Beginners Guide to APRS

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What is APRS?

- APRS stands for Automated Packet Reporting System
- Designed by Bob Bruninga, WB4APR, and introduced by him at the 1992 TAPR/ARRL Digital Communications Conference
- Supports rapid, reliable exchange of information for local, tactical real-time information, events or nets.
- Uses a standard simplex frequency.
- APRS established
  - standard formats for the transmission of POSITION, STATUS, MESSAGES, and QUERIES
  - guidelines for display of information

Like Packet but Different

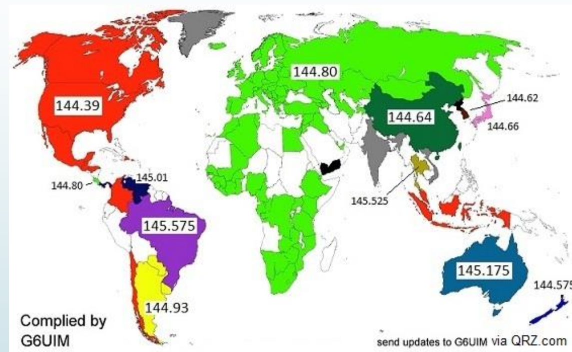
- APRS is different from regular packet in several ways:
  - It provides maps and other data displays, for vehicle/personnel location and weather reporting in real time.
  - It performs all communications using a one-to-many protocol, so that everyone is updated immediately.
  - It uses generic digipeating, with well-known callsign aliases, so that prior knowledge of network topology is not required.
  - It supports intelligent digipeating, with callsign substitution to reduce network flooding.
  - Using AX.25 UI-frames, it supports two-way messaging and distribution of bulletins and announcements, leading to fast dissemination of text information.
  - It supports communications with the Kenwood TH-D7 and TM-D700 radios, which have built-in TNC and APRS firmware.

APRS Features

- **Maps** — APRS station positions can be plotted in real-time on maps, with coverage from a few hundred yards to worldwide. Stations reporting a course and speed are dead-reckoned to their present position. Overlay databases of the locations of APRS digipeaters, US National Weather Service sites and even amateur radio stores are available. It is possible to zoom in to any point on the globe.
- **Weather Station Reporting** — APRS supports the automatic display of remote weather station information on the screen.
- **DX Cluster Reporting** — APRS an ideal tool for the DX cluster user. Small numbers of APRS stations connected to DX clusters can relay DX station information to many other stations in the local area, reducing overall packet load on the clusters.
- **Internet Access** — The Internet can be used transparently to cross-link local radio nets anywhere on the globe. It is possible to telnet into Internet APRS servers and see hundreds of stations from all over the world live. Everyone connected can feed their locally heard packets into the APRS server system and everyone everywhere can see them.
- **Messages** — Messages are two-way messages with acknowledgement. All incoming messages alert the user on arrival and are held on the message screen until killed.
- **Bulletins and Announcements** — Bulletins and announcements are addressed to everyone. Bulletins are sent a few times an hour for a few hours, and announcements less frequently but possibly over a few days.
- **Fixed Station Tracking** — In addition to automatically tracking mobile GPS/LORAN- equipped stations, APRS also tracks from manual reports or grid squares.
- **Objects** — Any user can place an APRS Object on his own map, and within seconds that object appears on all other station displays. This is particularly useful for tracking assets or people that are not equipped with trackers. Only one packet operator needs to know where things are (e.g. by monitoring voice traffic), and as he maintains the positions and movements of assets on his screen, all other stations running APRS will display the same information.

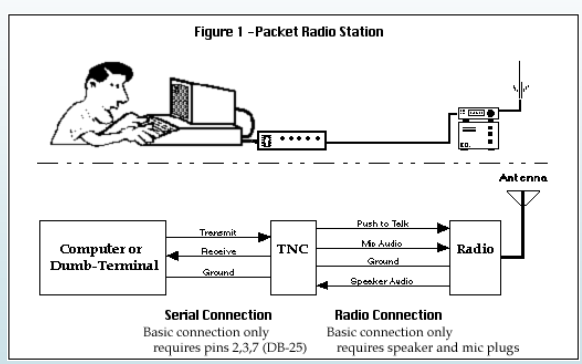
APRS VHF Frequencies

- APRS uses a standard simplex frequency
- 1200 baud



Physical Layer - Typical Station

- TNC (Terminal Network Controller)
  - A modem, a computer processor (CPU), and the associated circuitry required to convert communications between your computer (RS-232) and the packet radio protocol in use.
  - Assembles a packet from data received from the computer, computes an error check (CRC) for the packet, modulates it into audio frequencies, and puts out appropriate signals to transmit the packet over the connected radio. It also reverses the process, translating the audio that the connected radio receives into a byte stream that is then sent to the computer.



Data Link Layer - What is AX.25?

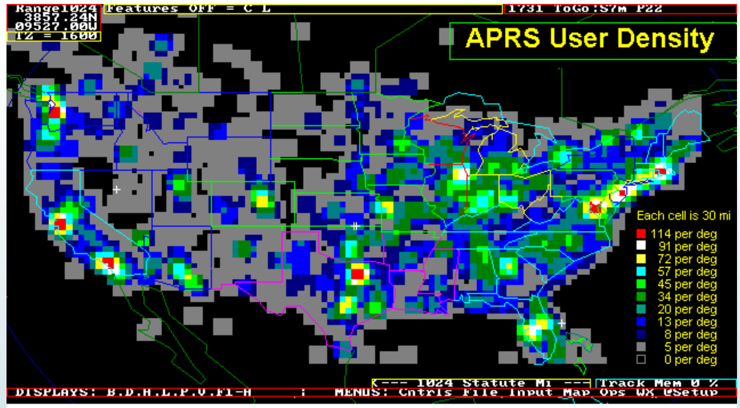
- **AX.25** (Amateur X.25) is a data link layer protocol derived from the X.25 protocol suite and designed for use by amateur radio operators
- A protocol is a standard for two computer systems to communicate with each other, somewhat analogous to using a business format when writing a business letter.
- AX.25 was developed in the 1970's and based on the wired network protocol X.25, modified to suit amateur radio's needs.
- AX.25 includes a digipeater field to allow other stations to automatically repeat packets to extend the range of transmitters.
- Every packet sent contains the sender's and recipient's amateur radio callsign, thus providing station identification with every transmission

What is Digipeating?

- Digipeater" is short for "Digital Repeater"
- A repeater for packet data rather than voice.
- Standard voice repeater that receives on one frequency and retransmits what it hears simultaneously on another frequency
- Digipeater is a single frequency device - It receives a packet of data, stores it in internal memory and then a moment later retransmits it on the SAME frequency.
- Standardized in 2004

Problems with Digipeating

- The good – area covered goes up
- The bad – capacity reduced in half by each digipeater used
- Typical areas where people use 2 hops with four or more digipeaters, can only support about 60 to 100 or so users in its RF domain.
- The ***more*** stations you see above about 60 to 100 or so in typical areas, the ***more*** packets you *don't* see due to collisions and the *less* reliable your network is for local real-time APRS use



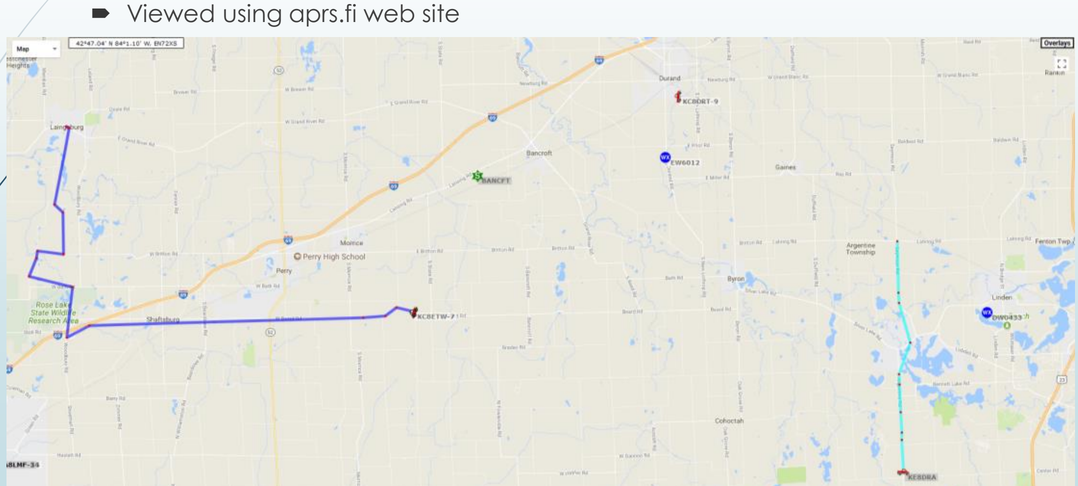
This data from Steve's FINDU is plotted on APRSdos to show the user denstiy in the USA in Feb 05. Although it appears that most of the USA is low density, remember that a WIDE5-5 launched anywhere in the remotest area will still get to the cities and add to the QRM there. ANd there are 100 times more low density users surrounding these cities on all sides that really adds up to heavy QRM. We recommend WIDE2-2 in [colored areas] and surrounding areas. 3-3 only in gray 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

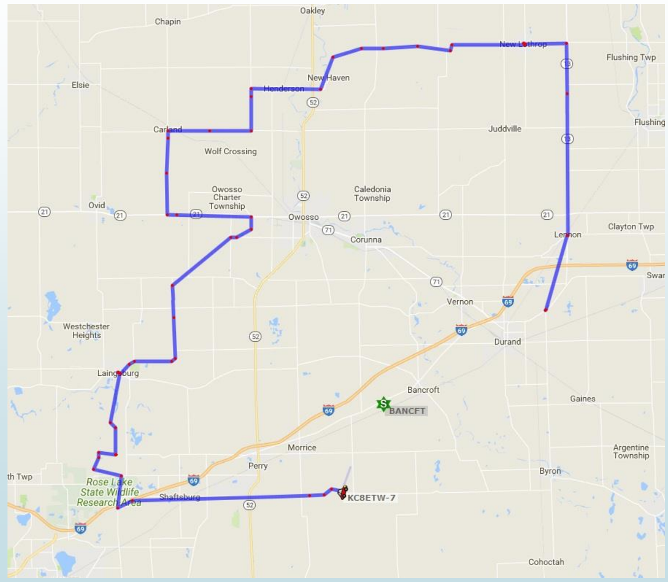
APRS Tracking on the Web

- iGate relays beacons to Internet
- Viewed using aprs.fi web site



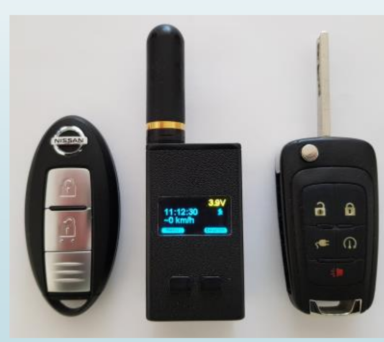
Shiawassee County APRS Coverage

- 5 Watt Output
- 3.5 db roof mounted antenna
- Each red dot on blue track line represents a beacon transmission

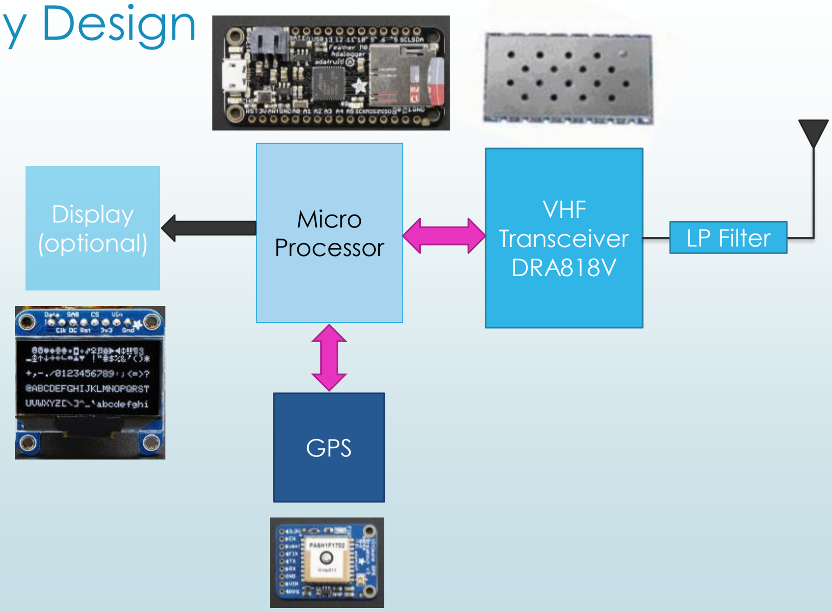


APRS Requirements

- Not all radios have APRS built-in and have dual VFOs
- Desire simple standalone APRS beacon transmitter
- Several currently on the market
- PicoAPRS seems like the nicest, ~$229 not including antenna and charger (hro)
- But what's the fun of buying something when you can build it?



My Design



Features

- Simple assembly – major components are existing preassembled modules attached to main circuit board using thru-hole headers
- Some surface mount components need to be attached to main board but use larger size SMC so easy to work with
- Main PCB – 4 layer to ensure proper shielding, grounding, and power distribution
- 1 Watt/ 0.5 Watt output
- Busy Channel Detection
- Receive Beacons
- Powered by battery or standard phone charger
- Built-in charger for LiPo battery
- GPS has built-in antenna or use external active antenna
- Able to log vehicle track to file on built-in SD card
- No reprogramming needed to configure, just edit simple file on SD-Card

Radio Characteristics

Symbol	Parameter (condition)	Min.	Typ.	Max.	Units
Freq	Frequency range	134		174	MHz
Sen.	Receiver sensitivity @12dB SINAD		-122		dBm
Sen_{SQ}	Squelch function sensitivity		-120		dBm
SNR_{R}	S/N in receive mode @ 1.5KHz Fdev.	45	50		dB
ACS	Adjacent channel selection @ CH_w = 25 KHz	55	60		dB
IR	Inter-modulation rejection @ CH_w = 25 KHz	55	60		dB
SPR	Spurious emission rejection@ CH_w = 25 KHz	55	60		dB
AF_{ZOUT}	Audio output impedance		200		Ohm
AF_{AMP}	Audio signal amplitude @1KHz		700		mV
Pout	Output power @ Low Power Mode @ High Power Mode		26 29	27 31	dBm
Fdev	Max. Frequency deviation @ Narrow band			2.5	KHz
Sen_{MOD}	Modulation Sensitivity @1KHz at 2.5KHz Fdev.		10		mV
AF_{TD}	Audio modulation distortion@1KHz at 2.5KHz Fdev.		2	5	%
SNR_{T}	S/N in Transmit mode @1KHz at 2.5KHz Fdev.	38	40	45	dB
$Fdev\_{C}$	CTCSS frequency deviation	0.35	0.5	0.75	KHz

Costs

Description	Price
Misc. components/cables	$ 22.45
FEATHER M0 ADALOGGER	$ 19.95
GPS BREAKOUT 66CH W/10HZ UPDATES	$ 39.95
DISPLAY OLED GRAPHIC MONO 128X64	$ 19.50
BATTERY LITHIUM 3.7V 2.5AH	$ 14.95
DRA818V VHF Transceiver	$ 9.58
Total not including case, circuit board, antenna, tax, shipping	***$ 126.75***

Current Status

- Prototype PCB created and received from manufacturer
- All components on hand to assemble
- Assembly begun
- Testing software currently being developed

References

- APRS Organization - www.aprs.org
- Wikipedia APRS - https://en.wikipedia.org/wiki/Automatic_Packet_Reporting_System
- *"AX.25 Link Access Protocol for Amateur Packet Radio" (PDF). Tucson Amateur Packet Radio. 1997. Retrieved 2014-01-15. http://www.tapr.org/pdf/AX25.2.2.pdf*
- *APRS Protocol Specification http://www.aprs.org/doc/APRS101.PDF*
- *APRS Yahoo Group - https://groups.yahoo.com/neo/groups/APRS/info*