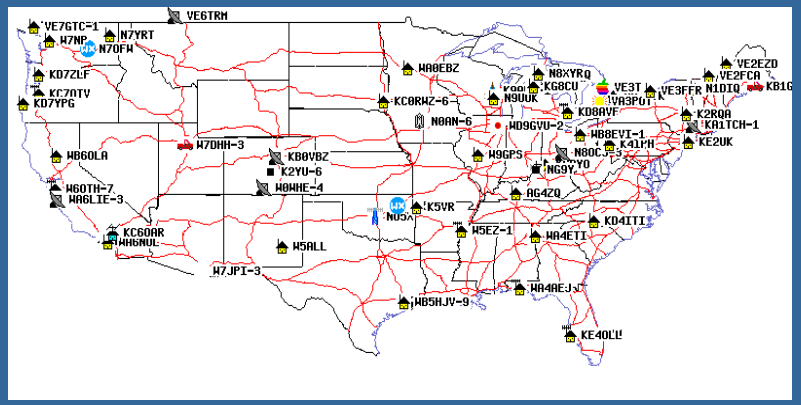
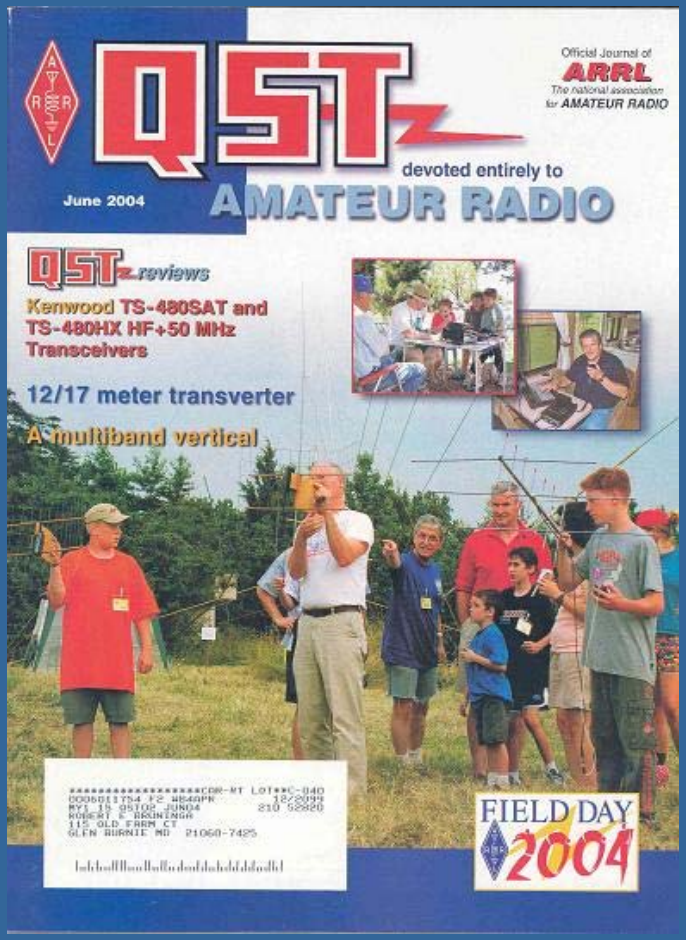
APRS Space Network

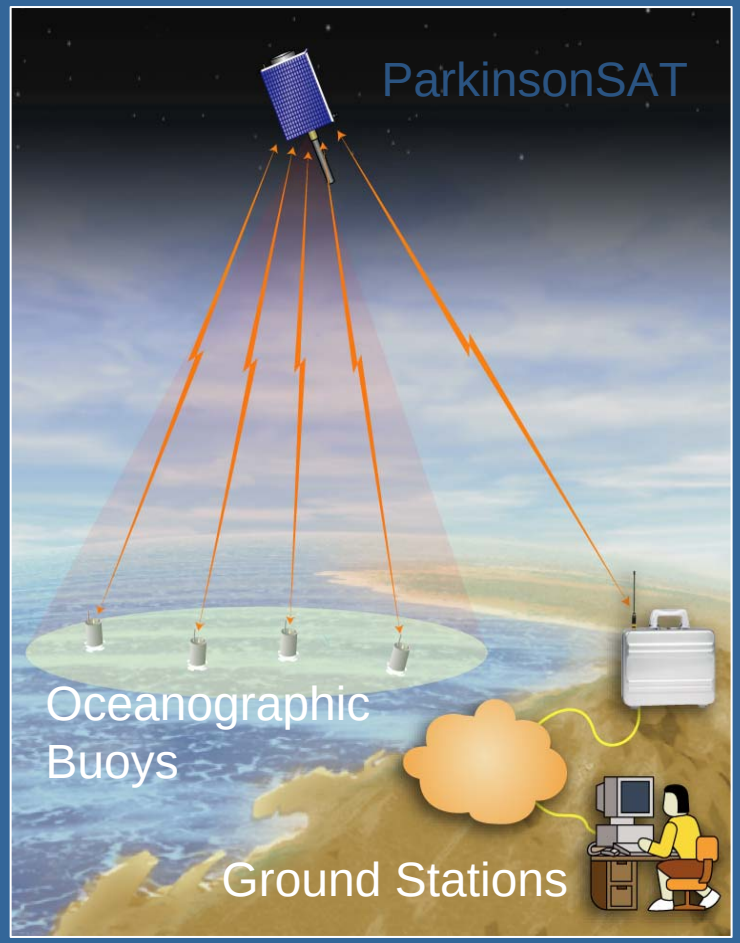




- APRS space frequency is 145.825 MHz
- Also via GO-32 on 435.225 downlink, 145.85 MHz up

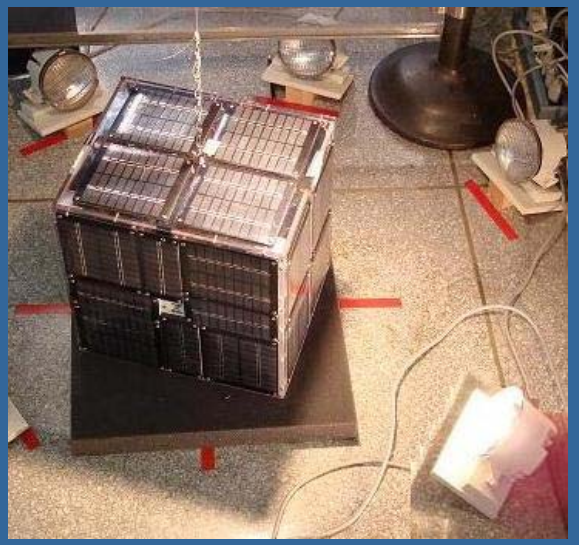
Cubesat 2008

P-SAT Mission Concept



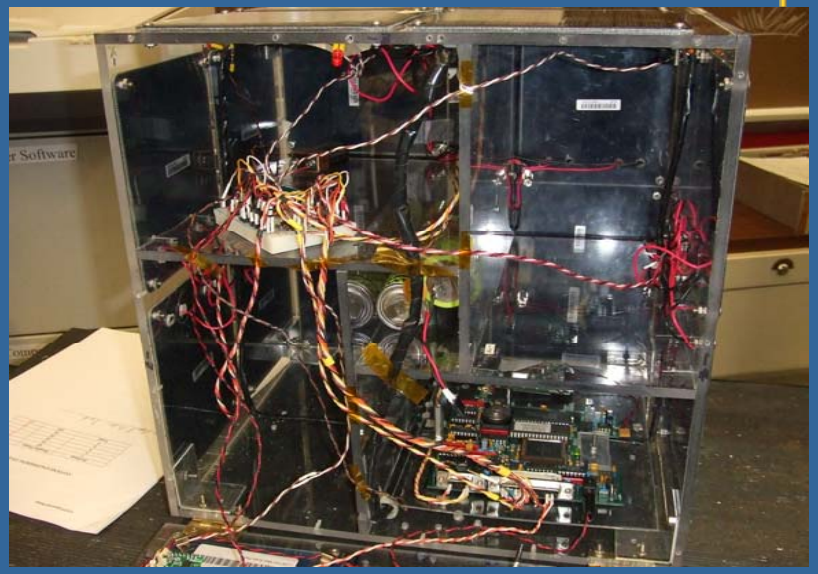
A transponder for the relay of remote environmental sensor and other low duty-cycle data.

3 Axis – Sun Pointing



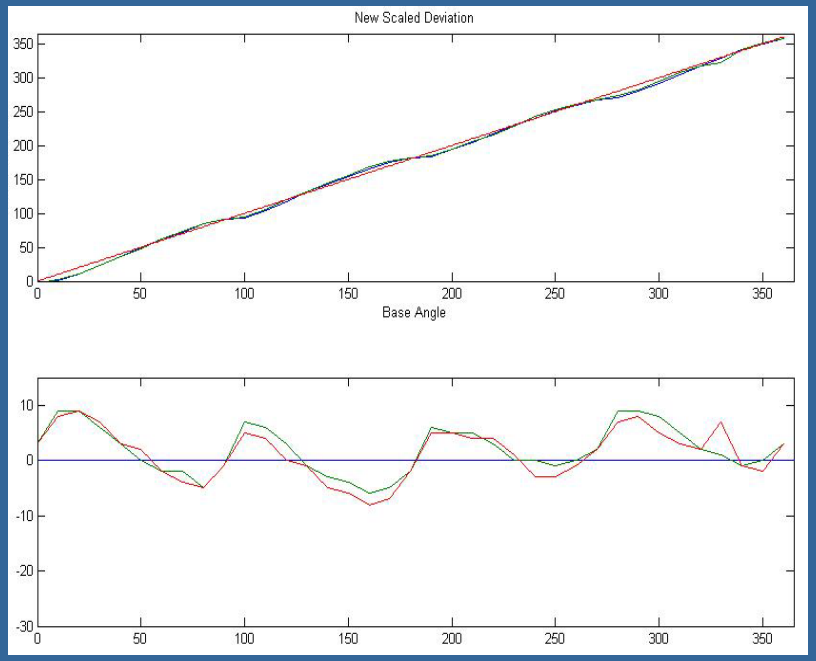
ADCS Simulator

- Structure
  - PSat Dimensions -1 cubic foot
  - 50% PSat Mass – 18lbs
- Hung from 16’ of 2x30lb fishing line
- 2 Operational Magnetorquing Coils
  - #30 wire 130 turns
  - 100 mA; approx. 55 ohms
  - Torque of 10E-4 N-m
  - Red LED coil indicators
- Magnetorquing Coils in X and Z-Plane
- Solar Panel Configuration
  - 6 Panels on the +Z face
  - 4.5 Panels on the –Z face
  - 4 Panels on X & Y faces

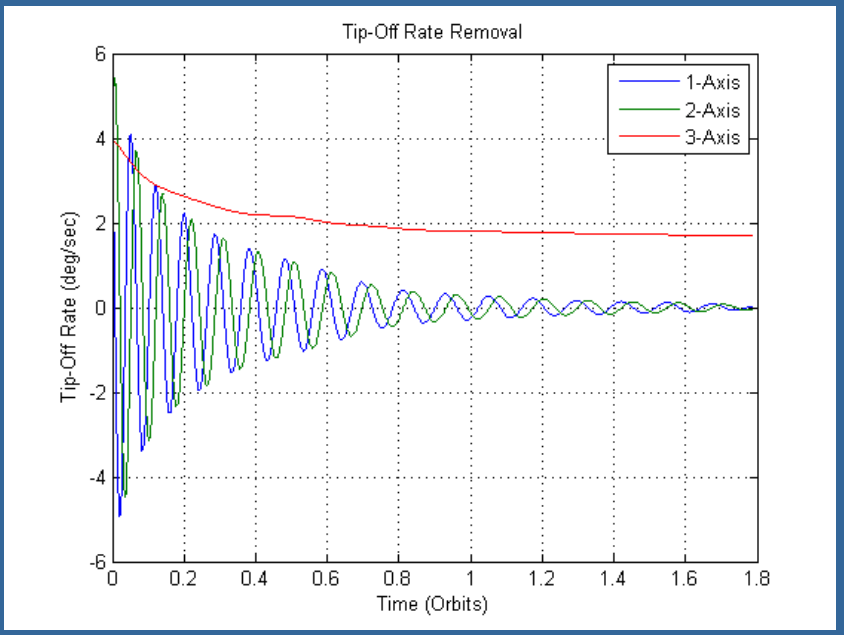


$50

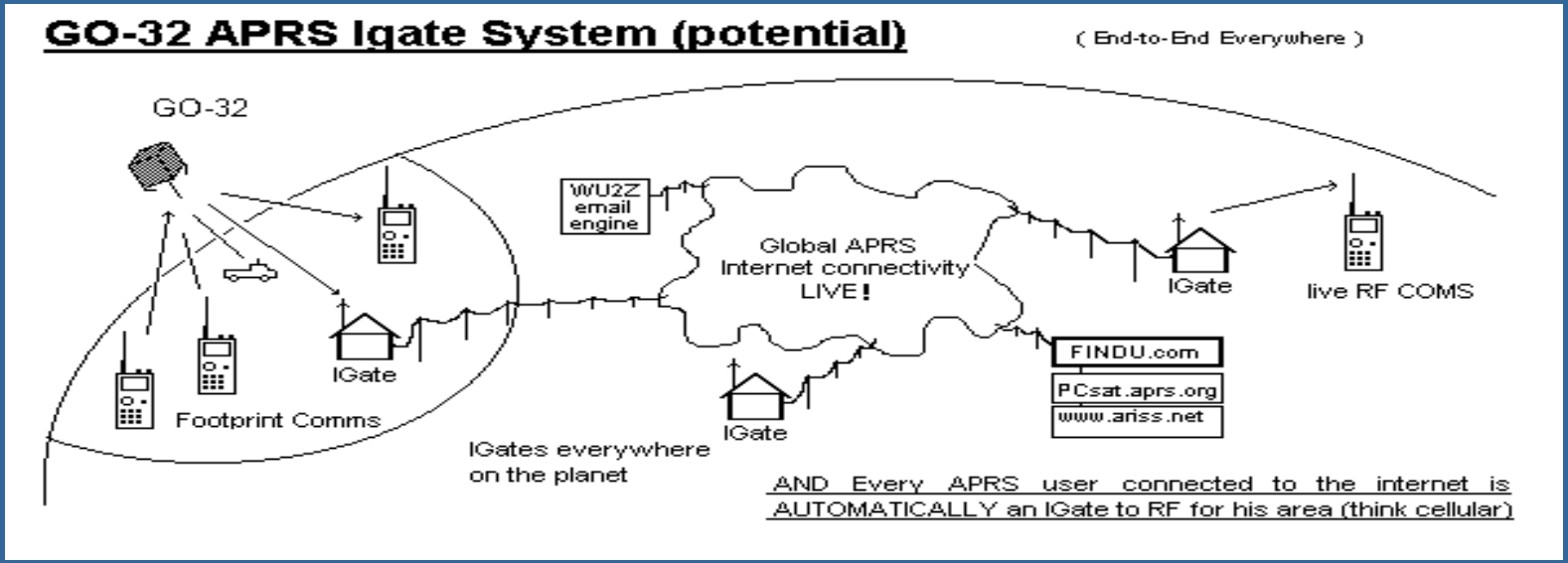
ADCS Test Results



- Lights too close!
- Re-test at 16 feet
- Results give max error of 9 degrees, within limits



Comms Satellites Benefit Others!

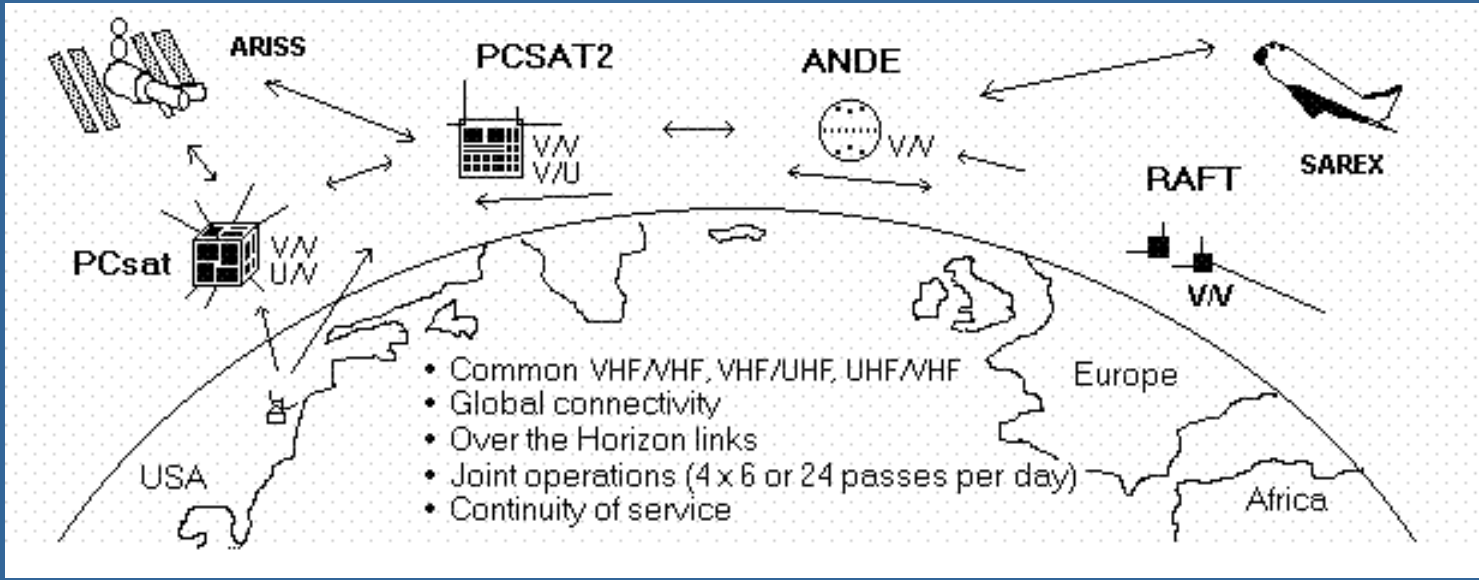


Satellites for education need to provide access to other Student Projects

IE - Environmental sensors, WX stations, position/status reporting

APRS Satellite Constellation

All on 145.825 MHz with *Generic* links



Generic Global Connectivity

8 Cubesats would provide 1 hour access 24/7/365 to handhelds

For mobiles, would provide 30 minute access

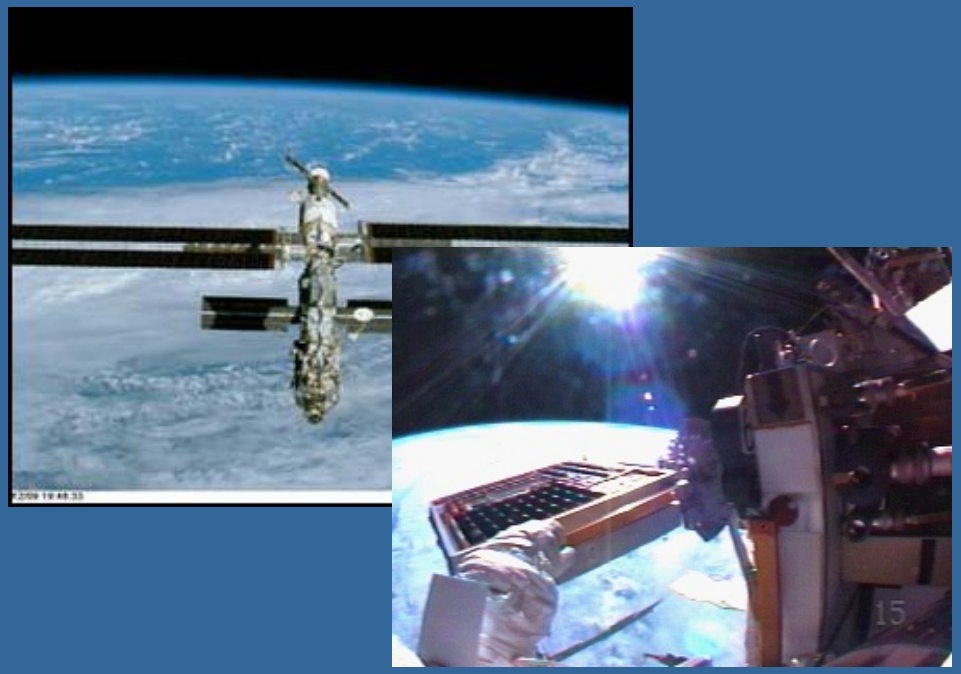
APRS Space Applications

- PCSAT-1 (Prototype Communications Satellite) is a US Naval Academy Aerospace student project.

ANDE and RAFT
in Dec 2006-2007

- APRS space frequency is published as 145.825

APRS on ISS!



- ARISS supports APRS on 145.825 too!
- Use digipeater path VIA ARISS.
- PCSAT2 was also on ISS 2005-2006

PCSAT2, was the second APRS digipeater satellite.

See live downlink on www.ariss.net

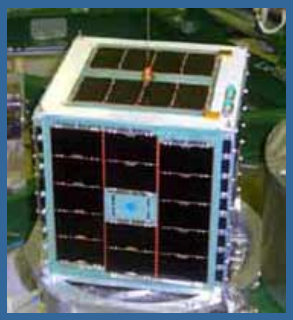
Now GO-32 TECHSAT-1b

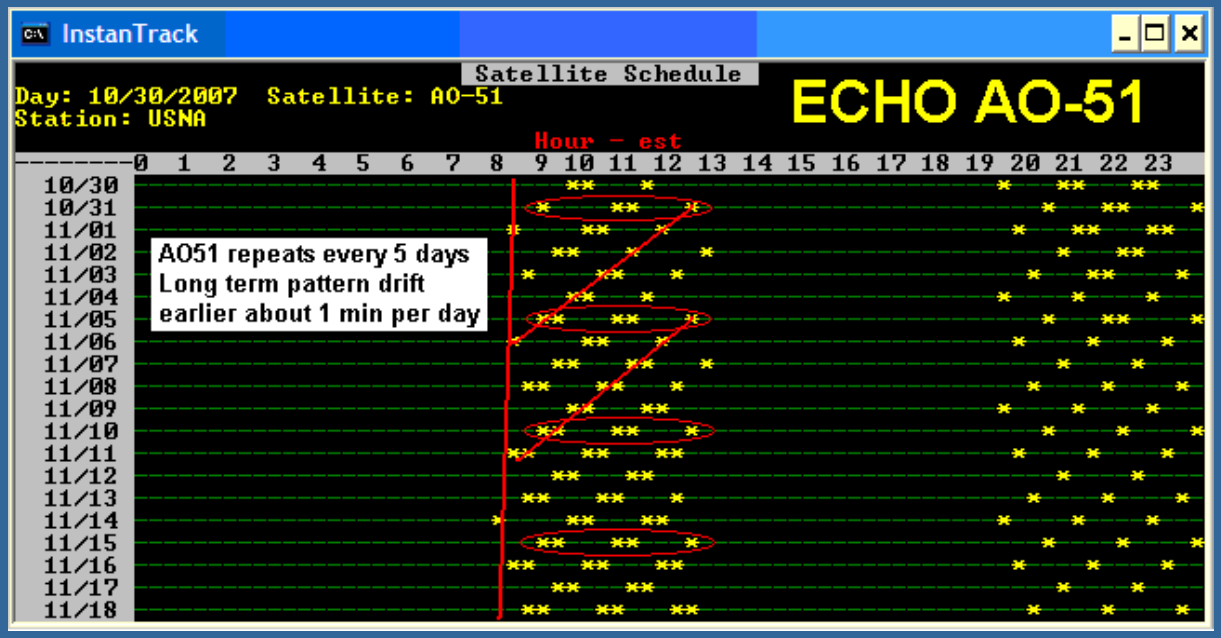
- GO-32 now supports APRS on its 435.225/145.85 packet system.
- APRS up on 145.85 (PC's and messages)
- Mic-E up on 145.93 (D7 and D700's)

9600 Baud!

See live downlink on www.ariss.net

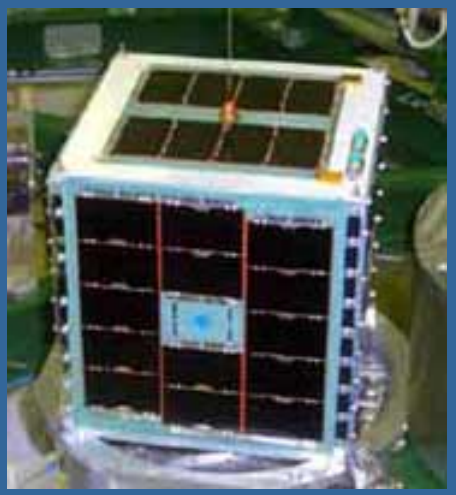
Tracking is EASY! (AO51)





- No computer needed
- Two or more solid passes to handheld every day

Tracking ECHO (AO51) too!



01Aug	07Aug	13Aug	19Aug	25Sep
0850	0950	0910	0830	0930
			1005	
2000	2100	2020	1940	2040
			2120	

for Wash DC and NYS

Thurs, 14 August

- No computer needed
- Two or more solid passes to handheld every day
- Five or more uplink passes for mobiles, etc

GO32 -EZ - MOBILE Satellite Prediction and Tracking

This table is for Washington/Baltimore but works for all points north and south.

01Aug	11Aug	21Aug	31Aug	10Sep	20Sep	30Sep	09Oct	19Oct
0930	0910	1025	1005	0940	0920	1040	1015	0950
	1050				1055			
2050	2030	2005	2125	2100	2040	2015	2135	2110
	2210	2145				2155		

WB4APR

Tracking GO-32 in the mobile is easy, because the passes repeat every 10 days. Just prepare a table like the above and stick it on your mobile dashboard, and then any day, morning or evening, you will know when the next pass you can hear will be in range. For uplink there will be a pass 100 minutes before and 100 minutes after too.

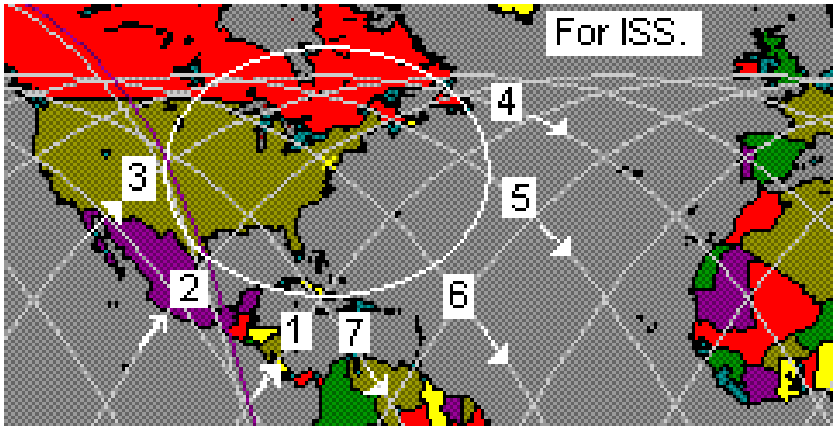
- No computer needed

Thurs 14 Aug is shown

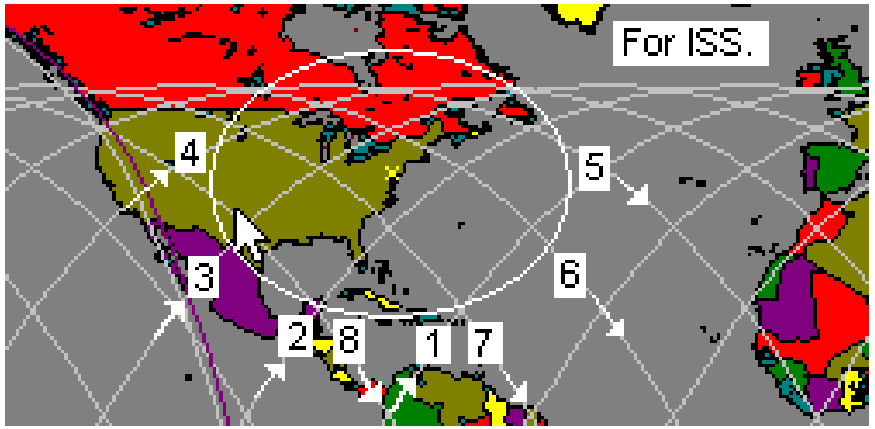
- Two or more solid TX/RX passes every day
- Two additional TX passes 100m before and after!

Tracking is EASY! (ISS)

Alternating ISS Pass Geometries for US Naval Academy at 39°N latitude



Two excellent overhead passes per day (2,6)
Four OK passes up to 10 deg (1,3,5,7). This pattern occurs every other day.

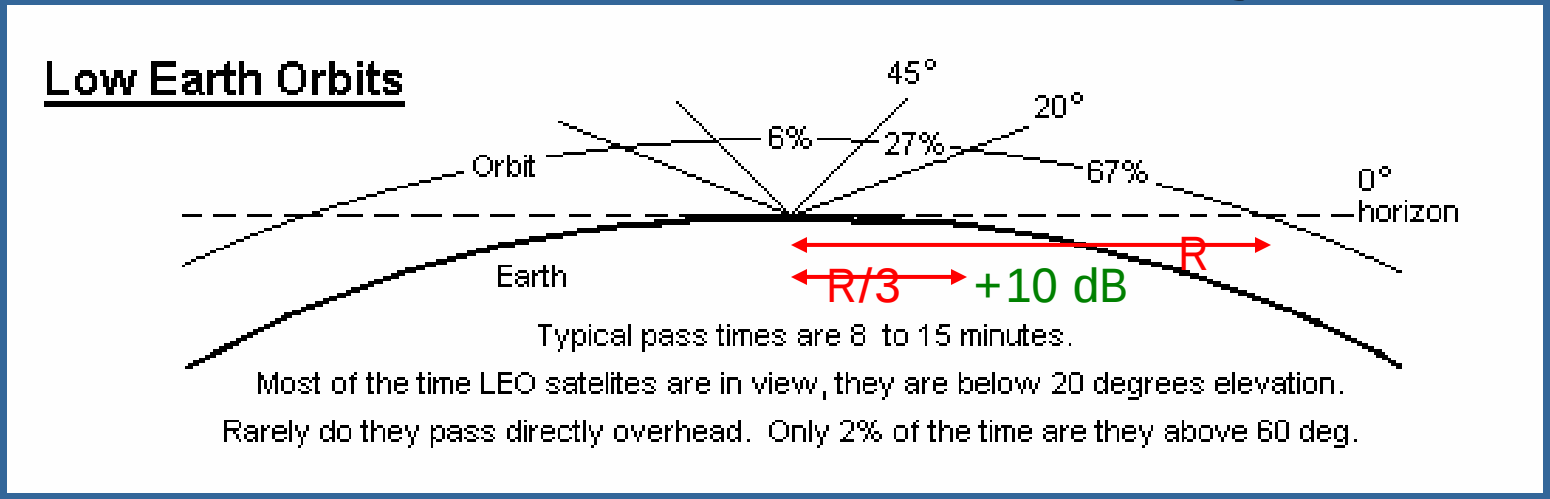


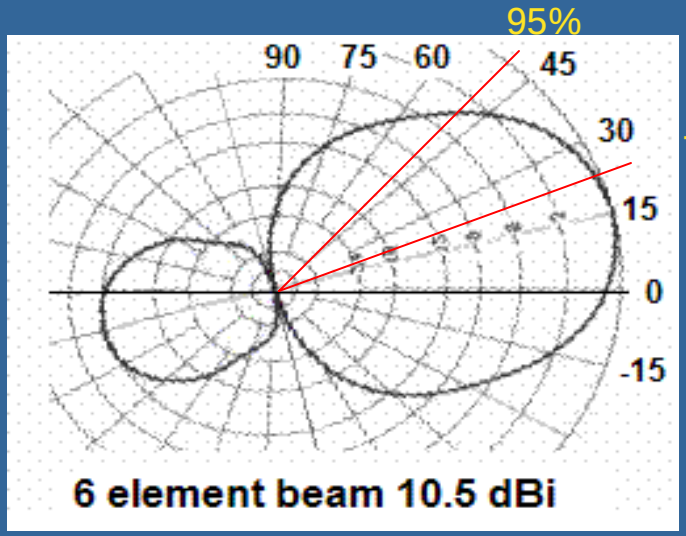
Four good 30 degree passes per day (2,3,6,7).
Four very low <5 deg passes per day (1,4,5,8).
Pattern occurs every other day.

WB4APR

- No computer needed!
- Similar Passes every other day.
- 22 minutes earlier each day???

LEO Pass Geometry





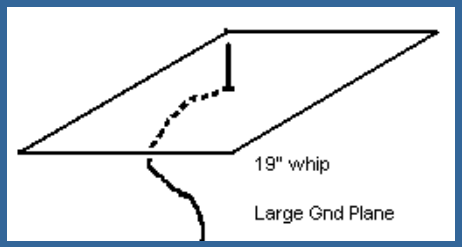
70%

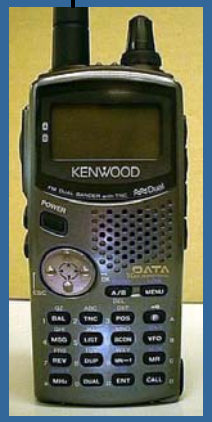
Only Azimuth Tracking is needed!

- 10 dB gain Horizon-to-horizon
- 98% of all in-view times
- Using $75 TV rotator only

Omni Antenna Gain 7 dBi !

¾ wave vertical



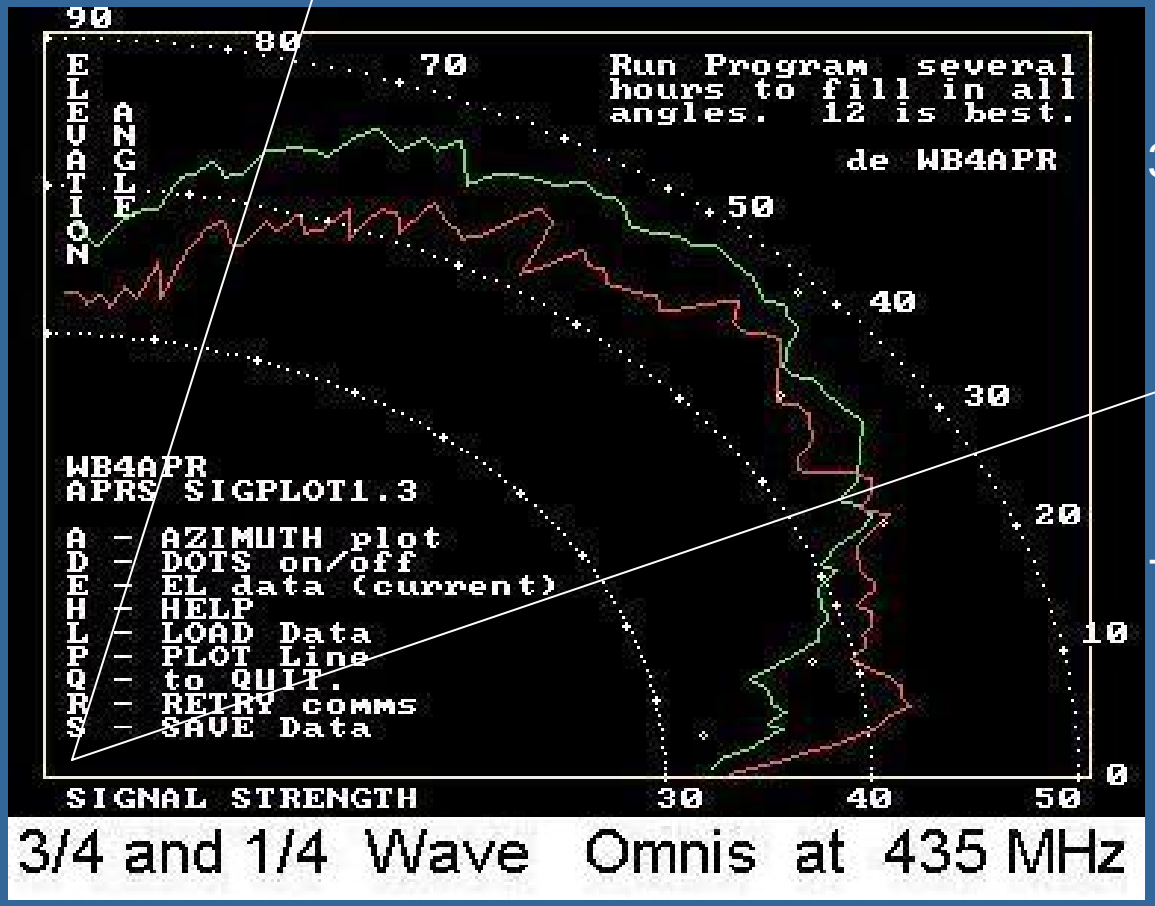


SATgate!

1%

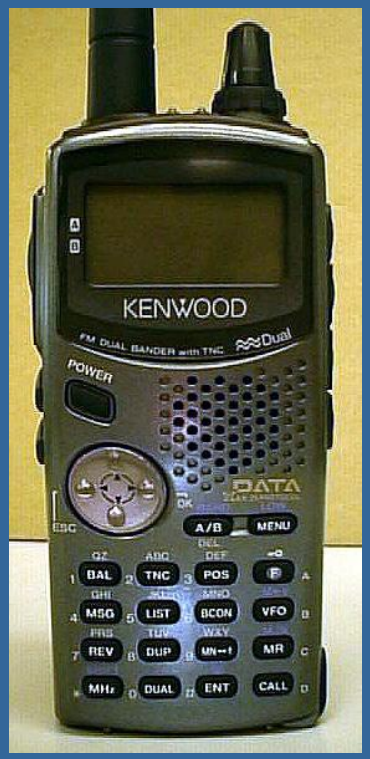
30%

70%

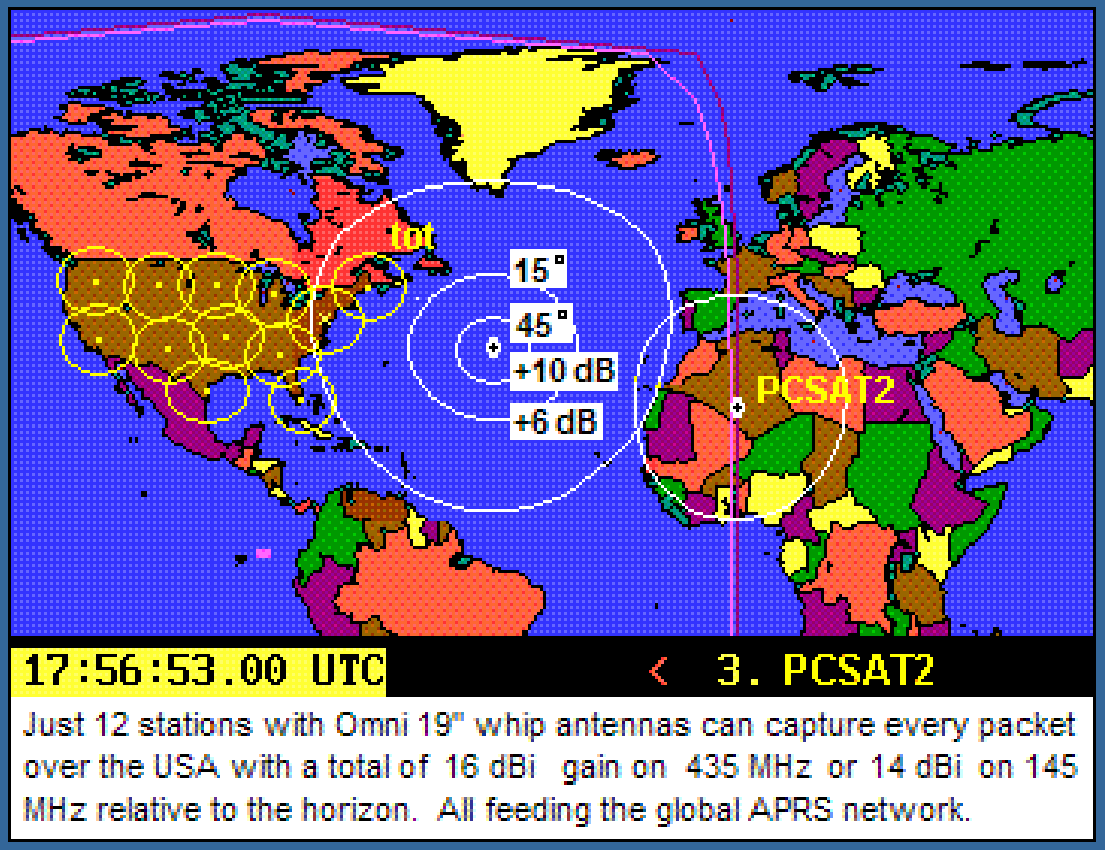


3/4 and 1/4 Wave Omnis at 435 MHz

Combined Omni Gain
Path Gain + Antenna Gain !



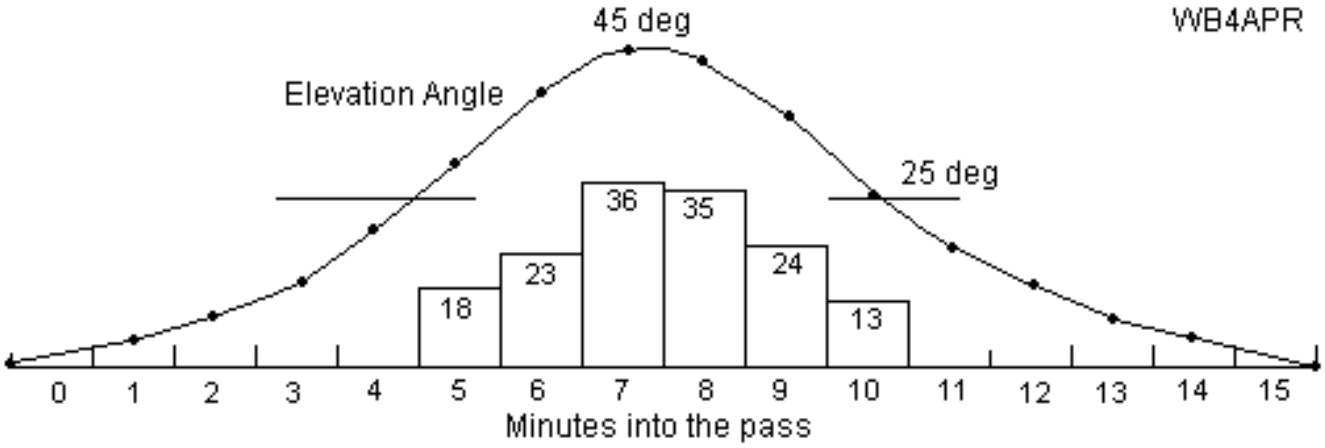
SATgate!



Just 12 stations with Omni 19" whip antennas can capture every packet over the USA with a total of 16 dBi gain on 435 MHz or 14 dBi on 145 MHz relative to the horizon. All feeding the global APRS network.

Omni SatGates

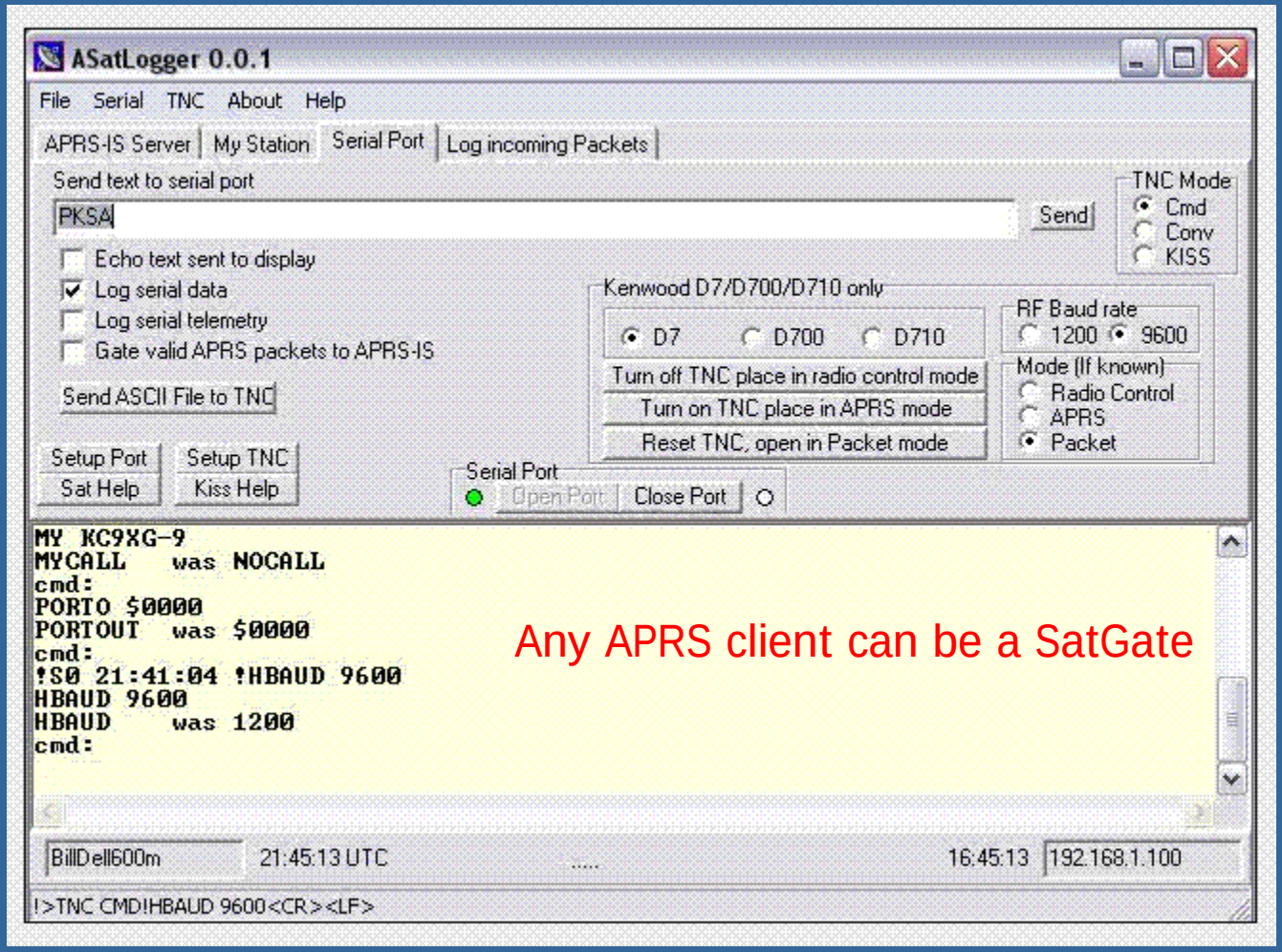
Get about 3 minutes of data (each)



This plot shows the total packets per minute received by my TM-D700 APRS mobile radio using a mag-mount 19" whip on the roof of my car. In this case I was tracking Doppler, starting at 435.230, then 435.225, and ending at 435.220 MHz. Since the satellite is too far away at any elevation below about 25 degrees, only the central frequencies are useful.

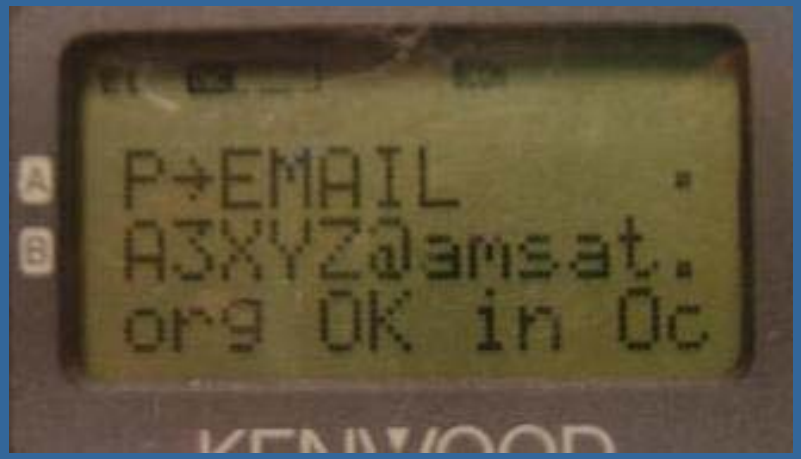
Promoting Student Ground Station Involvement worldwide!

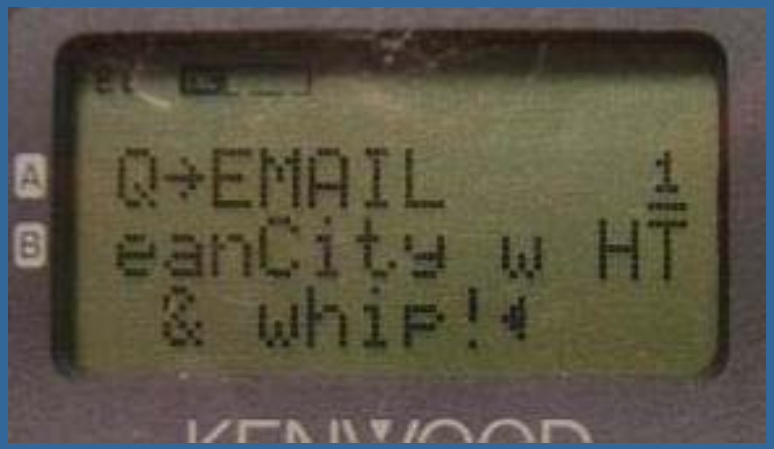
Omni SatGates (Alogger)



APRS Satellite Msgs/Email

MSG menu

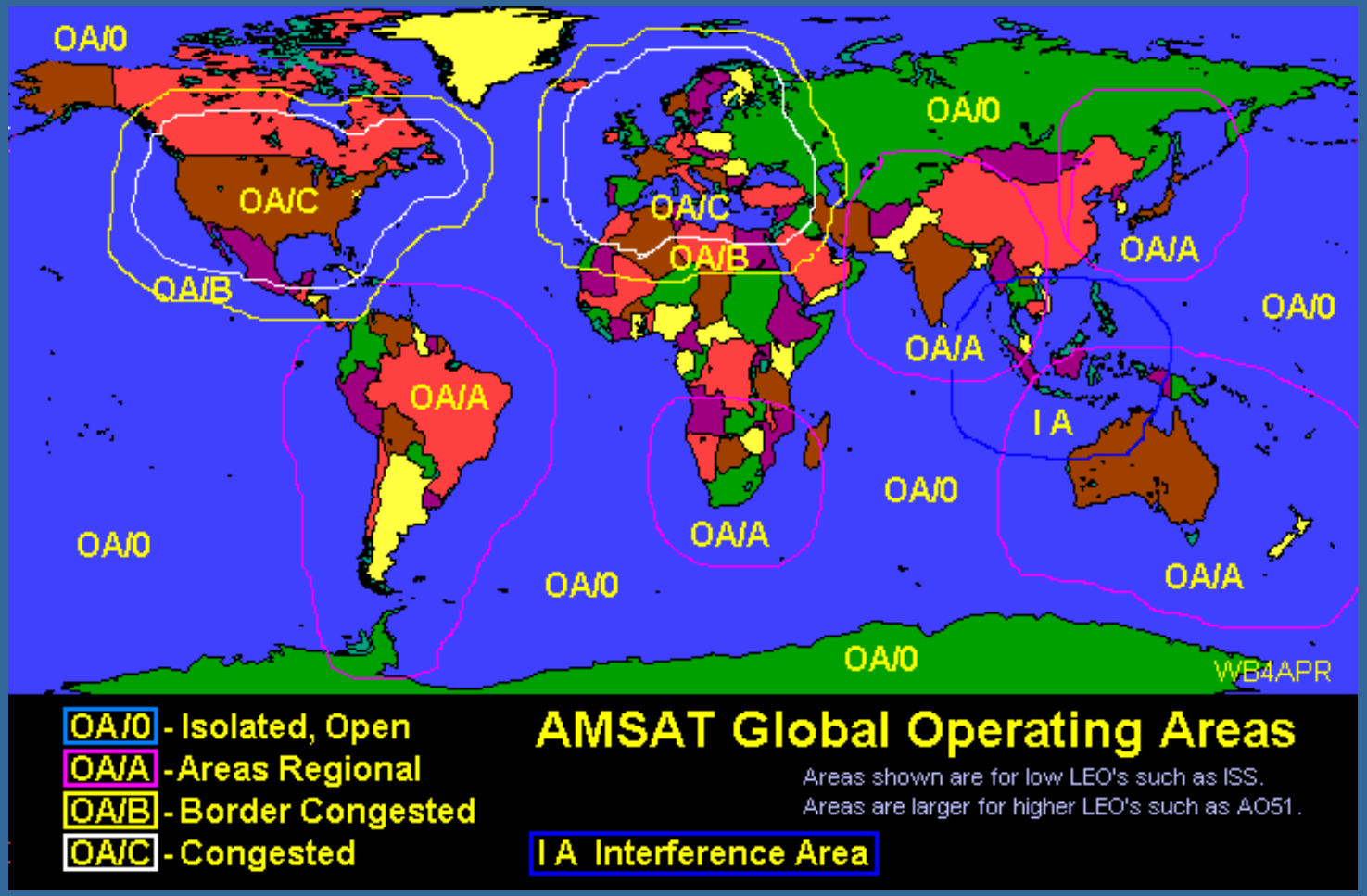




Send/Receive messages or email

Anywhere on the planet via APRS satellite

AMSAT Operating Areas



What is APRS?

- **APRS** = Automatic Packet Reporting System

- **APRS** was developed in the early 1990's for local tactical digital communications, situational awareness and TWO-WAY information exchange using Amateur radio.

- Not just Vehicle Tracking!

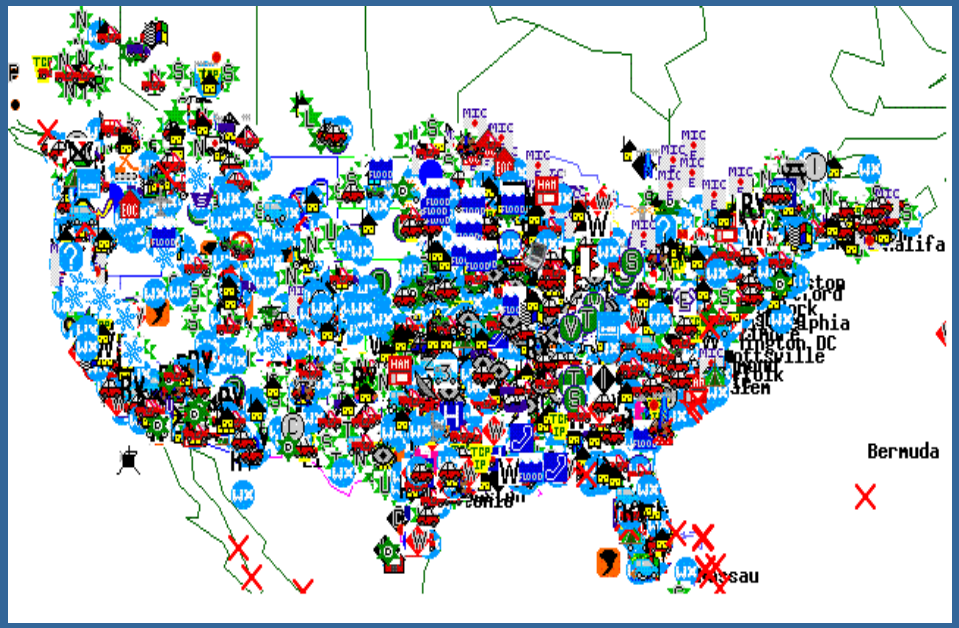
What is APRS all about?

- Immediate local digital and graphical information exchange between all participants in a local area or event. This includes:
  - Positions of all stations and objects
  - Status of all stations
  - Messages, Bulletins and Announcements
  - Weather data and telemetry
  - DF bearings and signal strengths for quick transmitter hunting
  - RF Connectivity plots of all stations
  - Local OBJECTS on a common map display for all users
  - Local Freqs, Nets, Meetings
- Typical applications are:
  - Routine local awareness of all ham radio events and assets around you
  - Marathons, races, events and public service
  - Search and rescue
  - Family communications and tracking and one-line emails
  - Mobile-to-mobile global messaging
  - Weather data exchange and display
  - Efficient multi-user Satellite communications

Scope of APRS

30,000 experimenters to draw from

- APRS consists of a very large land based wireless network. Almost 30,000 users around the world.
- This network works via RELAYS every 20-30 miles called “digipeaters.” And Globally via IGates to the internet.
- APRS is also used via some of the Amateur Satellites.
- It is also used to monitor telemetry values of weather stations for the National Weather Service (NWS)
- APRS has the capability to quickly relay telemetry values to research centers without the Internet.



But, only 10% try Satellites

Only 0.1% on any given orbit...

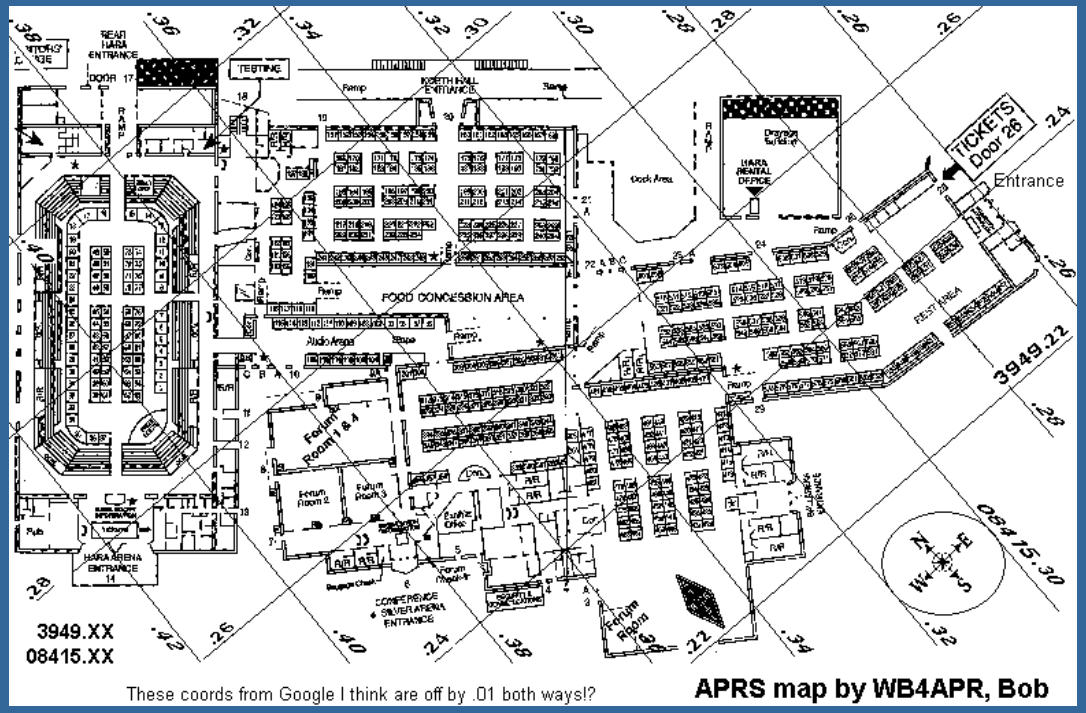
Peak User Transponder Load is < 4%

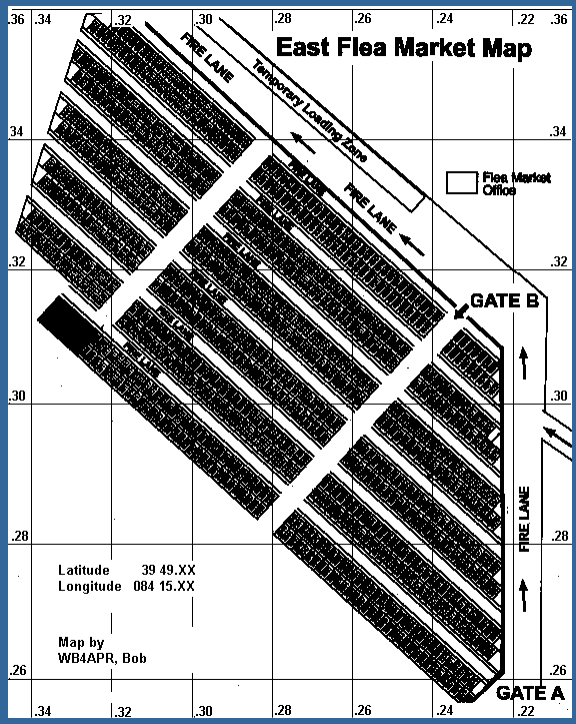
APRS MisConceptions!

See **APRS-tactical.html**

- That APRS is just Vehicle Tracking instead of a **Real-Time Information Distribution System**.
- That APRS is dependent on GPS for its value **(GPS is not needed. See Objects)**.
- Using APRS clients that only do maps and ignored **APRS Comms fundamentals**.
- Failure to understand the importance of OBJECTS: . See **Objects 101**
- Failure to use real-time messaging: . See **Messages 101** and **Message Operations**
- Failure to implement the original APRS Centralized **Common Bulletin Board**
- Not understanding the APRS operator's role of ***Data Input*** **(Objects, Bulletins and Messages)**
- Not realizing the importance of **Voice Operating frequencies** in APRS.

APRS, maps and events

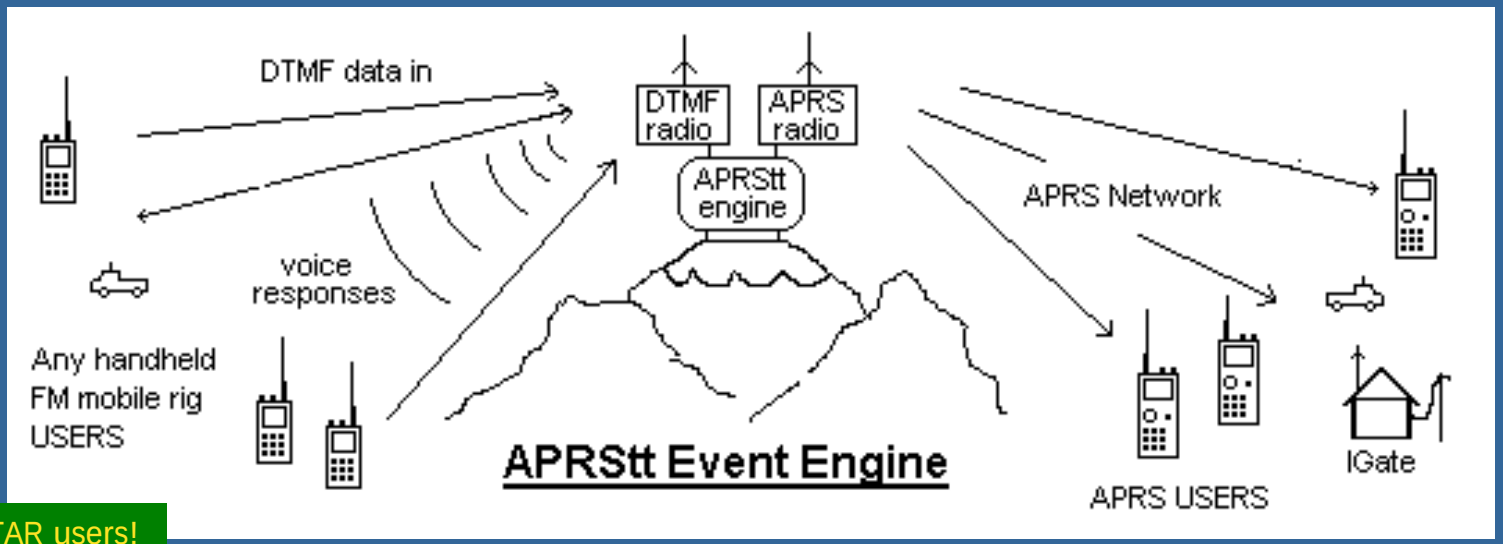




- That APRS is dependent on GPS for its value
- **(GPS is not required to put things on maps).**

APRStt (Touchtone) or any other source(Dstar)

See **aprstt.html**



& DSTAR users!

- Simple DTMF memory - One button puts you in APRS (Position, Frequency and Status)!
  - DTMF on voice freq translated to packet on APRS channel (or direct to APRS-IS)
  - Position is 10 mile ambiguity using repeater posit (or 60 mile ambiguity out west)
  - Frequency in packet is Frequency of Repeater
  - If Echolink or IRLP, APRS packet includes node number!

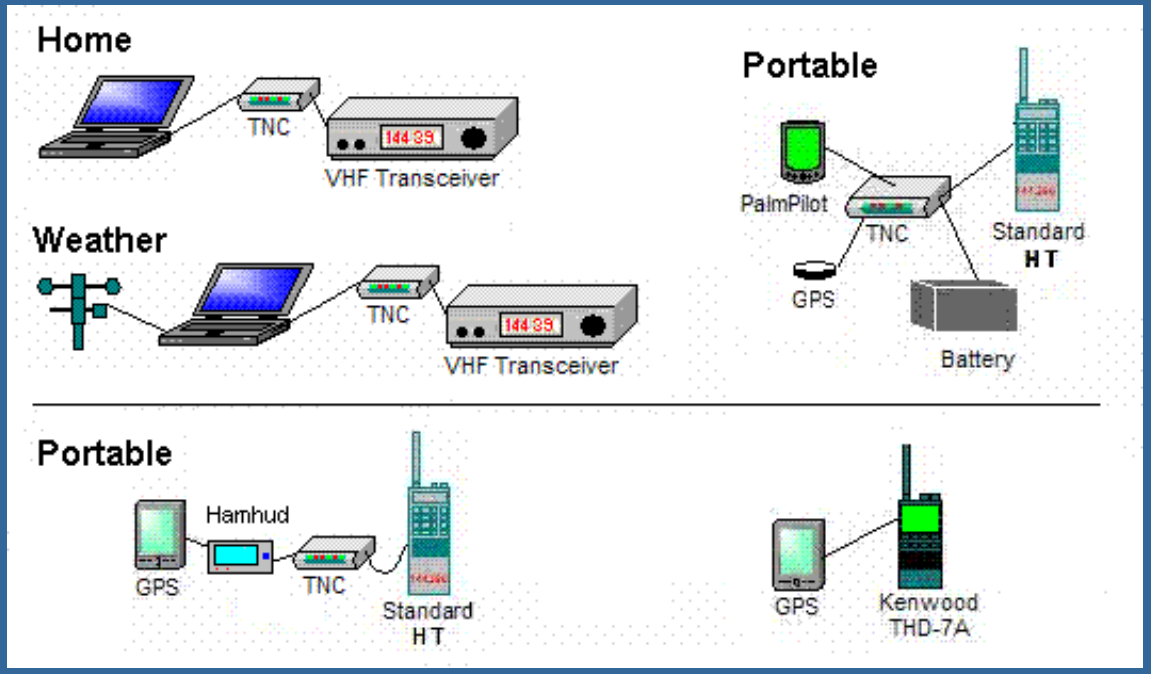
APRStt (Touchtone)

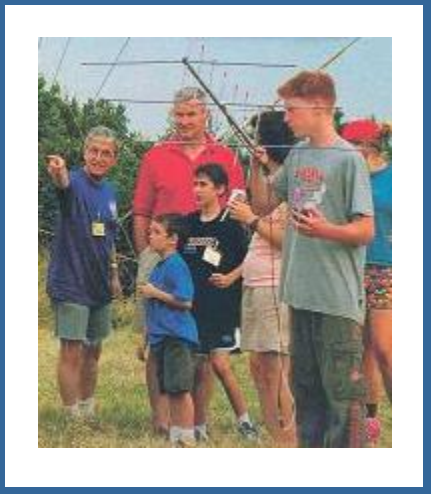
See **aprstt.html**

147.105MHz T107 R30m

- DTMF Report shows on APRS!
  - CALLSIGN with date and time
  - Position in vicinity of repeater or APRStt entry point
  - Voice Operating Frequency, Tone and other info
  - Node number if Echolink or IRLP, or reverse patch number if Repeater

Various APRS Stations (two-way)





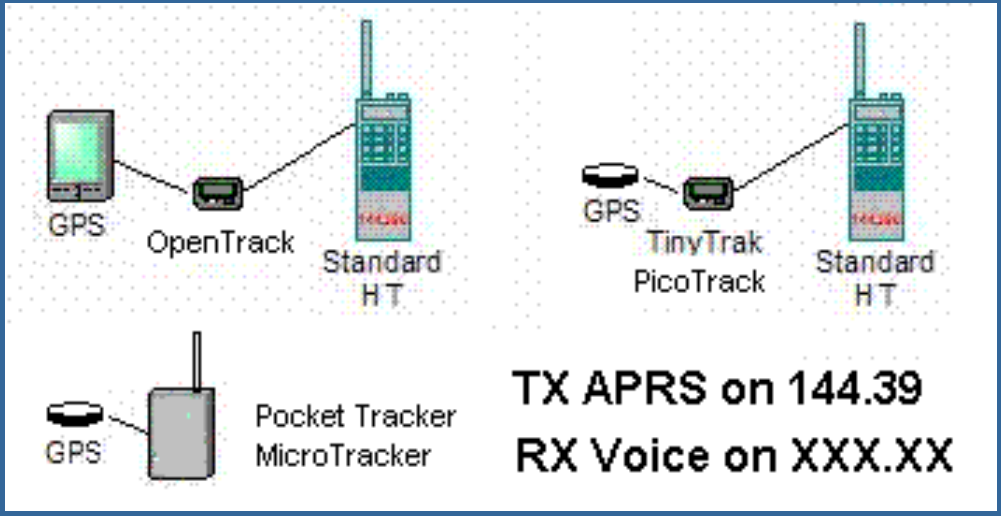
And Satellite

APRS is a Network intended for real-time Tactical INFORMATION exchange. This means 2-WAY.

TRACKERS (and Buoys)

One-way APRS is not normally recommended. APRS is a Network. We want good communications among all participants for maximum utility.

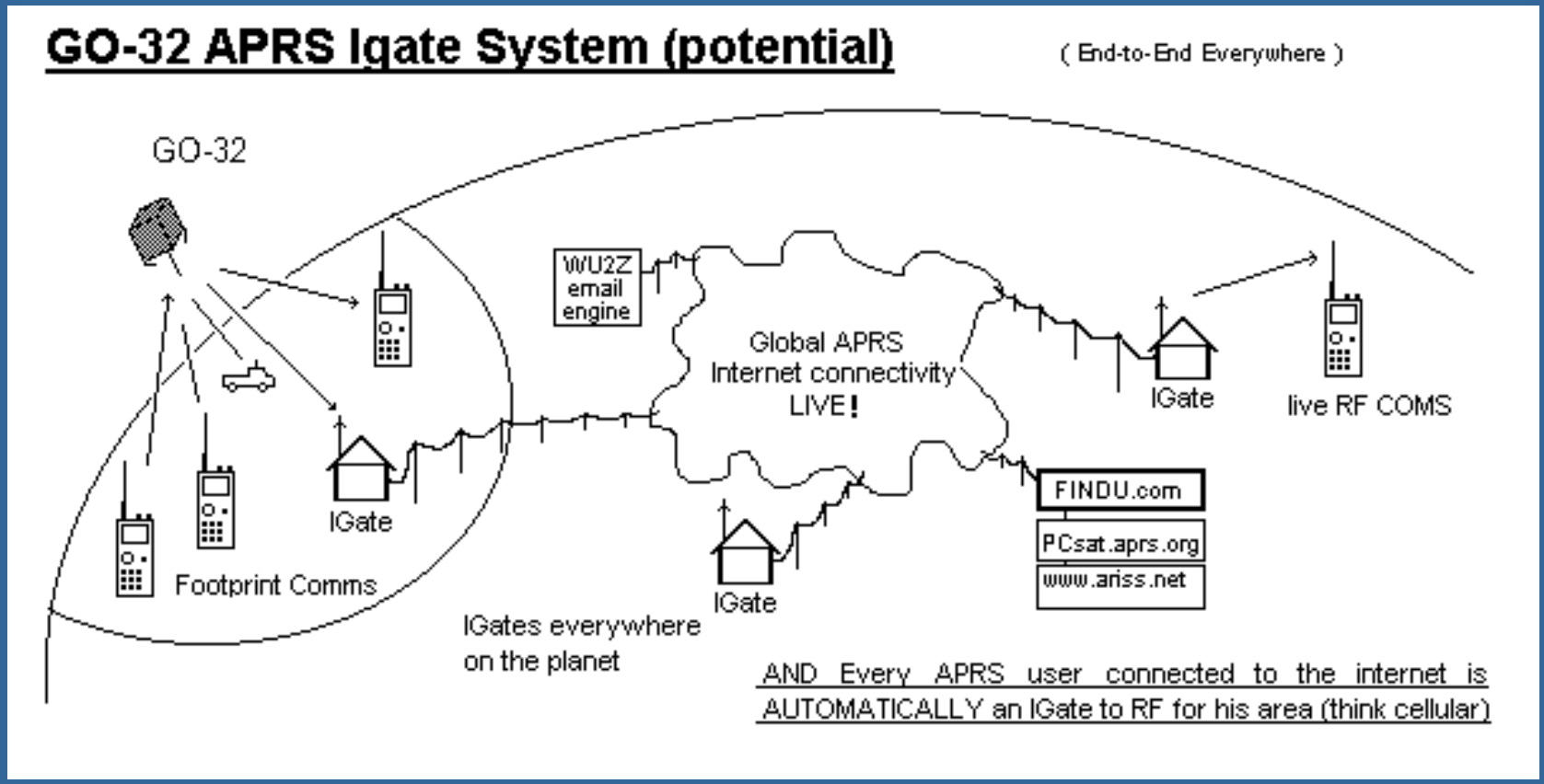
But for some very remote applications, APRS is a great way to communicate small data packets from remote locations...



Satellite APRS

On 145.825 MHz

Global Mobile and Portable Satcom



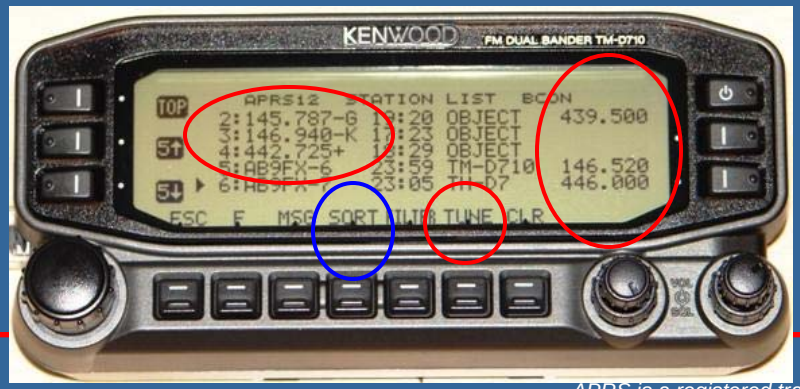
Mobile/Portable Satellite Terminals

Kenwood TM-D700A

- Dual band 144/440 MHz 50/35 Watts
- Built-in 1200/9600 bps TNC including digipeater
- Built-in screen display of other APRS stations and front-panel send/receive messaging.
- Other APRS station locations are sent to the attached GPS map for display.

TM-D710

- Adds operation Freq to every posit !
- Auto tunes to others with Freq!
- Shows local Voice Repeaters !



Kenwood TH-D7A(G)

Alinco DR-135T/EJ-41U

- Basic 2 M Radio with optional TNC.
  (Opentrack makes a drop in tracker module)
- Allows direct input from any standard GPS.

- Basic 1200/9600 bps TNC

- Unlike the Kenwood radios, it requires a PC to set it up, and there is no APRS display directly on the radio.

Yeasu VX-8R

- “APRS” announced at Dayton?
- Optional GPS in spkr-mic
- Features of D7

APRS Voice Alert! *

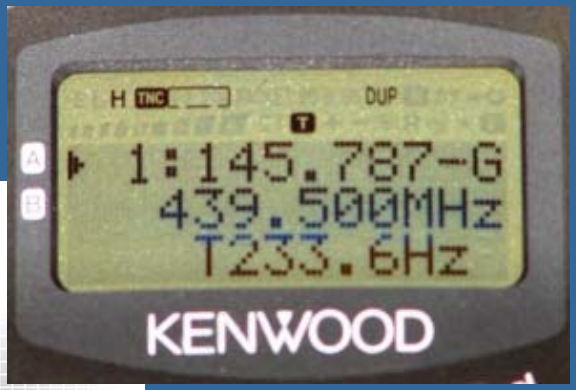
(For all mobiles!)

- Voice Alert is effectively 3rd Radio channel for the D7 and D700 APRS radios
- By setting the APRS Band, A, to PL-100, but keeping the volume turned up:
  - You wont hear any packets on 144.39 *
  - But you will hear a voice call using PL-100 on 144.39
  - And you will hear* an occasional Ping packet if another D700 comes in line-of-site to you, like a proximity radar alerting you to local presence.
- Great for long haul traveling and meeting other APRS users.

APRS – IS - Local Info/Data!

Last 100 stations!

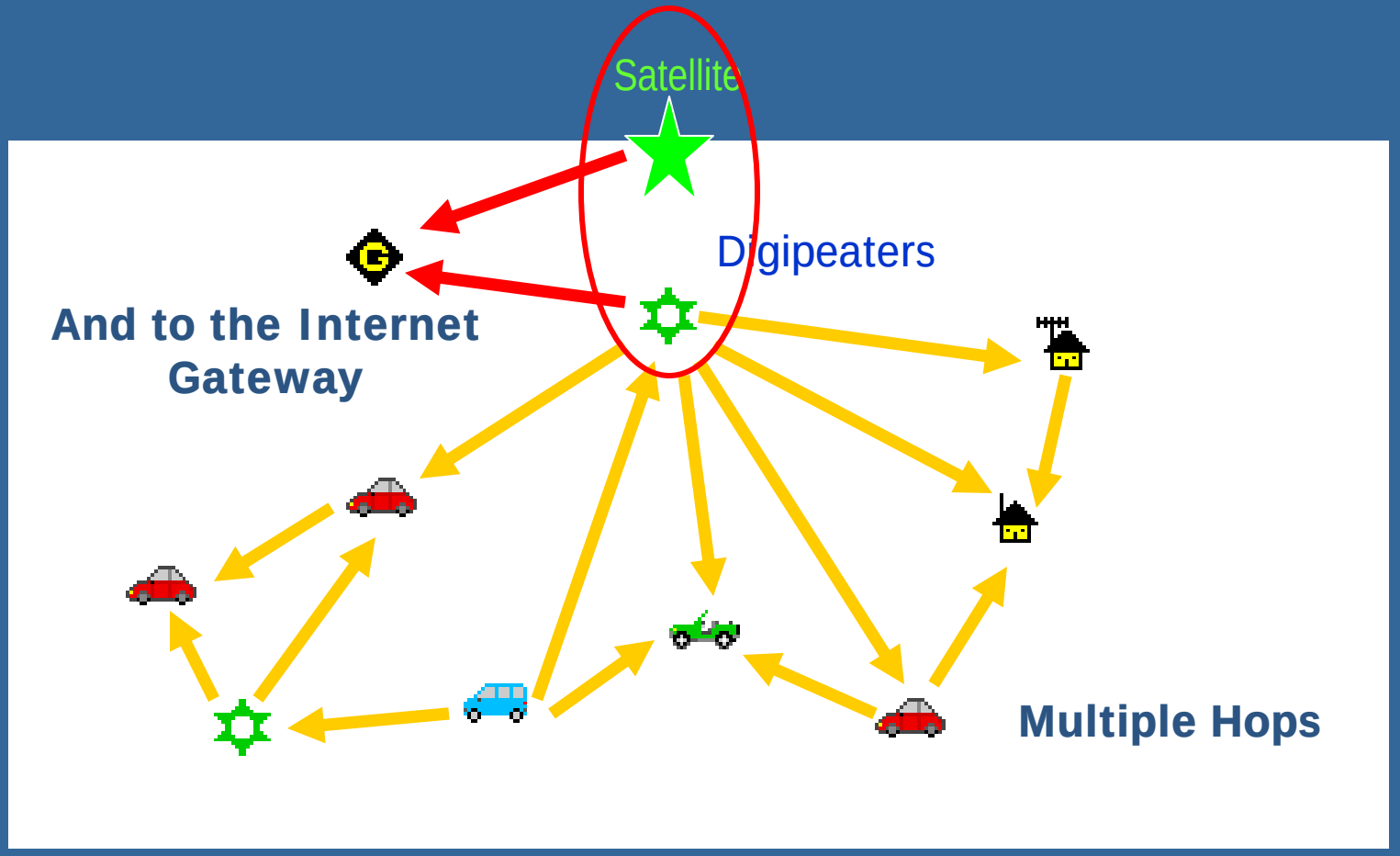
Mobiles and HT are 100% compatible

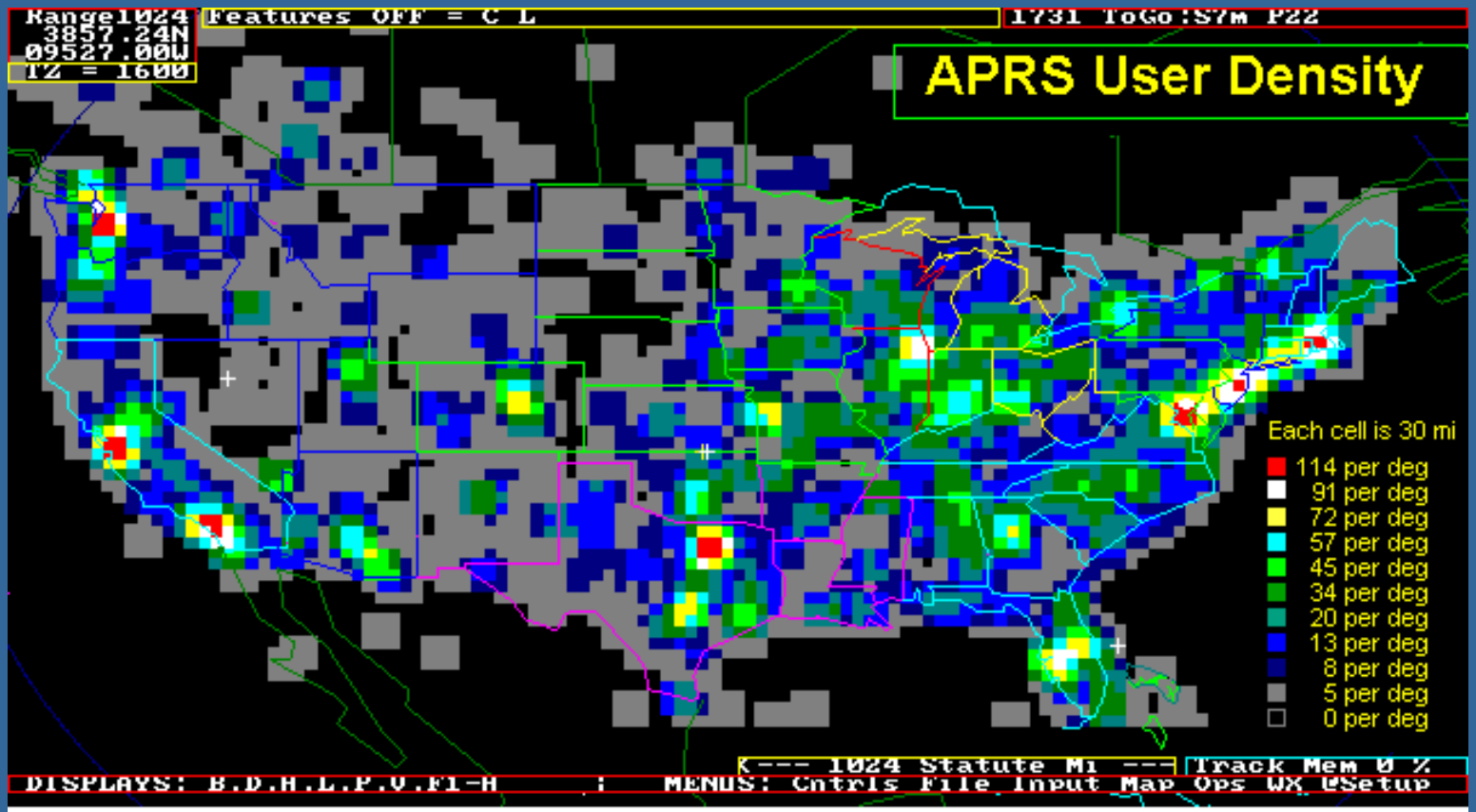


Direction & Distance

Frequency and Tone

The APRS Network





This data is plotted from Steve's FINDU data for 10 days and plotted on APRSdos shows the user denstiy in the USA in Feb 05. Although it appears that most of the USA is low density, remember that a WIDE5-5 launched anywhere in the remotest area will still get to the closer cities and add to the QRM there. ANd there are 100 times more low density users surrounding these cities hitting them from all sides that really adds up to heavy QRM. We recommend WIDE2-2 in ■ □ ■ ■ and surrounding areas

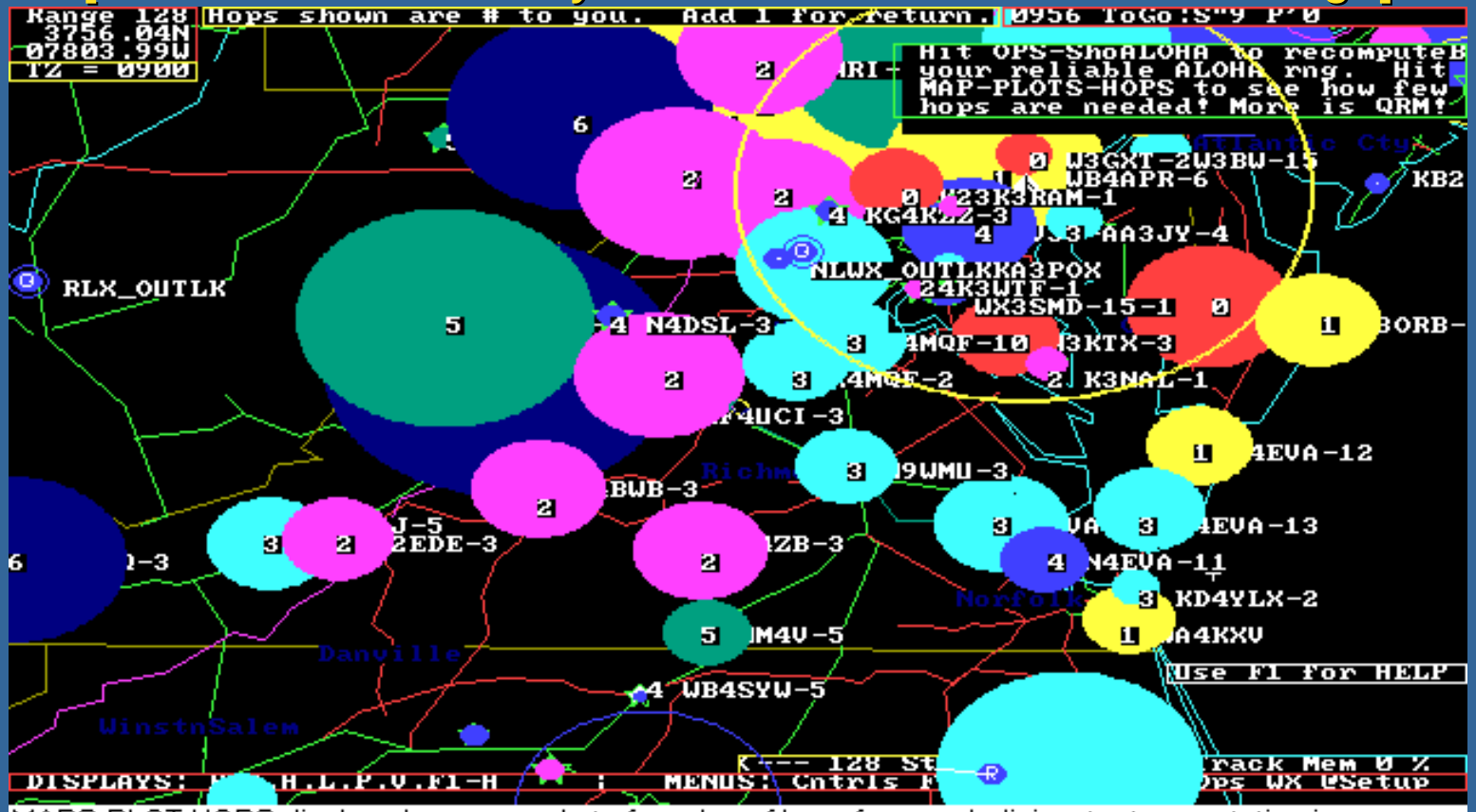
The grid size is 30 miles and each is averaged with all 8 of its surrounding adjacent grids.. The file is over 11,000 stations.

But the great news is that the New n-N Paradigm is the right approach. It encourages WIDEn-N everywhere while letting the high density areas trap large values of N to prevent overload in their areas only.

WB4APR

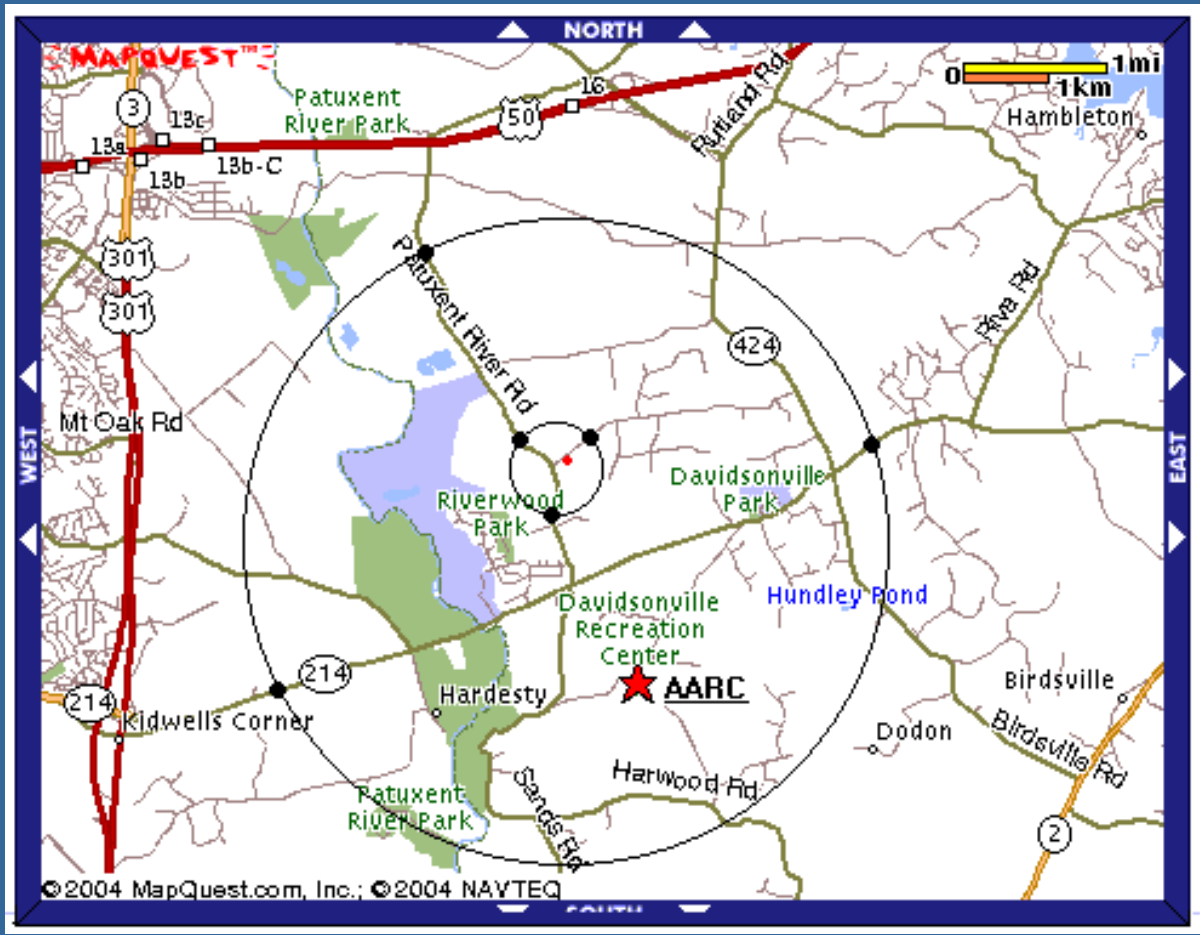
APRS (ALOHA circle and digipeater hops)

[Your ALOHA circle is your 100% saturated channel range]



MAPS-PLOT-HOPS display shows snapshot of number of hops from each digipeater to my station in Baltimore (at center of my ALOHA circle). Data is plotted from last-packet-received, so needs to be observed several times to average out circuitous packets and lucky shots.

APRS (Solo DF Fade Circle Technique)



Fade Circle Omni DF-ing

Technique was driving E/W on 214, then back to center and N/S on PaxRvrRd

First fade-circle based on loss of signal.

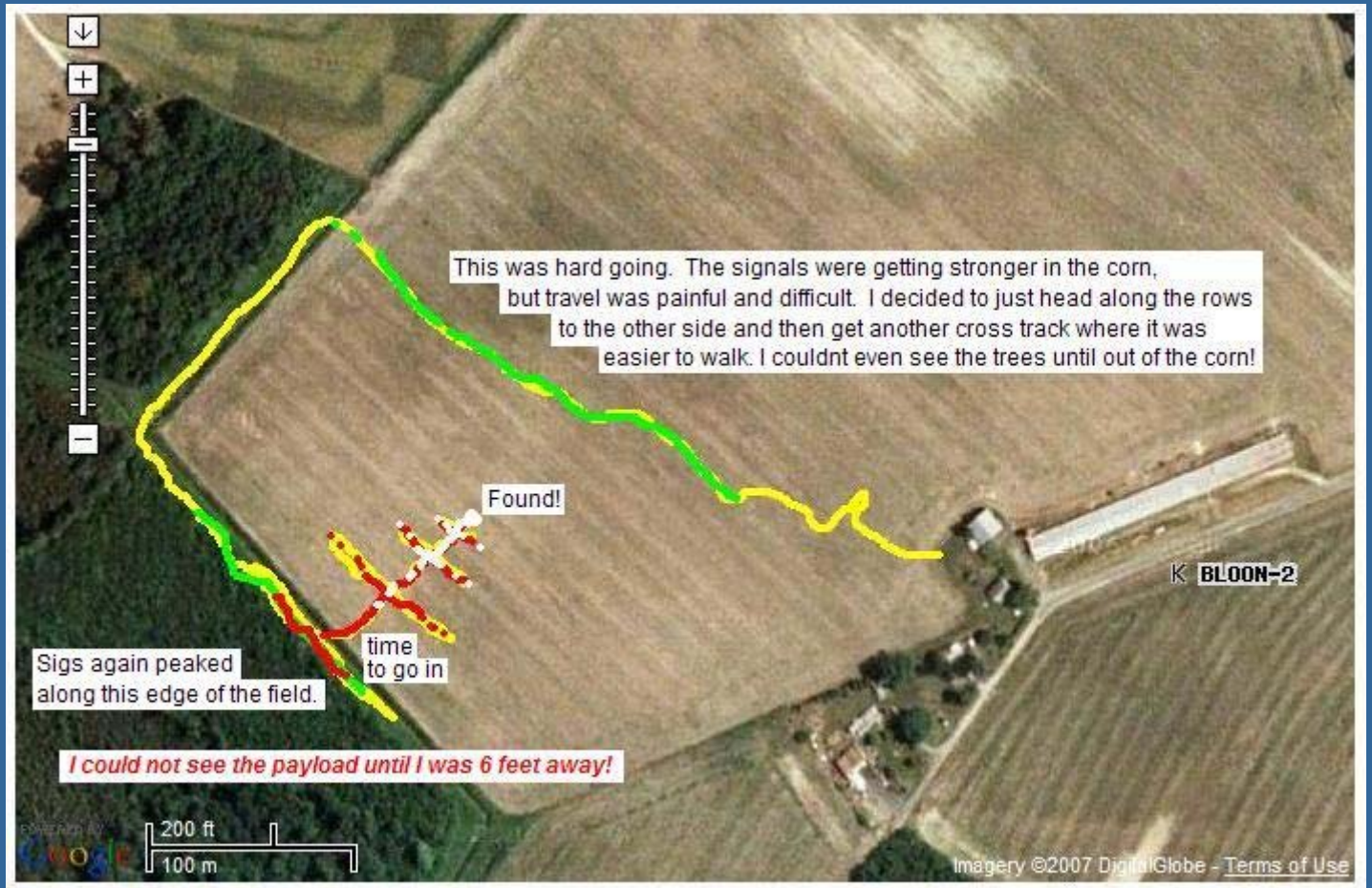
Second fade-circle based on full-scale.

Notice river valley skewed the big circle.

- Fox was 100 mW HT with rubber band

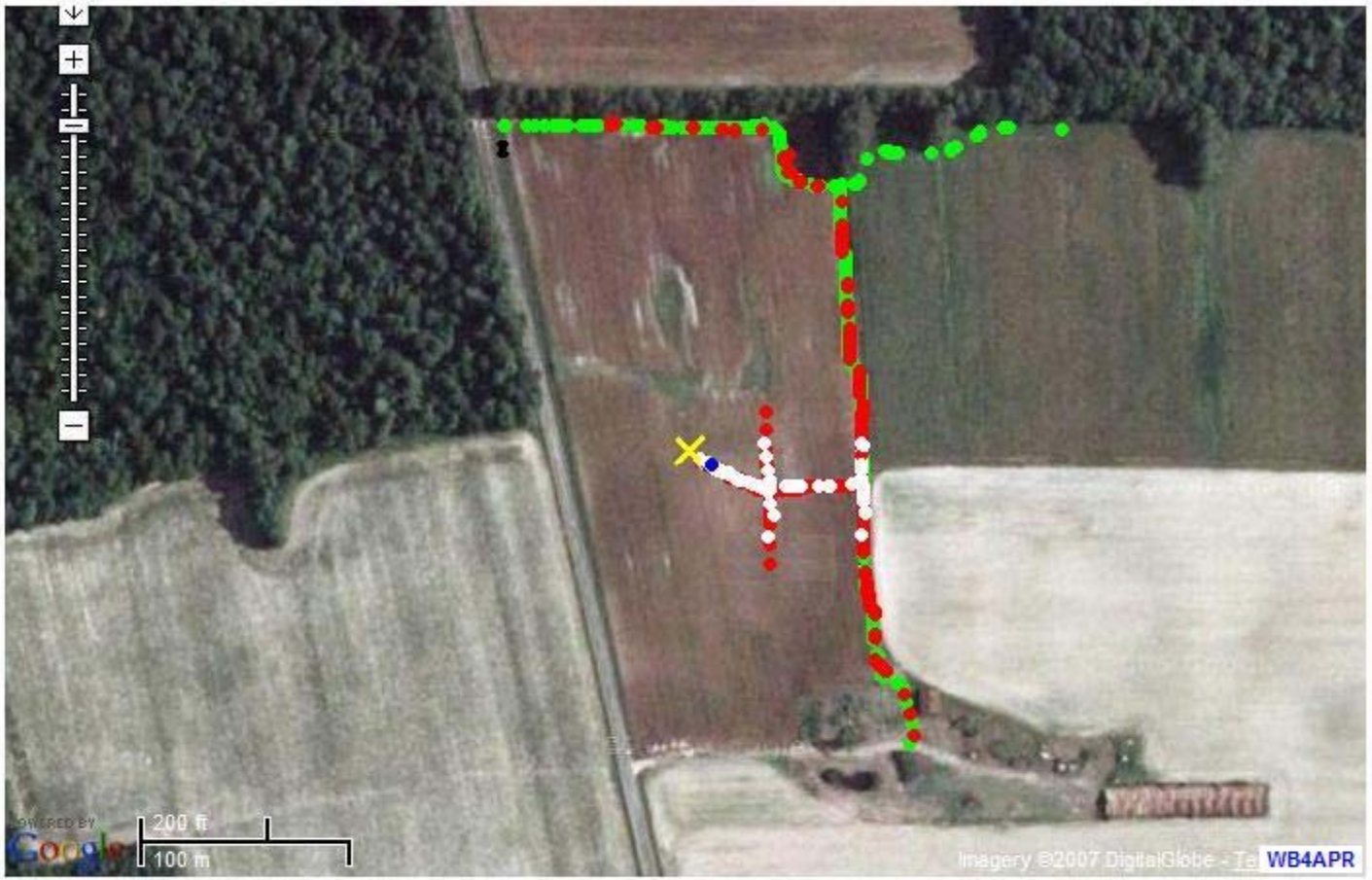
APRS (Solo DF Fade Circle Technique)

APRS (Solo DF Fade Circle Technique)



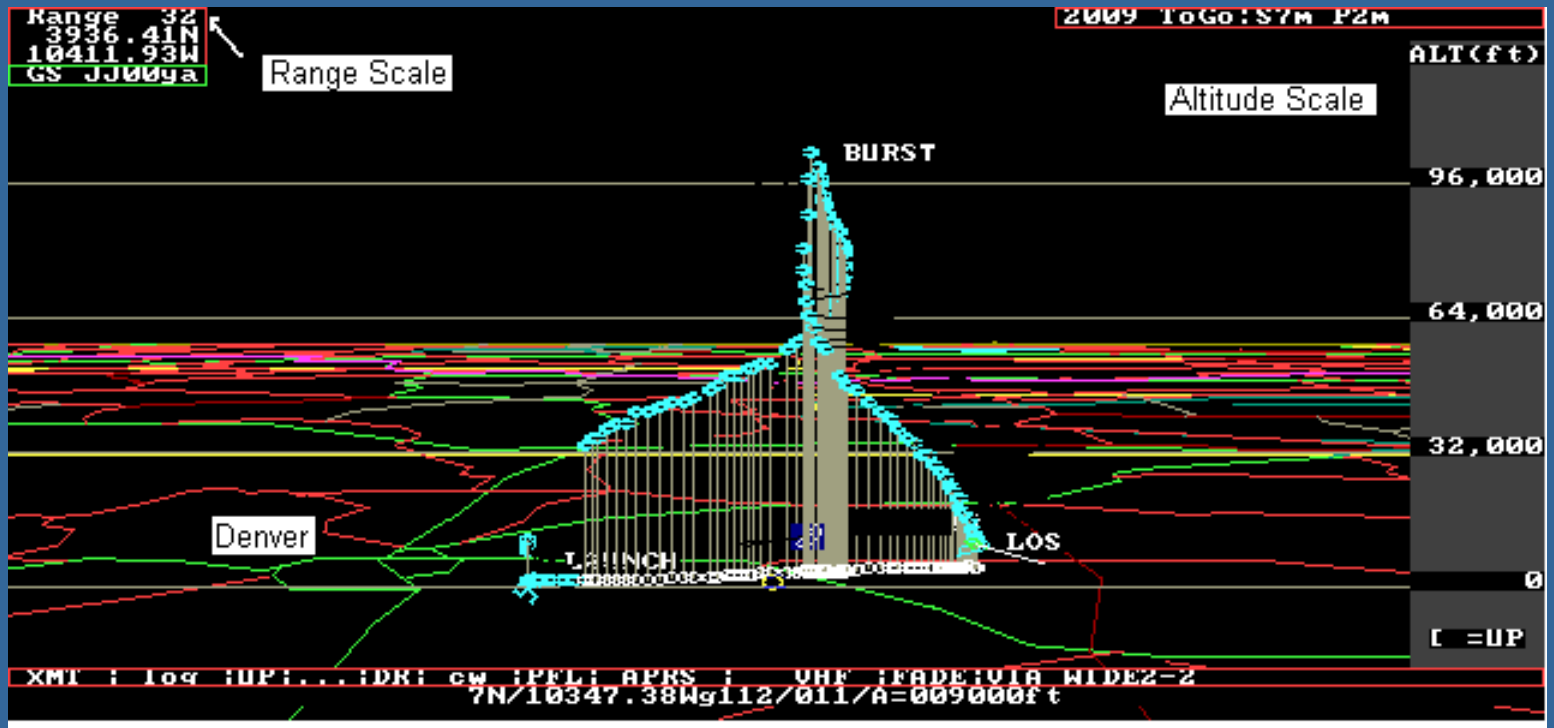
I have changed color scale down on this view, since I was now much closer than previous views. On previous views, RED showed places where signals were beginning to sometimes hit S9 full scale on my D7 HT. On this view, however, red shows where it was SOLID S9 with no dropouts. White shows where I could begin to hear signals without the HT antenna.

APRS (Solo DF Fade Circle Technique)



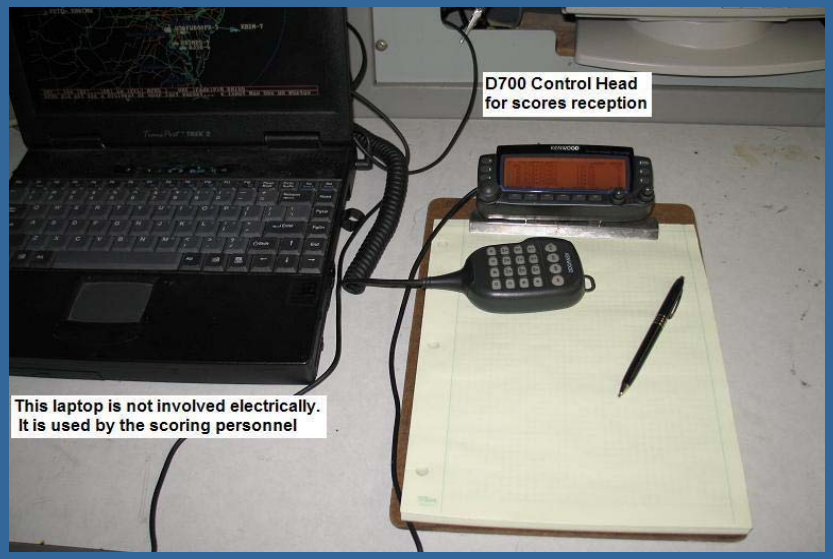
We knew Balloon was headed north at last posit, so I walked along North edge of field where Murphey's law would predict it would land in the thin tree line. Then headed south and sigs got stronger. In this field I was using short 3/4" antenna on my HT. White shows where I removed antenna completely. Blue is where I first could see package in summer crops.

APRS 3D views for Balloon tracking



APRSdos has a 3D map display mode. The vertical scale can be separately set from the normal Range Scale depending on the altitide of objects. This is a typical APRS balloon track.

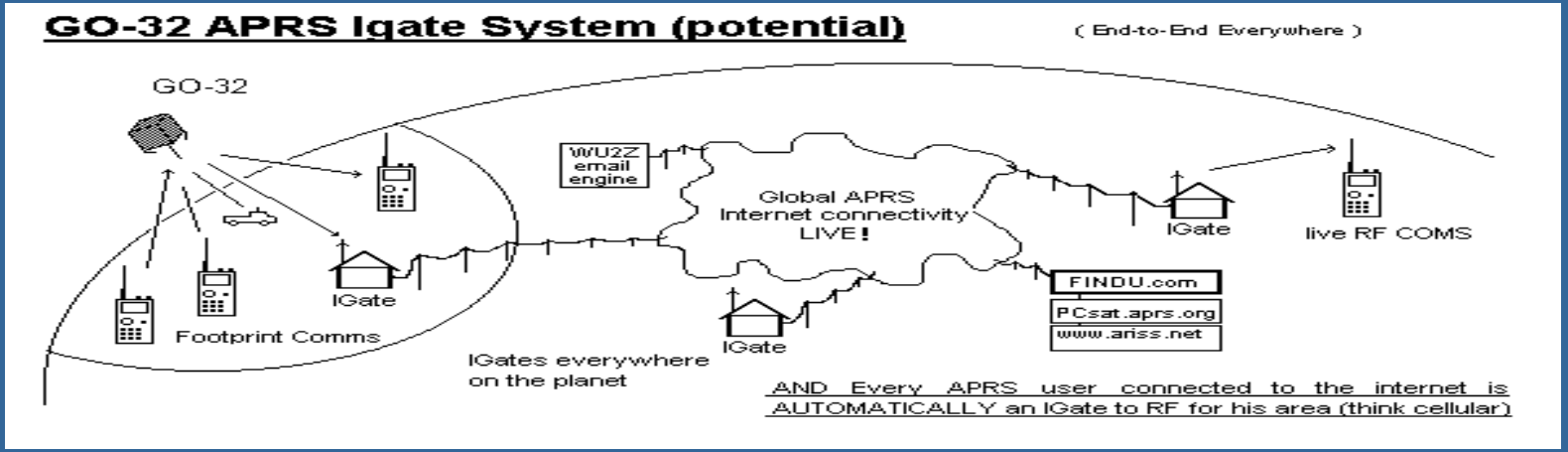
APRS Event Data Entry



Score Message Sent

Score Data Received

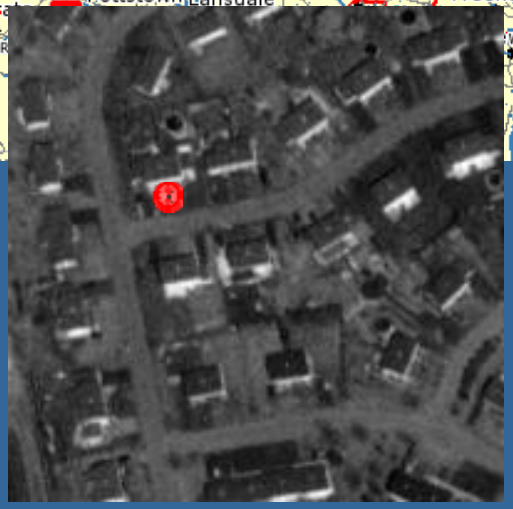
APRS IGates (Global APRS!)

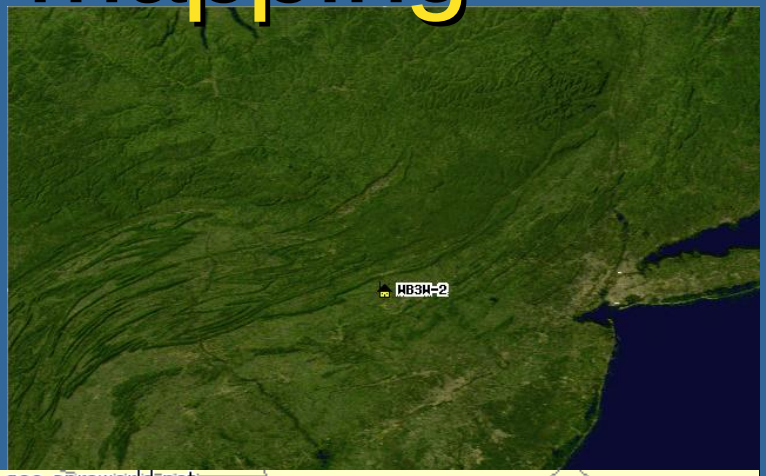


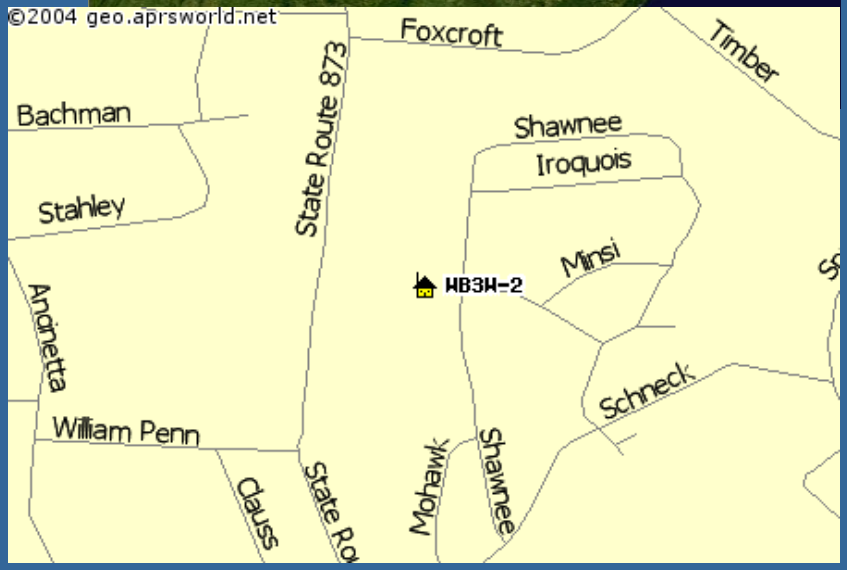
- An IGATE is a local APRS station that utilizes the APRS-Internet network to pass all packets heard on their local RF back to the Internet. (Gives global views to local activity.
- Also act as two-way gateways for ALL APRS MESSAGES worldwide (Internet ⇔ RF).

Findu.com mapping

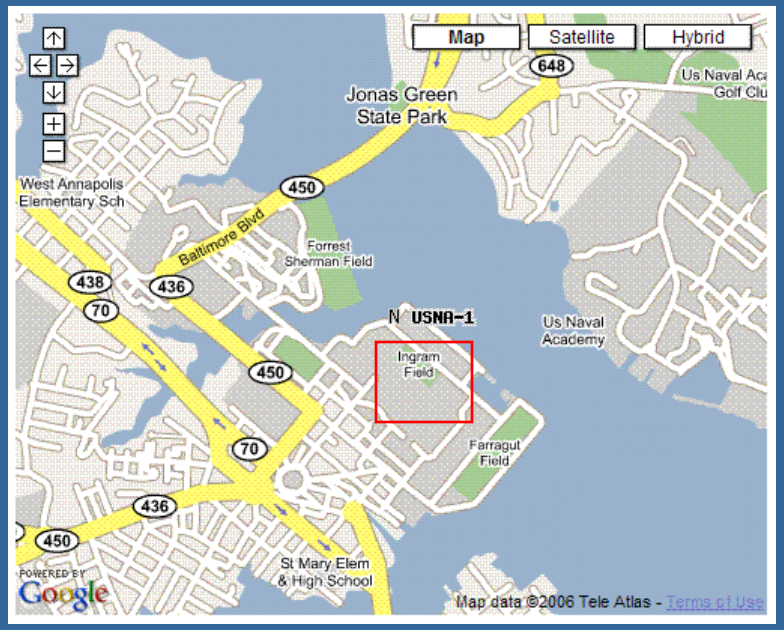
Internet tracking developed by
Steve Demise – K4HG

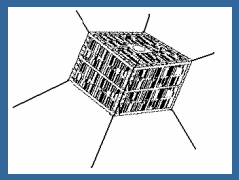






APRS-Internet (APRS-IS)





Google Maps

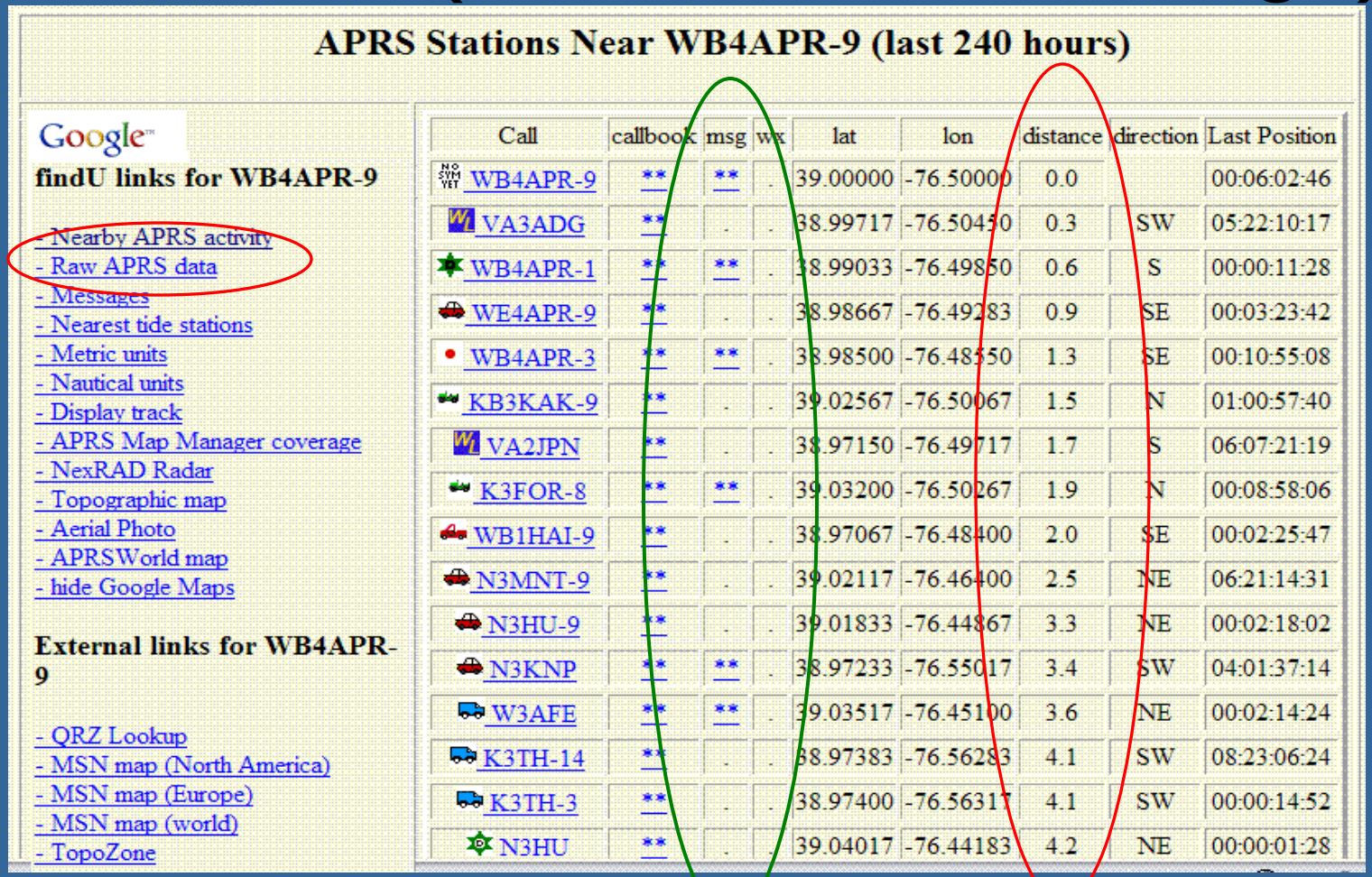
Situational awareness

This data is LIVE

http:// Pcsat.aprs.org

* Nearby APRS activity

APRS-IS (FINDU – Near Range)



APRS Stations Near WB4APR-9 (last 240 hours)

Google

findU links for WB4APR-9

- Nearby APRS activity
- Raw APRS data
- Messages
- Nearest tide stations
- Metric units
- Nautical units
- Display track
- APRS Map Manager coverage
- NexRAD Radar
- Topographic map
- Aerial Photo
- APRSWorld map
- hide Google Maps

External links for WB4APR-9

- QRZ Lookup
- MSN map (North America)
- MSN map (Europe)
- MSN map (world)
- TopoZone

Call	callbook	msg	wx	lat	lon	distance	direction	Last Position
WB4APR-9	**	**	.	39.00000	-76.50000	0.0		00:06:02:46
VA3ADG	**	.	.	38.99717	-76.50450	0.3	SW	05:22:10:17
WB4APR-1	**	**	.	38.99033	-76.49850	0.6	S	00:00:11:28
WE4APR-9	**	.	.	38.98667	-76.49283	0.9	SE	00:03:23:42
WB4APR-3	**	**	.	38.98500	-76.48550	1.3	SE	00:10:55:08
KB3KAK-9	**	.	.	39.02567	-76.50067	1.5	N	01:00:57:40
VA2JPN	**	.	.	38.97150	-76.49717	1.7	S	06:07:21:19
K3FOR-8	**	**	.	39.03200	-76.50267	1.9	N	00:08:58:06
WB1HAI-9	**	.	.	38.97067	-76.48400	2.0	SE	00:02:25:47
N3MNT-9	**	.	.	39.02117	-76.46400	2.5	NE	06:21:14:31
N3HU-9	**	.	.	39.01833	-76.44867	3.3	NE	00:02:18:02
N3KNP	**	**	.	38.97233	-76.55017	3.4	SW	04:01:37:14
W3AFE	**	**	.	39.03517	-76.45100	3.6	NE	00:02:14:24
K3TH-14	**	.	.	38.97383	-76.56283	4.1	SW	08:23:06:24
K3TH-3	**	.	.	38.97400	-76.56317	4.1	SW	00:00:14:52
N3HU	**	.	.	39.04017	-76.44183	4.2	NE	00:00:01:28

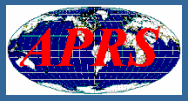
* Click to see all stations on map

APRS-IS (FINDU – Near Map)

APRS is a registered trademark Bob Bruninga, WB4APR

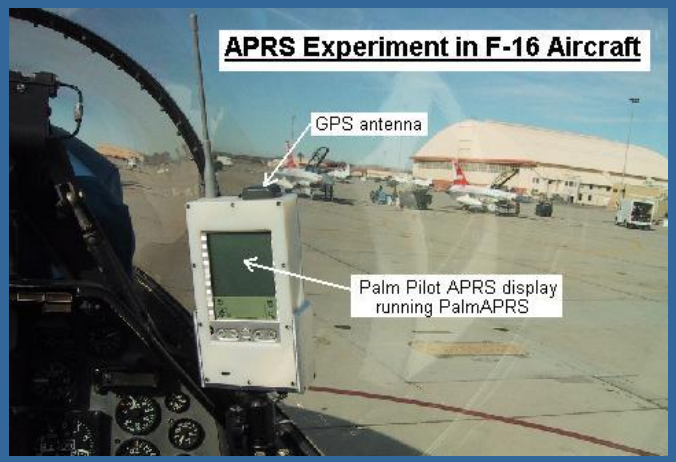
APRS-IS (FINDU - Messages)

from	to	time	message
WB4APR-9	JA1RBY-4	10/25 00:07:04z	no msg list?{44
WB4APR-9		10/25 00:02:47z	qsl!{43
JA1RBY-9	WB4APR-9	10/24 23:59:59z	hello{15
N3HEV-1	WB4APR-9	10/14 14:09:06z	GM hve a grt day! 73! {0
WB4APR-9	ALL	10/14 13:53:03z	in d700... ignore that msg. It was 4 satellite.{42
WB4APR-9	ALL	10/14 13:50:24z	in d700 {41
WB4APR-9	ALL	10/14 13:49:07z	in d700 use ptt mode to TX while RXing{40
KE4NYV-15	WB4APR-9	09/30 21:55:30z	S1, if that{7
KE4NYV-15	WB4APR-9	09/30 21:51:01z	noisy{6
WB4APR-9	KE4NYV-15	09/30 21:50:32z	6.85?{38
KE4NYV-15	WB4APR-9	09/30 21:49:45z	noisy{5
N8PK	WB4APR-9	09/30 21:12:16z	Try again on 6.835 {003
WB4APR-9	KE4NYV-15	09/30 20:48:11z	52?{37
N1TI	WB4APR-9	09/29 02:47:14z	Good luck @ DCC{82
N3IDX-1	WB4APR-9	09/28 02:06:44z	Greetings from Huntingtown, Md{2b}
KD8ATF-2	WB4APR-9	09/28 01:55:17z	r u going to be on the next pass of go-32 bob?{26
WB4APR-9	ALL	09/28 01:51:40z	ck in!{35
N1TVZ	WB4APR-9	09/28 01:45:12z	%private line{M
WB4APR-9	ALL	09/28 01:43:14z	what is pl?{34
N8PK	WB4APR-9	09/28 01:40:41z	Gud 2 C U on the CARA last night! -Pat {000

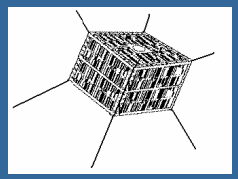


APRS for Special Uses

- Bicycle rallies, races
- Walk-a-thons, Parades
- Skywarn
- Weather Nets
- Crime prevention patrols
- Damage assessment
- Direction Finding – Foxhunts
- Voice for communications, APRS for visual mapping
- Now integrating into APRN (Automatic Picture Relay Network)



Sensor Buoy Prototype



Naval Academy Student Project

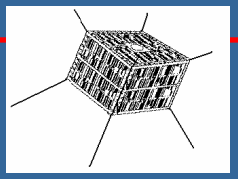
* If free-floating, do not disturb.
* If aground, move to deep water and advise bruninga@usna.edu
* If later than 30 Nov 2006, recover and advise above.

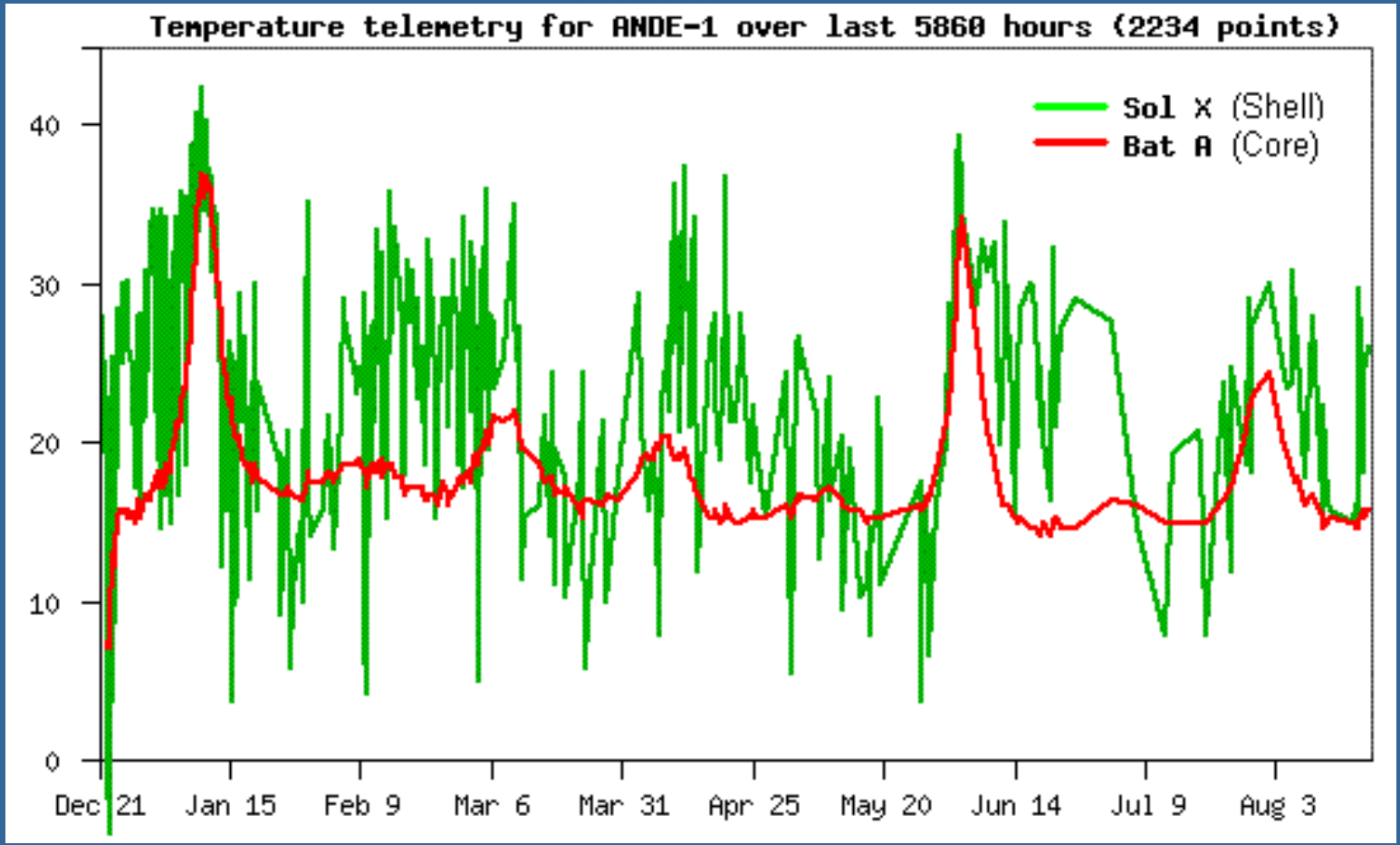
See Buoy Location and Telemetry at

http://www.ew.unsa.edu/~bruninga/buoy.html

Piggrem

Findu.com Telemetry Plots





APRS Emergency Power

200W Solar Power

- Continuous

10 kW gas Generator 220 VDC

- Auto-runs as needed
- lightweight wires

APRS in Space.
Comms, not just tracking!