The State Of
Amateur Radio Mesh Data Network

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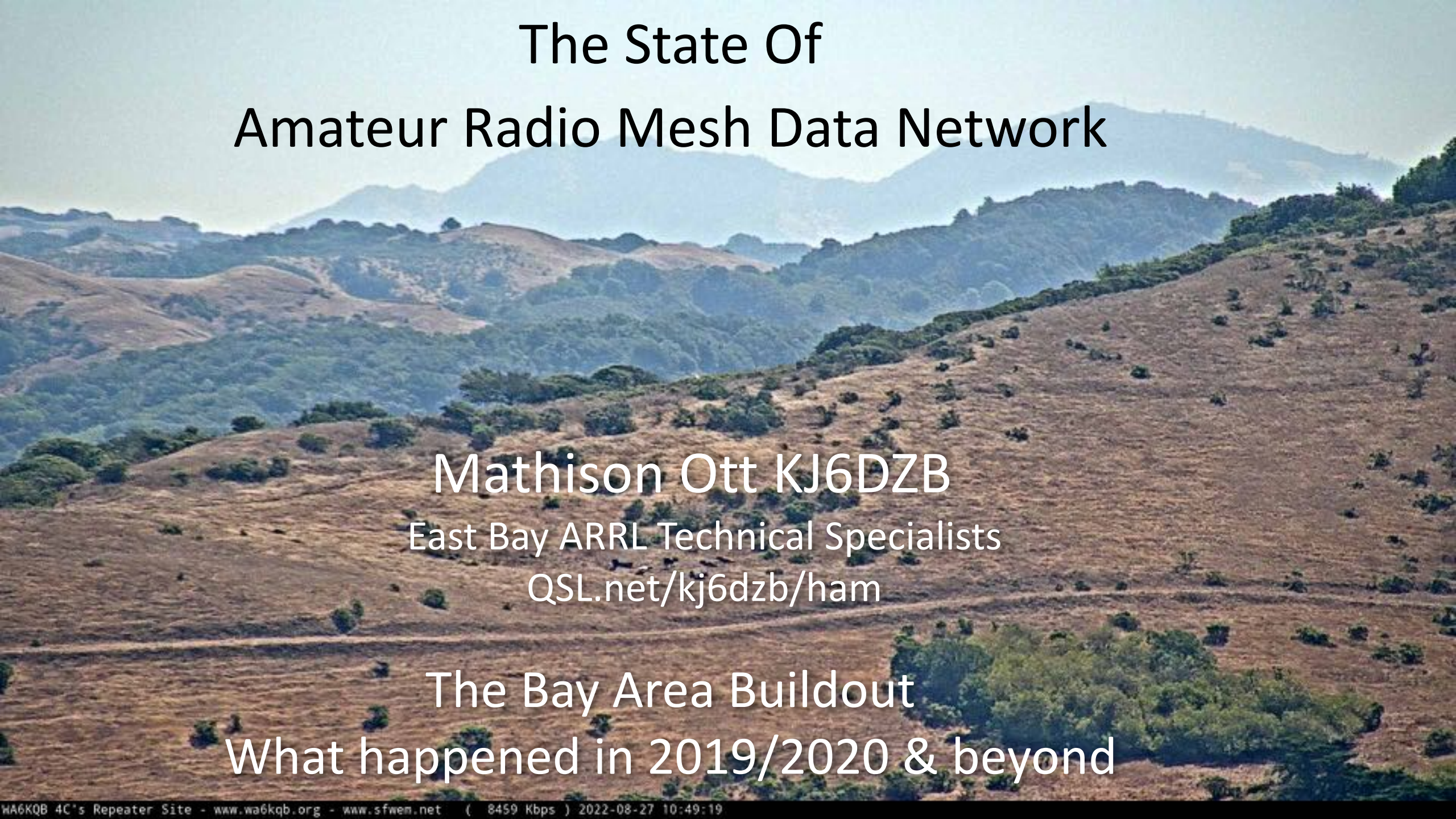
East Bay ARRL Technical Specialists

QSL.net/kj6dzb/ham

The Bay Area Buildout
What happened in 2019/2020 & beyond



ARRL “EB” Section

W6CUS Field Day 2015, 2016 2019

portable operation

5ghz Ham band (5650.0-5925MHz) 260mhz to 70mhz of Spectrum

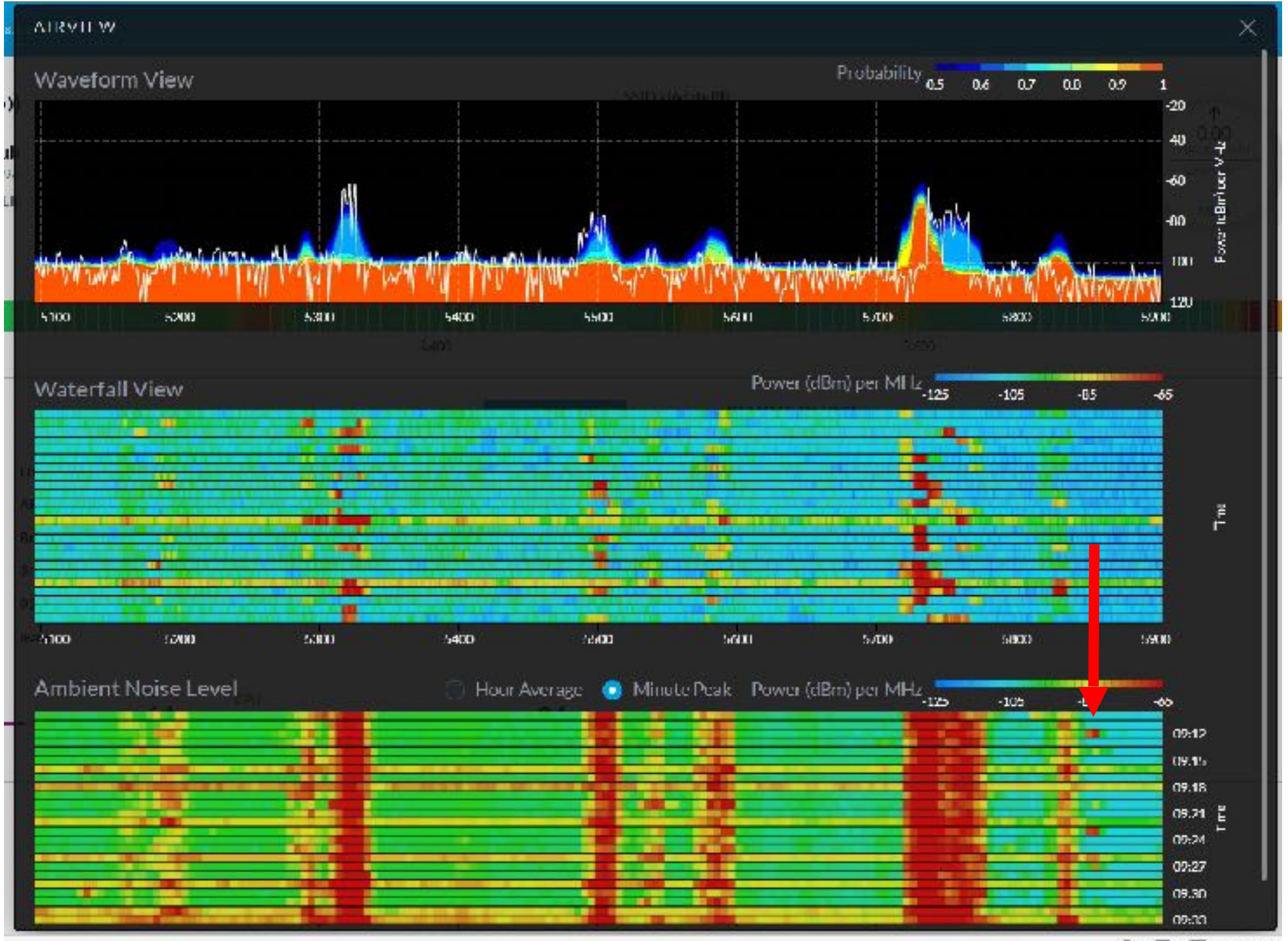
Broadband segment used for any combination of high-speed data, Amateur Television and other high-bandwidth activities. Channels Division and or separation may be done regionally based on needs and usage.

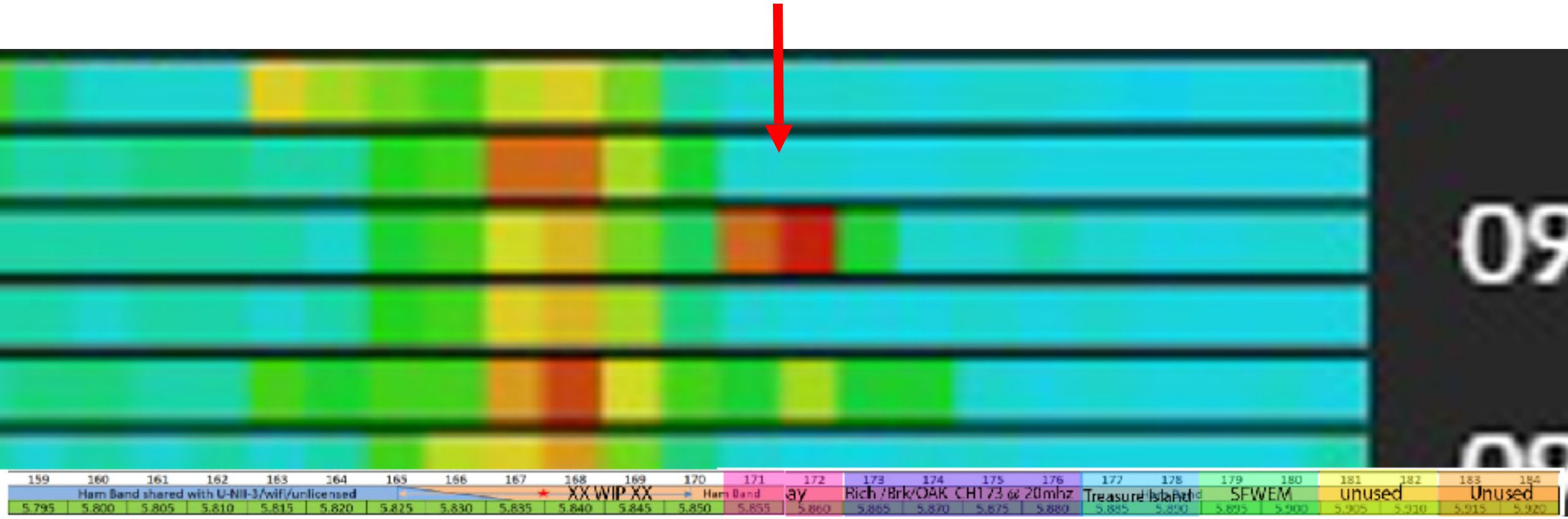
5.8 GHz																			
	Channel	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148
	Ctr Freq	5.655	5.660	5.665	5.670	5.675	5.680	5.685	5.690	5.695	5.700	5.705	5.710	5.715	5.720	5.725	5.730	5.735	5.740
	Status	Shared with US unlicensed indoor/outdoor DFS & Radar Avoidance (max 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.


Waveform View
Probability
0.5
0.6
0.7
0.8
0.9
1
-20
-40
-60
-80
-100
-120
Waterfall View
Power (dBm) per MHz
-125
-105
-85
-65
Time
Ambient Noise Level
Hour Average
Minute Peak
Power (dBm) per MHz
-125
-105
-65
Time


09
159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184
Ham Band shared with U-NII-3/wifi/unlicensed
XX WIP XX
Ham Band
ay
Rich /Brk/OAK CH173 @ 20mhz
Treasure Island
SFWEM
unused
Unused
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 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

900mhz & 2.4ghz Ham band

Division into channels and/or separation of uses within this segment may be done regionally based on needs and usage.

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

You are responsible for using frequencies, channels, bandwidths, and power levels that comply with your country's amateur radio license requirements.

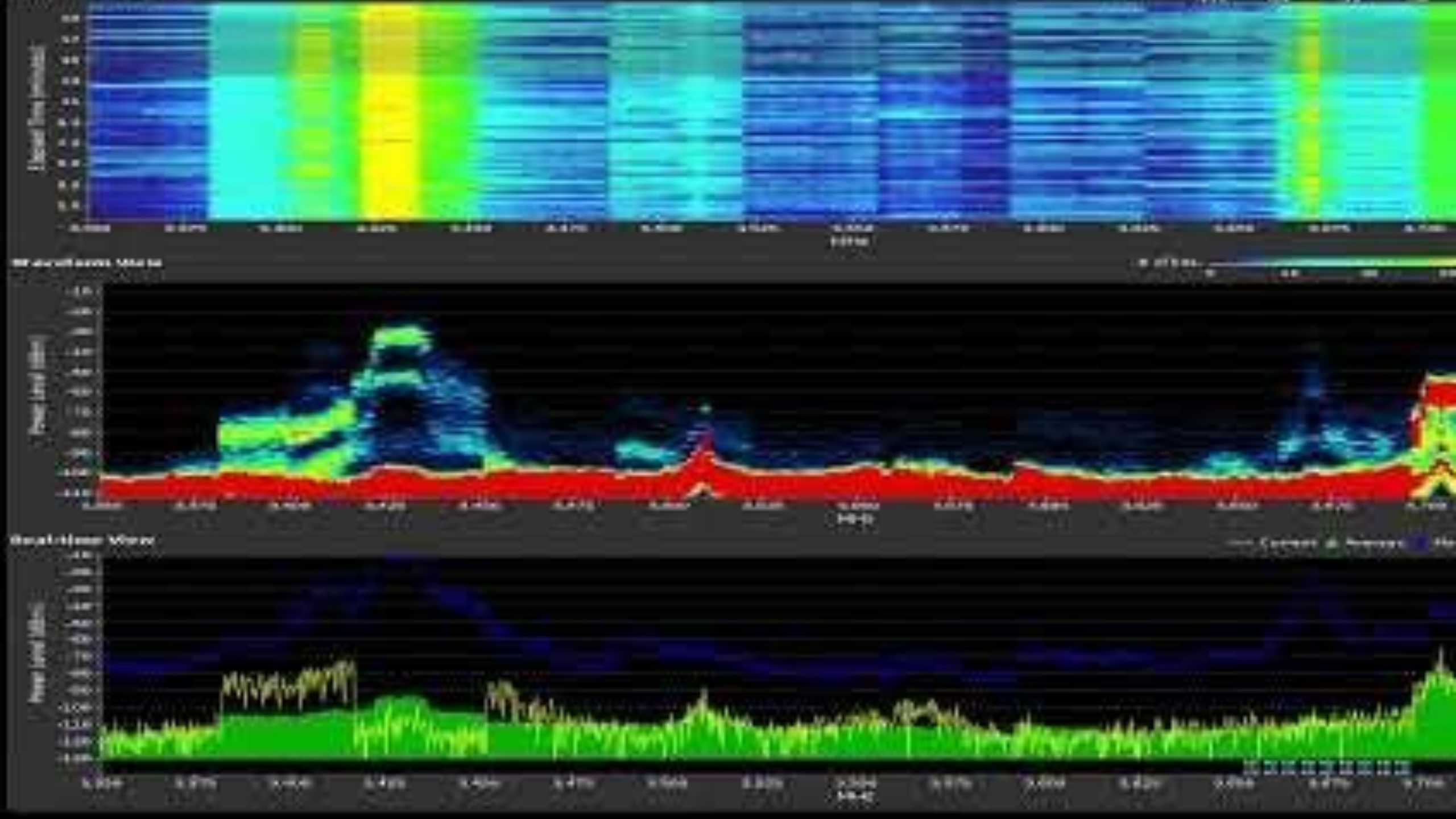
2.4 GHz															
	Channel	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8 *
	Ctr Freq	2.387	2.392	2.397	2.402	2.407	2.412	2.417	2.422	2.427	2.432	2.437	2.442	2.447
	Status	non-US only		*Unshared*		Cannot Use	Shared with US unlicensed							

* Only 5 MHz channel width is available on channel 8

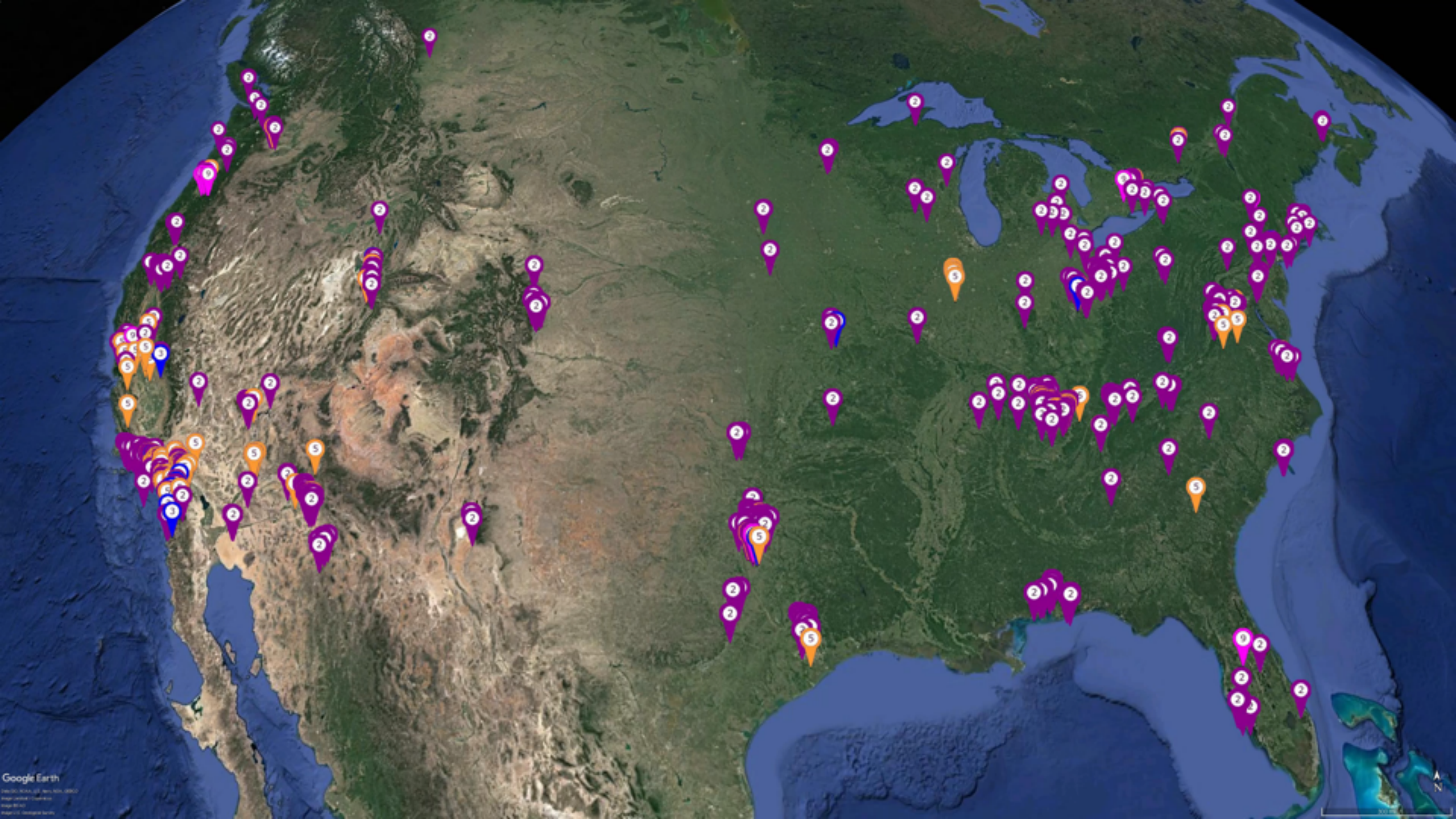
https://www.youtube.com/watch?v=ocxw8pC4JV8

3.4 GHz															
	Channel	76	77	78	79	80	81	82	83	84	85	86	87	88	89
	Ctr 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	Shared with US non-Amateur users													

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
Non-US Amateurs only									



BAM is a project to install resilient high-speed wireless connectivity throughout the Bay Area.


Google Earth

Broadband-Hamnet
formerly
HSMM-Mesh

It’s 2022

Regional Communications

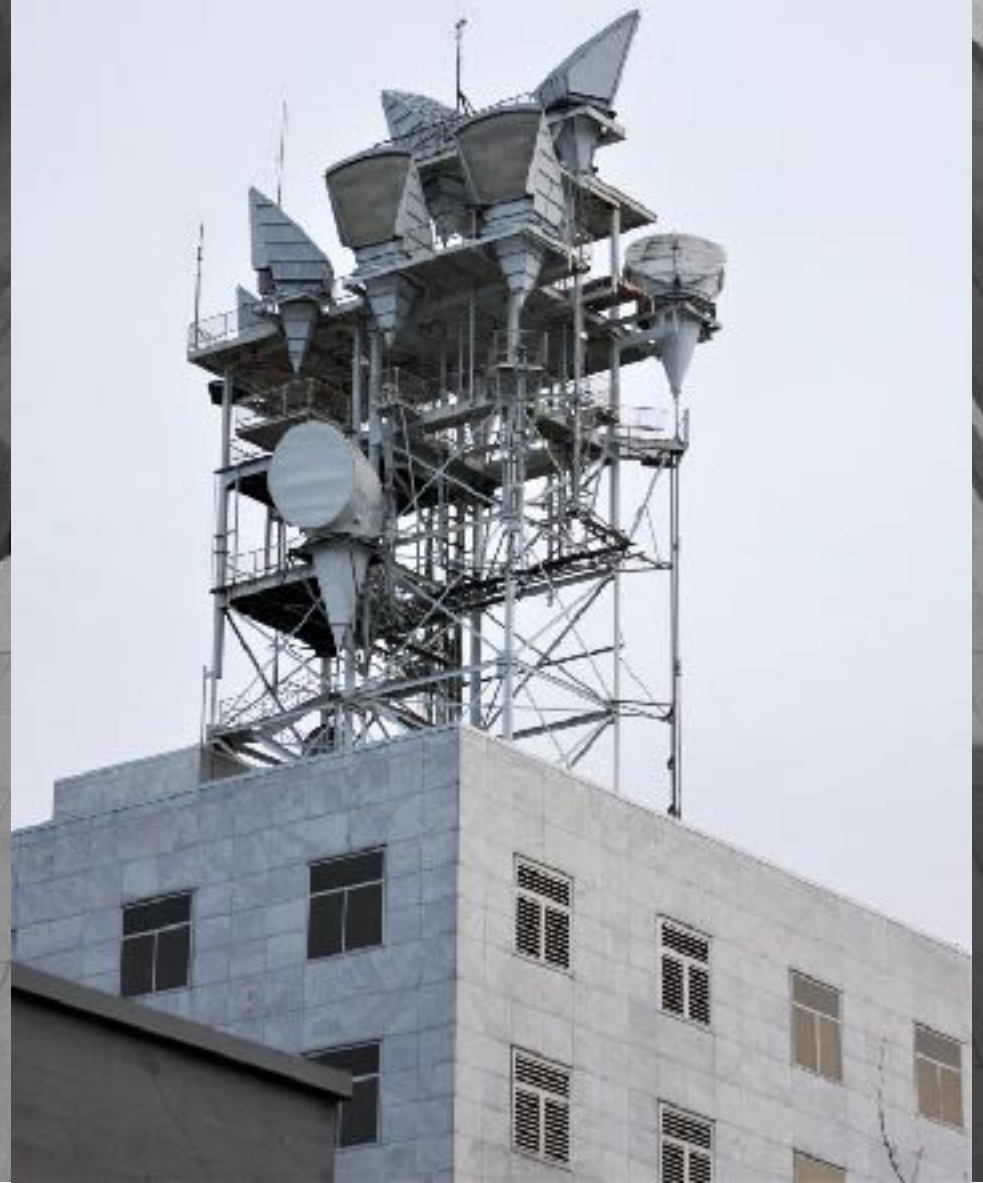
STATISTICS

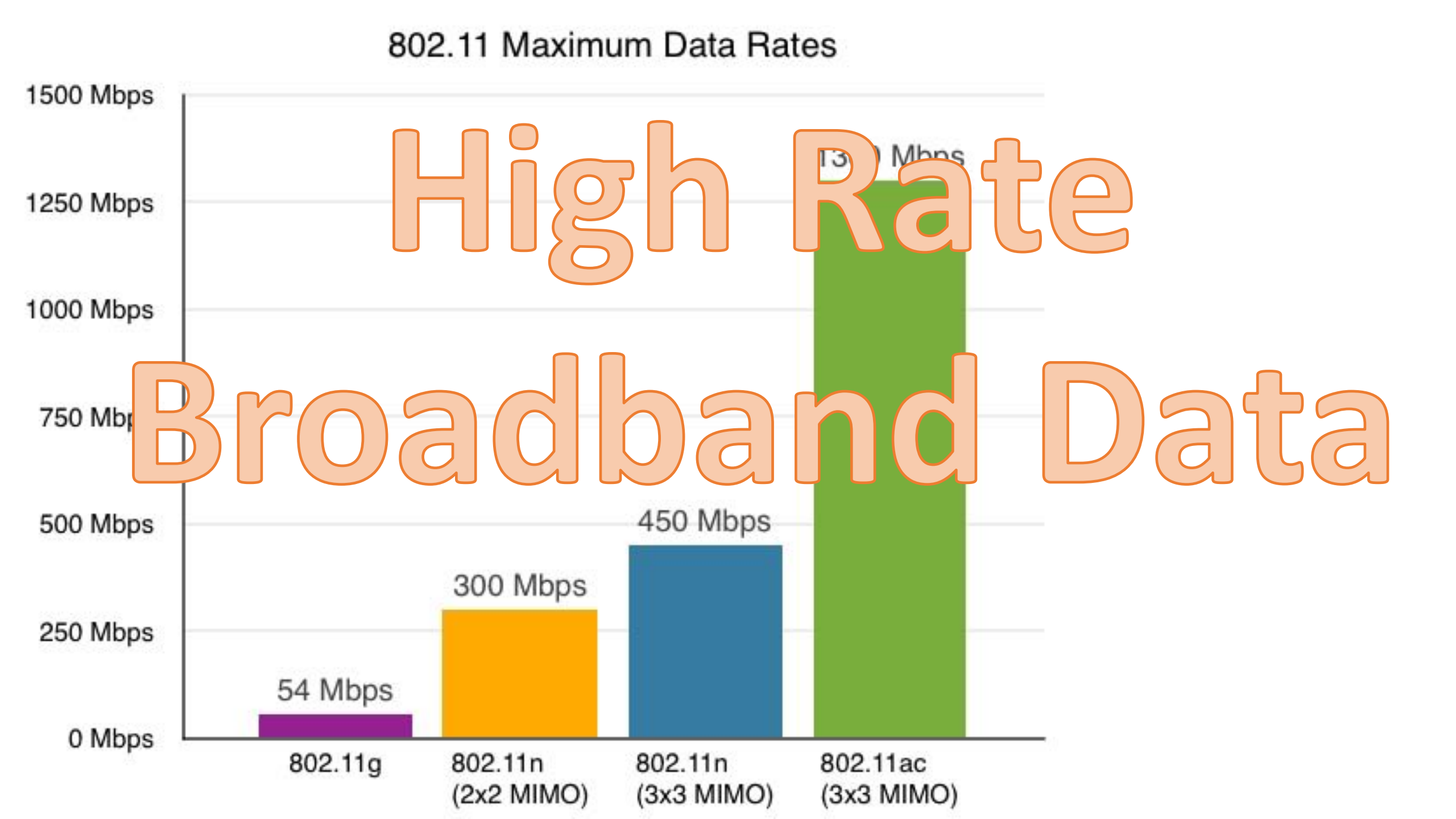
tions San Francisco-Los Angeles (including

e (San Francisco-Los Angeles)—376 miles.
ations—averages 37 miles.
ute—5280 feet above sea level.

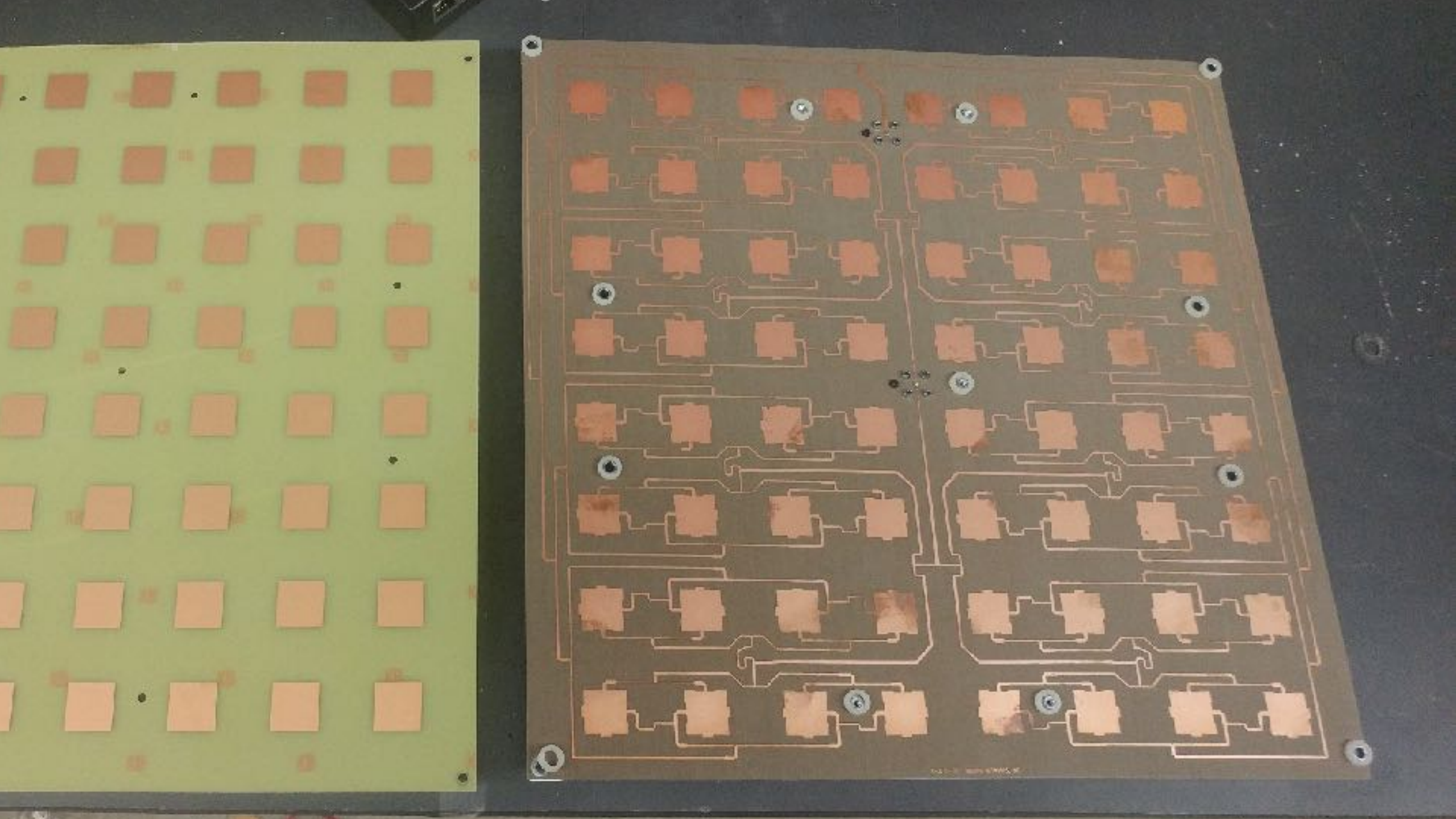
Lowest point on route—400 feet above sea level.
Weight of antennas—approximately one ton.
Frequency at which radio-relay operates—3,700 to 4,200 megacycle range (4,000,000,000 cycles).
Wave length—approximately three inches.

900Mhz, 2.3Ghz,
3.4Ghz, 5.8Ghz, 10.5Ghz




802.11 Maximum Data Rates
1500 Mbps
1250 Mbps
1000 Mbps
750 Mbps
500 Mbps
250 Mbps
0 Mbps
54 Mbps
300 Mbps
450 Mbps
802.11g
802.11n (2x2 MIMO)
802.11n (3x3 MIMO)
802.11ac (3x3 MIMO)
High Rate
Broadband Data


PCI-E WIRELESS LAN CARD - 802.11AC/
MADE IN CHINA
Ubit®
2974Mbps
5G:2400Mbps
2.4G:574Mbps
Dual-band 160MHz
AX200
WiFi 6
802.11 AC/AX
Bluetooth 5.0
RoHS COMPLIANT



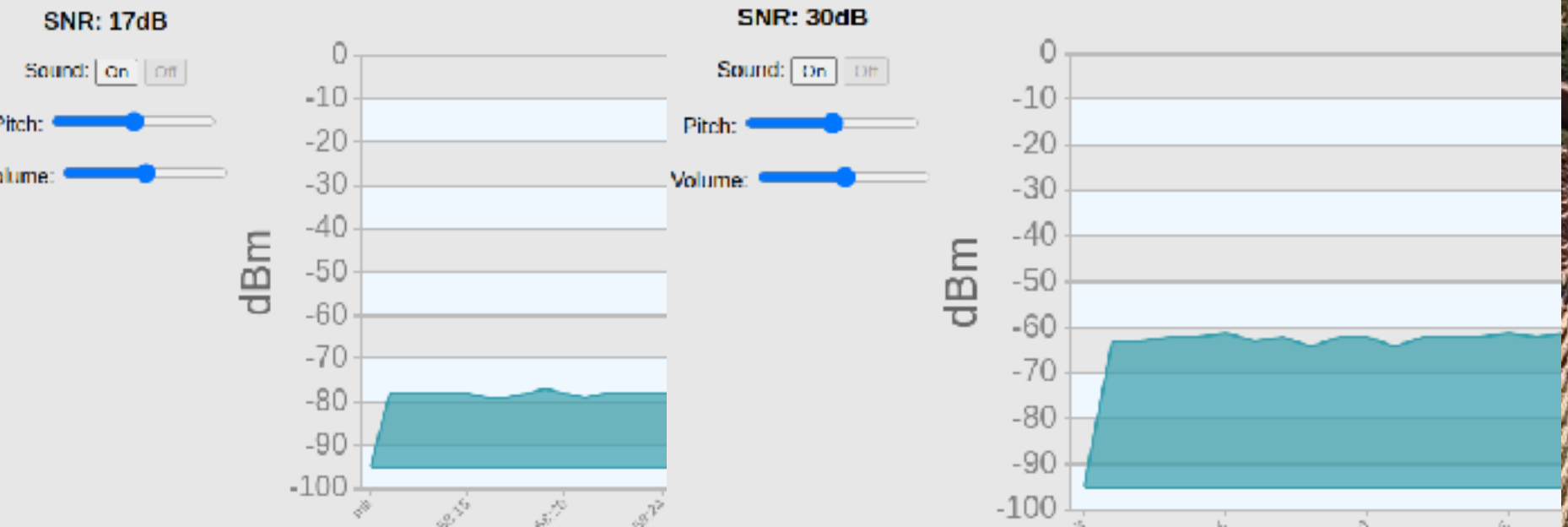
Strong network? or Week signal network?

Current Neighbors	LQ	NLQ	TxMbps	Services
K0DYY-LHG-XL-1	38%	87%	13.0	
KE6BEE-ElCerrito-PBM5	100%	93%	117.0	
KJ6DZB-ESR-MLHGXL5-East-Dish	87%	94%	35.3	
KJ6DZB-NSL5 (wan)	63%	89%	40.6	

BAD

Good

Radios automatically negotiate best modulation rate based on SNR



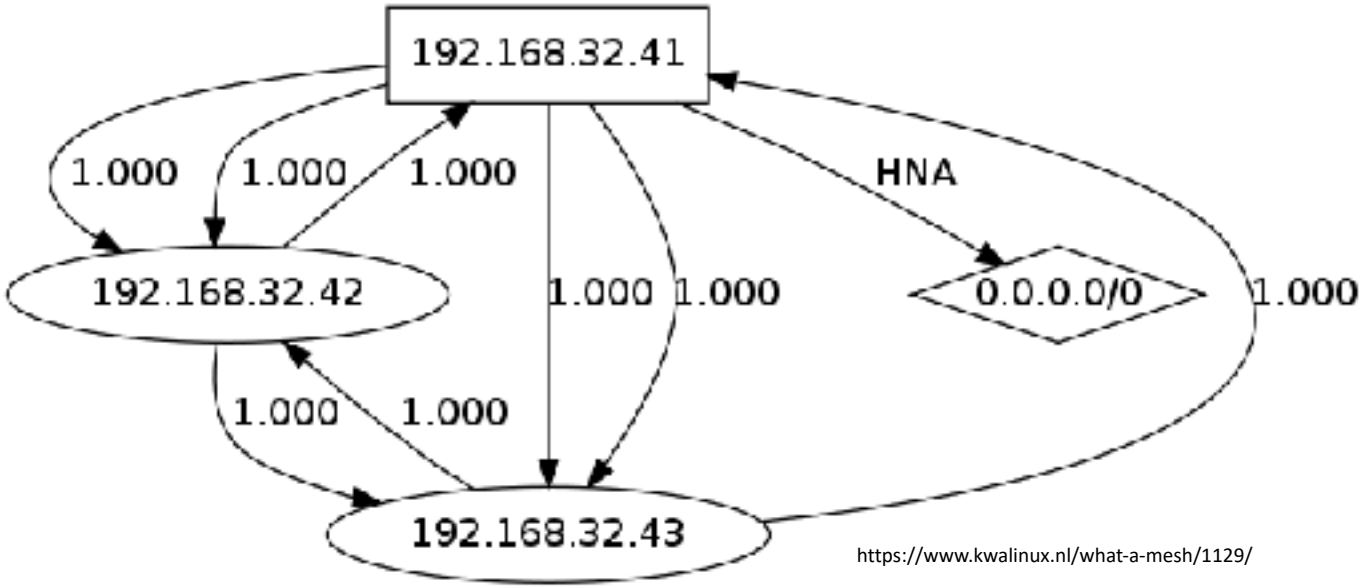
What is OLSRD it doing?

-Receive announcements from others nodes and responds with known routes.

-Each node calculates a metrics value for known routes, ranking them with an ETX metric.
12++ gets dropped.

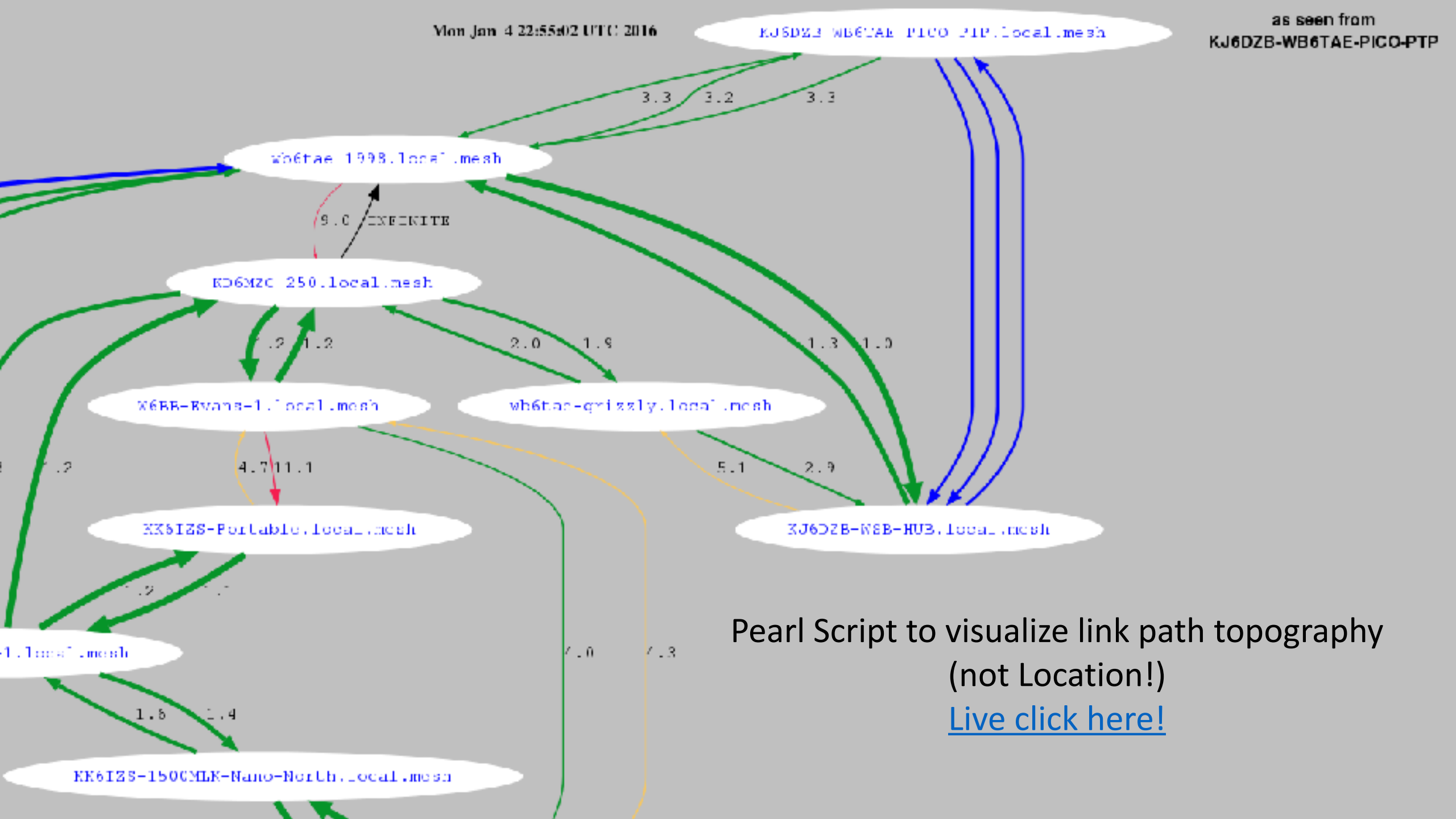
-Synchronizes Domain Names, Announce Services, Pole a node for Location, Link ETX metrics, routes.

Mesh Chat and Winlink search the service announcements



https://www.kwalinux.nl/what-a-mesh/1129/

Best Path !



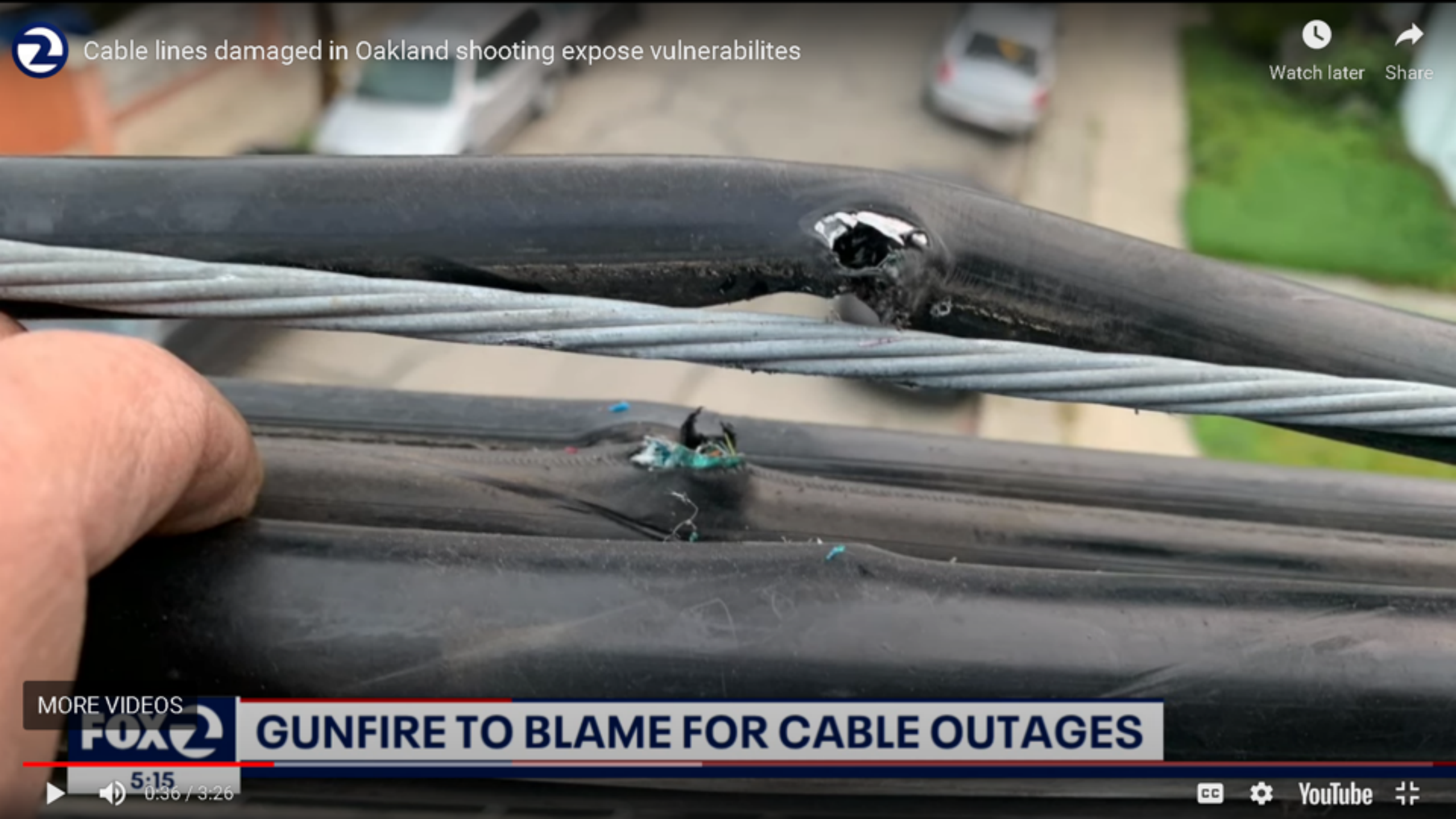
Pearl Script to visualize link path topography
(not Location!)
Live click here!

7 Layers of the OSI Model

7	Application	Human-computer interaction | HTTP, DNS, FTP, POP3
6	Presentation	Data representation and encryption | SSH, SSL, IMAP, FTP, JPEG
5	Session	Connection maintenance | API's, sockets
4	Transport	End-to-end connections | TCP, UDP
3	Network	Logical addressing for data path using packets | IP, ICMP, IGMP
2	Data	Physical addressing, formatting data in frames | switch, bridge, ethernet
1	Physical	Physical transmission of signals, media, or binary raw bits | coax, fiber, wireless

- Camera data video proxy
- Remote sensor
- Voice over IP
- Drag and drop File sharing (Own Cloud)
- Real-time Chat
- APRS / ADB-S / AIS relays
- Remote RX/TX Echo link / IRLP / Site linking
- Winlink / Rf Terminals
- Web based reporting applications!
- Collaborative Computing (Matter Most)
- Computer Aided Dispatch
- Network Visualization
- *Satellite downlink distribution. Weather / Data*
- Games (no Thermonuclear War)
- Network Time Services

For more visit: AREDN


Cable lines damaged in Oakland shooting expose vulnerabilites
Watch later
Share
MORE VIDEOS
FOX 2
GUNFIRE TO BLAME FOR CABLE OUTAGES
5:15
0:36 / 3:26
YouTube

The Arden firmware enables adhoc deployment of a network simpler*

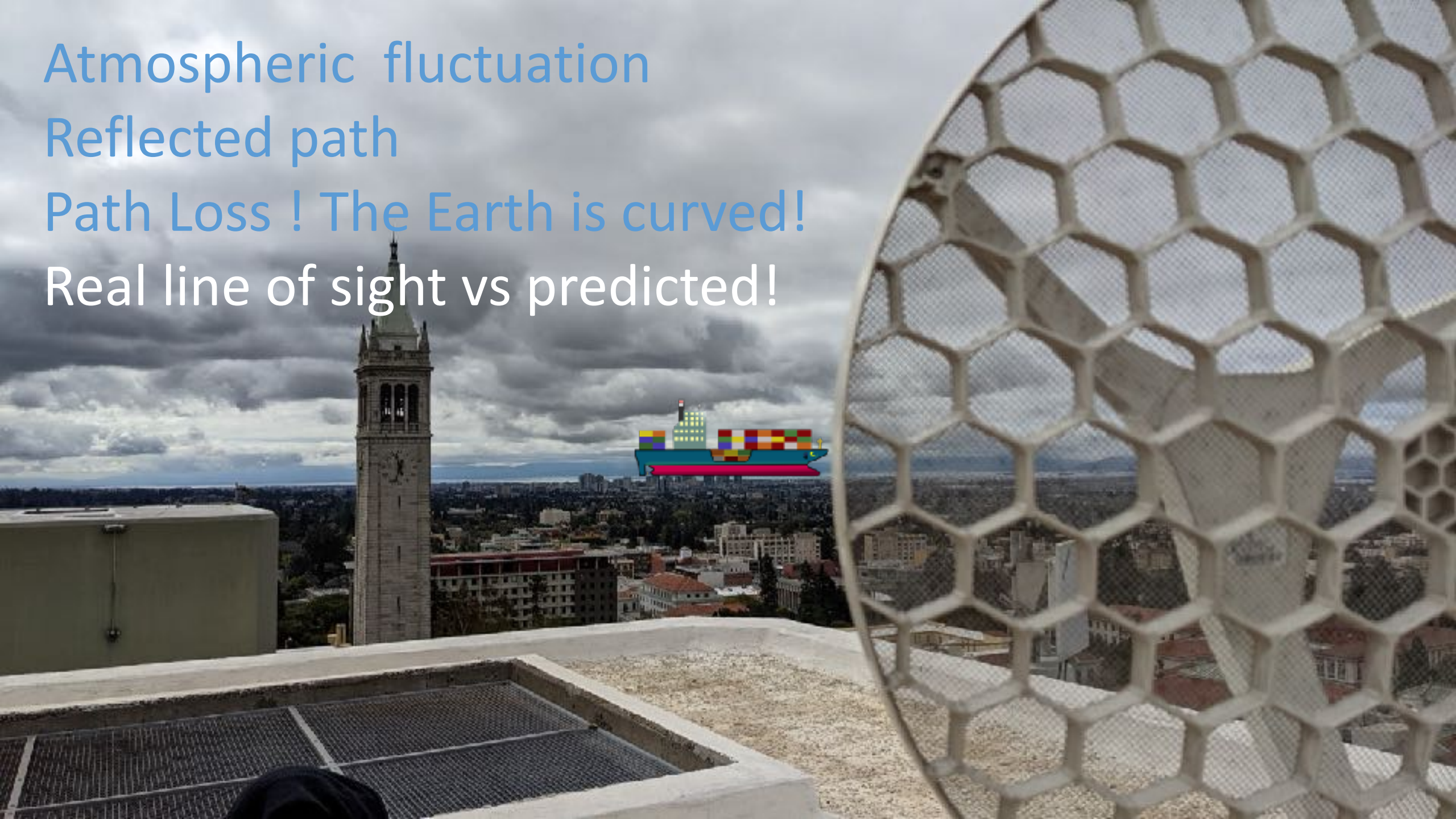
To allow Hams to build a regional radio accessible Data Network!

Atmospheric fluctuation

Reflected path

Path Loss ! The Earth is curved!

Real line of sight vs predicted!

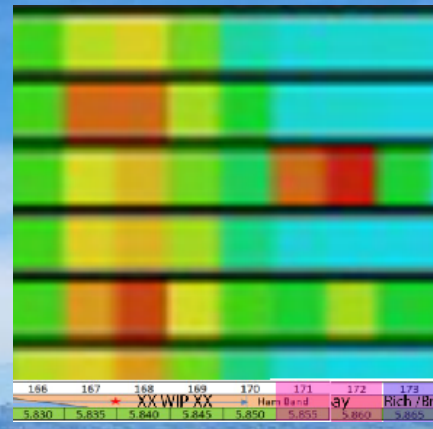


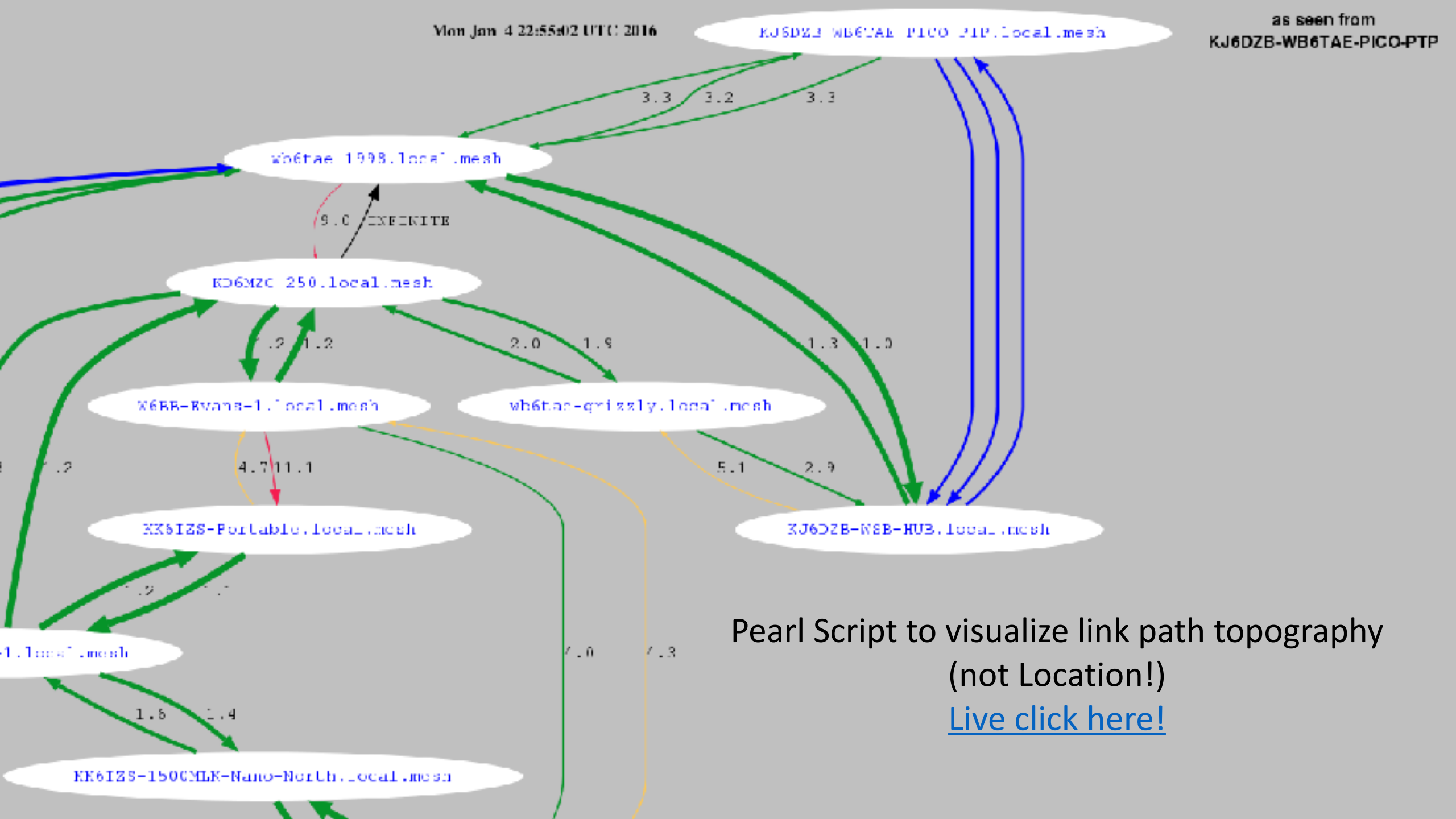
- Limited Access
- Line Of Site
- Mounting
- Power
- RFI (HF!) (NOISE FLOOR)


Make New Friends!

-Repeater site are key to regional coverage.

Verify LOS! & Verify the Spectrum!





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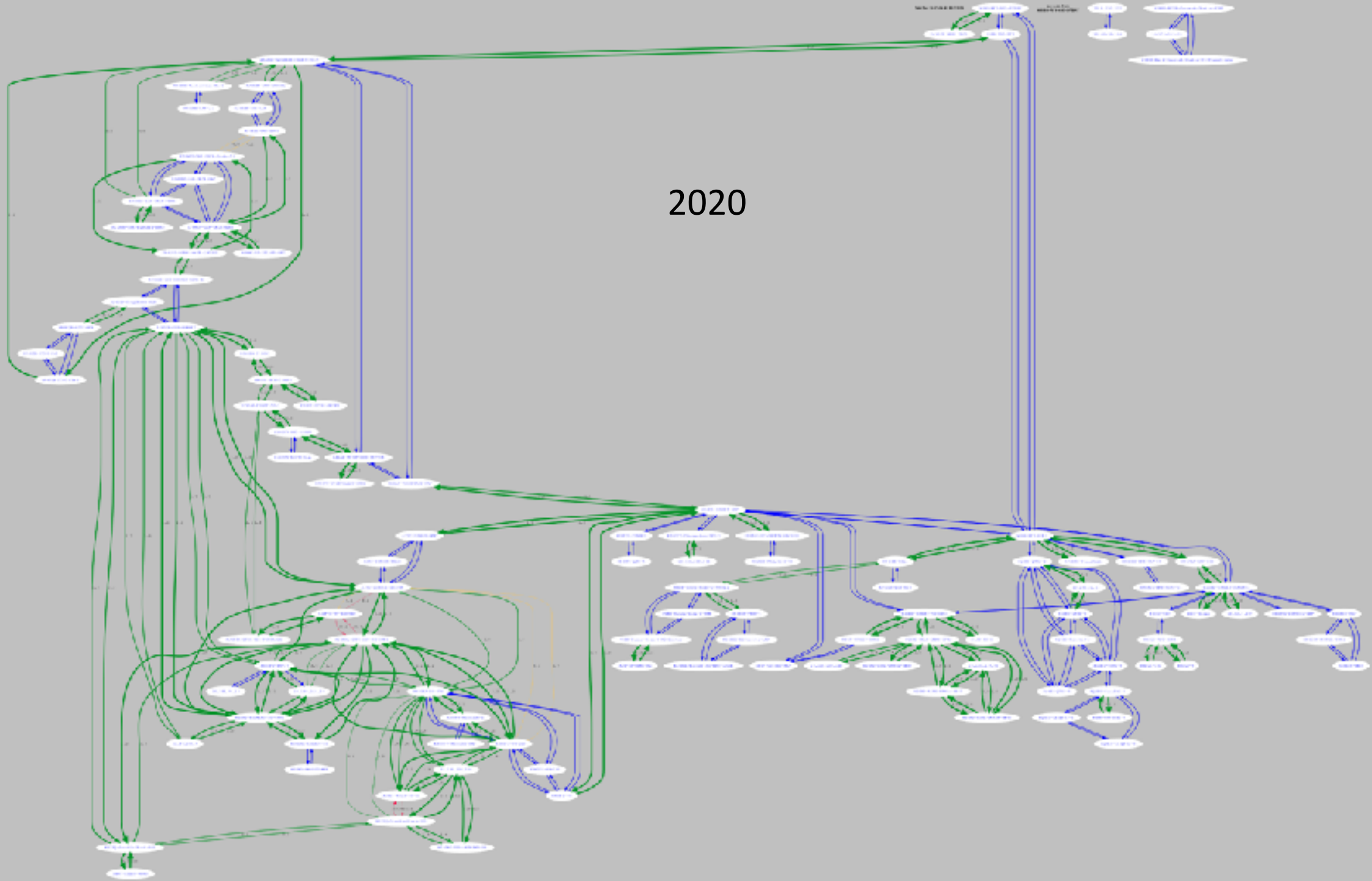
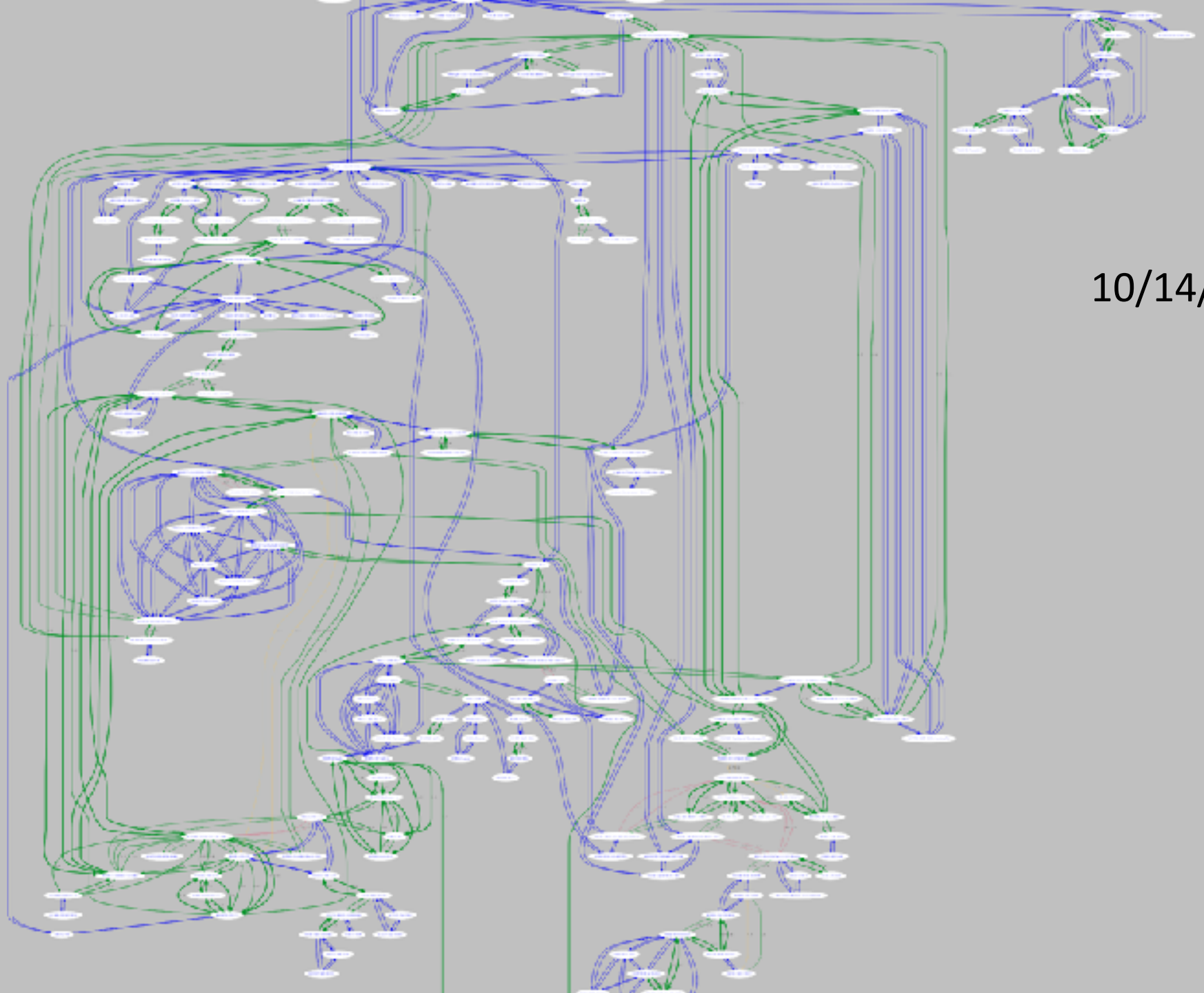
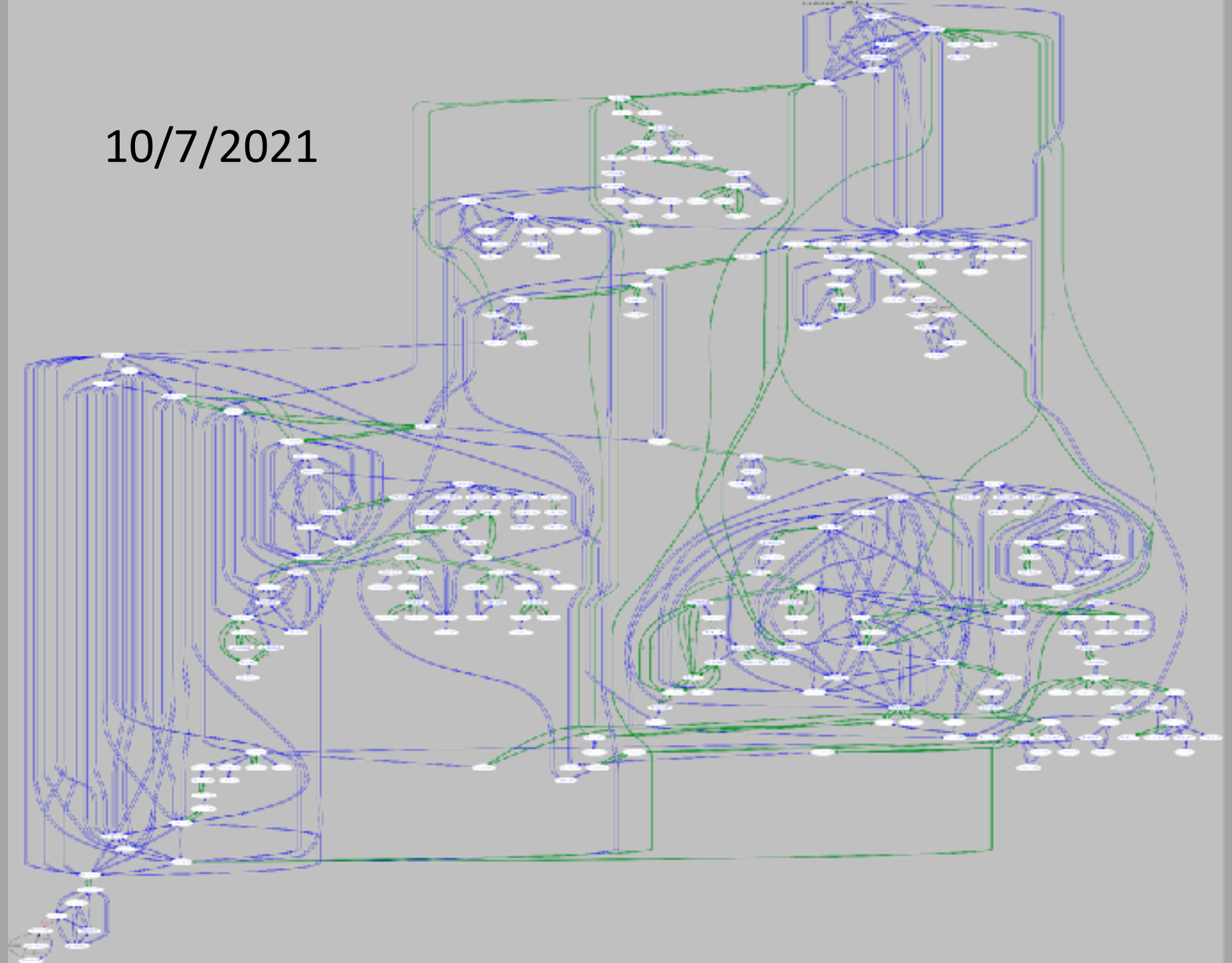

2020



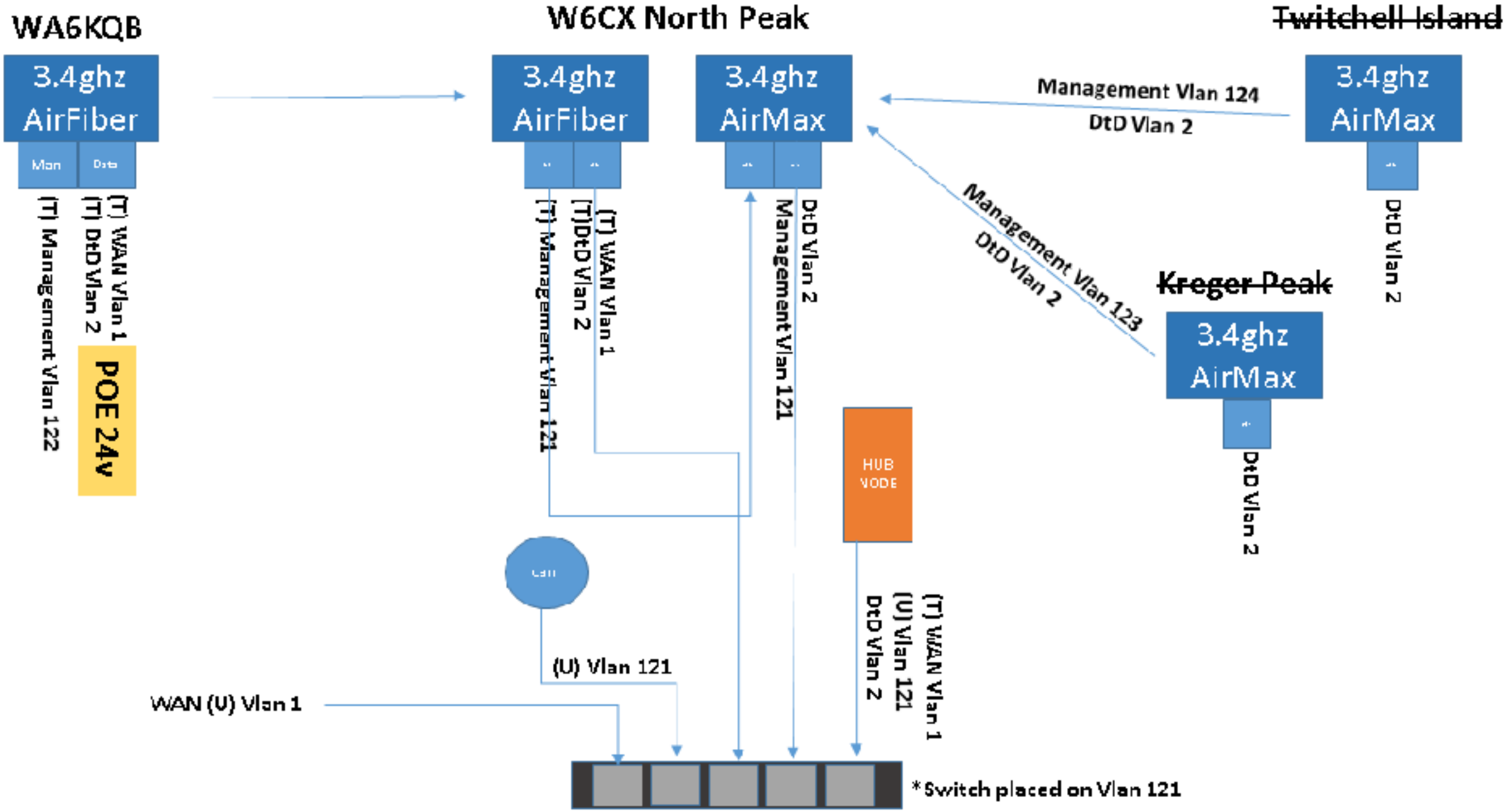
10/14/2021

10/7/2021




We need a Back Bone


Bay Area Backbone
RFS to WA6KQB
WA6KQB to Mt Diablo North
Fish Ranch to Mt Bruno
Mt Bruno to San Carlos
Tools to Monitor
Radio links
Bay Area Backbone
Health: Bad
Uptime: 97%
Sites
CCCC
Fish Ranch
Mount Diablo
ORCA
Richmond Field Stn
San Bruno Mtn
San Carlos
Links
ORCA
Fish Ranch
CCCC
Richmond Field Stn
Mount Diablo
CCCC
Fish Ranch
San Bruno Mtn
San Bruno Mtn
San Carlos


WA6KQB
3.4ghz AirFiber
Man
Data
(T) Management Vlan 122
(T) DtD Vlan 2
(T) WAN Vlan 1
POE 24v
W6CX North Peak
3.4ghz AirFiber
(T) Management Vlan 121
(T)DtD Vlan 2
(T) WAN Vlan 1
3.4ghz AirMax
DtD Vlan 2
Management Vlan 121
Management Vlan 124
DtD Vlan 2
Twitchell Island
3.4ghz AirMax
DtD Vlan 2
Management Vlan 123
DtD Vlan 2
Kreger Peak
3.4ghz AirMax
DtD Vlan 2
HUB
VODE
(U) Vlan 121
WAN (U) Vlan 1
(T) WAN Vlan 1
(U) Vlan 121
DtD Vlan 2
*Switch placed on Vlan 121

LOCAL

PB5ACG2-B-BFS
PowerBeam 5AC

37.931869 -122.331208
24:5A:4C:0E:23:40
TX POWER 24 dBm

0.16
THROUGHPUT
CAPACITY
273.38
Mbps

SSID W6BBoToWA6KOB

3.05 mi

Link Potential 100.0 %

Airtime 0.4 %

0.15
THROUGHPUT
CAPACITY
133.65
Mbps

REMOTE

PB5ACG2-A-4C
PowerBeam 5AC

37.957171 -122.311419
24:5A:4C:0E:25:14
TX POWER 24 dBm

Map | Link | Fresnel

LOCAL DEVICE

RF ENVIRONMENT

5755 MHz
80 MHz 5740 - 5790

SIGNAL -56 (-60 / -59) Δ1 dBm

NOISE FLOOR -94 dBm

LOCAL RX DATA RATE 6X (64QAM MIMO)

EXPECTED RATE 8X

1X 2X 4X 6X 8X

ISOLATED CAPACITY / THROUGHPUT | SIGNAL, NOISE & INTERFERENCE

4
2
ms

320
160
Mbps

capacity RX 277 Mbps
throughput RX 157 kbps
latency 0 ms

REMOTE DEVICE

RF ENVIRONMENT

5755 MHz
80 MHz 5740 - 5790

SIGNAL -69 (-70 / -78) Δ8 dBm

NOISE FLOOR -81 dBm

REMOTE RX DATA RATE 4X (16QAM MIMO)

EXPECTED RATE 6X

1X 2X 4X 6X 8X

ISOLATED CAPACITY / THROUGHPUT | SIGNAL, NOISE & INTERFERENCE

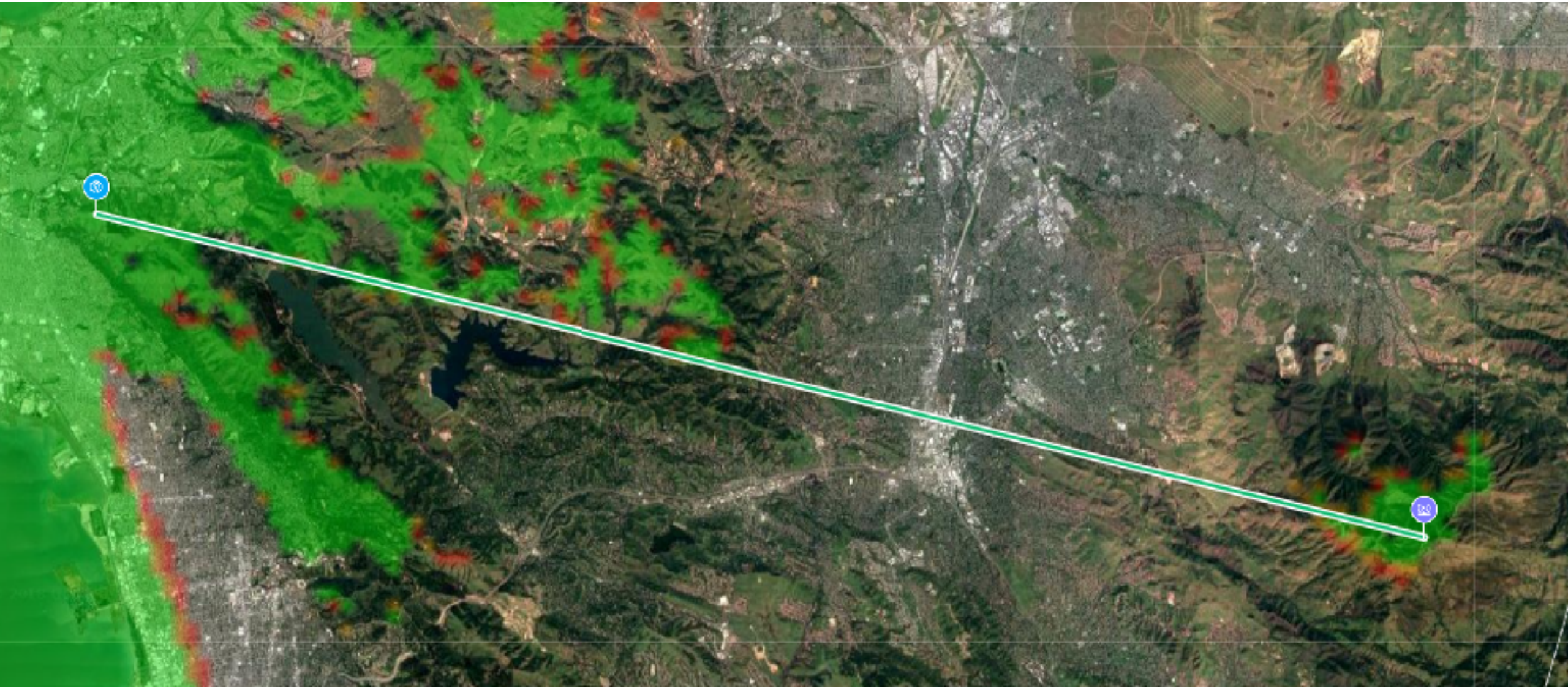
4
2
ms

200
100
Mbps

capacity RX 134 Mbps
throughput RX 145 kbps
latency 0 ms

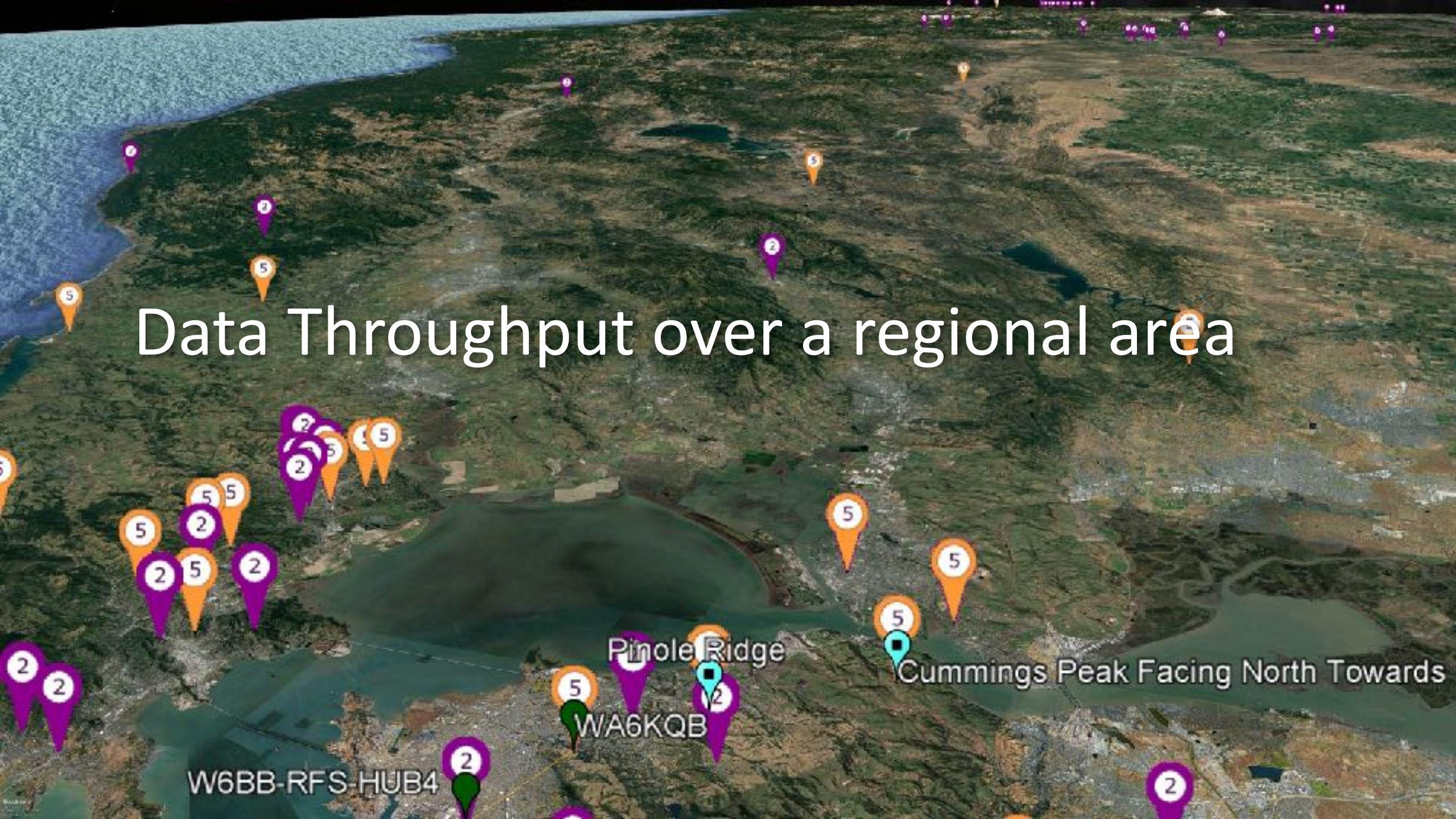
Verify LOS!
Verify the spectrum!

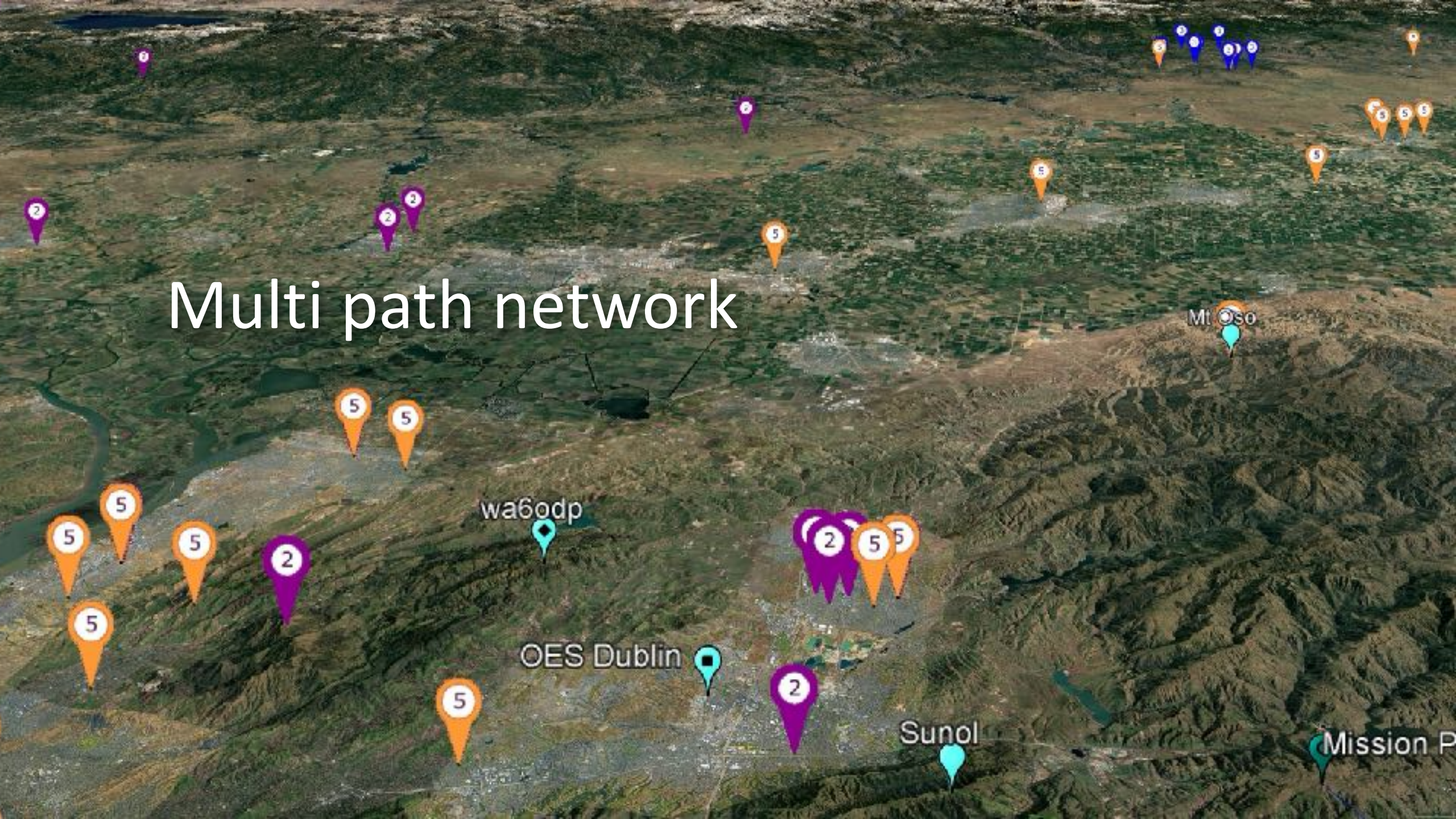
WA6KQB to W6CX

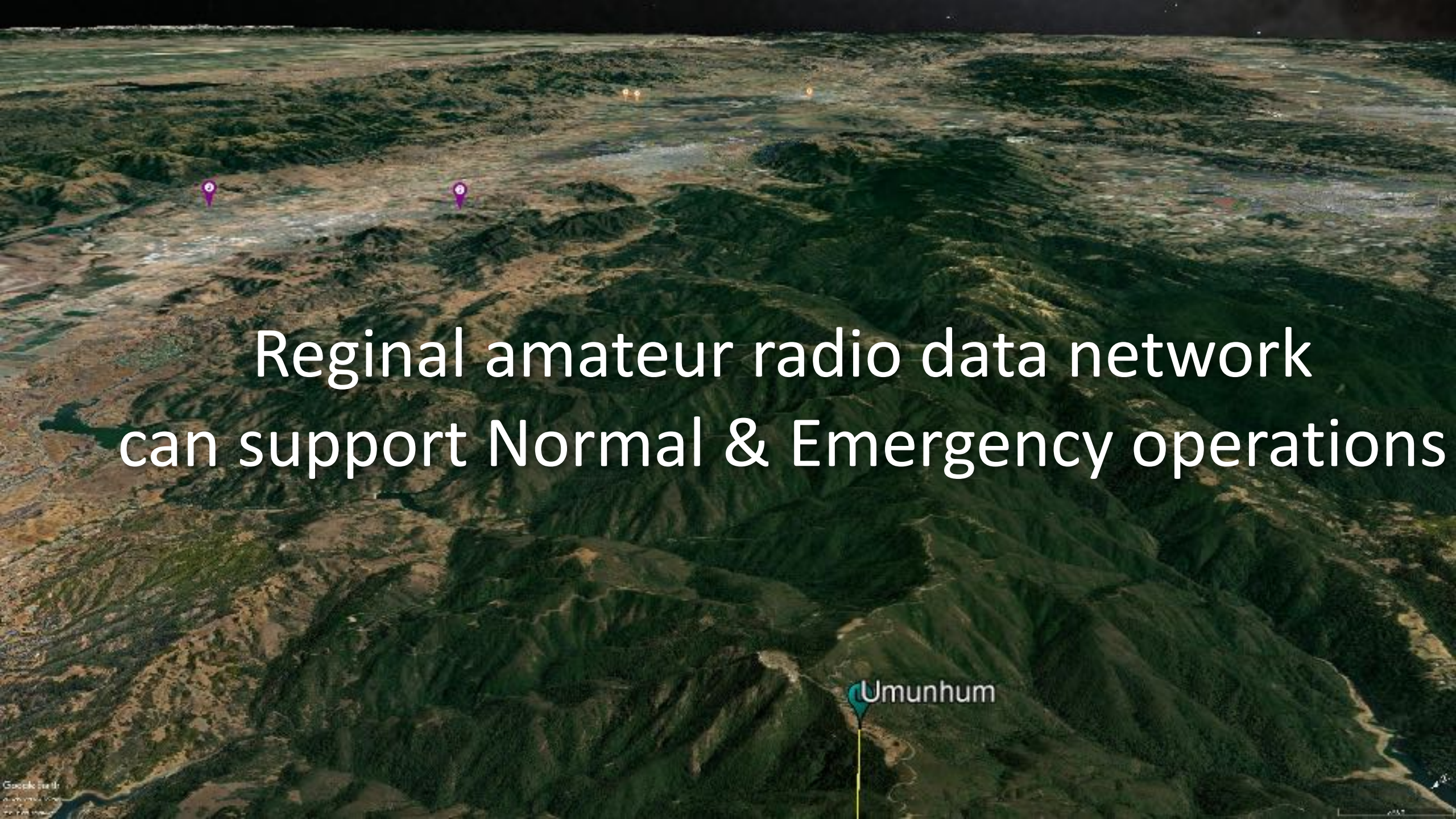


Time to take a drive!

Signal over Noise
Go for Gain!
for
Stable data rates


Data Throughput over a regional area
Pinole Ridge
Cummings Peak Facing North Towards
WA6KQB
W6BB-RFS-HUB4


Multi path network
wa6odp
OES Dublin
Sunol
Mission P



Reginal amateur radio data network can support Normal & Emergency operations

73 de KJ6DZB

- www.sfwem.net/start
- www.arednmesh.org
- My QSL.net site