Amateur Satellites-101

Joe Maguire (WA1ZZQ)

Disclaimer

I’m pretty new to this satellite stuff too! The following brief is based on what I have learned and experienced over the past year or so…

-Joe

Agenda

- Overview
- Satellite Basics
- Resources
- “Birds” (Satellites)
- Modes
- Equipment
- Location Considerations
- Getting on the Air
- Basic Digital Ops with ISS

Overview

- Satellite ops are a “niche” activity like DX-positions and SSTV
- Very challenging and fun!
- Completely dependent on the satellite schedules
- Windows of opportunity for satellites in Low-Earth Orbit (LEO) is less than 10 minutes
  - Virtually all Amateur satellites are in LEO
- You can get started with a modest investment
  - Good News: Much of the equipment you probably already own!

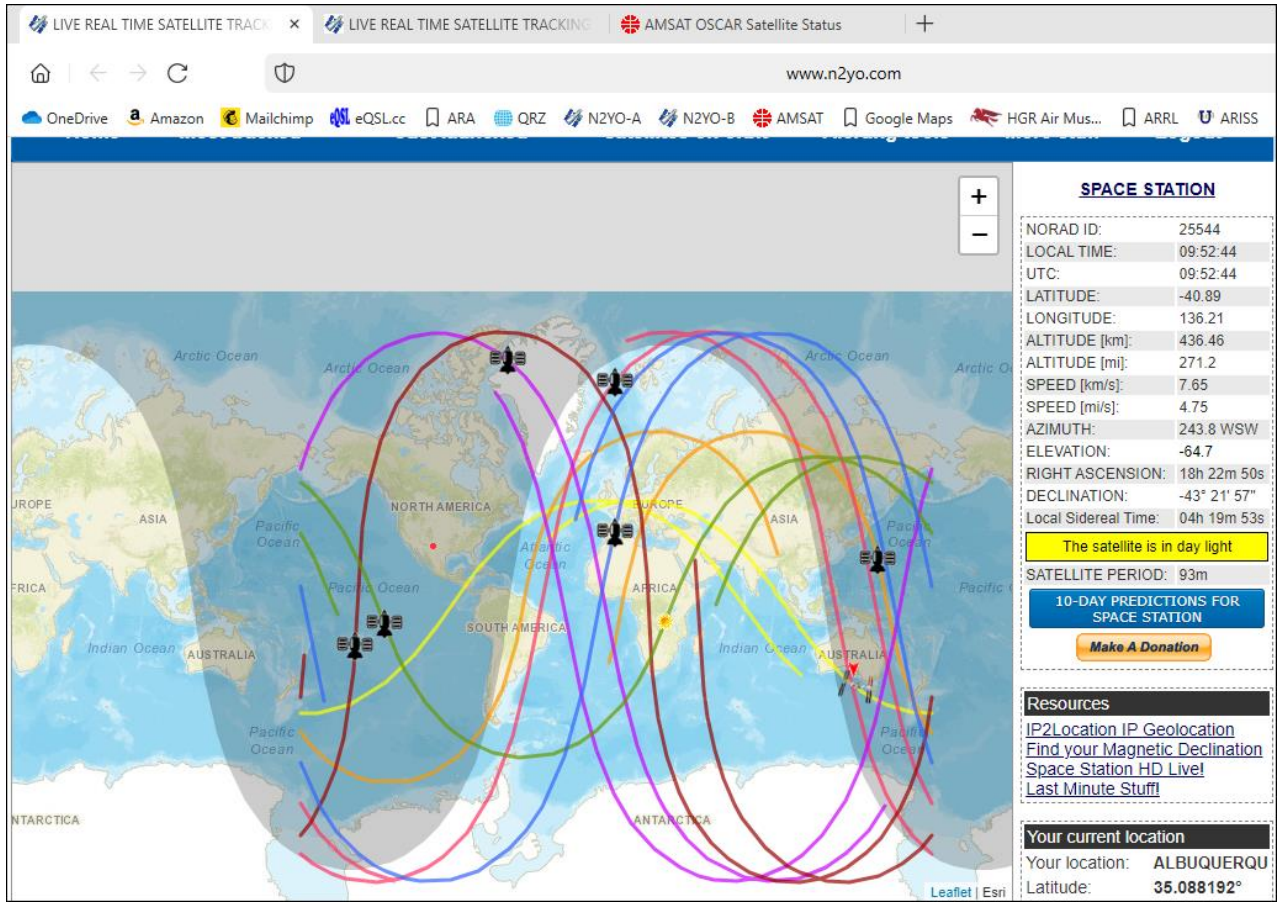
Satellite Basics

- Orbits
  - LEO: Low-Earth Orbit
  - MEO: Medium Earth Orbit
  - Geosynchronous Orbit (GSO) & Geostationary Orbit (GEO)
  - Polar, Sun-Synchronous (SSO) & Highly Elliptical Orbit (HEO)
- Modes
  - SSB, CW, FM, BPSK
- Output Power of Satellite
  - Except for ISS (up to 25 watts), most AMSATs power output is a fraction of a watt
- Uplink/Downlink always on different bands for voice
  - Sometimes the same frequency for digital
  - Satellite Transponders
    - https://www.onallbands.com/satellite-basics-part-3-upgrading-to-the-linear-satellites/
- Satellites Identifiers
  - Name, Abbreviation, NORAD ID (Best!)
- Satellite “Cube”
  - “1U” = $10cm^3$ (4” cube)
- Effects of Doppler Effect on frequency is significant
  - Requires CAT control or multiple frequencies loaded in memory
- Satellites work best with **Circularly Polarized** antennas
  - Typical Yagi antennas are linearly polarized

Resources

- Web-Sites
  - N2YO (https://www.n2yo.com/?s=25544)
    - Best satellite web-site ever!
    - 10 day look-ahead for satellite tracking based on your position
  - AMSAT.org (http://www.AMSAT.org)
    - Ham Satellite organization and good clearing house for satellite status
  - ARISS.net
    - Digital communications data with ISS presented on the Web
    - Provides another source to confirm an ISS contact
  - YouTube: Lots of videos on the subject
- Apps
  - GoSatWatch
    - Satellite schedules based on your position
  - SkyView
    - View satellites & planets on your smartphone by pointing in their direction
- Software
  - UISS (https://www.qsl.net/on6mu/uissdownload.htm)
    - International Space Station specific software for digital ops
    - Easy Term, Sound Modem
  - GreenCube Terminal and TNC
    - MEO satellite. Has not been active lately

N2YO.com



10-DAY PREDICTIONS

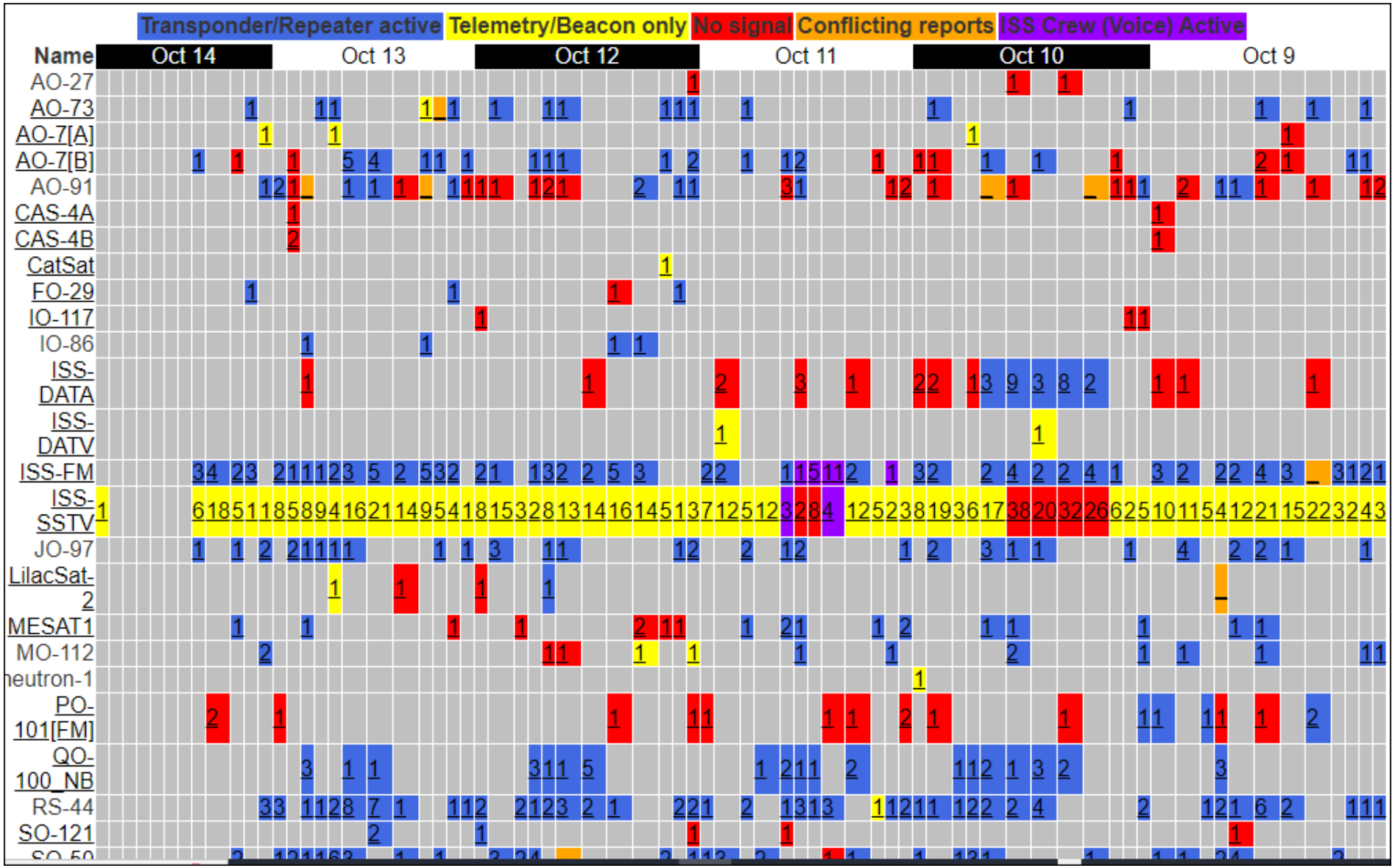
Object name	**SPACE STATION** Live tracking | More info
Catalog #	25544, 1998-067A
Observing location	172.58.241.44
Observing coord.	Lat: 39.29°, Lng: -76.61° Change
Local time zone	GMT -4

Uplink (MHz): 437.550
Downlink (MHz): 437.550
Beacon (MHz):
Mode: 1200bps AFSK
Call sign: RS0ISS
Status: Inactive

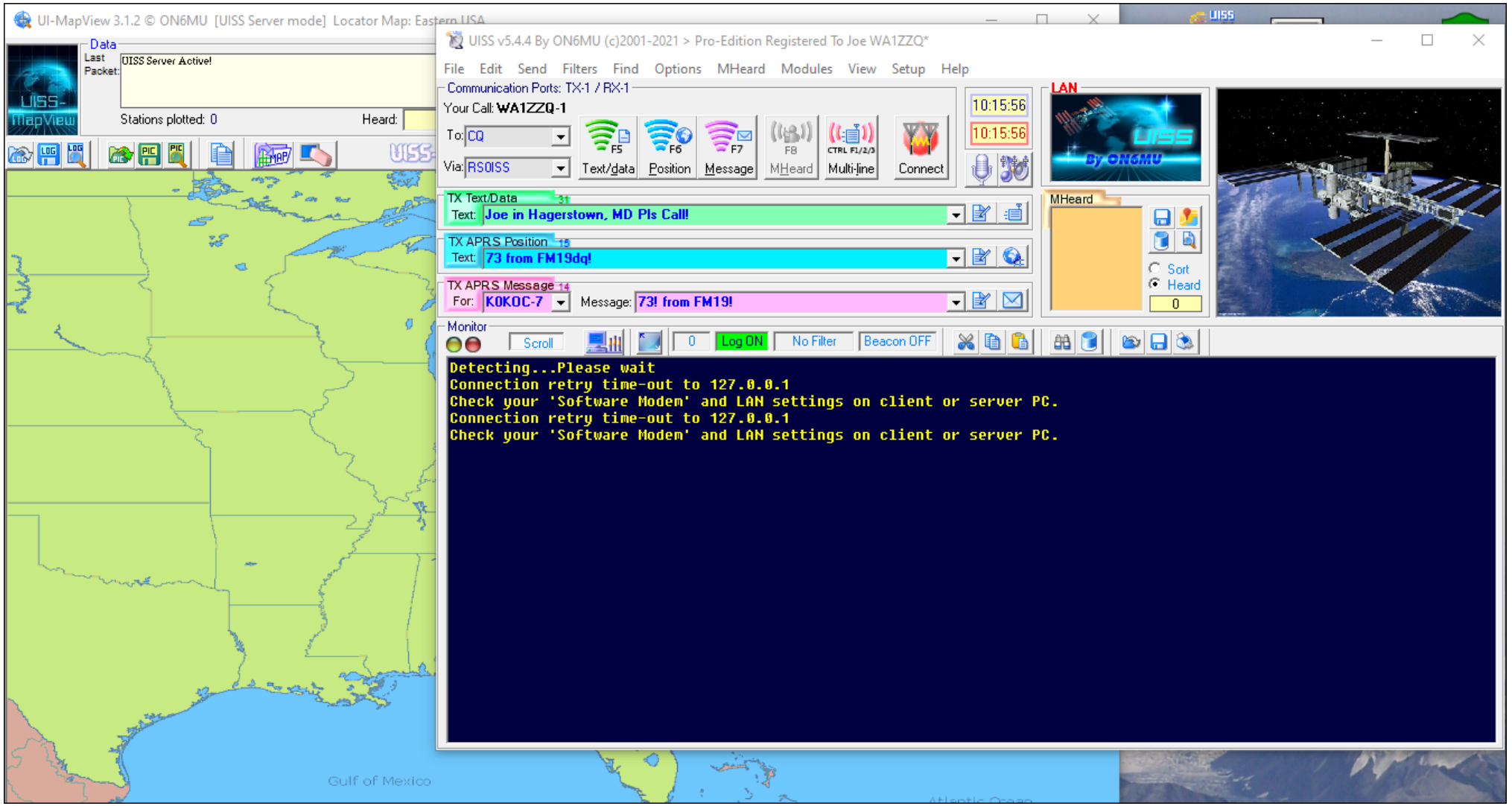
Visible passes | AM/PM time | UTC | Print as PDF

Start		Max altitude			End		All passes	
Date, Local time	Az	Local time	Az	El	Local time	Az	Mag	Info
15-Oct 07:18	SW 229°	**07:24**	**ESE 111°**	**83°**	07:29	NE 53°	-2.4	Map and details
15-Oct 08:56	W 273°	**09:01**	**NNW 337°**	**18°**	09:05	NE 43°	-0.3	Map and details
15-Oct 12:12	NW 316°	**12:16**	**NNE 18°**	**16°**	12:21	E 82°	-0.2	Map and details
15-Oct 13:48	NW 309°	**13:54**	**NE 54°**	**78°**	13:59	SE 126°	-2.4	Map and details
15-Oct 15:26	WNW 285°	**15:30**	**SW 234°**	**10°**	15:34	S 181°	+0.3	Map and details
16-Oct 06:30	SW 216°	**06:35**	**SE 139°**	**44°**	06:40	NE 58°	-1.7	Map and details
16-Oct 08:07	W 262°	**08:12**	**NNW 332°**	**24°**	08:17	NE 44°	-0.7	Map and details
16-Oct 09:46	WNW 300°	**09:50**	**N 355°**	**10°**	09:54	NE 46°	+0.3	Map and details
16-Oct 11:23	NW 316°	**11:28**	**N 14°**	**13°**	11:32	ENE 72°	+0.1	Map and details
16-Oct 13:00	NW 312°	**13:05**	**NE 37°**	**45°**	13:10	ESE 114°	-1.7	Map and details
16-Oct 14:37	WNW 293°	**14:42**	**SW 228°**	**18°**	14:46	S 165°	-0.3	Map and details
17-Oct 05:42	SSW 203°	**05:47**	**SE 132°**	**24°**	05:52	ENE 64°	-0.8	Map and details
17-Oct 07:19	WSW 252°	**07:24**	**NNW 332°**	**35°**	07:29	NE 46°	-1.3	Map and details
17-Oct 08:57	WNW 291°	**09:01**	**N 349°**	**12°**	09:05	NE 44°	+0.2	Map and details

AMSAT Status Page



UISS


UI-MapView 3.1.2 © ON6MU [UISS Server mode] Locator Map: Eastern USA
Data
Last Packet:
UISS Server Active!
Stations plotted: 0
Heard:
UISS v5.4.4 By ON6MU (c)2001-2021 > Pro-Edition Registered To Joe WA1ZZQ*
File Edit Send Filters Find Options MHeard Modules View Setup Help
Communication Ports: TX-1 / RX-1
Your Call: WA1ZZQ-1
To: CQ
Via: RS0ISS
F5 Text/data
F6 Position
F7 Message
F8 MHeard
CTRL F1/2/3 Multi-line
Connect
10:15:56
10:15:56
LAN
UISS By ON6MU
MHeard
Sort
Heard
0
TX Text/Data
Text: Joe in Hagerstown, MD Pls Call!
TX APRS Position
Text: 73 from FM19dq!
TX APRS Message
For: K0KOC-7
Message: 73! from FM19!
Monitor
Scroll
0
Log ON
No Filter
Beacon OFF
Detecting...Please wait
Connection retry time-out to 127.0.0.1
Check your 'Software Modem' and LAN settings on client or server PC.
Connection retry time-out to 127.0.0.1
Check your 'Software Modem' and LAN settings on client or server PC.
Gulf of Mexico

ARISS.net

Amateur Radio Stations heard via ISS

This page documents Amateur Radio data digipeated by the International Space Station. In order to appear on this page, a position report in a valid APRS format must be digipeated through ISS, then be heard by an internet gateway station, which then forwards it on to the APRS Internet System. All APRSIS data is archived on this machine. Packets that came through the ISS are recalled for this display. For more info on the technology involved, see the links at the bottom of the page.

The system will also show those stations that have been heard via ISS but have not sent a position report in the table at the end of the page.

If you are able to transmit through the ISS digi and wish to send a packet that will make your position appear on these maps and those of APRS users of ARISS, see:
http://www.aprs.org/iss-faq.html

The biggest weakness in the system right now is the lack of Internet Gateways, or IGates. Almost all APRS programs have the ability to function as IGates, consult the documentation of your program of choice for details...the more the better!

The current position of ISS, as well as the 5 and 10 minute future positions are also shown on the map.

Regrettabbly, because of the huge cost increase recently implemented by Google for its mapping service, google maps are no longer available.

Amateur “Birds” (Satellites)

- **SPACE STATION:** FM Voice and Data
- **GREENCUBE (IO-117):** MEO, Digital
- **XW-2B:** 9k6/19k2 GMSK/CW
- **FOX-1B (RADFXSAT AO-91):** FM
- **DOSAAF-85 (RS-44):** SSB, CW
- **SAUDISAT 1C:** FM Voice
- **JY1SAT (JO-97):** 1200bps BPSK SSB CW
- **DIWATA 2B (PO-101):** FM, CW
- **HADES-D:** 50/300/1k2-9k6 FSK FM CW
- **FUNCUBE 1 (AO-73):** 1200*bps BPSK SSB
- **OSCAR 7:** Launched in the 70’s – Still works! SSB, CW

Modes

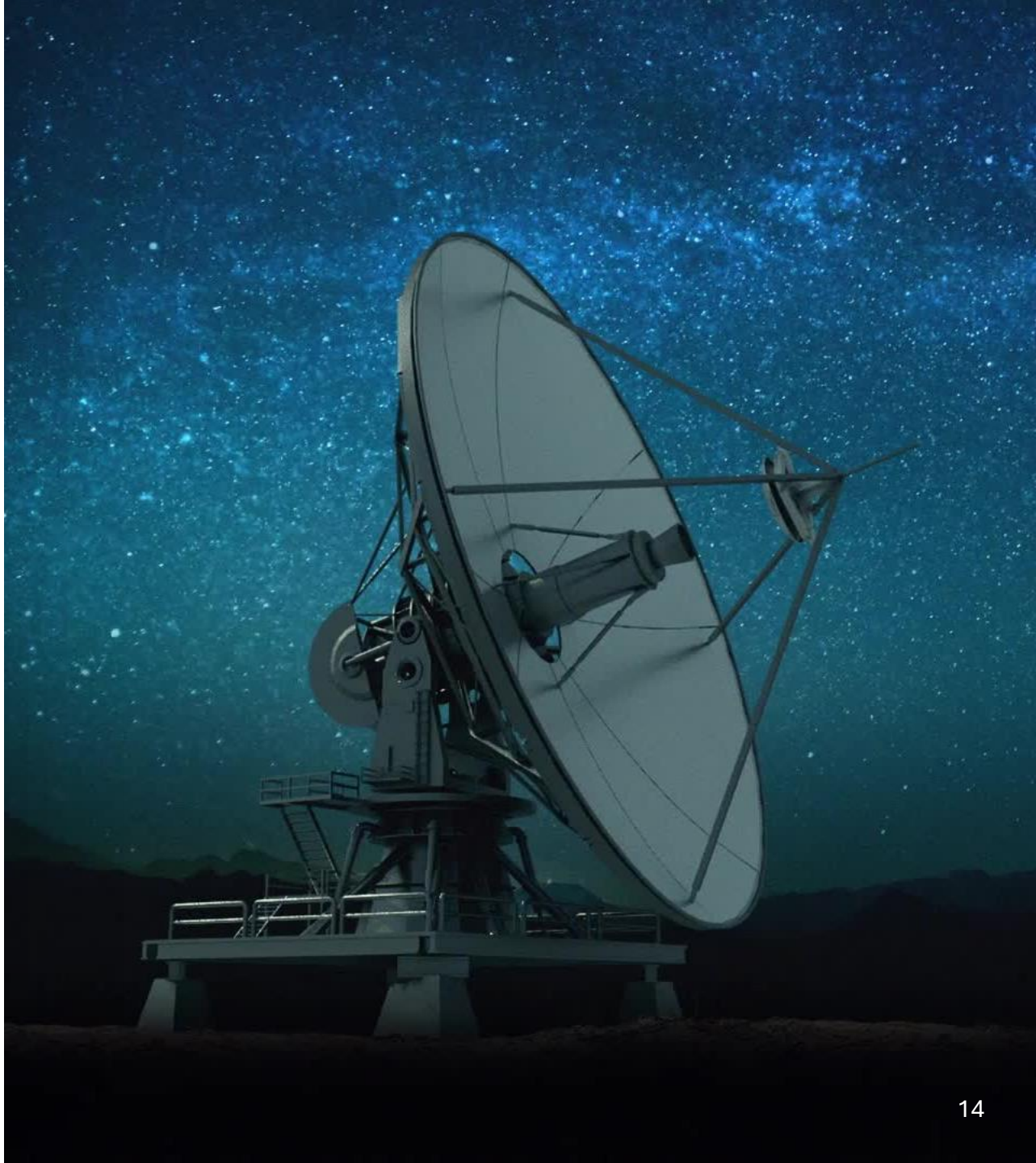
MODE	PRO	CON
Voice (FM)	• Minimal equipment • Relatively easy to monitor	• Very busy! • Tough to get a QSO
Voice (SSB)	• Easy to hear conversations	• Requires a multi-mode rig • Effects of Doppler very pronounced
Digital	• Highest probability of successful QSO • More “forgiving” than voice • Provides a written record of QSO’s	• Additional modem (SignaLink) or modern rig required
CW	• Very effective transmissions	• Effects of Doppler very pronounced • Not many participants

Equipment

- Rigs
  - FM V/UHF for International Space Station (ISS)
  - Modern multi-mode rigs with CAT control (FT-991A)
- Antennas
  - Simple 3 element VHF/ 5 Element UHF to get started (~$100 on Amazon)
    - Lot of on-line plans to build you own
  - Arrow
    - More expensive but much better antenna (~$200 with duplexer)
      - Less expensive options available
  - Circularly Polarized Antenna ($$$)
- Software
  - CAT control software
    - Ham Radio Deluxe (HRD)
  - Digital Interfaces
    - HRD ($$$)
    - UISS (Free! More features with a donation)
  - Antenna Control
    - HRD
    - Home-Brew software

Location Considerations

- Clear view of the sky is essential
- Obstructions are usually problematic at lower antenna elevations
- Satellite QSO’s at higher antenna elevations (45 degrees or higher) are easier but don’t offer the best DX
- Lower antenna elevations (below 30 degrees) are better for DX
    - Satellite “on the horizon”



Getting On The Air

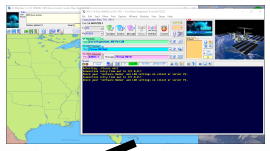
- **Listening to the ISS**
  - Simple hand-held
    - Hold it over your head with antenna parallel to the ISS
    - Shift frequencies based on satellite position (Doppler)
      - See “Chirp” slide

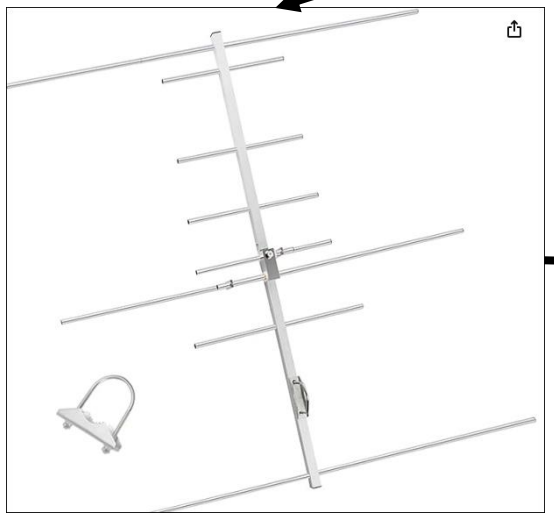
- **Operating with ISS**
  - Hand-held with a 3/5 element V/UHF antenna
    - Cheap antenna from Amazon
    - Arrow Antennas (https://www.arrowantennas.com/index.html)
    - Physically “Twist” antenna to compensate for linear polarization
  - Handheld? (Maybe!)
  - V/UHF mobile or Base station (20+ watts)? (Sure!)
  - CAT capability helps but preset frequencies can work
  - FM Voice is a “Food-Fight”
    - Good technique is to record the event audio on smart-phone for later analysis
  - Digital is a less of a food-fight and has built-in documentation

Getting On The Air

- **Robust Capability**
  - Rig with CAT, multi-modes, 50+ watts (Yaesu FT-991A)
  - Controlling software for Doppler and Antenna Position
    - Ham Radio Deluxe
    - Home-Brew Satellite Tracking Software
  - Directional Antennas with Tracking mechanism
    - Circularly Polarized Antennas
    - Equipment is commercially available but $$$

Basic Digital Ops with ISS





- Use UISS software
  - Use “RS0ISS” call-sign
- Break squelch
- Focus on Satellite apex
  - You’ll only have a minute or two to make a contact
  - 436.8 MHz
    - No Doppler correction
- Slowly move and “Twist” antenna for best signal
- Send “CQ” and/or respond to stations that show on map
  - Right-Click functionality in UISS
- Check ARISS.net for confirmation

Chirp Entries

DIGITAL

	Frequency	Name	Tone Mode	Tone	T Sq	DTCS	DTCS Polarity	Cross Mode	Duplex	Offset	Mode	Skip	Power
51	145.830000	ISSDGA							-	0.010000	FM		High
52	145.825000	ISSDGB									FM		High
53	145.820000	ISSDGC							+	0.010000	FM		High

Rising

Apex

Descending

VOICE

	Frequency	Name	Tone Mode	Tone	Tone Squelch	DTCS	RX DTCS	DTCS Polarity	Cross Mode	Duplex	Offset	Mode	Skip	Power	Comment
19	145.995000	ISS-UPA	Tone	67.0								FM		High	
20	145.990000	ISS-UPB	Tone	67.0								FM		High	
21	145.985000	ISS-UPC	Tone	67.0								FM		High	
22	437.810000	ISS-A										FM		High	
23	437.805000	ISS-B										FM		High	
24	437.800000	ISS-C										FM		High	
25	437.795000	ISS-D										FM		High	
26	437.790000	ISS-E										FM		High	

Rising

Apex

Descending

Questions?