WIRELESS MESH USING AMATEUR RADIO EMERGENCY DATA NETWORK

AREDN™
AMATEUR RADIO EMERGENCY DATA NETWORK

SUMMARY

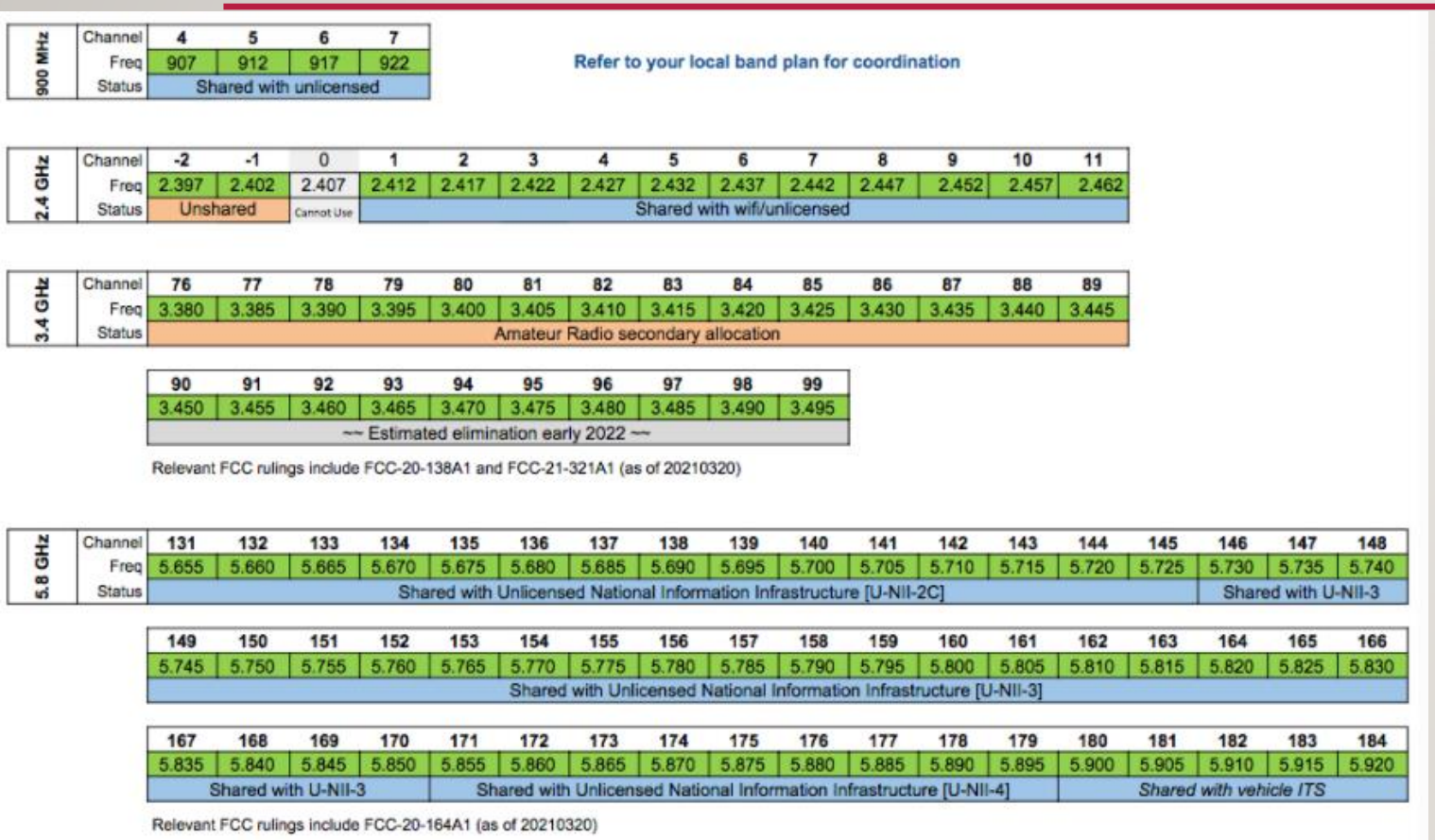
- What is AREDN?
- Frequencies
- Hardware and Firmware
- Ubiquiti Antennas
- Use cases and deployment in Maine
- Demo

WHAT IS AREDN

Amateur Radio Emergency Data Network (arednmesh.org)

- What is AREDN? (Amateur Radio Emergency Data Network)
- Uses commercial off the shelf low-cost wireless equipment (access points) to create a self discovering network. (Ubiquiti, TP-Link, Mikrotik and GL.Inet)
- The access points are loaded with the AREDN firmware and become ham radios.
- AREDN development team formed in February 2015 to create this firmware
- AREDN team includes Project Managers, Programmers and Testers (All volunteers)

FREQUENCIES



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

Refer to your local band plan for coordination

2.4 GHz															
	Channel	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11
	Freq	2.397	2.402	2.407	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447	2.452	2.457	2.462
	Status	Unshared		Cannot Use	Shared with wifi/unlicensed										

3.4 GHz															
	Channel	76	77	78	79	80	81	82	83	84	85	86	87	88	89
	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	Amateur Radio secondary allocation													

90	91	92	93	94	95	96	97	98	99
3.450	3.455	3.460	3.465	3.470	3.475	3.480	3.485	3.490	3.495
~~ Estimated elimination early 2022 ~~									

Relevant FCC rulings include FCC-20-138A1 and FCC-21-321A1 (as of 20210320)

5.8 GHz																			
	Channel	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148
	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 Unlicensed National Information Infrastructure [U-NII-2C]															Shared with U-NII-3		

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 Unlicensed National Information Infrastructure [U-NII-3]																	

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 U-NII-3				Shared with Unlicensed National Information Infrastructure [U-NII-4]									*Shared with vehicle ITS*				

Relevant FCC rulings include FCC-20-164A1 (as of 20210320)

- 900 Mhz
  - 4 Channels and shared
- 2.4 Ghz
  - 13 Channels, 11 shared and 2 unshared
- 3.4 Ghz
  - 14 Channels shared, 10 removed
- 5.8 Ghz
  - 54 Channels (lots of room)
  - All shared

HARDWARE AND FIRMWARE

- Supported Platform Matrix (arednmesh.org)
- Mikrotik, Ubiquiti, TP-Link and GL.iNet
  - MIMO (Multiple Input Multiple Output) is a must. Horizontal and Vertical polarization at the same time with dual antennas.
- Firmware creates the core critical needs for a self discovering network. Assigns IP addresses and allows for hostnames to be set (DNS and DHCP)
- AREDN® Documentation (arednmesh.readthedocs.io/en/latest)

LINE OF SIGHT (LOS)

- LOS is a must. (get above tree line or between them)
- Microwave signals can go over 30 miles. (or one tree!)
- Two's company and Tree's a crowd ☺ (Per Orv W6BI)
- Demo Ubiquiti free LOS tool (link.ui.com)

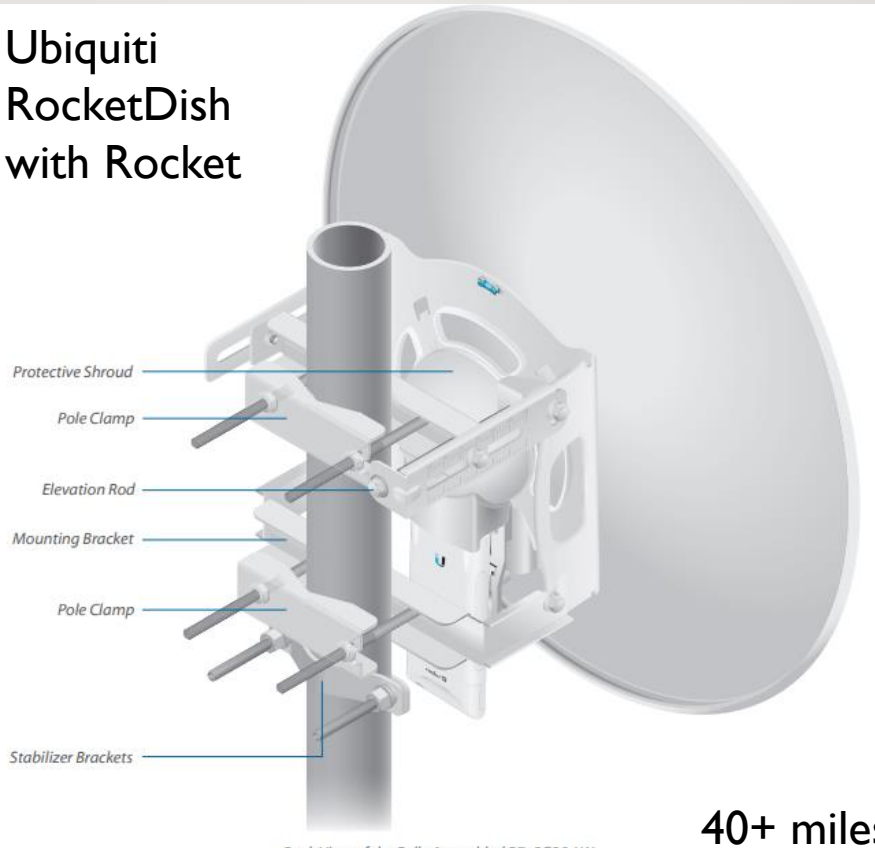
POINT TO POINT (REPEATER SITE) GEAR

The Mikrotik Basebox has 30 dBm of power output. When fed to a 30dBi gain dish that's 1 KW of ERP. Use caution!

Ubiquiti
PowerBeam M5
400mm 25dBi

25+ miles

Ubiquiti
RocketDish
with Rocket



Back View of the Fully Assembled RD-5G30-LW

40+ miles

Mikrotik
mANT30
with
BaseBox 5

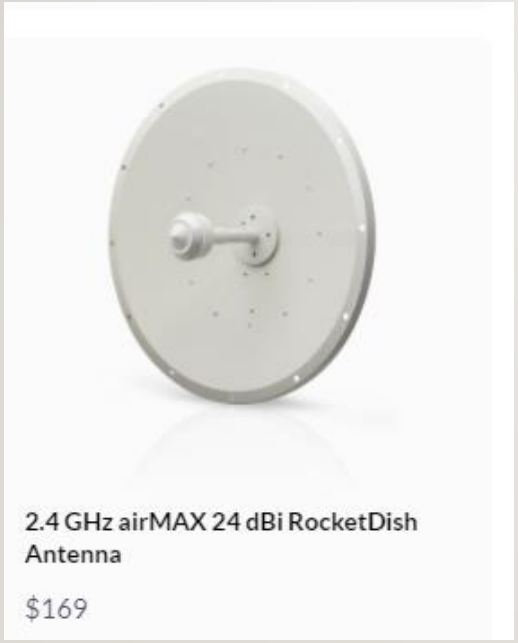
45+ miles

UBIQUITI ANTENNAS (FOR ROCKETS M2 OR M5)

airMAX Omni 5 GHz, 13 dBi Antenna

$165

7° beamwidth that goes 360° all the way around. downtilt is 4°



2.4 GHz airMAX 24 dBi RocketDish Antenna

$169

5° beamwidth

airMAX Sector 5 GHz, 120°, 19 dBi Antenna

$139

4° beamwidth that goes 120°side to side. downtilt is 2°

airMAX Sector 2.4 GHz, 120°, 15 dBi Antenna

$139

9° beamwidth that goes 120° side to side. downtilt is 4°

airMAX Sector 5 GHz, 120°, 16 dBi Antenna

$79

8° beamwidth that goes 120° side to side. downtilt is 4°

HOME AND PORTABLE GEAR

(Most common and recommended)

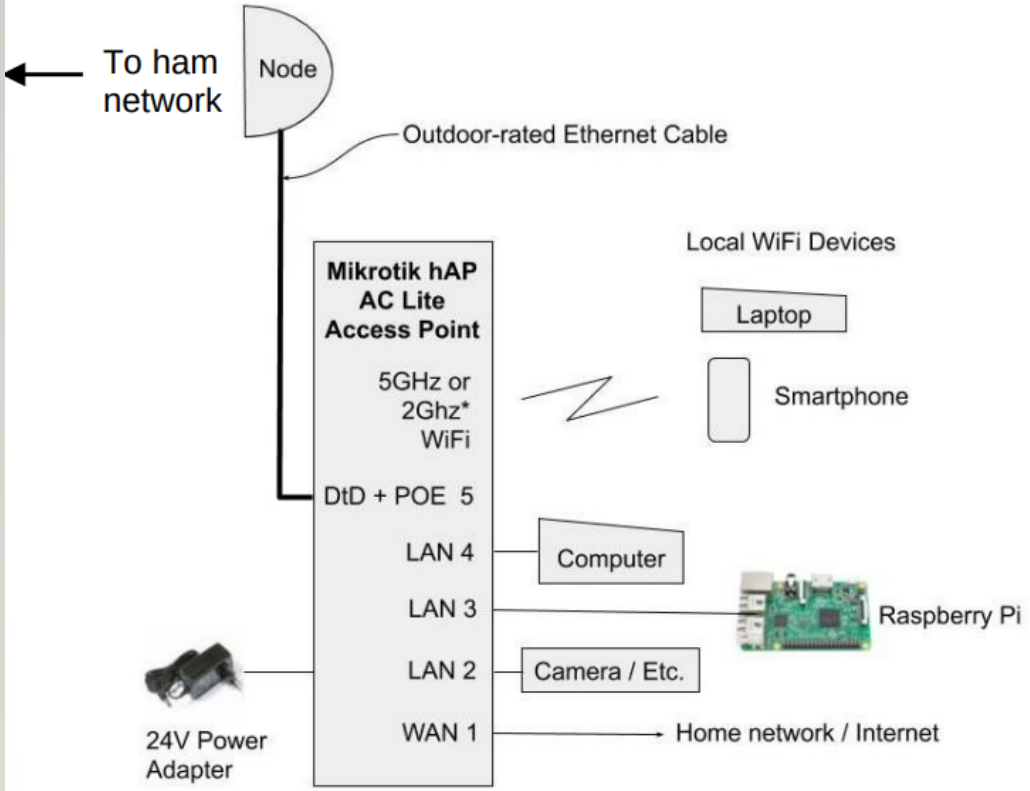
Ubiquiti

MikroTik

GL.iNet
(indoor rated)

HOME AND PORTABLE GEAR

Mikrotik hap ac lite running AREDN Firmware. (below is from Orv W6BI)



- Port 1 – Wired connection to home network
- Ports 2-4 – other devices on your ham network
- Port 5 provides POE power plus DtD (Device to Device) link for routing info to/from node – your link to the mesh network
- 2 & 5 GHz internal radios can be used as ham network node (2 GHz only), wireless access points or wireless access clients.
- Wired this way, devices on ports 2-4 or connected via the internal wireless access point have access to both the hamnet and the internet.
- The AREDN software firewalls the hamnet off from your home network.

USE CASES

- Emergency communication (The "E" in AREDN)
- Data backbone (provides for services and our own intranet running on its own with no reliance on the internet)
  - Repeater (digital linking)
  - Packet Radio (20Mbps + backbone)
    - ✓ BPQ node at each site (as needed) connected to the mesh
    - ✓ BPQ node to node super fast over the Mesh
    - ✓ VHF/UHF 1200 baud still in place (mesh gets higher quality priority routing)
    - ✓ Excellent emergency Statewide coverage
  - VOIP communication (PBX, direct dial phone to phone)
    - Teamtalk running on raspberryPI voice and video QSO's
    - Teamtalk works with smart phone, PC (Linux, Windows and Mac)
  - Camera equipment (PTZ types for fire reporting/surveillance)
  - Web services and data sharing

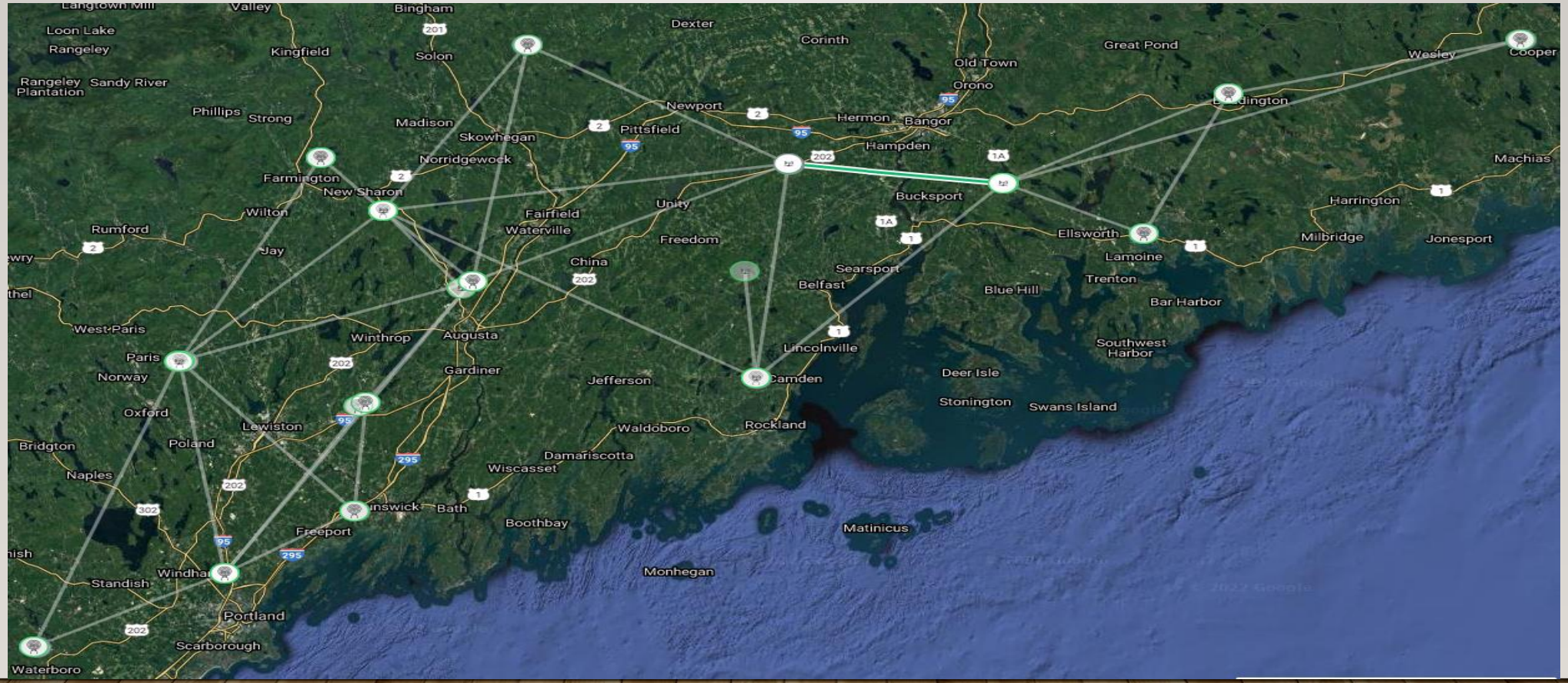
DEPLOYMENT IN MAINE

- Lots of possibilities
  - ✓ Use of current repeater sites is a must to create a backbone
  - ✓ Grant money needed to fund this effort
    - ➢ Amateur Radio Digital Communications at ampr.org (501c3)
    - ➢ ARRL will be offering limited funds starting in April 2022
  - ✓ 5.8Ghz as the point-to-point backbone (to mesh repeater sites)
    - ▪ Lots of channels to use to prevent overlap/interference
  - ✓ 2.4Ghz with an omnidirectional for home/remote access per sites
    - ▪ Use 5Mhz width so we can divide between 2 channels per site
  - ✓ Packet BPQ nodes connected at sites (as needed) with VHF or UHF 1200bps access

DEPLOYMENT IN MAINE

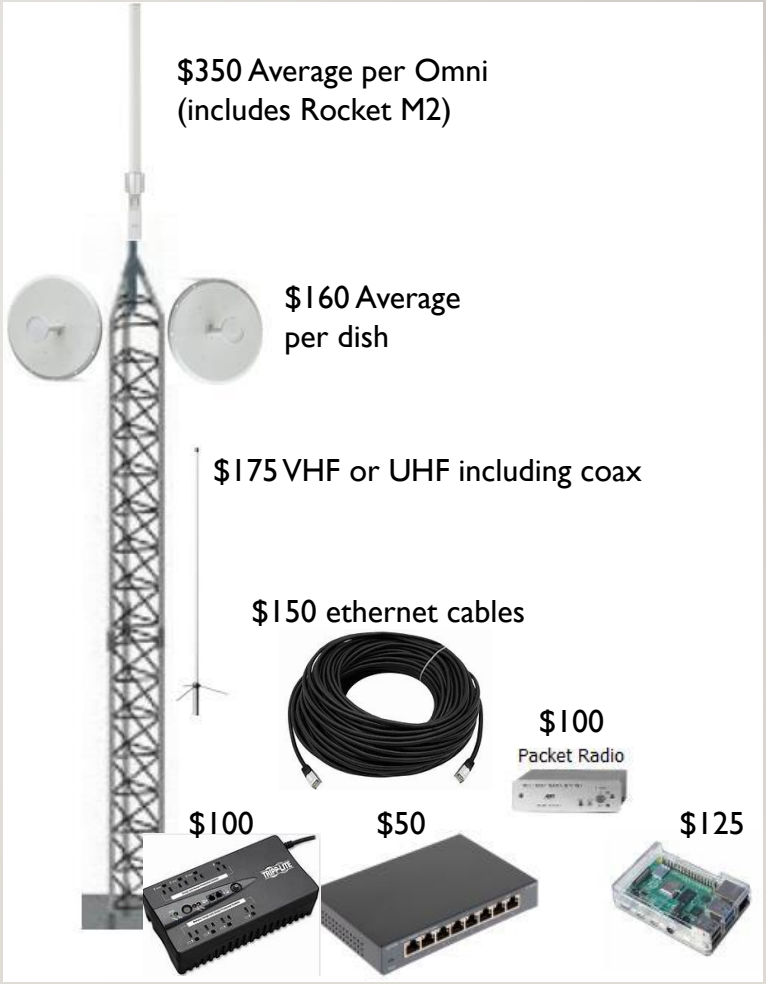
Link (ui.com) Demo (Map of what a future mesh backbone could look like)

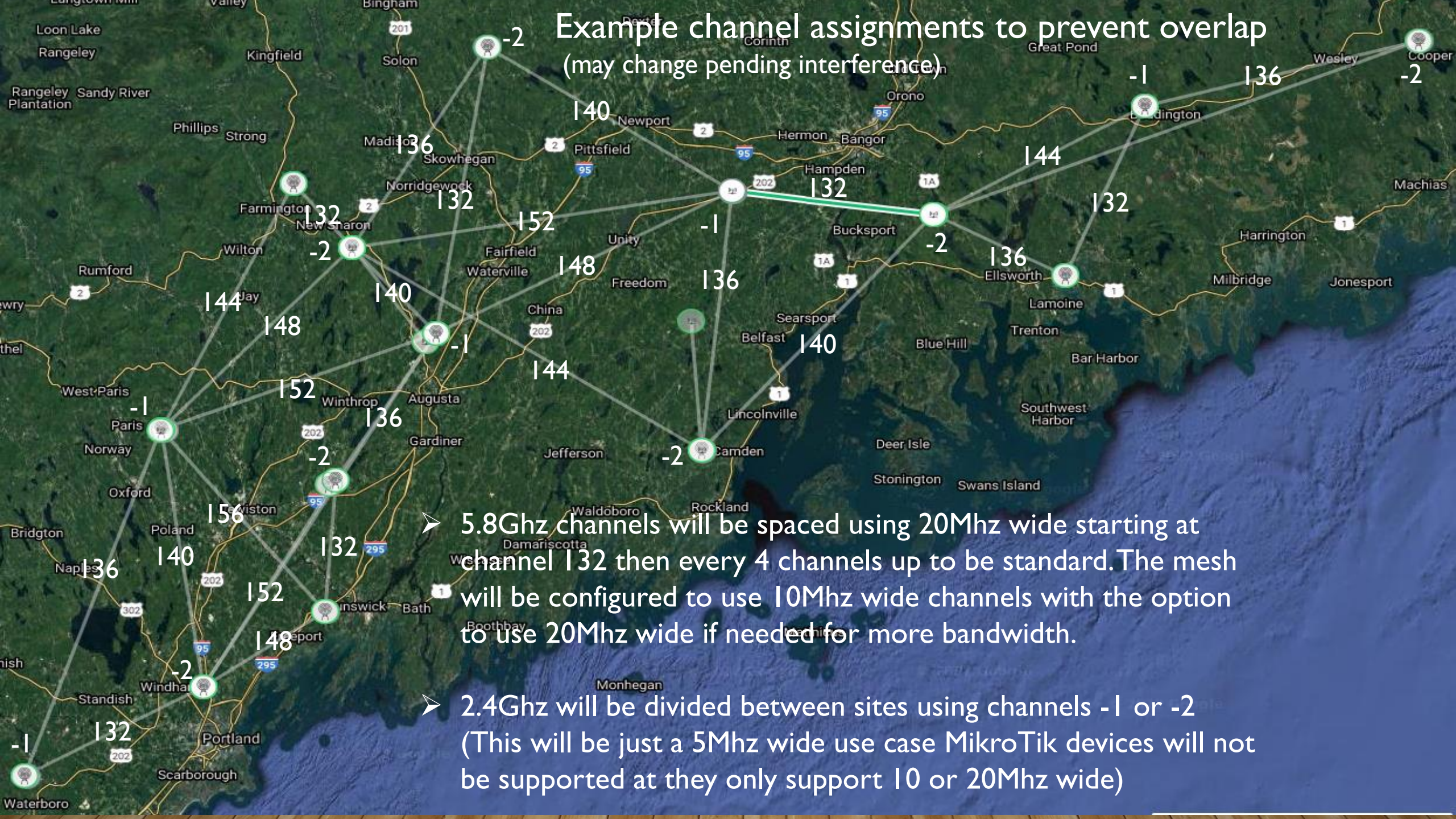
- Great free Line of Site (LOS) survey tool to show how current repeater sites could be linked



DEPLOYMENT EXAMPLE

- ✓ 3 (5.8Ghz) +/- point to point dish's (pending on need)
- ✓ 1 (2.4Ghz) omni + Rocket M2
- ✓ VHF or UHF omni for packet, coax and packet radio
- ✓ 1 RaspberryPi (BPQ node and other services as needed)
- ✓ 8 port VLAN capable switch (device to device connections)
- ✓ Small UPS (connect POE, switch and RaspberryPi)
- ✓ Shielded UV rated ethernet cables
- ✓ Certified tower climbers ($100 per hour)





- 5.8Ghz channels will be spaced using 20Mhz wide starting at channel 132 then every 4 channels up to be standard. The mesh will be configured to use 10Mhz wide channels with the option to use 20Mhz wide if needed for more bandwidth.
- 2.4Ghz will be divided between sites using channels -1 or -2 (This will be just a 5Mhz wide use case MikroTik devices will not be supported at they only support 10 or 20Mhz wide)

HOW TO GET STARTED?

- Cory KU1U has started a working group for this effort for New England. Email Cory (ku1u@nedev.arrl.org) to join in
  - Working on getting a grant to get more repeater locations on the mesh
- Get your own mesh node going (the more involved the bigger the mesh)
  - Device Selection Chart | Amateur Radio Emergency Data Network (arednmesh.org)
  - Supported Platform Matrix (arednmesh.org)
- Join the AREDN forums to build a better understanding (just about every question has been asked and answered (Read!) If you can't find the answer, ask a question)
  - Amateur Radio Emergency Data Network (arednmesh.org)
- Make friends with repeater owners ☺
- Tunnelling in as a temporary solution until an RF link is created. (Like in my live demo today)

DEMO

- Demo Network
- AREDN® is a registered trademark of Amateur Radio Emergency Data Network, Inc

THANK YOU!