

The background features a stylized illustration of a large, semi-circular sun with a yellow-to-orange gradient, rising behind a range of blue mountains. The sun's rays are depicted as sharp, triangular shapes pointing upwards. The entire scene is set against a light blue sky.

# **Ham Radio Microwave Usage**

**Willem AC0KQ**

**John W0VG**

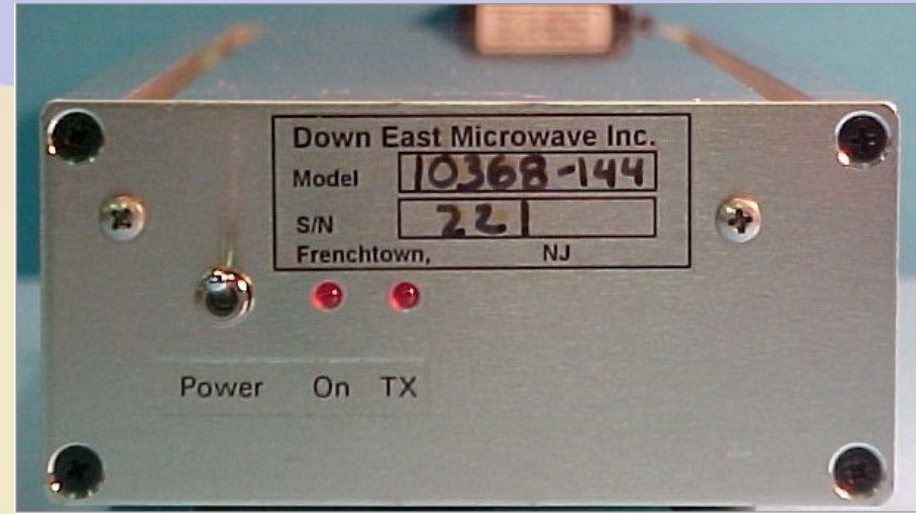
***Rocky Mountain Ham Radio***

# 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

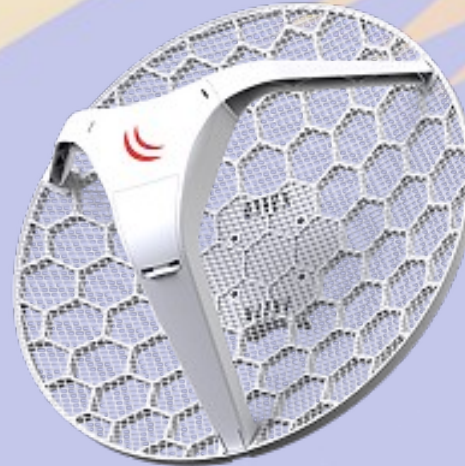
# Phone/CW Operations

- 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



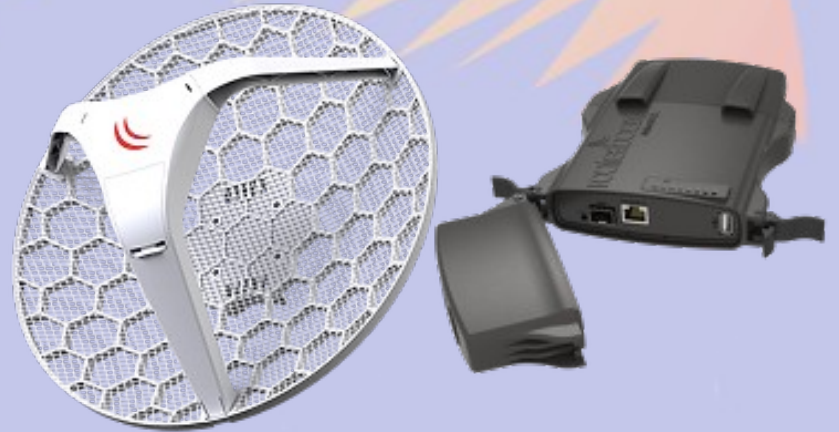
# Advantages of Using IP networking

- 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

Interface <wlan1>

General Wireless Data Rates Advanced HT HT MCS WDS ...

Mode: ap bridge

Band: 5GHz-A/N

Channel Width: 20MHz

Frequency: 5890 MHz

SSID: N0SZ-40

Radio Name: SADD-CENT-N0SZ

Scan List: 5890

Skip DFS Channels: disabled

Wireless Protocol: nv2

Interworking Profile: disabled

Frequency Mode: superchannel

Country: no\_country\_set

Installation: any

Bridge Mode: enabled

VLAN Mode: no tag

VLAN ID: 1

Default AP Tx Limit: bps

Default Client Tx Limit: bps

☒ Default Authenticate

☒ Default Forward

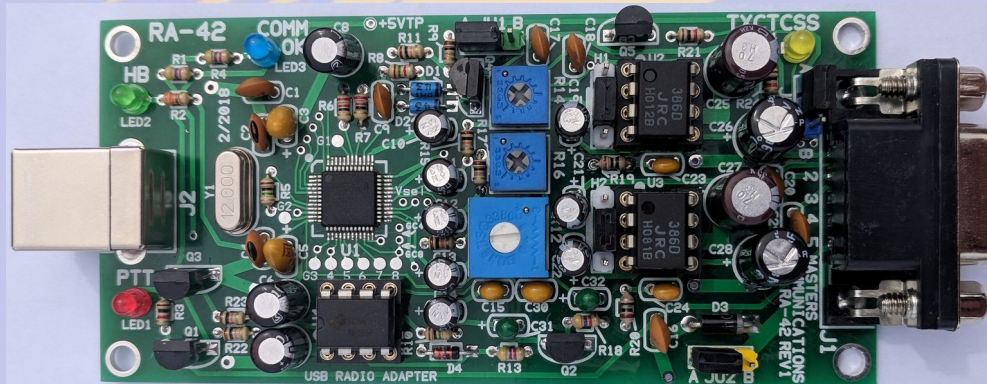
OK Cancel Apply Disable Comment Simple Mode Torch WPS Accept WPS Client Setup Repeater Scan... Freq. Usage... Align... Sniff... Snooper... Reset Configuration

enabled running slave running ap



# USB Analog adapters for AllStarLink

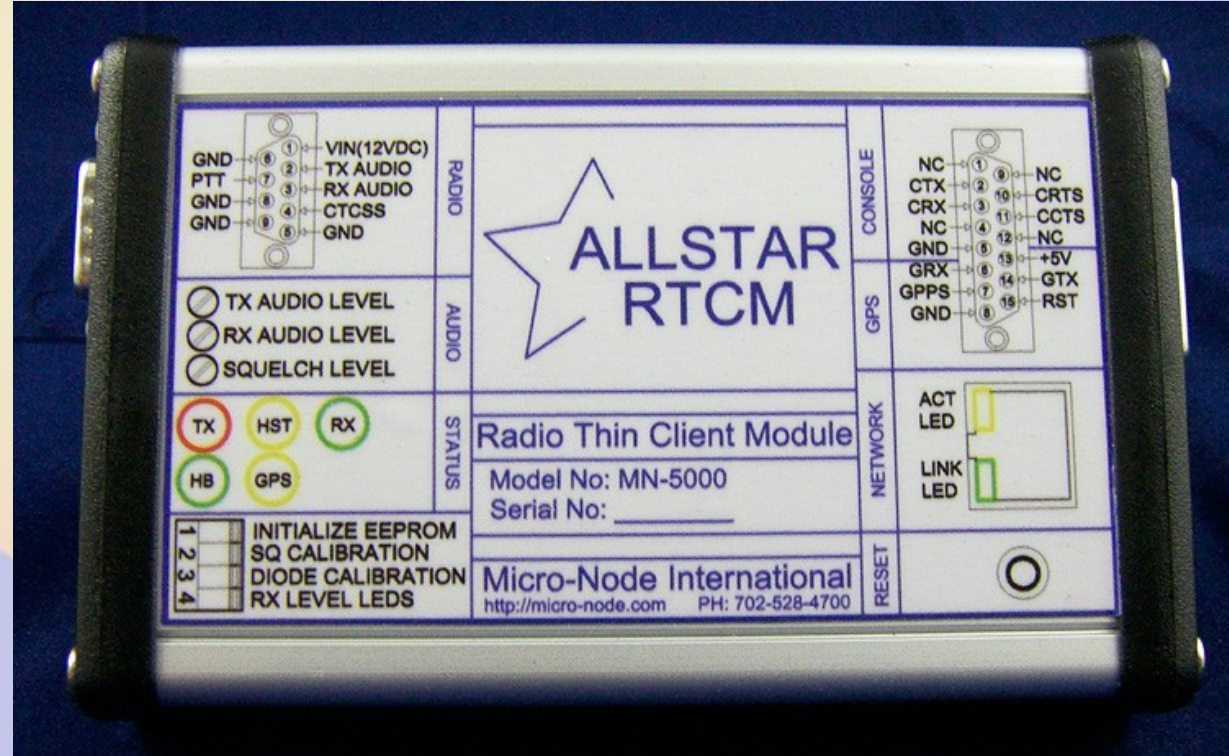
- Based on USB audio chips
- Should have isolated PTT and similar lines





# Radio Thin Client Module

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



# DMR natively supports IP

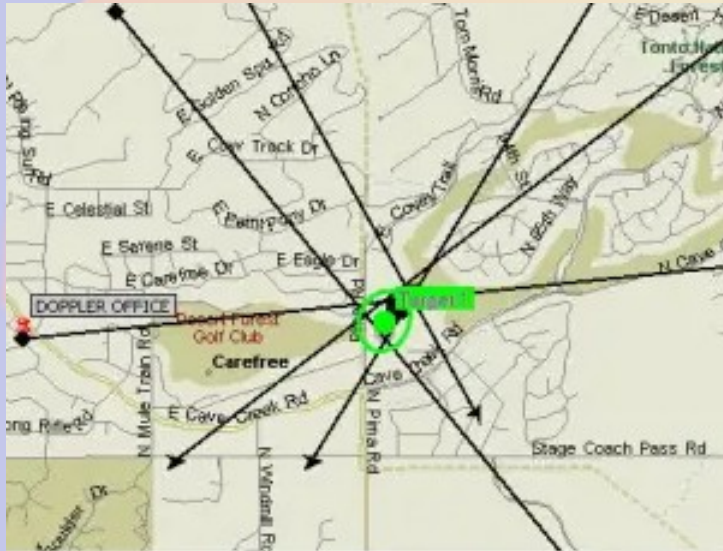
- Motorola IP Site Connect
- Master/Peer configuration
  - Limited to 16 repeaters
- Repeater Diagnostics and Control (RDAC)
  - Remote control of repeater
- RMHAM use c-Bridge
  - 3<sup>rd</sup> party DMR bridge



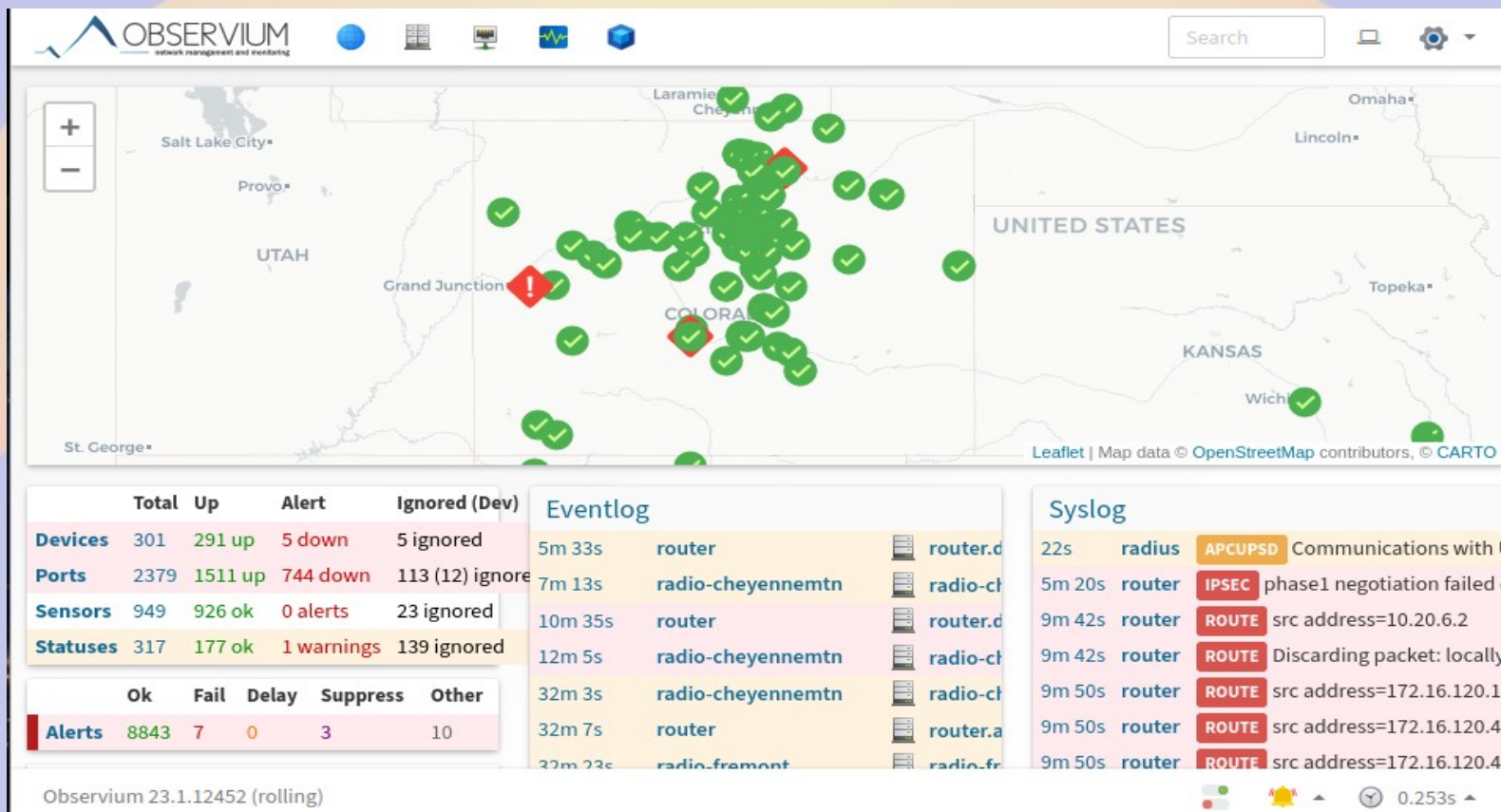


# Direction Finding

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



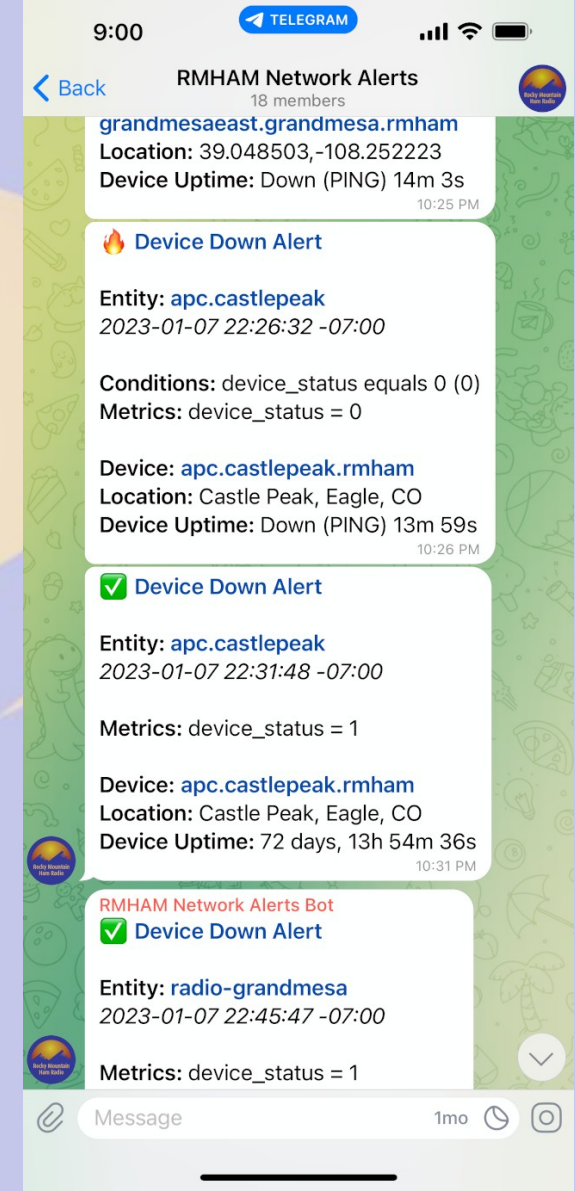
# Network Monitoring with Observium





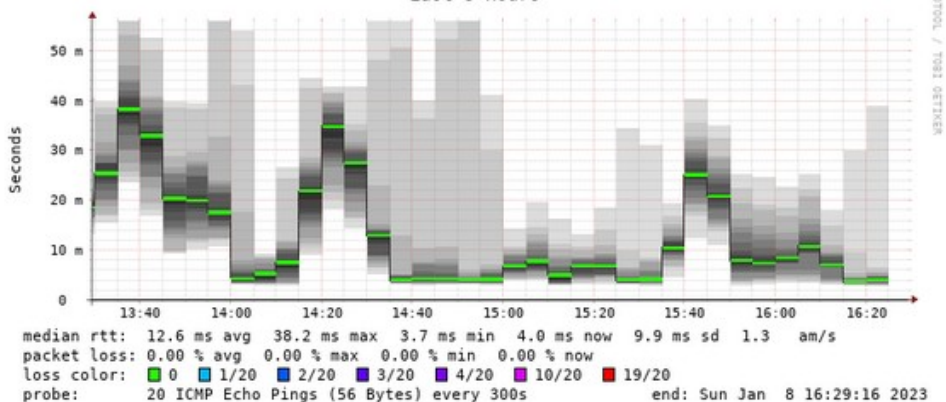
# System Alerts

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

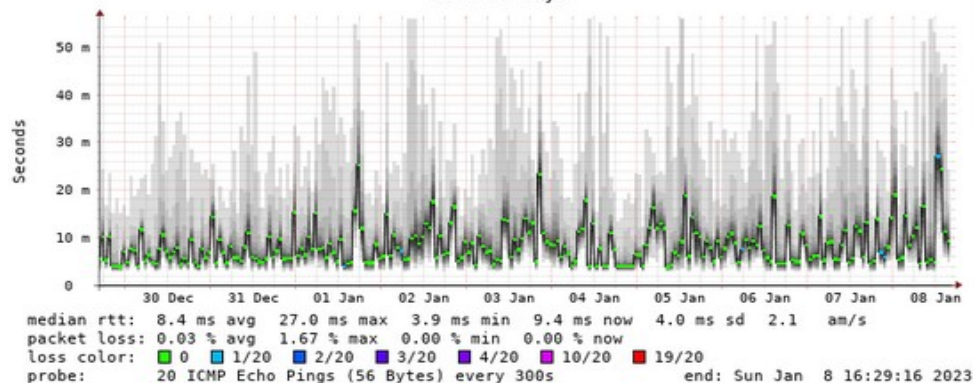


# SmokePing link quality monitoring

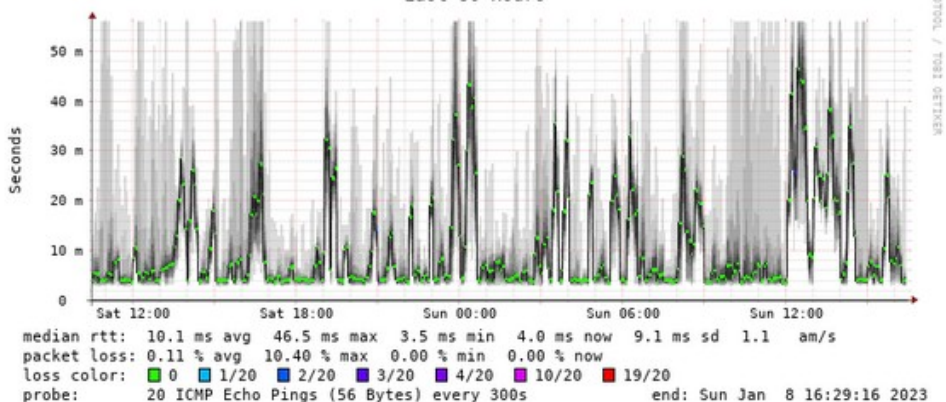
Last 3 Hours



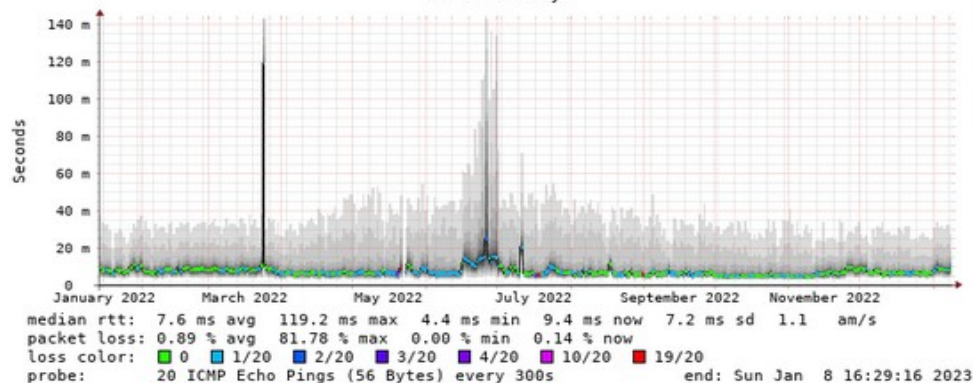
Last 10 Days



Last 30 Hours



Last 360 Days





***Questions?***