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
  - GNSS receiver (GPS/Glonass/Galileo/BeiDou)
  - 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 (last century) or more modern replacements both hardware and software.
- Primary frequencies are 144.390MHz in USA, 144.800MHz Europe.
- Intended as real-time, short range, tactical information communications channel.
- Range can be extended using Internet Gateways (remote viewing).
  - Receive only Internet Gateways break the system
- 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
  - APRS of Things
  - 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 WGS-84 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

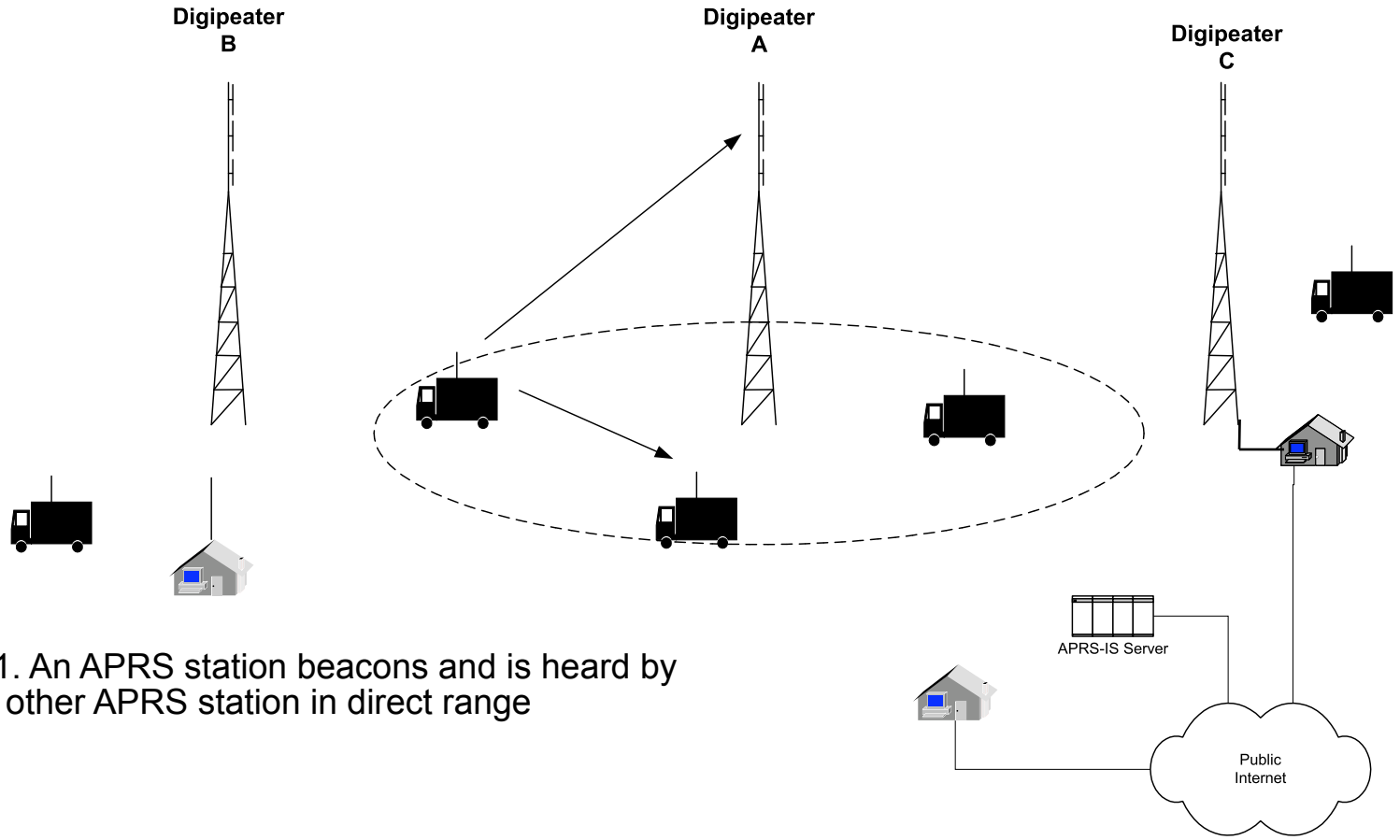
Aloha Circle

- 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

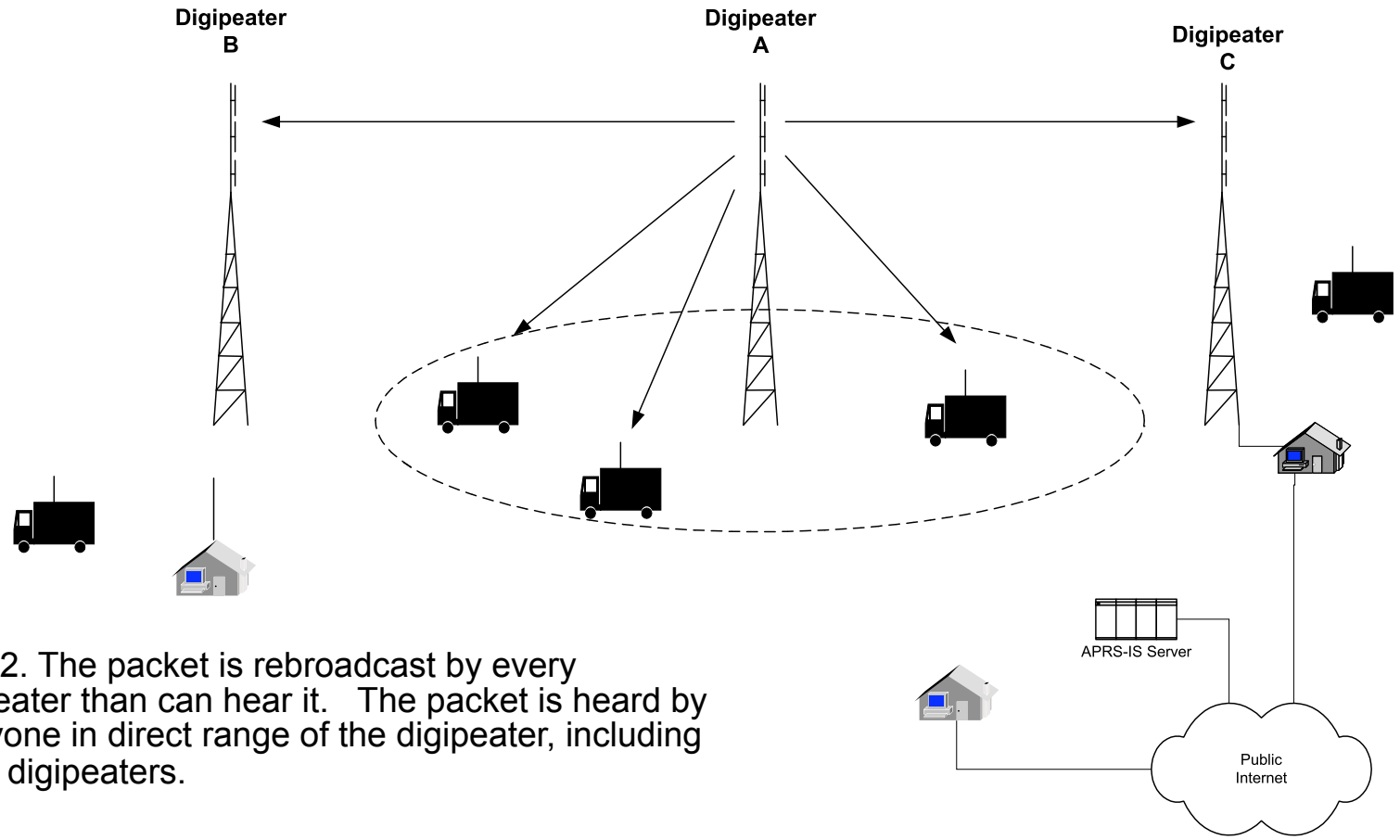
- The Aloha circle definition is based on the premise that APRS packets take a finite amount of time to transmit and so only a limited number of users may operate in a given area.
- Poor station configuration can cause packets to travel too far over RF, causing traffic into distant APRS networks, blocking 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



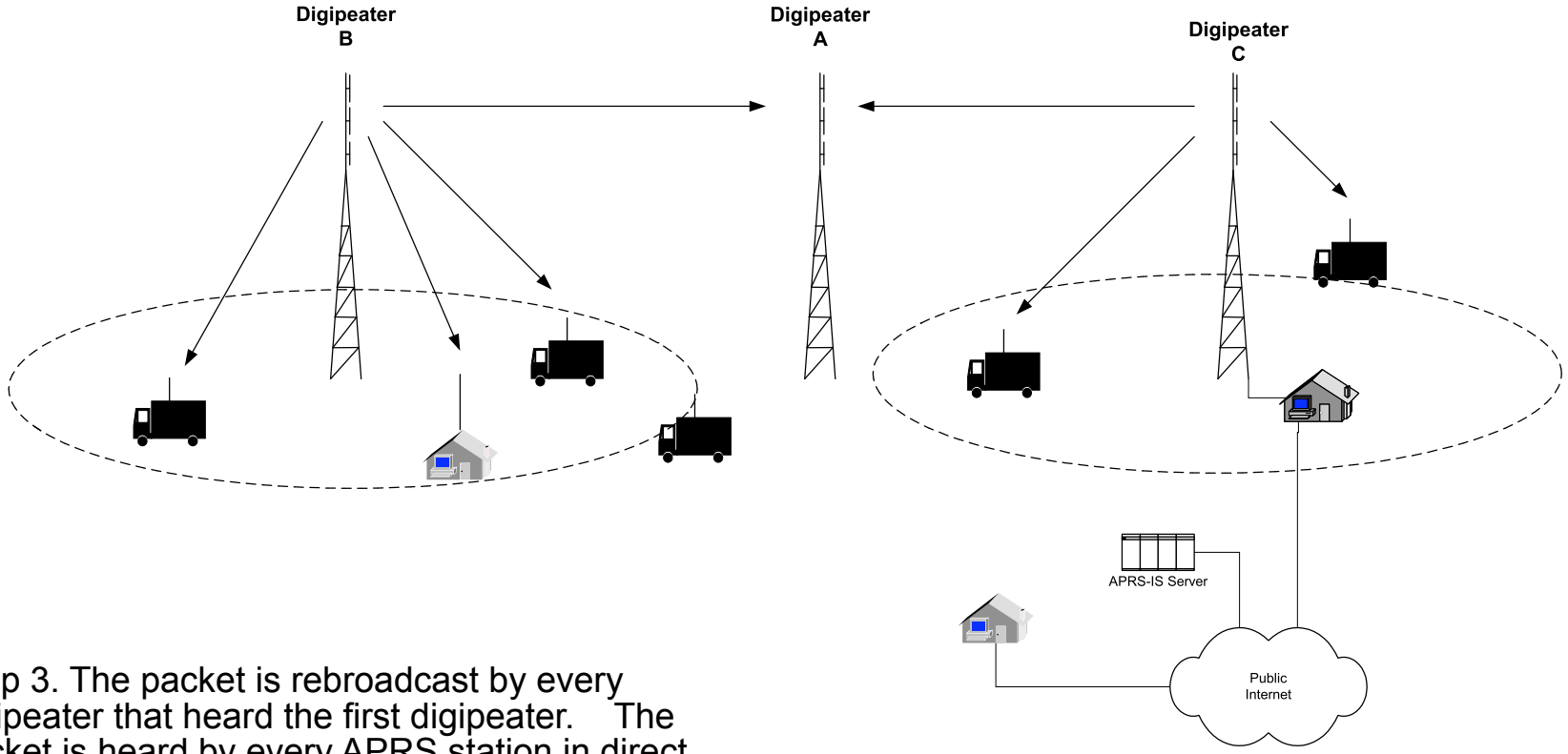
Step 1. An APRS station beacons and is heard by every other APRS station in direct range

Example (2) - Digipeater relays



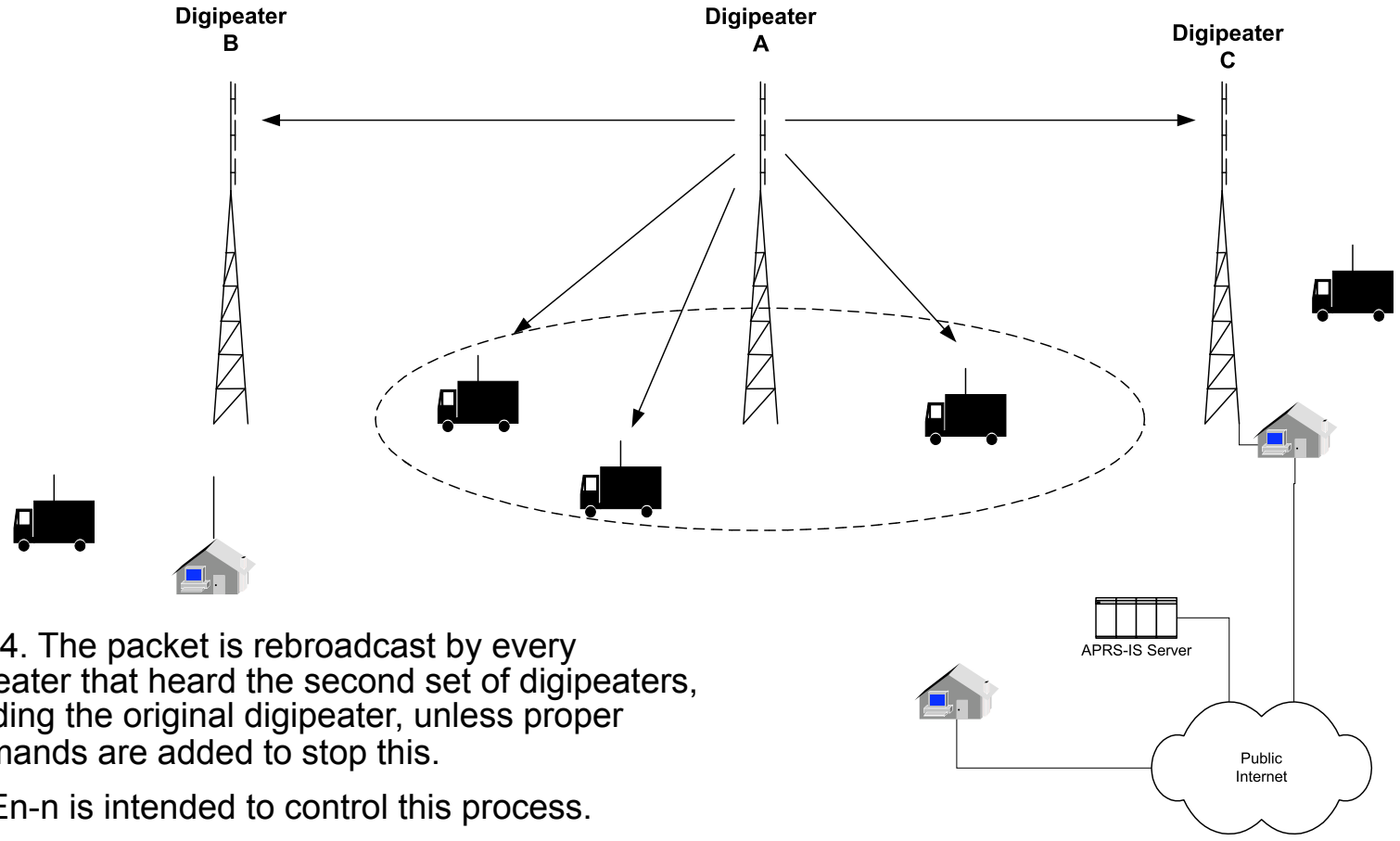
Step 2. The packet is rebroadcast by every digipeater than can hear it. The packet is heard by everyone in direct range of the digipeater, including other digipeaters.

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.

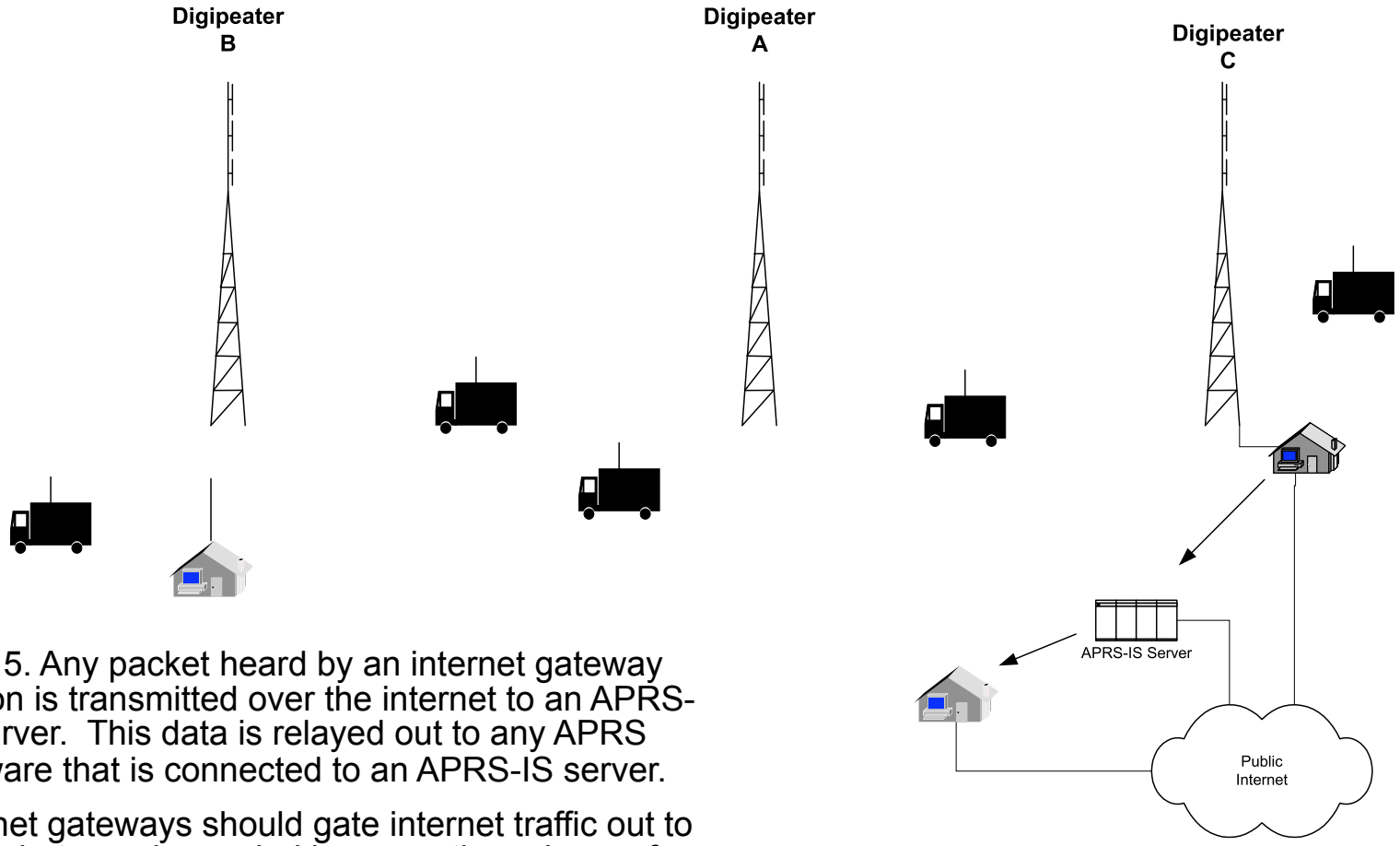
Example (4) – 1st digipeater relays again, etc.



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.

internet gateways should 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
- Via path or packet path
  - Called "Unproto" in older hardware
- 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)
  - I use EI7IG-9 on my TM-D710 and TH-D72, as I have never used both at the same time.

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 GNSS receiver connected to your station, you may not have to enter these manually

Some potential “via” paths

- 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

Via 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
- Mobile Stations
  - WIDE1-1,WIDE2-1 best path in most areas
  - WIDE1-1,WIDE2-2 use if far from ‘high’ digipeaters
    - I use WIDE1-1, WIDE2-2 around Ireland

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…"
  - "EFR, Monitoring SIRN, Monitoring TG2722"
- Having your web page here is not a bad idea so people can get in touch with you. I would suggest don't put your email address in there.

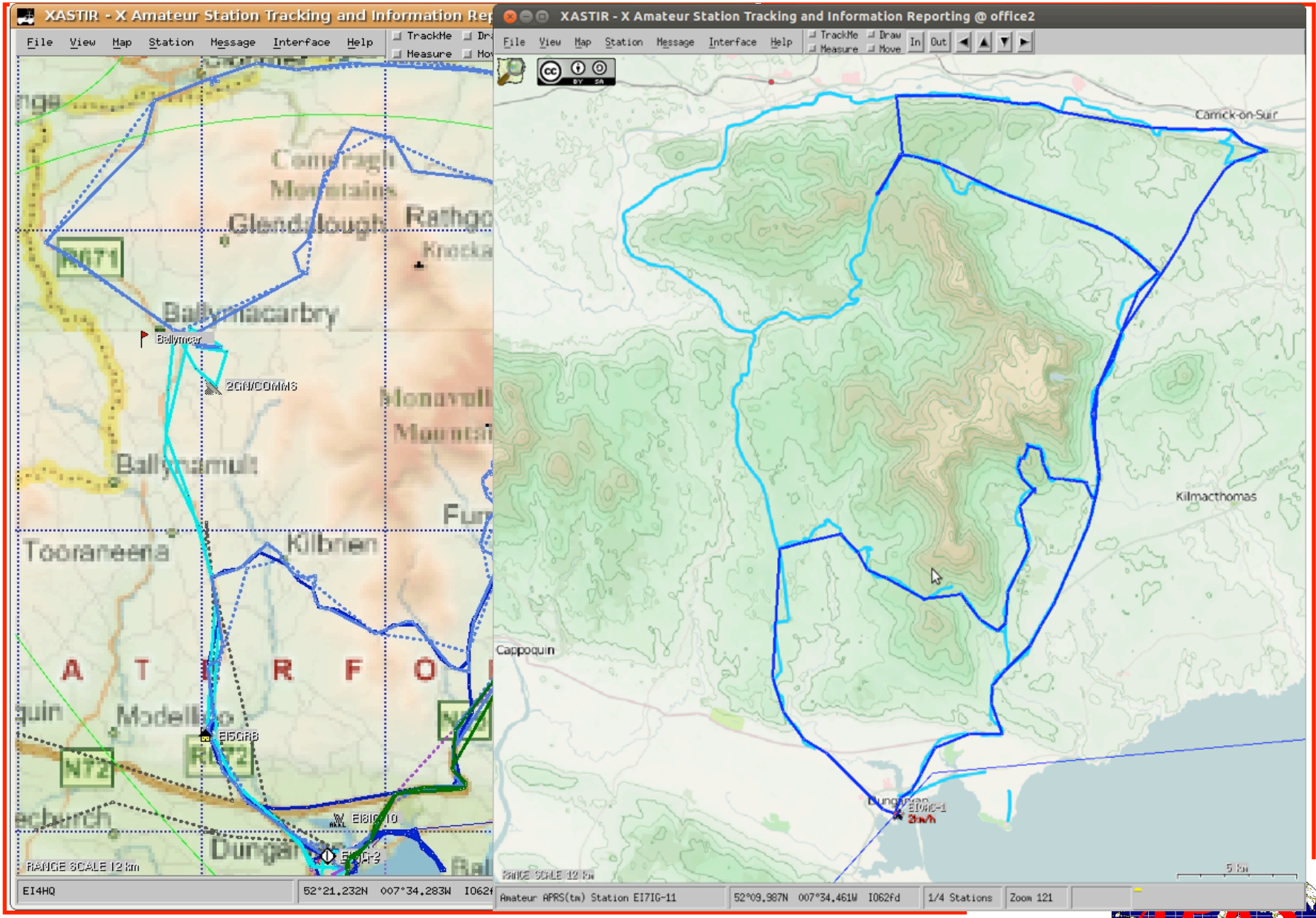
Beacon Rates

- 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
100kph (~62mph)	5km (~3miles)	Primary Road
50kph (~31mph)	2.5km (1.5miles)	Secondary Road
25kph (15.5mph)	1.25km (3/4mile)	Residential
15kph (~9.3mph)	0.75km (~1/2mile)	Runners pace
5kph (~3.1mph)	0.25km (~1/6mile)	Moderate walking pace



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 Stations

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

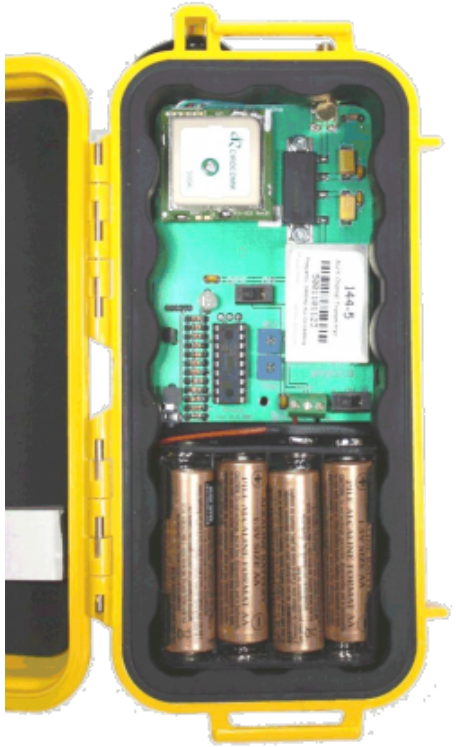
A passive station only listens to APRS packets, but doesn't transmit anything. Used with a computer to see other stations

Sample equipment

Kenwood TH-D72

Kenwood TM-D710

Byonics Micro-Trak AIO



Radio Interface - TNCs

- A Terminal Node Controller (TNC) is a basically a packet modem. One end hooks to a radio, the other to a computer (or GNSS receiver)
- Traditional TNC's from the 1980's and 1990's
- MFJ-1270, TAPR TNC-2, Paccom TNC-220, Paccom Tiny-2, Kantronics KPC3/3+/9612+ and other manufacturers
- Originally intended for point-to-point communications
- AX.25 "Connected" mode built-in
- Facilitated one-to-one communications with automatic retransmission
- Built in digipeater capability and additional features such as Bulletin Board Systems or Mailboxes
- Some will broadcast the position of attached GNSS receiver

Radio Interfaces - Trackers

- Broad term for newer, smaller, cheaper hardware that does not support AX.25 “connected” mode.
  - TinyTrak 4
  - Opentracker USB
  - T3 Micro
  - Tracker4
  - PLXTracker
- Generally a modem and some combination of
  - GNSS Receiver
  - Telemetry Input
  - Digipeater
  - KISS Interface

Radio Interfaces - Software TNCs

- DSP or Soundcard based modems
- Examples include Direwolf and UZ7HO's sound modems
- Performance dependent on quality of your PC's sound card
- Not plug-and-play
- With quality hardware, can outperform all pure hardware based TNC's
- See https://github.com/wb2osz/direwolf/blob/dev/doc/WA8LMF-TNC-Test-CD-Results.pdf for comparison

GNSS Receivers

- There are many GNSS receivers to choose from, in many shapes and sizes. Some are more practical than others for specific applications.
- Garmin, Magellan are still common handheld brands. Prices range from €100 and up. Bargains can be had if you look.
- Lots of embedded options available now
  - https://www.sparkfun.com/products/15733
- With astonishing accuracy
  - https://www.sparkfun.com/products/15136
- Note: Older hardware and software may not recognise NMEA sentences from newer GNSS receivers

Radios

- Whether you use a mobile or HT depends on how mobile you will want to be
- Cabling standards are radically different for each radio / TNC combination
- Japanese “Big Three” Yaesu, Kenwood, Icom standardised the Mini-DIN connector for connecting external modems.
- Commonly labelled “data”. Though not all radios have such an input.
  - (e.g. FT817/FT7100/FT1500/FT857/FT847/IC-7100 are all identical)

Radios - continued

- 1200 baud will work with pretty much any radio via microphone/ speaker.
  - Audio pre/de-emphasis will cause reliability issues if demodulator cannot compensate (i.e. older hardware TNCs)
- 9600 baud (not in use in EI), will have to use the data connector to bypass internal audio stages
- 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

Computers

- You really 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.
  - They may only have RS-232 ports, so you may need adaptors for newer USB only Interfaces
- Older TNC's will most likely have RS-232 ports.
  - Try and get a RS-232 to USB adaptor with a FTDI chipset
- Newer radio interfaces have USB, Ethernet, Wifi and Bluetooth
- The Raspberry Pi is a perfect low-powered platform for using as an APRS digipeater or I-Gate

Connecting Things up

- Lots of options nowadays,
  - USB probably the most common now.
    - https://www.amazon.com/gp/product/B00NWEEWW8/
  - Bluetooth becoming more common
  - SPI for embedded GNSS receivers
- Older TNC's may still use RS-232 ports
  - GNSS 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
    - Check if your RIG has a 6 pin Mini-Din "Standardised" connector

GNSS Accuracy & Precision

- Accuracy is how correct a position is
- Precision is how finely resolved a position is
- GNSS positions are often very precise, but not that accurate (sit still and watch the numbers change)
- More modern Consumer grade GNSS receivers are accurate to less than 5m
- Some newer GNSS modules can get down to less then 1.5m, with more expensive modules ($200 range) getting down to cm accuracy
- Accuracy is influenced by environmental factors including ionospheric distortion and satellite geometry

APRS Software - Interactive

- There are GUI based software packages for most operating systems.
  - Windows: YACC, APRSISCE/32, SARTrack, Xastir, PinpointAPRS
  - Mac: YACC, Xastir
  - Linux: YACC, Xastir
  - FreeBSD: YACC, Xastir
  - Raspberry Pi: YACC, Xastir
- And some more specialised include
  - UISS - For APRS Satellites, including the International Space Stations
  - APRS-TW - Telemetry Watcher

APRS Software - Non Interactive

- There are software packages that perform specialised functions such as Software TNC's, digipeaters or I-Gates.
- APRS Internet Service Servers
  - JavAPRS - APRS-IS Server
  - aprsc - APRS-IS Server - http://he.fi/aprsc/
- APRS Internet Gateway or Digipeater
  - Aprx - APRS I-Gate/Digipeater - https://github.com/PhirePhly/aprx
  - Aprs4r - APRS I-Gate/Digipeater - http://aprs4r.org
- Soundmodem/Software TNCs
  - AGW Packet Engine - https://www.sv2agw.com/downloads/
  - Direwolf - https://github.com/wb2osz/direwolf
  - UZ7HO Soundmodem - http://uz7.ho.ua/packetradio.htm

APRS Software - Online or Smartphone

- Online
  - https://aprs.fi
  - http://www.findu.com
  - https://aprsdirect.com
- Smartphone
  - https://aprsdroid.org
    - Also works via speakers/microphone
    - Can use some bluetooth capable TNCs
  - aprs.fi App for iPhone/iPad in the app store

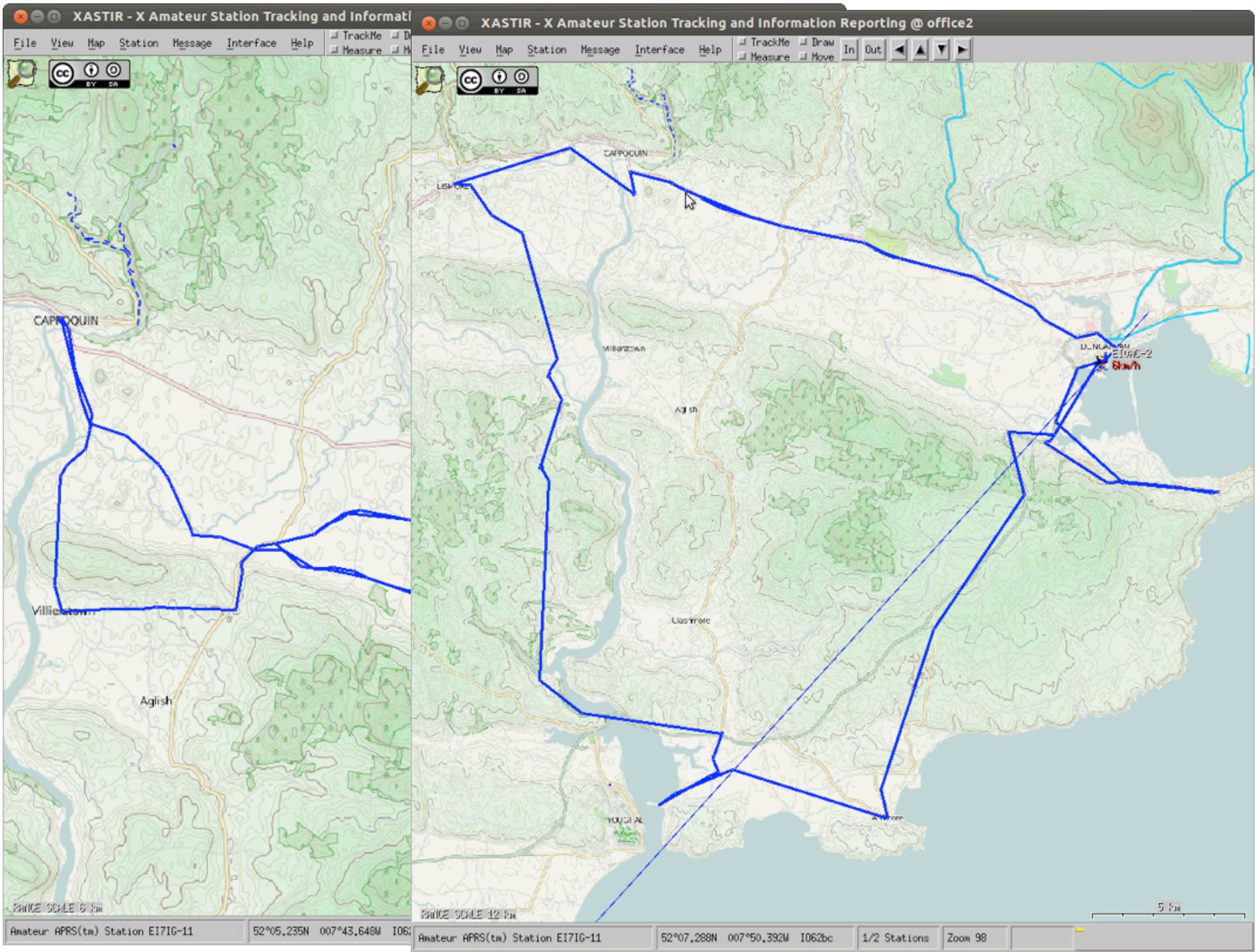
APRS Software - niche (& Neat) ideas

- Voice Alert
  - http://www.aprs.org/VoiceAlert3.html
  - Built into more modern APRS Capable radios
- APRS Touch Tone project
  - http://www.aprs.org/aprstt.html
  - Supported by Direwolf
    - https://github.com/wb2osz/direwolf/blob/master/doc/APRStt-Implementation-Notes.pdf
- FX.25 adding Forward Error Correction to AX.25
  - Again, supported by Direwolf
    - https://github.com/wb2osz/direwolf/blob/dev/doc/AX25_plus_FEC_equals_FX25.pdf

APRS - getting started

Suggestions from John Langner WB2OSZ

- Tune into national APRS frequency
  - Laptop microphone can pick up the sound to decode the APRS packets
- Install a free software Soundcard Modem to decode the signals
- Install one of the Interactive APRS applications
- Get transmitting
  - SignaLink USB or other interface used for FT8 could be borrowed
  - Some newer rigs have build in USB sound cards
  - Beacon time and place of local meetings/events, message friends, generate some telemetry.
  - Maybe deploy a two-way IGate if required


XASTIR - X Amateur Station Tracking and Informati
File View Map Station Message Interface Help
TrackMe
Measure
CAPPOQUIN
Villiestown
Aglish
RANGE SCALE 6 Km
Amateur APRS(tm) Station EI7IG-11
52°05.235N 007°43.648W
XASTIR - X Amateur Station Tracking and Information Reporting @ office2
File View Map Station Message Interface Help
TrackMe
Measure
Draw
Move
In
Out
CAPPOQUIN
Villiestown
Aglish
Clashmore
YOUGHAL
RANGE SCALE 12 Km
5 Km
Amateur APRS(tm) Station EI7IG-11
52°07.288N 007°50.392W
IO62bc
1/2 Stations
Zoom 98

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 GNSS for value
- APRS messages are useful and two way!
- Kenwood TM-D700/710, TH-D7/D72, and Yaesu? APRS 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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