AUSTIN REPEATERS AND NETWORK SYSTEMS OVERVIEW

AARC

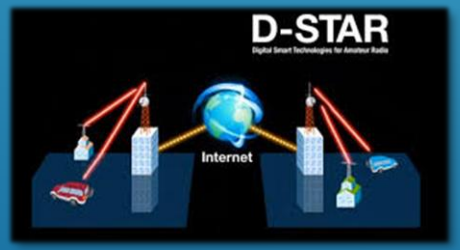
System Fusion

APCO International
Leaders in Public Safety Communications

AllStar Link

EchoLink

Roy Walker
WA5YZD



AARC Program
February 4, 2020

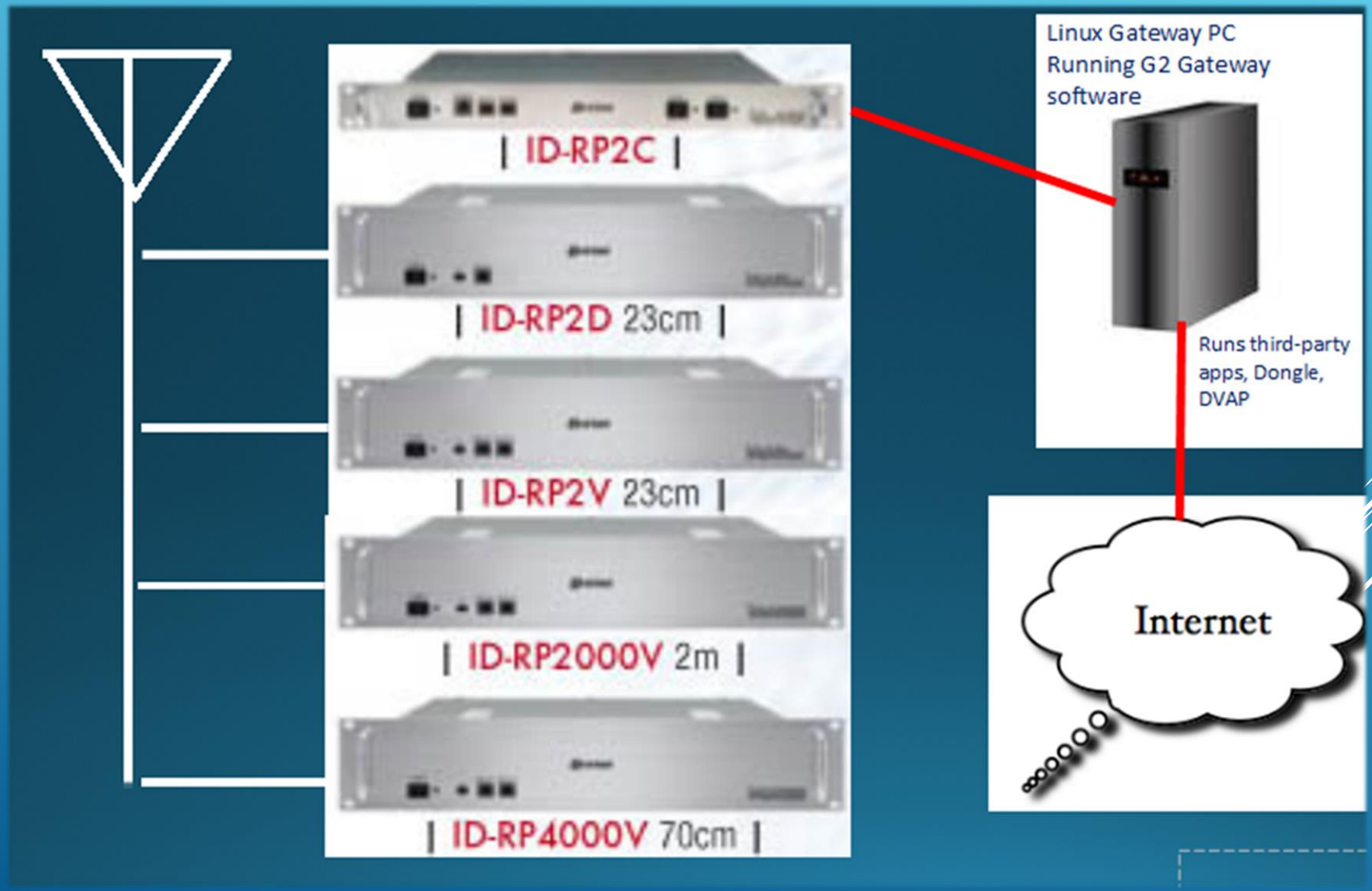
THANKS TO ALL OF OUR HOSTS

W5KA D-STAR FREQUENCIES - SAMC

- VHF DV MODULE C is 146.780 MHz (-600 KHz)
- UHF DV MODULE B is 440.650 MHz (+5.0 MHz)
- 1.2 GHz DV MODULE A is 1293.1 MHz (-20 MHz)
- 1.2 GHz DD MODULE A is 1248.1 MHz (No Offset)

D-STAR REPEATER ARCHITECTURE

The D-Star "Stack"



FRONT VIEW OF D-STAR RACK AT SAMC

REAR VIEW OF D-STAR RACK AT SAMC

NEW LARGER CAPACITY BATTERIES ON UPS

TOWER ON ROOF OF SOUTH AUSTIN MEDICAL CENTER

TOWER AND ANTENNAS AT SAMC

VIEW FROM ROOF OF SAMC

WALBURG KE5RCS D-STAR SYSTEM

Excellent Coverage in North Austin
I35 Corridor to Temple

- 145.13 MHz (-600 KHz)
- 440.575 MHz (+5 MHz)
- Stays on Reflector 004B on UHF Module

K5SOC – LAKE TRAVIS D-STAR

UHF

Repeater input freq. = 448.4
Repeater output freq. = 443.4

1.2 Gig

Repeater output freq. = 1293.6
Repeater input freq. = 1273.6

Stays connected to Reflector 004B

USING D-STAR

- Look up your local D-Star Repeater
  - http://www.dstarusers.org/repeaters.php?
    - Sort by state or call
  - Click on your repeater
  - Click on “Gateway Registration URL
    - https://w5ka.dstargateway.org:8443/Dstar.do

REGISTRATION REQUEST:

You only need to register one time. If you have registered in another city or country, no need to do it again.

USERS RADIO CHANNEL PROGRAMMING

Memory channel control

- Easy and Fast Method to Preset Your Radio
- Setup of a D-Star radio memory channel to communicate to other stations
- **Use of the "Calculator" from WWW.DSTARINFO.COM**

Stations heard control

- Collect 'Stations Heard' Callsigns
- Use Collected Callsigns to initiate a QSO

HANDY CALCULATOR FOR MEMORY CHANNEL PROGRAMMING

http://www.dstarinfo.com/dstar-web-calculator.aspx

QUESTIONS ON D-STAR?

UT PICKEL RESEARCH CENTER SITE

- AARC has two Yaesu DR2-X repeaters at this site
- 148.88 (-600 KHz, 107.2 tone for FM)
- 444.1 MHz (+5 MHz, 103.5 tone for FM)
- Both repeaters running in Auto Mode Switch
- Duplexer type systems

UT PICKEL RESEARCH CENTER SITE

- 146.88 W5KA Repeater normally connected to Texas Nexus Talk Group (Room)
- The 146.88 repeater can be connected to any Talk Group in the Wires-X system by the User
- It will return to the Texas Nexus Talk Group after 30 minutes
- 146.88 Wires-X support is by RF link from nearby data center
- 444.1 Repeater is not network connected

UT PICKEL RESEARCH CENTER SITE

UT PICKEL RESEARCH CENTER SITE

SYSTEMS AT KVUE / KEYE BUCKMAN MT. SITE

146.94 (-600 KHz, 102.7 tone) – Allstar and EchoLink Networked

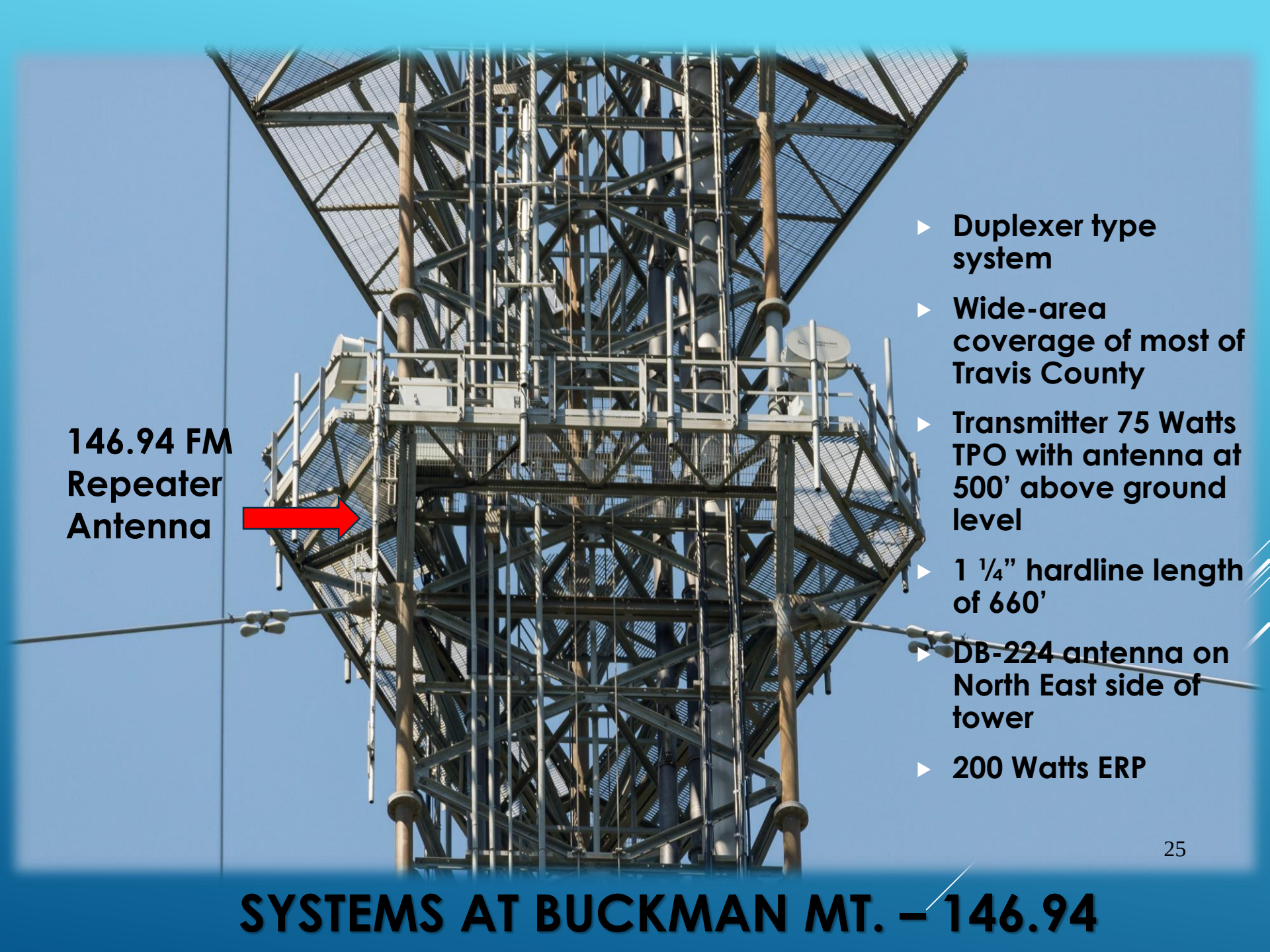
224.8 (- 1.6 KHz, no tone) error on Club Website

444.2 (+ 5.00 MHz, 102.7 tone) – Allstar and EchoLink Networked, Austin UHF Network

1.2924 GHz (-20 MHz, 102.7 tone) – Allstar Networked to 900 MHz South Texas Network, Talkback 441.525 MHz

SYSTEMS AT KVUE / KEYE BUCKMAN MT.

NEW KVUE TV ~125KW UPS



- Duplexer type system
- Wide-area coverage of most of Travis County
- Transmitter 75 Watts TPO with antenna at 500’ above ground level
- 1 ¼” hardline length of 660’
- DB-224 antenna on North East side of tower
- 200 Watts ERP

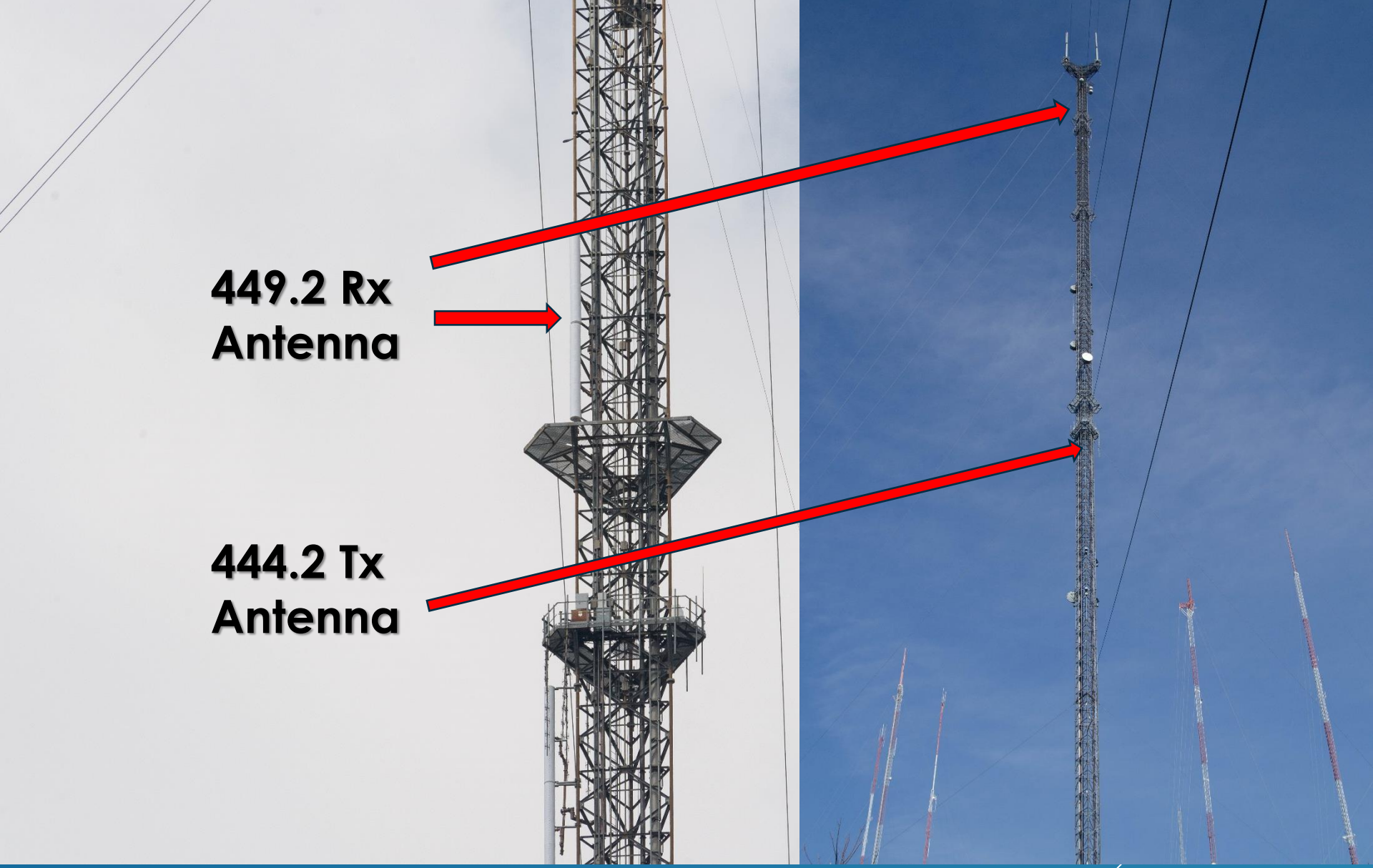
SYSTEMS AT BUCKMAN MT. – 146.94

SYSTEMS AT BUCKMAN MT. – 224.8

- Duplexer System
- Repeater Shares 1- ¼" Hardline with 146.94 and 444.2 TX
- 5 Watts TPO
- Antenna at 500' AGL on NE side of tower

BUCKMAN MT. – 444.2 FM REPEATER

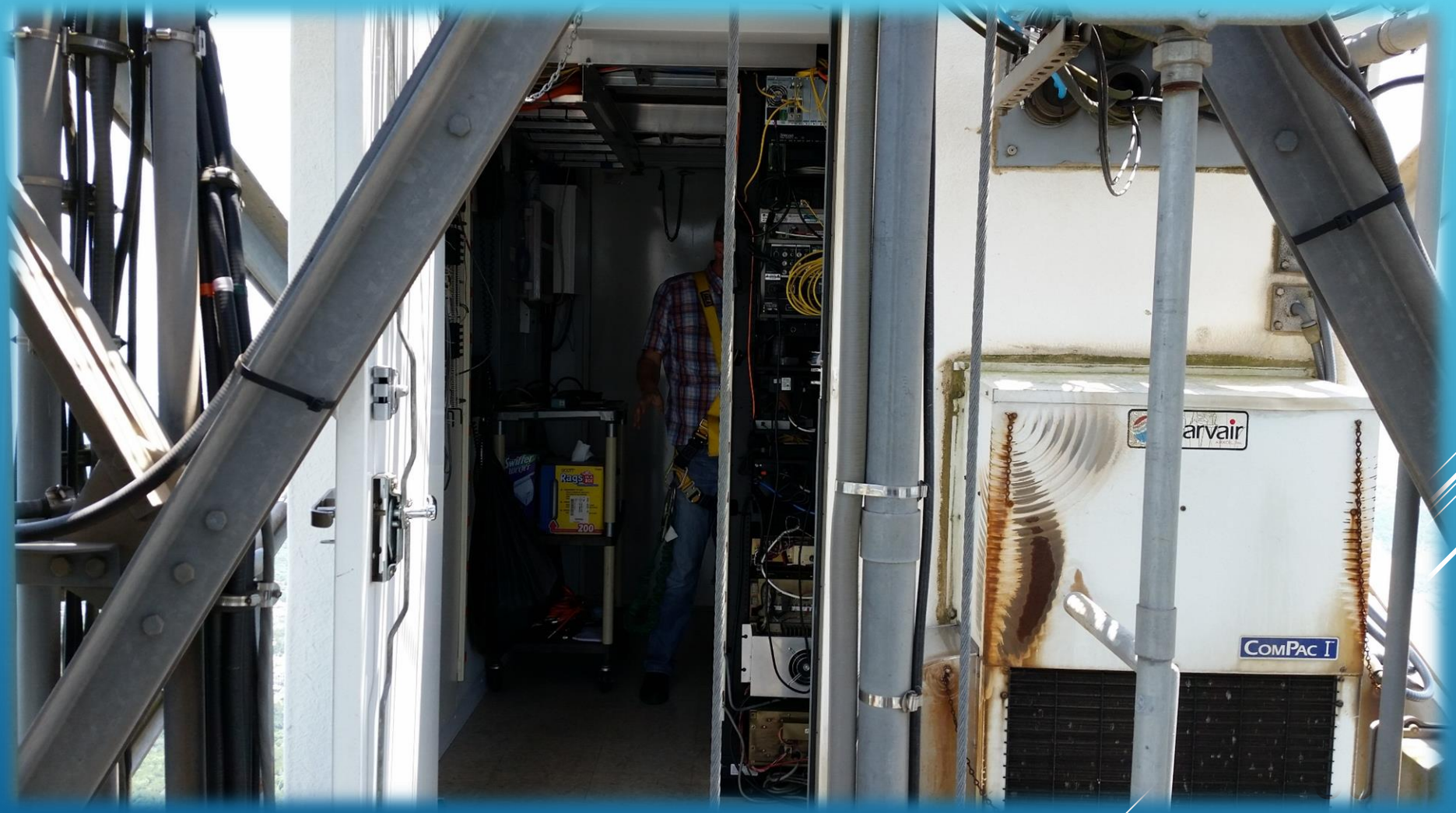
- Two Antenna System
  - Receiver Antenna at 980'
  - Receiver in building at top of tower
  - Transmitter Ant. At 500' on 1 ¼" shared hardline
- Transmitter power 75W TPO
- DB420 Antenna
- Allstar and EchoLink Network
  - Austin UHF Network –
    - 443.075 (+5.0 MHz, 123 tone)
    - 444.500 (+5.0 MHz, 110.9 tone)
    - 442.7 (+5.0 MHz, 123 tone)
    - 224.360 (-1.60 MHz, 100 tone)



BUCKMAN MT. – 444.2 REPEATER

BIRDHOUSE

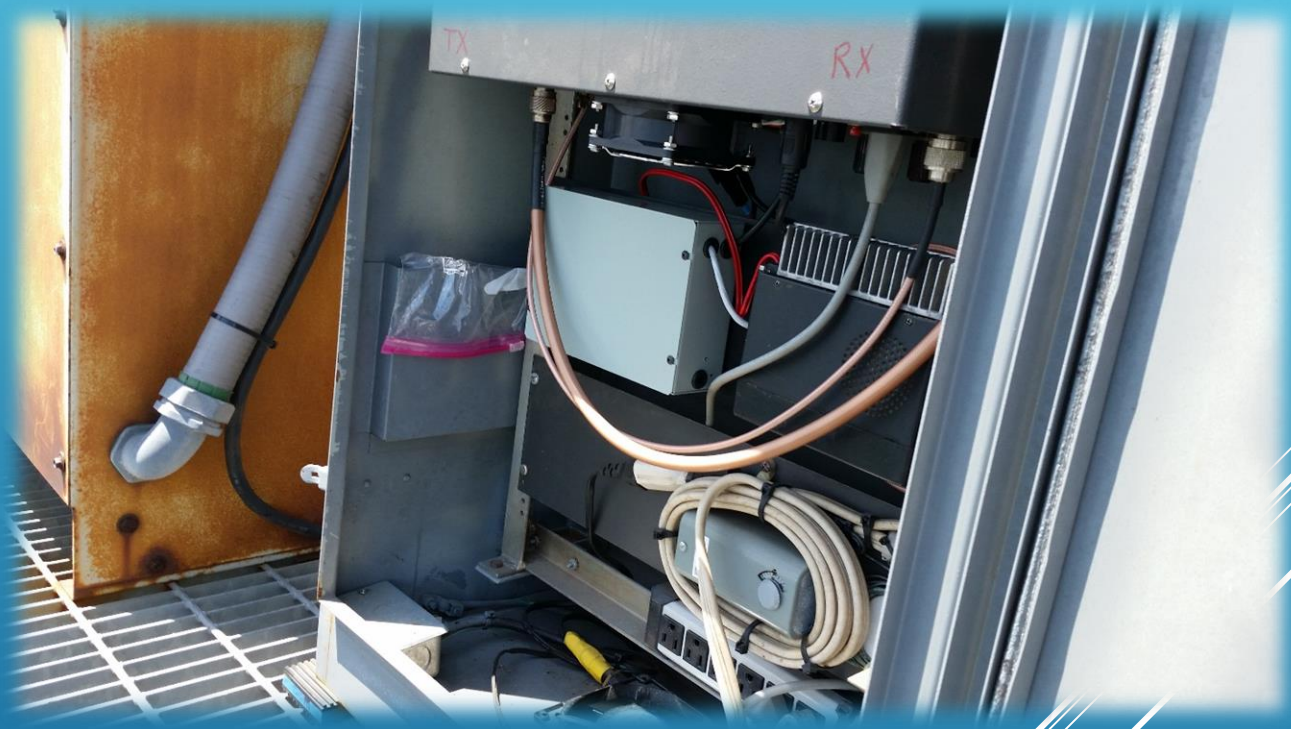
KVUE BIRDHOUSE

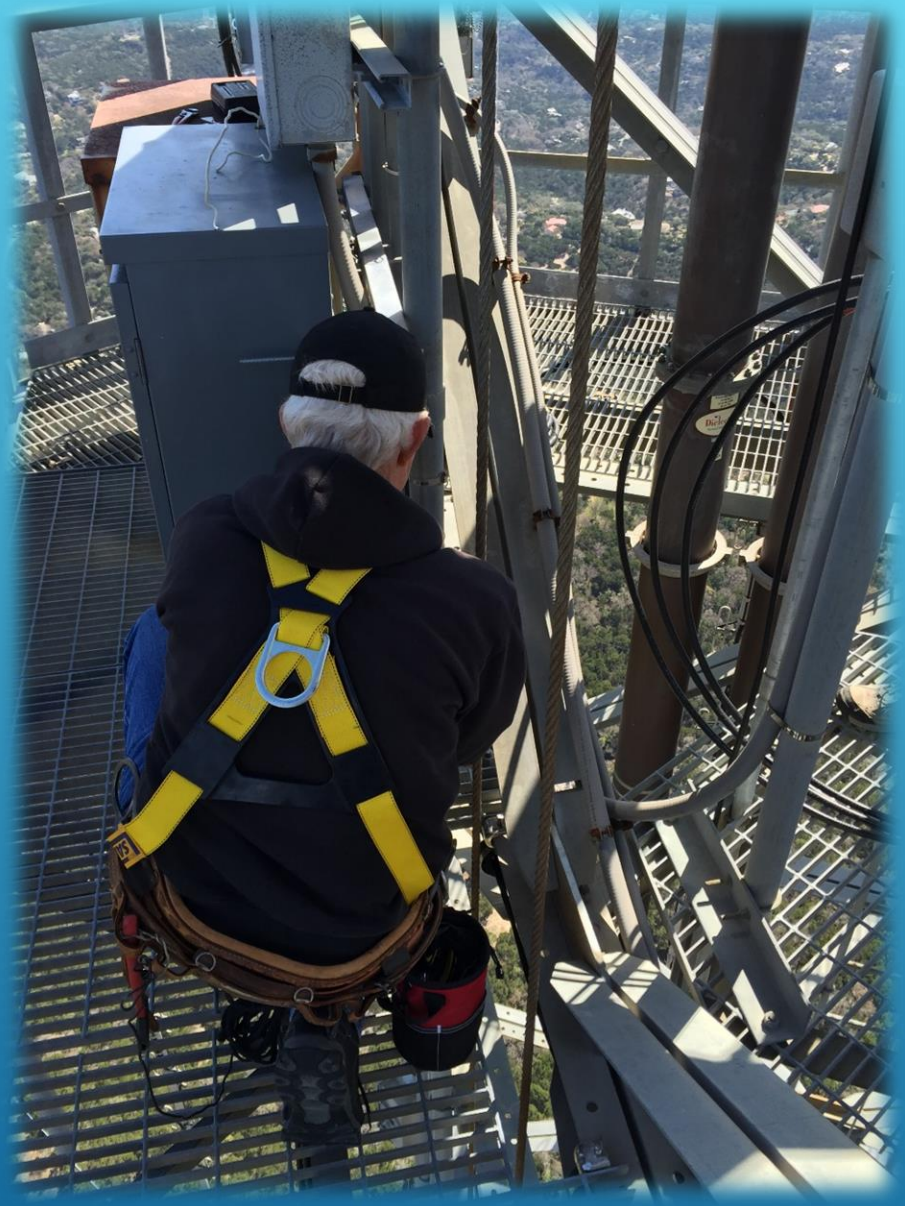


KVUE VUE

BUCKMAN MT. – 1.2 GIG REPEATER

- 1.2924 GHz (-20 MHz, 107.2 tone)
- Allstar Network
- Coverage is most of Travis County
- 900 MHz South Texas Net
- 10 Watts TPO
- Near zero line loss
- Receiver and Transmitter antennas at 960' AGL
- 441.525 Talkback

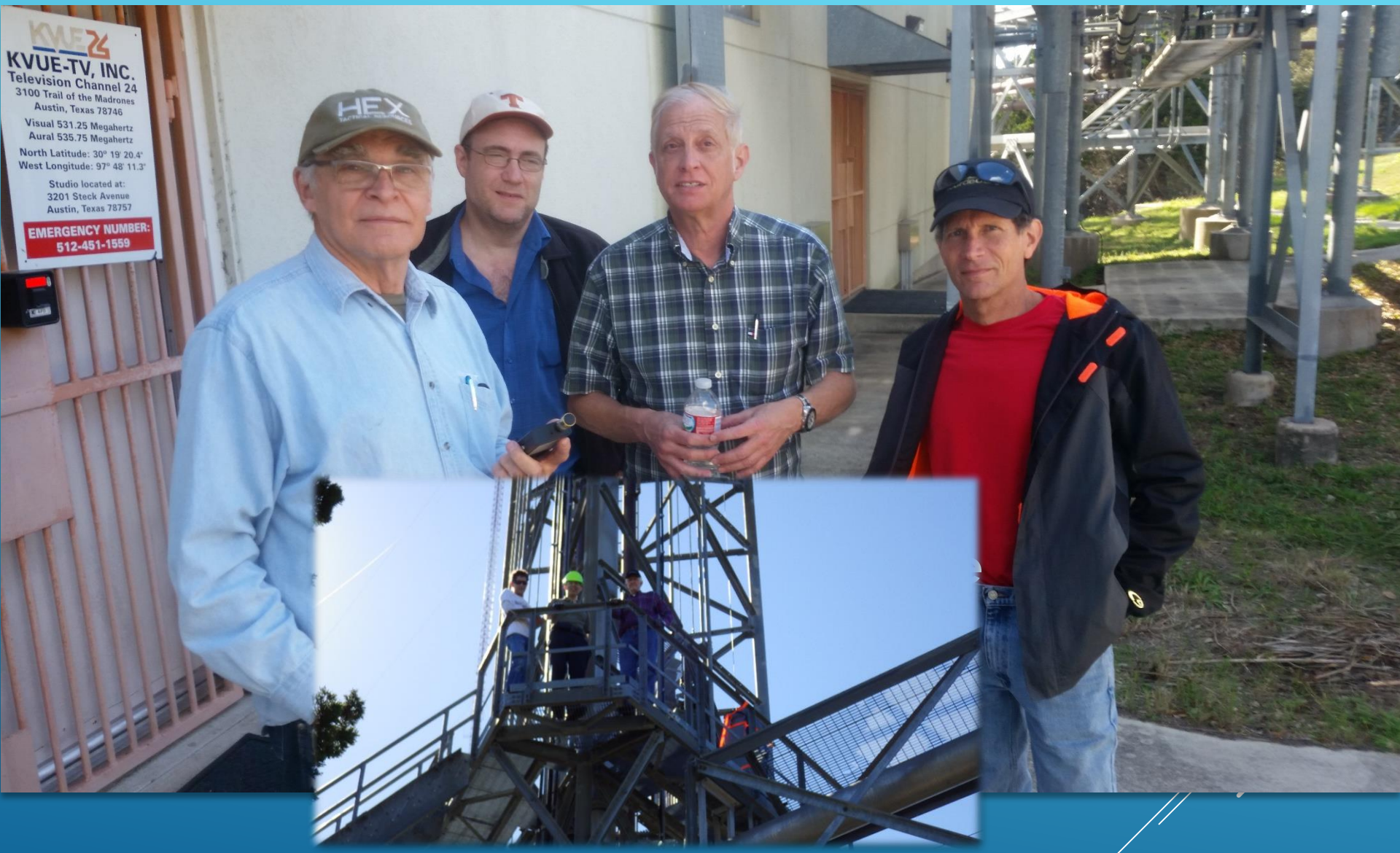




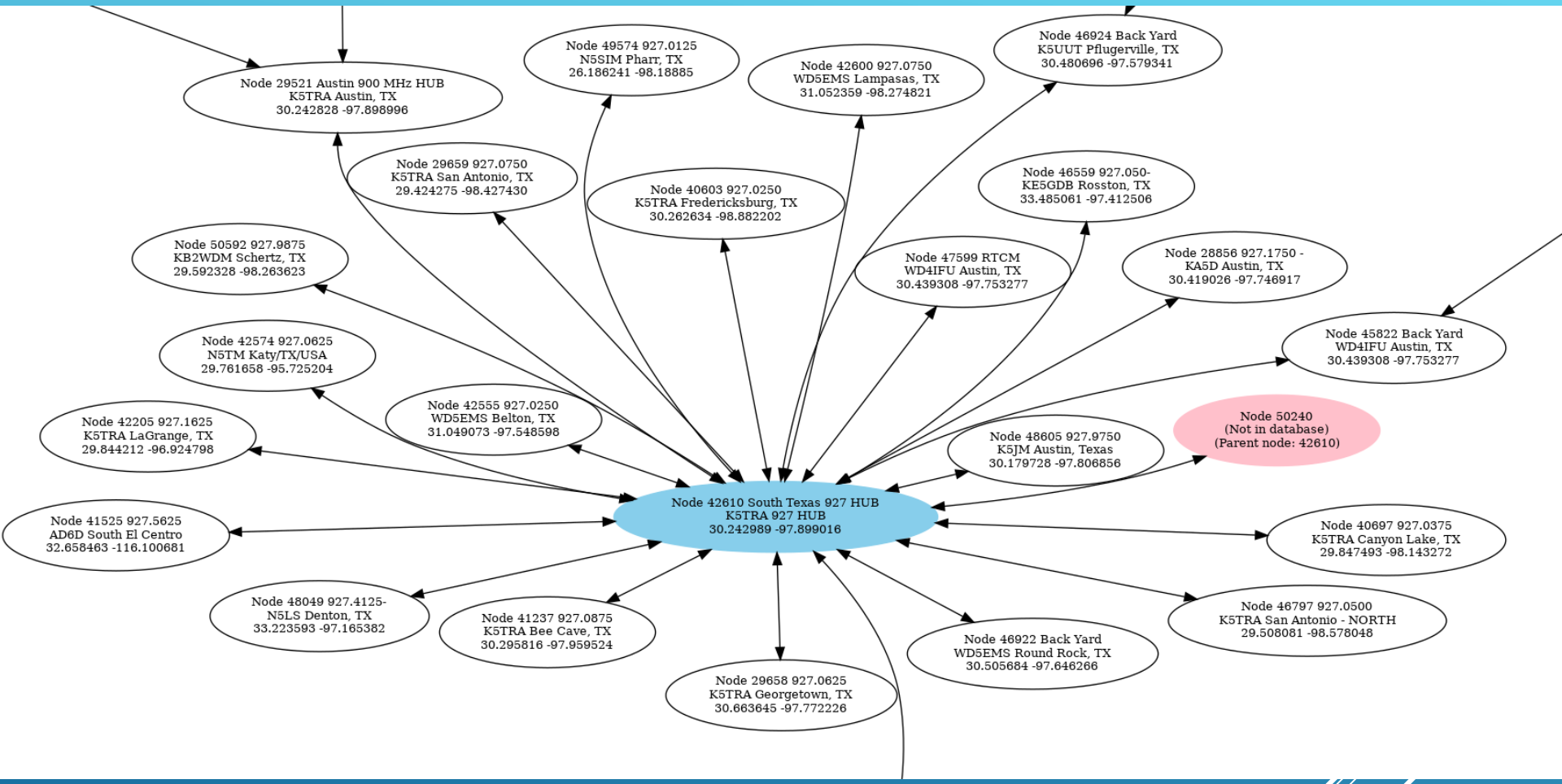
BUCKMAN MT. – 1.2 GIG REPEATER

1.2 GHZ REPEATER – BUCKMAN MT.

VIEW FROM TOP OF KVUE TOWER



1.2 GHZ REPEATER – BUCKMAN MT.



SOUTH TEXAS 900 MHZ NETWORK

NEW NODE ON SOUTH TEXAS 900 MHZ. NETWORK – *FREDERICKSBURG*

- 146.86 MHz (-600 KHz, 146 tone in FM)
- Uses AARC Antenna and Transmission Line
- Contact Ross, N0GSZ

N0GSZ P-25 / FM REPEATER AT MT LARSON

GO TO AUSTINHAMS.ORG – ABOUT – REPEATERS FOR DETAILS

QUESTIONS ?

DIGITAL MODES COMMON IN AMATEUR RADIO

CW	All Bands Text
RTTY (BAUDOT)	HF Text
AMTOR	HF Text
Packet	
APRS	GPS Positioning
Digipeaters	VHF Text
DX Clusters	VHF Text
PACTOR I/II/III	HF Email and Text
Winlink for VHF	Email/Text VHF Data
Winlink for HF	Email/Text VHF Data
Winmor HF	Email/Text HF Data
Clover	HF Text
PSK31	All Bands Text
MT-63	All Bands Text
MFSK16	All Bands Text
OLIVIA	HF Text
HSMM	Above 50 MHz
FSK441/WSJT HSMS	Above 50 MHz
D-STAR	HF-10GHz V/D
APCO25 (P25)	VHF/UHF/700/800 MHz V/D
Fusion/C4FM	VHF/UHF V/D

DIGITAL MODES SUPPORTING VOICE AND DATA

• APCO P25	• Uses IMBE or AMBE CODEC over C4FM modulation
• D-Star	• Open Spec using AMBE vocoder over GMSK modulation
• Fusion	• FDMA in conjunction with Special Type of C4FM FSK
• DMR	• European standard uses AMBE+2 vocoder and TDMA modulation
• MOTOTRBO	• Motorola version of DMR

A FEW COMMUNICATIONS CONCEPTS

- *The more information you transmit per second, the more bandwidth is required.* Therefore,

  Bandwidth ~ Information Rate

- *The amount of noise power in a radio channel is proportional to the bandwidth of that channel*

  Noise Power ~ Channel Bandwidth

- *To be copyable, the **signal power** in the receiver bandwidth must exceed the **noise power** by a minimum ratio*

$$\frac{S}{N} \equiv \frac{P_{Signal}}{P_{Noise}} \geq \text{Receive Threshold}$$

AND TO SUM IT UP……..

The ***Signal Power*** at the receiver is proportional to the *transmit power* diminished by *path loss or distance* from the transmitter to the receiver

$$P_{Receiver} \approx \frac{\text{Transmit Power}}{\text{Distance from Transmitter}^2}$$

(or path loss)

To sum it all up into one equation……..

The S/N Ratio at a Receiver is

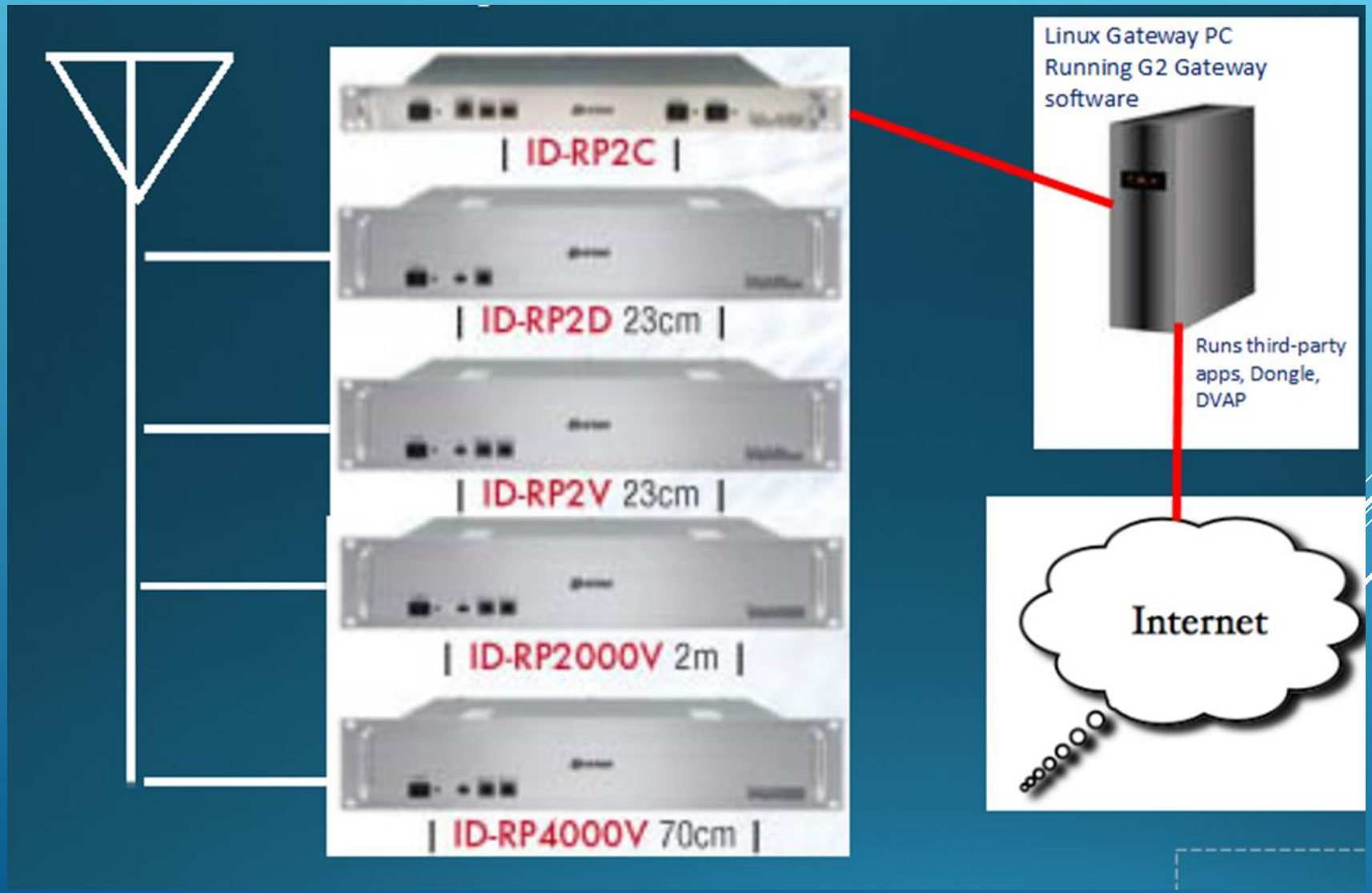
$$\frac{S}{N} \approx \frac{(\text{Tx Power})}{(\text{Distance})^2 \text{ x } (\text{Bandwidth})}$$

HOW DOES D-STAR WORK ?

- Voice is converted to digital and transmitted at 4800 bps using GMSK modulation
  - 2400 bits for voice
  - 1200 bits for Forward Error Correction on voice
  - 1200 bits for data (error correction usually in applications
  - New *Fast Data Mode* allows 3600 bps data
- True narrowband digital signal bandwidth
  - Only 6.25 KHz signal for voice & data (versus wider bandwidth for FM voice, DMR, Fusion and P25)
- Can operate simplex, repeater or linked to other repeater(s) with voice and data features

D-STAR REPEATER AT SAMC OWNED AND OPERATED BY AARC

The D-Star "Stack"



D-STAR - W5KA South AUSTIN MEDICAL CENTER

- What is D-STAR
- How it works
- What you can do with it
- How to use the system
- SAMC Site Information
- Examples of user radio setup
- DV Hotspots from DVMega and OpenSpot

- Digital Pulses are not transmitter by the radio
- A RF Modulator in the radio sends one or more analog signals that ‘carry’ the encoded digital information
- A Receiver demodulates the encoded information from the analog RF signal and turns that signal into a digital form
- More carriers and more complex modulation schemes will produce a higher data rate

DIGITAL MODE - DEFINED

SIGNAL MODES PERSPECTIVE

TERMS USED IN DIGITAL MODES

- TDMA – Time Division Multiple Access
- FDMA – Frequency Division Multiple Access
- GMSK – Gaussian minimum shift keying
- C4FM – Continuous Four Level Frequency Modulation

- APCO P25 – AMBE+2
- D-STAR - AMBE
- Fusion – Newer AMBE from D-STAR
- DMR - AMBE
- NXDN
- FreeDV

MODULATION VS. PROTOCOL VS. VOCODER FROM TRANSMISSION PERSPECTIVE

Modulation – RF Level

How the Bits get sent over the air

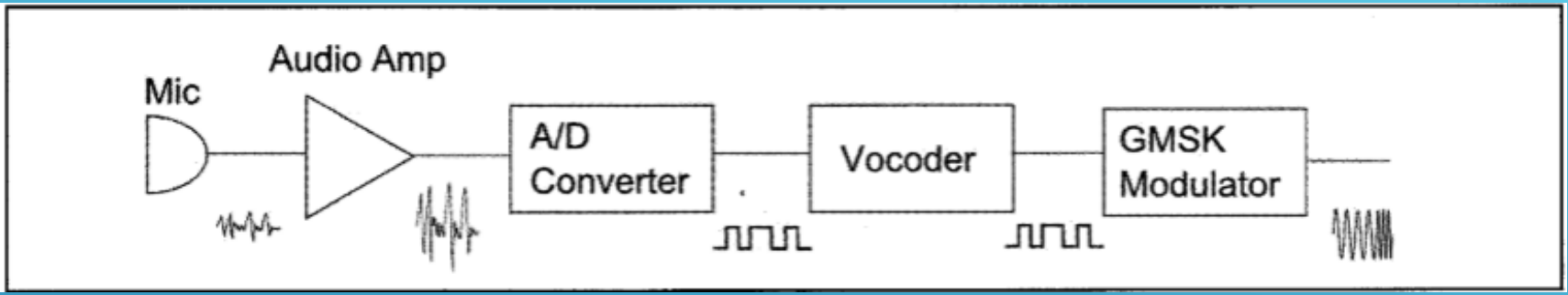
Protocol – Bit Stream Sent to RF Level

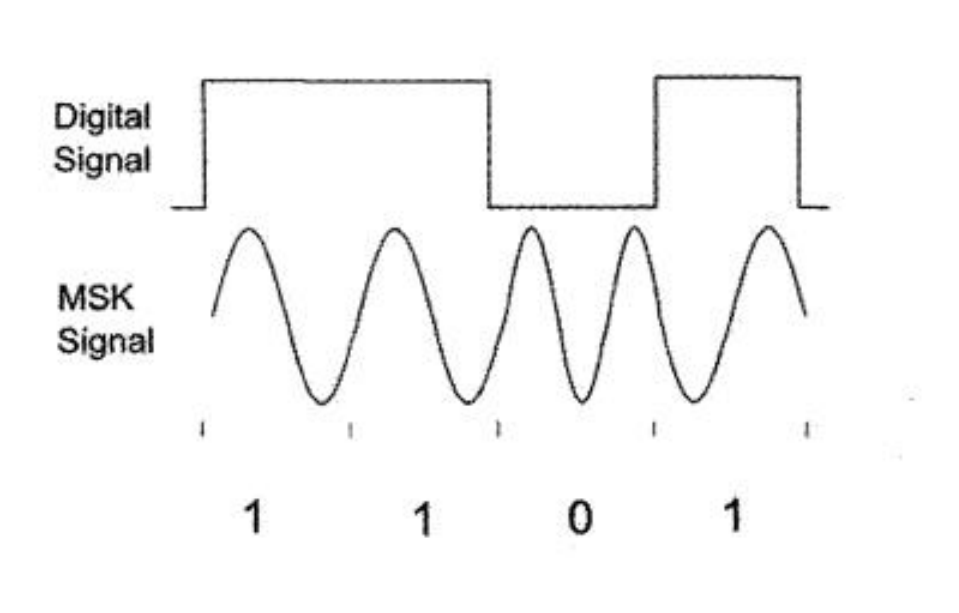
How the Bits are ordered and arranged in a stream

Vocoder – How the voice is encoded and made available to be placed into the Protocol

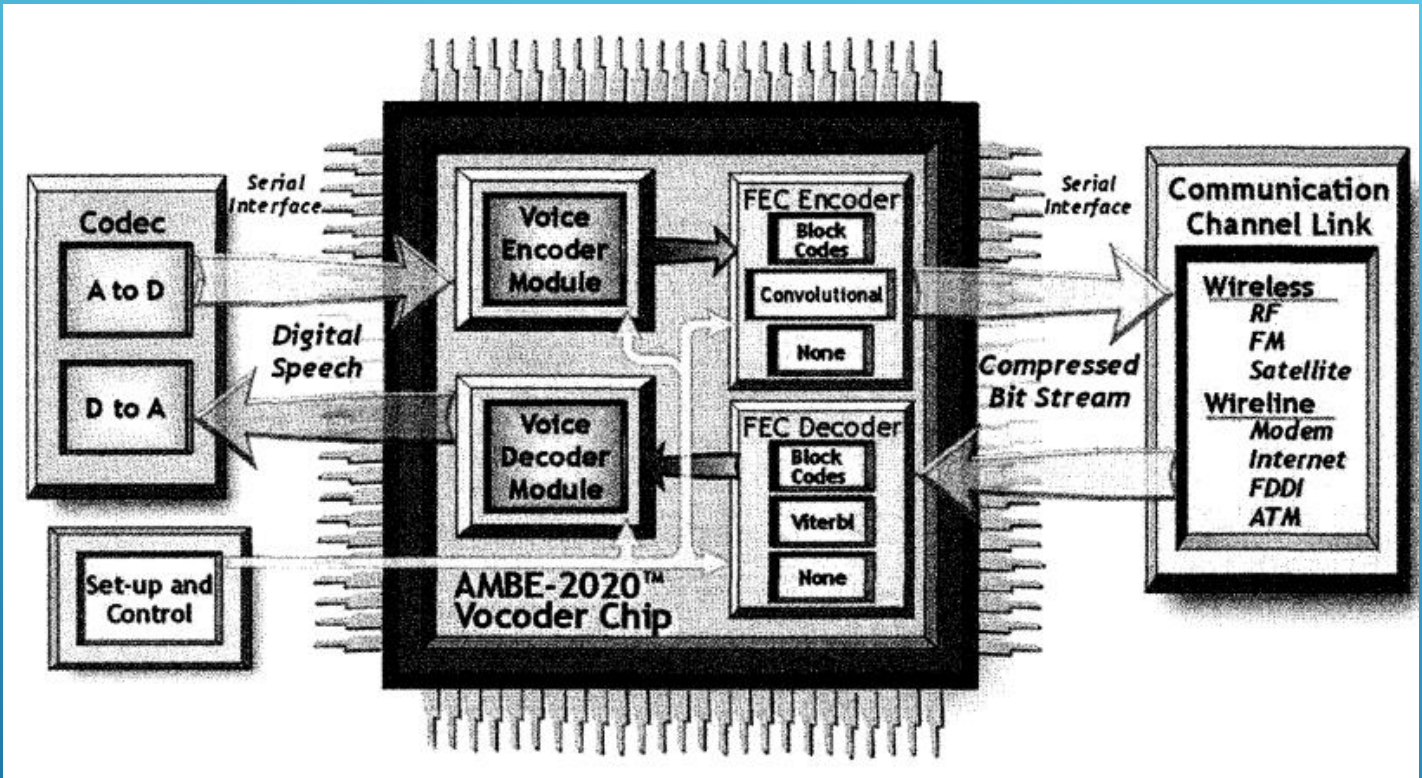
How the voice gets 'coded'

D-STAR MODULATION





AMBE-2020 VOCODER CHIP

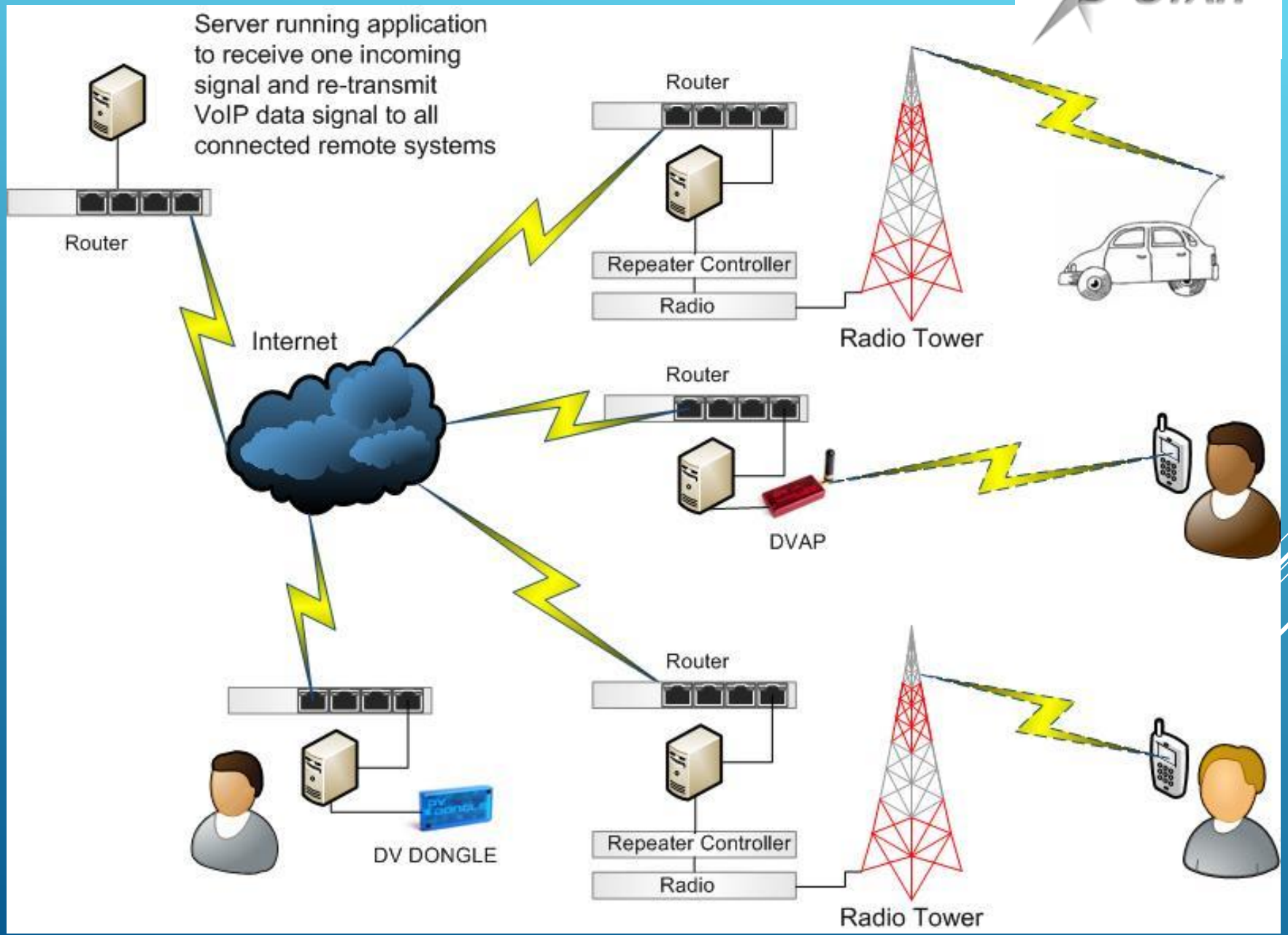


Icom use this vocoder made by *Digital Voice Systems*

WHAT IS D-STAR ?

- D-Star is an open standard for digital voice and data designed for Amateur Radio
- D-Star Was Originally Developed by Japan Amateur Radio League (JARL)
- D-Star uses AMBE vo-coder chip from DVSI to convert analog speech to data and vice versa
- D-Star standard is adopted by Icom, Kenwood, and others

SYSTEM DIAGRAM



WHAT CAN D-STAR DO?

- Voice and 1200 baud Data simultaneously on 2m, 440 and 1.2 GHz
- Repeater linking with a D-Star Gateway and an Internet connection
- D-PRS (digital APRS) automatic position reporting, simultaneous with voice
- Reflectors - act as Conference Bridge for linking multiple repeater worldwide

WHAT ELSE CAN D-STAR DO?

- DV Dongle, DV Access Point (DVAP)
- Hotspots and DV Node Adapters
- 128 Kb data transmission on 1.2 GHz with Internet connectivity

HOW TO USE D-STAR

- Local Repeater Operation
  - Just like an FM Repeater, but Digital Voice
- Cross-band Local Repeater Operation
  - Input on one band (VHF), output on another (UHF)
- Linked to a Reflector or another Repeater
  - Via the D-Star "Gateway" and the Internet
  - Anywhere on the planet !
- Direct to another Repeater or D-Star radio on another Repeater (Call-Sign Operation)

HOW TO DO D-STAR !

- "Register" your call on your (or any) Gateway
- Get "Approved" by the Gateway Admin
- Make calls through the Gateway (and Internet) to remote Repeaters, Reflectors, or Stations
  - Note: Register only once ! "Registered anywhere, registered everywhere"

D-STAR OPERATION

Roy Walker
WA5YZD

AARC Program
July 2, 2019

D-STAR TERMINOLOGY

- Modules
- MY CALL
- YOUR CALL
- MODE
- REPEATER 1
- REPEATER 2
- Reflectors

MY CALL

- WA5YZD (Example)
- Put your station callsign in your radio before you do anything else with D-STAR

YOUR CALL - THE STATION YOU ARE WANTING TO TALK TO

- W5IFQ (example)

MODE

- DV - MODE your radio must be set to for D-STAR DIGITAL MODE communications
- FM for regular repeater and simplex operation on other frequencies

MEMORY CHANNEL PROGRAMMING TO CALL CQ

Receive Frequency	Transmit Frequency	Offset Frequency	Offset Direction	Operating Mode	Name	Tone Mode	CTCSS	Rx CTCSS	DCS	DCS Polarity	Skip	Step	Digital Squelch	Digital Code	Your Callsign	Rpt-1 CallSign	Rpt-2 CallSign
146.78000	146.18000	600 kHz	-DUP	DV	AUS C	None	88.5 Hz	88.5 Hz	023	Both N	Off	5 kHz	Off	0	CQCQCQ	W5KA C	

This memory channel stored in your radio will be heard by any station listening to Module C of W5KA in DV mode.

MEMORY CHANNEL PROGRAMMING TO CALL CQ TO MODULE B OF W5KA

Programming for talking on W5KA (port DV C) to (port DV B)

YOUR:: **CQCQCQ**

RPT1: **W5KA▪▪▪C**

RPT2: **W5KA▪▪▪B**

Set Radio To: **146.7800 MHz Offset -0.6000 MHz**

"▪" represents a space

Help!

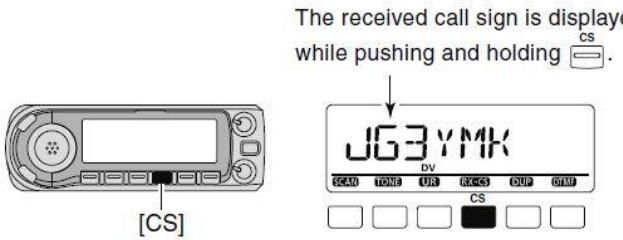
This transmission will be heard by anyone listening to either Module C or Module B of W5KA

USE COLLECTED CALLSIGNS TO MAKE A CALL

◇ One-touch reply using the call record

The stored call signs in the call record can be used to call the other station.

①After receiving a call, push and hold **[RX→CS]**(CS) for 1 sec.



- Set your own call sign (MY) in advance. (pgs. 31, 42, 43)
- The call sign in "CALLER" is stored as "UR," "RXRPT1" is stored as "R2" and "RXRPT2" is stored as "R1."
- Error beeps sound when a call sign is received incorrectly, and no call sign is set in this case.

②Push **[PTT]** to transmit; release to receive.

• Selecting a call record via RX CAL screen

①Select the desired record channel in steps ① and ② on the previous page.
②Push and hold **[MW]**(S.MW) for 1 sec. to copy the record channel to current call sign.
③Push **[PTT]** to transmit; release to receive.

Important!
Setting call signs with the "One-touch reply using the call record" operation as at left are for temporary operation only. Therefore, the set call signs will be over-written when another call record is used to set call signs.
• Never saved into a call sign memory.

If you want to save the set call signs, see "Copying the call record contents into call sign memory" (p. 47) for details.

✔For your information
When a call specifying your call sign is received, the call signs of the calling station and the repeater it is using can be automatically used for operation.

- When "CALL W (RX call sign auto write)" (p. 135) is set to "AUTO," the station call sign in "CALLER" is set to "UR" automatically.
- When "RPT W (Repeater call sign auto write)" (p. 135) is set to "AUTO," the repeater call sign in "RXRPT1" is stored as "R2" and "RXRPT2" is stored as "R1" automatically.

NOTE: The One-touch reply function can be used on the same network system, but it cannot be used over different network systems.

REPEATER STATUS

Receive Frequency	Transmit Frequency	Offset Frequency	Offset Direction	Operating Mode	Name	Tone Mode	CTCSS	Rx CTCSS	DCS	DCS Polarity	Skip	Step	Digital Squelch	Digital Code	Your Callsign	Rpt-1 CallSign	Rpt-2 CallSign
146.78000	146.18000	600 kHz	-DUP	DV	AUSCSTAT	None	88.5 Hz	88.5 Hz	023	Both N	Off	5 kHz	Off	0	W5KA I	W5KA C	W5KA G

D-STAR TALKY FROM KENWOOD

TH-D74A

http://www.kenwood.com/usa/com/amateur/th-d74a/

D-STAR DV DONGLES

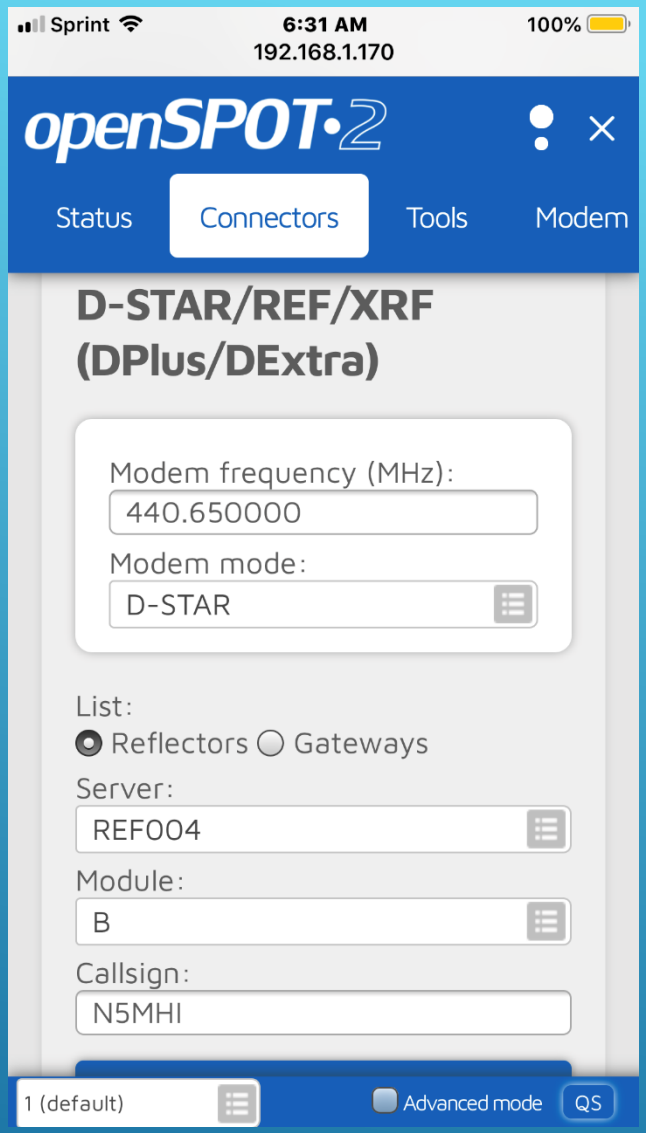
Jon Penner
N5MHI

AARC Program
July 2, 2019

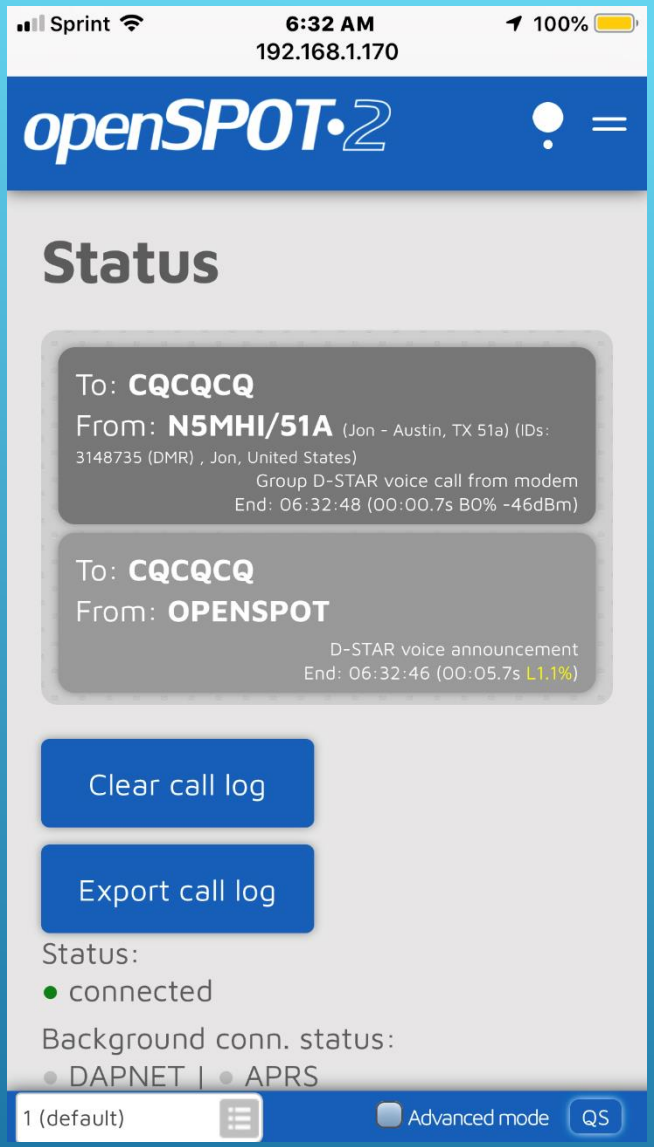
Compatible digital radio protocols and networks

- DMR (BrandMeister, DMRplus, DMR-MARC, Phoenix, XLX)
- D-STAR (DCS, REF/DPlus, XRF/DExtra, XLX)
- System Fusion/C4FM (FCS, YSF Reflector)
- NXDN (NXDN Reflector)
- P25 (P25Reflector)
- POCSAG (DAPNET)
- APRS messaging and location data forwarding (APRS-IS)
- Supports cross modem modes (example: talk with your C4FM radio on DMR, and with your DMR radio on System Fusion networks).

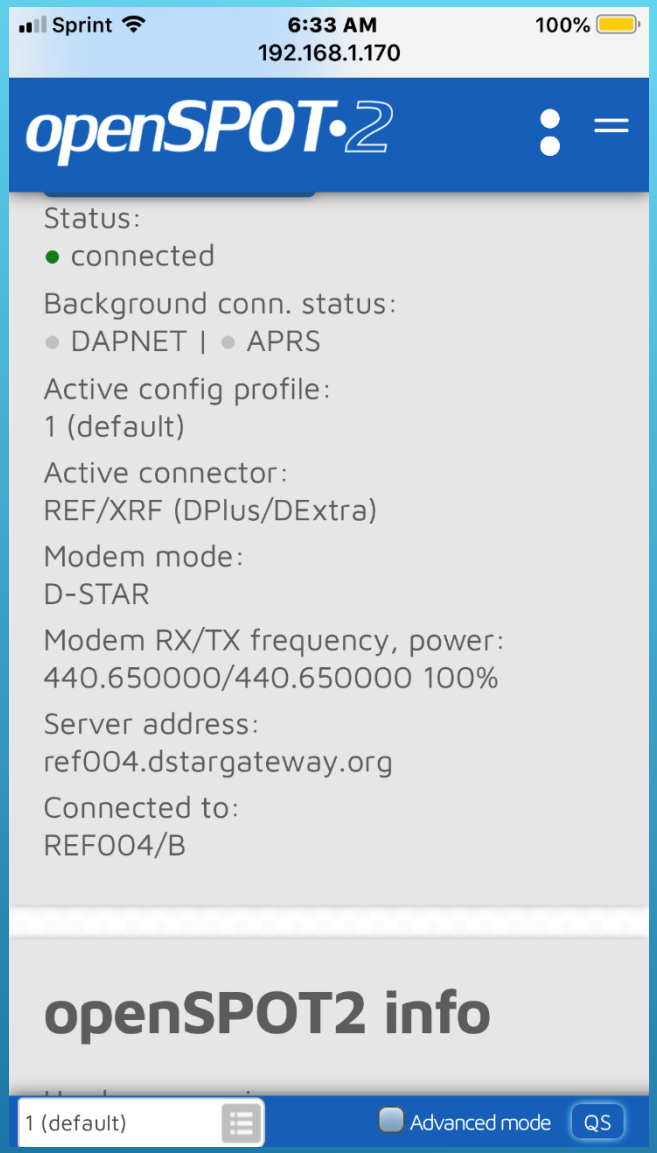
OPENSPOT*2 PROTOCOLS AND NETWORKS



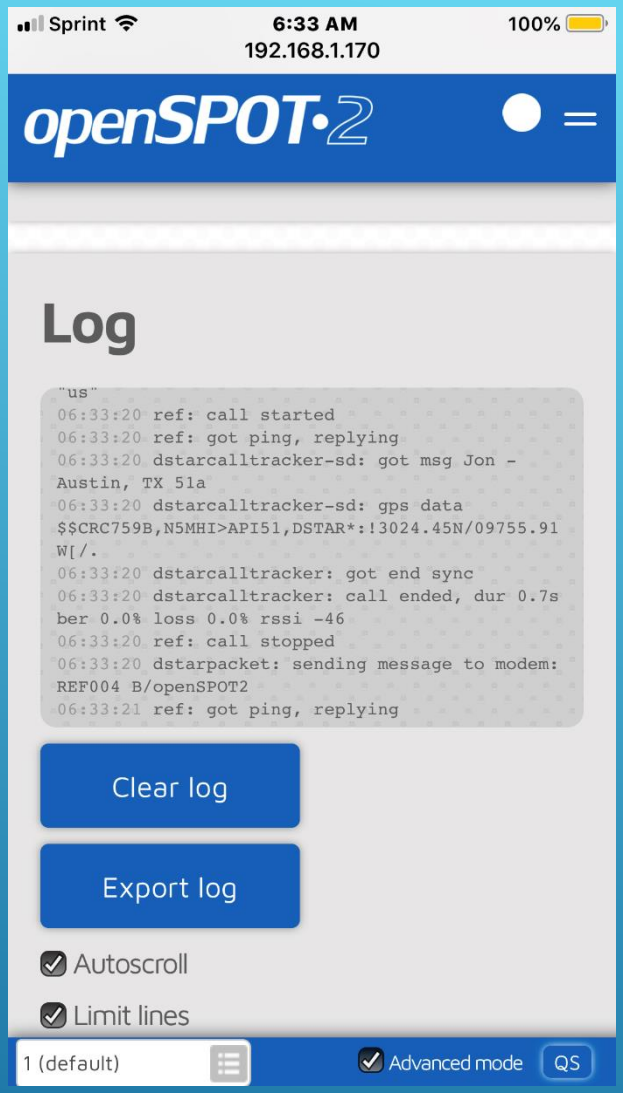
OPENSPOT*2 CONNECTORS



OPENSPOT*2 STATUS



OPENSPOT*2 INFO



OPENSPOT*2 LOG

DVMEGA HOTSPOT

- Hotspot transfers digital data packets from the radio to the internet
- Receives packets from the internet and back out over a low power transmitter to the radio
- Destination on the internet is a Reflector
- A Raspberry Pi is paired with the DVMega to make the IP connection to the Reflector
- Hotspot does not do any A/D conversion only passes encoded digital audio to and from the radio and internet

DVMEGA DASHBOARD

Status via Browser

Status-Dashboard N5MHI

Contact-E-Mail: n5mhi.jon@gmail.com

Gateway:

Location	Longtitude/Latitude	ircDDBGateway Server	APRS-Host
Austin Texas	30.000000 -97.000000	group1-irc.ircddb.net	rotate.aprs2.net

ircddb	DCS	DExtra	DPlus	D-Rats	Info	Echo	Log
🔴	🟢	🟢	🟢	🔴	🟢	🟢	🟢

System Info:

CPU-Temperature	CPU-Frequency	System-Load	CPU-Usage	Uptime	Idle
42.774 °C	600 MHz	6 %	2.6%	16 days, 13 hours, 30 minutes, 23 seconds	16 days, 7 hours, 55 minutes, 42 seconds

Repeaters:

Repeater	Module	Frequency Shift	Antenna Height. Range	Latitude Longitude	Default reflector	@Startup Reconnect
1	B	440.65000 0.0000 Mhz	0.000 m a.g. 0.000 Km	0.000000 0.000000	REF004 B	Yes Never

Links (incoming):

Repeater	Linked to	Link Type	Protocol	Last Change (UTC)
N5MHI B	not connected			

Links (outgoing):

Repeater	Linked to	Link Type	Protocol	Last Change (UTC)
N5MHI B	REF004 B	Dongle	DPlus	2017-03-13 15:24:10

Remote Control:

Repeater:	N5MHI B
Link-Target:	
Preset-Target:	please choose
Reconnect after:	never
Password:	

Submit

DVMEGA DASHBOARD

More Dashboard information

Currently transmitting:

Date & Time (UTC)	Call	ID	Yourcall	Repeater1	Repeater2	TX-Seconds

Currently maybe in QSO:

Date & Time (UTC)	Call	Frames (s)	Loss (%)/BER (%)
2017-03-30 04:45:38	2E0MJJ	5.3	0.0

Last 15 transmissions:

Date & Time (UTC)	Call	Frames (s)	Loss (%)/BER (%)
2017-03-30 04:45:38	2E0MJJ	5.3	Loss: 0.0
2017-03-30 04:41:19	N5MHI	7.3	Loss: 0.0
2017-03-30 04:10:41	N5MHI	7.5	Loss: 0.0
2017-03-30 04:09:46	N5MHI	7.3	Loss: 0.0
2017-03-30 04:07:16	N5MHI	7.5	Loss: 0.0
2017-03-30 04:06:26	N5MHI	7.3	Loss: 0.0
2017-03-30 02:19:37	N5MHI	7.5	Loss: 0.0
2017-03-30 02:18:47	N5MHI	7.3	Loss: 0.0
2017-03-30 02:16:47	N5MHI	7.5	Loss: 0.0
2017-03-30 01:26:22	W0FCM	5.4	Loss: 0.0
2017-03-30 01:07:50	W5GKP	2.5	Loss: 0.0
2017-03-30 01:07:47	W5GKP	2.1	Loss: 0.0
2017-03-30 01:00:09	WB5HJV	0.3	Loss: 0.0
2017-03-30 00:57:31	N5BKV	0.7	Loss: 0.0
2017-03-30 00:53:59	KB5ZZB	1.3	Loss: 0.0

Last 5 local transmissions:

Date & Time (UTC)	Call	Frames (s)	Silence (%)	BER (%)

Last 20 calls heard on N5MHI:

Date & Time (UTC)	Call	ID	Yourcall	Repeater1	Repeater2
2017-03-30 04:45:33	2E0MJJ	DNGL	CQCQCQ	REF004 G	REF004 B
2017-03-30 01:26:17	W0FCM		CQCQCQ	W0FCM C	REF004 B
2017-03-30 01:07:47	W5GKP	DNGL	CQCQCQ	REF004 G	REF004 B
2017-03-30 01:00:09	WB5HJV	DAVE	CQCQCQ	REF004 B	N5MDS G
2017-03-30 00:57:31	N5BKV		KB5ZVP	K5CTX G	REF004 B
2017-03-30 00:53:57	KB5ZZB	5100	CQCQCQ	REF004 B	W5SSV G

VIEW FROM RADIO USING DVMEGA