## SAR MESH Advanced Networking

## Special Presentation to the 2019 ASRC Winter Retreat

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> 12 Jan 2019 Revision v0.0

## Making a MESH of Things...

- What is this "MESH" technology? Where did it come from?
- Why does it matter, & how can the SAR Community leverage it?
- What Operational Mission Needs does it solve, and what new opportunities does it offer?
- What are MESH characteristics & capabilities?
- What can MESH do that we need, and other systems can't, or are inadequate?
- How about Reliability, Availability, Flexibility, Security, and so many other needs & concerns?
- How difficult is it to setup and use?
- OK, so what's it going to cost us to buy & maintain?
- Sooooo, what do we in the SAR Community do next to capture success??

### Where Did "MESH" Come From?



Amateur Radio Emergency Data Network

The MAJOR Developer of the Revolutionary MESH Technologies is the ARDEN Community!!

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#### Alerts

AREDN highly recommends upgrading to AREDN security release v3.18.9.0 For more information: https://www.arednmesh.org/content/aredn-v31890-available

#### News

#### AREDN Release Notes v3.18.9.0 – 26 September 2018

The AREDN team is pleased to announce the general availability of the latest stable release of AREDN firmware.

This release includes many significant improvements in the underlying OpenWRT code during the last 4 years, from July 2014 to August 2018. It also introduces a major upgrade in OLSR from version 0.6.7 to version 0.9.6.2.

#### **Navigation**

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#### User login

Callsign \*

## MESH (IP) Network Services!!

#### **Network Services**

Connect the disaster area to the outside world















## About that "MESH" Stuff...

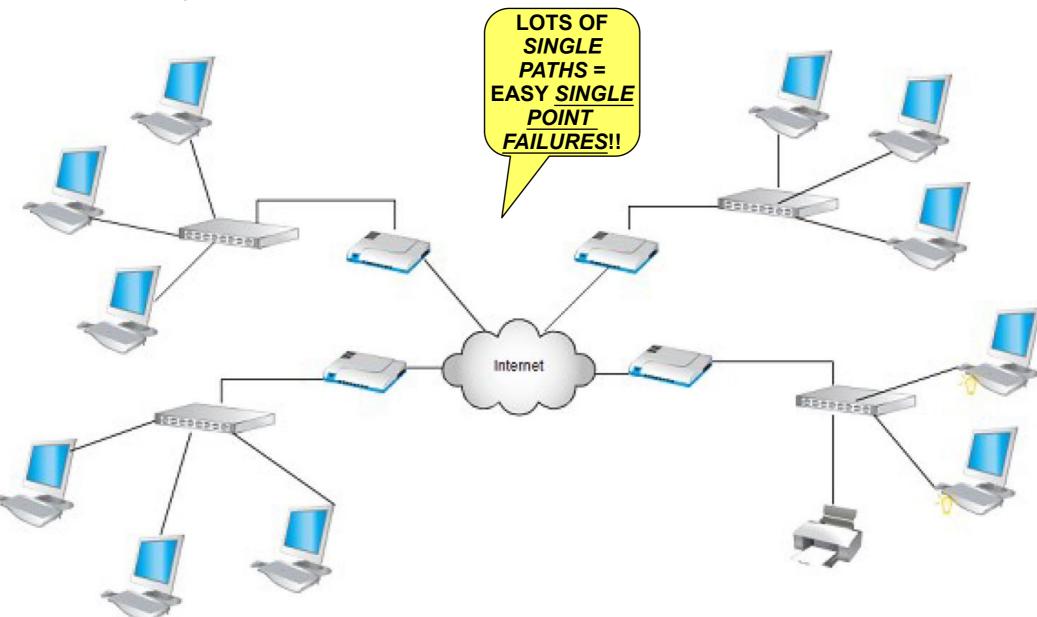
#### Excellent Characteristics for SAR:

- Reliable, Flexible, Survivable, Robust...
- Dynamic Configuration
- Self Healing & Auto ReRouting
- Serves Mobiles in Motion, too!
- Adapts to mitigate lost or failed Nodes
- Especially Fault Tolerant
- IF designed & implemented Right!
- What is this MESH technology?
- Compare to Other Known Systems?
  - Radios, Phones, Cellular, LANs, InterNet....

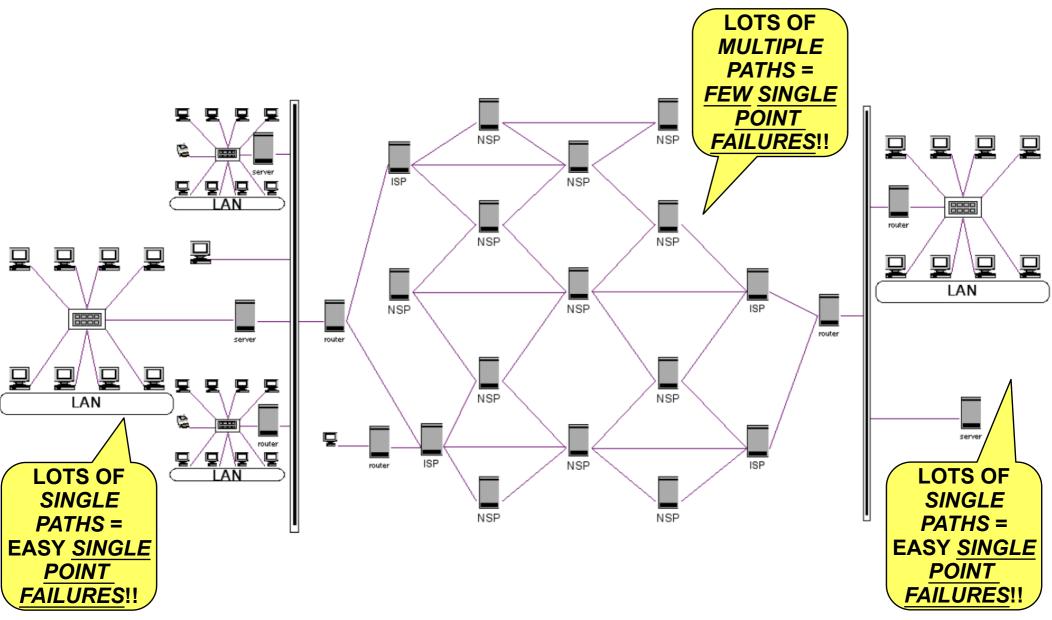
### Placeholder for Radio Networks

- Already discussed earlier...
- Bases, Mobiles, Handhelds...
- Simplex, Duplex....
- Relays, Repeaters, ReTransmitters...
- Of course, IF the radio link dosen't work, OR your radio fails, you're Still Out of Luck!!
- You DO have backup plans, don't you?
- Back to our MESH talk..... ;-)

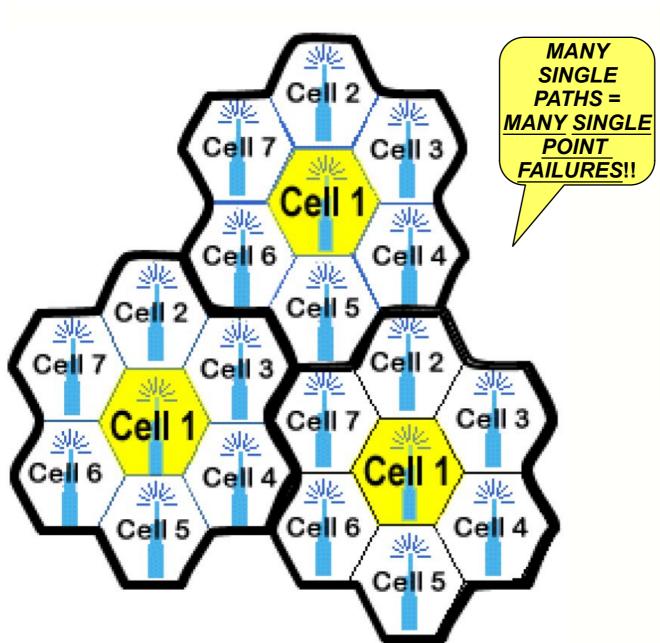
## Typical LANs plus Internet



## LANs with (MESH!!) Internet

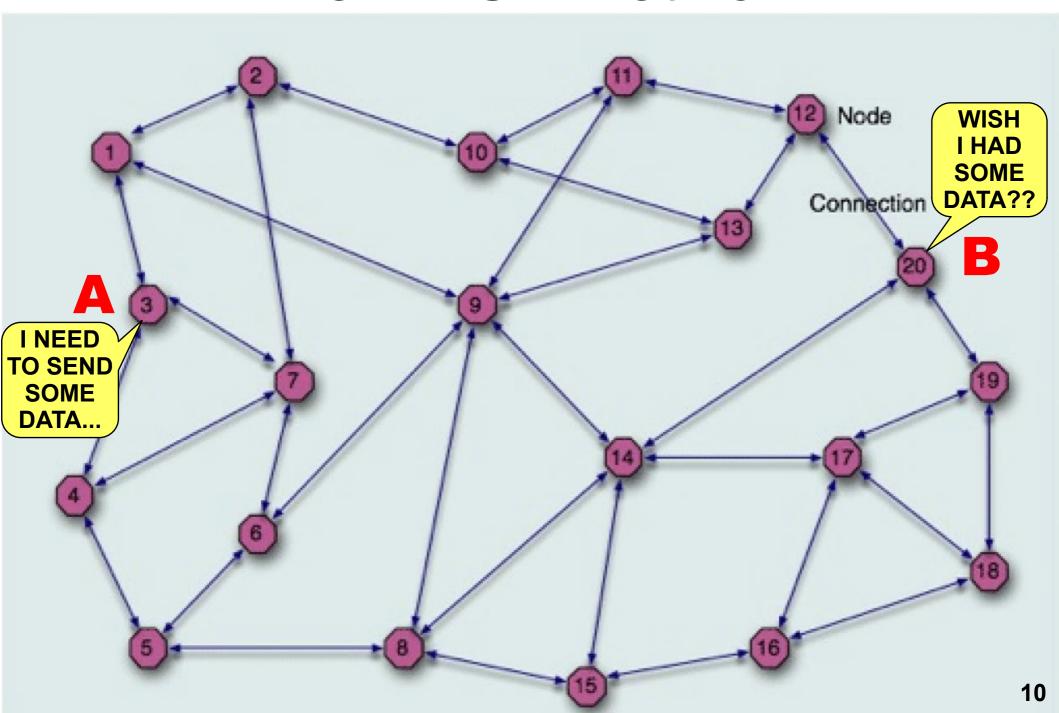


## Cellular Network (Mixed Cases)

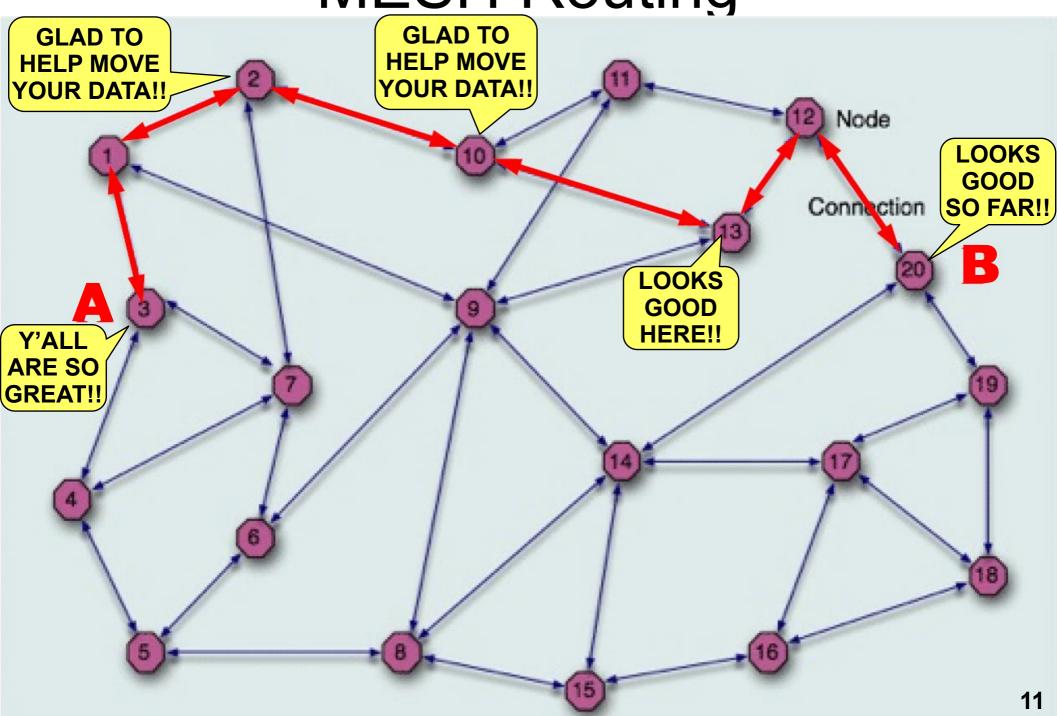




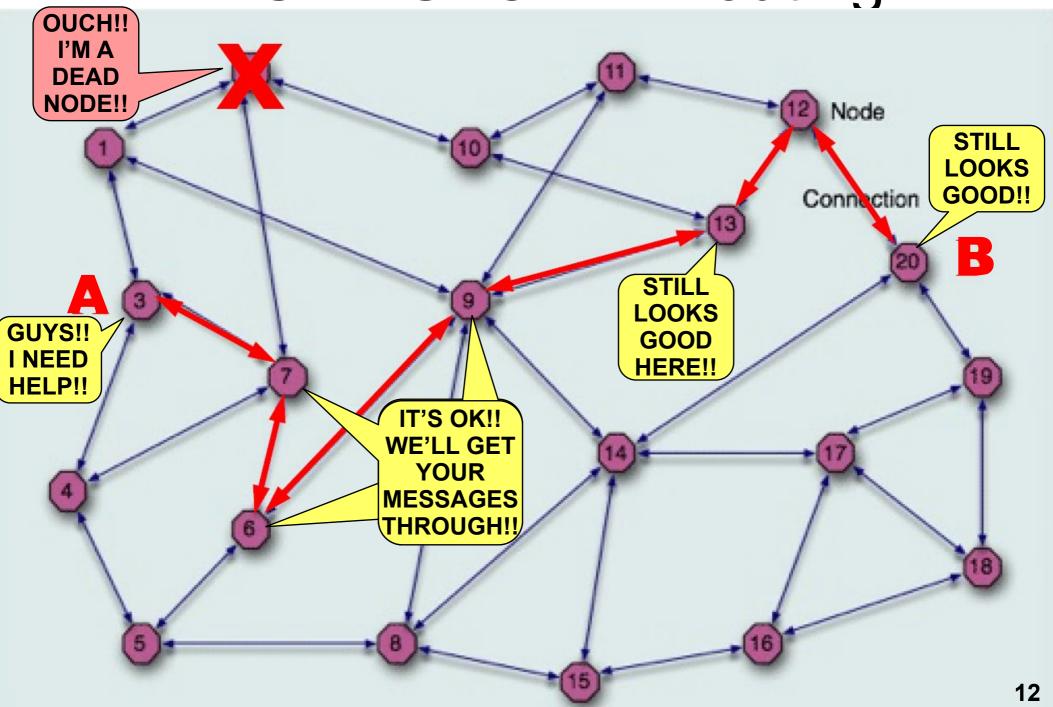
### The MESH Network



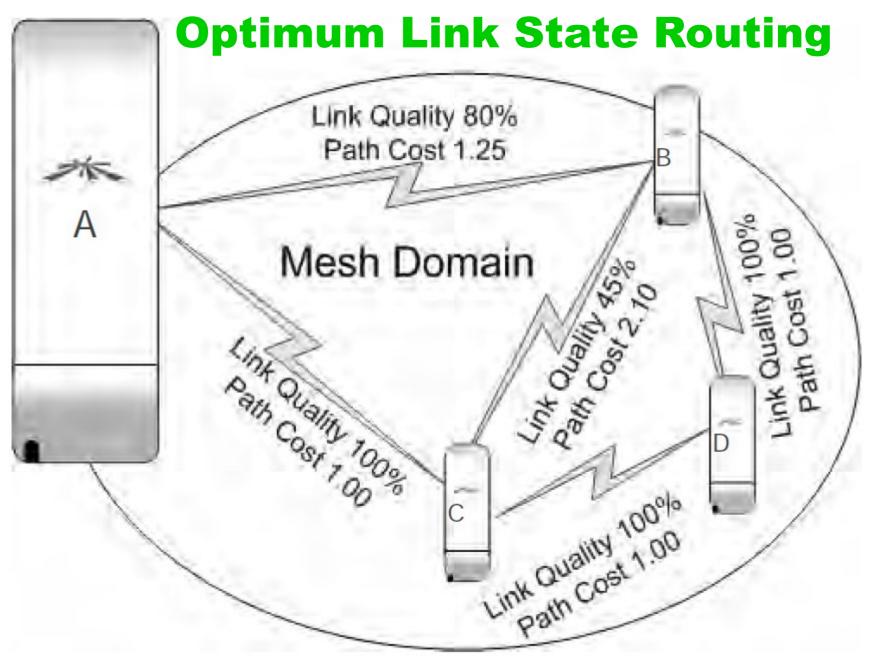
MESH Routing



## MESH AUTO RE-Routing



## MESH Magic Inside - OLSR



## Typical MESH Gear

- High Performance IP Based Data Networking (10-100 Mbps throughput rates)
- Familiar Data Routers & Switches (typical IP based)
- Radio Nodes (any station) & Relays (combined stations)
- Operate in "MicroWave" bands (ISM ~2.4 & 5.9 Ghz) (License-FREE!)
- Flexible Links & Coverage (antenna selections)
  - Omnidirectional (area)
  - Directional (beaming)
- Great for leveraging high points with clear Radio Line of Sight (RLOS)
  - PLUS several options to beat pesky trees & foliage...

## Typical MESH Gear

- Commercial grade durable equipment, but...
- Special "AREDN" MESH Software
- Simple configuration, most fully autonomous & automatic
- Self Configuring, and Failure Tolerant, including mobile movement, or node loss!
- Usually modest 12-24 VDC battery powered! (PoE)
- Can deploy chains of compact & very capable "breadcrumb" Relays!
- Excellent for Rapid Deployment to Remore Areas

### Preferred MESH Gear

#### Primarily Use Ubiquiti airMAX M-series WISP routers

- AirGrid
- AirRouter
- Bullet
- NanoBridge
- NanoStation
- Rocket



#### Robust Specifications

- Power Output: 23 28 dBm (200mW 630mW)
- Antenna Gain: 11 30 dBi
- Temperature: -40° to 176°F
- Some configurations capable of 50+ mile range

#### Also support TP-Link Devices

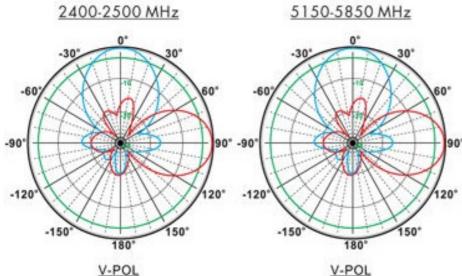
CPE210 & CPE510

#### Also the MikroTik Family of WISP Equipment





The <u>INITIAL</u>
Remote Site
Antennas
For <u>Most</u> Links



Tuvavco TP2458-13-40 13 dBi / 7dBi(?) <u>DualBand</u> ~\$45 total ~ 5" wide x 5.5" high



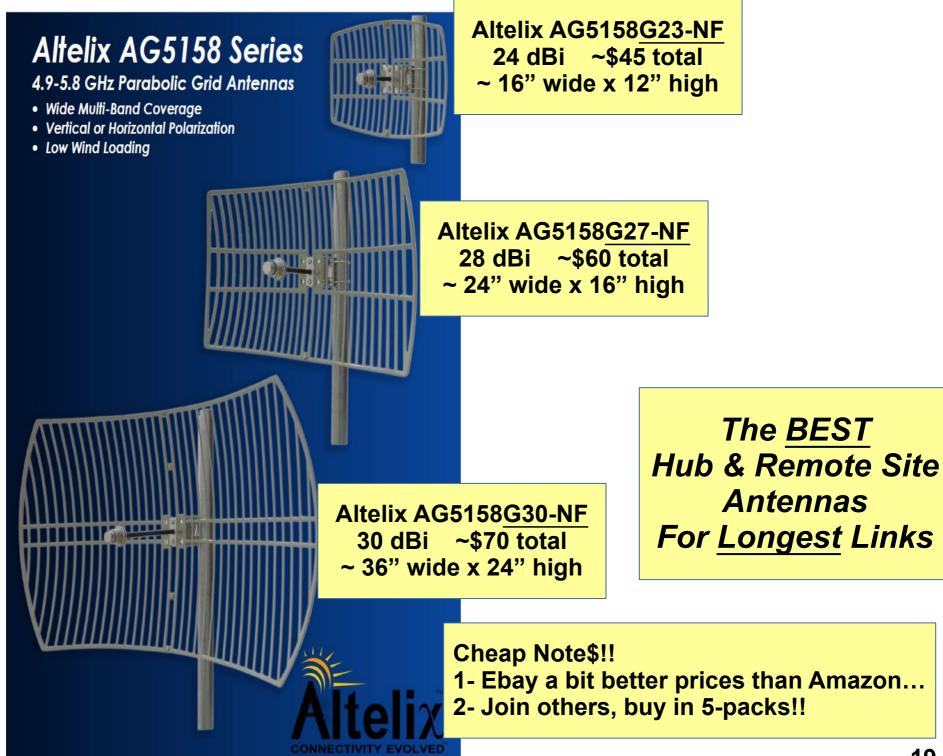
## The <u>BETTER</u> Hub & Remote Site Antennas For <u>Most</u> Links

Altelix AP5158<u>G19M2-NF</u> 19 dBi <u>MIMO</u> ~\$45 total ~ 12" wide x 12" high (Hub INITIAL)

Altelix AP5158<u>G23-NF</u> 23 dBi ~\$45 total ~ 12" wide x 12" high

#### **Cheap Note\$!!**

- 1- Ebay a bit better prices than Amazon...
- 2- Join others, buy in 5-packs!!



## Deployable Node Examples

- Marine Corps Marathon 2018
- Tiny lunchbox size
- Battery box size
- Roller toolbox size (ICP flavored?)
- Small Deployable Hilltop Relays
- Others...

## Marine Corps Marathon 2018 - Medical Data Net

ALPHA NET (NCS) BRAVO

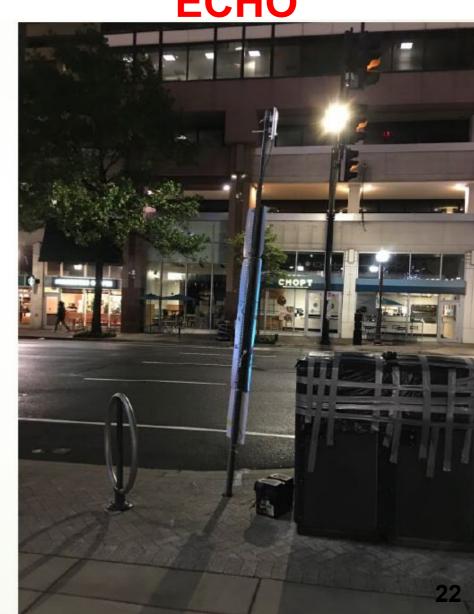






# Marine Corps Marathon 2018 - Medical Data Net





http://www.trevorsbench.com/portable-internet-mesh-node/



http://www.trevorsbench.com/portable-mesh-node-with-voip-and-wifi/



http://www.trevorsbench.com/portable-mesh-node-with-voip-and-wifi/

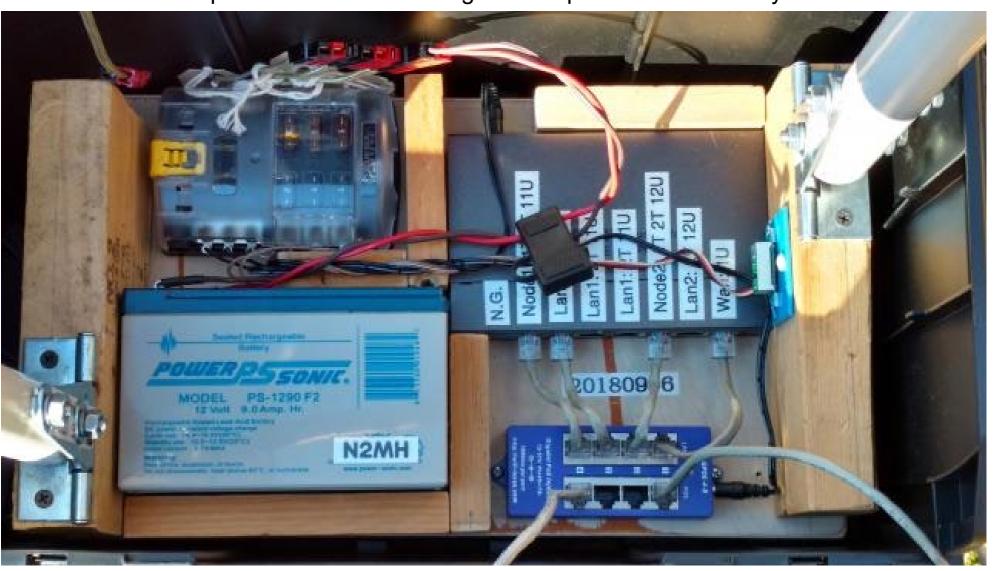


http://www.trevorsbench.com/portable-mesh-node-with-voip-and-wifi/















## MESH Small Hilltop Relays





Small Footprints / Wide Coverage Saddleback Peak - Mission Viejo, CA





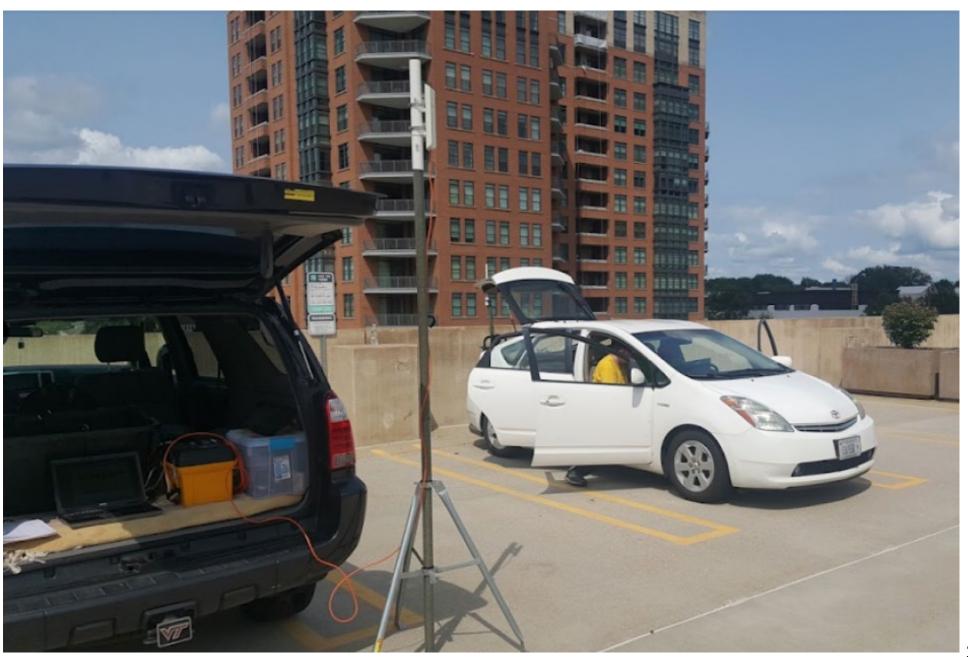
## MESH Deployed Mobile Nodes



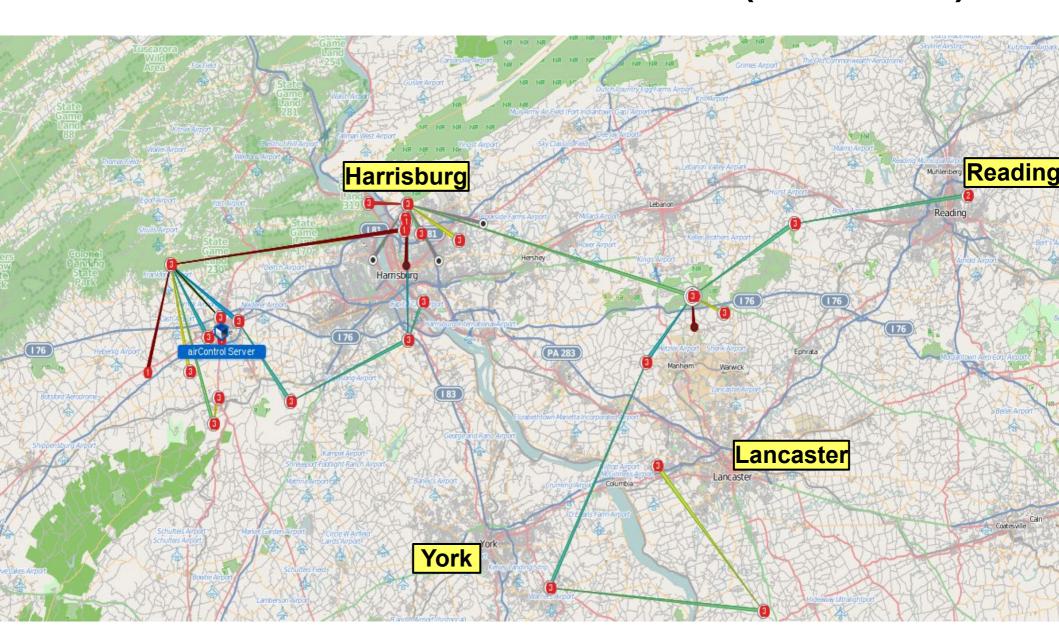
## Where Can MESH Work?

- <u>Almost everywhere!</u> IF done Right...!
- BUT best to PrePlan known or anticipated Operational Missions, Response Areas & Sites.
- PLUS Smart Procedures, using Flexible Gear, enables, "On-The-Fly" Rapid Deployment in unexpected scenarios & terrain.

### Field Test: Reston Town Center



## Central PA IP Network (CPIPN)



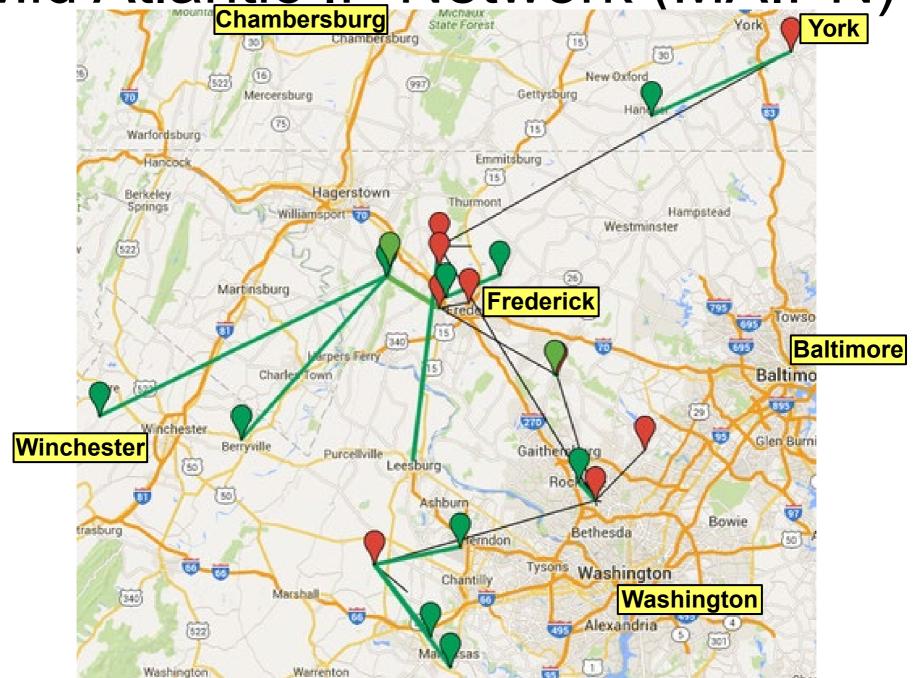
Mid Atlantic IP Network (MAIPN)

Chambersburg State Forest York

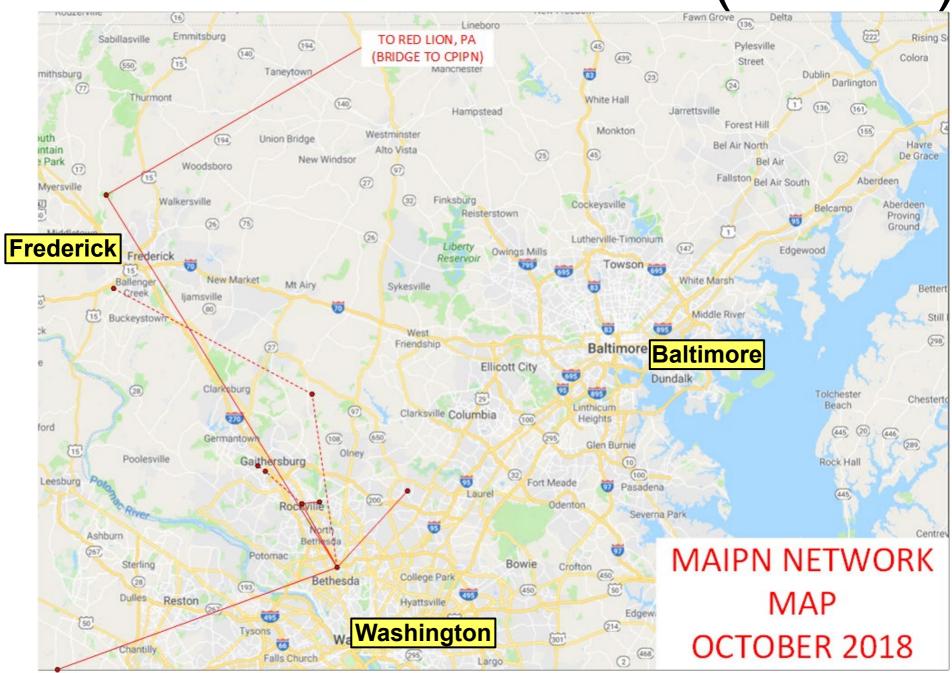
York

York

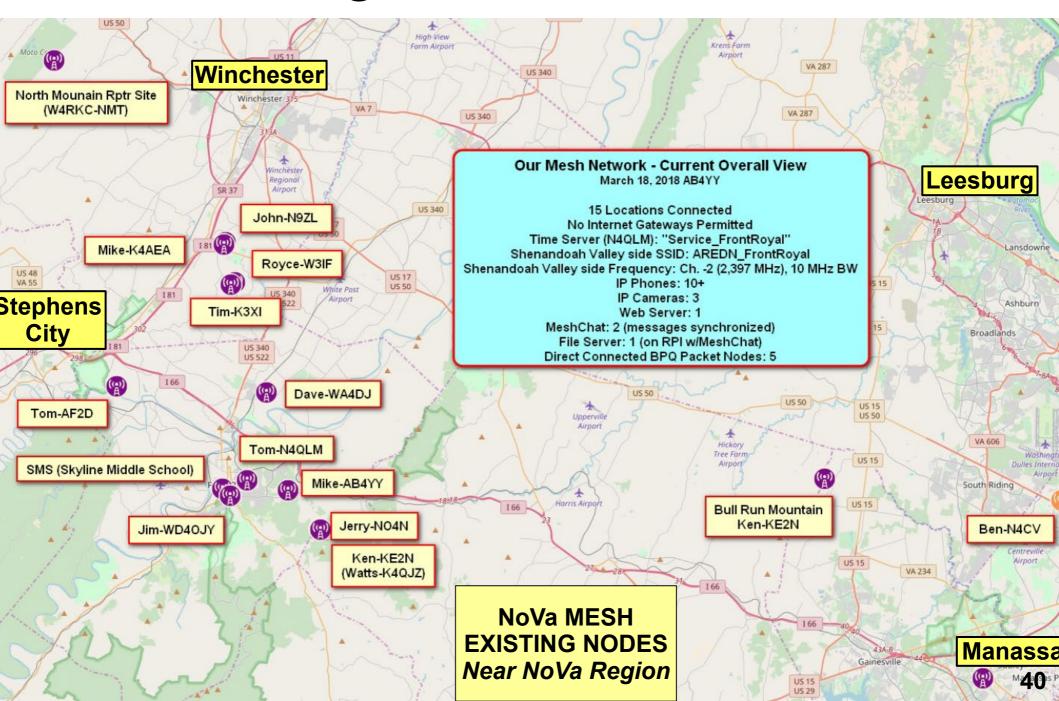
York



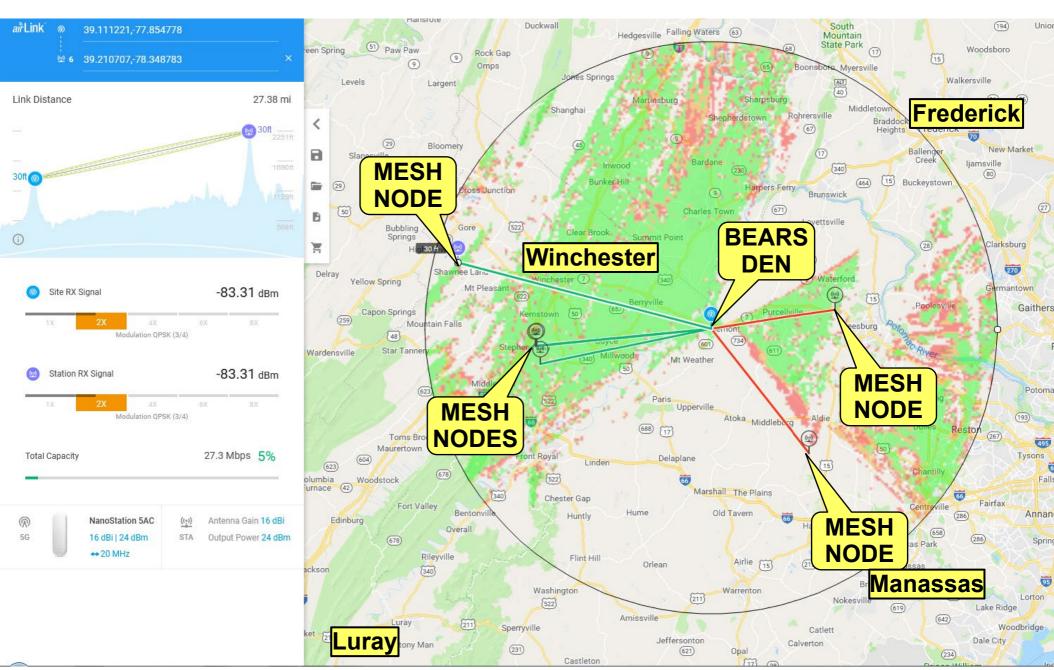
Mid Atlantic IP Network (MAIPN)



# Existing NoVa Area MESH

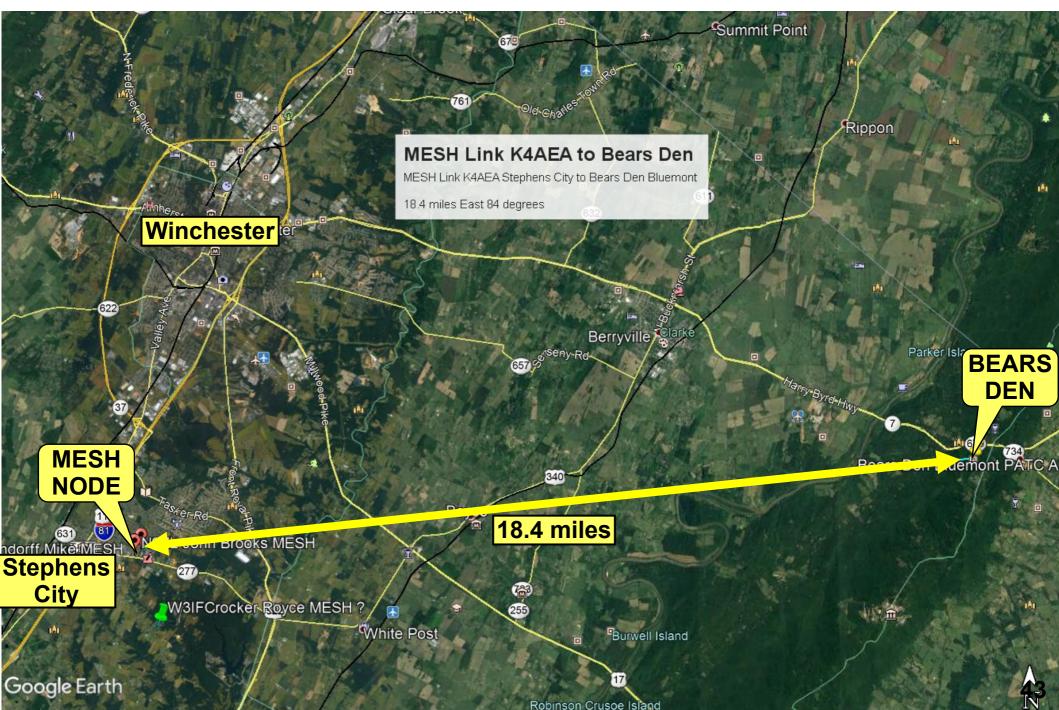


# Bears Den - Omni

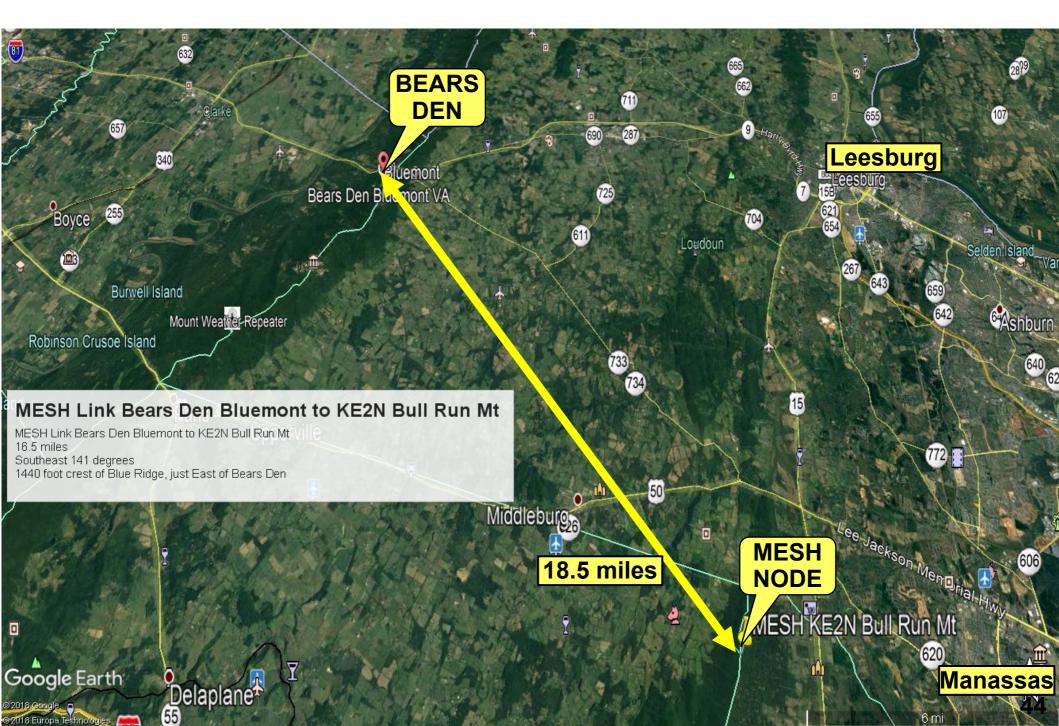


#### Bears Den - West North Mtn. **MESH NODE** Share Old airLink Feedback 39.111221,-77.854778 Winchester 713 Link Distance 18.34 mi Wickliffe **BEARS** DEN **MESH** -**NODES** 1 Site RX Signal -76.45 dBm 626 Airmont Modulation 64QAM (2/3) (719) (765) Station RX Signal Stephens Mt Weather (739) Trapp City Bloomfield Modulation 64QAM (2/3) (606) (719) (736) 36.4 Mbps 14% Berrys Total Capacity Pine Acres (733) (767) (630) **MESH** (619) NanoBeam 2AC NODE (766) 790 (50) STA Output Power 27 dBm St Louis Milldale ↔ 10 MHz (50) 623 Sky Meadows State Park Upperville (50) GR Thompson State Wildlife... (623) Map data @2018 Google Terms of Use Report a map erro

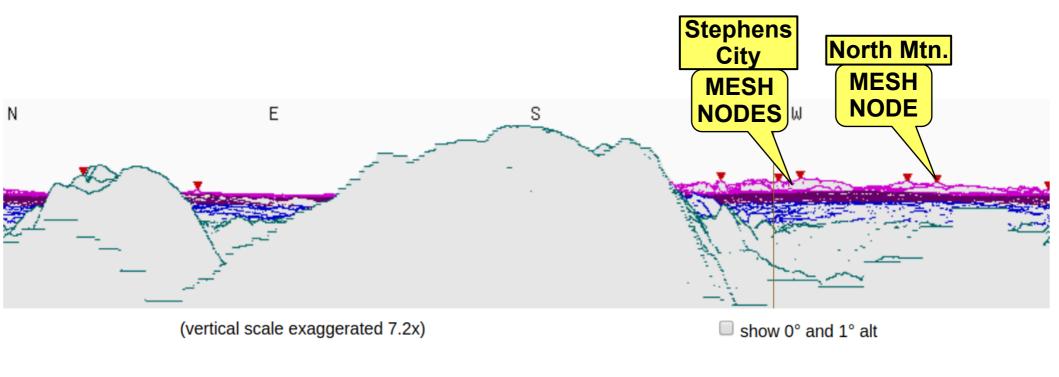
# Bears Den – Stephens City

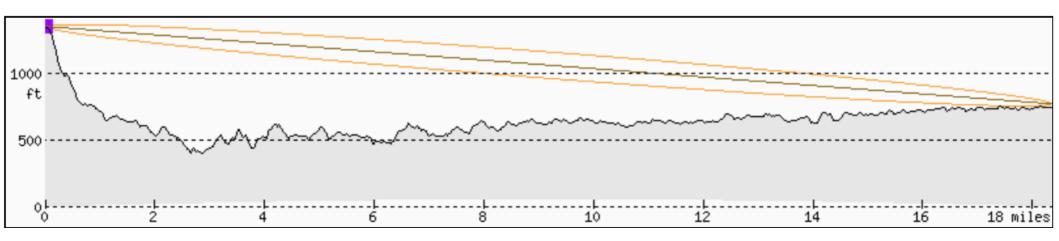


# Bears Den – Bull Run Mtn.



# Bears Den - SouthWest





### References

- arrl.org (Hams & lots of clues!)
- www.ardenmesh.org (THE Source!)
- www.youtube.com (lots of info!)
- maipn.org (MAIPN)
- AREDN –Marine Corp Marathon 2018 Results Mark Braunstein WA4KFZ
- Broadband Networking Primer: Network Concepts and Applications - Al Taylor, KN3U
- Mesh Networking -Mathison Ott KJ6DZB
- Building a High-Speed AuxCommData Network Hansen Andre K6AH
- (Lots more!)

### Summary

- The AREDN MESH Technologies offer an excellent suite of capabilities, and superior performance, to benefit many SAR and Other Operational Mission Needs
- MESH is rapidly evolving, with improved features and functions.
- MESH is also Ready for "Prime Time"
- It is already being deployed and leveraged by multiple other Organizations
- For SAR and Other Mission use, many systems available for our use, and we are Welcome!
- We in SAR need to coordinate & contribute, plus develop our own Unique plus Interoperable Protocols and Equipment.
- Our Companions in the MESH Community are already building out multiple Regional and Local MESH Systems.

#### Recommendations

- We need a SAR MESH Working Group to pursue these opportunities
- And in close coordination with SAR Leadership, Operations, and Communications Stakeholders.
- As an early step, conduct a more detailed briefing and training, with hands-on orientation and operation of actual MESH equipment.
- Jointly develop a CONOPS, plus preliminary Planning for Adoption
- As a follow-on step, build and exercise several deployable MESH Nodes (for ICPs etc), plus a few Tactical MESH Relays (for "breadcrumbs").

#### Recommendations

- Coordination & cooperation with adjacent systems (NoVA-MESH, CPIPN, MAIPN...) in and around our SAR Operational Regions.
- Collect data & do planning for existing/potential SAR-friendly MESH Sites
- Other Steps?
- Ideas for hot candidate sites?
- Ideas for other Stakeholders & User Organizations?
- Other useful tools?

# Questions??

#### **Demonstrations?**

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