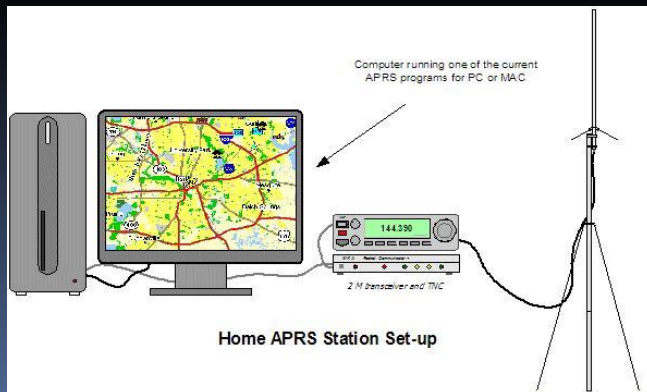


# Automatic Position Reporting System (APRS)

Presented by:  
Ron Milione Ph.D. W2TAP  
AAR2JD





# Overview

- The purposes of APRS
- How it works
- Who invented APRS
- Pros/Cons of APRS
- Moving towards standardization
- The future of APRS
- Demonstrations

# The purposes of APRS

- Monitor position data
- Using data to track moving objects
- Messaging Capabilities
- Assist in Search and Rescue (SAR) operations
- Track and gather satellite telemetry data
- Monitor remote weather stations for the National Weather Service (NWS)

# How it works



- The transmitter
  - Very High Frequency (VHF) on 144.390Mhz
  - Amateur Radio License required to operate
  - Experimental
  - Maximum output 200Watts, average 30Watts
  - Price ranges from \$50.00 to \$700.00 depending on options desired
  - Transmitter must support 1200Bps and 9600Bps, currently the two baud rates used.

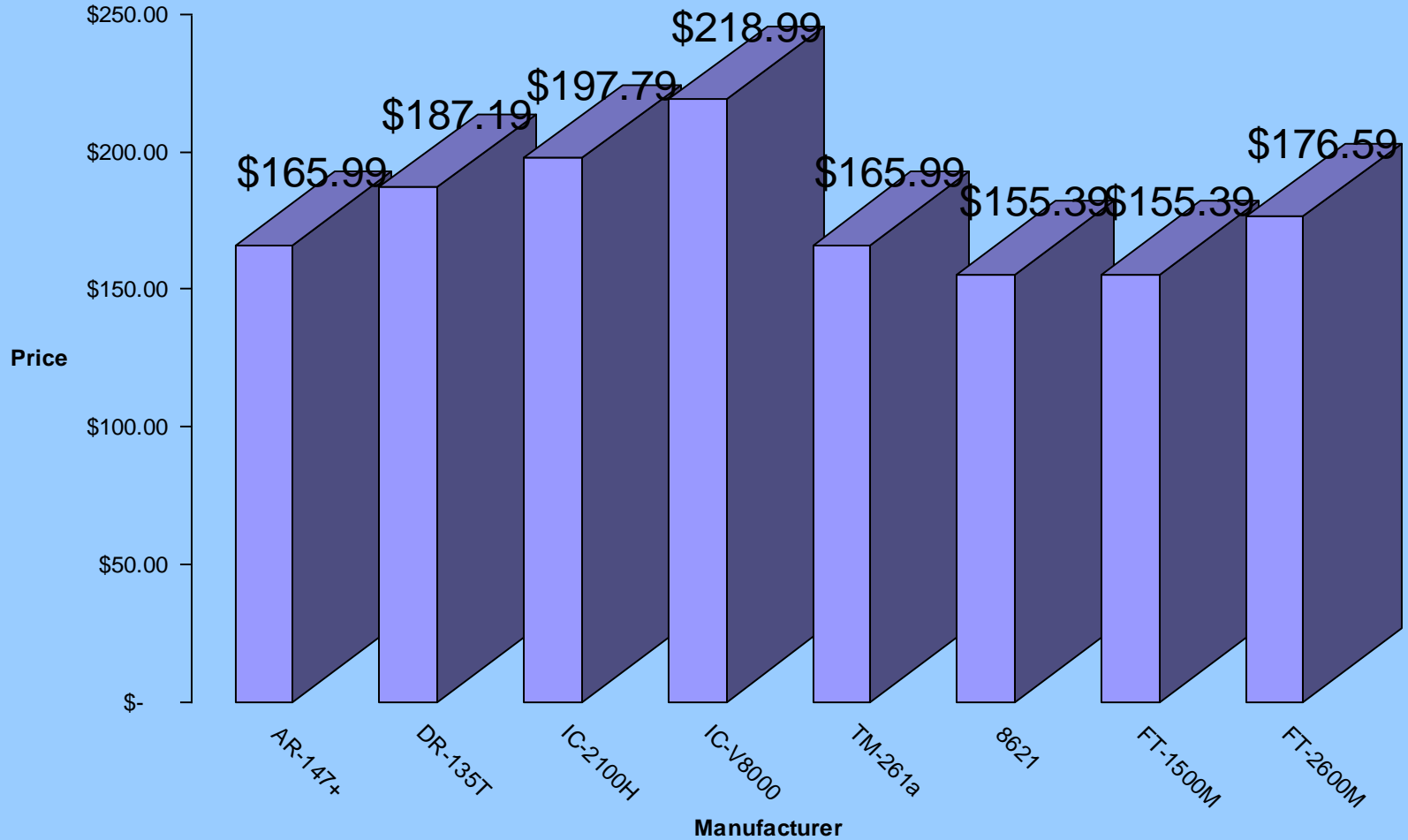
# APRS Compatible Transmitters

## Comparisons of several different transmitters for APRS

|   | ADI       | Alinco    | Icom      | Icom      | Kenwood   | MFJ       | Yaesu     | Yaesu     |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Manufacturer                              | ADI       | Alinco    | Icom      | Icom      | Kenwood   | MFJ       | Yaesu     | Yaesu     |
| Transmitter Model                         | AR-147+   | DR-135T   | IC-2100H  | IC-V8000  | TM-261a   | 8621      | FT-1500M  | FT-2600M  |
| TX Range (MHz)                            | 144-148   | 144-148   | 144-148   | 144-148   | 144-148   | 145.01    | 144-148   | 144-148   |
| RX Range (MHz)                            | 118-171   | 118-174   | 136-174   | 136-174   | 118-174   | 145.01    | 136-174   | 136-174   |
| Aircraft RX                               | Yes       | Yes       | No        | No        | No        | No        | No        | No        |
| High Power Output (Watts)                 | 60        | 50        | 50        | 75        | 50        | 5         | 50        | 60        |
| Tone Encode                               | Yes       | Yes       | Yes       | Yes       | Yes       | No        | Yes       | Yes       |
| Tone Decode                               | Yes/DCS   | Yes       | Yes       | Yes/DCS   | Yes       | No        | Yes       | Yes/DCS   |
| Memories                                  | 80        | 130       | 113       | 207       | 62        | 0         | 130       | 170       |
| Alphanumeric                              | No        | Yes       | Yes       | Yes       | Yes       | No        | Yes       | Yes       |
| PC Programmable                           | Yes       | No        | Yes       | No        | No        | No        | Yes       | Yes       |
| Amps at 13.8V DC                          | 12A       | 11A       | 12A       | 11A       | 11A       | <1A       | 8A        | 10A       |
| Antenna Connector                         | SO-239    | SO-239    | SO-239    | SO-239    | SO-239    | SO-239    | SO-239    | SO-239    |
| Price                                     | \$ 149.99 | \$ 169.99 | \$ 179.99 | \$ 199.99 | \$ 149.99 | \$ 139.99 | \$ 139.99 | \$ 159.99 |
| Shipping Charges                          | \$ 7.00   | \$ 7.00   | \$ 7.00   | \$ 7.00   | \$ 7.00   | \$ 7.00   | \$ 7.00   | \$ 7.00   |
| Taxes (6%)                                | \$ 9.00   | \$ 10.20  | \$ 10.80  | \$ 12.00  | \$ 9.00   | \$ 8.40   | \$ 8.40   | \$ 9.60   |
| Total Cost                                | \$ 165.99 | \$ 187.19 | \$ 197.79 | \$ 218.99 | \$ 165.99 | \$ 155.39 | \$ 155.39 | \$ 176.59 |
| Average Price (Before Shipping and Taxes) |           |           | \$ 161.24 |           |           |           |           |           |
| Average Total Cost                        | \$ 177.91 |           |           |           |           |           |           |           |
| Average Output Power (Watts)              | 111.5     |           |           |           |           |           |           |           |

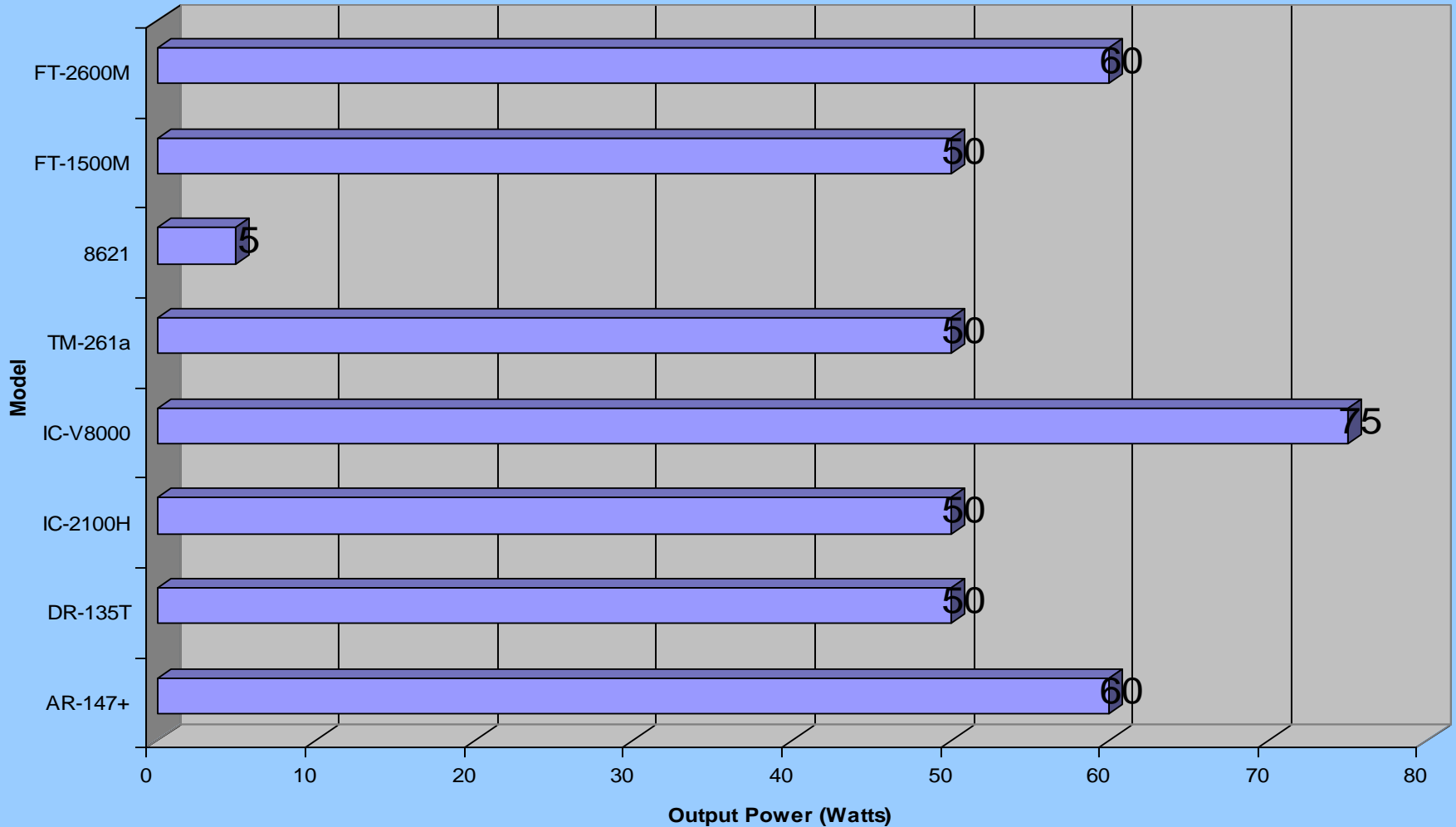
# Cost vs Model

Total Cost vs Transmitter Model



# Output vs Model

Power Output (Watts) vs Transmitter Model



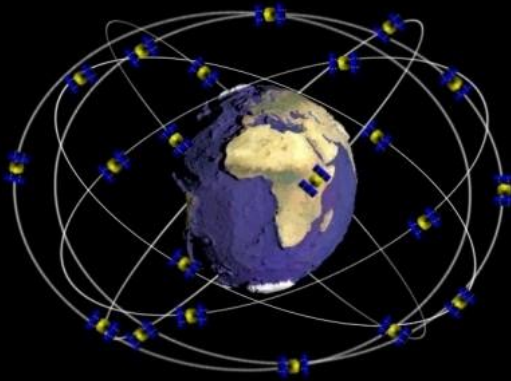
# Price vs Output

Price vs Output Power (Watts)





# How it works, cont'd



- The GPS Receiver
  - Uses military controlled GPS satellites – available to general public
  - Differential GPS receivers (DGPS) can be used to get data accurate within centimeters
  - Typical positions accuracy ranges from 1-5feet
  - Many models available for under \$150.00 by Garmin or Magellan, available at your local Best Buy.

# How it works, cont'd



- The Terminal Node Controller (TNC)
  - TNC is an amateur radio term, basically describing a radio modem (RF modem)
  - The TNC converts GPS data into AX.25 packet protocol for transmission via wireless APRS network
  - Manchester encoding techniques are used on the carrier frequency
  - TNC also calculates routing, delay of information, GPS header to use and more

# How packets get into the Network



# How the APRS Network Operates

- High towers are located every 20-30 miles running a transmitter and receiver on 144.390Mhz
  - These towers are called digipeaters
  - Each tower runs independent of any other towers
- These towers receive the packet information and relay it on to the next node.



# Operation Cont'd

- Once the packet has entered the digipeater network is taken as many hops as were set in the Terminal Node Controller. This depends on which state you are located in and the type of terrain you are dealing with.
- The packet is received at an Igate or Internet Gateway which is used for archiving and research studies around the world
- Check out the latest at <http://www.aprs.net/>

# How is the data viewed



While APRS is intended to be a primary network that does not require the Internet, many users use the national database, called Findu.Com, to track stations. Located at the left is the position of one of NY highest digipeaters in western NY.

# Other ways to view data

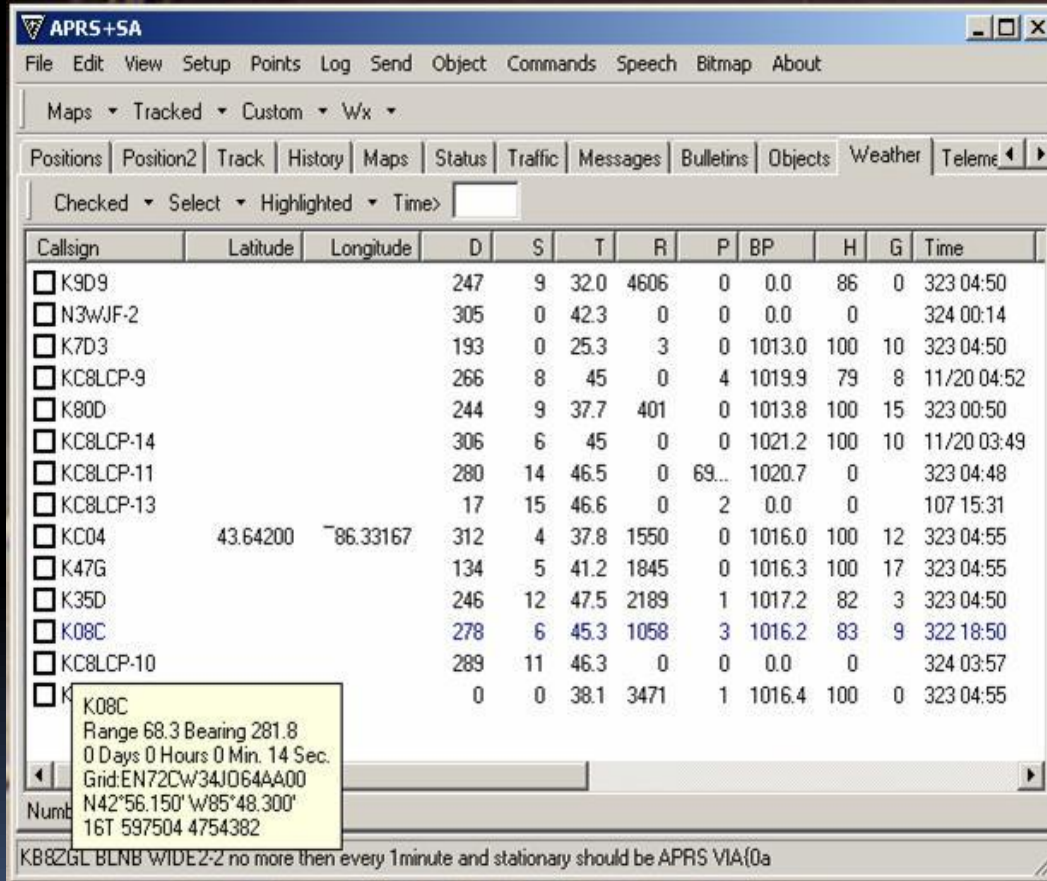
- There are many other ways to view data via live data clients

- This type of client utilizes a receiver, TNC and computer to generate data such as pictured to the left.

- On this example we can see several weather stations with telemetry readings displaying current weather information at that station

Clients include:

- APRS+SA, WinAprs, UiView, Xastir, AprsCE, APRS-Palm, and more

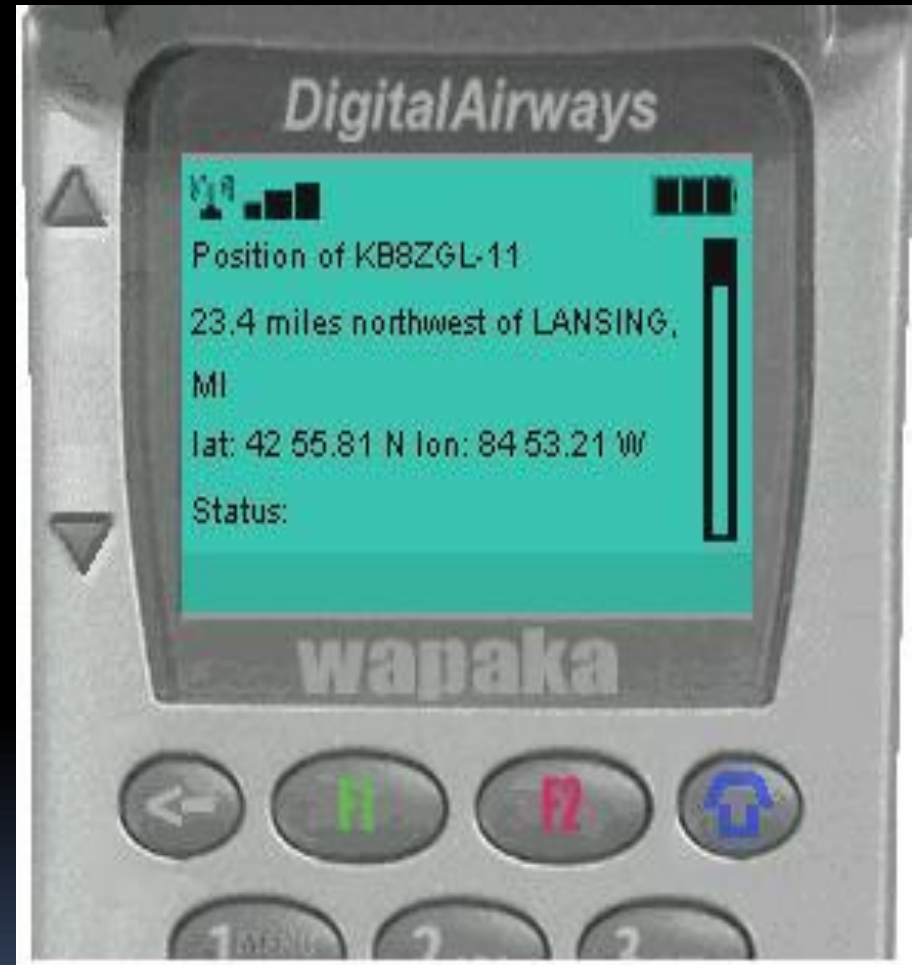


The screenshot shows the APRS+SA software interface. The main window displays a table of tracked stations with the following columns: Callsign, Latitude, Longitude, D, S, T, R, P, BP, H, G, and Time. A tooltip for station K08C is visible, showing the following information: Range 68.3 Bearing 281.8, 0 Days 0 Hours 0 Min. 14 Sec., Grid: EN72CW34J064A00, N42°56.150' W85°48.300', 16T 597504 4754382.

| Callsign                           | Latitude | Longitude | D   | S  | T    | R    | P     | BP     | H   | G  | Time        |
|------------------------------------|----------|-----------|-----|----|------|------|-------|--------|-----|----|-------------|
| <input type="checkbox"/> K9D9      |          |           | 247 | 9  | 32.0 | 4606 | 0     | 0.0    | 86  | 0  | 323 04:50   |
| <input type="checkbox"/> N3wJF-2   |          |           | 305 | 0  | 42.3 | 0    | 0     | 0.0    | 0   |    | 324 00:14   |
| <input type="checkbox"/> K7D3      |          |           | 193 | 0  | 25.3 | 3    | 0     | 1013.0 | 100 | 10 | 323 04:50   |
| <input type="checkbox"/> KC8LCP-9  |          |           | 266 | 8  | 45   | 0    | 4     | 1019.9 | 79  | 8  | 11/20 04:52 |
| <input type="checkbox"/> K80D      |          |           | 244 | 9  | 37.7 | 401  | 0     | 1013.8 | 100 | 15 | 323 00:50   |
| <input type="checkbox"/> KC8LCP-14 |          |           | 306 | 6  | 45   | 0    | 0     | 1021.2 | 100 | 10 | 11/20 03:49 |
| <input type="checkbox"/> KC8LCP-11 |          |           | 280 | 14 | 46.5 | 0    | 69... | 1020.7 | 0   |    | 323 04:48   |
| <input type="checkbox"/> KC8LCP-13 |          |           | 17  | 15 | 46.6 | 0    | 2     | 0.0    | 0   |    | 107 15:31   |
| <input type="checkbox"/> KC04      | 43.64200 | -86.33167 | 312 | 4  | 37.8 | 1550 | 0     | 1016.0 | 100 | 12 | 323 04:55   |
| <input type="checkbox"/> K47G      |          |           | 134 | 5  | 41.2 | 1845 | 0     | 1016.3 | 100 | 17 | 323 04:55   |
| <input type="checkbox"/> K35D      |          |           | 246 | 12 | 47.5 | 2189 | 1     | 1017.2 | 82  | 3  | 323 04:50   |
| <input type="checkbox"/> K08C      |          |           | 278 | 6  | 45.3 | 1058 | 3     | 1016.2 | 83  | 9  | 322 18:50   |
| <input type="checkbox"/> KC8LCP-10 |          |           | 289 | 11 | 46.3 | 0    | 0     | 0.0    | 0   |    | 324 03:57   |
| <input type="checkbox"/> K08C      |          |           | 0   | 0  | 38.1 | 3471 | 1     | 1016.4 | 100 | 0  | 323 04:55   |

# WAP added to APRS

- Recently APRS has grown to allow Wireless Access Protocol (WAP) enabled devices to view data from the Automatic Position Reporting Network.
- Shown here is an example of the information for KB8ZGL-11 in Portland, MI.





# Who invented APRS



- Bob Bruninga, WB4APR
  - United States Naval Academy, Aerospace Engineering Dept.
- First used to track horses in 1984
- Designed to “be a cost effective mapping program that would allow positioning of mobile stations using GPS receivers.”
- Bob Bruninga is considered the “Father of APRS” and is still active on a daily basis.

# Pros/Cons of APRS

## PROS

- Affordable, a tracker can be built for <\$200.00
- A network is in place, no need to build a new network
- APRS is used in Search and Rescue to save lives every day
- Manufacturers have begun implementing APRS into transceivers
- Large number of Elmers in Amateur Radio available to assist

## CONS

- APRS is still considered a developers system
- Available to licensed amateur radio operators only
- At 1200bps in a state like California traffic collisions quickly become a major concern
- APRS is limited to a single simplex frequency, such as 144.390, and spread spectrum has not yet been easily implemented.

# Moving towards standardization

The Automatic Packet Reporting System (APRS) has had a committee of the top 7 influential people in APRS to design and create an APRS specifications whitepaper. It is located at the above URL. This is a giant leap towards standardization.

Currently, `aprs101m` is the fourth update to the original APRS 100 specifications. Expectations among avid APRS users is that an APRS 2.0.0 specification will be released at the Digital Convergence Conference (DCC) in February of next year.

## PCSAT



# The future of APRS

- Launched at 0240z 30 Sept 2001 from the [Kodiak Alaska Launch Complex](#).
- Built by students at the US Naval Academy
- First APRS satellite, since joined by 3 other such satellites
- An APRS space frequency has been published as 145.825
- YES! Those are tape measures for antennas, just like you can buy at your local hardware store.

# Future, continued




- ## International Space Station (ISS)
- The ISS was equipped with an APRS receiver on 145.825 recently
  - Used for crew to send messages to friends, family, and amateur radio operators
  - Designed to track ISS in space
  - Used as a space digipeater in the APRS space satellite constellation
  - More info at [www.ariss.net](http://www.ariss.net)

# Demonstrations

- <http://www.aprs.net/vm/DOS/DEMOS.HTM>
- <http://www.aprs.net/vm/DOS/SPACE.HTM>
- <http://www.aprs.net/vm/DOS/WX.HTM>
- <http://www.aprs.net/vm/DOS/DF.HTM>



# Conclusion

- The future of APRS looks good
  - Currently 20,000+ users in the US alone
  - Track anything from animals to ocean currents
  - Commercial products emerging based on APRS specification
  - Being implemented and tested by many governmental emergency agencies
    - Air Force, NWS Spotters, Wild Fire Agencies, Search and Rescue – Coast Guard, National Emergency Operations Coordinators, and more.
- 

# Thank You



<http://www.limarc.org/>