Satellites for Beginners

CTRI Contest Group
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April 20, 2019

✗ Don’t think this…

✔ Think this…

Satellites are "Repeaters in the sky"

Today there are FOUR Easy FM Voice Satellites

- SO-50 (SaudiSat, Dec 2002)
- AO-85 (Fox1A, Oct 2015)
- AO-91 (Fox1B, Nov 2017)
- AO-92 (Fox1D, Jan 2018)

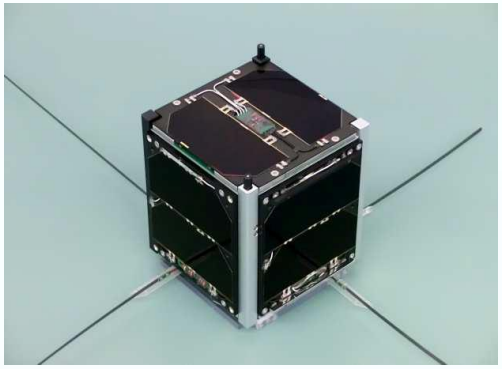
Notice Something? Lots of fairly new satellites!!!

There are TEN CW & SSB Satellites too

More coming all the time!

Why so many new satellites?

CubeSats !!!



- Standard Form Factor 10x10x10cm 1.3 Kilogram
- Off-the-shelf frames and PCBs available
- Low construction cost ($20K)
- Low launch cost ($50K – often free)

CubeSat Launch

Think really expensive Pez Dispenser

Repeaters in the sky

- Just like a Repeater we transmit on one frequency and listen on another
- Unlike most repeaters satellites are cross band
  - Mode U/V (We transmit on UHF, Listen on VHF) ✔
  - Mode V/U (We transmit on VHF, Listen on UHF) (SO50)
- Just like a repeater use CTCSS tone on TX (67.0 Hz)
- Full Duplex is best (listen while you talk)
  - Full Duplex Radio (Like Kenwood TH-D72A)
  - Use Two HT's (one on RX, one on TX)

Can use a single HT and not listen with FM sats

✔ “Sky” is good…

- Line of sight to everywhere
- Big coverage footprint (Continental United States)

✖ “Sky” is not so good…

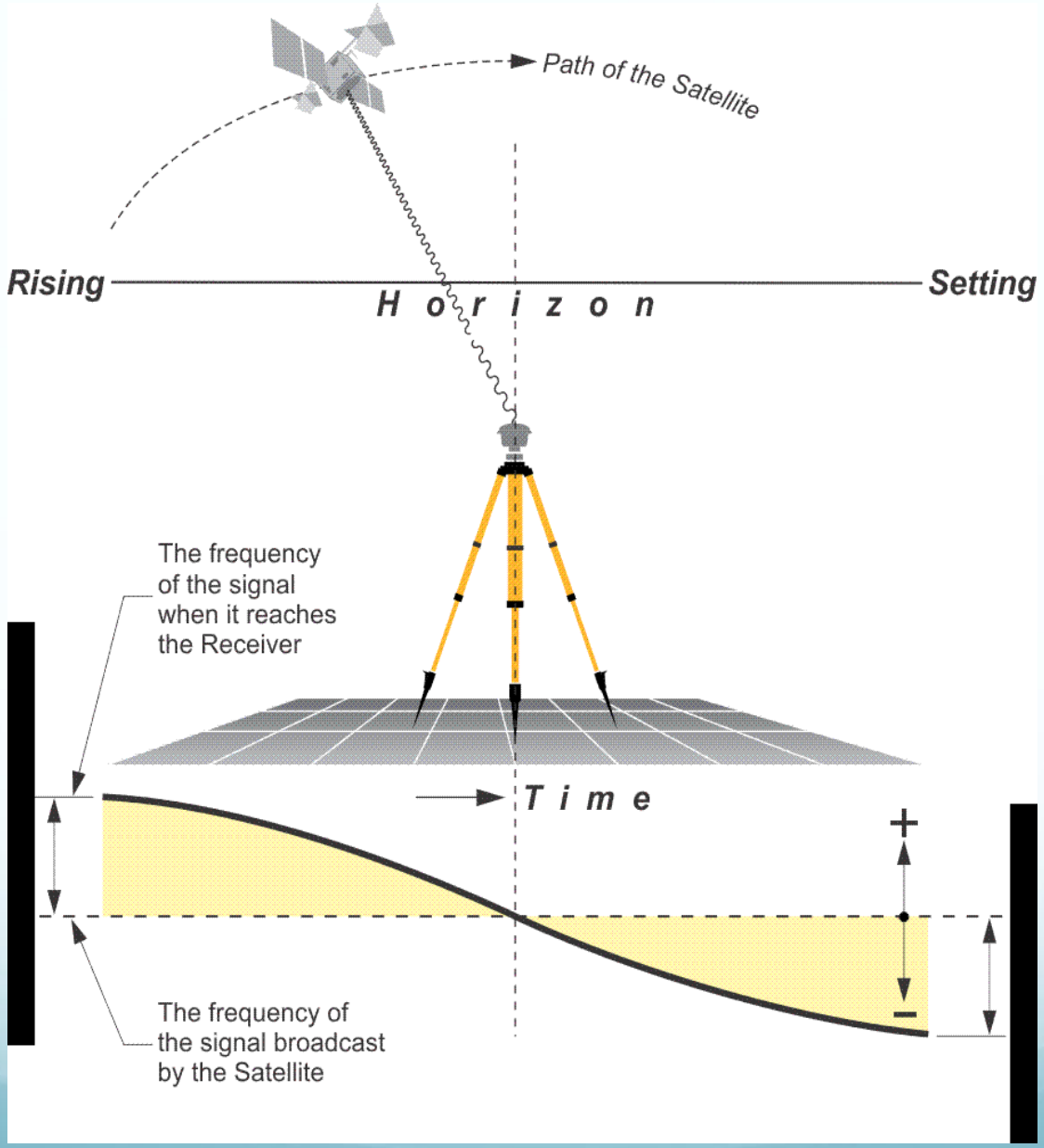
- Orbiting about 400 miles up so greater signal loss compared to a typical repeater 25 miles away
- Low Satellite TX power (maybe 0.3 to 3 watts)
- Moving FAST (16,000 MPH)
  - **Short time to access (about 10 minutes)**
  - **Doppler**
- Busy (especially weekends and Field Day)

What is Doppler?

- Perceived Frequency Shift because the Satellite is moving relative to us on the ground
  - Big deal on 70 cm (+/- 10 KHz) must adjust
  - Not as bad on 2 m (+/- 3 KHz) can ignore

As Satellite **approaches** us the frequency is **higher**

As Satellite **moves away** from us the frequency is **lower**


Path of the Satellite
Rising
Horizon
Setting
The frequency of the signal when it reaches the Receiver
Time
+
−
The frequency of the signal broadcast by the Satellite

What to do about Doppler?

All adjustments are made from the ground

- We have to adjust our UHF frequency
- We ignore our VHF frequency (FM “Capture”)

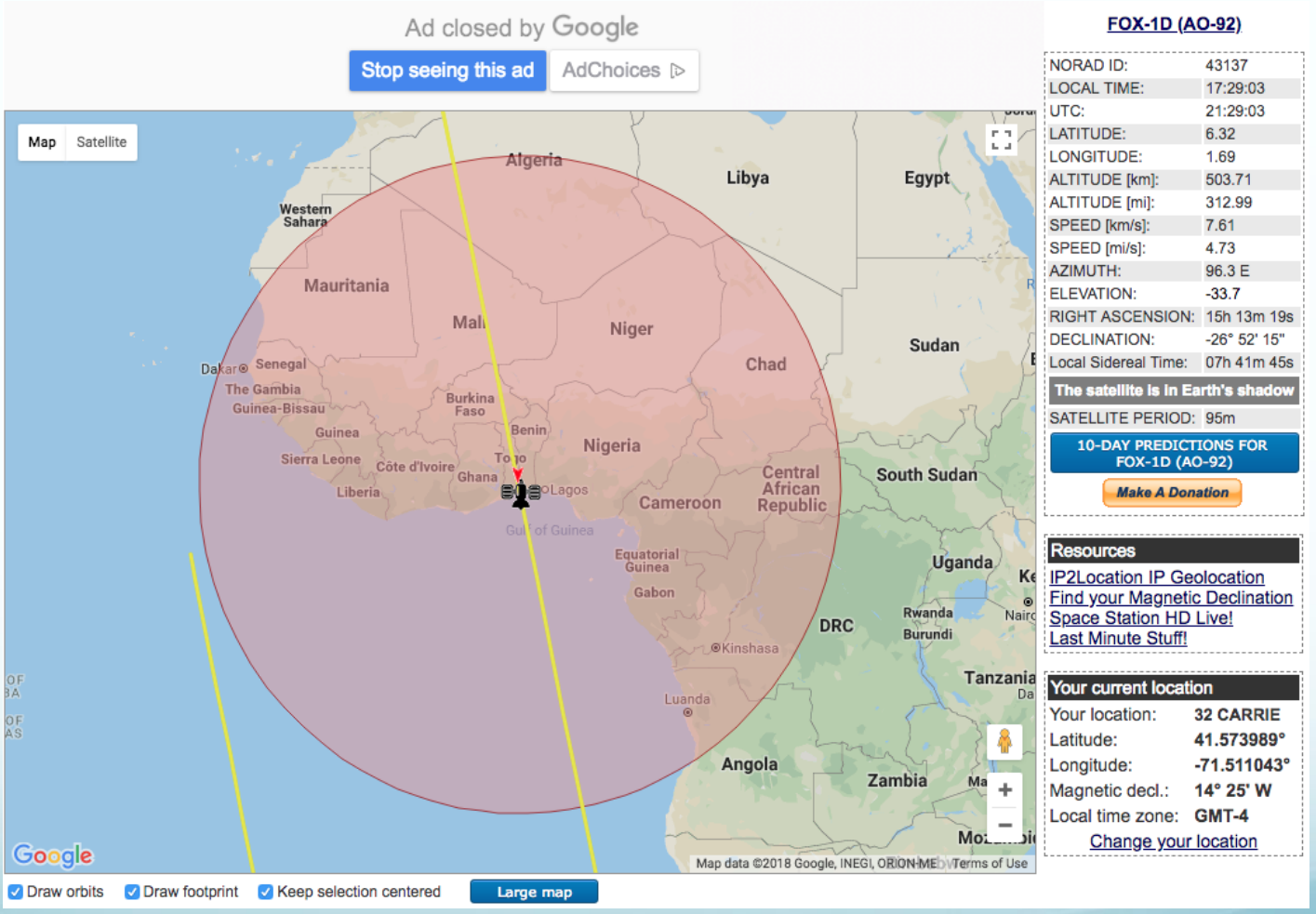
Typical Channel Programming for AO-92

Channel (When)	RX Frequency	TX Frequency
1 AOS (Start)	145.880	435.340
2 AOS+2 min	145.880	435.345
3 MID Pass	145.880	435.350
4 LOS -2 min	145.880	435.355
5 LOS (End)	145.880	435.360

How do we know where Satellites are?

- Use Online Prediction Services
  - http://www.N2YO.com
  - http://www.amsat.org/track/index.php
- Use Smartphone Tools (SatSat on iPhone)
- Use Installed PC tools
  - GPREDICT (Windows, Linux)
  - MacDoppler (Mac)

www.N2YO.com


Ad closed by Google
Stop seeing this ad
AdChoices
Map
Satellite
Algeria
Libya
Egypt
Western Sahara
Mauritania
Mali
Niger
Chad
Sudan
Dakar
Senegal
The Gambia
Guinea-Bissau
Guinea
Sierra Leone
Liberia
Côte d'Ivoire
Burkina Faso
Ghana
Benin
Togo
Nigeria
Lagos
Cameroon
Central African Republic
South Sudan
Gulf of Guinea
Equatorial Guinea
Gabon
Uganda
Rwanda
Burundi
DRC
Kinshasa
Tanzania
Luanda
Angola
Zambia
Google
Map data ©2018 Google, INEGI, ORION-ME
Terms of Use
Draw orbits
Draw footprint
Keep selection centered
Large map
FOX-1D (AO-92)
NORAD ID: 43137
LOCAL TIME: 17:29:03
UTC: 21:29:03
LATITUDE: 6.32
LONGITUDE: 1.69
ALTITUDE [km]: 503.71
ALTITUDE [mi]: 312.99
SPEED [km/s]: 7.61
SPEED [mi/s]: 4.73
AZIMUTH: 96.3 E
ELEVATION: -33.7
RIGHT ASCENSION: 15h 13m 19s
DECLINATION: -26° 52' 15"
Local Sidereal Time: 07h 41m 45s
The satellite is in Earth's shadow
SATELLITE PERIOD: 95m
10-DAY PREDICTIONS FOR FOX-1D (AO-92)
Make A Donation
Resources
IP2Location IP Geolocation
Find your Magnetic Declination
Space Station HD Live!
Last Minute Stuff!
Your current location
Your location: 32 CARRIE
Latitude: 41.573989°
Longitude: -71.511043°
Magnetic decl.: 14° 25' W
Local time zone: GMT-4
Change your location

www.N2YO.com

10-DAY PREDICTIONS

Object name	**FOX-1D (AO-92)** Live tracking | More info
Catalog #	43137, 2018-004A
Observing location	32 CARRIE LN, N
Observing coord.	Lat: 41.57°, Lng: -71.51° Change
Local time zone	GMT -4

Uplink (MHz): 435.350/1267.350
Downlink (MHz): 145.880
Beacon (MHz): 145.880
Mode: FM CTCSS 67.0Hz/200bps DUV
Call sign:
Status: **Active**

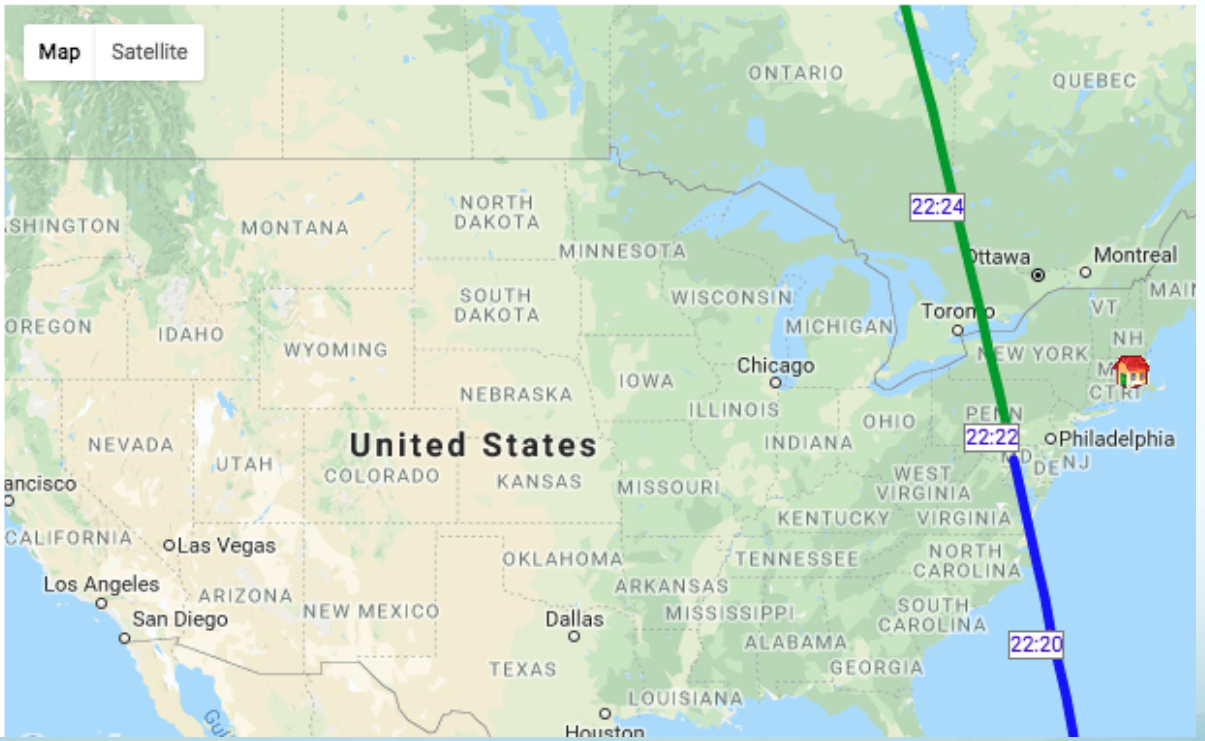
Visible passes | AM/PM time | UTC | Print as PDF

Start		Max altitude			End		All passes	
Date, Local time	Az	Local time	Az	El	Local time	Az	Mag	Info
6-May 20:44	ESE 119°	**20:48**	**ENE 67°**	**13°**	20:53	N 12°	-	Map and details
6-May 22:16	S 182°	**22:22**	**W 258°**	**43°**	22:27	NNW 340°	-	Map and details
7-May 09:45	NE 33°	**09:50**	**E 90°**	**15°**	09:55	SSE 151°	-	Map and details
7-May 11:19	N 2°	**11:24**	**WNW 285°**	**34°**	11:29	SW 215°	-	Map and details
7-May 21:56	S 169°	**22:01**	**SW 224°**	**80°**	22:07	N 347°	-	Map and details
8-May 10:58	N 8°	**11:04**	**WNW 290°**	**62°**	11:09	SSW 201°	-	Map and details
8-May 21:36	SSE 156°	**21:41**	**ENE 65°**	**53°**	21:46	N 354°	-	Map and details
9-May 10:38	N 14°	**10:43**	**E 85°**	**69°**	10:49	S 188°	-	Map and details
9-May 21:16	SE 143°	**21:21**	**ENE 71°**	**30°**	21:26	N 1°	-	Map and details
9-May 22:50	SSW 203°	**22:55**	**W 265°**	**17°**	22:59	NW 327°	-	Map and details

www.N2YO.com

Pass beginning	Max altitude	Pass ending
Date: 6-May 22:16:40	Date: 6-May 22:22:0	Date: 6-May 22:27:20
Az: 181.73° (S)	Az: 257.61° (W)	Az: 340.19° (NNW)
El (alt): 0.95°	El (alt): 42.77°	El (alt): 1.76°
Mag: -	Mag: -	Mag: -
Dist to sat: 2486.9 km	Dist to sat: 720.4 km	Dist to sat: 2414.7 km
Eclipsed?: YES	Eclipsed? NO	Eclipsed? NO

Barely visible pass | Add this pass on your notifications list



www.amsat.org/track/index.php

AMSAT Online Satellite Pass Predictions - AO-92

View the current location of AO-92

Date (UTC)	AOS (UTC)	Duration	AOS Azimuth	Maximum Elevation	Max El Azimuth	LOS Azimuth	LOS (UTC)
07 May 18	00:44:03	00:09:31	121	13	58	9	00:53:34
07 May 18	02:16:26	00:11:23	181	41	281	341	02:27:49
07 May 18	13:45:27	00:09:58	32	15	95	153	13:55:25
07 May 18	15:18:42	00:11:05	2	32	305	214	15:29:47
08 May 18	00:24:46	00:08:01	106	7	63	17	00:32:47
08 May 18	01:56:03	00:11:33	168	82	267	347	02:07:36
08 May 18	03:32:41	00:06:49	237	4	264	310	03:39:30
08 May 18	13:25:45	00:08:27	41	8	84	137	13:34:12
08 May 18	14:58:19	00:11:26	8	62	270	201	15:09:45
08 May 18	16:33:43	00:06:29	336	4	308	266	16:40:12

Basic Contact Plan

- Do pass predictions for times of rise, mid-pass, set
- Plan where in sky that will be (True North is 14 degrees CW from Magnetic North in RI)
- Select proper memory channel for AOS
- “This is Whisky One Sierra Echo Alpha, W1SEA, in Fox Nancy Forty”
- “W1SEA this is Whiskey Bravo Four Sierra Oscar November WB4SON in Fox Nancy Forty One over”

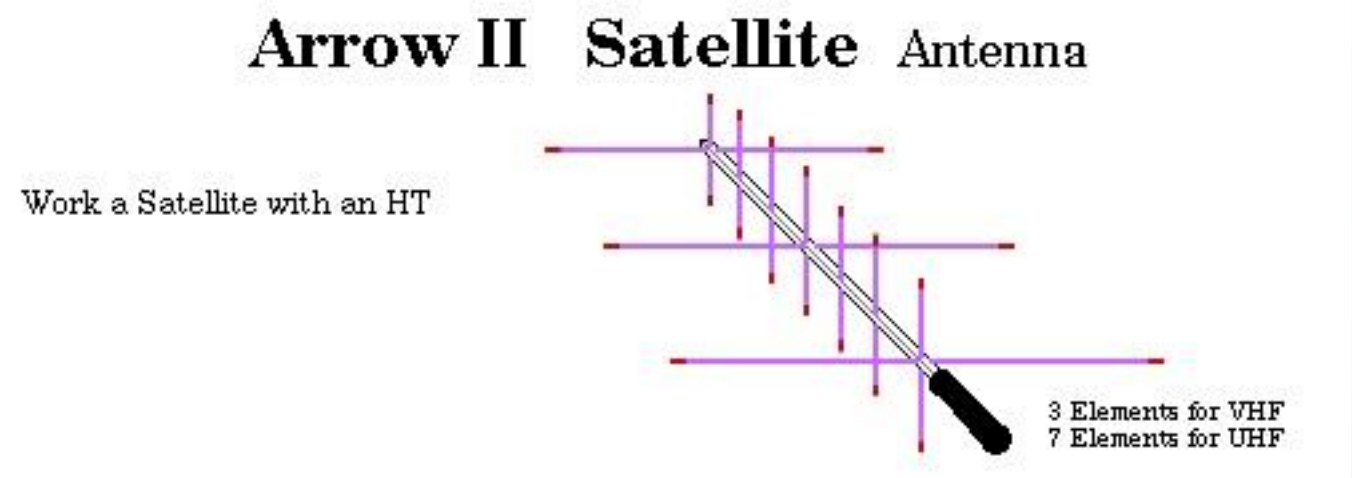
Contact Plan Pt 2

- Adjust the UHF frequency (usually uplink) during the pass (AOS, +2 min, +4 min, +8 min, +10 min)
- Move your antenna for max signal as satellite moves across the sky
- Log your contacts and upload to LOTW!

Keep contacts short!! (Allow others time)

Gear

Antenna Crossed 2m/70cm Beam:
www.arrowantennas.com/arrowii/146-437.html



Other choices: Elk Antenna, Homebrew

Gear

- Dual Band Full Duplex (only one in production is Kenwood TH-D72A – TH-D74A is NOT)
- Two HTs (one for 2m another for 70cm - $25 BaoFengs will work)
- Or, in a pinch, just one HT that can operate split band (but you give up receive while transmit)

Lots of USED HTs with full duplex

Lazy Man's Approach

Put your beam on a camera tripod and point it at the mid-pass Az/El.

Set your rig to the Satellite TX/RX frequency (No Doppler adjustment)

Wait for the satellite to find you (about two minutes before mid-pass thru two minutes after). Make contacts during that window.

Misc Info.

- Frequency List
  - https://www.amsat.org/fm-satellite-frequency-summary/
- FM Satellite Info page
  - http://www.work-sat.com/Home.html
- Satellite Status Page
  - http://www.amsat.org/status/
- AMSAT UK (good website)
  - https://amsat-uk.org/