This will be a VERY introductory look at amateur radio satellite communication. The skeleton of this presentation was taken from a presentation I found online, originally given by David Bowman, Golf Zero Mike Romeo Foxtrot
Here is a bit of a rundown on what I would like to talk about tonight

- Satellite types – Transponder Repeaters and Data
- Orbits - Where is it and who can I talk to?
- What do I need? - Radios and antennas
- Active satellites / A typical QSO / awards + challenges
We’ll start with a little bit of AMSAT history.

AMSAT got its start in 1962, just 4 years after the first satellite, SPUTNIK 1 was launched. Over the past 60 years, over 60 OSCARs (orbiting satellite carrying amateur radio) have been launched. Currently there are 18 active OSCARs.
AO(AMSAT OSCAR)-1 was the first AMSAT launched, and was powered by batteries and transmitted a 140mW beacon on 2m for 22 days. This first OSCAR was launched ~4 years after the world's first satellite (SPUTNIK 1) 570 hams shared their observations back to OSCAR. AO-1 had to be built to a specific size and weight to be inserted in the payload to replace a counter-balance weight.
AO-7 was a typical size of satellite launched between 1970 and the early 1990s, it still works in daylight today.

Interesting history behind this bird.
In the early 80s, the battery system died and became non-operational, and in 2002, one of the shorted batteries became open circuit, so the bird now works when it is not in eclipse and is powered by the onboard solar panel.
AO-40 was the largest ever produced and provided near world wide coverage when the satellite was at apogee, nearly 25,000 miles. It was equipped with many transponders from 145 MHz to 24GHz. It even carried a laser communications experiment.
Here we see the newer generation of OSCAR...the sat cubes. AO73 is 1U satellite is a 10cm (4 in) cube with a mass of ~3lb compared to the Ukube which is a 3U...10x10x30 (4x4x12)
And something a little different…ARISS…amateur radio on the International Space Station. ARISS consists of a newly operational FM crossband repeater, a 2m SSTV transmitter and an APRS digipeater.
This type of OSCAR is what I am most familiar with. These birds work very similar to what we are all used to...the local FM repeater. Unlike a standard 2m or 440 repeater with a 0.6 mHz or 5 mHz offset, these repeaters work across 2m and 440. Some of you may be familiar with this cross band repeat around your house, using your HT to operate through your base station...this is exactly the same. The repeater may function in U/V or V/U.
Here is the repeater aboard the ISS. You transmit on the 2m frequency 145.990 to the repeater, and your radio will receive on the 70cm frequency 437.800. Most of the OSCARs require a CTCSS tone to open the repeater, and most of them use the 67 Hz tone. They don’t tone squelch, so you don’t have to set a tone on receive.
Doppler shift causes the frequency of the signals to change due to the relative motion (speed) between the operator on the ground and the orbiting satellite. The effect is at a maximum with an overhead pass. (satellite travelling ‘directly’ towards you as it appears over the horizon) Acquisition of signal - AOS

As the satellite approaches, a signal from it transmitted on 436.800 will appear to the operator 9kHz high on 436.809. When overhead or at time of closest approach, it will appear on 436.800.

As the satellite moves away over the horizon at the end of the pass it will appear 9 kHz low on 436.791 MHz

Doppler depends on relative speed and wavelength of the signal.
Linear transponders will convert a signal from one band to another and uses narrow band modes, typically SSB or CW. These narrow band formats allow multiple QSOs at one time.
Orbits. Where is the satellite and who can I talk to?

- The higher the orbit the larger the communication 'footprint'
- Any stations who are within the satellite footprint can work each other. e.g. Florida, Maine, Texas
- Low orbit = shorter pass time e.g. ISS at 250 miles is 10 minutes
- Many software tracking packages for PC and android devices or online applications
Orbits: AO-27 @ 500 miles
Orbits: AO-40 @ 31,000 miles (non operational)
Orbits: Tracking software

**AmsatDroid.** Free download for android devices. World map + sky view for pointing antennas

**Heavens-Above** Free download for android

**ISS Detector** Free download for android

**Satellite Tracker** Free download for iOS

**Ham Radio Deluxe.** Rig control, doppler shift, etc

**Online:** N2YO.com Uses your location and google maps for display, or pass predictions

amsat.org predictions based on grid
Radios and Antennas

Duplex – transmitting and receiving at the same time. - Is a real advantage
Duplex radios are available but 2 separate radios will work as well.
Handhelds 3 – 5W. Base stations 10 – 50W. Any radio with 2 or 70 can work.
Radios and Antennas
Working satellites in Low Earth Orbit do not require complex antennas, but small beams will perform better than omnis, especially for transmitting.

This is a homebrew tape measure yagi, constructed for under $10 (all I had to purchase for the project was the PVC fittings KB9VBR Tape Measure Yagi)

This is a generic dual band 2m/440 yagi that has really improved my receive on 70cm
Radios and antennas

DD1US: Az/Elevation rotators with 2m / 70cm circular polarised yagis and 4 x helix for 23cm

Antennas at G0MRF
4 elements on 2m + 9 element Tonna on 70cm.
Rotate in azimuth but fixed at 30 degrees elevation.
### Active satellites for voice communication

(amsat.org/status for latest)

<table>
<thead>
<tr>
<th></th>
<th>FM repeater – up and down frequencies</th>
<th>Requirements</th>
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</thead>
<tbody>
<tr>
<td><strong>SO-50</strong></td>
<td>2m (145.850) up and 70cm (436.800) down</td>
<td>74.4 Hz tone to wake, 67.0 Hz to operate</td>
</tr>
<tr>
<td><strong>AO-91</strong></td>
<td>70cm (435.250) up and 2m (145.960) down</td>
<td>67.0 Hz tone to operate</td>
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<td><strong>AO-92</strong></td>
<td>70cm (435.350) up and 2m (145.880) down</td>
<td>67.0 Hz tone to operate</td>
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<tr>
<td><strong>AO-27</strong></td>
<td>2m (145.8500) up and 70cm (436.795) down</td>
<td>67.0 Hz tone to operate</td>
</tr>
<tr>
<td><strong>ISS</strong></td>
<td>2m (145.990) up and 70cm (437.800) down</td>
<td>67.0 Hz tone to operate</td>
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Making a satellite QSO

- Typical QSO: Usually short, as passes are 10-15 minutes. Longer on linear transponders
- CQ call: CQ satellite / CQ SO-50
- Answer: K9UO, N4JAH EM83
- Exchange: Signal Report and usually maidenhead locator. e.g. 59 EM83
- Power: Use minimum to complete contact. Lower power when short range
- Be prepared. – Know the satellite’s track across the sky and frequencies in advance.
- Estimate Doppler correction and set the initial TX and RX frequencies.
- Wait until you hear the beacon or transponder before you transmit
- When you find your signal, if clear call CQ or retune to find clear frequency or call someone
- As you are making the QSO, keep tuning the transmitter to keep the RX frequency constant

https://www.amsat.org/introduction-to-working-amateur-satellites/
Challenges and Rewards

- Making your first satellite QSO is always big challenge
- There is DX to be made on satellites.
- Awards are issued by AMSAT / Satellite teams and National organisations
Much like this dog, I had the equipment, I was heading in the right direction but I had no idea what I was doing...but I knew I was happy about it.
Much to my neighbors bewilderment, I stood out in the front yard with a phone, an HT and a chopped up tape measure, pointing it at an empty sky.

I heard a bunch of beeps so I hit record on the HT. The beeps disappeared, I stopped the recording and popped the SD card in the computer.
SSTV
Several OSCARs carry APRS digipeaters

In the US, APRS is 144.390, for OSCAR 145.825
APRS
ISS 02 Oct – Listen for K9UO
Much like this dog, I had the equipment, I was heading in the right direction but I had no idea what I was doing...but I knew I was happy about it.
VOICE CONTACT
THE REWARD?!?

ARIS SSTV Award
By W6EEI

[Image of SSTV Award document]

[Text about ARIS SSTV Award]

[Image of SSTV Award document]

[Text about ARIS SSTV Award]
THANK YOU