

Introduction to APRS

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Adapted and presented by John Ronan, EI7IG



Expectations for this presentation

- This presentation will tell you (briefly) what APRS is and what you can do with it
- Mostly we will discuss some parts of APRS that are important for you to know so you can get started
- We may have a demonstration afterward of APRS in action
- There is a lot of material here and we may not finish



Topics

- What is APRS
- How does it work
- What configuration information do I need
- What equipment do I need
 - Types of APRS Stations
 - TNCs
 - GPS
 - Radios
 - Computers
 - Software
 - How to connect things up
- Information resources



What the heck is APRS?

- Automatic Packet(Position) Reporting System developed by Bob Bruninga WB4APR.
- lightweight AX.25 based system allowing users to transmit position and other location in single packets.
- Normally stations being tracked use GPS's to provide accurate location information.
- Can use existing 1200 baud TNC's.
- Primary frequencies are 144.390 in USA, 144.800 Europe.
- Intended as real-time, short range, tactical information communications channel.
- Range can be extended using Internet Gateways (remote viewing).
- Not a replacement for Voice Communications, but Augments it.



APRS Applications

- Post Disaster Management
 - Damage assessment
 - Liaison tracking
 - Logistics management
 - Staging site talk in
- Search & Rescue
- Public Service Events
 - Bike rallies
 - Parades
 - Hill-walking
- Other
 - Weather Stations
 - Earthquake monitoring
 - Stream Gauges
 - Ocean Buoys
 - Repeater Advertising
 - VHF/UHF DX-ing
 - Event talk-in



How APRS Works

- An APRS station broadcasts (beacons) a single packet of information to all stations in range. This packet usually contains GPS co-ordinates and other information.
- The packet may be received and decoded by anybody who hears it.
- Digipeater stations hear the packet and rebroadcast it based on rules in the digipeater software and commands that you put in the packet.
- Packets that need to travel long distances should be routed across the public internet



Fundamental Principles

As described by Bob Bruninga ...

- The system should provide reliable real-time, tactical digital communications
- 1200 baud network system operating as an Aloha random access channel
- You should hear everything nearby or within 1 digipeater within 10 minutes
- You should hear everything within your Aloha circle within 30 minutes



Aloha Circle

- In an Aloha network, stations contend for access by waiting to transmit until they have listened to a channel for a random period of time and haven't heard anybody else.
- At 1200 baud, the channel can support 50 or so user stations at reasonable packet sizes and beacon rates.
- An Aloha Circle is the radius around you that contains enough stations to fully fill up the channel. Will be unique at any location
- Want to know more? Look up <http://www.aprs.org/aloha.html>
- See your aloha circle using Findu (www.findu.com). Just search for your SSID, then click on "See nearby stations".

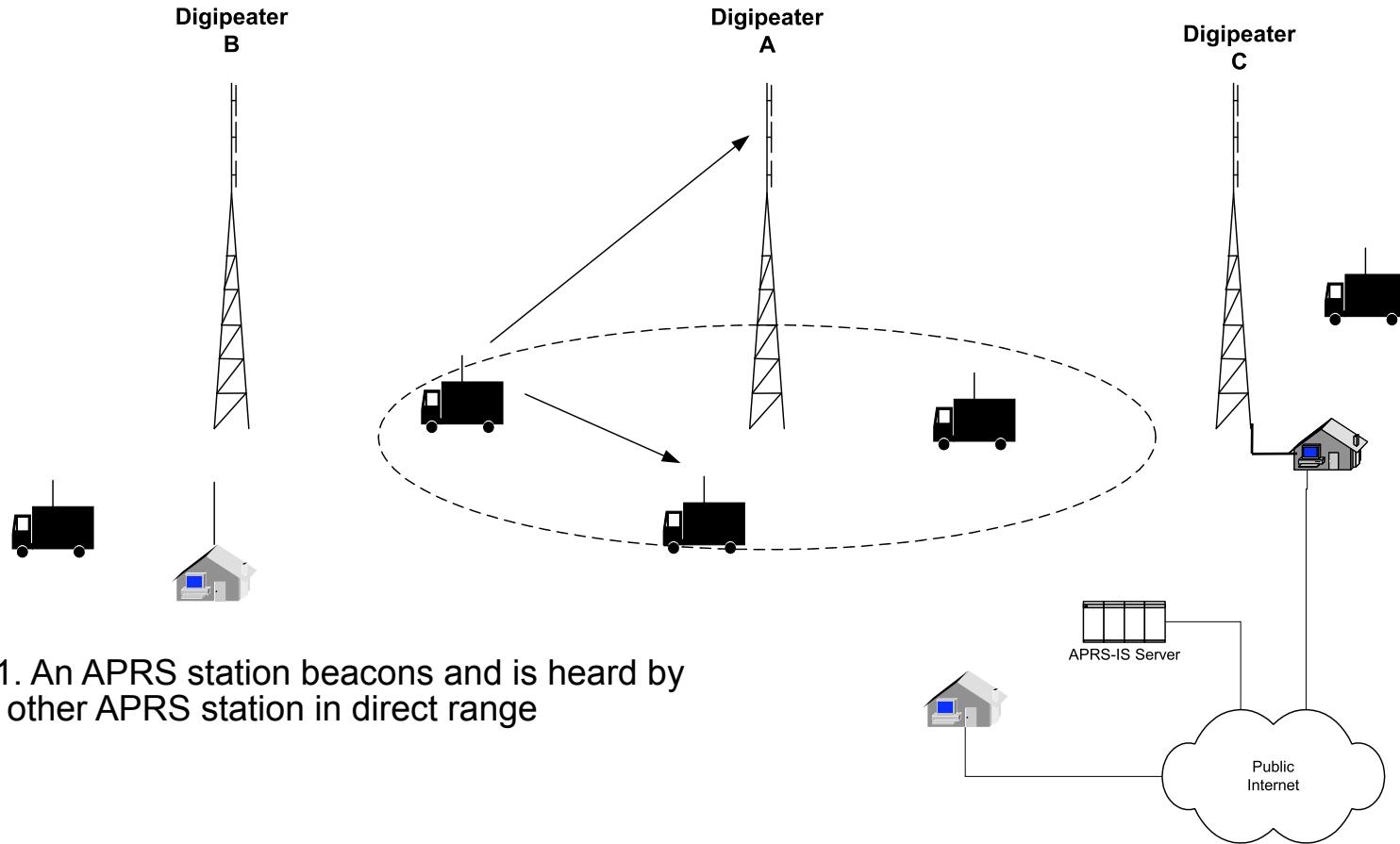


Potential problems

- The Aloha circle definition is based on the premise that APRS packets take a finite amount of time to transmit and so only a limited number of users may operate in a given area.
- Poor station configuration can cause packets to travel too far over RF, causing traffic into distant APRS networks, blocking those users.
- Also, station configuration can cause digipeaters to ping-pong a packet back and forth, blocking out other users in your area.
- In addition, stations that beacon too fast take transmit time away from other users without getting any benefit because the change in location is generally too small to be seen on a map.



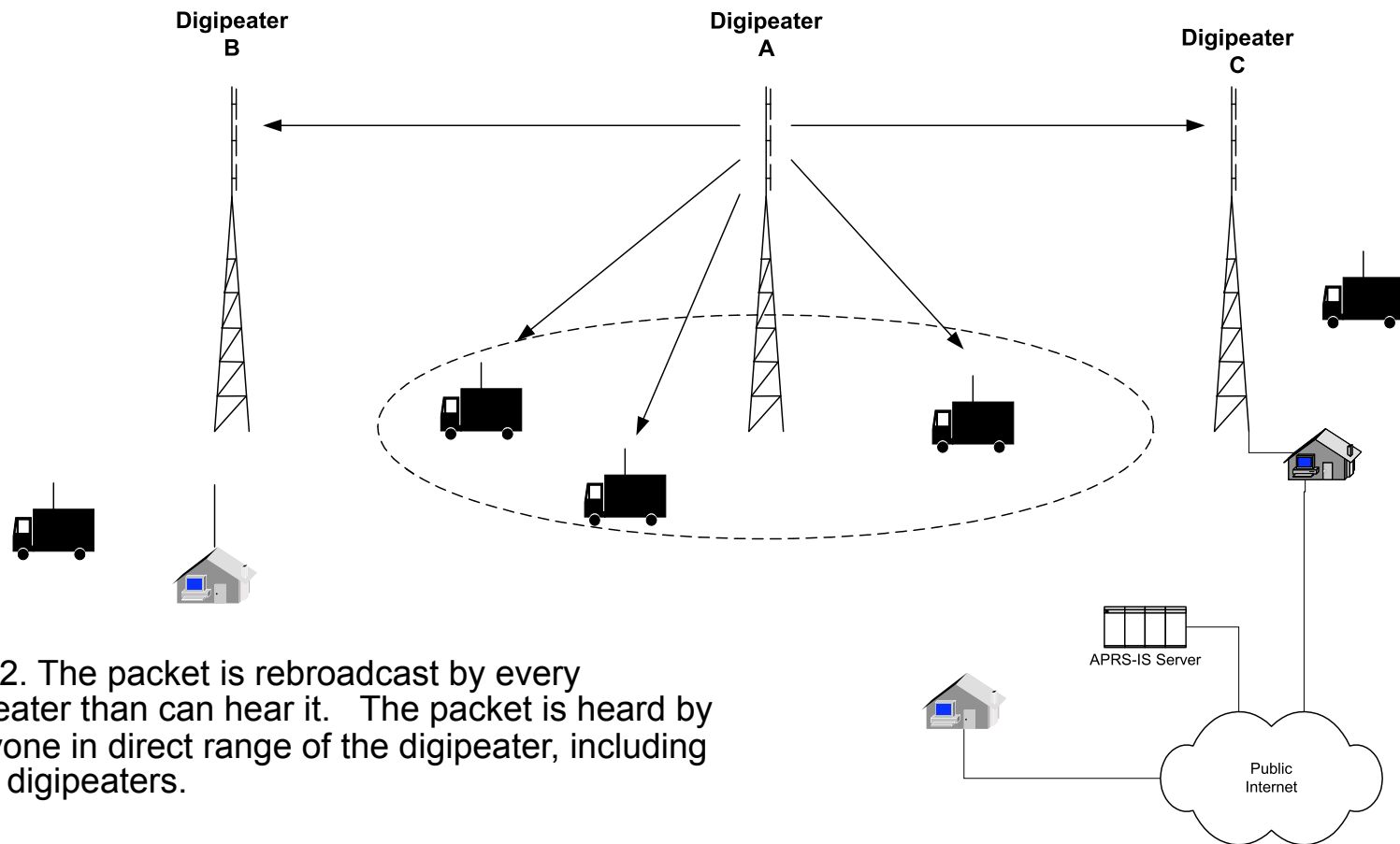
Example (1) – Mobile Station Beacons



Step 1. An APRS station beacons and is heard by every other APRS station in direct range



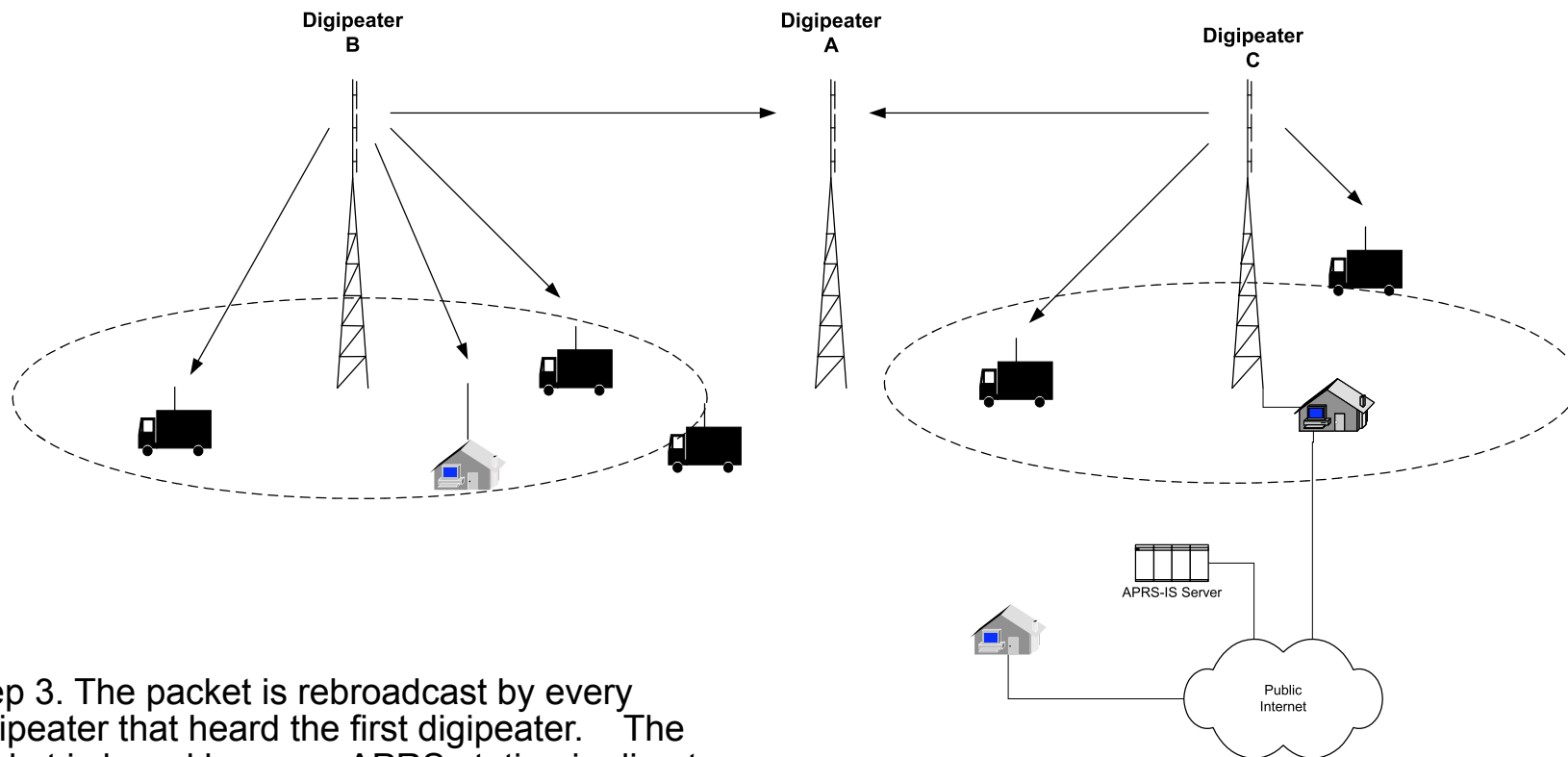
Example (2) - Digipeater relays



Step 2. The packet is rebroadcast by every digipeater than can hear it. The packet is heard by everyone in direct range of the digipeater, including other digipeaters.



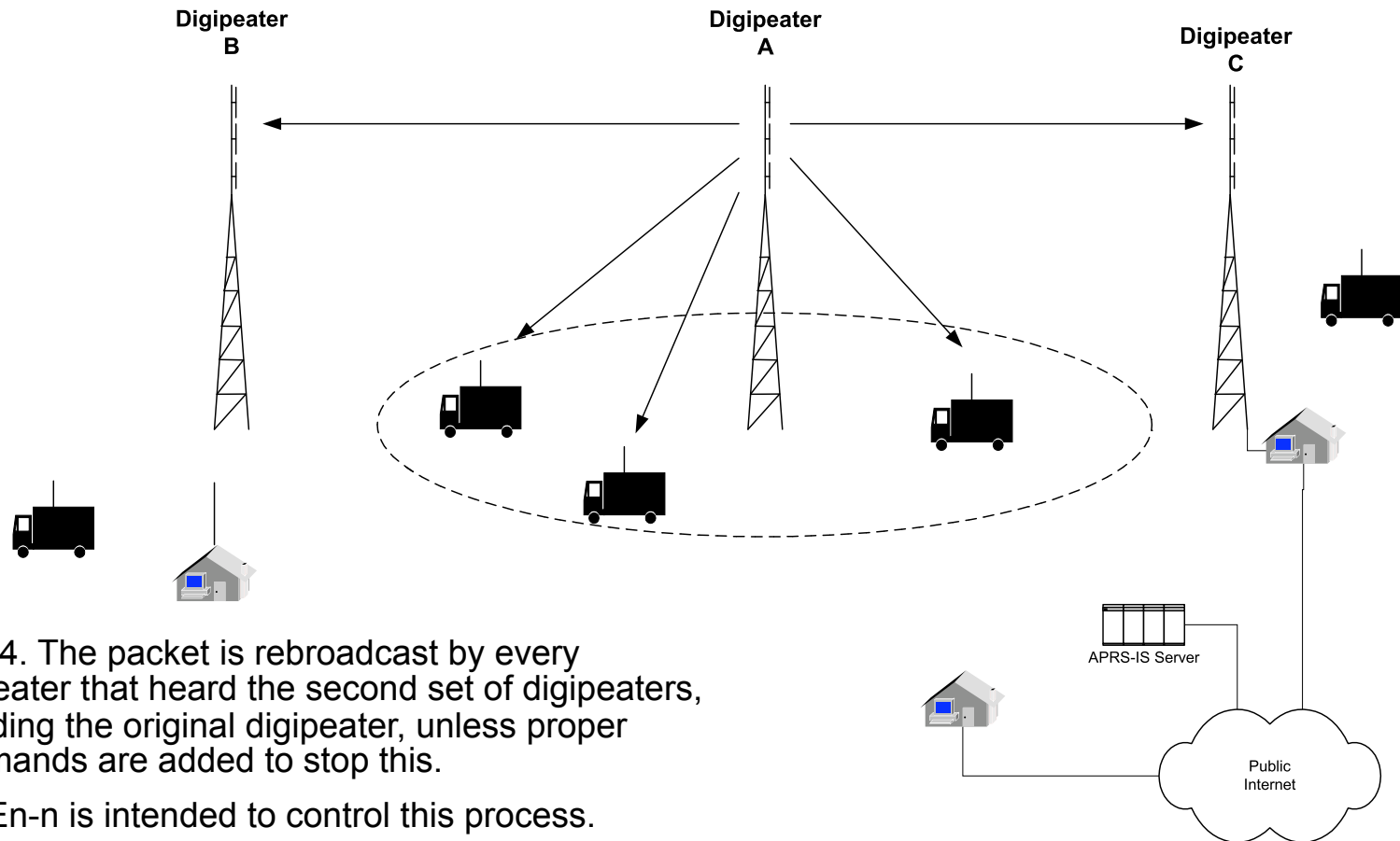
Example (3) - Other digipeaters relay



Step 3. The packet is rebroadcast by every digipeater that heard the first digipeater. The packet is heard by every APRS station in direct range of this second set of other digipeaters, including the original digipeater.



Example (4) – 1st digipeater relays again, etc.

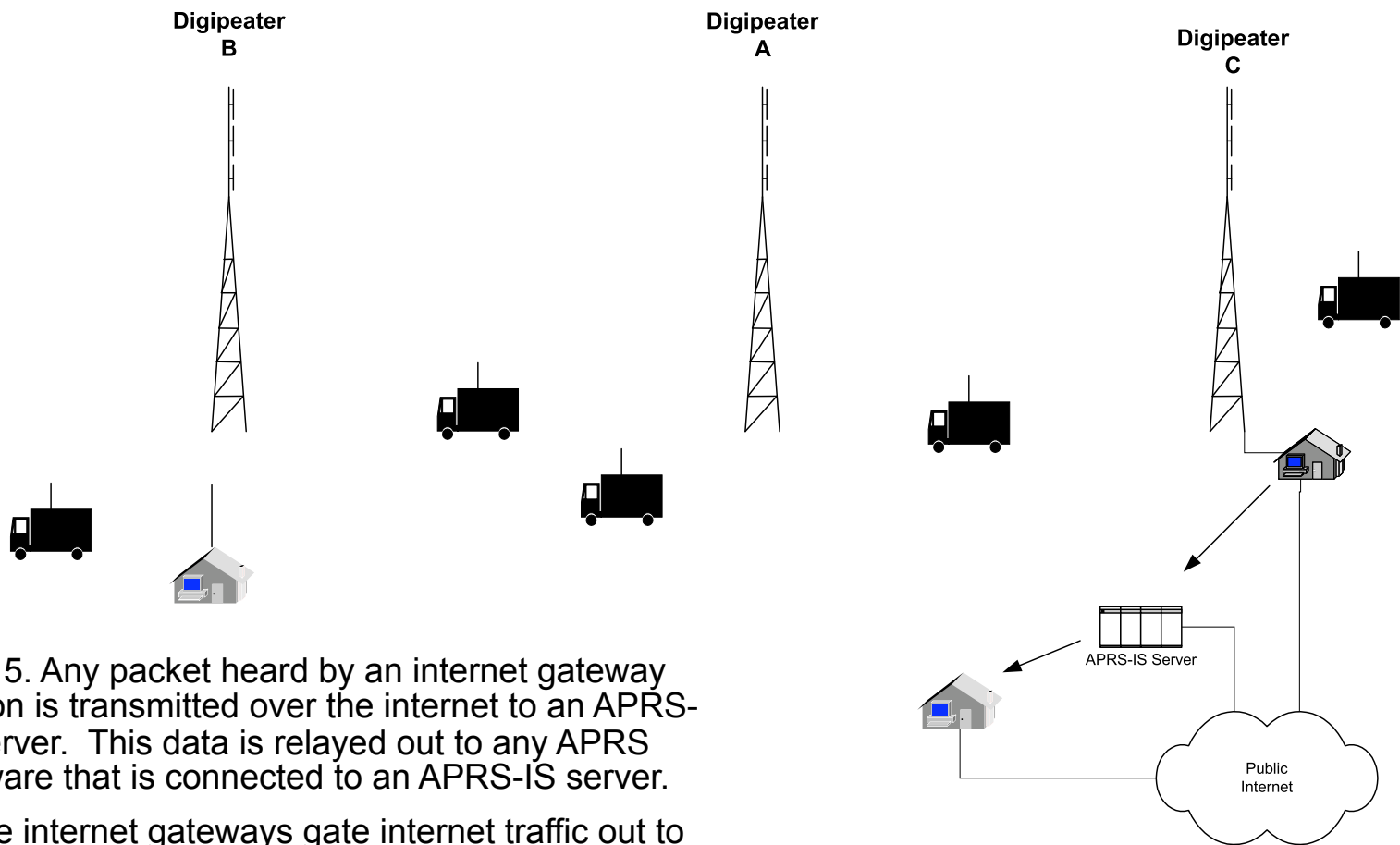


Step 4. The packet is rebroadcast by every digipeater that heard the second set of digipeaters, including the original digipeater, unless proper commands are added to stop this.

WIDEn-n is intended to control this process.



Example (5) – Internet gateway relays to APRS-IS server



Step 5. Any packet heard by an internet gateway station is transmitted over the internet to an APRS-IS server. This data is relayed out to any APRS software that is connected to an APRS-IS server.

Some internet gateways gate internet traffic out to radio, but care is needed because the volume of traffic can shut everyone else out of an area.



Configuration Information you'll need to know

- SSID (and your callsign!)
- Latitude and Longitude
- Unproto Address
- Beacon Comment
- Beacon Rate
- Status Text
- Status Rate



Callsign and Secondary Station Identifier

- Your Callsign is what identifies you uniquely
- Is transmitted every time you beacon
- And optionally a dash followed by a number from 1 to 15 (the SSID). This is particularly useful if you have more than one station operating.
- Example: EI7IG-9 (-9 is the APRS defined SSID for mobile stations, -7 for Handhelds, -6 for satellite -10 for Internet only connected clients)



Latitude & Longitude

- Latitude and longitude co-ordinates are angles that describe your location uniquely on the face of the earth
- Latitude runs north and south, with values from 0 degrees at the equator to 90 degrees at the poles. Latitudes also need a N/S identifier. This may be done by setting the value negative for south latitudes or including the letters "N" or "S"
- Longitude runs from 0 to +180 degrees starting at a line running through Greenwich, England and going east. It runs from 0 to -180 going west across the US. This may be alternatively noted by including the letters "E" or "W".
- APRS co-ordinates are expressed in degrees, decimal minutes format (+DD MM.mm). That is, the decimal places of the co-ordinate value are removed from the degrees and multiplied by 60. In other words, the latitude +32.5000 would be expressed as +32 degrees 30.00 minutes.
- If you will have a GPS receiver connected to your station, you may not have to enter these manually



Unproto Address Commands

- RELAY – obsolete in USA, Europe.
- WIDE – obsolete in USA, Europe.
- WIDEn-n – Should only appear once as first or second entry. Entering a number causes each digipeater to count down the number of times the packet will be digipeated. Never use numbers greater than WIDE3-3.
- TRACEn-n – obsolete in USA, Europe.
- GATE – Means “gate packet to HF”
- NOGATE, RFONLY – Means “don’t gate to Internet” (End Only)
- TCPIP, TCPXX, qXX – APRS-IS only, not used on RF



Unproto Paths

Generally you want your path to be just long enough so that your packet makes it to an Internet gateway and no further.

- Fixed Stations
 - WIDE2-1: suitable if within earshot of a “high” WIDEn-N digi
 - WIDE2-2: recommended maximum for routine and courteous use in most areas
 - WIDE3-3: only for very sparsely populated areas (you may only get one or two hops in urban areas even with this path)
- Mobile Stations
 - WIDE1-1,WIDE2-1 best path in most areas
 - WIDE1-1,WIDE2-2 use if far from ‘high’ digipeaters



Beacon Comment

- The beacon comment is a piece of text that goes out with each beacon
- Can be anything you want, as long as it is short
 - “Monitoring 145.525”
 - “Howdy from...”
 - Your email
 - Your web page
- Come to think of it, having your email or web page here is not a bad idea so people can get in touch with you.



Beacon Rates

- The rate at which an APRS station transmits beacons is an important consideration. The faster you beacon, the fewer users can use the system
- Your beacon rate should take into consideration what you are intending to accomplish and how fast you expect to be moving
- Stations that expect to be moving very slowly over a large area should beacon occasionally.
- Stations that are moving rapidly over a small area should beacon more often. If you will be tracked on a high-resolution map and the person tracking you needs to know exactly where you are, beacon faster.
- Stationary stations (digipeaters, etc.) should only beacon once every 10-30 minutes



Speed vs Beacon Rate

- Mobile stations should generally beacon no faster than once every 3 minutes. With a three minute beacon rate, a station will move the following distances at a given speed:

Speed	Distance Travelled	Comment
60 mph	3 miles	Highway Speed
45 mph	2.25 miles	Parkway speed
30 mph	1.5 miles	Residential
25 mph	1.25 miles	Bicycle rally lead
7 mph	0.35 miles	Bicycle rally trail





An example

- Solid Blue is EI7IG-9 (smart-beaconing)
- Dashed blue is EI7IG-8 (once every 5 minutes)

Status Message and Rate

- The status message is a text message that is transmitted with your beacon,
- But not necessary every time you beacon
- Generally you can set your station to transmit your status once every so many beacons
- Can be used to transmit the status of your station
 - “On duty”
 - “On station”
 - “En Route”
 - “Committed”
 - Etc



APRS Equipment

- There are a number of different types of APRS stations you may want to build.
- Before you can start building, you need to have an idea of what you want to do.
- The next slide provides some examples of stations



APRS Hardware

Digipeaters

A digipeater is a station that retransmits the packets that it hears. There should only be a few digipeaters in a given area.

Internet Gateways

An internet gateway relays packets from radio to the internet and vice versa. Can be combined with a digipeater and / or a fixed station. Requires a computer and internet connection

Fixed Station

A fixed station transmits packets, but remains in one place. Can be used to monitor other stations or to transmit local information objects

Trackers

A tracker is an APRS station that is capable of transmitting a packet containing location information. Usually small and portable for moving between vehicles.

Mobile Station

Usually a tracker semi-permanently fixed in a vehicle. Can have a computer for display.

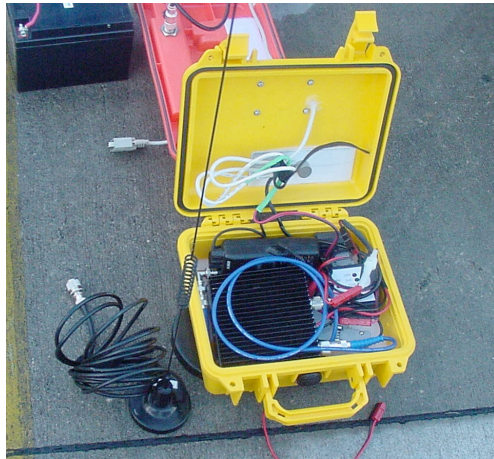
Passive Stations

A passive station only listens to APRS packets, but doesn't transmit anything. Used with a computer to see other stations



Trackers used during the 03 Red Hot Chili Pepper Rally

W5ADC
Mag-
mounted
to outside
of a
vehicle



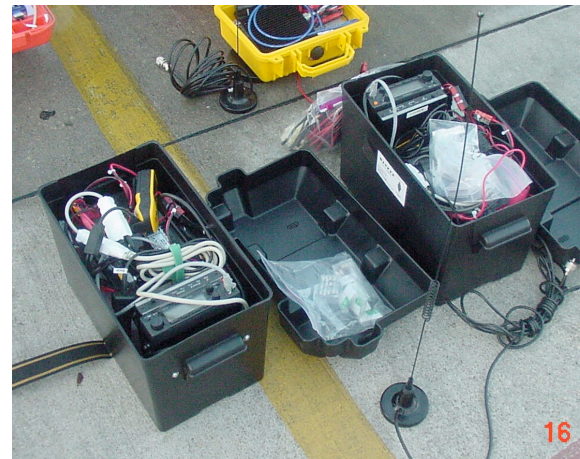
N5O0M
Carried
in a
vehicle



W5DCR
Dallas REACT



WA5KXX
Self-
contained
digipeaters



More equipment



E17IG-8 Temporary Tracker,
Sean Kelly Tour



E12DBP Digipeater

TNCs

- A TNC (Terminal Node Controller) is a basically a packet modem. One end hooks to a radio, the other to a computer (or GPS receiver)
- A Windows software package called AGWPE can replicate the functions of a TNC, reducing the cost of a system, ditto for Linux Soundmodem.
- There are some dedicated low cost devices that take the place of TNCs. These include the TinyTrak and the OpenTracker, in the \$50 range. The RTrack from rpc-electronics in the \$250 range. These devices are attached to a GPS receiver and are only for transmitting location data – they can't currently receive.
- The KPC-3+ and the older, obsolete KPC-3 have built in APRS functions. However, the 3+ unit can connect to a computer and a GPS receiver at the same time, which is a rare feature.
- The Tracker2 from Argent Data Systems, flexible tracker for fixed or portable use, supports KISS mode (TNC) and allows computer & GPS receiver to be connected at the same time.



GPS Receivers

- There are many GPS receivers to choose from, in many shapes and sizes. Some are more practical than others for specific applications.
- Garmin and Magellan are common handheld brands. Prices range from \$100 and up. Bargains can be had if you look.
- Any GPS receiver used for APRS must have a data connection and must output NMEA format data (most do, some Garmin Nuvis in combination with some products from Argentdata are exceptions to this rule).
- eBay is a good place to get cheap data cables (google for pFranc)
- Consider if you want to have your GPS receiver powered via external power (vs. internal batteries)



Types of GPS receivers

- **Handheld receivers** – These receivers are intended to be carried and used with the included display screen and use internal batteries. 12 channel receivers are common, cheap and tend to provide the best performance. Retail prices run €100 and up. These are fine for APRS use. Garmin eTrex models are common.
- **Navigation receivers** – Some receivers are intended for use only with other equipment or computers, sometimes for navigation. There are some that are sold for use with consumer navigation software (like Street Atlas). Not all are usable for APRS, but many are. Most won't have a display.
- **OEM modules** – These are intended for inclusion in another piece of equipment. Some are useable for APRS, and can be had quite cheap. You may need to add some RS-232 interface hardware, though.
- **Survey receivers** – These are intended for industrial surveying activities and are very expensive, though very accurate. Not generally used for APRS.
- **Timing receivers** – These receivers are intended to provide timing synchronisation to other equipment. Not generally used for APRS.



Radios

- Whether you use a mobile or HT depends on how mobile you will want to be
- In Ireland Handhelds/low powered trackers are still ok for general use in urban areas. However experience in the US has shown that attempts to use Handhelds have generally been unsatisfactory since they are having to fight mobile stations putting out 20 to 40 watts
- Cabling standards are radically different for each radio / TNC combination
- Some radios have packet DIN plugs that allow for simple, common connections
 - (e.g. FT817/FT7100/FT1500/FT857/FT847 are all identical)



Computers

- You only need a computer if you want to see other stations or you want to run an internet gateway or smart digipeater
- Older laptops tend to work fine with APRS. It's not a big program
- Newer laptops may not have RS-232 ports, which you will need to connect to a TNC. If your laptop has a USB port, you can get a USB to Serial adapter for €20 and higher which should do the job.
- If you want to run really portable, consider using a palm device or a pocket PC (such as a Compaq iPaq). These are really good if you want to be pedestrian-portable but still need to see other stations. And you may have trouble getting applications for these platforms.



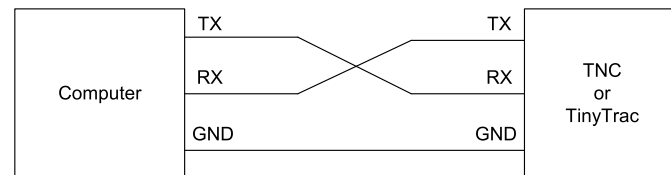
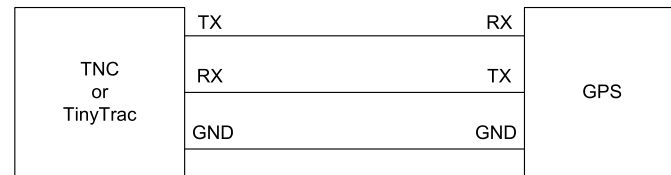
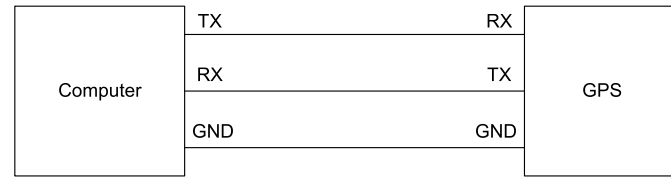
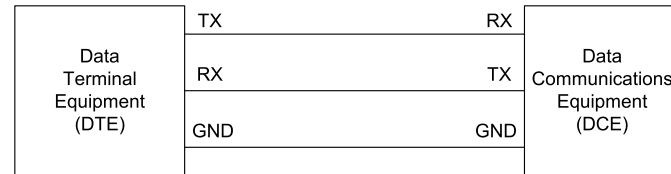
Connecting Things up

- GPS to TNC and TNC to Computer connections are generally RS-232 connections (more on this later)
- These tend to use either 9 pin or 25 pin “D style” connectors
- TNC to radio connections are custom depending on both the TNC and Radio



RS-232 Connections

- Most Computer to GPS, GPS to TNC and Computer to TNC connections use RS-232 connections.
- RS-232 connections were intended to connect a computer (DTE) to a piece of communications gear (DCE). In these boxes, the connectors were designed so that the TX of one would plug into the RX of the other, and vice versa.
- In some cases, the connectors will hook up TX to TX and RX to RX, which will not work. You will need to buy an adaptor or make up a cable to switch the TX and RX lines. This is called a 'null modem' or 'crossover' adapter. This should be clear in your equipments' documentation. These are usually cheap (\$5 and up) and easily found in computer stores.
- There are other signals in the RS-232 spec, but TX, RX and Ground are the important ones for hooking up your GPS. A TNC may require additional signal connections



Connecting a GPS to a TNC

- Most GPS receivers that are useable for APRS use an RS-232 connection.
- You will need to connect at least 3 wires between your GPS equipment and your APRS station
 - TX
 - RX
 - Ground
 - See your GPS manual (or maybe download one from the web)
- The physical connector at the GPS receiver is often proprietary, forcing you to buy from them. Garmin has a range of 3rd party connectors available (eBay and pFranc).
- The physical connector at the computer (or TNC) end is usually a DE-9 9 pin connector or a DB-25 25 pin connector
- Other connectors are possible (a stereo miniplug, as used by the Kenwood TM-D700). You will need to take into account what you are trying to connect.
- You can test your GPS by plugging it into your computer's RS-232 port and configure a terminal program (such as Hyperterminal) to look directly at the comm port rather than a modem.
- The most standard data configuration for GPS is 4800 baud, 8 bits, 1 stop bit, no parity
- The most common data standard that your GPS should be configured for is NMEA (maybe NMEA OUT / NMEA IN). NMEA stands for National Marine Electronics Association, and is a standard that defines all sorts of connection standards for shipboard navigation equipment.
- The most common datum that your receiver should be configured for is WGS-84 or NAD-83. The two are nearly identical as far as we're concerned.



GPS Position Accuracy & Precision

- Accuracy is how correct a position is
- Precision is how finely resolved a position is
- GPS positions are often very precise, but not that accurate (sit still and watch the numbers change)
- Consumer grade GPS receivers are accurate to 15 meters (50 feet), some are a bit better
- Some receivers have WAAS (Wide Area Augmentation System), a separate correction signal that adds additional accuracy, down to about 5 meters (15 ft)
- Accuracy is influenced by environmental factors including ionospheric distortion and satellite geometry
- More accuracy (down to milli-meters) requires more expensive equipment (up to tens of thousands of euro)



APRS Software

- If you want to see APRS stations, you'll need some software
- There are software packages for most operating systems
 - Dos: AprsDos
 - Windows: WinAprs, UIView, APRS+SA, APRSPoint, Xastir
 - Mac: MacAprs, Xastir
 - Unix: Xastir
 - PocketPC: APRS-CE
 - Palm: PocketAPRS, SmartPalm
- And some internet based services
 - www.findu.com
 - JavAPRS
 - aprs.fi
- For product comparisons, see WE7U's list at: http://www.eskimo.com/~archer/aprs_capabilities.html
- You'll need maps too, but that's another days presentation...



Information Resources

- APRS
 - Bob Bruninga's web site (new url)
 - <http://www.aprs.org>
 - TAPR
 - APRS Standards doc and various email discussion lists
 - <http://www.tapr.org/>
 - APRS Wiki
 - <http://info.aprs.net/>
- GPS
 - Joe Mehaffey's huge web site
 - <http://gpsinformation.net/>



Hardware sources

- TNCs/Trackers
 - Kantronics - <http://www.kantronics.com/>
 - TinyTrak, WeatherTrak - <http://www.tinytrak.com/>
 - Opentracker+/Tracker2 - <http://www.argentdata.com>
 - RTrack - <http://www.rpc-electronics.com>
 - Rigblaster - <http://www.westmountainradio.com/>
 - TNC7 - <http://nt-g.de/>
 - TNC-X - <http://www.tnc-x.com/>
 - CCW TNC/Digi/Tracker - http://www.crosscountrywireless.net/aprs_tnc.htm
- GPS
 - <http://www.garmin.com/>
- Cables and Connectors
 - Misc Cables and Connectors - <http://www.argentdata.com>
 - Bare garmin connectors - <http://www.pfranc.com/>
 - Radio to TNC cables - <http://www.packetradio.com/wiring.htm>

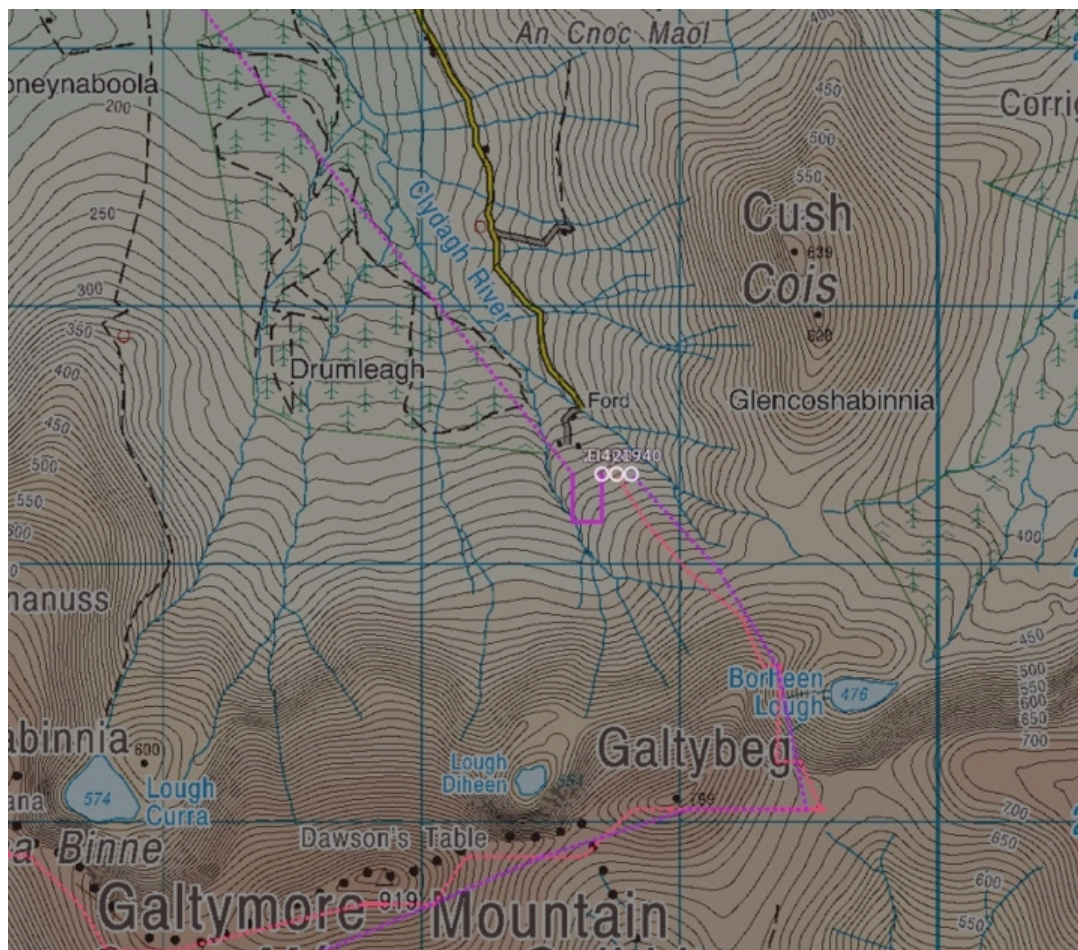


(Some) Software Sources

APRSDos	ftp://ftp.tapr.org/aprssid/dosstuff/APRSDos/
WinAPRS	ftp://ftp.tapr.org/aprssid/winstuff/WinAPRS/
Xastir	http://www.xastir.org
APRS+SA	http://www.tapr.org/~kh2z/aprsplus/
APRSPoint	http://www.aprspoint.com/
UI-View	http://www.uiview.com/
PalmAPRS	ftp://ftp.tapr.org/aprssid/palmstuff/
APRS+CE	http://www.tapr.org/~aprsce/
JavAPRS	http://www.aprs-is.net/javAPRS/
AGWPE	http://www.raag.org/sv2agw/index.html
Lots more listed here...	http://www.eskimo.com/~archer/aprs_device_capabilities.html



Does it work? Is it useful?



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Parting thoughts.....

- APRS is not just about vehicle tracking
 - It is a bi-directional tactical communications or information resource channel.
 - it is more about objects and information
- APRS does not depend on GPS for value
- APRS messages are useful and two way!
- Kenwood TM-D700/710, TH-D7, VX-8R are useful data input devices
 - in a pinch I admit, being slightly cumbersome.
- You are the resource, you need to input (and keep current) local information
- APRS is not plug in and forget, the network does need management
 - Repeater Objects, Satellite Tracking with Digi_Ned, Hamfests, Club Meetings, Traffic Stops, Accidents etc.
- Voice Alert (Rocks!)
 - Simplex voice back channel.



Any Questions?

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