Ham Radio Microwave Usage

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Rocky Mountain Ham Radio

Ham Radio Microwave Bands

- 2300-2310 & 2390-2450 MHz
- 3300-3500 MHz
- 5650-5925 MHz
- 10.0-10.5 GHz
- 24.0-24.25 GHz
- 47.0-47.2 Ghz
- 76.0-81.0 GHz
- 122.25-123.0 GHz
- 134-141 GHz
- 241-250 GHz
- All above 275 GHz

Phone/CW Operations

- Transverters from VHF/UHF
- Largely home brew

Commercial Digital Microwave Gear

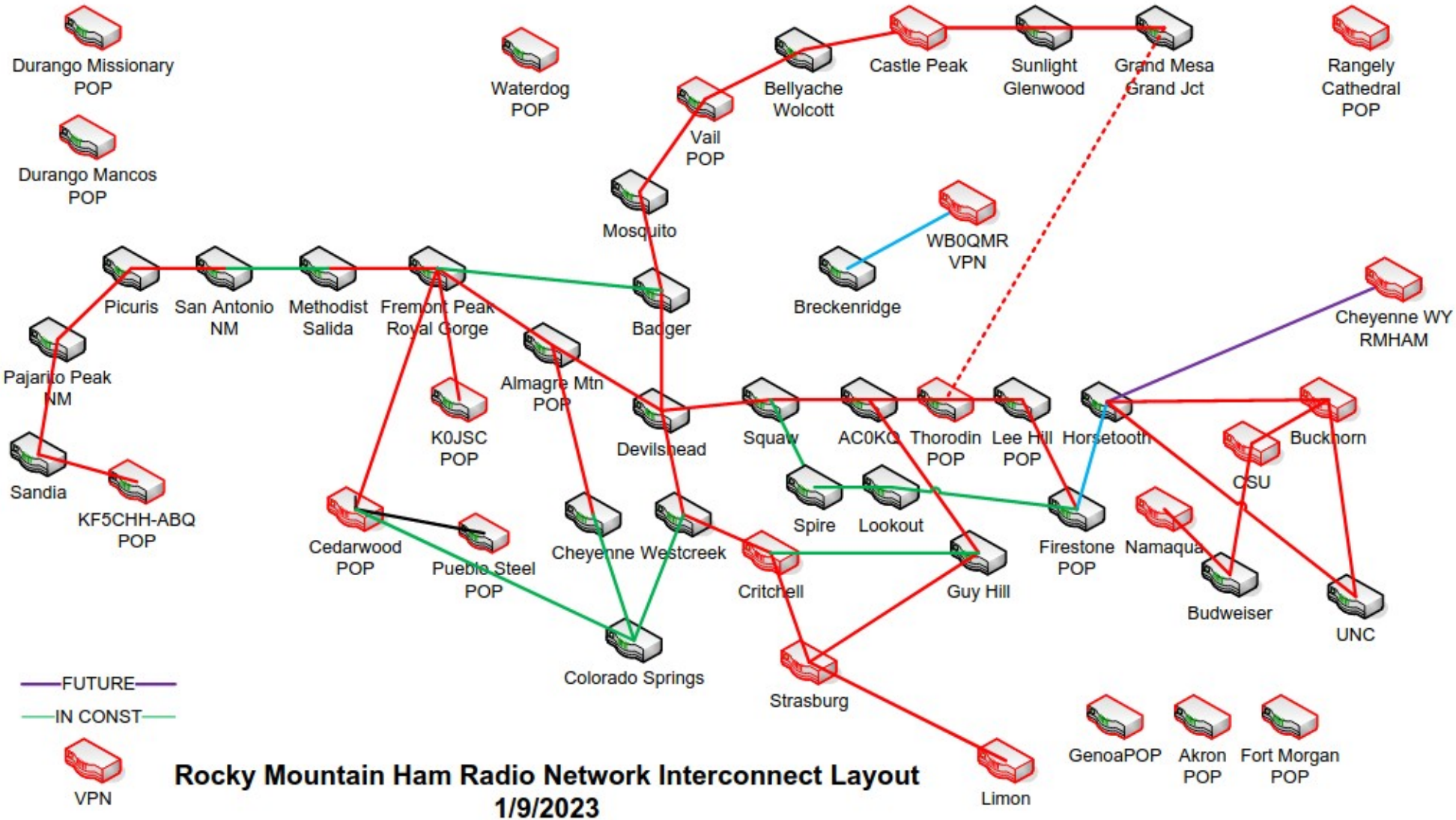
- IP based digital communications
- Targets wireless ISP market
- Covers 2-60GHz

Applications of IP based Microwave links

- Repeater linking
  - Native to DMR, DStar, P25, FUSION
  - Analog repeater linking with AllStarLink, Echolink, IRLP, etc.
- Site monitoring and control
  - Uninterruptible Power Supplies
  - AC and DC Power Distribution Units
  - Solar controllers
  - VoIP phones and web cameras

Rocky Mountain Ham Radio

- Ham radio club focusing on technology
- Best known for our multi-state IP microwave network
  - 138 backbone sites, 100 ancillary sites
  - 5Ghz and 60GHz site links (3GHz legacy)
  - About 800 attached devices
  - Partnerships with numerous clubs to link sites
  - Significant expansion planned using ARDC grant
- DMR Repeater Network
- Communications trailer and QRVs
- RMHAM University classes and Tech Talks



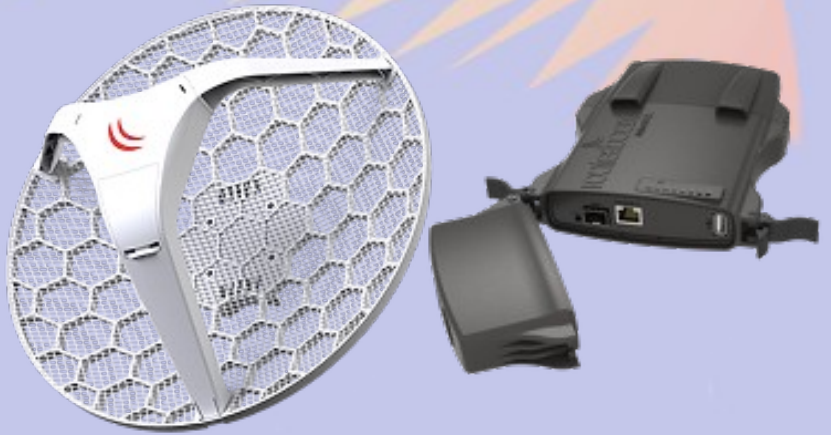
Rocky Mountain Ham Radio Network Interconnect Layout
1/9/2023

Advantages of Using IP networking

- Universal transport mechanism
  - Encapsulation of information
- Native support for robust routing
  - Redundant routes tolerates link failures
  - OSPF rapidly reconfigures network on failure
  - Integrates well into commercial internet with VPNs
- Inexpensive WISP hardware
  - We use mostly Mikrotik routers and 5 GHz radios
  - Any router port can perform any function

Mikrotik 5GHz IP hardware

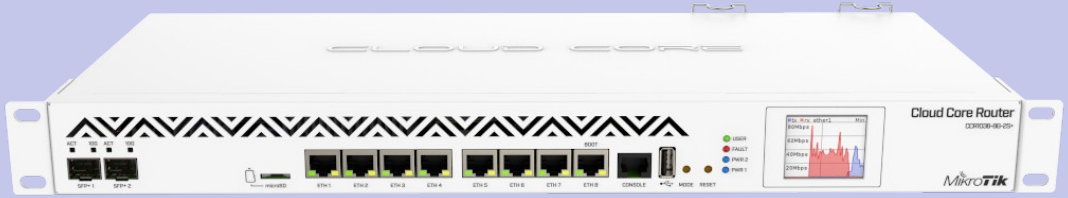
- International (INTL) hardware covers commercial and ham bands without requiring modifications to the firmware
  - US version is limited to just the Part 15 frequencies
- Frequency Mode=superchannel covers 4920-6100 MHz
- nstreme and nv2 protocols modify 802.11 for long range
  - 93 mile round trip time is 1 millisecond
- Same software on routers and radios
- Affordable ($50-$150 per radio)



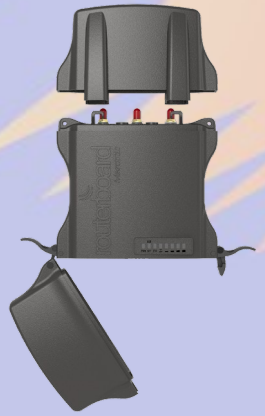
Mikrotik Hardware Selection

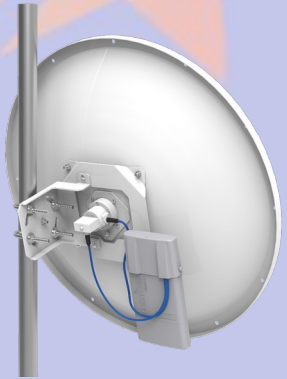
- RB2011 - 10 port ($100)
  - Good for repeater sites

- CCR1036 - 10 port ($1000)
  - Use for major hubs



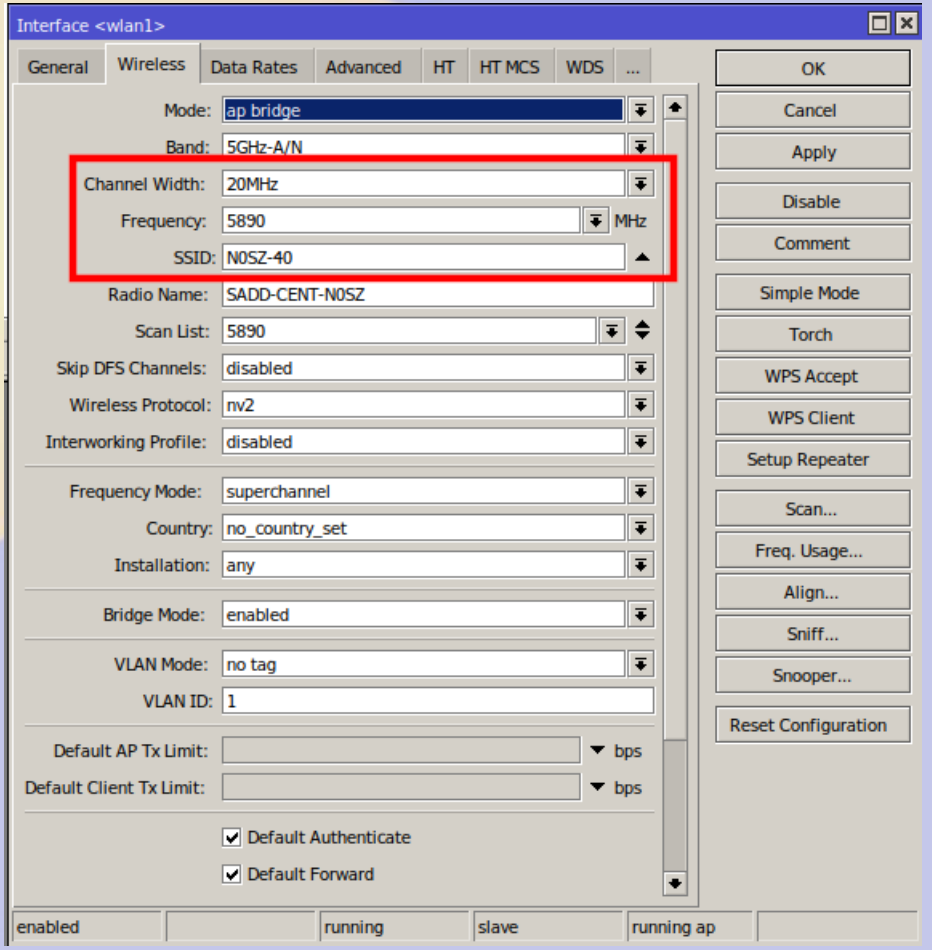
- LHG ($70)
  - 1-2 miles
- QRT ($150)
  - 2-5 miles
- LHG-XL
  - 5-7 miles
- NM5SHP
  - line of sight
  - requires dish
  - $500 incl dish





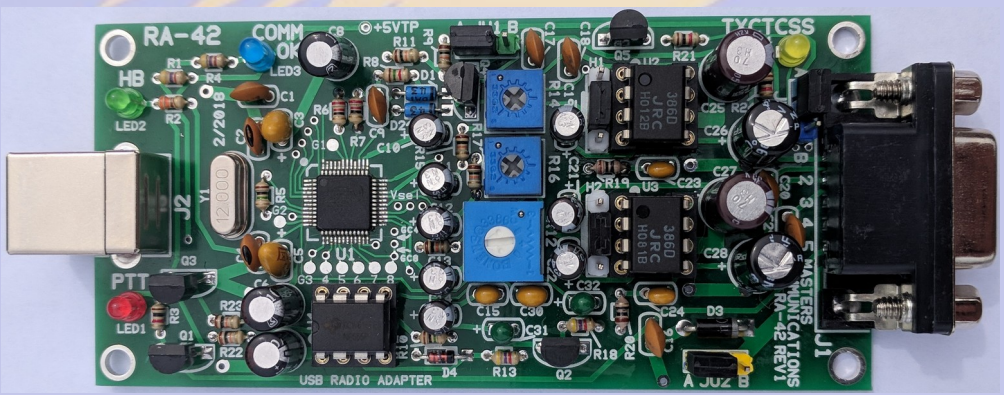
Part 97 Operations

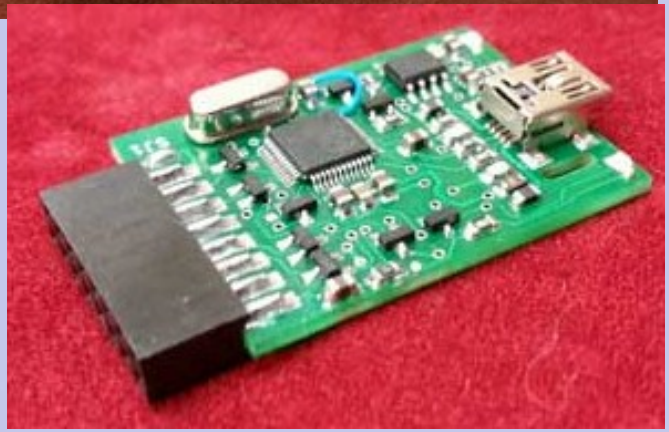
- Use Callsign in SSID
  - ID every packet
- NEVER use encryption
  - Limit access by MAC if security is an issue
- ssh OK if used for control
- Watch the band edges



USB Analog adapters for AllStarLink

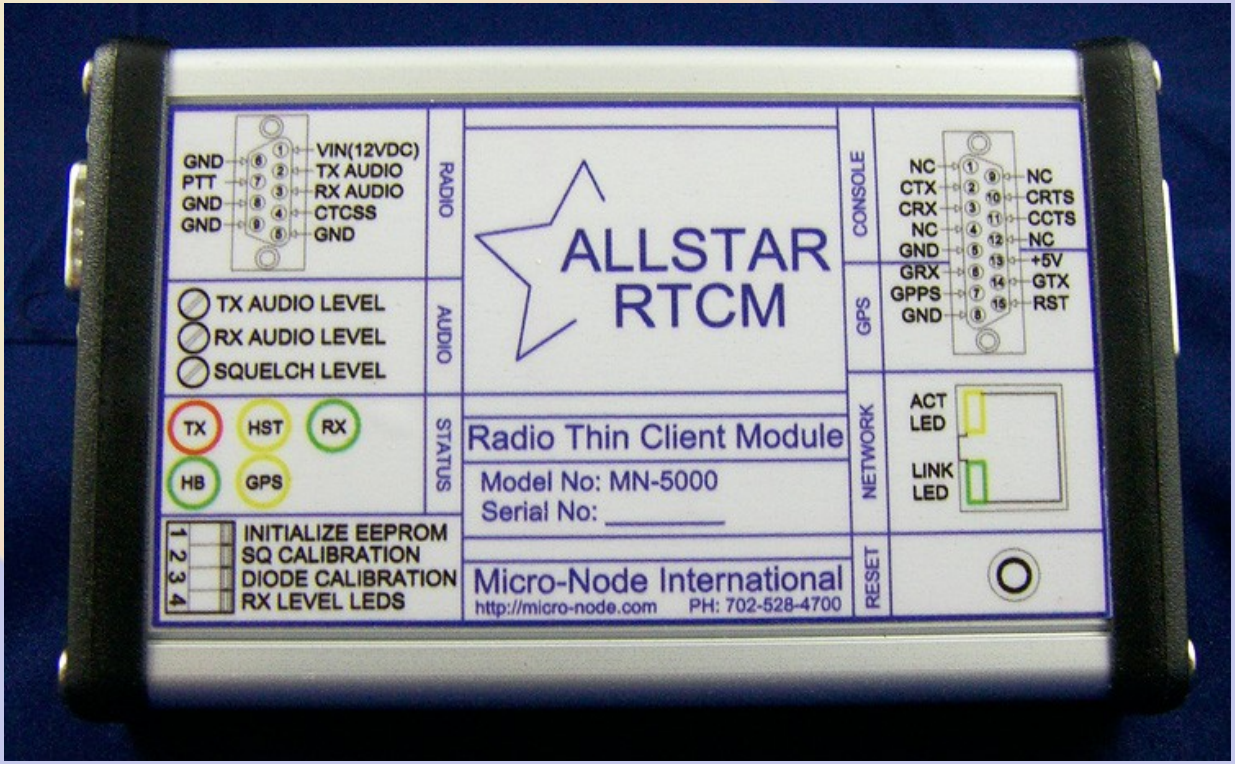
- Based on USB audio chips
- Should have isolated PTT and similar lines





Radio Thin Client Module

- Stand alone PIC based radio interface
- GPS based timing for voting & "simulcast"
- Used by Colorado Connnection for voting

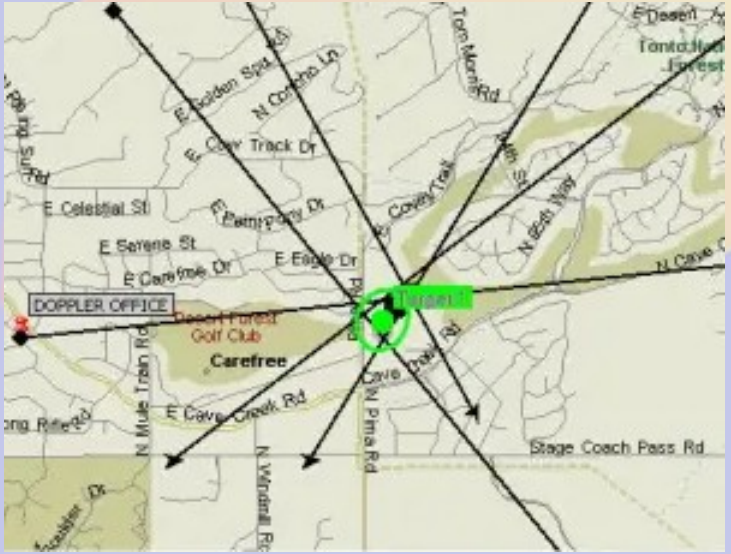


DMR natively supports IP

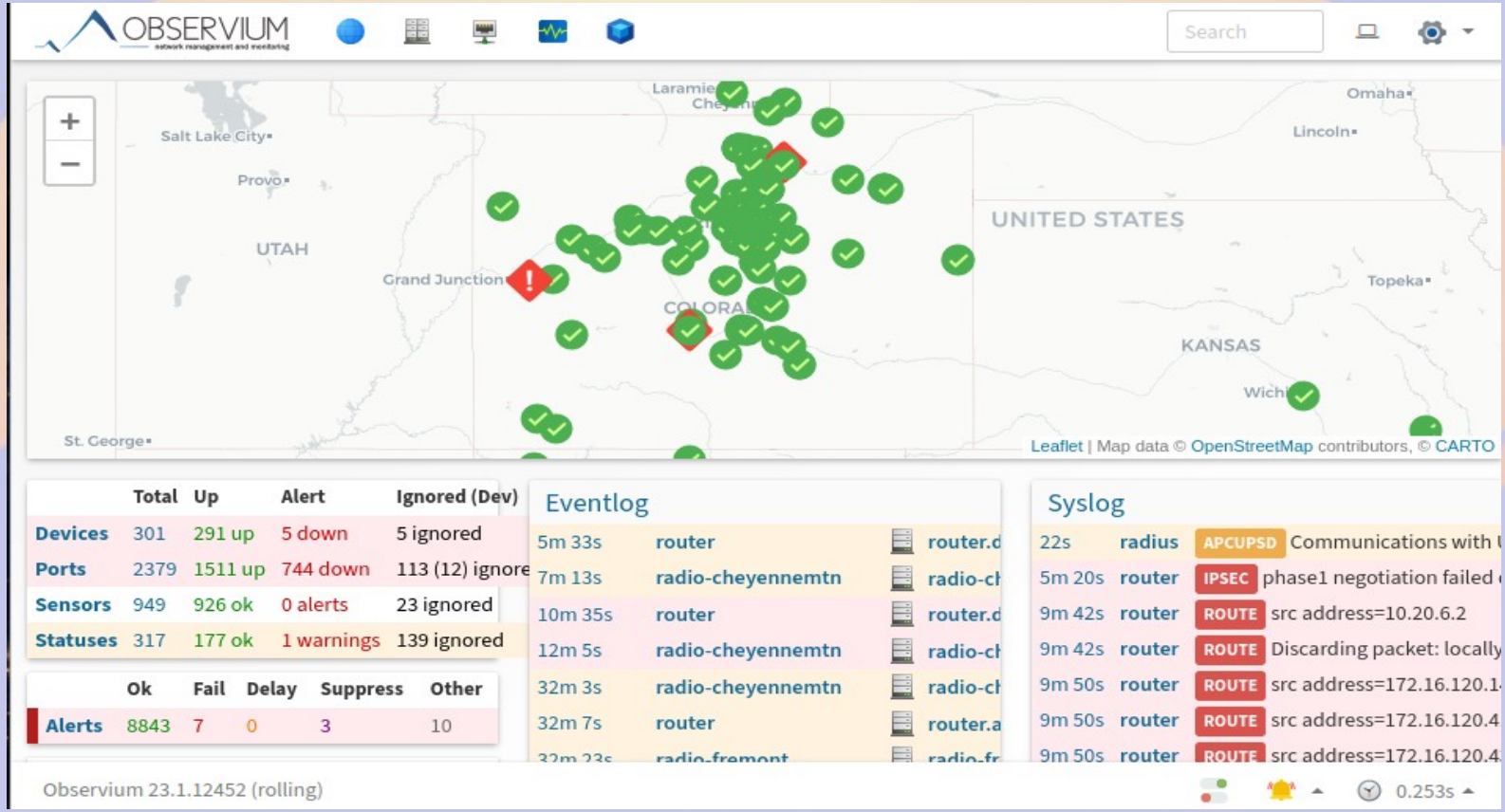
- Motorola IP Site Connect
- Master/Peer configuration
  - Limited to 16 repeaters
- Repeater Diagnostics and Control (RDAC)
  - Remote control of repeater
- RMHAM use c-Bridge
  - 3rd party DMR bridge

Direction Finding

- DDF7000 Doppler
- Links multiple units and mapping software with IP

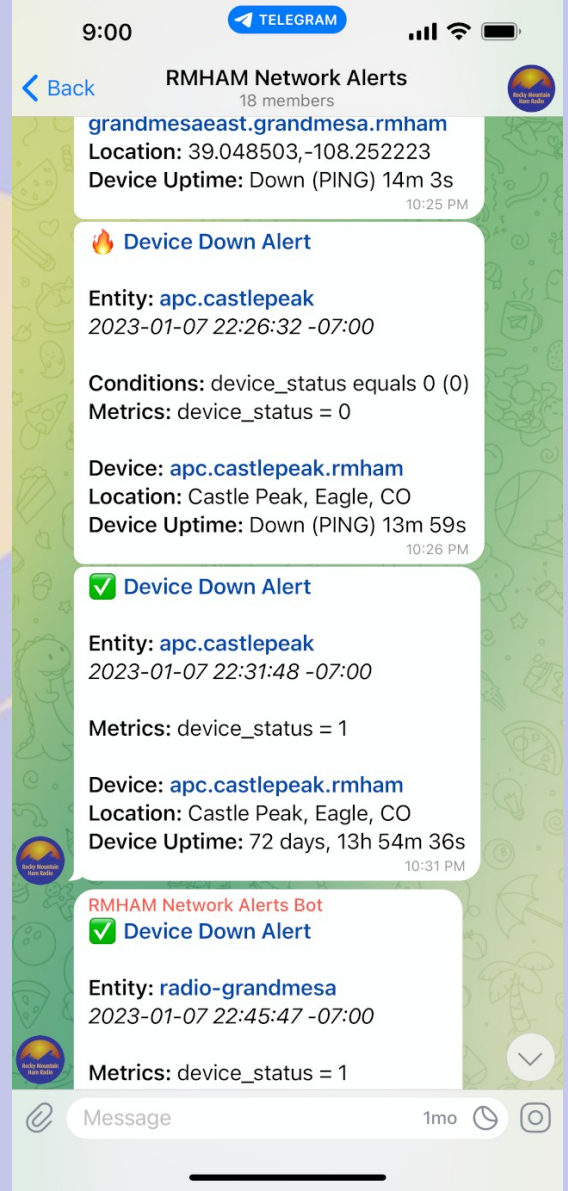


Network Monitoring with Observium

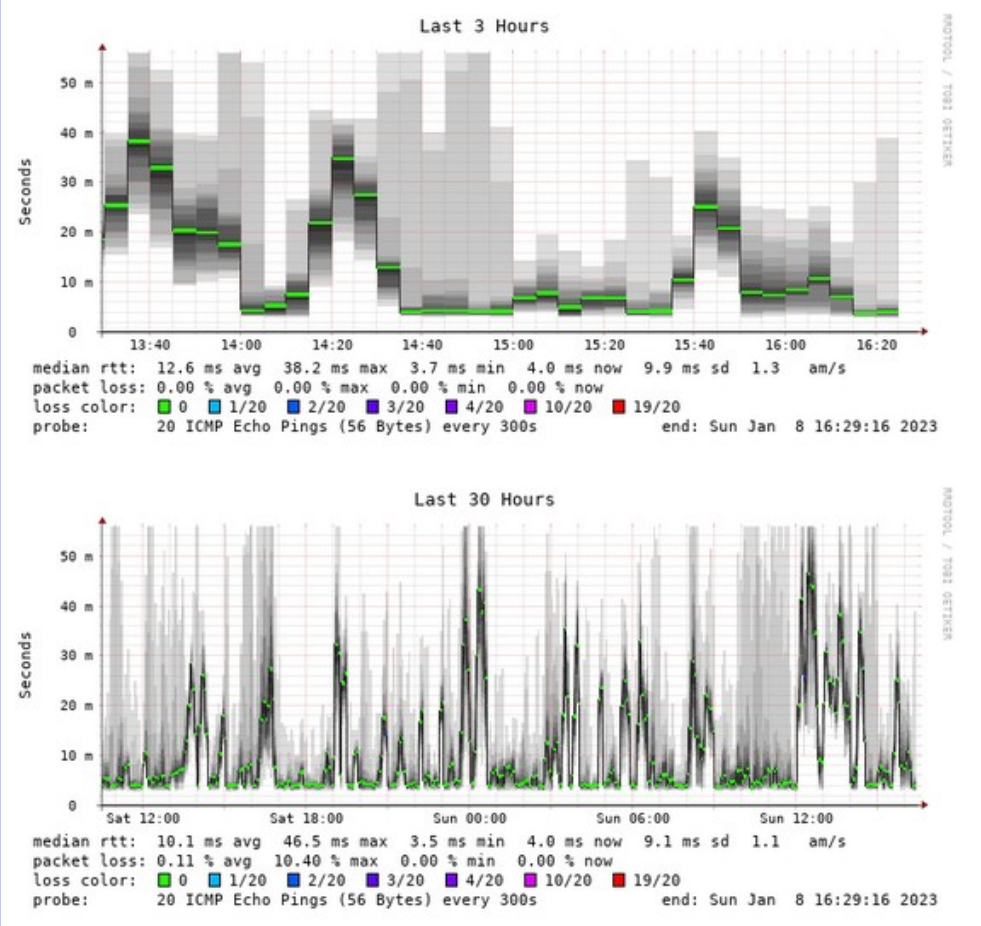


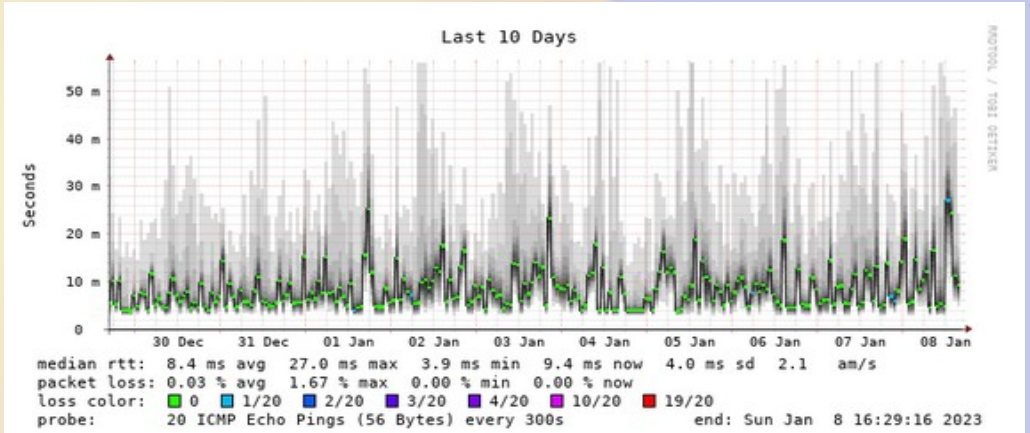
System Alerts

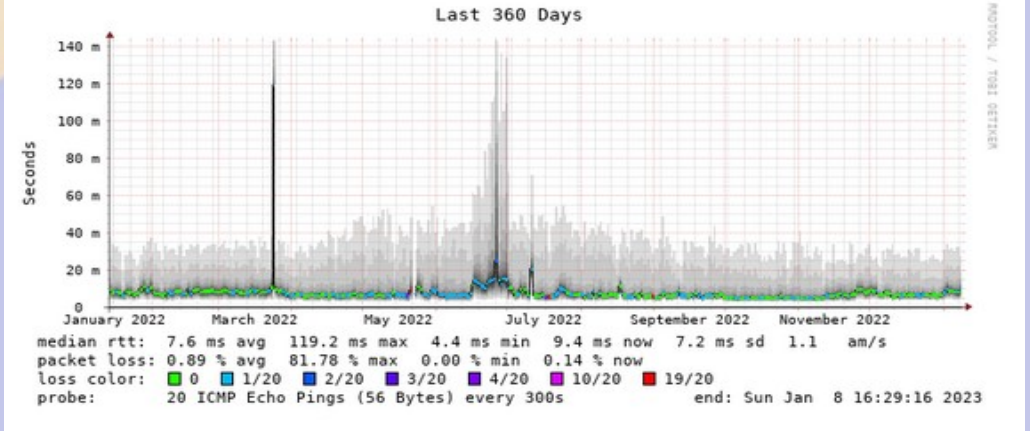
- Alert methods
  - Email
  - Telegram
- Alert on
  - power out
  - port down
  - device down
- Important to have adjustable sensitivity



SmokePing link quality monitoring







Questions?