



MESH NETWORKS/AREDN

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A decorative graphic consisting of white lines and circles, resembling a circuit board or network diagram, is positioned on the left side of the slide. The lines are of varying thickness and connect to small circles at various points.

MESH NETWORKS

- Introduction
- Applications
- Architecture
- Demo
- References

INTRODUCTION

- What are mesh networks?

- An RF data network utilizing microwave radios and ham frequencies
- Purpose: move large amounts of data across a wide area

- What is a “mesh?”

- A network with multiple possible paths between points
- The Internet core is a (ginormous) mesh

- This term is broadly abused

- Many “mesh” networks are not technically meshes at all
 - Does not matter for practical purposes

- What is “AREDN?”

- Amateur Radio Emergency Data Networks
- Repurposed commercial WISP gear with Linux-based open-source software for hams

MESH NETWORK ATTRIBUTES

- **Data speeds**

- Up to 150+ Mbps
- Varies with distance, frequency, bandwidth, topology, etc.

- **Low power**

- 200 – 630 mW (antenna gain 11 – 30 dBi)
- ~6 watt power consumption
- Yet signals travel over large distances (50+ miles)

- **Frequencies**

- 900 MHz, 2.4 GHz, 3.4 GHz, 5.8 GHz
 - 5, 10, or 20 MHz channel bandwidth
- Typically ham-only bands are used
 - Also unlicensed WiFi frequencies, shared ISM
- All Part 97, Technician Class
 - But with routes to Part 15 WiFi for end users

OPERATING FREQUENCIES

AREDN Offers 2 Non-Shared Channels on 2.4 GHz

2.4 GHz	Channel	-2	-1	0*	1	2	3	4	5	6
	Status	Ham Band			Shared Ham and ISM/WiFi Band					
	Freq	2.397	2.402	2.407	2.412	2.417	2.422	2.427	2.432	2.437

*Not available for use

24 Non-Shared Channels on 3.4 GHz

3.4 GHz	Channel	76	77	78	79	80	81	82	83	84	85	86	87
	Status	Ham Band											
	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
	Channel	88	89	90	91	92	93	94	95	96	97	98	99
	Status	Ham Band											
	Freq	3.440	3.445	3.450	3.455	3.460	3.465	3.470	3.475	3.480	3.485	3.490	3.495

52 Channels, 7 Non-Shared, on 5.8 GHz

5.8 GHz	Channel	133	134	135	136	137	138	139	140	141	142	143	144	145
	Status	Shared Ham and ISM/WiFi Band												
	Freq	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
	Channel	146	147	148	149	150	151	152	153	154	155	156	157	158
	Status	Shared Ham and ISM/WiFi Band												
	Freq	5.730	5.735	5.740	5.745	5.750	5.755	5.760	5.765	5.770	5.775	5.780	5.785	5.790
	Channel	159	160	161	162	163	164	165	166	167	168	169	170	171
	Status	Shared Ham and ISM/WiFi Band												
	Freq	5.795	5.800	5.805	5.810	5.815	5.820	5.825	5.830	5.835	5.840	5.845	5.850	5.855
	Channel	172	173	174	175	176	177	178	179	180	181	182	183	184
	Status	Ham Band												
	Freq	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

Refer to your local band plan for coordination

APPLICATIONS: HAMS

- Repeater linking

- IRLP, EchoLink, Allstar, custom VoIP

- Experimental

- Any IP network application you can come up with

- Community preparedness networks

- Voice over IP

- Part 97 rules apply*

APPLICATIONS: EMERGENCY NETWORKS



- **Game changer ... High-speed network ... anywhere**
 - *New capabilities for large files and streaming (voice/video)*
 - Fixed backbone and distribution infrastructure
 - Mobile “ad-hoc” network nodes in the field
- **WiFi network transparently replaces the cellular network when outside coverage area or cell network is down**
 - Make calls, send texts as usual with your smartphone ... transparent to the user
- **Backup network access to Internet, agency websites, etc.**
 - Local governments typically have no backup connectivity strategy or plan
- **Establish an intranet (“private Internet”) for an incident**
 - Remotely view and control webcams, collect monitoring device data
 - Post shelter information (list of evacuees, etc.) and securely share patient records
- **Mobile command and operational field units**
 - Full network capabilities in the field

INFRASTRUCTURE ELEMENTS

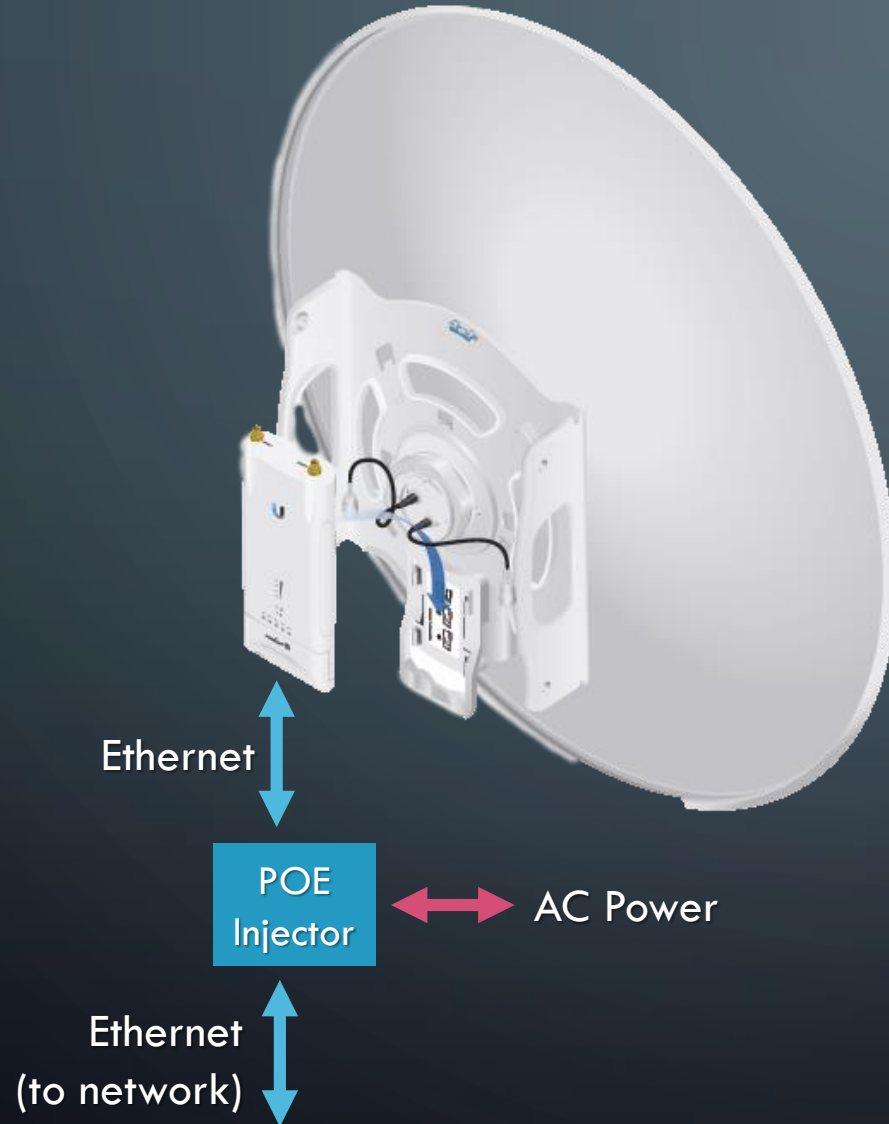


Dish:
Point-to-Point

Sector Antenna:
45/60/90/120°
Distribution

Note: installation not typical 😊

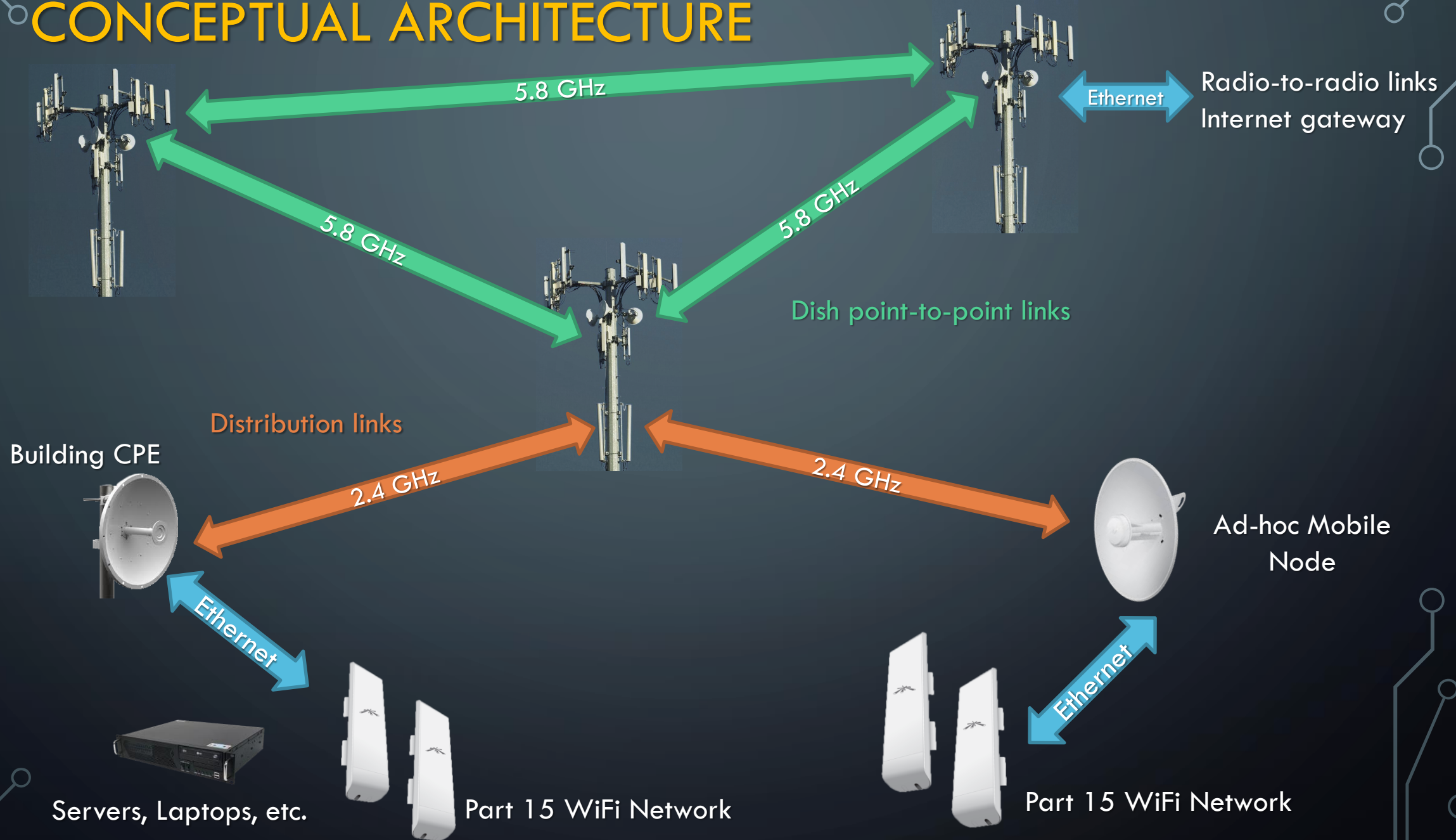
EXAMPLE: UBIQUITI ROCKET SERIES



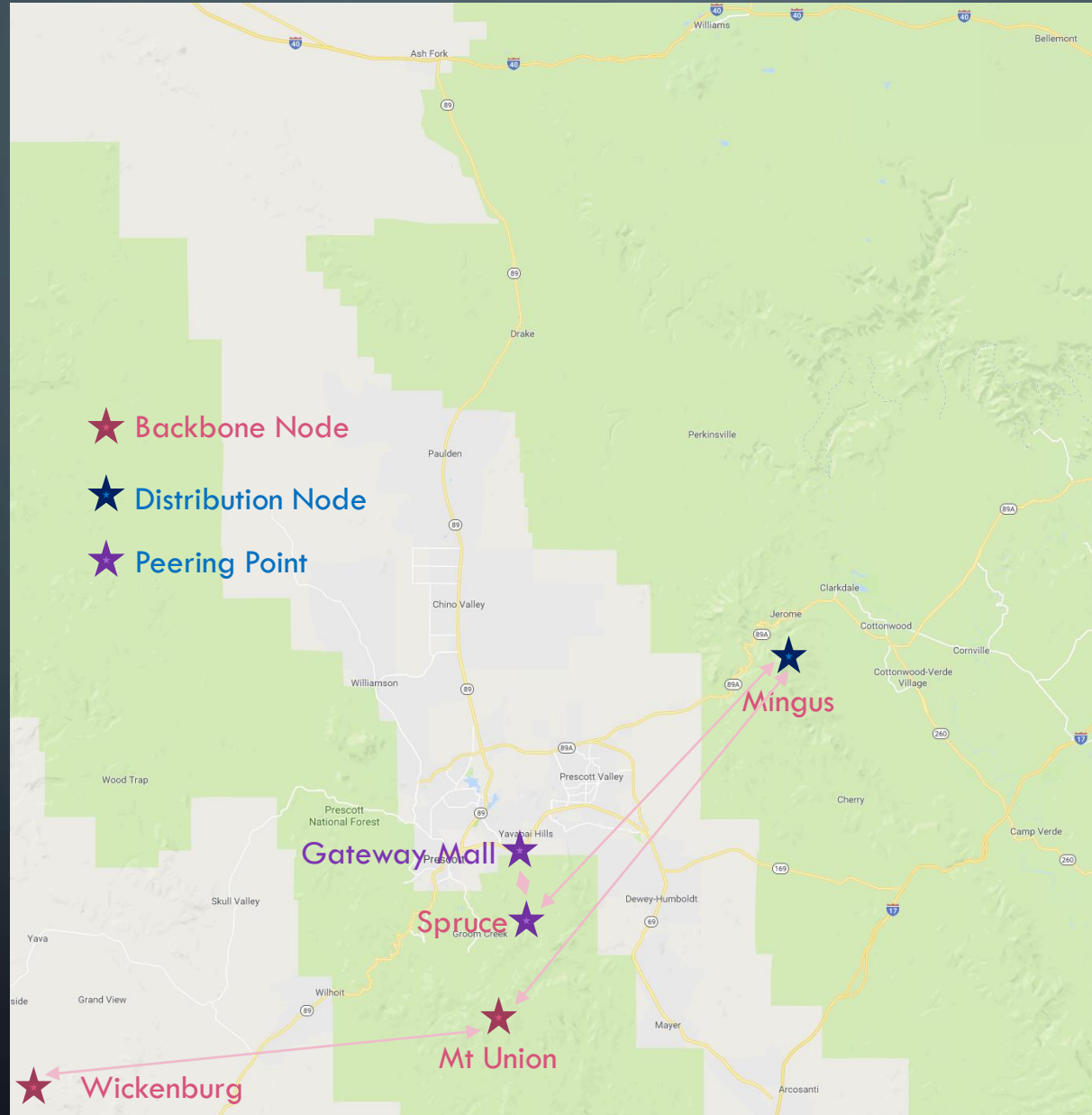
Antenna Compatibility

	Frequency Band			
	900 MHz	2.4 GHz	3/3.65 GHz	5 GHz
 Sector	AM-9M13	AM-V2G-Ti AM-2G15-120 AM-2G16-90	AM-3G18-120	AM-V5G-Ti AM-M-V5G-Ti AM-5G16-120 AM-5G17-90 AM-5G19-120 AM-5G20-90 AM-5AC21-60 AM-5AC22-45
 Rocket Dish		RD-2G24	RD-3G26	RD-5G31-AC RD-5G30-LW RD-5G30 RD-5G34
 Omni		AMO-2G10 AMO-2G13	AMO-3G12	AMO-5G10 AMO-5G13
 Yagi	AMY-9M16			

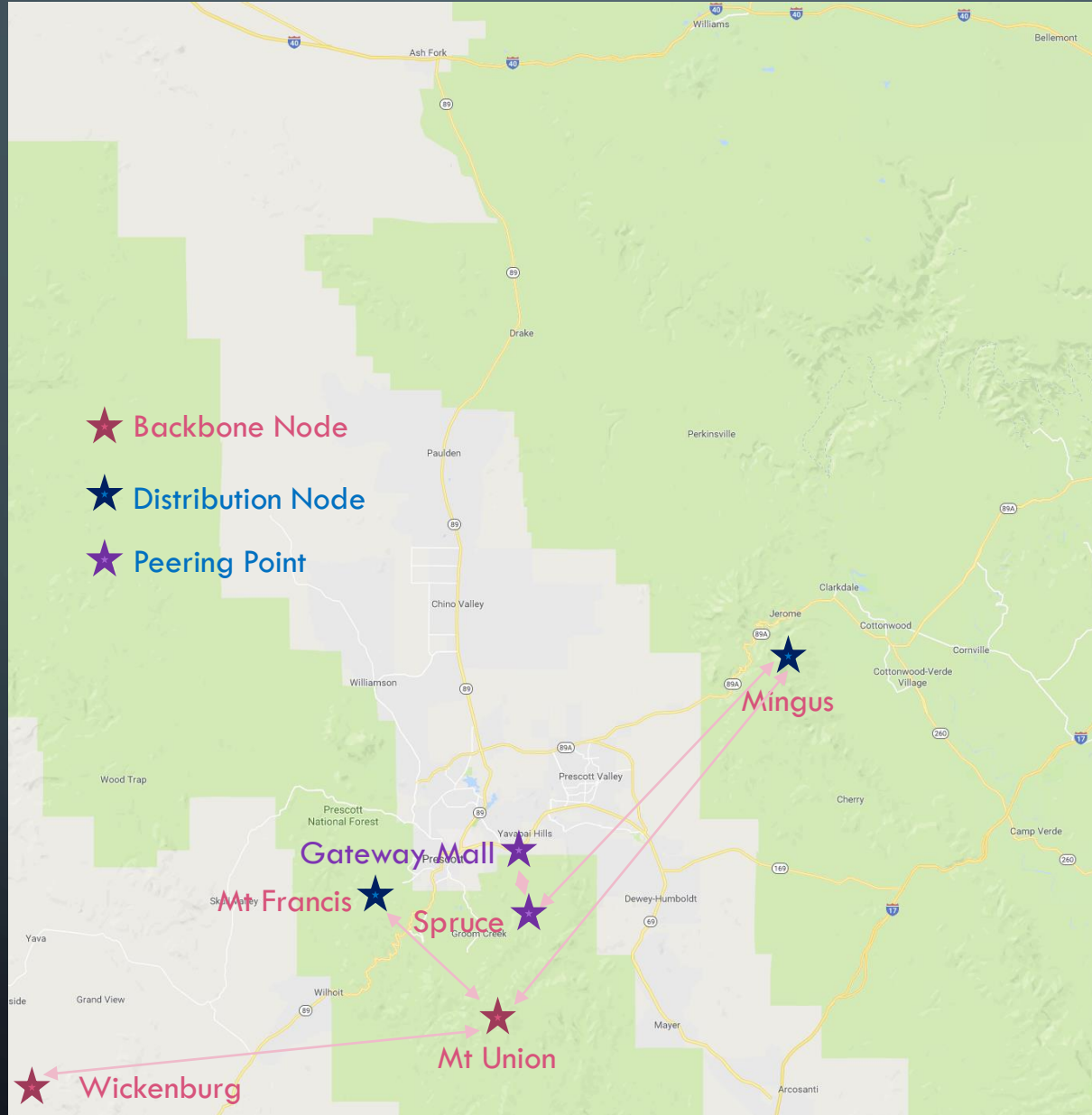
CONCEPTUAL ARCHITECTURE



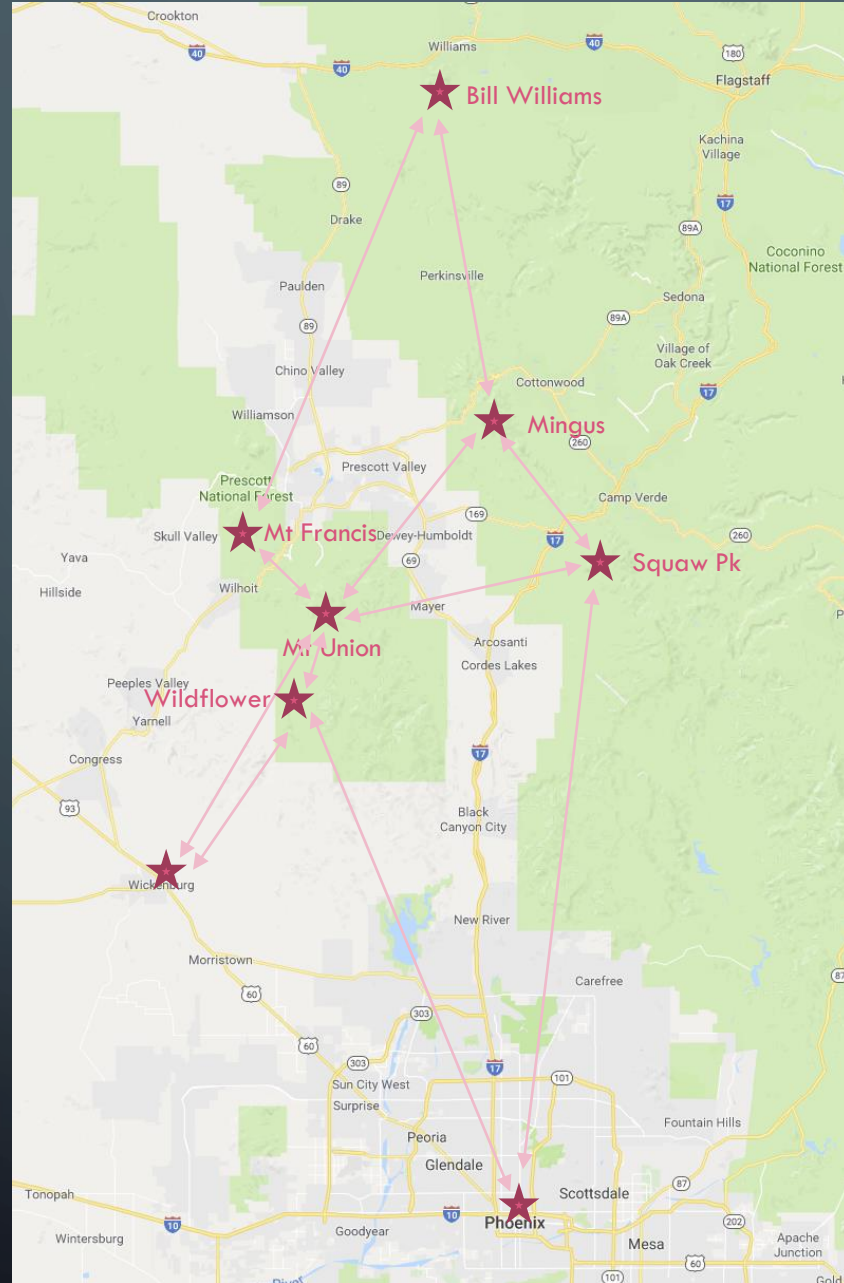
YC-ARDEN ARCHITECTURE PHASE I (DRAFT)



YC-ARDEN ARCHITECTURE PHASE II (DRAFT)



YC-ARDEN BACKBONE VISION



DEPLOYED AREDN EXAMPLES

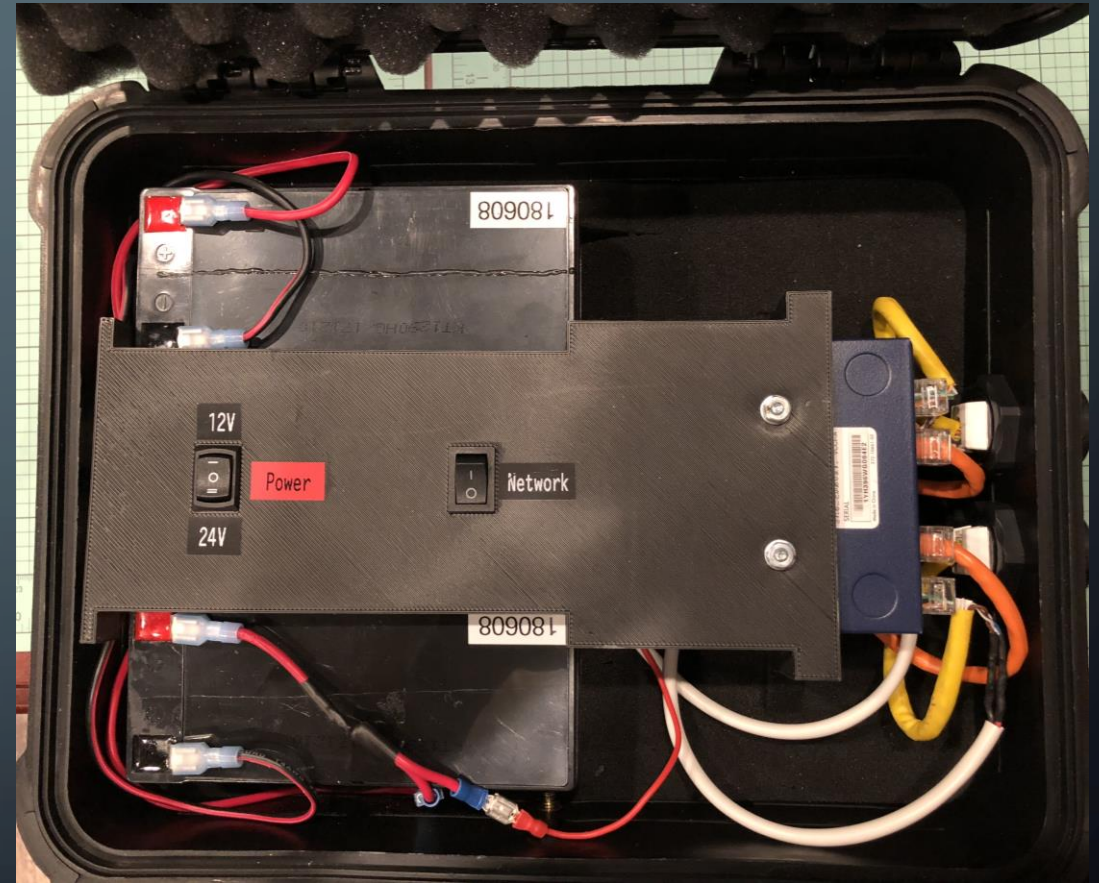


MOBILE COMMUNICATIONS EXAMPLE



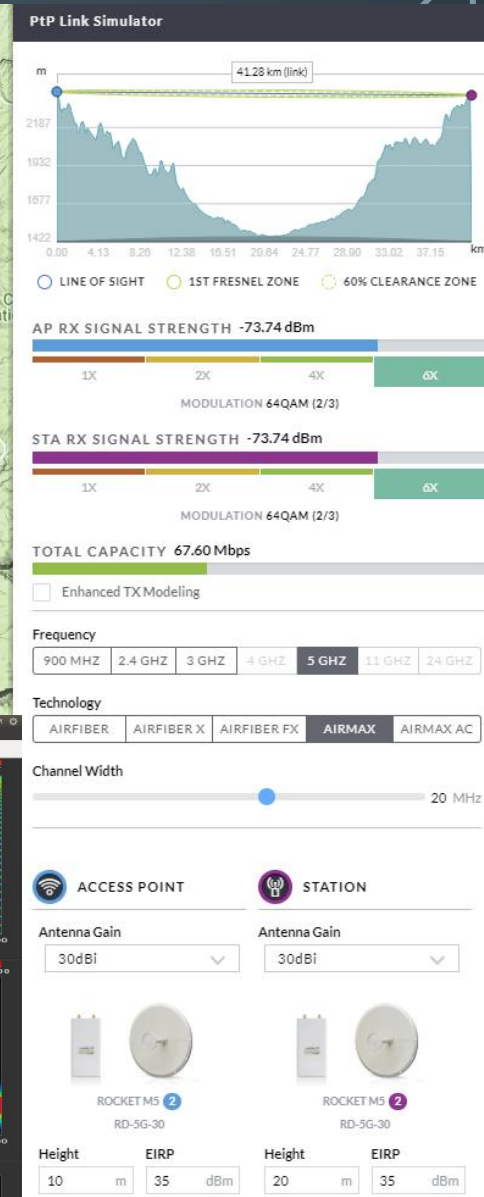
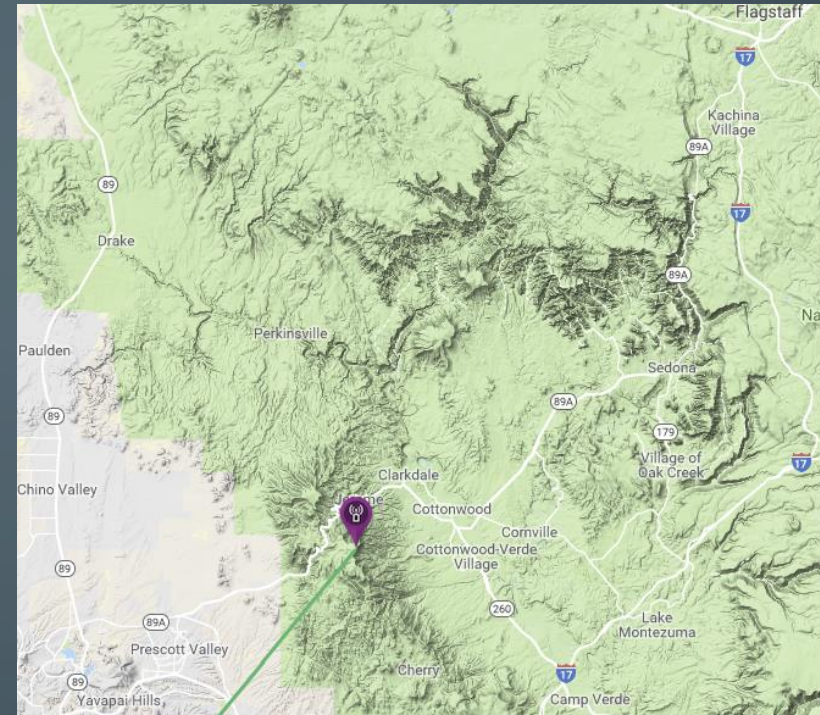
- Yavapai County ARES/RACES mobile communications vehicle (MARC)
- Currently:
 - Ham VHF, UHF, HF
 - Public safety VHF, UHF
 - APRS
 - FRS/GMRS
- Future additions:
 - ARDEN downlinks
 - Part 15 WiFi (local hotspot)

MOBILE OPERATION



NETWORK PLANNING

- Potential sites
- Path analysis
- Bandwidth requirements
- Frequency
 - Distance, terrain, foliage ...
 - Spectrum analysis
 - Required antenna gain
- Wind loading
- Weather
- Isolation
- Redundancy
- Backbone & distribution
- More ...



RESOURCES

- www.arednmesh.org (AREDN project)
 - www.arednmesh.org/content/aredn-help-file-31610 (closest thing to an AREDN tutorial ... good starting point)
- www.ubnt.com (Ubiquiti Networks)
- Purchasing:
 - www.amazon.com
 - www.newegg.com
 - www.streakwave.com
- Articles & education:
 - QST, June 2017
 - CQ, Jan 2017 <https://www.arednmesh.org/content/cq-january-2017>
 - YouTube: HamRadio 360, HamRadioNow, Ham Nation, etc.
- Analysis
 - www.ve2dbe.com/rmonline.html (Radio Mobile path and coverage analysis)
 - airlink.ubnt.com (Ubiquiti path analysis)

