



Arrowhead Radio Amateur Club
November 14, 2024
Jeffrey Nast – KCØMKS

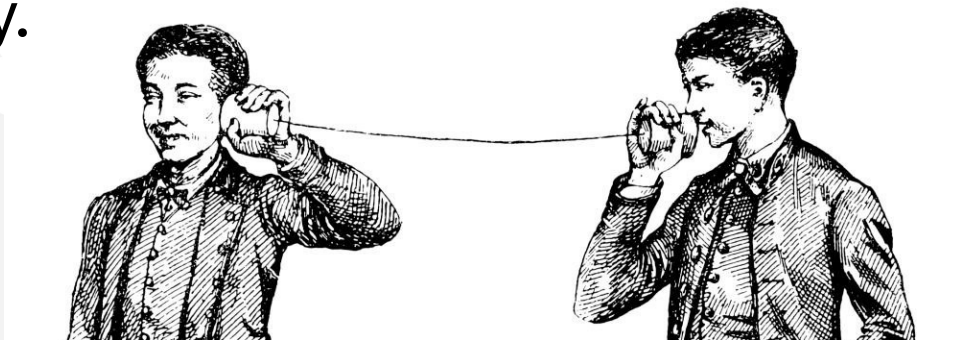


Agenda:

- Mesh Networks
 - What is it?
 - Types
 - Basics
- Future Plans
- Demonstrations
- Q & A

What is a “Network”

- A system, where two or more computing devices, like computers or smartphones, are connected together.
- The network enables the sharing and transmission of information and resources between the devices, essentially allowing them to communicate with each other.
- The connection can be made through physical wires, fiber or wirelessly.





The Mesh

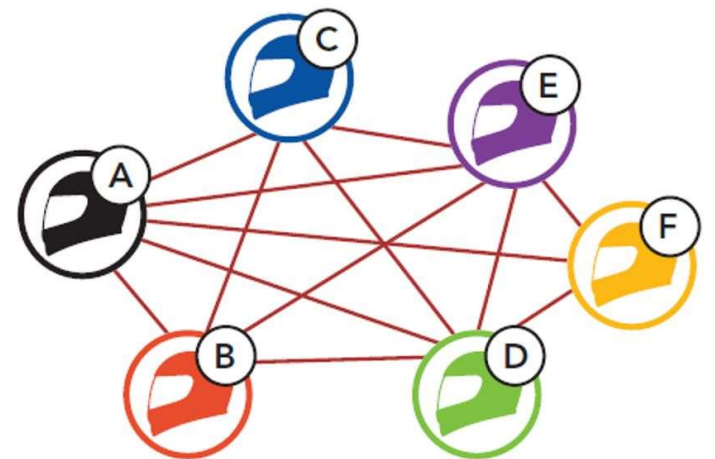


- **What is a Mesh Network?**

- A group of connectivity devices, such as Wi-Fi routers that act as a single network.
- There are multiple sources of connectivity instead of just a single router.
- All points are wirelessly connected to each other.
- As long as they're within range, they can communicate with each other without the need for a router or switch.



- **Mesh types...**
 - Commercial
 - Local multiple buildings
 - Private
 - Homes, garages
 - Neighbors (MeshTastic)
 - Motorcycles





Broadband-Hamnet™
HSMM-MESH™

- **Mesh types...**
 - Amateur radio
 - Broadband-Hamnet (HSMM-Mesh)
 - <http://www.hsmm-mesh.org/>
 - Supported hardware (website)
 - Firmware load (2014)
 - Linksys WRT54GL (Broadband-Hamnet)
 - WiFi antennas now used as Mesh Network
 - If you have an old Linksys router...





- **AREDN (Amateur Radio Emergency Data Network)**

- AREDN is a “forked” Broadband-Hamnet (BBHM)

- Limited compatibility with BBHM

- 2.4 GHz, SSID, Channel

- <https://www.arednmesh.org/>

- Supported hardware

- Different manufacturers

- Select your device carefully

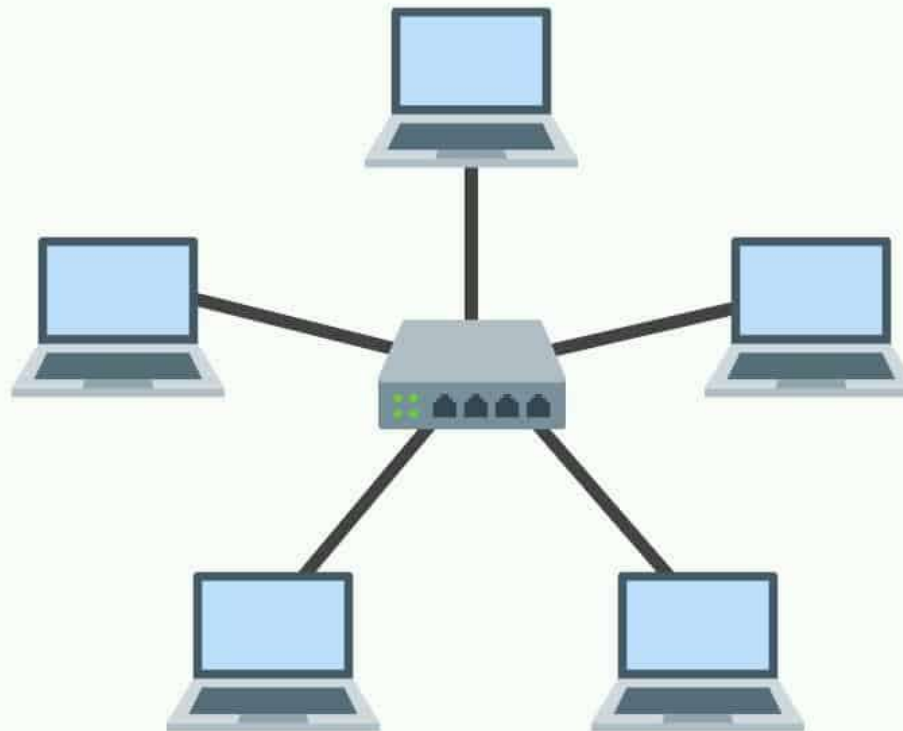
- Different manufacturers - all are compatible



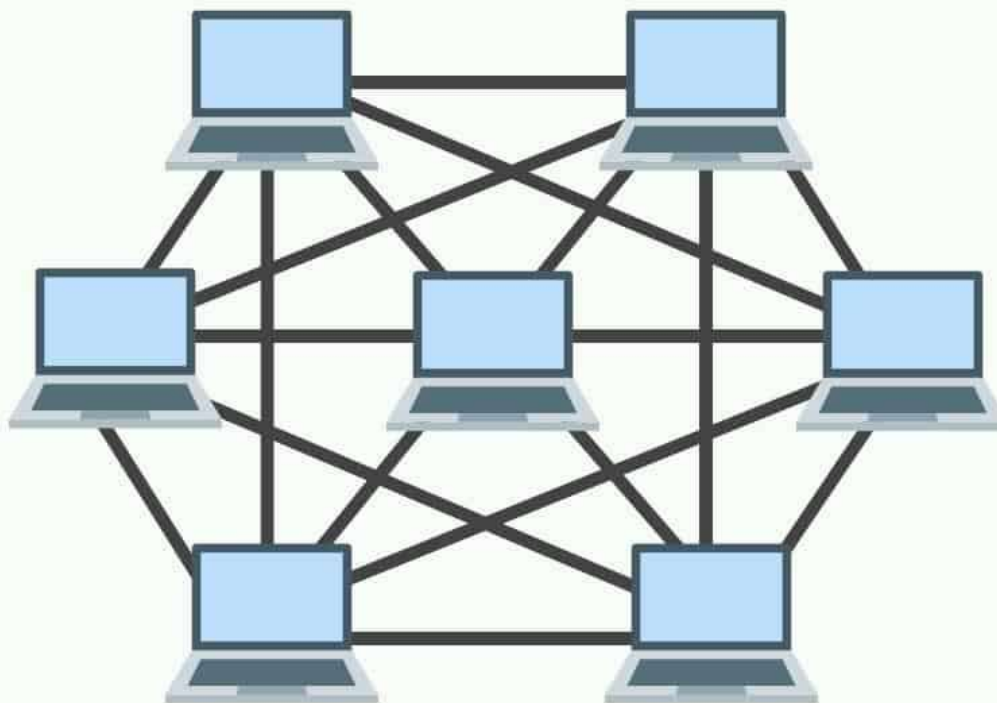
- MikroTik hAP ac Lite ~\$50
- AREDN Firmware load
- WiFi antennas now used as Mesh Network
- On dual band routers
 - 5.8 GHz is mesh
 - 2.4 GHz is Access Point
- From your cell phone, scan for WiFi Access Points
 - KC0MKS-1 through KC0MKS-6



- **Mesh basics...** What does it look like?
 - Typical Star Network Topology (Ethernet)

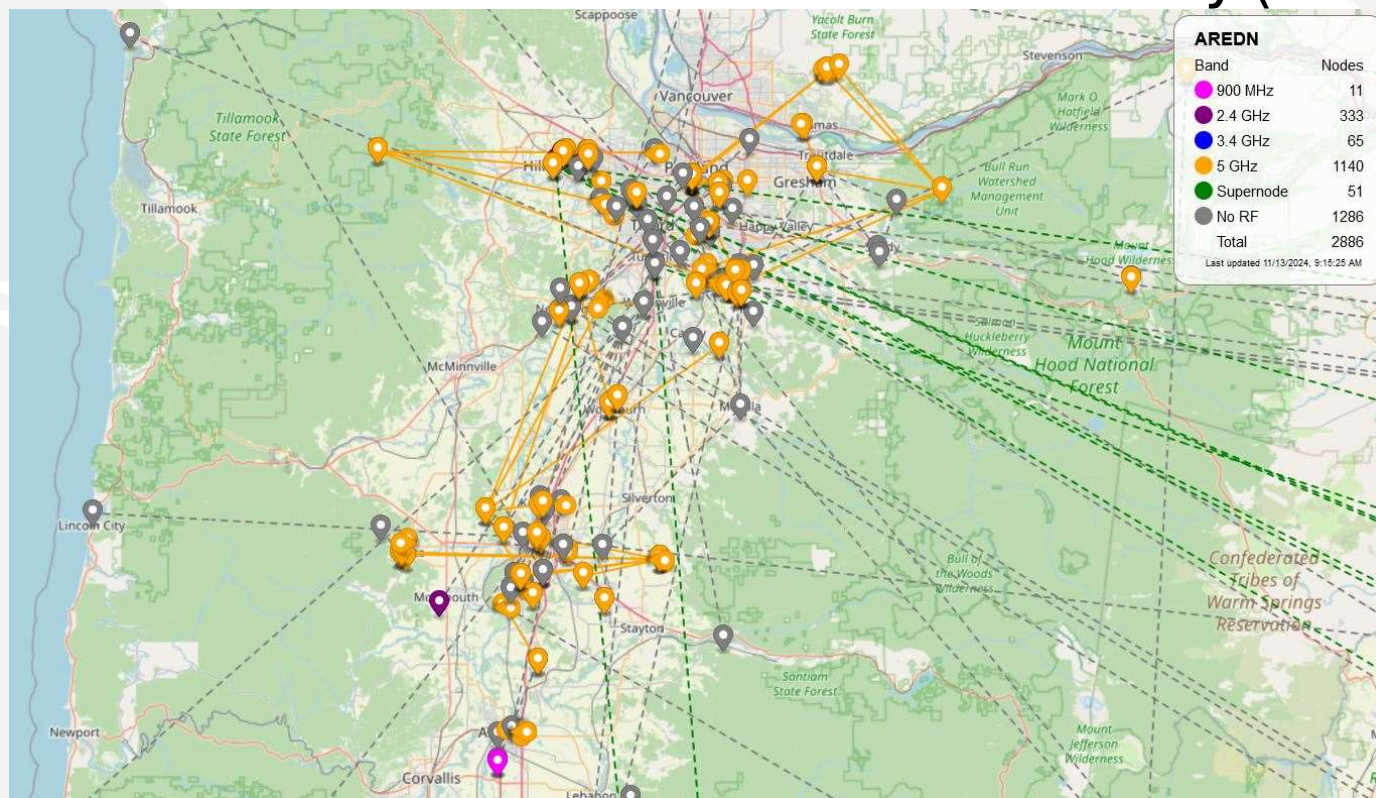


- **Mesh basics...** What does it look like?
 - Typical Mesh Network Topology

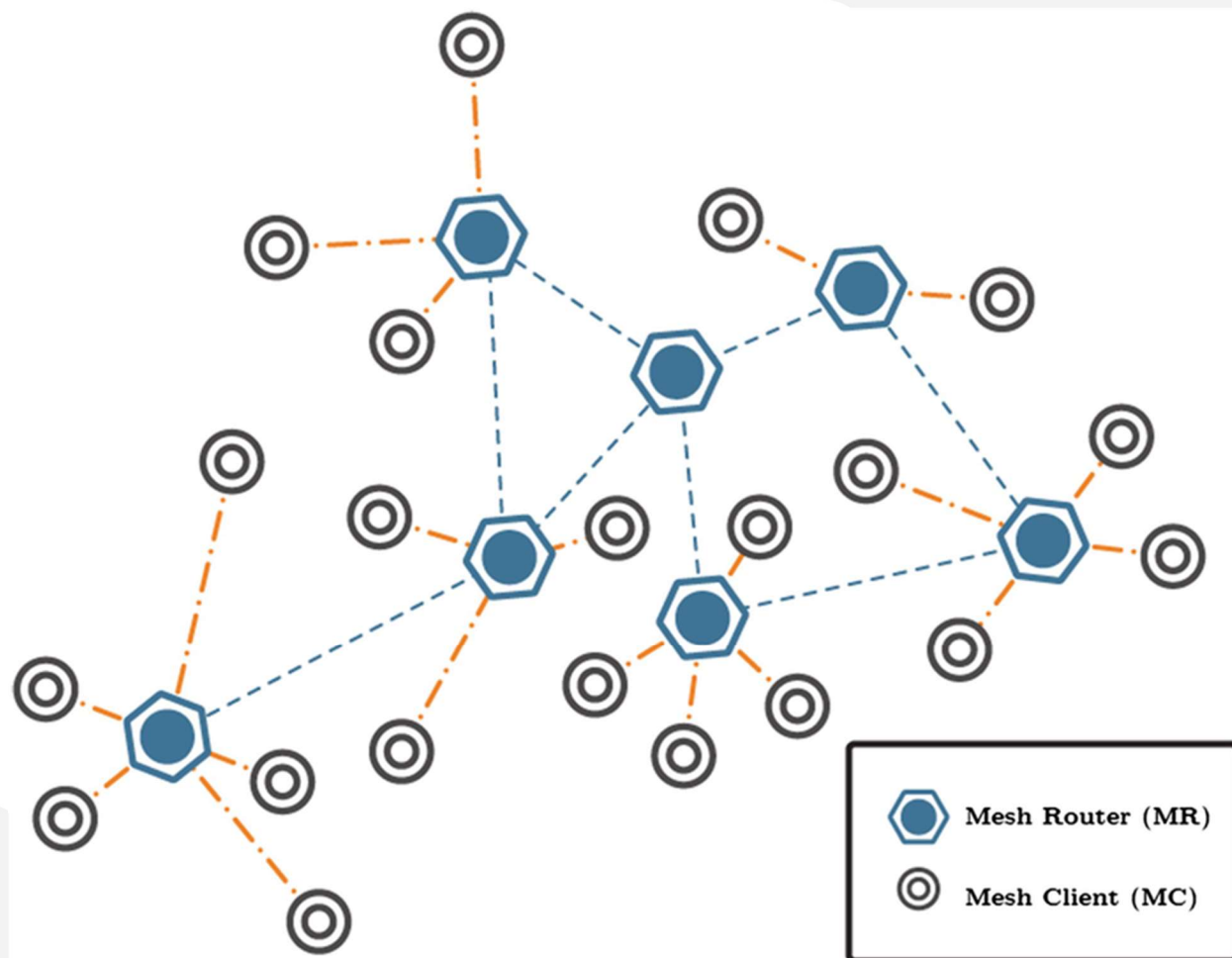




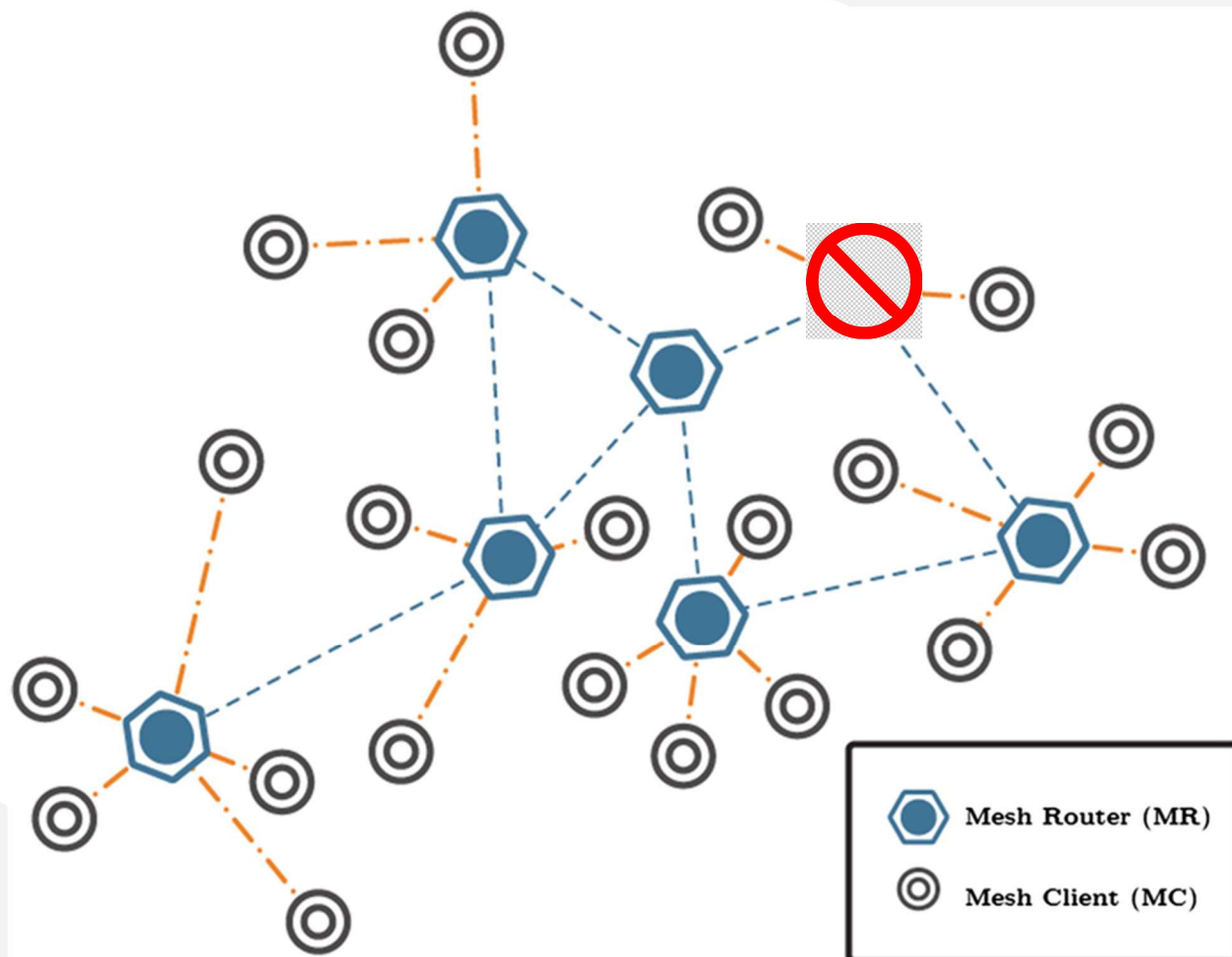
- **Mesh basics...** What does it look like?
 - Real life Mesh Network - Willamette Valley (World Map)



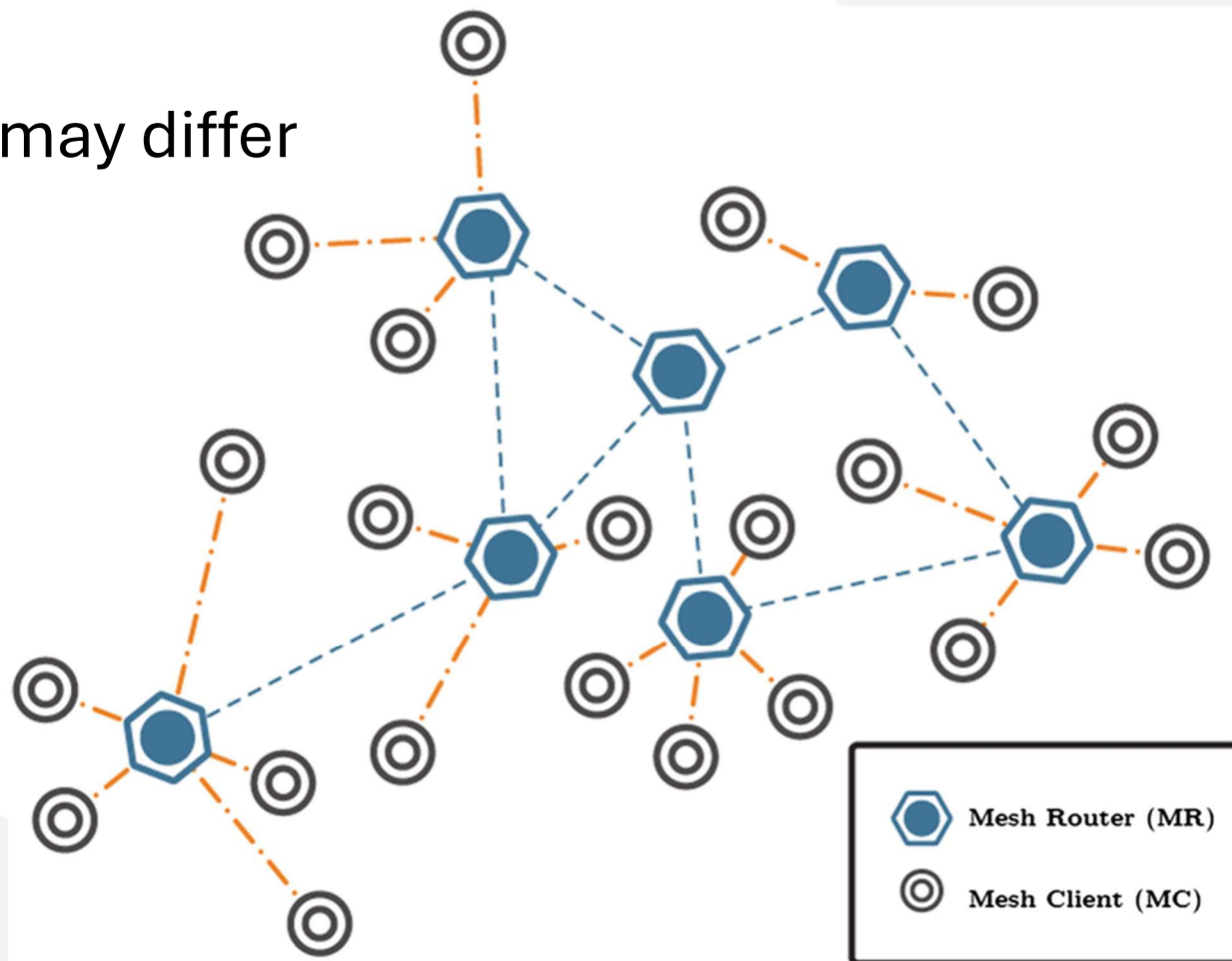
- **Mesh basics...**
 - Routing



- **Mesh basics...**
 - Broken Mesh



- **Mesh basics...**
 - Up/Down Links may differ



- **Network Speed Factors...**
 - Your computer
 - Line of Sight Technology
 - 2.4 GHz slower, but will go farther
 - 5.8 GHz faster, but won't go as far
 - **Safety Forced!!!**
- LQM
 - Link Quality Manager
 - 3X bandwidth improvement



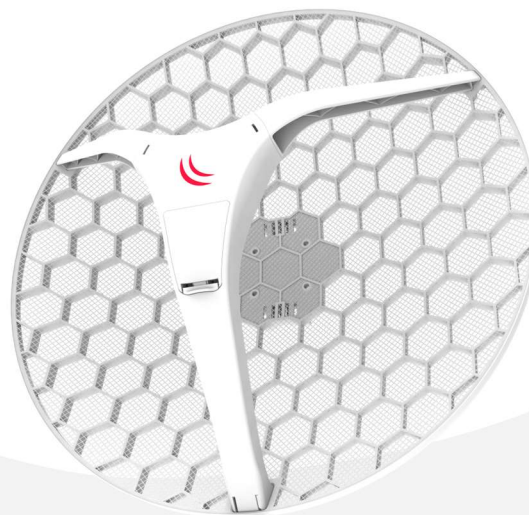
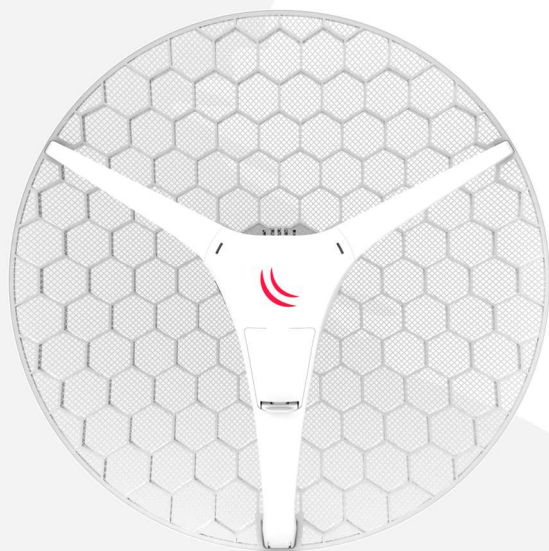
- 5.8GHz Mesh Network
 - Omni antennas
 - Local flat panel
 - Area wide flat panel



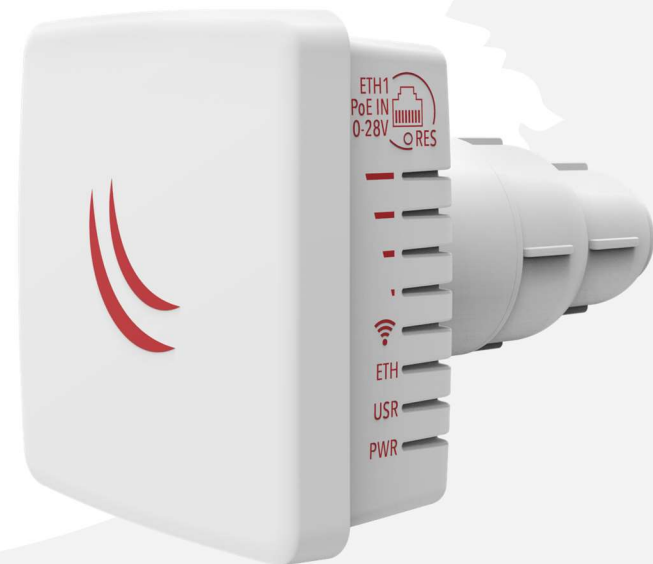
- 5.8GHz Mesh Network
 - 120° Sector antenna



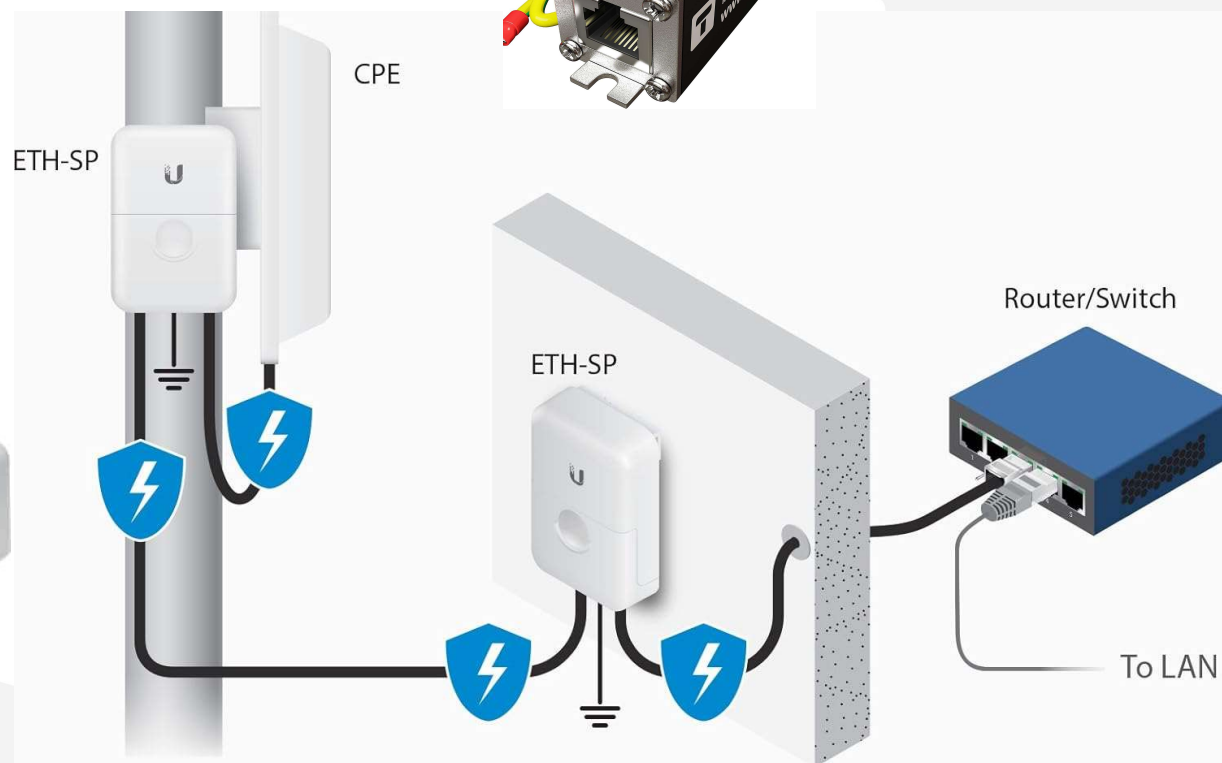
- 5.8GHz Mesh Network
 - Dish antenna
 - 21.5", 3° to 6° beamwidth, 24-31dBi
 - Up to 1 Kilowatt ERP!



- 5.8GHz Mesh Network
 - Convert a Direct TV or Dish Networks!
 - LNB – Low Noise Block Downconverter
 - MicroTik LDF-5



- 5.8GHz Mesh Network
- Surge suppressors



■ Channels...

900 MHz	Channel	4	5	6	7
	Ctr Freq	907	912	917	922
	Status	Shared with US unlicensed			

You are responsible for using frequencies, channels, bandwidths, and power levels that comply with your country's amateur radio license requirements.

2.4 GHz	Channel	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8 *
	Ctr Freq	2.387	2.392	2.397	2.402	2.407	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447
	Status	non-US only		Unshared		Cannot Use	Shared with US unlicensed							

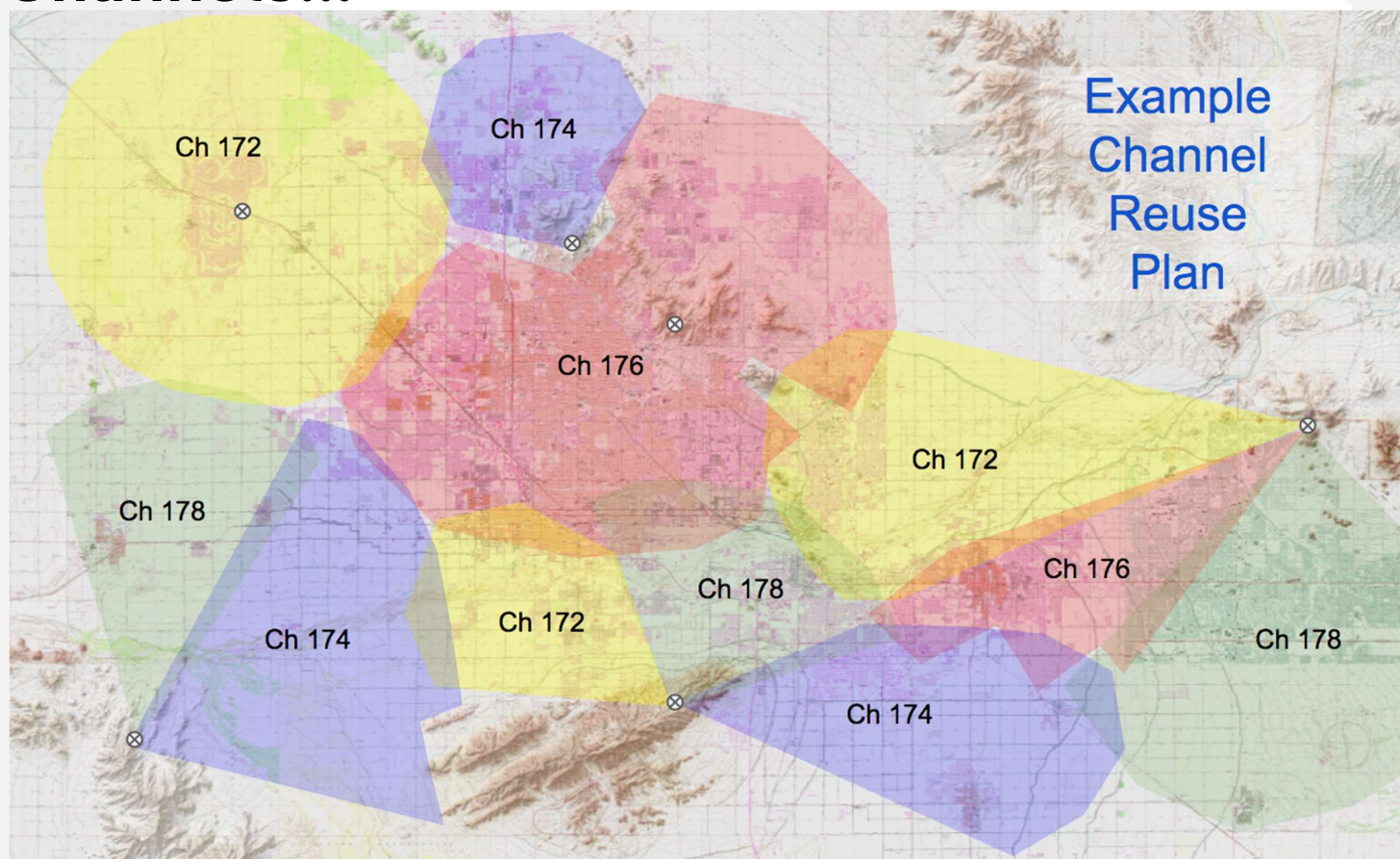
* Only 5 MHz channel width is available on channel 8

3.4 GHz	Channel	76	77	78	79	80	81	82	83	84	85	86	87	88	89
	Ctr Freq	3.380	3.385	3.390	3.395	3.400	3.405	3.410	3.415	3.420	3.425	3.430	3.435	3.440	3.445
	Status	US Amateur operations remain on a secondary basis but are subject to removal at any time by FCC notice*													

* per FCC 20-138 IV-E-69

5.8 GHz	Channel	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148
	Ctr Freq	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
	Status	Shared with US unlicensed indoor/outdoor DFS & Radar Avoidance														Shared with Unlicensed...			
	Channel	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166
	Ctr Freq	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
	Status	Shared with US unlicensed indoor/outdoor																	
	Channel	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184
	Ctr Freq	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
	Status	...Shared with Unlicensed				Shared with US unlicensed mainly indoor									Shared with Intelligent Transportation System				

■ Channels...



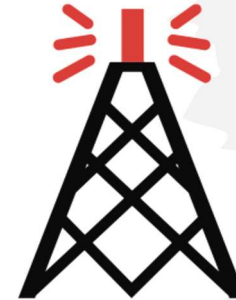
- **Mesh Network Peripherals...**
 - Client nodes (you/tower sites/EOC/Hospitals)
 - Router
 - Computer
 - Printer(s)
 - VoIP
 - IP Phone (Grandstream)
 - IP Soft Phone (Linphone)



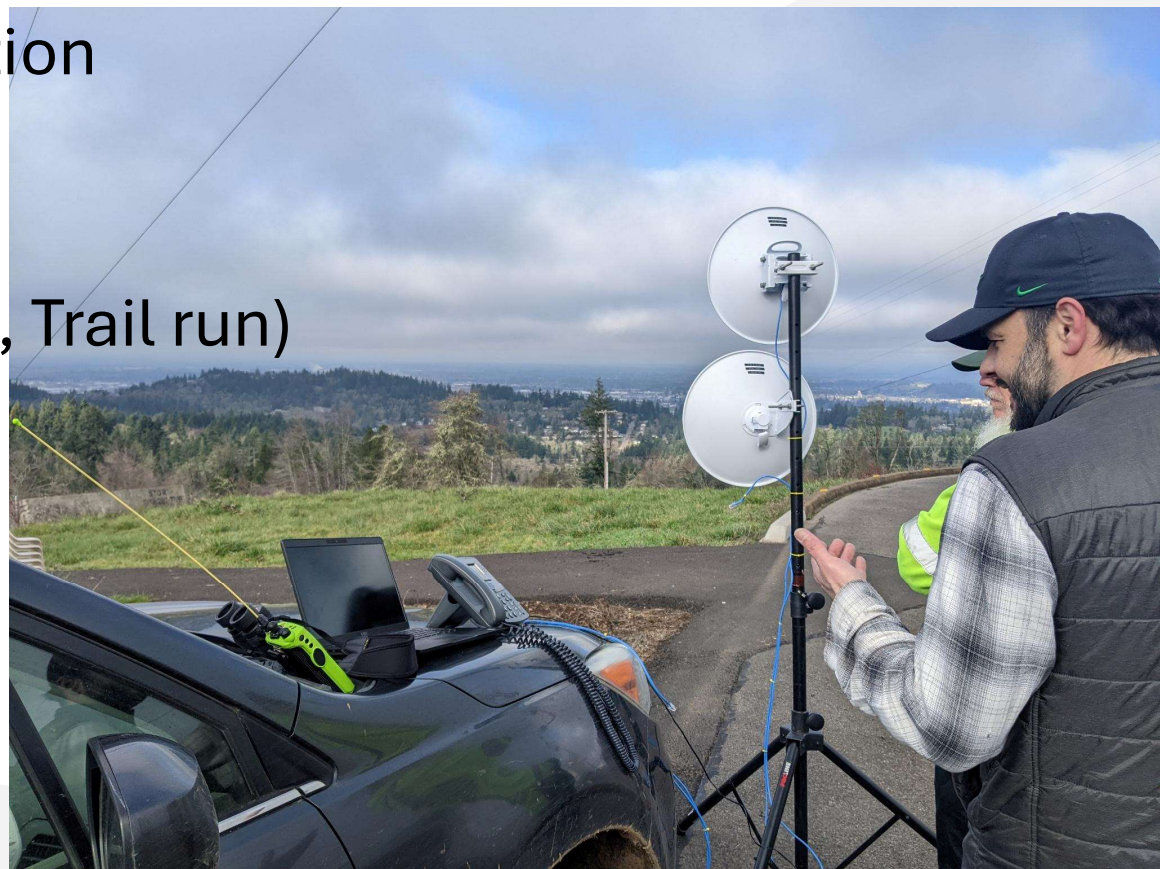


■ Mesh Network Peripherals...

- Digital radio
- Digital repeaters
- AllStarLink
- EchoLink
- Webcam
- Winlink Telnet
- Remote HF/VHF/UHF stations



- **Portable Nodes...**
 - Emergency Activation
 - Exercises
 - Special Events
 - Races (Grandma's, Trail run)





- **Servers...**

- PBX (IP Phones)

- PBX = Private Branch Exchange
 - In band/out of band

- Web

- Information/Documentation/Announcements
 - Mesh mapping service/Topology
 - Wiki

- Winlink RMS

- Packet Gateway/VARA FM Gateway



- **Servers...**

- Chat
- APRS Chat
- POP (email)
- File server
- Video conferencing
- Weather stations
- GOES Satellite
- DNS
- NTP Time



- **Servers...**
 - Internet access?
 - Yes, but... Part 97
 - Multiple internet access points
 - Firewall(s)
 - No commercial services
 - No monetary exchange
 - No encryption





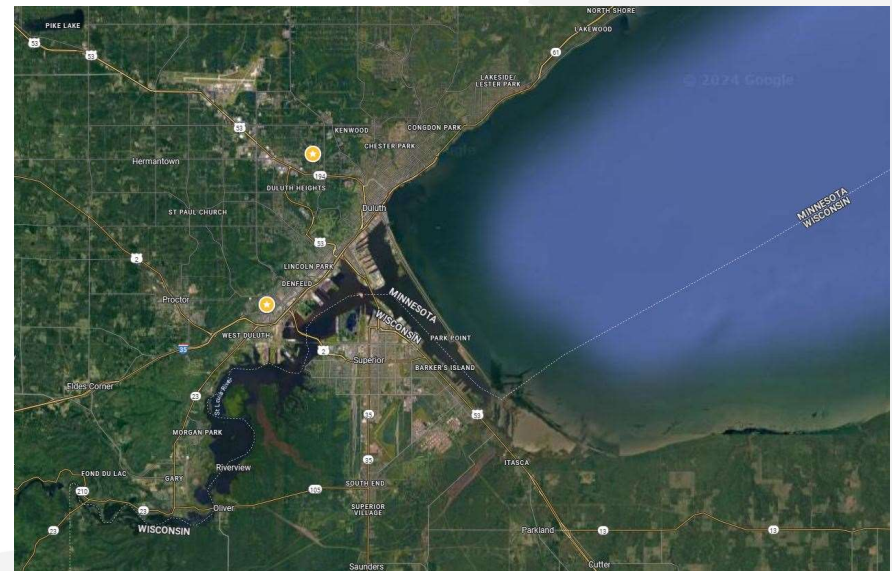
Future Plans



- **The Duluth area AREDN Mesh Network...**
 - Research
 - AREDN documentation
 - AREDN experts in other locations
 - Willamette Valley
 - <https://willamettevalleymesh.net/>
 - Create List Server/Reflector
 - Local testing/Remote testing/Distance testing
 - Location/Distance Surveys



- **The Duluth area AREDN Mesh Network...**
 - Local AREDN Group/Committee
 - One person cannot do this!
 - OM/YM/YL/XYL
 - Local Standards
 - Network architecture
 - Network maintenance
 - Division of labor
 - Help desk



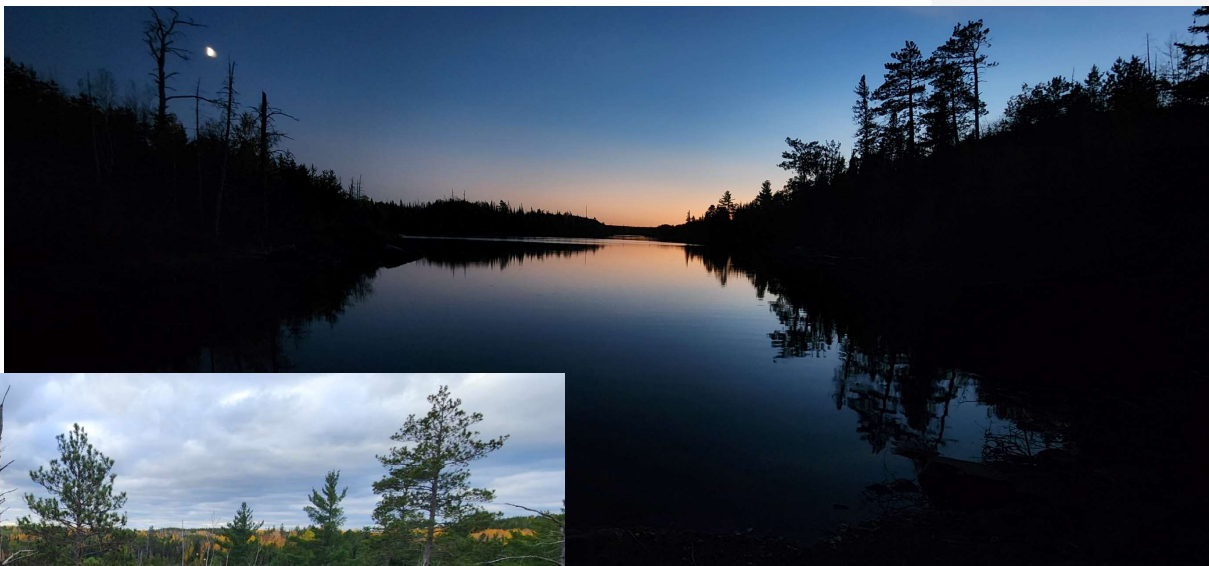


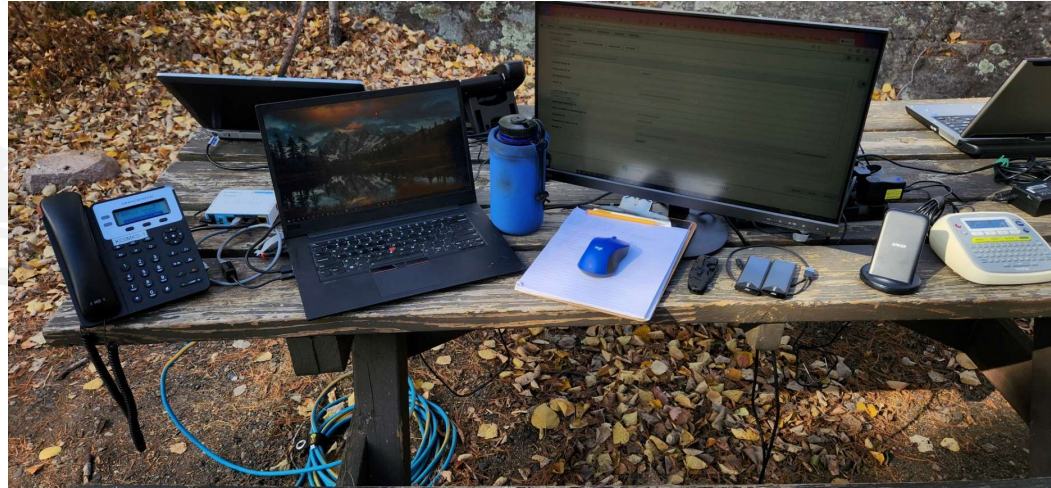
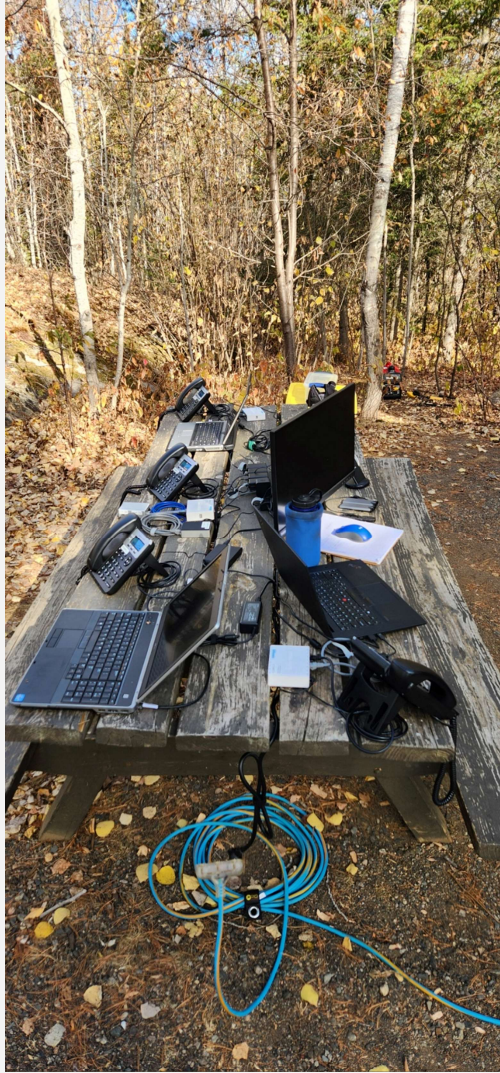
- **The Duluth area AREDN Mesh Network...**
 - Financials
 - Mostly **out of your pocket** expense for your location
 - Apply for ARDC Grant for “backbone” infrastructure mesh network, tower sites and County EOCs
 - County assistance
 - Hospital assistance



Demo!

■ Trail's End Campground...

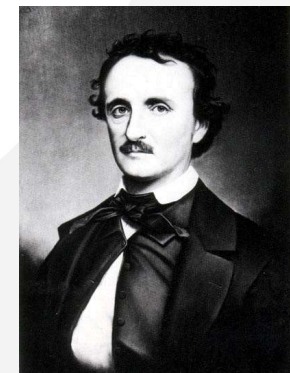
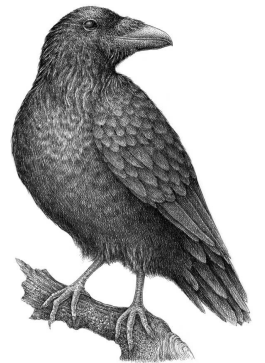






- **Demo stations setup...**

- Power strips
- Power supplies
- MicroTik hAP ac Lite Router (AREDN Firmware)
- POE
 - Edgar Allan Poe? (Never more sayeth the Raven!)
 - Nope! Power Over Ethernet
- IP Phones
- Servers (Web, PBX)
- Laptop(s)





- Web browser stuff...
 - Router GUI
- Ping
 - 10.71.150.113 (Router KC0MKS-6)
- TRACERT
 - `tracert -d 10.71.150.113`

```
C:\Users\jpnas>tracert -d 10.71.150.117
```

```
Tracing route to 10.71.150.117 over a maximum of 30 hops
```

1	<1 ms	<1 ms	<1 ms	10.185.34.73
2	1 ms	2 ms	1 ms	10.72.213.54
3	3 ms	2 ms	2 ms	10.72.242.206
4	4 ms	4 ms	4 ms	10.71.150.117

```
Trace complete.
```




- Web Server
 - Fir
 - Use Router GUI to find FIR server
 - <http://?..?..?>
- Winlink
 - Telnet P2P
 - Forms
 - Files (Max 5.2MB)



- IP Phones
 - PBX GUI
 - Extensions
 - Voicemail
 - IP Phone (Grandstream)
 - IP Direct Dial
 - Extension Call
 - IP Soft Phone (Linphone)
 - Laptop to Grandstream
 - Cell to Grandstream/Cell to Laptop



- Phone Numbers

- KC0MKS-1: 42001
- KC0MKS-2: 42002
- KC0MKS-1: 42003
- KC0MKS-1: 42004
- KC0MKS-1: 42005
- KC0MKS-1: 42006
- KC0MKS-Laptop: 42800
- KC0MKS-Cell: 42801



"Ultimate Question of Life, the Universe, and Everything"
"42"

-Deep Thought



Q & A