September 2020 W0TLM Meeting

- Digital VHF/UHF Radios and Modes
  - D-STAR
  - DMR
  - System Fusion (C4FM)
  - NXDN
  - P25

Presented by:
Tim Romashko – K4RA

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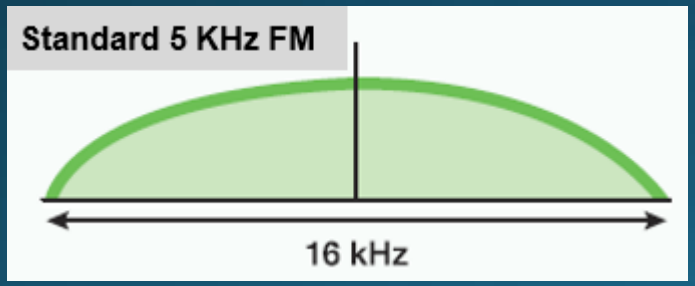
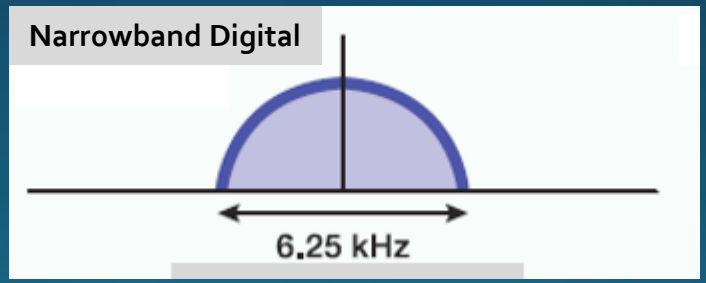
Digital Basics

- Voice (analog) is converted to data
- Data may be added to voice to produce a single data stream containing voice and data
- Radio is modulated as a data carrier
- Occupied bandwidth is determined by data bit rate and type of modulation
- Generally, digital voice and data occupies less spectrum than analog FM





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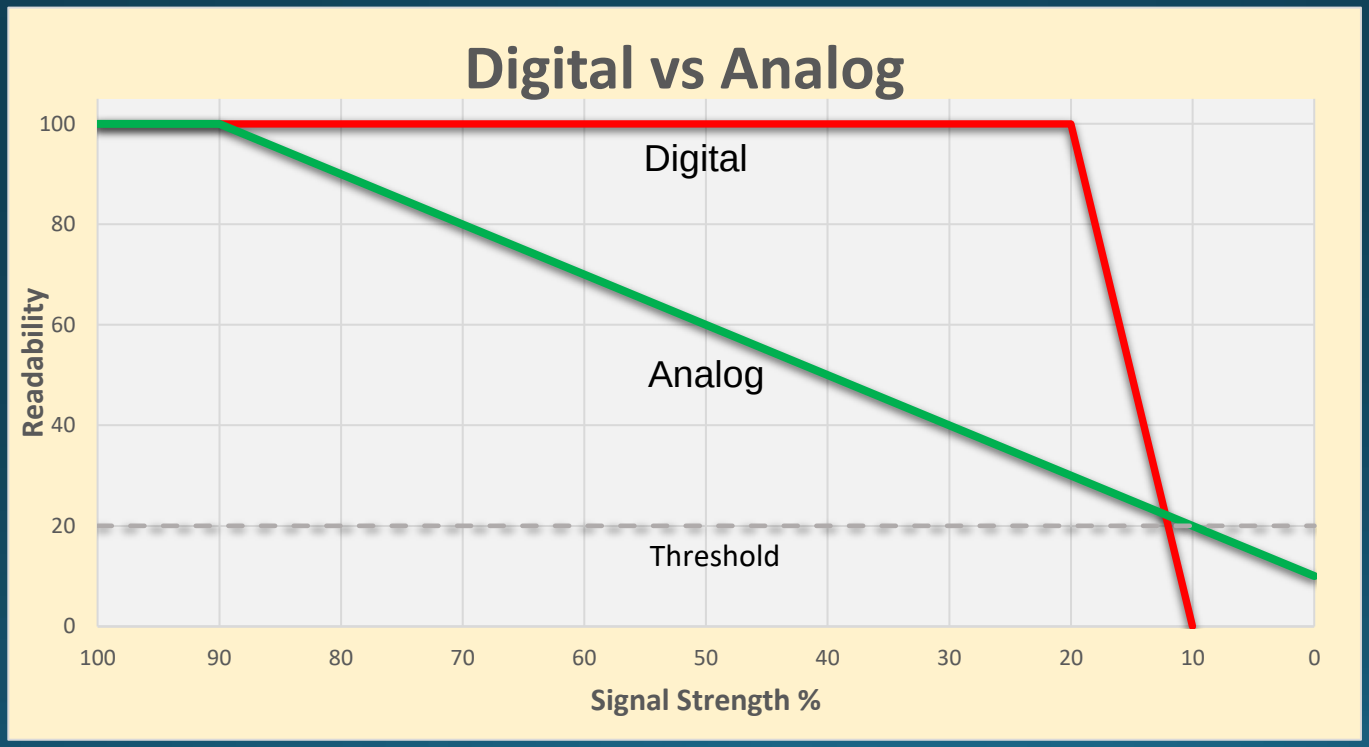
Digital Basics

- Digital voice does not gradually degrade in quality as signal level decreases



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Digital Mode Comparison

	D-STAR	DMR/MotoTRBO	System Fusion
Number of users	>74,000 +	172,000 +	>10,000 +
Repeaters	2,428	4,699	>10,644 (most operating in mixed or FM modes)
Bandwidth	6.25 KHz	6.25 KHz	7.6-9 KHz
Channel spacing	10, 12.5 KHz pairs	12.5 KHz pairs	20, 25 KHz pairs
Repeater Linking	Open via Internet (DPLUS or ircDDB)	Proprietary (Motorola IPSC) or Hytera, via Internet	2 servers for worldwide connectivity Wires-X nodes connect to radio
Linking / routing control	Determined by user, sent from radio	Defined by admin, sent from radio	Best information is that currently repeater linking in C4FM is still not available
Data	1200, 3600 bps 128 kbps (1.2 GHz)	SMS only implemented in Amateur Radio version	4800, 9600 bps
Radio Programming	Front panel, software, numerous vendors including CHIRP	Mfg. software or aftermarket app (written by Hams)	Front panel, software
Other user devices	Multiple vendors (Dongle, DVAP, GMSK modems, hotspot adapters)	Multiple radio vendors, Hotspots	Hotspots

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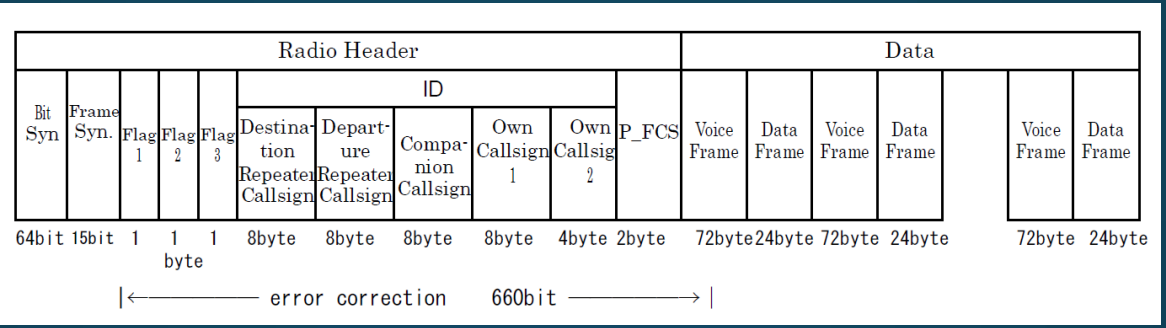
What is ircDDB?

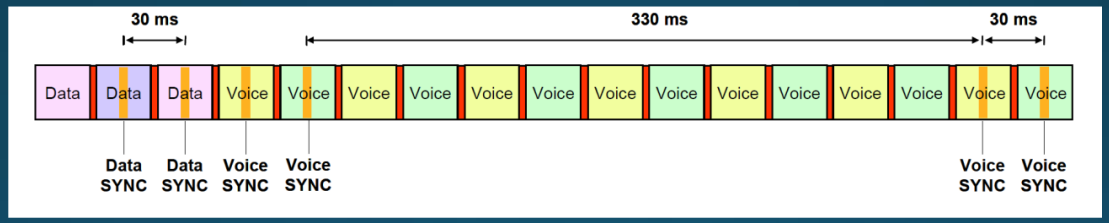
The ircDDB-Network is an amateur radio network for exchanging routing information. There are several amateur radio systems that are able to reach individual ham radio operators, due to the use of unique callsigns around the world. These systems need to be fed with the latest data where ham radio operators are reachable. For example, ICOM introduced the first radios with digital voice (D-Star) on the amateur radio market, which are capable of addressing QSO partners directly (call sign routing). The ircDDB-Network provides a solution to distribute the essential routing information across its entire network.

Pictorial View

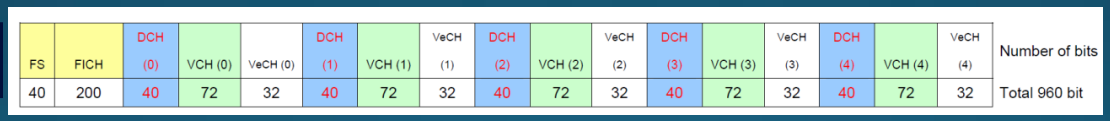
D-STAR



DMR



Fusion



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Tech Spec Comparison

	D-STAR	DMR	Fusion
Vocoder (see note)	AMBE+	AMBE+2	AMBE+2
Forward Error Corr.	Voice Only	Voice Only	Voice Only
Modulation	GMSK	4FSK	C4FM
Multiplex Method	FDMA	TDMA	FDMA
Transmission Rate	4.8 kbps	4.8 kbps x 2	9.6 kbps
Bandwidth	6.25 kHz	12.5 kHz	12.5 kHz
Channels Supported	1	2	1
Standard Developer	JARL	ETSI	Yaesu

GMSK = Gaussian Minimum Shift Keying
4FSK = 4-level Frequency Shift Keying
C4FM = Continuous 4-level Frequency Modulation
FDMA = Frequency Division Multiple Access
TDMA = Time Division Multiple Access

D-STAR = Digital Smart Technologies Amateur Radio
DMR = Digital Mobile Radio
AMBE = Advanced Multi-Band Excitation
ETSI = European Telecommunications Standards Institute
JARL = Japan Ameteur Radio League

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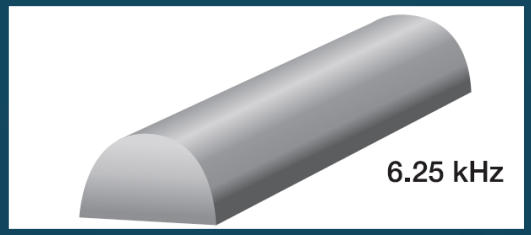
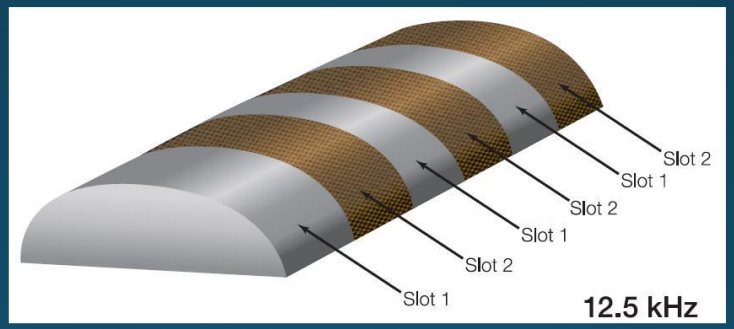
Bandwidth Comparison

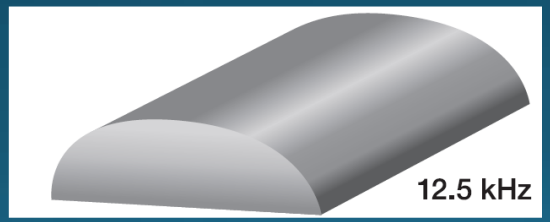
D-STAR



DMR



Fusion



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User Identification

	D-STAR	DMR	Fusion
Registration required?	Yes	Yes	No**
User identity	Call Sign	Subscriber ID	Call Sign
ID displayed on radio's display	Call Sign	Subscriber ID*	Call Sign
Other text display options	4 characters 20 characters	No	No
Adequate for FCC ID	Yes***	No	Yes***

* Call sign displayed if the receiving station's subscriber ID is in the radio's contact list; otherwise subscriber ID appears.

** No registration is necessary unless you want to have a WIRES-X Node on the network.

*** IDing by voice is still a good idea for the benefit of everyone listening.

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Repeater Connectability

	D-STAR	DMR	Fusion
Talk locally	Yes	Yes	Yes
Link to another repeater	Yes	No	No
Multi-repeater connection	Reflectors	Talk Groups	WIRES-X Rooms
Selection method	UR Entry	Channel Dial	Room name
Route to another Ham	Yes	No	No
Echo test	Yes	Yes	No
Request link status	Yes	No	No

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Radio Operating Features

	D-STAR	DMR	Fusion
Memory selection	Dial or GPS search	Key Press	Dial
Repeater connection selection	Dial	Dial	Key press
Mode selection method	Key press	Fixed in memory	Key press*
Radio programming complexity	Difficult/Easy **	Difficult	Easy
Newbie learning curve	Steep	Moderate	Fairly easy

* Fusion radios have AMS (automatic mode select)

** Older D-STAR radios are more difficult to program. Newer ones are pre-programmed, but must be updated as repeaters change.

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Signal Readability

	FM	D-STAR	DMR	Fusion
Voice naturalness	Good	Good	Good	Narrow –good Wide – very good
Signal noise	Varies	None	None	None
Sync robustness	N/A	Fair	Good	Good
Sync recoverability	N/A	Poor	Best	Best

- Fusion has two bandwidth voice modes. Wide sounds slightly better than narrow.
- Sync robustness is the tendency to fall out of sync
- Sync recoverability is the ability to recover sync quickly

- The opinions shown here are highly subjective. Your opinion my differ.

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Not near a Repeater?

Pi-Star
Hot Spot

Pi-Star:3.4.16 / Dashboard: 20200813

Pi-Star Digital Voice - Configuration

Dashboard | Admin | Expert | Power | Update | Backup/Restore | Factory Reset

Gateway Hardware Information

Hostname	Kernel	Platform	CPU Load	CPU Temp
k4rapi-star	4.9.35+	Pi Zero W Rev 1.1 (512MB)	2.52 / 1.95 / 1.87	41.2°C / 106.2°F

Control Software

Setting	Value
Controller Software:	○DStarRepeater ◉MMDVMHost (DV-Mega Minimum Firmware 3.07 Required)
Controller Mode:	◉Simplex Node ○Duplex Repeater (or Half-Duplex on Hotspots)

Apply Changes

MMDVMHost Configuration

Setting	Value			
DMR Mode:	●	RF Hangtime: 20	Net Hangtime: 20	
D-Star Mode:	○	RF Hangtime: 20	Net Hangtime: 20	
YSF Mode:	○	RF Hangtime: 20	Net Hangtime: 20	
P25 Mode:	○	RF Hangtime: 20	Net Hangtime: 20	
NXDN Mode:	○	RF Hangtime: 20	Net Hangtime: 20	
YSF2DMR:	○			
YSF2NXDN:	○			
YSF2P25:	○			
DMR2YSF:	○	Uses 7 prefix on DMRGateway		
DMR2NXDN:	○	Uses 7 prefix on DMRGateway		
POCSAG:	○	POCSAG Paging Features		
MMDVM Display Type:	OLED Type 3	Port: modem	Nextion Layout: ON7LDS L3	

Apply Changes

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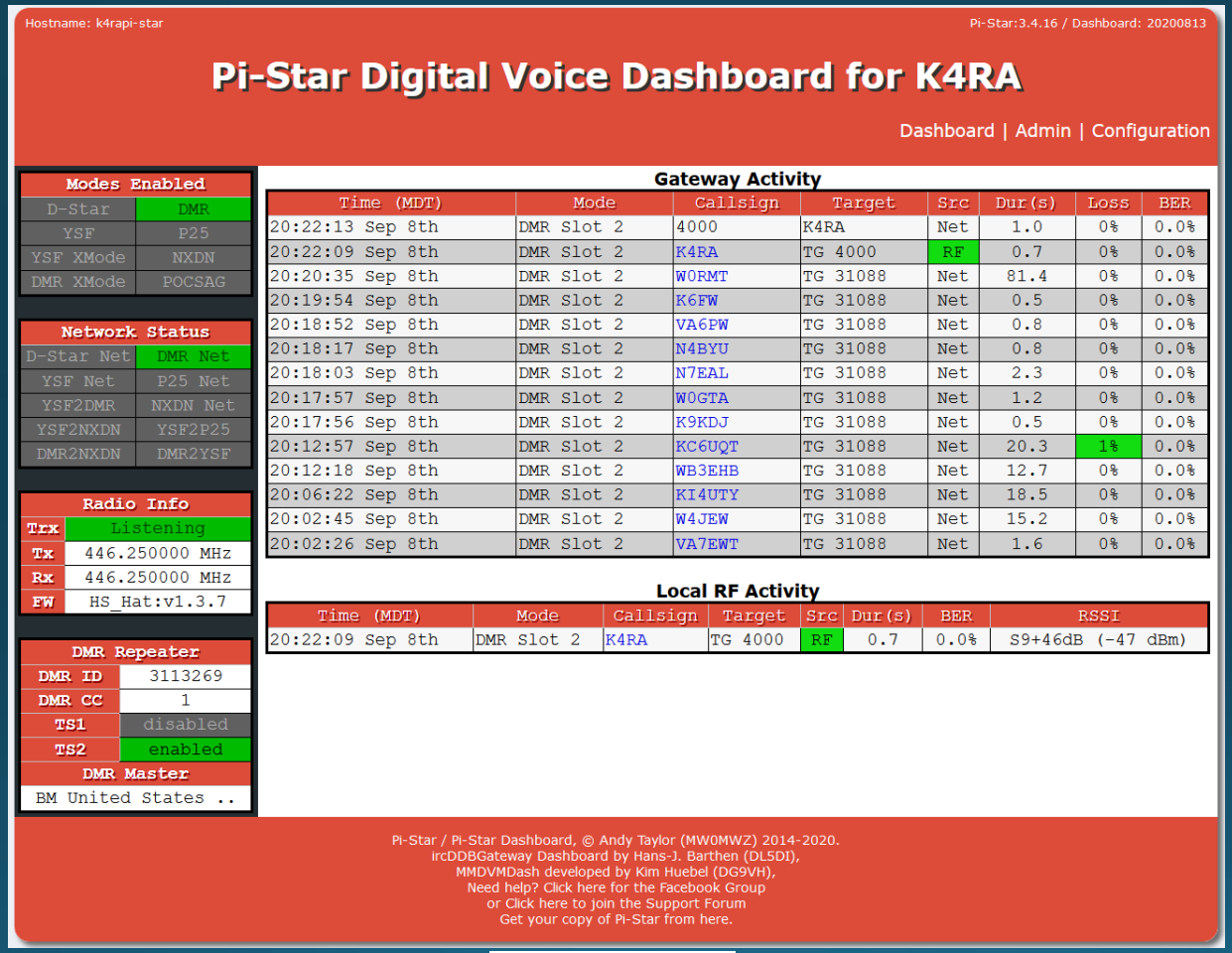
Pi-Star Hot Spot in Action



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The D-STAR Registration Process

- Why register?
- Registering your callsign allows access to more functions on DPLUS repeaters (not required for ircDDB repeaters)
- Registration is required for passing through Gateways
- Register on your local or the closest system, if possible
- Register on **one and only one** system (local registration syncs with all systems throughout world)
- Registration is a three-step process (*all three steps must be completed*)

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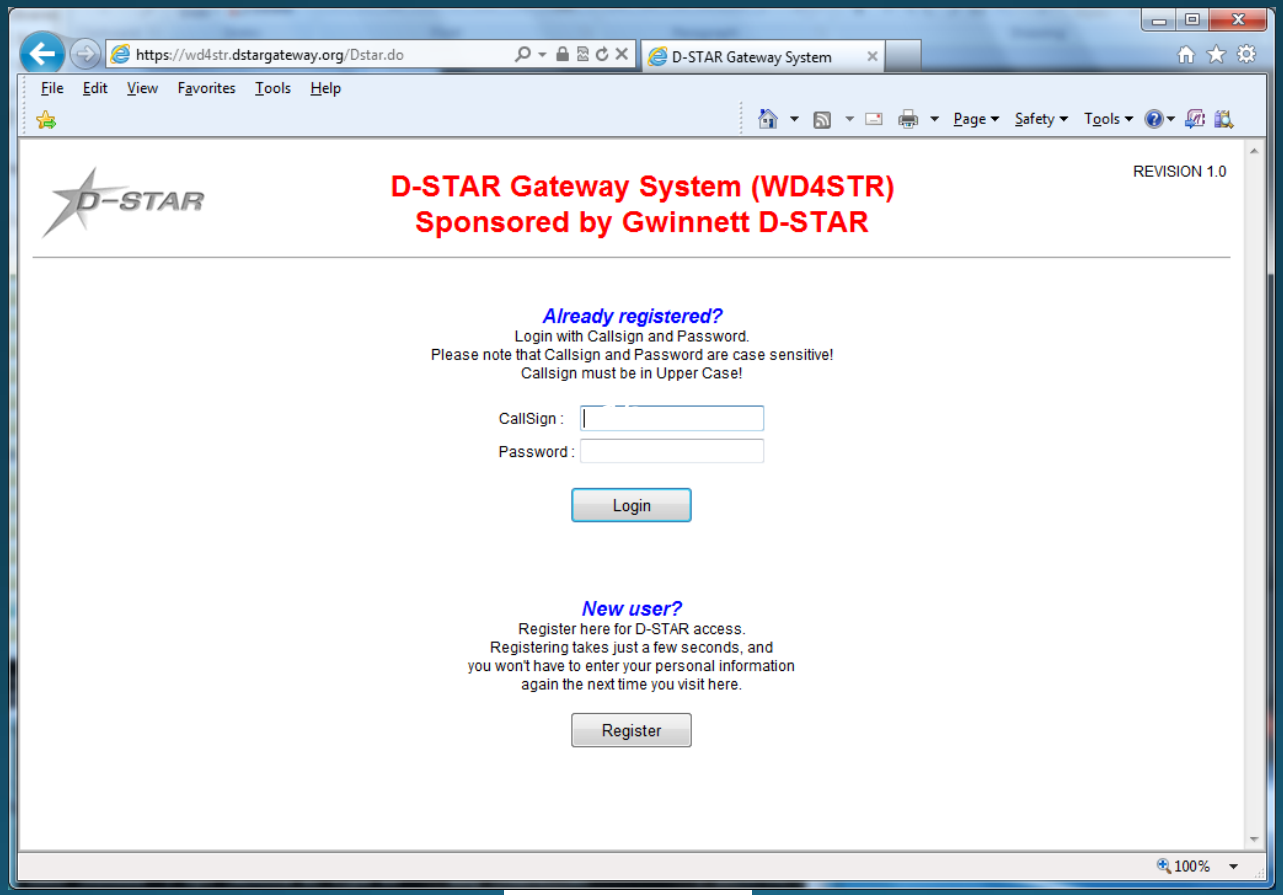
Starting Registration

- Step 1 – Browse to desired system and register as new user (https://*callsign*.dstargateway.org/Dstar.do)



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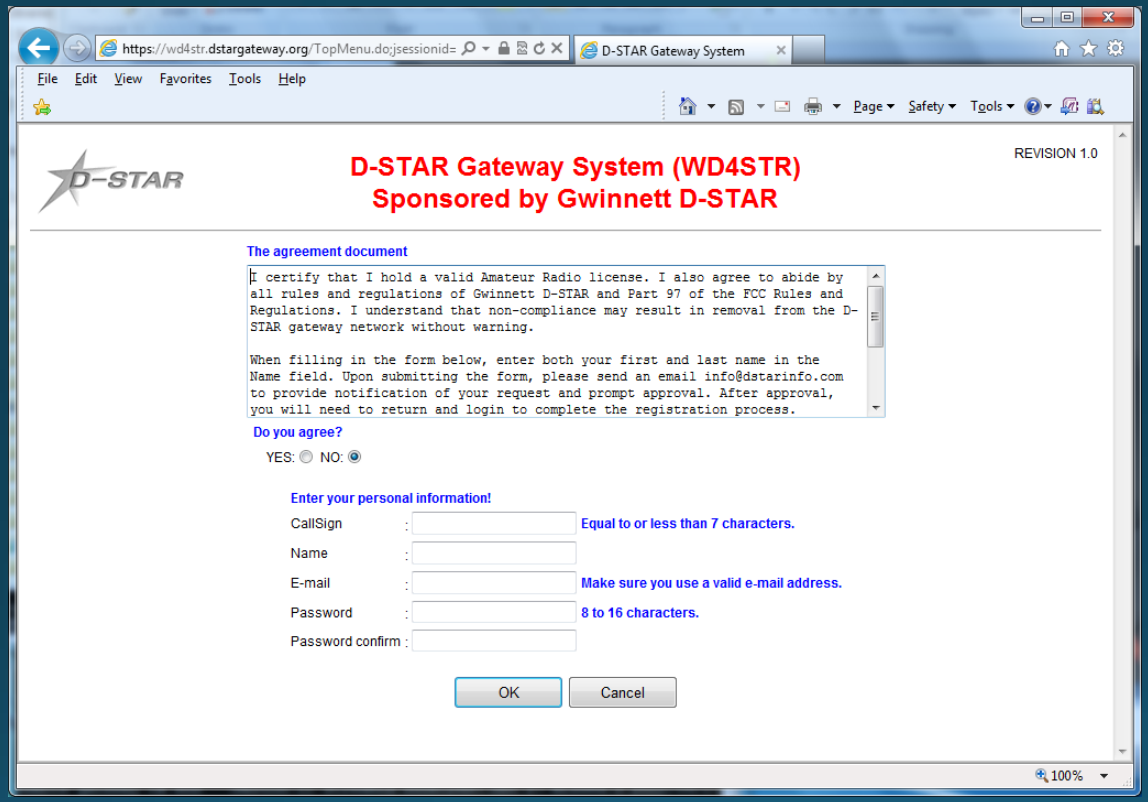
Fill Out Your Info

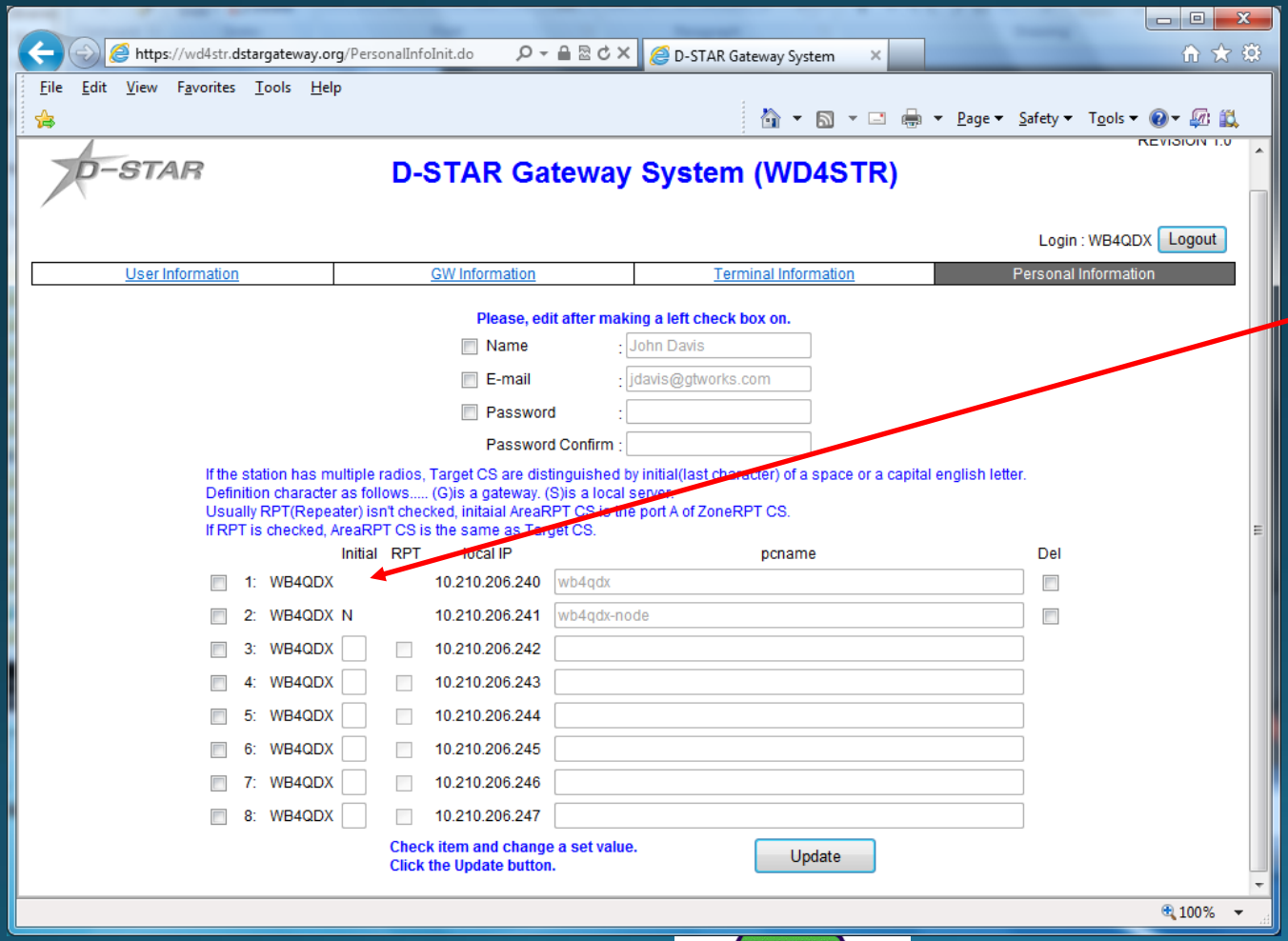
- Fill out the info (callsign, name, email address and desired password)



- Step 2 – System administrator must approve your initial registration. *You may need to send email to admin*.

Add a Terminal

- Step 3 – Add at least one terminal with a space in first row under Initial, then type a pc-name (lower case, e.g. wb4qdx-dstar)



Note: You only need one terminal, a "space" for use. Adding more terminals can add confusion

Add Your Callsign to your Radio

- For a radio, program your callsign (caps, no spaces) in MYCALL or MY field
  - Found in Menu under MY STATION in newer radios
- For a DVAP, DV Dongle or Hotspot, program call in callsign field exactly as entered in registration terminal

- Get on and talk!

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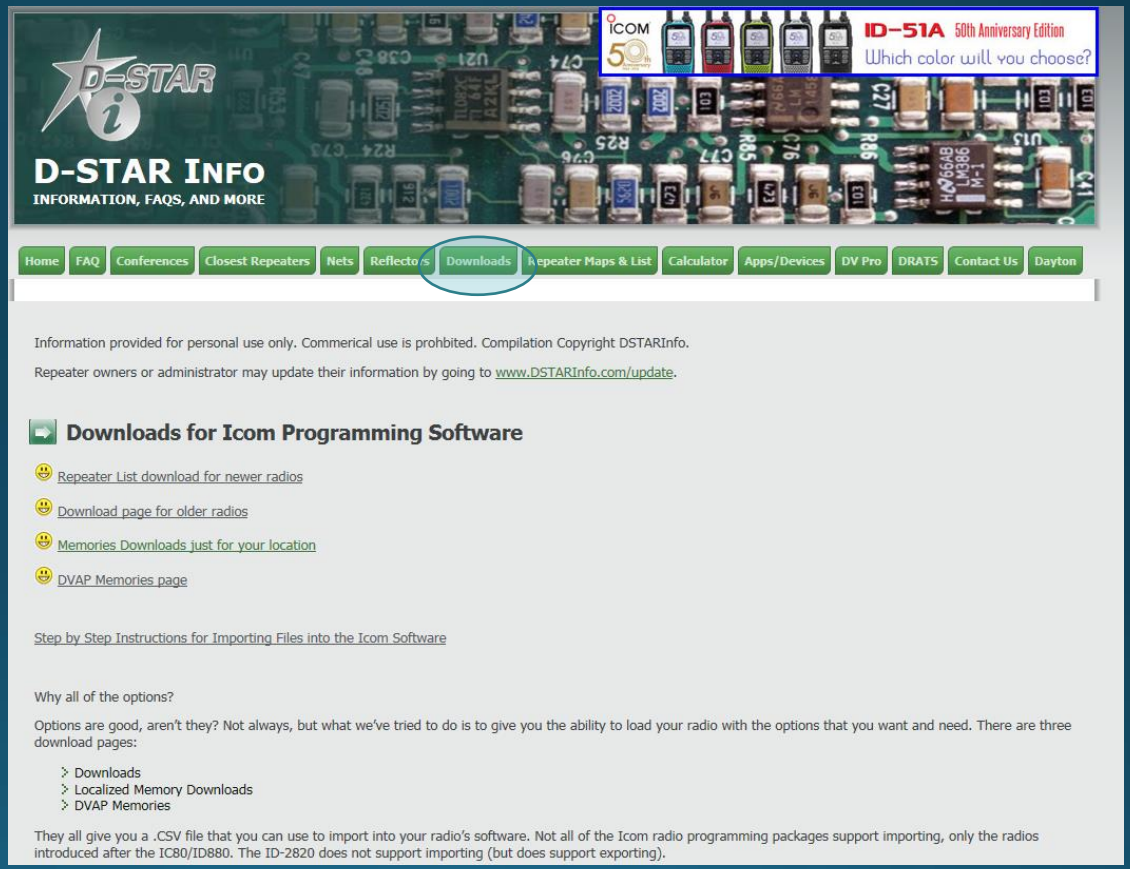
Updating Radio Memory

- Customized, localized download files available at www.DSTARinfo.com
- Creates CSV files to import to most Icom radios
- Create updated geocoded Repeater List for DR Mode
- Build DVAP Memories



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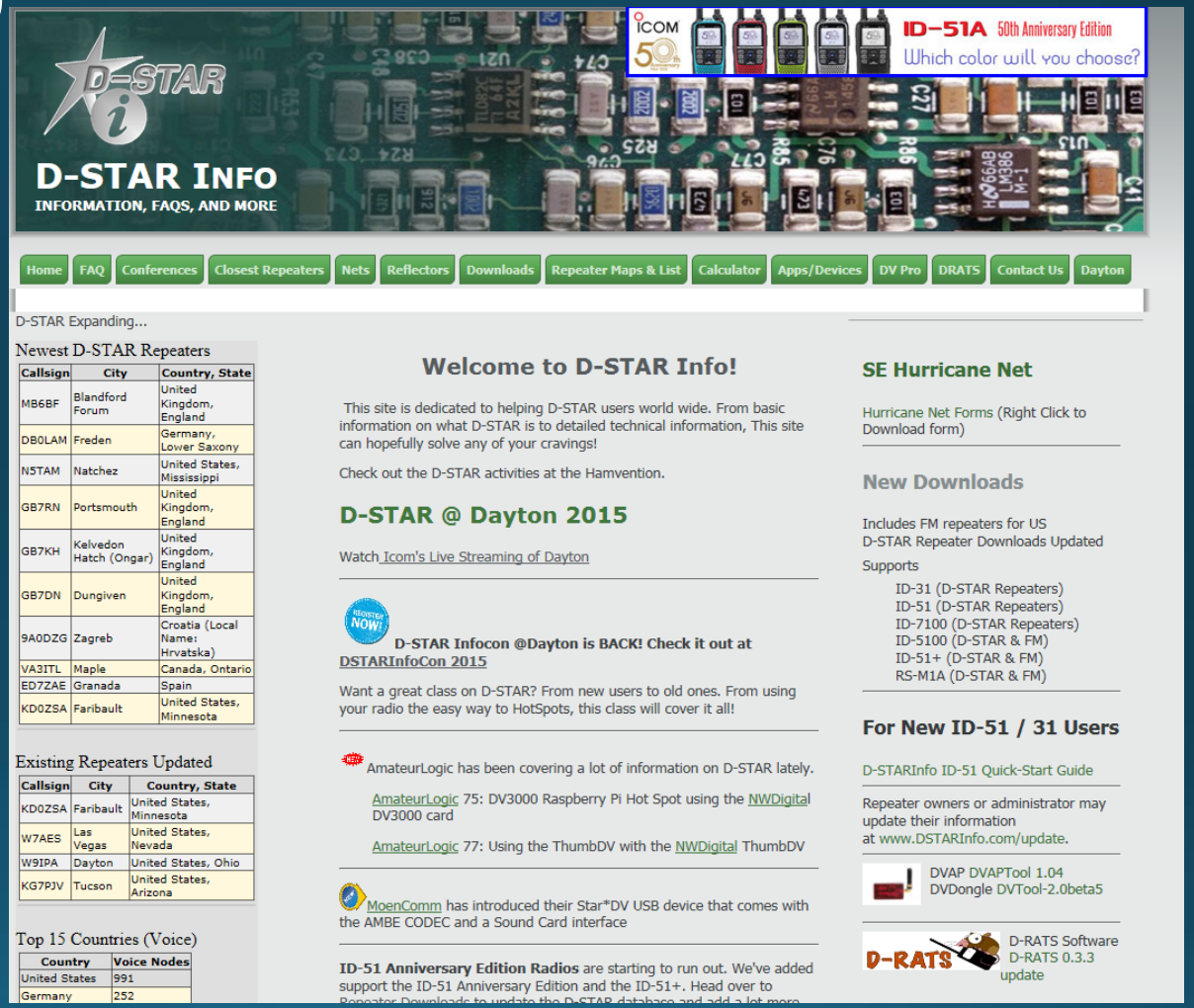
HF Operations

- Full quieting signals on HF
- D-STAR HF Net
- www.DSTARInfo.com/DSTARHFNet.aspx

- IC-9100
- IC-7100
- Flex 6000 series
- Many radios with added GMSK Modem

Getting Help

- Website: www.DSTARinfo.com
- Email: info@dstarinfo.com



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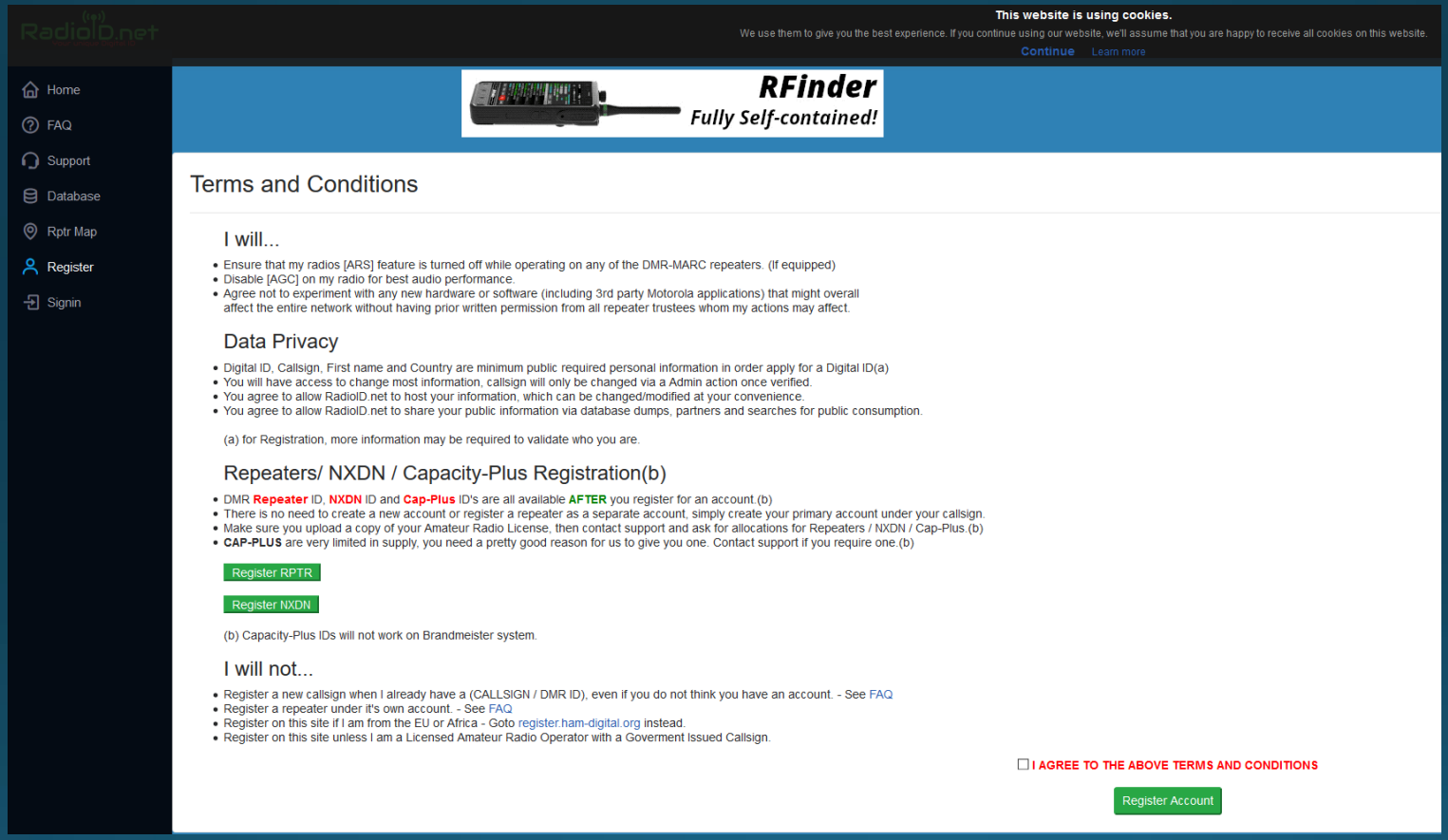
DMR Registration – RadioID.net



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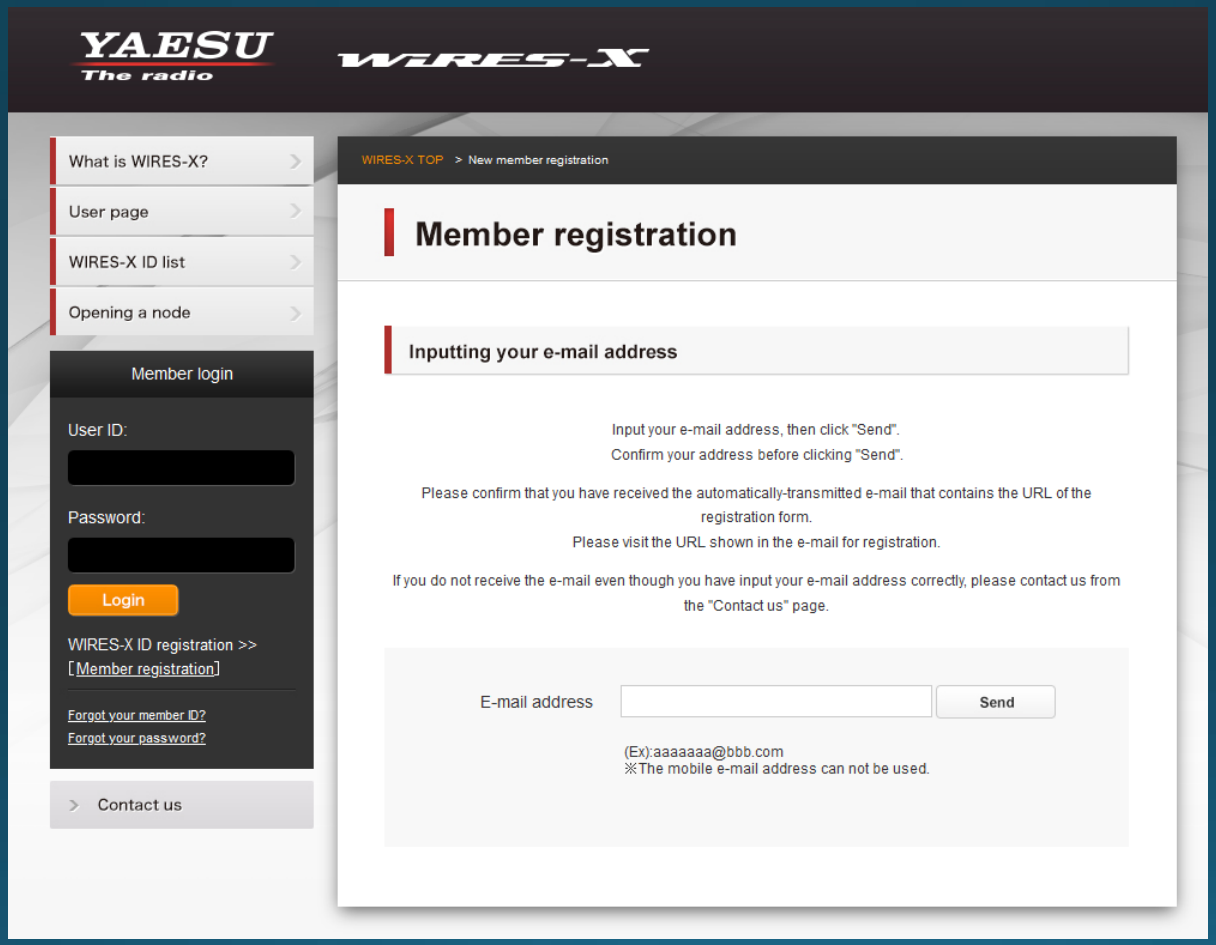
Register for C4FM (WIRES-X)



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Can I talk on one mode to another ham on a different mode?

- Digital modes are not cross-compatible
- Cross-mode connectivity can be accomplished by using a Mega site
- Nearby Mega sites:
  - Parker Radio Association (www.parkerradio.org)
  - High Country Digital Radio (www.coloradodigital.net)

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So what? Why should I care?

- Technician license gets you talking globally!
- Relatively low cost of entry (under $250)
- Digital systems are very flexible
- Reflectors/Talk Groups/Rooms for most any hobby and location
- Digital platforms support experimentation
- FCC is very interested in Digital modes due to smaller bandwidth requirements

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What do I do next?

- Find an Elmer!
- Discuss your goals with your Elmer
- Decide what mode is best for you to get started with digital radio
- Get your FCC license
- Buy a radio (and hot spot if possible)
- Get your Elmer to help you program your radio and hot spot (very important)
- Get on the air and have FUN!

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Questions?