

Amateur Radio Emergency Communications in the Modern Era

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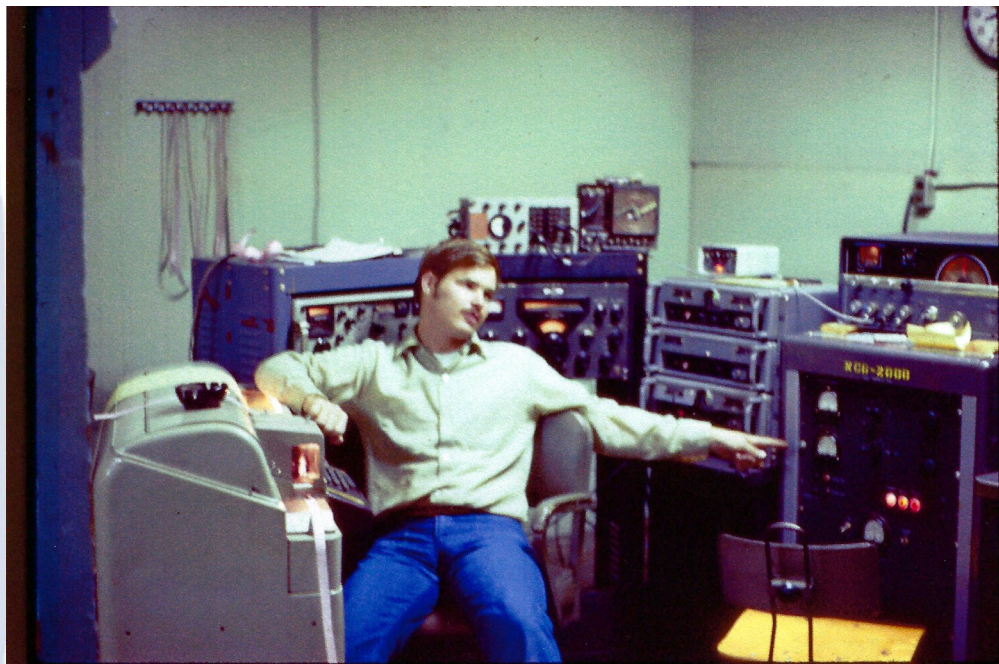


In the Beginning... Morse code, then voice



In the Beginning...

Radioteletype, then AX.25 packet radio



Winlink

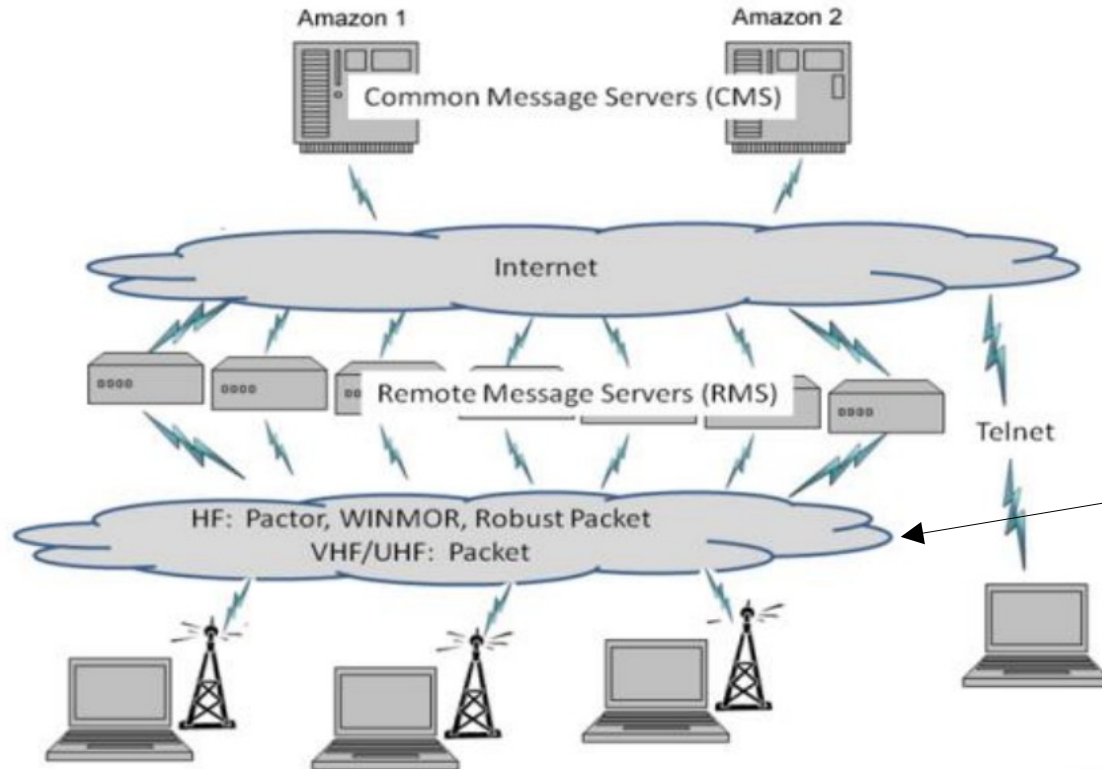
(Winlink Global Radio Email)

A worldwide messaging system. Can use these relatively low speed modulations/protocols. Data rates (not throughput) typically between 350 bits/second and 6 kilobits/second:

- ALE (Automatic Link Establishment)
- APRS (Automatic Packet Reporting System)
- AX.25 Packet Radio
- D-Star (“(Digital Smart Technologies for Amateur Radio)” – digital voice
- PACTOR, PACTOR-II, PACTOR-III, PACTOR-IV
- VARA FM, VARA HF
- Recently added support for: amateur radio IP networks
 - ◆ Significantly faster: data rates can be over 100 Megabits/second. Throughput between 5 and 10 Megabits/second
- Has a large set of standardized messaging templates: FEMA, ICS (Incident Command System), SATERN, various state-specific templates, and more

Winlink Architecture (Conventional Mode)

- CMS
- RMS (gateway)
- Client (you)



Ham IP networking goes here

Winlink Express (Client). Like email but considerably more complex to configure, depending on protocol and route specified

The screenshot shows the Winlink Express 1.5.33.0 - W6BI interface. The window title is "Winlink Express 1.5.33.0 - W6BI". The menu bar includes "Settings", "Message", "Attachments", "Move To:", "Saved Items", "Delete", "Open Session:", "Telnet Post Office", "Logs", and "Help". The toolbar contains various icons for navigation and actions.

The main window displays "No active session." and a list of messages. The left sidebar shows folders: System Folders (Inbox (1 unread), Read Items (0), Outbox (0), Sent Items (14), Saved Items (0), Deleted Items (27), Drafts (0)), Personal Folders, Global Folders, and Contacts (AI6BX, AJ7C, KE6WEZ, KG6WXC, W6BI, winlink@vccomm.org).

Date/Time	Message ID	Size	Source	Sender	Recipient	Subject
2020/12/17 0...	HPU5KT78SS...	697	AJ7C	AJ7C	W6BI	Re: Questions
2020/12/16 18:52	UWSJ174F8FOZ	457	AJ7C	AJ7C	W6BI	Re: Questions
2020/12/16 05:55	O7ZND764Q4XJ	270	SMTP	SMTP:winlink@v...	W6BI	Your Winlink Checkin Was Received
2020/12/16 03:06	F8X7HKQPRJ9J	1194	K7SDW	K7SDW	SMTP:winlink@v...	Express Check In [Net Check In]-K7SDW-AREA 2
2020/12/15 06:08	SLD866PWPTTL	675	WEBMAIL	AI6BX	W6BI	Re[2]: Testing via mesh
2020/12/15 05:50	PLVI7W5EWYFV	370	WEBMAIL	AI6BX	W6BI	Re: Testing via mesh
2020/12/15 05:48	SZSCKXE80K2G	360	WEBMAIL	AI6BX	W6BI	Re: Testing via mesh

Message ID: UWSJ174F8FOZ
Date: 2020/12/16 18:52
From: AJ7C
To: W6BI
Source: AJ7C
Downloaded-from: Post-office:CCARES SEC TEAMTALK/WINLINK POST OFFICE - AJ7C-TEAMTALK
Subject: Re: Questions

Good morning!

It is not. It is another application altogether. It is a SysOp app called RMS Relay that you put on a Windows machine on the Mesh. The trick is configuring it correctly, which is simple, but not totally straightforward.

Kevin

----- Message from W6BI sent 2020/12/15 05:36 -----

Message ID: PID2QNV45FO3

Ham Radio Networking

Uses stock outdoor wireless access points – few hardware mods

- Ham radio network links can be more than 100 Megabits/second
 - (That's modulation rate, not throughput)
- Access points are loaded with custom software
- Together, they create a ham radio TCP/IP network

Amateur Radio Emergency Data Network (AREDN) Software

Derived from OpenWrt open source router software

Supports:

- Ubiquiti, TP-Link, Mikrotik and GL.Inet brands - 70+ different models
- Four ham radio bands
- Internet tunneling between nodes
- **Allows operations in Part 97-only channels***
- **MIMO/802.11n operation***
- **Provides DNS & DHCP services, route discovery and routing information***
- *These three combined make ham radio networks easy to construct!

The Digital Networking Bands supported by AREDN Software

■ 902-928 MHz

- not used much: only one 5 MHz wide channel, very noisy in urban and suburban areas, we're secondary on that band, and the gear is relatively expensive

■ 2.4 GHz – 2300-2450 MHz

- Only one usable 10 MHz wide Part 97 channel (Channel -2); Channel -1 may work OK away from cities.
- Noisy due to splatter from poorly designed Part 15 wireless gear

■ 3 GHz – 3300-3500 MHz

- The good news: it's all ours! No U.S. Part 15 in this band
- The bad news: we have to buy export equipment and it's almost double the price of 2 or 5 GHz equipment
- The worse news: in November of 2020, the FCC took away this band and gave it to the 5G carriers; we'll have one to two years of grandfathered use before being required to vacate.

■ 5 GHz Band – 5650-5925 MHz

- Lots of channels.
- The Part 97 band overlaps a lot of Part 15 channels, which can be useful for spreading traffic out.
- We're secondary in this band. In October of 2020 the FCC took away primary occupancy of this band from the DOT (Department of Transportation). They'll be allowing Part 15 users to spread into the entire band in the near future.

Networking is a modern ham radio activity

But it's just infrastructure.

It doesn't accomplish anything...

It's all about the “Services”

Networking Services

Services = things you can actually use

- Keyboard to keyboard (text)
- Voice
- Video
- Email
- Document editing/management
- Dropboxes
- Web servers
- Repeater linking
- *Anything else you can think of subject to the Part 97 regulations*

**Applications
(Services)
Some examples**

Team Communications Tools

- E.g., Slack, Mattermost, RocketChat
- Text & pictures
- Multiple channels available
- Web access + Windows, IOS, MacOS, and Android apps available

Mattermost

File Edit View History Window Help

Mesh Related St... @w6bi

MeshLink
Chat back and forth with MeshIRC (yes, on the mesh)

15 People Search

PUBLIC CHANNELS +

- General
- MeshLink
- MeshMap
- More...

PRIVATE CHANNELS +

DIRECT MESSAGES +


- clifford-kk6qms
- k6ccc
- kg6wxc
- More...

Switch Channels - CTRL+K

Reya was freaked out during but then was kind of enjoying the aftershocks after we exained how safe of a spot we were actually in...
Val is a ca native... It dont bother her 😊

w6bi 10:25 AM
👍

kg6wxc 1:01 PM
Ground deformation
image-18386a1b-3683-49a2-80fd-2818b05248c0.jpg



w6bi 1:14 PM
Interesting!
How far was that from where you were camping?

kg6wxc 1:18 PM
20-30 as the crow flies
They were repairing water pipe right that had broken along that same fissure line.
The pipe was displaced about 1'

Write to MeshLink

Help

VOIP (Voice Over IP w/Phones)





- VOIP PBX installed in mountaintop repeater building (WD6EBY – Sulphur Mountain, Ojai, California)
- Voice mail, conference calls, etc

VOIP Phones



- Showing a missed phone call
- Showing one or more voice messages waiting

Another VOIP PBX



- Raspberry Pi 3 running FreePBX
- Deployed to the adjacent valley; trunked to first PBX
- Offers extensions, voice mail, conference bridges, etc.

Collaboration Servers

- Like the gamers use to coordinate their teams
- Voice and/or video chat. Very useful – and fun!
- Like the gamers use to coordinate their teams
- TeamSpeak, Mumble, TeamTalk, etc.
- Teamtalk provides these features:
 - One to one chats
 - Many to many (chat rooms)
 - Can set up as many channels as necessary
 - Multiple, **simultaneous** conversations possible – all **full duplex** (you can interrupt whomever's speaking :-D)
 - Speaker/microphone or headset (**HIGH quality audio**; not limited to 300-3,000 Hz like regular ham radio)
- PTT, VOX or open mic (each audio stream uses about 30 kbps – minimal load on a healthy network)
- File sharing and desktop sharing are also available
- The Teamtalk server runs nicely on a Raspberry Pi (RPI 3: typically < 10-15% CPU utilization)
- Clients available for Windows, Debian Linux, MacOS, IOS, and Android

Teamtalk Weekly Net – Call of person talking has green background; when they unkey it turns yellow

The screenshot shows the TeamTalk v. 5.4 interface. The window title is "TeamTalk v. 5.4". The menu bar includes "Client", "Me", "Users", "Channels", "Server", and "Help". Below the menu bar is a toolbar with icons for various functions. The main interface is divided into two main sections: a user list on the left and a chat window on the right.

User List: The user list is titled "K6PVR Ventura County Teamtalk (14)". It contains the following users and their status (indicated by checkmarks in a 2x2 grid):

User	1	2	3	4
Brian - AE7WY	✓	✓	✓	✓
Dale WA6MZW Cathedral City	✓	✓	✓	✓
Dave km6fq	✓	✓	✓	✓
Endaf - N6UTC Long Beach.	✓	✓	✓	✓
eric - kg6wxc - oxnard	✓	✓	✓	✓
Ian AJ6GZ - Redlands	✓	✓	✓	✓
Jim - K6CCC	✓	✓	✓	✓
K3CAQ Andy Thousand Oaks	✓	✓	✓	✓
K6CCC iPhone	✓	✓	✓	✓
Kevin - AJ7C - Culver City	✓	✓	✓	✓
KM6FQ Dave	✓	✓	✓	✓
Orv - W6BI - Simi Valley	✓	✓	✓	✓
Ryan - K1BLU - Lakewood	✓	✓	✓	✓
Steve - K6CRW	✓	✓	✓	✓
Aux Channel 1 (0)				
Aux Channel 2 (0)				

Chat Window: The chat window is titled "Chat" and shows a log of messages. The messages are as follows:

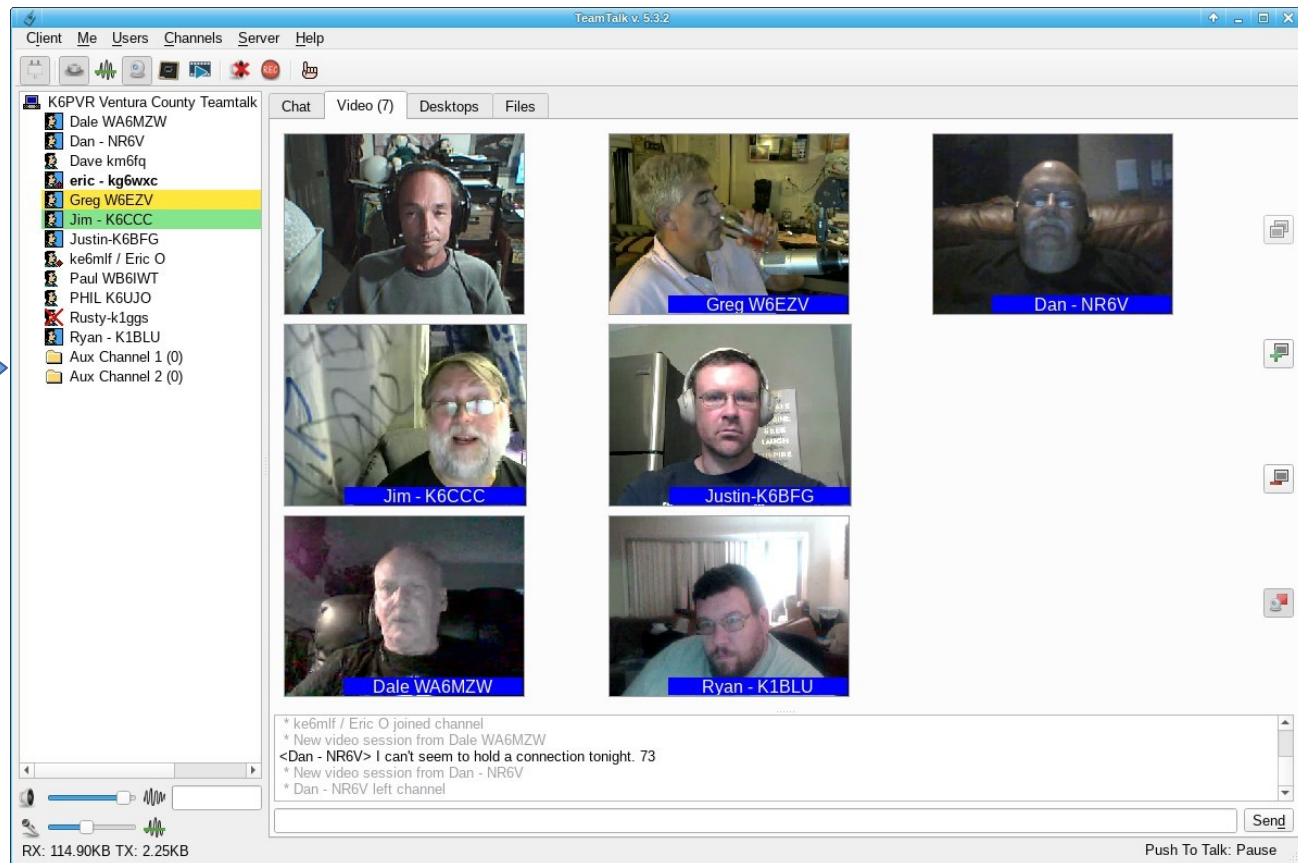
2020-04-15T20:04:05 *Ryan - K1BLU - Lakewood left channel
2020-04-15T20:04:11 *Ryan - K1BLU - Lakewood joined channel
2020-04-15T20:04:18 *Endaf - N6UTC Long Beach. joined channel
2020-04-15T20:06:26 <Endaf - N6UTC Long Beach. > no im here
2020-04-15T20:07:49 *K3CAQ Andy Thousand Oaks joined channel
2020-04-15T20:07:58 *Endaf - N6UTC Long Beach. left channel
2020-04-15T20:08:43 *K3CAQ Andy Thousand Oaks left channel
2020-04-15T20:09:17 *K3CAQ Andy Thousand Oaks joined channel
2020-04-15T20:13:29 *Dale WA6MZW Cathedral City joined channel
2020-04-15T20:14:45 *Endaf - N6UTC Long Beach. joined channel
2020-04-15T20:15:11 *Endaf - N6UTC Long Beach. left channel
2020-04-15T20:18:11 *Endaf - N6UTC Long Beach. joined channel
2020-04-15T20:19:47 *Endaf - N6UTC Long Beach. left channel
2020-04-15T20:20:16 *Endaf - N6UTC Long Beach. joined channel
2020-04-15T20:24:12 *Dave km6fq joined channel
2020-04-15T20:25:56 *Dave km6fq left channel
2020-04-15T20:26:14 *Dave km6fq joined channel
2020-04-15T20:26:30 *Kevin - AJ7C - Culver City joined channel
2020-04-15T20:26:32 *Dave km6fq left channel
2020-04-15T20:26:37 *K3CAQ Andy Thousand Oaks left channel
2020-04-15T20:26:45 *Dave km6fq joined channel
2020-04-15T20:27:41 *eric - kg6wxc - oxnard joined channel
2020-04-15T20:27:41 *eric - kg6wxc - oxnard left channel
2020-04-15T20:28:12 *eric - kg6wxc - oxnard joined channel
2020-04-15T20:28:37 <eric - kg6wxc - oxnard> me 2, client is junk now.
2020-04-15T20:29:06 *K3CAQ Andy Thousand Oaks joined channel
2020-04-15T20:29:24 <Brian - AE7WY> <rtsp://AE7WY-Cam-Clark-WY.local.mesh:554/s2>

The chat window also has tabs for "Video", "Desktops", and "Files". At the bottom of the chat window is a "Send" button. Below the chat window is a microphone icon and a volume slider. At the bottom left of the interface, it shows "RX: 0.00KB TX: 0.00KB". At the bottom right, there is a "Push To Talk: Alt" button.

Teamtalk Net

Video can be bandwidth-heavy. It's optional

Aux channels; switch to one by double-clicking
Green – who's talking
Yellow – who talked last



EmComm

Network nodes are deployed to EOCs, hospitals, etc., alongside existing amateur radio installations.

- Computer is equipped with
 - Teamtalk app
 - Winlink Express app
- Also equipped with VOIP phone

The Thomas Fire – Ventura, CA Dec 2017. Streamed to from ham network to YouTube for wide viewing

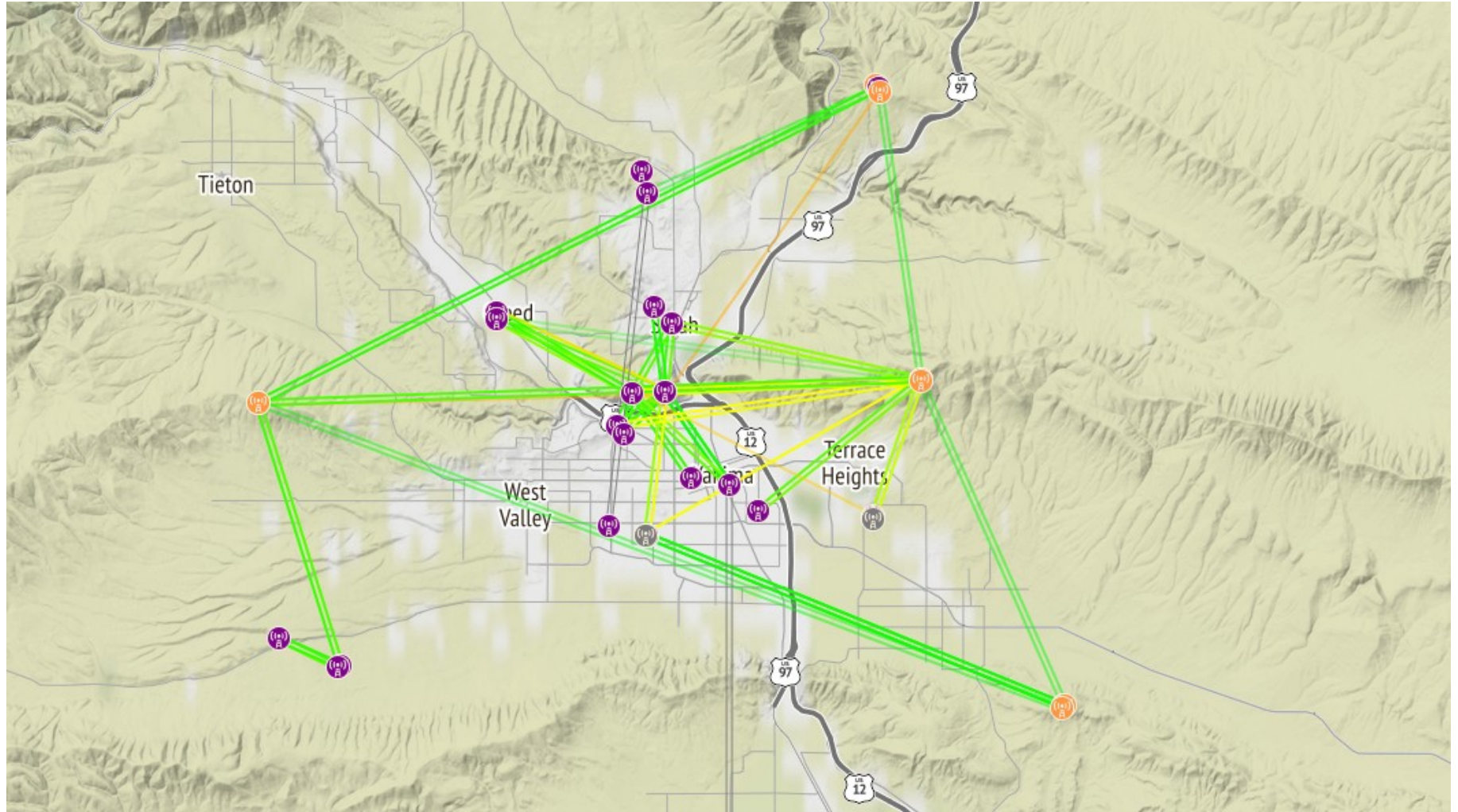


The Woolsey Fire – Thousand Oaks, CA 11/2018

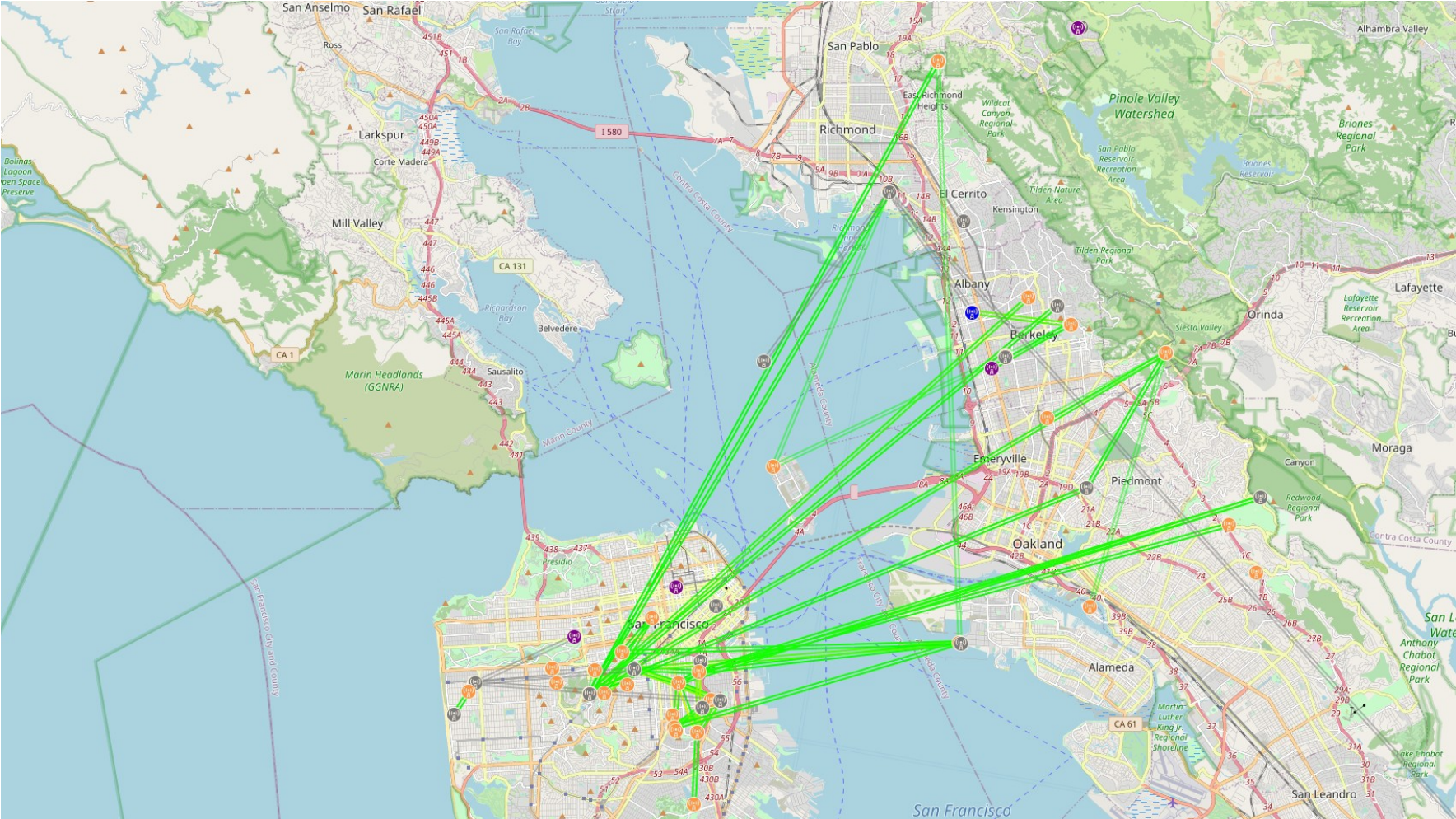
Also streamed to YouTube



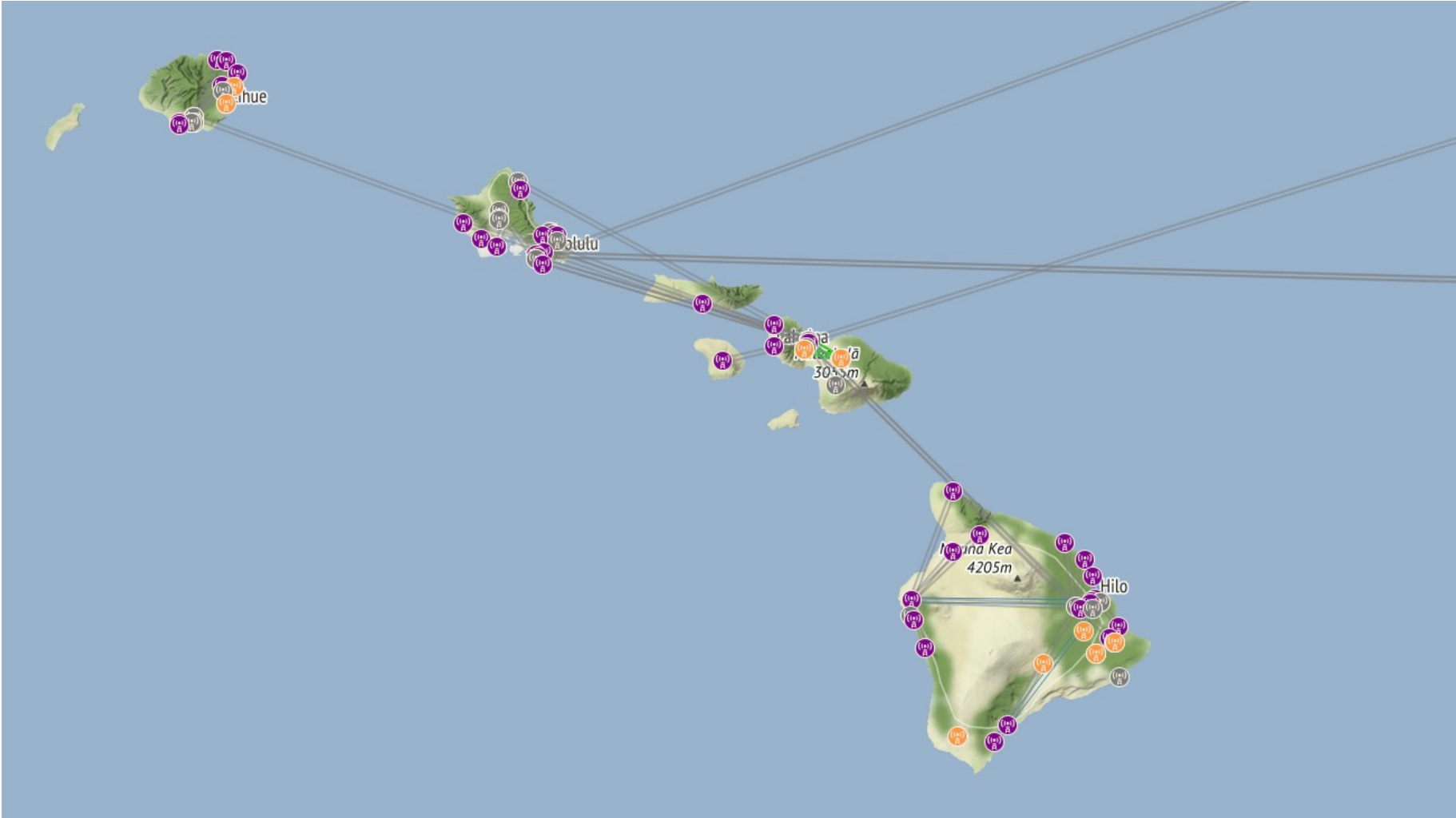
Network map – Yakima, WA



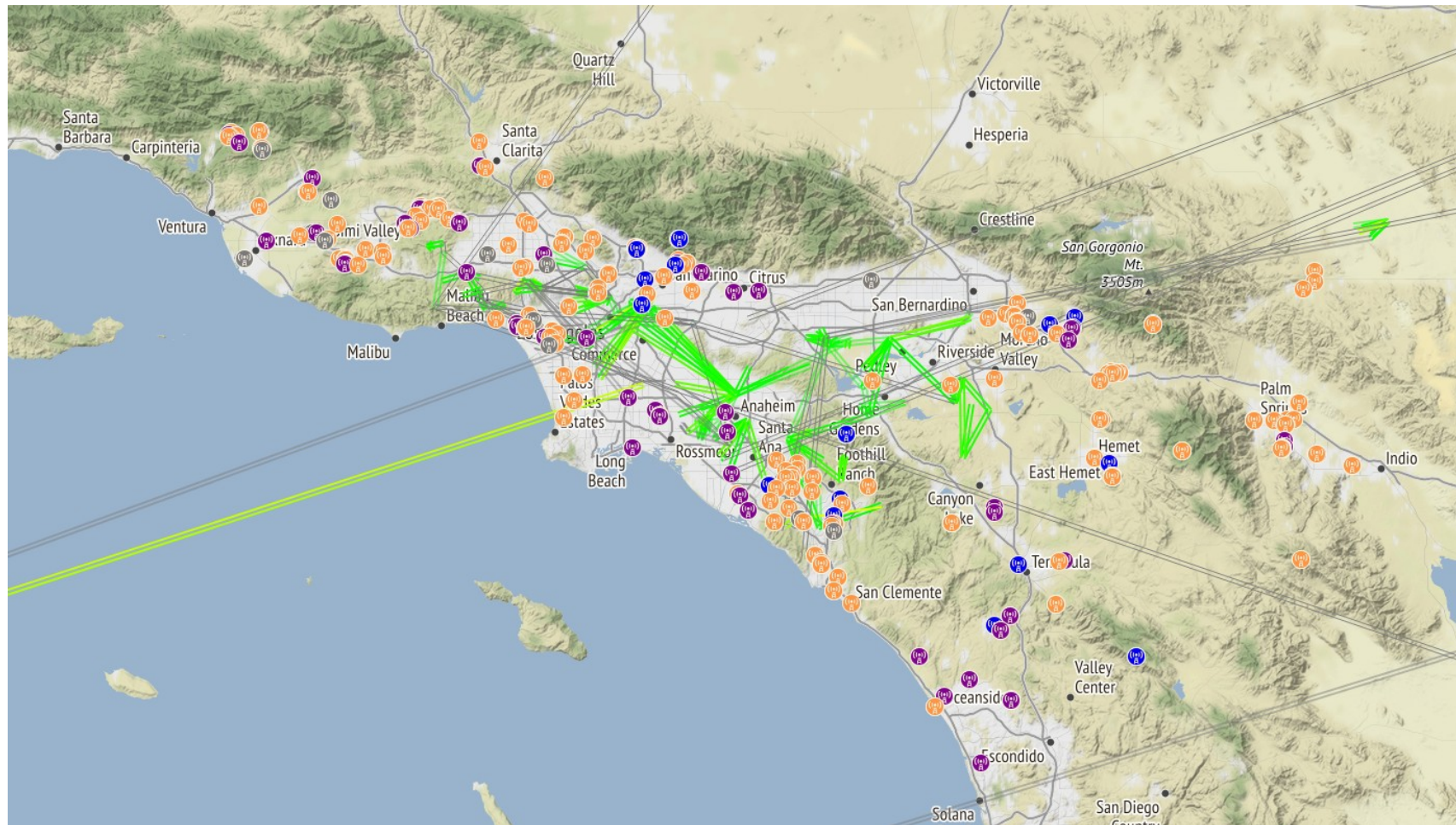
Network map – San Francisco, CA



Network map – Hawaiian Islands



Network map – SoCal (~410 reachable nodes visible)



Typical end-user Configuration



AREDN nodes for both 2 and 5 GHz;
provides redundancy.
Done when possible at EOCs, hospitals
and other critical sites.

Typical end-user Configuration



High-gain dish for access to distant network backbone node;
Lower-gain node for local user access (neighborhood)



Mikrotik LDF 5 (5 GHz) installed at surplus satellite dish feedpoint using universal mount (\$8 from Amazon)

Ideal for hams under an HOA, as satellite dishes are allowed

LDF 2 (2 GHz) now also supported by AREDN software

Small site Example - North Orange County, California

120 degree sector antennas + nodes for 2.4, 3 & 5 GHZ



Medium Site Example – Chatsworth Peak, California

User access points on 2.4 & 5 GHz; dish for backbone link; PTZ camera

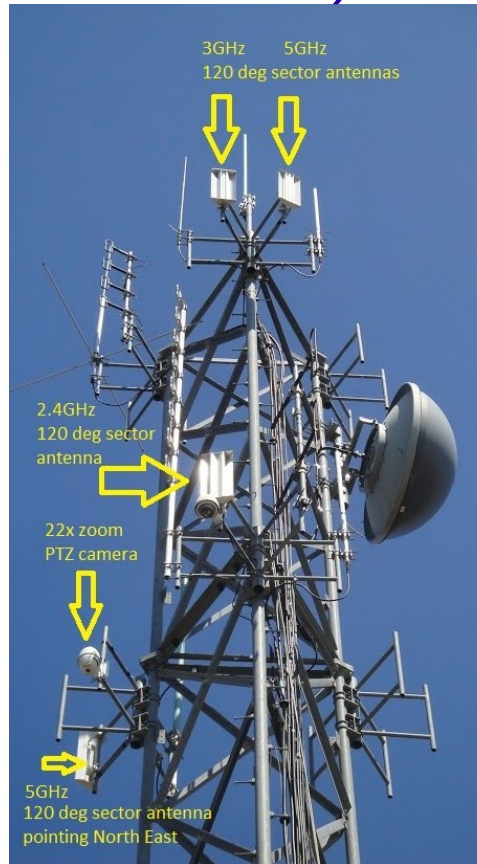


Another medium-sized site (post wind-storm)
(80% FM repeaters, 20% networking) Verdugo Peak, California



Large site (co-located at commercial site)

Yellow-highlighted gear is for mesh network. Multiple sector antennas provide for 360 degree user access. Backbone links (not visible, lower on tower) + PTZ camera



Ham Radio Allocations – 2.4 & 3 GHz

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

Only one usable 10 MHz channel. Splatter from Part 15 limits usefulness

~~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
	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

Refer to your local band plan for coordination

11/2020 – FCC removed amateur allocation; will be given to 5G carriers.
We'll have 1-2 years to vacate.

Ham Radio Allocations – 5 GHz

52 Channels, 14 Non-Shared, on 5.8 GHz

5.8 GHz	Channel	133	134	135	136	137	138	139	140	141	142	143	144	145
	Status	Ham Band shared with U-NII-2C/wifi/unlicensed												
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	
	146	147	148	149	150	151	152	153	154	155	156	157	158	
	Ham Band shared with U-NII-3/wifi/unlicensed													
	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	
	159	160	161	162	163	164	165	166	167	168	169	170	171	
	Ham Band shared with U-NII-3/wifi/unlicensed										Ham Band			
	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	
	172	173	174	175	176	177	178	179	180	181	182	183	184	
	Ham Band													
	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; ★ 5825 to 5850 Shared under Part 15.247 with a limited number of WISP operators and may be encountered at tower sites

11/2020 – FCC removed DOT’s primary allocation (they hadn’t started using it). We kept our secondary allocation but the FCC will let Part 15 users expand into the entire band.

Over time, expect channel noise levels to rise. Will need to deploy higher gain devices to compensate.

Questions, comments?

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