

900 MHz FM – CENTRAL TEXAS



WHY 900 MHz ?

- 900 MHz is a new frontier for FM operation
- It is very much like 70 cm was 50 years ago
 - *Radios are modified commercial gear: mostly Motorola or Kenwood*
 - *Propagation is more challenging than lower frequency bands (2M – 70CM)*
 - *Technical interest*
 - *Weak signal compatible*

WHAT IS 900 MHz OPERATION LIKE ?

- Similar to 70 CM with
 - *Faster mobile flutter*
 - *More multipath*
 - *Greater building penetration due to reflections*
 - *A bit more path loss*
- A good antenna is extremely important
- 12W to 15W is adequate
- 30W radios are available
- Feed line losses are greater (use low loss coax)
- *900 MHz culture is not typical FM*

SOME HISTORY

- *August 2007 I visited friends in W. Texas*
- *We talked about 900 MHz and plans for ROIP linking*
- *I returned to Portland 'stoked' to get on 900 MHz*

- *My 1st 900 MHz repeater was operational in 2007 (Portland)*

- *The 2nd machine on the air -March 2008 (Larch Mountain SW Washington)*



MORE HISTORY

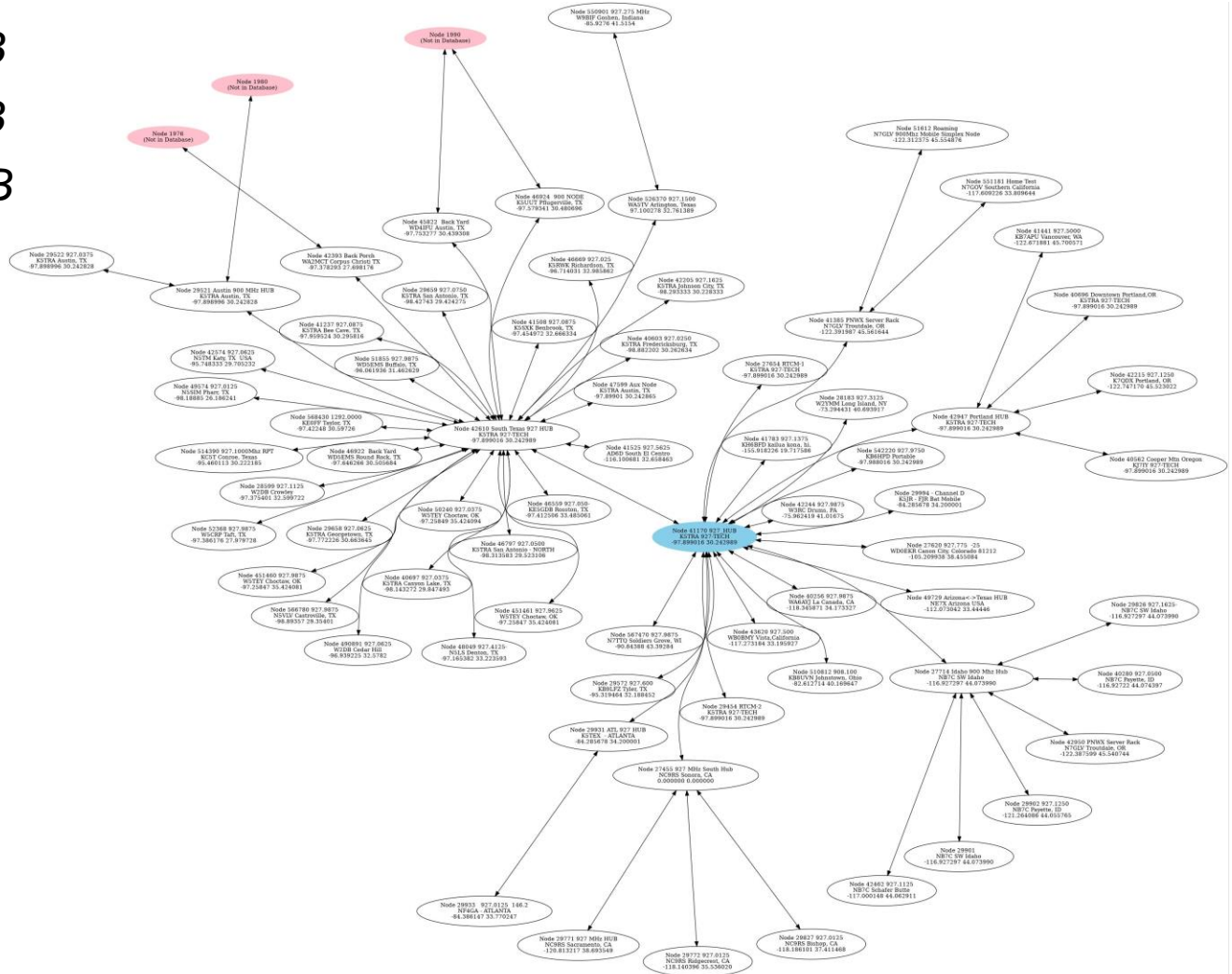
- *Early internet linking of 900 MHz began in 2008*
- *1st Austin 900 MHz repeater operational in 2009*
- *K5TRA moved back to TX in 2010*
 - *Several additional RF linked Austin area 900 repeaters added*
 - *Linked to other areas/states via ROIP*
- *Austin based 927 TECH linking HUB began in 2011*
 - *Many 900 MHz repeaters joined the network*
 - *EchoLink private linking conference*
- *Allstar link transition from EchoLink began early in 2013*
 - *Linux based control*
 - *Better audio BW*
 - *EchoLink HUB also maintained as ‘back door’ when traveling*
 - **927_TECH* is “whitelist” access only . . . no “drive by keying”*
 - *Main **927 HUB** is Allstar node **41170***
 - *Regional **South Texas HUB** is Allstar node **42610***



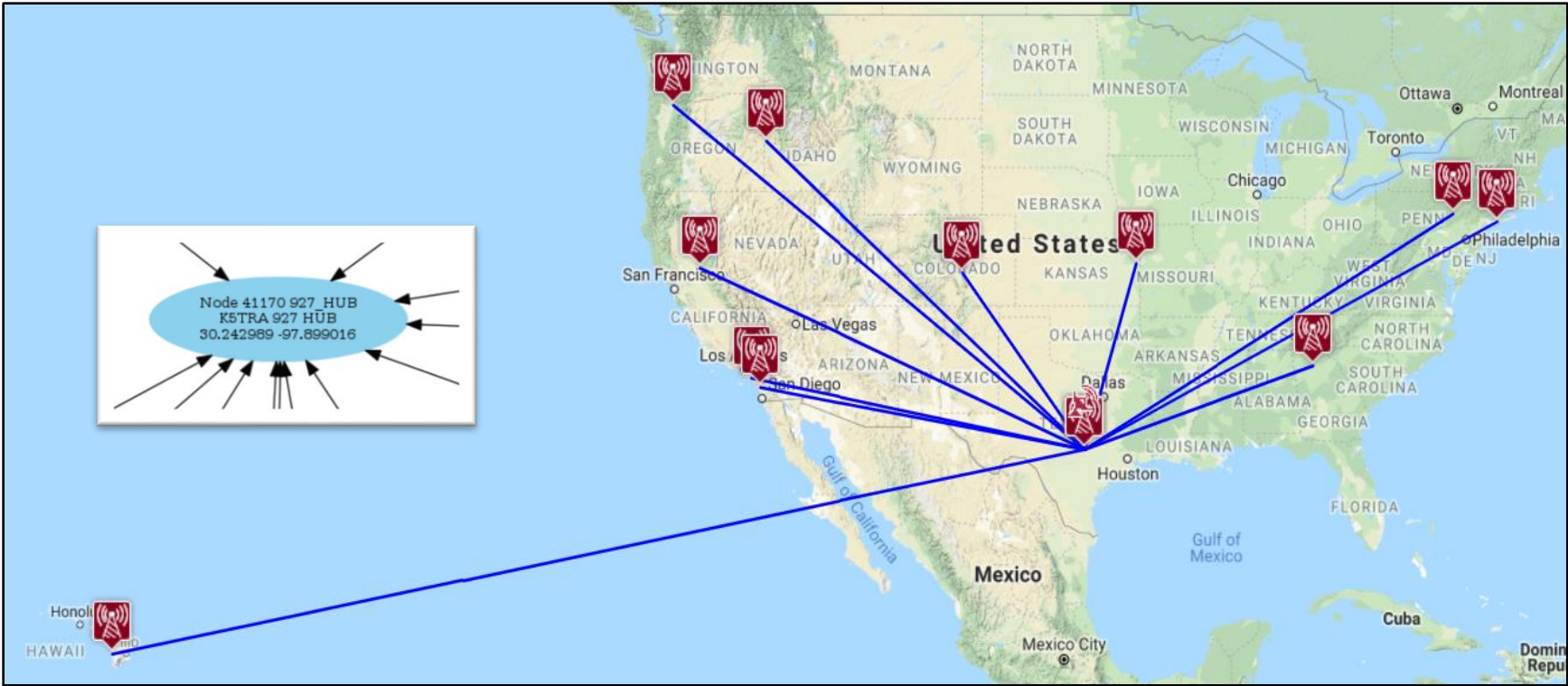
SIXTEEN YEARS LATER

- Main 927 HUB
- South Texas HUB
- Northern CA HUB
- Southern CA HUB
- Portland HUB
- Idaho HUB
- Also connections from:

- Atlanta
- Long Island
- Colorado
- Ohio
- Arizona
- Hawaii



LINKED 900 MHz NETWORK MAP



INTERNET RADIO LINKING

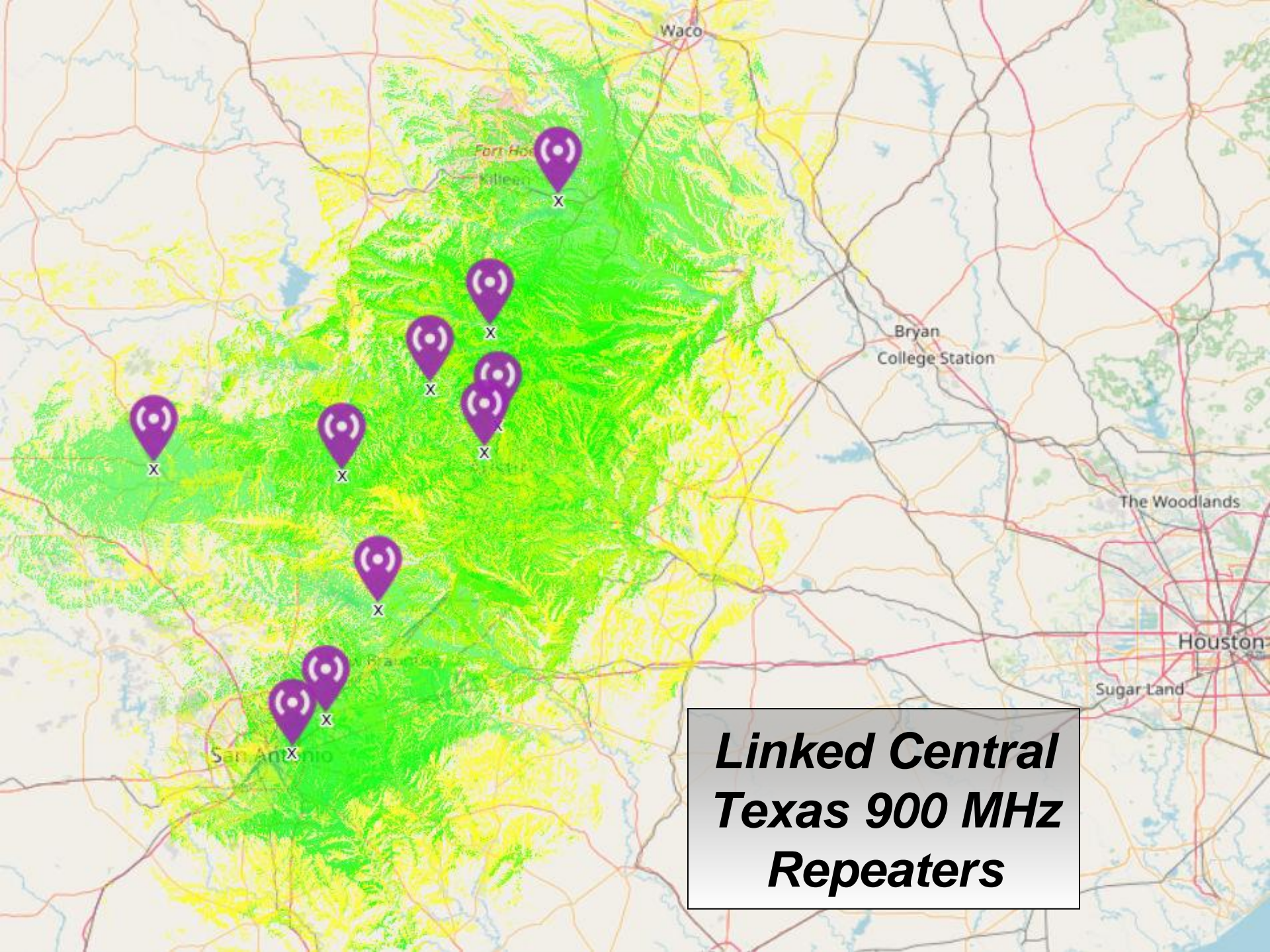
- Popular internet radio linking protocols:
 - EchoLink
 - IRLP
 - AllstarLink
- Commonality:
 - Peer to peer linking
 - Open ports required
- Differences:
 - Audio quality
 - Technical flexibility and customization
 - Stability

AllstarLink is built on Asterisk (an open source PBX)

Note: “HAMVOIP” is not open source

ALLSTARLINK IS PREFERRED

- Multiple codecs available depending on available BW
- Customizable DTMF functions and macros
- Commands can be activated by DTMF or remote login
- Shell scripts can be executed from DTMF commands
- Linux OS stability
- Server can be as simple/inexpensive as Raspberry Pi
- EchoLink can be added to the same server hardware
- IAX access can be added to the same server hardware



Linked Central Texas 900 MHz Repeaters

CENTRAL TEXAS 900 MHz LINKED REPEATERS

| FREQUENCY | OFFSET | TRANSMIT PL | RECEIVE PL | INFORMATION | LINKED |
|-----------|--------|-------------|------------|-----------------------------------|---------|
| 927.0125 | -25.0 | 225.7 | 225.7 | North Austin and Pharr | 927tech |
| 927.0250 | -25.0 | D532 | D532 | Fredericksburg and Belton | 927tech |
| 927.0375 | -25.0 | 141.3 | 141.3 | Canyon Lake and Troy and Angleton | 927tech |
| 927.0375 | -25.0 | 141.3 | D532 | K5TRA QTH | 927tech |
| 927.0500 | -25.0 | 110.9 | 110.9 | Round Rock and San Antonio (NE) | 927tech |
| 927.0625 | -25.0 | 203.5 | 203.5 | Georgetown and Katy | 927tech |
| 927.0750 | -25.0 | 218.1 | 218.1 | San Antonio (Red Cross) | 927tech |
| 927.0875 | -25.0 | 151.4 | 151.4 | Bee Cave | 927tech |
| 927.1125 | -25.0 | D432 | D432 | South Austin (Larson) | 927tech |
| 927.1250 | -25.0 | 103.5 | 103.5 | Lago Vista | 927tech |
| 927.1375 | -25.0 | 131.8 | 131.8 | La Grange | 927tech |
| 927.1625 | -25.0 | 151.4 | 114.8 | Johnson City | 927tech |
| 927.1875 | -25.0 | --- | --- | Austin P25 NAC-293 | |

NORTH TEXAS 900 MHz LINKED REPEATERS

| FREQUENCY | OFFSET | TRANSMIT PL | RECEIVE PL | INFORMATION | LINKED |
|-----------|--------|-------------|------------|------------------------------------|----------------|
| 927.0250 | -25.0 | D532 | D532 | Richardson (K5RWK / KE5GDB) | 927tech |
| 927.0500 | -25.0 | 110.9 | 110.9 | Rosston (W5FKN / KE5GDB) | 927tech |
| 927.0625 | -25.0 | D432 | D432 | Cedar Hill (W2DB) | 927tech |
| 927.0875 | -25.0 | 151.4 | 151.4 | Fort Worth (K5S XK) | 927tech |
| 927.1125 | -25.0 | D432 | D432 | Crowley (W2DB) | 927tech |
| 927.1500 | -25.0 | D432 | D432 | Arlington (WD5DBB) | 927tech |
| 927.4125 | -25.0 | D432 | D432 | Denton (N5LS) | 927tech |

900 MHz MOBILE RADIOS



KENWOOD TK-981

GOOD CHOICES



MOTOROLA MCS-2000-3



KENWOOD TK-941



MOTOROLA XTL-2500



MOTOROLA MCS-2000-2



KENWOOD TK-931



MOTOROLA SPECTRA



MOTOROLA MCS-2000-1

900 MHz PORTABLE RADIOS – GOOD CHOICES

GOOD CHOICES



**KENWOOD
TK-481**



**MOTOROLA
MTX-9250**



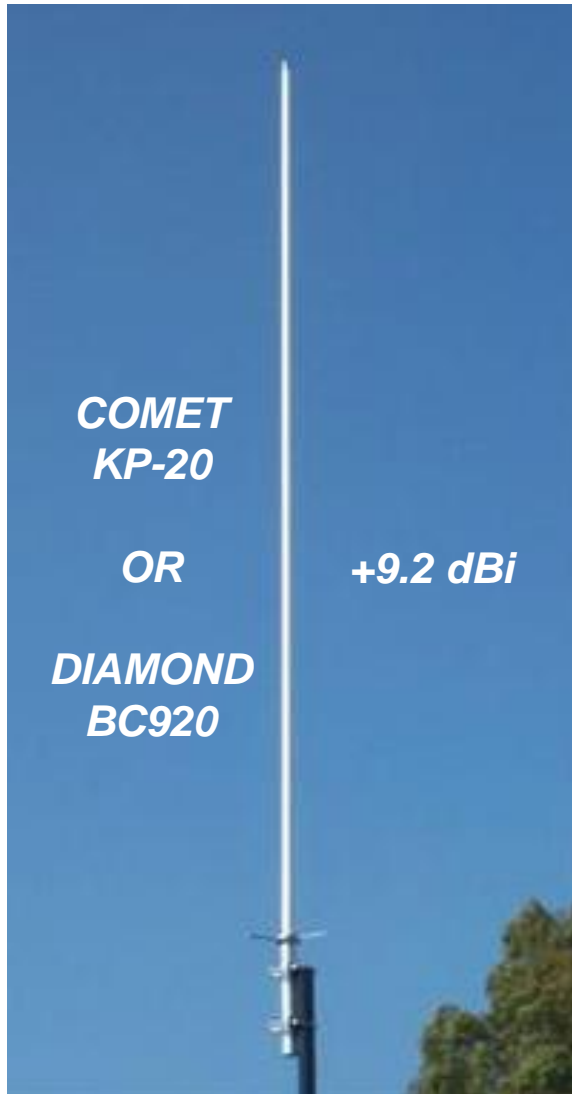
**ALINCO
DJ-G29**



**MOTOROLA
MTS-2000**

900 MHz ANTENNAS

BASE

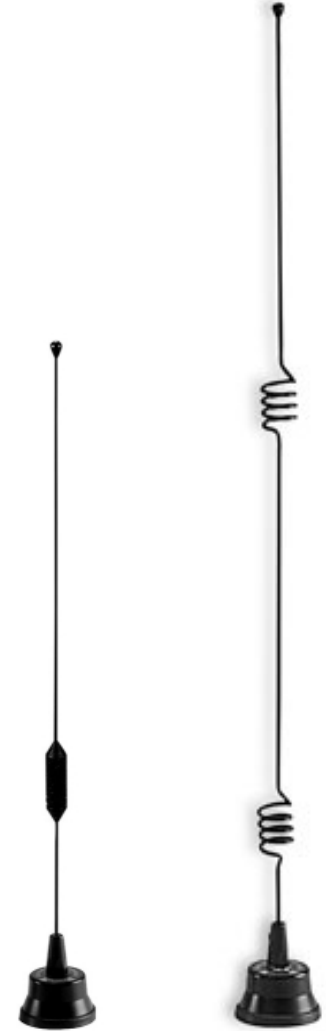


MOBILE



PHANTOM
ANTENNAS

LAIRD



NMO3E900B NMO5T900B
LARSEN

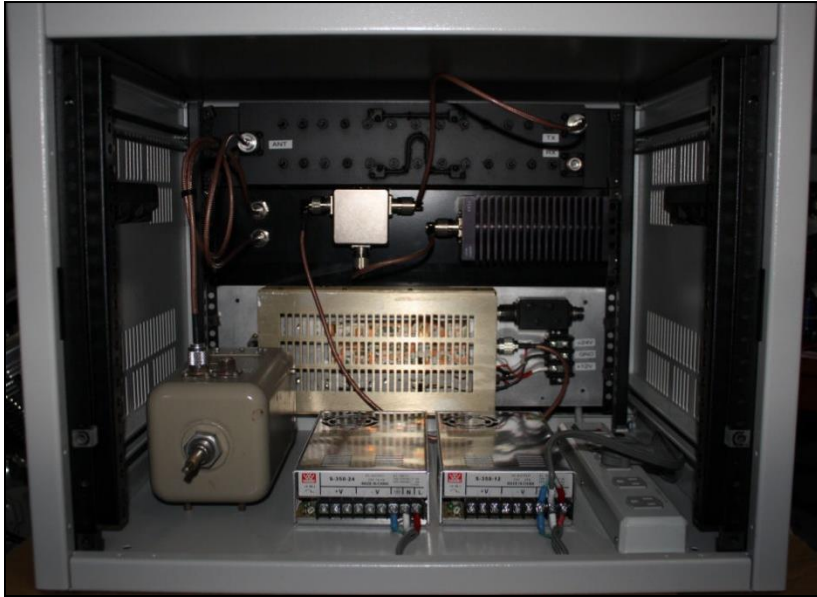
900 MHz BAND UTILIZATION

- In 1985 ARRL's band plan: 12 MHz split for FM repeaters
 - Not used due to available equipment limitations
- > 600 repeaters are 927 MHz – 902 MHz (25 MHz split)
- Weak signal SSB/CW and FM share the band very well
 - Both groups are populated by “Techies”
 - In many areas weak signal hams also have 900 MHz FM
 - High power repeater outputs are at 927 MHz (far from 902)
- Repeater inputs are in the 902 - 903 MHz
 - Some areas begin FM at 927.1125 (1st channel above 902.1)
 - Some share the lower 100 KHz
 - Noise floor often degrades above 902.2 MHz due to interference from spread spectrum transmitters that share the band

TYPICAL 900 MHz NOISE FLOOR

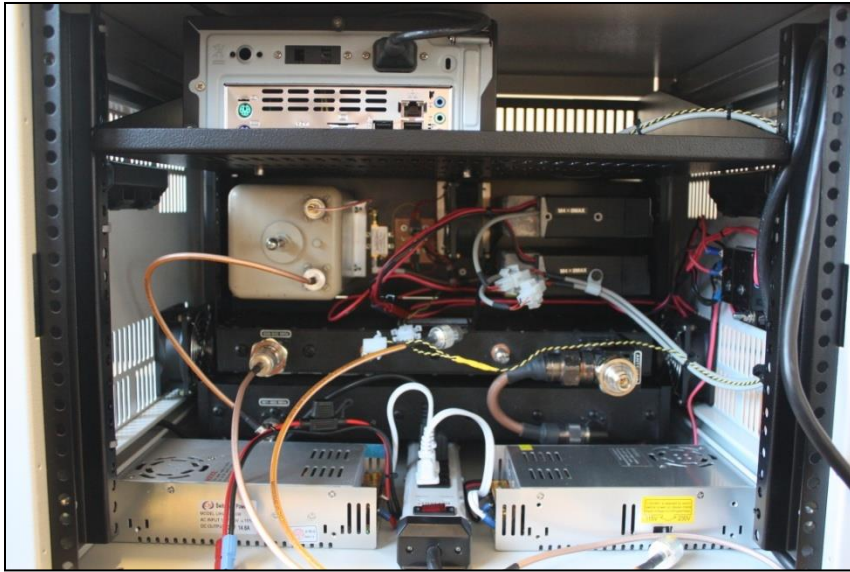


RF LINKED REPEATER



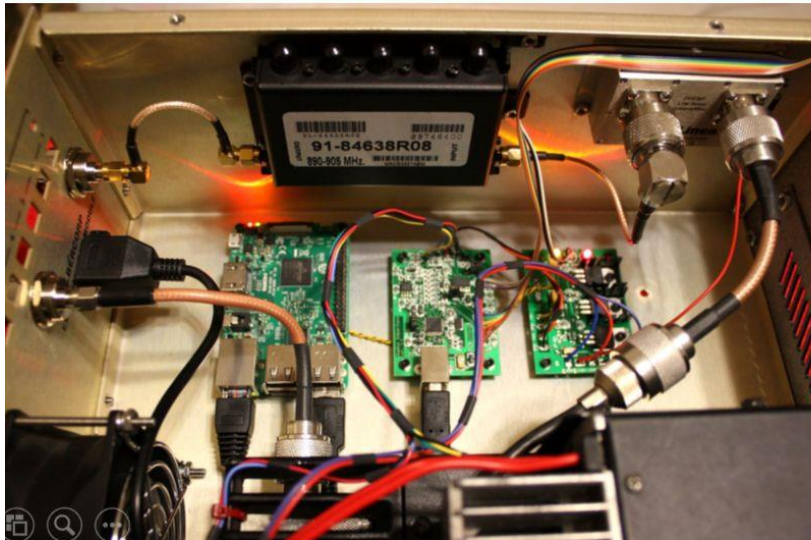
- TK-941 TX / RX and TK-840 Link
- Angle Linear LNA with Wacom preselector cavities
- Motorola 120W cellular PA (in TPL housing)
- Celwave Isolator
- Narda cellular combline duplexer
- ICS Linker-IIa controller

ALLSTAR LINKED REPEATER

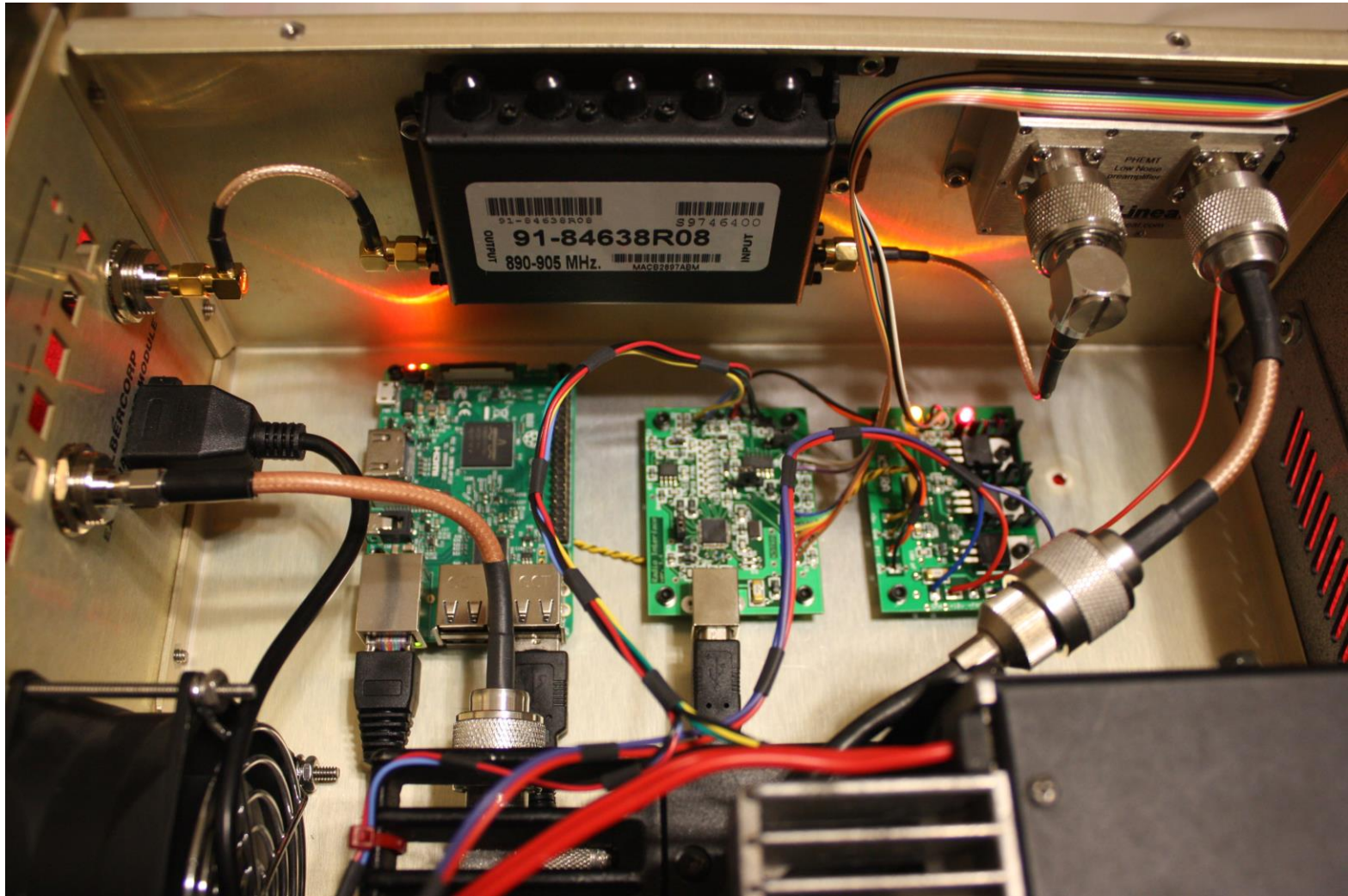


- TK-941 TX / RX and Linux Allstar Link (mini-ITX / SSD)
- Minicircuits LNA with Telewave preselector cavity
- GE MASTR-III 110W PA (w/ integrated isolator)
- WACOM combline duplexer
- **NO controller board: Allstar controller !**

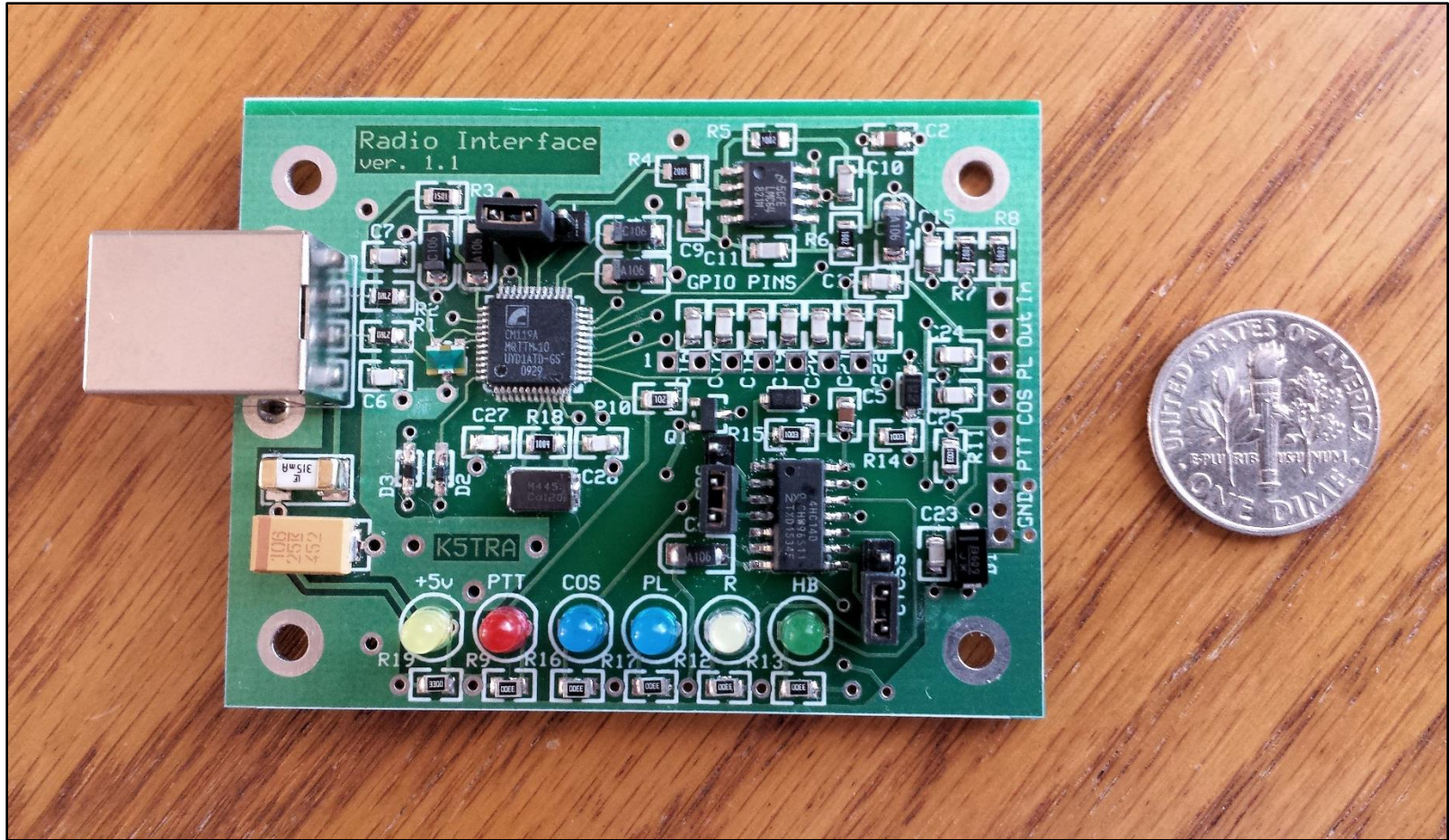
COMPACT ALLSTAR LINKED REPEATER



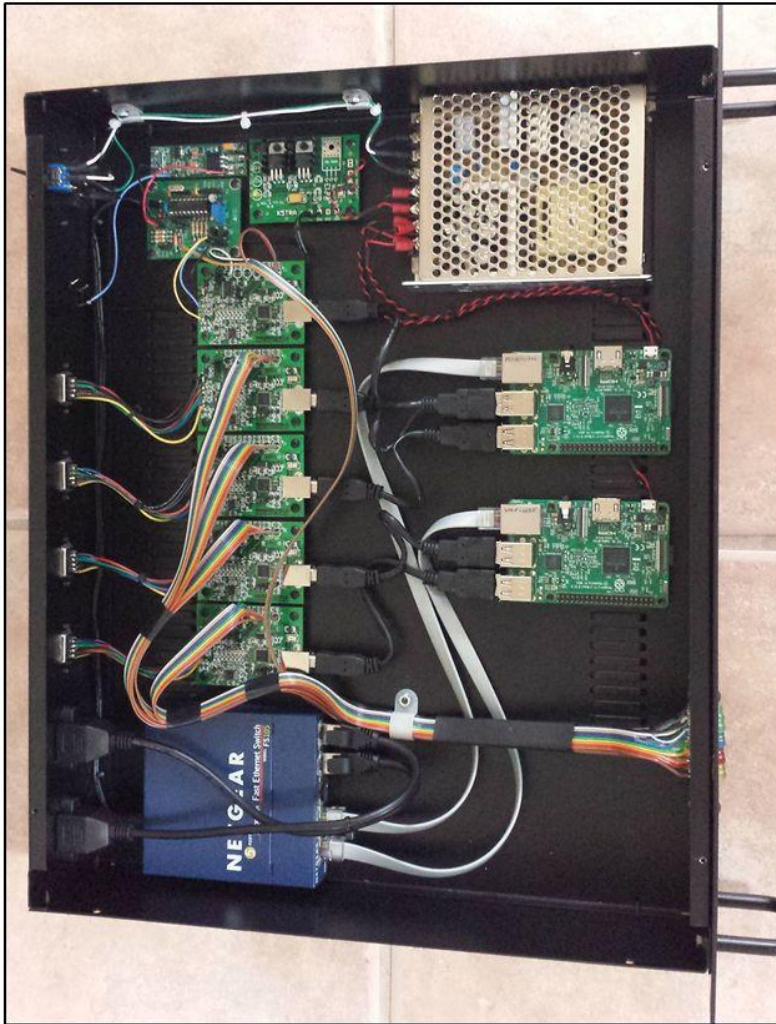
RASPBERRY Pi-3 CONTROLLER and ALLSTAR LINKER



ALLSTAR USB – RADIO INTERFACE



FOUR REPEATER CONTROLLER and ALLSTAR LINKER



LARCH MOUNTAIN SITE



SEPTEMBER 2008

*IN CENTRAL
TEXAS WE DON'T
HAVE MOUNTAINS*

LARCH MOUNTAIN SITE



*WE CAN GET TO OUR
SITES YEAR ROUND*

MARCH 2008

Looking to Portland and Salem from Larch Mountain

