



### Appendix 1: Amateur Equipment / Usage in 144-146 MHz

The 144-146 MHz band is the cornerstone of VHF amateur activity worldwide. It can be assumed that almost every licensed UK amateur is the owner of at least one VHF radio. This is given the extensive applications, repeater/gateway network coverage, rising participation in contests and it featuring prominently in the UK amateur radio training and exam system.

There is an increasingly attractive range of equipment on the market (with an entry-level price of just twenty pounds for a Chinese FM handheld) through to more expensive and sophisticated automotive and home base transceivers.

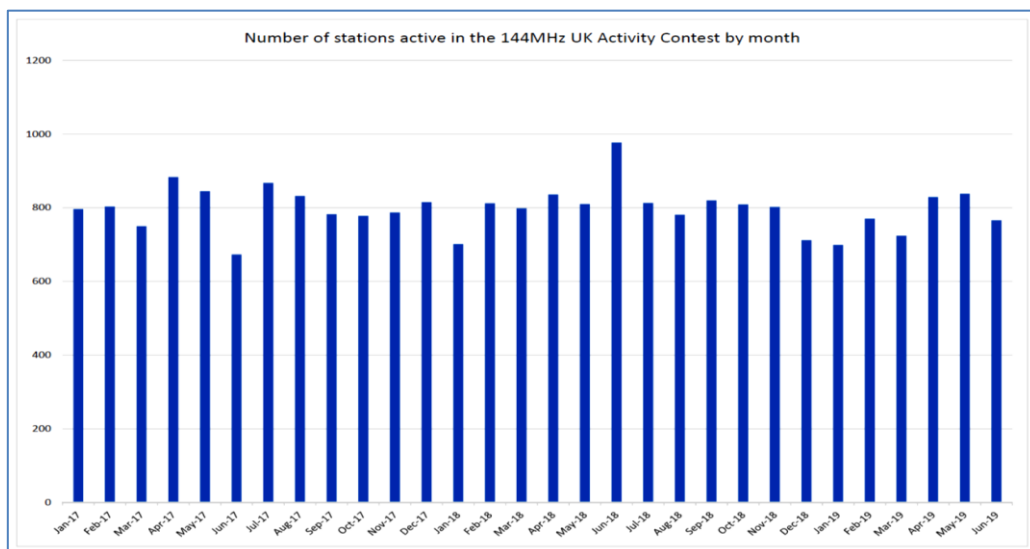
Any agenda item, such as that being proposed, could have a serious commercial and market impact as well as for end users. In addition to commercial equipment, amateur-developed multimode hotspots are now widely available supporting several digital voice protocols.



Multimode Handhelds – FM, D-Star, DMR, C4FM-Fusion



Mobile FM / Digital Voice (with integrated GPS) / 144, 430, 1290 MHz Software Defined Radio



Strong participation in monthly 144 MHz UK Activity Contests over the past several years

## UK 145 MHz Infrastructure

An extensively deployed and active network includes:

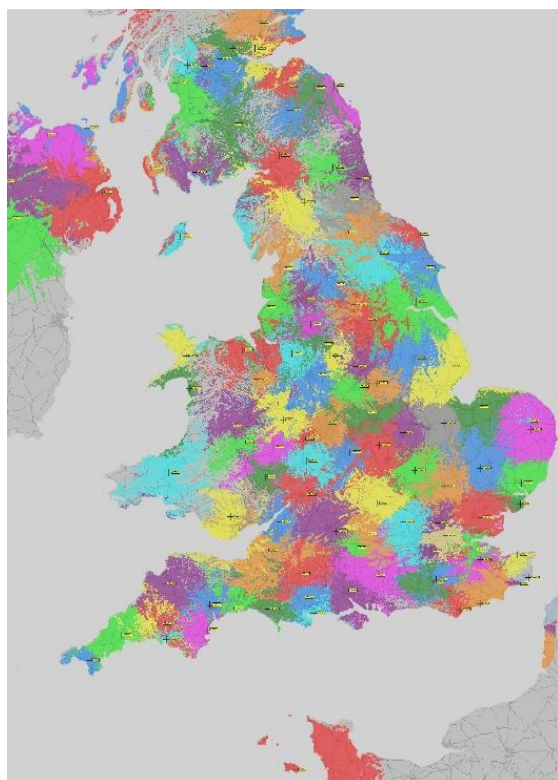
- Analogue & Digital Voice (DV) Repeaters
- Simplex Gateways
- APRS and Packet nodes
- Digital Voice hotspots etc.

Many of these are internet-linked into clusters to relay voice over wider ranges (nationally or internationally). All repeaters and gateways are licensed by Ofcom Spectrum Licensing for unattended 24/7 operation. The 145 MHz band is ideal for urban and rural coverage.



Intelligent Dual-mode FM/DV 'Fusion' digital voice repeater

**UK Statistics as at end of June 2019:** 368 Licensed Repeaters and Gateways of which:



- 131 licensed analogue (or dual-mode) repeaters (see map)
  - 64 licensed digital (or dual-mode) repeaters
  - 43 licensed simplex analogue gateways
  - 72 licensed simplex Digital Voice (DV) gateways
  - 6 licensed RF link gateways
  - 14 DV repeaters with DMR capability
  - 32 DV repeaters with DSTAR capability
  - 39 DV repeaters with FUSION capability
  - 4 new applications in vetting prior to Ofcom submission
- Generally all vertically polarised

### Summary:

Hundreds of repeaters

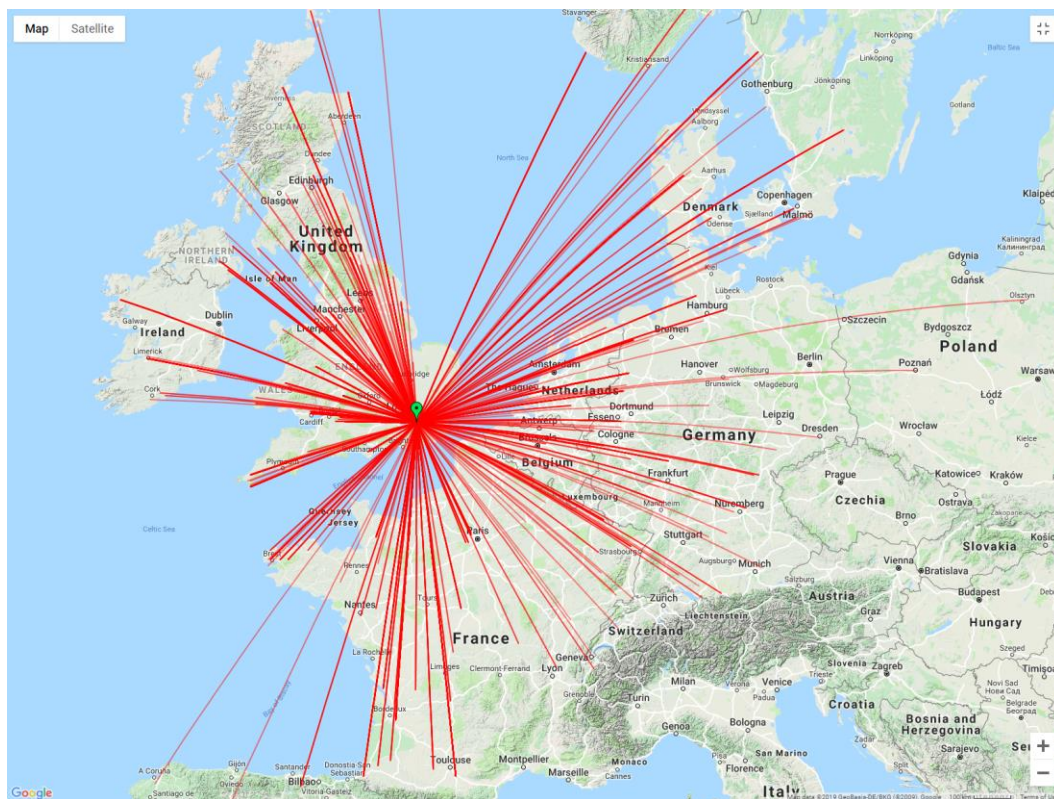
Thousands of end users/radios

Millions of pounds in investment

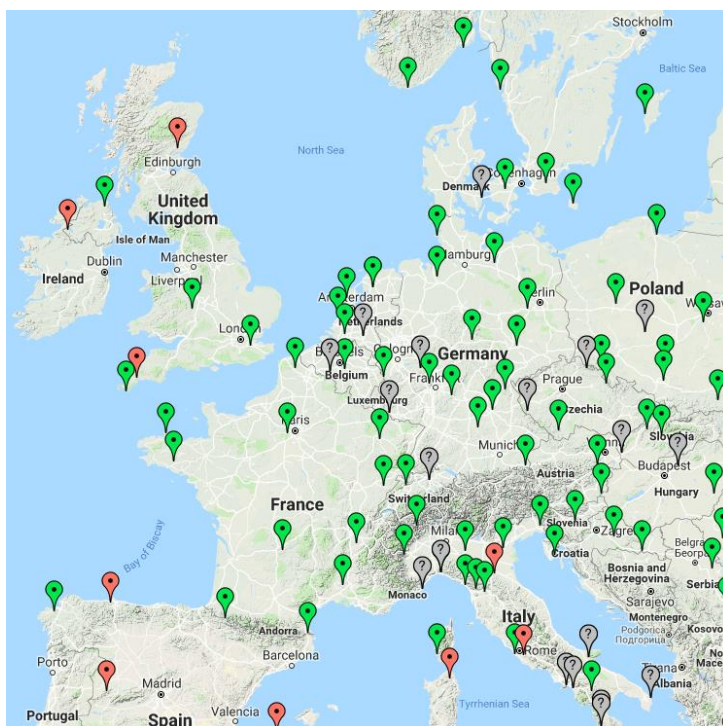
Source: RSGB-ETCC [www.ukrepeater.net](http://www.ukrepeater.net)



## 144 MHz Propagation Beacon Network



Reception reports for GB3VHF beacon - 144.4300 MHz, 100W erp from its site at BT Fairseat in Kent



### Key features:

- 24/7 Transmissions (CW and Digital)
- Dense 1kHz frequency spacing raster
- GPS frequency locking commonly used
- Manual and automated monitoring
- Extensive ranges (see example above)
- Generally horizontally polarised
- Protected sub-band from interference
- Many UK sites supported by Government and industry
- Some receive-only web-SDR sites as well

Source: [www.beaconspot.uk](http://www.beaconspot.uk)

## Amateur Satellite Service

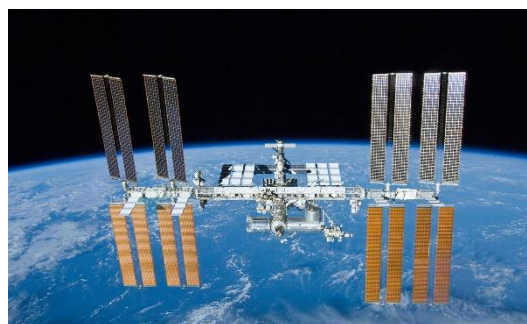
Number of amateur satellite systems currently active in VHF/UHF as of end of June 2019: **155**<sup>1</sup>

**Of which in 145 MHz there are:**

- Uplinks to 20 satellites
- Downlinks from 40 satellites
- Telemetry beacons from 23 satellites
- International Space Station voice and data

Duplex voice and data for the International Space Station (ISS) include astronaut-schools contacts, with downlinks on 145.8 MHz, plus packet data relays. This has proven to have major outreach and STEM benefits. The 145 MHz radios on the ISS also provide a vital backup communications function for the entire station which we know has been used on a number of occasions.

The amateur satellite service is experiencing significant growth from CubeSats launched in collaboration with universities, UKSpace/ESA/NASA. The 145 MHz band is the only VHF band with an amateur satellite service allocation and provides a vital low-Doppler resource for low earth orbit communications.



**All ISS schools contacts use 145 MHz**



**AMSAT-UK Amateur Radio satellites – FUNcube-1, UKube-1 (FUNcube-2)**

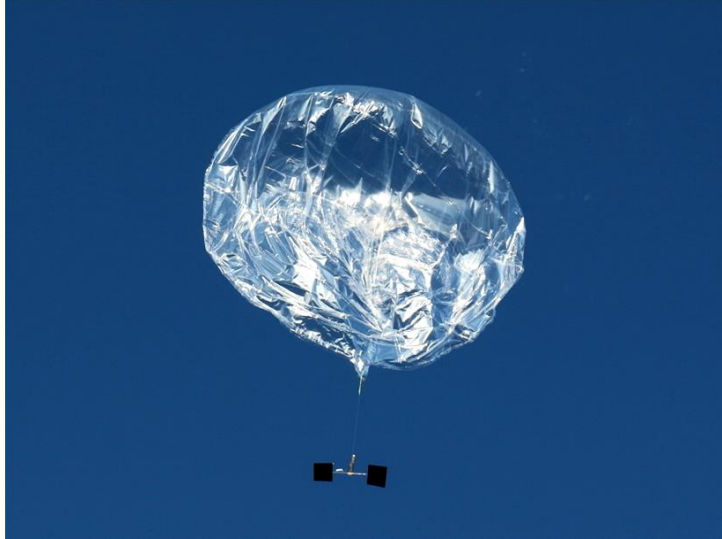
<sup>1</sup> Reference: <http://www.ne.jp/asahi/hamradio/je9pel/satslist.htm> . In addition IARU satellite coordinators have data and statistics for planned systems



## Amateur Airborne usage

Examples:

- Global circumnavigation by innovative high altitude balloons (see example below)
- Amateur radio on manned aircraft permitted in many countries (including telemetry, APRS)



**Balloon UBSEDS21 with 144/145MHz GPS-APRS tracking transmitter**

## Earth-Moon-Earth (Moonbounce)

**144 MHz Yagi arrays** - Ultra-low noise receivers and high ERP transmissions are all aspects of moonbounce - one of the most technically challenging uses of 145 MHz (and indeed any band).



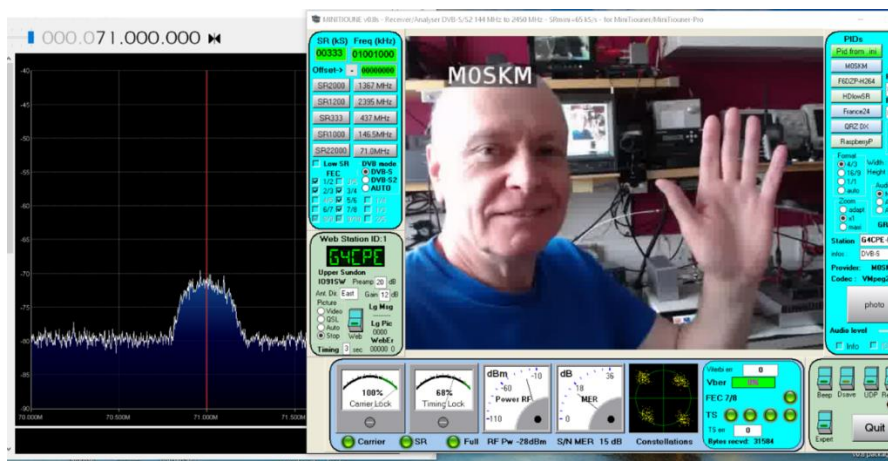
**UK and Europe - EME stations**

NB: Some UK amateurs have Ofcom Special Research Permits that enable higher transmit power (1kW typical) being fed into the antenna array.

## Appendix 2: Amateur Innovation in VHF

With respect to WRC-19 AI-1.1 and AI-10, UK amateurs and in particular members of the British Amateur Television Club (BATC) have been pioneering spectrally-efficient low-rate video developments.

The example below is 333kb/s real-time video within a 500 kHz channel bandwidth. This was first developed in the experimental 146-147 MHz spectrum made available to UK amateurs by Ofcom and is now being further developed and tested in UK amateur experimental spectrum at 71 MHz courtesy of an Ofcom licence variation (NoV).



It is one of the key innovations that form part of the amateur spectrum requirement associated with 52-54 MHz access. Such developments have wider value to the UK and Ofcom in demonstrating that largely fallow low-VHF spectrum can be put to better use than at present. There is literally an 'opportunity cost' by not enabling and fostering this. Regular updates are presented by the RSGB to Ofcom's Business Radio Interest Group (BRIG) organisation and other fora.

The above is supported by a collaboration between UK amateur transmit hardware developments and French amateur SDR hardware/software for receive. For narrowband users, there continues to be development of innovative new weak signal digital modes for long distance contacts in marginal propagation conditions.

## Appendix 3: Amateur Research at VHF

Weak signal modes and propagation research are a key ongoing feature of the 50 MHz band, which can exhibit both HF and VHF characteristics and can also feature 'Sporadic-E'. Modes such as FT8 and WSPR have also contributed to a resurgence in 145 MHz weak-signal contacts. Recent research work has included assessments of Faraday-polarisation rotation within Sporadic-E events as well as forecasting their meteorological drivers.

From  
RSGB Convention video:

<https://youtu.be/13Cs4nB1TjI>

'Polarisation of  
50MHz signals'



[www.rsgb.org](http://www.rsgb.org)