
Communicating with the
International Space Station

Agenda

- Amateur Radio Satellites
- International Space Station (ISS) Amateur Radio Capabilities
- Equipment Needed to Communicate with the ISS
- The Process Involved

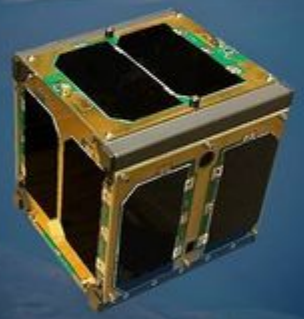
You will be able to communicate with the ISS

Amateur Radio Satellites

The first amateur radio satellite (Oscar 1) was launched in 1961. ***It was built in the basements & garages of the Oscar team!***

Oscar 1 was a secondary payload. It was ejected by a high tech mechanism – a Sears & Roebuck $1.15 spring!

Amateur Radio Satellite Service

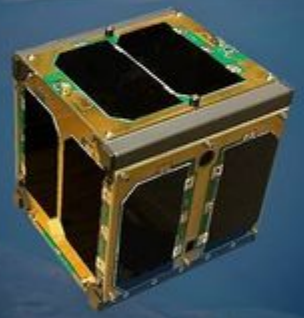


ACTIVE AMATEUR SATELLITES

AO-7	CAS-4A	IO-86	XW-2A
AO-73	CAS-4B	NO-84	XW-2B
AO-91	FS-3	QO-100	XW-2C
AO-92	FO-29	SO-50	XW-2D
			XW-2F

Considerable knowledge has been gained through amateur radio satellites. Currently, there are around 162 active ones in orbit!

Amateur Radio Satellite Service



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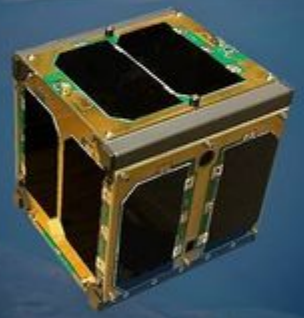
			XW-2F

They tend to be small with limited power sources and run at 1W or less RF Output, typically SSB or CW

Amateur Radio Satellite Service



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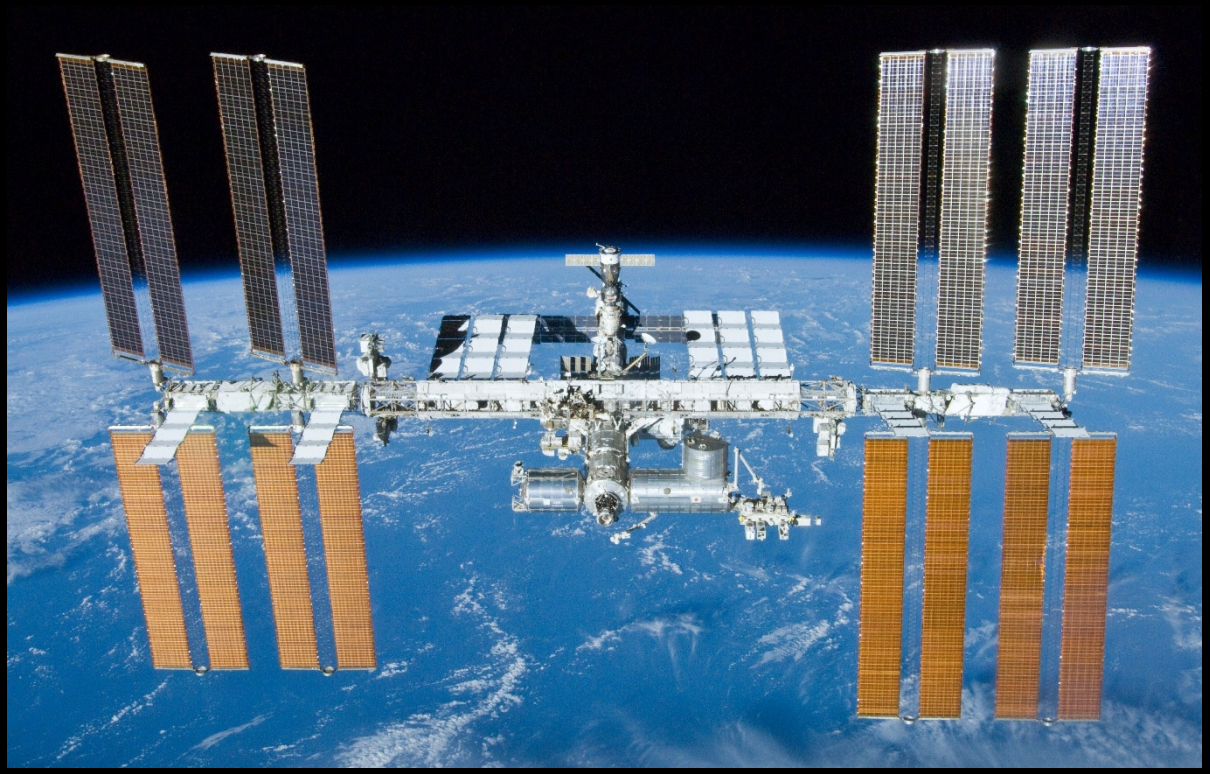
			XW-2F

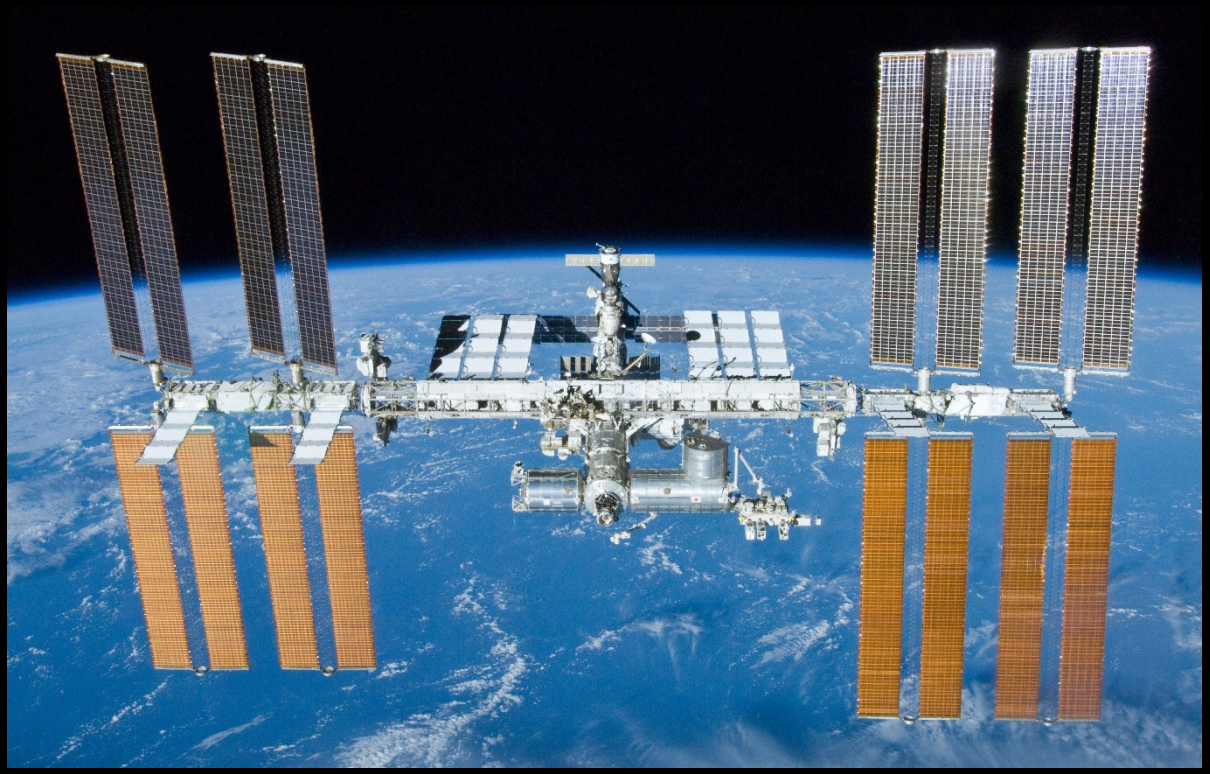
Some modern satellites are FM (easy-sats) and are a great way to get started! However, there are VERY few …… typically only operating at 250 mW.


Now we have the International Space Station!



The ISS is large space station

- It has an **EXCELLENT** power source
- It can house **NORMAL** radio equipment



The ISS has had LIMITED amateur radio capability since 2000, when astronauts were available. *But, there has been a more recent significant development!*

SPACE STATION

CROSS BAND FM REPEATER

HAM RADIO

2M/440 FM

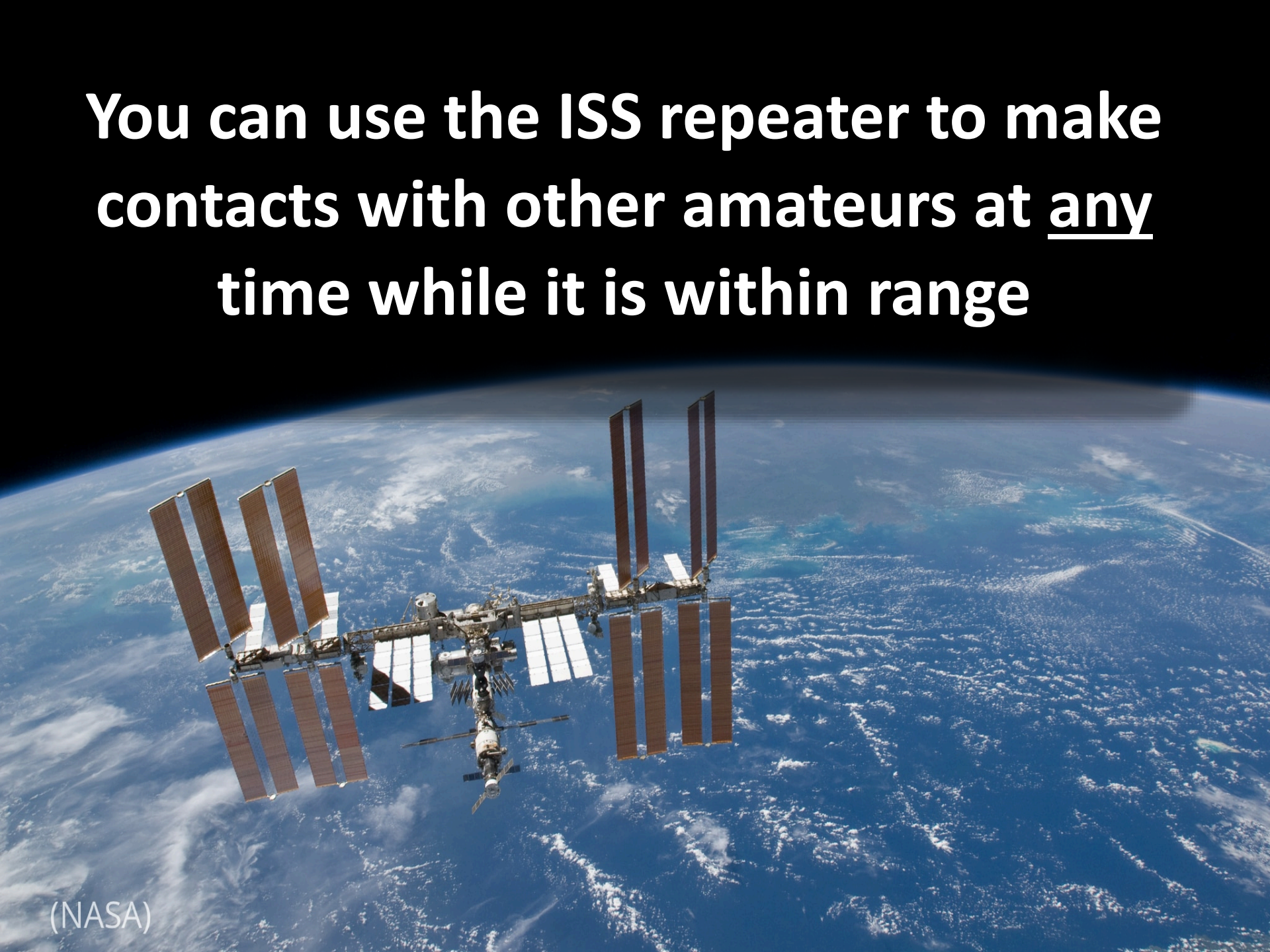
5W – 25W

The **NEW** InterOperable Radio System (IORS), was installed in the International Space Station Columbus module and activated on **September 2, 2020.**

The new ISS Cross-Band Repeater is ON FULL TIME

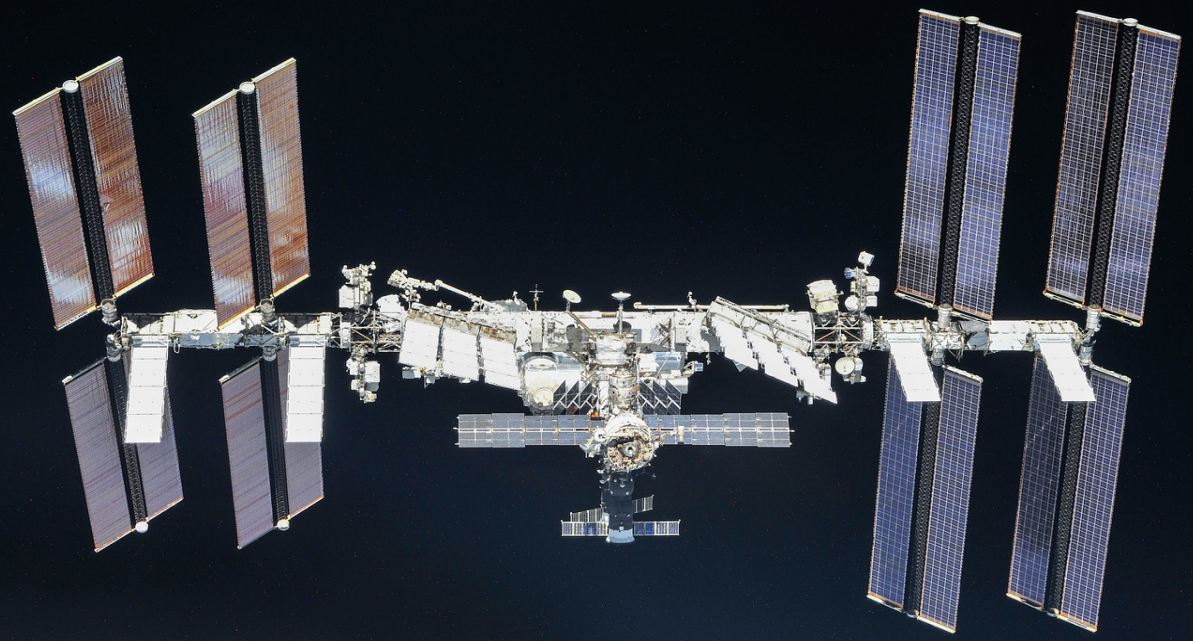
(except during educational contacts, EVAs, and dockings or un-dockings)

You can use the ISS repeater to make contacts with other amateurs at <u>any</u> time while it is within range



(NASA)

Many of you probably already have everything it takes to work the ISS!



You can actually access it with an HT running 5W!

(NASA)

The Amateur Radio Equipment Aboard the ISS

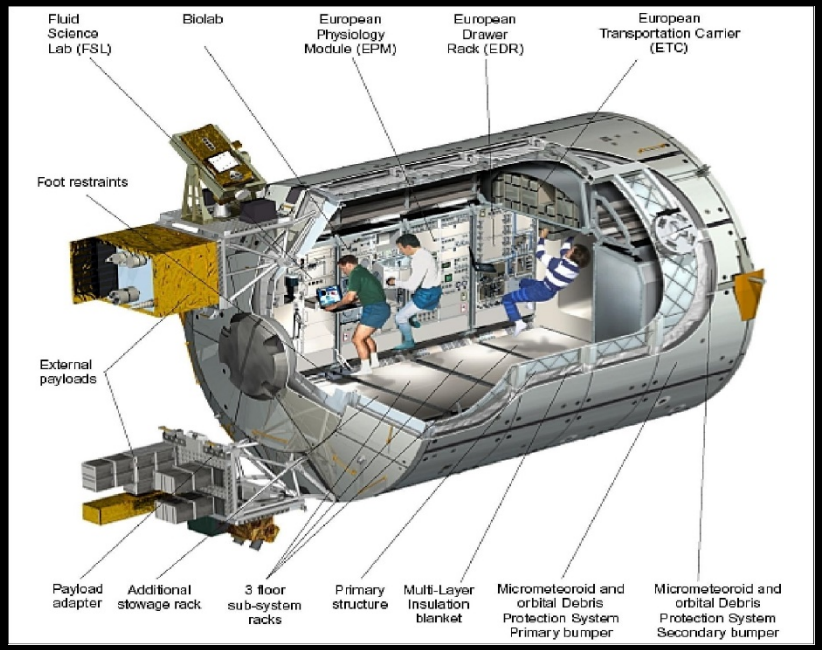
New Interoperable Radio System

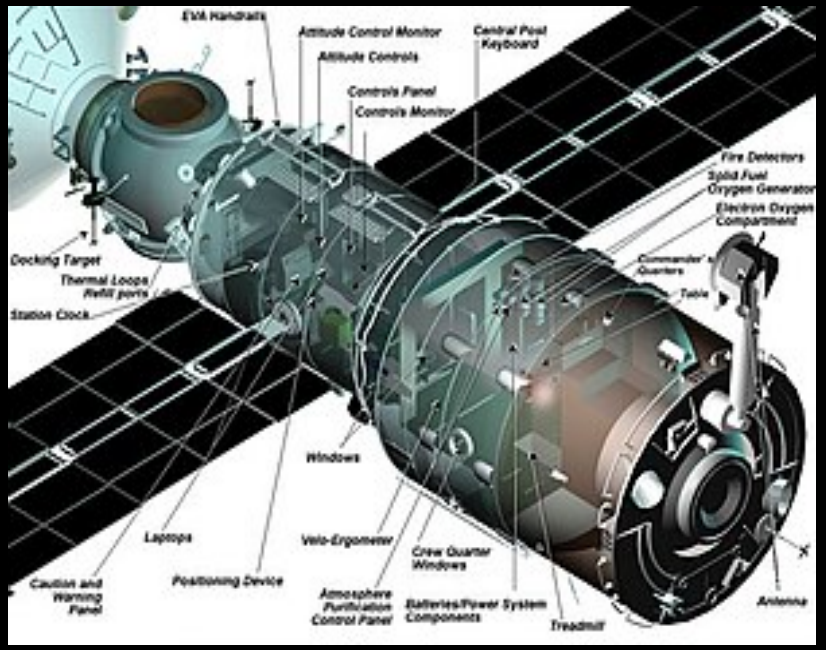
Columbus Module:

- IORS (Kenwood D710GA)
- Default: **Cross Band Repeat**
- 145.990 MHz up (PL 67)
- 437.800 MHz down (5W typical, 25W max)

Service Module:

- IORS (Kenwood D710E)
- Default: **APRS/Packet operations**
- 145.825 MHz up & down (10W)





Columbus Module (USA)

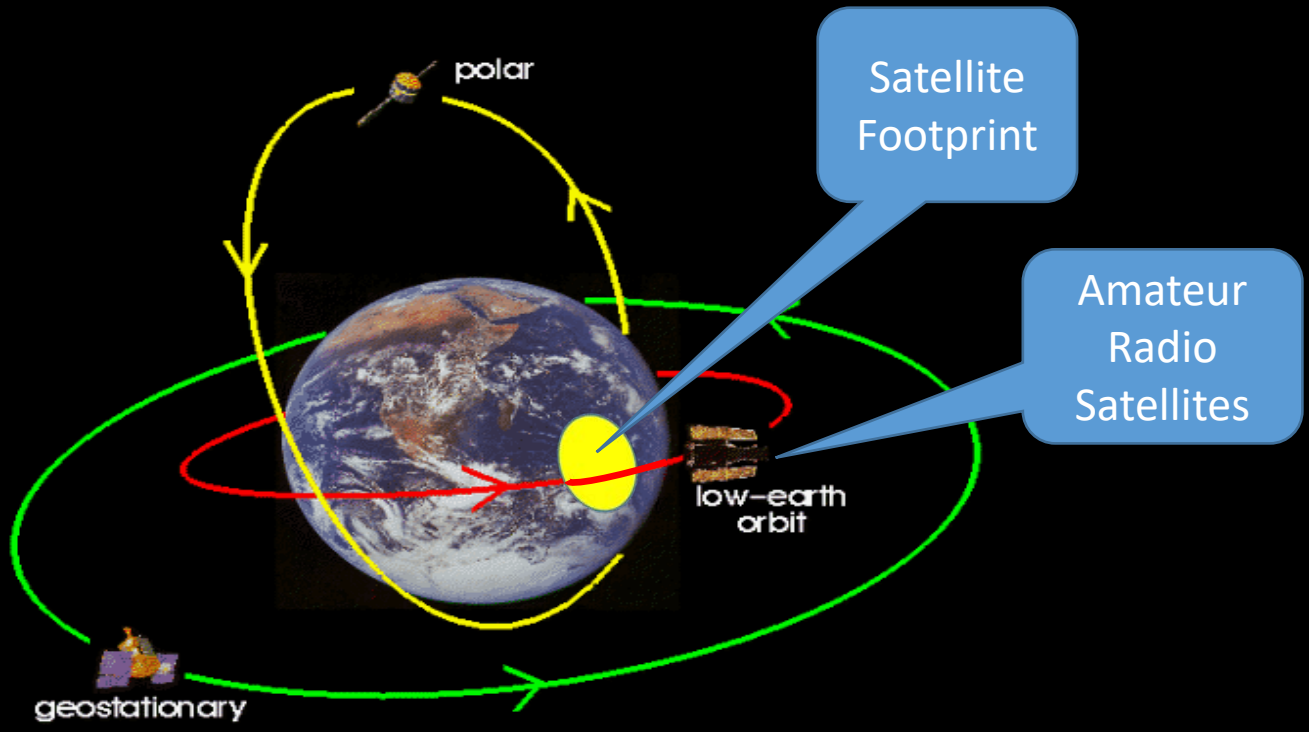
IORS FM Voice

Service Module (Russia)

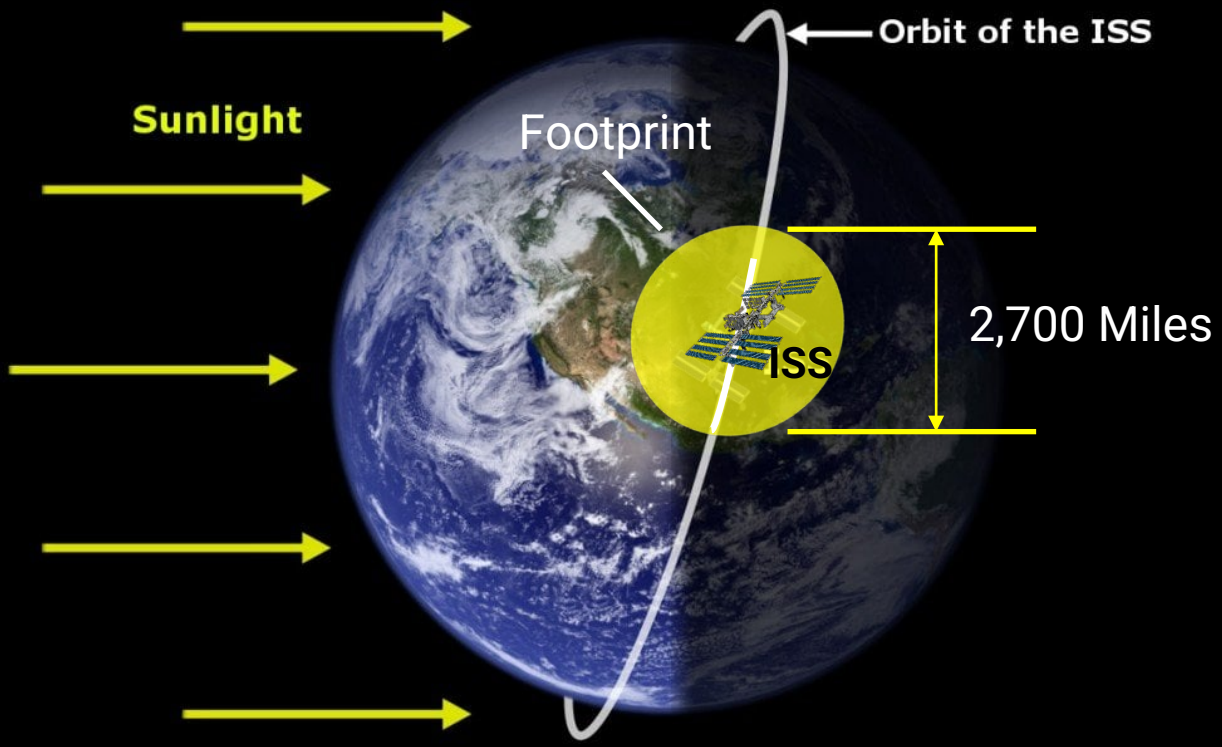
IORS APRS/Packet

Can run FM voice & APRS/Packet simultaneous

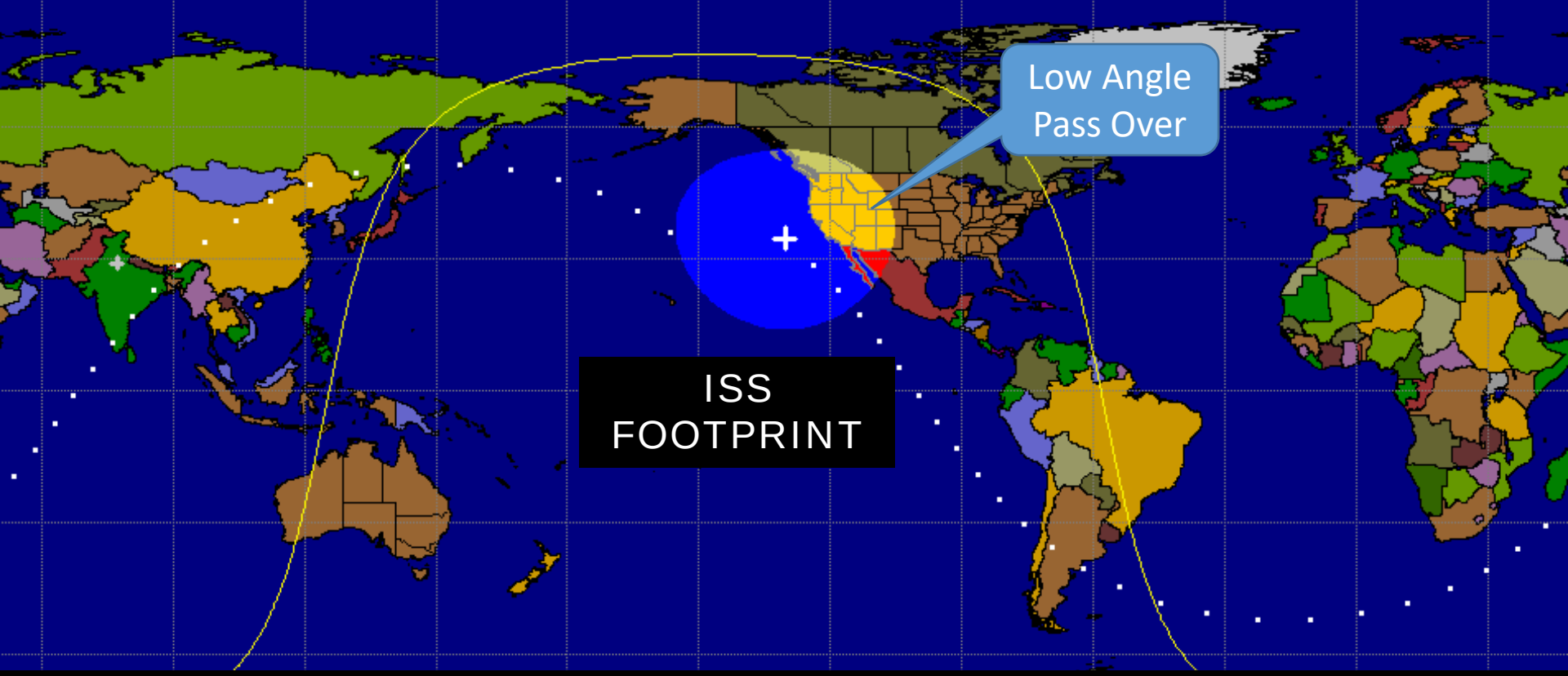
Amateur Satellite Orbits



- **Most Amateur Radio satellites** travel in low Earth orbits (LEO) **at altitudes of 800 to 1500 km (497 to 932 miles)**.
- **At this altitude**, a satellite completes one orbit every 90 to 100 minutes.
- **At the same time**, the Earth is turning beneath the satellite.
- **A small moving FOOTPRINT** on earth is covered during each pass



- **The ISS is in Low Earth Orbit** & travels at 17,500 Mph
- **It orbits once every 90 minutes** (16 orbits / day)
- **Its footprint is about 2,700 miles** (1,350 miles to horizon)
- **When directly overhead**, its altitude is about 245 miles

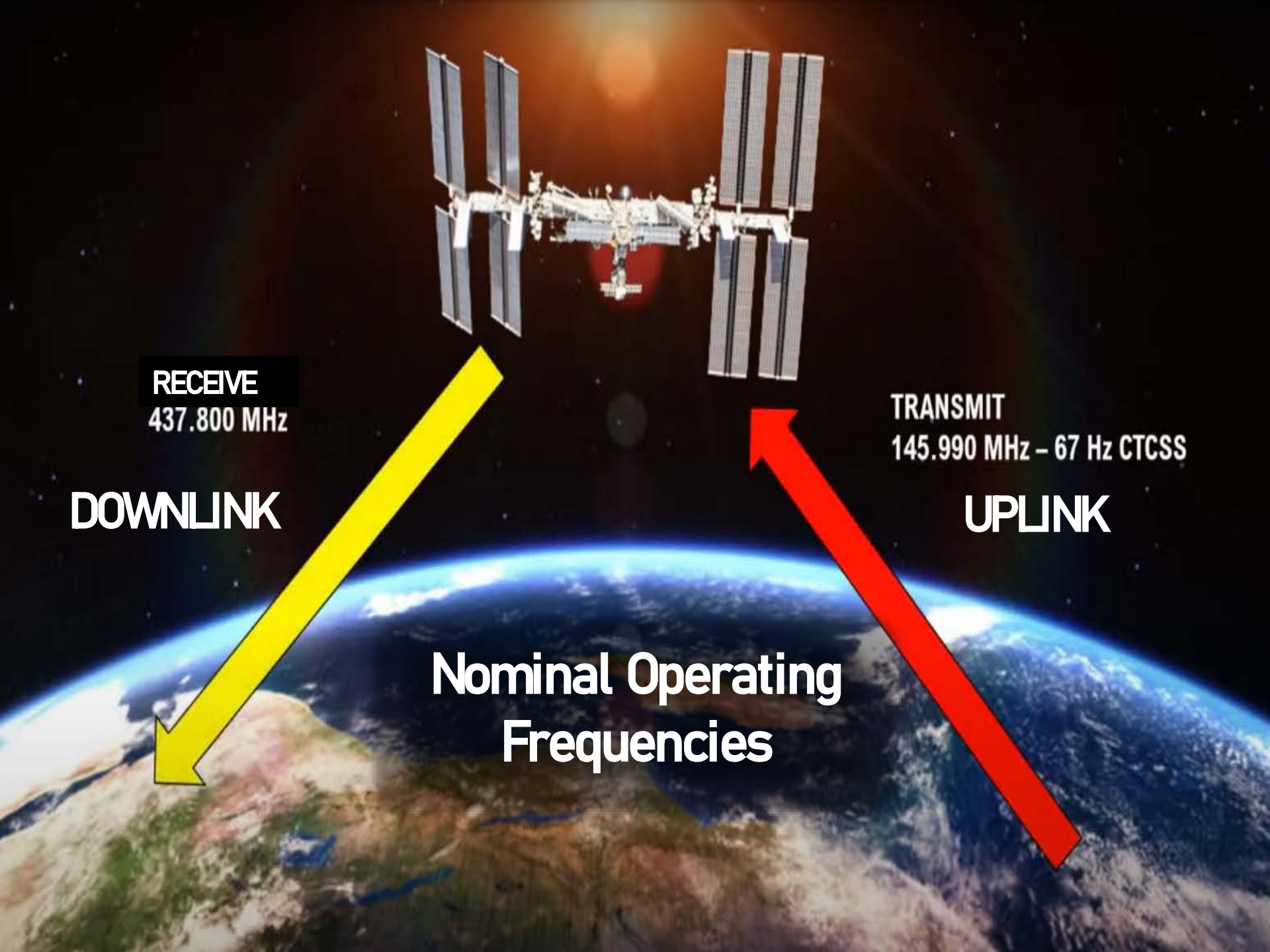


Operating Time Depends on the Angle of the Pass

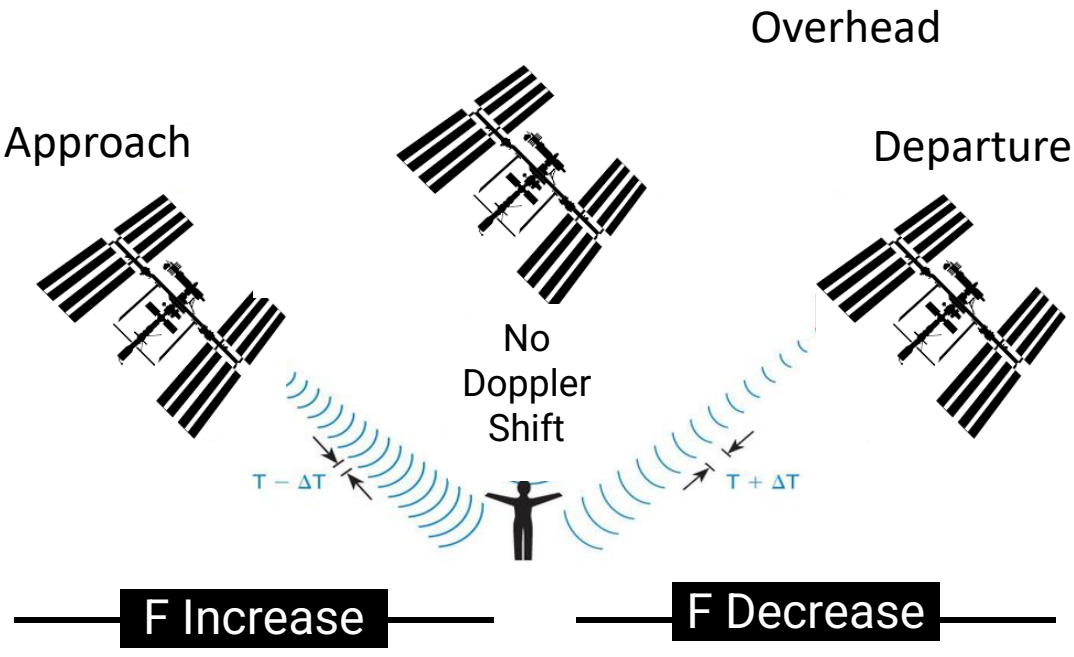
INCLINATION	ISS CROSS BAND REPEATER IN RANGE
1 Degree	Approximately 3 Minutes Total (Along the Horizon)
55 Degrees	Approximately 9 Minutes Total
90 Degrees	Approximately 10 Minutes Total (Passes Overhead)

- We normally see ONE to THREE ISS passes in a row (various inclinations)
- They are 90 minutes apart
- They repeat about every 10 hours

ISS Repeater Frequency & Doppler Shift


RECEIVE
437.800 MHz
DOWNLINK
TRANSMIT
145.990 MHz – 67 Hz CTCSS
UPLINK
Nominal Operating
Frequencies

ISS Doppler Shift



- The ISS is travelling about 2,700 Mph
- Frequency is HIGHER as ISS approaches
- Frequency LOWER as ISS departs

Radio Program for ISS Cross Band Repeater

Uplink	Downlink	Tone	FM Mode	Memory Name	Posistion
145.990 MHz	437.810 MHz	67 Hz	Wide	ISS-2	Approaching
145.990 MHz	437.805 MHz	67 Hz	Wide	ISS-1	
145.990 MHz	437.800 MHz	67 Hz	Wide	ISS-0	Overhead
145.990 MHz	437.795 MHz	67 Hz	Wide	ISS-1	Departing
145.990 MHz	437.790 MHz	67 Hz	Wide	ISS-2	

- Doppler shift is more pronounced **at 440 MHz** & needs compensation (+/- 9 KHz max)
- Doppler shift is limited on 2M and no compensation needed (+/- 3 KHz max)

FULL DUPLEX

Full Duplex Transceivers Recommended

- Full-duplex allows you to monitor your own signal in real time
- You can tell if you're hitting the ISS repeater
- Helps you adjust your antenna positioning for the best signal and compensate for polarity shift fading

About Full Duplex

- Dual Band does not imply **FULL DUPLEX**
- A **FULL DUPLEX** transceiver contains TWO independent receivers
  - Transmit 440 MHz while receiving 2M
  - Transmit 2M while receiving 440 MHz

EXAMPLES:

- An FT-DR70 HT is Dual Band but **NOT FULL DUPLEX**
- A Kenwood TH-D72A HT is Dual Band & **FULL DUPLEX**

Full Duplex HT's

Kenwood TH-D72A

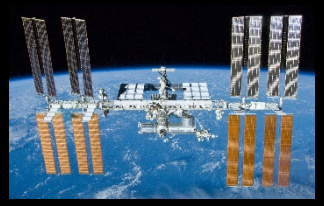
Wouxun KG-UV8E

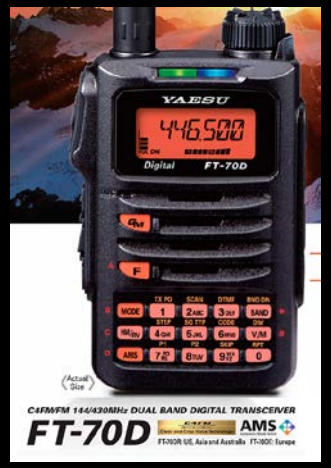
DISCONTINUED

While a FULL DUPLEX HT is recommended, there does NOT appear to be ANY current models with this feature

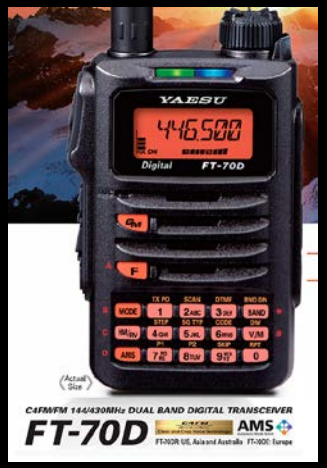
Full Duplex With Two HT's

- Full duplex can be achieved with **TWO RADIOS**
- **Use one to RECEIVE**
- **Use the other to TRANSMIT**





Transmit



Receive

Dual Band & Full Duplex Mobiles

(Plenty Available)

Icom 2370A

Yaesu FTM300

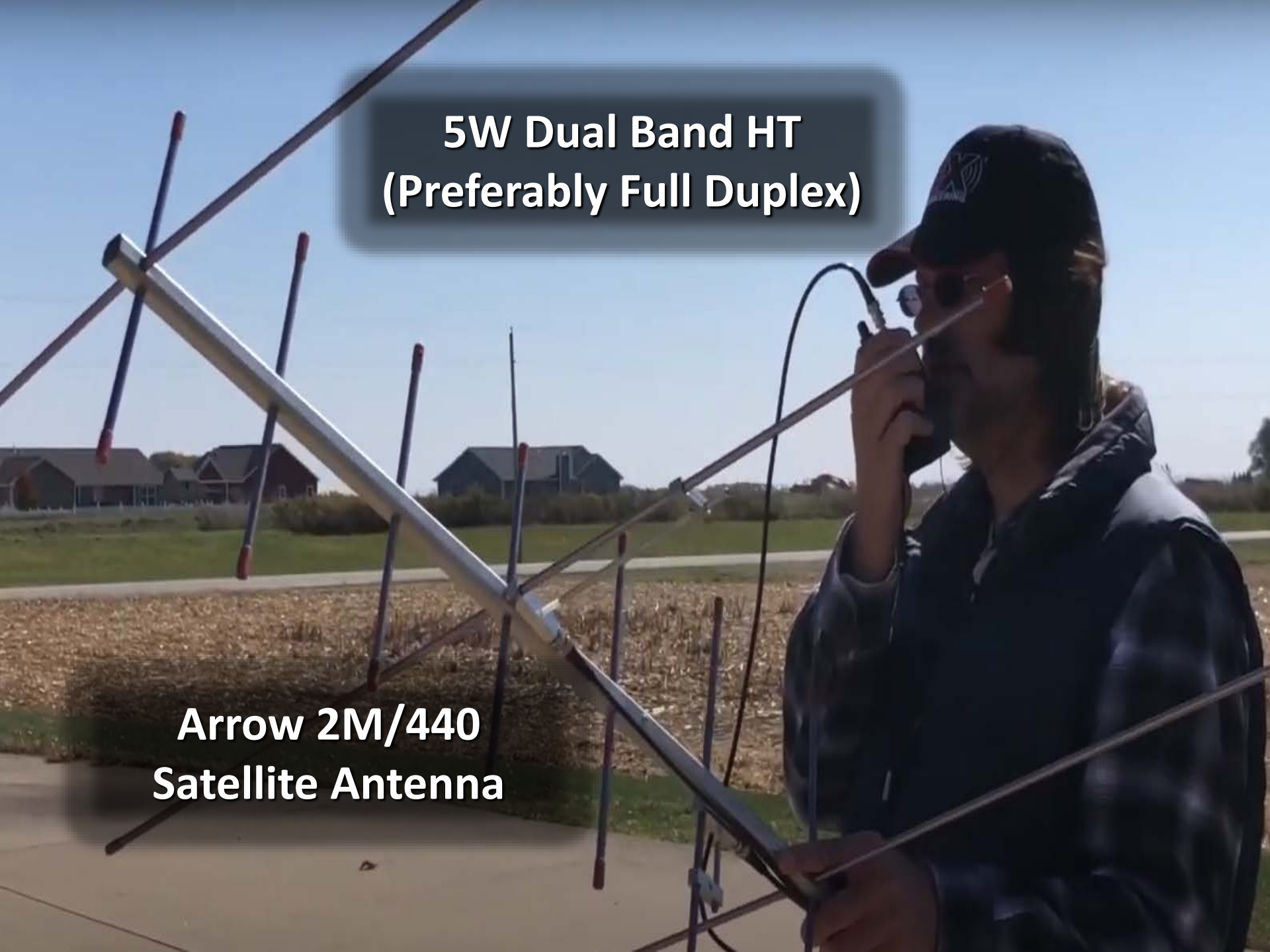
Kenwood TM-V71A

TYT-TH9800

Prior to acquisition, ALWAYS OPEN THE SQUELCH with the downlink frequency set to 437.810 MHz

RADIOS & ANTENNAS

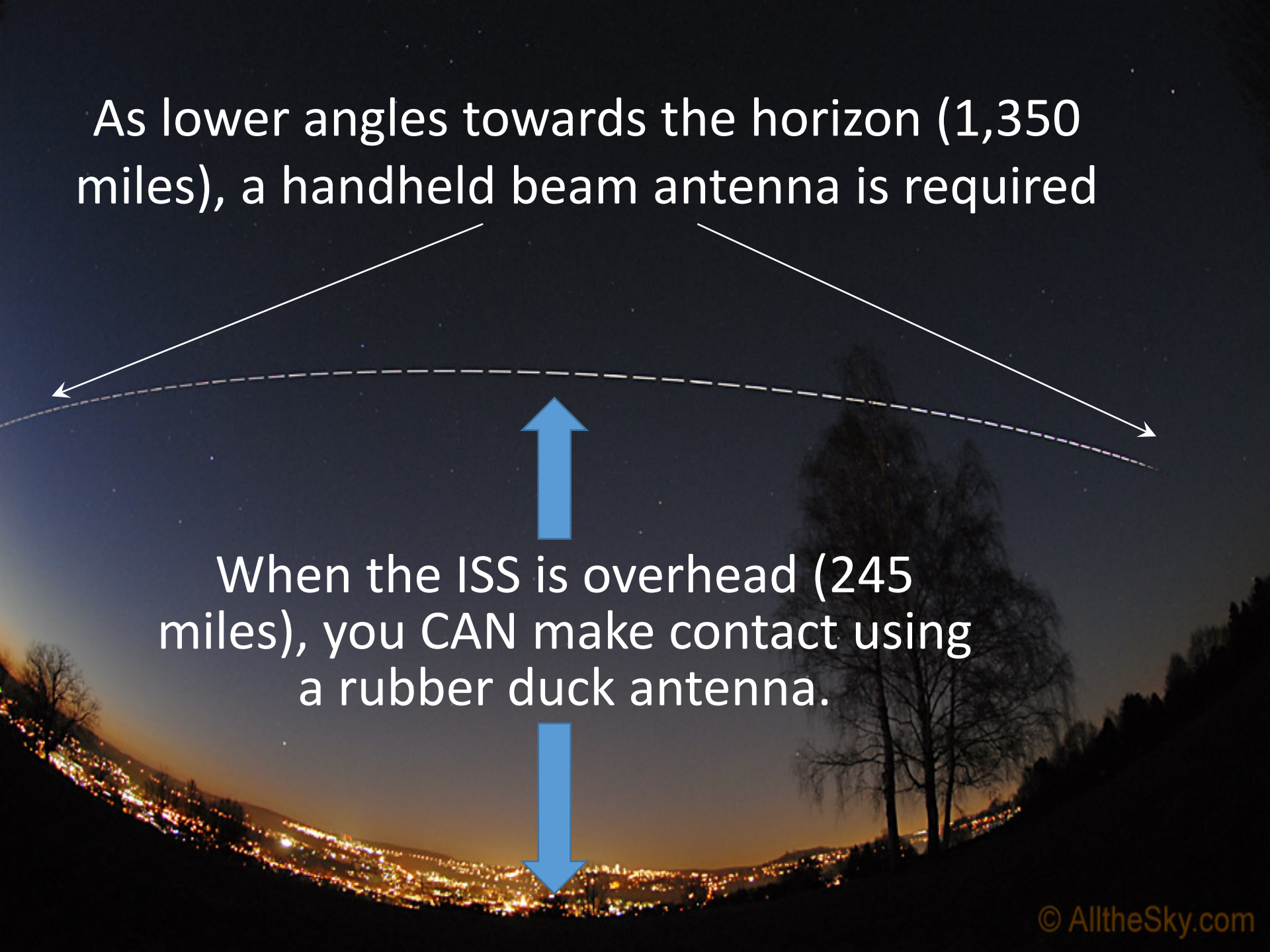
A handheld Yagi attached to a 5 watt HT radio is the typical starting setup for most hams seeking satellite contact


5W Dual Band HT
(Preferably Full Duplex)
Arrow 2M/440
Satellite Antenna


Setup using TWO
Yaesu 817's for
Full Duplex

IF USING AN HT & WHIP ANTENNA:

- Don't hold your whip antenna upright!
- The satellite isn't on the ground, which is what HTs and vertical antennas were designed for.
- Tilt it about the same amount as the satellite's elevation.


As lower angles towards the horizon (1,350 miles), a handheld beam antenna is required
When the ISS is overhead (245 miles), you CAN make contact using a rubber duck antenna.
© AlltheSky.com

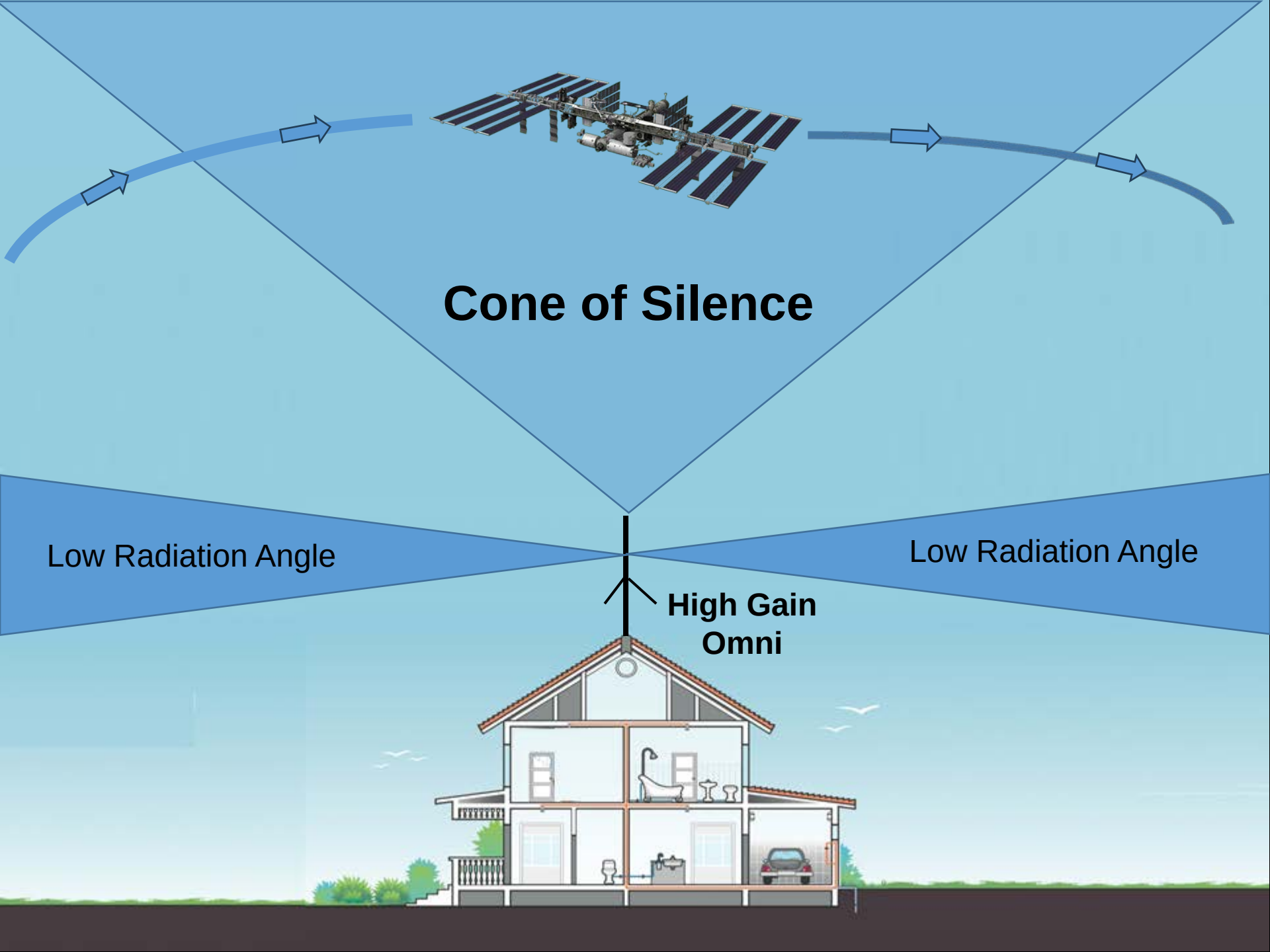
Dual Band Mobiles Work (Preferably Full Duplex)

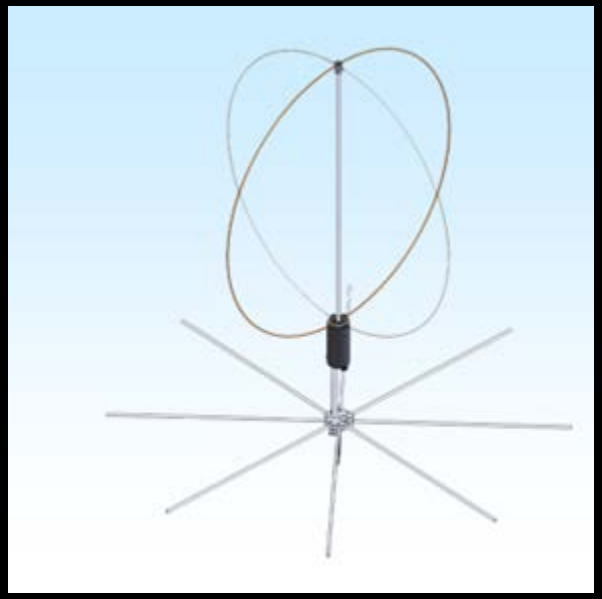
¼ Wave Mag Mount Recommended

Avoid High Gain / Low Radiation Angle Antennas


Live Satellite Tracking
Satellite Tracking
01 16
Dual Band Base
(Preferably Full Duplex)

Base Antenna Considerations


Cone of Silence
Low Radiation Angle
Low Radiation Angle
High Gain
Omni



Eggbeater

2M/440 Yagi
Azimuth/Elevation Adjust

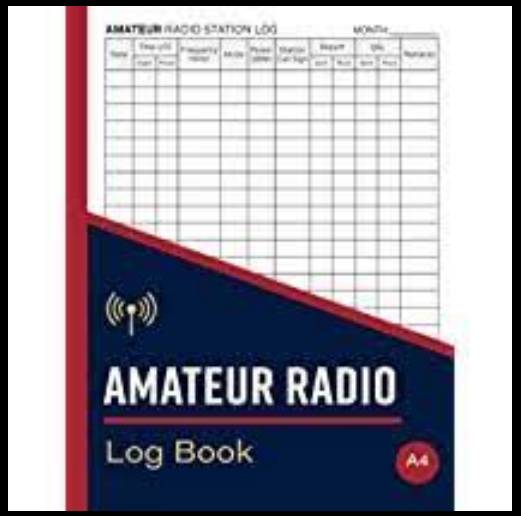
Simple antennas such as an outdoor ¼ wave ground plane or dipole should give good results

Logging Considerations

Portable Operation

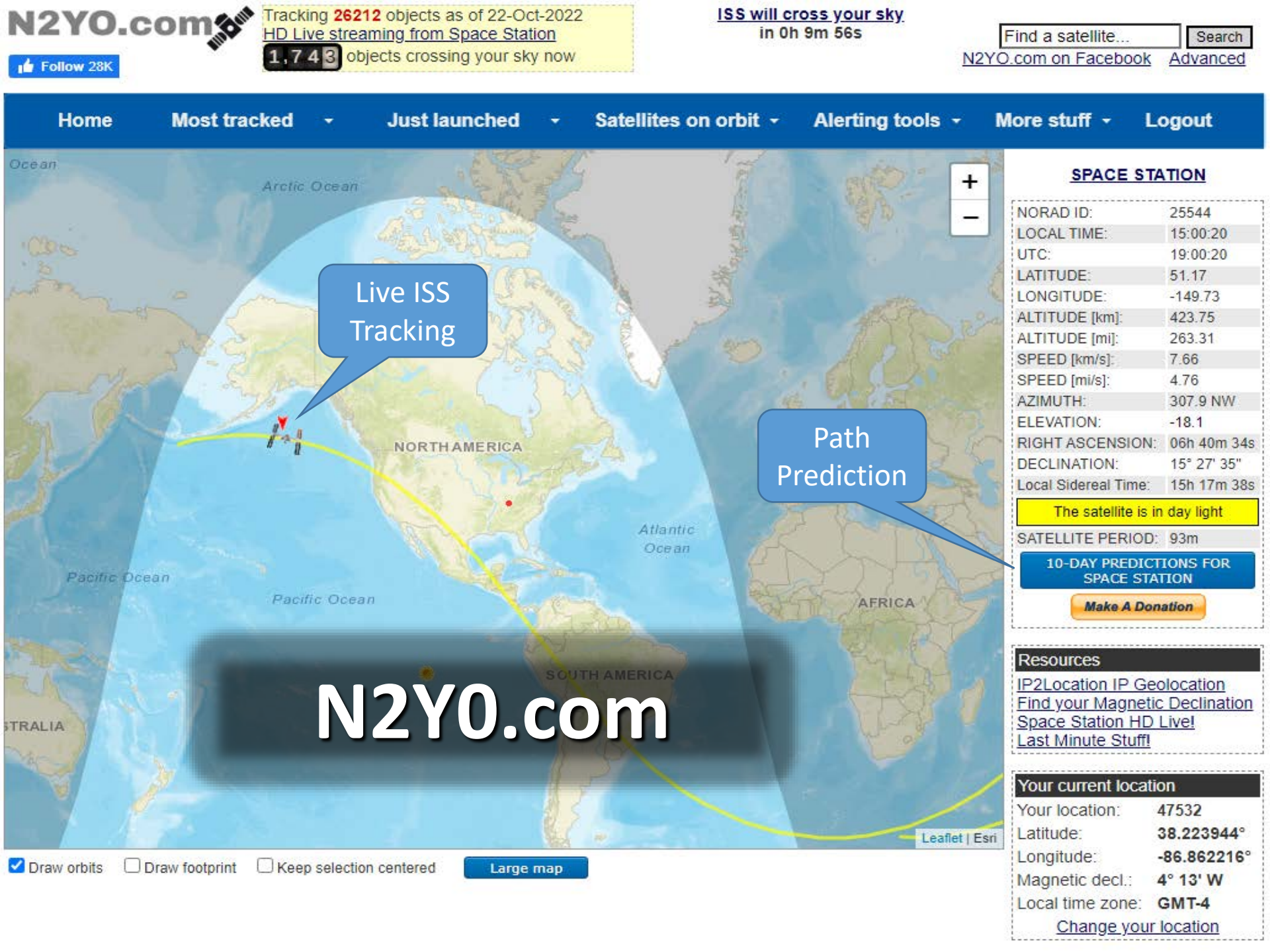
- Your hands are full
- Holding Radio & Antenna
- Can’t write down call signs
- Voice recorder (or cell app) extremely helpful

Base/Mobile Operation



- Hands are free
- Normal logbook or scratch pad will be adequate

To contact the ISS we need to know when it will pass over our area


N2YO.com
Follow 28K
Tracking 26212 objects as of 22-Oct-2022
HD Live streaming from Space Station
1,743 objects crossing your sky now
ISS will cross your sky
in 0h 9m 56s
Find a satellite...
Search
N2YO.com on Facebook
Advanced
Home
Most tracked
Just launched
Satellites on orbit
Alerting tools
More stuff
Logout
Live ISS Tracking
Path Prediction
N2YO.com
SPACE STATION
NORAD ID: 25544
LOCAL TIME: 15:00:20
UTC: 19:00:20
LATITUDE: 51.17
LONGITUDE: -149.73
ALTITUDE [km]: 423.75
ALTITUDE [mi]: 263.31
SPEED [km/s]: 7.66
SPEED [mi/s]: 4.76
AZIMUTH: 307.9 NW
ELEVATION: -18.1
RIGHT ASCENSION: 06h 40m 34s
DECLINATION: 15° 27' 35"
Local Sidereal Time: 15h 17m 38s
The satellite is in day light
SATELLITE PERIOD: 93m
10-DAY PREDICTIONS FOR SPACE STATION
Make A Donation
Resources
IP2Location IP Geolocation
Find your Magnetic Declination
Space Station HD Live!
Last Minute Stuff!
Your current location
Your location: 47532
Latitude: 38.223944°
Longitude: -86.862216°
Magnetic decl.: 4° 13' W
Local time zone: GMT-4
Change your location
Draw orbits
Draw footprint
Keep selection centered
Large map
Leaflet | Esri

10-DAY PREDICTIONS

- **Designate you Location**
- **Select “ALL PASSES”**
- **Select “UTC” or “LOCAL TIME”**

Select This Pass

Object name	**SPACE STATION** Live tracking | More info
Catalog #	25544, 1998-067A
Observing location	47532
Observing coord.	Lat: 38.22°, Lng: -86.86° Change
Local time zone	GMT -4

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

Start		Max altitude			End		All passes	
Date, UTC	Az	UTC	Az	El	UTC	Az	Mag	Info
23-Oct 10:11	SW 229°	**10:17**	**E 97°**	**87°**	10:22	NE 51°	-2.1	Map and details
23-Oct 11:49	W 274°	**11:54**	**NNW 339°**	**16°**	11:59	NE 41°	-0.2	Map and details
23-Oct 15:05	NW 320°	**15:10**	**NNE 17°**	**13°**	15:14	E 77°	+0.1	Map and details
23-Oct 16:42	NW 312°	**16:47**	**NNE 30°**	**59°**	16:52	SE 122°	-2.1	Map and details
23-Oct 18:19	WNW	**18:24**	**SW**	**13°**	18:28	S	+0.1	Map and details
24-Oct 09:23			133°			56°		Map and details
24-Oct 11:01	W 263°	**11:06**	**NNW 332°**	**22°**	11:10	NE 41°	-0.6	Map and details
24-Oct 14:17	NW 319°	**14:21**	**N 13°**	**11°**	14:26	ENE 68°	+0.3	Map and details
24-Oct 15:54	NW 315°	**15:59**	**NE 35°**	**35°**	16:04	ESE 110°	-1.3	Map and details
24-Oct 17:31	WNW 297°	**17:36**	**SW 230°**	**23°**	17:40	SSE 160°	-0.6	Map and details
25-Oct 08:36	SSW 203°	**08:41**	**SE 131°**	**25°**	08:46	ENE 63°	-	Map and details

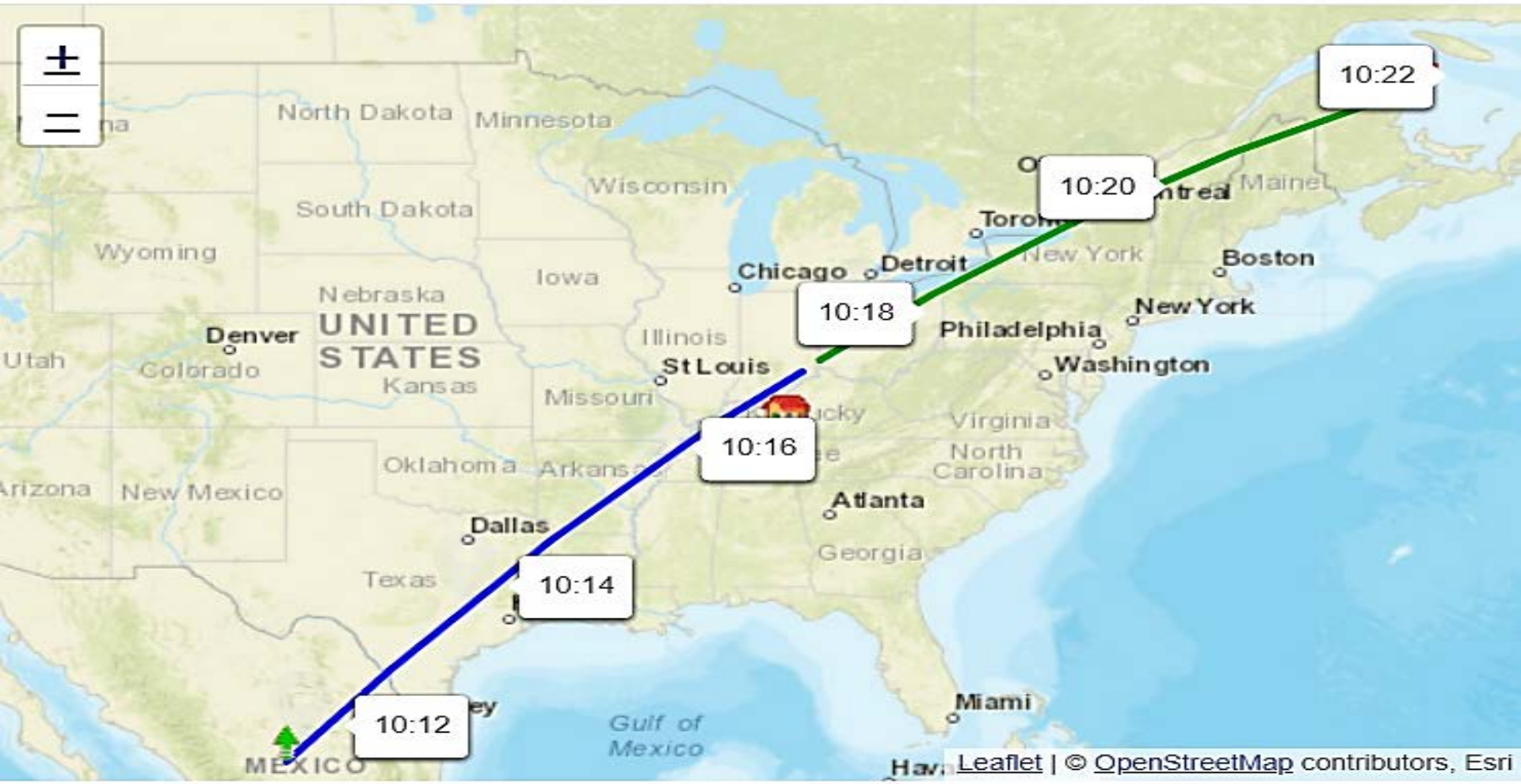
Upcoming ISS Passes

ISS Pass Mapped

Pass beginning	Max altitude	Pass ending
Date: 23-Oct 10:11:50	Date: 23-Oct 10:17:10	Date: 23-Oct 10:22:20
Az: 228.77° (SW)	Az: 96.53° (E)	Az: 51.26° (NE)
El (alt): 0.40°	El (alt): 86.56°	El (alt): 0.92°
Mag: -	Mag: -	Mag: +1.3
Dist to sat: 2300.6 km	Dist to sat: 418.7 km	Dist to sat: 2249.5 km
Eclipsed?: YES	Eclipsed? YES	Eclipsed? NO

Good visible pass

Add this pass on your notifications list



ALERTS BY EMAIL AND TEXT/SMS

Now you could be alerted on your mobile device[1)] and/or email just before your favorite satellite comes over the horizon!

This is what you have to do:

- Register with n2yo.com. It's simple and free. If already registered, just login.
- Set your email address and your mobile phone number[1)] on your profile. Make sure the information is valid.
- Create your default observing location. If you already have one created, it would be automatically selected. If you have more than one, make sure you select a location where you are physically located so the alert would make sense.
- You are now ready to create your first notification. Select a LEO (Low Earth Orbit) satellite so that you could see the "10-day predictions" link. A great choice could be the International Space Station (ISS). Click the "10-day predictions" link. Take this shortcut for ISS.
- By default you will see the visible passes of the satellite over your area for the next few days. You could display all satellite passes once you click on "See all passes" button. The "all passes" list could be useful for those performing radio communications via LEO satellites (e.g. amateur radio enthusiasts). Click on "Mas and details" link.
- You should now see among other things the "Add this pass on your notification list". The button is visible only if you are currently logged in. Click it.
- The pass is now added on your notification list so you just have to select **when** to be alerted and **how**.

  When? There are 3 choices: 10, 20, 30 or 60 minutes before pass beginning. Choices are selectable via a dropdown list.

  How? By email (the message is sent at the address on your profile) and/or by SMS (Short Message Service) known also as

Shoot for passes with maximum elevation greater than 10 degrees!

Other Path Prediction Apps

AMSAT™

AMSAT Online Satellite Pass Predictions

HEAVENS ABOVE

Numerous Cell Phone Apps

App Store Preview

See the International Space Station fly by

ISS Detector 4+

See the Space Station

Derk Vrijdag

4.1 • 102 Ratings

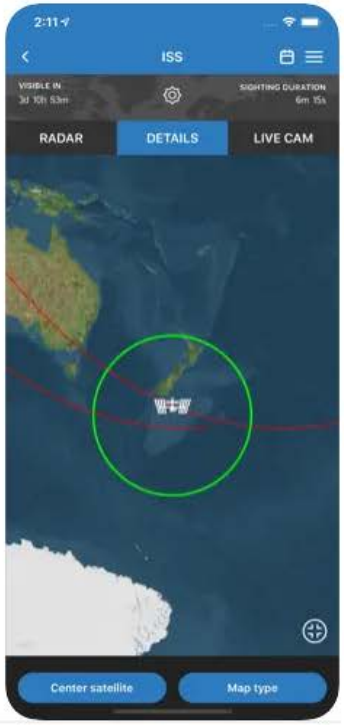
Free · Offers In-App Purchases

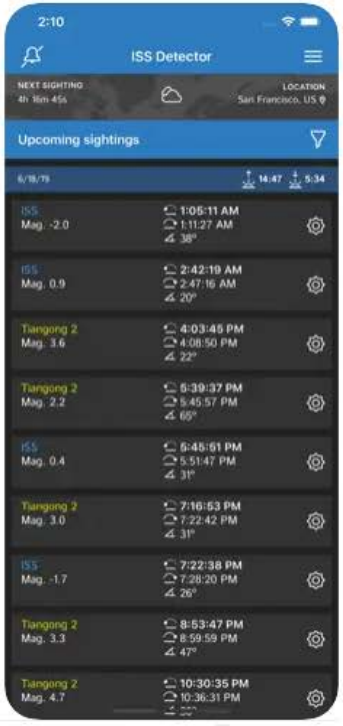
ISS Detector is the easiest way to spot the station. Find out when and where to look.
If you want to see more, you can expand the app to see comets, planets and many other satellites.

Google Play App store

Screenshots

iPhone iPad





Satellite Communications Etiquette

Satellite Communications Etiquette

- PASSES ONLY LAST A FEW MINUTES!
- FIRST LISTEN, LISTEN, LISTEN to see how its done before attempting your first contact
- WAIT FOR A BREAK IN THE ACTION before jumping in
- CONTACTS ARE NORMALLY VERY BRIEF and are only an exchange of call signs and grid locators
- ANNOUNCE YOUR CALL SIGN AND GRID LOCATOR using phonetics
- NEVER CALL CQ ON A SATELLITE!

WD9EWK (Call Sign)

"WHISKEY-DELTA-NINE-ECHO-WHISKEY-KILO, DELTA-MIKE-FOUR-THREE.“

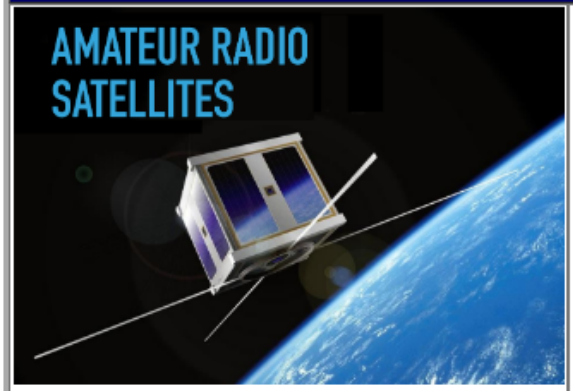
DM43 (Grid Square)

In Summary

- SELECT EQUIPMENT NEEDED to contact the ISS
  - *A proper antenna will make ALL the difference*
- PROGRAM YOUR RADIO(S) for the appropriate uplink & downlink frequencies accommodating doppler shift
- DETERMINE AN AVAILABLE UPCOMING PASS
- SET UP YOUR EQUIPMENT AHEAD OF TIME
- KEEP YOUR SQUELCH OPEN during operations
- KEEP YOUR ANTENNA POINTED towards the ISS
- OBSERVE RECOMMENDED ETIQUITTE while operating

Links:
Advanced Forecast
Amateur Radio
Amateur Satellites
Climatology
Corona Virus
Current Conditions
Disaster Maps
Earthquake
Flood
Forums
Forecast
Home
Hurricanes
Jumpstart
Links
Models
NWS Offices
Radar
Satellite
Spotter Training
Storm Chase Live
Watches/Warnings
Winter
Local Forecast:
Indianapolis NWS
Louisville NWS
Paducah NWS
Nationwide

Amateur Radio Satellites



Amateur radio enterred the space age when OSCAR-1 was launched in 1961. Since then, amateurs from more than 22 different countries have launched over 70 satellites, exploring both digital and analog satellite technology. Some operate FM and can actually be worked using a dual-band HT. Many amateur radio operators already have most of the equipment needed to work these "birds". But, you do need to know their operating frequencies and when they will be overhead in order to work them. This web page provides all the information you need top get started.

Getting Started with Amateur Satellites

Basics	AMSAT-UK	AB1OC	FM Satellites (Video)	Guide (Video)

Path Prediction Tools

N2YO	Heavens-Above	AMSAT	ISS Tracker

Amateur Satellite Antennas

Arrow	DX Engineering	M2	Videos

International Space Station

Home Page	Live Streaming	Amateur Station Status	Upcoming Educational Contacts

Amateur Radio Satellites

Satellite List	By Type	FM Satellites	LIVE OSCAR Status

Miscellaneous Links

ARISS	AMSTAT	AMSTAT-UK	ISS Fan Club


Getting Started on Amateur Satellites
with Sean Kutzko, KX9X

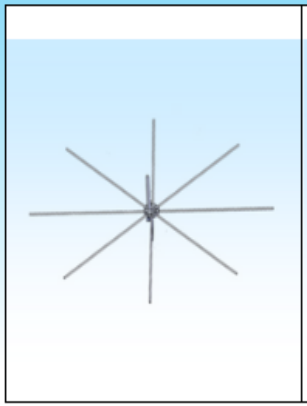
SATELLITE PRODUCTS

CATEGORIES

Commercial

- Antennas
  - Circular Polarized Yagis
  - Parabolic Reflectors
  - Reflector & Dish Feed Assortments
  - Unmanned Aircraft System (UAV) Antennas
  - Cross Polarized Yagis
  - Circular Polarized Omni / Cross Dipoles
  - Omnidirectional
  - Helical
  - Linear Yagis
  - Log Periodic
  - Dish Feeds, Components, Polarity Units & LNA's
  - ISP 700/900/2.4
    - 700 MHz Antennas
    - 900 MHz Antennas

Sort by: Price: Low to High



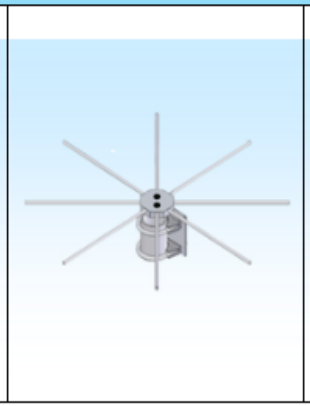
RK-2M, 2 METER RADIAL KIT

$63.95

Not Rated

Compare

ADD TO CART



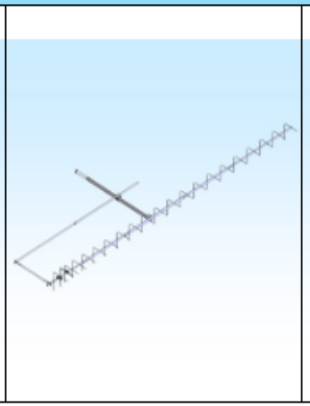
RK-70CM, 70CM RADIAL KIT

$63.95

Not Rated

Compare

ADD TO CART



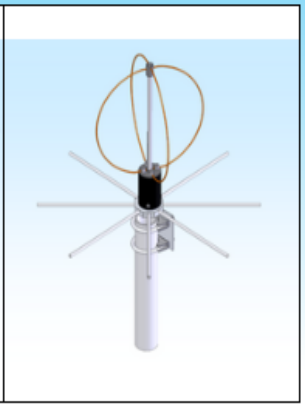
L-BRACE KIT

$218.95

Not Rated

Compare

ADD TO CART



EB-432/RK70cm, 400-470 MHz

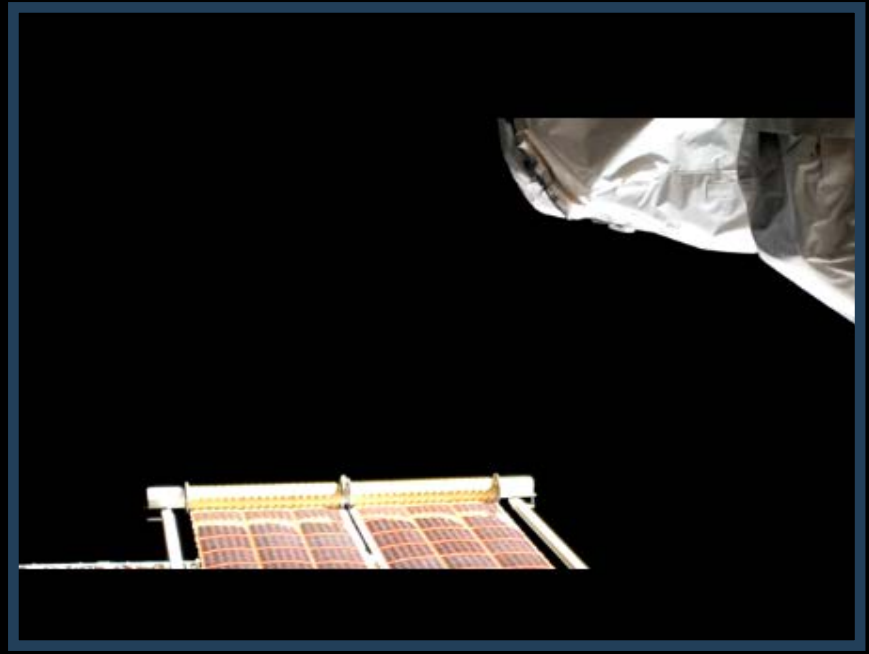
$321.99

Not Rated

Compare

ADD TO CART


SPACE STATION
LAT: 20.21
LNG: -151.30
ALT: 415.27
SPD: 7.66
ASIA
NORTH AMERICA
Pacific Ocean
Atlantic Ocean
SOUTH AMERICA
AUSTRALIA
Leaflet
owered by N2YO.com
Local Time: GMT
NEXT PASS OF SPACE STATION OVER YOUR CURRENT LOCATION
START AZIMUTH
MAX ELEVATION
END AZIMUTH
TOTAL DURATION
Oct 6
320°
17:08
12°
17:12
74°
08m 55s




SPACESTATION


Once you are successful with the ISS, there are many other satellites (FM, Digital, SSB) available for amateur radio communications


Thanks!