

Rocky Mountain Ham University

DMR TRBO Network Configuration



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RMHR - What we are

Externally focused group of leaders with a focus on bringing clubs and needs together.

ARES:

- We align to their communication needs and create MOUs as to those needs.
- We provide technical expertise and systems for their use providing local, regional, and statewide communications systems and tools for their uses.
- We provide assets available for emergency deployment to augment and create communications existing communications channels.
- Trailers Towers Radios kits & deployables Repeaters Communications Restoral Vehicles

Experiment with the latest in technology:

- We promote new technology.
- We are constantly trying to push the envelope and find ways to do things better.
- Don't always keep going down the 40 year old repeater and phone patch mentality.
- Microwave backbones IP linking Smart Routing IRLP, Echolink, All Star, D-STAR

Amateur Radio:

- We work with other groups to find the synergies
- We work with other groups and individual to create cooperatives whereby we can
 - Aurora Repeater Association - Has been a long time partner for RMHAM in D-STAR and Mixed Mode TRBO
 - Colorado Repeater Association - Starting to work together to provide support for other groups.
 - Colorado Connection Repeaters - Why do we support the Colorado Connection Repeaters? This venture costs us money and time, but it brings good karma because it's a worthwhile alternative.
 - Cherry Creek Young Amateur Radio Club
 - HamCon Colorado, HamCon Wyoming New Mexico HamVention

FUN!

- Go out and do these items while having fun.
- Create opportunities with our members to teach and learn.
- Build and deploy tools while learning how to operate on these tools.
- Find and develop good people.

RMHR - How we do it

- RMHAM has built a considerable network and operates a significant amount of equipment
- How do we maintain forward progress and remain financially sound?
- Doug's view of radio clubs – There are three kinds
 1. Dues based club
 2. Donation based club; includes cash donations and grants
 3. Project/Equity based club; gifts of time and material

RMHR - The future

To stay healthy, RMHAM must every day:

- Maintain forward progress
- But do not over-eat
- Remain externally focused
- Innovate every day
- Educate
- Serve

vision

Rocky Mountain Ham Radio desires to promote efficient use of technology at our fingertips to advance amateur radio and to ensure readiness to handle communications for any situation that may come along.

RM Ham has started construction of a high speed point-to-point microwave IP backbone connecting our sites within the Colorado Front Range.

One of the varied digital technologies served by the backbone is the RMHAM TRBO network, with local, regional and wide area narrowband digital voice repeaters utilizing the DMR / Motorola TRBO™ technology.

It's not about the repeater. It's about designing an efficient network supporting multiple access technologies.

Multiple Access Techniques

FDMA – Frequency Division Multiple Access

- Users are separated by frequency.
- Traditional Analog Repeaters.

CDMA – Code Division Multiple Access

- Users are separated using digital codes.
- Spread Spectrum

TDMA – Time Division Multiple Access

- Users are separated by time
- System use a number of pre-defined timeslots.

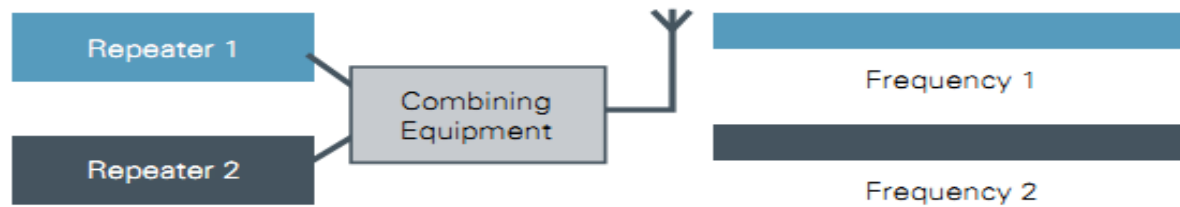
DMR / TRBO is Two-Slot TDMA .

TDMA Time Slots - TWO Repeaters in One!

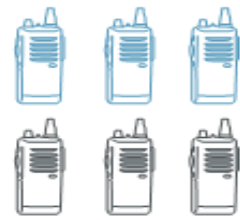
DMR / TRBO is TDMA: Time Division Multiple Access

TDMA saves licensing and equipment costs by enabling the equivalent of two 6.25 kHz channels within a single licensed 12.5 kHz channel

Two-channel Analog or Digital FDMA System



One call per repeater and channel



Radio Groups

Two-channel Digital TDMA System



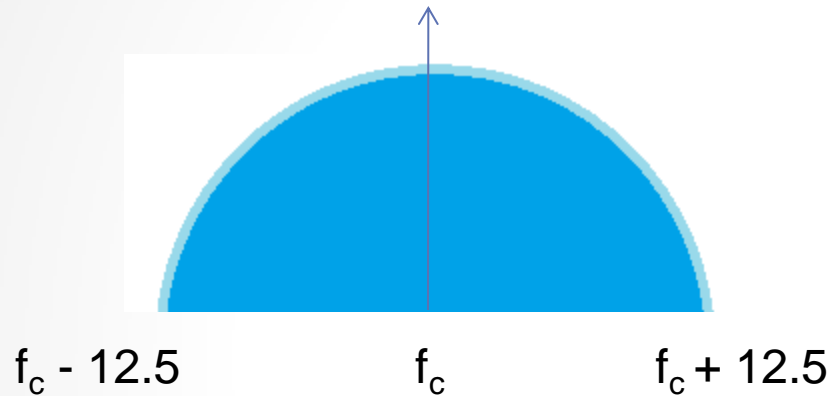
Two calls per repeater and channel



Radio Groups

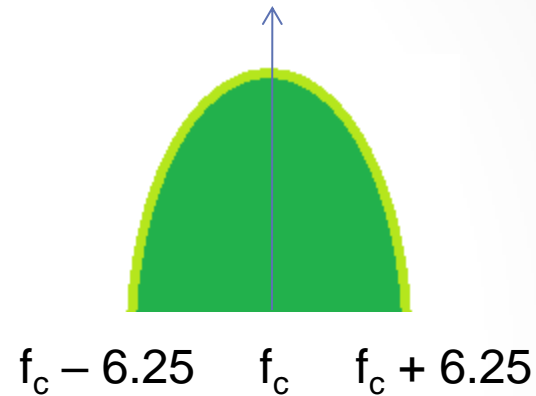
Lower infrastructure cost, 1 box in rack
TWO voice channels from one repeater

Half the Channel Bandwidth



Traditional Analog
25 kHz
Channel Bandwidth

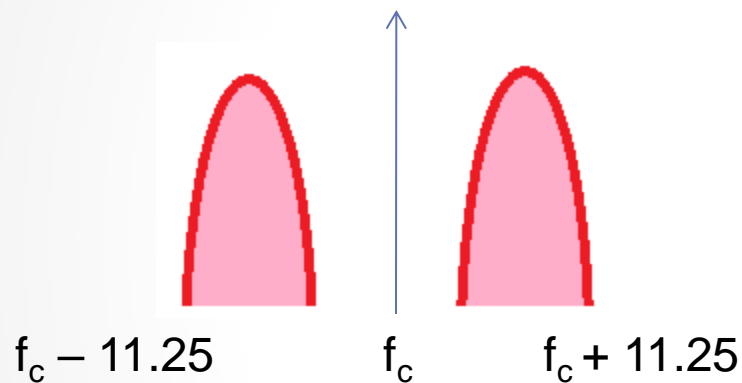
1 Channel
1 Repeater



DMR
12.5 kHz
Channel Bandwidth

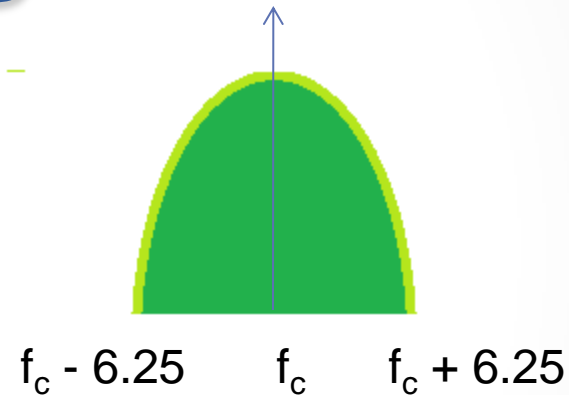
2 Channels
1 Repeater

More Spectrum Efficient than Older Digital Modes



Guard Band
as large as 10 kHz
between channels

Total BW= 22.5 kHz



No Guard Band
between 2
channels

Total BW= 12.5 kHz

Dynamic Mixed Mode: First in – First Out



Our DMR / TRBO Status

The first generation DMR/TRBO network is on-air and performing well.

Great Success examples:

- Determined DMR is legal under Part 97.
- Established reliable repeater base covering a large geographic area. (A coverage model.)
- Seeing a good up-take of DMR technology.
- Started construction of dedicated private 3 GHz IP backbone. The backbone enables the repeaters, not vice versa.


We are now working to achieve:

- Establish a Capacity based model.
- Established reliable IP at all DMR sites.
- Expand outside of the Denver Metro.
- Establish any MOUs with ARES groups.
- Bring cBridge on-line.
- Establish links to DMR MARC.

A great start with DMR/TRBO. It's time to take the next step!

The evolution of the RMHR DMR Network

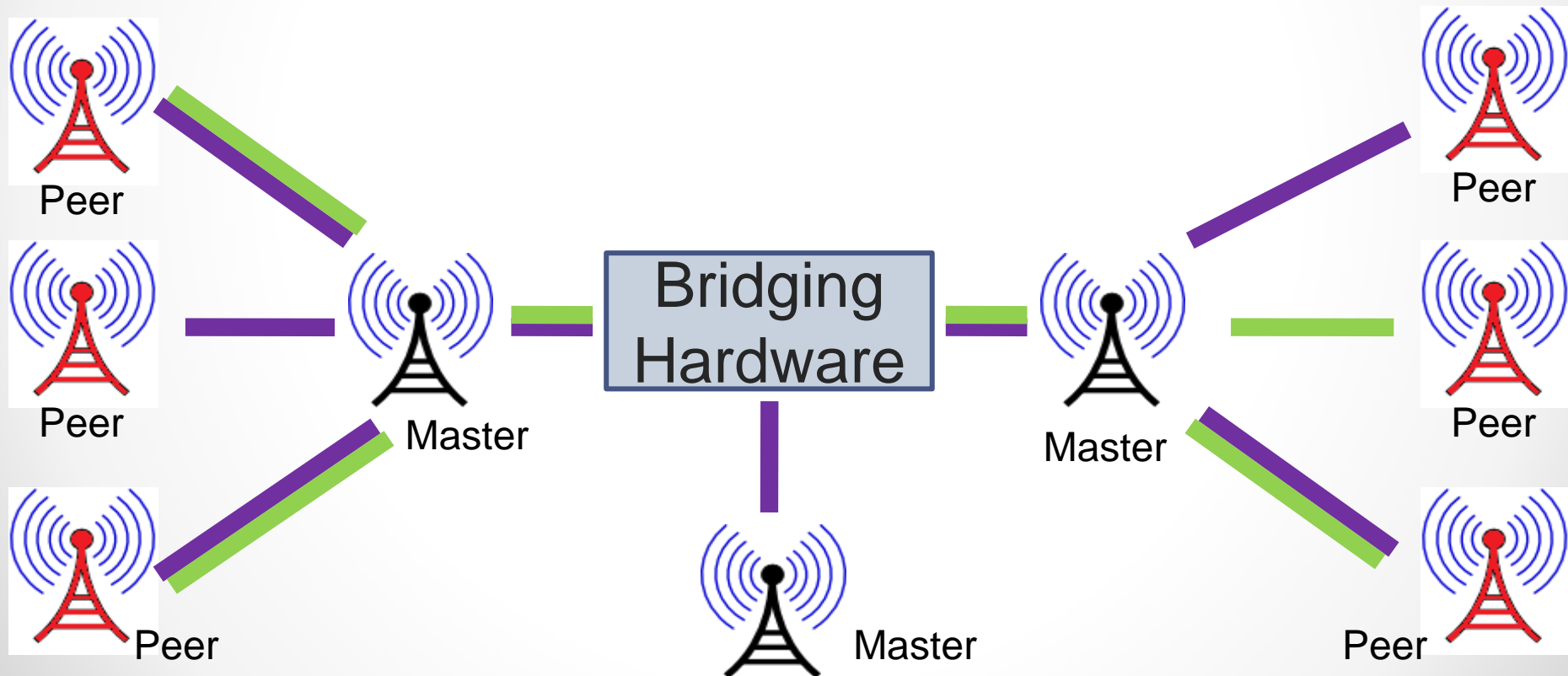
From	To
<ul style="list-style-type: none">• Digital only system• Heavy Coverage based Model• Mixed Public and Private Backhauls.• “ALL CALL” only. No national or cBridge support.• Single IP Site Connect system between all sites.• No Outside Connectivity	<ul style="list-style-type: none">• Mixed Analog and Digital• Balanced Coverage and Capacity Model• Focus on Private RMHR backhauls. New IPv4 structure.• Create Group Call structure to route calls with national support.• Multiple IP Site Connects with cBridge capability.• Connectivity to DMR MARC as desired.



The transition to an optimal multi-site narrowband digital system will take time ...
but it will be worth it!

IP Site Connect

- *Built-in linking capability to create regional, statewide, nation wide and world wide systems.*



IPSC – IP Site Connect

- IP Site Connect (IPSC) is specific to Motorola
- IPSC creates a collection of linked digital repeaters
- Either or both Time Slots can be linked on the IPSC
- Each IPSC has one MASTER and up to about a dozen PEERS

RMHAM utilizes five IPSC systems on our network

- IPSC1: Northern Colorado Network
- IPSC2: Central Colorado Network
- IPSC3: Southern Colorado Network
- IPSC4: Connection to AuxComm Connection
- IPSC5: Bridge to DMR-MARC national network.

Talk Groups

- A Talk Group is a signaling method to assemble a set of users operating on a DMR system.
- A Talk Group is somewhat like a CTCSS tone on an analog repeater.

Examples

- ALLCALL = Everyone hears the transmission regardless of Talk Group
- Talk Group 123 = Only users which have selected Talk Group 123 hear the transmission.
- Routing between TRBO Repeaters using IP Site Connect can be performed using Talk Groups.
- Only one Talk Group per Time Slot can be used at a time.

Network Layout

- IPSC1: Northern Colorado Network
 - Boulder South
 - Horsetooth Mt
 - Fort Morgan
 - Cheyenne, WY
- IPSC2: Central Colorado Network
 - Thorodin Mt
 - Squaw Mt
 - Lookout Mt VHF
 - Lookout Mt UHF
- IPSC3: Southern Colorado Network
 - Canon City
 - Almagre Mt
 - Pueblo
- IPSC4: Connection to AuxComm Connection
 - Devils Head
- IPSC5: Bridge to DMR-MARC national network.
 - Boulder North / Lee Hill

c-Bridge

- The c-Bridge is a smart connection bridge sold by Rayfield Communications.
- It allows network control operators to bridge voice and data calls across:
 - Different IPSC Systems
 - Time Slots
 - Talk Groups
- It's not cheap!
 - Entry level c-Bridge supporting 3 IPSC systems is \$2000
 - Upgrade to support 5 IPSC systems is \$1000
 - A new "c-Bridge Mini" will be available soon supporting a single repeater with an approximate \$500 price tag.

c-Bridge: Gateway Functions

- Each IPSC and Timeslot is defined within the Gateway function to create a “Link ID”
- RMHAM has decided to generally only support a single talk group on each Link ID.

Configure Gateway functions on CO-RMHR

I.P.S.C. Manager

RMHR IPSC1 – Northern Regional Network	1 Reg. peers (4)
RMHR IPSC2 – Denver Regional Network	2 Reg. peers (3)
RMHR IPSC3 – Southern Regional Network	3 Reg. peers (3)
RMHR IPSC4 – Aux Comm Bridge Network	4 Reg.
IPSC5 – DMR MARC Network	5 Reg.
Serial device	

Time Slot 1

RMHR IPSC1 TS1 – CO Wide 700	Link ID #1
RMHR IPSC2 TS1 – CO Wide 700	Link ID #3
RMHR IPSC3 TS1 – CO Wide 700	Link ID #5
RMHR IPSC4 TS1 – So CO 719	Link ID #7
IPSC5 TS1 – DMR MARC 1&3	Link ID #9

Time Slot 2

RMHR IPSC1 TS2 – No CO 721	Link ID #2
RMHR IPSC2 TS2 – DEN CO 720	Link ID #4
RMHR IPSC3 TS2 – SoCO 719	Link ID #6
RMHR IPSC4 TS2 – DEN CO 720	Link ID #8
IPSC5 TS2 DMR-MARC Local	Link ID #10

Channel common

System

Restart system

c-Bridge: Bridge Groups

- Bridge Groups are used to connect link IDs across multiple IP Site Connect Systems

Manage Bridge Groups on CO-RMHR

Connection type	Bridge Groups	Site name	Link ID	Group ID
all	all	all	all	all

Bridge Group ?	Site Name ?	Link ID ?	Alert on Absent ?	Group ID ?
Colorado Wide 700	CO-RMHR	1	<input type="checkbox"/>	700

<i>I.P.S.C.</i>	Add Entry	Delete Entry	Modify Entry
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edit	<i>I.P.S.C.</i>	Colorado Wide 700	CO-RMHR	1	silence	700
edit	<i>I.P.S.C.</i>	Colorado Wide 700	CO-RMHR	3	silence	700
edit	<i>I.P.S.C.</i>	Colorado Wide 700	CO-RMHR	5	silence	700

c-Bridge: Group Status Screen 700

- The “Netwatch” screen with Colorado Wide 700 active



Control Center CO-RMHR

7456.2013.11.16
02:40:47 December 07, 2013 UTC
k2ad [Single connection](#) [Log Out](#)

- Home
- Config
- Connections
- Calls
- Diagnostics
- Net watch
- Help

RMHR IPSC1 - Northern Regional Network	310861	310899	310812	310862	315601
RMHR IPSC2 - Denver Regional Network	310800	310898	310801	310810	
RMHR IPSC3 - Southern Regional Network	310815	310897	310816	310821	
RMHR IPSC4 - Aux Comm Bridge Network	310817	310896			
IPSC5 - DMR MARC Network	310807	310895			

-1	+1	MIA
DMR-MARC 31	DMR-MARC 1	DMR-MARC 3
-1	+1	

Gateway (1) CO-RMHR

start time	duration	ch	name	source peer id	source radio id	source peer alias	source radio alias	Bridge Group	Dest. RadioId	RSSI (dBm)	site name
02:40:41.055 Dec 7	6.8	3	RMHR IPSC2 TS1 - CO Wide 700	g310800	3108058	Denver - Colorado - USA --N0SZ	K2AD Doug Sharp Firestone Colorado United States - 3108058	Colorado Wide 700	700	-77.3	CO-RMHR

-1 +1

Total calls

3 Network

0 Local

Peers 12

CC-CC 3

History											
02:40:26.109 Dec 7	3.4	3	RMHR IPSC2 TS1 - CO Wide 700	g310800	3108058	Denver - Colorado - USA --N0SZ	K2AD Doug Sharp Firestone Colorado United States - 3108058	Colorado Wide 700	700	-77.6	CO-RMHR
02:40:20.230 Dec 7	1.6	3	RMHR IPSC2 TS1 - CO Wide 700	g310800	3108058	Denver - Colorado - USA --N0SZ	K2AD Doug Sharp Firestone Colorado United States - 3108058	Colorado Wide 700	700	-79.2	CO-RMHR

c-Bridge: Group Status Screen 720

- The “Netwatch” screen with Denver 720 active



Control Center CO-RMHR

7456.2013.11.16
02:44:45 December 07, 2013 UTC
k2ad

Home

Config

Connections

Calls

Diagnostics

Net watch

Help

RMHR IPSC1 - Northern Regional Network

310861

310899

310812

310862

315601

RMHR IPSC2 - Denver Regional Network

310800

310898

310801

310802

310810

RMHR IPSC3 - Southern Regional Network

310815

310897

310816

310821

RMHR IPSC4 - Aux Comm Bridge Network

310817

310896

IPSC5 - DMR MARC Network

310807

310895

-1

+1

MIA

DMR-MARC 31

DMR-MARC 1

DMR-MARC 3

-1

+1

start time

duration

ch

name

source peer id

source radio id

source peer alias

source radio alias

Bridge Group

Dest. RadioId

RSSI (dBm)

site name

02:44:40.019 Dec 7

5.5

4

RMHR IPSC2 TS2 - DEN CO 720

g 310801

3108058

Denver - Colorado - USA --N0SZ

K2AD Doug Sharp Firestone Colorado United States - 3108058

DEN CO

720

-83.8

CO-RMHR

-1

+1

History

02:42:37.414 Dec 7

0.6

3

DMR MARC North America

p 311214

3112138

311214

N4IRS Steven Zingman Palm City Florida United States - 3112138

English - Call Group 3

0

-117.4

DMR-MARC

02:41:11.602 Dec 7

7.7

3

RMHR IPSC2 TS1 - CO Wide 700

g 310801

3108058

Denver - Colorado - USA --N0SZ

K2AD Doug Sharp Firestone Colorado United States - 3108058

Colorado Wide 700

700

-89.8

CO-RMHR

02:40:41.055 Dec 7

8.5

3

RMHR IPSC2 TS1 - CO Wide 700

g 310800

3108058

Denver - Colorado - USA --N0SZ

K2AD Doug Sharp Firestone Colorado United States - 3108058

Colorado Wide 700

700

-77.4

CO-RMHR

02:40:26.109 Dec 7

3.4

3

RMHR IPSC2 TS1 - CO Wide 700

g 310800

3108058

Denver - Colorado - USA --N0SZ

K2AD Doug Sharp Firestone Colorado United States - 3108058

Colorado Wide 700

700

-77.6

CO-RMHR

02:40:20.230 Dec 7

1.6

3

RMHR IPSC2 TS1 - CO Wide 700

g 310800

3108058

Denver - Colorado - USA --N0SZ

K2AD Doug Sharp Firestone Colorado United States - 3108058

Colorado Wide 700

700

-79.2

CO-RMHR

Gateway (1)

CO-RMHR

Total calls

6 Network

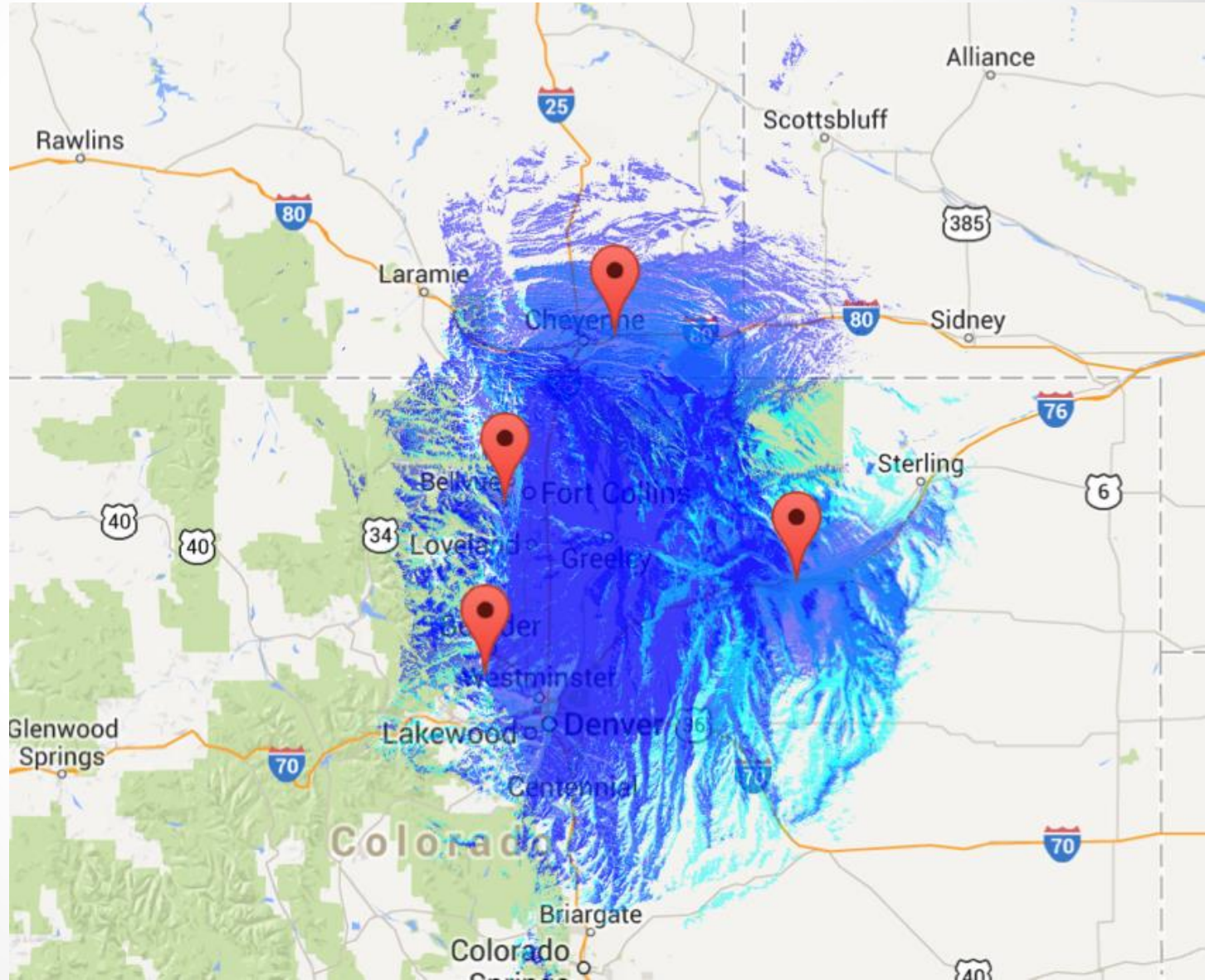
0 Local

Peers 13

CC-CC 3

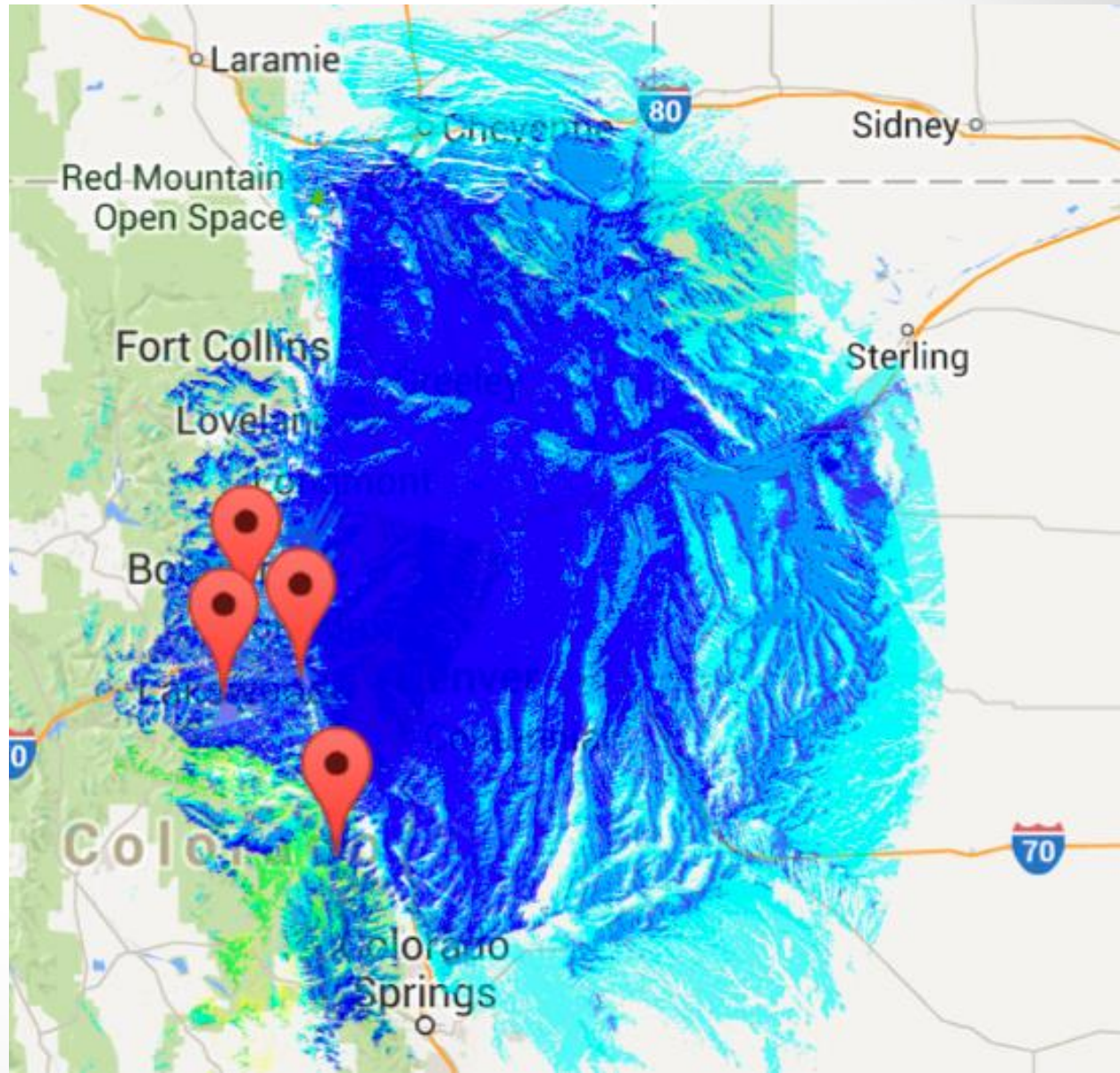
Northern Network - 721

- Boulder South (master)
- Horsetooth Mt
- Fort Morgan
- Cheyenne, WY



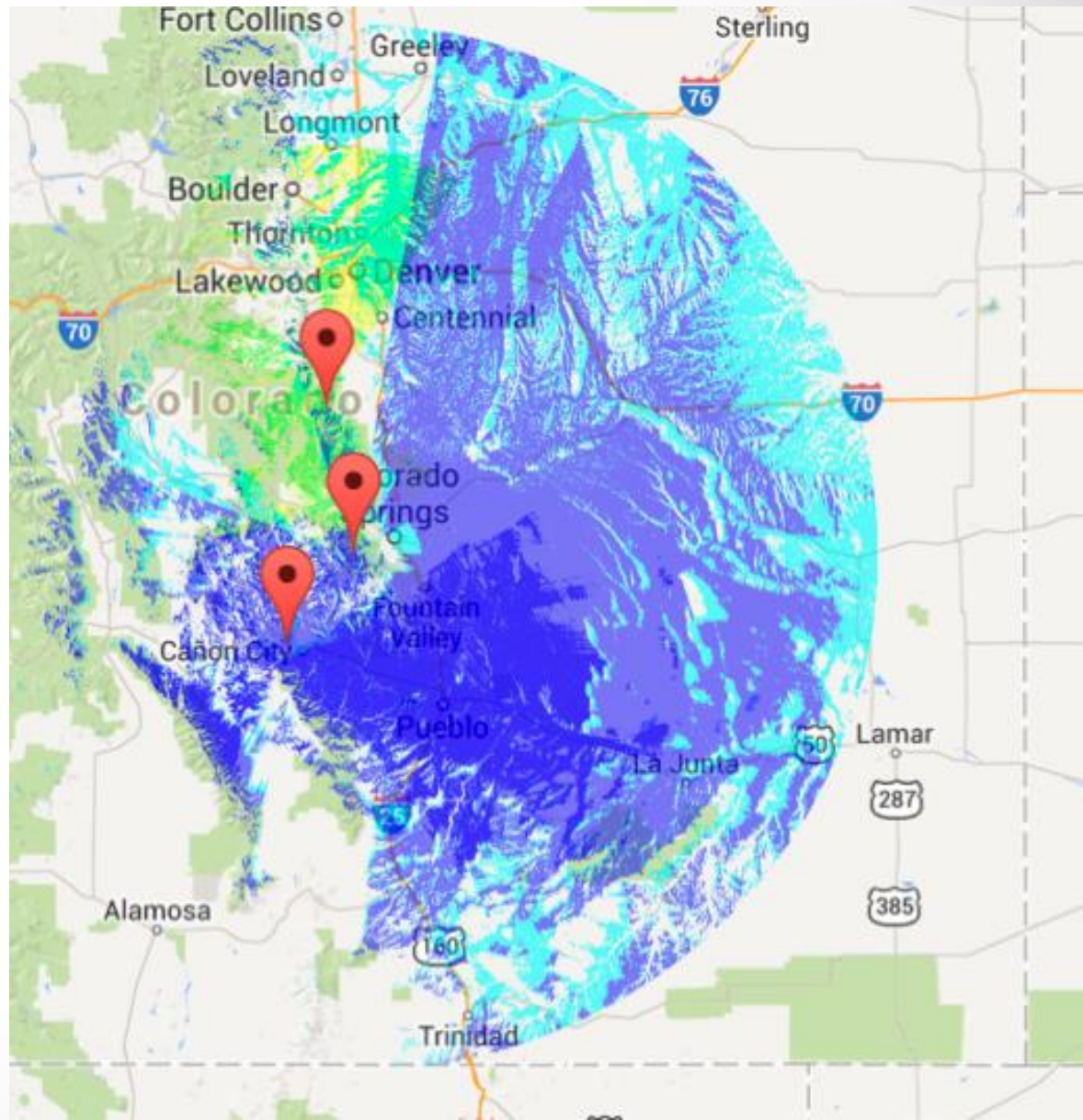
Central Network - 720

- Thorodin (master)
- Squaw
- Lookout
- Devils Head



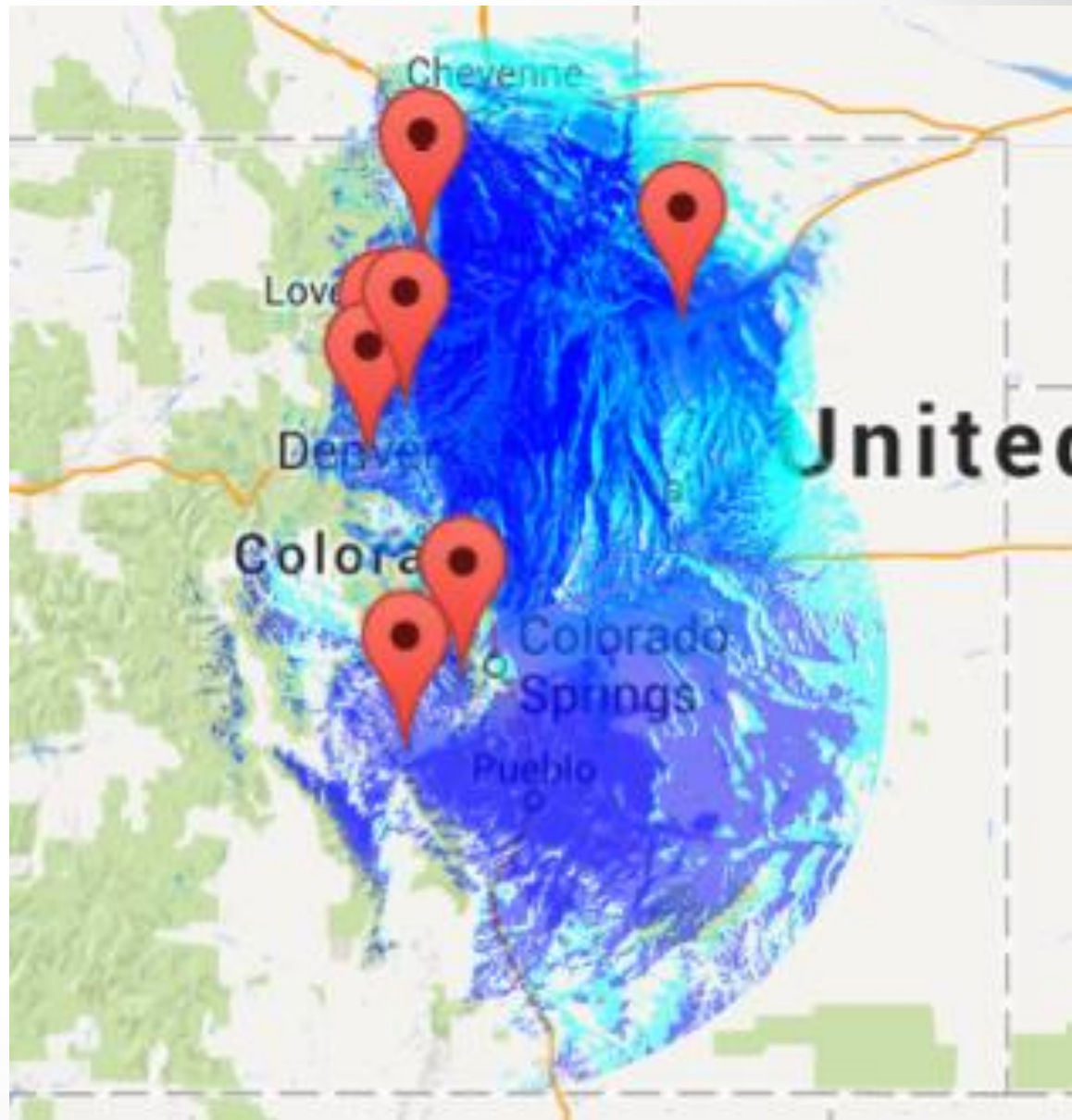
South Network - 719

- Canon City (master)
- Almagre
- Pueblo (temporary)
- Devils Head

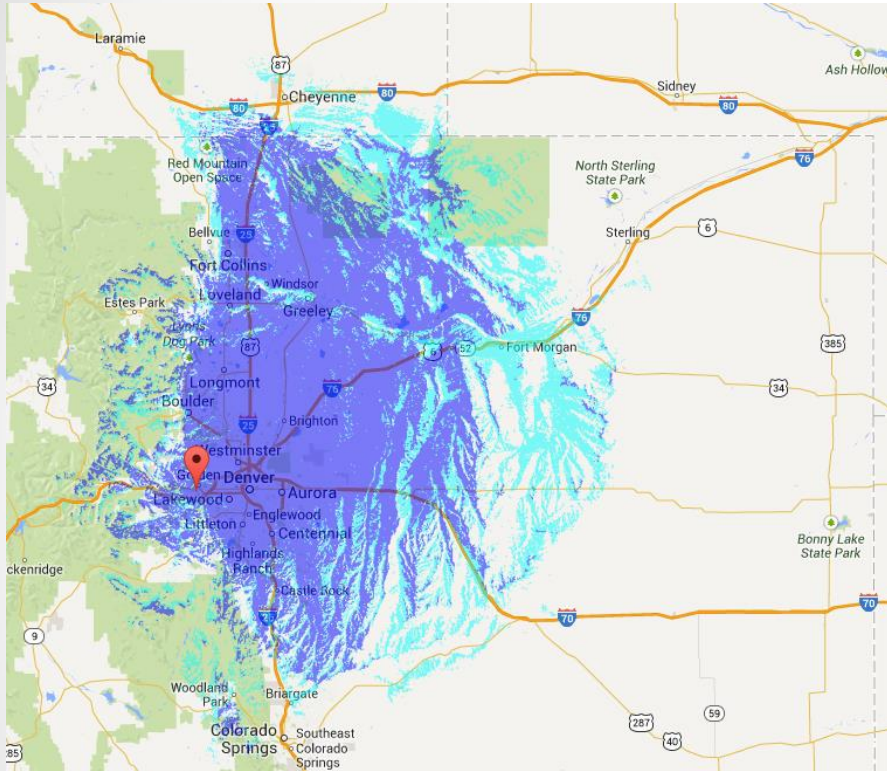


Colorado Wide- 700

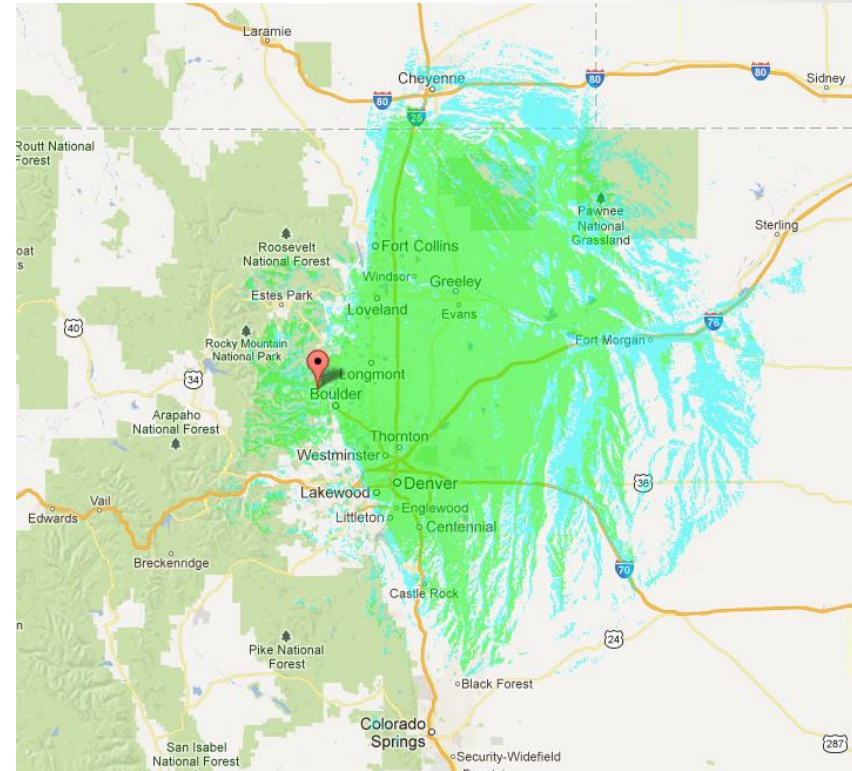
- Canon City
- Almagre
- Pueblo
- Thorodin
- Squaw
- Lookout VHF
- Lee Hill South
- Horsetooth
- Fort Morgan
- Cheyenne



Lee Hill DMR-MARC – 1, 2, 3, 3177



Lookout Local - 710



Lee Hill North – DMR MARC

The “Secret Repeater”

- I'm going to tell you the secret ... there are actually two secret repeaters!
- Trailer UHF:
 - Repeater TX: 438.2250 MHz
 - Repeater RX: 433.2250 MHz
 - Color Code 7
 - Usually connected to IPSC2 Central Region
 - Usually used for testing and experiments
- Denver VHF Mixed Mode:
 - Repeater TX: 145.175 MHz
 - Repeater RX: 144.575 MHz
 - Mixed Mode
 - TRBO Color Code 1 – ALLCALL on Timeslots 1&2
 - Analog narrowband (12K0F3E) using DPL/DTCSS code 073
 - Can be connected to IPSC2 as needed
 - Jointly operated by RMHR and ARA



Rocky Mountain Ham Radio

TEACH...LEARN...OPERATE...SUPPORT. Be a part of our team!

www.rmham.org