



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)



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	2.407	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?

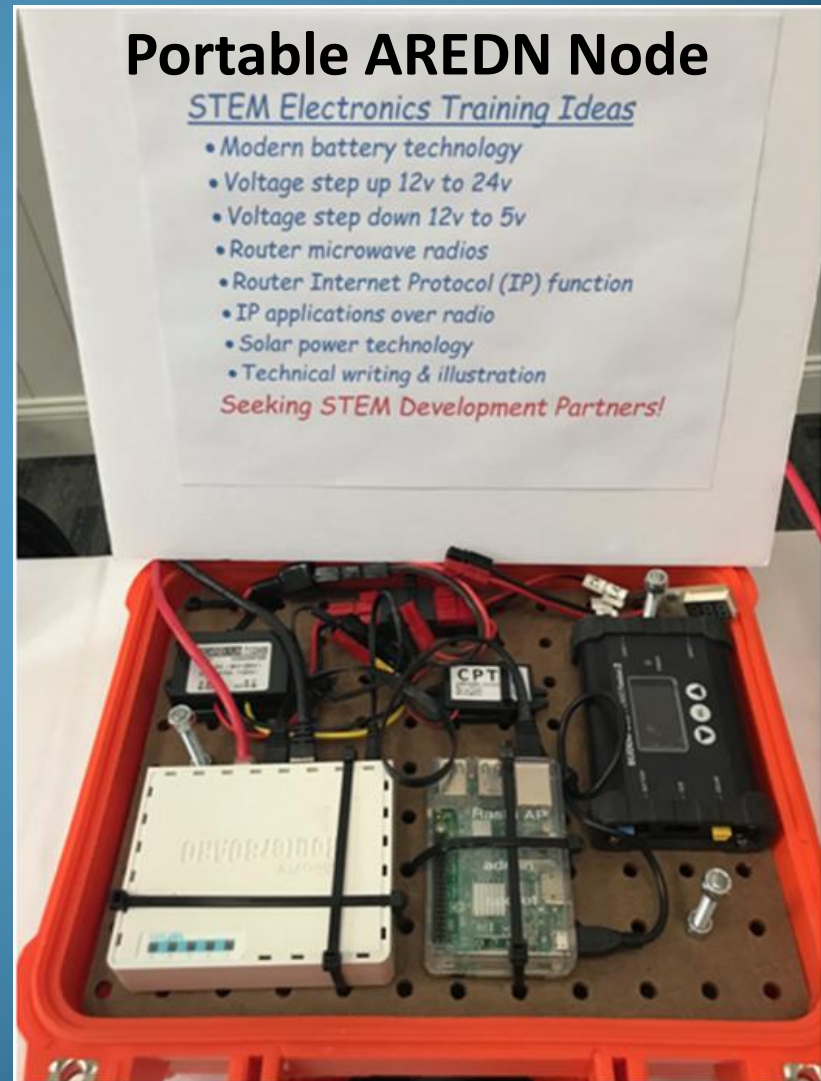
- **Broadband** – 5 to 40 MHz bandwidth on 5.8 GHz band
- **IP Based** – supports most internet applications
 - VOIP Telephone
 - Email & Chat
 - Streaming Video, including AI event recognition (wild fire smoke)
 - Remote Data Sensors
 - Remote Radio Operation
- **Microwave radio** system independent 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



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

Career Directions

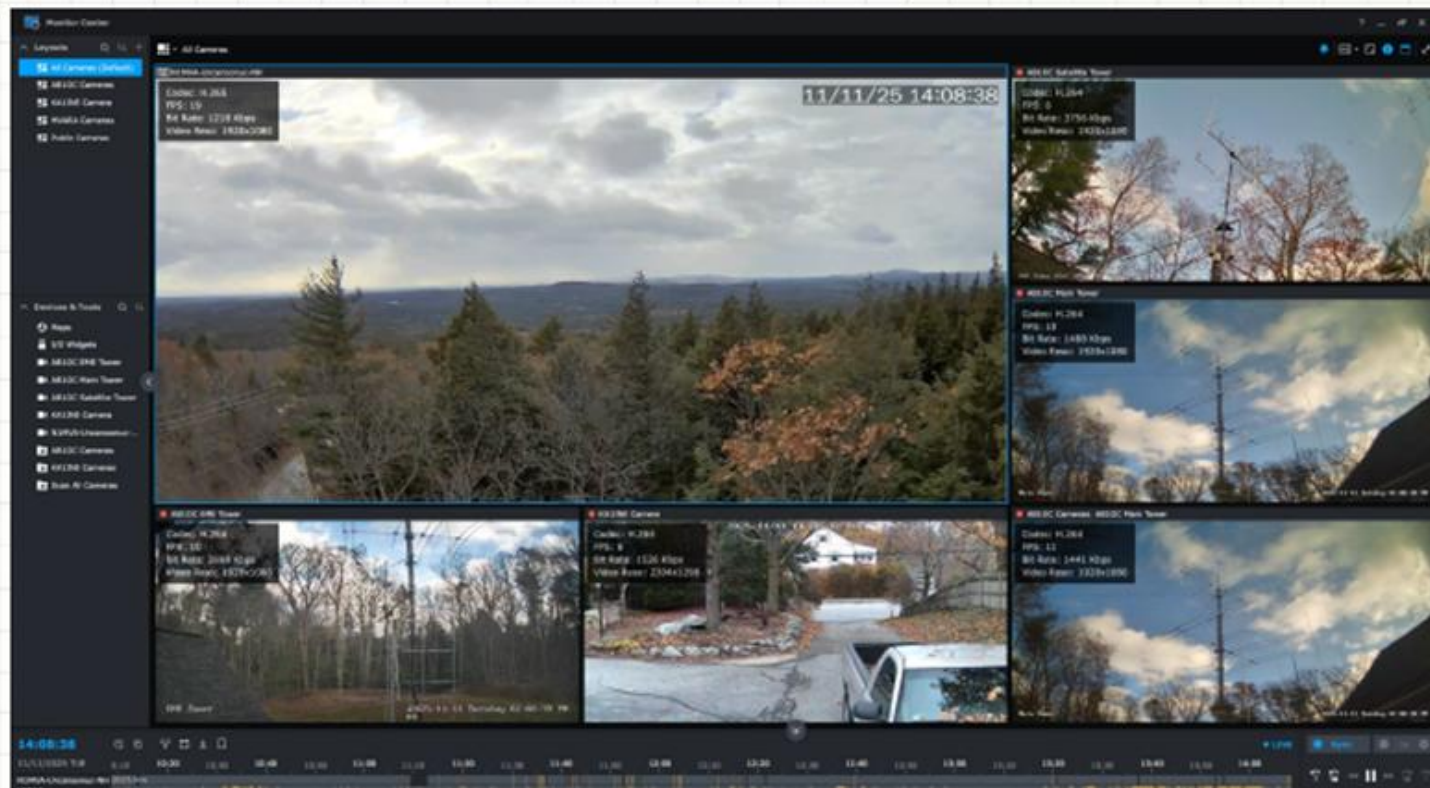
- IP Networks
- Microwave Radio Networks
- Video Systems
- **Artificial Intelligence Applications**
- **Earth <-> Space Communications**
 - For Science and Consumers
- Research
- Engineering
- Technology Applications
- Teaching
- Writing, Illustrating, Publishing
- General Broadcasting, Gaming

Artificial Intelligence Example

Streaming Video for Event Recognition – Wild Fires

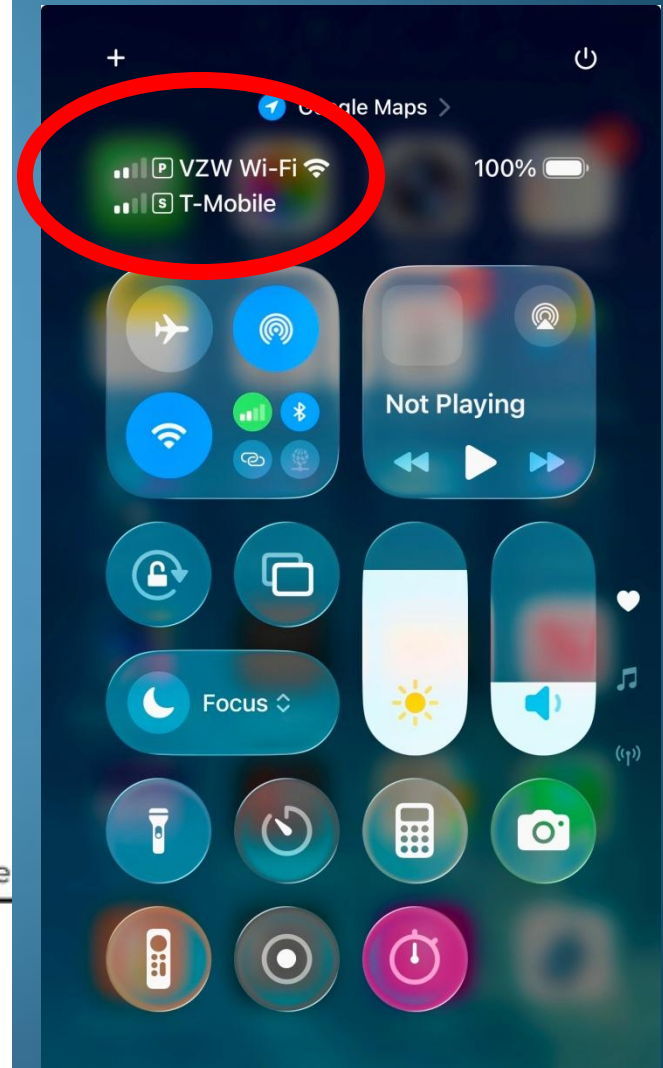
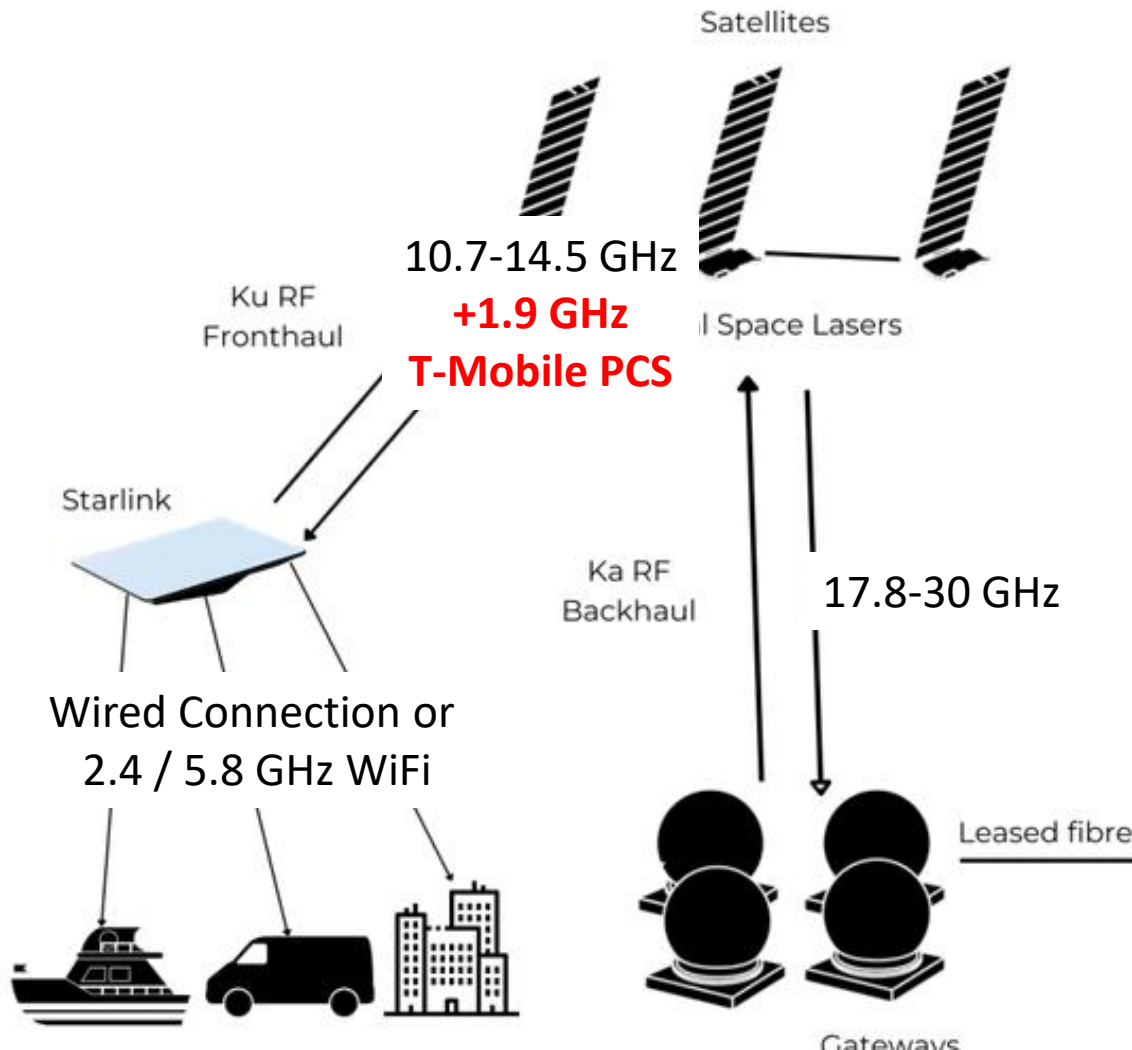
A View from AREDN...

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



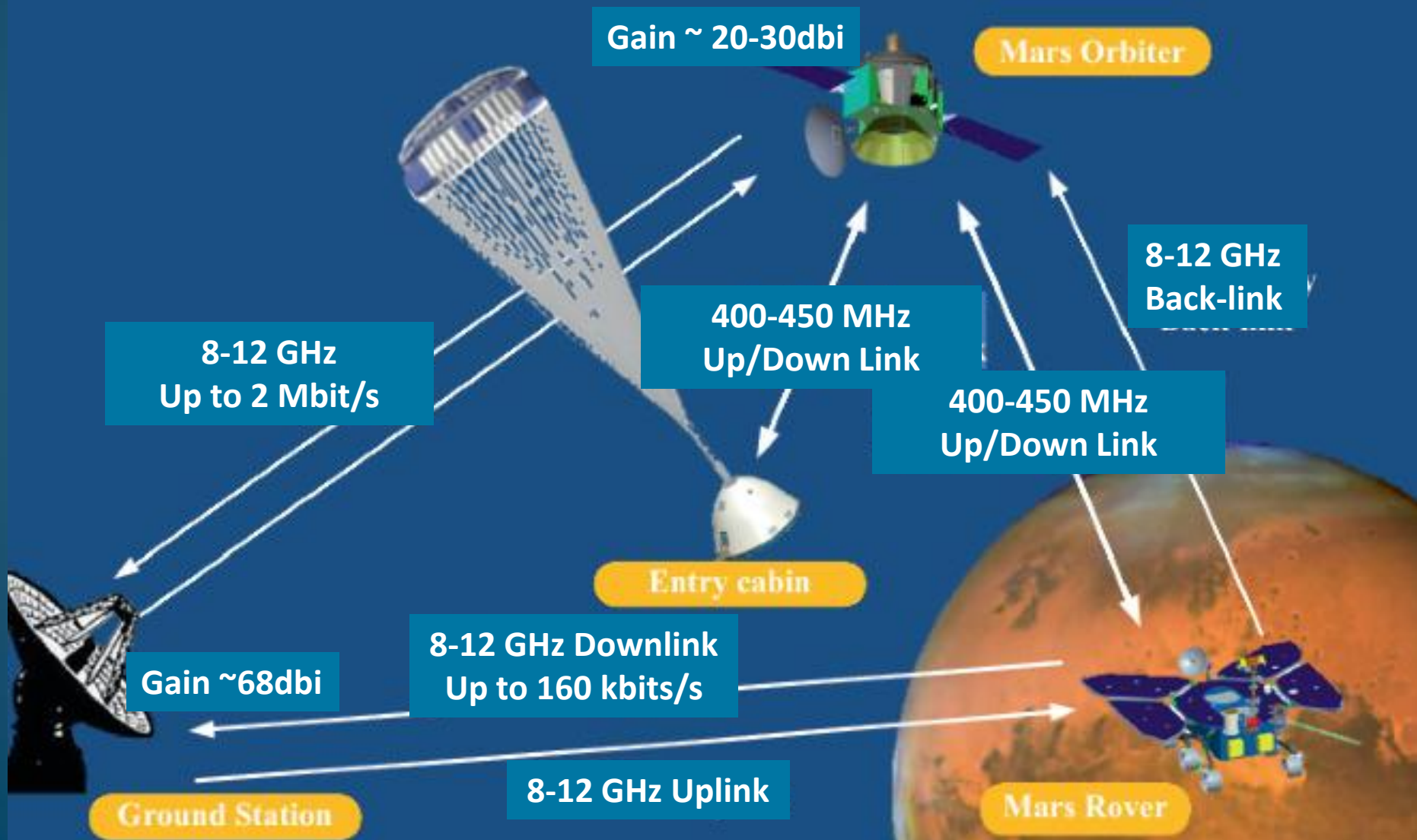
Earth <-> Space Communications Example

StarLink + T-Mobile Esim for Consumer Texting



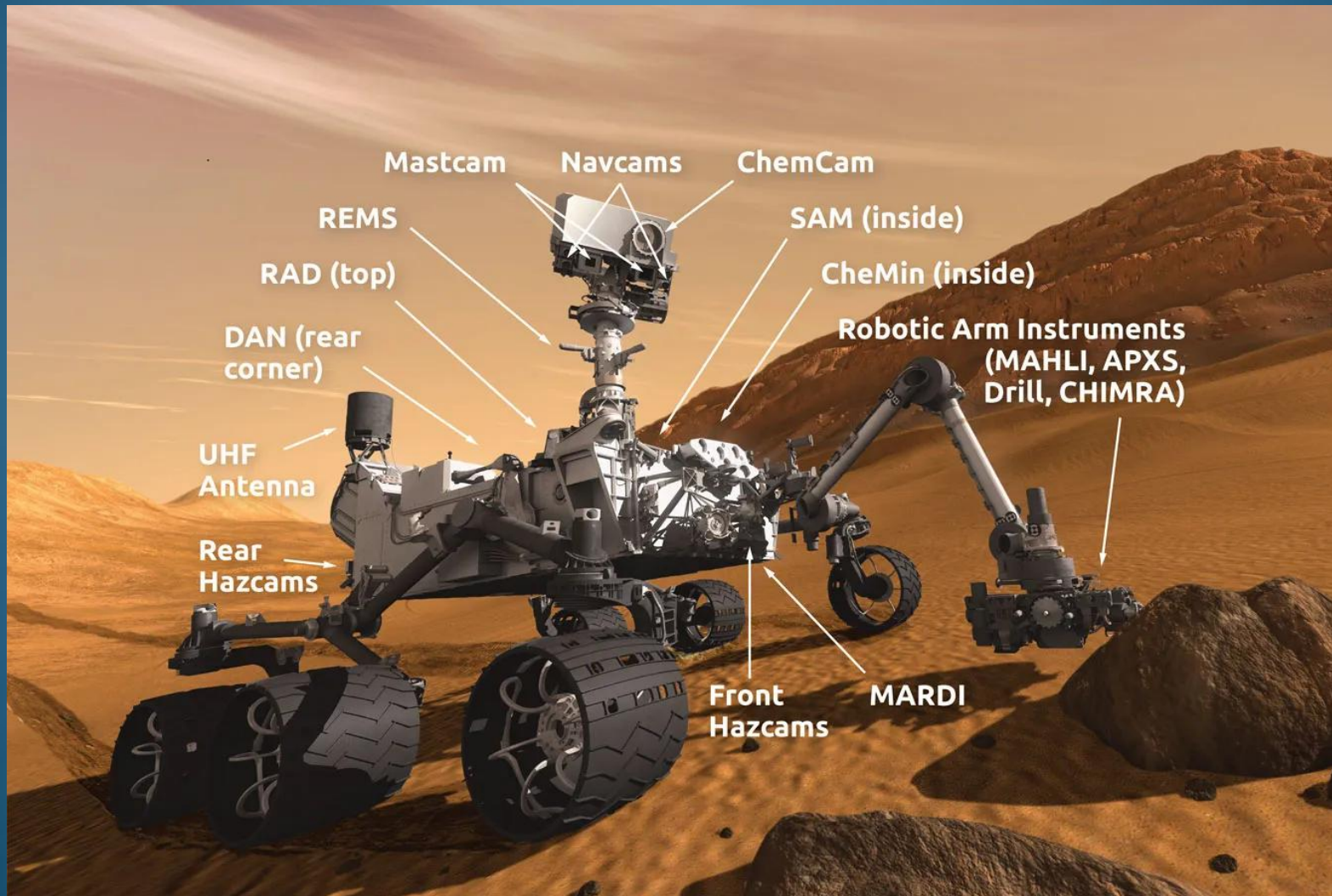
Earth <-> Space Communications Example

Mars Rovers

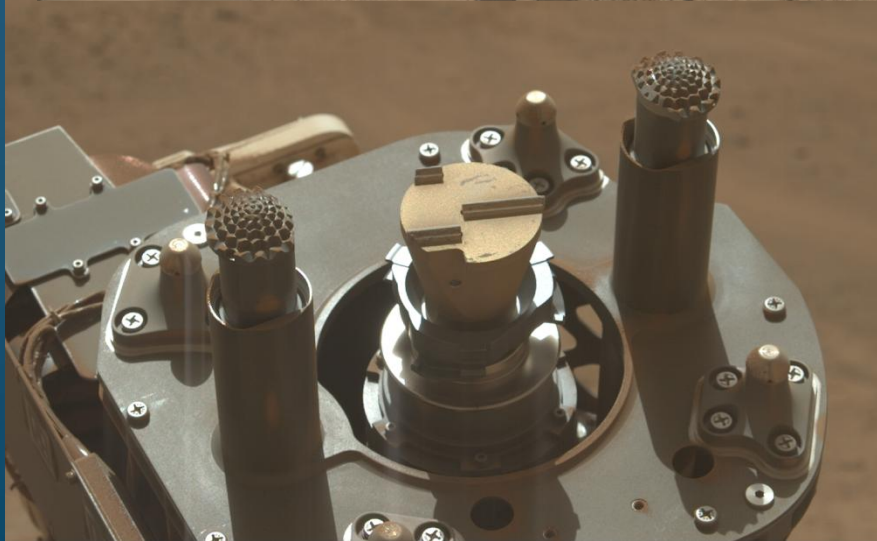


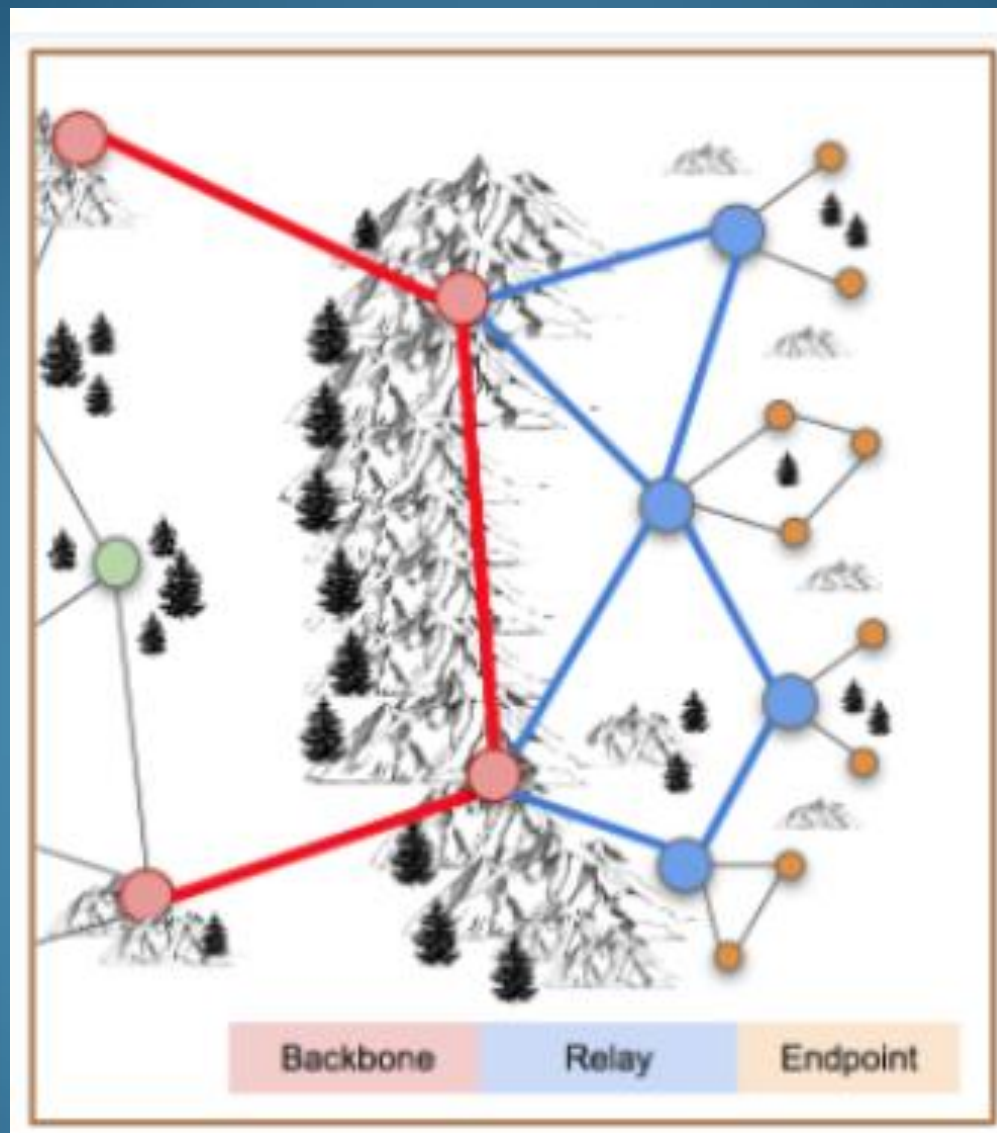
Curiosity Rover

Control and Data Recovery by Microwave Radio
Operating since August 5, 2012



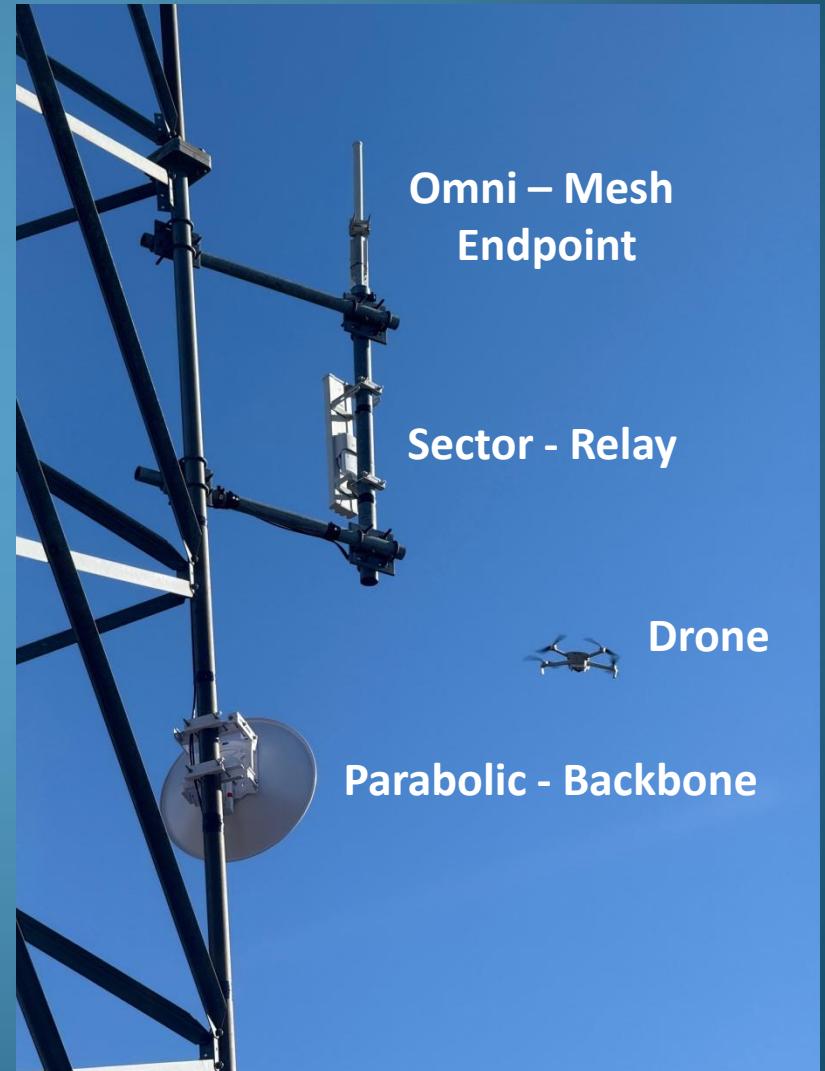
Perseverance Rover Images Sent via Microwave Radio





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



Single Path to c-Bridge - Internet is Primary Route

AREDN Adds Resilience to Linked Radio Systems

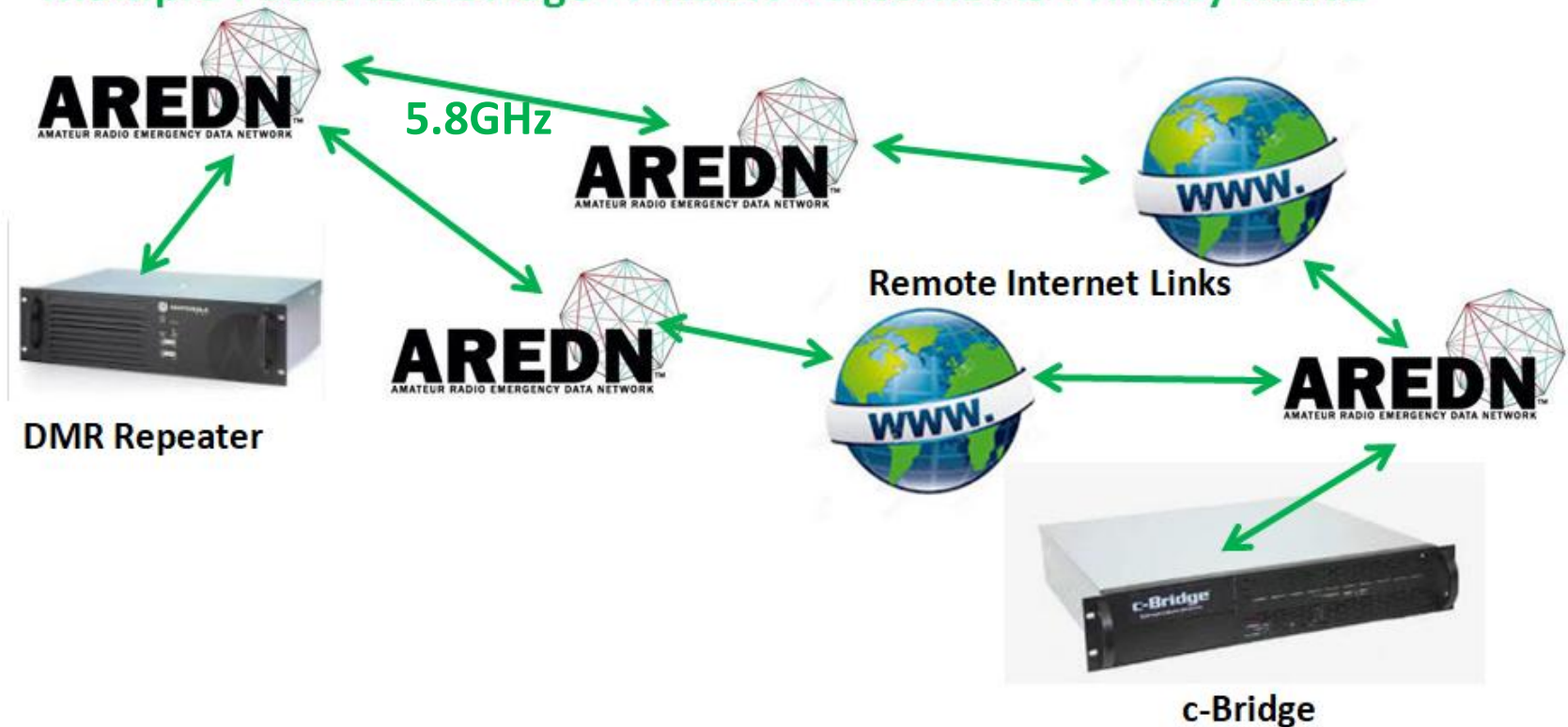
Example - DMR with Single Internet Path to the Common c-Bridge Server



Single Path to c-Bridge - Internet is Primary Route

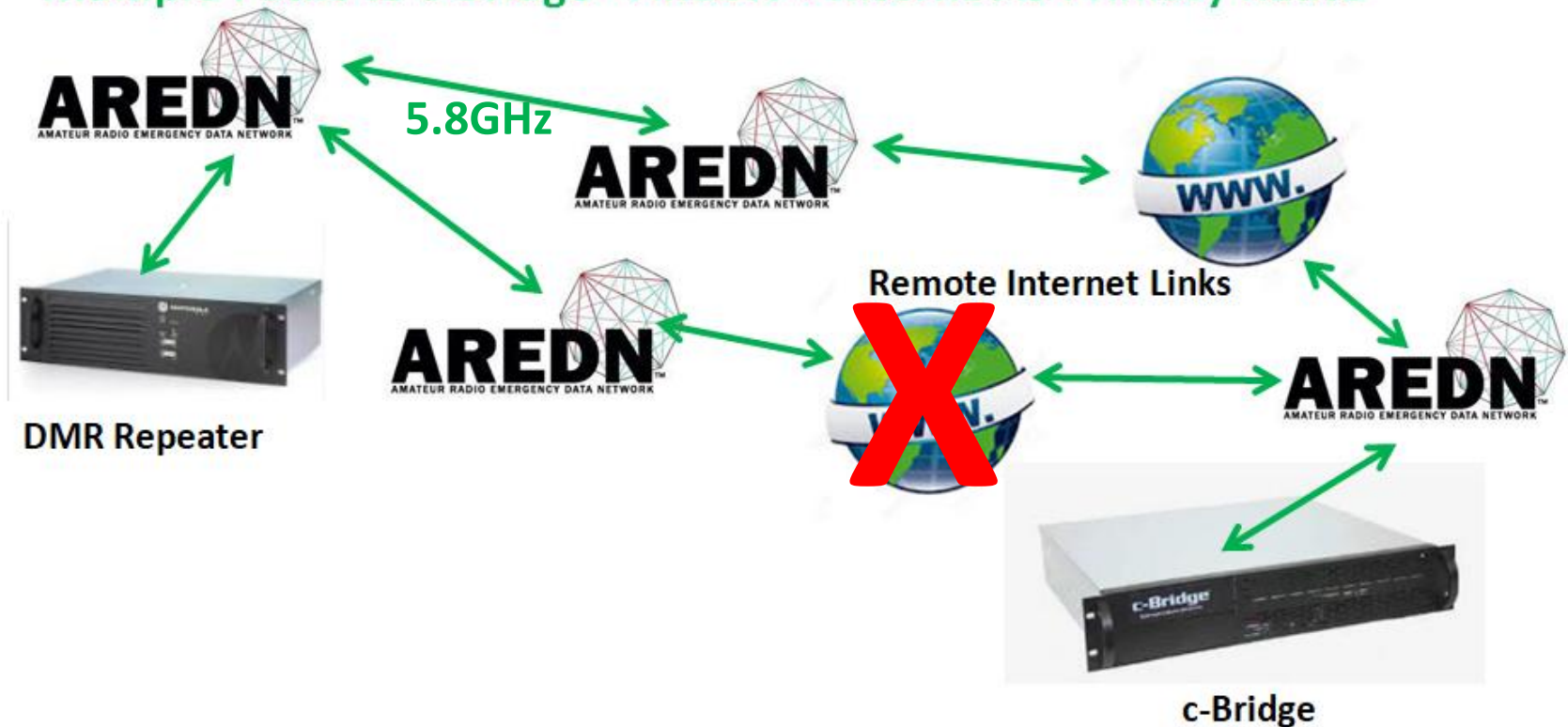
AREDN increases DMR resilience with a hybrid network having multiple internet access points and routes to the c-Bridge

Multiple Paths to c-Bridge - AREDN + Internet is Primary Route



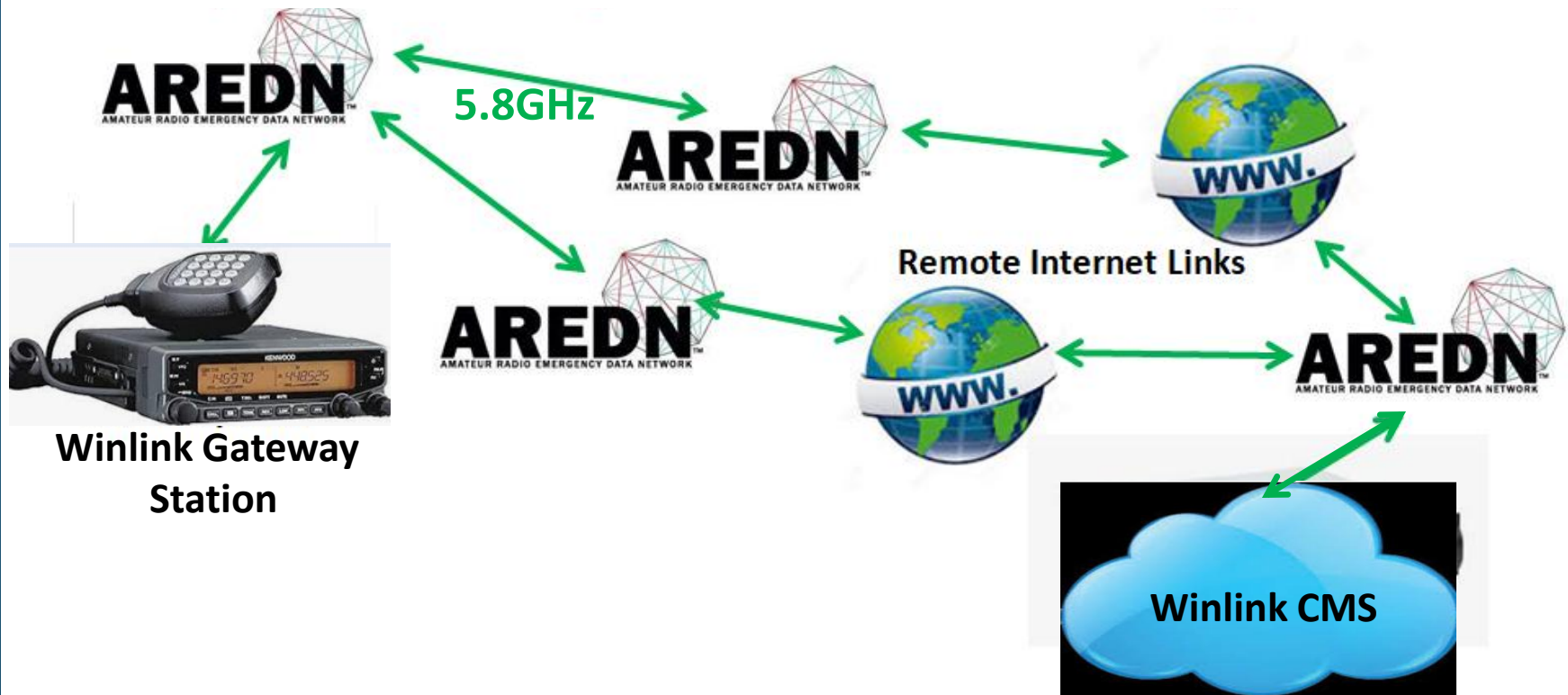
AREDN increases DMR resilience with a hybrid network having multiple internet access points and routes to the c-Bridge

Multiple Paths to c-Bridge - AREDN + Internet is Primary Route



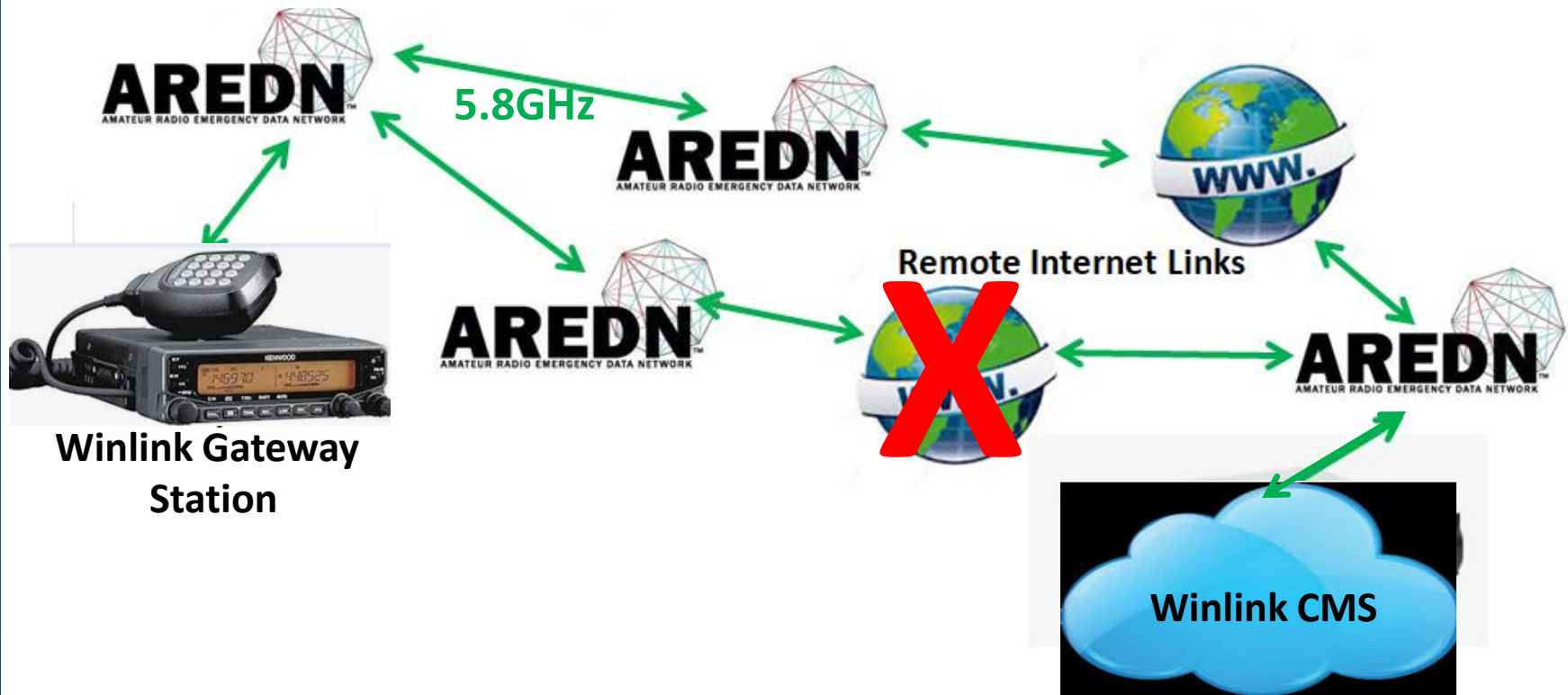
AREDN increases Winlink resilience with a hybrid network having multiple internet access points and routes to the Winlink CMS

Multiple Paths to the Central Messaging Servers – AREDN + Internet is Primary Route



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

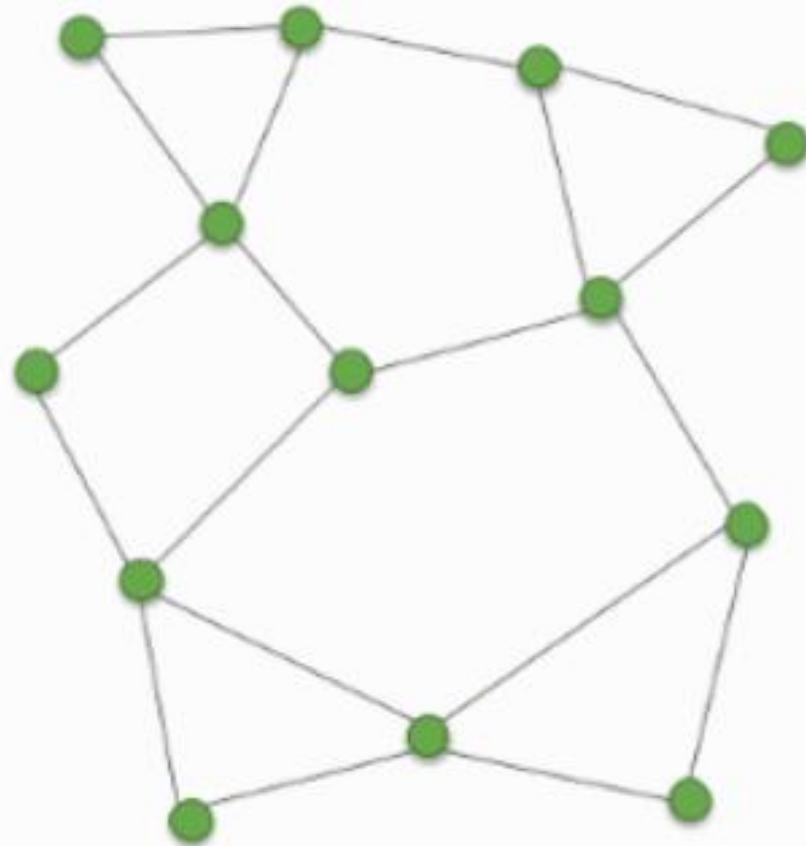
Multiple Paths to the Central Messaging Servers – AREDN + Internet is Primary Route



Mesh Configuration

From AREDN Documentation

All nodes on
same SSID, RF
channel and
bandwidth

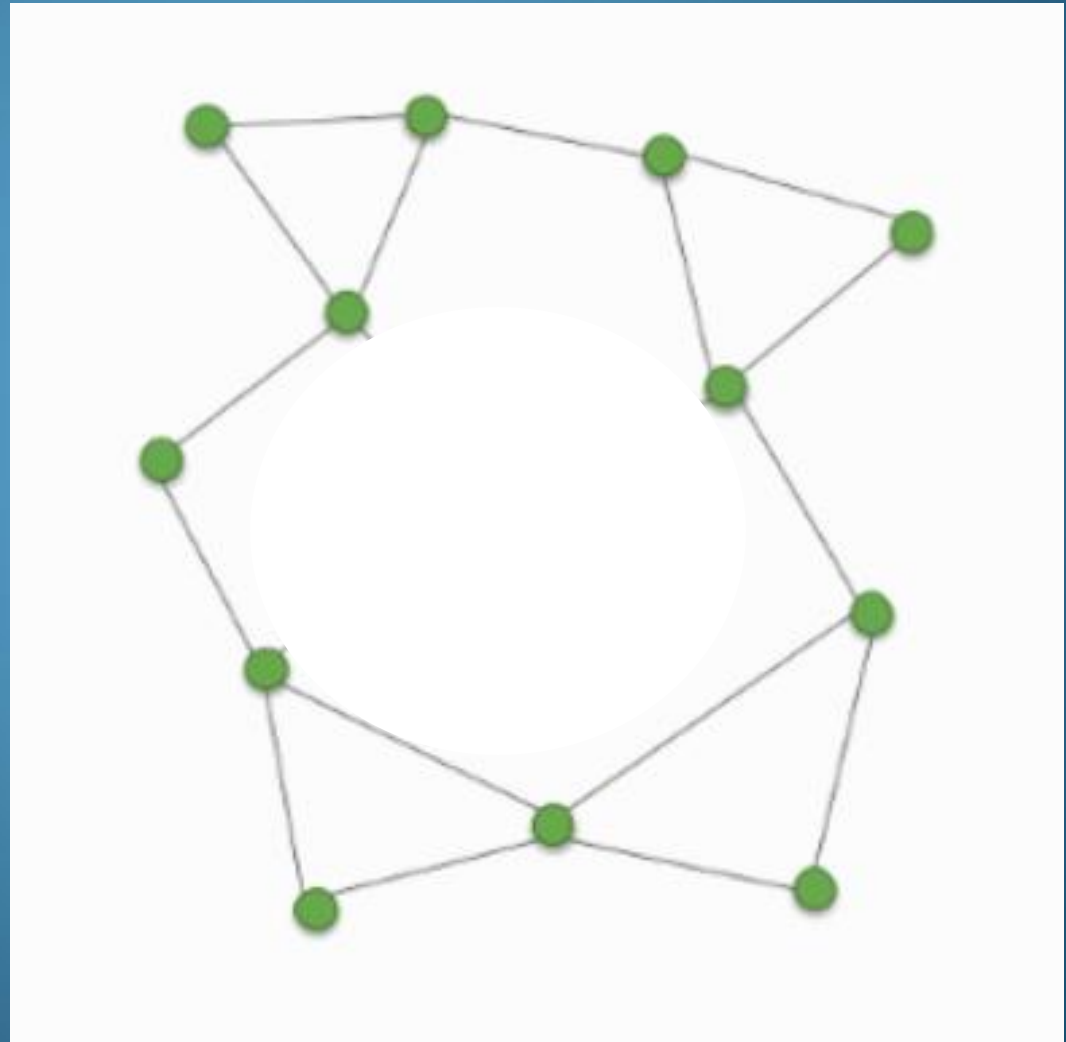


Mesh Configuration

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

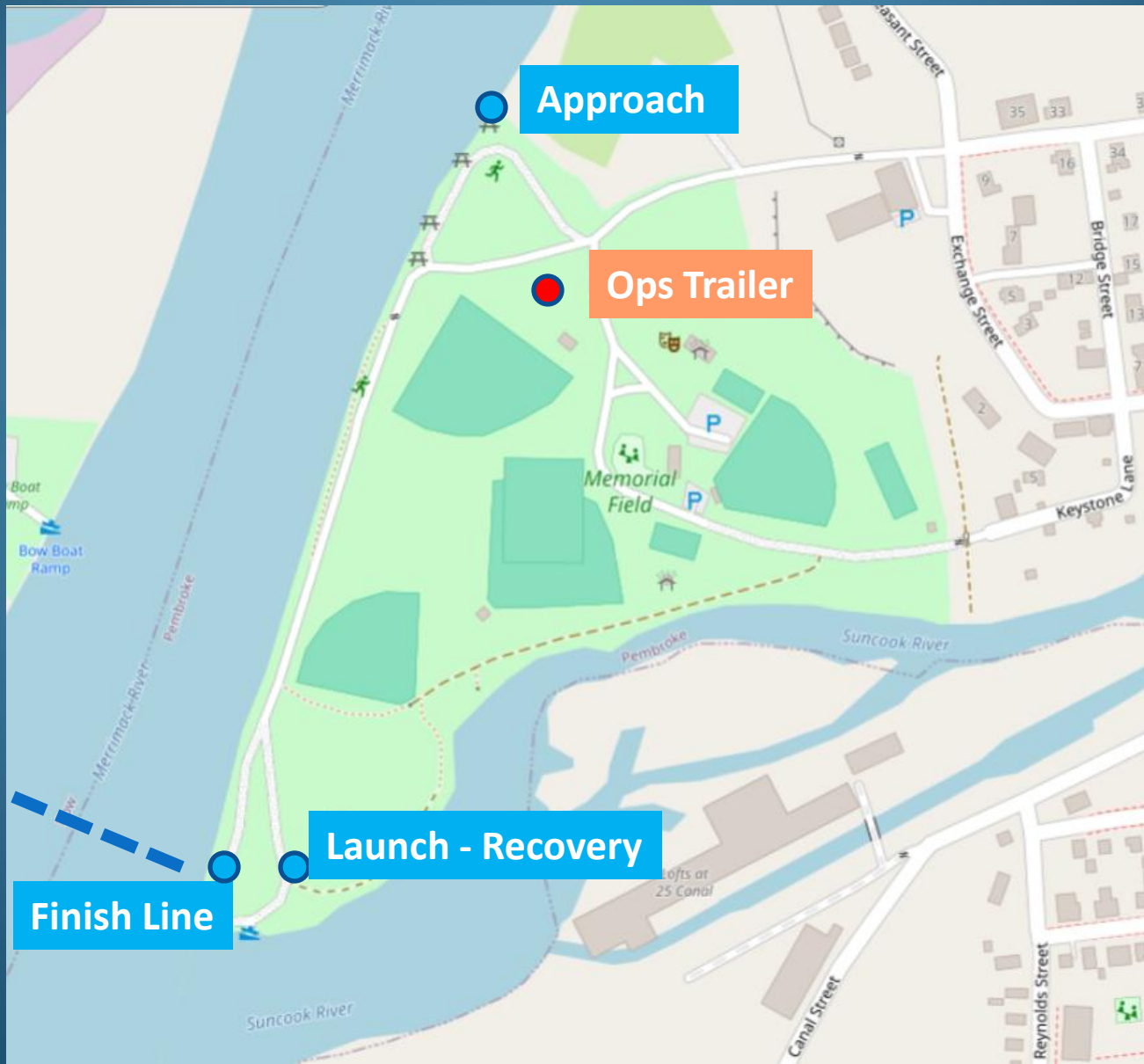


Mesh at 3 Sites with Omni Antennas on South Uncanoonuc Mt to Share Internet Connections

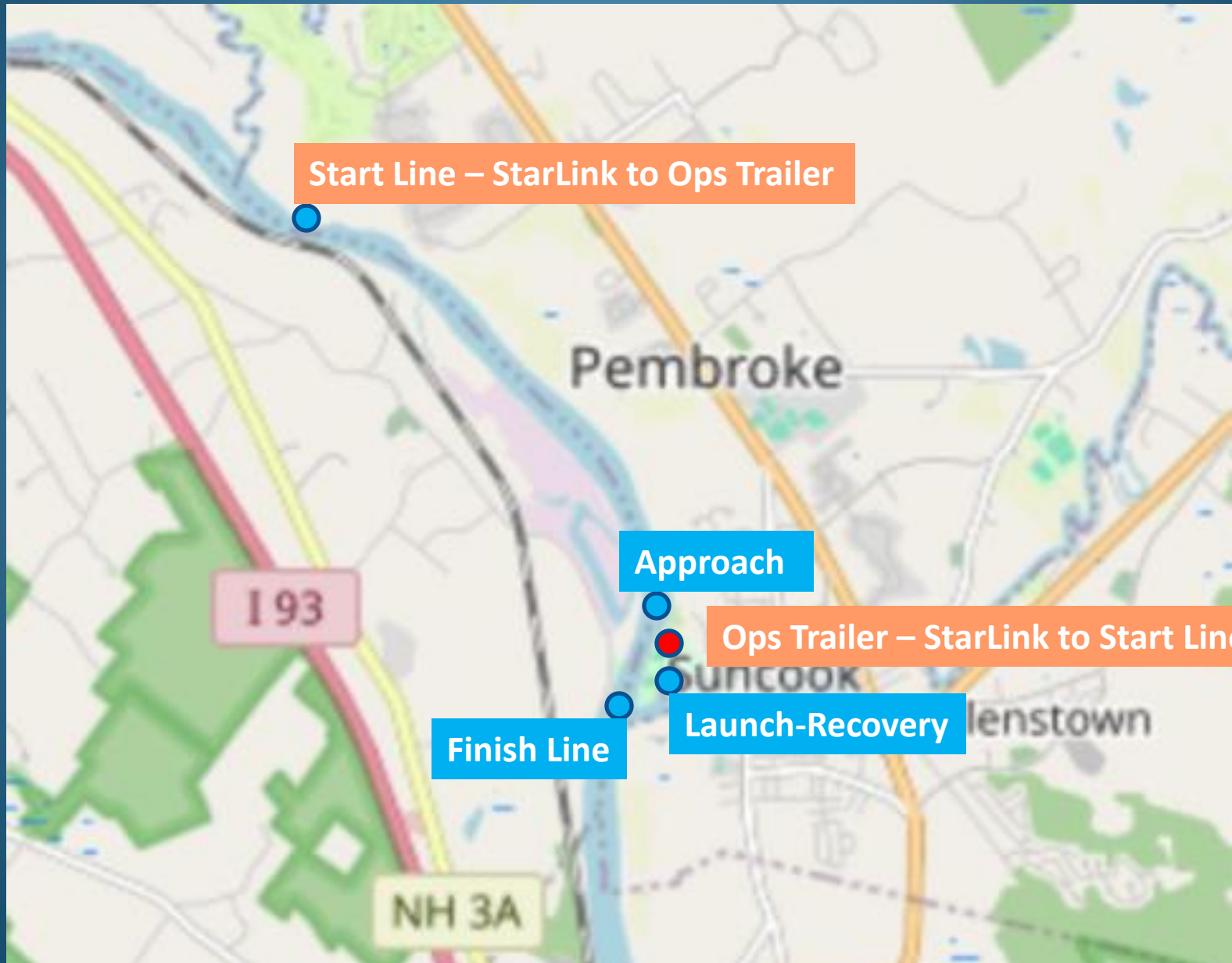


New Hampshire Championships Regatta

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

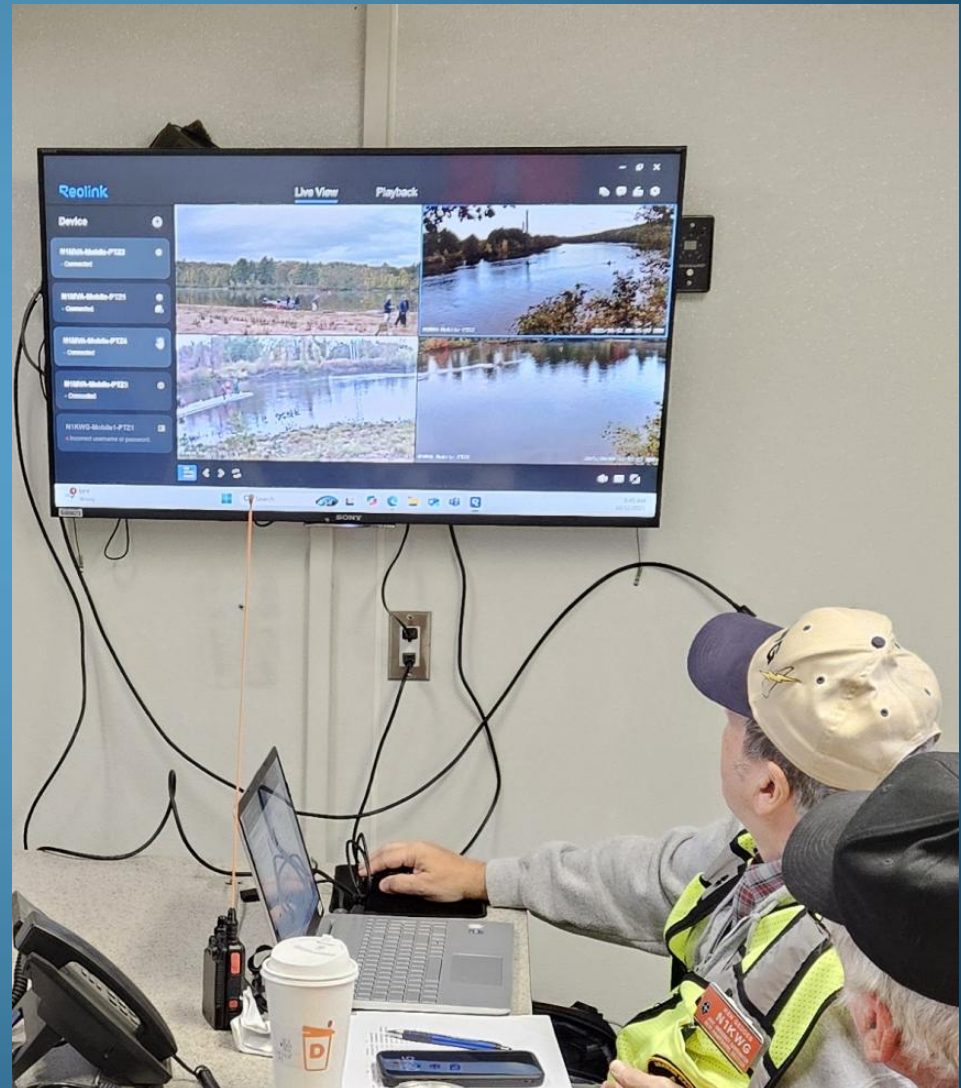
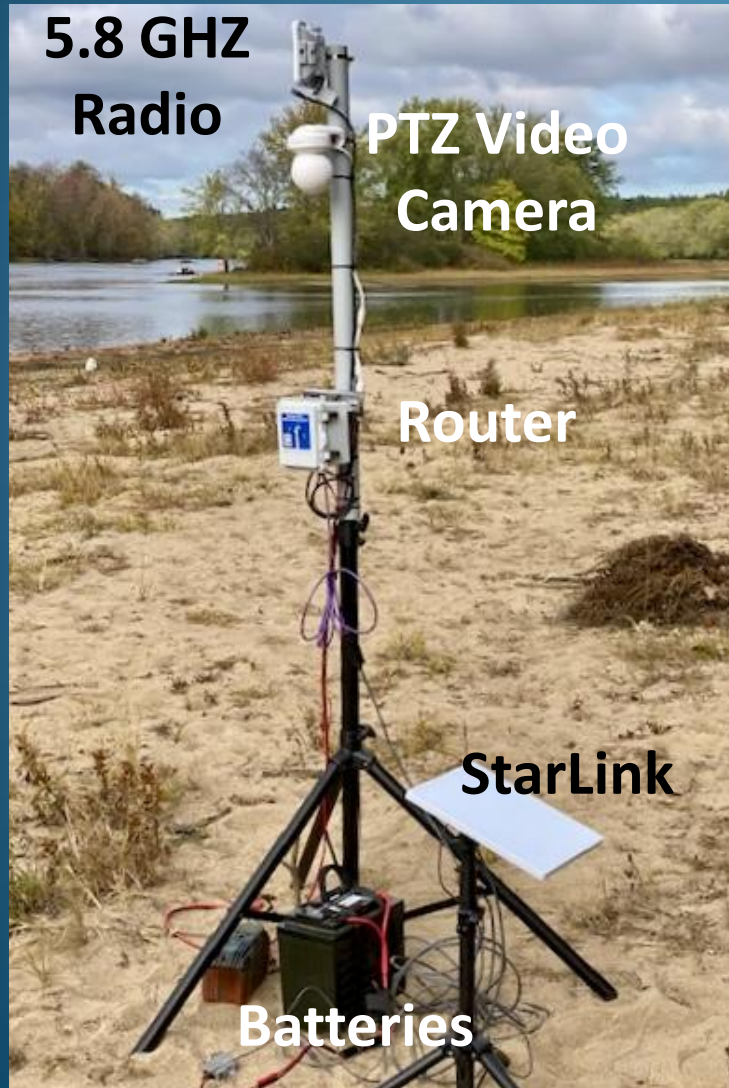


Regatta Start Line Connected to Mesh Via StarLink



Left - Camera Node & StarLink at Regatta Start Line

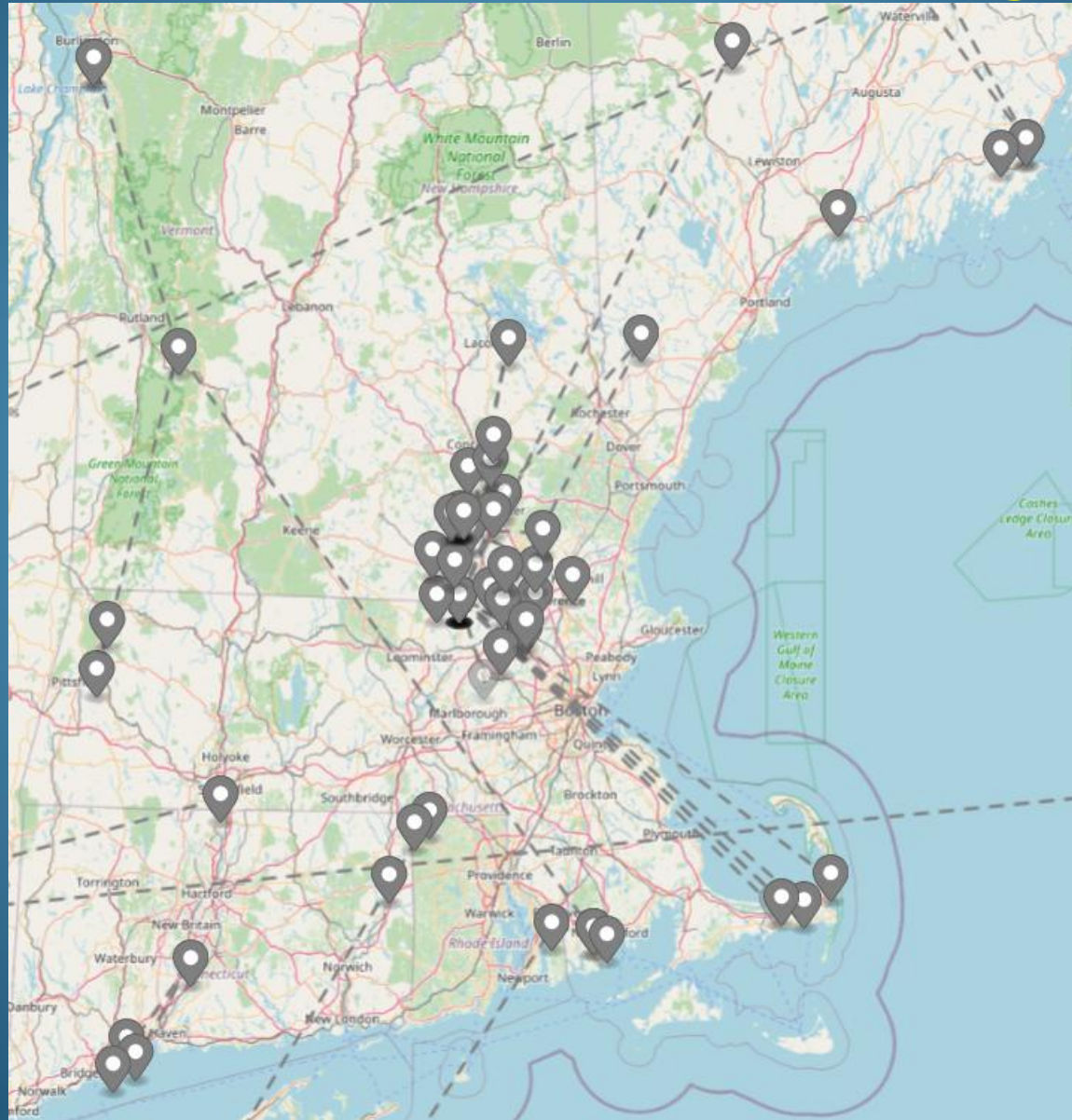
Right - Streaming Video in Operations Trailer



AREDN IN NEW ENGLAND

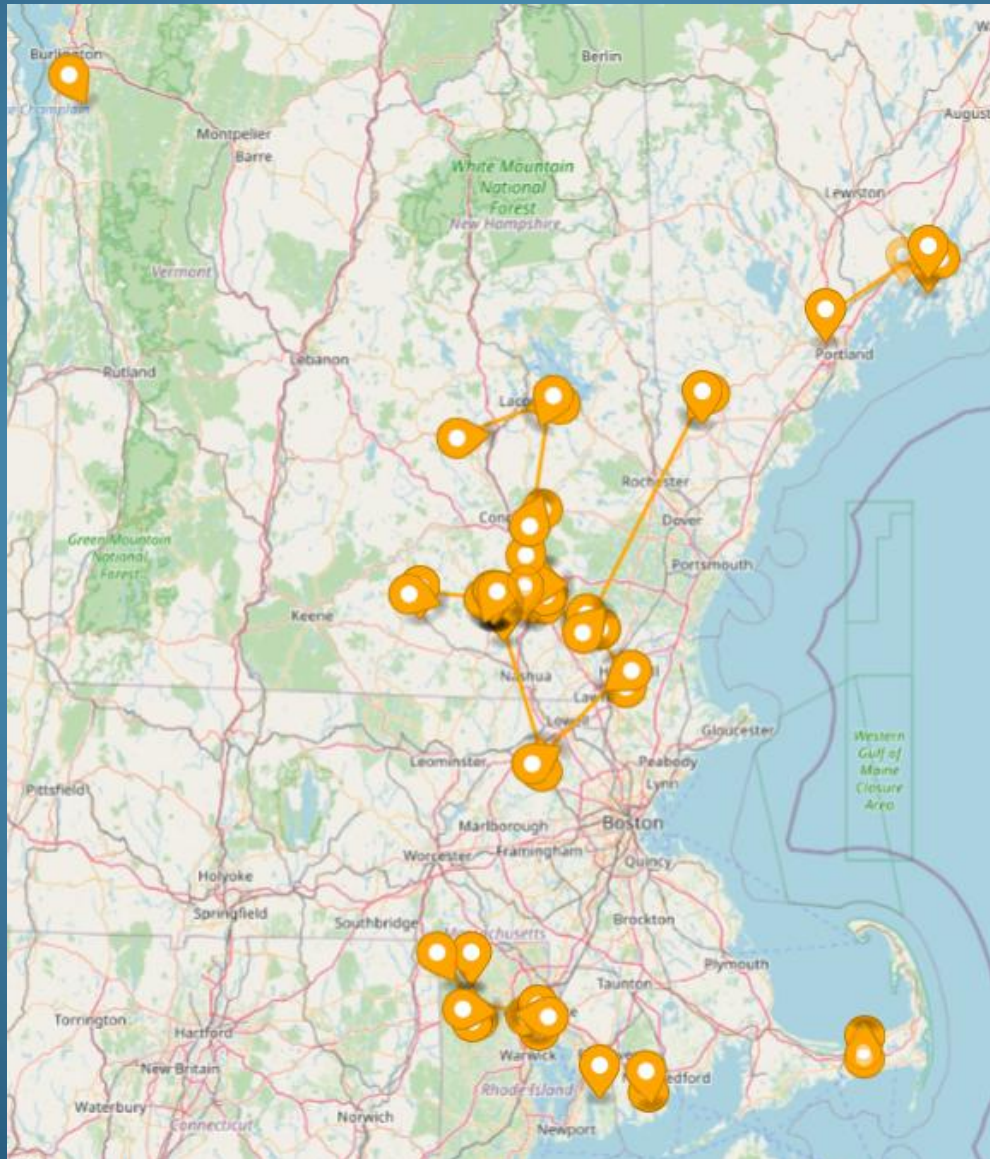
AREDN Map

Internet Tunnel Nodes in New England



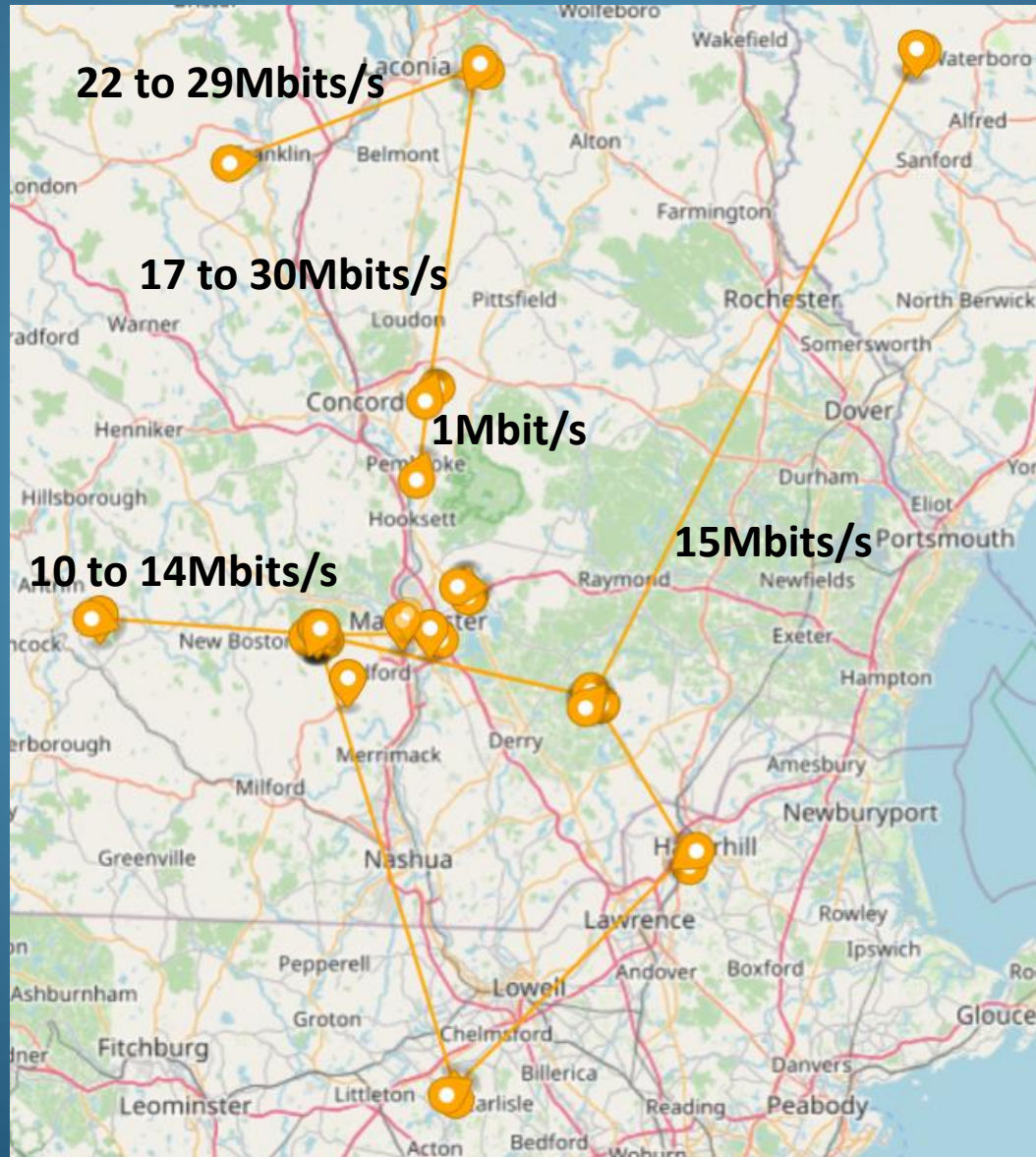
AREDN Map

5GHz RF Nodes in New England



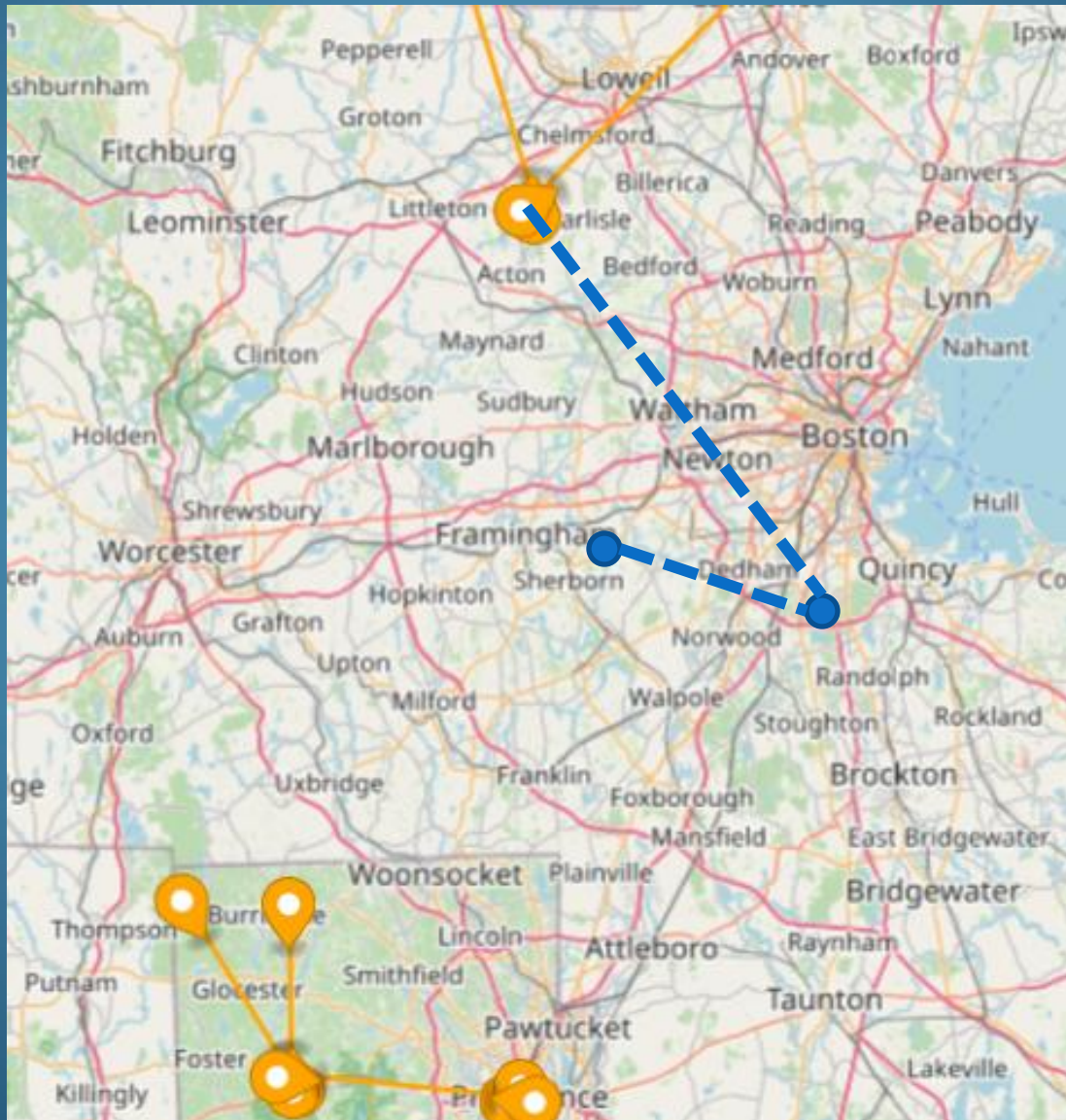
AREDN Map

Merrimack Valley Digital Network 5GHz Nodes



AREDN Map

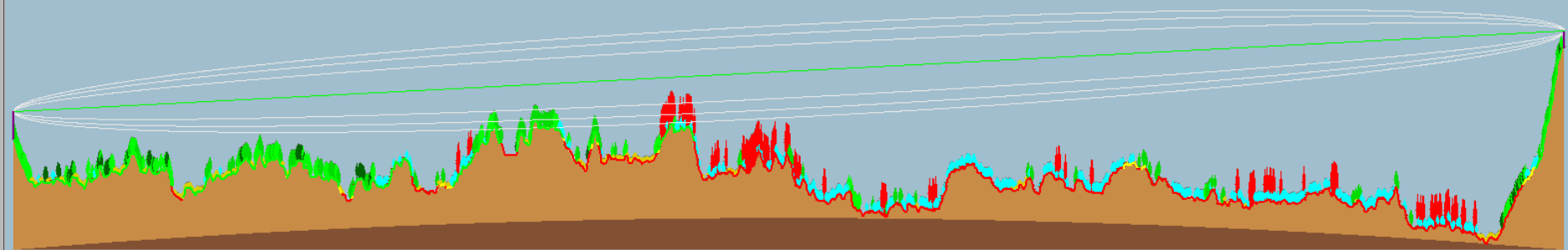
Theoretical 5GHz Link to NEST via Blue Hills



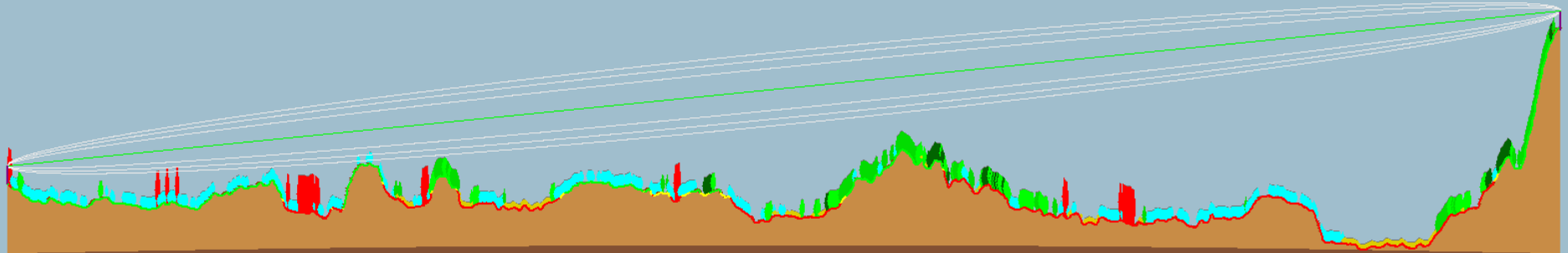
5GHz Propagation Plots Promising

Still need to account for local conditions

Westford to Blue Hills

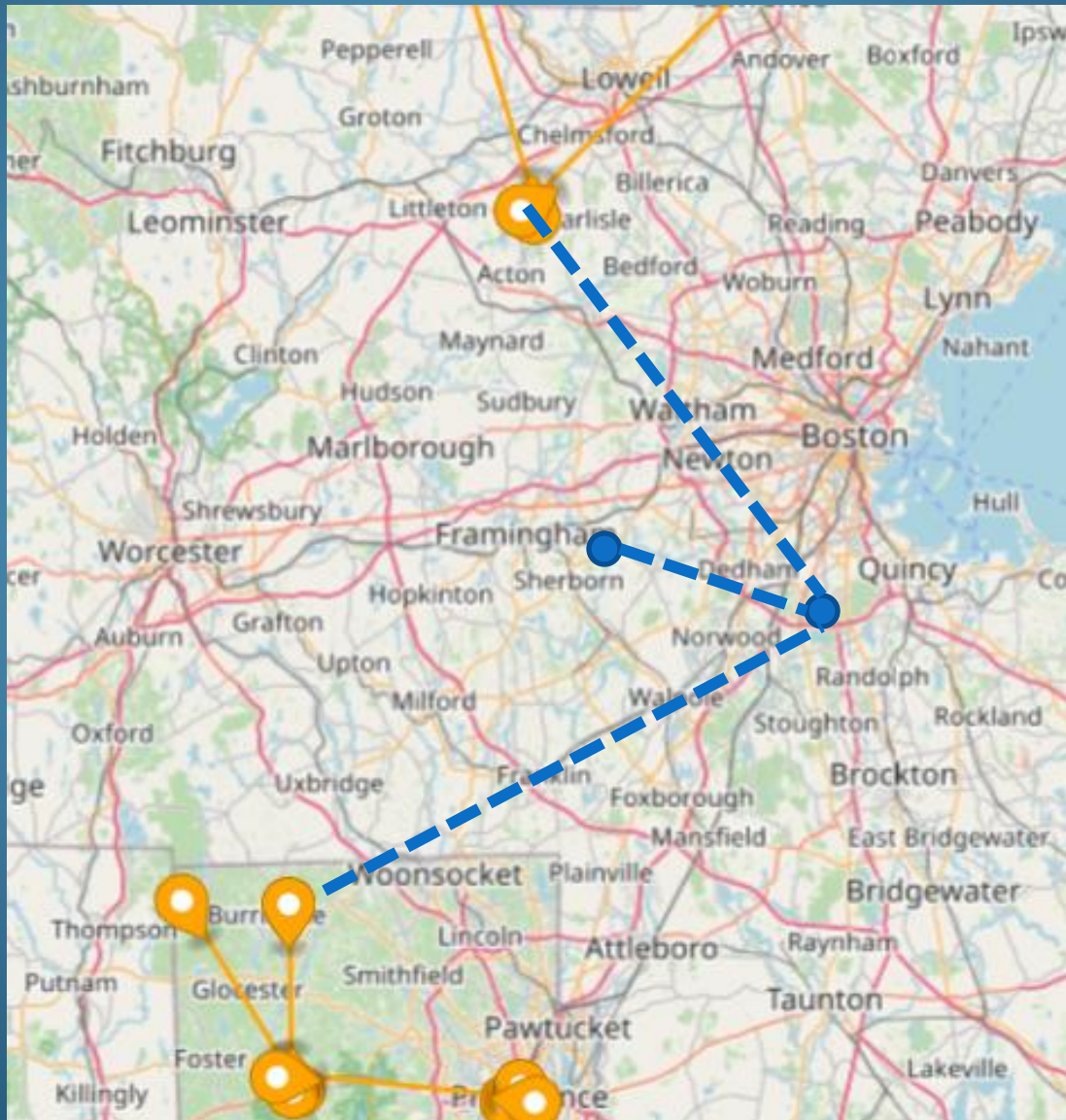


Natick to Blue Hills



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?

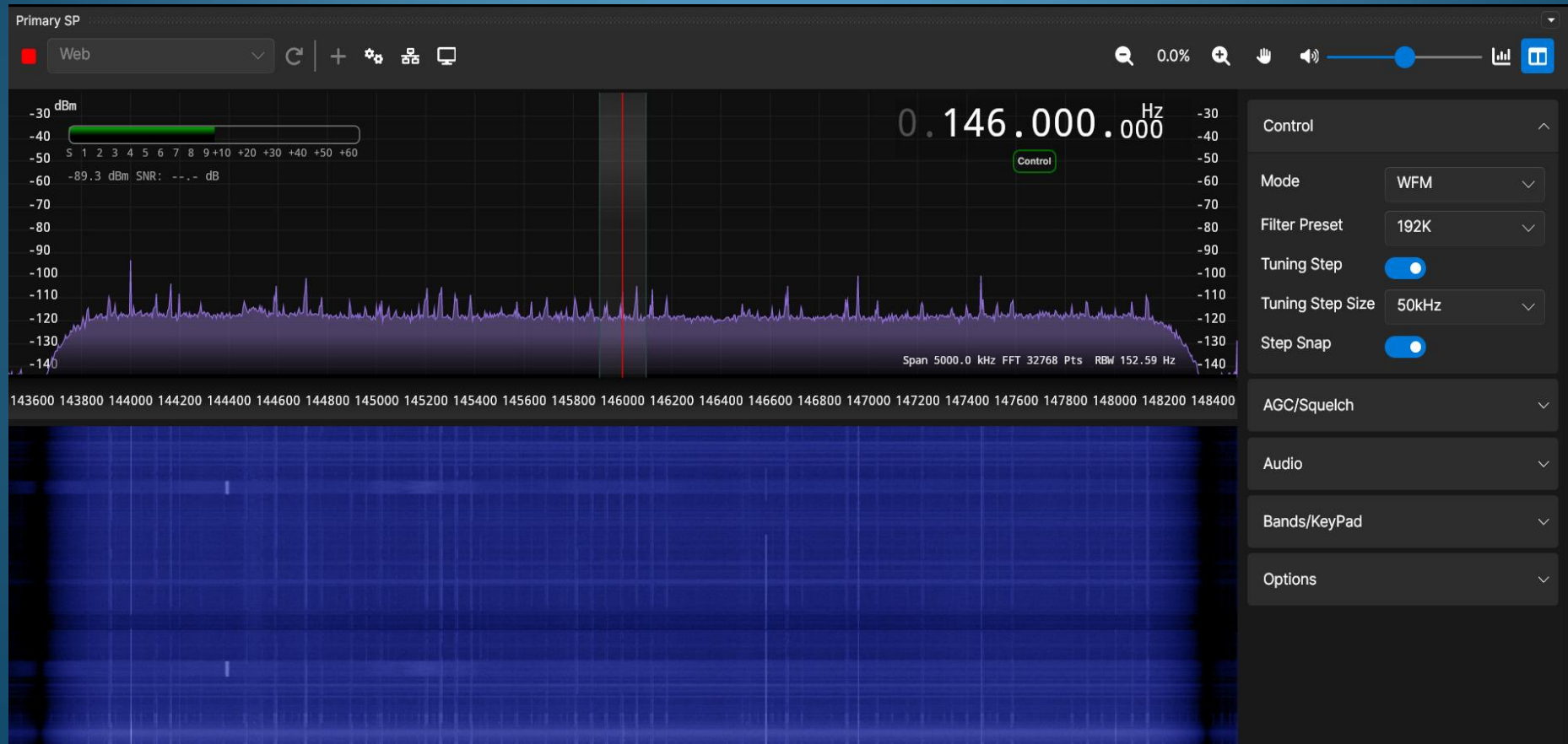
Add an SDR Spectrum Analyzer



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

Total Packets Received



Name ^	Mean	Min	Max
— n1mva-chester3-nh-hvl	30.6 Mp/s	30.1 Mp/s	31.0 Mp/s
— n1mva-gunstock2-nh-fri	17.8 Mp/s	17.3 Mp/s	18.3 Mp/s
— n1mva-haverhill3-ma-wes	31.2 Mp/s	30.7 Mp/s	31.7 Mp/s
— n1mva-shapleigh2-me-chs	48.9 Mp/s	48.5 Mp/s	49.4 Mp/s
— n1mva-uncanoonuc1-nh-crt	7.24 Mp/s	1.03 kp/s	9.12 Mp/s
— n1mva-westford2-ma-unc	4.68 Mp/s	4.17 Mp/s	5.17 Mp/s

Signal Strength



Name ^	Mean	Min	Max
— n1mva-chester3-nh-hvl	-67.9 dB	-72 dB	-66 dB
— n1mva-gunstock2-nh-fri	-54.8 dB	-59 dB	-51 dB
— n1mva-haverhill3-ma-wes	-62.9 dB	-67 dB	-62 dB
— n1mva-shapleigh2-me-chs	-51.3 dB	-58 dB	-47 dB
— n1mva-uncanoonuc1-nh-crt	-54.7 dB	-61 dB	-52 dB
— n1mva-westford2-ma-unc	-69.6 dB	-75 dB	-67 dB

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

CITADEL

Summary page for Jay Taft K1EHZ
Thursday, 06/05/25

Language: en_US

Ungoto Read new messages Read all messages Enter a message Skip this room Goto next room

Messages	Tasks	Today on your calendar
Mail 0/0 Lobby 0/0	(None)	(Nothing)

Who's online now

User name	Room
(not logged in) [2]	
Jay Taft K1EHZ	Tasks

About this server
You are connected to Citadel Citadel 931 with WebCit 931, and located in (null). Your sys is admin

Summary Mail Calendar Contacts Notes Tasks Rooms Online users Chat Advanced Log off

N1MVA Network TeamTalk - TeamTalk v. 5.18

Client Me Users Channels Server Help

N1MVA Network TeamTalk (3)

- k1ehz-pc, 🗿
- k1ehz-phone, 🗿
- k1ehz-server client, 🗿 - Away - Please leave chat...

Chat Files Media Video Desk

6/5/2025 3:08 PM * Using sound input: Internal Microphone (Cirrus Logic Superior High Definition Audio)
Using sound output: Speakers (Cirrus Logic Superior High Definition Audio)
6/5/2025 3:08 PM * Connecting to 10.159.26.220 TCP port 10333 UDP port 10333

6/5/2025 3:08 PM Server Name: N1MVA Network TeamTalk
6/5/2025 3:08 PM Message of the day: Welcome to Merrimack Valley Digital Network Team Talk
6/5/2025 3:08 PM * Connected to N1MVA Network TeamTalk

Telnet Session to Network Post Office Server

Network server: N1MVA WINLINK NETWORK POST OFFICE Add server Remove server Edit server

Exit Settings Start Stop Time to next Autoconnect = Disabled

```
*** Connecting to network post office N1MVA WINLINK NETWORK POST OFFICE at 10.23.162.68 port 8772
*** Connected to N1MVA WINLINK NETWORK POST OFFICE at 10.23.162.68 port 8772 at 2025/06/05 19:17:17
Network post office. Messages will be stored locally for pickup by the recipient.
.WL2K-Post_Office
[WL2K-3.2.14.0-B2FWIHM$]
.PQ: 42742893
K1EHZ RMS Relay >
.FW: K1EHZ
[RMS Express-1.7.23.1-B2FHM$]
.PR: 33012412
.WL2K DE K1EHZ (FN42FW)
FF
FQ
*** End of session with WL2K at 2025/06/05 19:17:20 ---
*** Messages sent: 0. Total bytes sent: 0. Time: 00:01, bytes/minute: 0
*** Messages Received: 0. Total bytes received: 0. Total session time: 00:01, bytes/minute: 0
*** Disconnected at 2025/06/05 19:17:25
```



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 ★★★★★ (1,937) | [Ask questions and search reviews](#)

Overall Pick

300+ bought in past month

-17% **\$33⁹⁹**

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

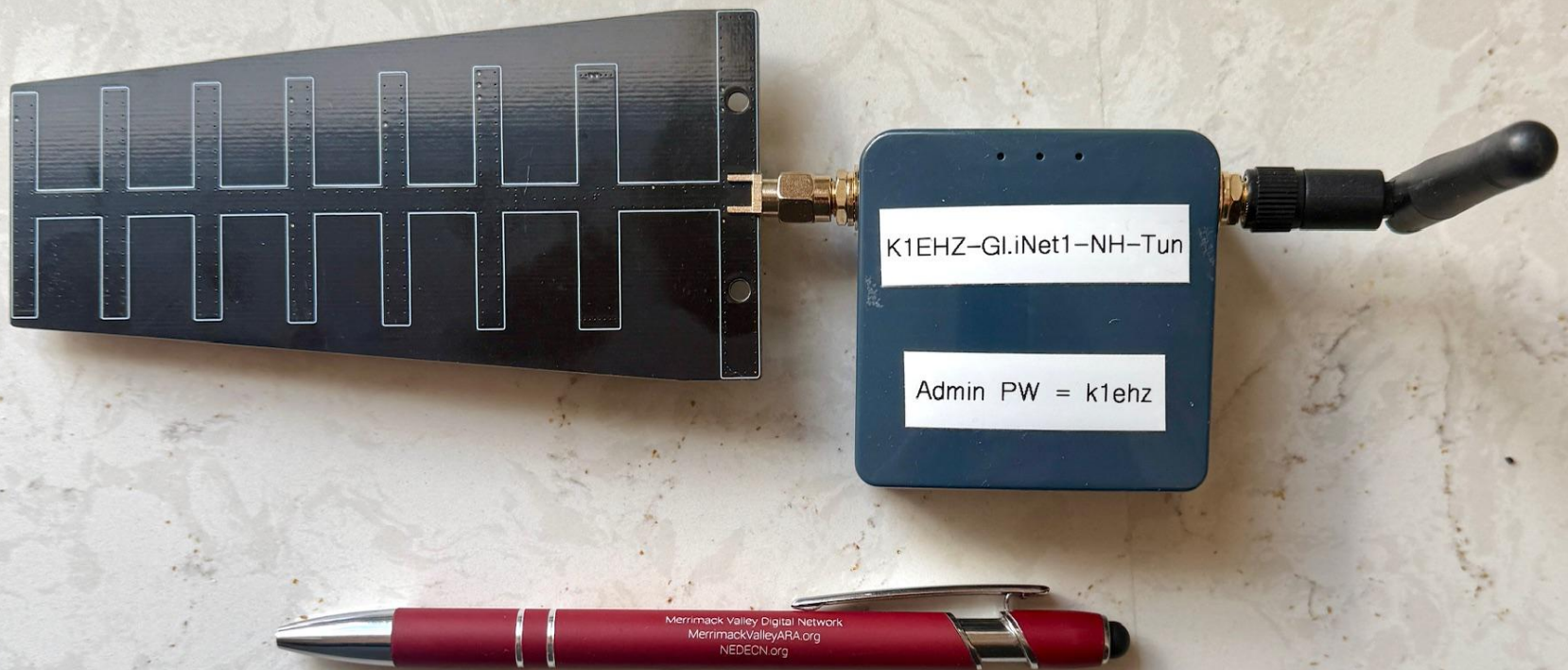
Wireless 2.4 GHz Radio Frequency

Communication

▼ [See more](#)

2.4GHz GL.iNet with 12dB Yagi

USB Powered – EIRP* ~750mw



* Effective Isotropic Radiated Power

GL.iNet Has All AREDN Capabilities

Radios & Antennas

Help

Radio 2.4GHz

Radio purpose

MAC Address

Mac address

Channel

Channel and frequency of this connection

Channel Width

Channel bandwidth

Transmit Power

Transmit power

Mesh

Off

Mesh

Mesh PtMP

Mesh PtP

Mesh Station

LAN Hotspot

WAN Client

Two Ham Channels in 2.4GHz Band

Ch -1 and Ch -2

Radios & Antennas

Help

Radio 2.4GHz

Radio purpose

Mesh

MAC Address

Mac address

94:83:c4:36:59:25

Channel

Channel and frequency of this connection

-2 (2397)

Channel Width

Channel bandwidth

10 MHz

Transmit Power

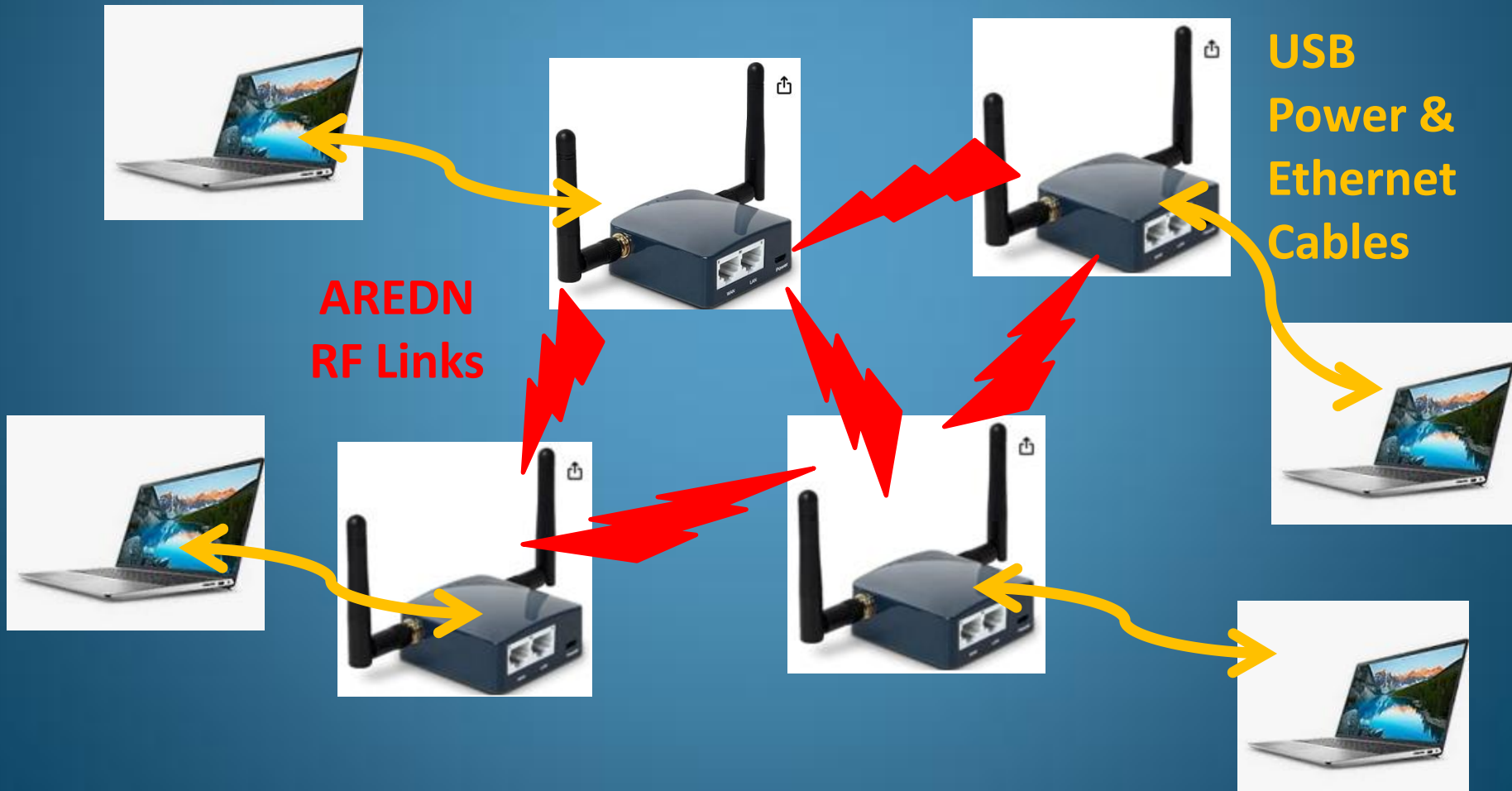
Transmit power

23

Classroom Network

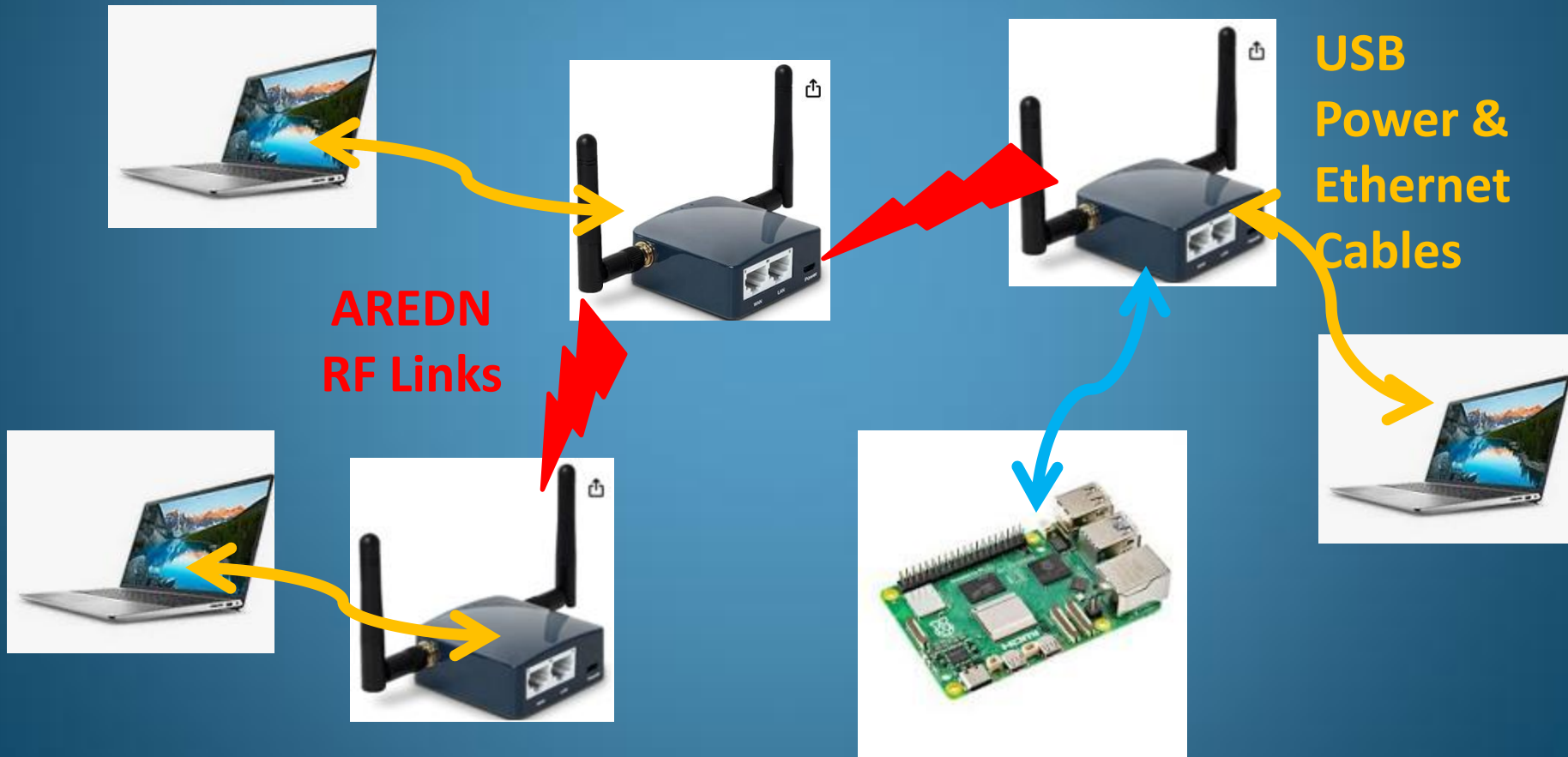
2.4GHz AREDN Mesh – WiFi Distances

5v USB Power and Ethernet Connections to Computer



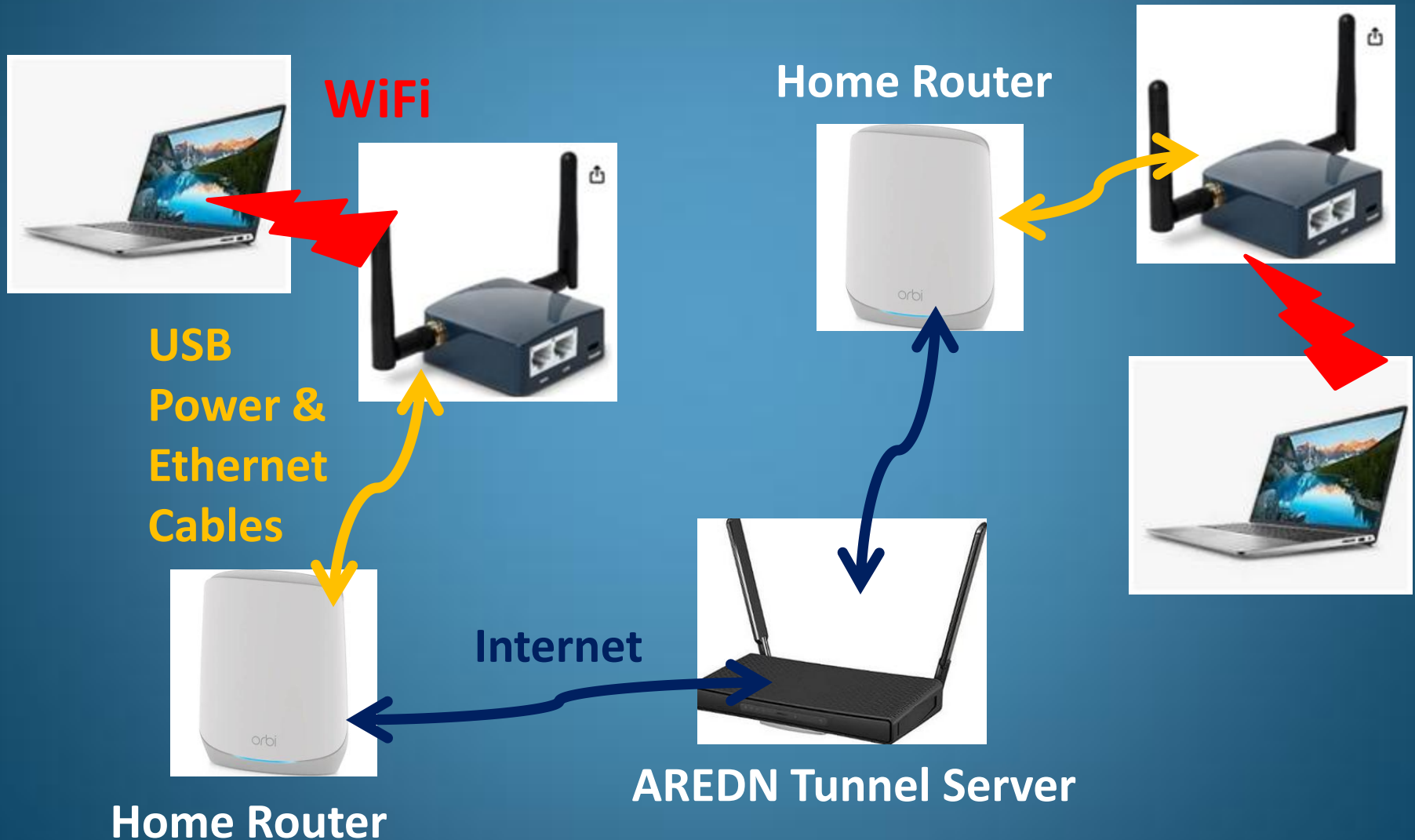
Classroom Network

Add Email, Conferencing on Raspberry Pi



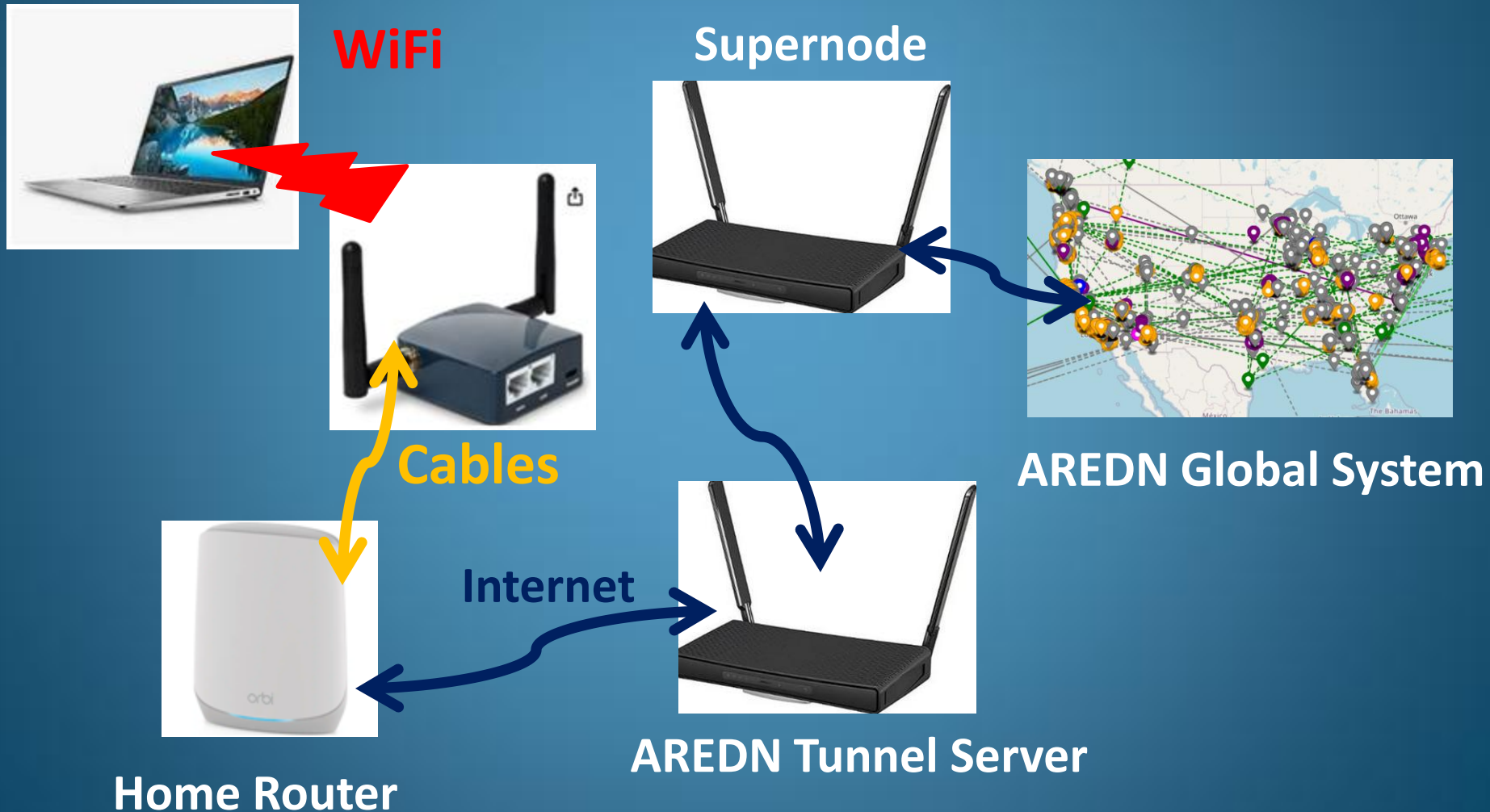
Network from Home

Internet Tunnel Client in AREDN Firmware



Global Access through a Supernode

Internet Tunnel Client in AREDN Firmware



Merrimack Valley Digital Network

Public Access Links

- [Public Network RF Dashboard](#)
- [Network Status Summary](#)
- [Power Monitoring Prototype](#)
- [ADS-B Air Traffic Monitor \(AB10C\)](#)
- [Merrimack Valley Amateur Radio Association](#)
- [Amateur Radio Emergency Data Network](#)
- [AREDN Global Map](#)

AREDN as a Platform for 21st Century Amateur Radio

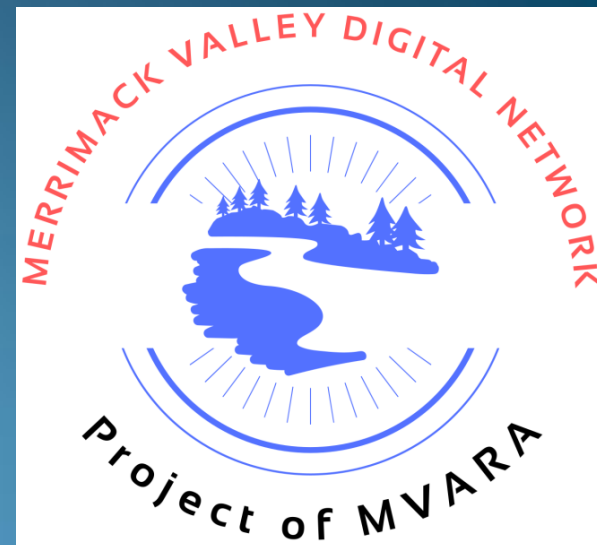
- High-speed microwave data network
- STEM opportunities
- Career preparation
 - AI Video Pattern & Event Recognition
 - Earth <-> Space Communications
- Merrimack Valley Digital Network
& New England-wide microwave network
- Community service events
- EmComm voice & data applications
- Get started with 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

