



# **INTERNET DOWN: Digital Ham Radio to the Rescue!**

Lee Lukehart K7AVR  
Bonner County ARES  
May 20, 2023



# First, what IS the internet?



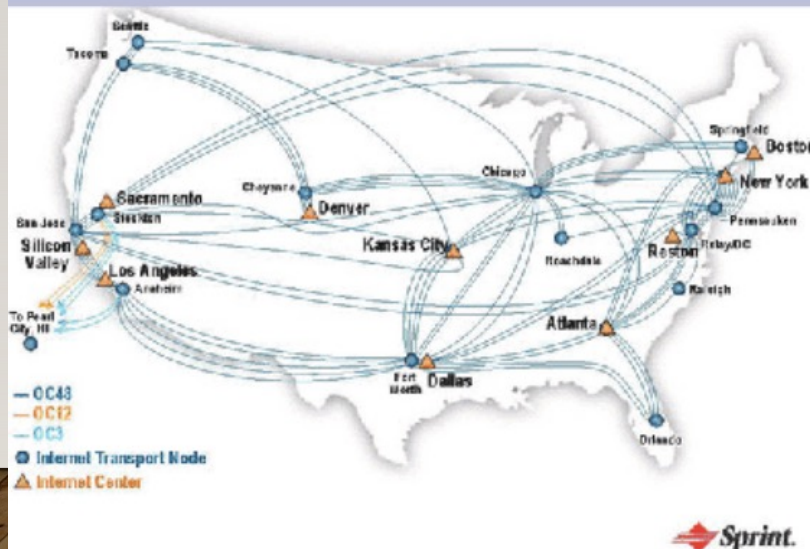
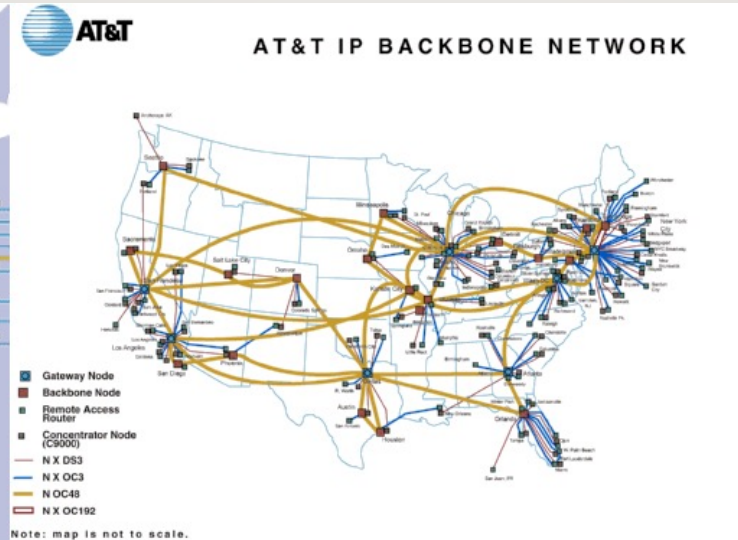
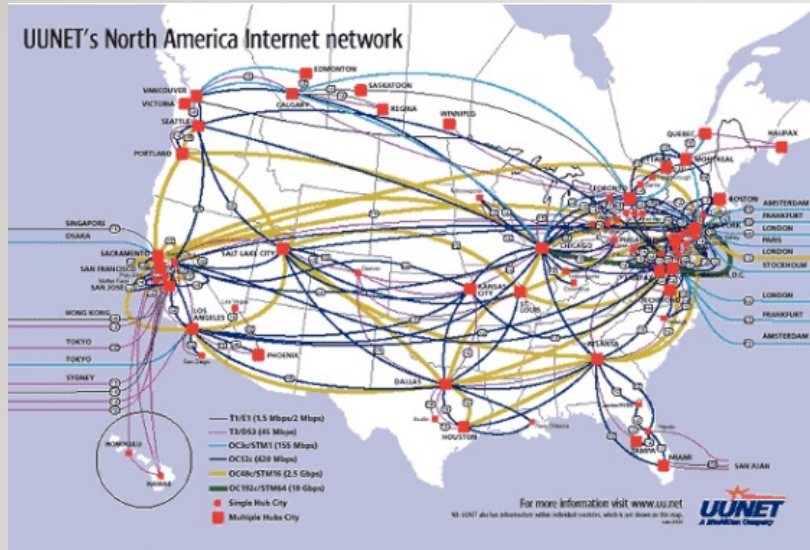


# First, what **IS** the internet? Answer: **Connection**

- A worldwide network of *connected computers*
- A worldwide network of *connected webservers* (e.g. DBs, web pages)
- A worldwide network of *connected things* (e.g. thermostats, Alexa, IoT)
- A worldwide network of *connected networks* (e.g. home & business)
- A conduit for *connected commerce* (e.g. ATMs, CC terminals, gas station pumps)
- A conduit for *connected communication devices* (doorcams, phones, etc.)



# First, what IS the internet? Answer: Infrastructure



## Long-haul backbones:

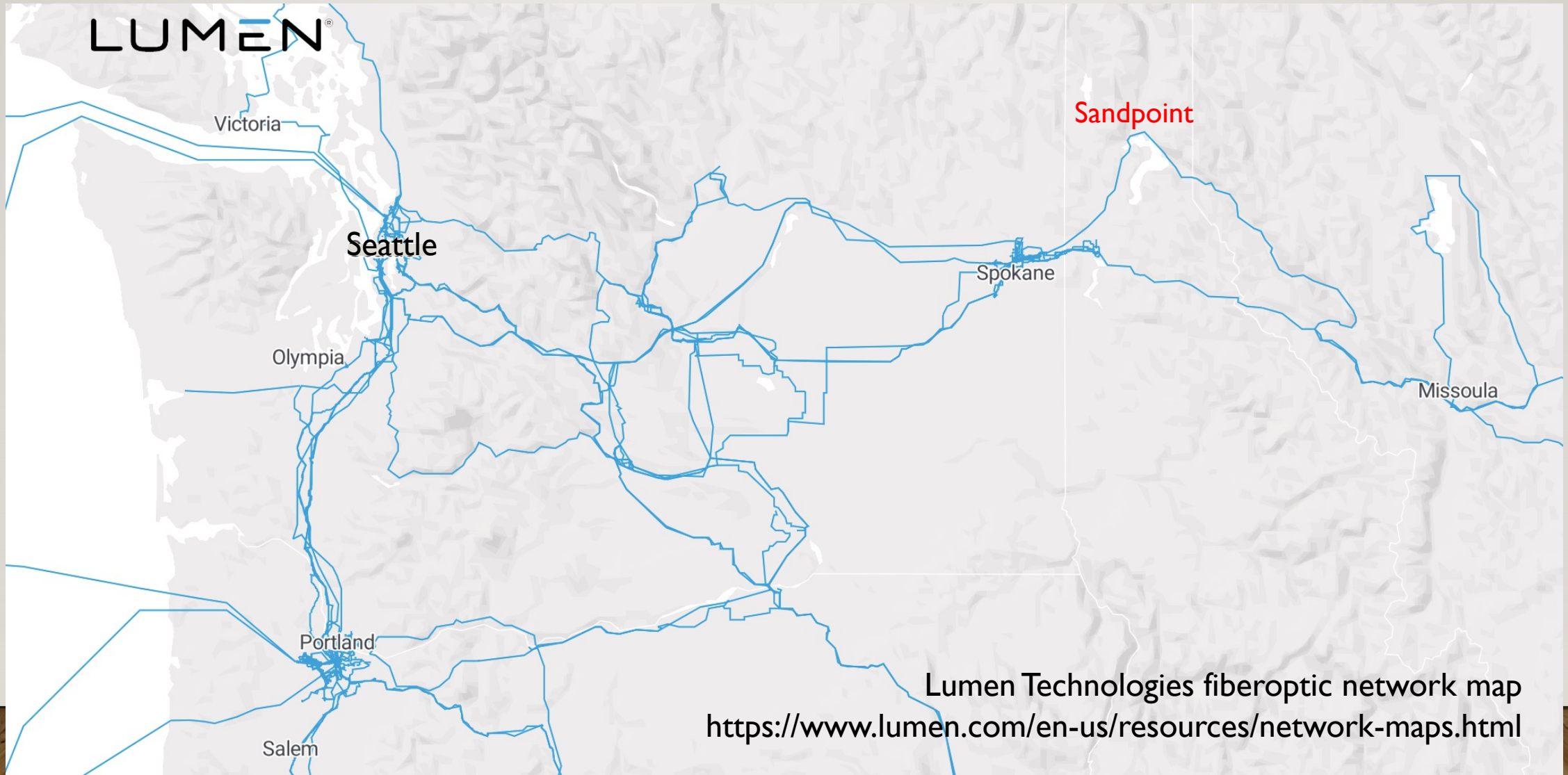
The US internet backbone has been privatized, with business taking over the job of carrying long-haul internet traffic.

The backbones carrying the most traffic are Level(3) [merged w/ CenturyLink > Lumen], UUNET [now Verizon], AT&T, and Sprint/T-Mobile.

Nine out of ten of the world's largest telecom carriers use Level(3) services, as do five of the top six U.S. Internet Service Providers, and nine out of ten of the largest European telecom carriers (historically as of ~2016).



# SEATTLE is OUR main internet source



# If the internet fails, these go with it...

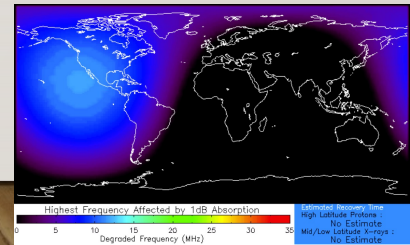
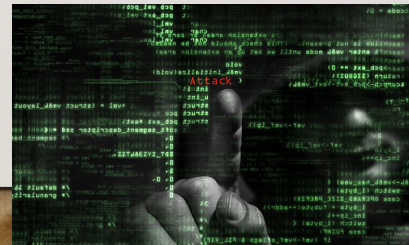
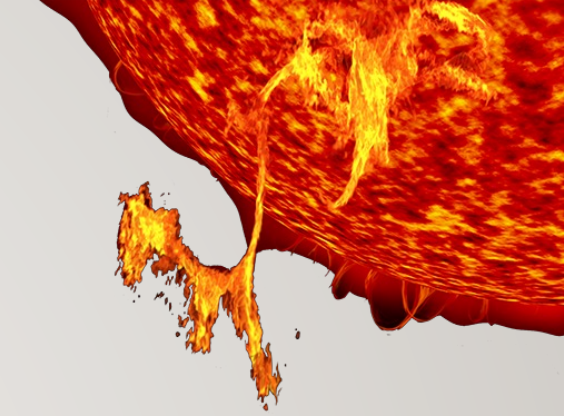
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# How could our internet possibly fail?

- Wide-area power loss for an extended time
- Cyber Attack
- 9.0 earthquake in Seattle (due to Cascadia Subduction Zone)
- Solar Coronal Mass Ejection (CME)
- Electromagnetic Pulse (EMP)
- Disruption of Power Grid or Satellite Links by any of above



# **We need an alternative communications conduit!**

- Does not rely on any infrastructure (power nor internet)
- Proven technology
- Widely available

**Solution:** “Marconi” wireless (signals over radio waves)

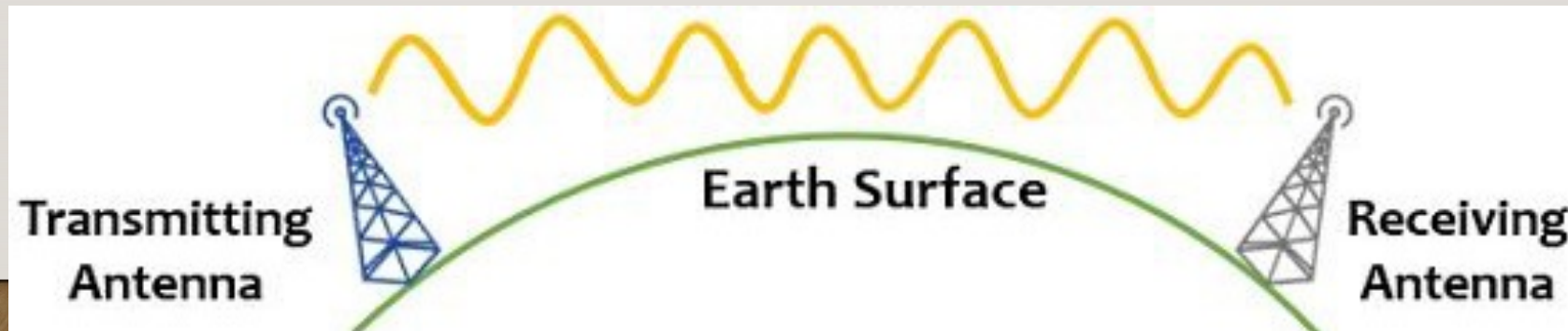


Image Credit: <https://electronicsdesk.com/radio-wave-propagation.html> via John K7BSV



## However, voice radio\* has limitations:



- Slow speed (we can read faster than we can talk)
- Poor accuracy (“Did you say *Bay* or *Pay*?”) )
- Anyone can hear message (no encoding/encryption)
- Poor use of radio spectrum (voice takes more bandwidth )
- Higher radio power required for longer distances
- Atmospheric noise (static due to lightning, etc.)
- Must be tuned-in real time (no voicemail)

\*Radio User Survey:

☐ Family Radio (FRS)?

☐ GMRS?

☐ Ham licensed, VHF/UHF?

☐ Ham licensed, HF?

☐ Other?

# What is Digital Comms via Radio?

- Transmit computer-generated sounds via radio
- Provides ways to MOdulate and DEModulate signals
- Software apps exist to easily create & transmit signals
- Signals are encoded (not encrypted) in *modes*
- Can operate asynchronously (email-like, store & forward)





# Why Use Digital Modes?

- Fast & accurate data transfers
- Low RF power – never need more than 25 watts
- Many modes – select best for conditions
- Reliable comms – error correction built in



# Amateur (Ham) Radio has solutions!

- Hardware & Software for **Digital Comms**
- Almost ANY radio will work to some degree
- 1st software reco: **FLdigi Suite** (“texting via radio”)
- 2nd software reco: **Winlink Express** (“email via radio”)





# FLdigi Application Suite

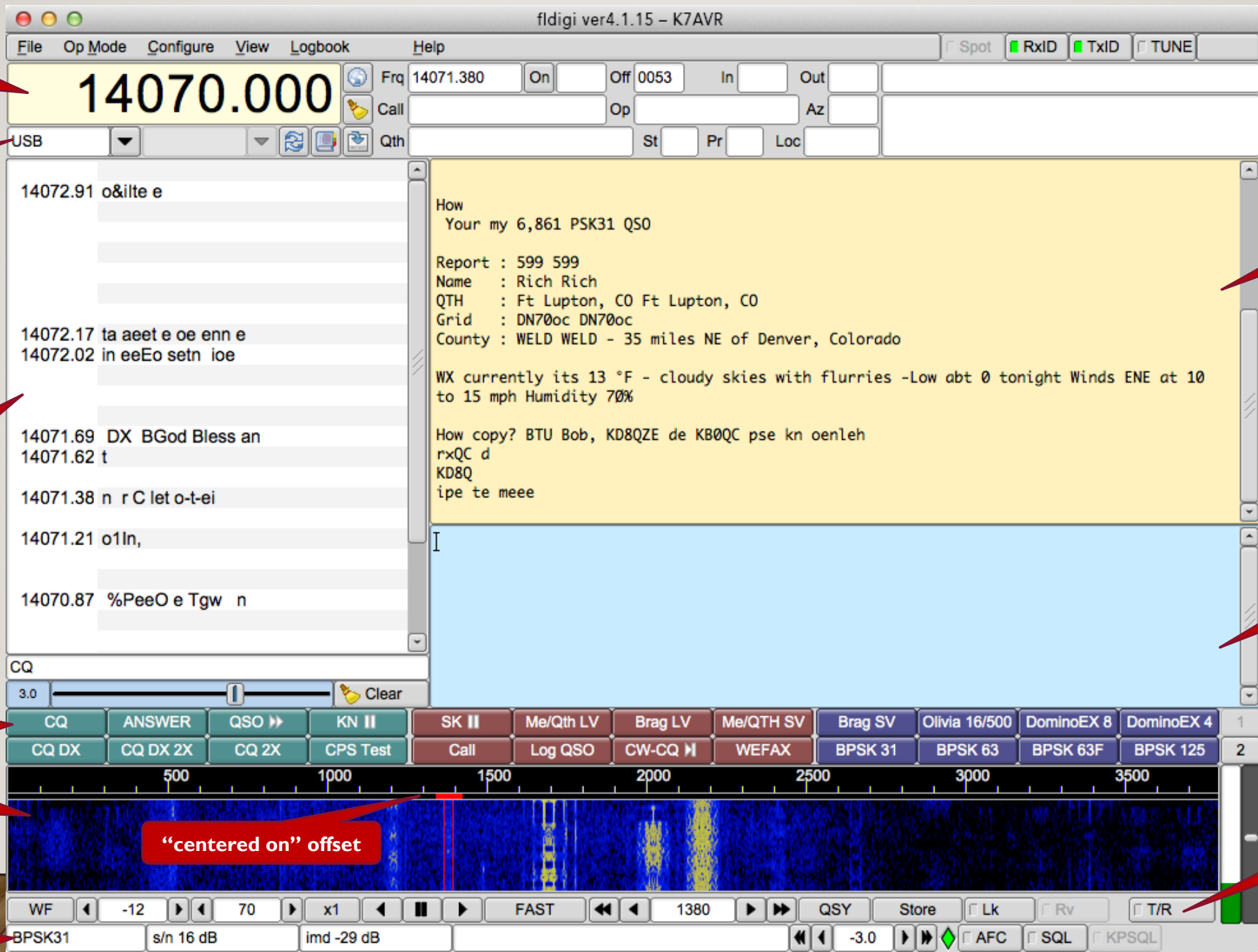
“FL” in name indicates GUI built with **Fast Light** Toolkit

<b>FLdigi</b>	– digital keyboard-to-keyboard*
<b>FLarq</b>	– Automated Repeat reQuest *
<b>FLmsg</b>	– message forms management (ICS,ARC)*
<b>FLamp</b>	– Amateur Multicast Protocol *
<b>FLrig</b>	– transceiver control *
<b>FLwrap</b>	– file encapsulation *

\* collectively referred to as NBEMS  
(Narrow Band Emergency Messaging Software)

Many thanks to creator Dave Freese W1HKJ





Tuned frequency

Radio mode

Signal browser

Text macros

Signal waterfall

Digital mode

Read text received

Type text to send

Click to transmit

"centered on" offset



# Computer Operating Systems

- Linux / Unix
- Windows (Win7 – Win11)
- macOS
- Desktop / Notebook / Netbook / Tablet
- “Android” for Android

# What Equipment do you need for FLdigi?

- Radio
- Computer (Mac / Win / Linux)
- Software

Also useful hardware to have:

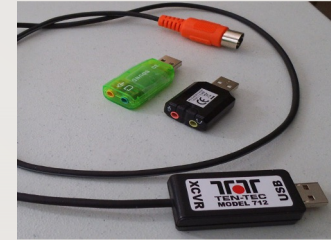
- Sound card interface (e.g. Signalink, RIGblaster)





# Sound Card Interface

- Connects computer sound card to the radio
- Radio frequency isolation
- Ground loop isolation (transformer coupling)
- Can automate the PTT when you transmit



- Some radios have sound interface built in



# FLdigi Demonstration!

Three computers set up:

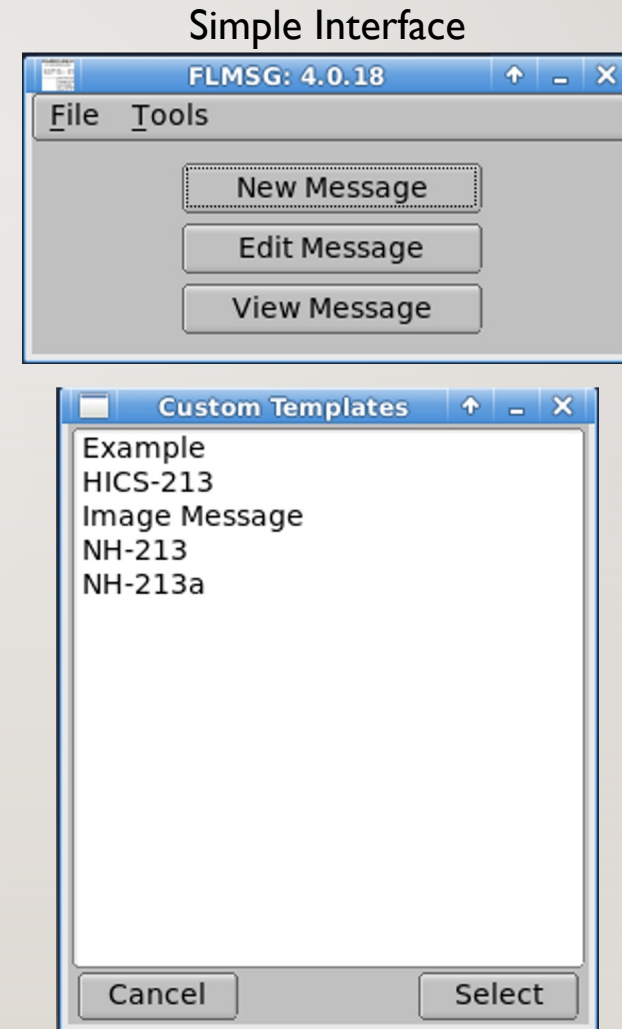
- Windows
- Linux (on Raspberry Pi 4)
- Mac



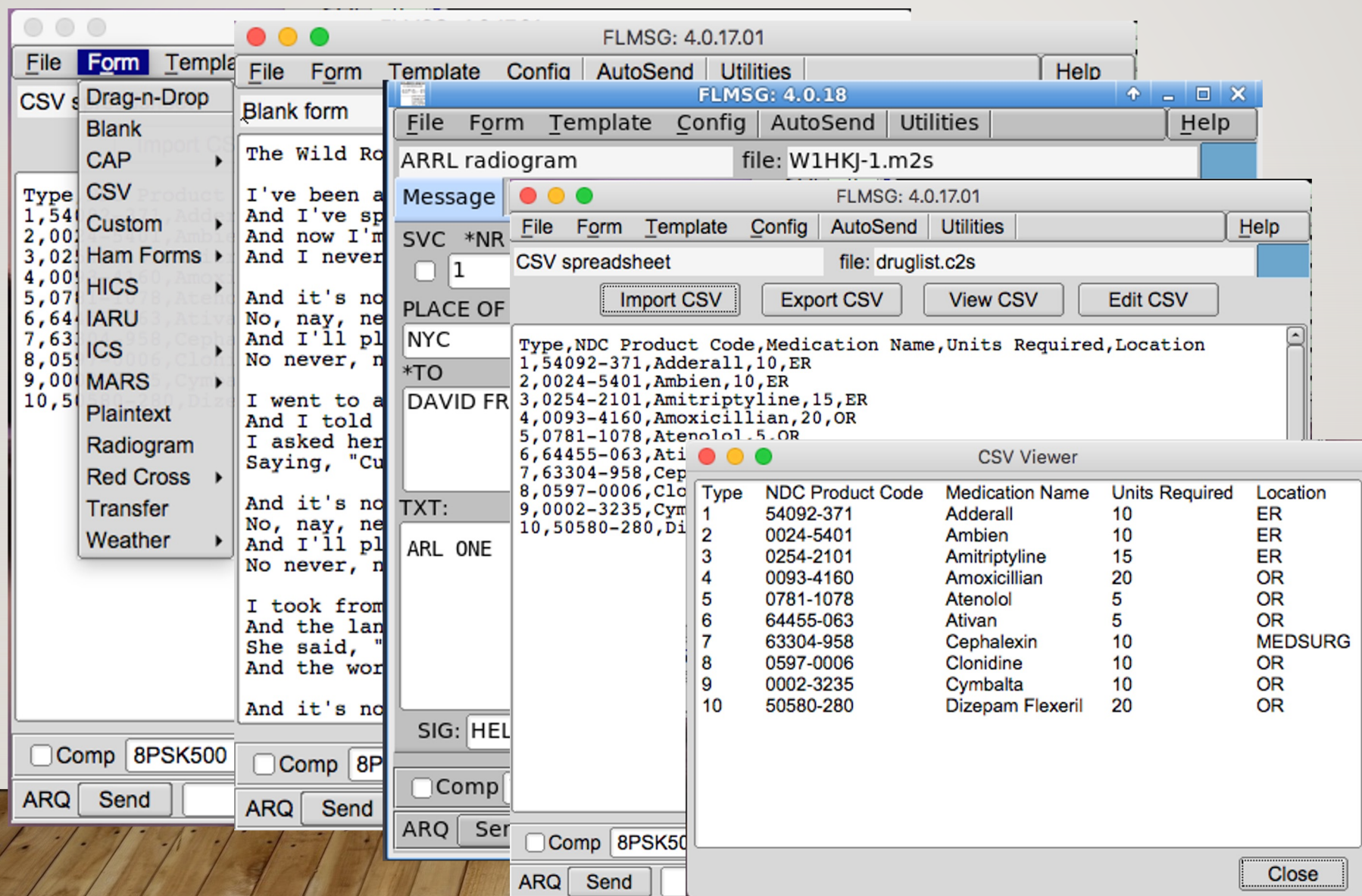
# FLmsg (for common forms)

## Message manager

- Generate
- Store
- Send
- Receive
- Fixed format
- Custom HTML



# FLmsg Built-in Forms





# FLmsg Custom Forms

(you can design to include legends, photos, illustrations, etc.)

127.0.0.1:8080

Search

Most Visited

fldigi

SF-files

☆

📁

⬇

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☰

## Select the Damage Level


From the Damage Level Pictures 1 through 4 shown below, choose the damage level that more closely resembles the damage in the address you are reporting.

1




NO/MINOR DAMAGE HABITABLE

2




MAJOR DAMAGE HABITABLE

3



MAJOR DAMAGE UNINHABITABLE

4



DESTROYED

Select damage level: 2. Major, habitable

Submit Form



- Worldwide system for sending & receiving email **via radio**
- *Can use internet*, if available (so non-Hams can receive/send)
- Well-tested, robust and resilient system
- Provides hybrid architecture for transferring messages:
  - Peer-to-Peer (similar to FLdigi) or
  - Remote Gateways (nodes), and/or
  - Common Message Servers (if internet is available)

Many thanks to Phil Sherrod W4PHS, Steve Waterman K4CJX, and dozens of other contributors

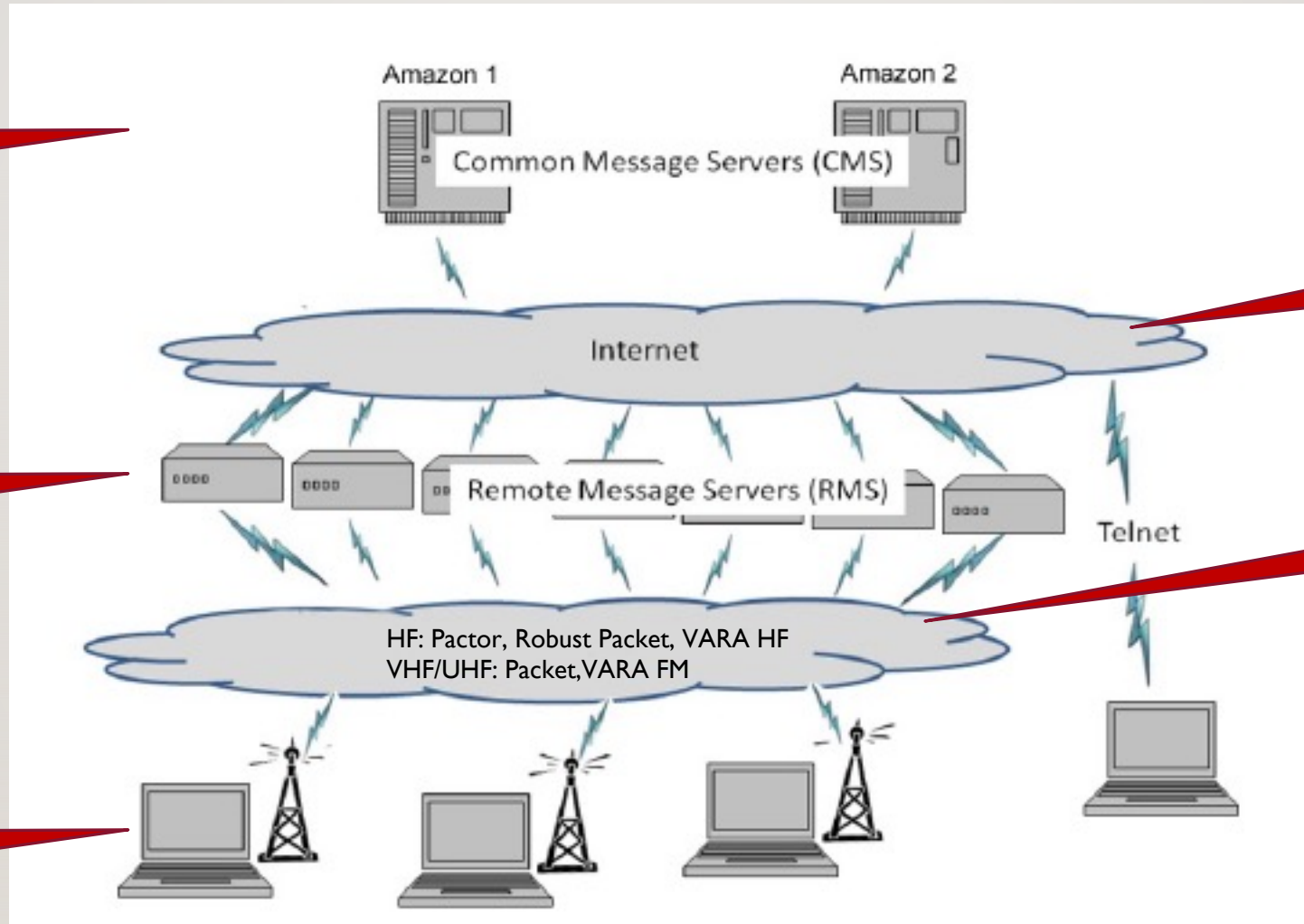


# Winlink System Architecture

**Winlink Servers  
(on the internet)**

**Winlink Gateways  
(via radio)**

**Winlink Client  
(YOU)**



**Internet connection**

**Radio connection**

# *Take your pick...* **Types of Winlink Messages**

- **Winlink Message** (Your messages are sent via radio to a remote message server (RMS) which then connects through the internet to a Common Message Server (CMS) where your message is stored and synchronized with other CMSs. Your recipient can connect to any RMS to retrieve any messages addressed to them. It doesn't matter which RMS the sender and recipient connect to. Also, because CMS is internet-connected, you can send & receive email to/from non-Winlink users!)
- **Radio-Only Message** (Does not need the CMS nor the internet connection CMS relies upon. Instead, messages are sent to the designated RMS for storage until they are retrieved by the recipient from that specific RMS.)
- **Peer-to-Peer Message** (P2P does not use CMS nor RMS; both radio stations must be on the air at the same time, on the same frequency and mode.)



# Winlink Global Reach

## ➤ Winlink HF Gateways (RMS) in America & Europe

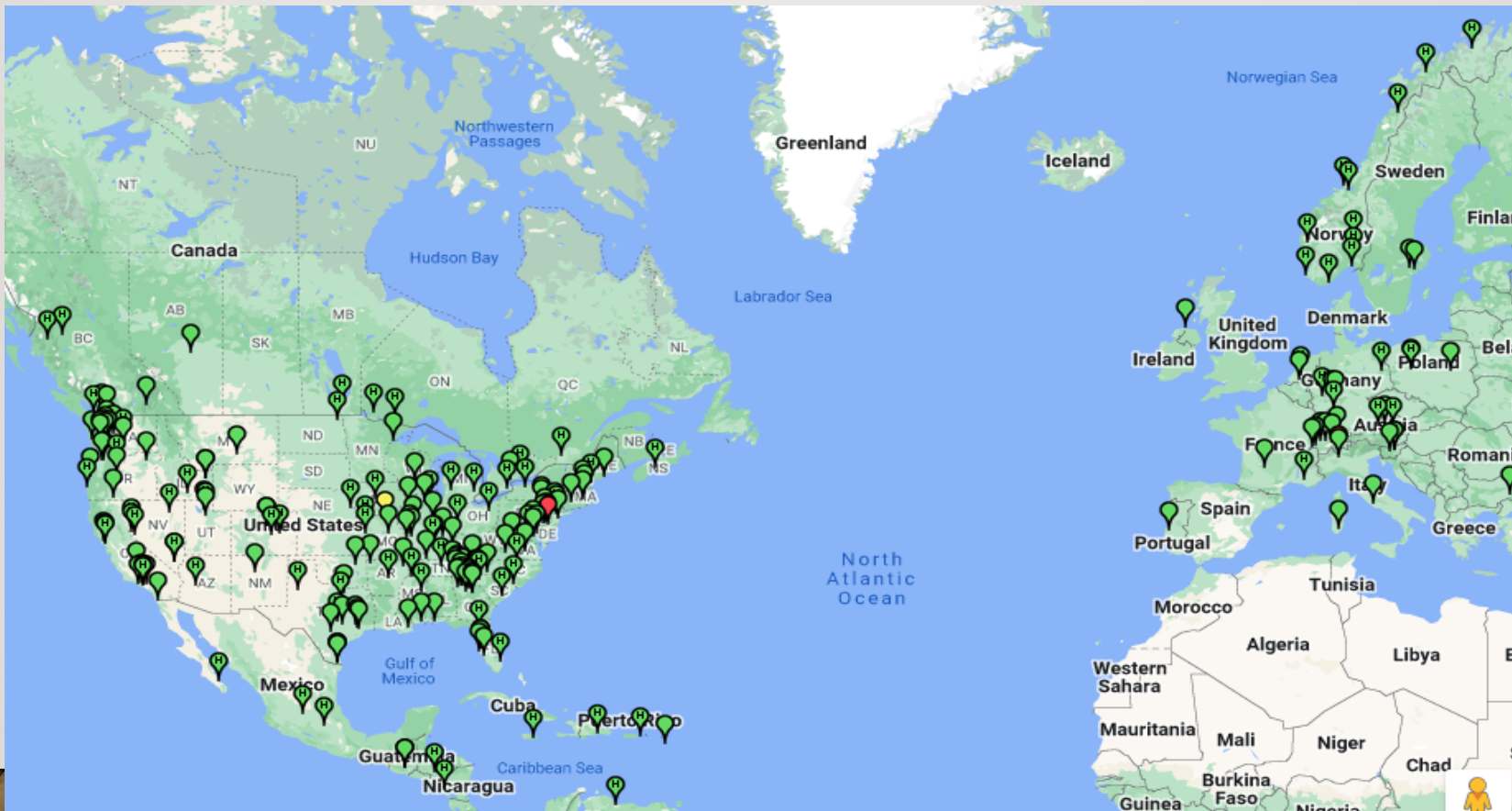


Image Credit: Amateur Radio Safety Foundation, Inc.



# What Equipment do you need for Winlink?

- Radio (VHF/UHF or HF)
- Windows Computer (or Linux/Mac running Pat)
- Winlink Express Software

Soundcard options vary with digital mode used:

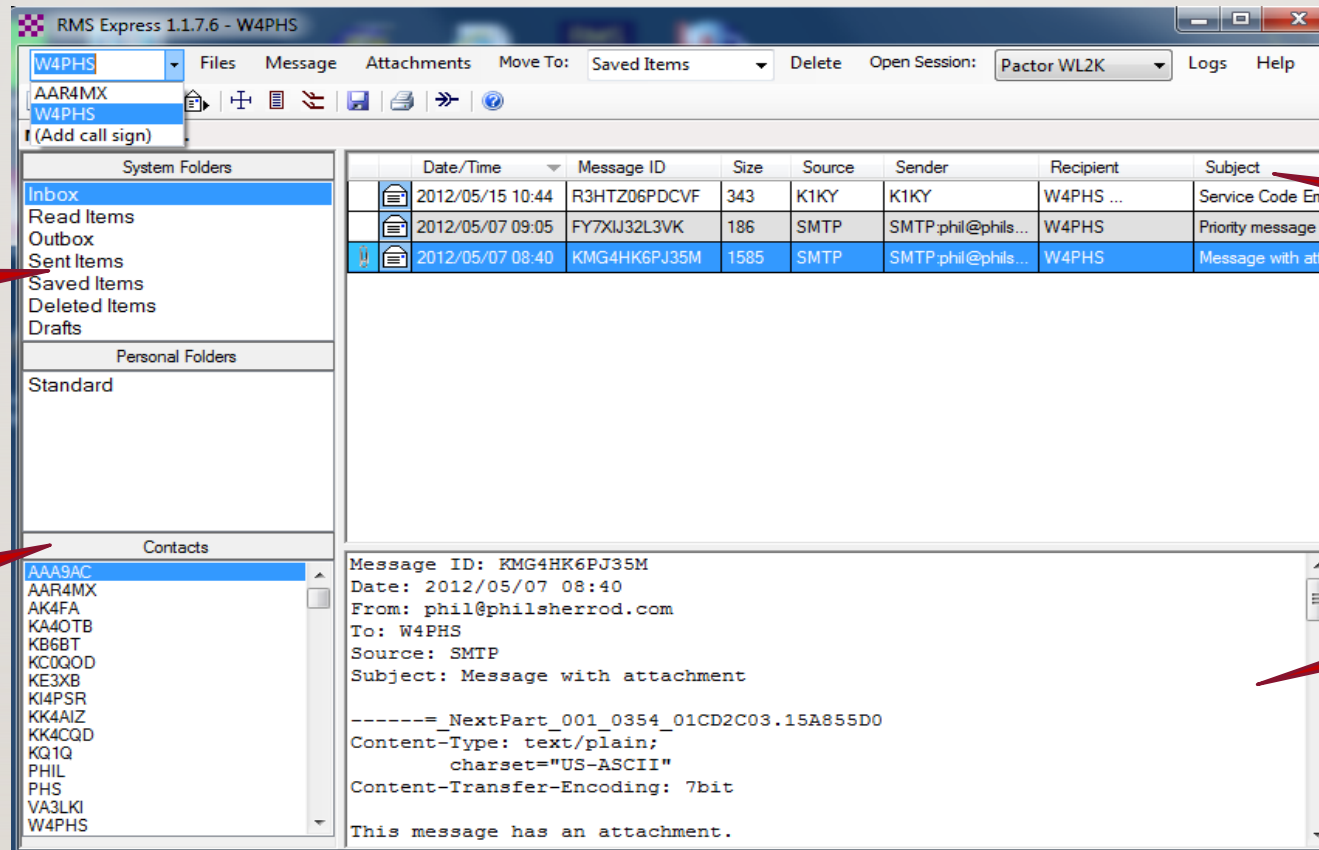
- Sound card interface for Packet or VARA modes
- Pactor TNC\* for any Pactor mode (HF only)

\* Pactor Terminal Node Controllers are proprietary and can be expensive



# Winlink Main Window

➤ Looks like a typical email app with panes...



Organized Folders

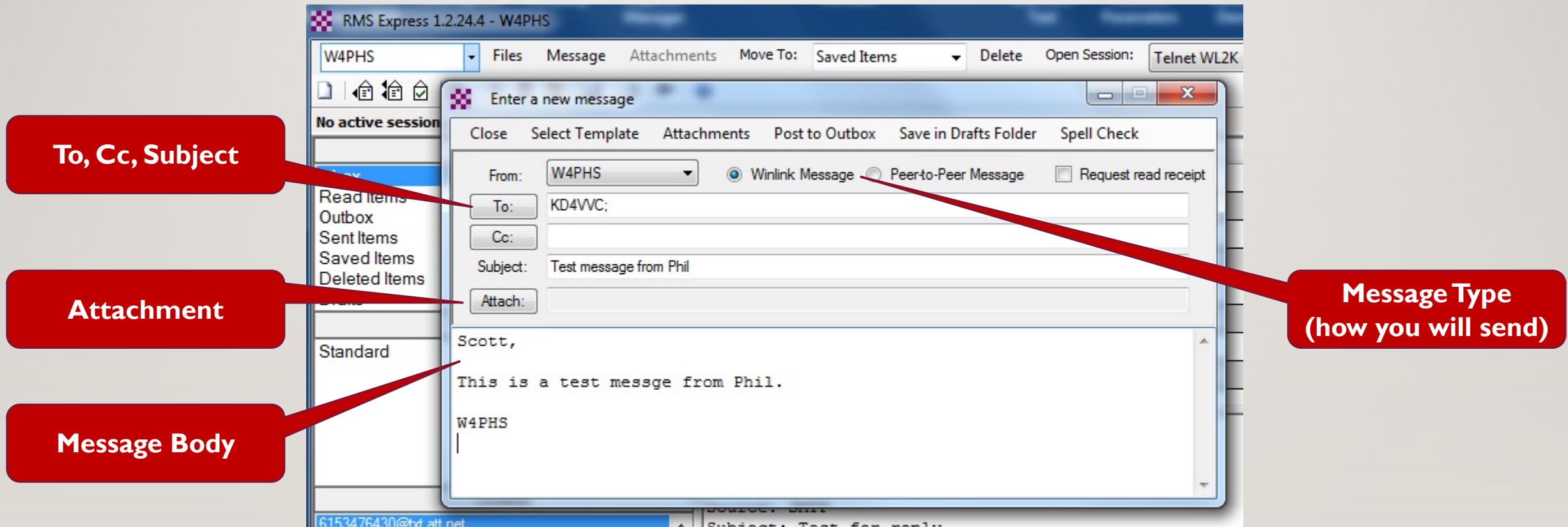
Message List

Contacts

Message Body

# Winlink Compose Email Window

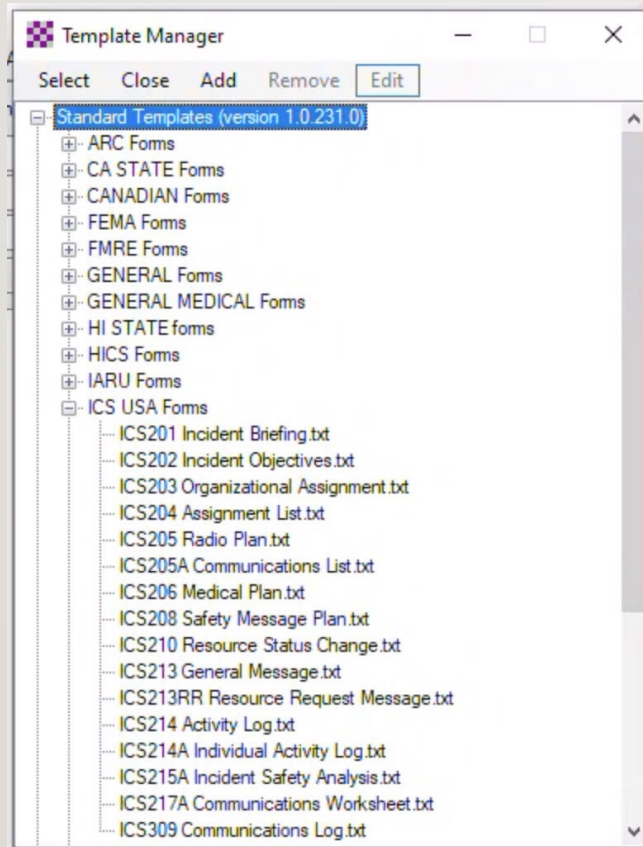
➤ All the usual fields (plus a couple special ones)





# Winlink Express Forms

- Like FLdigi, Winlink Express has dozens of built-in forms

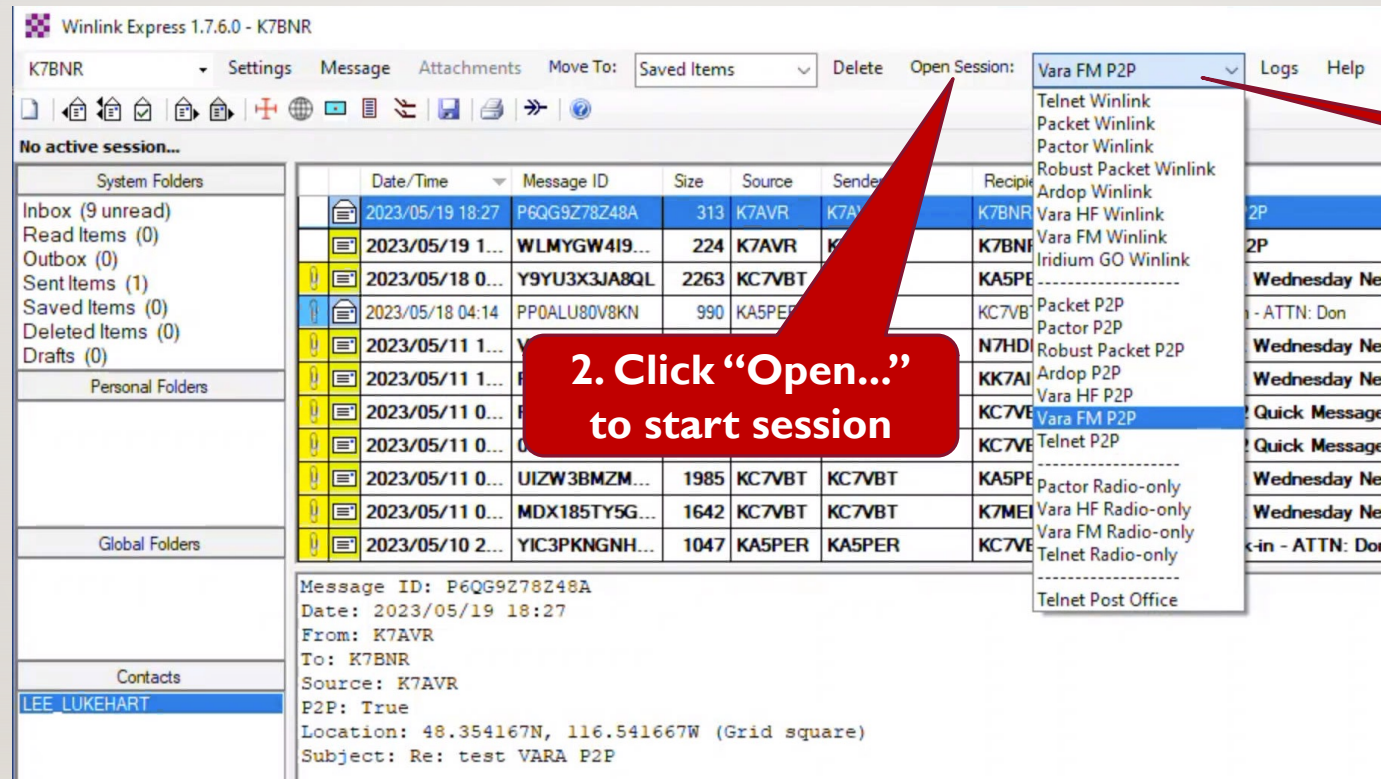


Select a Template to open, and complete the form.

When you send it, only the data is sent to make standard reporting even more efficient.

# Winlink Open Session

➤ Select how you wish to send the message...





# Winlink Channel Selector

➤ If not P2P, Winlink can suggest a node to connect to...

The screenshot shows the Winlink Express 1.7.6.0 interface. The 'Channel Selection' menu is open, and the 'Vara FM Channel Selector' dialog is displayed. The dialog shows a list of stations found within 300 kilometers of the user's grid square. The station K7RHT-10 is selected, and its frequency (145.030) is highlighted. A red arrow points from the 'Channel Selection' menu to the dialog, and another red arrow points from the selected frequency to the 'Frequency' field in the main window.

Callsign	Frequency (MHz)	Channel Width	Grid Square	Group	Distance (km)	Bearing (Degrees)
KB3CME-10	145.070	Narrow	DN17OW	PUBLIC	033	146
NV2Z-10	432.425	Wide	DN17KQ	PUBLIC	056	187
NV2Z-10	145.510	Wide	DN17KQ	PUBLIC	056	187
N7SDH-10	145.070	Wide	DN18UQ	PUBLIC	078	045
N7XRD-10	145.060	Wide	DN16XF	PUBLIC	230	161
WA7WWC-10	145.530	Narrow	DN06XB	PUBLIC	248	198
KE7RGP-10	144.910	Wide	DN06IG	PUBLIC	273	219
K7RHT-10	145.030	Narrow	CN97RD	PUBLIC	286	247

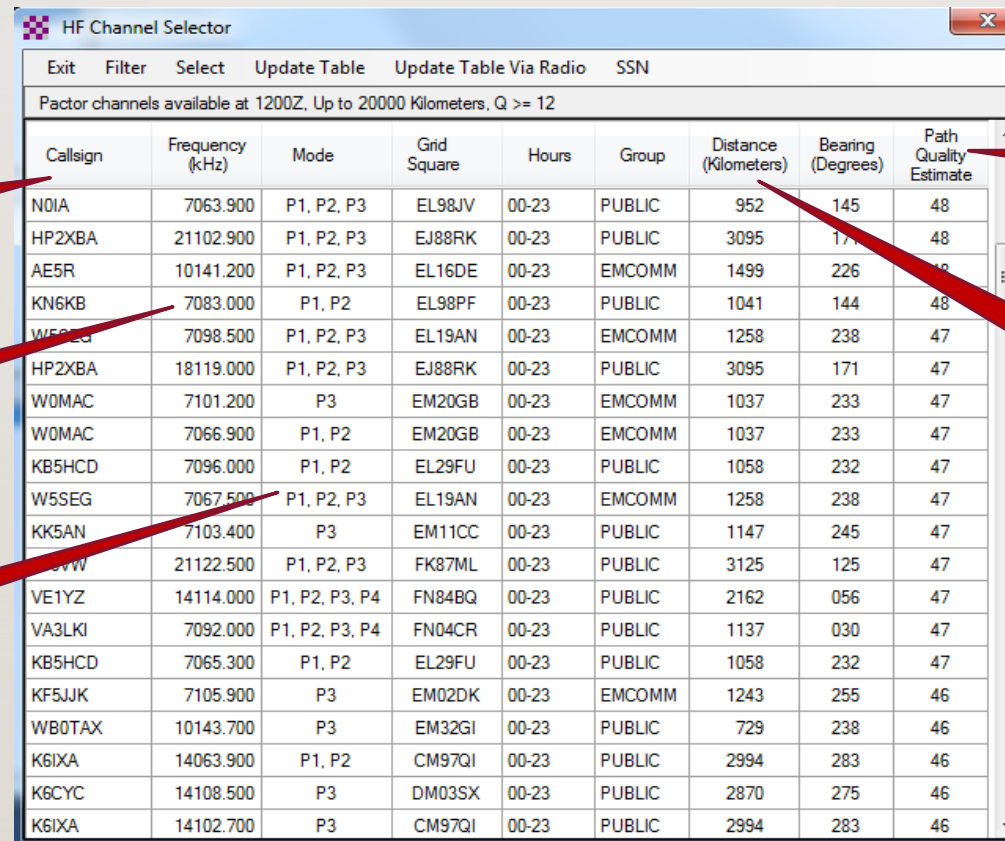
1. Click "Channel Selection"

2. Select to autofill frequency



# Winlink Channel Selector Window

➤ Select an RMS (or digipeater) with likely good signal...



The screenshot shows the 'HF Channel Selector' window. It has a menu bar with 'Exit', 'Filter', 'Select', 'Update Table', 'Update Table Via Radio', and 'SSN'. Below the menu bar, it says 'Factor channels available at 1200Z, Up to 20000 Kilometers, Q >= 12'. The table has 9 columns: Callsign, Frequency (kHz), Mode, Grid Square, Hours, Group, Distance (Kilometers), Bearing (Degrees), and Path Quality Estimate. Red callout boxes point to specific columns: 'Gateway Identifier' points to the 'Callsign' column, 'Radio Frequency' points to the 'Frequency (kHz)' column, 'Modes Supported' points to the 'Mode' column, 'Likely Quality' points to the 'Path Quality Estimate' column, and 'Distance from you' points to the 'Distance (Kilometers)' column.

Callsign	Frequency (kHz)	Mode	Grid Square	Hours	Group	Distance (Kilometers)	Bearing (Degrees)	Path Quality Estimate
N0IA	7063.900	P1, P2, P3	EL98JV	00-23	PUBLIC	952	145	48
HP2XBA	21102.900	P1, P2, P3	EJ88RK	00-23	PUBLIC	3095	171	48
AE5R	10141.200	P1, P2, P3	EL16DE	00-23	EMCOMM	1499	226	48
KN6KB	7083.000	P1, P2	EL98PF	00-23	PUBLIC	1041	144	48
W5SEG	7098.500	P1, P2, P3	EL19AN	00-23	EMCOMM	1258	238	47
HP2XBA	18119.000	P1, P2, P3	EJ88RK	00-23	PUBLIC	3095	171	47
W0MAC	7101.200	P3	EM20GB	00-23	EMCOMM	1037	233	47
W0MAC	7066.900	P1, P2	EM20GB	00-23	EMCOMM	1037	233	47
KB5HCD	7096.000	P1, P2	EL29FU	00-23	PUBLIC	1058	232	47
W5SEG	7067.500	P1, P2, P3	EL19AN	00-23	EMCOMM	1258	238	47
KK5AN	7103.400	P3	EM11CC	00-23	PUBLIC	1147	245	47
W5VW	21122.500	P1, P2, P3	FK87ML	00-23	PUBLIC	3125	125	47
VE1YZ	14114.000	P1, P2, P3, P4	FN84BQ	00-23	PUBLIC	2162	056	47
VA3LKI	7092.000	P1, P2, P3, P4	FN04CR	00-23	PUBLIC	1137	030	47
KB5HCD	7065.300	P1, P2	EL29FU	00-23	PUBLIC	1058	232	47
KF5JJK	7105.900	P3	EM02DK	00-23	EMCOMM	1243	255	46
WB0TAX	10143.700	P3	EM32GI	00-23	PUBLIC	729	238	46
K6IXA	14063.900	P1, P2	CM97QI	00-23	PUBLIC	2994	283	46
K6CYC	14108.500	P3	DM03SX	00-23	PUBLIC	2870	275	46
K6IXA	14102.700	P3	CM97QI	00-23	PUBLIC	2994	283	46

Gateway Identifier

Radio Frequency

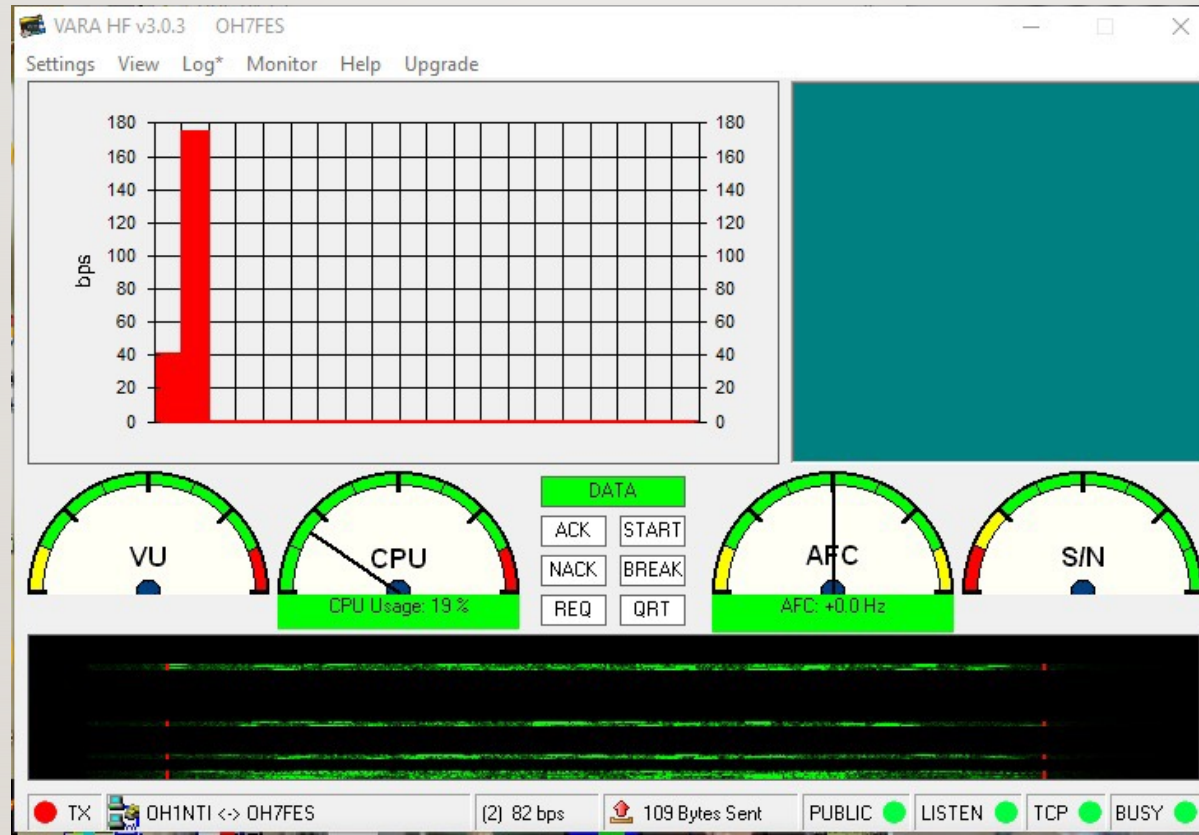
Modes Supported

Likely Quality

Distance from you

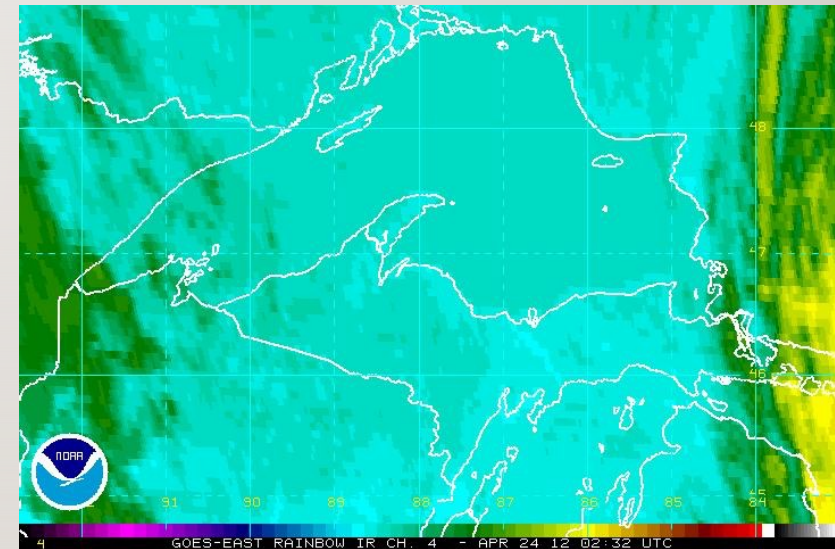
# Winlink Session (example, VARA HF mode)

- Some modes will provide in-progress info during send...



# Plus, Information Requests via Radio

- Use the “Winlink Catalog Request” feature to request:
  - Weather maps for most areas of the world
  - Weather forecasts
  - Maritime HF nets and frequencies
  - Satellite images
  - Location of closest 30 stations
  - ARRL Newsletter, e-letter, etc.
  - Misc. bulletins



Weather Map Image returned upon request



# Winlink Express Demonstration!

Two computers set up:

➤ Windows 10 to Windows 10, Peer-to-Peer

# Useful Resources

Main FLdigi website:

<http://w1hkj.com>

FLdigi files download from Source Forge:

<http://sourceforge.net/projects/fldigi/files/>

FLdigi on-line mode identification, sights & sounds

<http://w1hkj.com/modes/>

Windows fldigi user group:

<https://groups.io/g/winfldigi>

Linux / Mac fldigi user group:

<https://groups.io/g/linuxham>

Winlink Global:

<https://winlink.org>

Ham Radio Digital Data Modes (ARRL)

<http://www.arrl.org/digital-data-modes>

Signalink by Tigertronics

<https://www.tigertronics.com>

Raspberry Pi 4:

<https://www.raspberrypi.com/products/raspberry-pi-4-model-b/>

NBEMS EMCOMM user group:

<https://groups.io/g/nbems>

Bonner County ARES:

<https://bonnerares.org/>