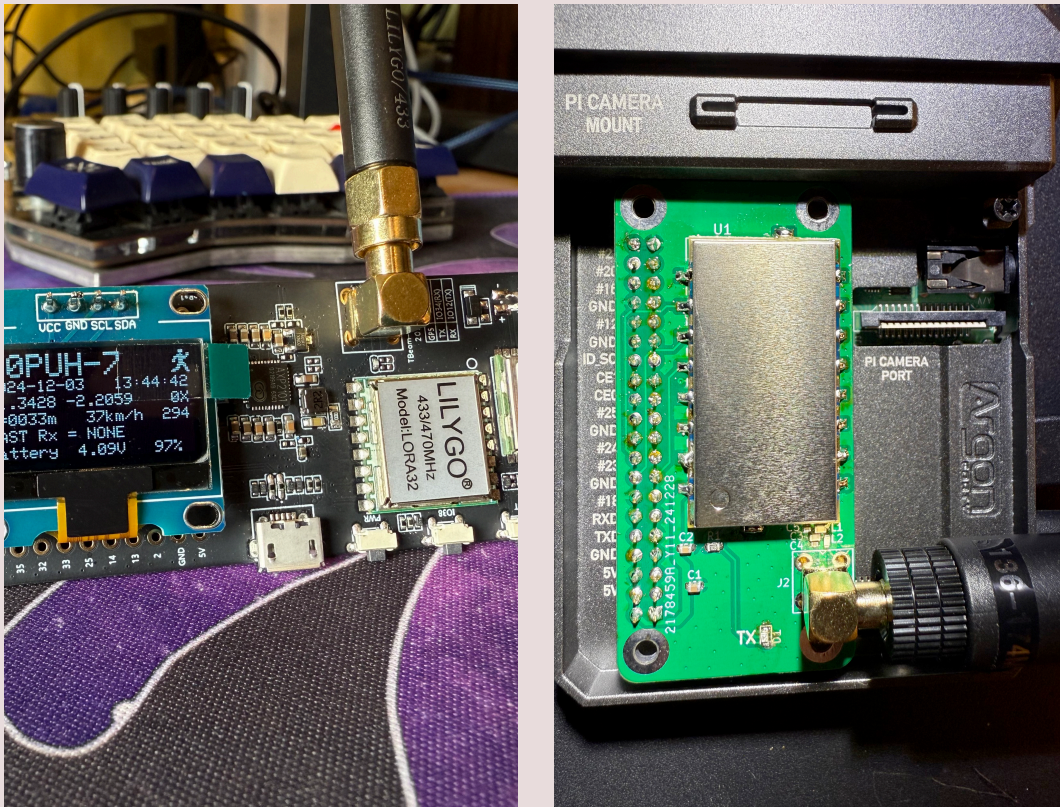
As well as APRS, people are using more modern communications schemes and hardware to build networks and systems.

One popular example at the moment is meshtastic. This uses LoRa hardware (which is cheap and you don't need a license for) to build a mesh network which you can then use for off grid comms (text messaging etc).

The left image here shows a tracker which transmits in the hand band and uses APRS over LoRa.

There are also some attempts to reinvent things like APRS using more modern tools. One project, cats.radio has firmware written in rust, and uses cheap Chinese radio modules. The image on the right shows a Pi had for CATS, next my list is building a tracker board, but I've not had time to get to that yet.

Other similar projects include NPR (new packet radio) which bridges and ethernet interface over a radio link.

SDRs

Software defined radios started transforming how people build radio almost 20 years ago, by removing the need for a lot of single purpose hardware.

I expect some people here have used cheap RTL SDR dongles for some things like receiving aircraft transponders, and there are hundreds of web SDRs online which you can use to listen to basically anything. I sometimes like listening to numbers stations.

As well as that you can buy tools like the HackRF which let you transmit as well as receive, and give you full control over the software. GNU Radio is one project that gets heavy use in this space, as it lets you build full radio systems in software, but there are also loads of desktop listening apps.

Licensing

Amateur Radio Licence
Licence de radio amateur
Amateurfunklizenz

United Kingdom of Great Britain & Northern Ireland, the Channel Islands & the Isle of Man
Royaume–Uni de Grande Bretagne et d'Irlande du Nord
Vereinigte Königreich von Großbritannien und Nordirland, die Kanalinseln und die Isle of Man

Wireless Telegraphy Act 2006
Législation sur la télégraphie sans fil 2006
Gesetz über drahtlose Telegrafie 2006

Licence details
Renseignements sur la licence
Lizenzdetails

Spectrum Licensing
Riverside House
2a Southwark Bridge Road
SE1 9HA
UNITED KINGDOM

Interested? Get the Foundation License Manual and check out Bath Based Distance Learning

Licence class Classe de licence Lizenzklasse	Amateur Full Radio Licence
Licensee's name* Nom du titulaire Name des Lizenzinhabers	Dr Matthew Foster
Club name Nom du club Name des Klubs	
Callsign	'#' can be replaced with an appropriate RSL

I got my foundation license in 2017 because my dad (an actual OM) had been hassling me for years and I was interested in learning something new and topping up my electronics knowledge. I started by reading the RSGB foundation license manual, decided it seemed pretty straightforward, then eventually found "Bath Based Distance Learning", which exists to help people get licensed. I emailed the organiser, Steve, and he quickly emailed me some sample exam questions and organised a in–person meeting to take me through there basics (at that point there was a practical part of the exam). That was at the end of October. I booked and passed the exam in the first half of December and enrolled immediately onto a distance learning intermediate course which had already started, then did the intermediate exam in mid January (this also had a practical element at the time, which disappeared in the pandemic).

Finally, I joined an "advanced" classroom course in Bath to study for a full license (it was a couple of hours a week, plus homework), this ran until June, and I passed that in the end of June.

I found the process pretty fun and learned a lot about practical electronics (despite having an electronics degree!) and radios. You can probably tell I don't really do the speaking part much, but hopefully I've shown that there's masses of other things you can do as well.

I haven't even touched on so many things here, like radio astronomy, science, clubs, etc.

References

- UK Band plan
- Bath Based Distance Learning
- [British Amateur Television Club: https://wiki.batc.org.uk/BATC_Wiki
- UK packet radio
- HRB 229
- DigiPi
- NPR
- Numbers stations
- CATS
- Meshtastic