# Merrimack Valley Digital Network

## Learning and Deploying 21st Century Amateur Radio

## Using a firmware platform developed by Amateur Radio Emergency Data Network

New England Sci-Tech
January 20, 2026

Jay Taft K1EHZ

# Acknowledgements

## Merrimack Valley Digital Network

a project of

**Merrimack Valley Amateur Radio Association, Inc**

supported by

- **Amateur Radio Digital Communications** (ARDC) Grant
- **Partner** - **New England Digital Emergency Communications Network** (NEDECN)
    - 90+ DMR repeater sites in New England
- **Collaborators**
    - **Central New Hampshire Amateur Radio Club**
    - **Capital Area Repeater Society**
    - **Manchester, NH area agencies and hospitals**
    - **Pembroke, NH Fire Dept**
    - **Goffstown, NH Police Dept**
- **Organizations and individual radio amateurs who generously volunteer time, money, equipment, expertise, and site access**

## AREDN Mission

The primary goal of the AREDN® project is to empower licensed* amateur radio operators to quickly and easily deploy high-speed data networks when and where they are needed.

***Only need a Technician license!**

***Don't need to be an IT expert or a microwave radio expert to get started, but you could become one!***

# Why high-speed data networks over amateur radio?

## Internet Functionality With & Without the Internet

# AREDN as a Platform for 21st Century Amateur Radio

# Adding New Dimensions to Traditional Operating Modes

# Topics

- Microwave supports different functions than HF, VHF, UHF
- STEM opportunities
- Career directions such as
  - AI Programming
  - Earth <-> Space Communications  For Science and Consumers
- Merrimack Valley Digital Network
  & New England-wide Microwave Network
- Community service events
- EmComm voice & data applications
- Get started with a Technician license and a $35 router

# AREDN coders develop firmware to be flashed into readily available equipment

## Radios & Frequencies

- Uses inexpensive *off-the-shelf* wifi radios
- Rugged & weatherproof for outdoor deployment
- Single *Power-over-Ethernet* cable *(data + power)*
- High gain antenna options *(some integrated w/ radio)*

***(for example, 400mw at 30dB gain ~ 55w EIRP)***

- AREDN® firmware opens ham freqs *(some non-shared)*
- Bands: 900MHz *(33cm)*, 2.4GHz *(13cm)*, 5.8GHz *(5cm)*
- Line of sight required for microwave freqs
- Distance: ¼ mile to >30 miles

***(our longest 5.8GHz link is 48 miles)***

AREDN

# Frequencies Available for AREDN

## Most are Shared with Unlicensed Uses

| 4 | 5 | 6 | 7 |
|---|---|---|---|
| 907 | 912 | 917 | 922 |
| Shared with US unlicensed | | | |

| -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 * |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.397 | 2.402 | .407 | 2.412 | 2.417 | 2.422 | 2.427 | 2.432 | 2.437 | 2.442 | 2.447 |
| *Unshared* | | Cannot Use | Shared with US unlicensed | | | | | | | |

| 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.655 | 5.660 | 5.665 | 5.670 | 5.675 | 5.680 | 5.685 | 5.690 | 5.695 | 5.700 | 5.705 | 5.710 | 5.715 | 5.720 | 5.725 | 5.730 | 5.735 | 5.740 |
| Shared with US unlicensed indoor/outdoor DFS & Radar Avoidance | | | | | | | | | | | | | | | Shared with Unlicensed... | | |

| 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 | 163 | 164 | 165 | 166 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.745 | 5.750 | 5.755 | 5.760 | 5.765 | 5.770 | 5.775 | 5.780 | 5.785 | 5.790 | 5.795 | 5.800 | 5.805 | 5.810 | 5.815 | 5.820 | 5.825 | 5.830 |
| Shared with US unlicensed indoor/outdoor | | | | | | | | | | | | | | | | | |

| 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 | 181 | 182 | 183 | 184 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.835 | 5.840 | 5.845 | 5.850 | 5.855 | 5.860 | 5.865 | 5.870 | 5.875 | 5.880 | 5.885 | 5.890 | 5.895 | 5.900 | 5.905 | 5.910 | 5.915 | 5.920 |
| ...Shared with Unlicensed | | | | Shared with US unlicensed mainly indoor | | | | | | | | | *Shared with Intelligent Transportation System* | | | | |

# How is AREDN different from typical HF / VHF / UHF ham radio?

- Broadband – 5 to 40 MHz bandwidth on 5.8 GHz band
- IP Based – supports most internet applications
  - VOIP Telephone
  - Email & Chat
  - Streaming Video, including AI event recognition (wild fire smoke)
  - Remote Data Sensors
  - Remote Radio Operation
- Microwave radio system independent from the internet
  - 54 channels 5GHz-wide in the 5.8 GHz range
  - **Adds resilience to systems that rely on internet connectivity**
    - **Winlink Global Email gateways**
    - **Linked repeaters like Digital Mobile Radio (DMR)**
  - Internet tunnels for training and remote network maintenance

# AREDN as a Platform for Learning and Career Preparation
# A Few Examples

## STEM Opportunities

- Modern battery technology
- DC volt step up 12v to 24v
- DC volt step down 12v to 5v
- Microwave radio systems
- Microwave propagation
- Network design
- **Directional antenna design & build**
- IP routing and networking
- IP over microwave radio
- Software routing protocols
- AI data analyses tools
- Modern video technology
- Remote data collection & analyses
- Solar power technology
- Technical writing & illustration

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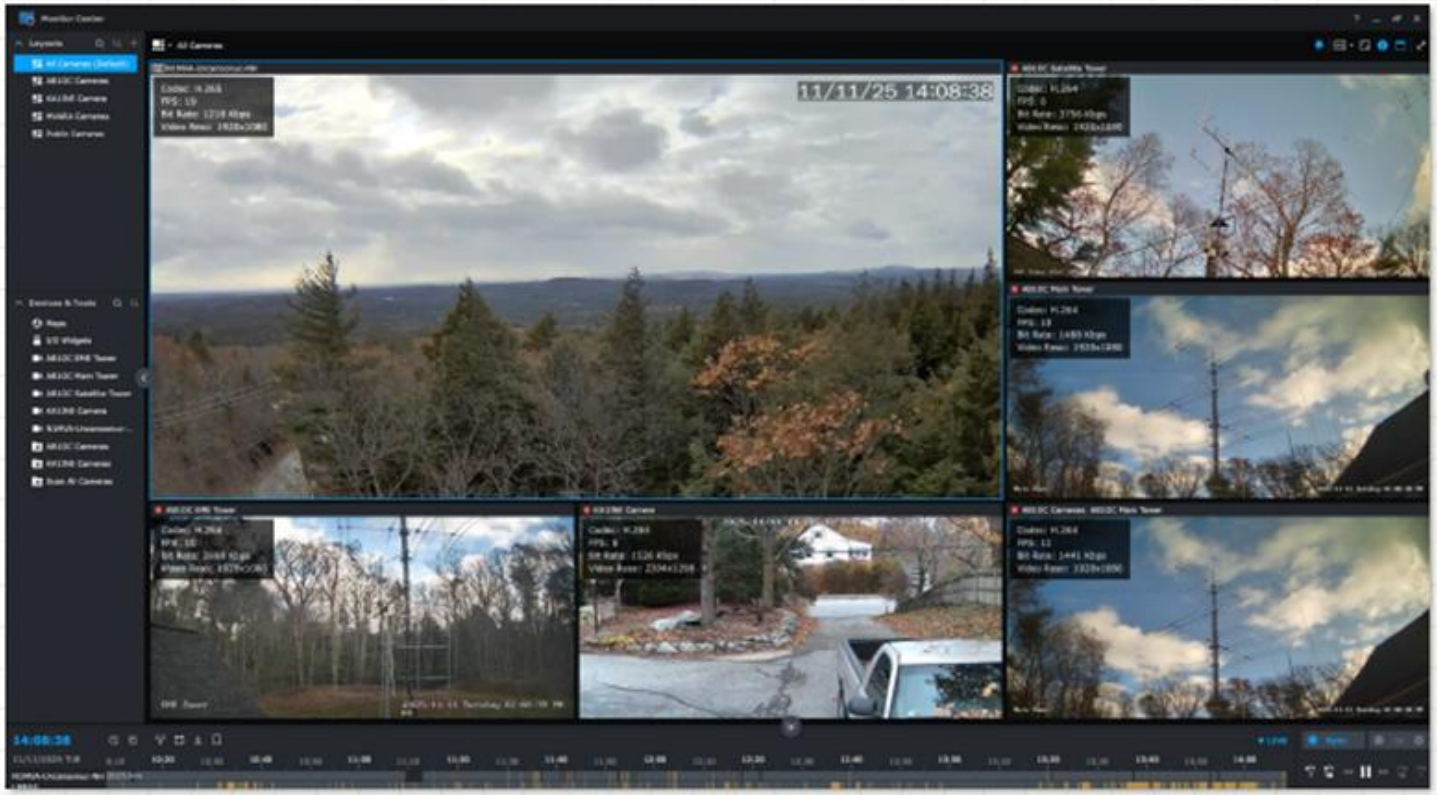
## Career Directions

- IP Networks
- Microwave Radio Networks
- Video Systems
- **Artificial Intelligence Applications**
- **Earth <-> Space Communications**
  - **For Science and Consumers**
- Research
- Engineering
- Technology Applications
- Teaching
- Writing, Illustrating, Publishing
- General Broadcasting, Gaming

# Artificial Intelligence Example
# Streaming Video for Event Recognition – Wild Fires

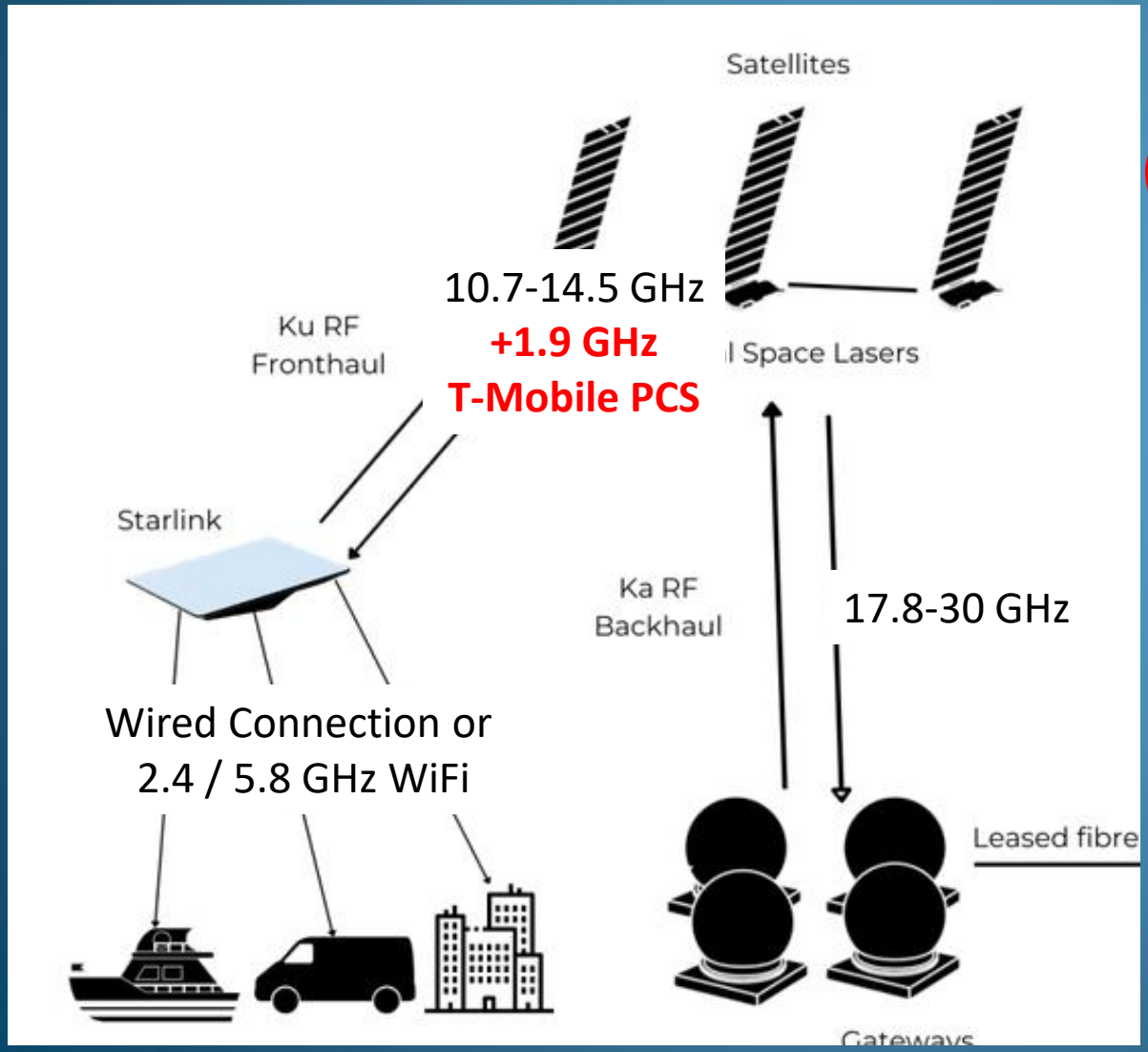
## A View from AREDN…

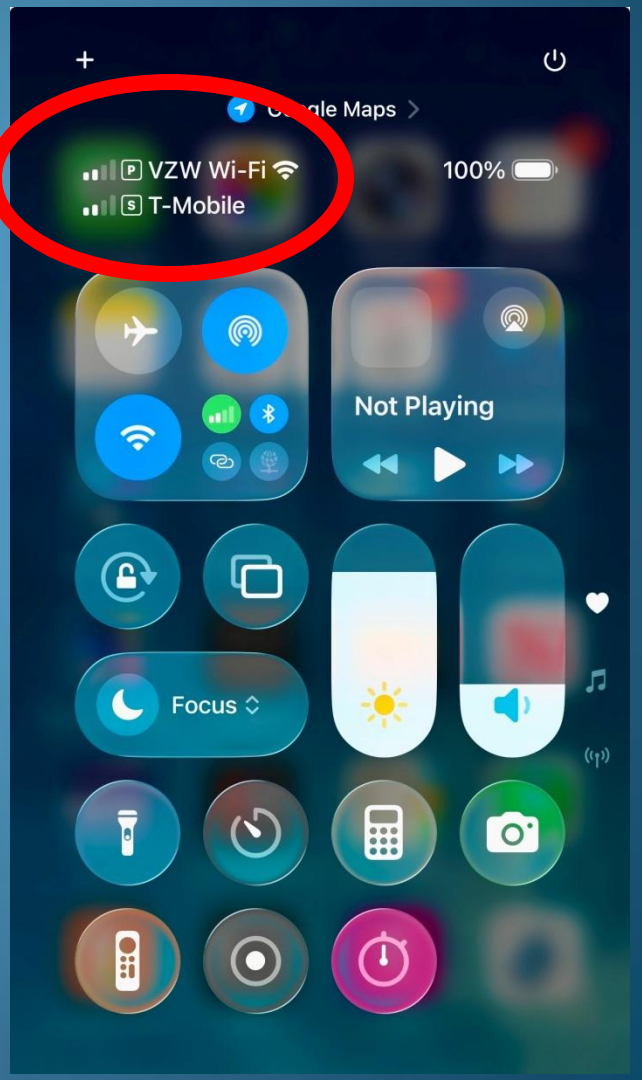
- Test Cameras at KA1INE, N1KWG, and AB1OC
- Camera at the Mt. Uncanoonuc Site
- More to come, including AI-based search and event recognition



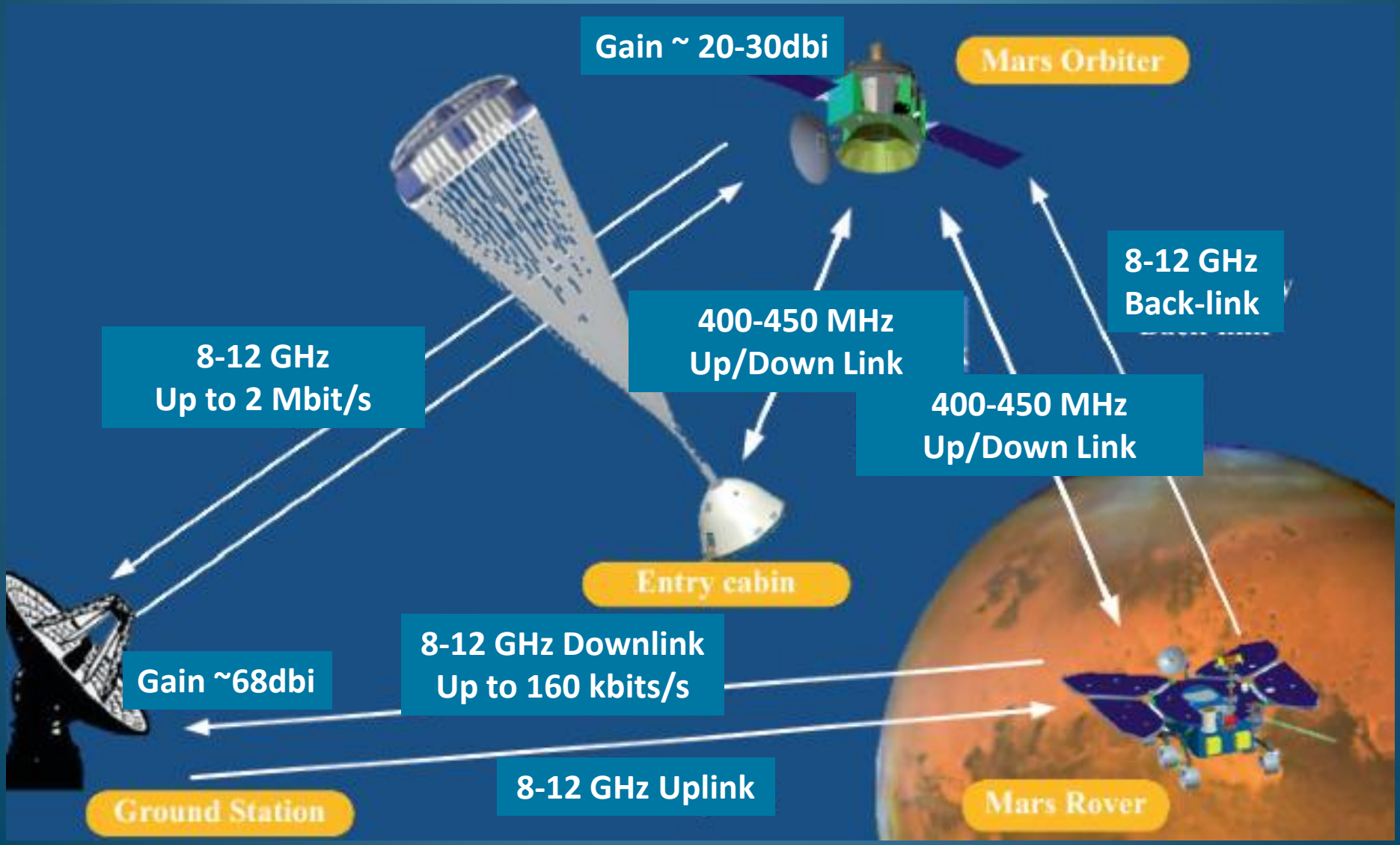
# Earth <-> Space Communications Example

## StarLink + T-Mobile Esim for Consumer Texting



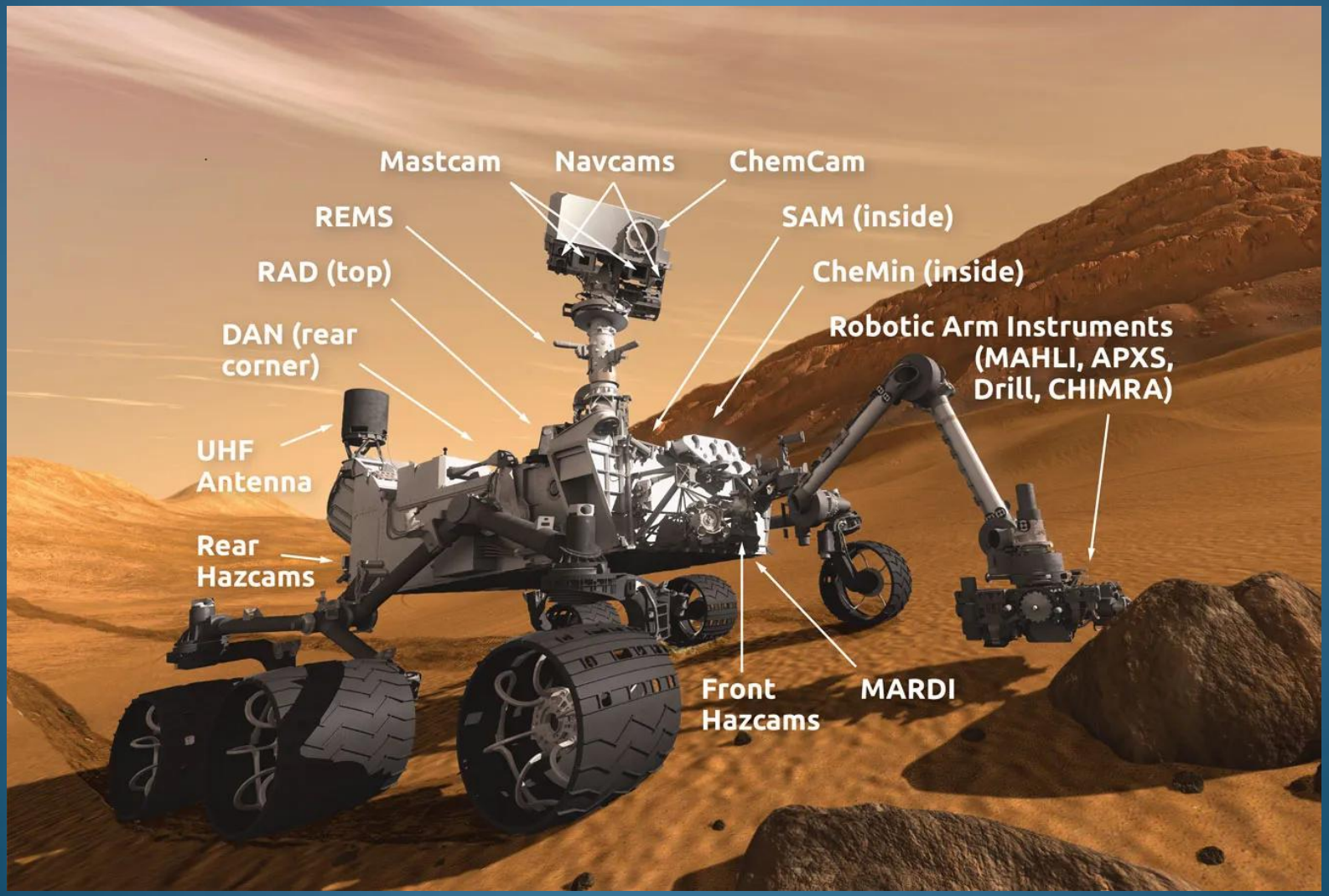
# Earth <-> Space Communications Example
# Mars Rovers



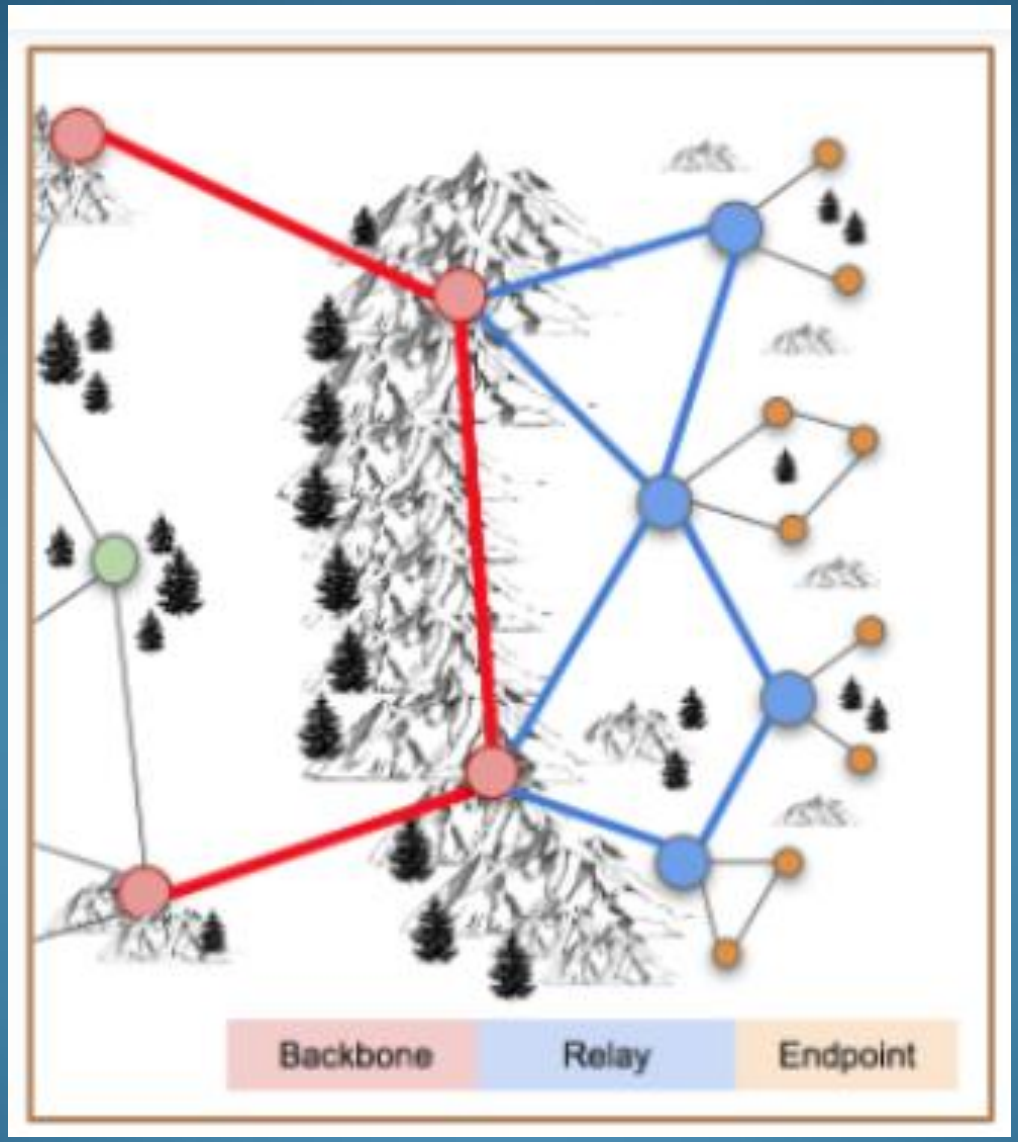
# Curiosity Rover

## Control and Data Recovery by Microwave Radio

## Operating since August 5, 2012

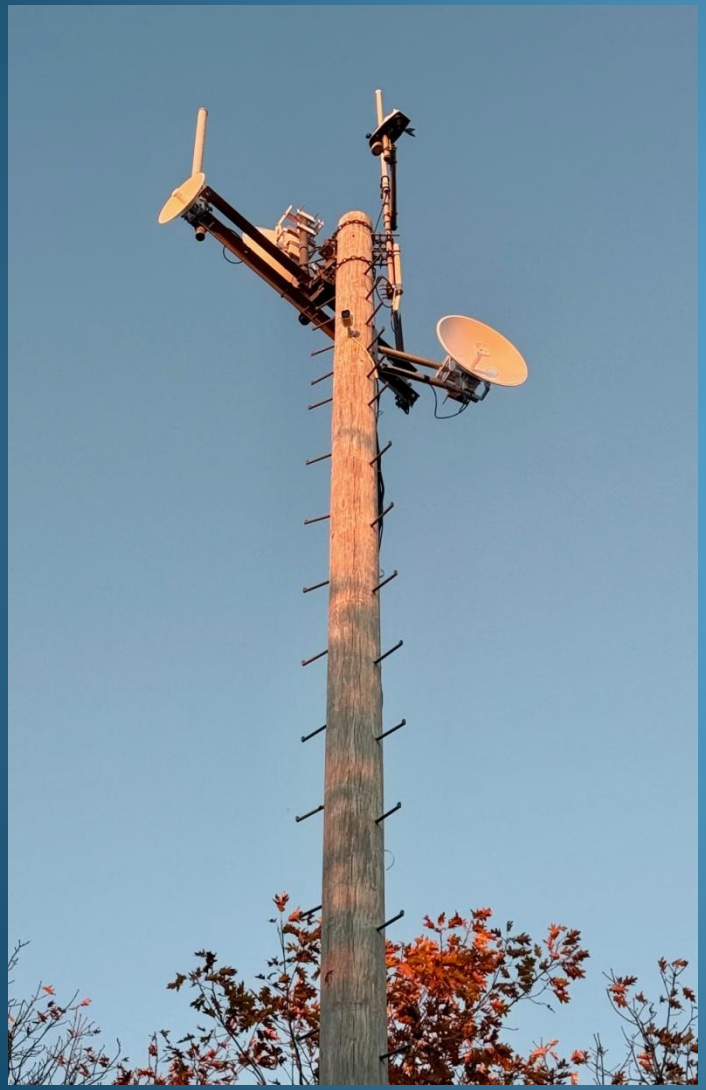


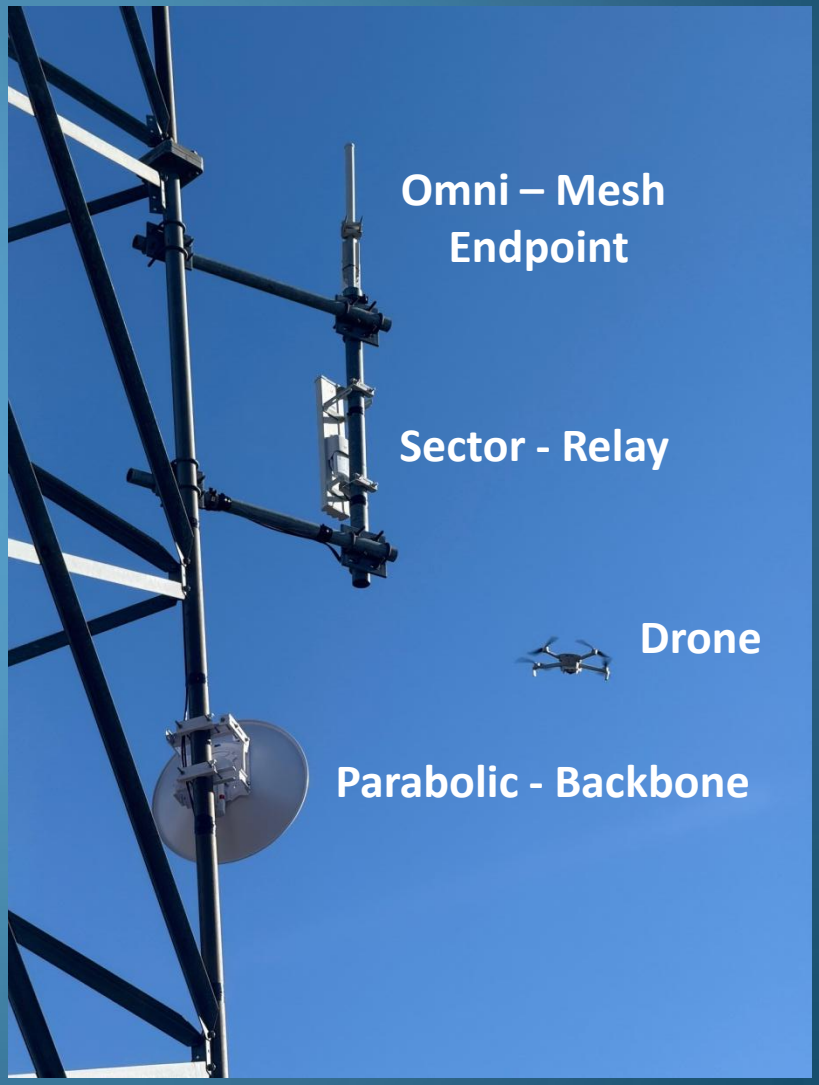
# Perseverance Rover Images Sent via Microwave Radio




# AREDN Configurations

# Merrimack Valley Digital Network





# Example Backbone Nodes at DMR Repeaters

## AREDN increases DMR resilience with multiple paths to the c-Bridge

# AREDN Adds Resilience to Linked Radio Systems

## Example - DMR with Single Internet Path to the Common c-Bridge Server

# AREDN Adds Resilience to Linked Radio Systems

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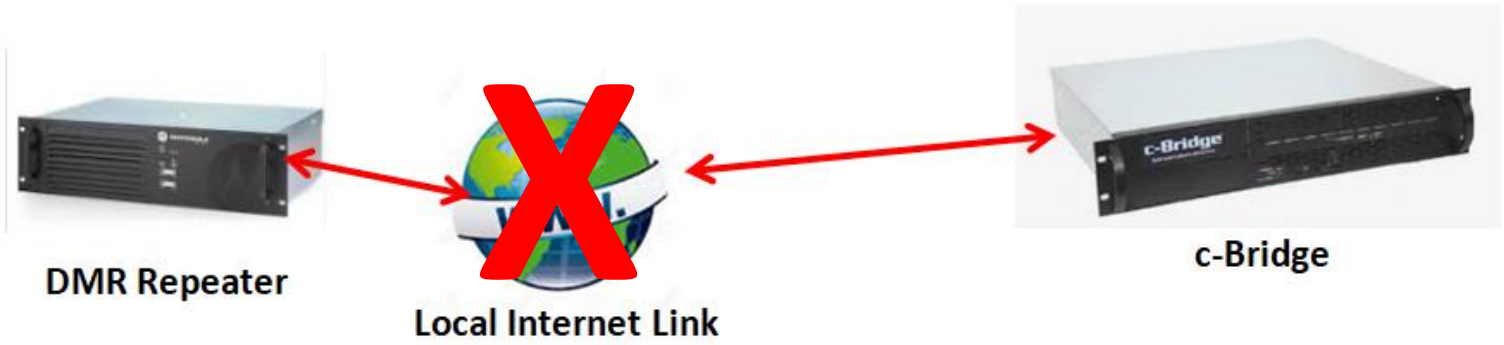
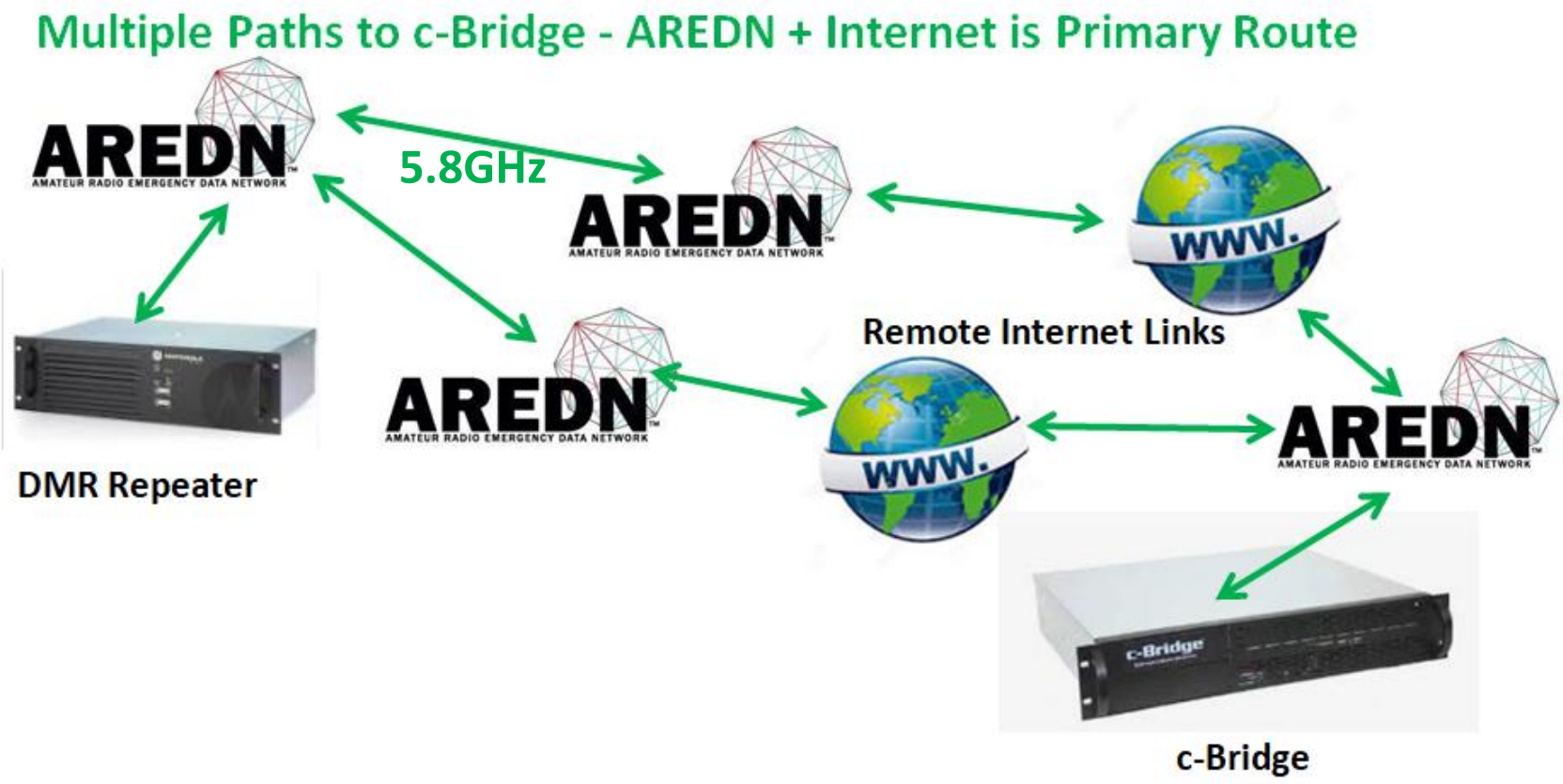


# AREDN increases DMR resilience with a hybrid network having multiple internet access points and routes to the c-Bridge



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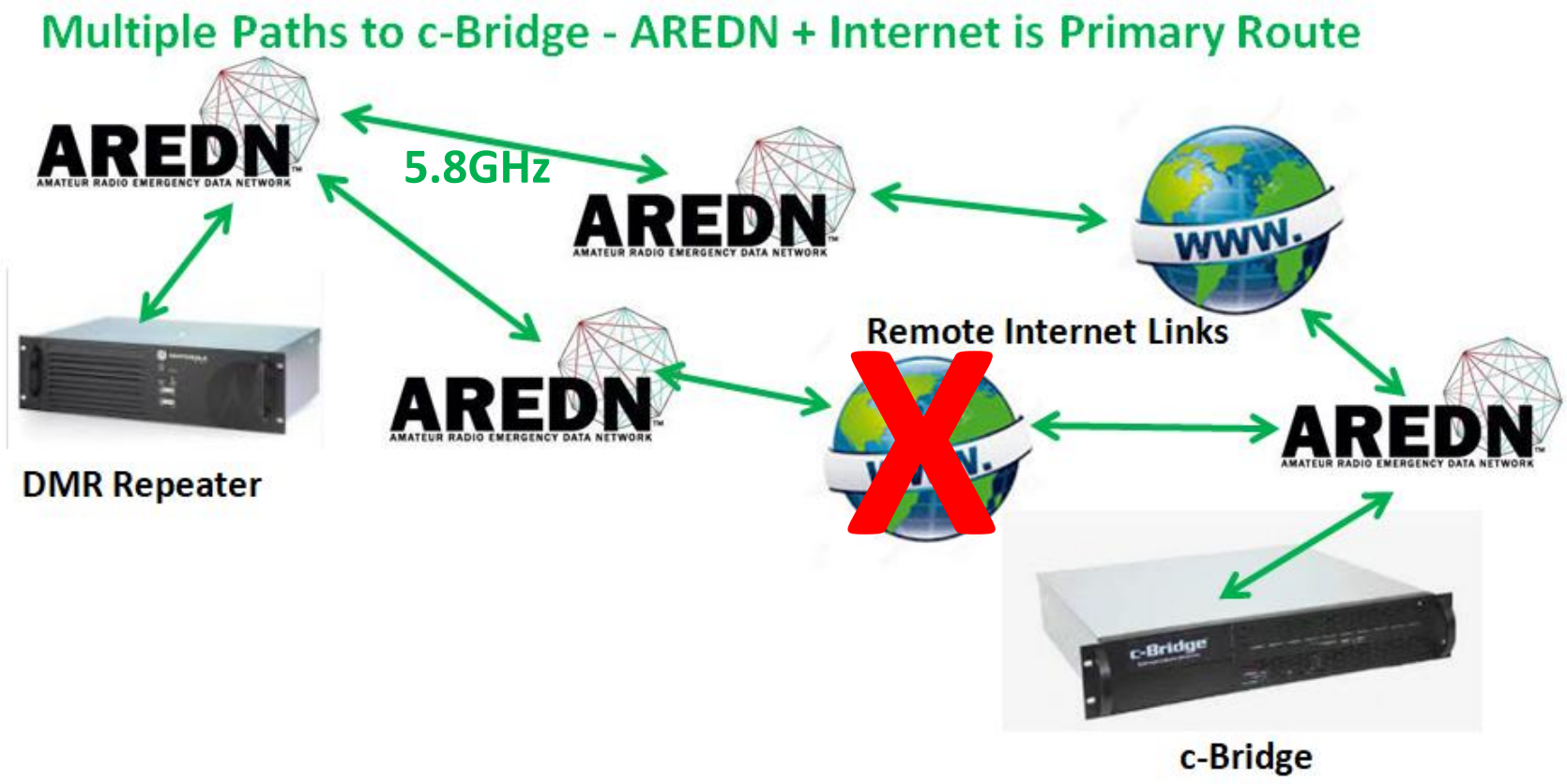
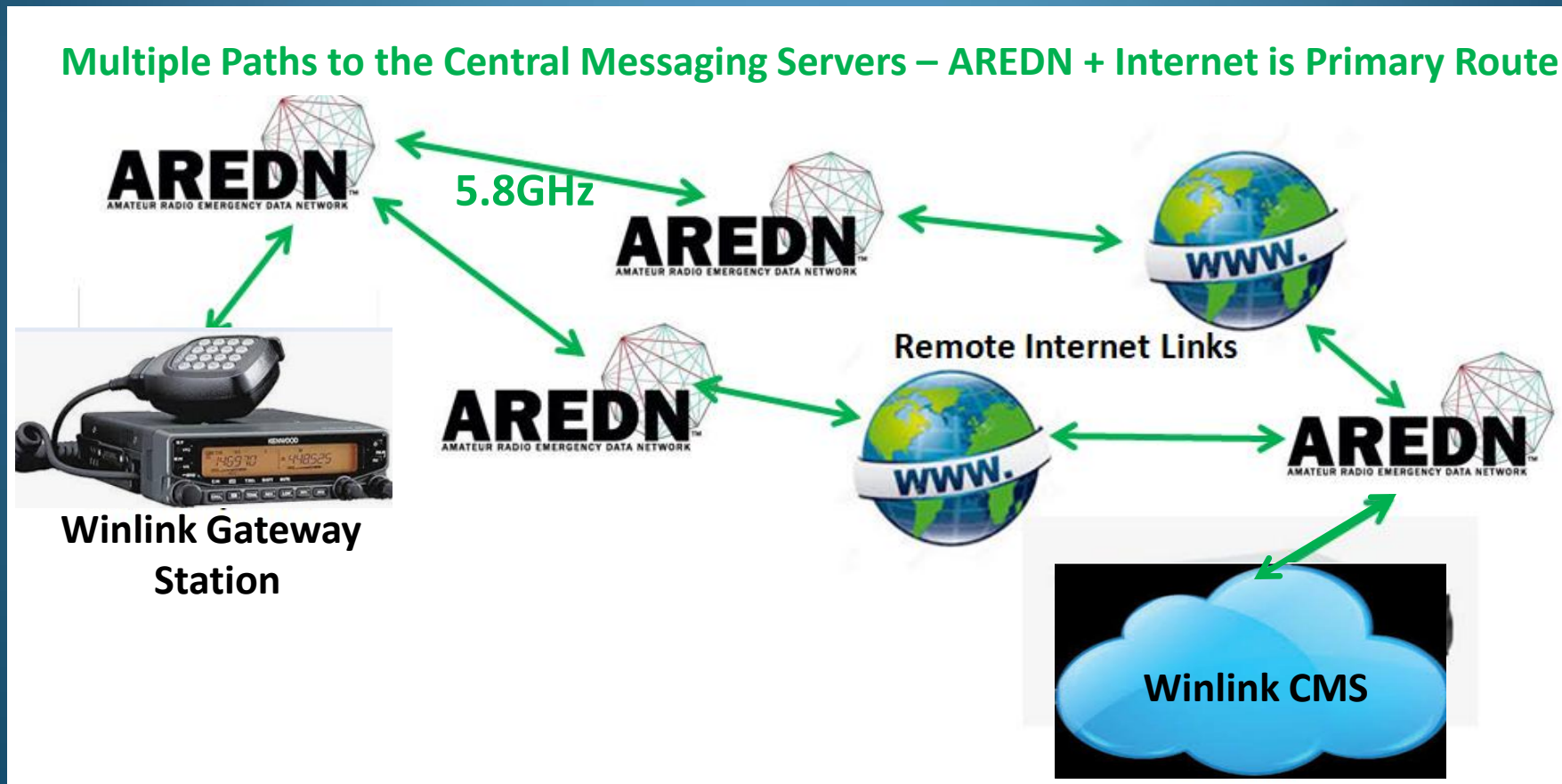


# AREDN increases Winlink resilience with a hybrid network having multiple internet access points and routes to the Winlink CMS



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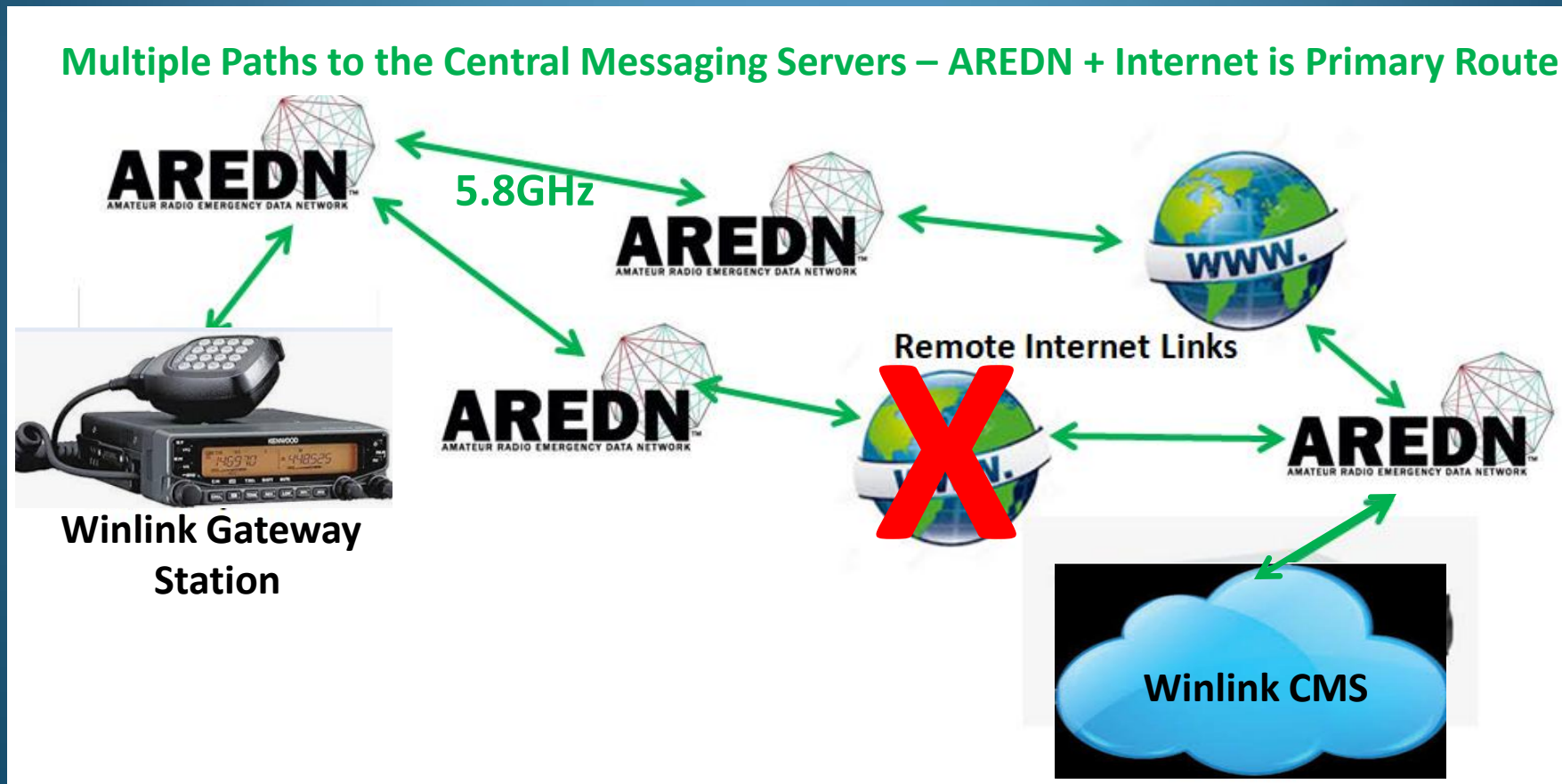
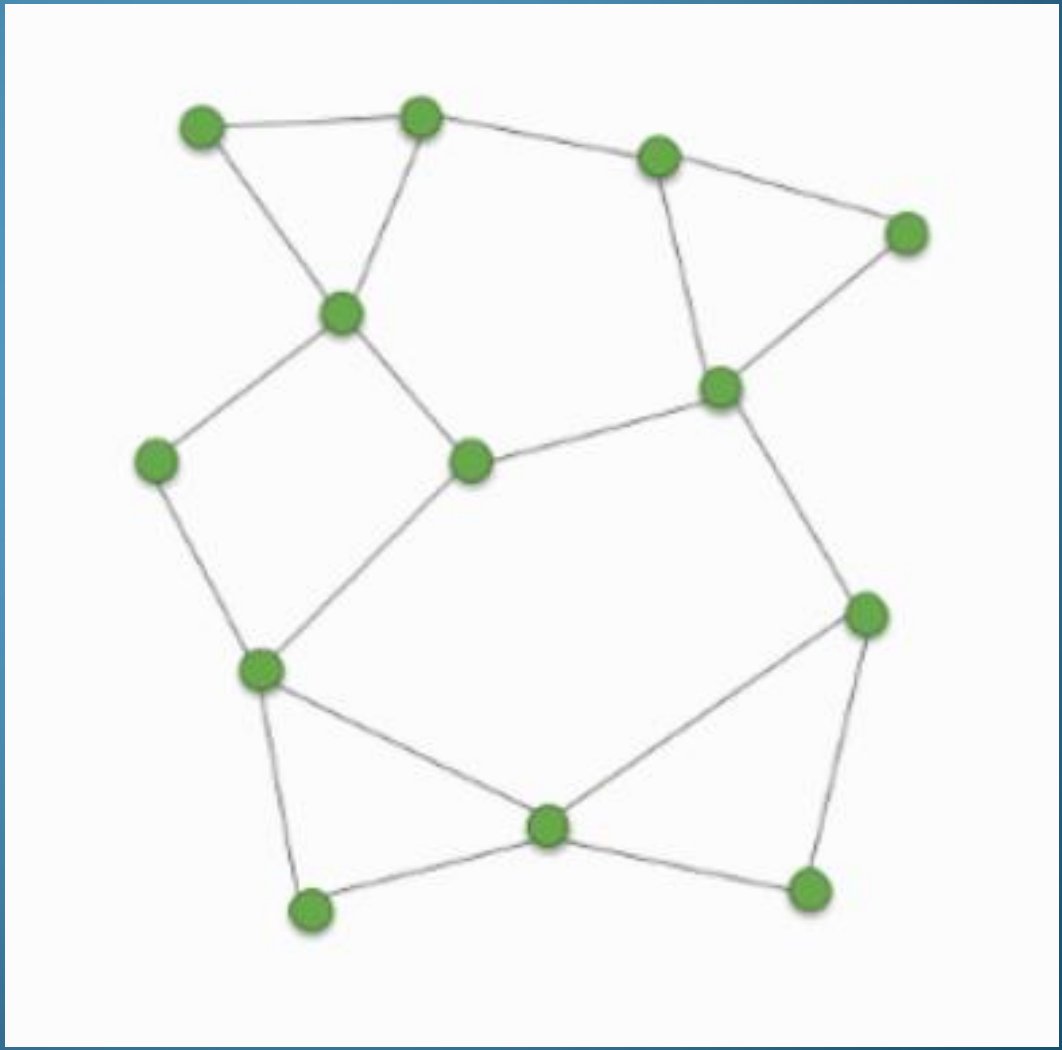


# Mesh Configuration

## From AREDN Documentation

All nodes on same SSID, RF channel and bandwidth

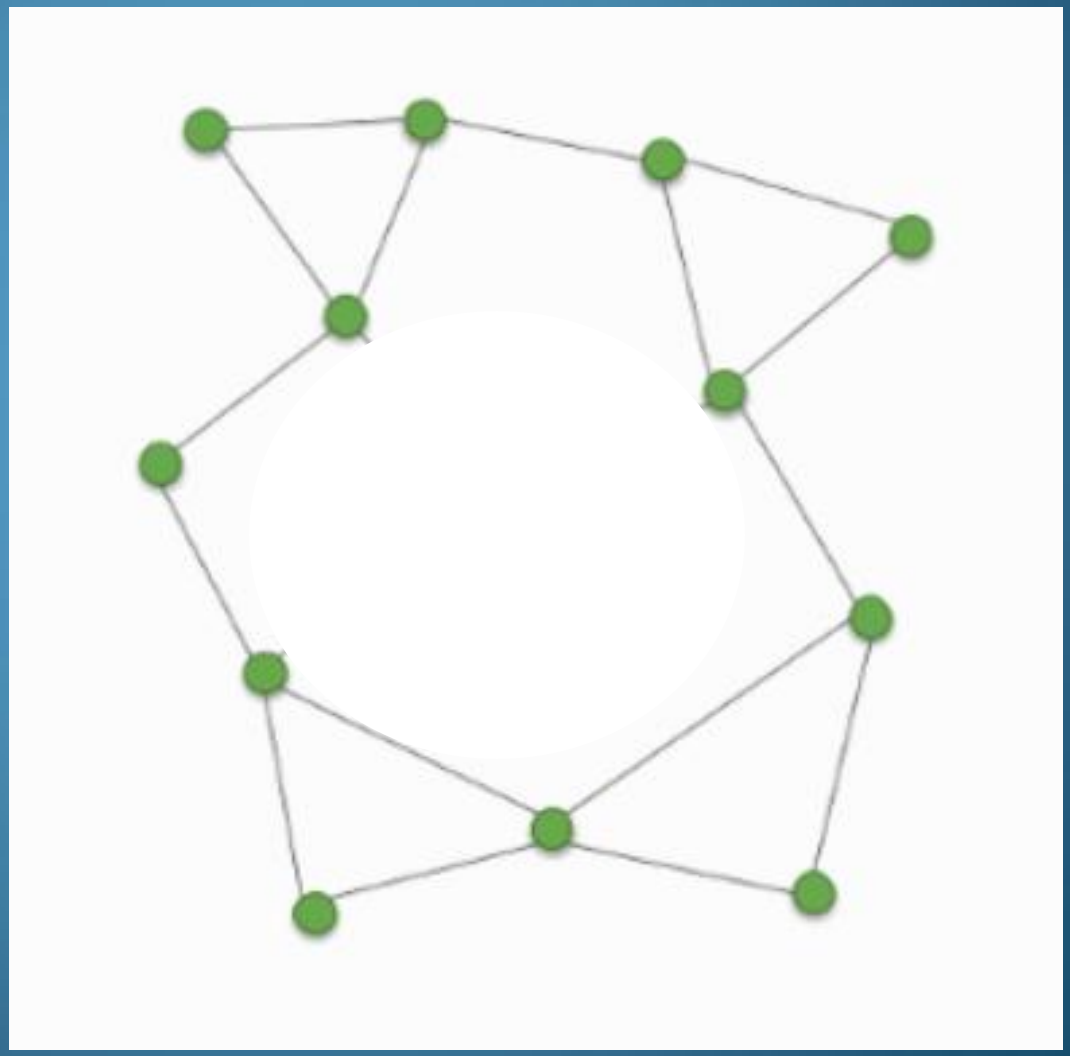


# Mesh Configuration

## From AREDN Documentation

**Self-Healing**

**Alternate paths remain if one node drops out**

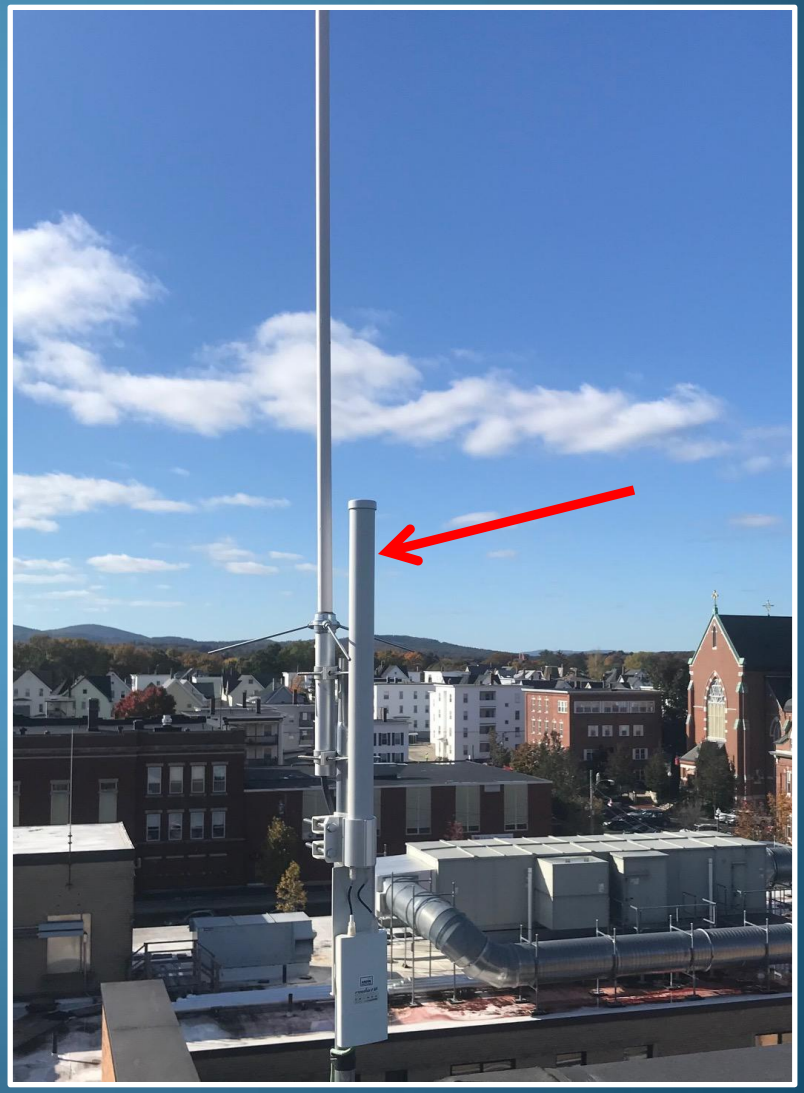


# Mesh Nodes – Omni Antennas

## First MVDN Sites Established in 2020 – Still Operating

### Elliot Hospital

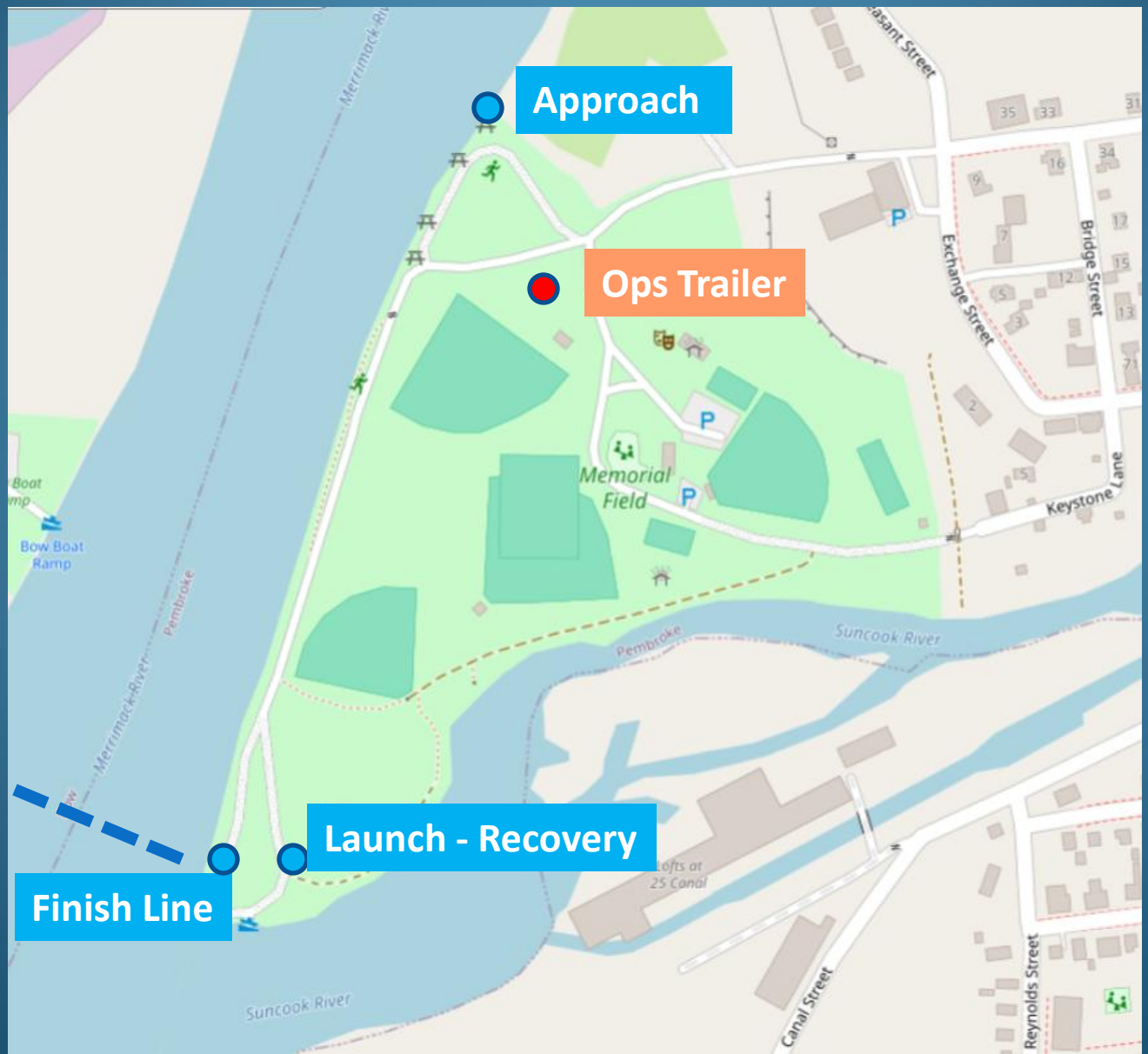
### Catholic Medical Center



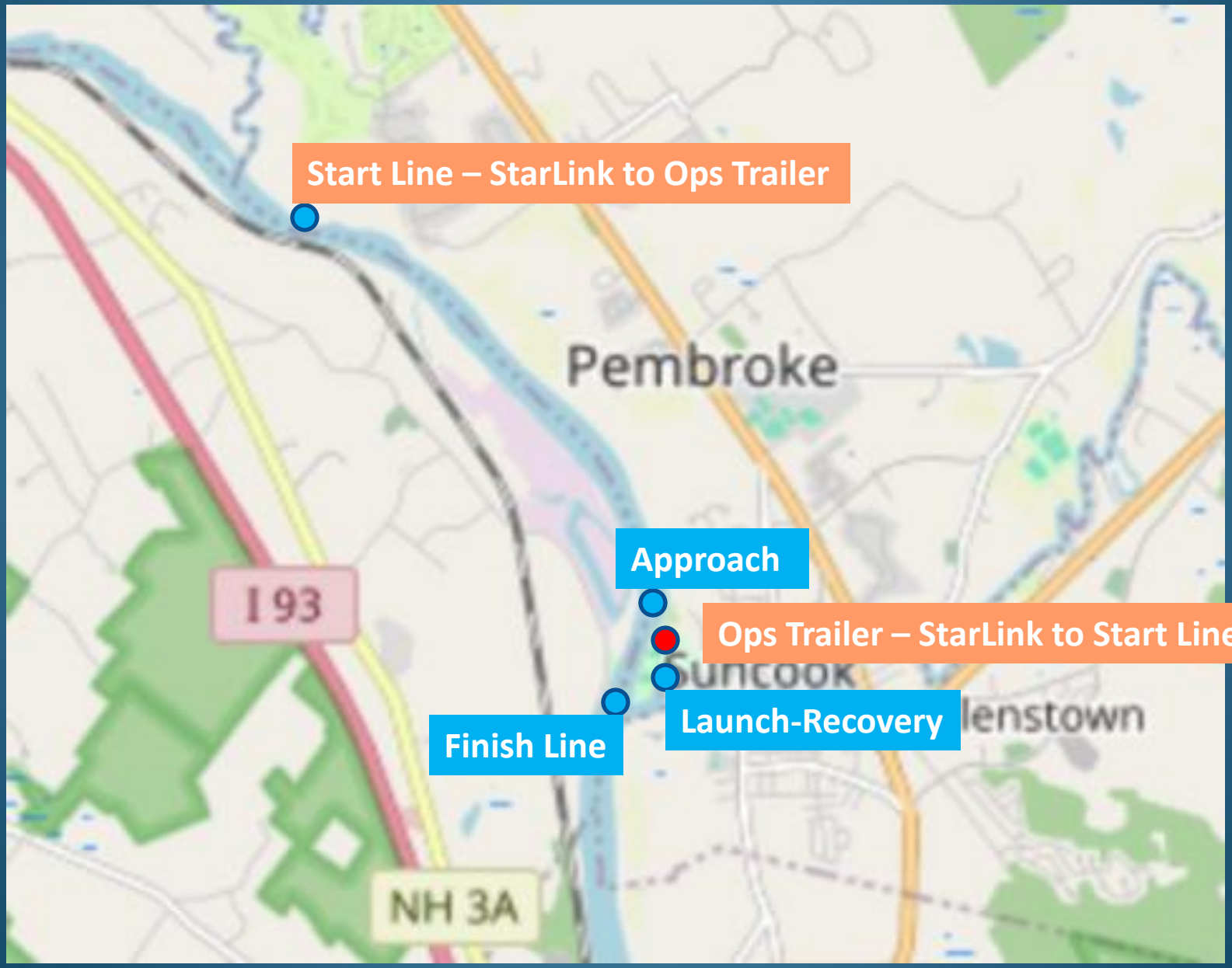
# Mesh at 3 Sites with Omni Antennas on South Uncanoonuc Mt to Share Internet Connections

# New Hampshire Championships Regatta

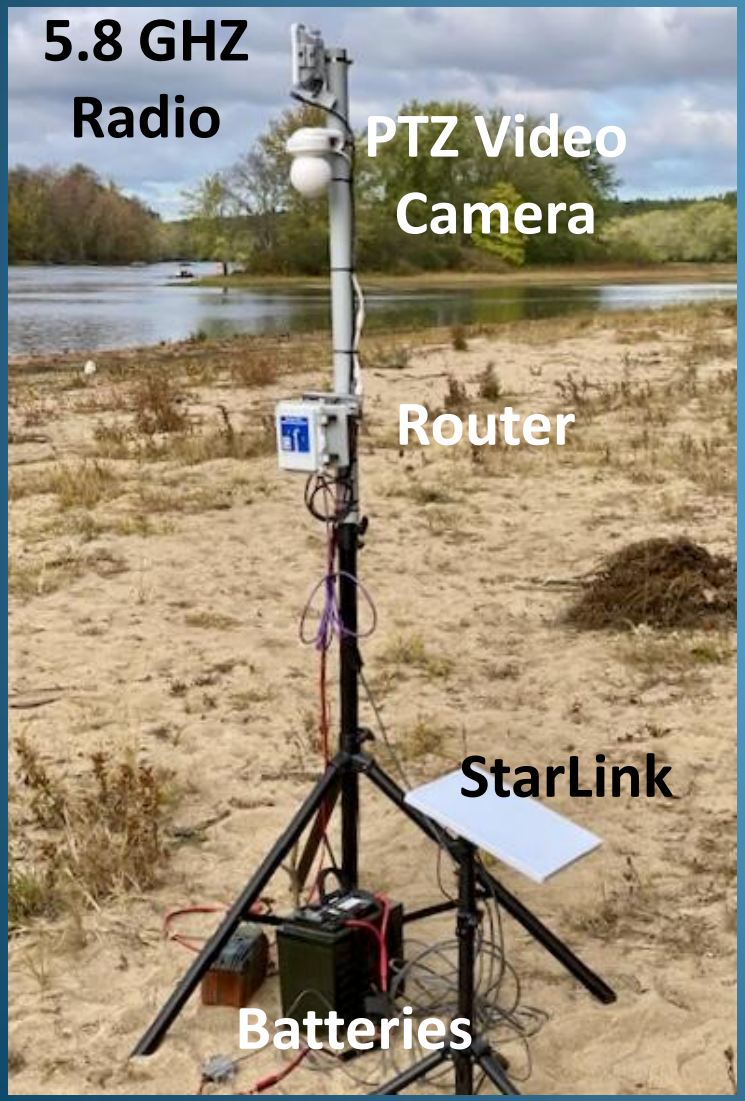
## 5.8GHz Mesh with Video for Situational Awareness on the Merrimack River

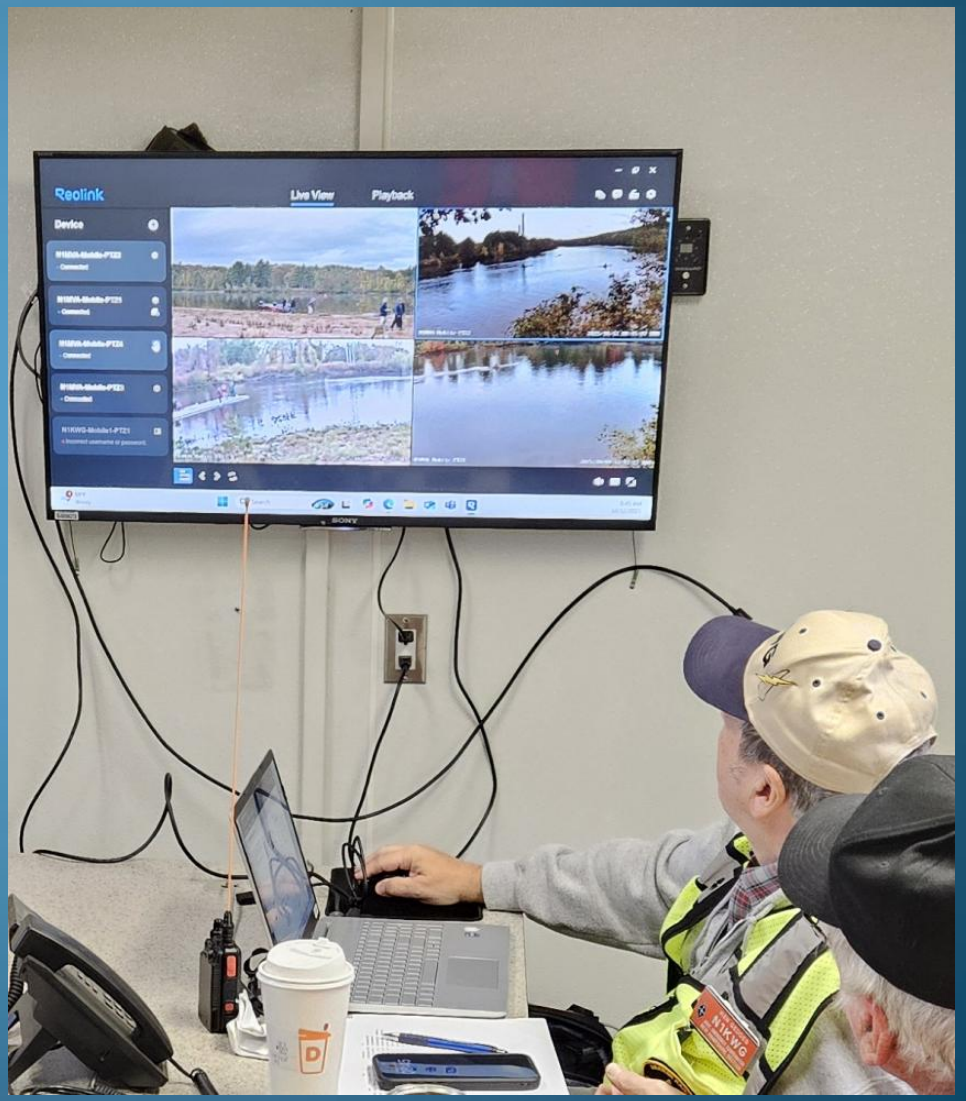


# Regatta Start Line Connected to Mesh Via StarLink



# Left - Camera Node & StarLink at Regatta Start Line
# Right - Streaming Video in Operations Trailer

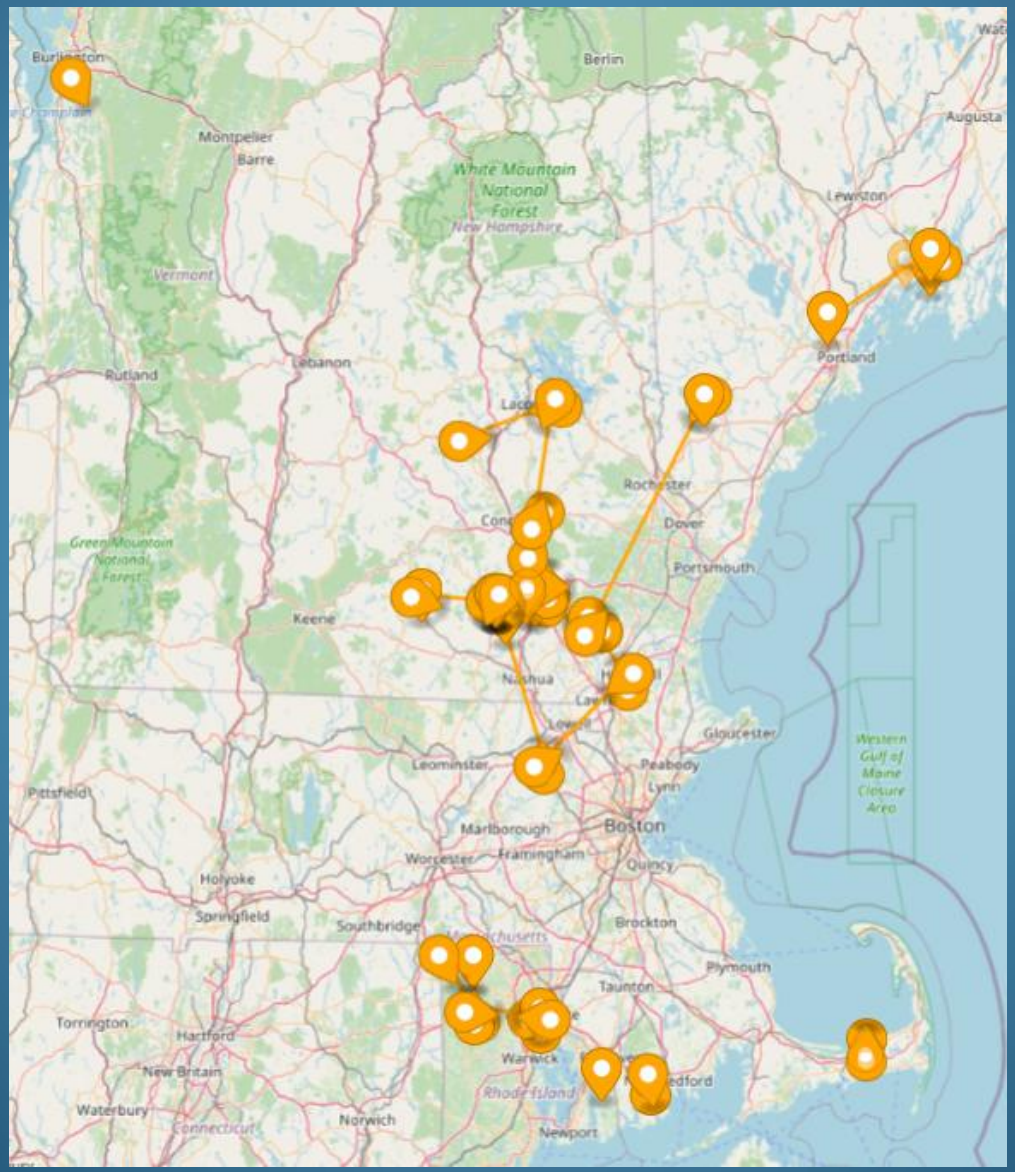


# AREDN IN NEW ENGLAND

# AREDN Map
## Internet Tunnel Nodes in New England

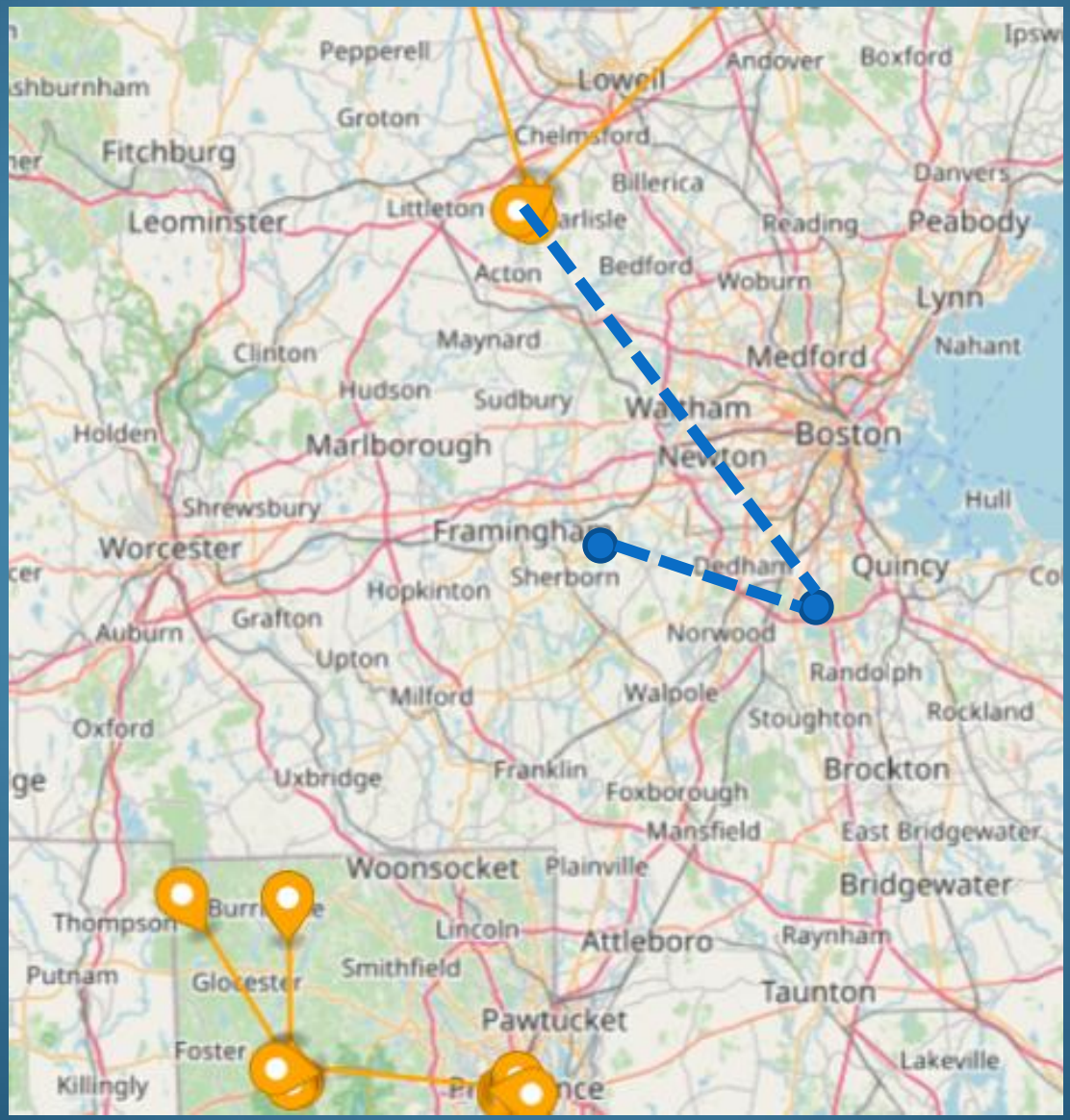
# AREDN Map
# 5GHz RF Nodes in New England



# AREDN Map
## Merrimack Valley Digital Network 5GHz Nodes

# AREDN Map

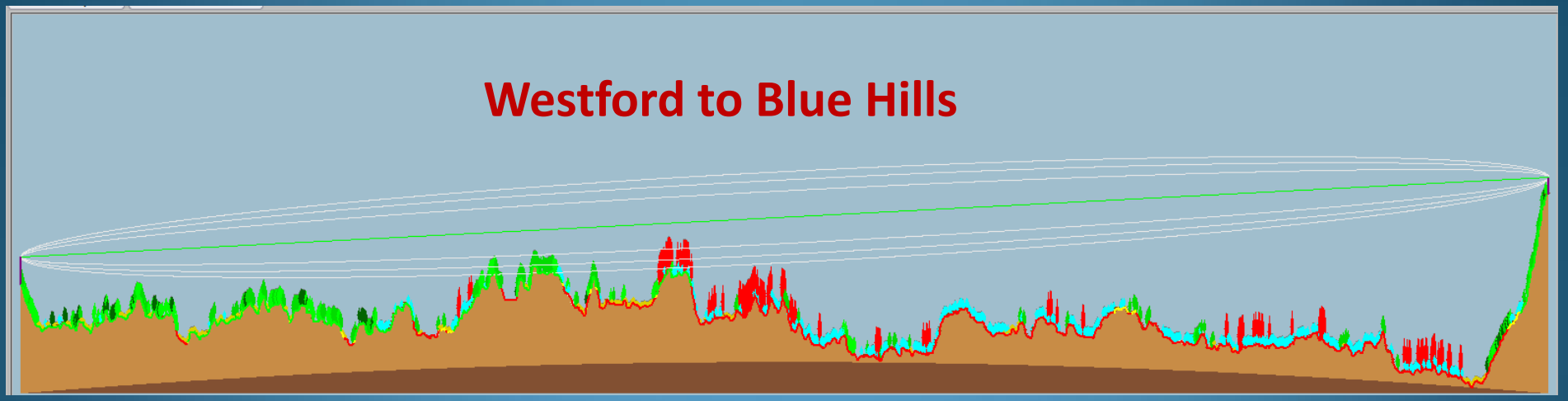
## Theoretical 5GHz Link to NEST via Blue Hills



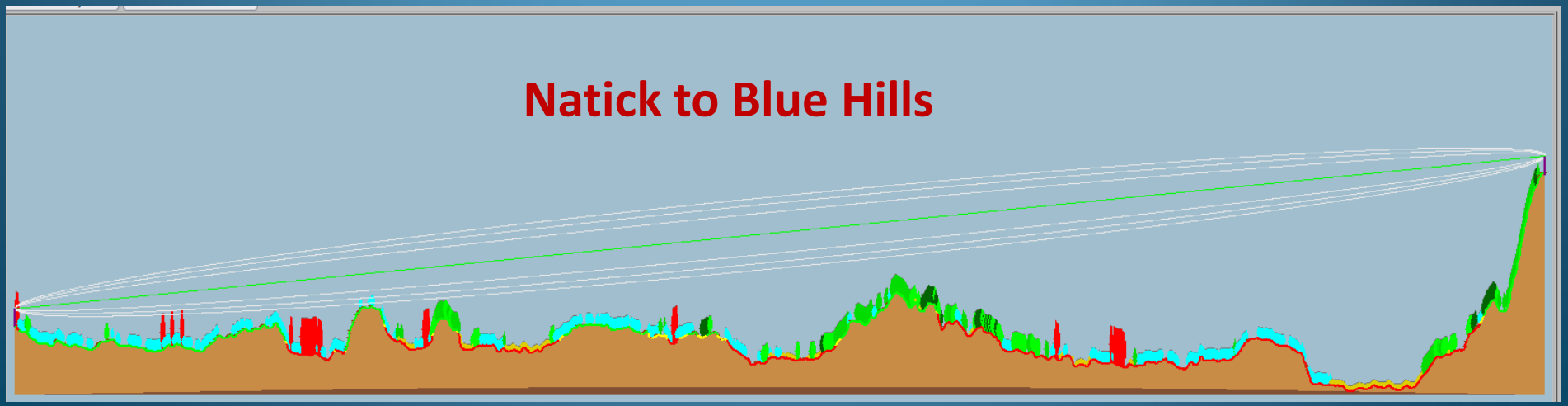
# 5GHz Propagation Plots Promising

## Still need to account for local conditions

Westford to Blue Hills

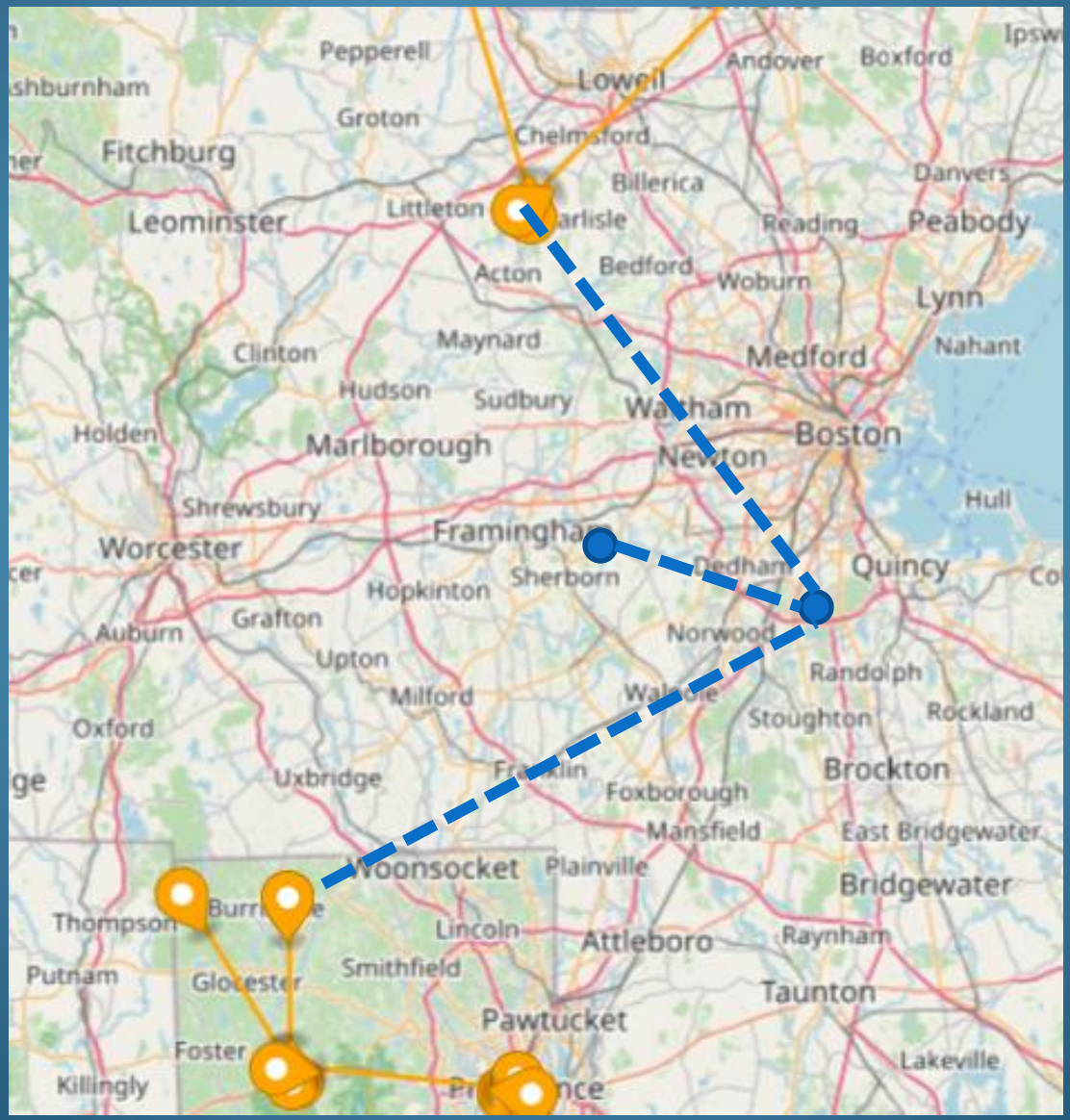


Natick to Blue Hills



# AREDN Map

## Theoretical 5GHz Link to Rhode Island Net via Blue Hills



# WHAT CAN WE DO WITH AREDN?

# What can we do with AREDN?

## Access AREDN Router with Browser and IP Phone

Connect over WiFi with a Browser

# What can we do with AREDN?

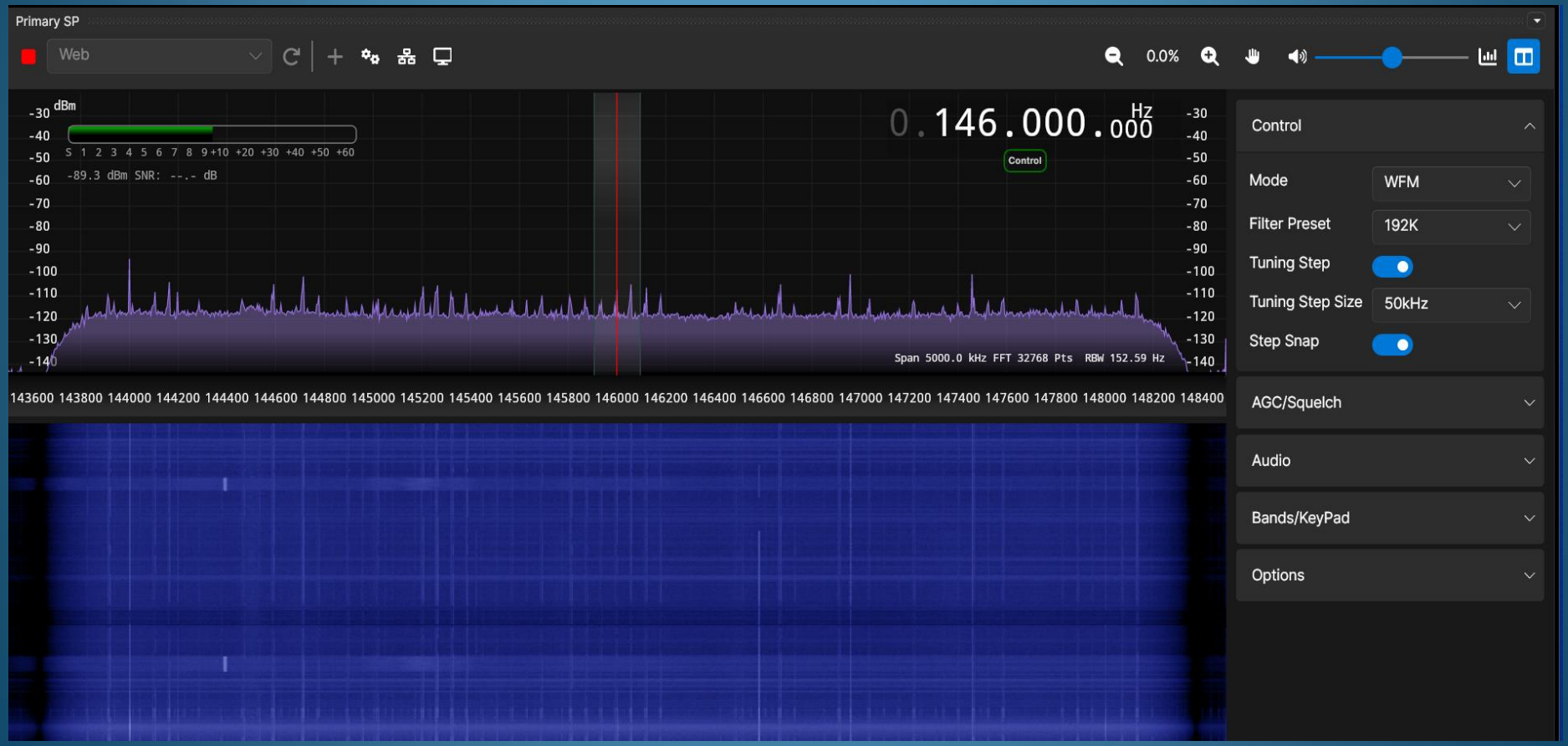
## Router Ports: WAN, LAN, and Device-to-Device to Backbone

# What can we do with AREDN?

## Add an SDR Spectrum Analyzer


**Network SDR Spectrum Analyzer**

# Network SDR on South Uncanoonuc Mt
# Remote Spectrum Analysis and Interference Monitoring



# What can we do with AREDN?

## Remote VHF / UHF Radio Operation via Computer

# What can we do with AREDN?

## Remote HF Radio Operation

# What can we do with AREDN?

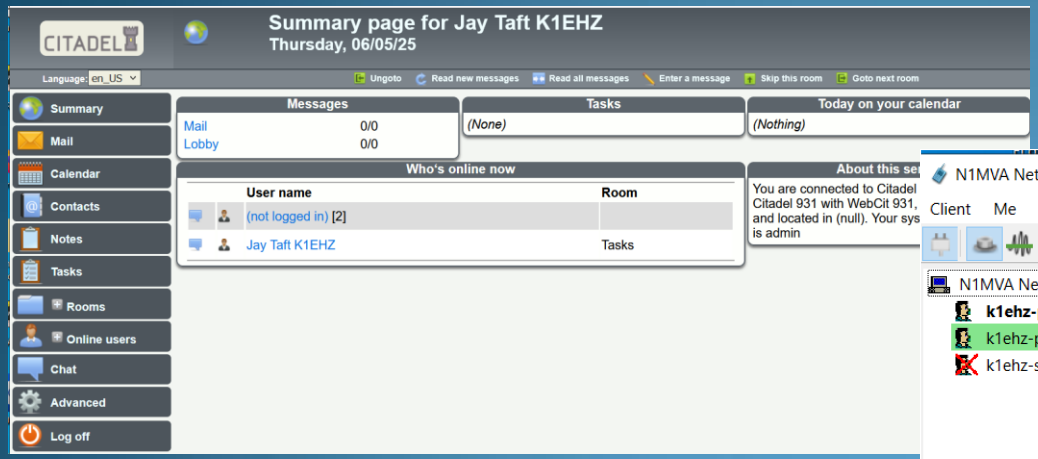
## DMR Repeater Link to c-Bridge and DMR Hotspot

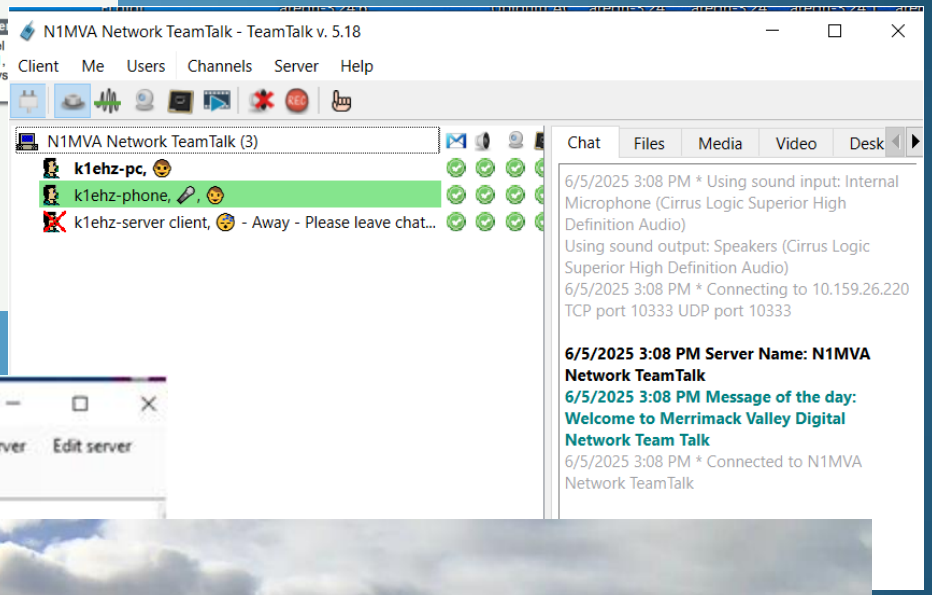
# Real-time Network Performance Dashboard

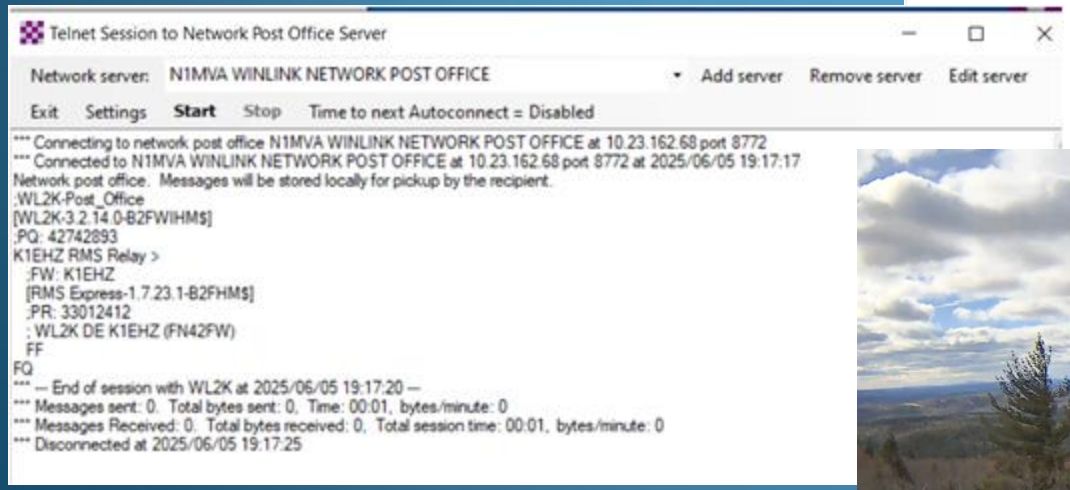
## Bryan King KX1B – Program, Fred Kemmerer AB1OC -- Platform

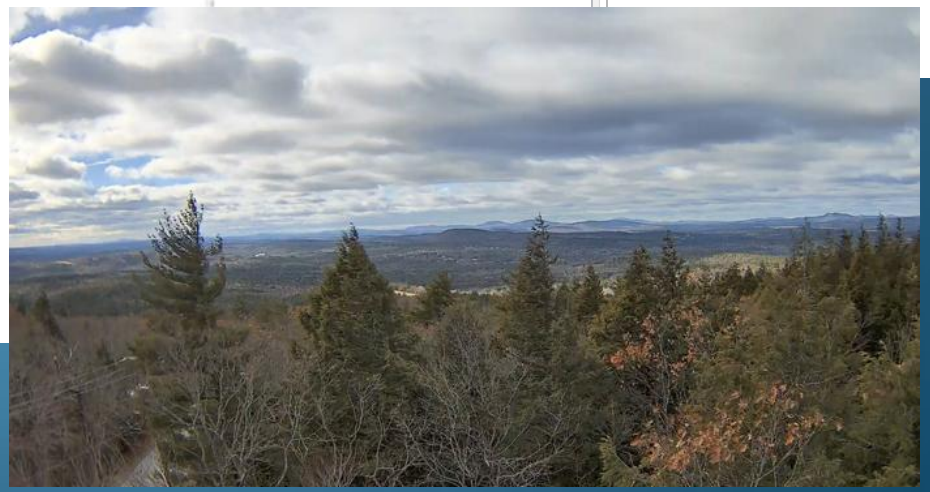
## Prometheus to collect data from nodes, Grafana to graph data

# Services: Citadel Email, TeamTalk Conferencing, Winlink Network Post Office, Streaming Video



# HOW TO GET STARTED WITH AREDN

# Start Learning with Basic Network Configurations

- Classroom Networking
- Networking from Home
- Global Access through a Supernode

# Getting Started for $35

## AREDN 2.4GHz RF Node & Tunnel Router

## HamXpo 2023 Workshop by Jim Garner KC1BHD

## Great Club Workshop Project


GL.iNet GL-AR300M16-Ext Portable Mini Travel Wireless Pocket Router - WiFi Router | OpenWrt | 2 x Ethernet Ports | OpenVPN/Wireguard VPN for Public & Hotel Wi-Fi | USB 2.0 Port | 2 x External Antennas

Visit the GL.iNet Store

4.3 ★★★★½ (1,937) | Ask questions and search reviews

Overall Pick

**300+ bought** in past month

-17% $33.99

List Price: ~~$40.99~~

FREE Returns

Save 10% at checkout Shop items ›

With **Amazon Business**, you would have **saved $395.11** in the last year. Create a free account and **save up to 16%** today.

| | |
|---|---|
| **Brand** | GL.iNet |
| **Model Name** | Shadow |
| **Special Feature** | Access Point Mode, Internet Security, Remote Access |
| **Frequency Band Class** | Single-Band |
| **Wireless Communication** | 2.4 GHz Radio Frequency |

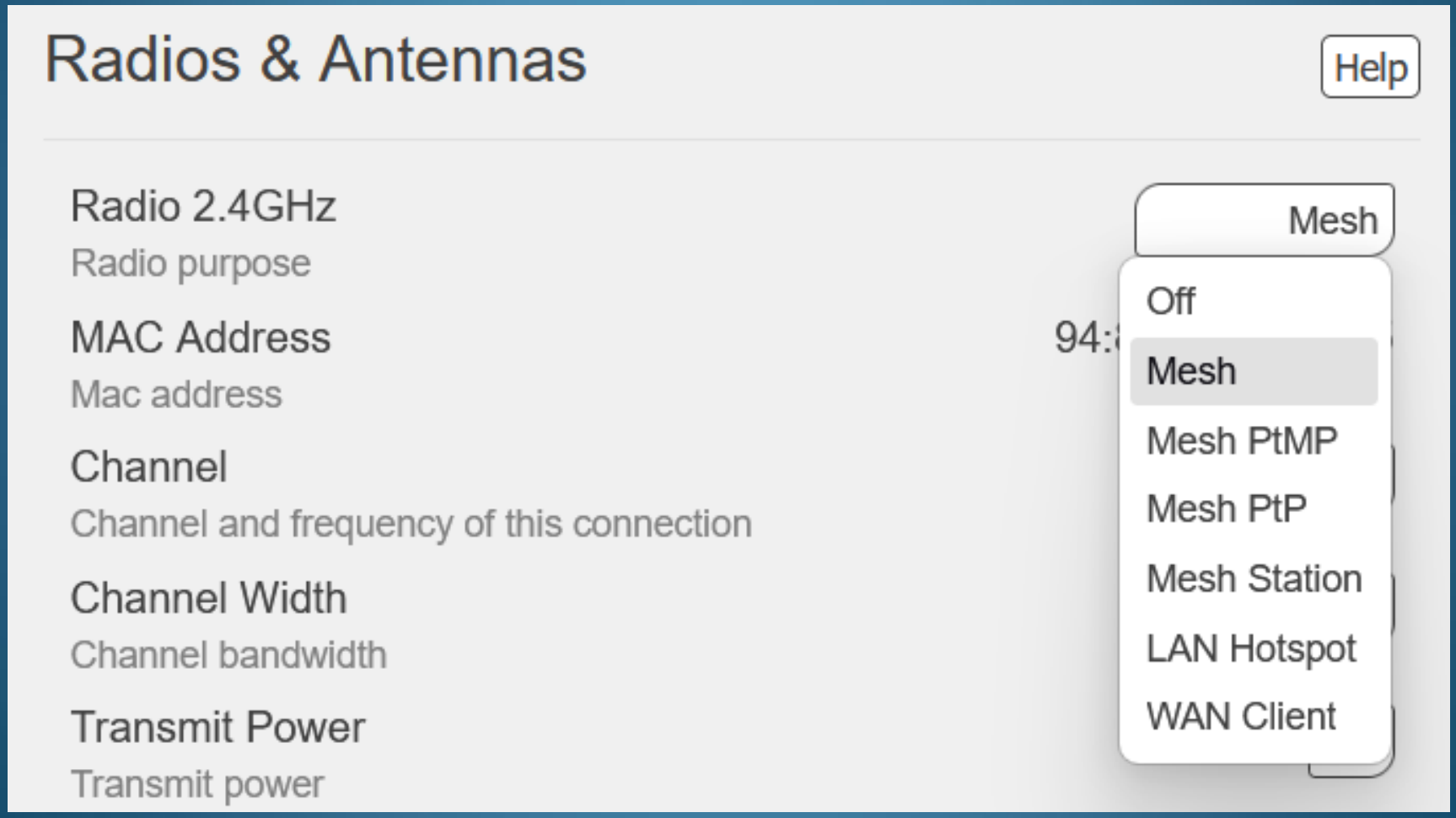
See more

# 2.4GHz GL.iNet with 12dB Yagi

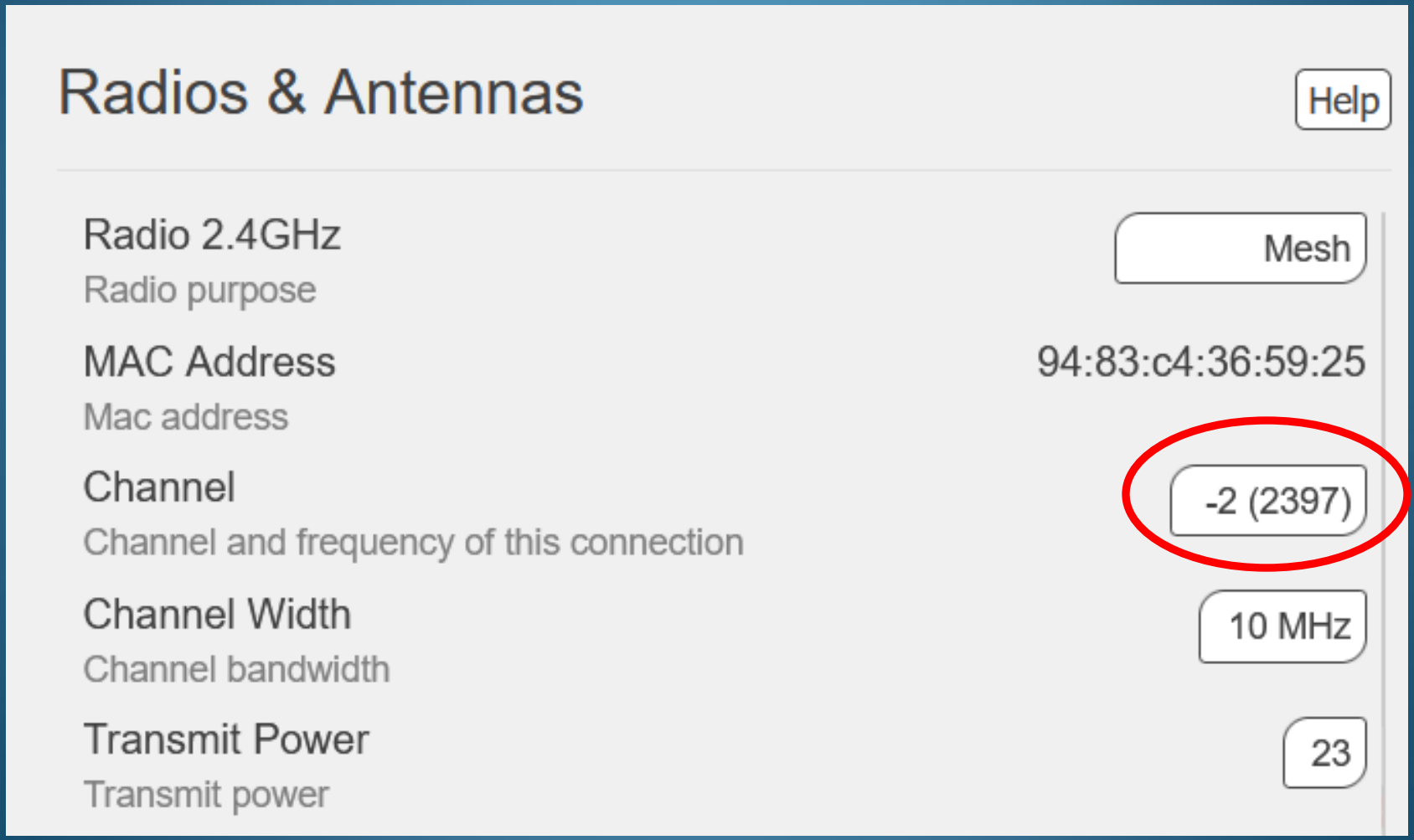
## USB Powered – EIRP* ~750mw


* Effective Isotropic Radiated Power

# GL.iNet Has All AREDN Capabilities



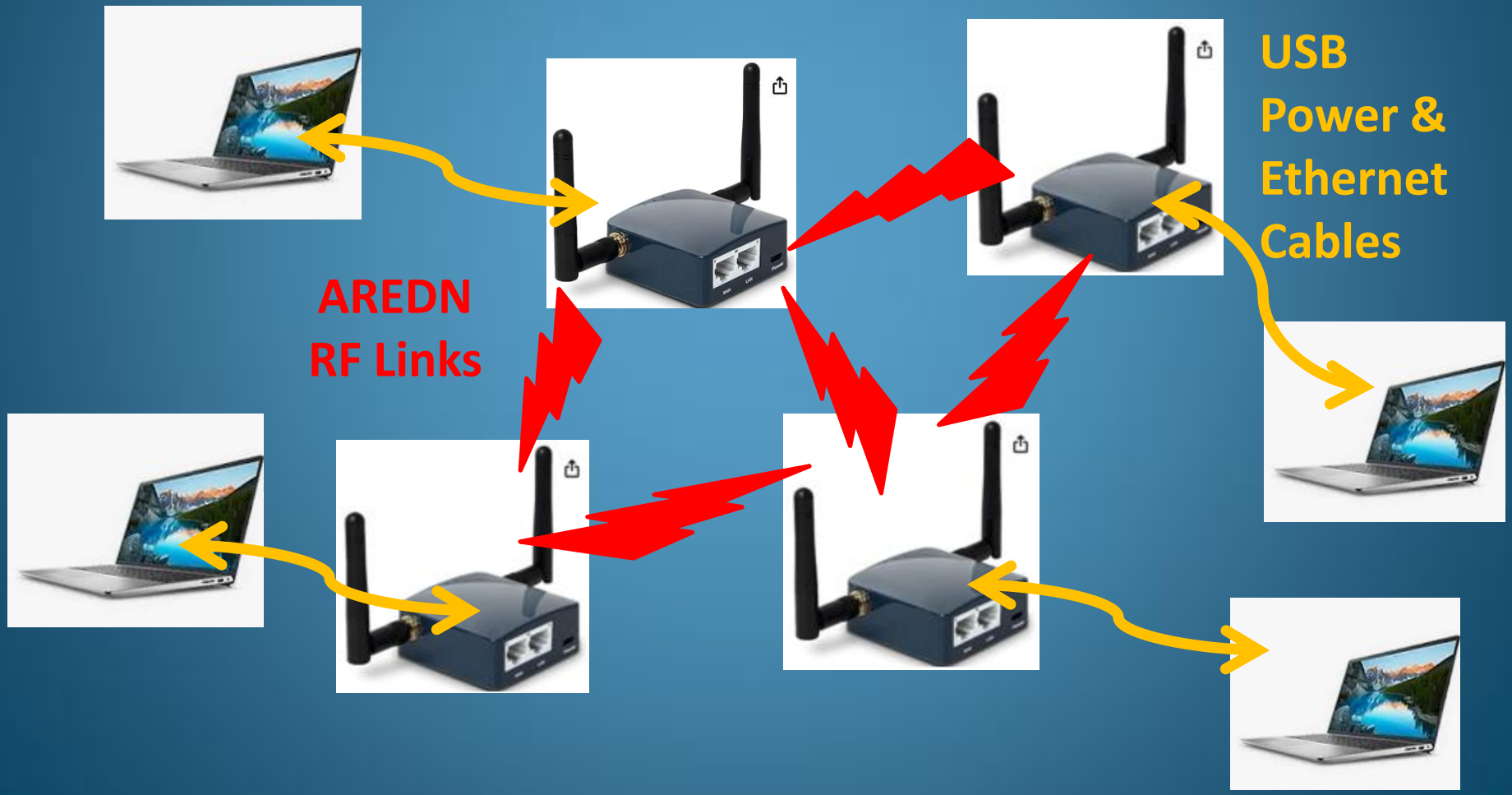
# Two Ham Channels in 2.4GHz Band
## Ch -1 and Ch -2



# Classroom Network

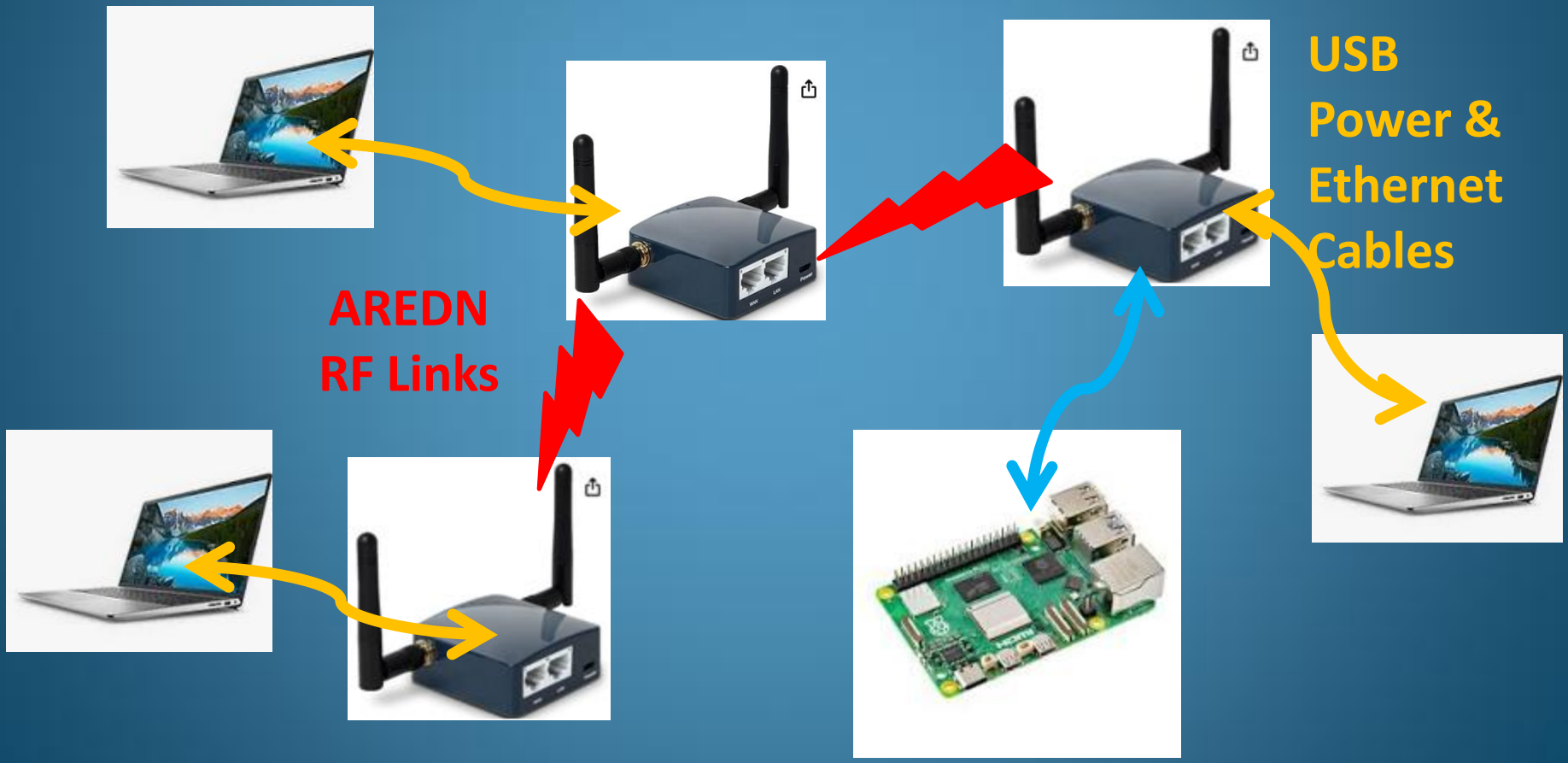
## 2.4GHz AREDN Mesh – WiFi Distances

### 5v USB Power and Ethernet Connections to Computer



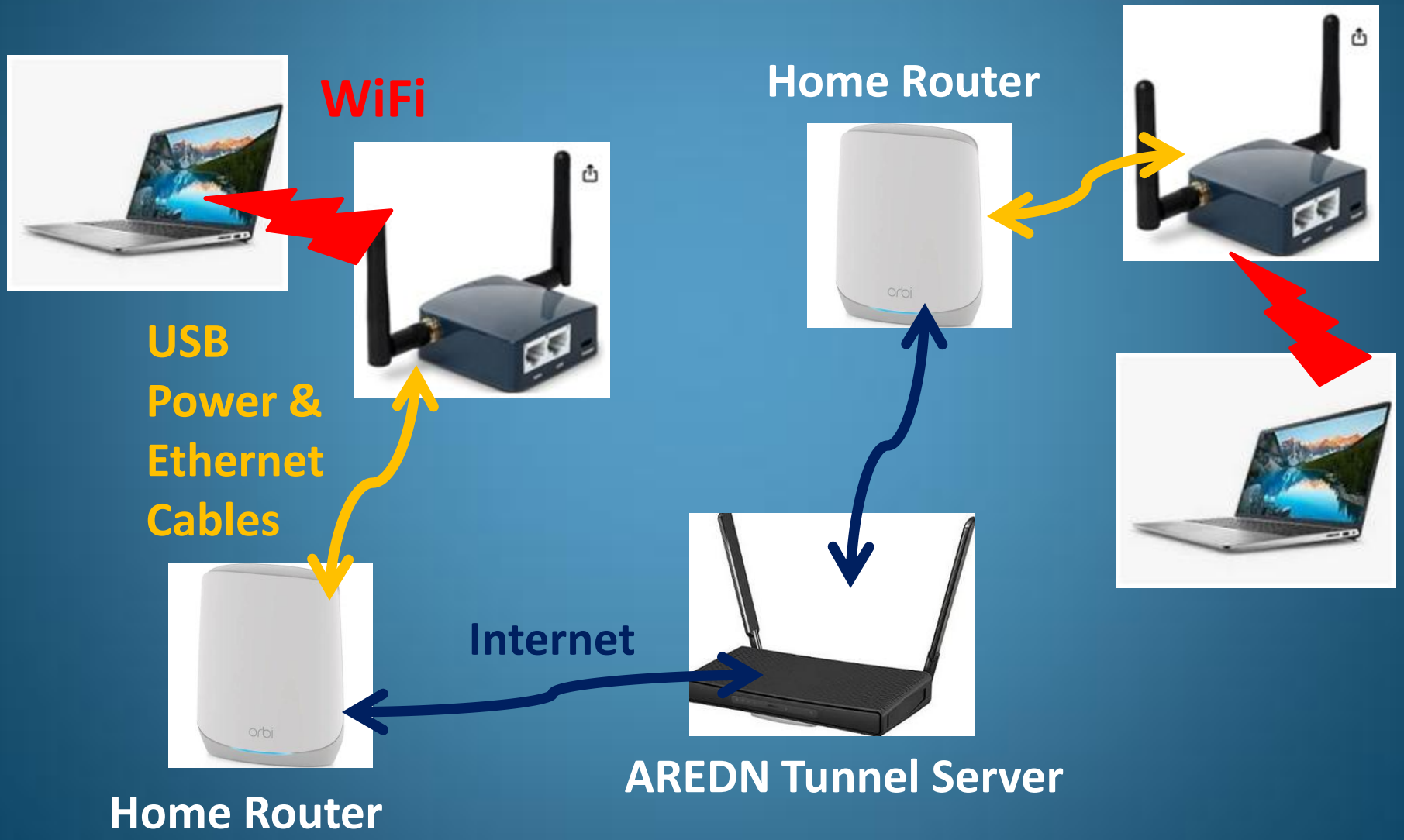
# Classroom Network

## Add Email, Conferencing on Raspberry Pi



# Network from Home

## Internet Tunnel Client in AREDN Firmware



# Global Access through a Supernode

## Internet Tunnel Client in AREDN Firmware

WiFi

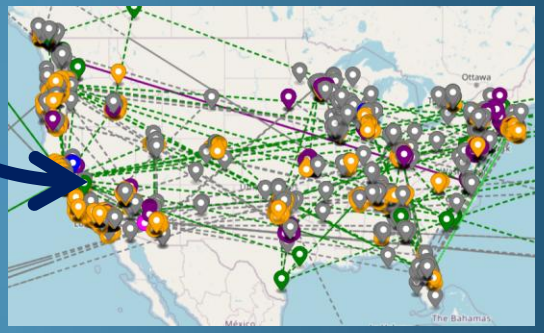
Cables

Home Router

Internet

AREDN Tunnel Server

Supernode



AREDN Global System

# Merrimack Valley Digital Network Public Access Links

- Public Network RF Dashboard
- Network Status Summary
- Power Monitoring Prototype
- ADS-B Air Traffic Monitor (AB1OC)
- Merrimack Valley Amateur Radio Association
- Amateur Radio Emergency Data Network
- AREDN Global Map

# AREDN as a Platform for 21st Century Amateur Radio

- High-speed microwave data network
- STEM opportunities
- Career preparation
  - AI Video Pattern & Event Recognition
  - Earth <-> Space Communications
- Merrimack Valley Digital Network
  & New England-wide microwave network
- Community service events
- EmComm voice & data applications
- Get started with a Technician license and a $35 router
- Open invitation to explore joining the network if you like

# Merrimack Valley Amateur Radio Association

## 501(c)3 Nonprofit Corporation

**We welcome members 18years +**
**with Amateur License wherever you live.**
**Students under 18 always welcome to participate as well.**

# Discussion