Maps – Mobiles - Users

Introduction to APRS!

Bob Bruninga, WB4APR

Updated by Tyler N7UWX Kevin N7RXE & Brandon KD7IIW

What is APRS?

- **APRS** = Automatic Packet Reporting System
- **APRS** was developed in the late 1980's for local tactical digital communications, situational awareness and TWO-WAY information exchange
- Messages + maps for OBJECTS – everyone sees the same situation
- Not just GPS Vehicle Tracking!

APRS Messages

Built on AX.25 UI Packet Radio

Text message
Location (GPS Coordinates)
Weather information
Status message
Position Comment
Icon symbol

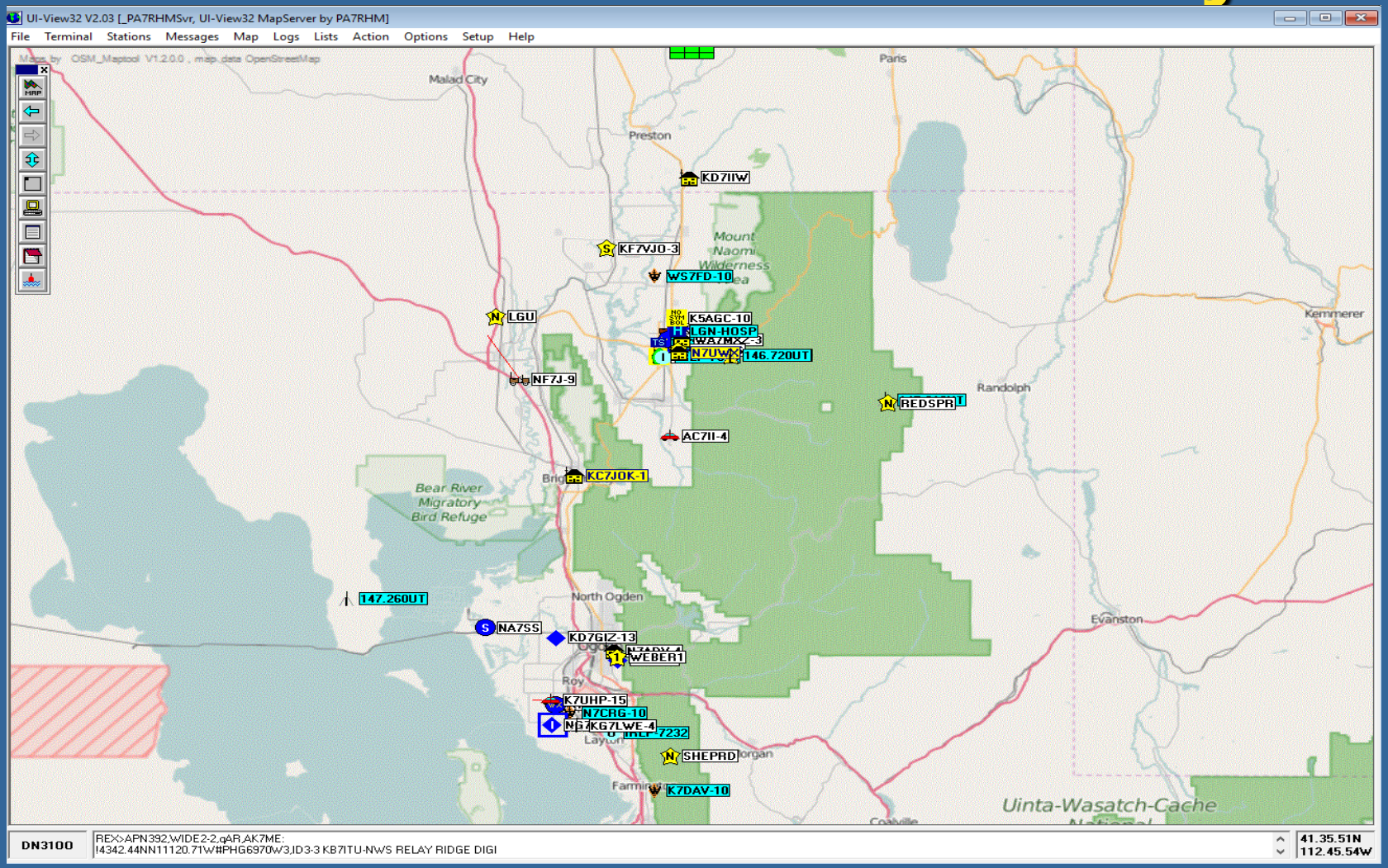
2m / 70cm FM Radio +
AX.25 Packet TNC +
APRS software

APRS Network Evolution

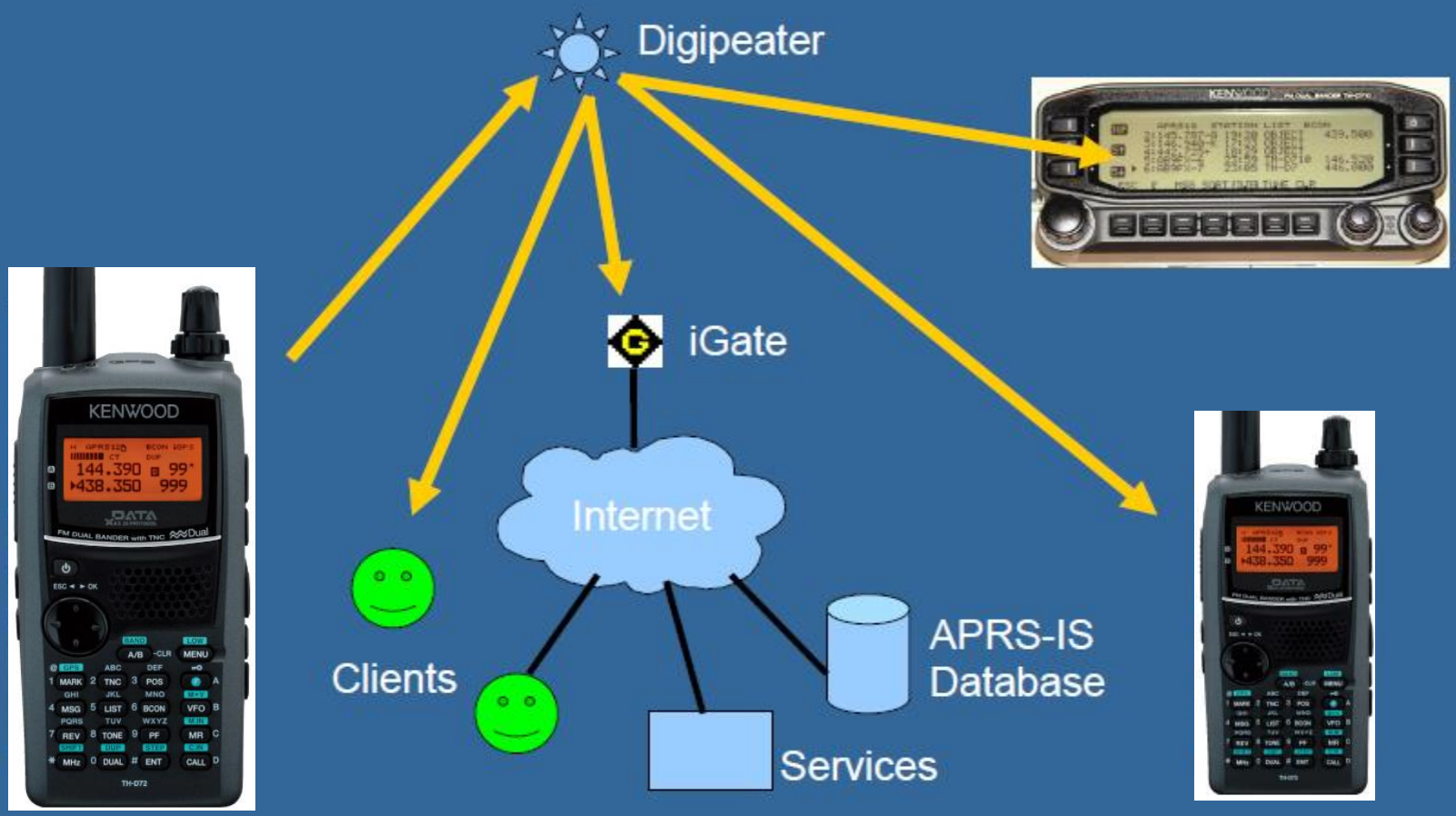
Digipeater

Clients

Client View: It's all about Objects



APRS Network Evolution



APRS Network Evolution

Satellite!

Digipeater

SatGate

iGate

Internet

Clients

APRS-IS Database

Services

*** THE "New Paradigm": Changes In Path Settings ***

- With the increasing popularity of APRS, channel congestion has increased dramatically. Much of this congestion is caused by unnecessary duplicate packets generated by WIDE digipeaters hearing and re-transmitting their own packets after they have been transmitted by a neighboring digipeater.

THE "New Paradigm":

- Packets with paths like RELAY,WIDE,WIDE or RELAY,WIDE2-2 would ping-pong back and forth between pairs of adjacent digipeaters repeatedly, creating numerous additional transmissions for every original made by a user. Additionally, users that failed to understand the limitations of a shared 1200-baud channel were abusing the channel by placing paths like WIDE4-4, WIDE5-5 or higher in their transmissions.

THE "New Paradigm":

- A large proportion of all the digipeaters in the U.S. use Kantronics KPC3+ TNCs. These TNCs have internal software that can detect duplicate packets and avoid retransmitting them, **but only if the path is a WIDEn-N path**. They will stupidly retransmit plain WIDE or RELAY repeatedly.

THE "New Paradigm":

- In late 2004 and early 2005, an entirely new path convention was introduced to address this problem. The "New Paradigm" path convention **completely discontinues** the use of "RELAY" and "WIDE", and **exclusively** uses WIDEn-N-type paths. Furthermore, many digipeaters are now set to ignore (or truncate) paths greater than WIDE2-2. This greatly reduces channel congestion caused by duplicate packets generated by dumb "RELAY" and "WIDE" digipeaters, and stops out-of-area QRM from distant clueless channel abusers.

THE "New Paradigm":

- The problem that arose is that since high-level digipeaters no longer respond to "RELAY", users have the dilemma of whether to:
  1. Place "RELAY" in the first hop of their paths to take advantage of home stations which guarantees that they won't go anywhere if no home station hears them first, even if a WIDEn-N high-level digi is nearby.
  2. Use only WIDE2-2 or WIDE3-3 in their paths which will be acted on by high-level digis, but forfeits the possible help of nearby home stations.

THE "New Paradigm":

The solution was to turn home stations into "fake" WIDEn-Ns also. The replacement alias for the home station fill-in RELAY is now WIDE1-1 . (To enable it, you just place "WIDE1-1" into MYALIAS of the home station instead of "RELAY") The home station digi typically isn't smart enough to understand how to decrement WIDEn-N. It will simply process it as a callsign of "WIDE1" with an SSID of "-1". It will "use it up" and mark it as used in one hop, no matter what number is in the SSID.

THE "New Paradigm":

By placing two WIDEn-N statements in series in the path, you allow a simple home station "new relay" to "eat" the first hop while leaving the second n-N hop(s) for "real" WIDEn-N digis to properly process and decrement. However, WIDE1-1 will also work with a real WIDEn-N, if it happens to be the first digi to hear a station.

THE "New Paradigm":

In areas without home station fill-in digipeaters, a "real" WIDEn-N digi will act on the first hop and decrement it to zero (WIDE1-0) which shows on-the-air as " **WIDE1*** " . By contrast a dumb home station will retransmit the packet as " **WIDE1-1*** "; i.e. not N-n decremented but still marked as used. The next digi to hear the packet will act on the second hop WIDE2-2 and transmit it decremented to WIDE2-1. The third digi, if any, will transmit the packet decremented to to WIDE2-0 . (actually shows as "**WIDE2***"). No further digipeating will occur.

THE "New Paradigm":

Thus the life of this packet looks like this:

- WIDE1-1,WIDE2-2 (as the user transmitted it)
- WIDE1-1*,WIDE2-2 (if a home fill-in digi does the first hop.)

--or--

- WIDE1*,WIDE2-2 (if a high-level digi does the first hop.)
- WIDE1*,WIDE2-1 (as the next high-level digi transmitted it)
- WIDE1*,WIDE2* (as the final high-level digi transmitted it)

APRS Digipeater Operation

Demonstration of "New Paradigm" digipeater paths using a home fill-in digipeater and two tiers of high-level digipeaters. Note the changes in the path string as the packet passes through three digipeaters.

IMPORTANT! For illustration purposes, this example uses a path setting with three digipeater hops (WIDE1-1,WIDE2-2), in order to clearly show how WIDEn-N decrementing works.

In actual use, **one should ALMOST NEVER use more than TWO hops**, to minimize congestion in distant locations on the shared APRS radio channel. The recommended path setting for a mobile station is:

WIDE1-1,WIDE2-1

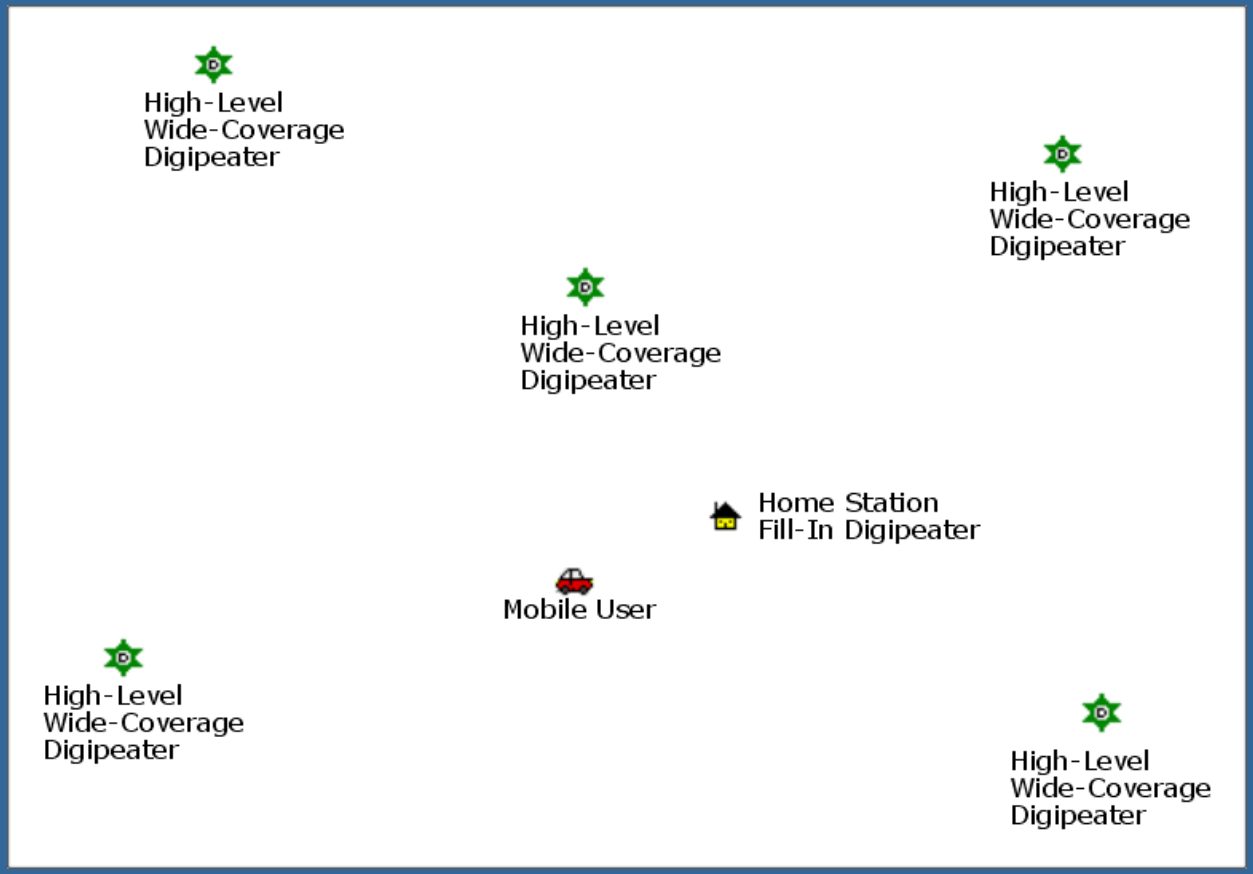
The recommended path setting for a fixed station is:

WIDE2-1 only.

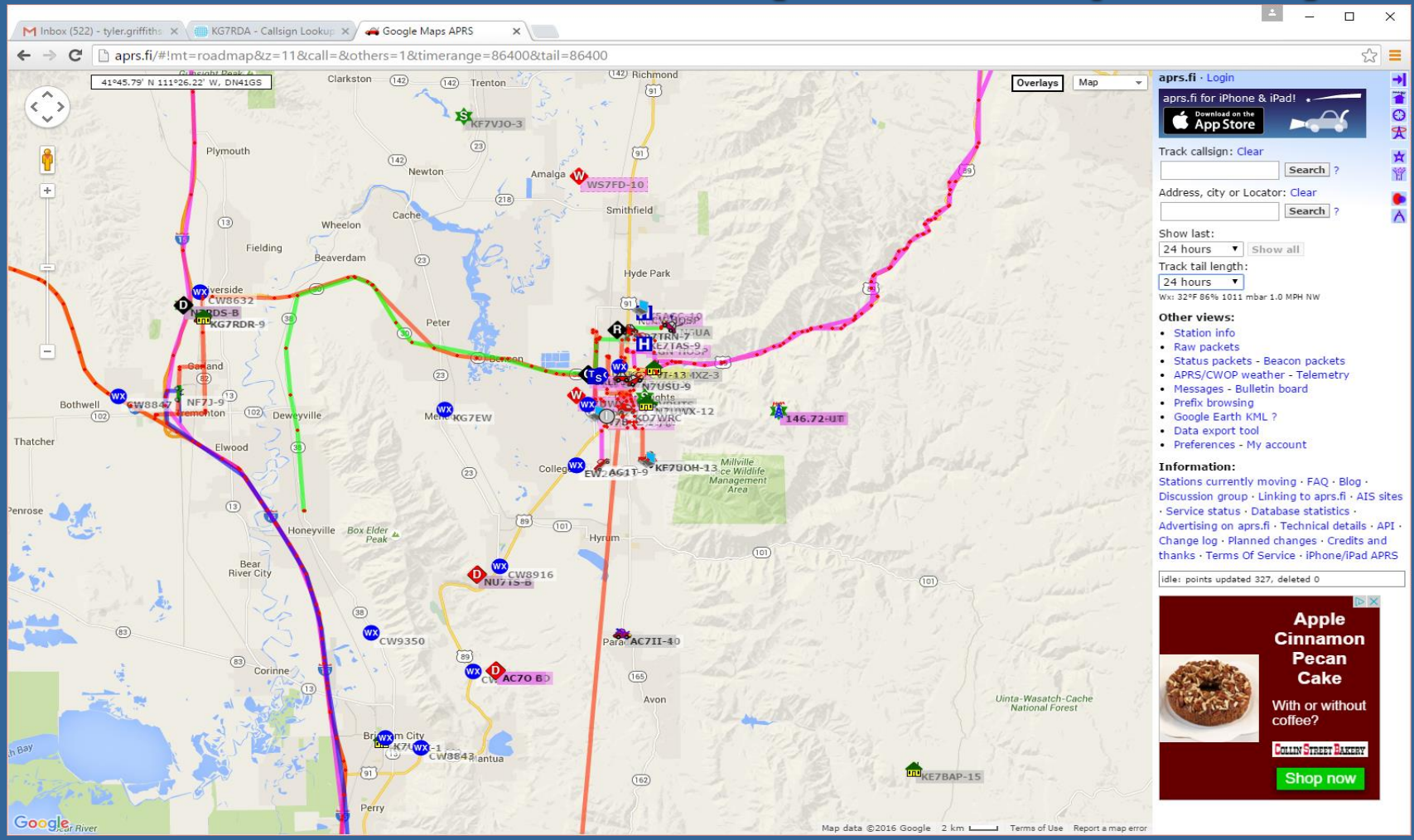
The recommended path setting for an airborne station is **NO** path at all above a few thousand feet, or at the maximum, only one hop:

WIDE2-1 only.

APRS Digipeater Operation

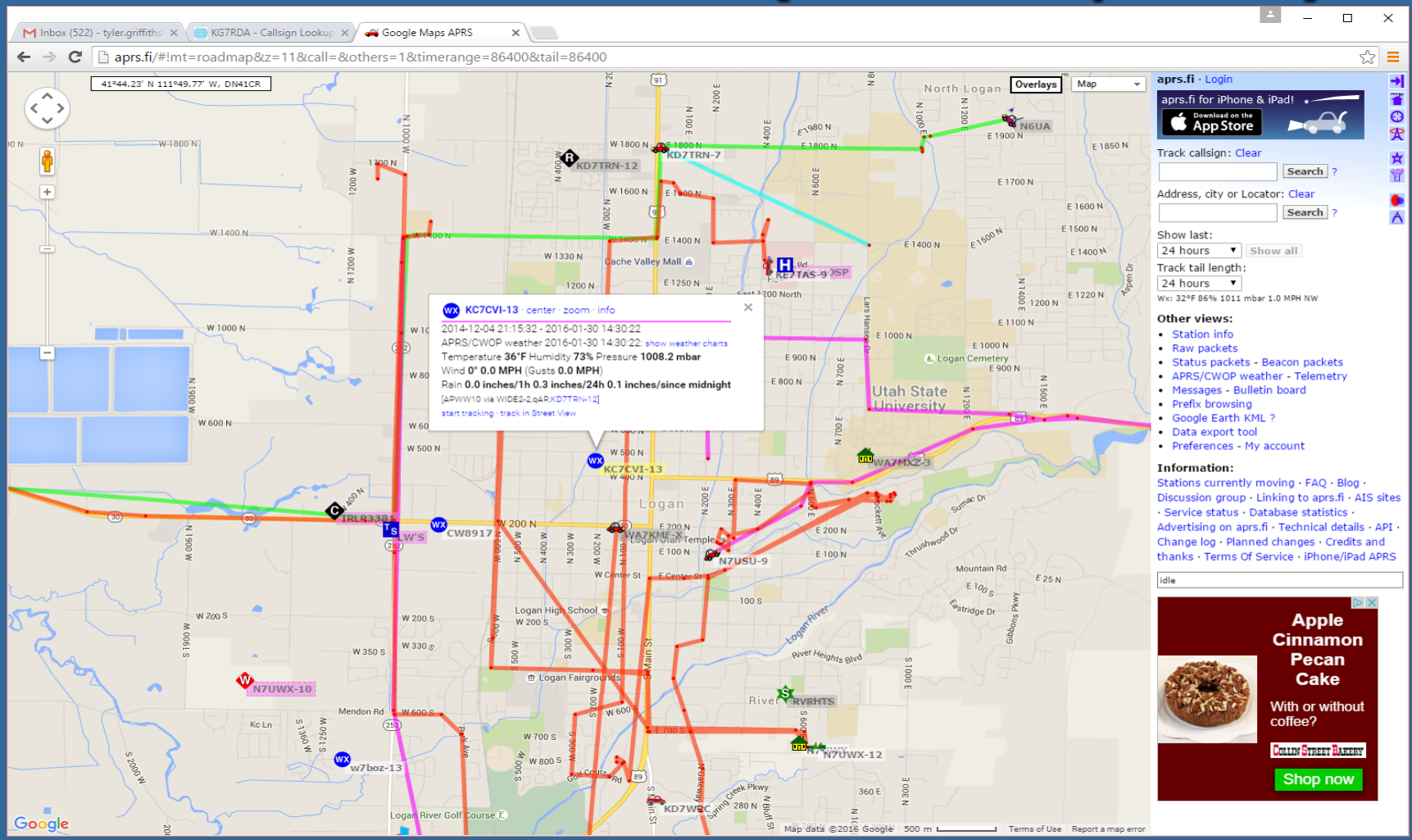


APRS-Internet (www.aprs.fi)



APRS is a registered trademark Bob Bruninga, WB4APR

APRS-Internet (www.aprs.fi)



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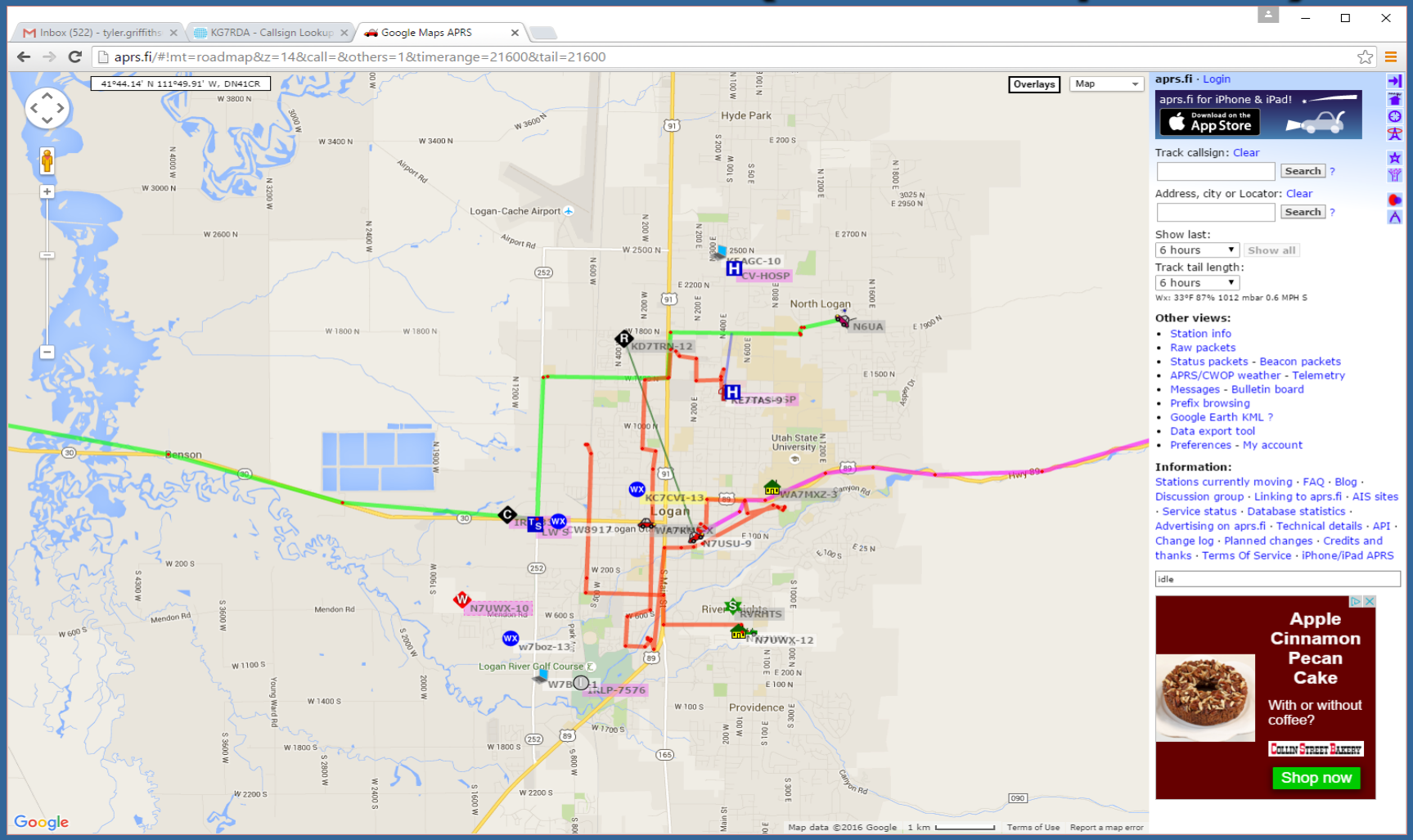

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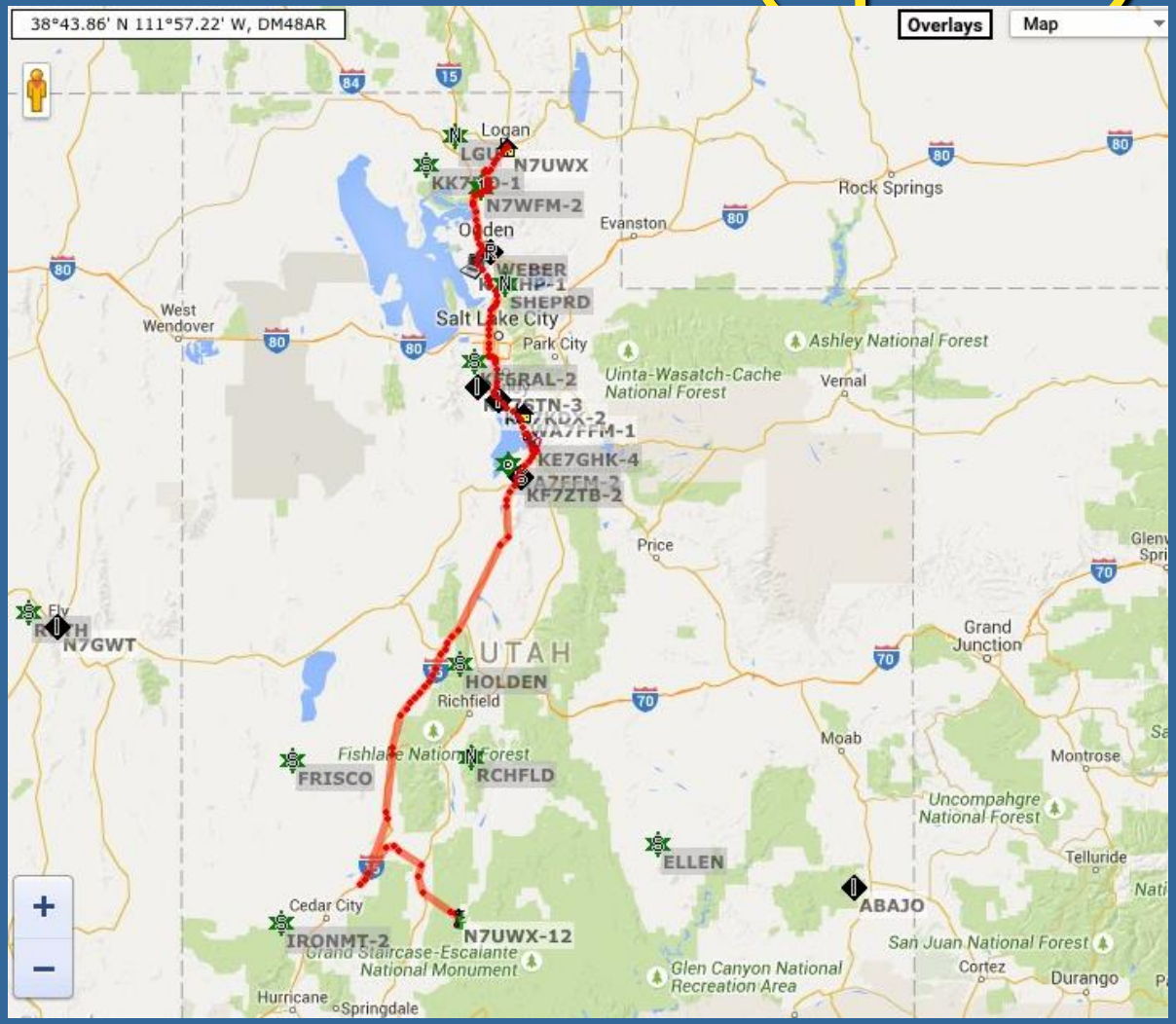
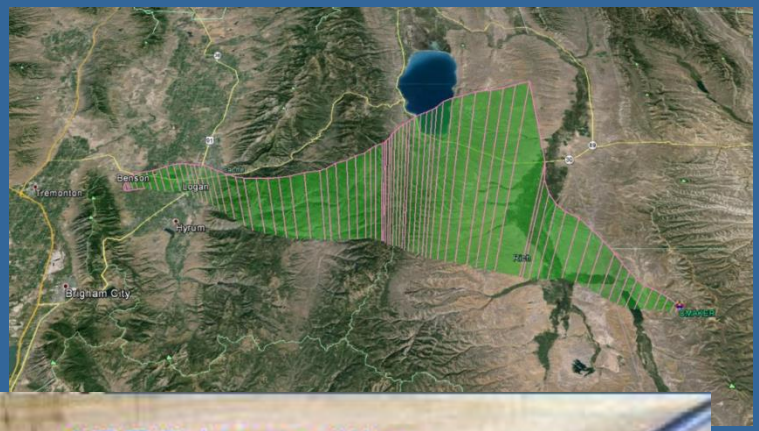
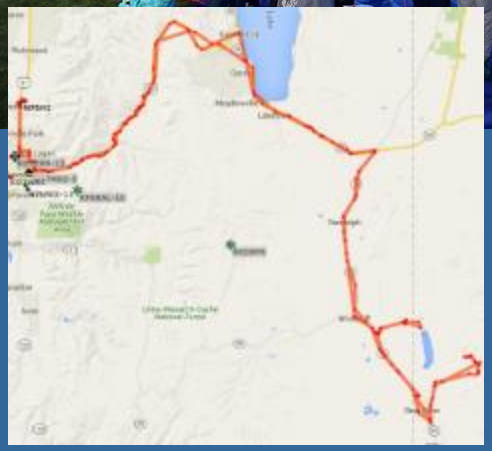


APRS Balloons



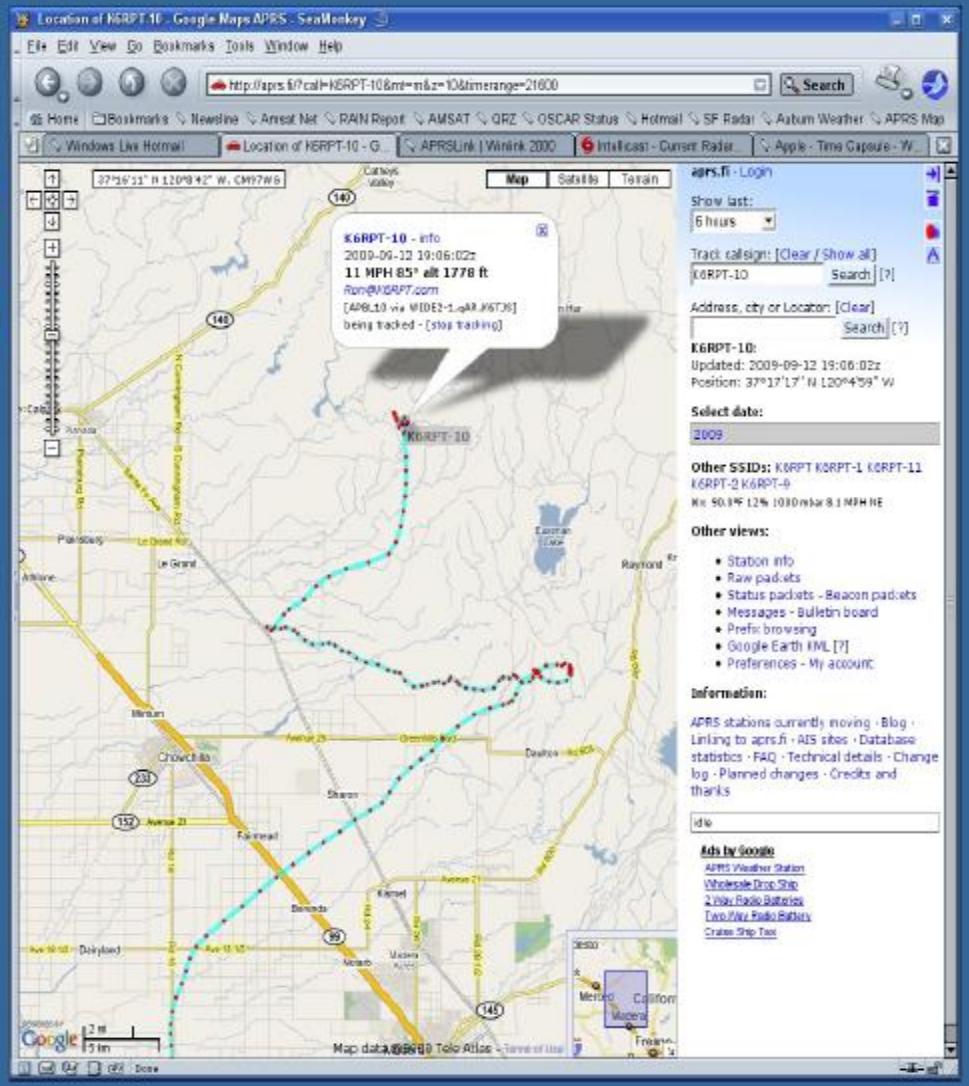


K6RPT-10 Balloon Flight Sept 12, 2009

Real-time tracking available to anyone with an Internet connection.

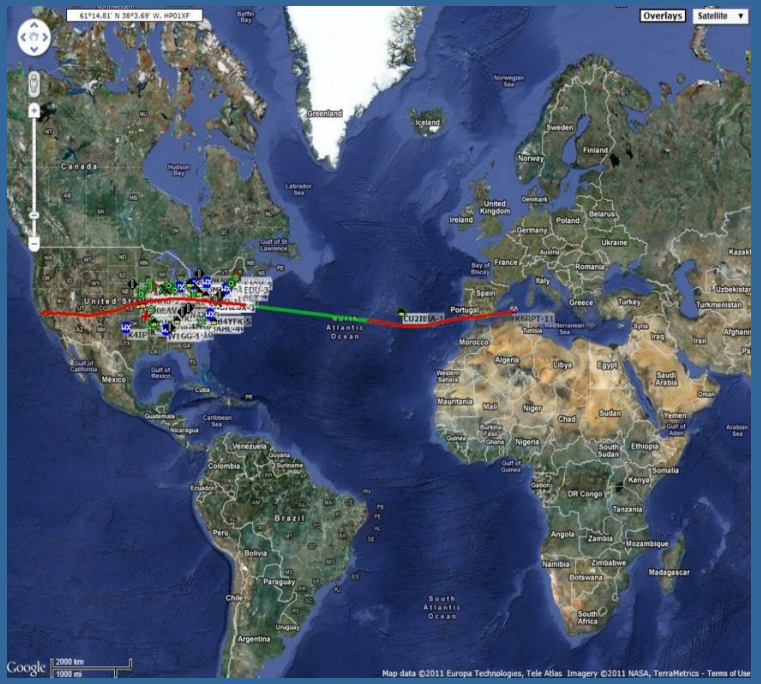
Real-time telemetry (think Wx)

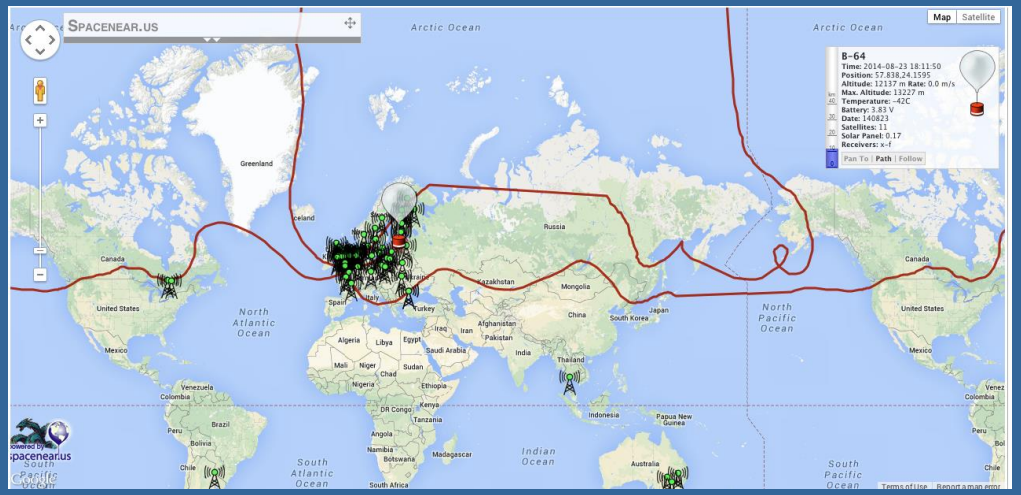
Beacon provided location information for recovery crew, without the need for wide-scale Direction Finding.



K6RPT-11
Trans-Alantic Balloon Flight
Dec 11 2011

- California Near Space Project
- MOXER-4 July 12- Nov 23 2014
  - First APRS balloon flight
  - Around the world (Party Balloon)
  - 11 gram payload

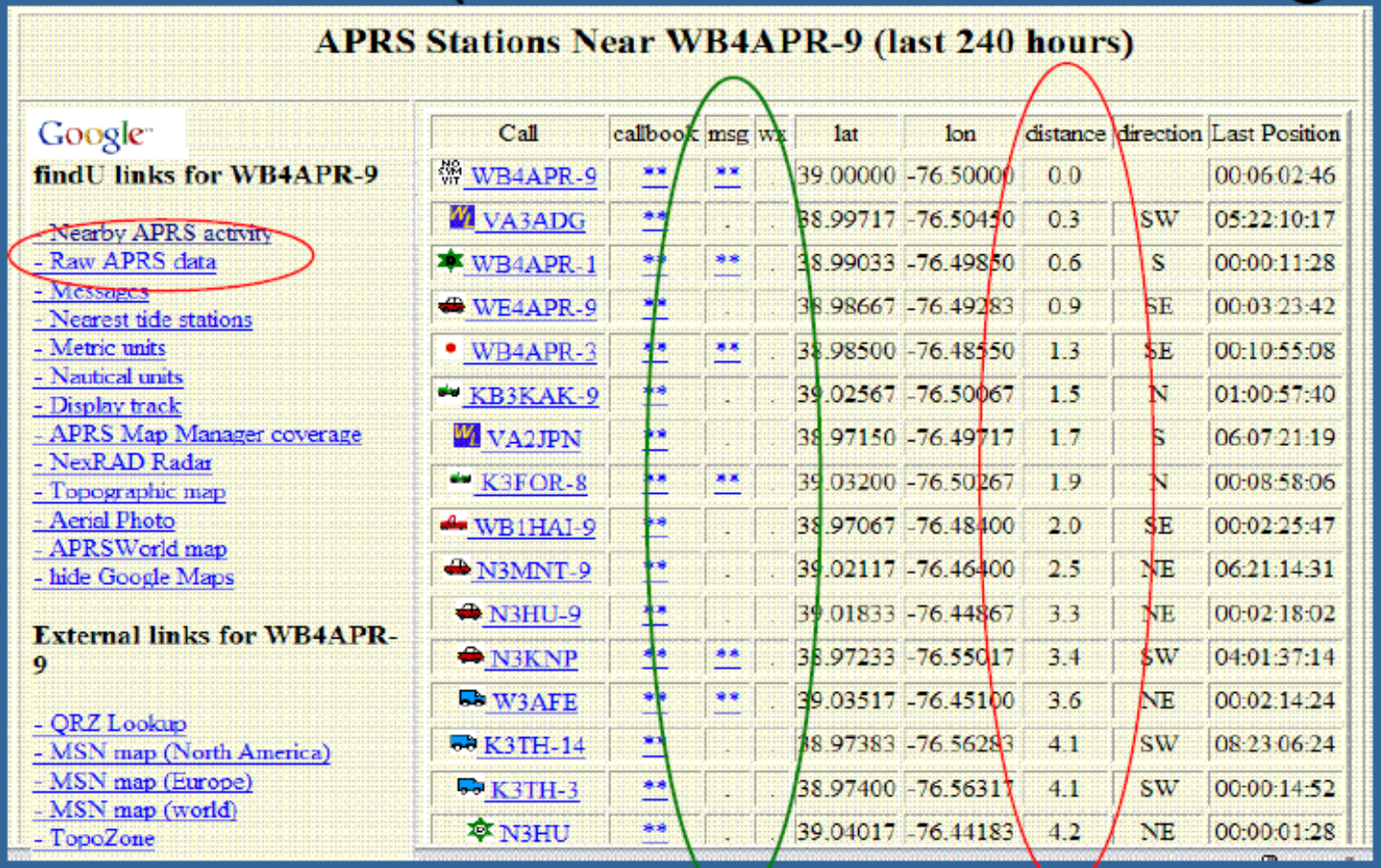




Findu.com Internet Interface

Internet tracking developed by
Steve Demise – K4HG

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

What is APRS all about?

(Humans communicating INFO with Humans)

Immediate local digital and graphical information exchange between all participants in a local area or event. This includes:

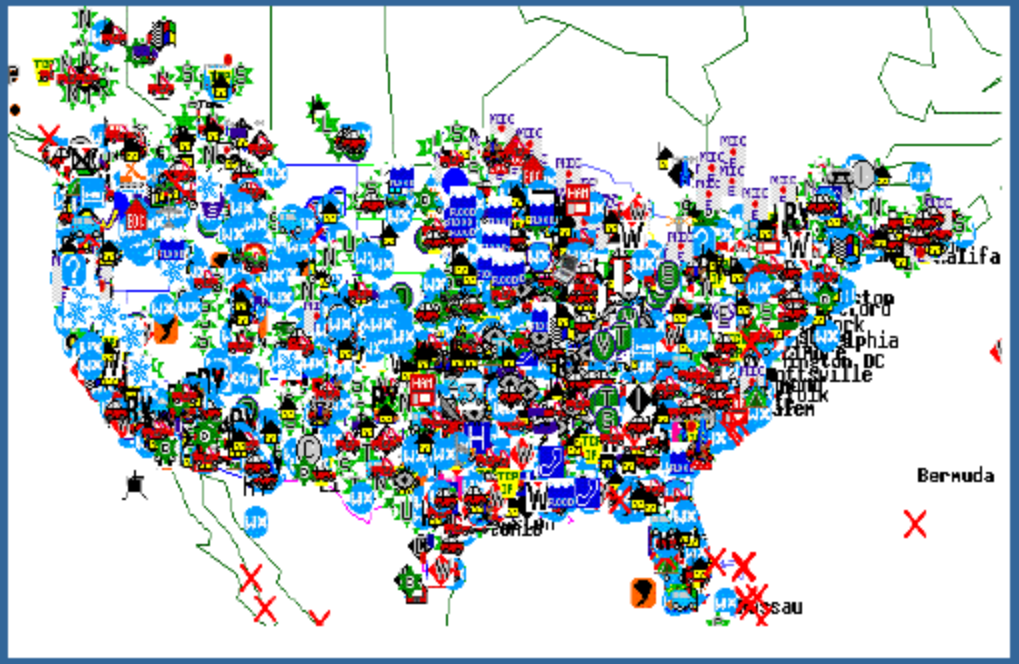
- Positions of all stations and objects
- Status of all stations
- Messages, Bulletins and Announcements
- Weather data and telemetry
- DF bearings and signal strengths for quick transmitter hunting
- RF Connectivity plots of all stations
- Local OBJECTS on a common map display for all users
- Local Freqs, IRLP, ECHOlink, Winlink, 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 text messaging
- Weather data exchange and display
- Efficient multi-user Satellite communications

Scope of APRS

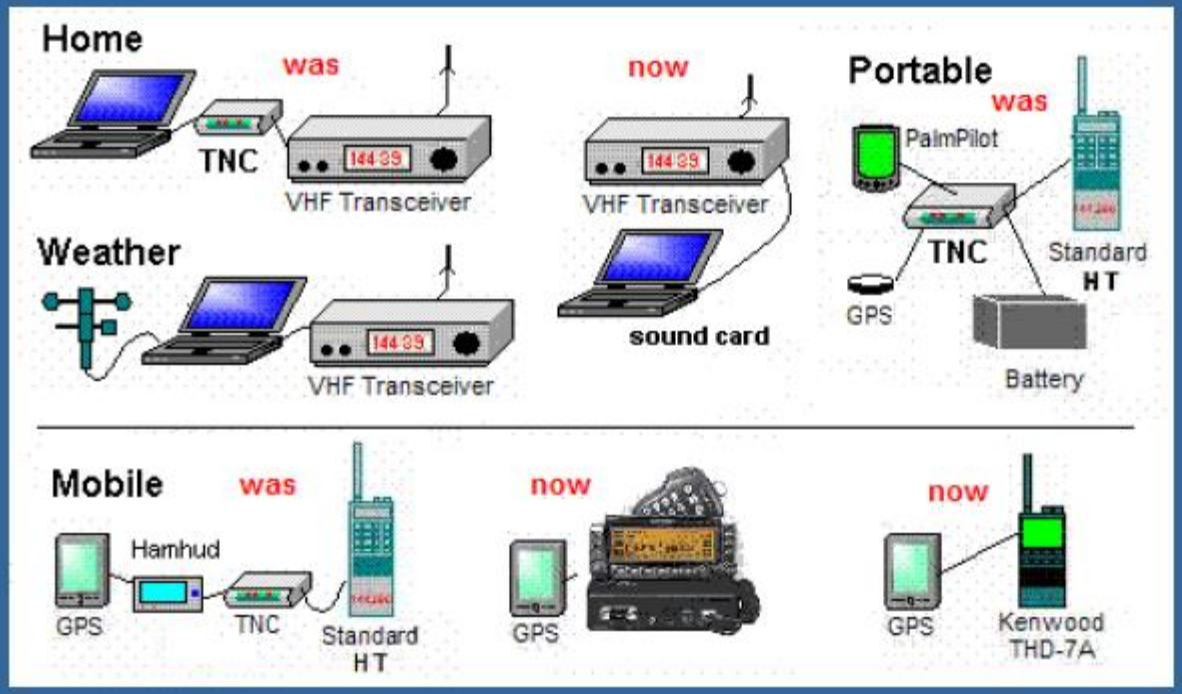
- Over 30,000 users worldwide.
- RELAYS every 20-30 mi called “digipeaters.”
- All linked by home station Igates
- Global links by Amateur Satellites
- Thousands of Weather stations
- Telemetry and data everywhere



But, only 2% of local ham radio users…

(a side show)…

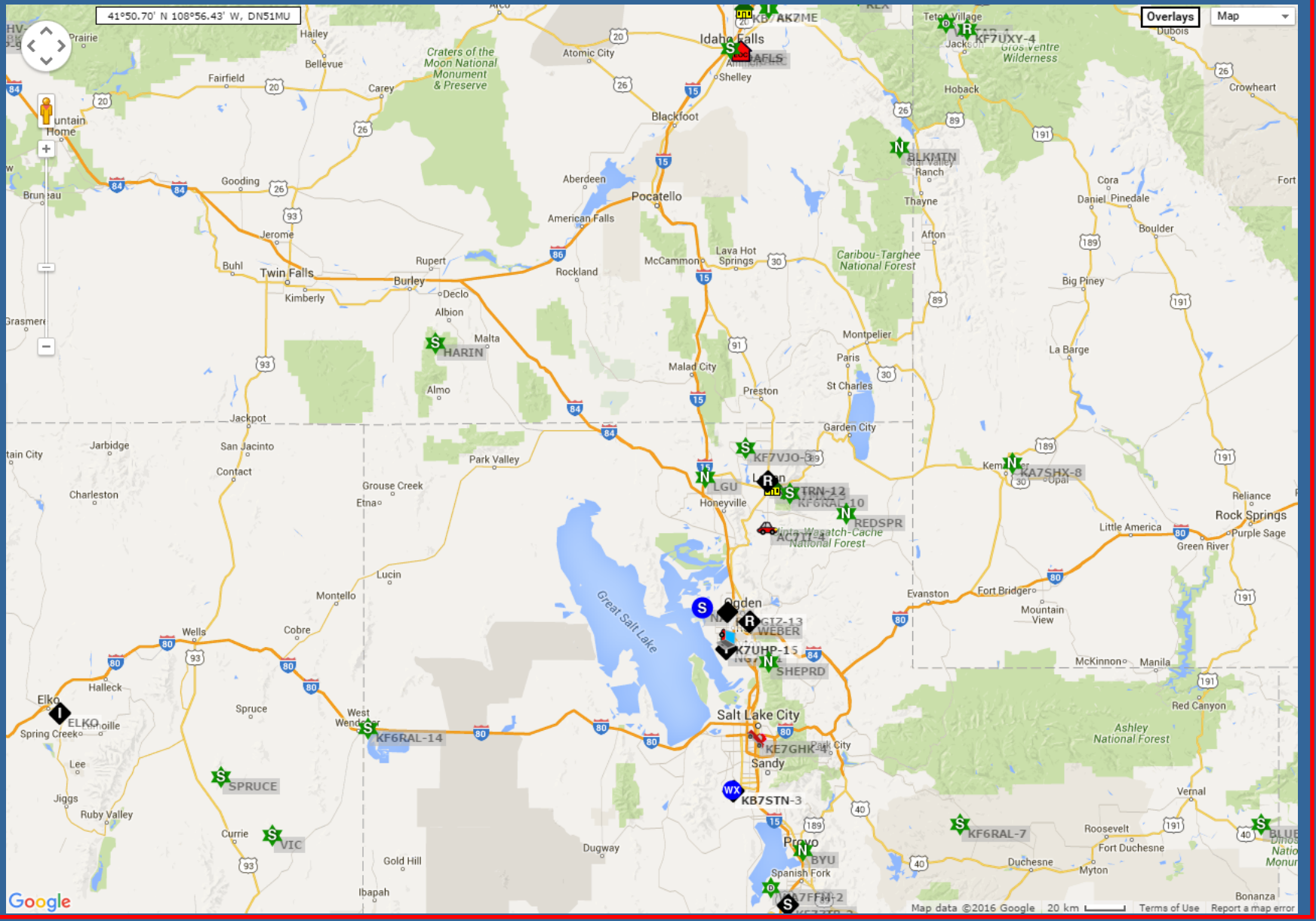
Various APRS Stations (two-way)



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

APRS Weater Stations

APRS Digipeaters



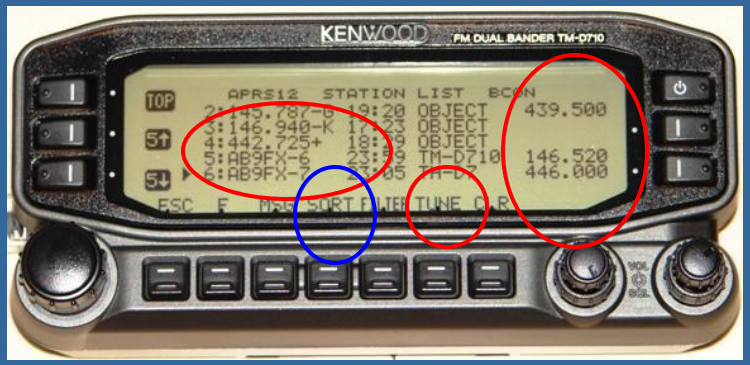
Mobile/Portable APRS Terminals

Kenwood TM-D700A

- Dual band 144/440 MHz 50/35 Watts
- Built-in 1200/9600 bps TNC including digipeater
- Built-in APRS Displays and messaging.
- Other APRS stations show on attached GPS map

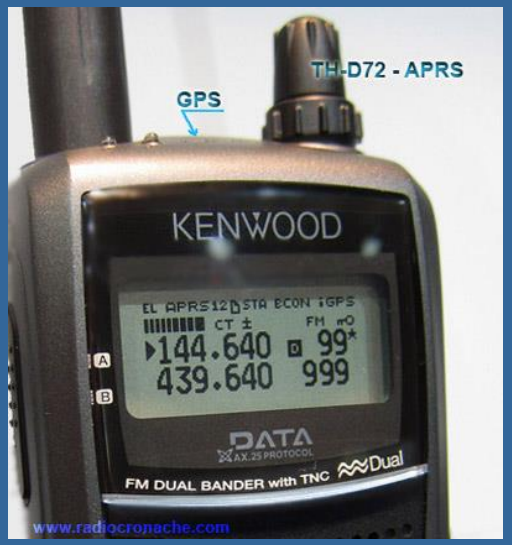
TM-D710

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



Kenwood TH-D72A

- The New Kenwood Mobile
  - TH-D72a
    - Internal GPS, Includes Logging abilities
    - Internal TNC
      - 1200/9600 Baud Data Rates
      - Mini USB to connect to computer for winlink or Packet
    - Digipeater
    - Dual Band, Wide Rx, Good Battery life
    - Built in Messaging & Email via APRS MSG



Evolution

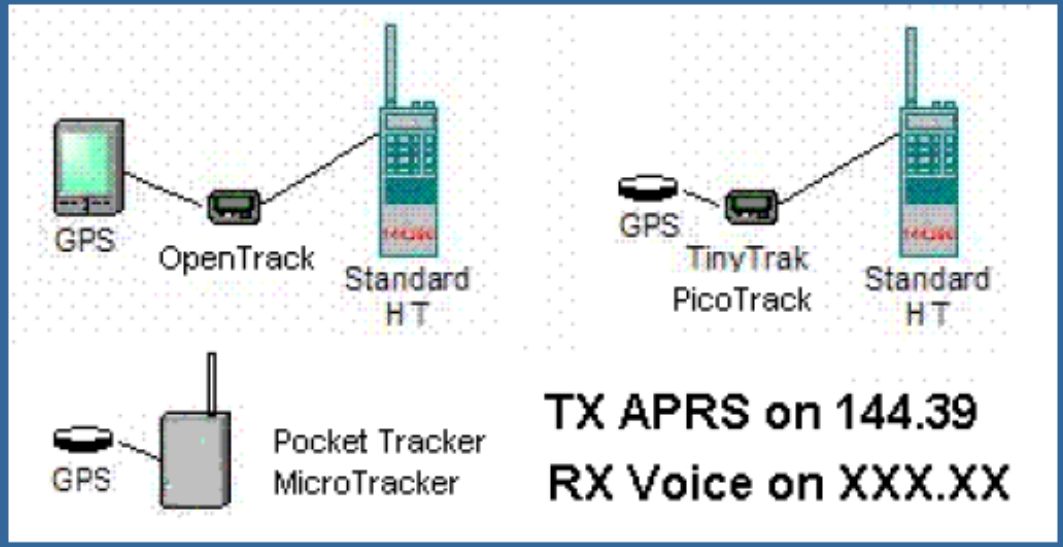
Other APRS radios

- The New Yaesu Digital Mobile's
  - FTM-400DR & FTM-100DR
    - D-APRS
    - No external (computer) access to TNC
- Yaesu HT's
  - VX8R thru FT2DR

TRACKERS (should be two-way)

One-way APRS is not normally recommended. APRS is a Network. We want good 2-way 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!

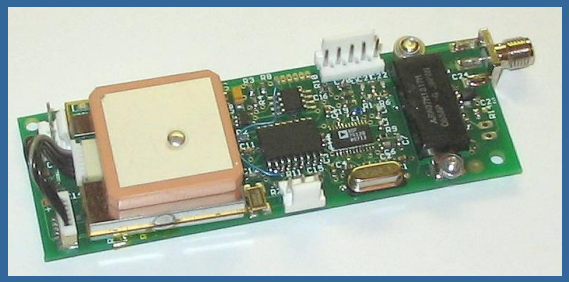


One-way trackers are good for non-manned assets at large movement events.. Not as the only APRS asset for a ham.

Trackers may be his 2nd, 3rd or 4th unit for APRS support… not his 1st!

One Way Trackers

- BigRedBee
  - 2 m APRS
  - 70 cm APRS



- Byonics
  - Byonics TinyTrak 3
  - Byonics MicroTrak
  - Byonics AIO
  - Byonics MTG

TRACKERS (Now are two-way!)

And should ALWAYS include their voice contact frequencyh in their packets

TT4 with $34 display and AVMAP G5 GPS

Argent Data Systems

OT2m case front

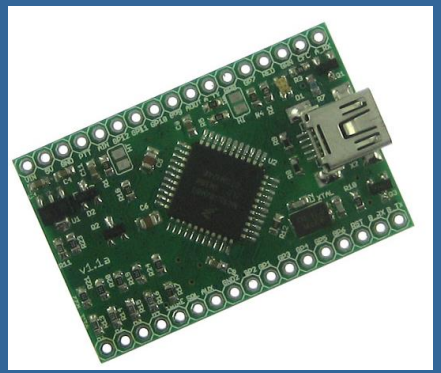
OT2m case rear

OT2m circuit board

More Two Way TRACKERS

- Argent Data Systems
  - Open Tracker USB

- T3 Series
  - T3m
  - T3-Mini
  - T3-Micro



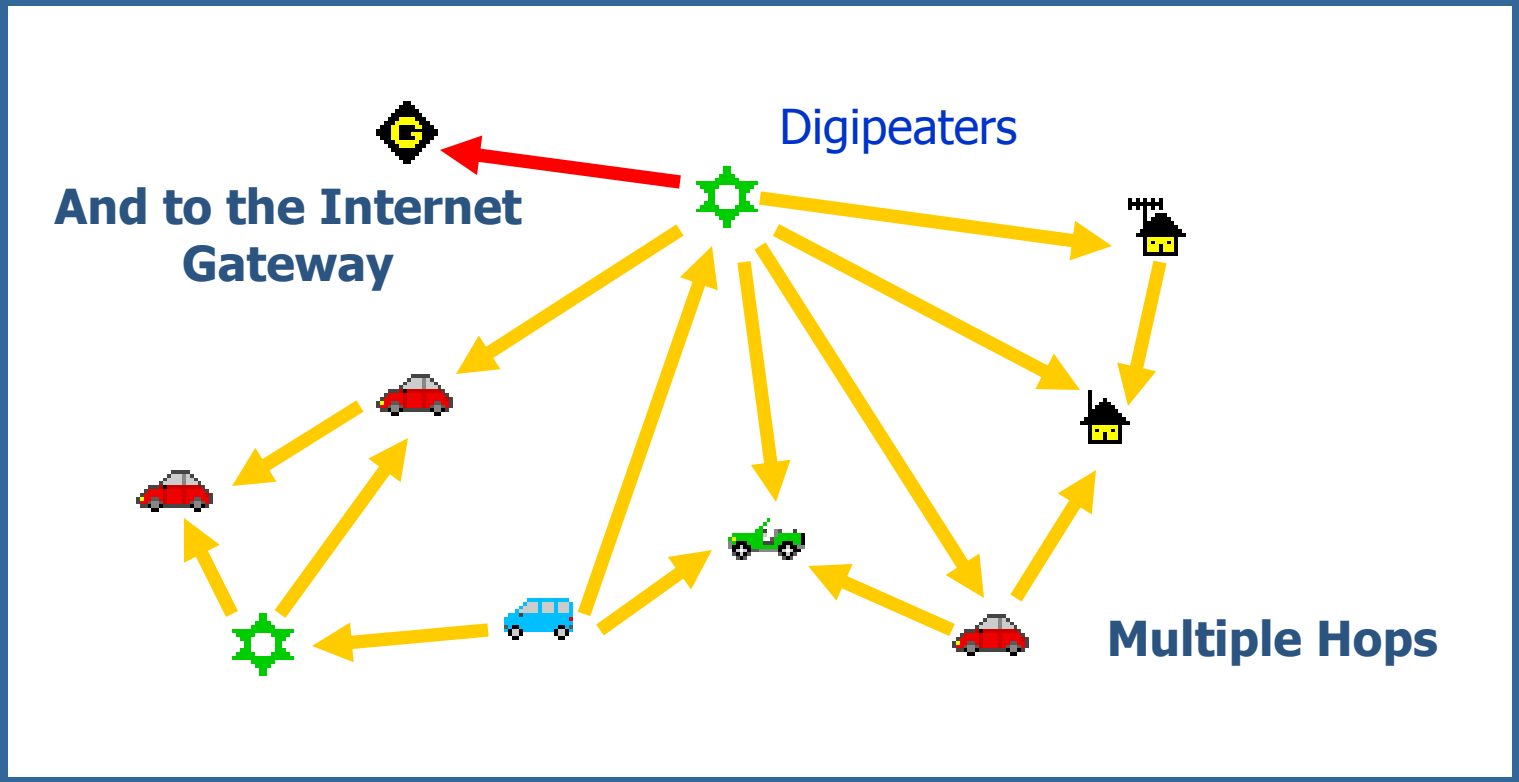
APRS MisConceptions!

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)**.
- 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 the importance of 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.
- Too much focus on **Large Screen** Displays **–vs- Individual Operator displays for** 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.

The APRS Network

Information exchange between everyone



Global APRS Email!

To: EMAIL

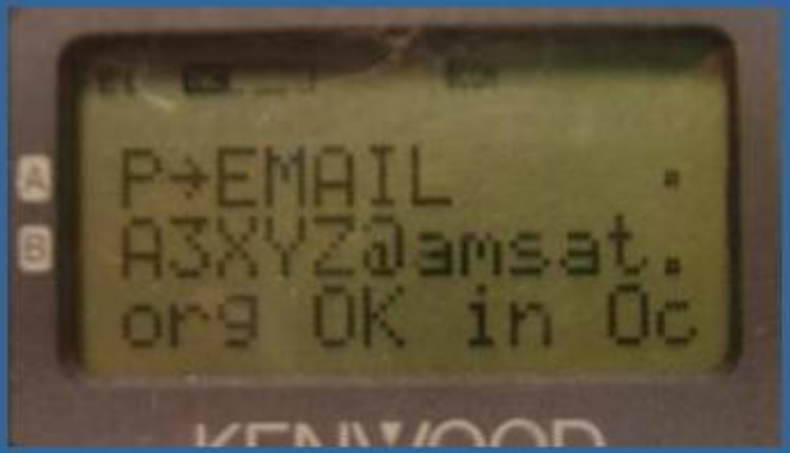
MSG: wb4apr@amsat.org ET call home!

- APRS Global Text Messaging since 1993; from HT's since 1998!
- Send Email from any APRS radio anywhere to anyone on the planet, anywhere LIVE.
- WU2Z Email Engine on the APRS-IS gates it to Internet

Great Demos. Send an Email to a SmartPhone in the audience.

APRS Msgs/Email

MSG menu



Send/Receive messages or email

Anywhere on the planet via APRS satellite

Confirmation of Relay =>

Global APRS Email Services

Several to choose from!

EMAIL: RF->email only, single line messages.

EMAIL-2: RF->email only, single line messages; supports aliases

- See: http://www.aprs-is.net/Email.aspx

WLNK-1: Send/Receive, multiple lines. Need Winlink account

- See http://www.winlink.org/aprslink

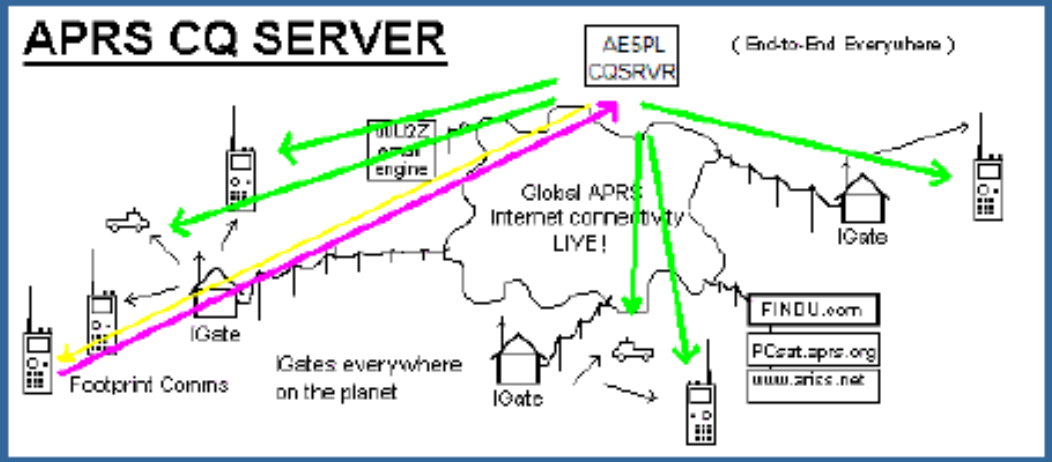
APRSMail: Email->RF only, single line messages. Need account.

- See http://www.aprsmail.org

APRS Global

CQ's

www.aprs.org/cqsrvr.html



- We needed a CQ System for SCOUTS, JOTA, SATERN, IOTA, SCR and Field Day!
- AE5PL responded with CQSRVR
- Allows anyone to send a global message to everyone involved in an XXXXX activity
- Just send a message to CQSRVR starting with CQ XXXX CQ XXXX message
- Everyone who has sent a similar CQ XXXX message to CQSRVR will get your CQ

- From then on, once you see callsigns, you message normally point-to-point
- To limit load, only one CQSRVR message per 30 minutes is forwarded.

- Can also be used any day, any time, anywhere! CQ CQ CQ CQ anyone around?
- Can also be used for global GROUP comms if 30 minute timer is changed.

APRS Voice Alert! *

(For all mobiles!)

Voice Alert is effectively 3rd Radio channel for the D7 and D700 APRS radios

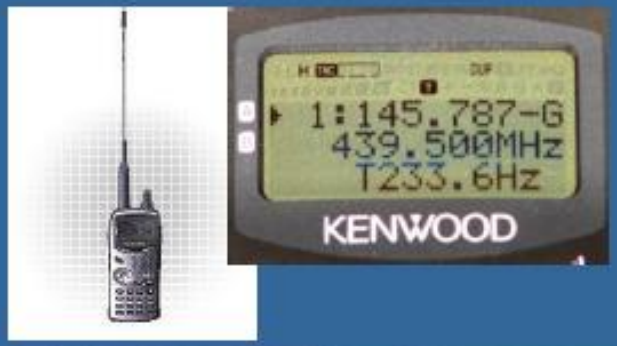
By setting the APRS Band, A, to CTSS-100, but keeping the volume turned up:

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!

Last 100 stations!



Direction & Distance

Frequency and Tone

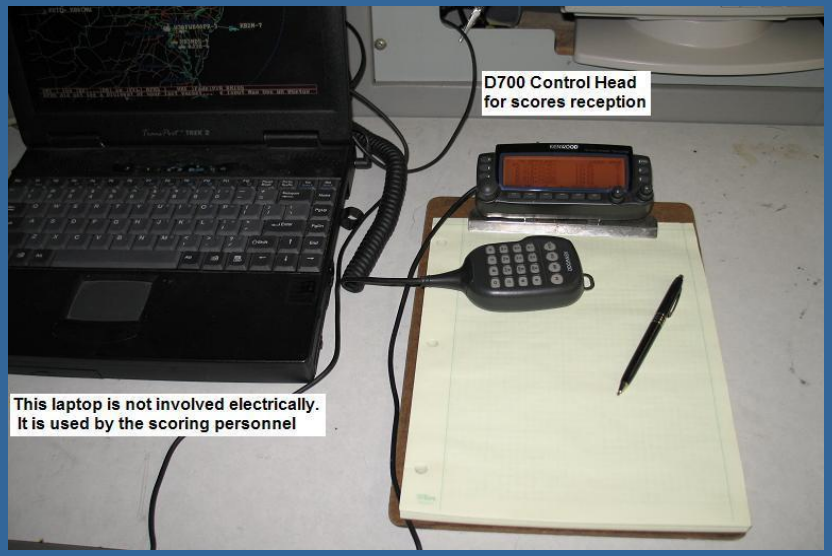
APRS for Special Uses

- 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)

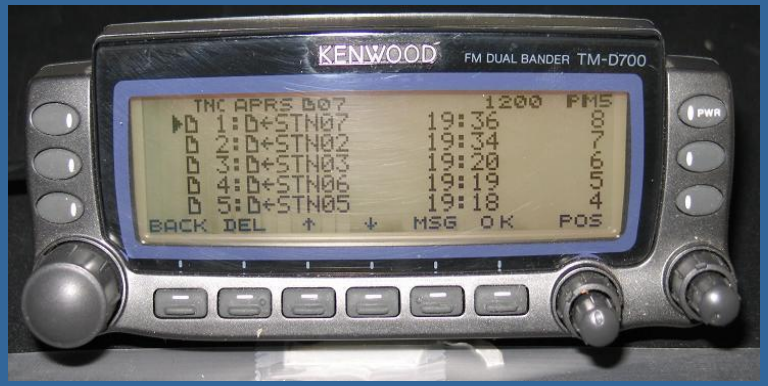
LOTOJA 2015
by Jared Smith

- LOTOJA Neutral Support 2015
  - https://www.youtube.com/watch?v=FONr3LyHMAo

APRS Event Data Entry



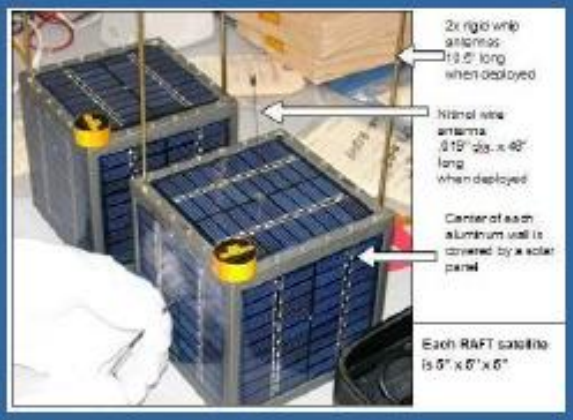
Score Message Sent



Score Data Received

APRS in Space

- 2001 PCSAT-1 Prototype Comms.
- 2006 PCSAT2 on ISS
- 2007 ANDE
- 2008 RAFT



- APRS space frequency is published as 145.825

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

Anybody can participate

In the Shack: XASTIR, UIView, several others

- Radio+TNC+PC (Win, DOS, Linux, Mac, Palm, etc.)
- Internet connection, optional

At home, work, or the odd Internet Cafe

- Aim your browser to www.aprs.fi

On the Road

- Kenwood, Yaesu handhelds, mobile rigs
- Radio parameters:
  - Tune to 144.390 simplex; PL 100 optional
  - 1200 BPS AX.25 packet radio
  - Use “via” of “wide1-1,wide2-1”, not “relay,wide”
    - Packet routing method changed in 2005 to fix congestion

More info: www.aprs.org (Bob’s main site, with lots of resource links!)

- The original (uncut) version of this presentation is at the link on this page.

APRStt (Touchtone) (every radio!)

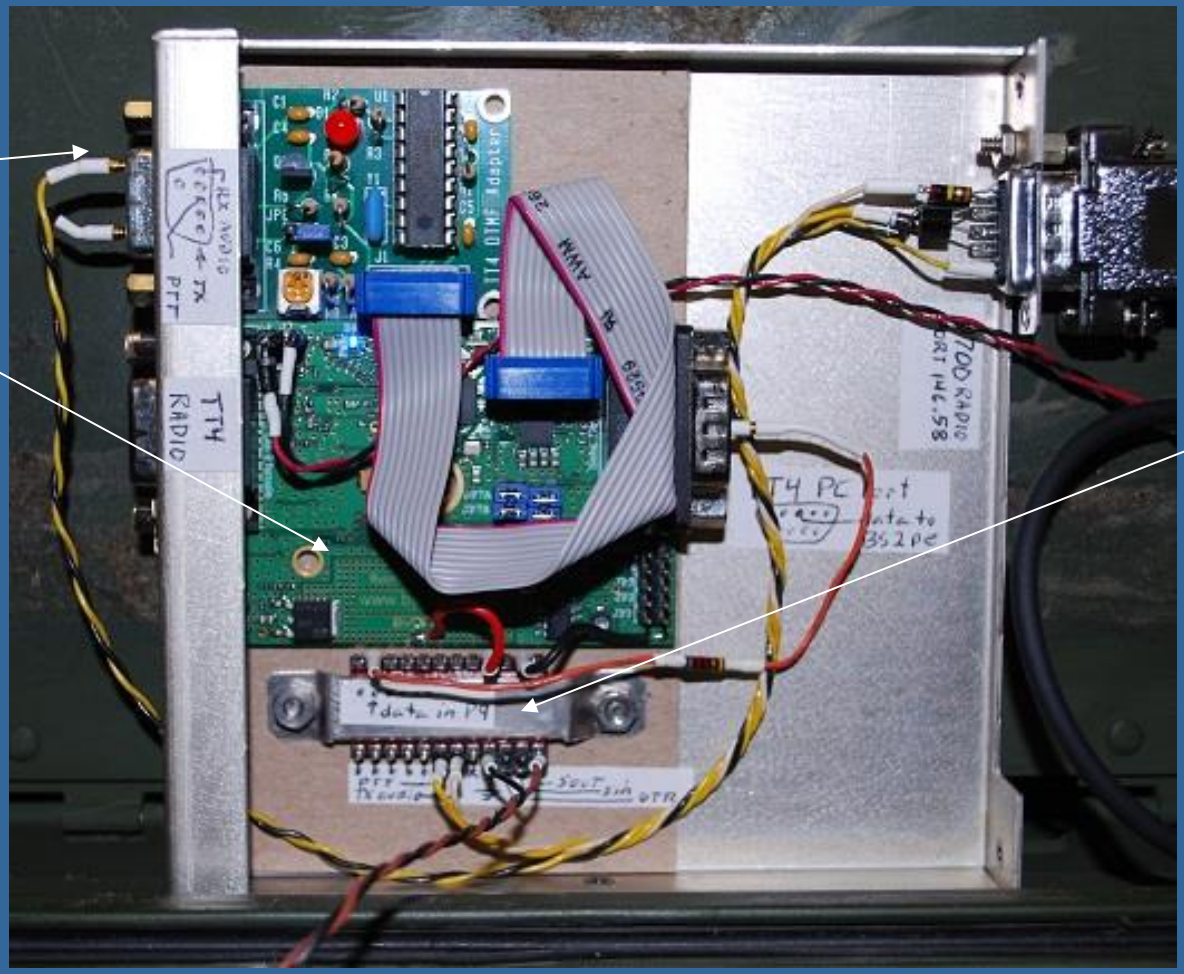
See aprs.org/**aprstt.html**

- For WB4APR, the DTMF Sends: **A9A2B42A7A7C79#**
- This is converted to an APRS packet on the APRS channel as:
  WB4APR-12>APRStt,WIDE1-1:!DDM_.__N/DDDM_.__W$146.58MHz HAMvention
- **Puts you on global map near Hara Arena, with your immediate calling frequency, your Tone and your Echolink node number and that a Hamfest is going on.**
  - That is everything you need to be known to the Global APRS system!
  - Exists since 2001 (in DOS w DTMF chip). Now we have a Windows Version! By W4PC
  - Also Needed in Echolink, IRLP, and some repeater controllers with a serial port!
- APRStt and therefore 100% situational awareness of any Ham mobile or HT then APRS will always be a side show only used by 10% of any club or organization.
- Other Positions: #B95*234*1D => Milemark #234 on Route 95, northbound

APRStt (hardware)

See **aprstt.html**

Byonics DTMF Add-on To TT4



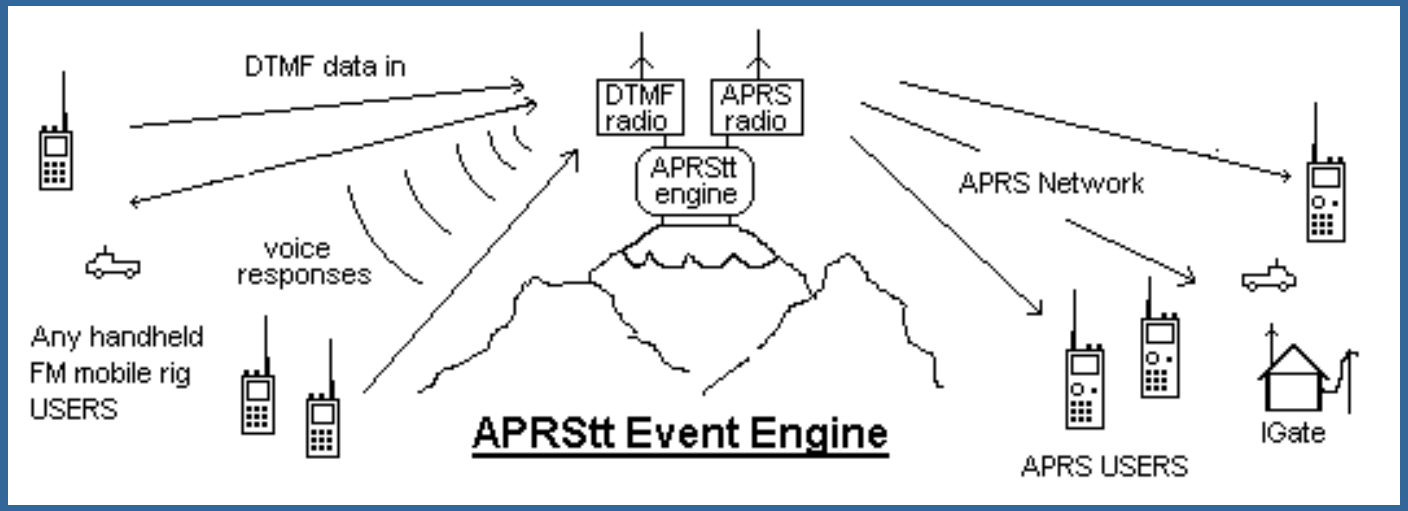
Marathon MM Converter

And PACE generator

APRStt (special event)

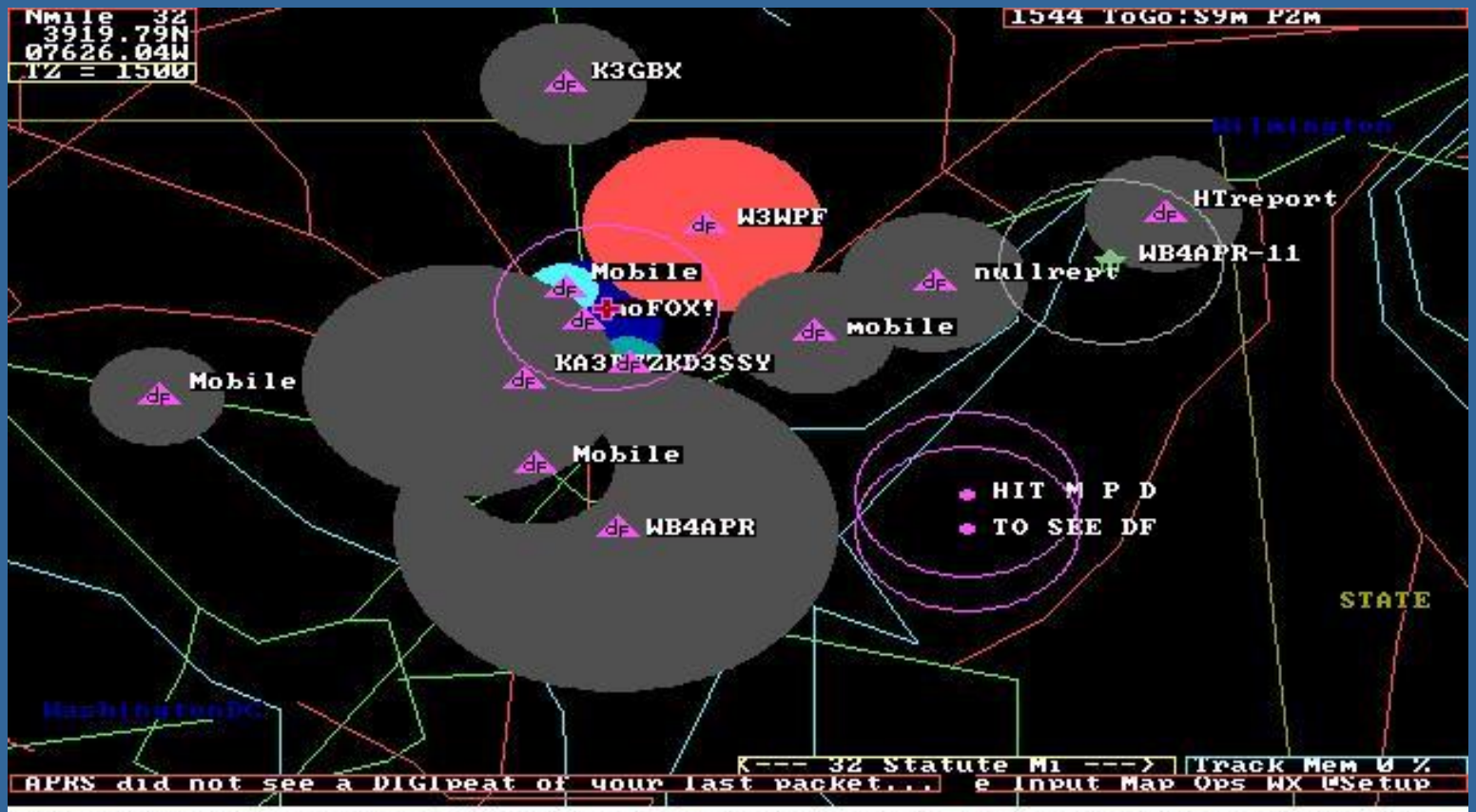
(every radio!)

See **aprstt.html**



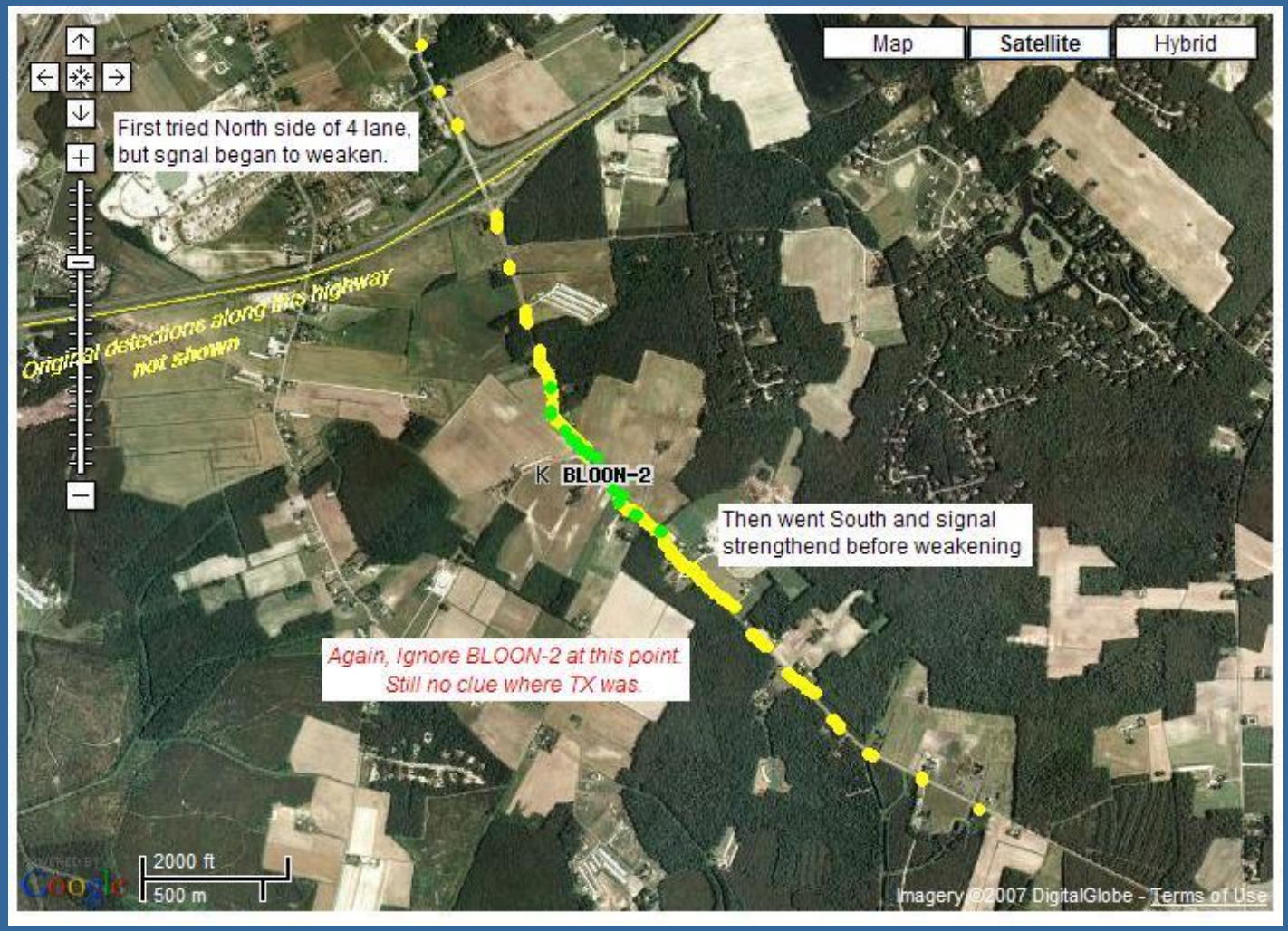
- Simple DTMF memory - One button puts you in APRS (Position, Frequency and Status)!
  - DTMF on voice freq translated to packet on APRS channel (or direct to APRS-IS)
  - Position is .1 mile LIST on map display adjacent to repeater or FREQ object
  - Frequency used is inserted in packet (for return contact)
  - If Echolink, IRLP or Autopatch, APRS packet includes node or Phone number!
  - All responses in Voice

APRS (DFing by signal strength)

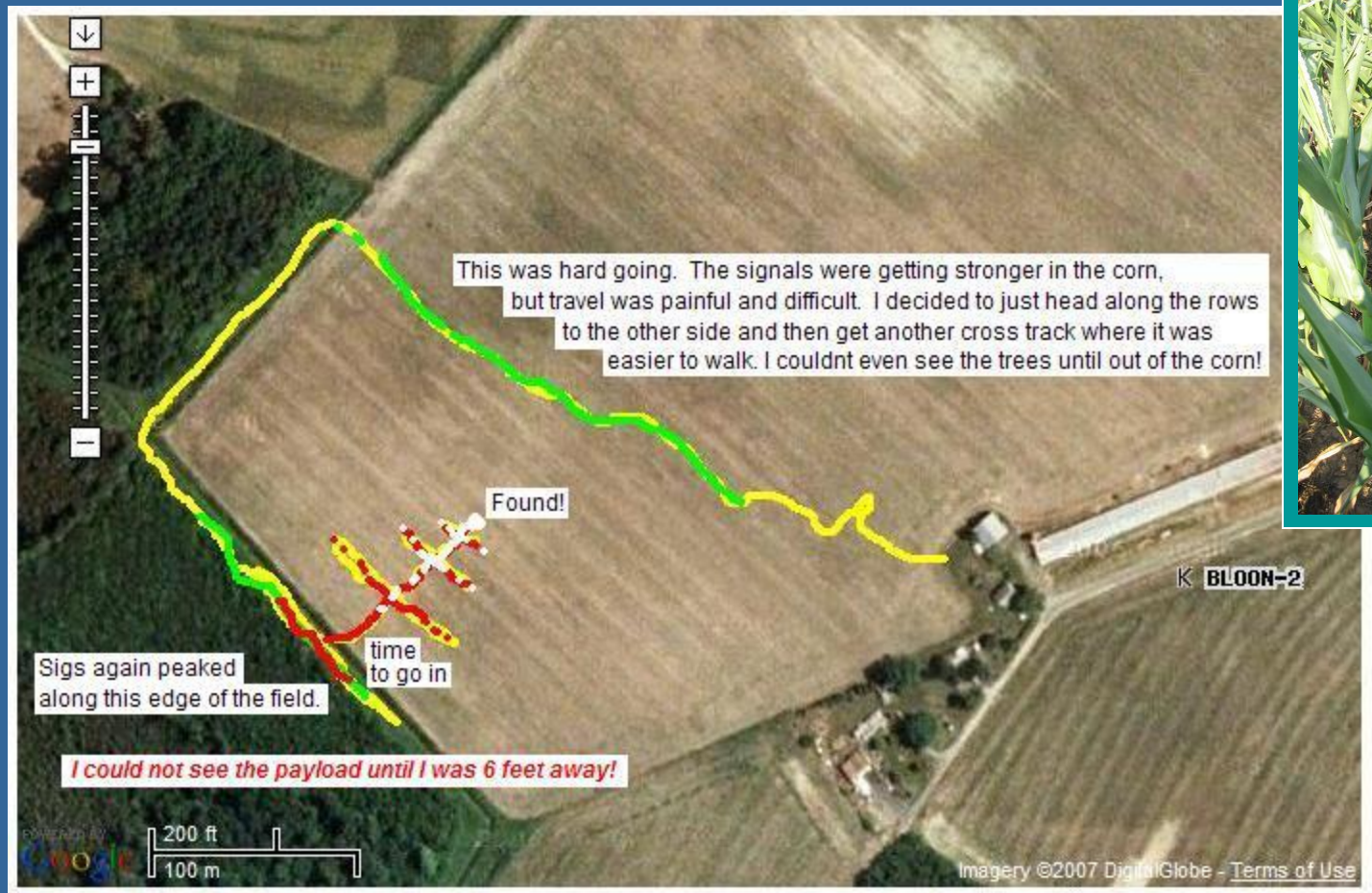


MAPS-PLOTS-DF-OMNI display of overlapping signal strength contours. All of these "voice" signal reports were entered rapidly on APRS as objects, and everone can see that the FOX was found near the intersection of the colored circles. Notice how VALUABLE the "no-signal" reports were. THey show you almost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

APRS (Solo DF Fade Circle Technique)

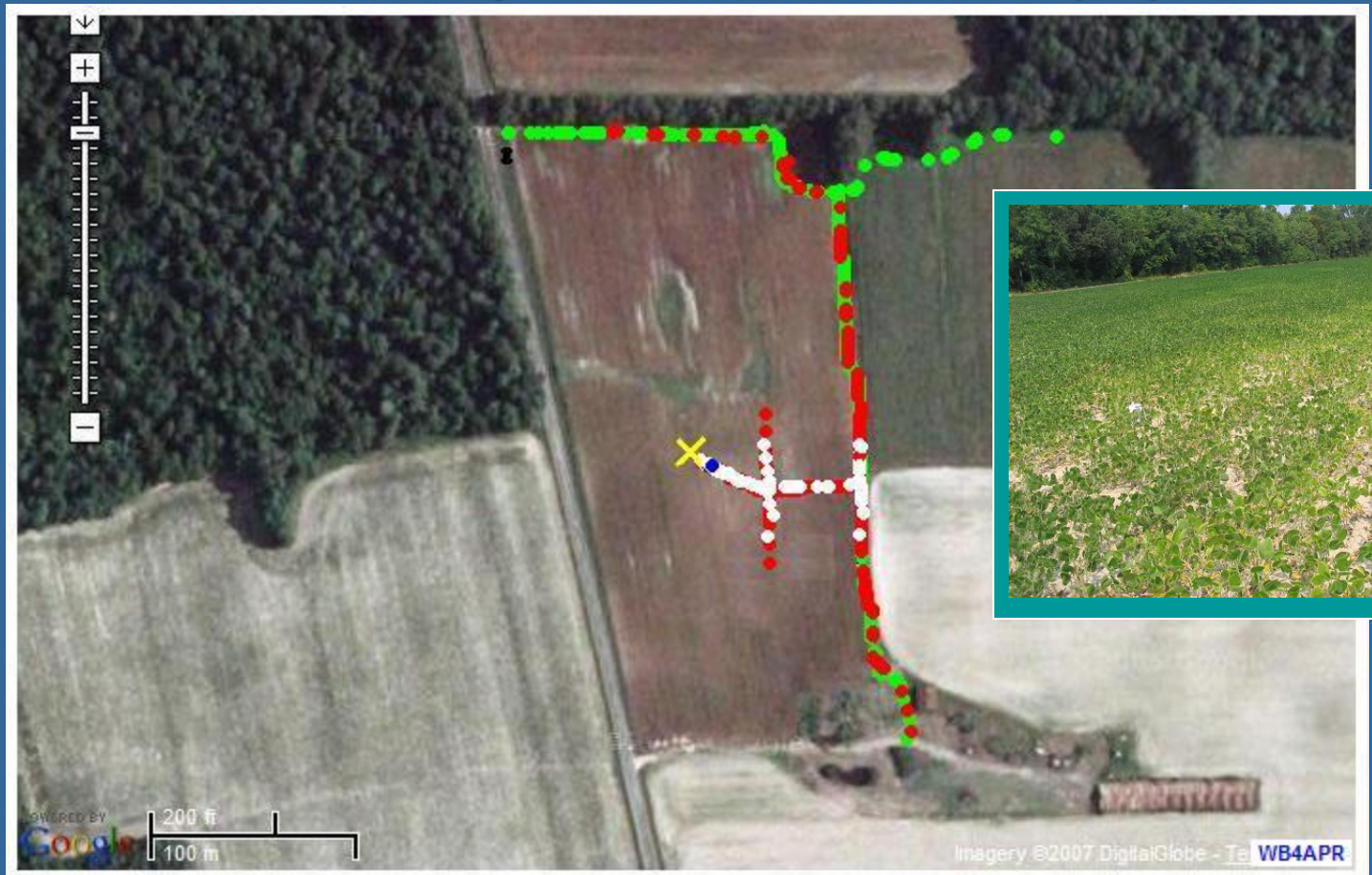


APRS (Solo DF Fade Circle Technique)



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 is INFO not just tracking!

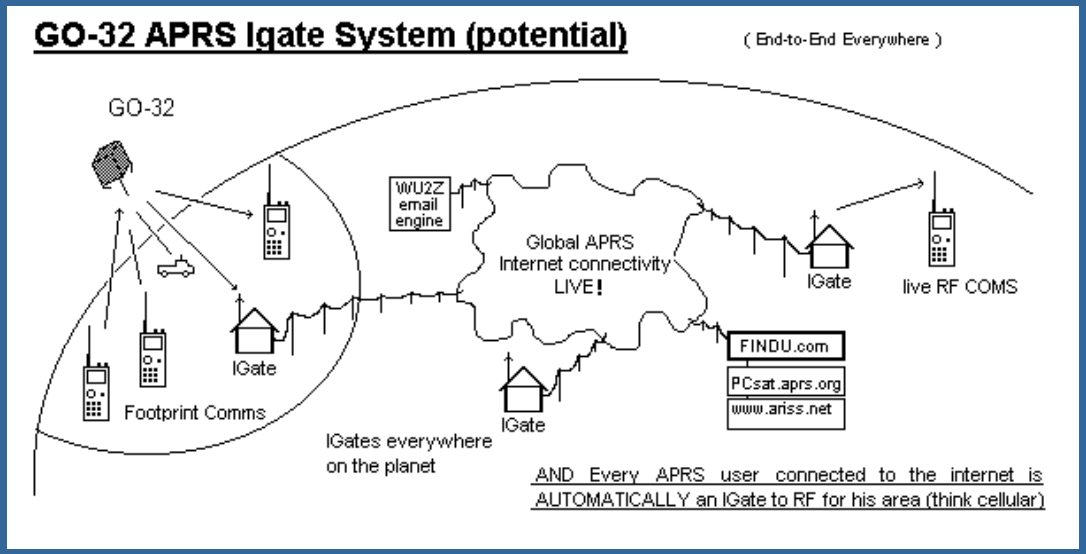
Milemarks?

APRStt?

Field Data?

Voice Alert?

Signal Finding?



Nets?
Meetings?

Tracker-Voice?

Frequency?

RF Range?

AVRS (Ham Radio Mobile Cell via APRS=>VOIP)?

Traffic?

National Trail Golden Packet Event

26 July 2009

25 July 2010

July 2014 SUCCESS!

2000 Miles

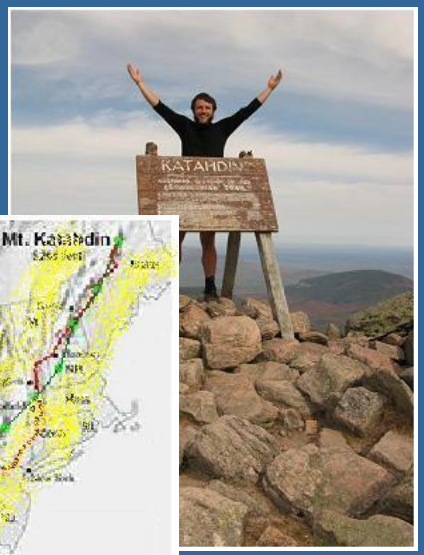
15 Stations

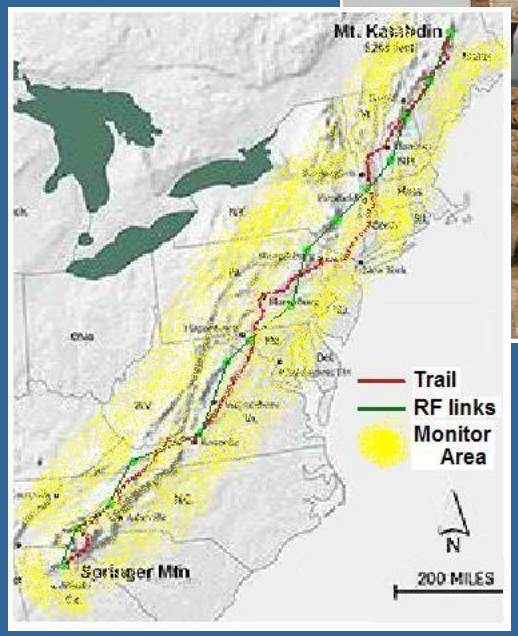
Two HOP7-7 paths

Golden Packets end-to-end

Omni Antennas

WE4APR at the plaque marking the start of the Appalachian Trail on Springer Mt with WB4APR

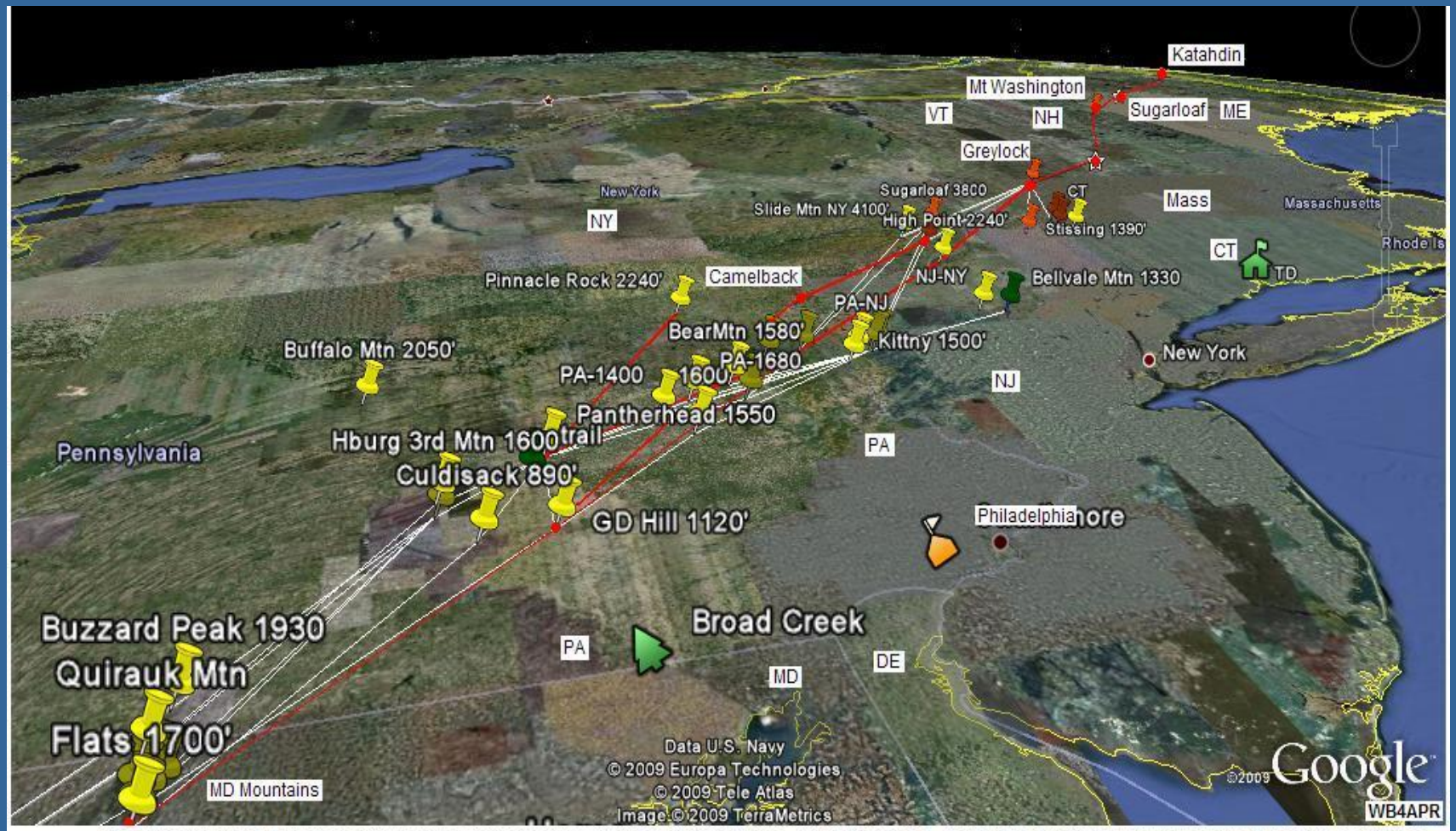




Others can Monitor!

aprs.org/at-golden-packet.html

Appalachian Trail Golden Packet

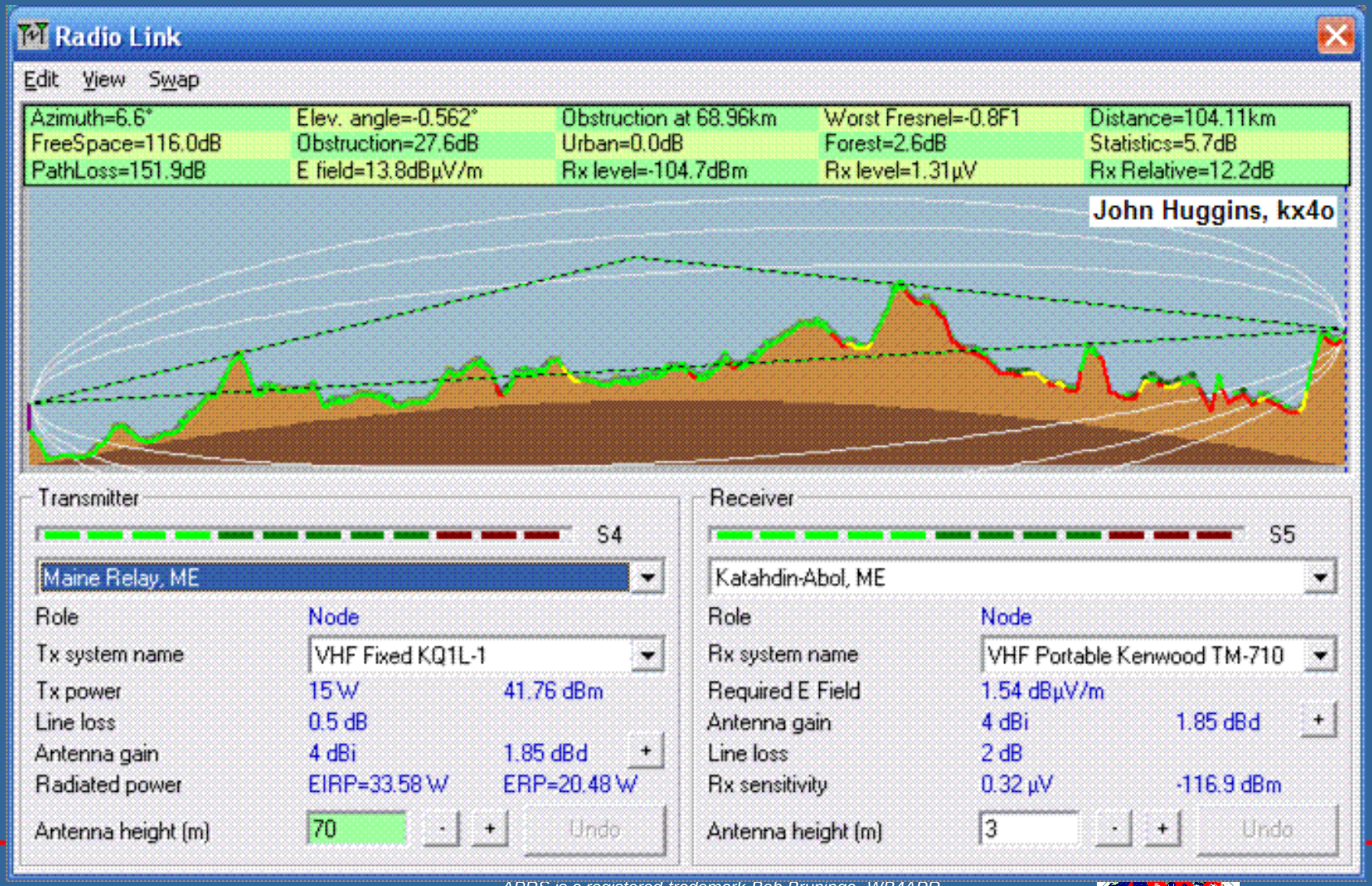


The hardest part of the path is going across Pennsylvania with its many low ridges. From NY onward, the path is simply peak-to-peak on popular high mountains.

Using Google Earth for Links
50,000 miles of national linear trails!

Appalachian Trail Golden Packet

KX4O John Huggins Complete RF Link Analysis!



APRS at Rocket Recovery

Typically teams have used One way trackers like the BigRedBee

Typical APRS settings for the event

Beacon Rate 5 seconds

Path WIDE 1-1

Multiple UHF Frequencies to eliminate packet collisions

Lots of Packets!

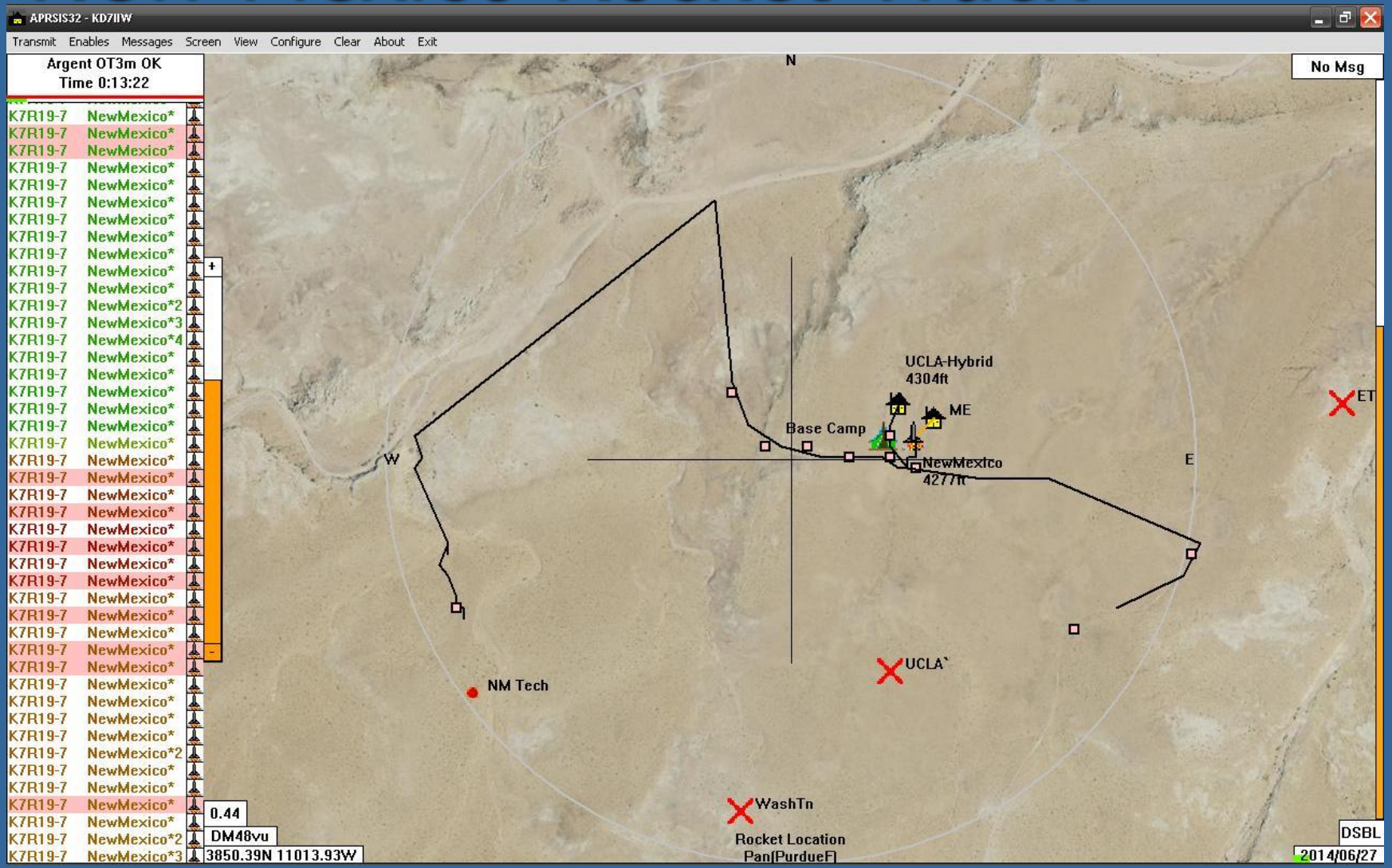
APRS at Rocket Recovery

- This year we are planning to Use Argent Data TNC built in with very small Radio to gain two way support
- APRS and other electronics are armed an hour or more before launch, so there are many unnecessary packets, and wasted battery life
- With The Argent TNC in the Rocket, we can send it a message to change beacon rate to 10 mins, or even disable it entirely.
- Have access to Digital I/O pins, Easy Data Telemetry back to us. And just about anything else, because Argent has a Slick Scripting ability

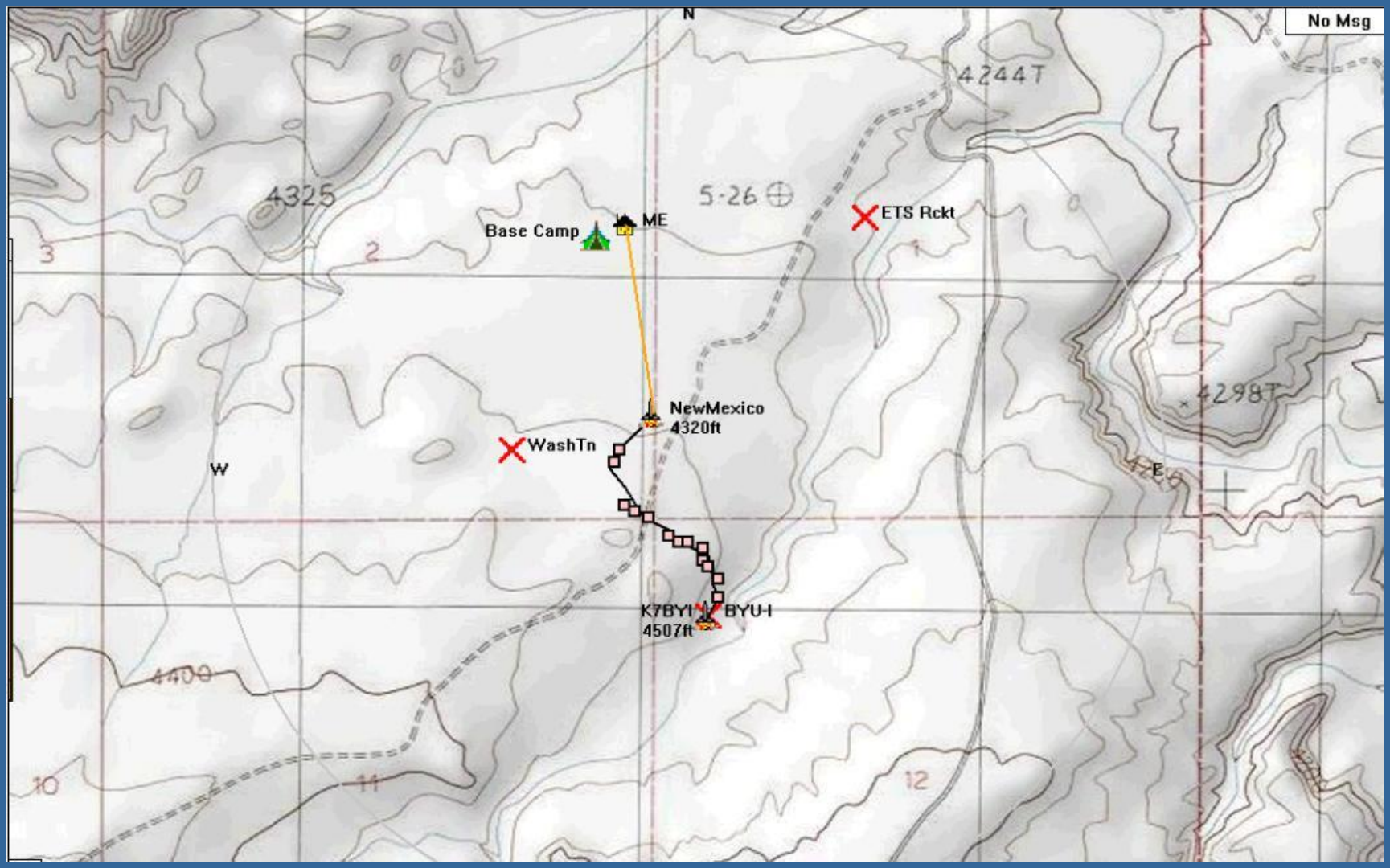
APRS at Rocket Recovery

- Double Digipeaters - VHF/UHF
  - Single Dual Band Antenna
    - Diplexer to mix both radios
  - Kenwood Commercial Radio - VHF 144.390
    - Argent T3-Mini TNC
  - Motorola GM300 Radio - UHF x 16 Frequencies
    - 16 Steerable Channels
    - Argent T3-Mini TNC

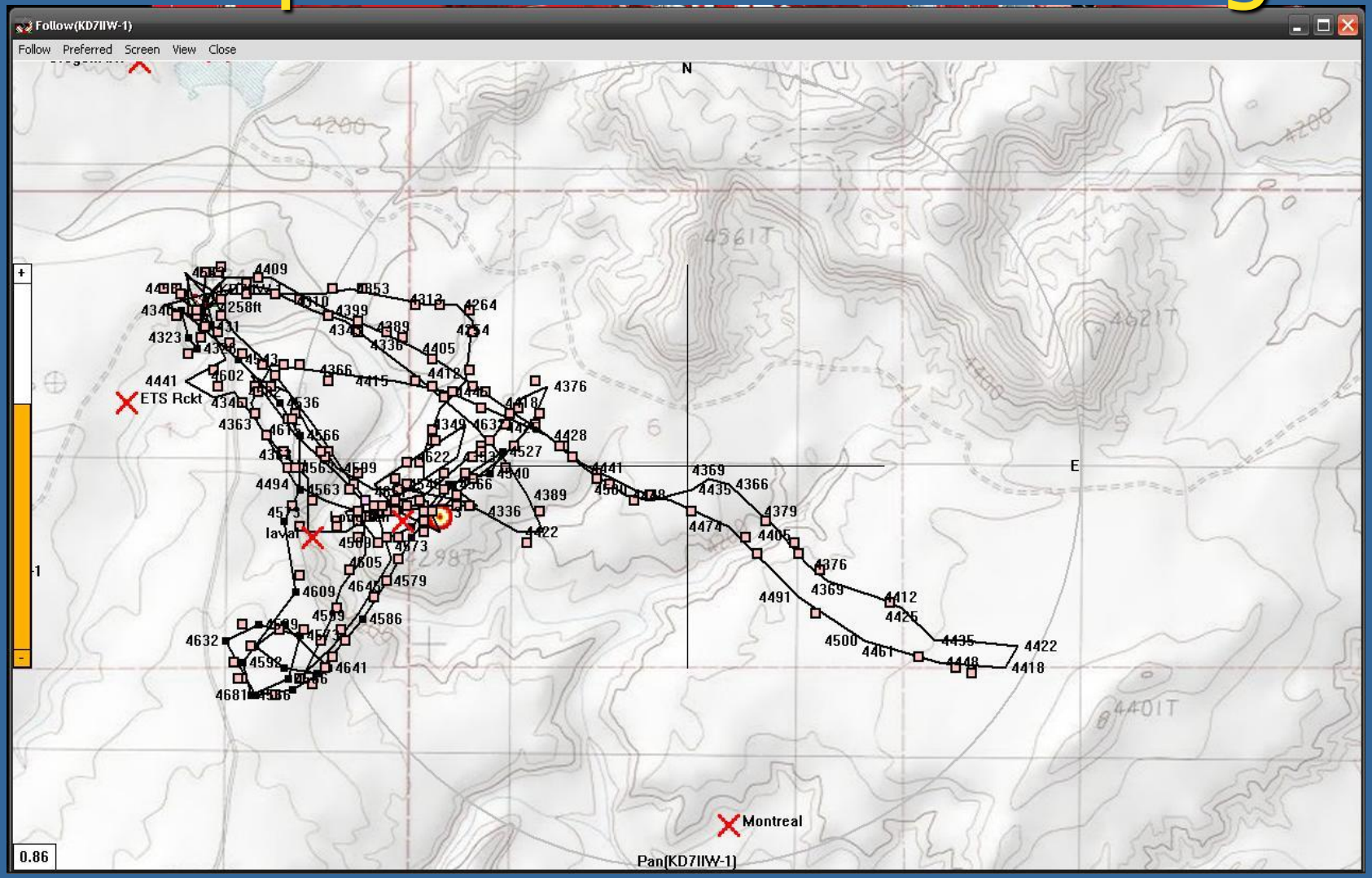
New Mexico Rocket Track



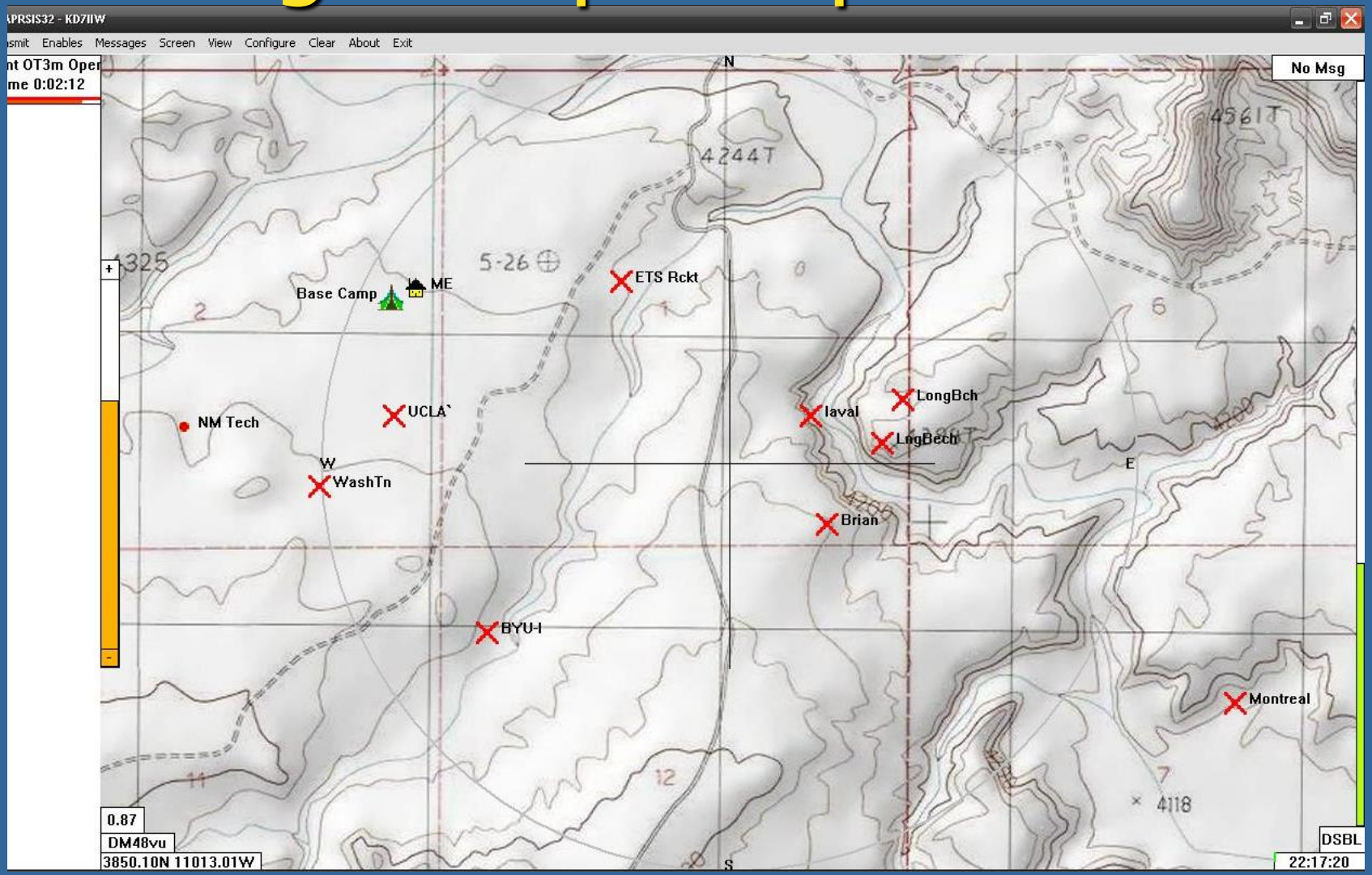
BYU - IDAHO Rocket Track



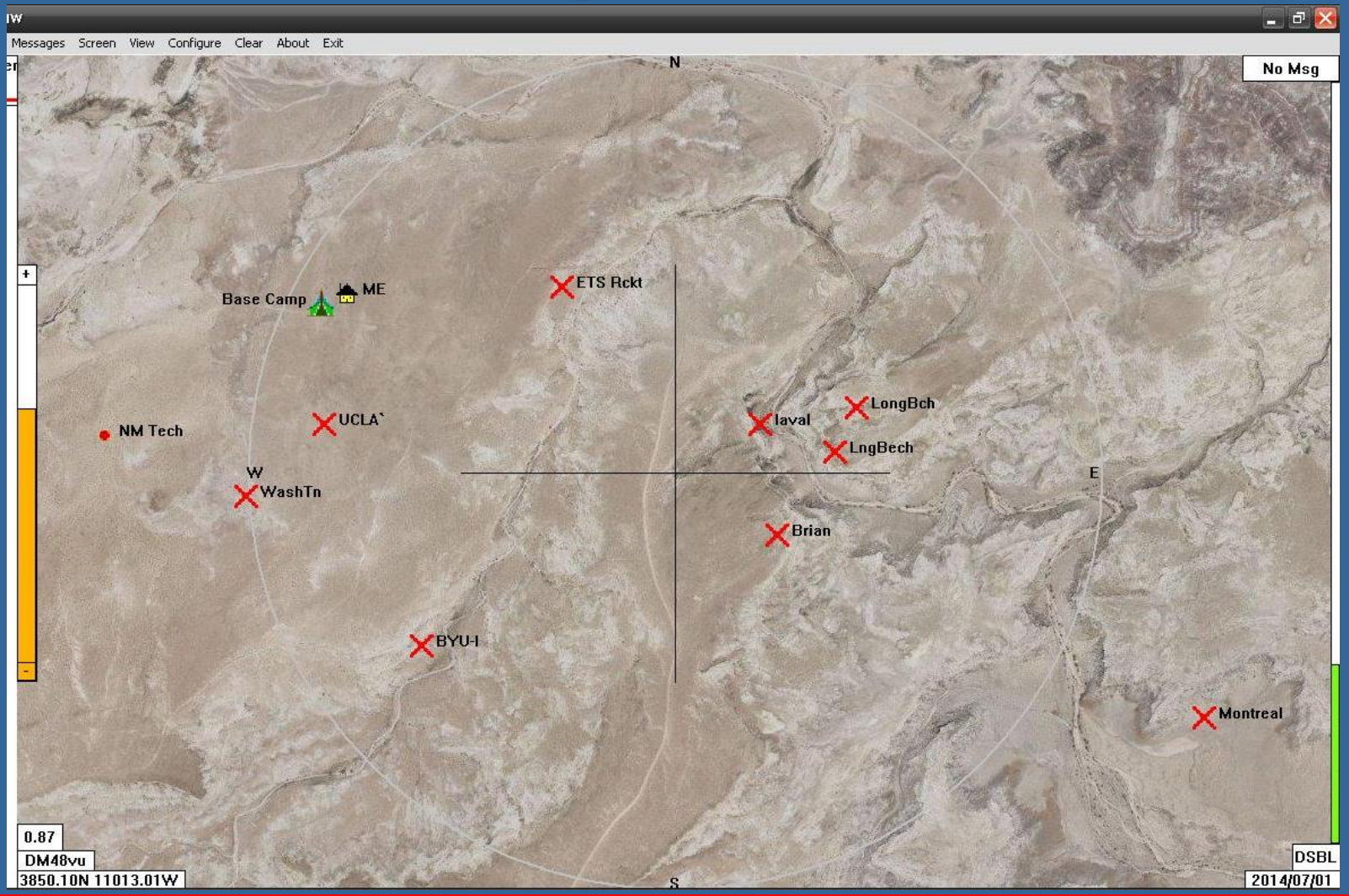
RC Airplane Track - Searching



Landings - Topo Map



Same Landings - Satellite Aerial



APRS Prices

- KPC-3 www.hamradio.com $199.95
- PK-96/100 www.hamradio.com $199.95
- TNC-X http://tnc-x.com/ $123.00 (built and tested)
- Mobilinkd http://www.mobilinkd.com/tnc2/ $64.95
- TinyTrak4 http://www.byonics.com/tinytrak4/ $75.00 (built and tested)
- Micro-Trak http://www.byonics.com/microtrak/ $220 (complete)
- TinyTrak3 http://www.byonics.com/tinytrak/ $42.00 (built and tested)
- Argent Tracker3 http://www.argentdata.com/products/tracker3.html $45.00
- Open Tracker USB http://www.argentdata.com/products/otusb.html $95.00
- Kenwood TM-D710 http://www.kenwood.com/usa/com/amateur/tm-d710ga/ $579.95
- Kenwood TH-72A http://www.kenwood.com/usa/com/amateur/th-d72a/ $449.95
- Yaesu FTM-400R http://www.yaesu.com/ $539.95
- Yaesu FT-1DR http://www.yaesu.com/ $269.95

APRS Links

- Digi Paths http://wa8lmf.net/DigiPaths/
- APRS Home page www.aprs.org
- FindU.com http://www.findu.com/ (map.findu.com/kf7vjo-3)
- Northwest Info http://www.nwaprs.info/index.php/Main_Page
- UI-View 32 http://www.ui-view.net/
- APRSISCE/32 http://aprsisce.wikidot.com/
- OpenAPRS http://www.openaprs.net/ (iPhone version)
- APRSdroid https://aprsdroid.org/ APRS for your Android device
- TNC Cables www.packetradio.com

Questions?