The QO-100 Satellite

(Almost) All you need to know to have a go.

Peter Taylor G8BCG

Es'hailSat سهيل سات

Qatar Satellite Company الشركة القطرية للأقمار الصناعية

AMSAT-DL

AMSAT P4-A

First geostationary amateur radio transponder (incl. DATV) on

Es'hail-2

Q.A.R.S. QATAR AMATEUR RADIO SOCIETY

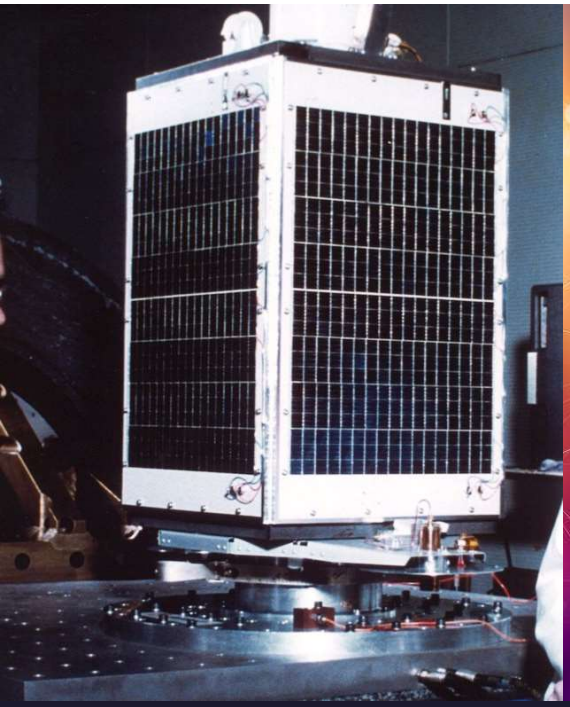
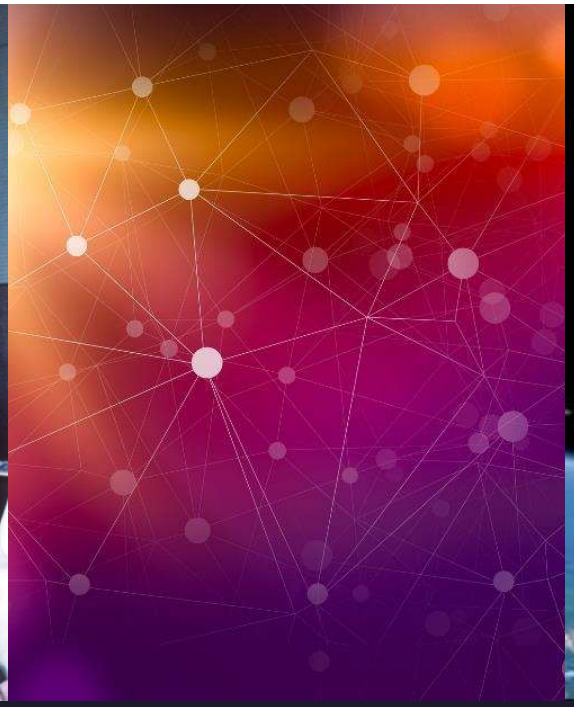
What's Occurring

AMSAT-UK
Radio Amateur Satellites

- History of Amateur Radio Satellites
- Types of Satellite
- Satellite Orbits
- QO-100
- Ways to listen
- Getting going on Transmit
- Let's have a Play

AMATEUR RADIO IN SPACE
AMSAT®

Peter Taylor G8BCG

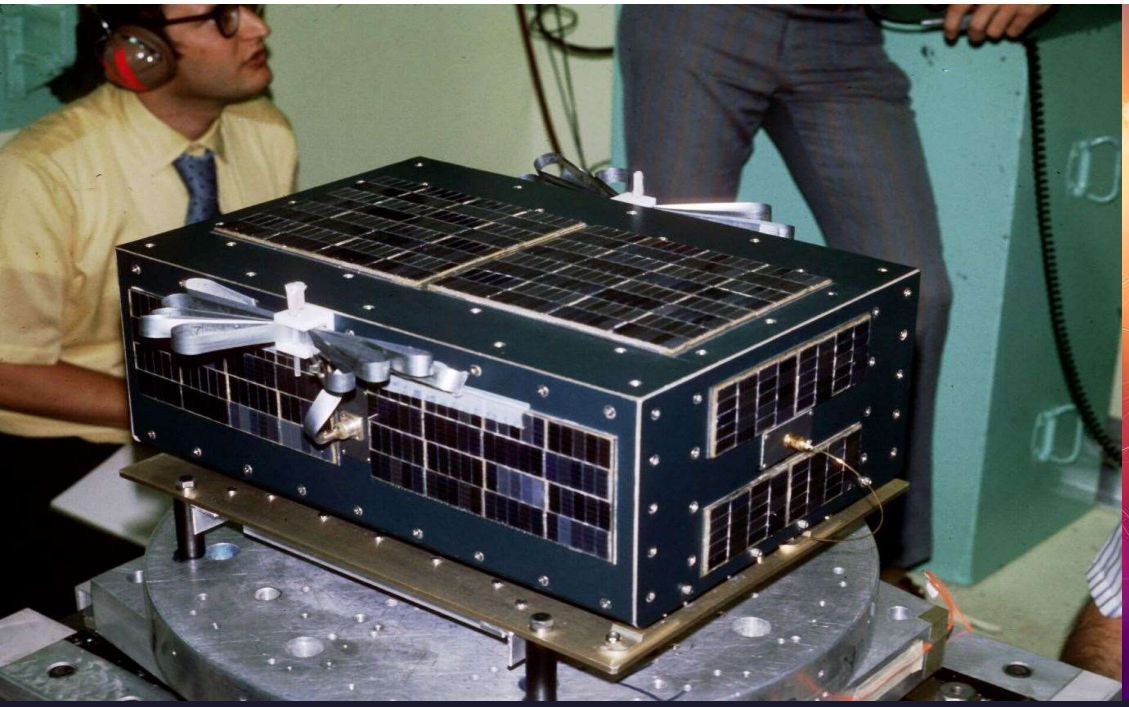



Early History of Amateur Satellites

- **Project OSCAR** The first amateur satellite, OSCAR 1, was launched in December 1961 barely four years after the launch of the world's first satellite, Sputnik I.
- It got a free ride as of one of the weights necessary for balancing the payload in the rocket stage. This was to become a trend.
- It Orbited for only 22 days but over 500 amateur radio operators in 28 countries forwarded observations to Project OSCAR.
- **I listened at the NW VHF Group in Manchester - I was 10. Hooked!**

Early History of Amateur Satellites

- Through the 60s and 70s there were several further OSCARs and also RS-satellites launched by the USSR.
- **AMSAT**
  The Radio Amateur Satellite Corporation (AMSAT) was formed in 1969 as a not-for-profit educational organization. Its aim is to foster Amateur Radio's participation in space research and communication.
- ASMSAT HISTORY the full story https://www.amsat.org/amsat-history/



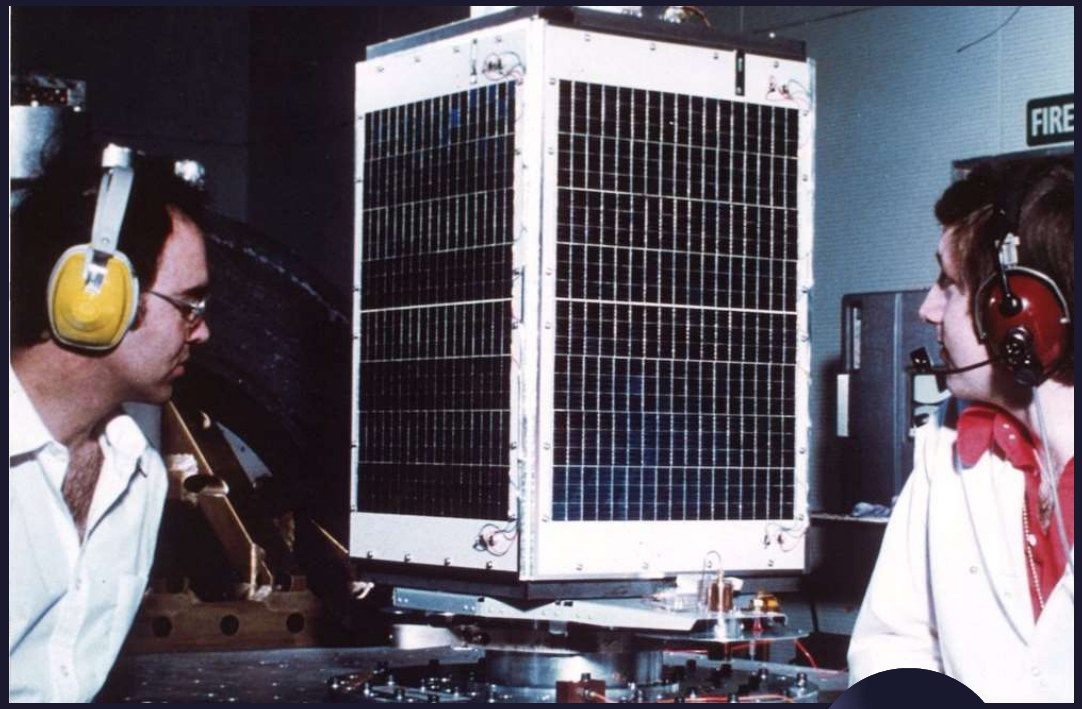
Early History of Amateur Satellites

- **OSCAR 6** launched in 1972 was immensely successful and a small group of UK hams got together to produce OSCAR News. It contained information on recommended equipment, active stations on OSCAR, Hints & Kinks, and listed orbits with reference and general advice.
- From this point on most satellite construction became an international affair with AMSAT NA, UK, DL and AMSAT JA (JAMSAT) playing major roles in design and fabrication.
- AMSAT-UK was formed In 1975 with the backing of AMSAT-USA and has had an active membership ever since. https://amsat-uk.org/

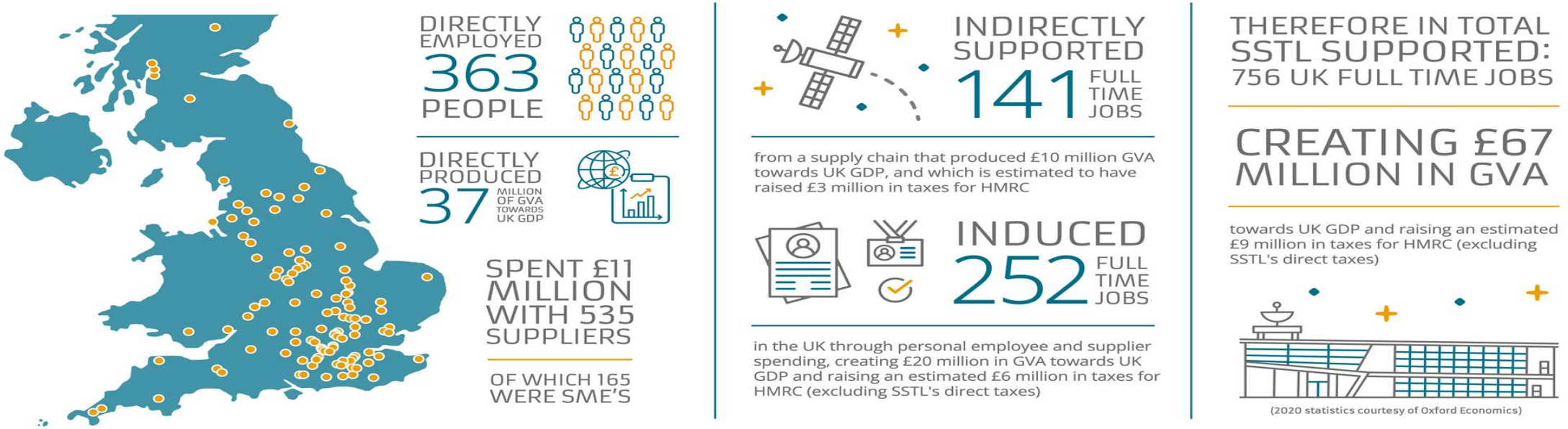
Early History of Amateur Satellites

- **AMSAT-OSCAR 7** was launched in 1974. AO-7 became non-operational in mid 1981 due to battery failure . However, In 2002 one of the shorted batteries became an open circuit and to this day spacecraft is still working - able to run off solar panels only.
- **AMSAT OSCAR-10** launched in 1983 opened completely new dimensions in amateur radio. As a high-flying satellite in an elliptical orbit (Molnija orbit) with an apogee of 35,000 km and a perigee of 4,000 km, radio communications of up to several hours duration with the whole world were possible for the first time.
- **After a brief aside, I'm now going to leap forward a few decades** but if you want to know the full story of the 100+ Amateur Radio Satellites this is a good place to start http://www.dd1us.de/historical%20sounds%20from%20space.html

AN ASIDE: SURREY SATELLITE TECHNOLOGY LIMITED



- The SSTL story is a showcase of British ingenuity, ambition and engineering expertise.
- In the mid-1970s space was the preserve of a few super-powers
- Satellites used components specially manufactured and tested to perform reliably in the harsh space environment but with only limited functions that could not be reprogrammed once in orbit.
- In the late 1970s, a group of researchers working at the University of Surrey, led by a young **Martin Sweeting G3YJO**, decided to experiment by creating a satellite using commercial off-the-shelf components. The idea was bold and audacious and the results were surprising.



AN ASIDE: SURREY SATELLITE TECHNOLOGY LIMITED

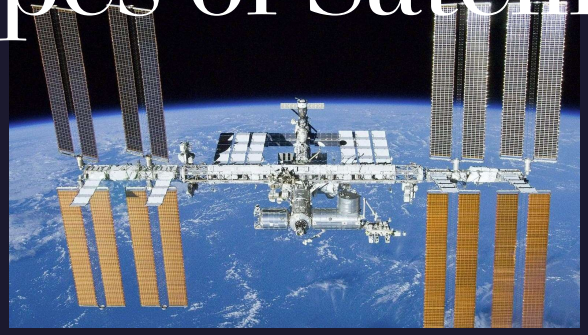
SSTL has pioneered the design, build, test and operation of small satellites and has been a world leader in the field for over 40 years.

- That first satellite, UoSat-1, was built in a small university lab in a cleanroom fabricated from B&Q - and with printed circuit boards designed by hand on a kitchen table. Launched in 1981 with the help of NASA UoSAT-1 was the first modern re-programmable small satellite and was a great success. Most importantly, the team showed that relatively small and inexpensive "micro" satellites could be built rapidly to perform successful and sophisticated missions.
- In 1985 Surrey Satellite Technology Ltd was formed as a spin-out company to transfer the results of research into a commercial enterprise. The Company grew steadily and has worked with a wide range of international customers and partners, building and launching ~70 satellites for 22 countries over the following three decades.

AN ASIDE: Radio amateur and Executive Chairman of SSTL, Sir Martin Sweeting G3YJO

In this video recorded from his home during the Coronavirus lockdown Sir Martin Sweeting talks about how his passion for Space was sparked…

Types of Satellite

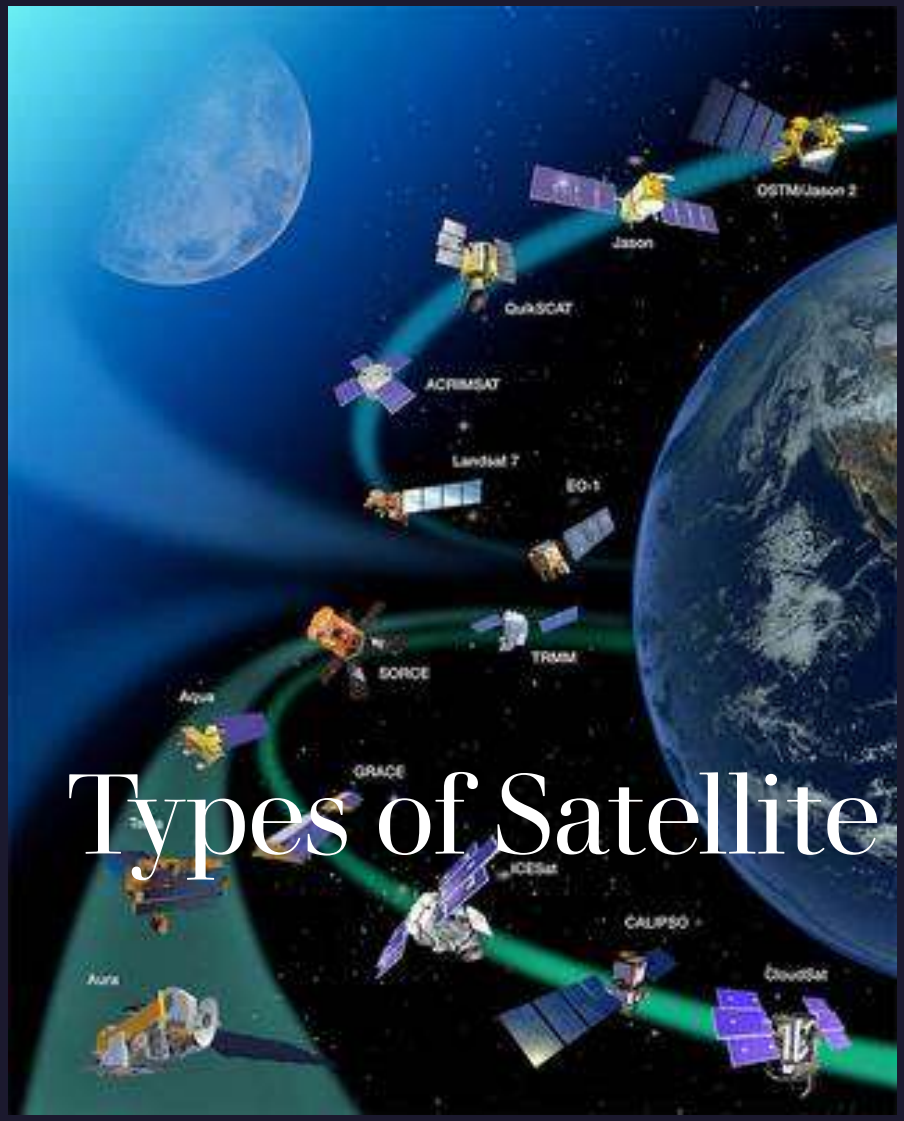


What's in a satellite?

- The Moon is a satellite of Earth – We can reflect radio signals off it (Moonbounce) – it is a PASSIVE satellite.
- As Radio Hams we can (and do!) reflect signals off all manner of stuff from meteors to aircraft and even the ISS. And of course E and F layer propagation is simply reflection or refraction (bending) from ionised regions in the ionosphere.

Amateur Radio Satellites

- These do not rely on reflection.
- Like communications satellites and TV Broadcast satellites they are ACTIVE rather than passive.
- They are solar powered and have receivers transmitter and control systems.

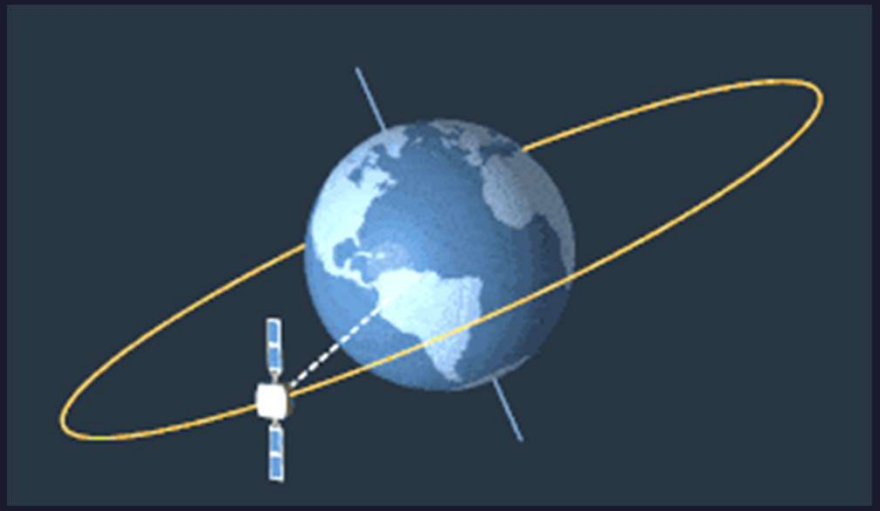


Types of Satellite

Types of Satellite

Earth orbit is full of stuff doing all kinds of work. Amongst that lot there are three basic types of AMATEUR satellite:

- **FM Repeaters** – just like terrestrial FM repeaters but usually with their input and output on different bands e.g. 432/144MHz. There are several active satellites plus of course the ISS Crossband Repeater which switches between packet and FM voice mode.
- **Digital Repeaters / Store and Forward Satellites -** a whole subject in itself. Not covered here!
- **Transponder Satellites**– sometimes also referred to as linear transponders - they receive a whole band of frequencies and re-transmit the whole band back to earth on a second band of frequencies. This permits multiple simultaneous QSOs and also any mode.
- QO-100 carries two very powerful transponders which we'll talk about in a few minutes.



Geostationary Orbit

Satellite Orbits

QO-100 is the first Amateur Radio Satellite in Geostationary Orbit.

Types of Satellite Orbit

There are three basic types of satellite orbit:

- LEO Satellites – These are the Low Earth Orbit satellites that are typically placed at altitudes above the earth in the range of 200-2000 Km. Due to low altitudes, they have relatively small footprints. The ISS is in Low Earth Orbit. ***Fast moving hard to track.***
- MEO Satellites – These are Medium Earth Orbit satellites that usually have orbital altitude above earth's surface in the range of 2000-35000 Km. They feature longer orbit periods and typically offer a larger footprint. However, few amateur radio satellites fall into this category though Oscar 10 was in a large elliptical orbit taking it out to 35000km. ***Slower moving but need to track accurately.***
- GEO Satellites – Geosynchronous satellites are placed at 35786 Km above the earth along the Equator. This makes them unique in that their orbital time period is exactly equal to the time taken for the earth to complete a rotation. Thus, they appear to be in the same position in the sky. QO-100 is the first Amateur Radio Satellite in Geostationary Orbit. ***EASY TO TRACK – IT DOESN'T MOVE!***

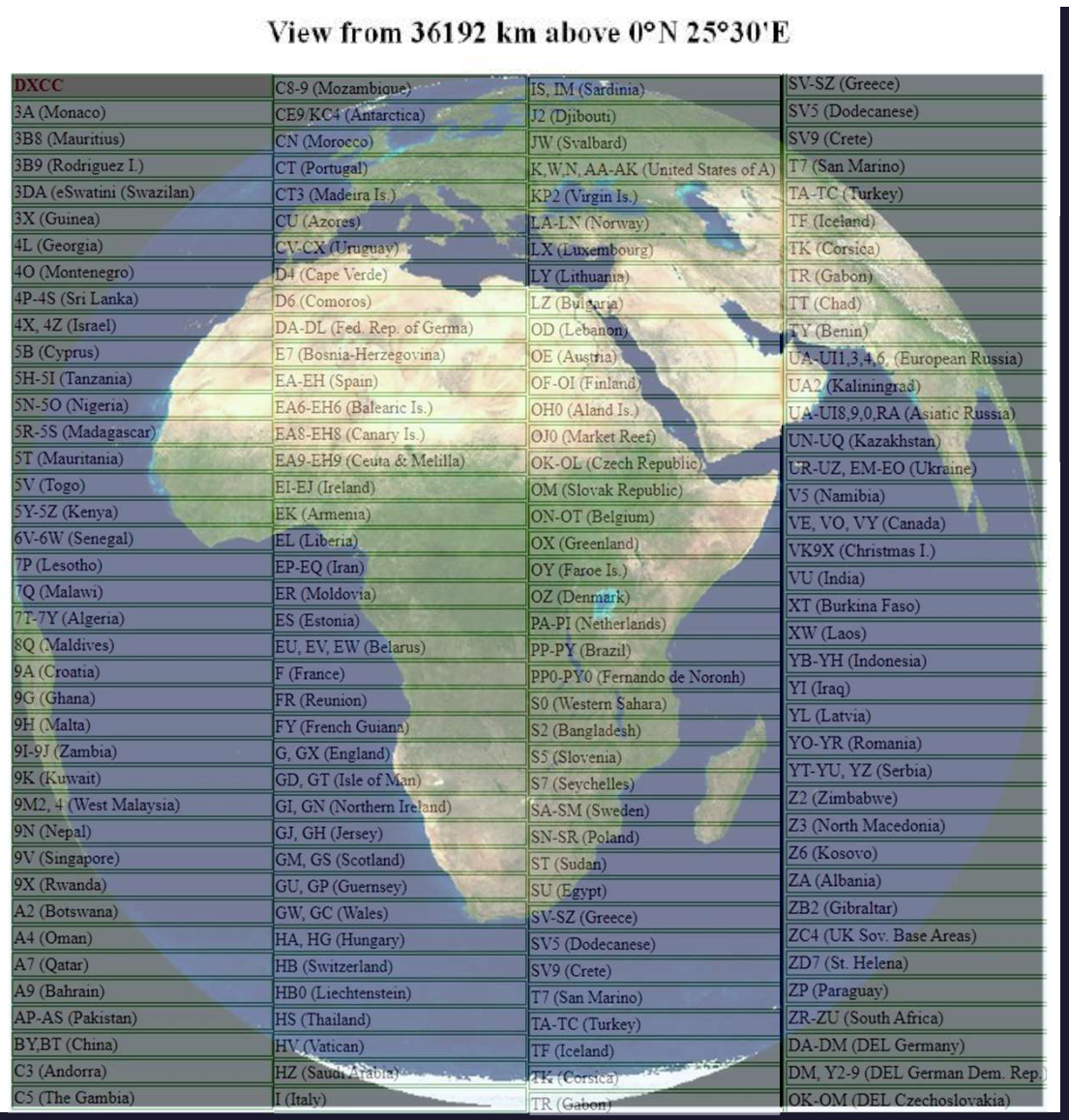
QO-100

SO - MOVING SWIFTLY ON A FEW DECADES to Es'hail-2 / AMSAT Phase 4-A / Qatar-OSCAR 100

What's so special about QO-100

The first geostationary amateur radio transponder (P4-A) on Es'hail-2 is a joint project by the Qatar Satellite Company (Es'hailSat), the Qatar Amateur Radio Society (QARS) and AMSAT Deutschland (AMSAT-DL).

- In truth it is an amateur radio system installed on a commercial satellite.
- Just like SKY TV, QO-100 is geostationary **NO NEED TO TRACK – FIXED ANTENNAS☺**
- It has a 500kHz Transponder with several Beacons and is effectively an extra ham band the size of 15m !!
- CW, DATA and SSB can all be used (FM is NOT permitted as it would waste satellite power).
- There is also an Amateur Digital TV wideband transponder – but that's another subject!



QO-100 footprint

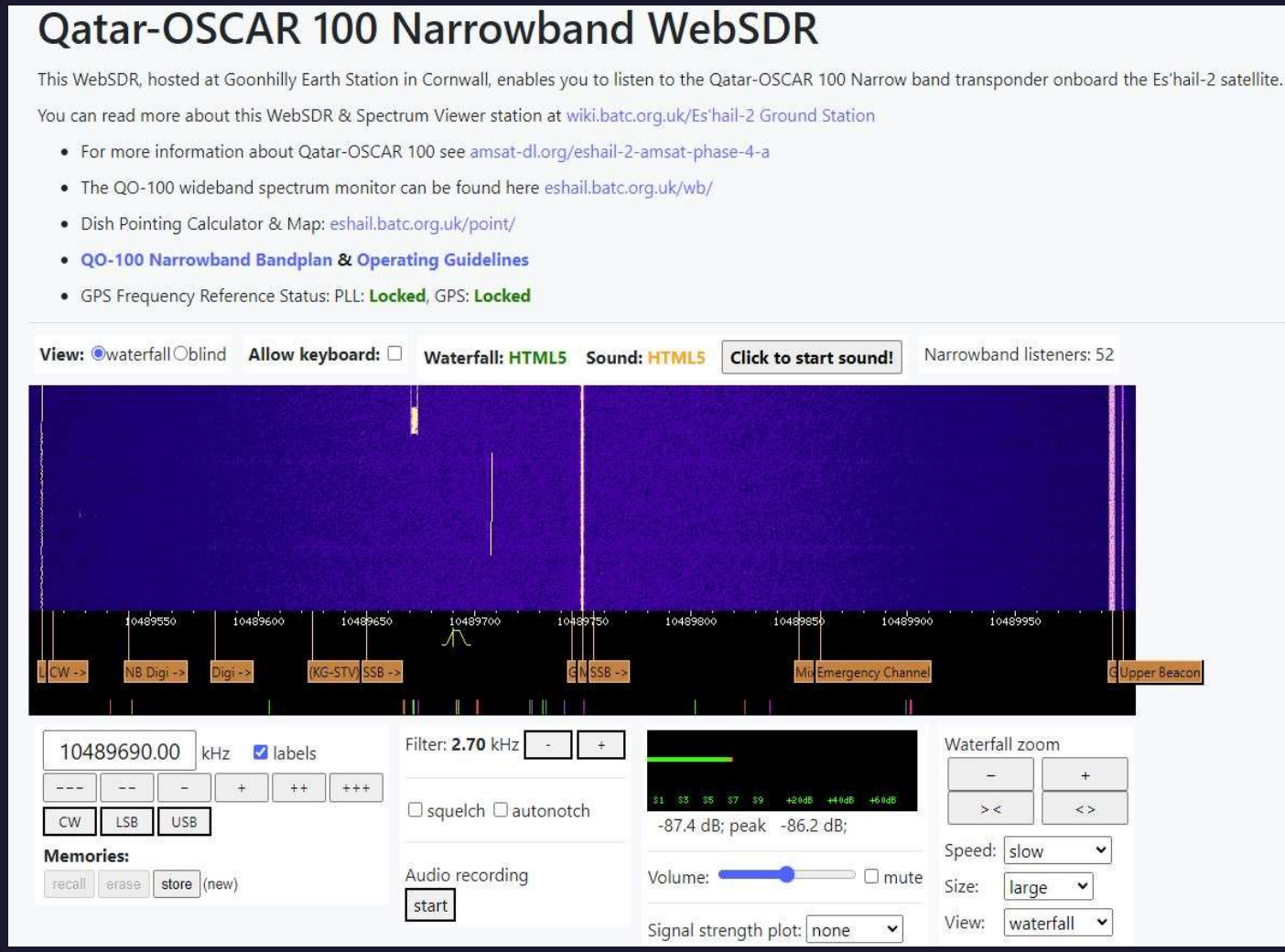
Where can I Expect to Work

- From geostationary orbit 1/3 of the earths surface can be seen.
- From 25.9 East over Africa this is from pole to pole and Brazil to Indonesia.
- Commercial “footprints” normally only extend to where the satellite is 5deg above the horizon.
- Amateurs push that boundary to 0deg and even beyond to negative horizons where there is often huge QSB – and difficulties but hey, that’s what we love.
- Potentially there are around 197 DXCCs “visible” from the satellite. To date I have worked 146 of them.

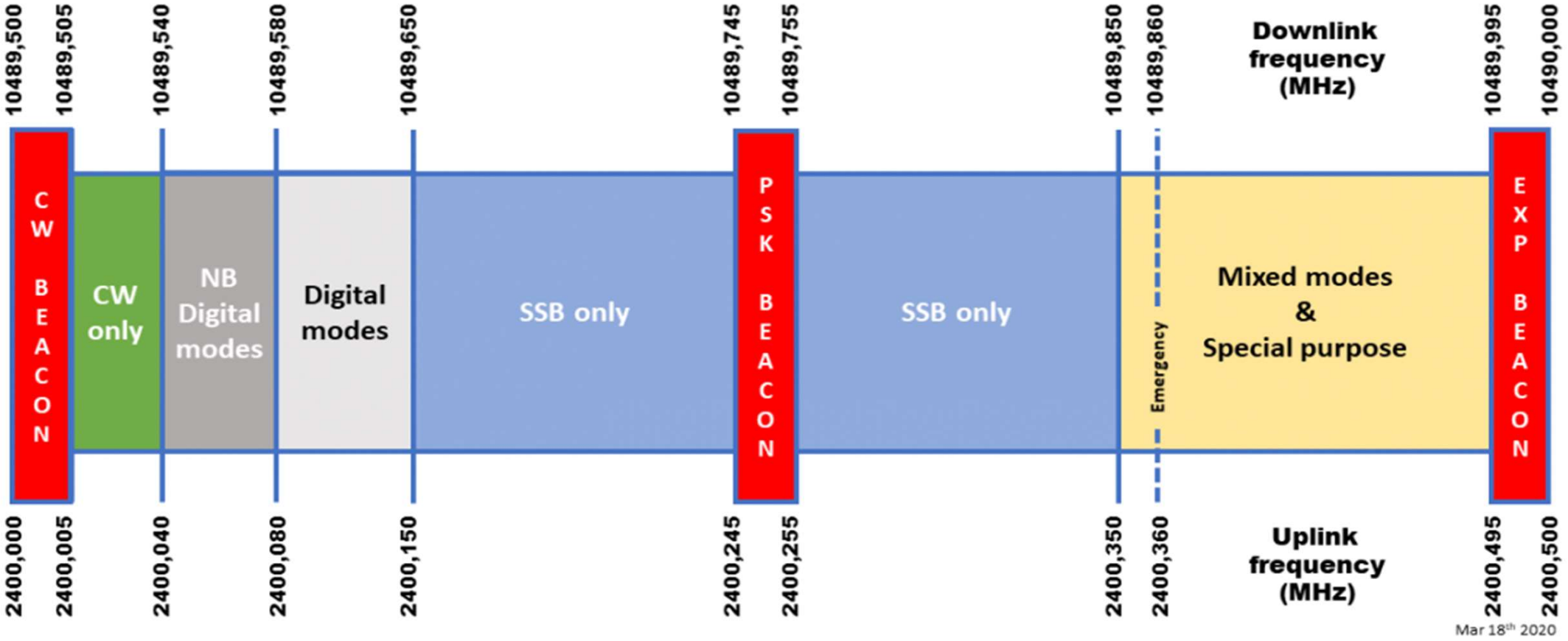
Getting Started

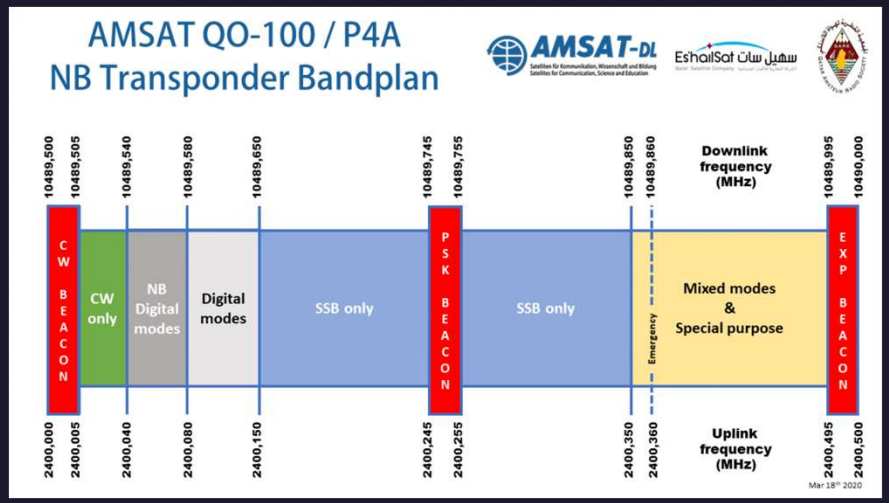
What do I need to just take a listen?

- The QO-100 “narrow band mode” Transponder transmits on 3cm 10489.500MHz to 10490MHz (3cm).
- That’s a similar to satellite TV and you could modify an old Sky dish and LNB and use an SDR “dongle” and SDR Console on your PC.
- But for a no-cost start - use Goonhilly!! https://eshail.batc.org.uk/nb/
- You will be able tune around and listen to both CW and SSB. There is also Data (FT4/8) and even SSTV.



AMSAT QO-100 / P4A
NB Transponder Bandplan

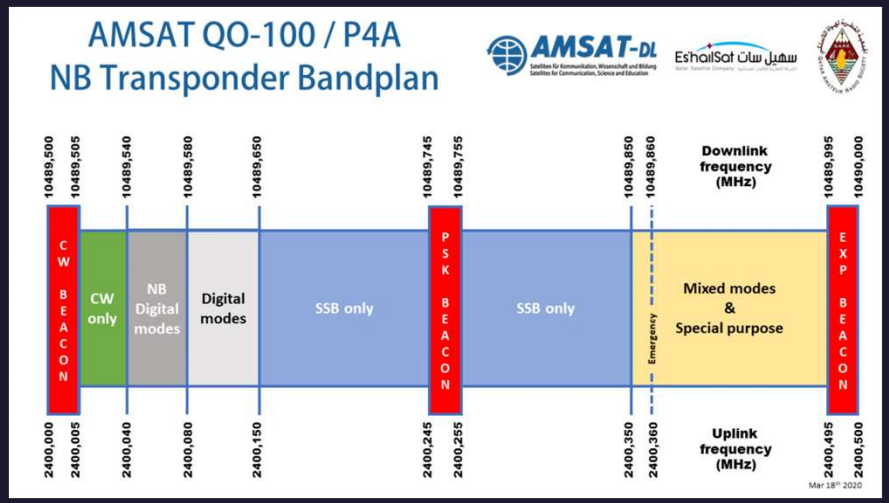




Getting Started

Getting Started – Your station requirements

- You will need to
  - receive on 10489.500MHz to 10490MHz (3cm)
  - transmit on 2400MHz to 2400.500MHz (13cm).
- You will need an antenna for both the above
  - this is usually a “SKY TV” 80cm dish with
  - a modified satellite LNB for receive and
  - a 13cm helical or patch “POTY” antenna for transmit.
- There are many options for the shack
  - some “digital techy” QO-100 operators use an Adalm Pluto SDR kit and SDR Console for completely SDR TX /RX system
  - many use a conventional TX and SDR for receive
  - many already have a VHF/UHF multimode transceiver so they start there **(we will focus on this).**

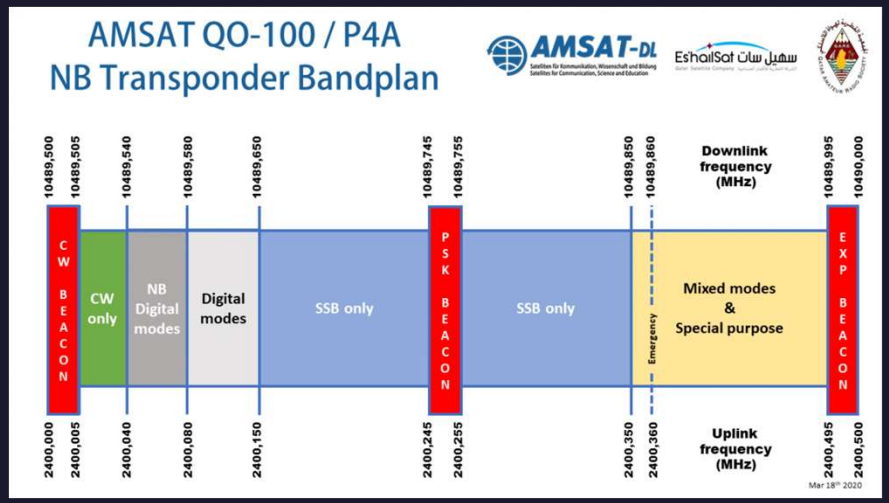


Getting Started

** an almost essential extra is a GPSDO to stabilise the LNB and any other sources of TX/RX drift

Getting Started –a simple setup

- 80cm Dish with modified LNB and POTY or helix TX antenna
- Any CW/SSB rig for 144MHz or 432MHz
- A receive converter to convert the LNB output (around 1GHz) down to 144 or 432MHz eg DXPatrol
- A 13cm transmit converter to convert your 144 or 432MHz TX output up to 2400MHz (about 2w output) eg SG Labs
- You don't need /cannot use high power in fact "Leila" will jam you if you try. **LEILA??**
- All stations through the transponder are limited to a maximum strength. This is both good news and bad news in a pileup – but you can't blame it on the other blokes big illegal Linear or huge antenna☺



Getting Started

** an almost essential extra is a GPSDO to stabilise the LNB and any other sources of TX/RX drift

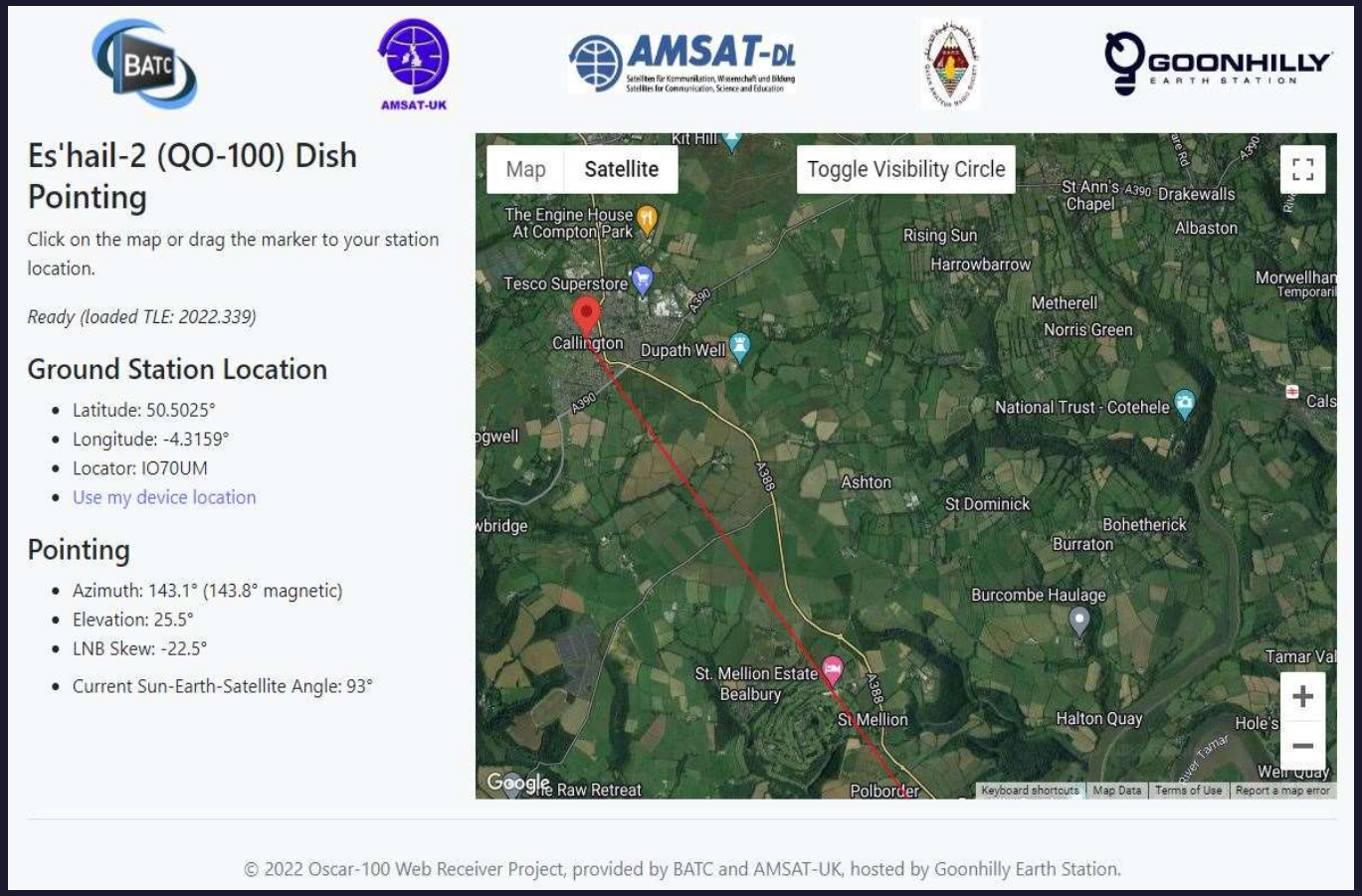
Getting Started –a full duplex setup

- WITH A FULL DUPLEX SETUP YOU CAN TRANSMIT AND RECEIVE AT THE SAME TIME TO
  - monitor your own signal
  - find the gaps in the pileups
  - generally have more fun.
- 80 -120cm Dish with modified LNB and POTY or helix TX antenna
- A multimode rig for 144MHz and 432MHz **with satellite (full duplex capability)**
- A receive converter to convert the LNB output (around 1GHz) down to 432MHz
- A 13cm transmit converter to convert your 144MHz TX output up to 2400MHz
- Oh, and a 13cm 10w PA for a little bit extra☺

Commercial Options

Getting Started

OK so where is the satellite?



OK so where's the satellite?

- Goonhilly and BATC to the rescue https://eshail.batc.org.uk/point/
- Callington Az 143.8deg El 25.5deg
  Also gives LNB skew – the amount by which you need to rotate your RX LNB away from vertical
- Using a smartphone app such as Theodolite (iPhone) Dioptra (Android) or just a compass and protractor point your dish in roughly the right direction.
- listen for the centre beacon on 10489.750MHz and peak the dish for best signal.
- **You are ready to go!**

See you on QO-100

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Let's have a go now!

Peter G8BCG

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www.g8bcg.org.uk