# The World of APRS

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# Michael Ford, WZ0C

- Ham since 1989
- Originally from Iowa – hence the 10th region callsign
- One of two ARRL Assistant Section Traffic Managers in Eastern Massachusetts, with role of ARES-NTS Liaison
- Interests in the hobby include:
  - Digital communications on HF, VHF, UHF, and SHF.
  - National Traffic System (NTS)
  - Short-term events in the field
    - Public service events
    - ARES Simulated Emergency Tests (SETs)
    - Parks on the Air (POTA)

# Purpose of this presentation?

- Provide an overview of what APRS is
- List ways to get set up with APRS
- Talk about what you can do with APRS
- Mention some of the newer things in APRS

Goals:
- Share information on various uses of APRS to pique interest
- Give you the knowledge to get going with APRS.

# What is APRS?

# What is APRS?

- Automatic Packet Reporting System. Created by Bob Bruninga WB4APR (SK) in 1992.

- APRS is a **tactical information system**. Provides multicast of information packets, allowing stations to get context of the local environment within ten to twenty minutes.

- Station beacons packets on a regular interval. Allows other stations to know about this station.

- Not just positions! Data types include: Messages, Bulletins and Group Bulletins, Announcements, NWS Bulletins, Weather reports, Position reports, Status reports, Object locations (such as repeaters)

# How does it work?

- An APRS station transmits small packets of data (usually less than 70 characters) into surrounding RF environment.

- Uses 144.39 MHz in North America (FM)

- Also found on 30m on HF (10147.6 kHz USB / 10151 kHz LSB)

- Stations beacon using generic paths. Based on the path in the packets, "digipeaters" (digital + repeater) receive these packets and retransmit them, for greater coverage. Common is "WIDE1-1,WIDE2-1" for mobile stations. (RELAY,WIDE is deprecated.)

- Each packet contains a DTI (Data Type Identifier) that specifies what kind of data it has: message, bulletin, position report, etc.

# APRS frequencies around the world
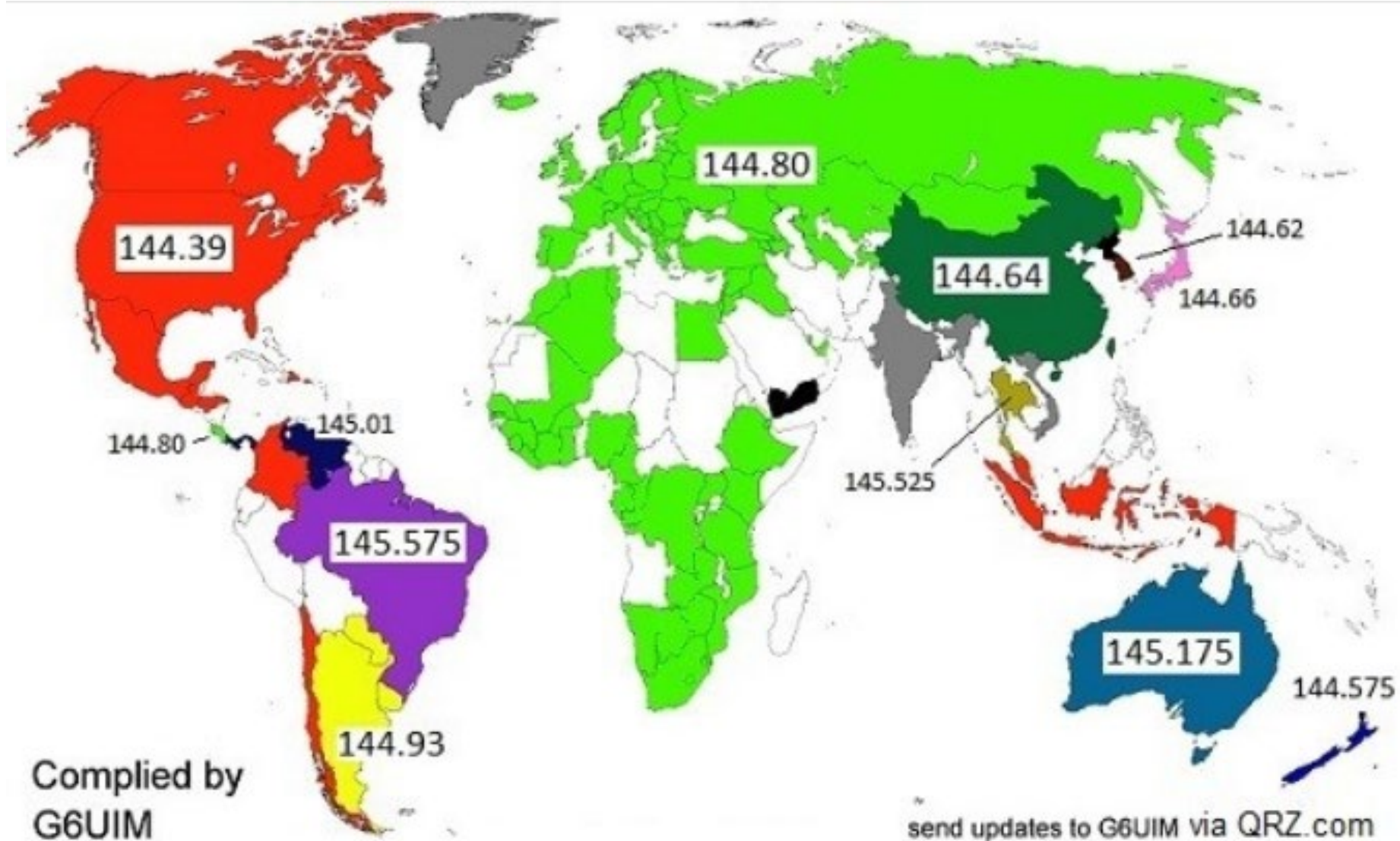
# APRS-IS

- An Internet based network for linking disparate RF islands.
- IGates gateway traffic between RF and APRS-IS.
- Receive-only iGates forward packets from RF to APRS-IS.
- Bidirectional iGates also forward packets from APRS-IS to RF.
- Allows a VHF station to communicate with VHF stations around the world.
- Sites like findu.com and aprs.fi save data from the APRS-IS stream to show tracking information for each station.

# aprs.fi

Originating callsign: WZ0C-4 | Search | Clear | < previous | Show: 50 ∨ | Normal ∨

Found over 50 packets. 270 seconds between packets on average during 13233 seconds. Lookup took 0.017 seconds.

Raw APRS-IS packets are stored for 2 days. Unsupported and unparseable packets are shown in red. Some formats are unsupported at the moment. AIS data is not shown here. It is possible to search using wildcards (*?) after a prefix.

2024-02-23 12:28:53 EST: **WZ0C-4**>ID,qAR,N3LEE-4:WZ0C-4 BBS [MAYNARD, MA]
2024-02-23 12:29:07 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LLO-1:=4226.14N/07127.18WBPHG8050WZ0C-4 145.09 Packet/50.640 USB VARA
2024-02-23 12:29:08 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LLO-1:>NOSaprs 2.0h WZ0C-4 BBS 145.09 Packet/50.640 USB VARA
2024-02-23 12:38:54 EST: **WZ0C-4**>ID,qAR,W1XM:WZ0C-4 BBS [MAYNARD, MA]
2024-02-23 12:39:08 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LEE-4:=4226.14N/07127.18WBPHG8050WZ0C-4 145.09 Packet/50.640 USB VARA
2024-02-23 12:39:08 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LLO-1:>NOSaprs 2.0h WZ0C-4 BBS 145.09 Packet/50.640 USB VARA
2024-02-23 12:48:55 EST: **WZ0C-4**>ID,qAR,N3LLO-1:WZ0C-4 BBS [MAYNARD, MA]
2024-02-23 12:49:09 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LLO-1:=4226.14N/07127.18WBPHG8050WZ0C-4 145.09 Packet/50.640 USB VARA
2024-02-23 12:49:09 EST: **WZ0C-4**>APN20H,WIDE1-1,WIDE2-1,qAR,N3LLO-1:>NOSaprs 2.0h WZ0C-4 BBS 145.09 Packet/50.640 USB VARA
2024-02-23 12:58:56 EST: **WZ0C-4**>ID,qAR,AA2T-10:WZ0C-4 BBS [MAYNARD, MA]

,N3LLO-1:=4226.14N/07127.18WBPHG8050WZ0C-4 145.09 Packet/50.640 USB VARA
,N3LEE-4:>NOSaprs 2.0h WZ0C-4 BBS 145.09 Packet/50.640 USB VARA

BBS WZ0C-4 · center · zoom · info
2024-01-20 07:17:23 - 2024-02-23 16:09:25
WZ0C-4 145.09 Packet/50.640 USB VARA
NOSaprs 2.0h WZ0C-4 BBS 145.09 Packet/50.640 USB VARA
power 64W, antenna HAAT 10 ft, gain 5 dBi omni,
range 8.0 miles
[APN20H via WIDE1-1,WIDE2-1,qAR,N3LLO-1]
being tracked · stop tracking · track in Street View

Track callsign: Clear
| | Search | ?

Address, city or Locator: Clear
| | Search | ?

Show last:
1 hour ∨ | Show all
Track tail length:
1 hour ∨

**WZ0C-4** BBS
Updated: 2024-02-23 16:09:25
Position: 42°26.14' N 71°27.18' W

| 2022 | 2023 | 2024 | 📅 ← →

Other SSIDs: WZ0C-12 ✈ WZ0C-3 💻

WZ0C-9 BBS  WZ0C-5 BBS  WZ0C-8 ●  WZ0C-11

🚶 WZ0C BBS

# APRS map for Southeast Massachusetts

All APRS stations

From aprs.fi

# Common uses of APRS

- Position tracking
  - High altitude balloons
  - Public service events – cyclist and resource tracking
  - Vehicle tracking
- Messaging
  - Short text messages from ham to ham
- Bulletins
- Information services
- Report weather observations

# Part 97 paragraphs relevant to APRS

- 97.111(b)(6) One-way communications allowed to disseminate information bulletins

- 97.111(b)(7) One-way communications allowed for telemetry

- 97.205(b) Repeaters only on 10m and shorter wavelength bands

- 97.221(b,c) On HF, Automatically Controlled Digital Stations (ACDS) confined to specified sub-bands on 80m, 40m, 30m, 20m, 17m, 15m, 12m, and 10m,
  *unless* responding to non-ACDS stations and using signal bandwidth of 500 Hz or less.  ACDS are not allowed on 60m.

I am not a lawyer.

# 97.221 ACDS subbands

- 80m:  3.585 – 3.600
- 40m: 7.100 – 7.105
- 30m: 10.140 – 10.150
- 20m: 14.0950 – 14.0995,  14.1005 – 14.112
- 17m: 18.105 – 18.110
- 15m: 21.090 – 21.100
- 12m: 24.925 – 24.930
- 10m: 28.120 – 28.189

# How do I get set up with APRS?

# Traditional APRS and Packet Radio

- Layered on Packet Radio, which is based on the AX.25 protocol, started to be used by amateurs in 1978

- Modulation sounds like early telephone modems

- Found mostly on VHF 2m (1200 baud) and HF 20m and 40m (300 baud)

- Some use of 9600 baud.

- Many stations can share single channel, each sending individual packets of information when the channel is clear

- Callsigns often have SSID's, a number between 1 and 15 appended (e.g. WZ0C-4)

# Approach #1

Use a radio that APRS functionality built in, such as the Kenwood TH-D72/TH-D75 or TM-D710, or the Yaesu FTM-350/FTM-400/FTM-500

# Approach #2

Use a mobile app, such as APRSdroid (Android) or aprs.fi (iOS). Mobile apps access APRS via Internet access to APRS-IS.
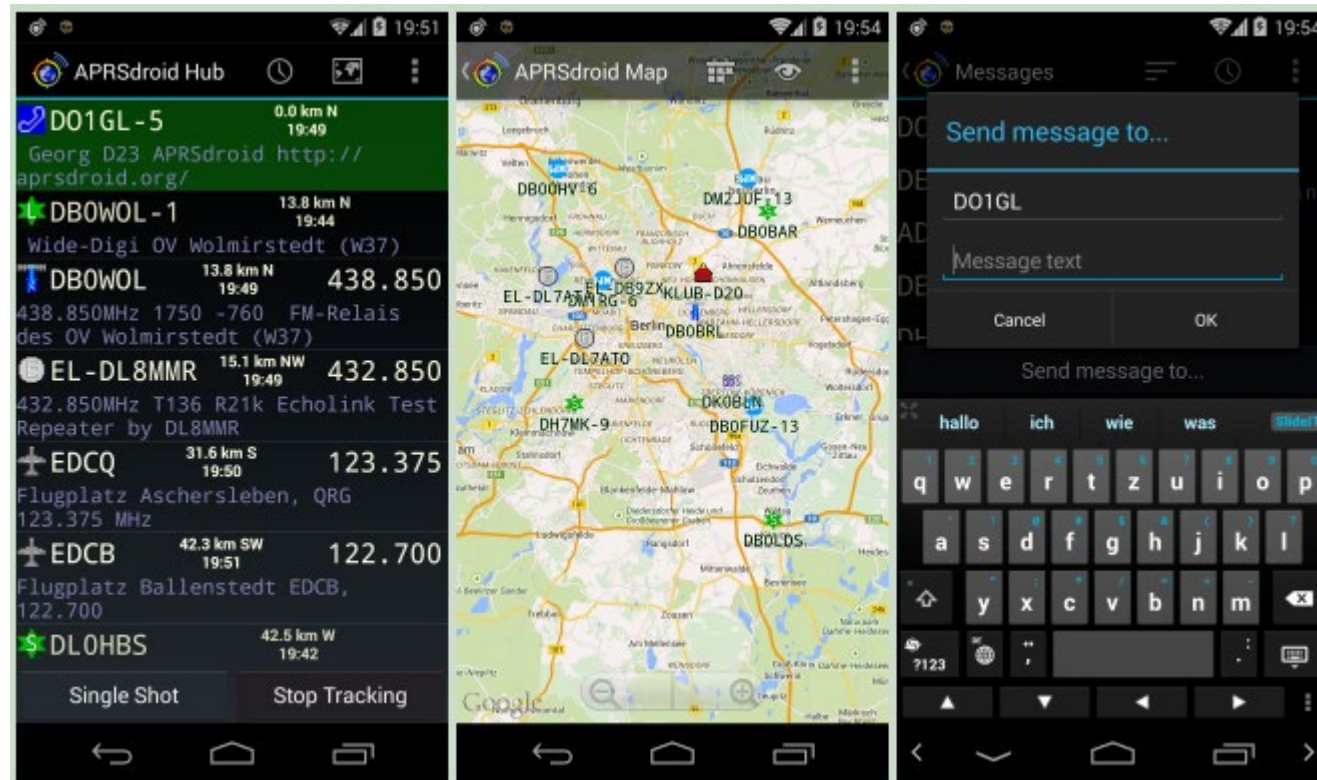
# Approach #3

Use a computer with a TNC and radio.
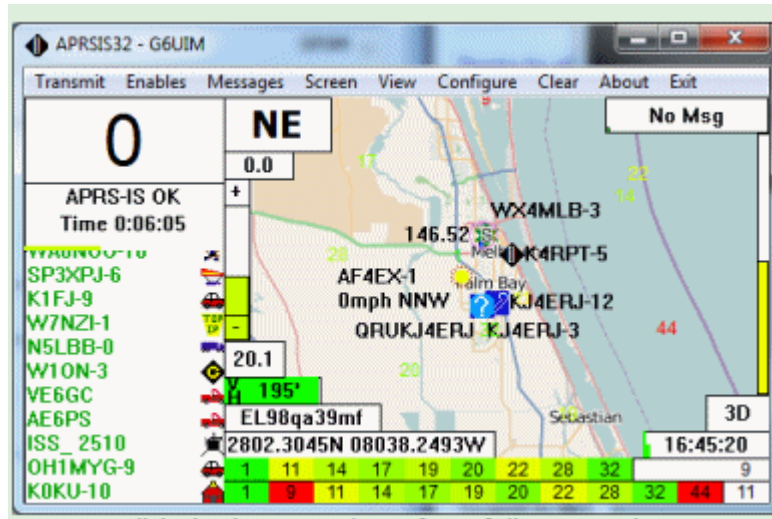


Example software is APRSIS32 (Windows) or Xastir (linux).
(Can also connect directly to APRS-IS.)

# Can I still use my old TNC?

- PK-232, MFJ-1270/1278, KPC3+    can still work.

- Get latest firmware.  (KPC3+ v9.1 is available on EPROM)
- Configuration changes for new standards (e.g. APRS paths)
- KISS mode gives options to use modern software.

# Approach #3a – Mobile TNC

## Mobilinkd TNC

- Allows for very portable APRS station.
- APRSdroid app on phone connects via Bluetooth to Mobilinkd TNC
- TNC connects via cable to radio.

# Approach #4

Use software on a computer connected to a Digital Mode Interface connected to a radio.



Similar to approach #3 but also requires a soundcard modem.

# Digital mode interfaces

Basically, a USB sound card, with PTT line.

- Tigertronics Signalink

- Digirig

- DINAH
  (kitsforhams.com)

# Soundcard modems

Provide KISS interface to application and convert packets to audio

Examples:

- SV2AGW AGWPE (Packet Engine Pro) (released in 2003)
- UZ7HO soundmodem (created in 2011)
- Direwolf (released in 2014)
  - Excellent decode performance
  - Built-in APRS decoder
  - Digipeater function
  - IGate function

# Approach #5 - Trackers

- Byonics MicroTrak

# Setting up digital modes

- Cable everything up (computer to audio card to radio)
- Install digital software
- Common software configuration
  - Set your callsign
  - Select soundcard
  - Set up rig control
  - Test PTT
  - Verify VFO control (usually not needed with APRS)
  - Verify audio receive
  - Adjust audio levels
- Go!
- Troubleshoot ☹
- Go again!

# Troubleshooting Tips

- Are you hearing other stations?  If not:
  - Adjust receive audio.  Too high or too low level can inhibit decoding.
- Are other stations hearing you?  Verify on aprs.fi
  If not:
  - Verify rig is keying up
  - Check transmit audio
- Are other stations decoding you?  If not:
  - Packet needs strong S/N ratio, especially on FM
  - Check TxDelay (both in key-up and unkey)
  - Bad antenna system can cause audio signal distortion
- Can't connect to remote system?
  - Try intermediate digipeaters

# What can I do with APRS?

# APRS Information services

- APSPOT – self spot on POTA, get information on other activators
- SMS – send SMS message to given phone number
- NTSGTE – send Radiograms into National Traffic System
- EMAIL-2  - send email to given email address
- WXBOT – get weather report
- WTSAPP – gateway to WhatsApp
- WHO-IS – Name and address associated with given callsign
- MPAD – information on community resources (atm, banks, grocery store, gas stations)
- WA1GOV-10 – gateway to Twitter
- WLNK-1 – send messages to Winlink users
- APRSPH – An APRS net
- ANSRVR – group chat server
- SATSRV – satellite server
- ISS – get location of the International Space Station

# Examples:

- MPAD

- WXBOT

- APSPOT

```
/r MPAD
atm
* sending with msgid 2 *
MPAD: ack2
MPAD: Main Street 146 Maynard Dst 1 mi Brg 163 deg SSE
```

```
/r wxbot
01754
* sending with msgid 4 *
WXBOT: ack4
WXBOT: Maynard MA. Overnight,Patchy Fog Low 67
```

```
/r apspot
spots pota ssb
* sending with msgid 5 *
APSPOT: ack5
APSPOT: SPOT 1: DS0KDN | HL-0588 | 7083 | SSB
APSPOT: SPOT 2: EA6KB | EA-1196 | 7135 | SSB
APSPOT: SPOT 3: SP4VIT | SP-1181 | 7192 | SSB
```

# Weather tracking

- Severe weather
  - Hurricanes
  - Tornadoes
  - Floods
- Weather station observations
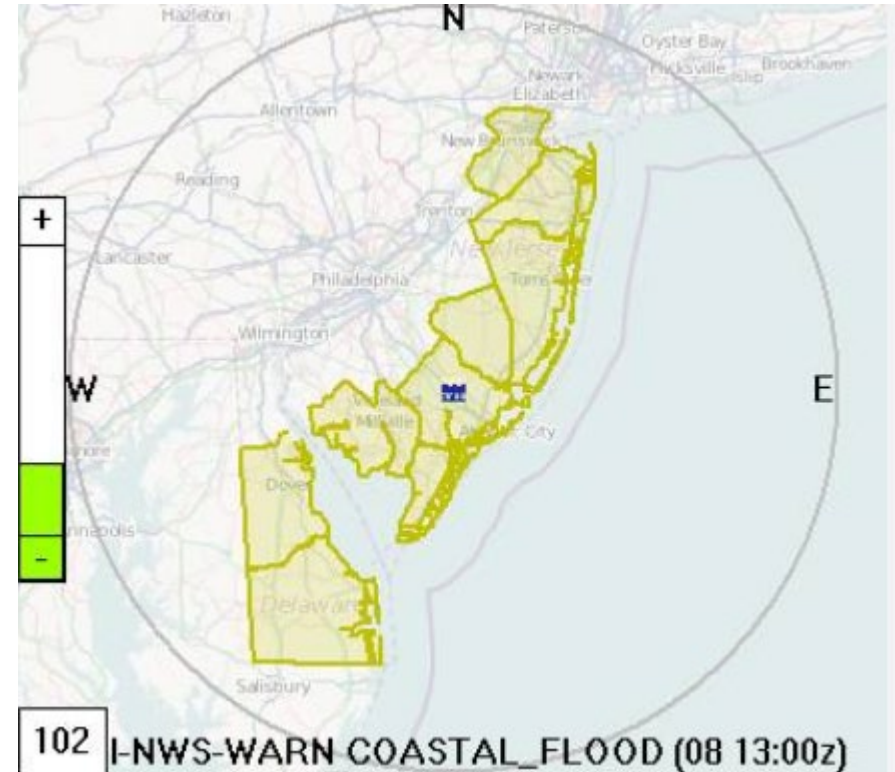
# SMS gateway

- Send text messages between APRS and a phone number

- Developed by NA7Q

- Phone numbers must be opted-in at http://aprs.wiki/SMS/

- Send APRS message in the form:   @5558675309 Hi Jenny

- Phone user will receive a text message and can just reply to that message or send a message to a specific callsign:
  @WZ0C-2 Hi Michael

- Add contacts like this:

  #alias #add jenny 5558675309
  Then send to the alias:          @jenny This SMS gateway is cool.

# Example APRS bulletins

```
Bulletins
Callsign    ID  Message
KC1HHO-9    3   EASTERN MA 2M Traffic Net Daily 2000 hrs W1BOS Rpt 145.230 pl 88.5 /
                send  NTS Radiogram to KC1HHO
KC1HHO-9    4   Great Hill Gang Radio Club  K1GHG ham meet up Sunday, August 20 - 7am
                https://www.qrz.com/db/k1ghg ... call 146.520
N1SFT       0   NEW ENGL. FUSION GROUP TECHNET SUNDAYS 3PM, WIRES-X RM 28941
WXBOT       0   WxBot 1.31 US weather forecast via APRS message.
WXBOT       1   Send a message to WXBOT for a weather forecast at your location.
WXBOT       2   see https://sites.google.com/site/ki6wjp/wxbot
KD0TLS-1    0   Gopher Radio Club weekly meet, Sat. 2 PM, U of MN hamshack
KD0TLS-1    1    Hams in the Park, 9/9, Long Lk Regional Park, New Brighton noon
W5TWM-10    1   NVIS NET Sun 7:00pm 7.216
```

# APRS Objects

- Similar to GPS waypoints.  Can mark a location or a frequency.
- Examples:

**Net announcements**
Many local nets are displayed as objects. Some radios will receive these and allow you to hit a button to tune right to that frequency.

**Talk-in announcements**
Recent hamfest in Metrowest had an APRS object showing hams where the event was located.

**Public service event stations**
Mark water stops or first aid stations
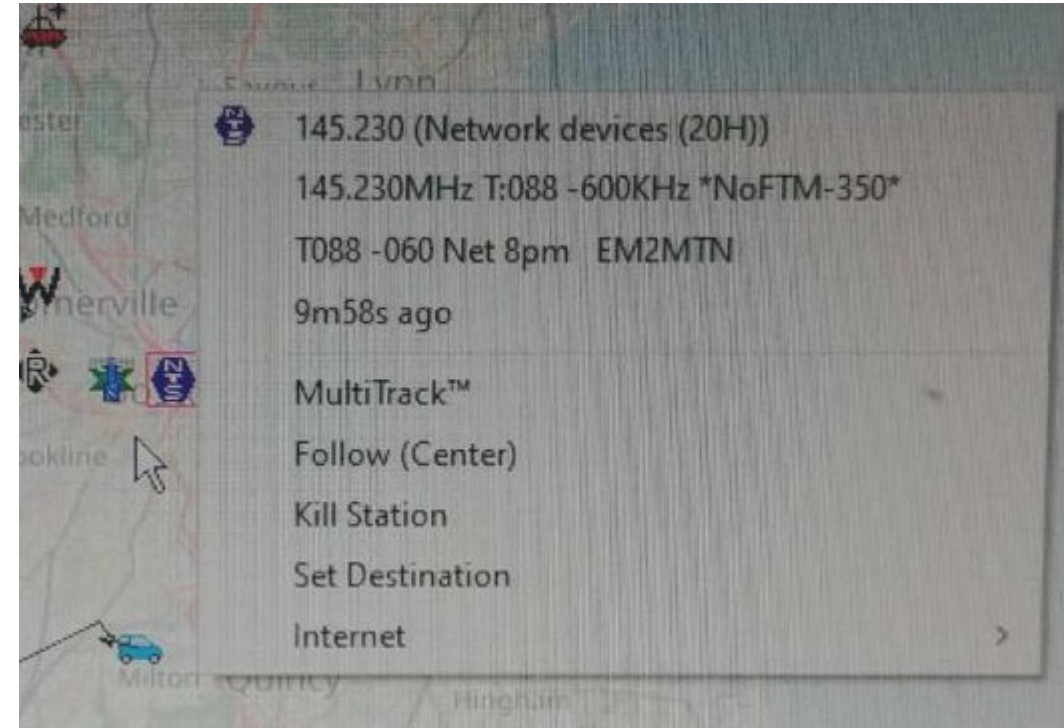
# Occasions to use APRS

- APRS Thursday
  Weekly worldwide check-in APRS net managed by KC8OWL.  Several hundred check-ins each week via ANSRVR.
  Some people do Worked All States via APRS
  Send message to ANSRVR in the form:
       CQ HOTG Happy APRS Thursday!


- Appalachian Trail Golden Packet (ATGP) event
  One day every July, hams set up APRS stations on summits of 16 mountains along the Appalachian Trail and link up.
  Next event: July 20, 2024
  More information at http://atgoldenpacket.net/

# APRS NTS Gateway (NTSGTE)

- Use APRS to send NTS Radiogram to hams or third parties

**NTS Radiograms**

APRS can be used to transport NTS radiograms. This uses the existing APRS message format for backwards compatibility, by adding a 3-character NTS format identifier **N**x\ at the start of the APRS Message Text, as follows:

**N#**\number\precedence\handling\originator\check\place\time\date
**NA**\address_line1\address_line2\address_line3\address_line4
**NP**\phone number
**N1**\line 1 of NTS message text
**N2**\line 2 of NTS message text
**N3**\line 3 of NTS message text
**N4**\line 4 of NTS message text
**N5**\line 5 of NTS message text
**N6**\line 6 of NTS message text
**NS**\Signature block
**NR**\Received from\date_time\sent_to\date_time

All of these fields comes from the ARRL NTS Radiogram form and are described in the NTS handbook.

Each message line is addressed to the same station.

The **N#**\, **NA**\ and **NR**\ lines are multiple fields combined for APRS transmission efficiency. The backslash separator is used so that conventional forward slashes may be embedded in messages. (The backslash does not exist in the RTTY or CW alphabets, so it therefore cannot appear in an NTS radiogram).

Each line may be up 67 characters long, including the 3-character NTS format identifier. Lines in excess of 67 characters will be truncated.

There is a maximum of 6 lines of NTS message text.

**Note**: The **N#**\, **NA**\, **NS**\ and **NR**\ fields are required. The others are optional.

Serialization of each line is handled by the normal APRS Message ID **{**xxxxx.

An APRS application is not required to understand or generate these messages. The information can be read and understood in the normal message display.

# APRS NTS gateway

- For a quick start, try the APRSdroid app on Android or APRSIS32 on Windows.
- Send APRS messages to "NTSGTE"
- You can use lower case if you prefer (it will be converted to upper case)
- For a reminder of the message format, send "info"
- To see what fields the gateway has received, send "read back"
- Have fun!

# Satellite packet

- Several satellites running packet digipeaters and/or APRS.
  - NO-44, AISAT-1, BRICSAT2, PSAT2
  - Greencube (IO-117) on 70cm
  - LEDSAT on 70cm (contains LED based payload)
- ARISS (International Space Station)
- Standard satellite APRS frequency is 145.825 MHz.
- PSAT2 has APRS-to-Voice capability.

# POCSAG + APRS

- Use pagers to receive APRS messages.
- Pager is recrystaled for the Amateur 70cm band.
- A node is setup to receive APRS messages and retransmit them via POCSAG to the pager.
- Pi-Star MMDVM supports POCSAG.

# What else is new with APRS?

# Ham Radio of Things

- Moving beyond "person to person" and "person to computer".
- Now also "computer to computer".

- Hams experimenting with:
  APRS + MQTT (Mosquitto) + Node-Red
- MQTT is an IoT messaging protocol
  Node-Red is a visual flow editor
- Using sensors to control other devices via radio.
  Use APRS for home automation.

# APRS over VARA

- APRS developed by Jose EA5HVK from Spain in 2017

- Closed source.  Higher throughput with licensed version ($69)

- VARA, VARA-FM, VARA-SAT are closed source soundcard modems

- VARA has throughput up to 7kbps, VARA-FM up to 12kbps

- Offer multiple signal bandwidths

- Uses OFDM (Orthogonal Frequency Division Multiplexing) modulation (multiple subcarriers with low symbol rates)

- Used by NTS digital network and Winlink network

- Some hams experimenting with APRS over VARA on 40m (7.103 MHz USB) as an alternative to APRS on Packet
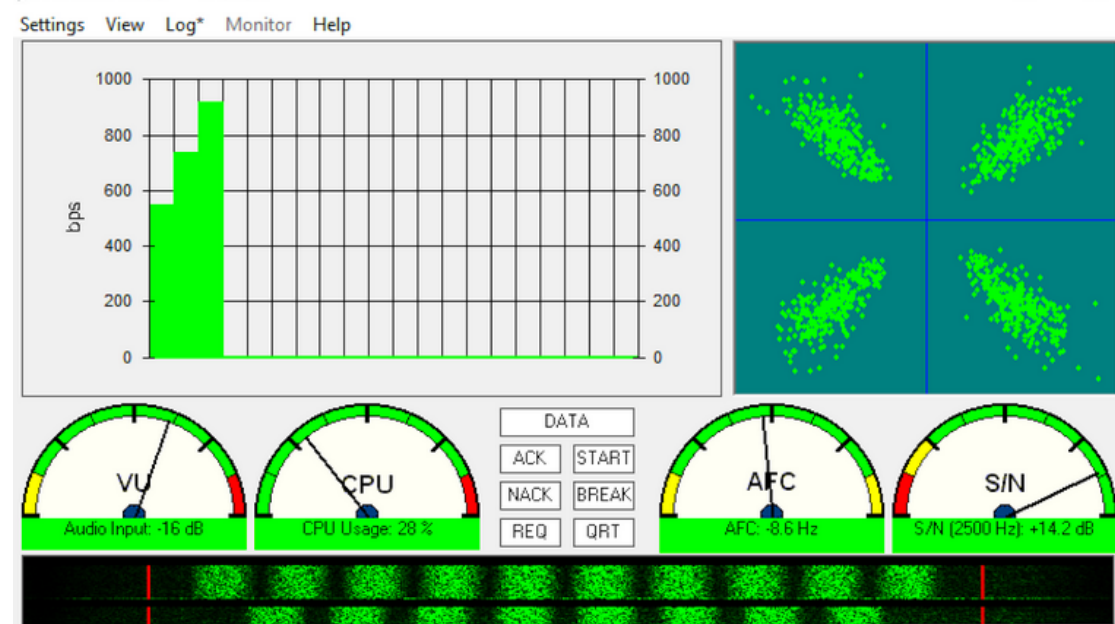
# APRS on LoRa

- LoRa uses chirp spread-spectrum and can receive signals with -13dB SNR.

- Can achieve data rates from 300 bps to 27 Kbps.

- Transmits at 100 mW.

- LoRa APRS is on 433.775 MHz.

- More info at: https://www.lora-aprs.info/
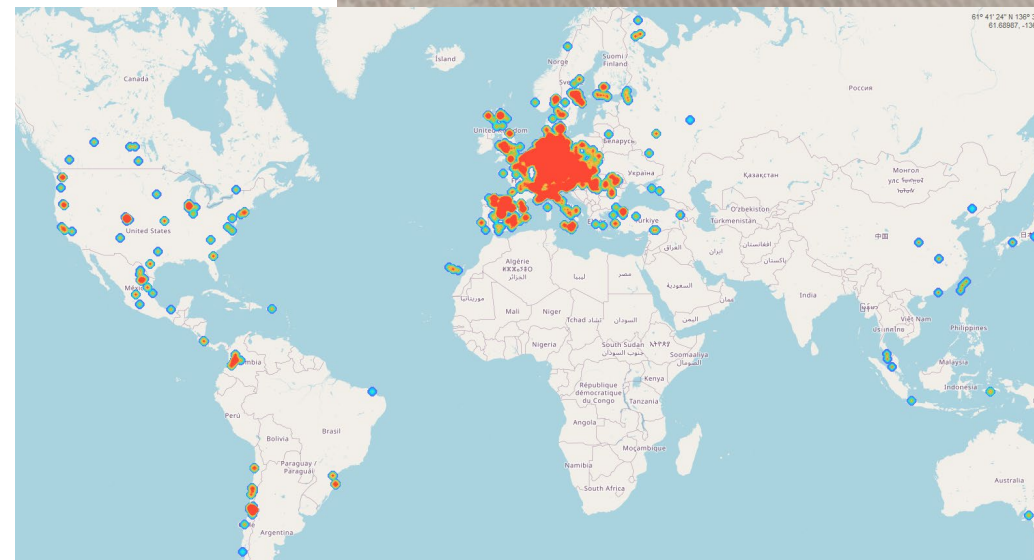
# WZ0C-4 BBS

- Located in Maynard, MA
- Ports:
  2m Packet on 145.09 MHz
  40m Packet on 7.104 MHz LSB
  40m VARA on 7.1009 MHz USB
- Services:

| Bulletins | NWS alerts | APRS Bulletins |
|---|---|---|
| Personal Messages | DX Cluster | APRS messaging |
| NTS Radiograms | POTA "Cluster" | Winlink gateway |
| Converse (chat) | NWS warnings to APRS | APRS gateway for NTS |

# Q&A

# Appendix

# Packet setup in the 1980's

- Computer
- TNC
- Radio

# Diagram of old hardware stack

- Get input from human

- Assembled letters into packets, apply protocol

- Turn packets into series of digitized tones

- Convert digitized tones into audio signal

- Transmit audio onto the air



Terminal

TNC

Radio

# Comparison to modern stacks

- Input

- Protocol

- Digitized tones

- Audio signal

- Transmit



Application including digital mode

Digital Mode Interface

Radio with mic/spkr or data interface

Application supporting KISS interface

KISS TNC

Soundcard modem

Radio with CAT interface

Terminal program

Software TNC

Radio with internal TNC and serial port

# Digital mode interfaces

- Rigblaster

- Tigertronics Signalink

- Digirig

- Masters Communications DRA

- Yaesu USB interface unit

# Radios with USB ports and CAT control

- Elecraft: K3S, K4
- FlexRadio: FLEX-6400M
- Icom: IC-7100, IC-7300, IC-7610, IC-705
- Kenwood: TS-590S, TS590SG, TS-890S, TS-990S
- Yaesu: FT-991, FT-991A, FT-DX3000