VHF Packet Radio
With a Focus On EMCOMM

by

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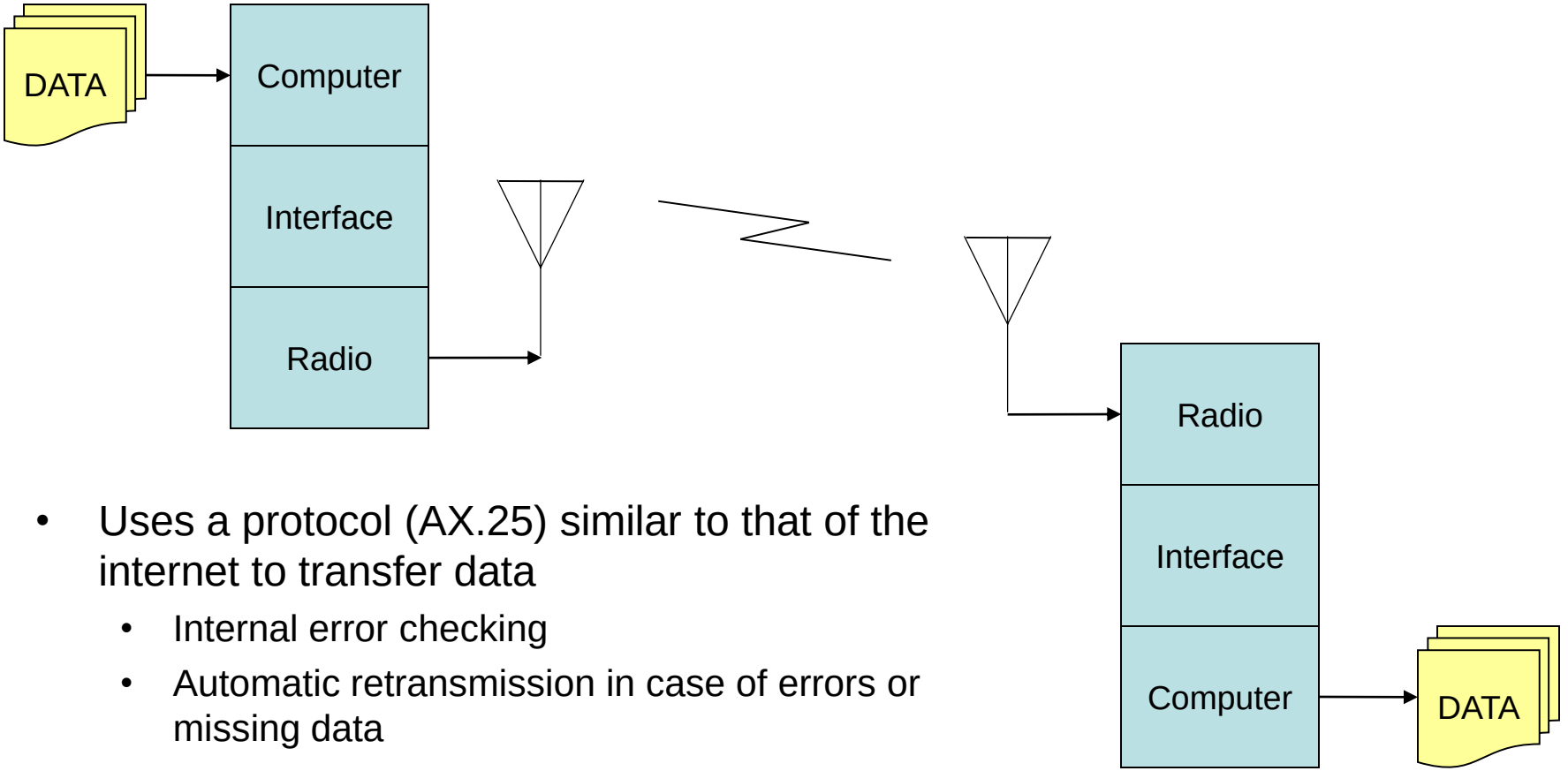
In an EMCOMM situation, it is expected that the bulk of information sent by ham radio is data and not voice

- Data examples
  - Shelter population lists
  - Logistics lists
  - Volumes of health and welfare messages
  - Stuff that can be stored on computers, sorted, processed, printed, etc.
- Why not voice?
  - We are not “first responders”, we are not field search and rescue
  - We can expect to be at shelters and other fixed sites communicating volumes of information
  - Voice is a much less efficient means of communicating volumes of information
  - Data can be stored on computer, can be further processed, can be sorted and summarized, etc.

Contrast with Public Service scenarios that are mostly short-message, real-time voice

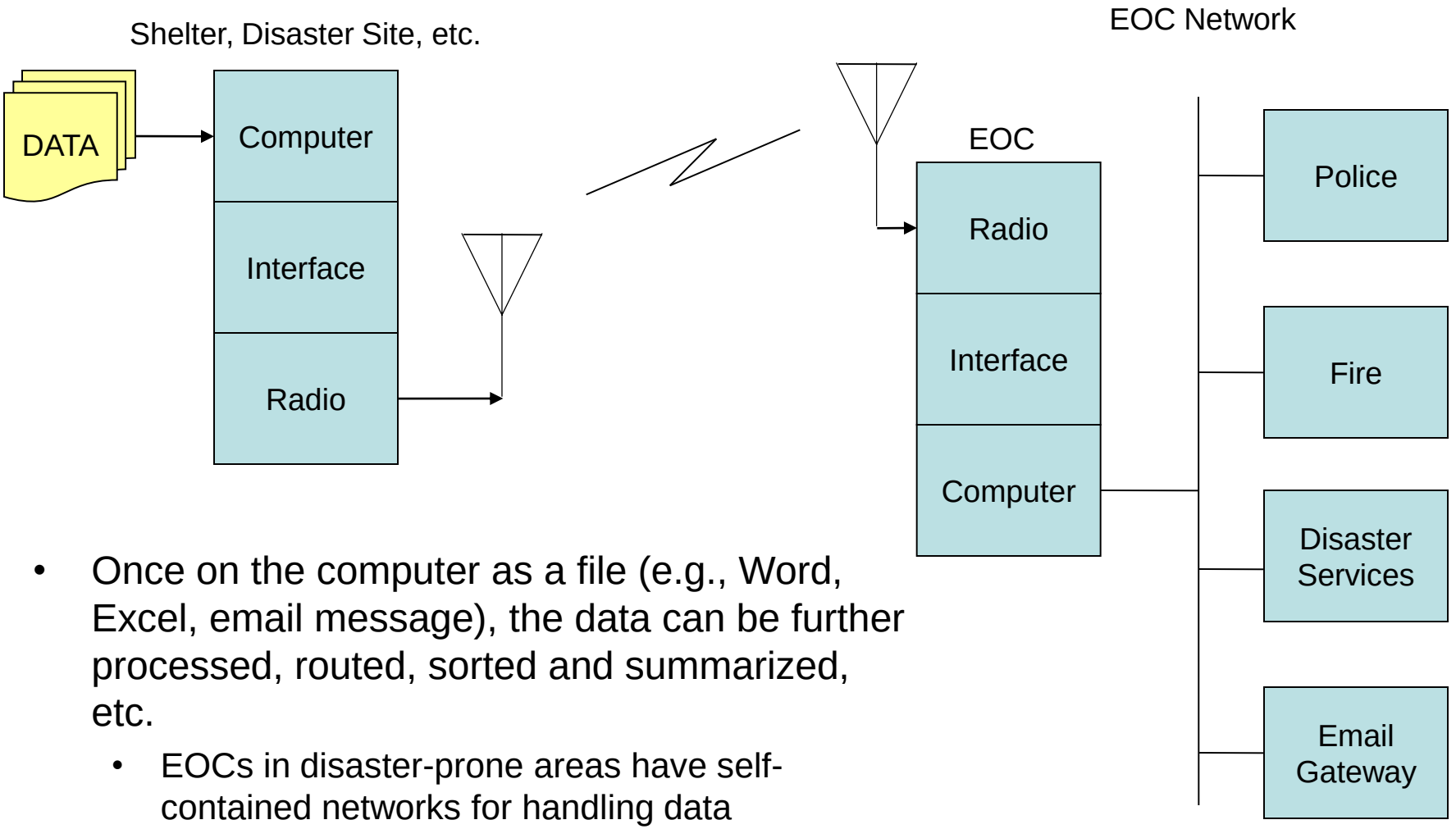
VHF Packet uses FM radio and a computer to send data reliably

- For ham radio, generally 1200 or 9600 baud
- Packet on VHF is usually FM



- Uses a protocol (AX.25) similar to that of the internet to transfer data
  - Internal error checking
  - Automatic retransmission in case of errors or missing data

Data sent via Packet Radio can be stored on computer



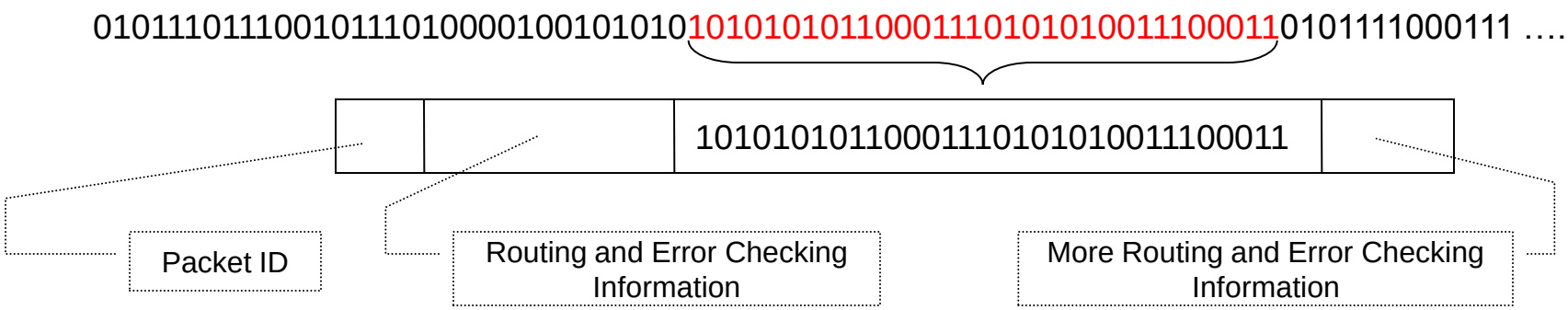
- Once on the computer as a file (e.g., Word, Excel, email message), the data can be further processed, routed, sorted and summarized, etc.
  - EOCs in disaster-prone areas have self-contained networks for handling data

Packet Radio is a form of digital communications

- What is “digital communications”?
  - Sending information as digital “bits” (0s and 1s)
  - Can be:
    - Voice that has been digitized (e.g., Voice over IP)
    - Data (letters, numbers, punctuation)
    - Digital representations of amorphous objects like pictures (e.g., JPGs, MPEGs, WAVs)
- In ham radio, “digital communications” mostly refers to sending data
  - Not much digitized voice (D-Star still relatively limited)
- Digital is generally more efficient than voice or CW
  - Lower power (versus voice)
  - Reduced bandwidth needs (versus voice)
  - Error checking and correction (versus voice, CW)
  - Extensive skill not required (versus CW)

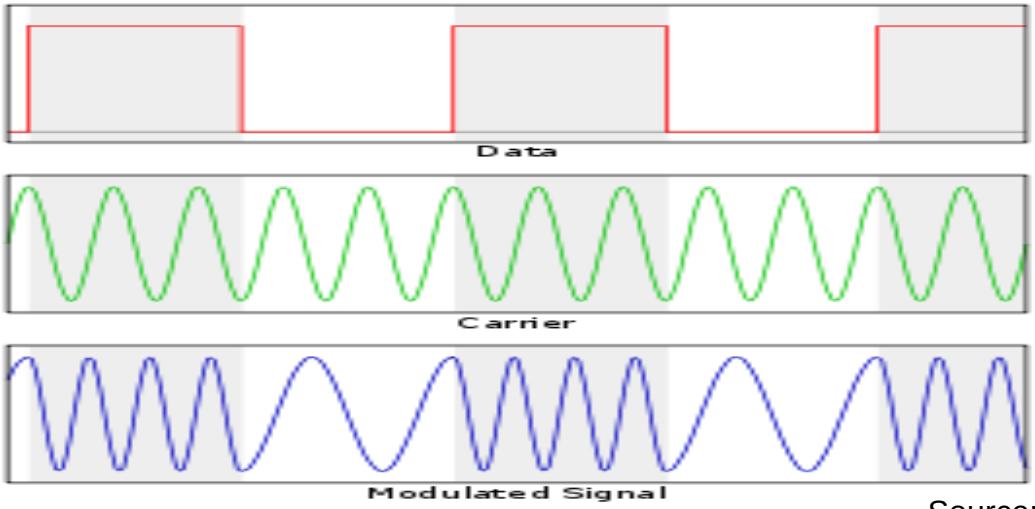
A brief refresher – digital representation

- ASCII code – used in Packet Radio -- uses 8 bits (combinations of eight 0s and 1s) to represent the alphabet, numbers, punctuation, and control codes.
  - With 8 bits, ASCII can represent 256 letters, numbers, punctuation, other characters and control symbols
  - ASCII is the standard for most computers



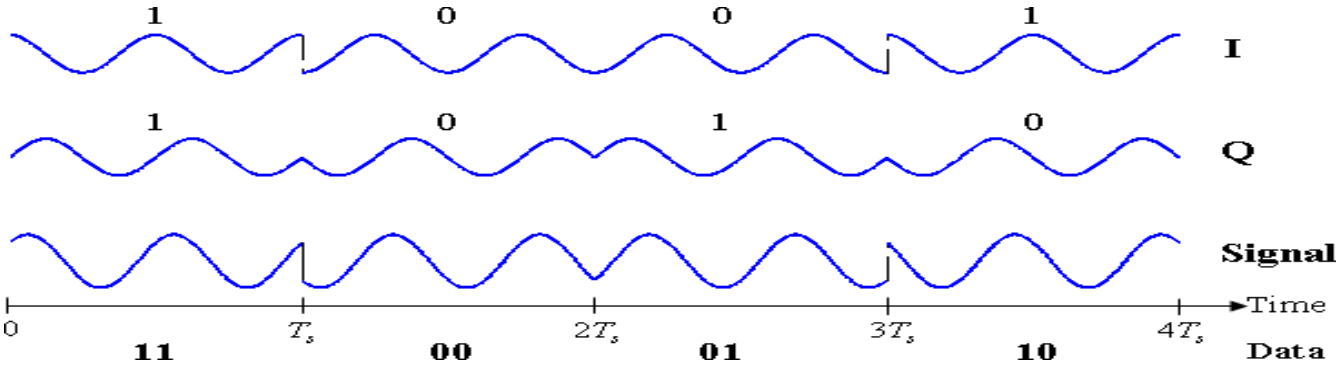
- The data is sent as discrete “packets” of bits, with each packet containing error checking and routing information.
- The receiver uses the information to determine if it received everything and received it correctly
  - Retransmission if errors detected
  - Not perfect, but very very very good

Digital is sent over radio by modulating AM, SSB or FM



Source: Wikipedia Commons

Frequency Shift Keying (FSK) simply uses two tones, one to represent 1's, one to represent 0's



Source: Wikipedia Commons

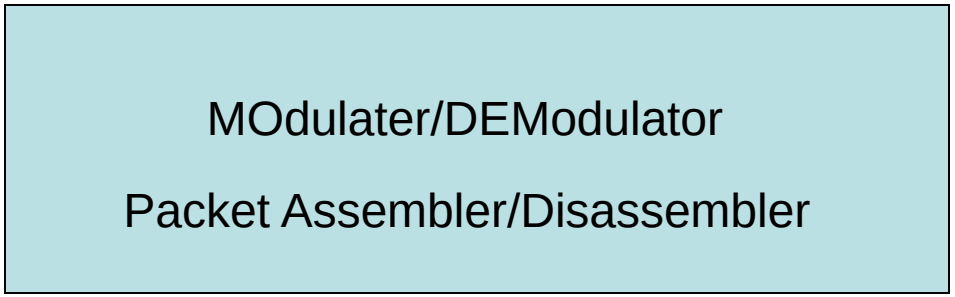
Phase Shift Keying (PSK) uses phase differences between two tones

WARNING: Most digital data communications is continuous duty cycle

- Duty cycle: percent of time the transmitter is outputting at set power
- In SSB voice, the transmitter is rarely outputting at full power because it is amplitude modulation
- CW is not continuous duty because of pauses between dots and dashes
- For most digital, and especially for packet, the transmitter is outputting continuously during a transmission
- Most ham equipment CANNOT handle continuous duty cycle at full power
  - e.g., a 100 watt multimode rig that will run 100 watts on CW/SSB, but is limited to 50 watts on AM/FM
- It's not just the transceiver – antennas, transmission lines, tuners, baluns, etc. may not be able to take continuous duty cycle at full power

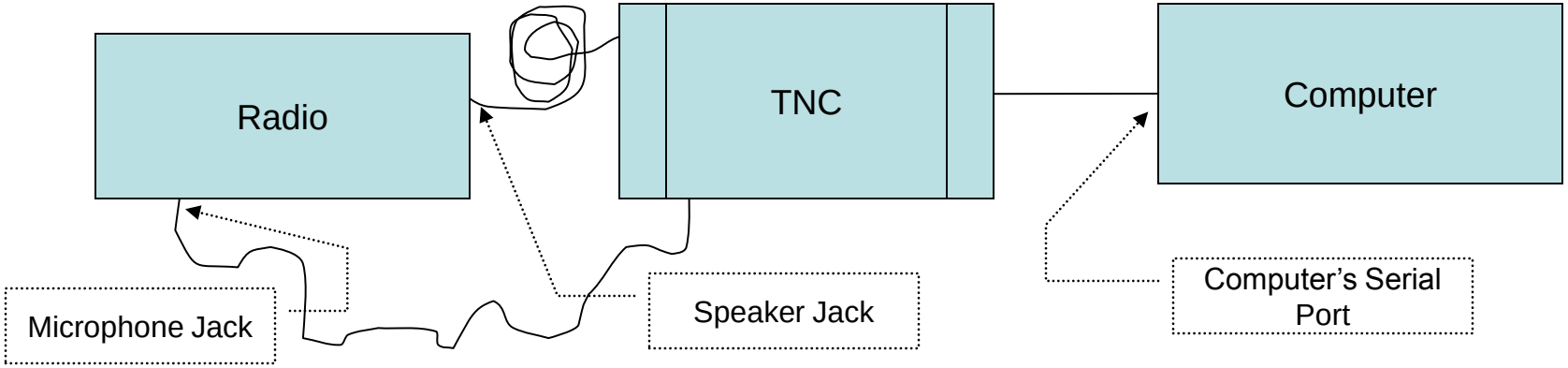
Even if you are within the rig's continuous duty cycle rating, can the antennas, etc. take it?

To get the data to/from the radio, we need two things:



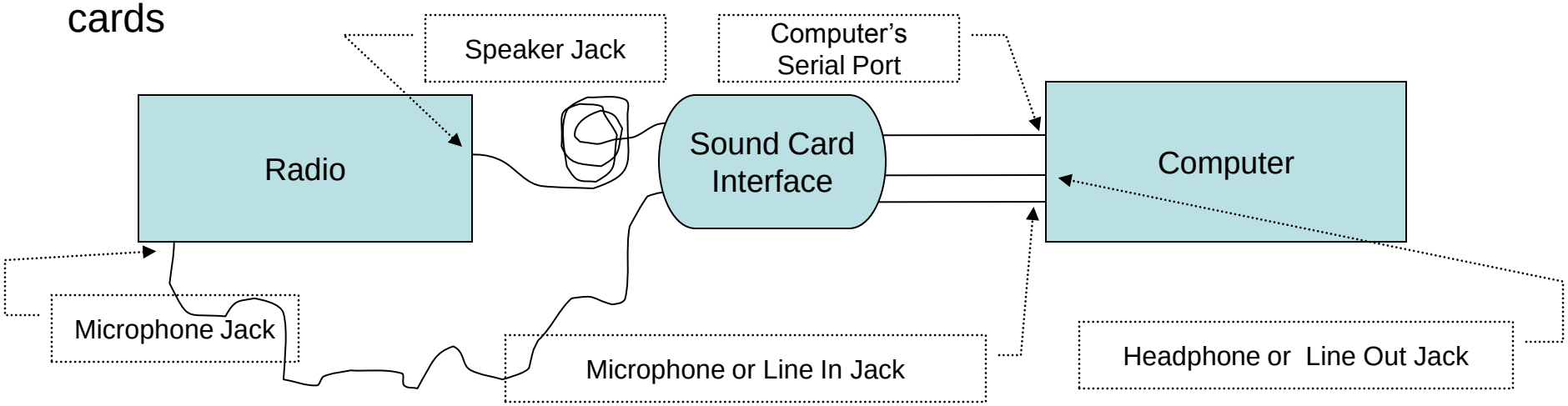
- MOdulator/DEModulator converts bits to sounds and converts sounds to bits
  - a/k/a MODEM
  - Used for years to let computers communicate over land lines
- Packet Assembler/Disassembler (PAD)
  - Create packets for outbound data
  - Decode packets on inbound data (include the error checking)
  - Communicate with the other station and arrange for re-transmissions when there are errors

Early interfaces were Terminal Node Controllers (TNCs), which provide a MODEM, PAD, and HOST services



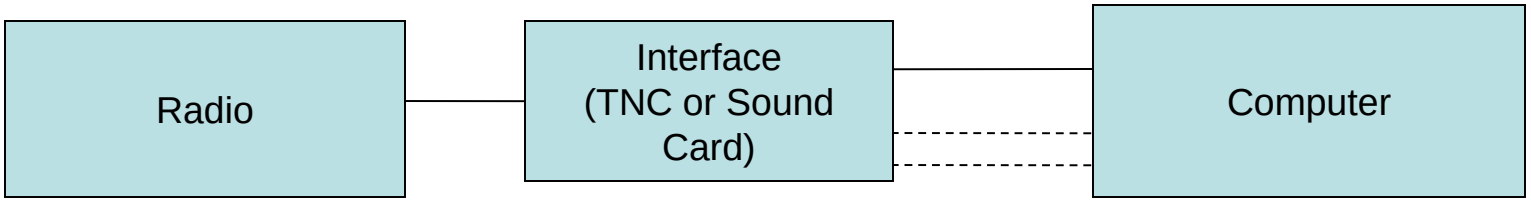
- Two modes of operation
  - KISS: Basic MODEM plus PAD
  - HOST: Advanced services such as Bulletin Board systems
- Needed TNCs in the "early days" when our computers could not handle both the text processing and the packet processing at the same time (not to mention the HOST services)
- Best known name: Kantronics
  - TNCs ranging from about $200 to over $500 (new)
  - More advanced models can control multiple rigs and multiple computers
  - Relatively bulky (until recently) and need their own power supplies

But more current computers have plenty of computer power and have sound cards



- Basic computer sound card does everything a modem does
- Plenty of software that can process packets; plenty of processing power
- Enter the RIGblaster
  - Need a good sound card in good working order and a reasonably fast computer
    - Circa 2002 or beyond
  - Does not provide HOST services
  - Prices range from $60 to about $200
    - Less than half the price of a full Kantronics TNC
  - Small and lightweight, no power supply needed if connected to computer via USB

Newer radios have data jacks for a single connection for sound in, sound out, and some rig control



- Eliminates connectors to mic and headphone jacks
- Basic rig control functionality such as PTT and squelch
  - Does not include tuning, mode/band switching, etc.
- Example: Yaesu FT-897 6 pin mini-DIN

Pin Description
1 Data IN
2 GND
3 PTT
4 Data Out (9600 bps)
5 Data Out (1200 bps)
6 Squelch

Some of the newest TNCs are light, small, inexpensive, and much easier to use

- Generally under $100, e.g.
  - TNCs: Coastal Chipworks TNC-X, Byonics TinyTrak4
  - Sound card interfaces: RIGblaster (NOMIC and Plug&Play), Buxcomm Rascal
  - External sound card: Tigertronics SignaLink USB
- No HOST mode
- With USB interface, powered by computer
- Provide packet processing for equipment that doesn't have packet processing capabilities such as GPS receivers
- Suitable for very portable operations (e.g., field APRS transmitter, digipeater)

Byonics MicroTrak AIO (GPS field tracker) uses a MicroTrak4 connected to a 2m HT

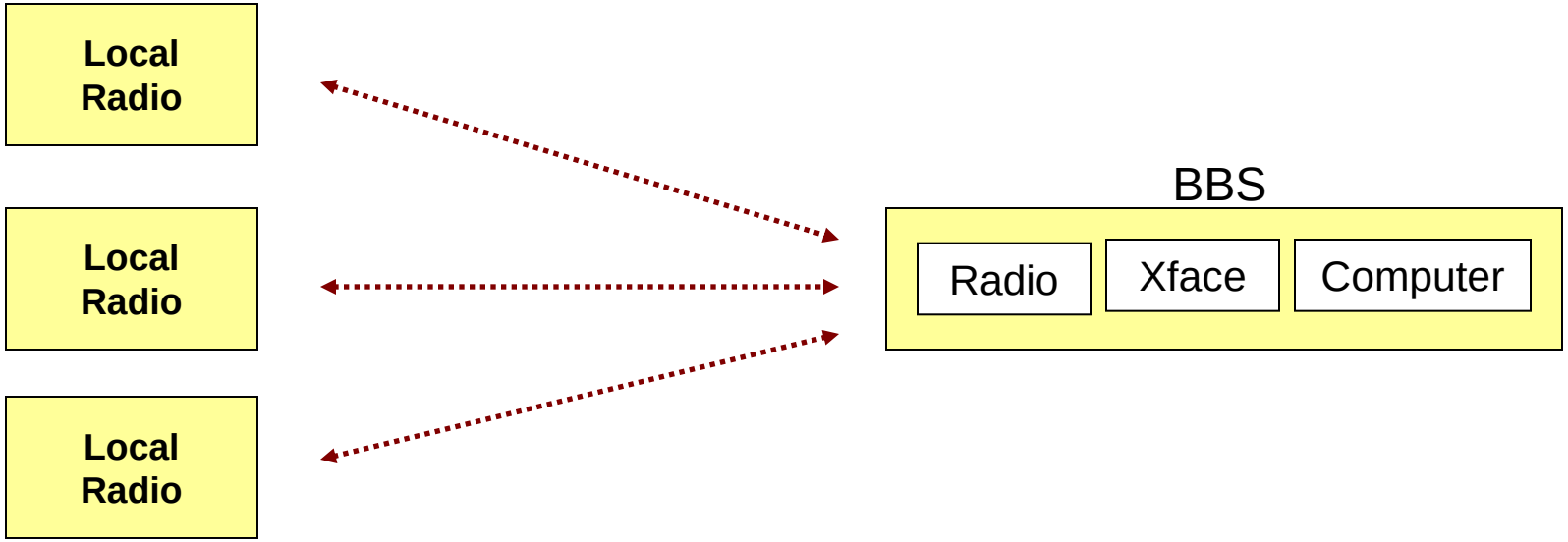
So what do I buy?

- Older TNC, Sound Card Interface, or Newer TNC?
- Some of the issues:
  - Widest range of software works with TNCs (older or newer)
    - Some of the software works with sound card interfaces but not all
  - Newer TNCs better suited for use with APRS transmitters and with digipeaters
  - Newer TNCs not as complex as older, easier to implement, and lower cost
    - Do you need all the capabilities of a big mother Kantronics? Probably not.
  - Most field testing says sound card interfaces no more difficult to implement than older TNCs and probably easier
  - $s
  - No known compatibility issues re: signals sent through older TNC being read by newer TNC/soundcard or vice versa

- **Does the software you want to run work with soundcard?**
- **Do you need the complexity and pain of the older TNCs?**

One approach to implementing packet is Bulletin Board Systems (BBSs)

- BBS provides
  - Public postings (think of a bulletin board in the supermarket)
  - Private postings from one individual to another (not exactly email, but is user-to-user focused)



- Stations within the disaster area can pass messages to each other via the BBS
  - BBS can be inside the disaster area (emergency power) or outside the disaster area

BBS networks have grown up in some areas to provide extensive coverage inside and outside a disaster area

- Northeast FlexNet map
  - Radio-to-radio
  - Some stations still in operations, although map is not current
- Stations communicate with each other via packet

Fewer and fewer BBS stations on the air

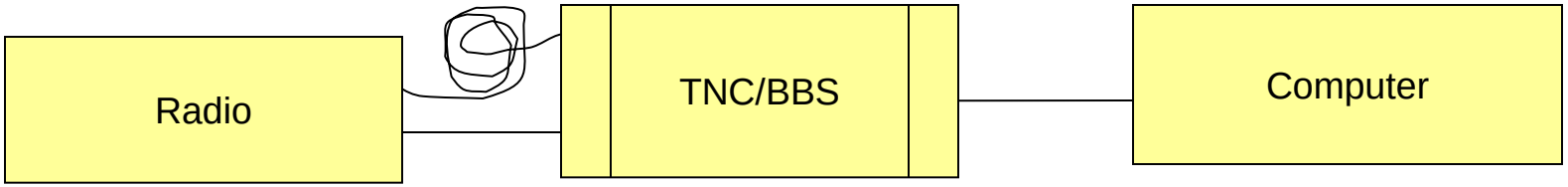
Sample transmission times using packet to a BBS

- Stamford to Rowayton (10 miles), using an older Dell laptop (Latitude D600) and a Yaesu FT-7800 at 25 watts FM
- Notes:
  - 3600 seconds in an hour
  - Includes time to connect/handshake and time to disconnect
  - Random generated message contents

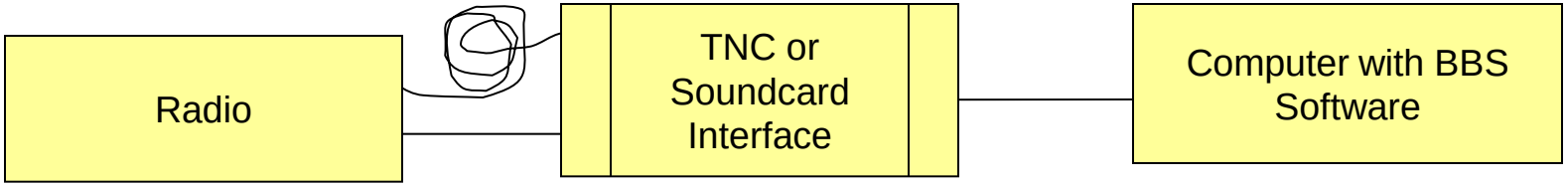
Chars	Seconds	Equiv Minutes	Characters/ Second	Equiv lines of text (100 chars/line)	Equiv H&W emails (200 chars)
10	52	<1 min	<1	n/a	n/a
100	49	<1 min	2	1	n/a
1,000	73	1:13	13	10	5
10,000	403	6:43	25	100	50

No substantial difference in transmission time for real-world text

Older BBSs were based in the TNC; newer ones are based in the computer

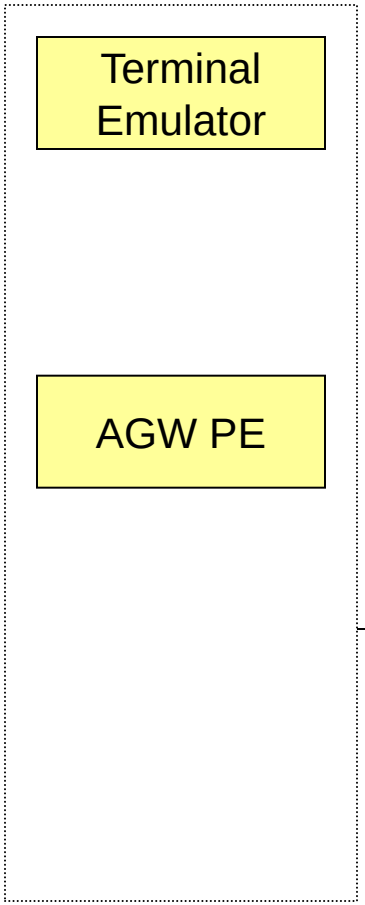


- BBS in the TNC made it difficult to get data from the BBS into the computer
  - The best that could be done was to display the contents of the BBS on the computer monitor and maybe screen capture it.



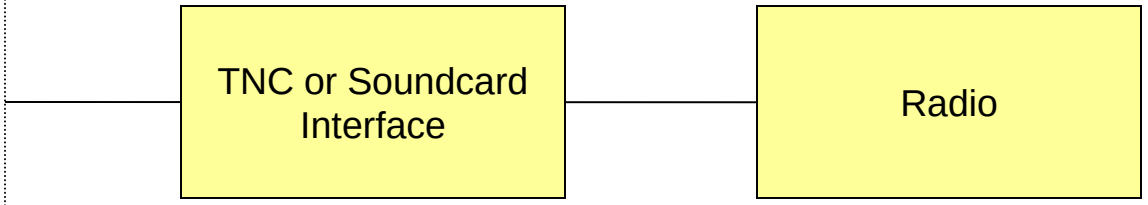
- BBS in the computer makes it possible to access the messages as data
  - Once accessed as data, can be forwarded or processed
  - BUT
    - Most BBS systems allow only text (i.e., printable characters) in their messages
    - They do not allow non-text attachments such as spreadsheets or images

What software/hardware for the local station accessing a BBS?



Simple emulator like Hyperterm that comes with Windows or something more sophisticated, depending on user preference

Packet engine software (processes the packets) – AGW PE (free) or AGW PE Pro ($30) from SV2AGW

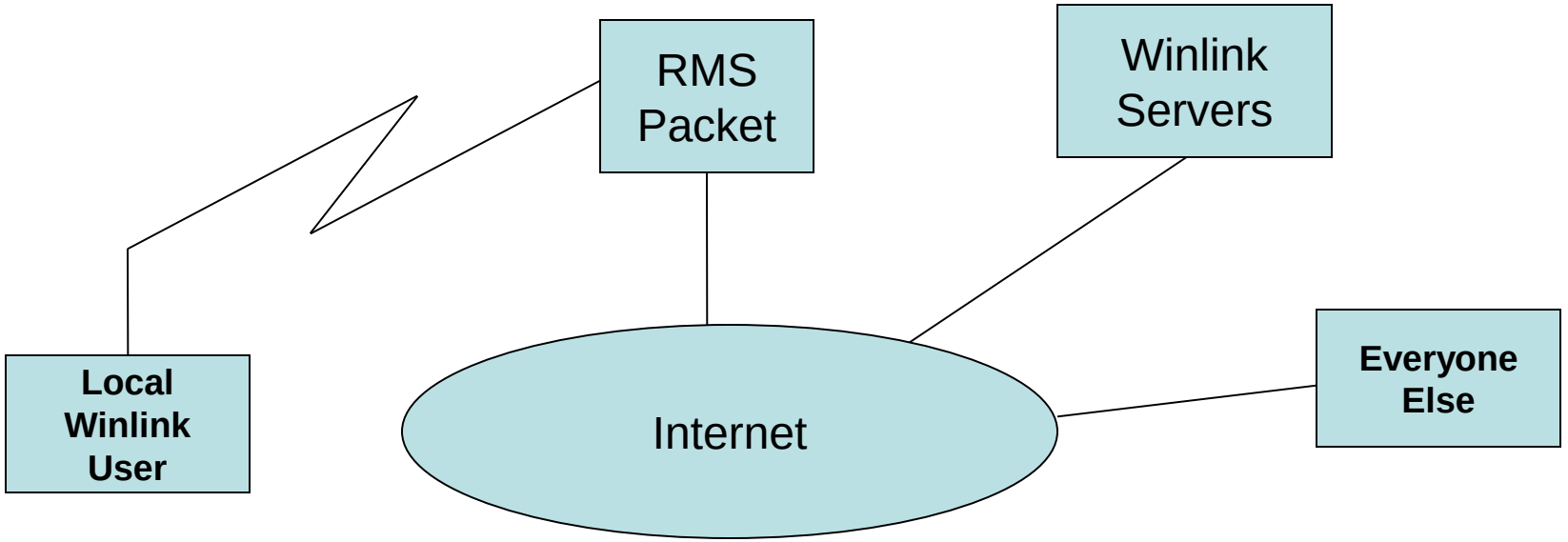


Don’t need AGW if using a TNC, but many people use the AGW software and leave the TNC in KISS mode

Most BBSs have low limits for messages sizes

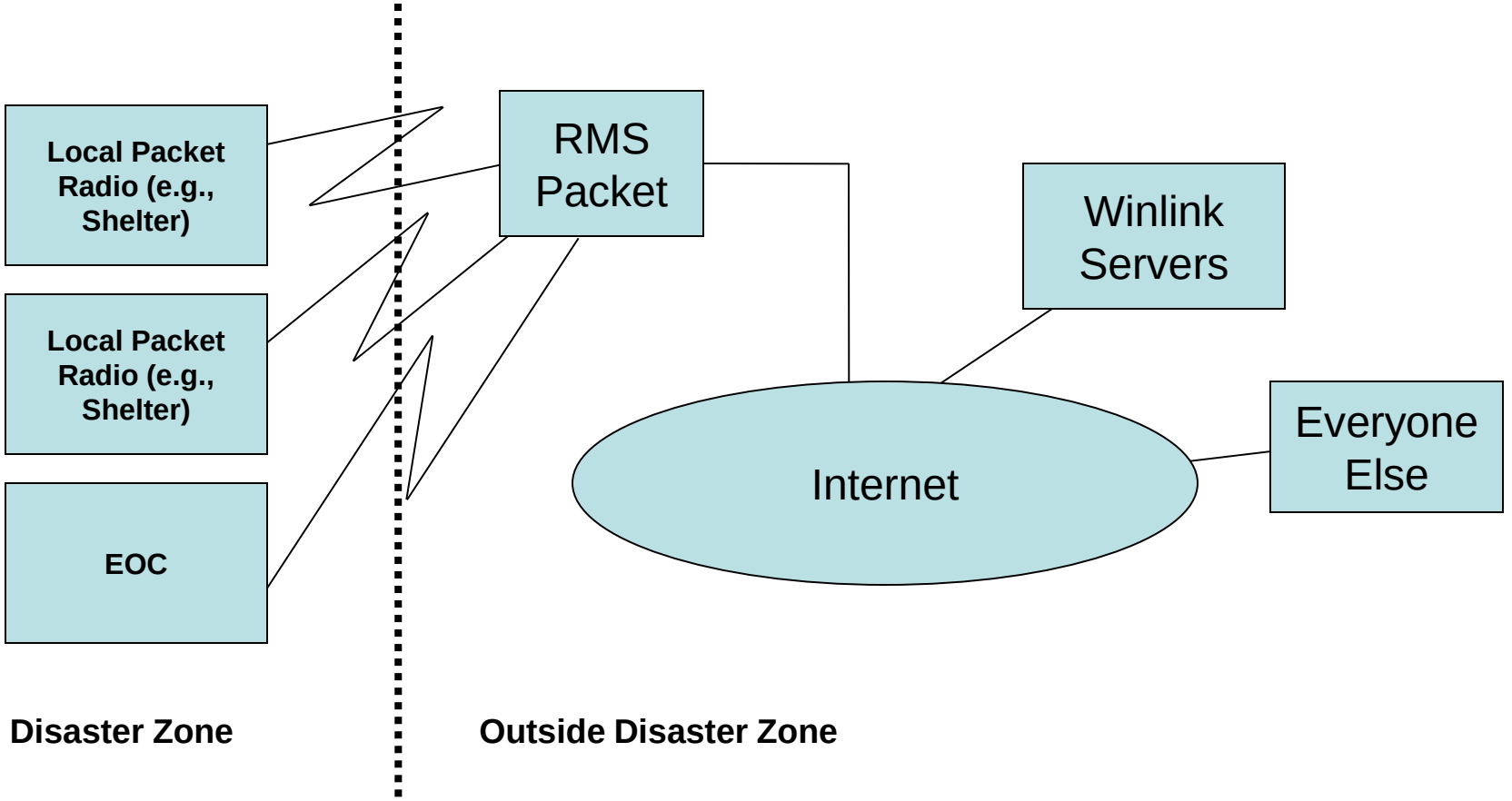
Some EMCOMM groups are focusing on VHF packet with Winlink

- Winlink is a worldwide emergency email system connected to the Internet
  - Five servers around the world
  - Radio access (RMS) from local stations
  - Once a message makes it to a Winlink server, it enters the Internet as a standard email message
  - RMS station is VHF packet radio interfacing to a computer running RMS software
  - http://www.winlink.org



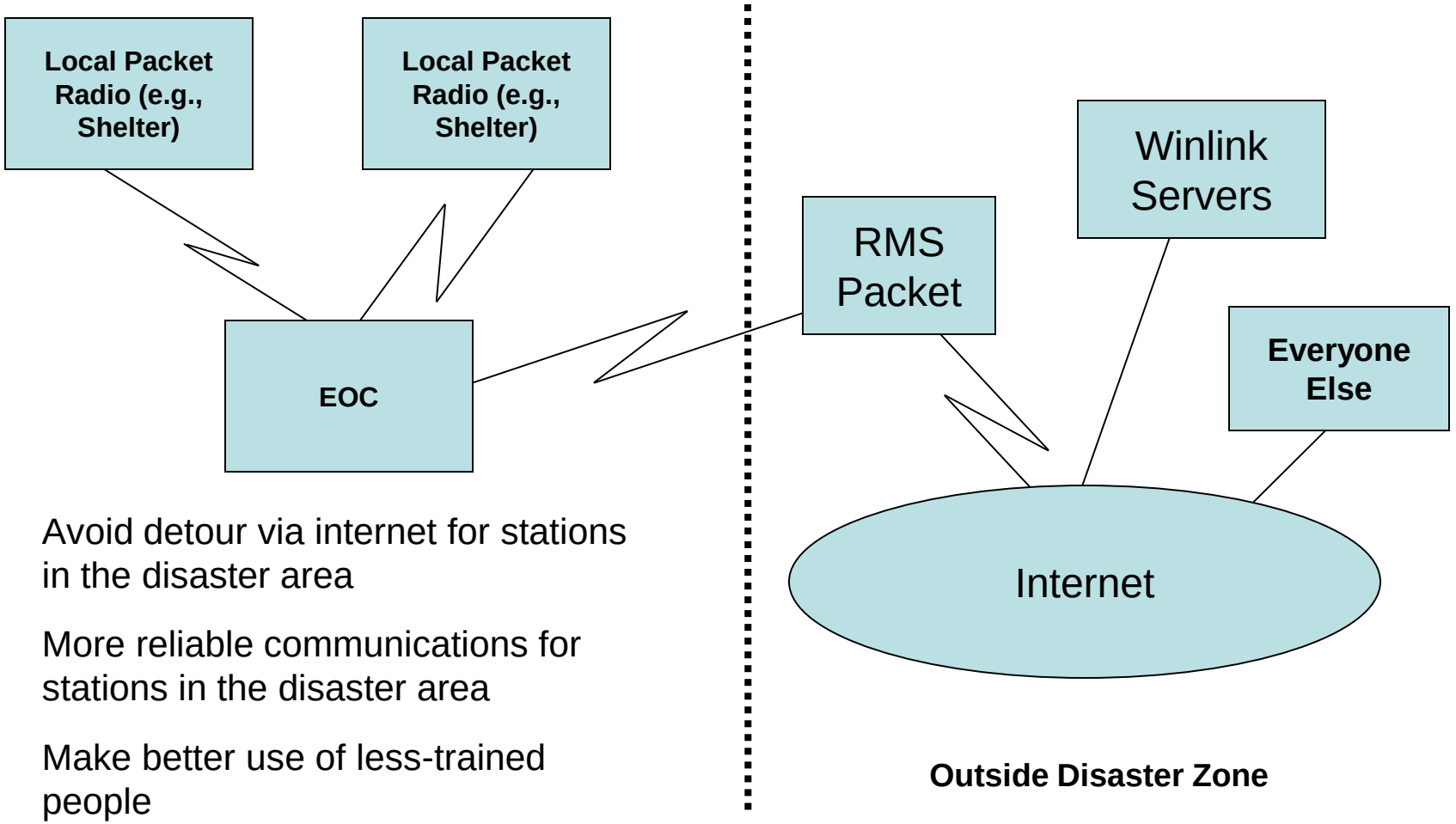
Basic concept is packet radio within the disaster area to an RMS packet station outside the disaster area

- Local stations can communicate via RMS Packet station(s) outside the disaster area



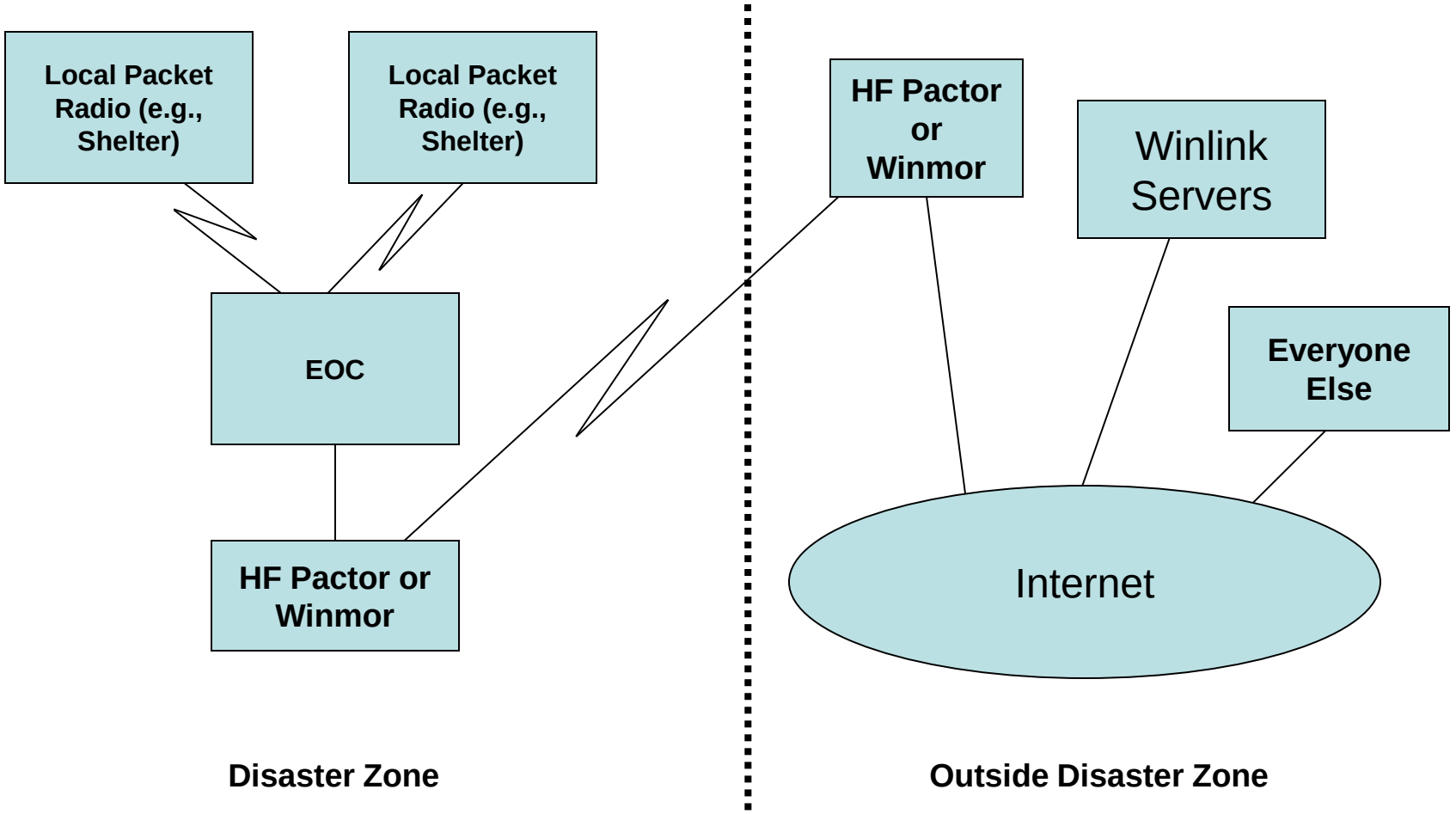
Note the individual stations do not talk with each other in this model

Stations within the disaster area can communicate with each other using Winlink Point-to-Point (P2P)

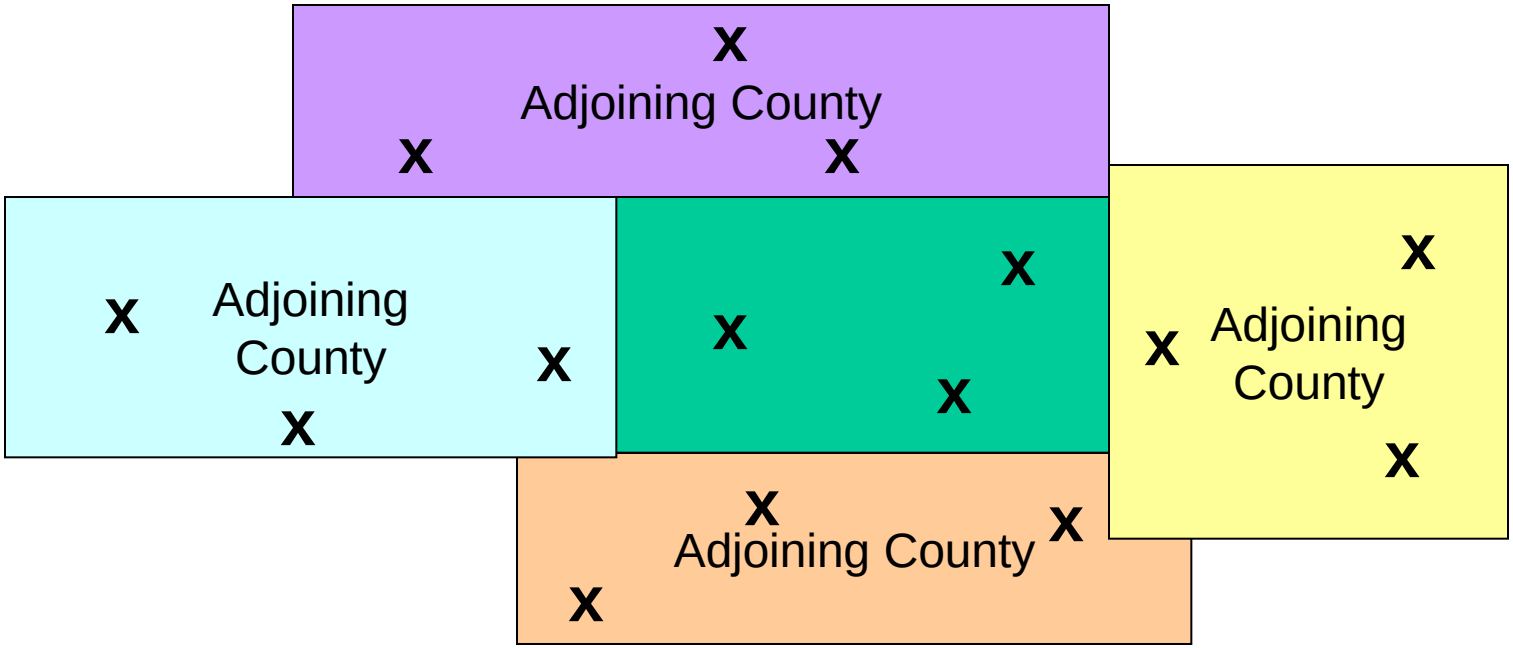


- Avoid detour via internet for stations in the disaster area
- More reliable communications for stations in the disaster area
- Make better use of less-trained people

Messages can be sent to/from the disaster area using HF Pactor or Winmor



Some Emcomm organizations are setting up Winlink networks



- Winlink nodes are coordinated within the county to maximize reach and coordinated with adjoining counties to get further coverage
  - Coordination includes locations, electric, and internet grids
- Winlink nodes in EOCs, or at least secure, safe buildings with good emergency power

Sample transmission times for Winlink messages

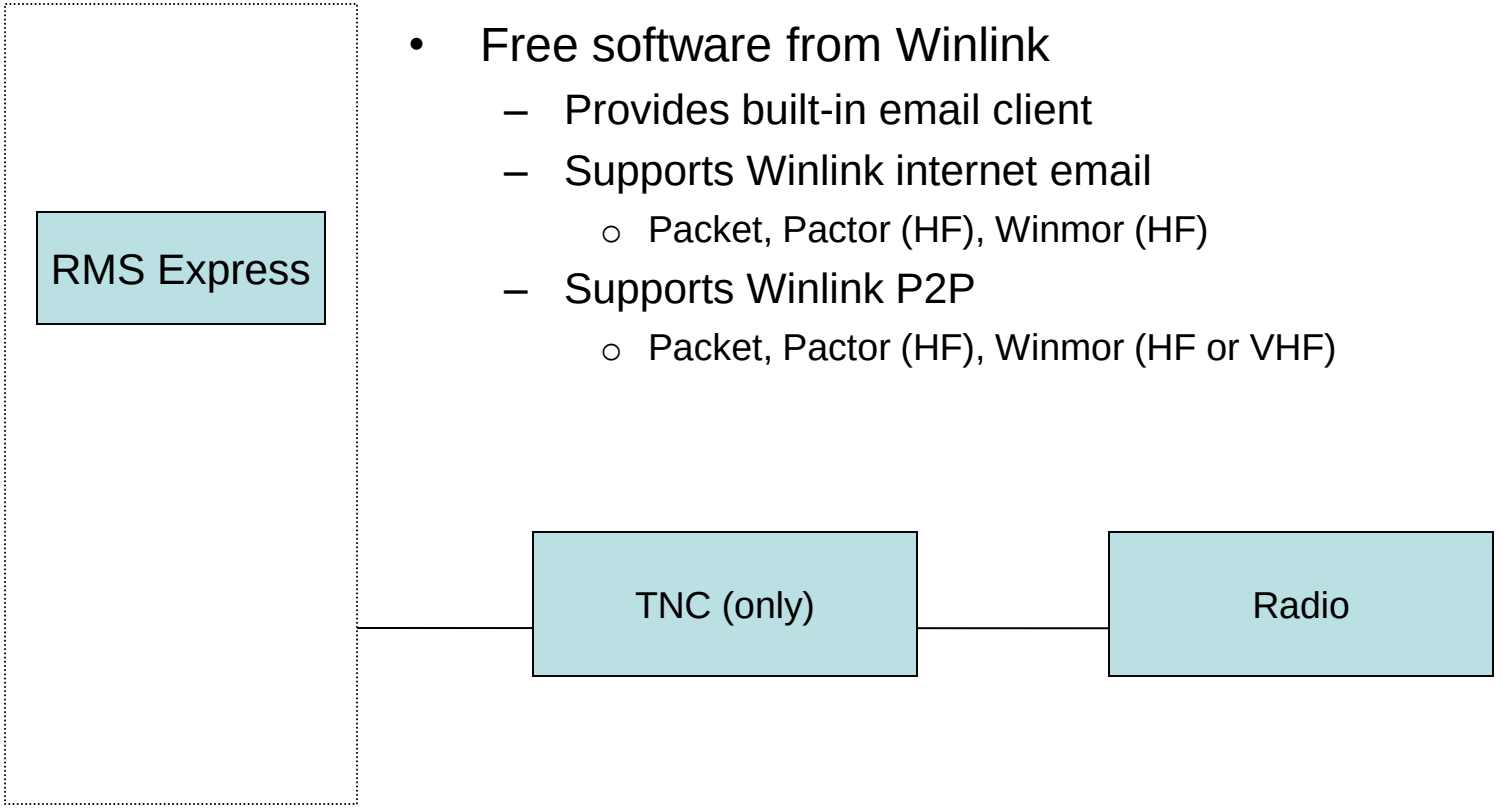
- Stamford to Rowayton (10 miles), using an older Dell laptop (Latitude D600) and a Yaesu FT-7800 at 25 watts FM at 1200 baud
- Notes:
  - Includes time to connect/handshake and time to disconnect

Chars	Characters/ Second RANDOM	Characters/ Second SOME REPEAT	Characters/ Second MASSIVE RPT
100	2	10	100
1,000	12	20	150
10,000	26	45	320
100,000	29	50	1500
	All random chars	Representative real-world text	Same 10 chars repeated

1500 char/sec at 1200 baud. Say what?????!!!

Winlink-specific programs (e.g., Paclink) compress the message before sending

Preferred connection uses a TNC with RMS Express

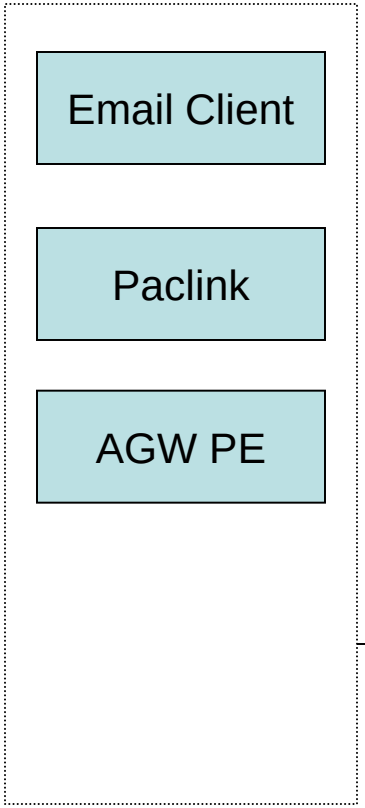


- Free software from Winlink
  - Provides built-in email client
  - Supports Winlink internet email
    - Packet, Pactor (HF), Winmor (HF)
  - Supports Winlink P2P
    - Packet, Pactor (HF), Winmor (HF or VHF)

Except for Winmor, requires that each station has a TNC – not always practical given general lack of packet use among hams

Limit of 120,000 characters per message, including attachments

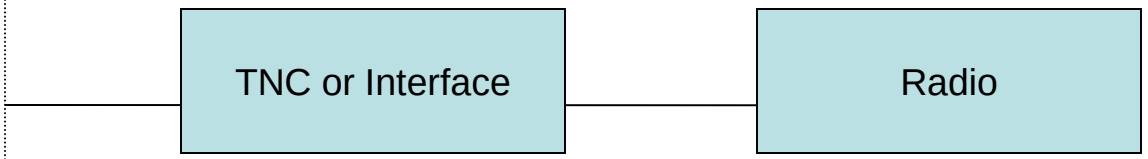
Paclink can operate with soundcard interface, but does not support P2P



Standard email client such as Outlook, Outlook Express, or Thunderbird

Free software from Winlink – interfaces between the email client and the packet engine. Replaces Airmail, which was its own email client

Packet engine software (processes the packets) – AGW PE (free) or AGW PE Pro ($30) from SV2AGW



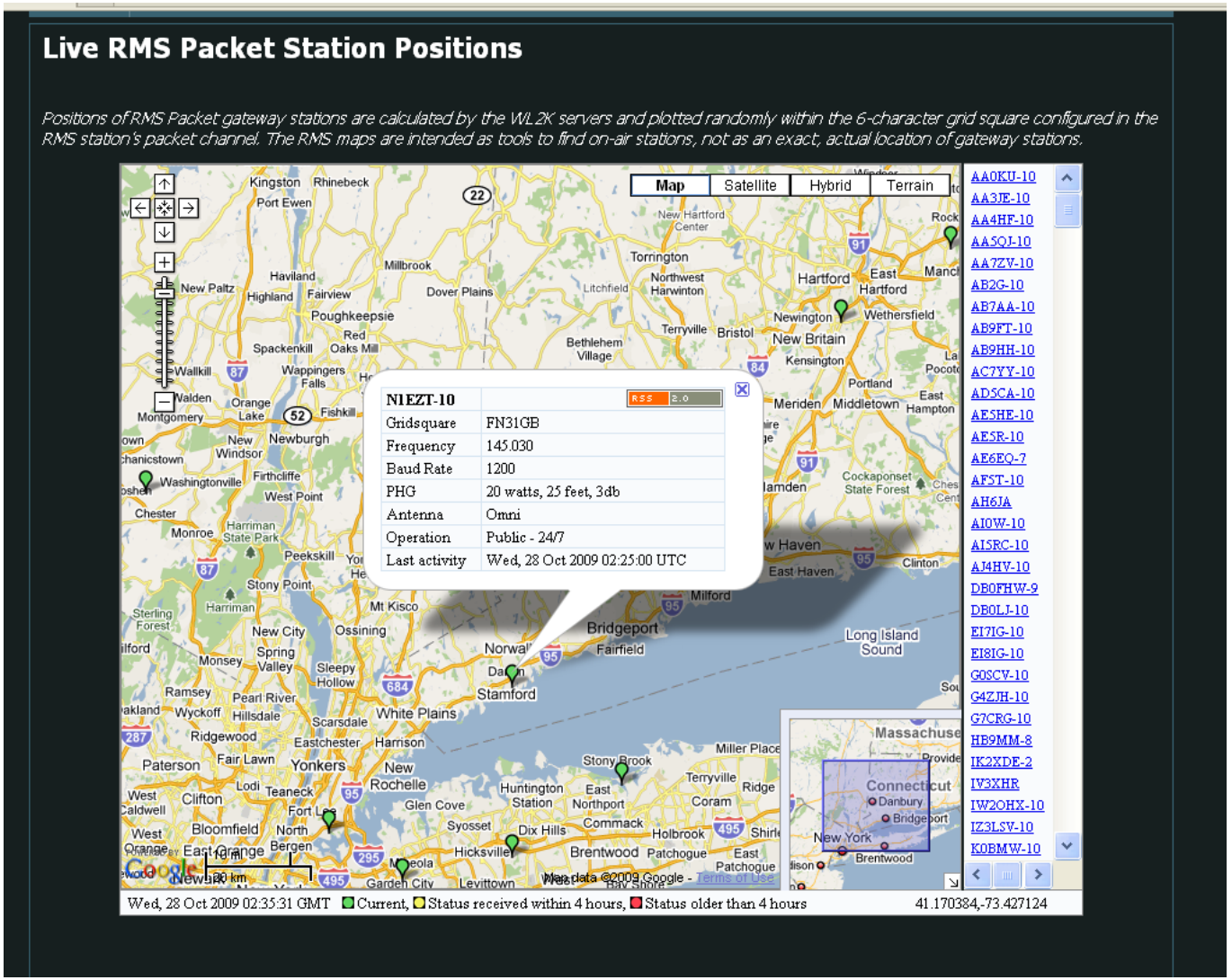
Don't need AGW if using a TNC

Limit of 120,000 characters per message, including attachments

What computers/operating systems for Winlink?

- In general Paclink, AGWPE, RMS Express run on Windows XP/Vista/7 computers
  - Under Vista/7 must be loaded outside of c:\Program Files
  - Generally run okay in Win XP virtual partitions (e.g., VMware)
  - Generally run well on Macs in Windows emulation
  - Generally run well on Linux with WINE
- Download Paclink, RMS Express from Winlink, download AGW from SV2AGW site
  - Often provided on CD with TNC, sound card interface, other interface products
- If using Paclink
  - Configure a host called “LOCALHOST” to talk with your email client
- If using AGW
  - Configure AGW as to port, baud, etc.
  - Start AGW before Paclink
- If using RMS Express
  - Configure email client to talk with your email provider (if desired)

You can see a map of local Winlink stations



http://www.winlink.org/RMSPacketPositions

Repeaters, digipeaters, and Packet Radio

- Typical VHF Packet Radio does not work well with regular VHF ham repeaters
  - Typical repeater's delay between unkeying and carrier drop will often cause time-outs
  - Courtesy tones do ugly things to packets
- Digipeaters (DIGItal rePEATERS) are repeaters specifically designed for extending digital communications (and especially Packet Radio communications).
  - Generally small, lightweight (size of a typical VHF mobile radio *or smaller*)
  - Some digipeaters can run for days on one set of batteries (low power, primarily for getting around obstacles)
  - Can be quickly deployed with a portable antenna

Byonics MicroTrak 4 configured as a digipeater

Other protocols may also be of interest

- NBEMS (Narrow Band Emergency Messaging System) – a newer method focused on HF for direct communications from disaster areas to EOCs (inside or outside of the disaster area)
  - Can also be used for VHF
- HF Pactor – Packet Radio over HF for longer-range communications, including Emcomm from within a disaster area to outside the disaster area
  - High-end TNCs ($$$s)
  - Does not work with sound cards interfaces
- WINMOR – HF protocol for use with Winlink
  - Targeted for “typical” Windows computer with sound card
  - Targeted at 300-1200 baud
- PSKMail – mail via PSK31 (or other PSK modes)
  - Works well with relatively short HF messages
  - No error checking or correction

Useful Web Sites

- Winlink: //http:www.winlink.org
- SV2AGW (AGW Packet Engine): //http:www.sv2agw.com/ham
- Yahoo Loading WL2K group: groups.yahoo.com/group/LOADING_WL2K_USER_PROGRAMS/
- Yahoo Winlink EMCOMM group: //http:groups.yahoo.com/group/wl2kemcomm/
- Yahoo Paclink group: //groups.yahoo.com/group/PaclinkMP/
- Narrow Band Emergency Messaging System: //w1hkj.com/NBEMS/
- Good overview of digital modes: //www.wb8nut.com/digital.html
- Yahoo DigitalRadio group: //groups.yahoo.com/group/digitalradio/