Satellite Basics & AMSAT Update

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Satellite Options

- Telemetry monitoring and reporting
  - AO-85, AO-91, AO-92, AO-73
- FM Transponders
  - SO-50, AO-85, AO-91, AO-92
- Linear Transponders
  - AO-7, FO-29, AO-73, XW series

Orbital Terminology

- ***LEO (Low Earth Orbit)*** – 160 km – 2,000 km (100 -1,240 miles) above earth
- ***Ascending Pass*** – relative to you, travels South to North
- ***Descending Pass*** – relative to you, travels North to South
- ***AOS (Acquisition of Signal)*** – time at which signal is first heard
- ***LOS (Loss of Signal)*** – time at which the signal is lost
- ***Duration*** – the time between AOS and LOS
- ***Azimuth*** – the compass direction between observer and satellite
- ***Elevation*** – height in degrees above your horizon
- ***Maximum Elevation*** – highest point of the pass in degrees
- ***Pass Predictions*** – a listing showing times when you can see satellite
- ***Footprint*** – the area on the ground covered by the satellite at any given time

Pass Predictions

- Multiple Offerings
  - PC based
  - Mac based
  - Smartphone based
- Things to watch
  - Is your location correct?
  - Are your Keps current? (especially important ISS)
  - Is your clock correct –watch UTC versus Local

Pass Prediction Sites/Software

- http://tinyurl.com/amsat-predict
- http://amsat.org.ar/sat.htm

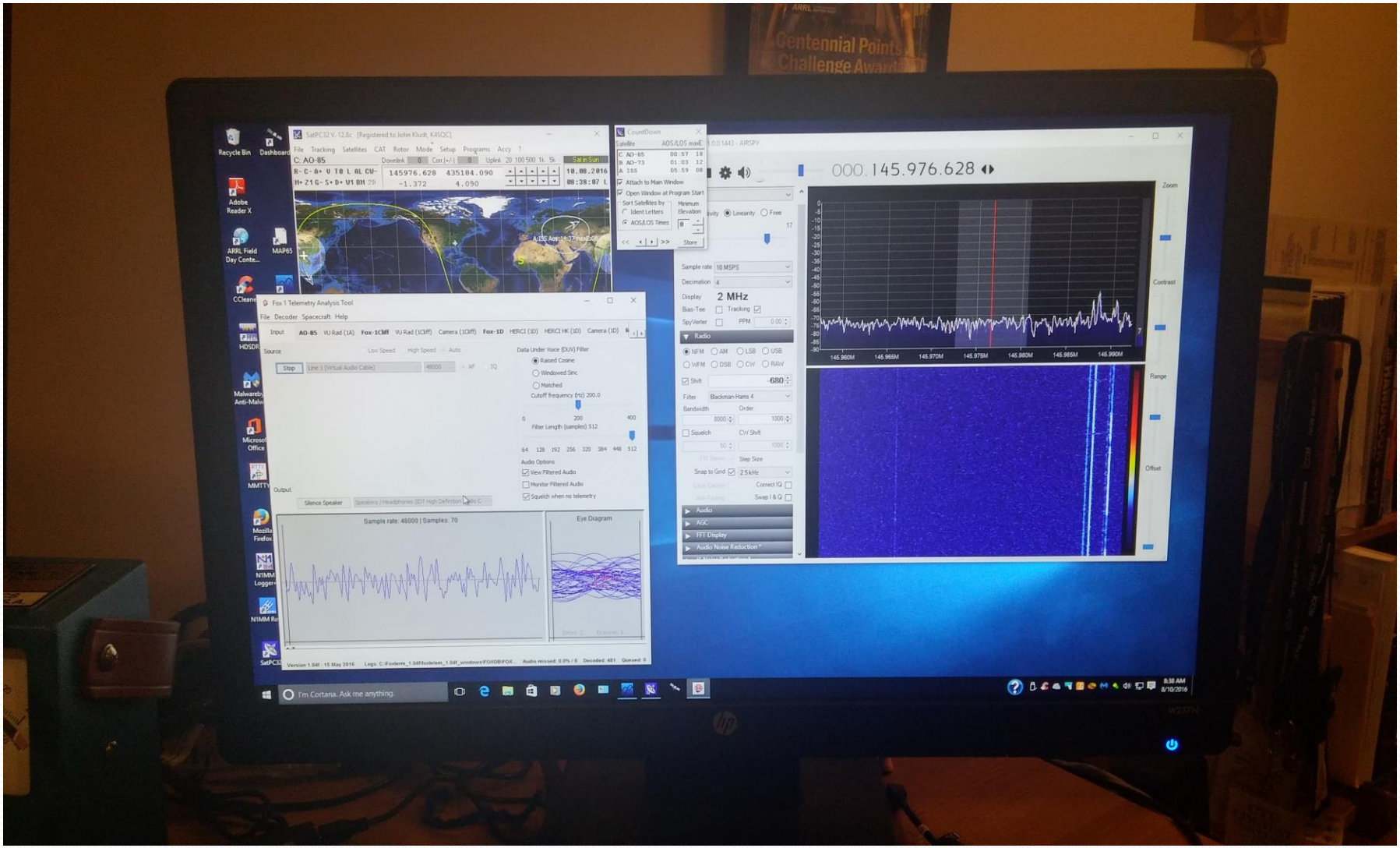
- SatPC32 (Windows)
- Macdoppler Pro (Mac)
- Predict (Linux)
- Gpredict (Linux)
- Numerous Smartphone Apps

Sample Pass Predictions

- WinAos QTH: -84.2/34.1 T#: 13607 Sat.: 5 [Standard]
- ---
- Day Objects AOS (U) LOS Period maxEl AZ
- ---
- 04.04.2015 AO-73 15:11 15:20 09 38 028 - 172
- 04.04.2015 AO-73 16:48 16:55 07 17 337 - 237
- 04.04.2015 FO-29 18:59 19:05 06 09 077 - 025
- 04.04.2015 AO-07 19:27 19:42 15 25 114 - 001
- **04.04.2015 FO-29 20:38 20:54 16 56 148 - 354**
- 04.04.2015 SO-50 20:51 20:58 07 14 149 - 055
- 04.04.2015 AO-07 21:17 21:36 19 65 173 - 340
- 04.04.2015 FO-29 22:24 22:38 14 25 209 - 329
- 04.04.2015 SO-50 22:29 22:39 10 48 224 - 021
- 04.04.2015 AO-07 23:17 23:23 06 08 248 - 296
- 04.04.2015 ISS 23:21 23:24 03 08 149 - 095
-
- WinAos QTH: -84.2/34.1 T#: 13608 Sat.: 5 [Standard]

Telemetry Opportunities

- Another way to “work the satellites”
- Transponder plus data satellites
  - AO-85/91/92
    - (DUV) (Fox 1 Telemetry Analysis Tool)
    - http://www.amsat.org/tlm/leaderboard.php?id=1&db=FOXDB
  - AO-73 (Funcube Dashboard)
    - https://funcube.org.uk/ground-segment/gui/
- Numerous “Data Only” satellites
  - Decode and Upload
  - Contributes to the science


Centennial Points Challenge Award
SatPC32 V. 12.8c (Registered to John Kludt, K4SQC)
C: AO-85
145976.628
435184.090
10.08.2016
08:38:07
CountDown
Satellite
AOS/LOS mawE
C AO-85 00:57 10
B AO-73 01:03 12
A 155 05:59 08
Attach to Main Window
Open Window at Program Start
Sort Satellites by
Ident Letters
AOS/LOS Times
Elevation
Store
000.145.976.628
Zoom
Contrast
Range
Offset
Sample rate 10 MSPS
Decimation 4
Display 2 MHz
Bias-Tee
Tracking
SpyVerter
PPM
Radio
NFM AM LSB USB
WFM DSB CW RAW
Shift -680
Filter Blackman-Harris 4
Bandwidth 8000
Order 1000
Squelch
CW Shift
Step Size
Snap to Grid 2.5 kHz
Audio
AGC
FFT Display
Audio Noise Reduction *
Fox-1 Telemetry Analysis Tool
File Decoder Spacecraft Help
Input
Source
Stop
Data Under Voice (DUV) Filter
Raised Cosine
Windowed Sinc
Matched
Cutoff frequency (Hz) 200.0
Filter Length (samples) 512
Audio Options
View Filtered Audio
Monitor Filtered Audio
Squelch when no telemetry
Output
Silence Speaker
Sample rate: 48000 | Samples: 70
Eye Diagram
I'm Cortana. Ask me anything.
8:38 AM
8/10/2016

Transponder Types

FM Transponders

- FM Only
  - Single Channel
  - Capture Effect
- Fox Series
  - AO-85
  - AO-91
  - AO-92
  - Fox-1B
- SO-50

Analog Transponders

- SSB
- CW
  - Bandpass of 20 to 100 KHz
  - Many signals at once
- Examples
  - AO-7
  - FO-29
  - AO-73
  - XW series

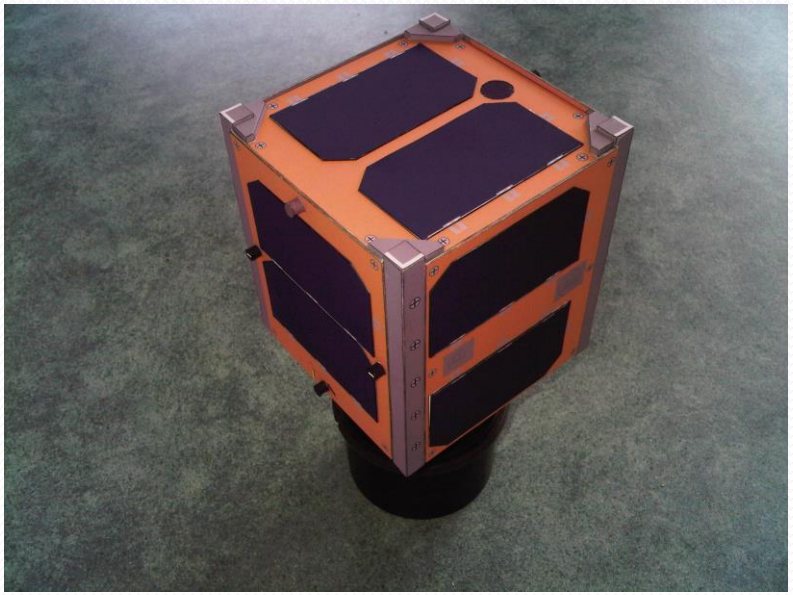
Operational Modes

U/v (435 MHz up/144 Mhz down)

- AO-7*
  - (Sometimes V/a - 144 up/29.5 down)
- AO-73
- AO-85
- AO-91
- AO-92
  - (Sometimes L/v 1.2 GHz up/145 MHz down)
- XW series

V/u (144 MHz up/435 MHz down)

- FO-29
- SO-50



Work SO-50 (V/u FM Transponder)

- LEO satellite
  - Altitude 426 miles avg
  - Speed 16,754 MPH (10 minutes horizon-to horizon)
- FM Transponder
  - Uplink 145.850 MHz (PL 67.0) (-124dBm)
  - Downlink 436.795 (250 mW)

SO-50 Equipment Requirements

- HT or Transceiver with 2m & 70 cm capabilities
  - 5 watts adequate
  - Capable of at least 2.5 KHz steps
  - Full duplex strongly recommended
  - Antenna
    - Arrow +/- preamp
    - Alaskan Arrow
    - Elk
    - Home Brew (VE2ZAZ design)
  - Clock
  - A compass
  - A recording device

Tricky Part - Doppler

SO-50 Downlink 436.795

- Doppler +/- 10 KHz
- Use several memories
- Half above midpoint
- Half below midpoint
- Tune for best audio
- You should be at 436.795 at Max Elevation

SO-50 Uplink 145.850

- Doppler +/- 3.4 KHz
- Stays within standard FM bandpass
- Easy way out – just use 145.850 **PL 67.0** for every step
- "Wake up PL" PL 74.4 for 2 seconds

Doppler Correction Card

By: KK4RGK	Wakeup:	145.850 PL 74.4
SO-50	RX	TX
#1	436.815	145.850 PL 67.0
#2	436.810	145.850 PL 67.0
#3	436.805	145.850 PL 67.0
#4	436.800	145.850 PL 67.0
#5	436.795	145.850 PL 67.0
#6	436.790	145.850 PL 67.0
#7	436.785	145.850 PL 67.0
#8	436.780	145.850 PL 67.0

AO-85/91/92 Equipment Requirements

- HT or Transceiver +/- SDR with 2m & 70 cm capabilities
  - 5 watts adequate, a little more is better
  - Capable of at least 2.5 KHz steps
  - Full duplex *absolutely required*
  - Antenna
    - Arrow +/- preamp *(Tx polarization "twist" may be needed)*
    - Alaskan Arrow
    - Elk
    - Home Brew (VE2ZAZ design)
  - Clock
  - A compass
  - A recording device

AO-85 Frequencies (example)

- Uplink (Pl 67.0)
  - 436.160 MHz (AOS)
  - 436.165 MHz
  - 436.170 MHz (Max E)
  - 436.175 MHZ
  - 436.180 MHz (LOS)
- Downlink
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz
  - 145.978 MHz

Don't forget to turn on your PL – no PL = no contacts
No "easy way out" on U/v

AO-73 (U/v Linear Transponder)

- AMSAT-UK and AMSAT-NL
- Launched November 21, 2013
- 400 mw analog transponder (SSB/CW)
  - Uplink 435.150 MHz – 435.130 MHz
  - Downlink 145.950 MHz – 145.970 MHz
- 400 mw BPSK telemetry beacon (Dashboard)
  - 145.935 MHz
- Per AMSAT-UK website "***not more than 5 watts into a 7dB gain antenna***"

AO -73 Tuning

- Some what tricky
  - Doppler &
  - *Drift* in the master oscillator
  - So, *cat control really doesn't work very well*
- Follow "The One True Rule"
  - Find yourself by tuning the *higher* frequency link
  - *Uplink* on AO-73
  - Then tune uplink to stay on a relatively constant receive frequency that will itself drift and require retuning

Pass Reminders

- It is going to seem to be very busy
- Compass
- Visual AOS reminder
- Visual Max Elevation reminder
- Visual LOS reminder
- An elevation reminder
- An easy to read clock
- Tape recorder
- Open your squelch all the way on FM birds

I Didn't Hear Myself or Anything!

- Pass predictions correct?
  - Location
  - Keps
  - Time
  - True North?
- Was the satellite on?
  - http://www.amsat.org/status/
- FM – did you have your PL (67.0 Hz) turned on?
- Rig/antenna issues?

“Five and Dime”

- Forward looking effort to explore new technology
- New SDR based communications platform
  - 5 GHz up
  - 10 GHz down
- Ground station component
  - AMSAT Phase 4 Ground Terminal team
    - http://www.arrl.org/arrlletter?issue=2016-02-25#toc07
  - Work underway – “water tower test system”

“Five and Dime” Flight Possibilities

- “Five and Dime” Space Team
  - Phase 4B Geosynchronous Ride share
    - Huge ARES potential
    - Several important groups on board
    - 2018 timeframe
  - Phase 3E (?)
    - Highly elliptical orbit, similar to AO-40
    - Long communications periods at apogee

AMSAT Membership

- Great way to explore new opportunities in a time of decreasing HF propagation
- Satellites expensive to build
  - Good parts (don't just drive up to the site to fix!)
  - Huge amounts of engineering
  - Rigorous NASA flight testing
  - As much as $100,000 per launch
- Basic membership $44 per year
  - AMSAT Online Store http://store.amsat.org/catalog/

Questions?