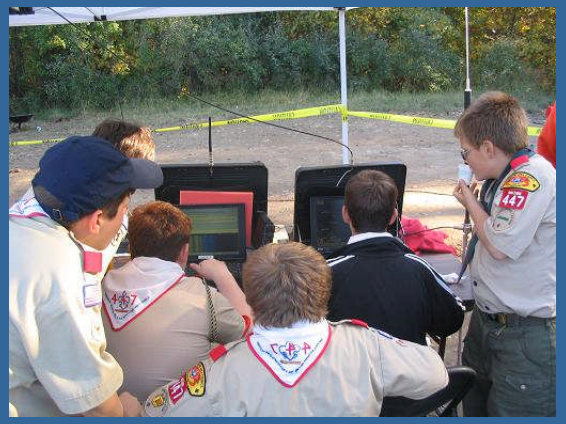
Maps – Mobiles - Users

A General Overview of the APRS System

Updated Feb 2008

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!!!

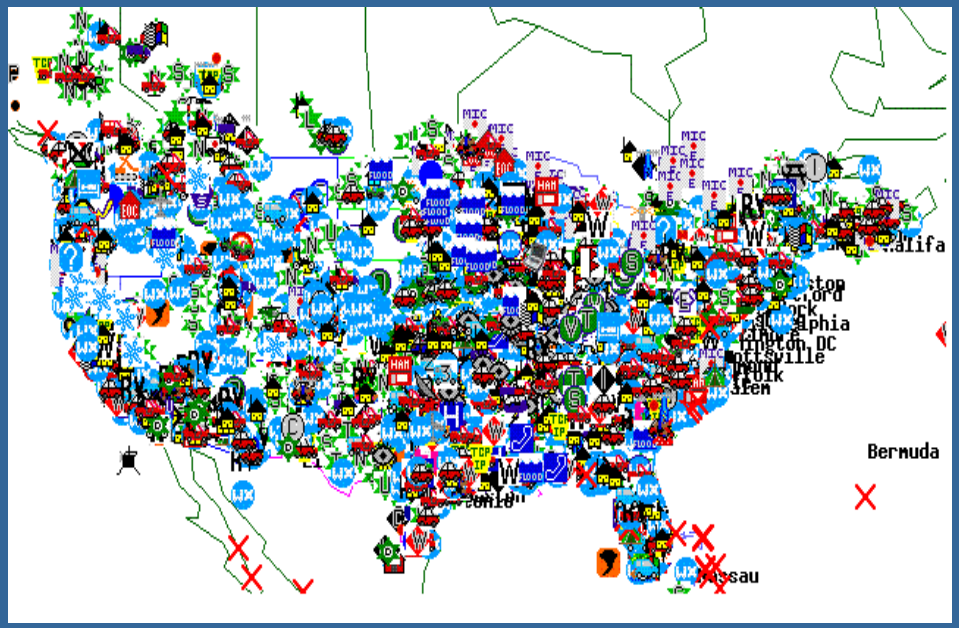


What is APRS all about?

- The APRS System was developed to provide immediate local digital and graphical information exchange between all participants in an event. This includes not only tracking and monitoring position data, but also status, messaging, bulletins all without having to maintain packet connections.
- Typical data:
  - 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
  - Local information of value to the traveler
- 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

- 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.

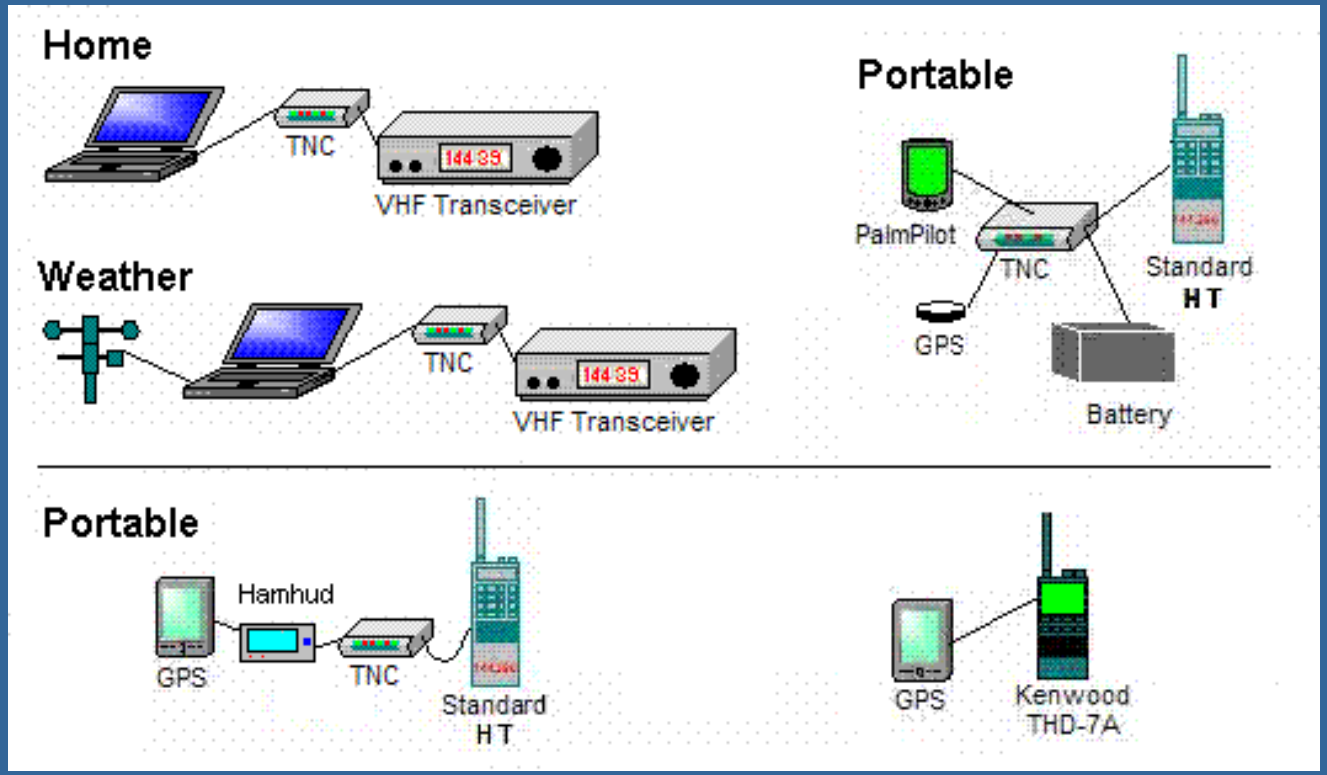


APRS MisConceptions!

- 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)**.
- Failure to use the APRS built-in **Mile-Marks** for tracking all other non-APRS mobiles.
- Using APRS clients that only do maps and ignored **too many of the APRS fundamentals**.
- Ignored the fundamental **Decay Algorithm** to accelerate new data, and decay old data!
- Failure to understand that APRS is all about OBJECTS: . See **Objects 101** and **Operations**
- Failure to use real-time messaging: . See **Messages 101** and **Message Operations**
- Failure to implement the original APRS Centralized **Common Bulletin Board** concept.
- Not understanding the APRS operator's role as a ***Data Input*** **(Objects, Bulletins and Messages)**
- Not using the D7 and D700 as ***data entry and clipboard display units*** at field events.
- Failure to understand how to best use APRS **Displays** in support of real-time events.
- Failure to display APRS **symbols with all their attributes** and colors without clicking them
- Failure to manage the network by **adjusting the local digipeater** for the situation at hand.
- Not realizing the importance of **Voice Operating frequencies** in APRS.

See **APRS-tactical.html**

Various APRS Stations (two-way)

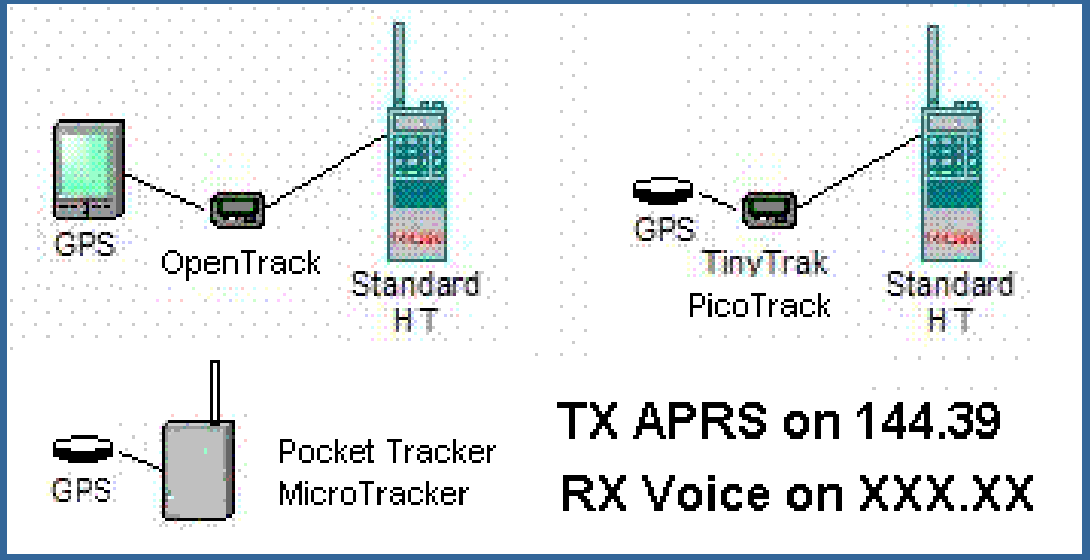


APRS is a Network intended for real-time Tactical INFORMATION exchange. This means TWO-WAY.

TRACKERS (two-way)

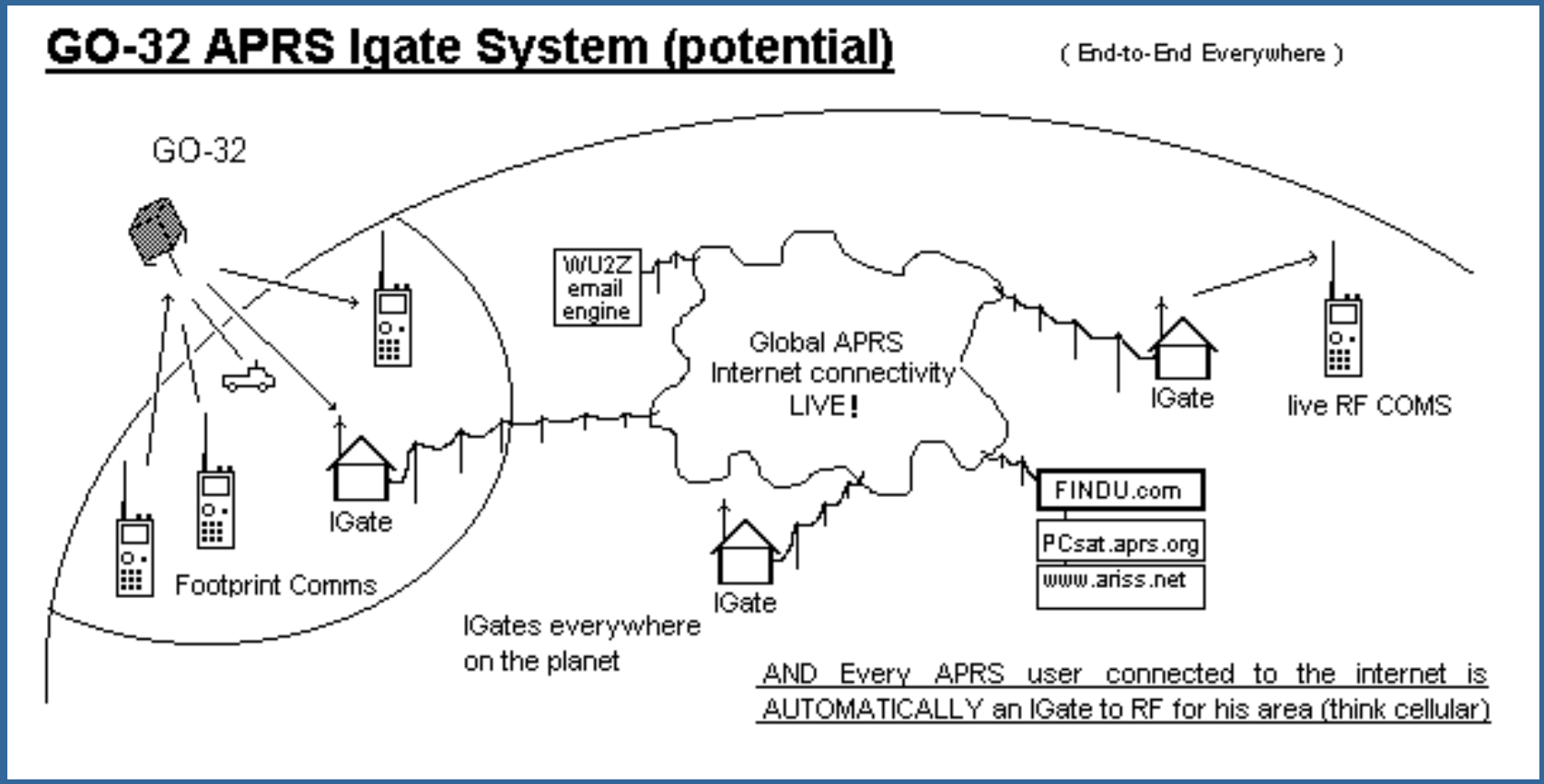
One-way APRS is not normally recommended. APRS is a Network. We want good communications among all participants for maximum utility.

Trackers have no APRS data display. So the receiver should be tuned to a beaconed Voice frequency so the operator can be involved in the Net!



The only value for these units are tracking some non-manned assets at large movement events such as marathons, bike-a-thons, parades and other community events, and maybe search & rescue teams.

Global Mobile and Portable Satcom



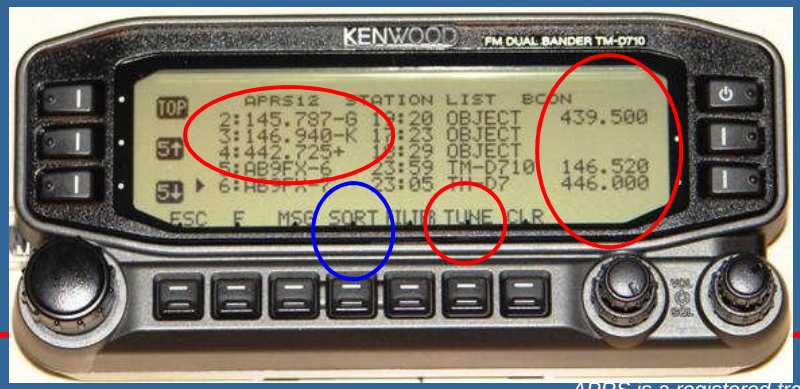
Mobile/Portable Satellite Terminals

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)

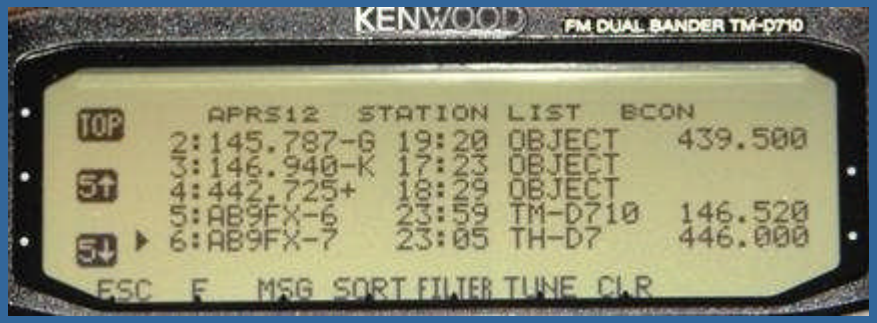
Alinco DR-135T/EJ-41U

- Basic 2 M Radio with optional TNC.
  (Opentrack makes a drop in tracker TNC)
- 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.

APRS – IS - Local Info!

Last 100 stations!



Mobiles and HT are 100% compatible

Direction & Distance

Frequency and Tone

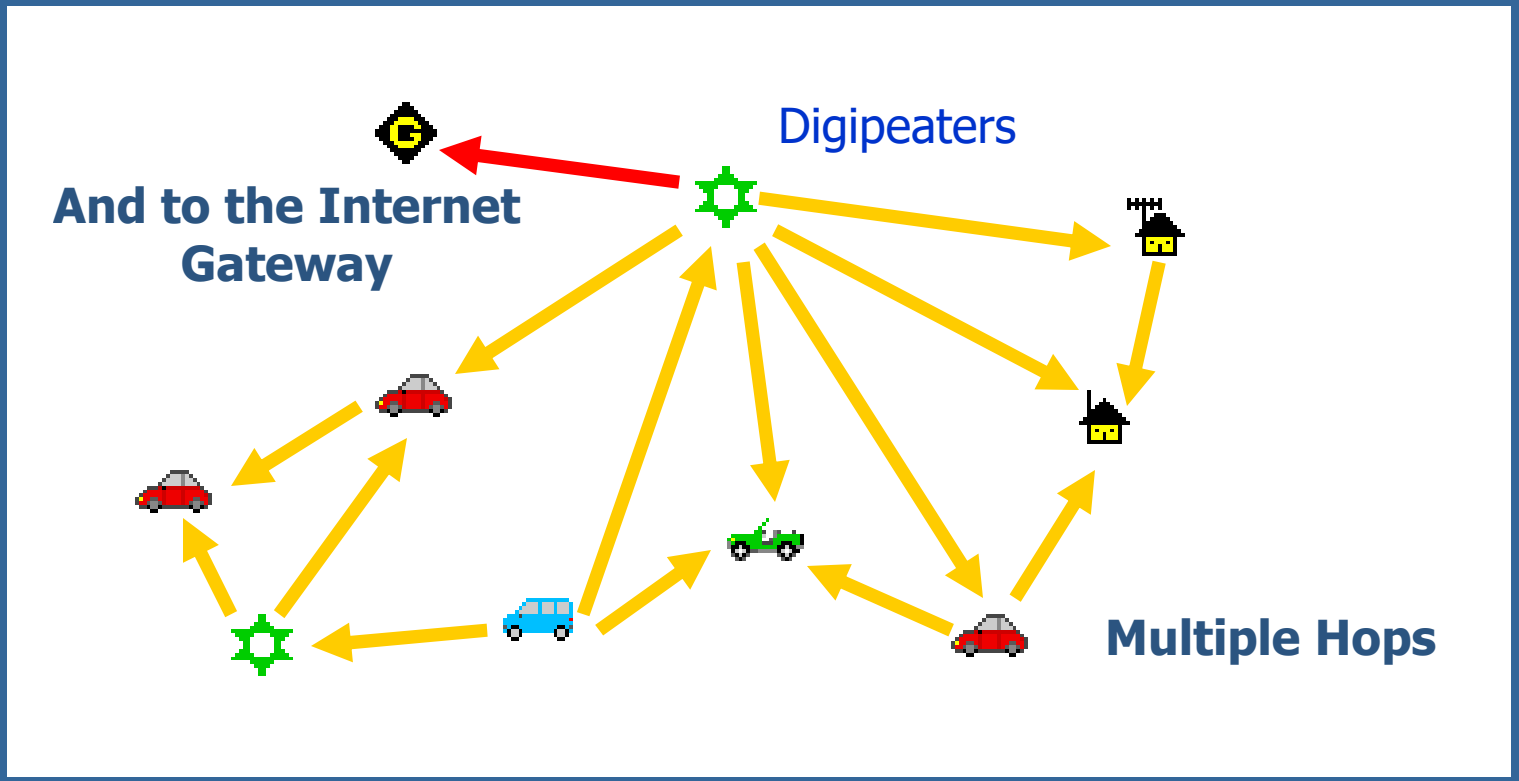
APRS is a registered trademark Bob Bruninga, WB4APR

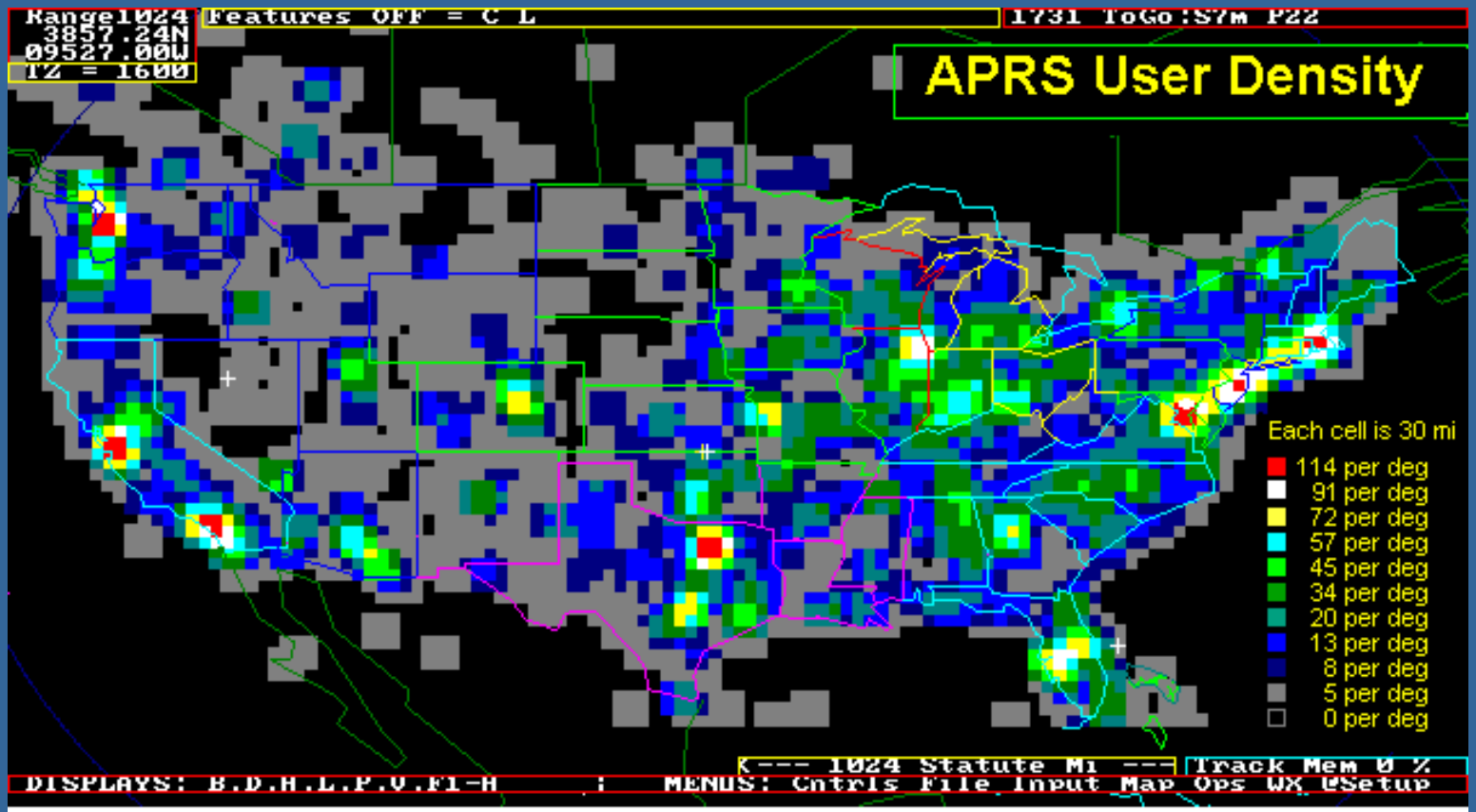
APRS Voice Alert! *

(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.

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

The New-N Paradigm 2005

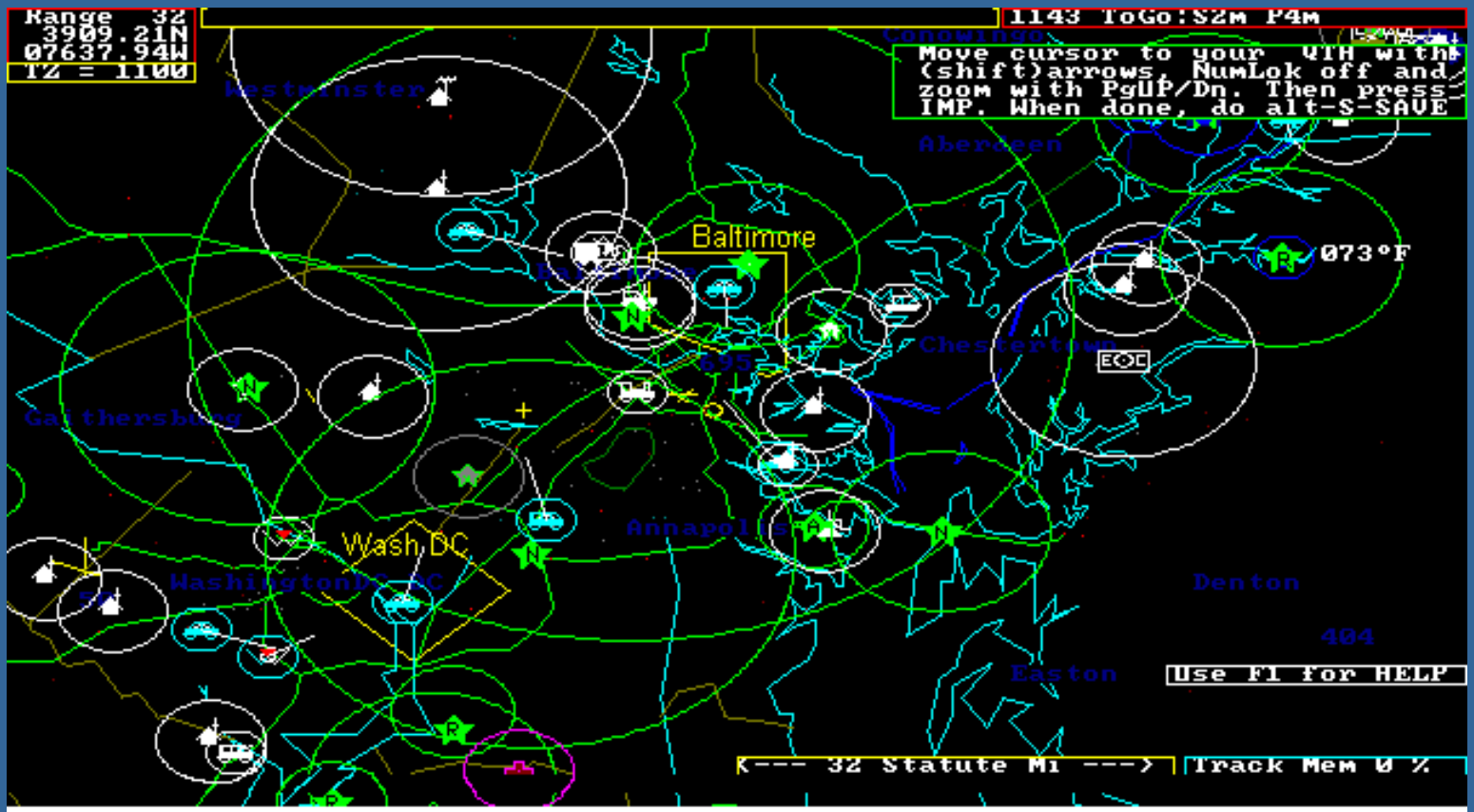
Factor of 3 to 5 improvement!

- APRS Generic Paths evolved over 13 years and the presence of many old legacy formats and procedures were really bogging down the network making it saturated and unreliable in busy areas.

- In 2005 all old paths were declared obsolete (RELAY & WIDE) and the entire APRS system in the US was then focused only on the WIDEn-N type of generic paths with small values of N.

- A WIDEn-N path goes N hops outward in all directions.
- N=2 in most areas colored on next slide

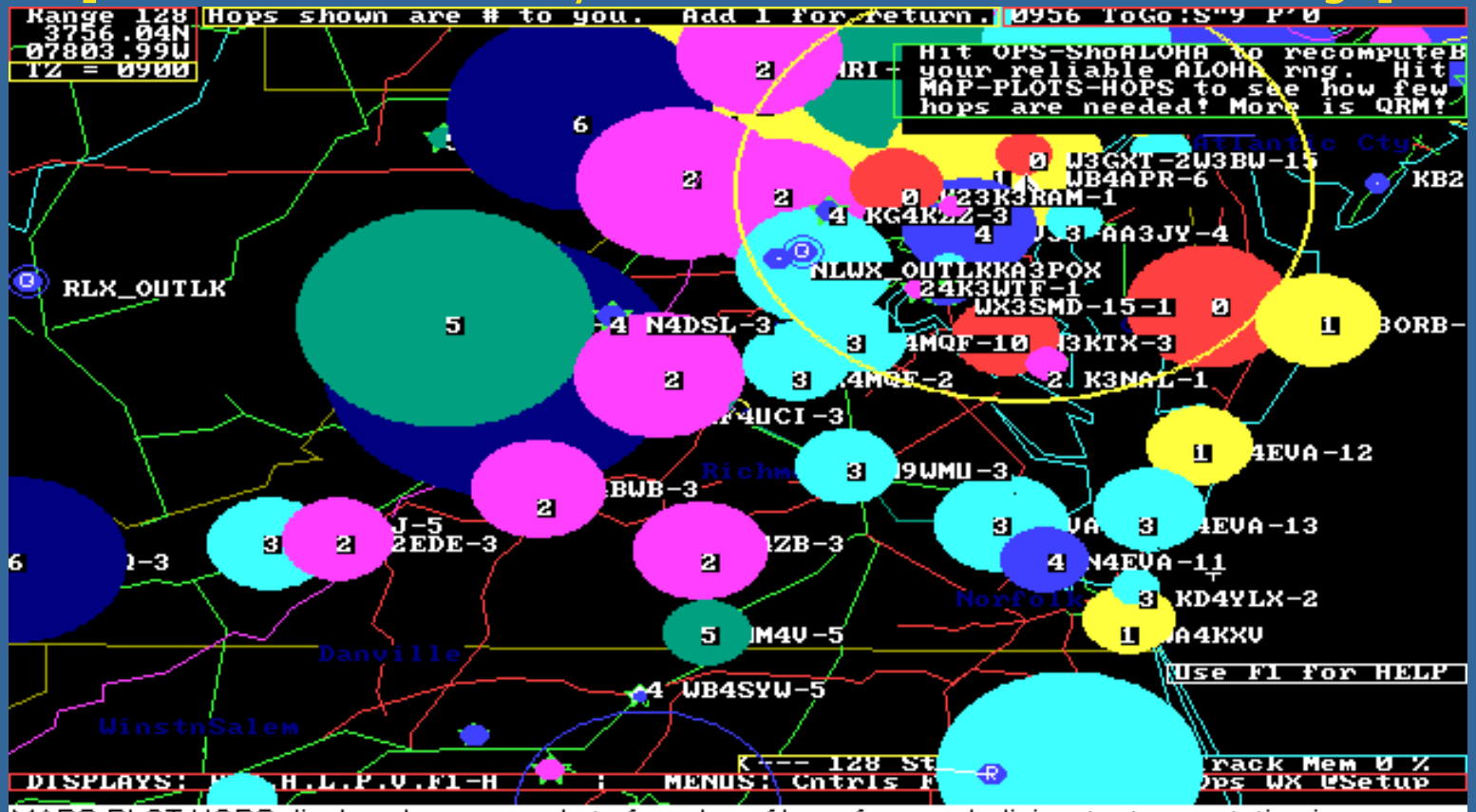
APRS (Range Circles)



APRSdos map with PHG circles displayed and calls, roads, and rivers turned off to reduce clutter. The green interstates remain and you can see WashDC in the lower left and Baltimore in the upper center. Notice the three WIDEn-N digis cover the area though there are more than 15 digis around. Two stations in the upper center live on hills... 2 hops covers everywhere.

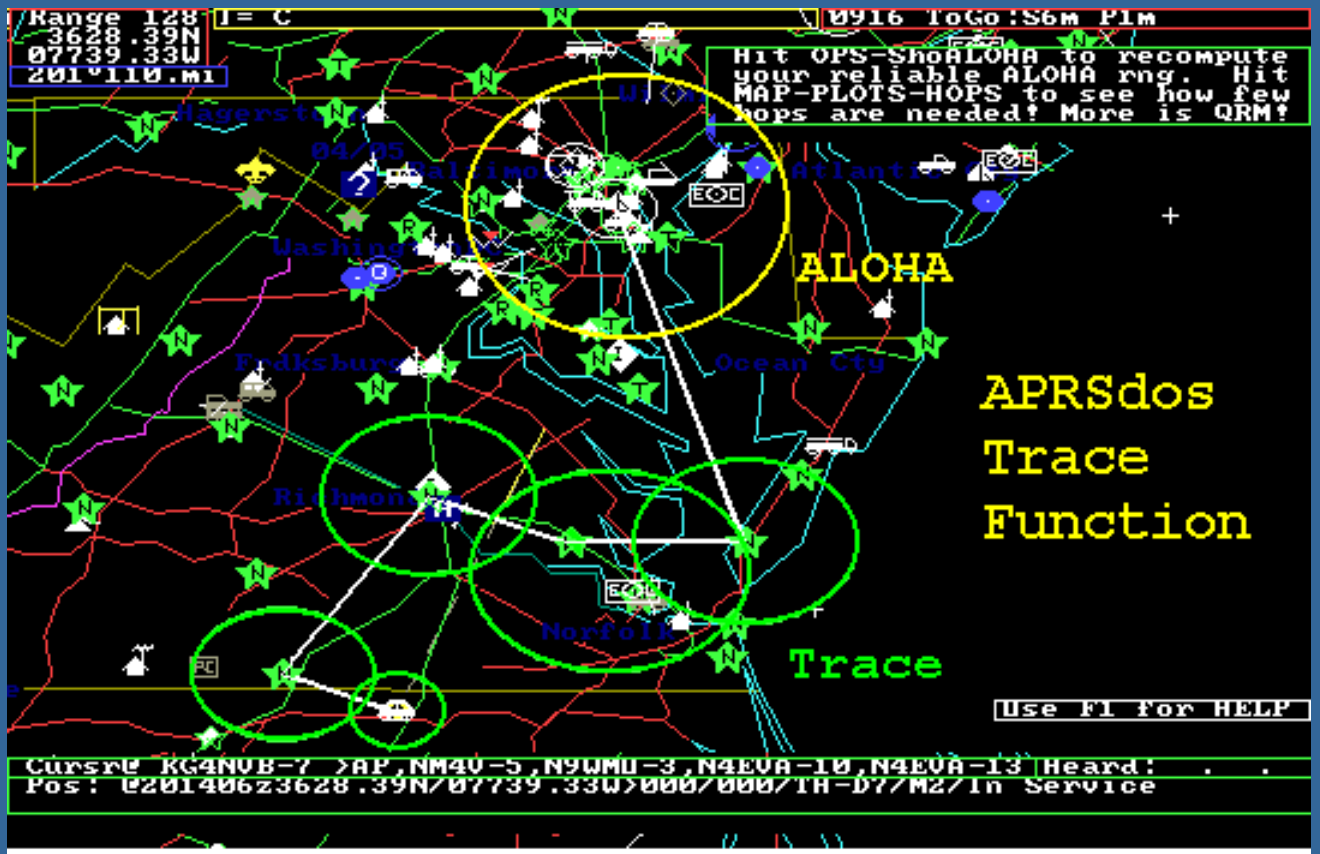
APRS (ALOHA circle and digipeater hops)

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



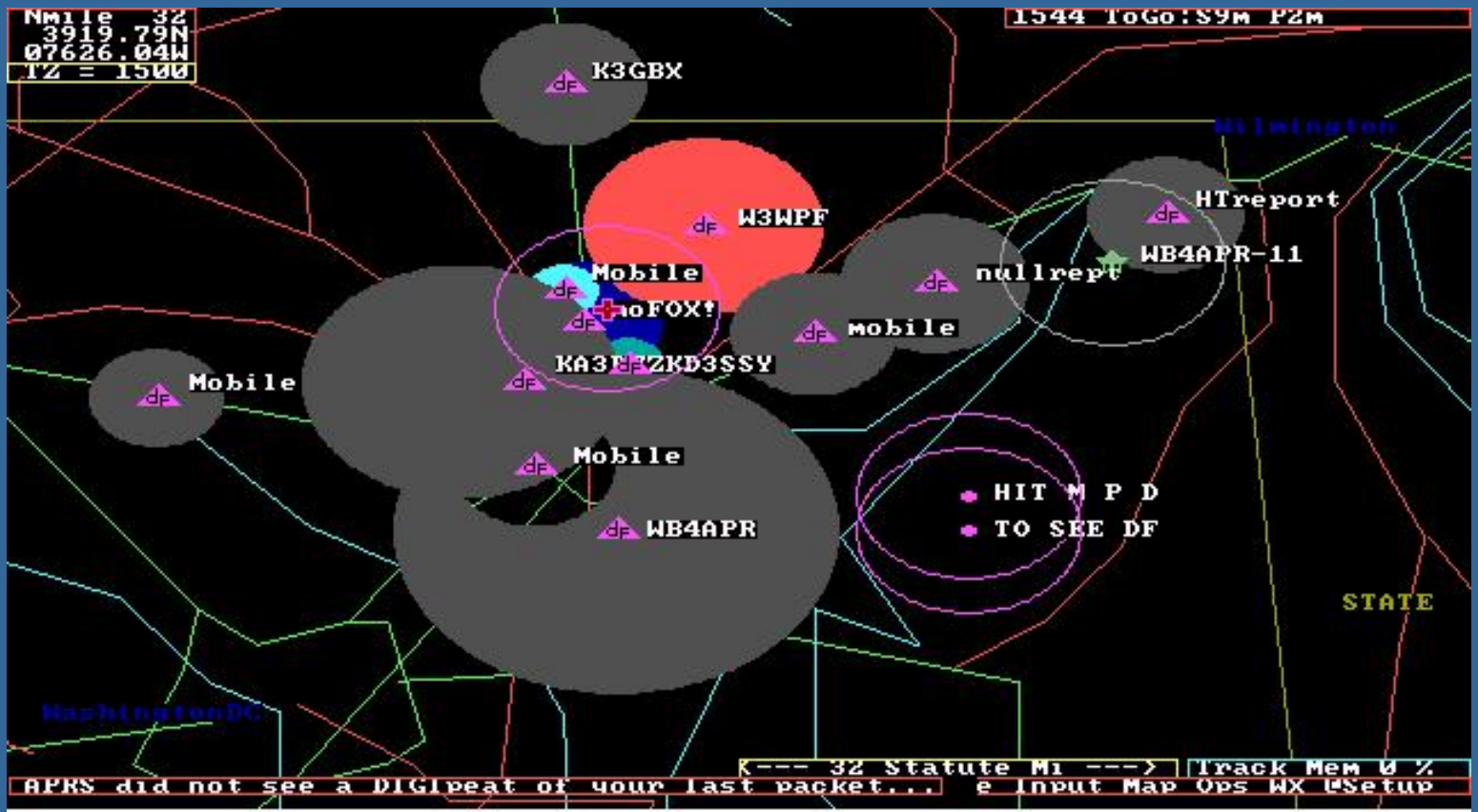
MAPS-PLOT-HOPS display shows snapshot of number of hops from each digipeater to my station in Baltimore (at center of my ALOHA circle). Data is plotted from last-packet-received, so needs to be observed several times to average out circuitous packets and lucky shots.

APRS Range circles and Path tracing



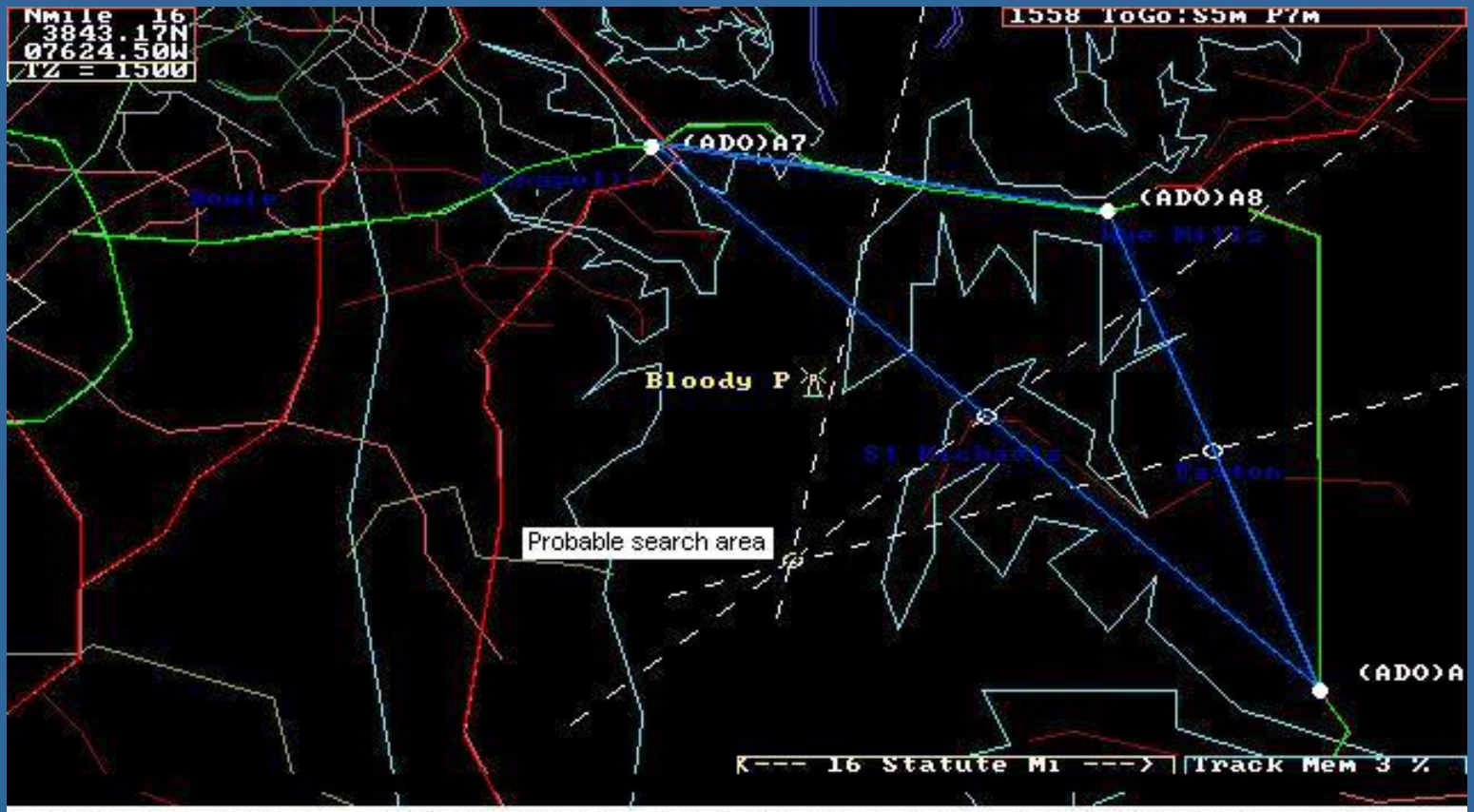
The TRACE function shows the path through the digipeaters it took to get to your station. This is a 5 hop mobile well outside of my ALOHA circle that got a lucky hop over water up the Bay from Norfolk to Baltimore. The fixed PHG RF range of each digi is also shown

APRS (DFing by signal strength)



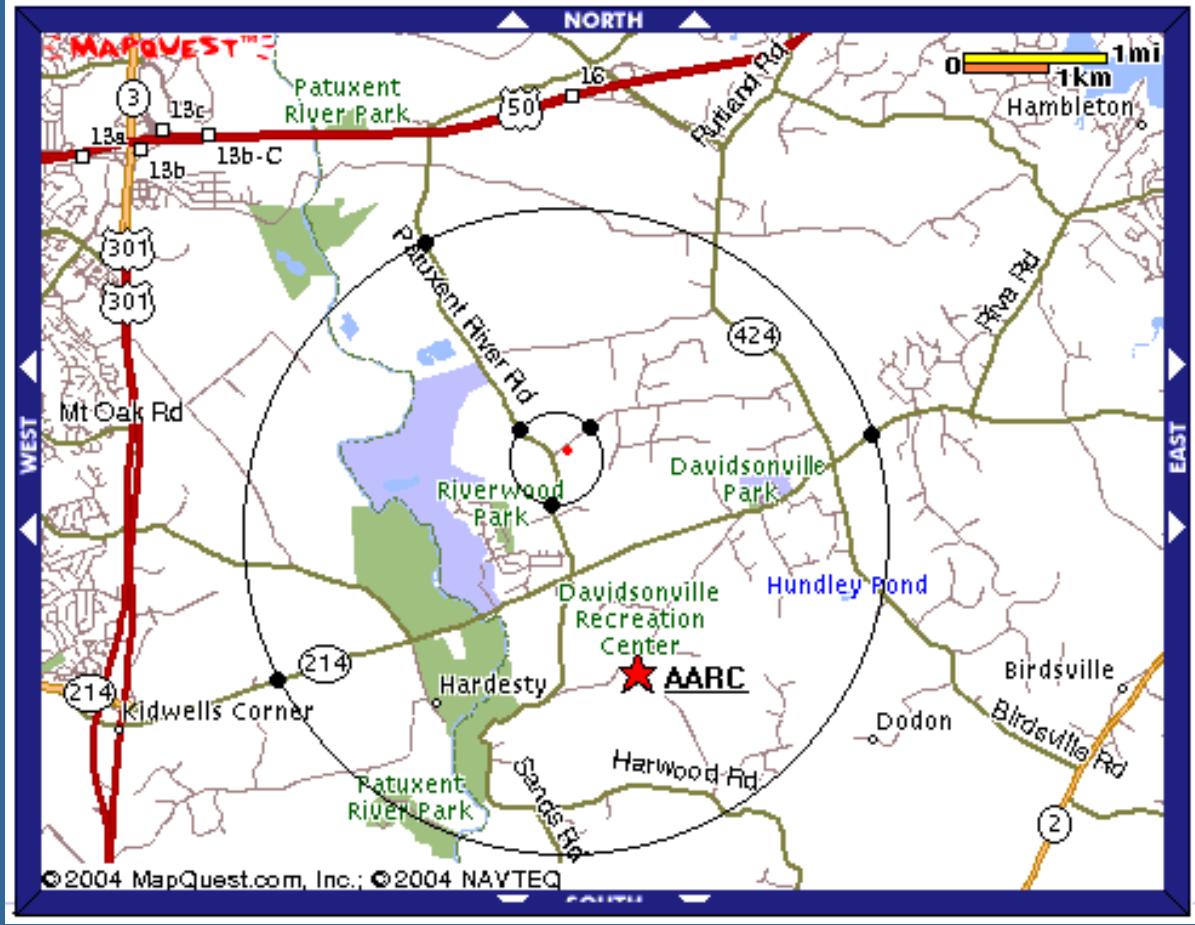
MAPS-PLOTS-DF-OMNI display of overlapping signal strength contours. All of these "voice" signal reports were entered rapidly on APRS as objects, and everone can see that the FOX was found near the intersection of the colored circles. Notice how VALUABLE the "no-signal" reports were. THey show you almost immediately where the fox is NOT. Great info!

APRS (Solo DF Fade Circle Technique)



MAPS-PLOTS-DF-FADEcircle - This technique allows a single individual to locate the approximate source of a signal. Just Drive until the signal fades out. Hit F5 key. Turn around, drive the other way to the fade. Hit F5 key. Go a third direction until it fades again. Hit the F5 key. Then hit MAPS-PLOTS-DF-FADE and APRS will compute the approximate location of the signal. Then drive to the indicated area and do it again! THis time mark equal points of signal level X. Do it again. Go to the center, do it again.... and again! You WILL find the signal as long as you have enough gas...

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

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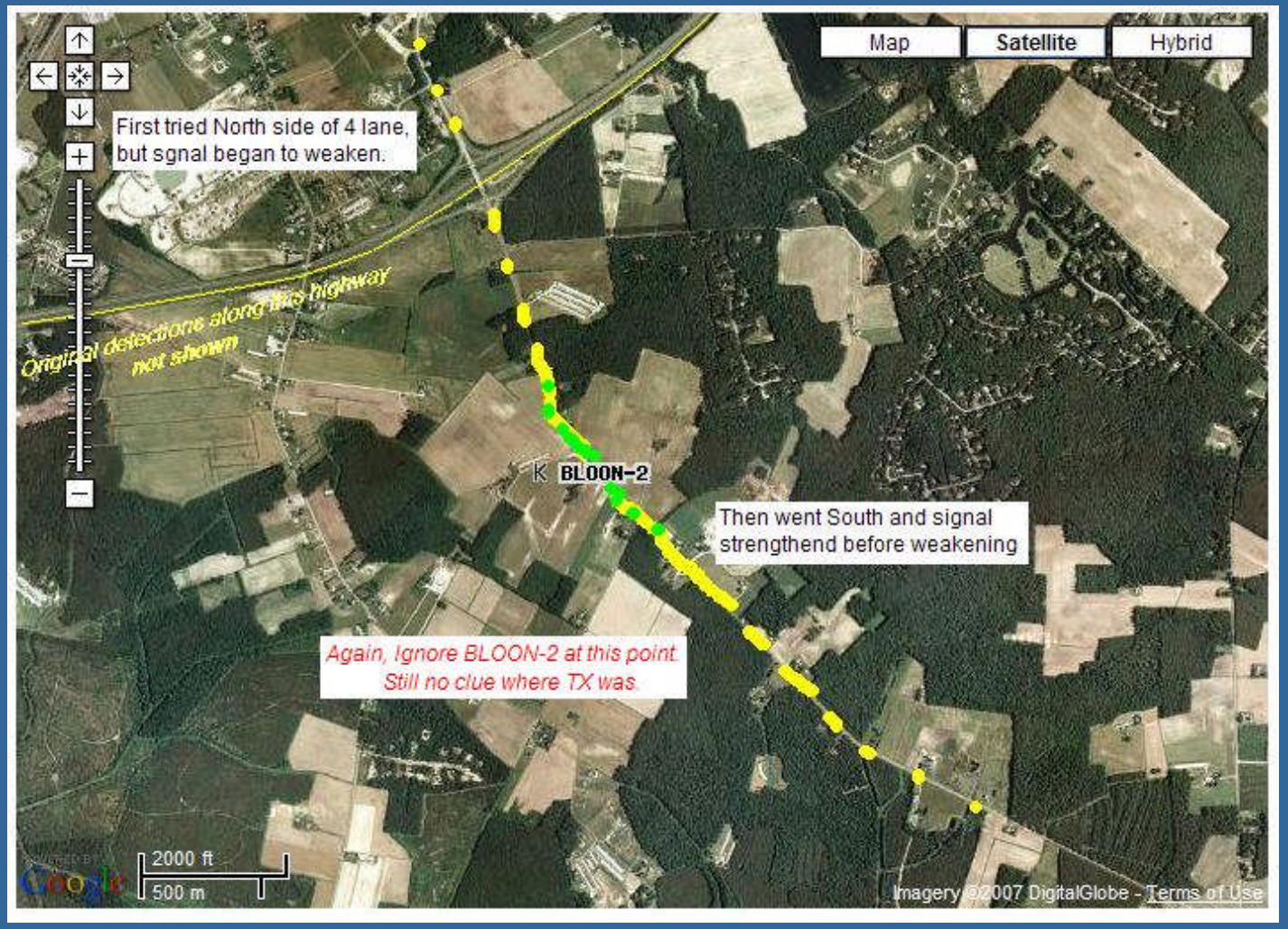

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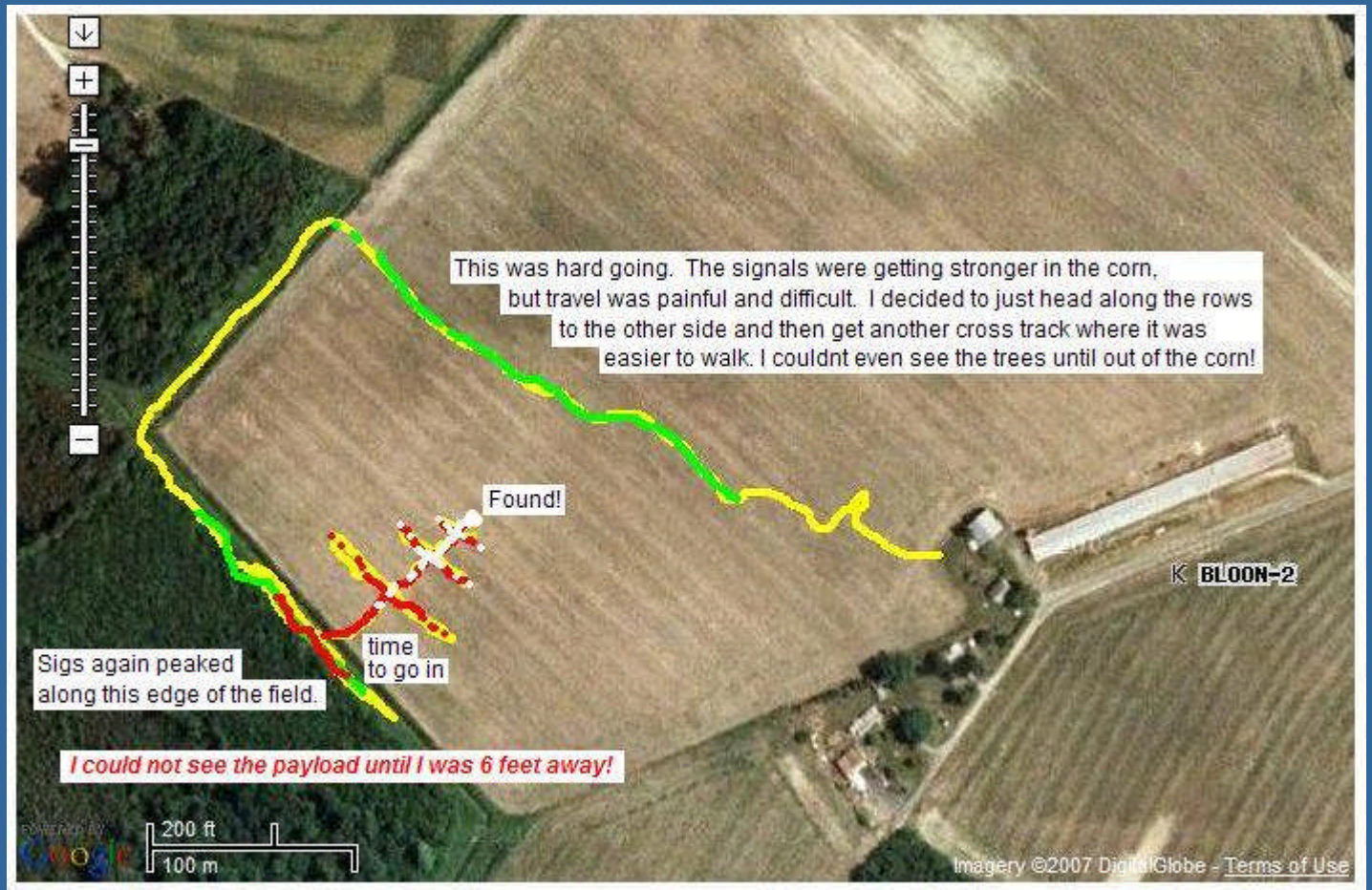
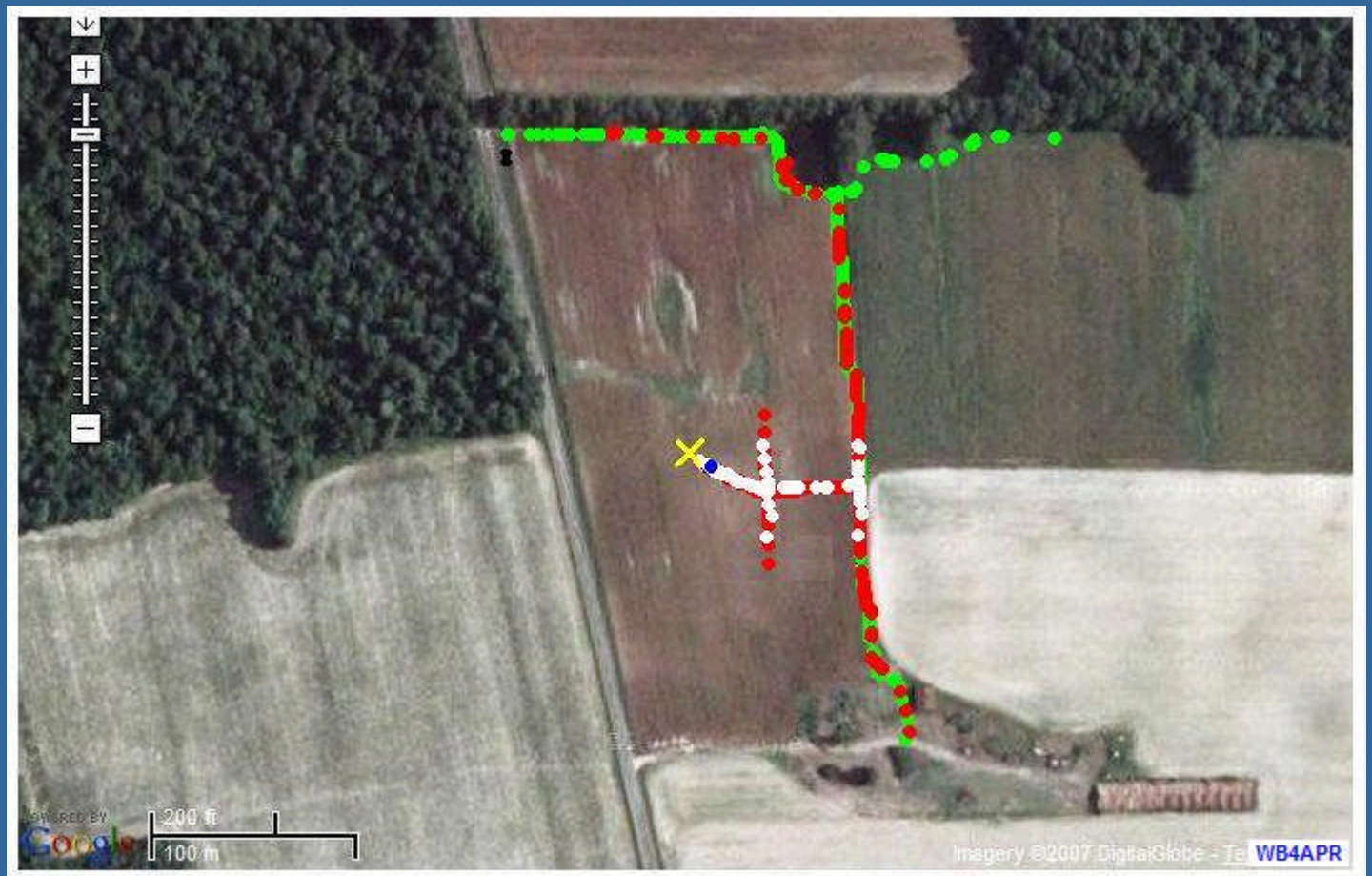


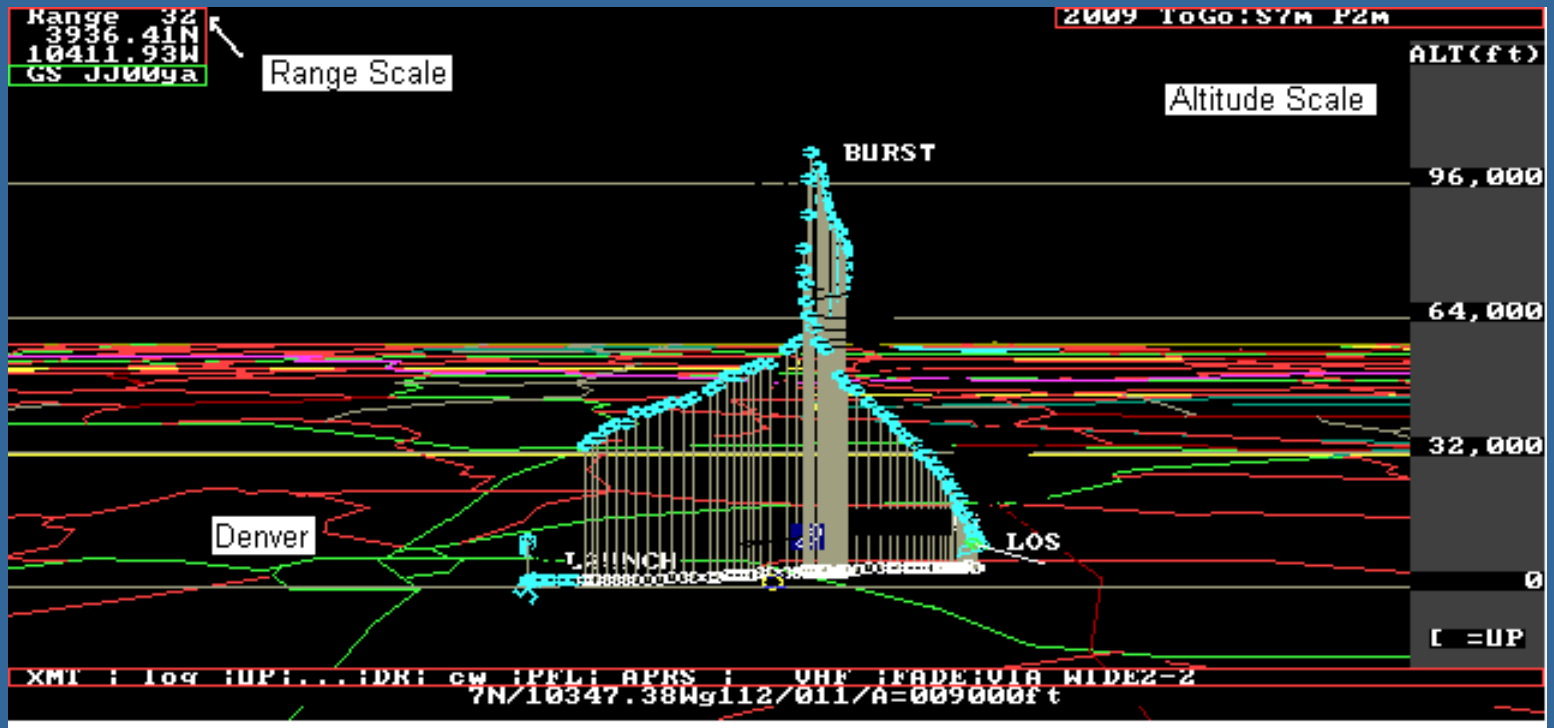
I have changed color scale down on this view, since I was now much closer than previous views. On previous views, RED showed places where signals were beginning to sometimes hit S9 full scale on my D7 HT. On this view, however, red shows where it was SOLID S9 with no dropouts. White shows where I could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

APRS (Solo DF Fade Circle Technique)



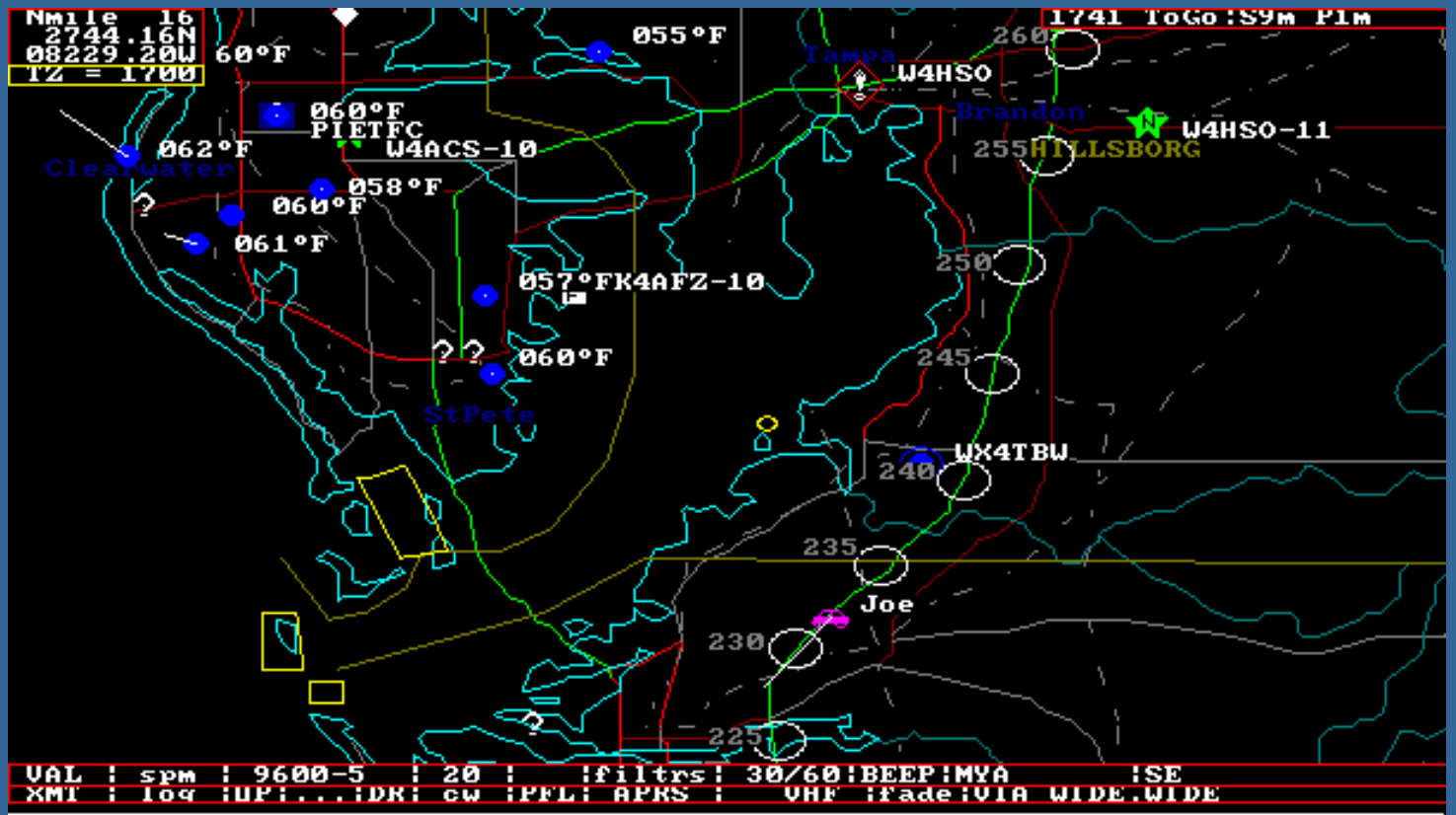
We knew Balloon was headed north at last posit, so I walked along North edge of field where Murphey's law would predict it would land in the thin tree line. Then headed south and sigs got stronger. In this field I was using short 3/4" antenna on my HT. White shows where I removed antenna completely.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

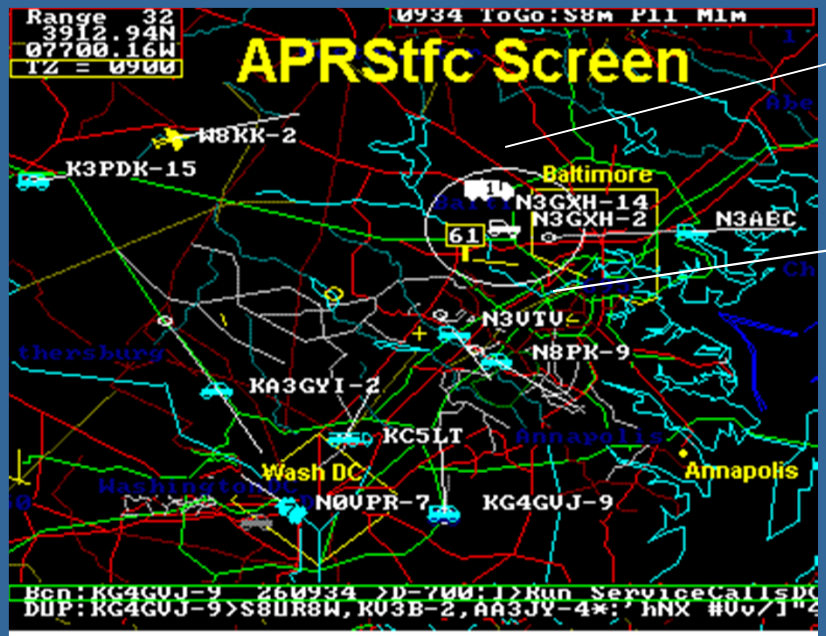
APRS Tracking with Milemarks



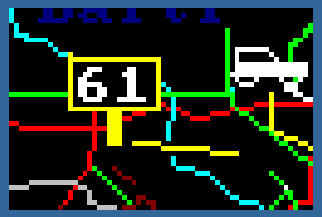
This APRSdos map of Tampa shows how Mile Marks can be overlayed on the map with the "MM" keys. Notice how I have placed the non-APRS mobile "Joe" on the interstate at mile mark 232 headed south west. Since APRSdos deadreckons all objects, Joe will continue to move on my map without update.

This is very handy going to Dayton with many folks on the road. You can keep an eye on all the other non-APRS travelers that are in QSO range even though they have no APRS capability.

APRS – Traffic Speed Posts



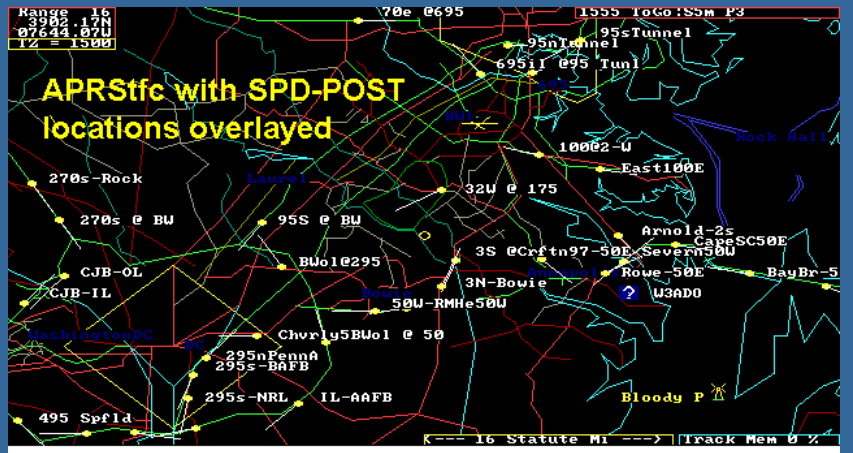
SPEED-POST showing 61 MPH E bound I-70 approaching Baltimore Beltway
Dead Reckoned age of KA3GYI's position (probably 10 minutes or more)



Shows speed of traffic past special points

How a SPEED-POST looks on the TH-D7 HT's displays

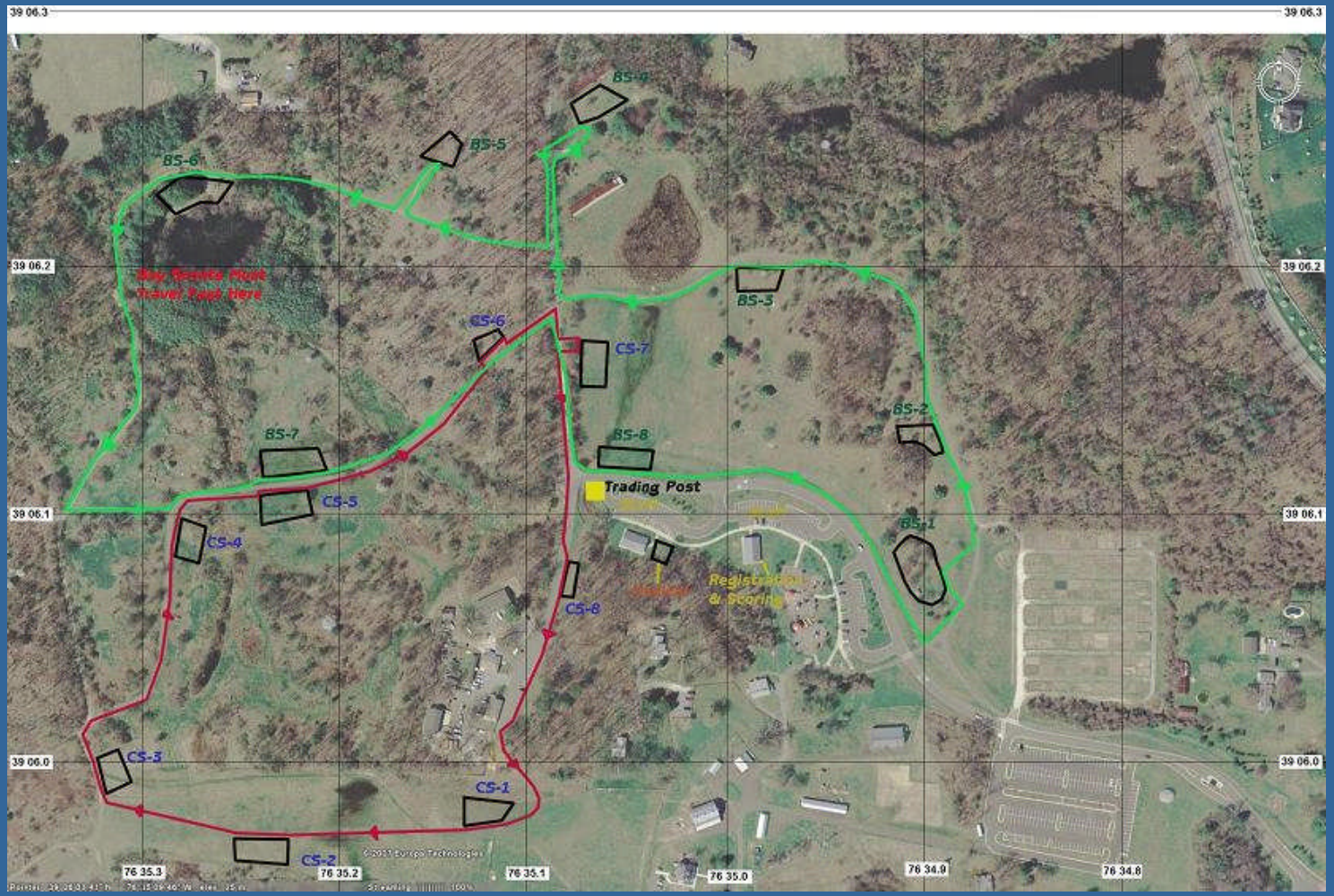
1:Bowie-50W {45} MPH Time 0735	1:Bowie-50W FM19sx \m 3 mi	1:Bowie-50W CSE214 s038 fm:W3ADO
Speed measured and Time	Direction and distance from you to Speed-Post	Direction of measured vehicle and call of APRStfc server



Use MAPS-OVERLAY-Traffic (MOT) command for this view:

Notice how it is important to place the SPEED-POST in the middle of where the typical backups occur. These are usually at different locations even on the same road between morning and evenings (see the route 3N and 3S near the middle of the map.) APRS objects can only be 9 characters in length and should not contain any punctuation, so it takes some creative work to come up with meaningful names. I used "il" and "ol" for inner-loop and outer-loop of the beltway. W3ADO is the APRStfc server located in Annapolis.

APRS Event Data Entry



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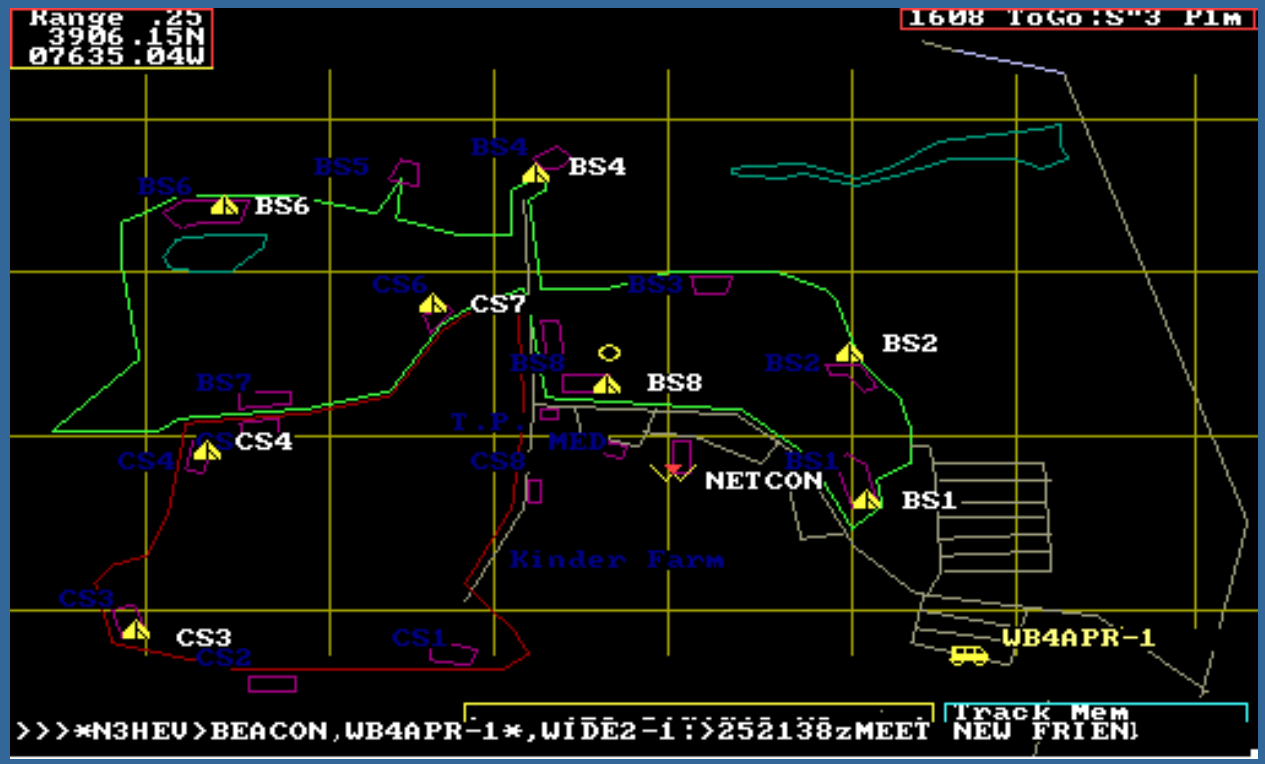
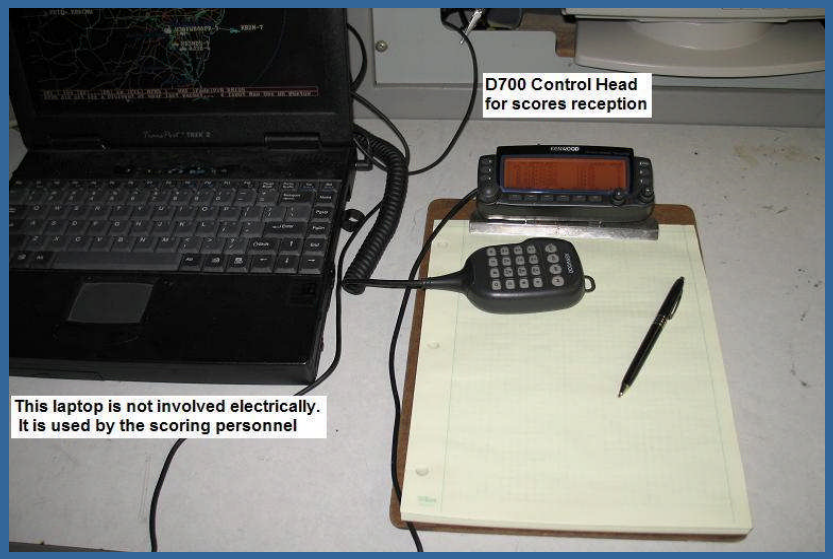
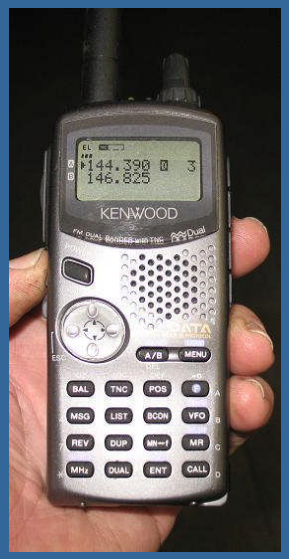


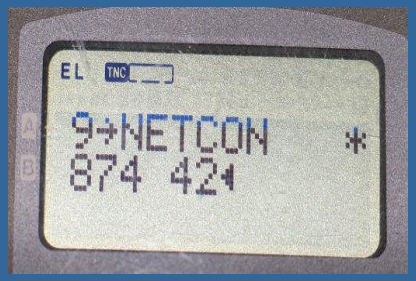
Typical APRS map display of positions

But this is only HALF of the APRS function!

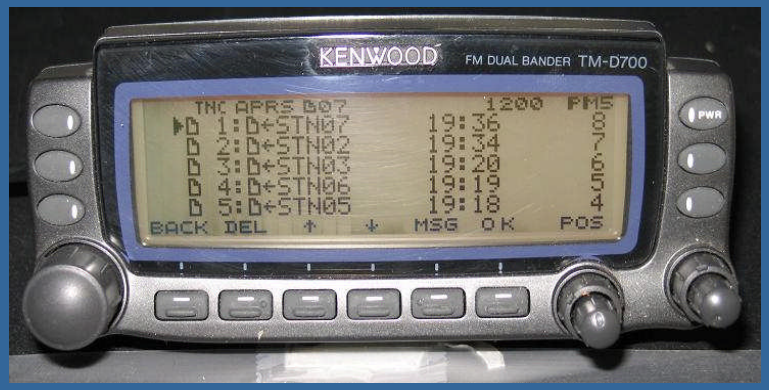
APRS Event Data Entry

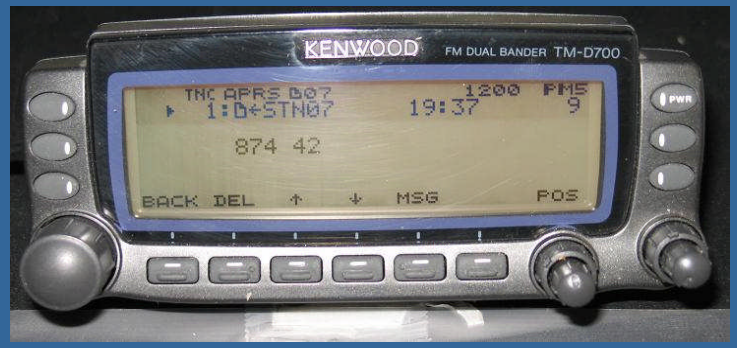






Score Message Sent





Score Data Received

APRS is a registered trademark Bob Bruninga, WB4APR

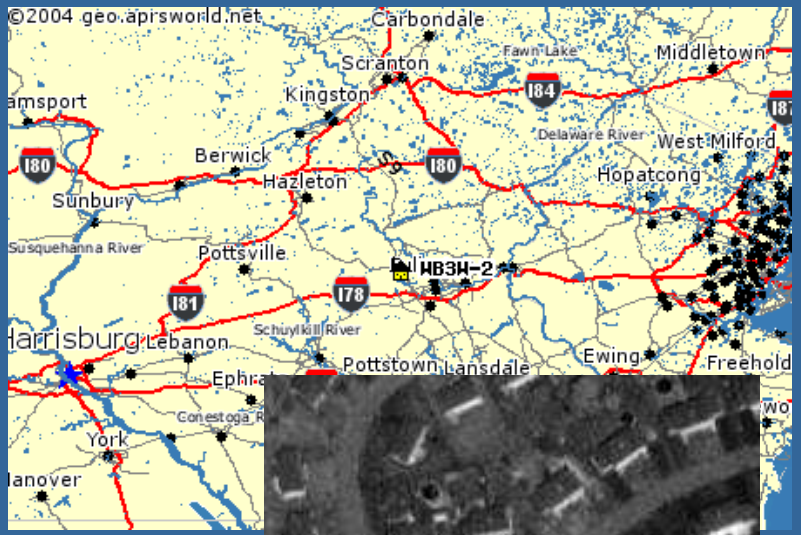
APRS IGates (Global APRS!)

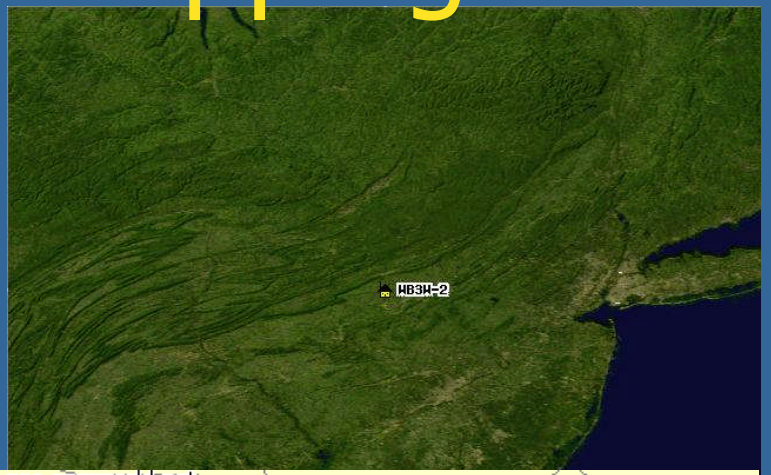
- An IGATE is a local APRS station that utilizes the APRS-Internet network to pass all packets heard on their local RF back to the Internet. (Gives global views to local activity.)

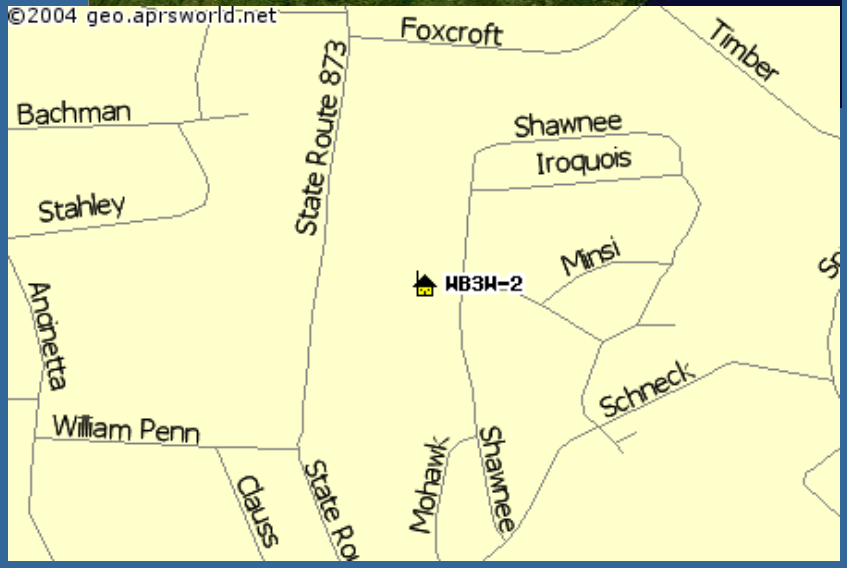
- Also act as two-way gateways for ALL APRS MESSAGES worldwide (Internet ⇔ RF).

Findu.com mapping

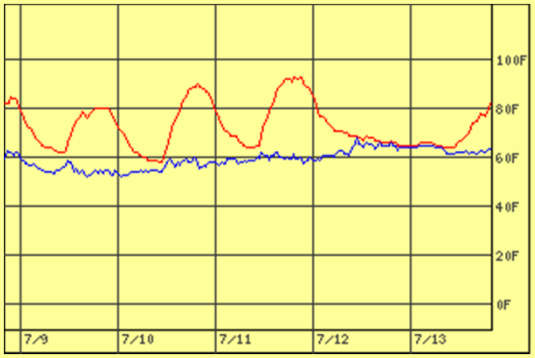
Internet tracking developed by
Steve Demise – K4HG



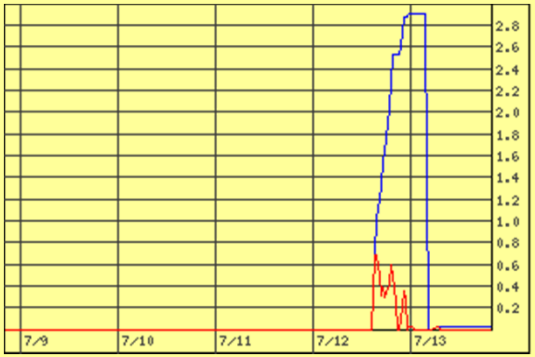




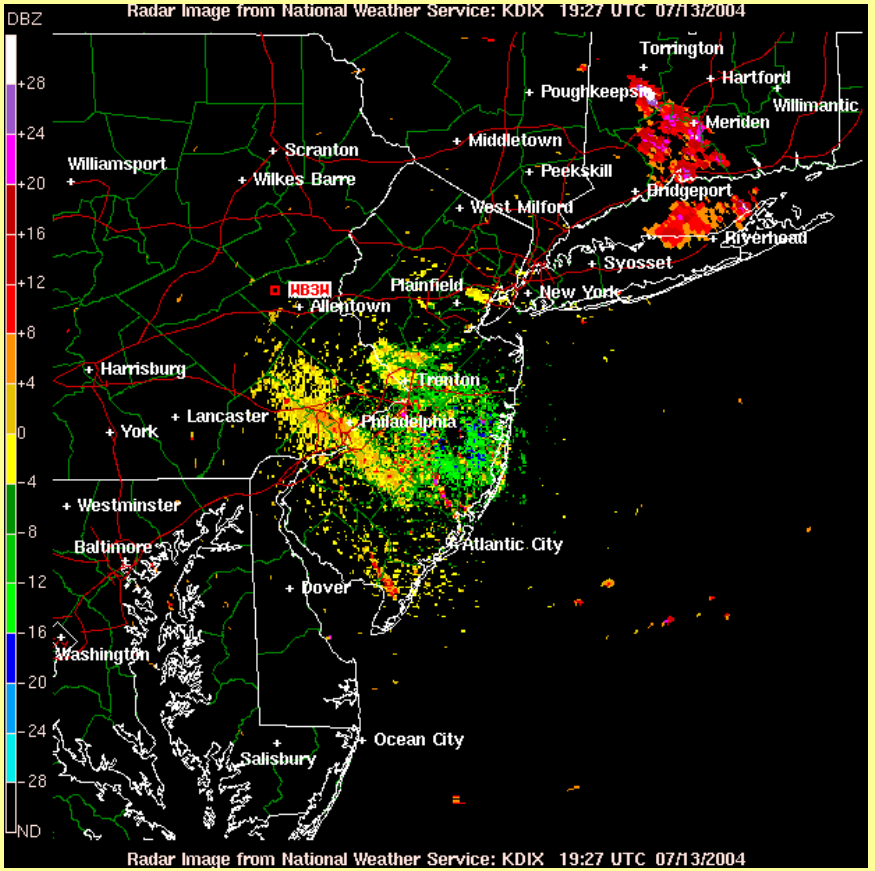
Findu.com Weather Data



Temperature & Dew Point

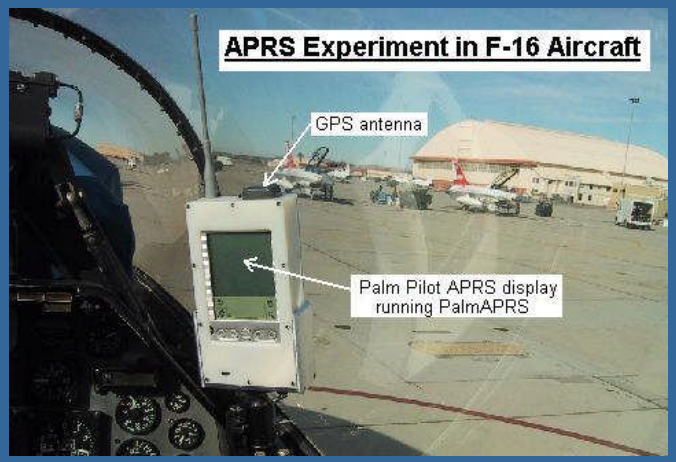


Rainfall Rates

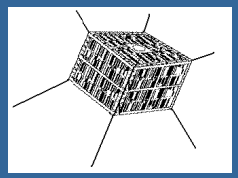


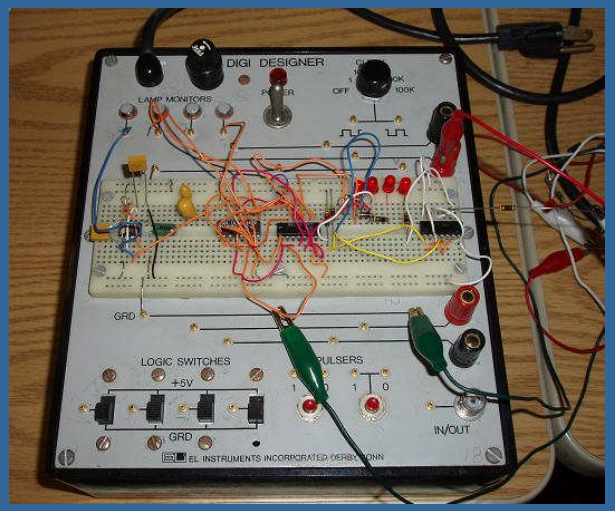
APRS for Special Uses

- 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.

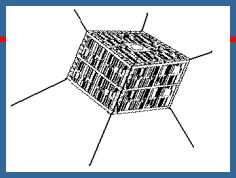
See Buoy Location and Telemetry at

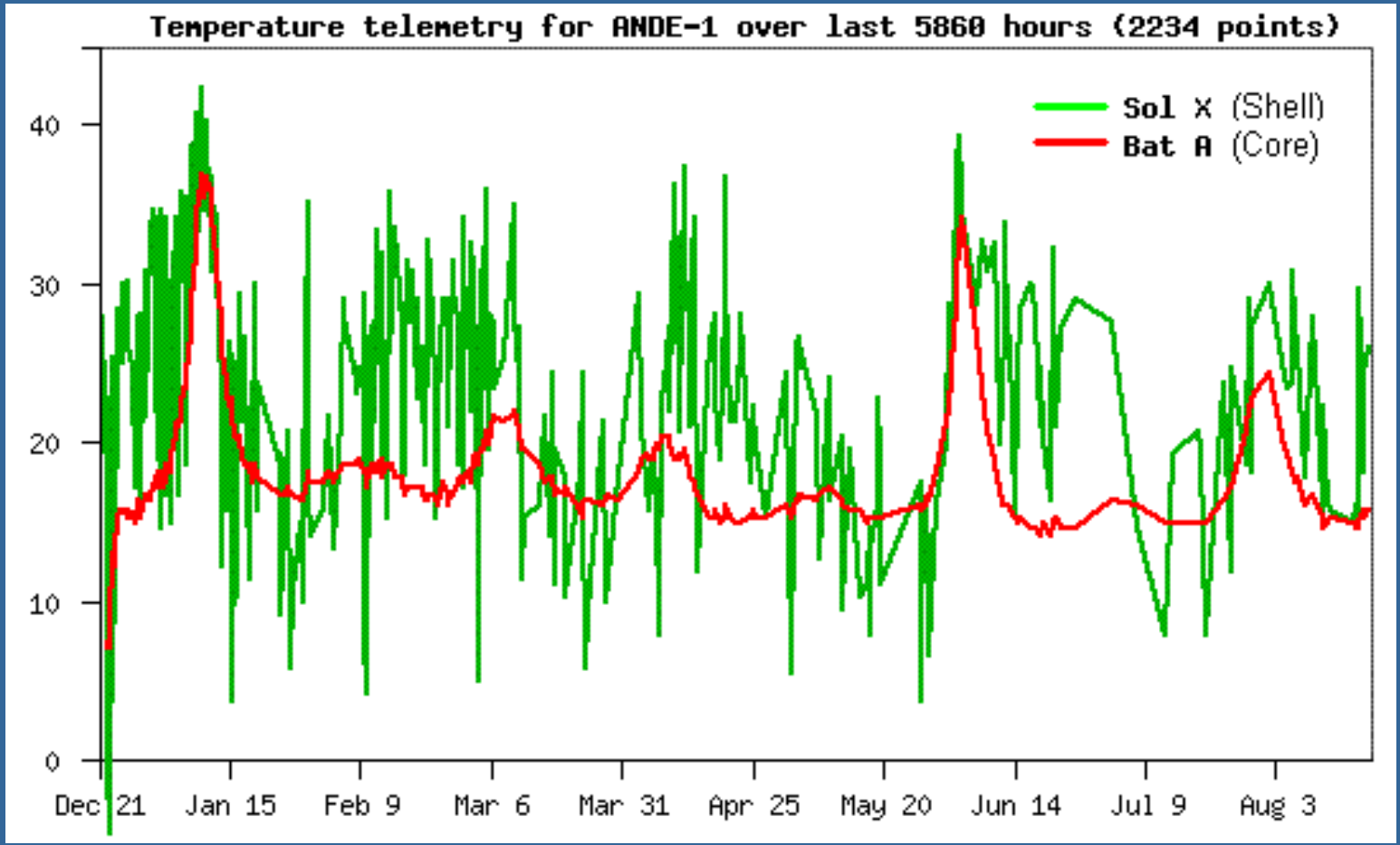
http://www.ew.unsa.edu/~bruninga/buoy.html

APRS is a registered trademark Bob Bruninga, WB4APR

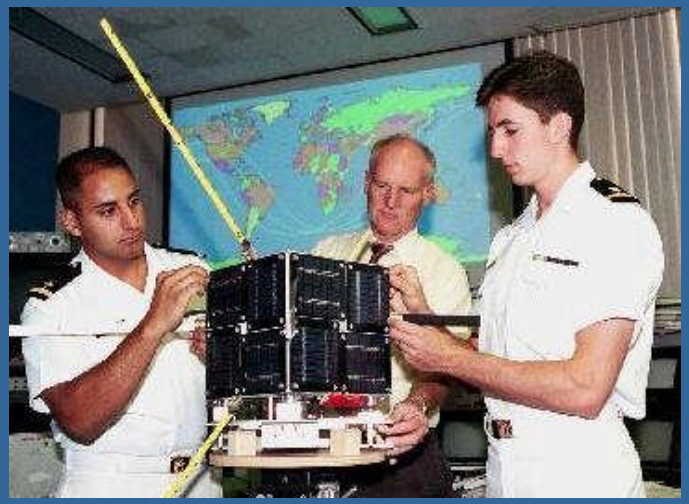
Piggrem

Findu.com Telemetry Plots



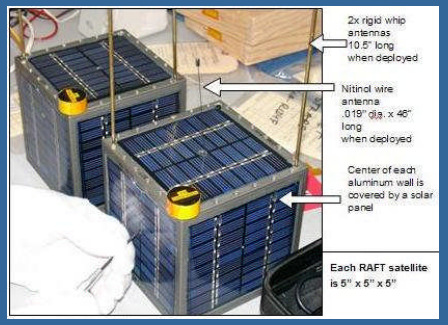


Into Space..PCSAT



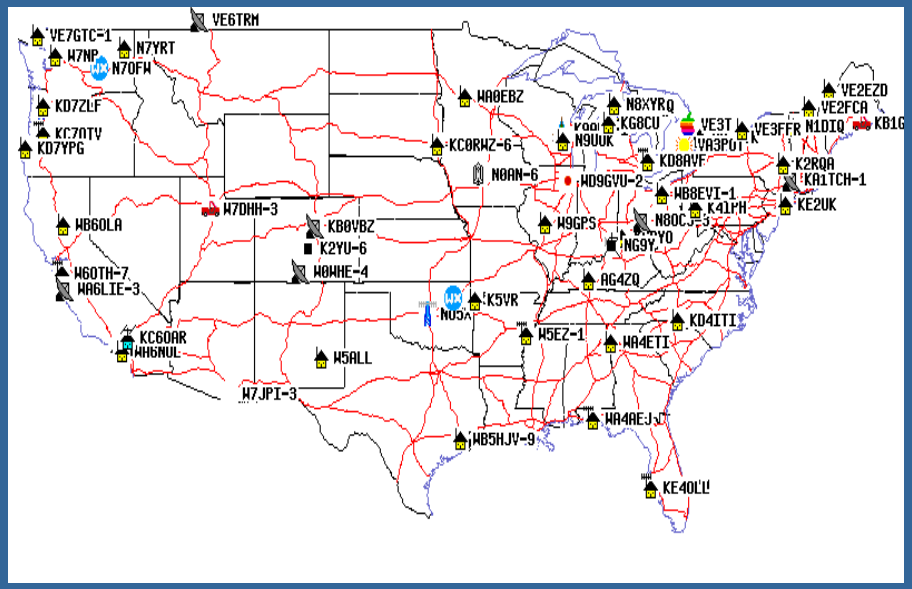
- The Prototype Communications Satellite, is a US Naval Academy Aerospace student project.

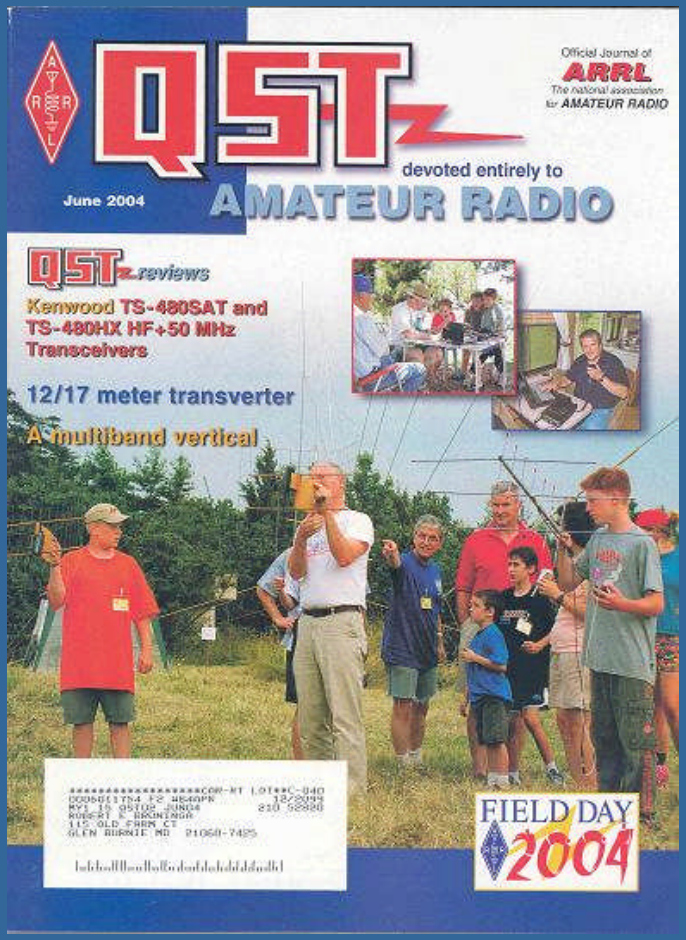
ANDE and RAFT in Dec 2006



- APRS space frequency is published as 145.825

APRS via Space





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

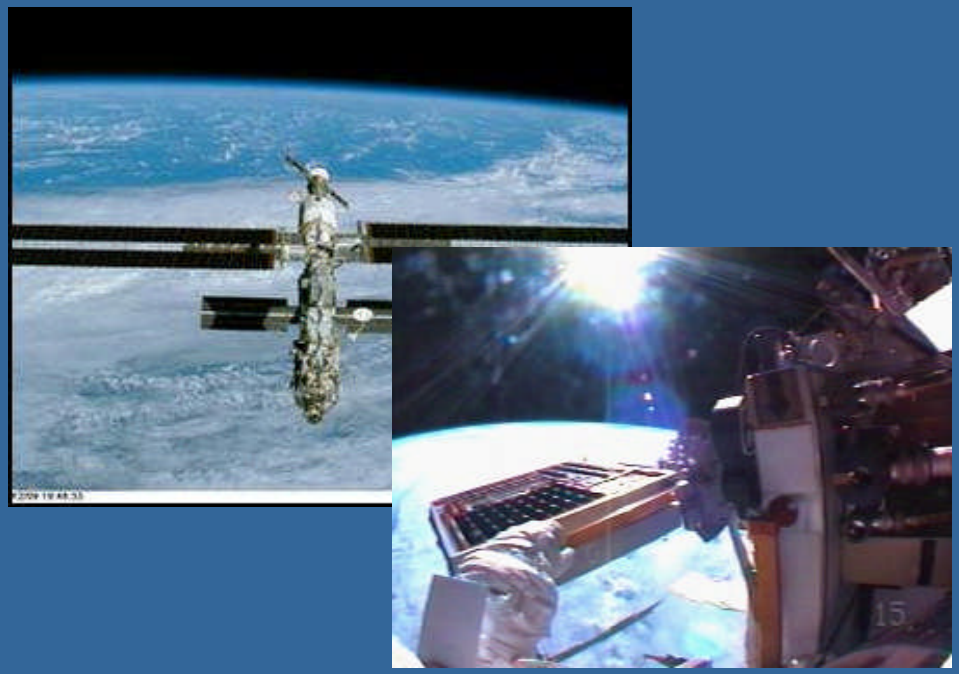
PCSAT Satellite

See live downlink on http://pcsat.aprs.org

- Launched Sept 2001 from Kodiak Alaska
- The first APRS satellite, and has since been joined by 5 other such satellites
- It still works during mid-day sunny passes.

- Can capture Emergency /Priority messages from THD7 / D700 radios anywhere on the globe and retransmit these signals on the USA VHF 144.39 APRS frequency.

International Space Station

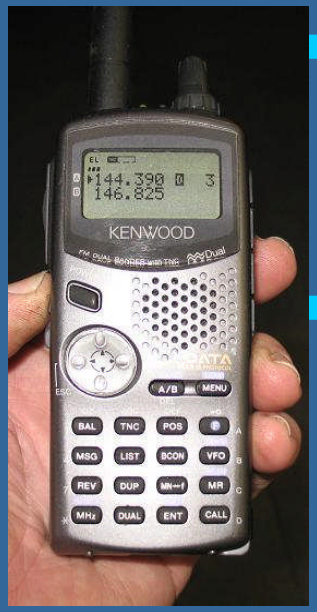


- ARISS supports APRS on its 145.80/145.99 packet system.
- Use digipeater path VIA ARISS.
- PCSAT2 was also on ISS 2005-2006

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

GO32 -EZ - MOBILE Satellite Prediction and Tracking

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

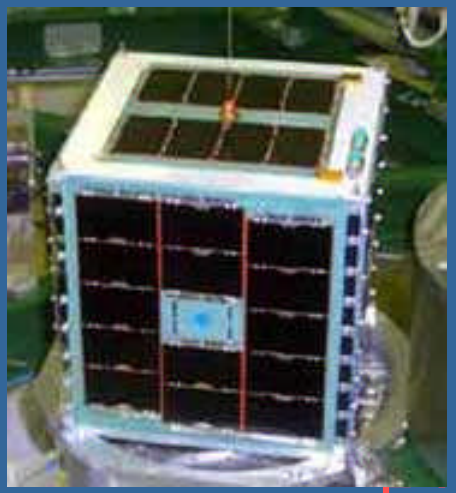
Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8	Day9	Day1	REPEAT
0930	0910	1025	1005	0940	0920	1040	1015	0950	0930	
	1050				1055					
2050	2030	2005	2125	2100	2040	2015	2135	2110	2050	
	2210	2145				2155				WB4APR

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

Fri 26 Oct is day8

Tracking ECHO (AO51) too!



Day1	day2	day3	day4	day5
0850	0950	0910	0830	0930
			1005	
2000	2100	2020	1940	2040
			2120	

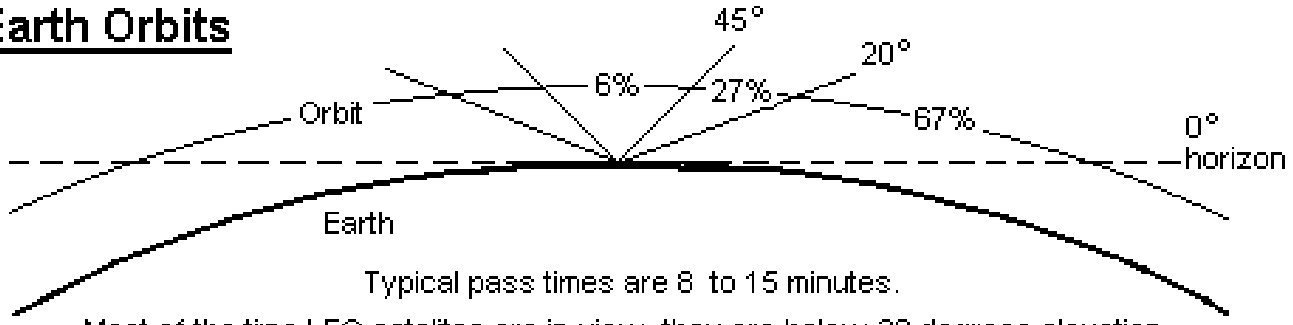
for Wash DC and NJS

Friday October 26th is day 4!

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

LEO Pass Geometry

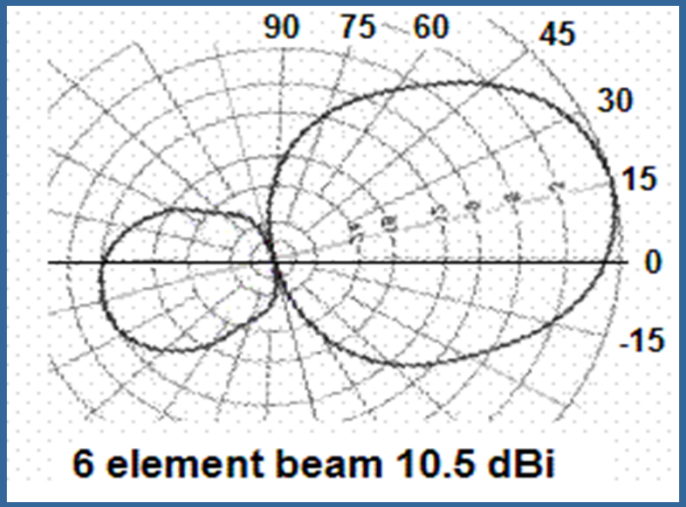
Low Earth Orbits



Typical pass times are 8 to 15 minutes.

Most of the time LEO satelites are in view, they are below 20 degrees elevation.

Rarely do they pass directly overhead. Only 2% of the time are they above 60 deg.

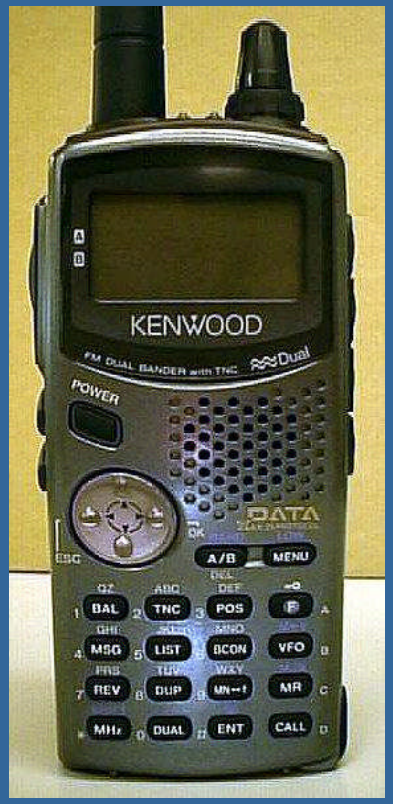


6 element beam 10.5 dBi

Bottom line:

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

Omni Antenna Gain 7 dBi !

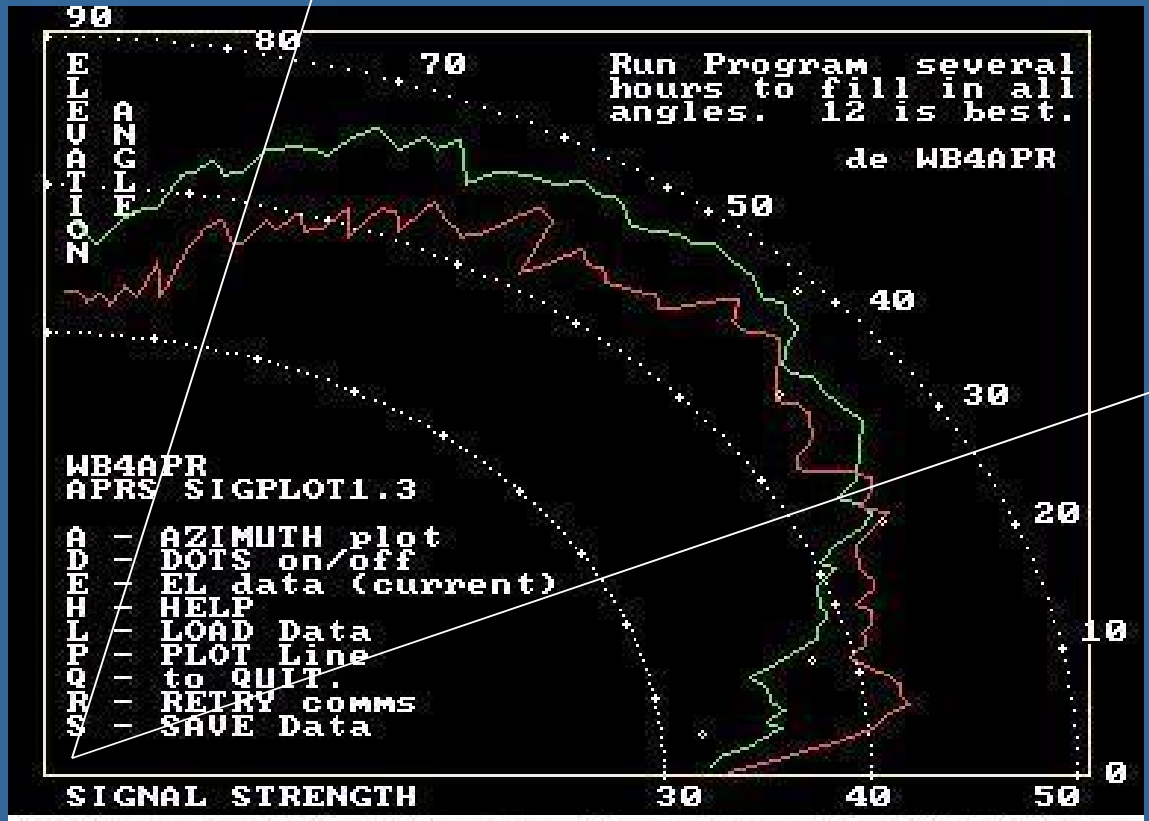


SATgate!

1%

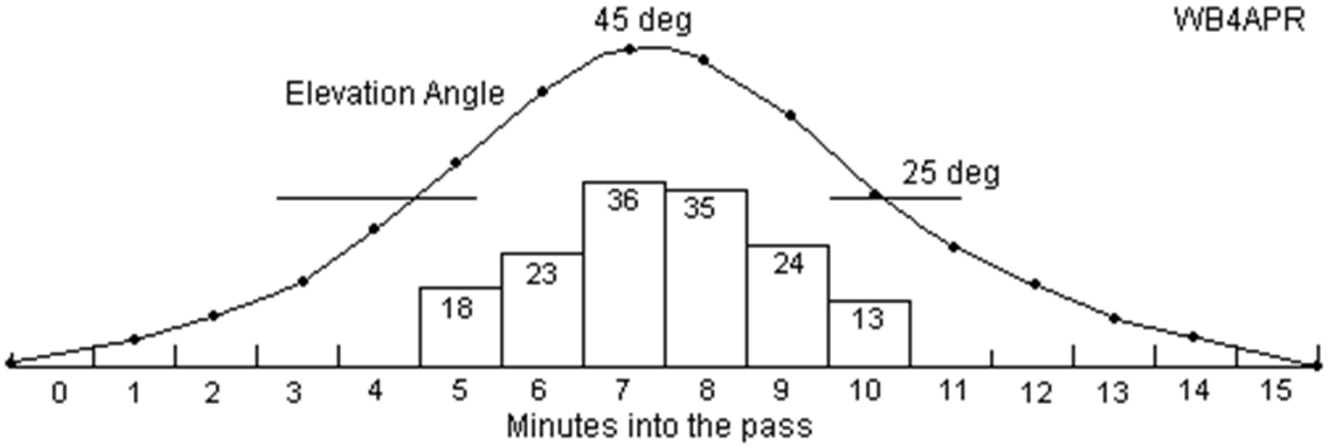
30%

70%



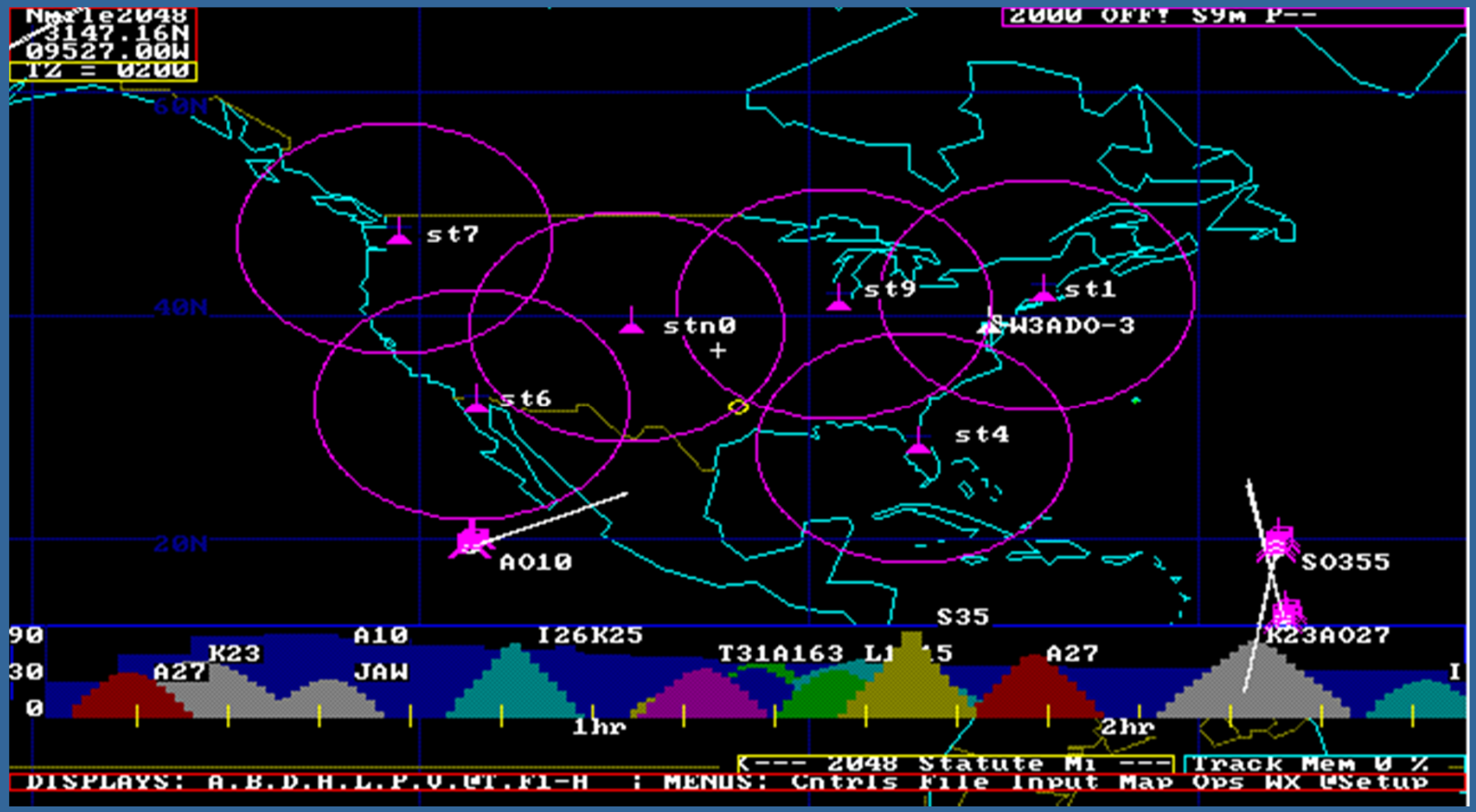
3/4 and 1/4 Wave Omnis at 435 MHz

Omni SatGates

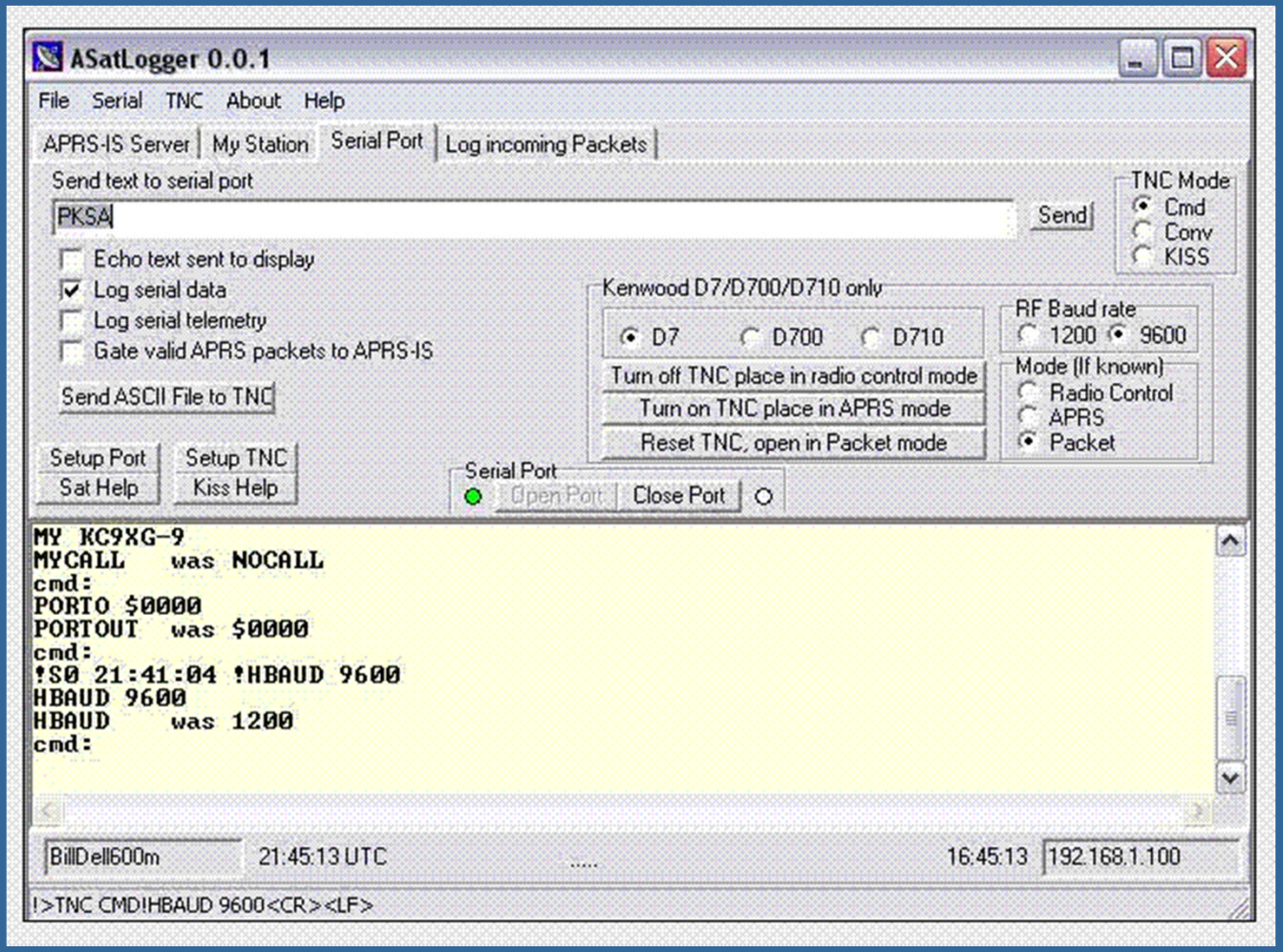


This plot shows the total packets per minute received by my TM-D700 APRS mobile radio using a mag-mount 19" whip on the roof of my car. In this case I was tracking Doppler, starting at 435.230, then 435.225, and ending at 435.220 MHz. Since the satellite is too far away at any elevation below about 25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

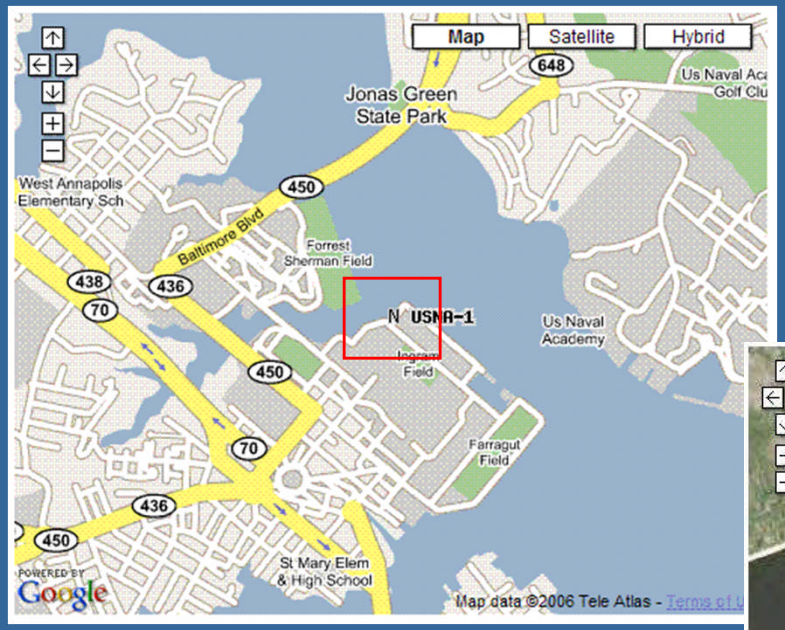
Omni SatGates

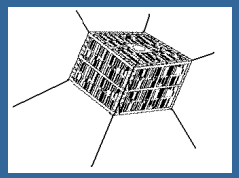


Omni SatGates (Alogger)



APRS-Internet (APRS-IS)





& situational awareness

This data is LIVE

http:// Pcsat.aprs.org

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

APRS-IS (FINDU – Near Map)

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

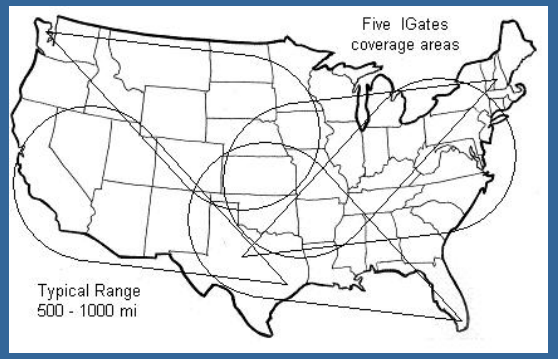
APRS Emergency Comms

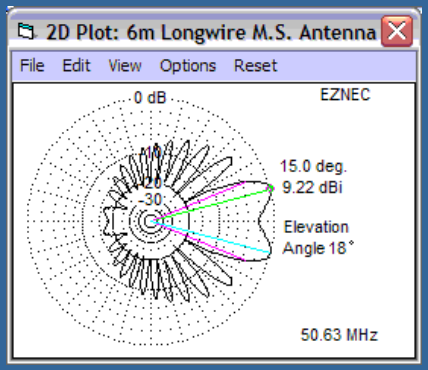
Satellite-Simulated Emergency Test – SSET

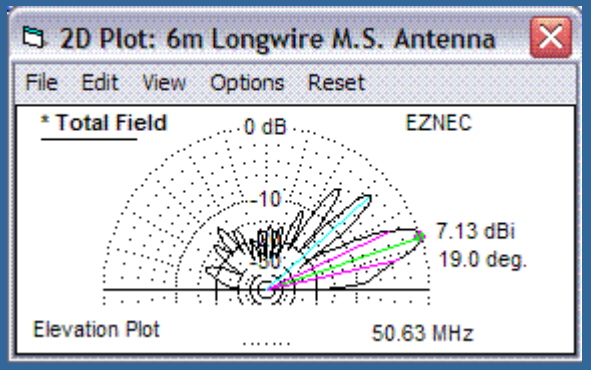
- Send an emergency Email via Satelilite

Meteor-Scatter Monitoring Network (6 meters)

- Dozens of Igates monitoring 50.62 MHz
- Message Throughput in minutes
- Using surplus 110 Watt 6m radios
- Simple 100’ long wire gain antennas







APRS Emergency Power

200W Solar Power

- Continuous

10 kW gas Generator 220 VDC

- Auto-runs as needed
- lightweight wires

Questions ? ? ?