

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

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#### 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...

- > A worldwide network of connected computers
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   A worldwide network of connected things (e.g. thermostats, Alexa, IoT)
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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



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JUAN D FUCA PLATE

Pacific Ocean CANADA

#### 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)

\*Radio User Survey:
Family Radio (FRS)?
GMRS?
Ham licensed, VHF/UHF?
Ham licensed, HF?
Other?

Higher radio power required for longer distances
 Atmospheric noise (static due to lightning, etc.)

Must be tuned-in real time (no voicemail)

## 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
- > Ist 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

FLdigi

– digital keyboard-to-keyboard\*

**FLarq** 

FLmsg

FLamp

FLrig

FLwrap

- -Automated Repeat reQuest \*
- message forms management (ICS,ARC)\*
- -Amateur Multicast Protocol \*
- transceiver control \*
- file encapsulation \*

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

Many thanks to creator Dave Freese W1HKJ



#### **Computer Operating Systems**

- Linux / Unix
- ➤ Windows (Win7 Win11)
- ➤ macOS
- Desktop / Notebook / Netbook / Tablet
- "AndFlmsg" 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

Simple Interfa	ice		
FLMSG: 4.0.18	4		×
<u>-</u> ile <u>T</u> ools			
New Message Edit Message View Message	2 2 e		
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## **FLmsg Built-in Forms**

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	CAP +	The Wi	ld Ro	ARRL radio	ogram		fi	le: W1HKJ-1.r	n2s			
Type	CSV	I've b	een a	Message	•••			FLMSG	: 4.0.17.01			
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## **FLmsg Custom Forms**

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





- > 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



#### 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



#### 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...

	🗱 RMS Expre	ess 1.1.7.6 - W	4PHS	-	-	-							J			
	W4PHS		Message	Attachm	ents Move T	o: Saved Items	-	Delete	Open Session: Pac	tor WL2K	- Logs	Help				
	AAR4MX W4PHS	<b>₽</b>   <del>1</del>	∎ ≿		≫											
	I (Add call sign	1) .														
	Sys	stem Folders		Da	ate/Time	Message ID	Size	Source	Sender	Recipient	Sub	oject				
	Inbox			20	12/05/15 10:44	R3HTZ06PDCVF	343	K1KY	K1KY	W4PHS	Serv	vice Code Erro		ſ		
	Outbox			20	12/05/07 09:05	FY7XIJ32L3VK	186	SMTP	SMTP:phil@phils	W4PHS	Prior	rity message		Me	ssage List	
Organized Folders	Sent Items			20	12/05/07 08:40	KMG4HK6PJ35M	1585	SMTP	SMTP:phil@phils	W4PHS	Mes	sage with atta		The	ssage List	
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Concaces	KA4OTB			To: W4P	HS											
	KCOQOD			Source:	SMTP											
	KE3XB KI4PSR			Subject	: Message	with attaching	ent									
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				Concent	Transfel.	Encouring. /L										
	VAJEN															

## Winlink Compose Email Window

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

	RMS Express 1.2.24.4 - W4PHS	
	W4PHS  Files Message Attachments Move To: Saved Items  Delete Open Session: Telnet WL2K	
	□ 🕯 🕯 🖉 👔 Enter a new message	
To, Cc, Subject	No active session Close Select Template Attachments Post to Outbox Save in Drafts Folder Spell Check	
	From: W4PHS    W4PHS     W4PHS	
	Nead items     To:     KD4VVC;       Outbox     Cc:	
Attachment	Deleted Items Attach:	Message Type (how you will send)
	Standard Sector,	
	This is a test messge from Phil.	
Message Body	W4PHS	
	6153476430@bt att get	

## **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 Express 1.7.6.0 - K7E	BNR									
K7BNR - Setting	gs Me	essage Attachmen	ts Move To: Sa	ved Item	s v	Delete	Open Session:	Vara FM P2P	Logs Help	
	•	1 🗄 눈 🔒 🎒						Telnet Winlink Packet Winlink		
No active session								Pactor Winlink	1	
System Folders		Date/Time 👻	Message ID	Size	Source	Sender	Reci	Robust Packet Winlink		
Inbox (9 unread)		2023/05/19 18:27	P6QG9Z78Z48A	313	K7AVR	K7A	K7BN	R Vara HF Winlink	2P	1. Choose Message
Read Items (0)		2023/05/19 1	WLMYGW4I9	224	K7AVR	ĸ	K7B	Vara FM Winlink	2P	Type & Mode
Sent Items (1)	<u>)</u> [	2023/05/18 0	Y9YU3X3JA8QL	2263	KC7VBT		KA5	*E	Wednesday Net	Type & Houe
Saved Items (0)	16	2023/05/18 04:14	PP0ALU80V8KN	990	KA5PEF		KC7V	B Packet P2P	1 - ATTN: Don	
Drafts (0)	<u>0</u> E	2023/05/11 1		•			N7H	Robust Packet P2P	Wednesday Net	
Personal Folders	1 🕴 🗉	2023/05/11 1	2. CI	ICK	"Ope	en'	KK7/	Ardop P2P	Wednesday Net	
	<u>0</u> E	2023/05/11 0	tos	tar	teas	sion	KC7	Vara FM P2P	Quick Message	
	<u>8</u> E	2023/05/11 0		Lai		SIUT	KC7	Telnet P2P	Quick Message	
	l l	<b>2023/05/11 0</b>	UIZW3BMZM	1985	KC7VBT	KC7VBT	KA5	Pactor Radio-only	Wednesday Net	
	<u>8</u> E	2023/05/11 0	MDX185TY5G	1642	KC7VBT	KC7VBT	K7M	Vara HF Radio-only	Wednesday Net	
Global Folders	<u>)</u> [	<b>2023/05/10 2</b>	YIC3PKNGNH	1047	KA5PER	KA5PEF	KC7	Telnet Radio-only	k-in - ATTN: Don	
	Mess	sage ID: P6QG9	Z78Z48A					Telnet Post Office		
	Date	e: 2023/05/19	18:27					Temer Post Office		
	To:	K7BNR								
Contacts	Sou	rce: K7AVR								
LEE_LUKEHART	P2P:	: True								
	Loca	ation: 48.3541	67N, 116.5416	67W (	Grid squ	lare)				
	Sub	Ject: Ke: test	VARA P2P							

#### Winlink Channel Selector

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

Winlink Express 1.7.6.0 - K7BNR Vara FM Radio-only Session - K7 Exit Settings Switch to Peer-to-F Connection: Direct • Favorites: In: 0/0 Out: 0/0 BPM: 0/0 Disconne	7BNR Peer Channel Sel via [ Vara FM Ch Exit Select	ecti <u>on <b>Start</b></u> annel Selector Channel Up	Stop Abo	nt Internet Up	0.000 Idate Table Vi	Range: a Radio	Bearing:	Logs Help P2P P2P	I. Click "Channel Selection"
*** Launching VARA FM TNC: C:VARA *** Successfully connected to VARA FM *** Ready *** Radio-only session	Stations found Callsign KB3CME-10 NV2Z-10 NV2Z-10 N7SDH-10 N7XRD-10	within 300 kil Frequency (MHz) 145.070 432.425 145.510 145.070 145.060	Channel Width Narrow Wide Wide Wide Wide	Grid Grid Square DN17OW DN17KQ DN17KQ DN17KQ DN18UQ DN16XF	Group PUBLIC PUBLIC PUBLIC PUBLIC PUBLIC	Distance (km) 033 056 056 078 230	Bearing (Degrees) 146 187 187 045 161	k Wednesday Net in - ATTN: Don k Wednesday Net 2 Quick Message 2 Quick Message k Wednesday Net	2. Select to autofill frequency
Contacts E_LUKEHART EE_LUKEHART Sub	WA7WWC-10 KE7RGP-10 K7RHT-10	145.530 144.910 145.030	Narrow Wide Narrow	DN06XB DN06IG CN97RD	PUBLIC PUBLIC PUBLIC	248 273 286	198 219 247	k Wednesday Net ck-in - ATTN: Don	

#### Winlink Channel Selector Window

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

	😫 HF Chann	el Selector							<u>Σ</u>	×
	Exit Filter	Select U	lpdate Table	Update Tab	le Via Radio	SSN				
	Pactor channe	els available at 1	200Z, Up to 2000	00 Kilometers,	Q >= 12					
	Callsign	Frequency (kHz)	Mode	Grid Square	Hours	Group	Distance (Kilometers)	Bearing (Degrees)	Path Quality Estimate	
	NOIA	7063.900	P1, P2, P3	EL98JV	00-23	PUBLIC	952	145	48	Likely Quality
Gateway Identifier	HP2XBA	21102.900	P1, P2, P3	EJ88RK	00-23	PUBLIC	3095	1/	48	
	AE5R	10141.200	P1, P2, P3	EL16DE	00-23	EMCOMM	1499	226	4	
	KN6KB	7083.000	P1, P2	EL98PF	00-23	PUBLIC	1041	144	48	
	WEC	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	
Radio Frequency	W5SEG	7067.500	P1, P2, P3	EL19AN	00-23	EMCOMM	1258	238	47	
	KK5AN	7103.400	P3	EM11CC	00-23	PUBLIC	1147	245	47	Distance from you
	WW	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	
Modes Supported	WBOTAX	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	<b>•</b>

#### 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: <u>http://w1hkj.com</u>

FLdigi files download from Source Forge: <u>http://sourceforge.net/projects/fldigi/files/</u>

FLdigi on-line mode identification, sights & sounds <u>http://w1hkj.com/modes/</u>

Windows fldigi user group: https://groups.io/g/winfldigi

Linux / Mac fldigi user group: https://groups.io/g/linuxham Winlink Global: <u>https://winlink.org</u>

Ham Radio Digital Data Modes (ARRL) http://www.arrl.org/digital-data-modes

SignaLink by Tigertronics https://www.tigertronics.com

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

NBEMS EMCOMM user group: https://groups.io/g/nbems

Bonner County ARES: <u>https://bonnerares.org/</u>