Automatic Packet Reporting System

(APRS*)

Rick Fletcher, W7YP

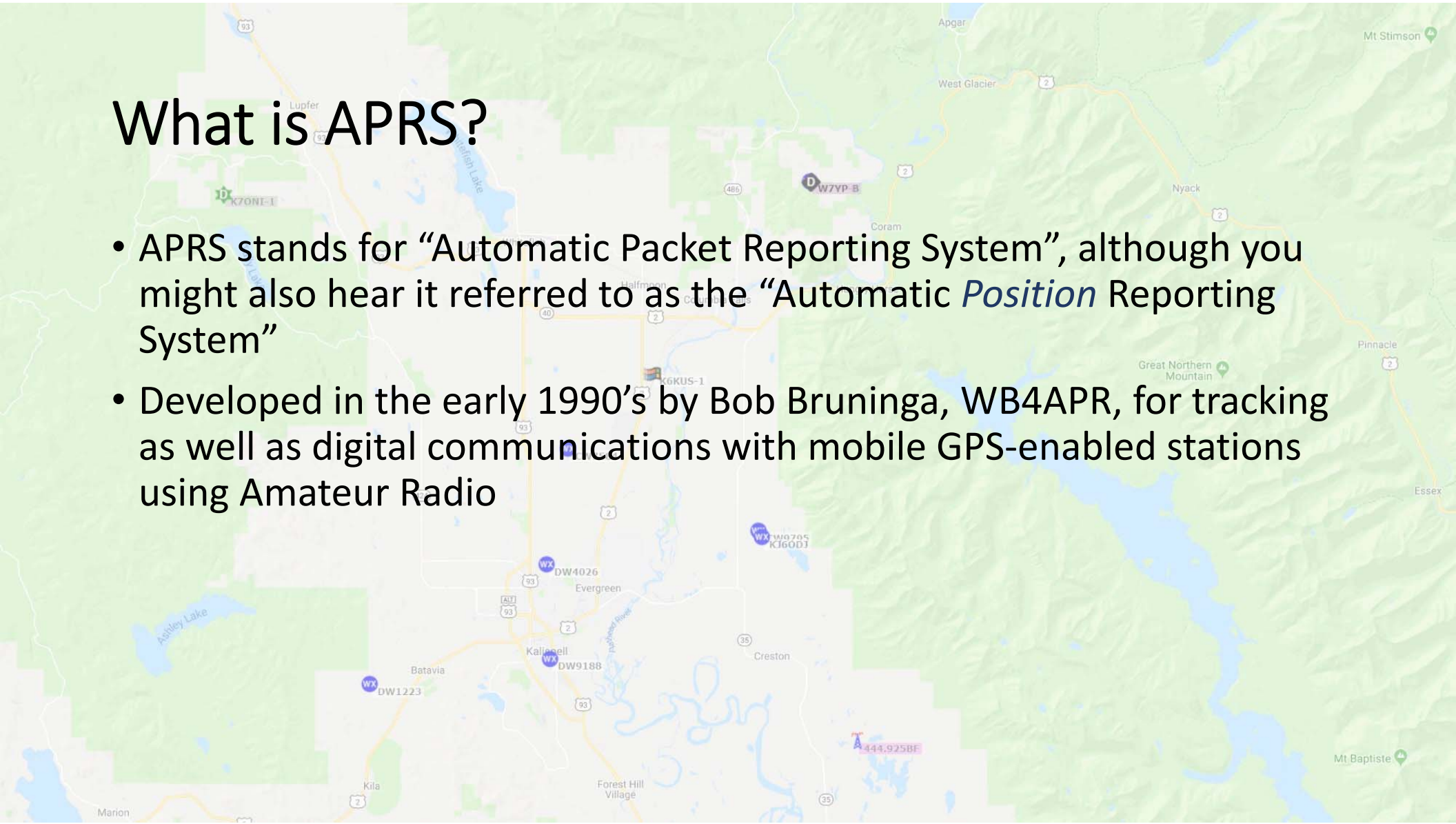
FVARC

October 16, 2018

***APRS is a registered trademark of Bob Bruninga, WB4APR**

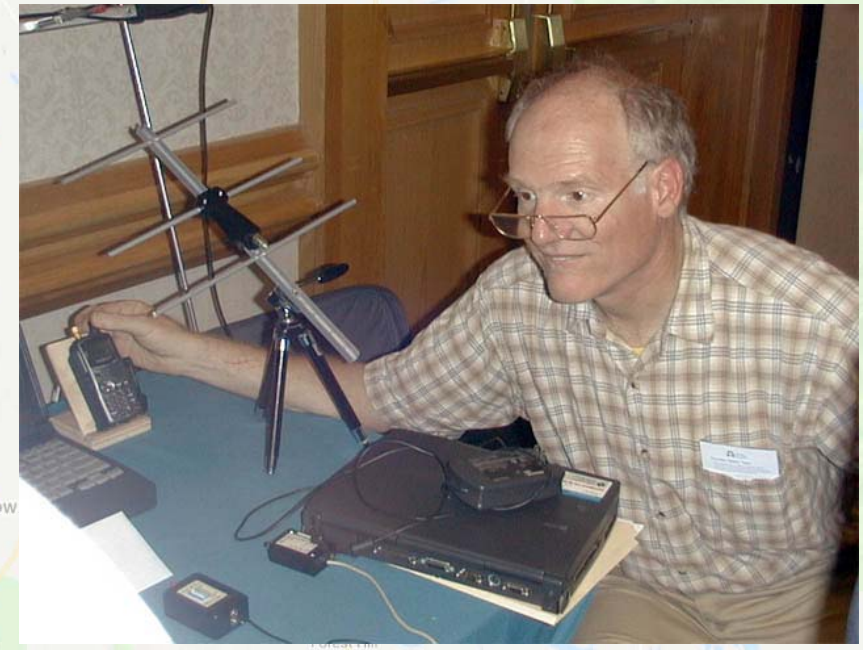
What is APRS?

- APRS stands for “Automatic Packet Reporting System”, although you might also hear it referred to as the “Automatic *Position* Reporting System”
- Developed in the early 1990’s by Bob Bruninga, WB4APR, for tracking as well as digital communications with mobile GPS-enabled stations using Amateur Radio



WB4APR – the “Father of APRS”

- The predecessor to today’s APRS protocol was first released in 1991 and was named “APLS” for “Automatic Packet Location System”



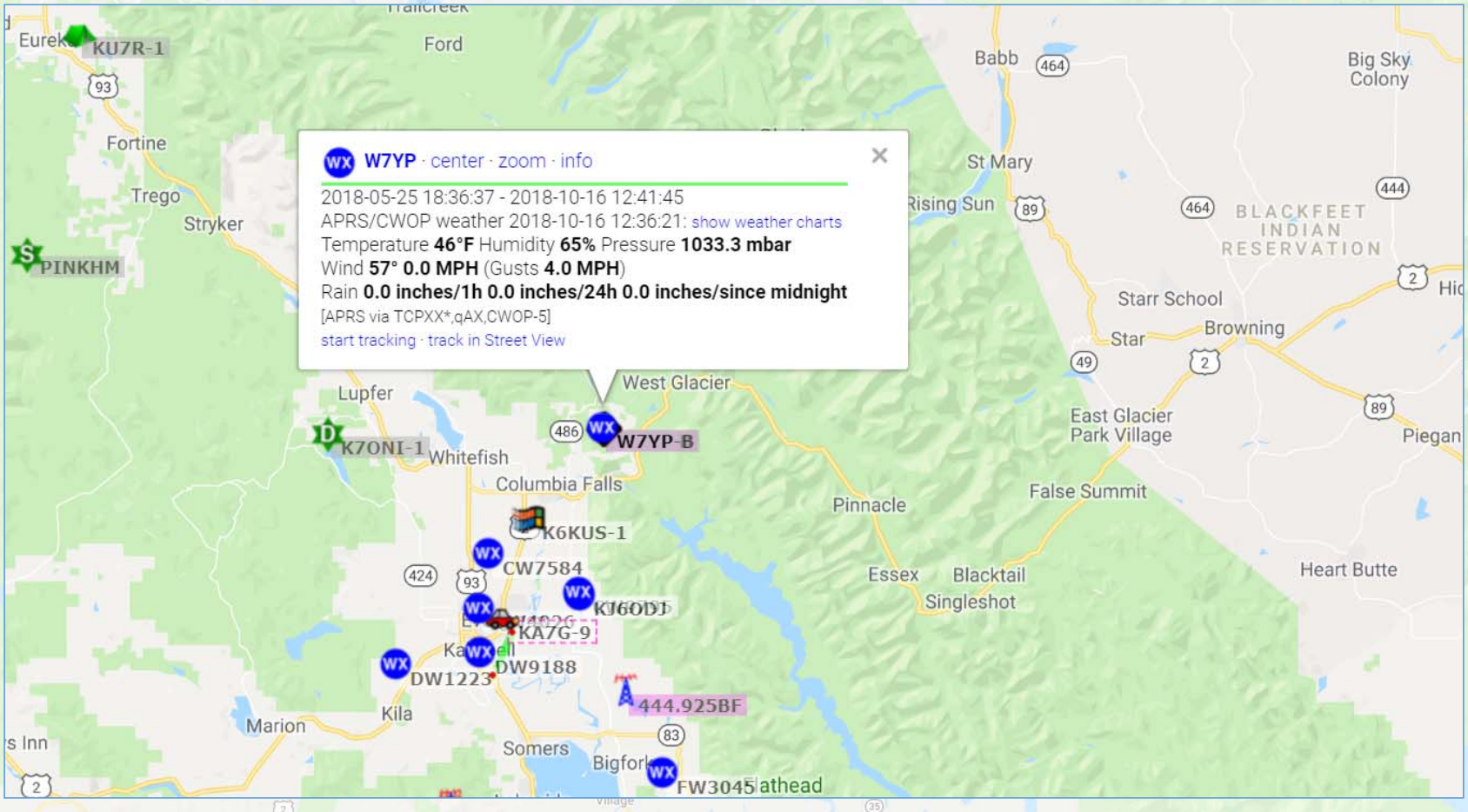
What Does APRS Do?

- APRS was developed as a means for amateur radio operators to exchange data and the location of the source providing that data.
- APRS is often used to assist in search and rescue operations due to its tracking capabilities
- APRS was intended to be a reliable messaging system which would work even when the Internet was down
- APRS systems can transmit location data, course and speed information and weather information in a timely manner using a packet network

The APRS Network

- The APRS system is a very large land-based wireless network
- It consists of a large network of nodes with an average distance between nodes in the U.S. of approximately 30 miles
  - Obviously, in same regions, distances are much smaller, while others they're considerably greater
- APRS nodes relay their messages through "digipeaters"
- APRS is used in space to track satellite and GPS data
- APRS is used to monitor telemetry values of the weather stations reporting to the National Weather Service (NWS)
- APRS also has the ability to quickly relay telemetry data to research centers without requiring the Internet

Weather Data Shown at https://aprs.fi



How It Differs From ‘Regular’ Packet Radio

- Uses graphical mapping and other types of data displays
- Communication is via a “one-to-many” protocol, so that all nodes are updated in near real time
- Uses simple generic digipeating so that knowledge of the network isn’t required
  - A “digipeater” (Digital Repeater) is a repeater for packet data rather than voice
- Turns packet radio into a real-time tactical communication and display system for emergencies and public service applications

Digipeater

- Relays packet data rather than voice
- Unlike most voice repeaters, most digipeaters receive and transmit on the same frequency (simplex)
- A short time after receiving a packet of data, it retransmits it, normally on the same frequency
- Digipeating is critical to APRS because packets are often transmitted from moving vehicles
  - Traditional packet radio was primarily between fixed stations
  - Signal levels need to be higher for data packets than for voice
    - ALL of the packet has to be successfully decoded or its tossed
      - No ACK/NAK, so packets are retransmitted at intervals in the hope that it will be received error free

APRS Digipeater Usage

- Two categories of Digipeaters to promote successful use among mobile stations
  - WIDE-Area – digipeaters placed in strategic locations such as mountain tops, high buildings, towers, etc.
    - These digipeaters are generally installed with the guidance of a state APRS Coordinator
    - They respond to the Alias call sign “WIDEn-N”
  - FILL-in – digipeaters in areas where mobile stations have poor access to WIDE-Area digipeaters
    - Typically home stations running an APRS client with digipeating enabled
    - This type once responded to the alias call sign “RELAY”, but that has been replaced with “WIDE1-1”
  - APRS frequency (North America): 144.39 MHz

How APRS Paths Are Used

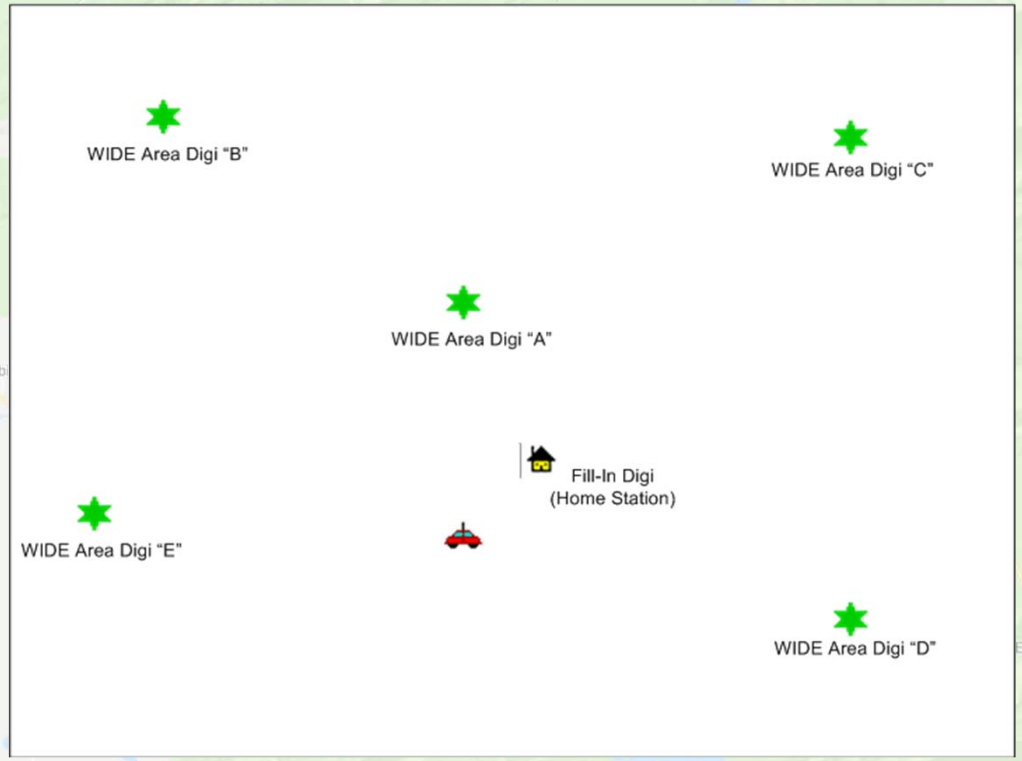
- PATH settings determine what kind and how many digipeaters will be used to deliver your packets to their destination
  - Typical “destination” is either other stations listening on RF or an “I-Gate” that will transfer the packets into the APRS Internet Servers (“APRS-IS”)
- As in conventional packet radio, each digipeater in the chain ‘crosses off’ the call sign it responded to
- In the example coming up, a user tries to use three wide area digipeaters in succession
  - The path string will change as the packet propagates from digi to digi.
    - These advanced paths require that the "call sign" actually be changed by each digi that processes it
    - This process of "call sign substitution" is unique to APRS and requires special APRS awareness in TNCs

APRS Path Processing

This example on the right shows the results as a user tries to use three wide area digipeaters in succession.

By placing two WIDEn-N statements in series in the path, you allow a simple home station "FILL-In digipeater" to "relay" the first hop while leaving the second n-N hop(s) for "real" WIDEn-N digis to properly process and decrement.

The example shows the life of a packet that has been digipeated in this way:



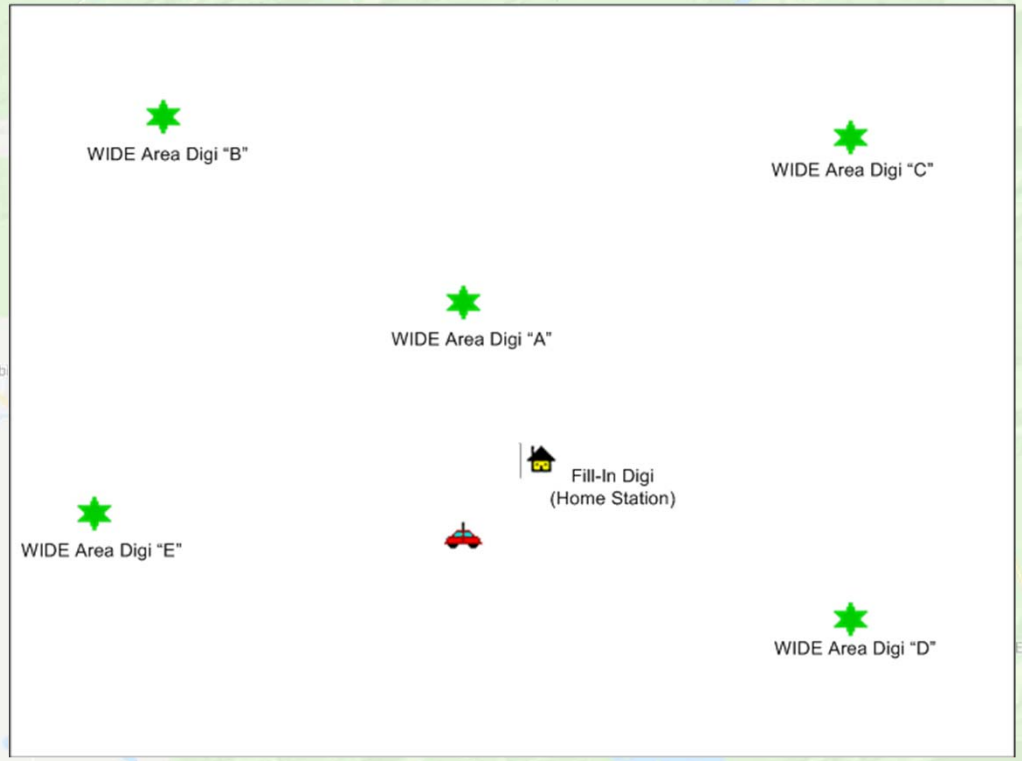
WIDE1-1,WIDE2-2	(as the user transmitted it)
WIDE1*,WIDE2-2	(as a home fill-in digi or the first high-level digi transmitted it)
WIDE1*,digicall1*,WIDE2-1	(after first WIDE digpeat)
WIDE1*,digicall1*,digicall2*,WIDE2*	(after second WIDE digipeat)

APRS Path Processing

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 non-APRS-aware 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

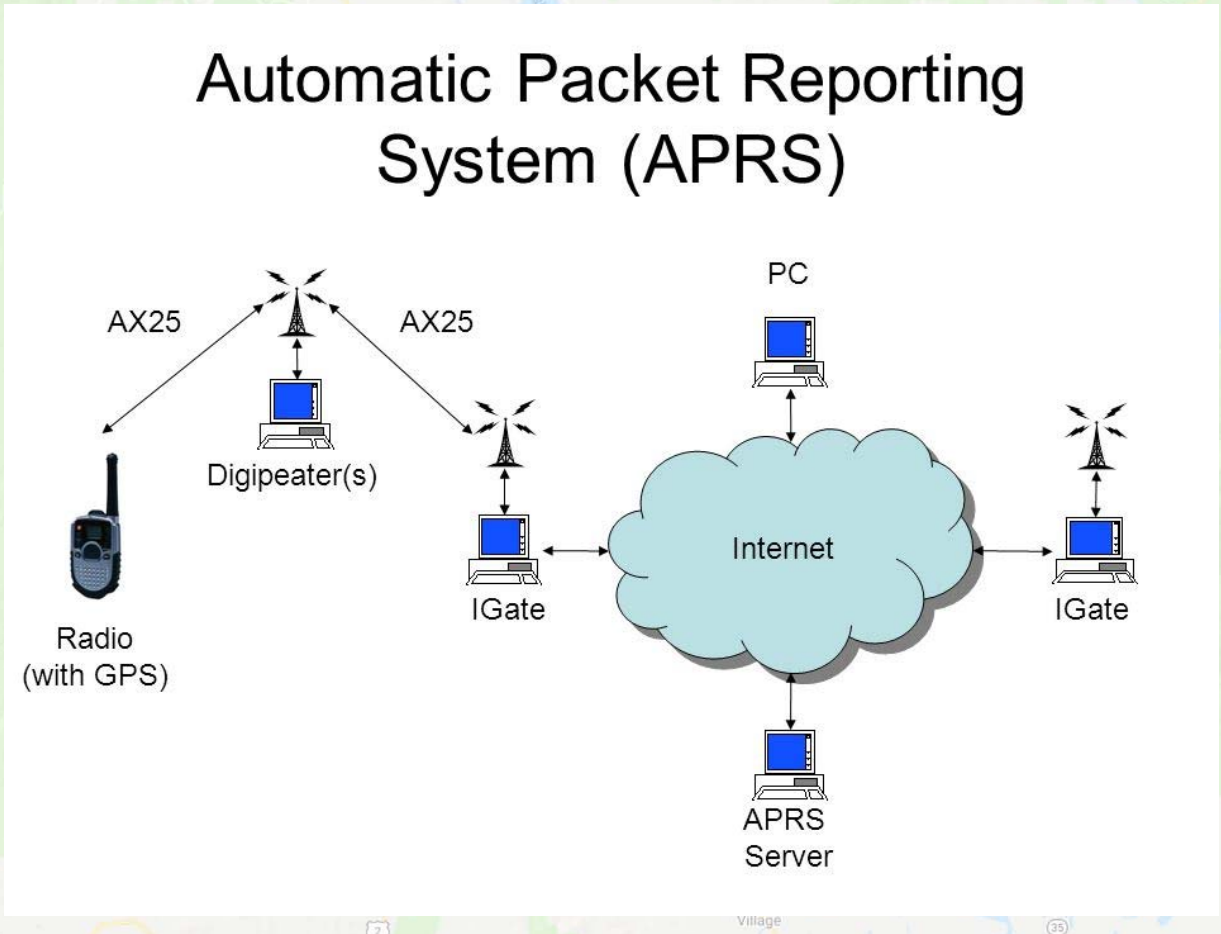


The third digi, if any, will transmit the packet decremented to WIDE2-0 (actually shows as "WIDE2*") and no further digipeating will occur. Because all APRS digipeaters use the same generic call signs, the re-transmission process can happen in several geographic directions simultaneously if several more digipeaters are within range of the one transmitting. A widening circle of digipeats involving more and more digis on each hop will spread outward from the user in all directions. This phenomenon, known as UI flooding, is sharply different from the directed linear sequence of digis, each identified by a unique call sign, used in traditional connected packet radio.

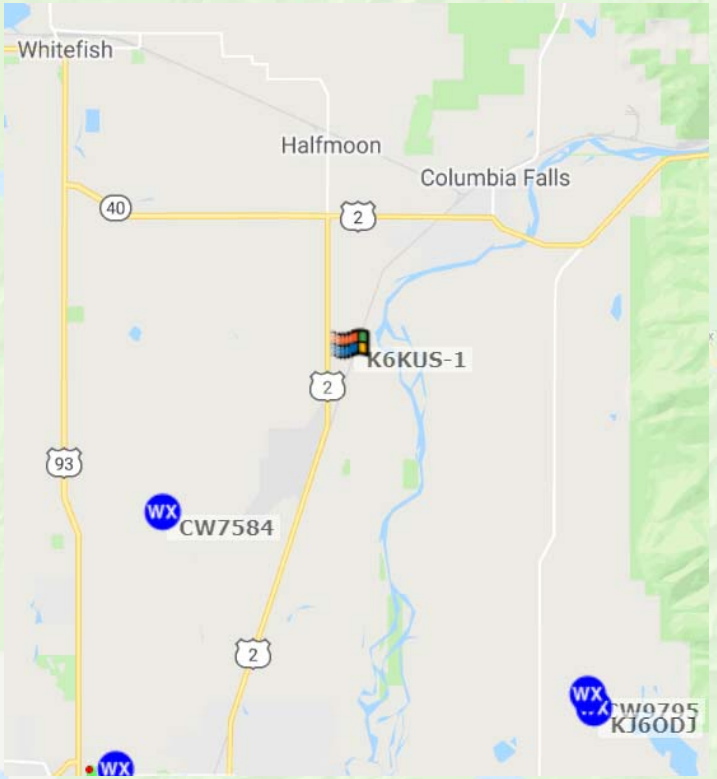
APRS Path Processing

- The APRS RF network is designed to limit the number of digipeaters any pack will pass through to a maximim of 3 (i.e. WIDE1-1,WIDE2-2)
- **Today's recommended universal path settings:**
  - **“WIDE1-1, WIDE2-2”** (Will produce three hops and will take advantage of home fill-in digis)
    - Use in rural areas with low APRS activity only
  - **“WIDE1-1, WIDE2-1”** (Will produce two hops and will take advantage of home fill-in digis
    - Use in busy urban and suburban areas

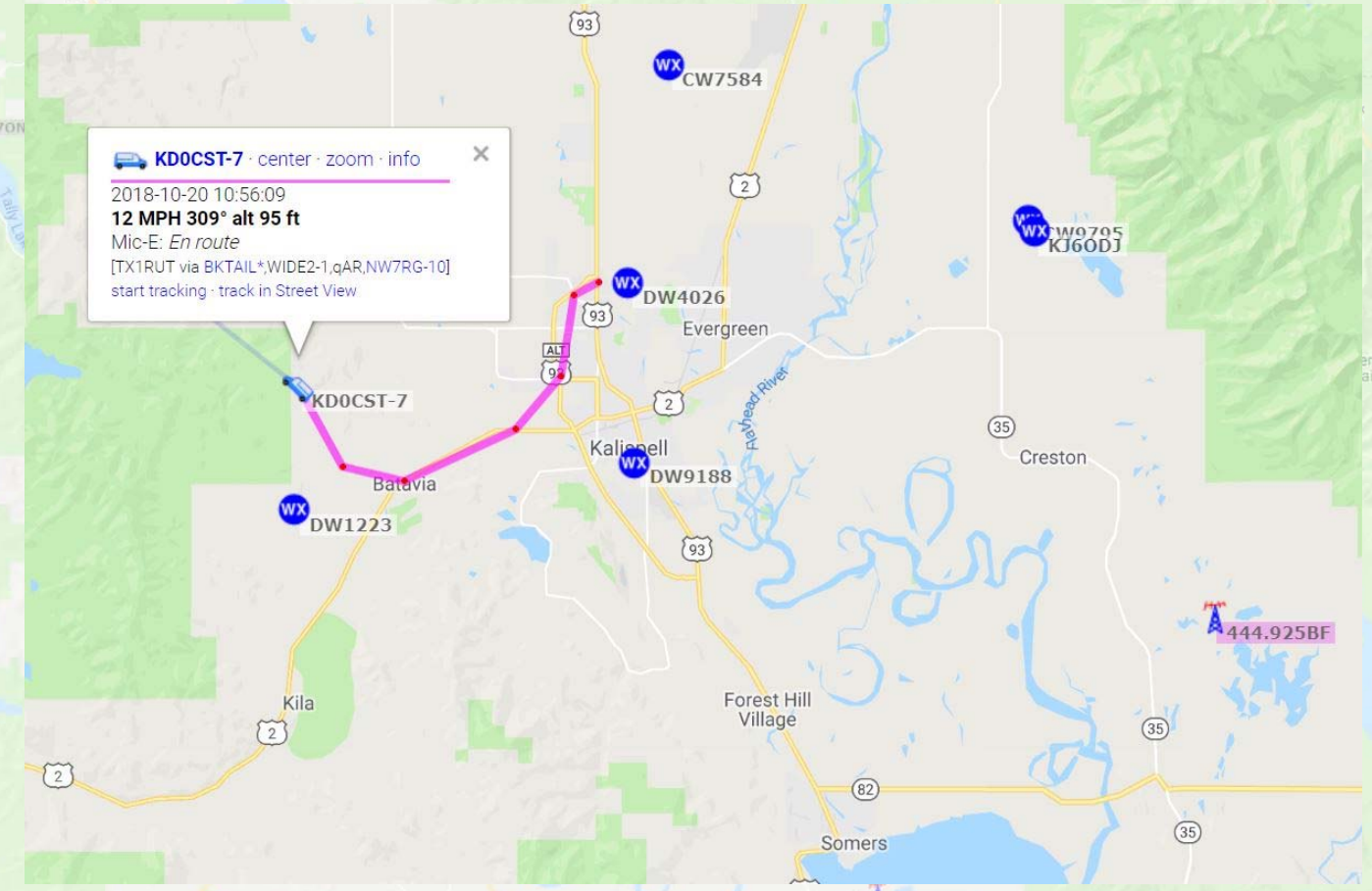
APRS Network



Our local I-Gate is K6KUS-1, run by K6KUS (Larry Ellsworth) and is located south of Columbia Falls



APRS Map (https://aprs.fi)



Symbols: http://www.aprs.org/symbols.html

What Equipment is Needed?

- Just three things are needed:
  - A transceiver capable of operating on 144.390 MHz
    - Must be a transceiver, as APRS uses a collision detection system to know when to send data
  - A GPS system
  - A TNC (Terminal Node Controller)
    - Also known as an “RF modem” or “Radio modem”
- Many of today’s “APRS Ready” transceivers have both the GPS and the TNC built in; others just need an external GPS connected to them
- ICOM radios support D-PRS (DSTAR) instead, so you need to connect to a repeater or gateway that can transfer your location data to the APRS network

Radios With Built-In TNC

- Kenwood TM-D700A (Discontinued – used price: $250)
  - VHF/UHF
  - Screen display showing other APRS station and messages
  - If in fixed location, no external GPS is required – just key-in your location

- Kenwood TH-D7AG (Discontinued – used price: $100)
  - VHF only
- Alinco DR-135T MK II with EJ-41U TNC (used: $100)
  - VHF only
- External GPS must be NMEA-0183 compatible

Mobile Radios With GPS and TNC

- Kenwood TM-D710GA ($570)
  - VHF/UHF
  - GPS and TNC built-in

- Yaesu FTM-100DR ($300)
  - VHF/UHF
  - Supports C4FM

- Yaesu FTM-400DR/XDR ($500)
  - VHF/UHF
  - Supports C4FM
  - Color Touch Screen

HT’s With GPS and TNC

- Yaesu FT1DR (used: $125)
  - VHF/UHF
  - Supports C4FM
- Yaesu FT2DR ($360)
  - VHF/UHF
  - Supports C4FM
  - 1.7 inch touch screen

HT’s With GPS and TNC

- Kenwood TH-D74A ($500)
  - DSTAR enabled VHF(144/220)/UHF radio
  - Bluetooth enabled
  - Beautiful color touch screen
  - Wideband and multimode reception
  - Enhanced DSP processing
  - Standalone digipeater
- Kenwood TH-D72A ($380)
  - VHF/UHF
  - Standalone digipeater

And Another Way to Do APRS

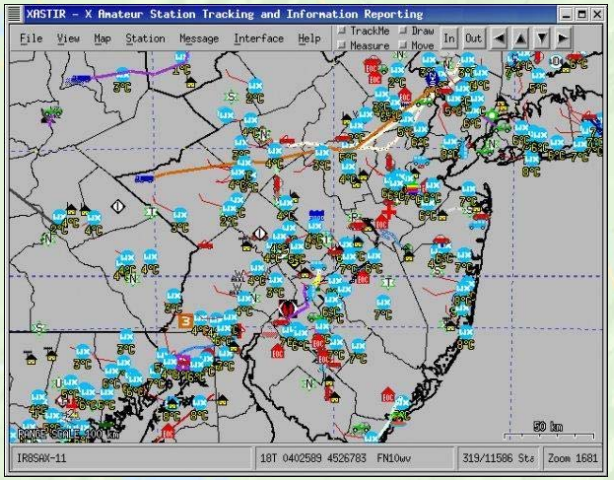
- With your PC sound card and and radio interface such as the SignaLink
  - Basically the same setup you'd use or are using for digital mode radio work
  - If you have an HF transceiver with such an interface and the radio covers VHF, you're almost done
- AGWPE software (free) for Packet Radio
  - https://www.soundcardpacket.org/2agwget.aspx

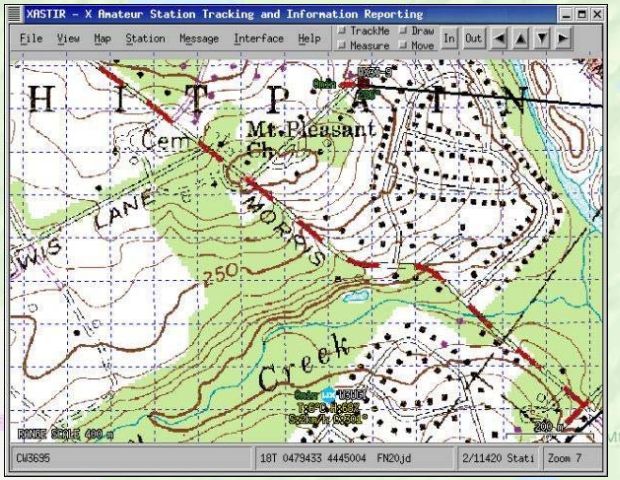
Mapping/Tracking Programs

- DOS-APRS – Bob Bruninga
- WinAPRS – Mark Sproul
- MacAPRS – Keith Sproul
- APRS+SA – Brent Hildebrand
- UI-View – Roger Barker
- Xastir – Open Source
- XAPRS – Sproul Brothers
- PocketAPRS – Mike Musick

Xastir (Open Source)

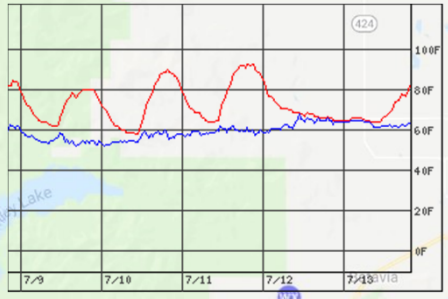
- Supports many map formats and is highly customizable
- Runs on Windows, MaxOSX, Linux, FreeBSD, Solaris and Lindows
- Free under the GPL license
  - Includes source code

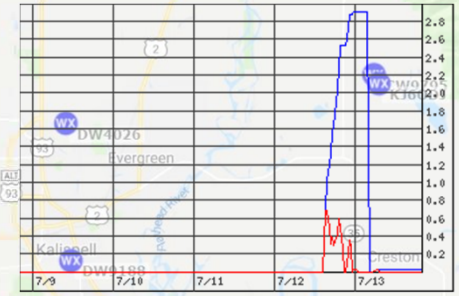


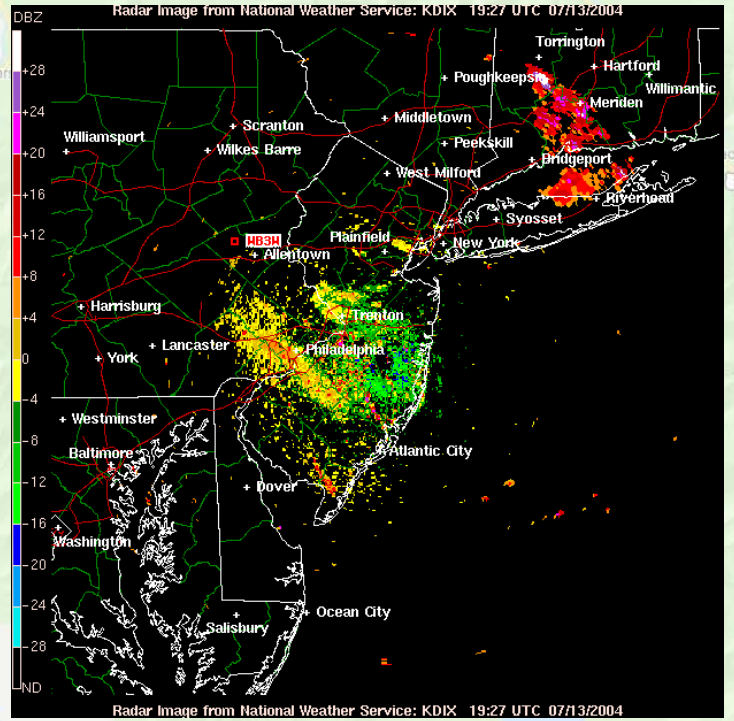


Findu.com

- Internet tracking by Steve Demise, K4HG
- Sophisticated mapping
- Powerful weather data displays

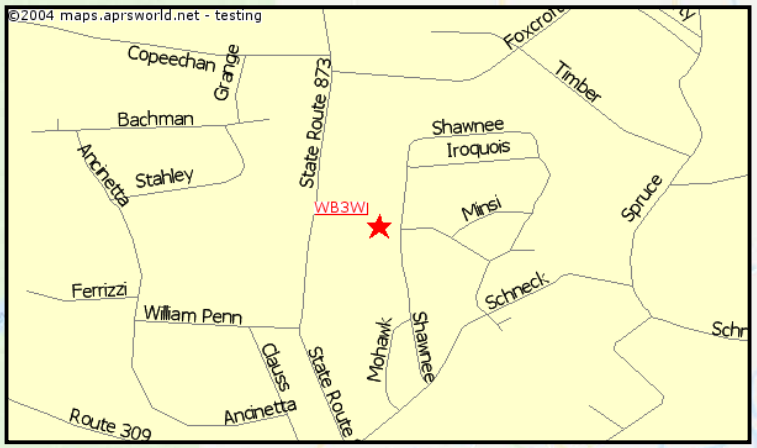




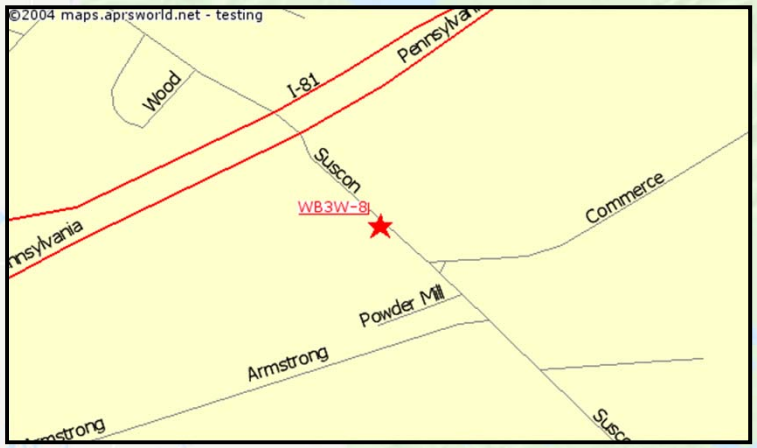


Aprsworld.com

- Developed by James Jarvis, KB0THN
- Allows simultaneous tracking and mapping of the different SSID's used by a station



Home WX Station



On the Way to Work

Citizens Weather Corps

- Citizens Weather Observer Program (CWOP)
  - Allows non-Amateurs to utilize the APRS network to collect and report on local weather conditions
  - No radio required
  - Available as a public service for non-commercial use
  - Provides feedback and guidance to weather station operators to help them improve

International Space Station

- ISS has an APRS station on 145.825 MHz
  - Same frequency used by AMSAT and CubeSATs
- Acts as a digipeater in the APRS space satellite constellation
- Used by the crew to send messages to friends, family and amateur radio operators


Q&A
Apgar
Mt Stimson
West Glacier
Lupfer
Whitefish Lake
K7ONI-1
W7YP-B
Nyack
Coram
Whitefish
Tally Lake
Halfmoon
Columbia Falls
Hungry Horse
Great Northern Mountain
Pinnacle
CW7584
Essex
KJ6ODJ
DW4026
Evergreen
Ashley Lake
Kalispell
Creston
Batavia
DW9188
DW1223
444.925BF
Mt Baptiste
Kila
Forest Hill Village
Marion