Digital Voice Modes

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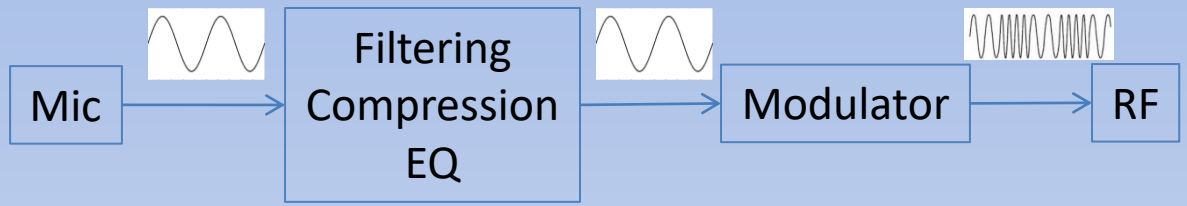
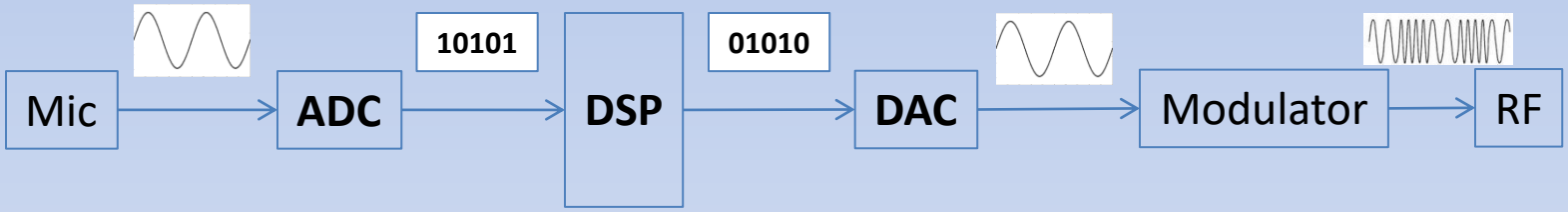
Why Digital Voice?

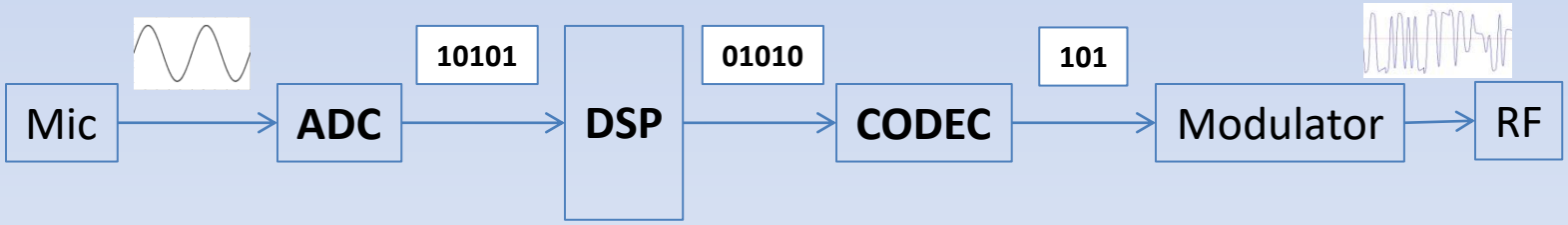
- Efficient bandwidth management, 6.25 / 12.5KHz
- No noise
- Longer distance (good audio down to -120dBm)

- Enhancements (Trunking, Control, Text Messaging, Data transfer)
- Internet connected systems

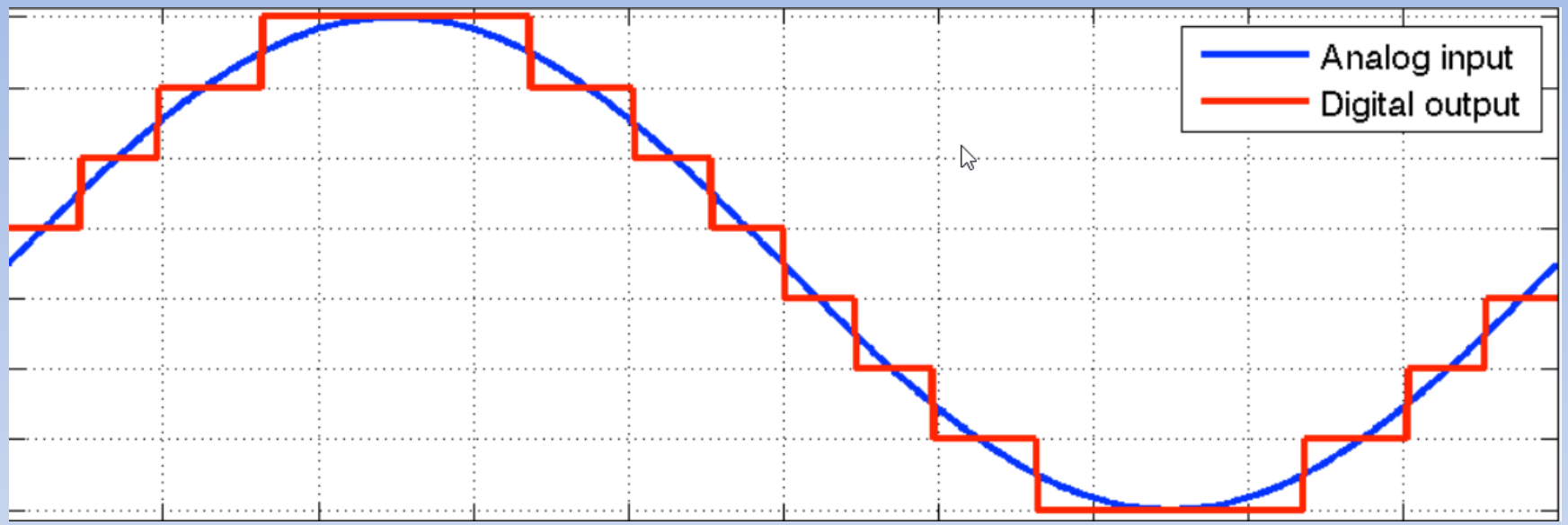
Analog, Hybrid, Digital







ADC / DAC



Analog-to-Digital Converter (**ADC**) measures amplitude of the input signal periodically (this is called "**sampling rate**"). *8KHz is enough for voice*. The range of amplitudes (zero to max) is called "**resolution**" and is measured in bits

Digital Voice "**CO**der**DEC**oder"

- **Uncompressed** or **lossless** digital audio sounds great but is inefficient
- **Lossy *codec*** uses "psycho-acoustic" models to produce a **much smaller** digital file, but will suffer acoustic losses and "compression" artifacts.
- **Error correction**
- *Very hard to implement a high efficiency codec that still sounds good*
- In 1990s only one such codec existed

AMBE codec

- Proprietary closed source high efficiency audio codec developed by DVS Inc.
- Multiple versions are currently in use by all digital amateur radio modes
- The patent has expired but the source is still closed and unavailable. Reverse engineering efforts are partially successful

Digital Voice Modes

- **D-Star (1990s) –**
- **P25 (early 2000s) – Public Safety Digital Radio**
- **DMR (late 2000s) –**
- **System Fusion (2013)**

D-Star

- Internet connected repeaters, linking
- **Call sign routing,** reaching specific call signs regardless of where you and they are
- **Repeater database**, **GPS** tracking and **roaming**
- Name / Location could be transmitted with Call Sign
- Reflectors (rooms) – **REF050C** = New England

D-Star Call Sign Routing / Linking

D-Star Repeater Call Signs have “ports” added to them A, B, C, D, E … I etc.

W1MRA B means it’s a W1MRA repeater operating on 70cm band (2m band would be port **C**)

W1MRA G means “Gateway” port

W1MRA E means “Echo” port, a parrot

Local repeater call:

MYCALL:	**W1JAR**
URCALL:	**CQCQCQ**
RPT1:	**W1MRA B**
RPT2:	**W1MRA B**

Global repeater call:

MYCALL:	**W1JAR**
URCALL:	**CQCQCQ**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

Calling KB1VXY:

MYCALL:	**W1JAR**
URCALL:	**KB1VXY**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

D-Star call sign routing / linking

Call **WB1GOF** repeater port **B**

MYCALL:	**W1JAR**
URCALL:	**WB1GOF B**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

Link to **WB1GOF** repeater port **B:**

MYCALL:	**W1JAR**
URCALL:	**WB1GOFBL**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

Link to reflector **050C**

MYCALL:	**W1JAR**
URCALL:	**REF050CL**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

Unlink

MYCALL:	**W1JAR**
URCALL:	**U**
RPT1:	**W1MRA B**
RPT2:	**W1MRA G**

D-Star Repeaters

- **W1MRA** Marlborough 448.225 (-)
- **WB1GOF** Westford 442.450 (+)
- **W1DSR** Holliston 447.075 (-)

- **D-Star shortcomings:**
  - Lower voice quality compared to others
  - Slow “re-sync” after loosing connection, 3-5 seconds of garbled audio

In-Stock | Free Shipping!

ICOM ID-4100A

DUAL BAND VHF UHF DSTAR GPS MOBILE TRANSCEIVER

HRO Discount Price: $329.95*

Buy It

*After Coupons & Promotions.

Tweet | Share | Pin it | Add To Wish List

In-Stock | Free Shipping!

ICOM ID-5100A DELUXE

144 / 430 MHz Dual Band D STAR Mobile - W/ MBA-2 Mounting Bracket

HRO Discount Price: $411.95*

Buy It | 1 YEAR BUY WITH Warranty | 2 YEAR BUY WITH Warranty

*After Coupons & Promotions.

Tweet | Share | Pin it | Add To Wish List

Yaesu **System Fusion (C4FM)**

- Easy to use and program
- **Automatic Mode Selection**, FM/C4FM switching and backwards compatibility
- "**Voice Wide**" mode sounds better than others

WIRES-X

- Proprietary **WIRES-X** Internet Voice system maintained by Yaesu, requires a connected repeater or a $$$ **simplex node**

- All WIRES-X enabled repeaters could access the same “rooms” across the globe (unfortunately, not all repeaters are WIRES-X enabled)

- **AMERICALINK** room is very active

System Fusion Repeaters

- **W1BRI** – Hopkinton, 449.575 (-), PL 88.5 (71.9 FM)
- **WO1VES** – Stoneham, 147.075 (+), PL 151.4

In-Stock | Free Shipping!

YAESU FT-70DR

C4FM/ FM 144/ 430MHz Dual Band 5W Handheld Transceiver

HRO Discount Price: $174.95*

Buy It

*After Coupons & Promotions.

Tweet | Share | Pin it | Add To Wish List

In-Stock | Free Shipping!

YAESU FT5DR

5W C4FM/FM 144/430MHz Dual Band Digital Transceiver includes SHB-26 black holster

Included With Purchase

SHB-26 ORANGE SBP-01 included for FREE!

HRO Discount Price: $479.95*

YAESU FT5DR Buy It

*After Coupons & Promotions.

In-Stock | Free Shipping!

YAESU FTM-300DR

Dual Band 144/430 MHz C4FM Digital/Analog FM Mobile Transceiver with BT, GPS, & APRS

HRO Discount Price: $459.95*

Buy It

*After Coupons & Promotions.

Tweet | Share | Pin it | Add To Wish List

In-Stock | Free Shipping!

YAESU FTM-400XDR

144 / 430 MHz Dual Band C4FM Digital / Analog FM Mobile Transceiver - Improved GPS - 50 Watts

HRO Discount Price: $589.95*

Buy It

*After Coupons & Promotions.

Tweet | Share | Pin it | Add To Wish List

DMR

- Based on Project 25 specifications developed in Europe in the late 2000s
- Was adopted in commercial communications by Motorola, Hytera and other manufacturers
- Uses TDMA digital modulation to allow 2 calls on the same 12.5KHz band at once, was illegal for amateur use in the US until 2014

Why **DMR**?

- Cheap (er) and more available equipment from used Motorola commercial gear to a multitude of brands producing Ham-centered radios – Baofeng, TYT, Alinco, Anytone
- Very efficient spectrum usage (2 conversations at the same time on the same 12.5KHz channel)
- Interconnected repeaters thanks to MotoTRBO and Hytera used equipment.
- Some radios allow “roaming” to preprogrammed repeaters

DMR Call

- ID **1234567** on Time Slot **1 (or 2)** to Talk Group **1234**
- Talk Groups could be **Static or Dynamic**
- **Static** talk groups are always active on the repeater
- **Dynamic** talkgroups are PTT activated and have an inactivity timeout

DMR Contacts Database

- www.radioid.net maintains a global database of DMR IDs and Call Signs (over 200,000 right now)
- Each radio needs the database programmed to be able to show the call signs and locations of the caller
- Some radios can fit the whole database, others can’t forcing users to choose which continents/countries to include

Programming DMR channels

- Zones are collection of channels (usually each Zone is one repeater)

- Each DMR channel consists of
  - Frequency pair (RX / TX)
  - Color Code (**0, 1, 2, 3** …) – “access code” similar to PL tone and is the same for one repeater
  - Time slot **1 or 2**
  - Talk Group ID Number (**network specific**) (some radios allow selecting TG on the fly without having to program each TG as a separate channel)

- “Digital monitor” or “promiscuous mode” to monitor both time slots at the same time regardless of the talkgroup number

DMR Networks

- DMR-MARC / DMR +
  - The “original” world wide network connecting repeaters running Motorola equipment. No hotspots allowed (not true anymore)

- Brandmeister
  - Cloud network that does not require physical repeaters and rely mostly on hotspots for access

- TGIF
  - Another cloud network

The most confusing part is that these are all **separate** networks and they are **not** (*for the most part*) linked. TG **3125** on **DMR-MARC** is not linked to TG **3125** on **Brandmeister**.

NEDECN (DMR-MARC)

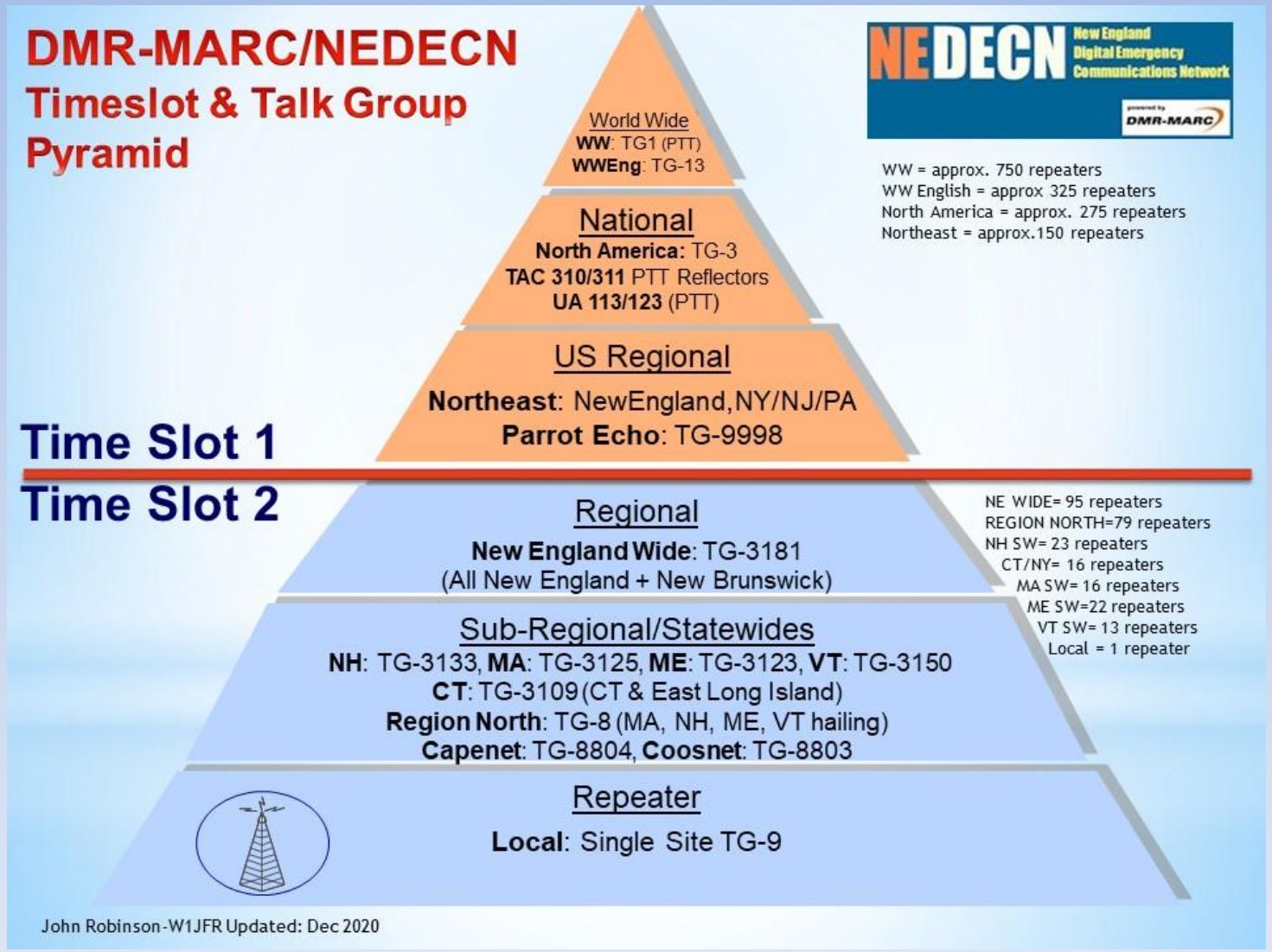
- www.nedecn.org
- All repeaters are linked into **DMR-MARC** network **across the globe**
- Southborough **AE1C** VHF / UHF machines provide great coverage to the Metrowest and Central MA
- NEDECN website has “codeplugs” available for download for different radios to get you started

NEDECN cont'd

- Talk groups are assigned to specific timeslots at the repeater, you can find specific assignments on NEDECN web pages

- All repeaters in the DMR-MARC network are linked together in a uniform fashion:
  - All **MA** repeaters will wake up on **MA 3125** talkgroup activation
  - All **North American** repeaters will activate on **North America 3** talkgroup

NEDECN Talk Group Pyramid



TYT MD-380 / MD-390 / UV-380 5W
~ $100

100,000 contacts supported at the moment, not even enough for North America

RandL.com BuyTwoWayRadios.com

TYT MD-9600 50W dual band mobile
~ $250

100,000 contacts *officially* supported at the moment, not even enough for North America, reports indicate 150,000 contacts could be loaded

RandL.com BuyTwoWayRadios.com

Radioddity GD-77
~ $100

Third party **OpenGD77** firmware exists for this radio to add many features and contacts storage. Can be used as a hotspot.

Radioddity.com

Alinco DJ-MD5XT
$190

Dual band 5W, +GPS, 200,000 contacts

RandL.com HRO

Alinco DR-MD500T
$380

Dual band 50W, +GPS, 300,000 contacts

HRO

Anytone AT-D878UVII Plus
$299

Dual band 5W, +Blutooth, +GPS, 500,000 contacts

RandL.com HRO

Anytone AT-D578UV PRO
$399

Triband 50W (220 5W) +Blutooth +GPS, 500,000 contacts. Non-PRO versions exist (without Blutooth or GPS)

HRO

Hotspots

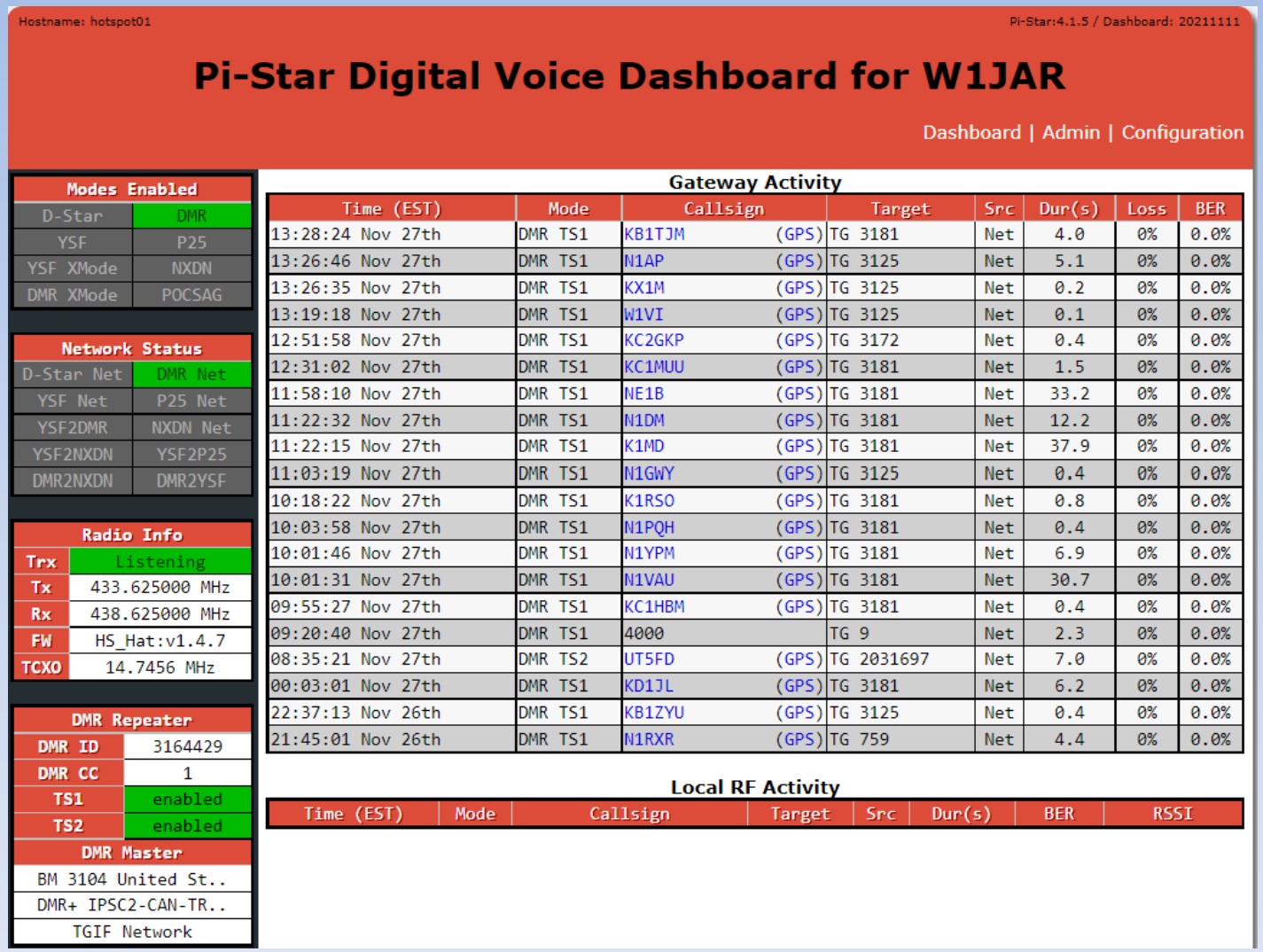
- Your own mini repeater to access DMR / System Fusion / D-Star networks, can be had for as low as **$100**

- Hotspots could be connected via your cell phone 4G connection making them portable. Some have a battery

Hotspots cont’d

- WIRES-X is not available on hotspots directly but other similar (and cross-linked) networks exist
- Hotspots allow you to “cross-mode” – connect to **DMR** with **System Fusion** radio and vice versa
- **D-Star** stands separate because of incompatible codec, you cannot easily “cross-mode” D-Star

Pi-Star


Hostname: hotspot01
Pi-Star:4.1.5 / Dashboard: 20211111
Pi-Star Digital Voice Dashboard for W1JAR
Dashboard | Admin | Configuration
Modes Enabled
D-Star
DMR
YSF
P25
YSF XMode
NXDN
DMR XMode
POCSAG
Network Status
D-Star Net
DMR Net
YSF Net
P25 Net
YSF2DMR
NXDN Net
YSF2NXDN
YSF2P25
DMR2NXDN
DMR2YSF
Radio Info
Trx
Listening
Tx
433.625000 MHz
Rx
438.625000 MHz
FW
HS_Hat:v1.4.7
TCXO
14.7456 MHz
DMR Repeater
DMR ID
3164429
DMR CC
1
TS1
enabled
TS2
enabled
DMR Master
BM 3104 United St..
DMR+ IPSC2-CAN-TR..
TGIF Network
Gateway Activity
Time (EST) Mode Callsign Target Src Dur(s) Loss BER
13:28:24 Nov 27th DMR TS1 KB1TJM (GPS) TG 3181 Net 4.0 0% 0.0%
13:26:46 Nov 27th DMR TS1 N1AP (GPS) TG 3125 Net 5.1 0% 0.0%
13:26:35 Nov 27th DMR TS1 KX1M (GPS) TG 3125 Net 0.2 0% 0.0%
13:19:18 Nov 27th DMR TS1 W1VI (GPS) TG 3125 Net 0.1 0% 0.0%
12:51:58 Nov 27th DMR TS1 KC2GKP (GPS) TG 3172 Net 0.4 0% 0.0%
12:31:02 Nov 27th DMR TS1 KC1MUU (GPS) TG 3181 Net 1.5 0% 0.0%
11:58:10 Nov 27th DMR TS1 NE1B (GPS) TG 3181 Net 33.2 0% 0.0%
11:22:32 Nov 27th DMR TS1 N1DM (GPS) TG 3181 Net 12.2 0% 0.0%
11:22:15 Nov 27th DMR TS1 K1MD (GPS) TG 3181 Net 37.9 0% 0.0%
11:03:19 Nov 27th DMR TS1 N1GWY (GPS) TG 3125 Net 0.4 0% 0.0%
10:18:22 Nov 27th DMR TS1 K1RSO (GPS) TG 3181 Net 0.8 0% 0.0%
10:03:58 Nov 27th DMR TS1 N1PQH (GPS) TG 3181 Net 0.4 0% 0.0%
10:01:46 Nov 27th DMR TS1 N1YPM (GPS) TG 3181 Net 6.9 0% 0.0%
10:01:31 Nov 27th DMR TS1 N1VAU (GPS) TG 3181 Net 30.7 0% 0.0%
09:55:27 Nov 27th DMR TS1 KC1HBM (GPS) TG 3181 Net 0.4 0% 0.0%
09:20:40 Nov 27th DMR TS1 4000 TG 9 Net 2.3 0% 0.0%
08:35:21 Nov 27th DMR TS2 UT5FD (GPS) TG 2031697 Net 7.0 0% 0.0%
00:03:01 Nov 27th DMR TS1 KD1JL (GPS) TG 3181 Net 6.2 0% 0.0%
22:37:13 Nov 26th DMR TS1 KB1ZYU (GPS) TG 3125 Net 0.4 0% 0.0%
21:45:01 Nov 26th DMR TS1 N1RXR (GPS) TG 759 Net 4.4 0% 0.0%
Local RF Activity
Time (EST) Mode Callsign Target Src Dur(s) BER RSSI

“Basic” Raspberry Pi Zero W + MMDVM modem board

Pi-Star

RandL.com

OpenSpot 3 Portable hotspot with battery

SharkRF.com

TGIF hostpots

Pi-Star, multiple products, some with touch screens very nicely built by TGIF admin Robert K4WZV

TGIFSpot.com

Thank you

- Any questions or need help with any of the digital modes?

- I frequently monitor W1FY repeater or you can send me an email to **w1jar.art@gmail.com**