CAIECN Project

Cape and Islands Emergency Communications Network

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Presentation To BARC
Sept 5, 2022

Agenda

- What is Mesh? - Jason (via zoom)
- Why MESH for EmComm – Frank (zoom)
- What is CAIECN Doing – Bruce
- What's Next for CAIECN – Tom
- How Can You Help? - Tom

WHAT IS MESH?

What is AREDN

- Amateur Radio Emergency Data Network (AREDN) is a self healing and self configuring mesh network for Amateur Radio Communications
- AREDN is only a mesh networking technology that uses commercial off-the-shelf hardware to provide the basis to move digital traffic

What is Mesh

- Mesh is a network topography where Nodes are linked together to branch out to other devices or nodes
- Mesh networks create multiple routes for information in the network making themselves self healing
- Used commercially for home-based networks (NETGEAR Mesh Network, SONOS, etc.) and being deployed commercially and for government use (Mexico / US Border, etc.)

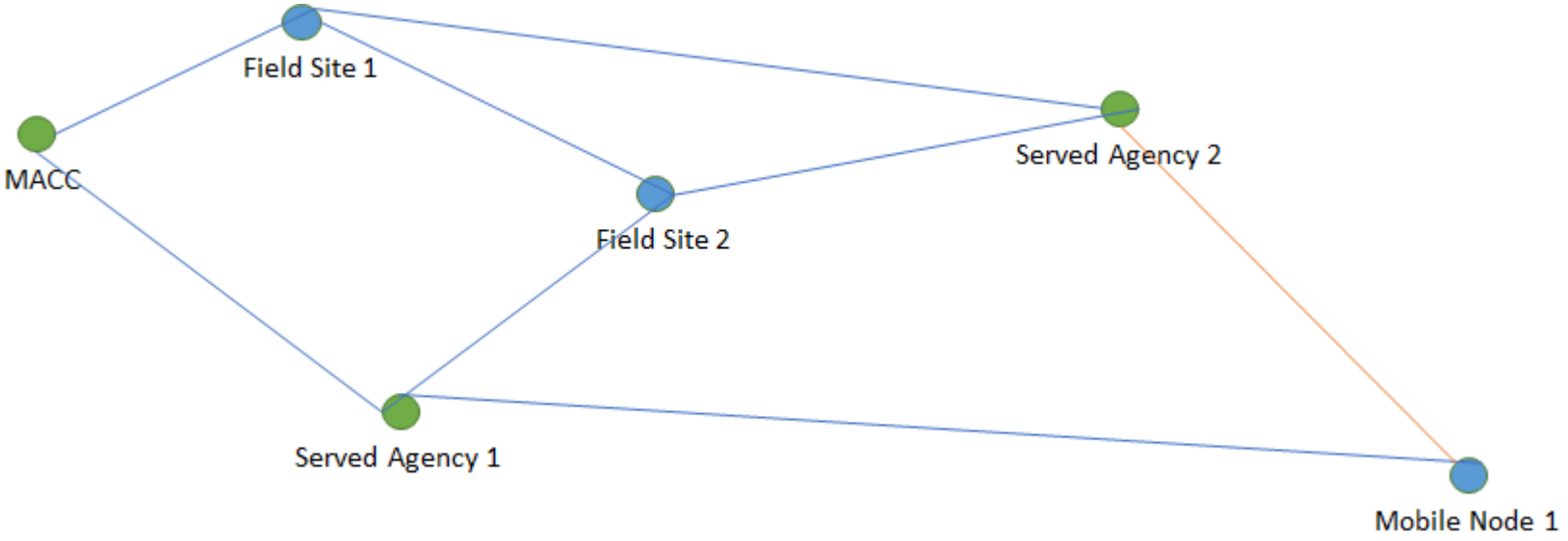
Pros:

- High speed network
- Suitable for digital communications, Limited Voice over IP and Video

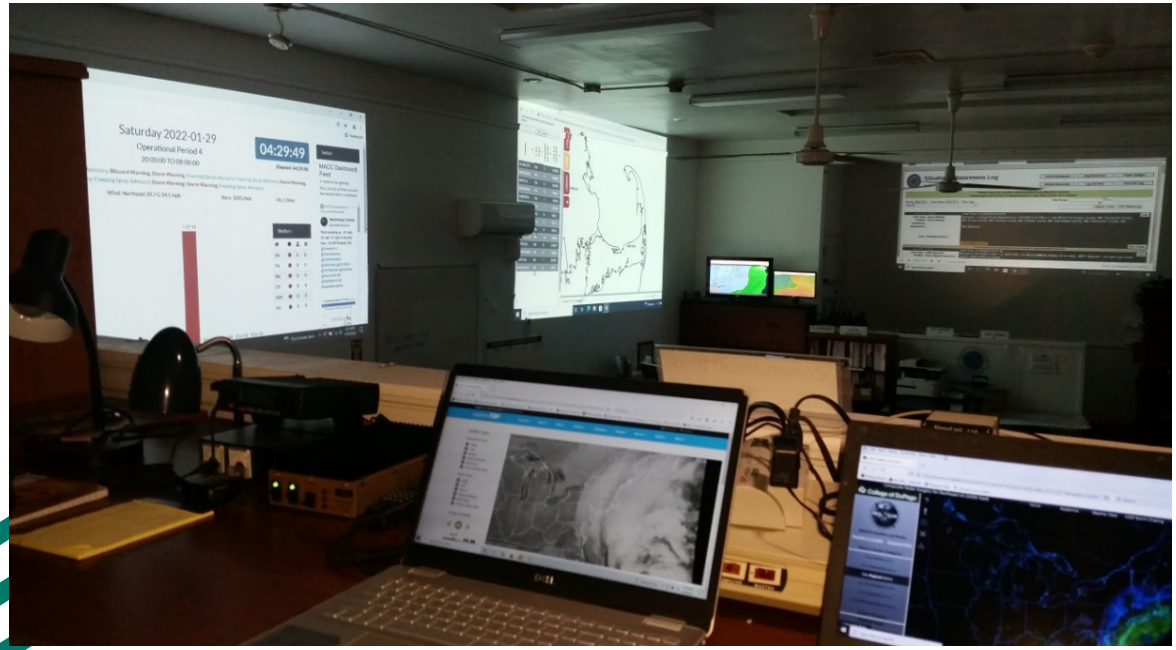
Cons

- Line of sight (factoring FRESNEL zone)
- Relies on hardware that is suspectable to the same issues as other technologies (wind / storm damage, etc.)

Self Healing Mesh Network



WHY MESH for EmComm



CAIECN is focused on providing substitute communications “when all else has failed”

- Internet, no cell service, no public safety (800mHz) are all down
  - Maybe site-specific, maybe wider in scope
- Served agencies will use commercial systems if available
- CAIECN can provide intra- and inter-site voice, video, file transfer (documents, photos, forms…), etc.
- Support provided by mobile mesh nodes
  - Pick-ups with mobile masts
  - Mesh access point with sector antennas and video cameras
  - IP server on Raspberry Pi
  - Old android phones for voice, text, video, and still photos
- We have demonstrated the capability to some public safety personnel
- We are continuing to test to identify the best paths between sites
  - Trees and topography win

EmComm FUNCTIONS

- MeshChat
  - Text messaging via a browser interface between all the nodes in the network
  - Replaces messaging on failed cell service
- IP Phone Network
  - CAIECN personnel would provide pre-configured Android phones to agency personnel
  - Provide basic Voice Communications to agency personnel to replace failed cell service
- Shared Drive
  - Provide source of data for a Common Operating Picture
  - Repository for photos collected from field operations
  - Documents, Spreadsheets, etc.
- Information WebSite
  - CAIECN would provide WiFii network for agency personnel to connect IPAD/Phone browsers
  - Quickly disseminate key information - shelter status, contact phone numbers, chain of command
- Live Video Feeds
  - Feeds from affected areas
- WinLink P2P (telnet)
  - ICS Forms

WHAT IS CAIECN DOING?

First Attempt – July 2021

- Part of ARES Summer exercise
- Basic 3 node mesh over short distance
  - COA – relay node – Oak Ridge School
  - 500ft - 1000 ft between each node
- Functions
  - Mesh Chat
  - Video
  - VOIP Phone Call

COE Node

- Mesh Chat

Un-attended Relay Node

Oak Ridge School Drivay Node

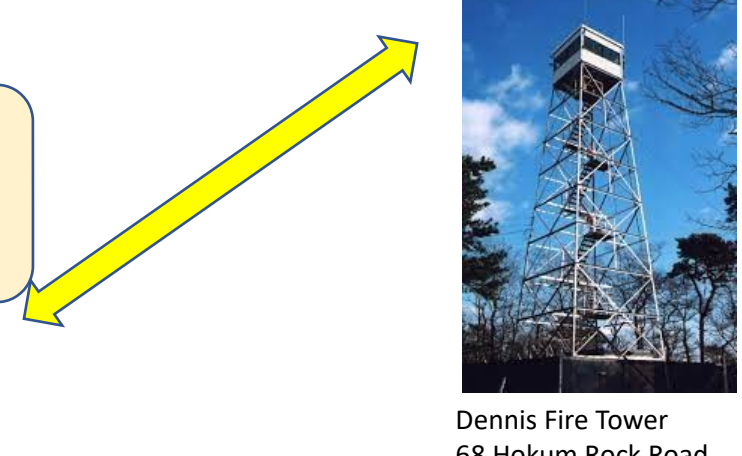
- Video Camera
- VOIP / PBX

Our 2nd Attempt 03/26/2022 – Too Optimistic!

Ant: 120deg sector
Radio:

Ant: Dish RD-5G-34
Radio: Rocket 5AC Light
P2P mode
Network: bridged

Ant:
Radio:
P2P mode
Network: bridged



Dennis Fire Tower
68 Hokum Rock Road
41.734113,-70.183198
-- OR –
Barnstable Fire Tower
(576 Oak St)
41.69164790376069, -70.36043413729752

MACC
3195 Main St
Barnstable
41.700267,-70.30531

Sandwich EOC
270 MeetingHouse Rd
41.72132089357992, -70.46055922835717

Dennis Fire Tower –
Cabin 60ft above ground level

EOC to Dennis FT
14 mi 86 deg

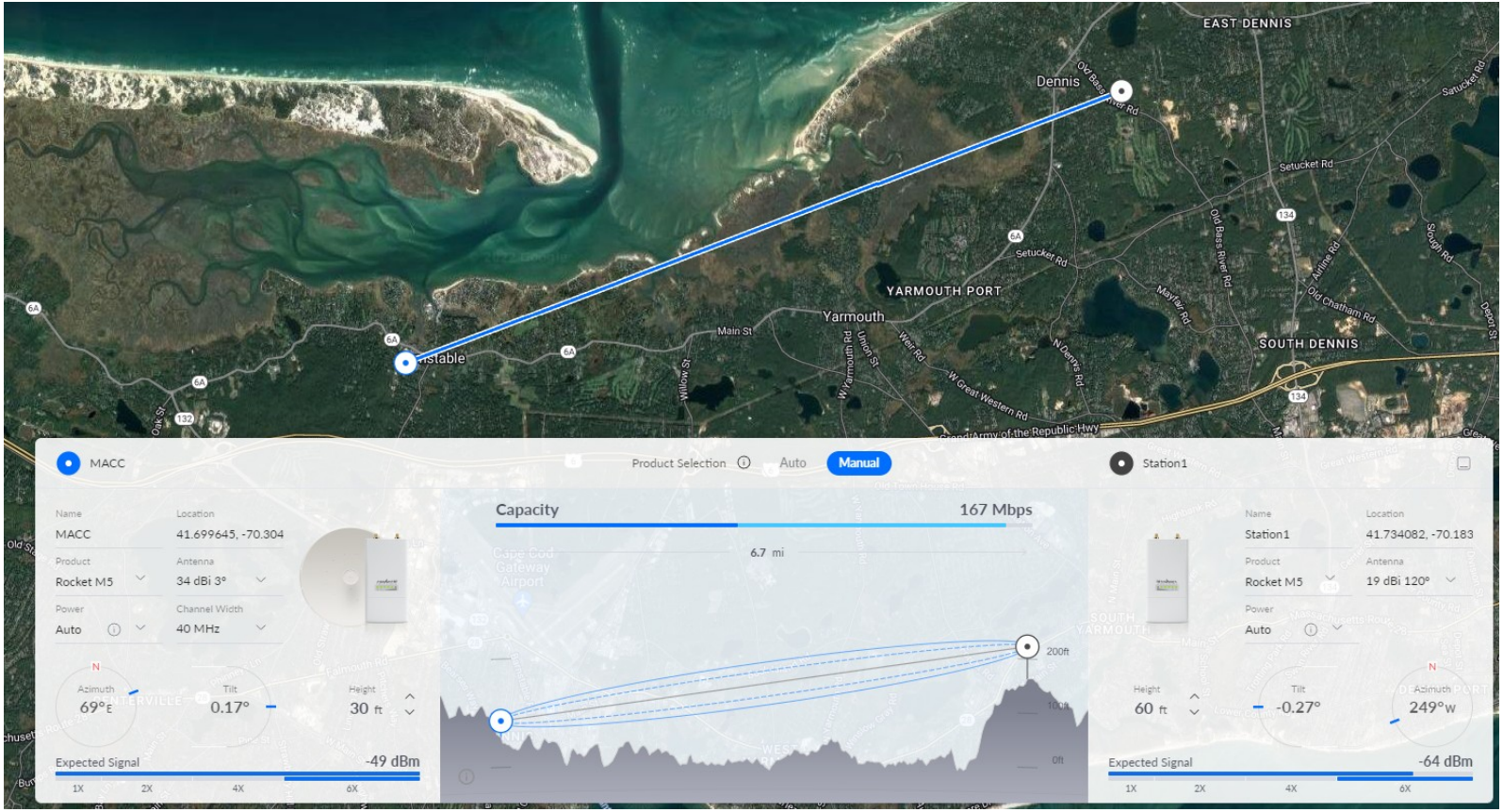
MACC to Dennis FT
7mi 69 deg

UBIQUITY Link Quality Tool

However - Does not know about Trees & buildings/structures)

Sandwich EOC to Dennis Fire Tower .. 13 dbi ant at both ends

MACC to Dennis Fire Tower – 6.7 miles –




AREDN
AMATEUR RA
EMERGENCY DATA NE

At the MACC

– telescoping mast with azimuth rotor .. (no elevation control)

March 26 Results –

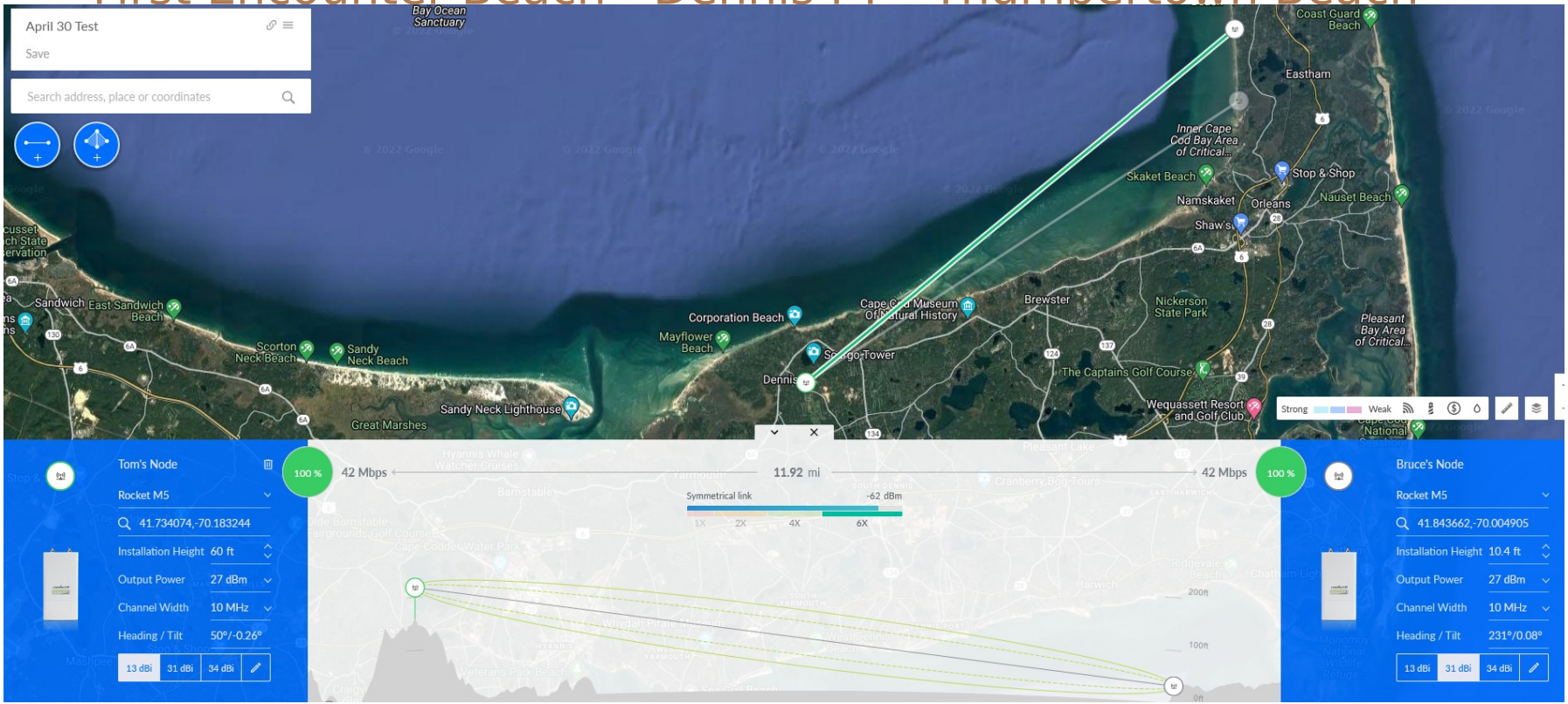
Complete Fail – could not establish links …

- At the MACC
  - We did a parking lot test with the radios and they all worked .. however during the field test discover a bug in the firmware of the radio model I was using that was preventing it going to high power
  - Aiming the dish - while we had a rotator for azimuth .. the elevation angle (+/-) could not be checked. If the tower was not perfectly perpendicular to the ground ..
- At the EOC
  - Radio / antenna combination appeared not to be powerful enough

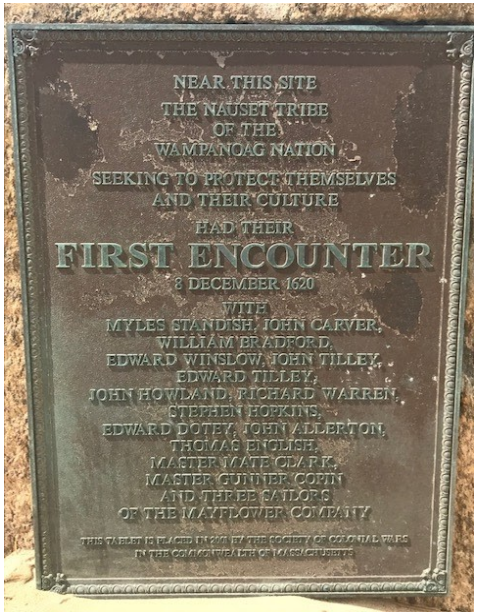
Discovered audio signal level tuning tool to enable you to aim the antennas

3rd Attempt – April 30, 2022

First Encounter Beach - Dennis FT - Thumpertown Beach

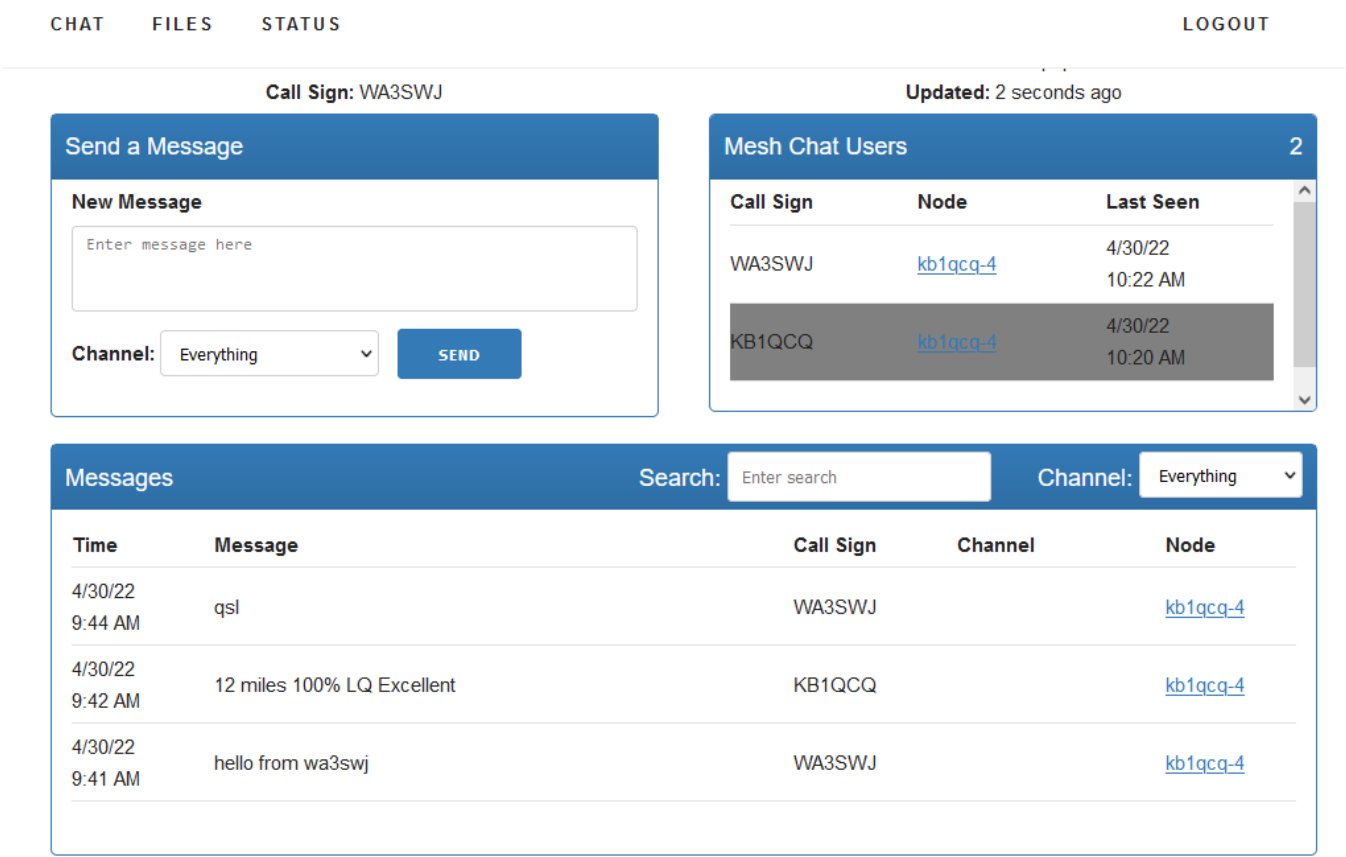


First Encounter Beach - Setup

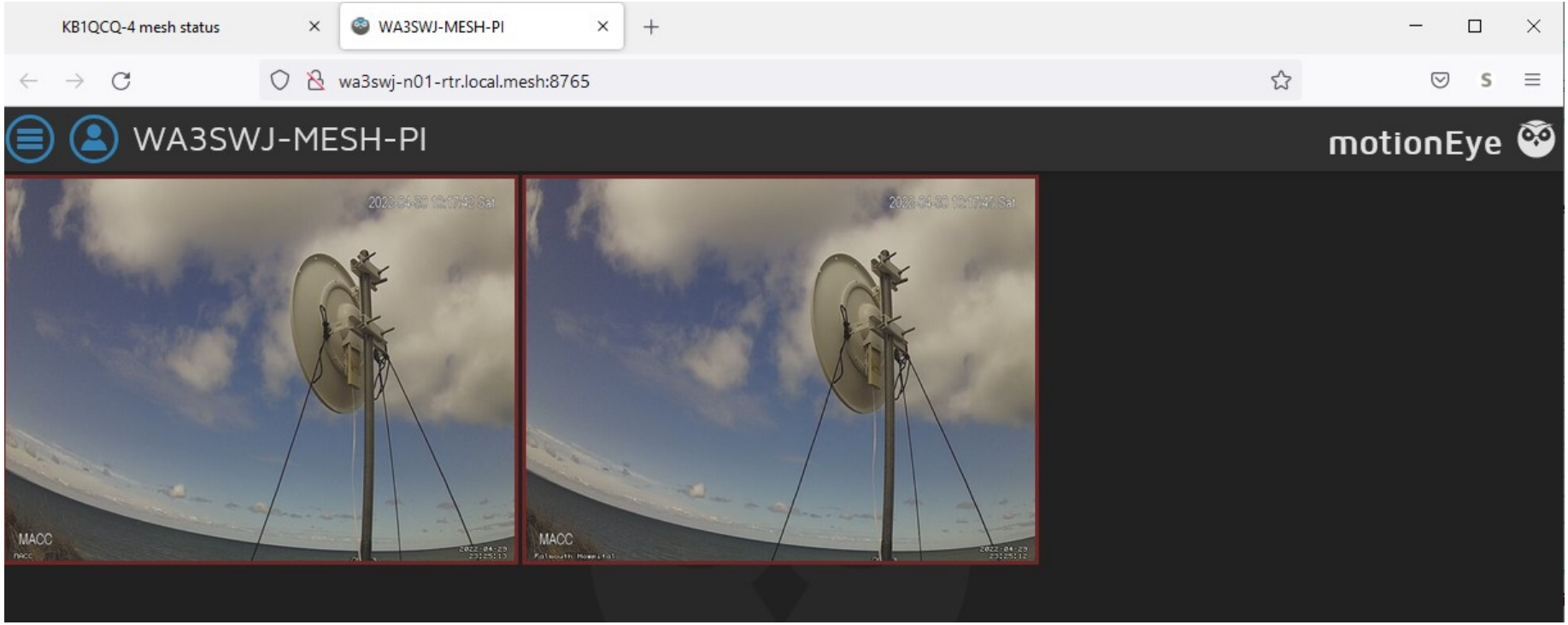


Thumpertown Beach Setup

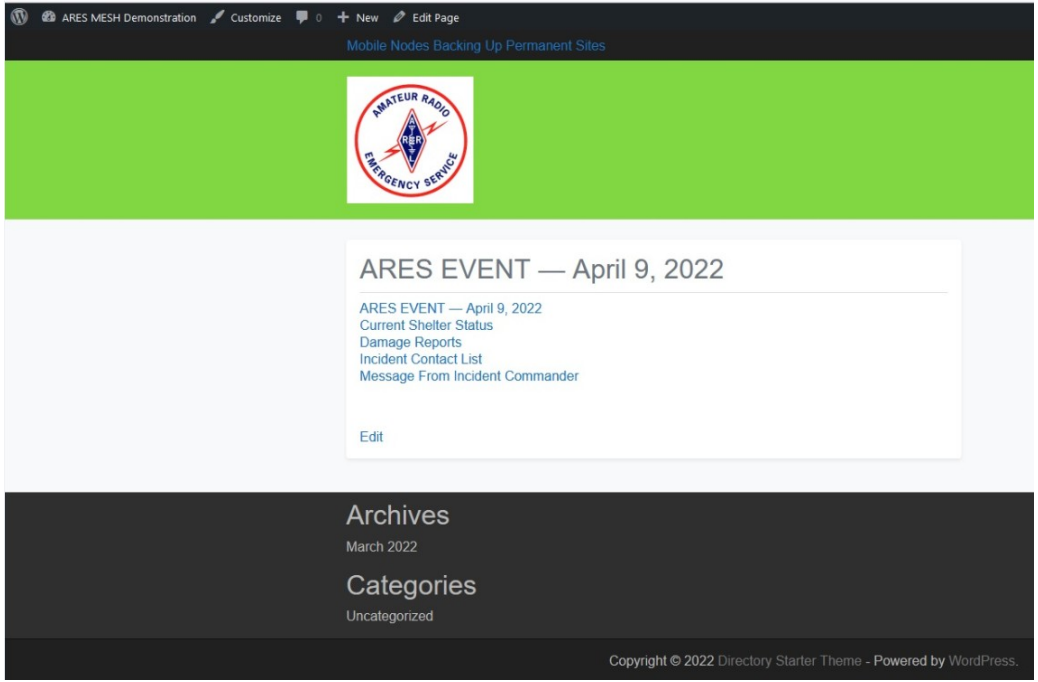
“Mesh Chat” service from KBIQCQ-4 node



The IP Camera view provided by the Motion Eye App. It allows multiple cameras to be displayed from a single WEB URL



Brought up the WebSite ..
Rendered by WordPress Service.



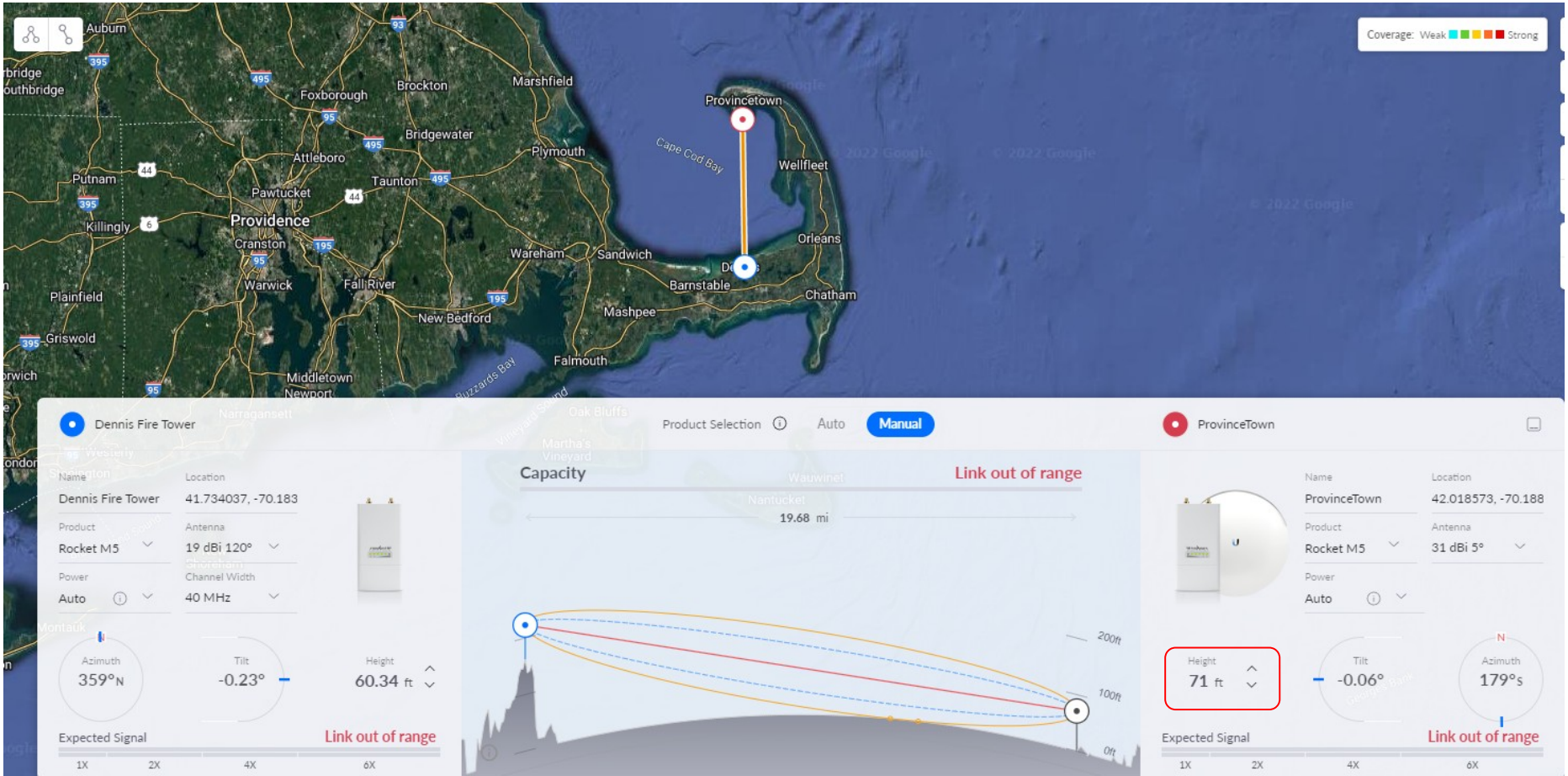
3rd Attempt – June 18, 2022

Try the MACC to Dennis FT link again …

Success – got link established .. but ..
Signals intermittent. Windy day …

Site host preferred we not drive any stakes into ground for guy wires.

20 Mile link – dealing with the curvature of the earth …



Key Take-a-ways … So Far

- Audio signal strength tool provided by Ubiquity equipment is a must for correctly orienting the antennas
- The AREDN (Amateur Radio Emergency Data Network) mesh software works well
  - https://www.arednmesh.org/
- The Fresnel Zone is real .. and becomes more of an issue as the distances increase
  - Line of Sight does not guarantee a connection
  - Curvature of the earth a factor @ 20 miles
- Antenna stability on temporary masts set up “after the storm” is problematic on windy days
  - Ability to stabilize masts up guy lines is needed.
  - May be more a mechanical engineering problem
  - Dish (highly directional) antenna at top of a flexing mast is hard to aim
    - May be better to trade off gain/bandwidth for ease of aiming - establishing a link

What’s Next

- Expanding The Network
- Still working to identify key mobil setup sites
- Goal .. Connect Served Agencies
    - Public Safety
    - MACC
    - Shelter OPs

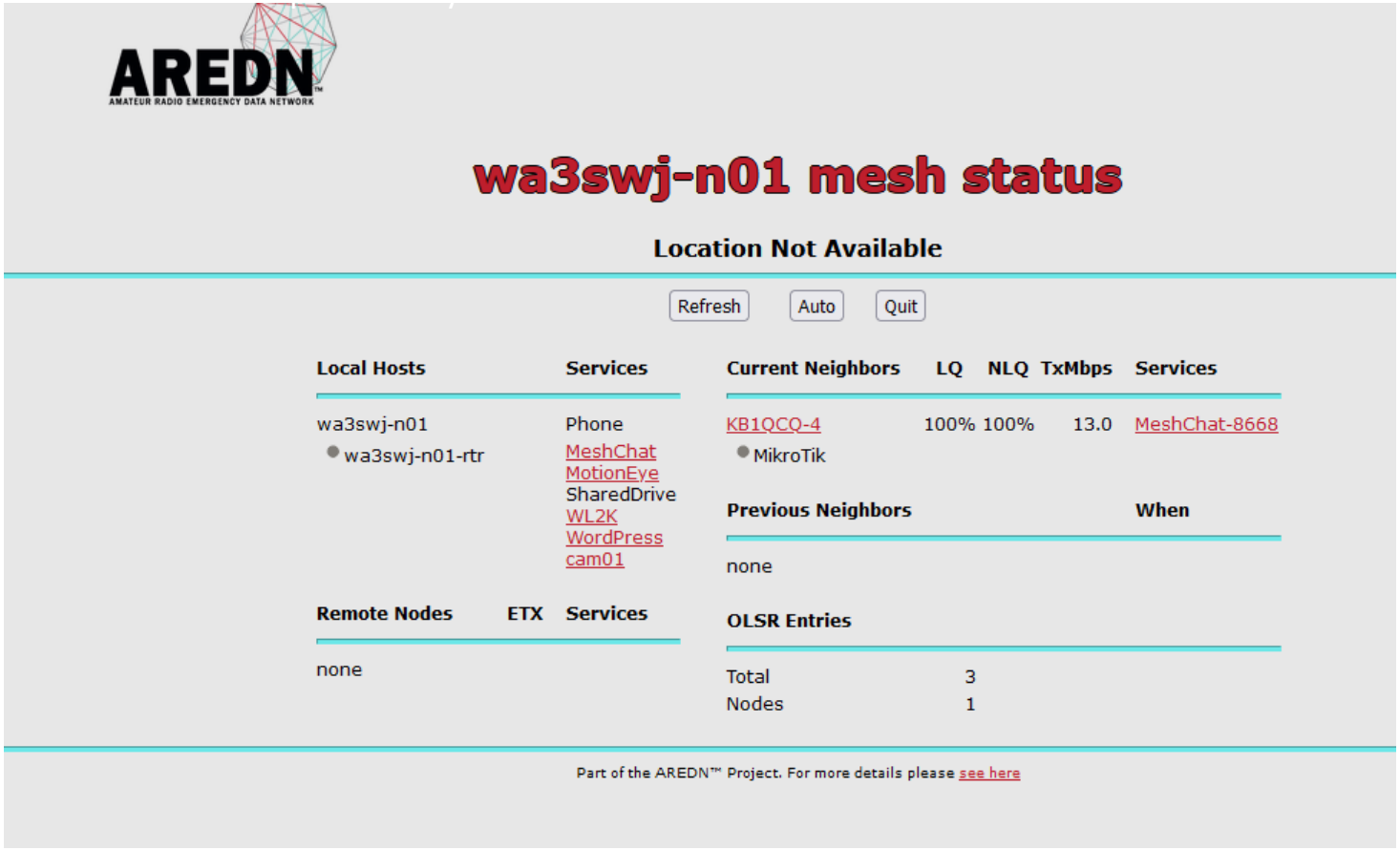
What’s Next

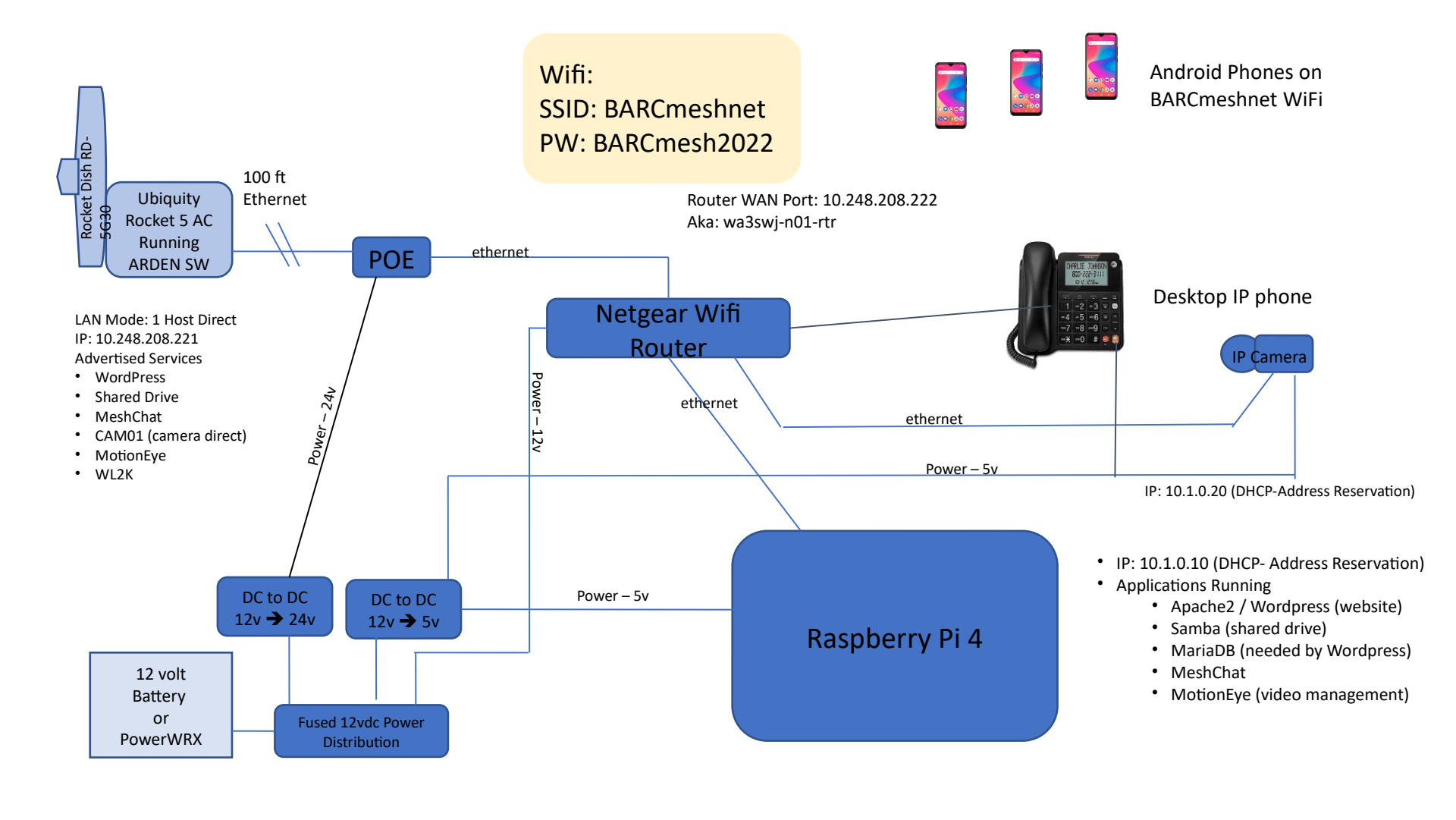
How Can You Help

- Volunteers
- Equipment Donations
    - Old Raspberry Pis
    - Old Routers …
    - Portable Masts
    - Old Android Phones
    - Shielded CAT6 cables
    - POE injectors
    - Laptops
- Databases needed for Offline access (when internet not available)
    - For example Wikipedia Download

QUESTIONS ?

SUCCESS … Got the Dennis FT to Thumpertown Beach Link Established ….




Wifi:
SSID: BARCmeshnet
PW: BARCmesh2022
Android Phones on BARCmeshnet WiFi
Rocket Dish RD-5G30
Ubiquity Rocket 5 AC Running ARDEN SW
100 ft Ethernet
POE
ethernet
Router WAN Port: 10.248.208.222
Aka: wa3swj-n01-rtr
Netgear Wifi Router
Desktop IP phone
IP Camera
LAN Mode: 1 Host Direct
IP: 10.248.208.221
Advertised Services
WordPress
Shared Drive
MeshChat
CAM01 (camera direct)
MotionEye
WL2K
Power – 24v
Power – 12v
ethernet
ethernet
Power – 5v
IP: 10.1.0.20 (DHCP-Address Reservation)
DC to DC 12v ➔ 24v
DC to DC 12v ➔ 5v
Power – 5v
Raspberry Pi 4
IP: 10.1.0.10 (DHCP- Address Reservation)
Applications Running
Apache2 / Wordpress (website)
Samba (shared drive)
MariaDB (needed by Wordpress)
MeshChat
MotionEye (video management)
12 volt Battery or PowerWRX
Fused 12vdc Power Distribution

5 Mhz Band Channel Allocation

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 (max EIRP 1000mW)															Shared with Unlicensed...		

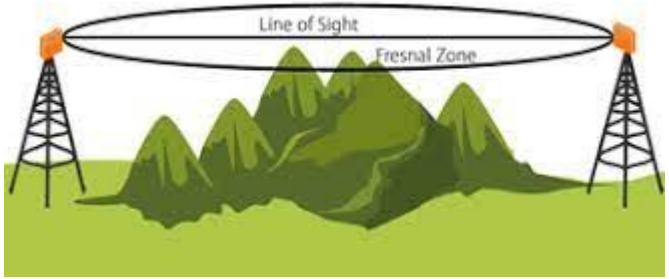
149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166
5.745	5.750	5.755	5.760	5.765	5.770	5.775	5.780	5.785	5.790	5.795	5.800	5.805	5.810	5.815	5.820	5.825	5.830
Shared with US unlicensed indoor/outdoor (max EIRP 200W)																	

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 (max EIRP 200W)									*Shared with Intelligent Transportation System*				

Power limits shown are for non-Amateur services which share the specified channels.

Credit: arednmesh.org

A Fresnel Zone .. (Wikipedia)



Credit proxim.com

A **Fresnel zone** (English: /freɪˈnɛl/ *fray-NEL*), named after physicist Augustin-Jean Fresnel, is one of a series of confocal prolate ellipsoidal regions of space between and around a transmitter and a receiver. The primary wave will travel in a relative straight line from the transmitter to the receiver. Aberrant transmitted radio, sound, or light waves which are transmitted at the same time can follow slightly different paths before reaching a receiver, especially if there are obstructions or deflecting objects between the two. The two waves can arrive at the receiver at slightly different times and the aberrant wave may arrive out of phase with the primary wave due to the different path lengths. Depending on the magnitude of the phase difference between the two waves, the waves can interfere constructively or destructively. The size of the calculated Fresnel zone at any particular distance from the transmitter and receiver can help to predict whether obstructions or discontinuities along the path will cause significant interference.

Agenda (limit to 30 minute presentation)

- (5) What is Mesh? – Jason
- (5) Why MESH for EmComm – Frank
  - Portability
- (5) What is CAIECN Doing – Lem
  - Not trying to duplicate existing commercial systems
  - When all else fails (permanent structures, antennas)
- (5) What EmComm Functions is CAIECN providing – Bruce / Tom
  - Tests we have run
    - Dennis Fire Tower …
- (5) Next Steps for the team – Tom
  - Always looking for more volunteers
- (5) How Can BARC Help .. (send us an email :-)
  - Suggestions … what services do you think we need to provide
  - Hardware donations –
    - Old Raspberry Pies
    - Old Routers …
    - Portable Masts
    - Old Android Phones
    - Shielded CAT6 cables
    - POE injectors
    - Laptops
  - Databases needed for Offline access