How APRS Works

Understanding

Leads to

Good Operating Practices
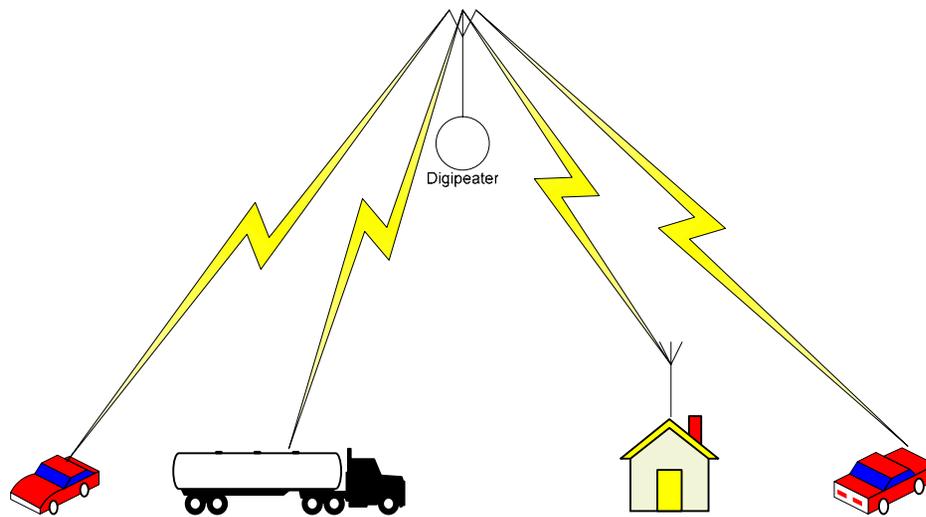
Automatic **P**osition **R**eporting **S**ystem

- Original Name – **A**utomatic **P**acket **R**eporting **S**ystem

- Developed in 1990 based on 2 meter AX.25

- Designed for one-to-many communication of automated information

- Support for SMS (Short Messaging Service)

One-to-Many Communication

Digipeater

One-to-Many Communication

- Not Broadcast (according to FCC).

- Everyone sees all packets from everyone else.

- Information of value to amateur radio communicated.

- Two-way communication possible (most APRS is two-way).

- Unnumbered Information (UI) subset of AX.25

Digipeater

- AX.25 <u>Digital Repeater</u>

- APRS digipeaters only repeat UI packets

- APRS is not ALOHA (University of Hawaii communications experiment)

- APRS is CSMA (Carrier **<u>Sense</u>** Multiplex Algorithm)

ALOHA vs. CSMA

- ALOHA allows for any station to transmit when it has traffic, regardless of activity on the channel.

- CSMA allows for any station to transmit when it has traffic, only if there is no other station transmitting.

- Due to terrain, power, etc., some APRS operation will be ALOHA, although most is CSMA.

- **<u>Collision Avoidance</u>**

One-to-Many Communication (CSMA)
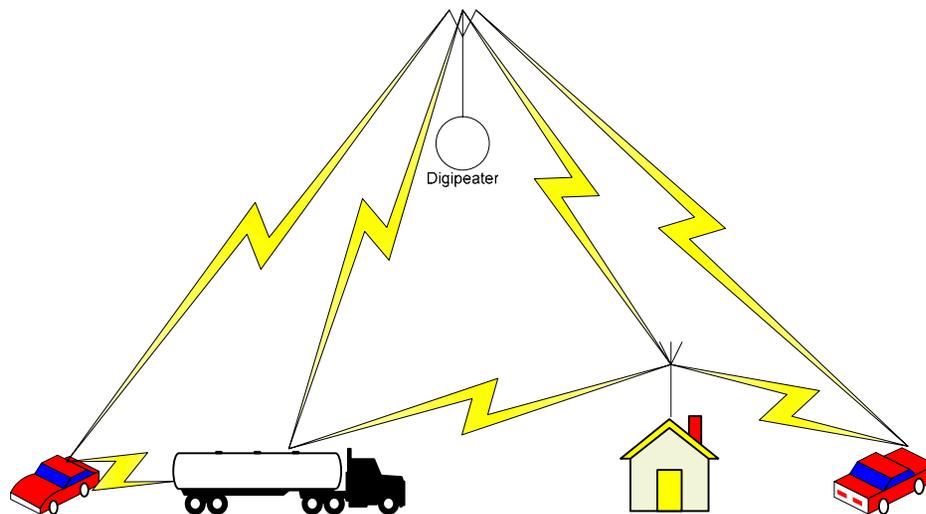
APRS is Tactical

- Tactical – "used or made to support limited military operations".

- Bob Bruninga, WB4APR, worked for the Navy.

- APRS provides information and support for LOCAL RF operations.

- APRS is NOT a long-distance (strategic) RF network.

Tactical Information

- Vehicle Position and Movement Reporting

- Weather Reporting

- Telemetry Reporting

- Objects (includes fixed station positions)

- Bulletins

- Direction Finding Information

Tactical Messaging

- Short (40 character) station-to-station messaging.

- Short bulletins of general interest.

Digipeater Evolution
Original

- Standard TNC-2 alias digipeat (Source Routing).

- No callsign substitution.

- RELAY for most fixed stations

- WIDE for digipeaters with a wide area view.

- Large packets when traversing multiple digipeaters

- No duplicate checking causing multiple digipeats by the same digipeater
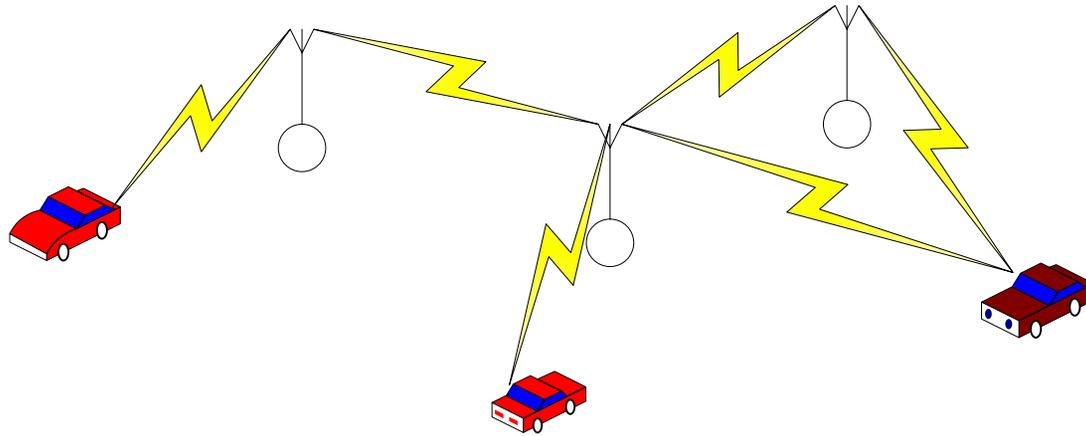
Digipeater Evolution
UIFlood and UITrace

- WIDEn-n, TRACEn-n – Original UIFlood and UITrace aliases

  - WIDEn-n allows up to 7 hops with only one via.

  - Digipeater software/firmware checks for duplicates

  - Added to provide wide area RF coverage when APRS activity was low.

  - Algorithm implemented with bugs on Kantronics KPC3+

Multi-hop Digipeating

Multi-hop Digipeating

- Packets from distant stations can adversely affect local operations.

- Remote stations have no ability for CSMA with local stations.

- Remote digipeaters may not be seen by local stations.

- NOT tactical.

Digipeater Evolution
LANn-n

- Variation on UIFlood where wide area digipeaters digipeat RELAY, WIDE, and WIDE2-2 as aliases.

- Digipeaters can be configured as a "LAN" by using a unique prefix for the UIFlood alias.

- Protects metro areas from WIDE7-7, etc. flooding from remote areas.

- Still leaves open long distance digipeating by using aliases.

Digipeater Evolution
Digipeater Routing

- Digipeater repeats all packets heard directly.

- Digipeater repeats any packets heard directly from a digipeater on its "ok to repeat" list.

- Original paths stripped to reduce packet size and prevent unwanted damage to surrounding area networks.

- No source routing (user's path no longer has meaning).

- All digipeated packets dupe checked.

- Local area digipeater rules enforced by digipeater sysops, not users.

I'm Confused.
What Path Should I Use?

- It Depends…

  – What is your intent?

    – Does your intent match APRS design?

  – Where will you operate?

    – What are the local "standards"?

  – What will minimize QRM yet provide effective communications?

What is Your Intent?

- Broadcast to the entire world my position, my weather, etc.

  - How many hops away is the nearest Internet Gateway (IGate)?

- Send short messages to the entire world.

  - How many hops away is the nearest IGate?

- Participate in a local activity.

  - RELAY,WIDE for mobile/portable.

  - WIDE digipeater callsign as via for fixed.

- Communicate with a station 5 hops away.

  - How many hops away is the nearest IGate?

Where Will You Operate?

- Metropolitan area

  - Follow local standards.

    - Mobile – RELAY,WIDE

    - Fixed – Digicall (WIDE digipeater call)

    - Airmobile – WIDE

- Rural America

  - Mobile – RELAY,WIDE2-2

  - Fixed – Digicalls (path to nearest IGate, if desired)

  - Airmobile – WIDE

What Will Minimize QRM?

- What affects transmit bandwidth?

  – Packet length (+/- .5 seconds)

  – Number of Digipeats (packet time * # of digipeats)

    – This is number of actual digipeats, not number of digipeaters

  – Beacon rate (1 second packet with no digipeats every 30 seconds consumes 3-4% of available bandwidth)

What Will Minimize QRM?

1) Number of Digipeats

   - **Minimize Path**

2) Beacon Rate

   - Seldom is anything less than **3 minutes** for mobiles useful

   - Weather Stations should be **5 – 15 minutes**

   - Fixed Stations should be **20 – 30 minutes**

3) Packet Length

   - **Eliminate** non-informative comments from packets

APRS Clients

- Software

  - DosAPRS

  - MacAPRS/WinAPRS

  - APRS+SA

  - UI-View

  - APRSPoint

  - Xastir

  - javAPRS

  - PocketAPRS

  - APRSce

- Hardware

  - PacComm TNC's

  - TinyTrack

  - HamHUD

  - Kantronics KPC 3/3+

  - Kenwood TH-D7
    & TM-D700

  - OpenTrack
    (in APRS mode)

Vehicle Position and Movement

- The Original Purpose of APRS.

- Position Formats:

  - GPS NMEA strings

    - Primarily TNCS connected to GPS & Radio with no PC

  - APRS format

    - Most APRS client software, some trackers

  - Compressed APRS format

    - UI-View (possibly some other software/hardware)

  - Mic-E compressed format

    - Kenwood D7, D700, and some trackers

Weather Reports

- APRS format

- "RAW" format for select station types

- NWS now using much of the data

- Provides "hole" coverage where NWS stations don't exist.

Telemetry Reports

- APRS format

- Flexible enough to allow fully user-defined telemetry

- Valuable for monitoring remote radios

Objects

- Objects – Time-stamped position reports for other than the transmitting station

- Items – Same as objects without the time-stamp.

- Used for sending information of general interest to the area APRS users.

- Objects generated on the Internet for NWS events are gated to RF in many areas.

- Paths should be kept to a minimum.

- Beacon rate should be low, except in the case of the NWS objects which can change rapidly.

Bulletins

- Non-location specific information of general interest to area amateurs.

- NWS weather statements.

- Objects are used more frequently as they provide a location.

Direction Finding

- There is built-in support for DF reports.

- Some automated equipment can generate such reports.

- Manual reports can also be entered in some software.

Short Messaging

- 40 character maximum

- Station to station using unconnected UI protocol

- For short, local, tactical messaging

- Support for NTS traffic, though most software does not implement this

Should I Put Up a Digipeater?

- Is your area already covered by a wide area digipeater?

- Is you location in a coverage hole?

- Will adding a digipeater at your location ADD to the usability of the local APRS frequency?

How Does the Internet Interact with APRS?

- APRS-IS – APRS Internet Service – Interconnect network of local APRS RF networks.

- IGate – Internet Gateway – Software/Hardware which gates packets to/from RF.

- APRS-IS = EchoLink = IRLP

  – Internet backbones for Amateur Radio services.

IGate

- Gates ALL RF packets to the Internet.

- Gates select packets to RF.

  – Messages for stations seen by the IGate on RF.

  – Posits for the sending stations of those messages.

  – Any packets which meet criteria established by individual sysops.

- Why selectively gate to RF?

  – 12,000 bps on APRS-IS

  – 1,200 bps on 2 meter packet

Why APRS-IS?

- World-wide backbone

  – World-wide messaging

  – World-wide visibility

  – Non-ham visibility

  – Ham's without RF have visibility

Should I Put Up an IGate?

- Yes, if it is a unidirectional (RF->Internet) gateway.

- Yes for a bidirectional (RF<->Internet) gateway **IF** there are **NO** other bidirectional IGates in your area.

    – This is due to the collisions (QRM) caused by multiple IGates gating the same information to RF at the same time.

How Do I Contribute?

- Establish a digipeater which fills a coverage hole.

- Establish an IGate which fills a coverage hole.

- Establish a server for area APRS-IS connectivity.

- Establish a weather station.

My Area is Well Covered. How Do I Contribute.

- Establish a fixed station capable of messaging.

- Use APRS in the mobile while participating in activities.

- Work with local groups to improve capabilities during emergencies.

- Listen.

I Still Don't Get It!

- APRS is similar to the VHF voice network.

  - Both are 2m FM

  - Both use repeaters with specific areas of coverage

  - IGates similar to linked repeaters

  - APRS "tuned" for precise and concise digital data

  - Voice "tuned" for interactive communication

What Else Can Be Done With APRS?

- **SMS Email**

  - Send a message to EMAIL with the email address of the recipient as the first thing in the text.

  - Send a message to AE5PL-10 with the text starting with em: followed by the email address of the recipient

What Else Can Be Done With APRS?

- **QRZ Lookups**

  - Send a message to AE5PL-10 with the following format:

    - l:callsign

      - 3 lines of information are returned

    - w:callsign

      - 1 line of information is returned

- Any other automated operation you can come up with and write the program for.

APRS Is…

- A one-to-many, unconnected packet protocol.

- A tactical protocol designed for local RF use.

- A protocol with many reporting capabilities.

- A protocol with SMS capabilities.

- A protocol also adapted to the Internet.

- A protocol with extensive flexibility built-in.

- A protocol still under development.

Q&A

- For More Information:

  - http://www.tapr.org

  - http://web.usna.navy.mil/~bruninga/aprs.html

  - http://www.aprs-is.net

  - http://www.aprs.net