

Ham Radio Networking v 1.0

Prepared by Orv Beach, ham callsign W6BI
Technical Specialist, ARRL Santa Barbara Section



Ham Radio Networking

- Uses commercially available Wi-Fi access points
- Custom firmware for ham radio use
 - Moves Wi-Fi radios into ham bands adjacent to Part 15 bands!
- Based on OpenWRT (which is based on Linux)

The Ham Radio (Part 97)

Digital Networking Bands

- 902-928 MHz
- 2.4 GHz – 2300-2310; 2390-2450 MHz
- 3 GHz – 3300-3500 MHz
- 5 GHz Band – 5650-5925 MHz

2.4 GHz – 2300-2450 MHz

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

ISM - industrial, scientific and medical

3 & 5.8 GHz Bands

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
		88	89	90	91	92	93	94	95	96	97	98	99
		Ham Band											
		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
		146	147	148	149	150	151	152	153	154	155	156	157	158
		Shared Ham and ISM/WiFi Band												
		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
		Shared Ham and ISM/WiFi 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

Mesh networking is a modern ham radio activity

But

It's just a network. It doesn't do anything...

It's all about the “Services”

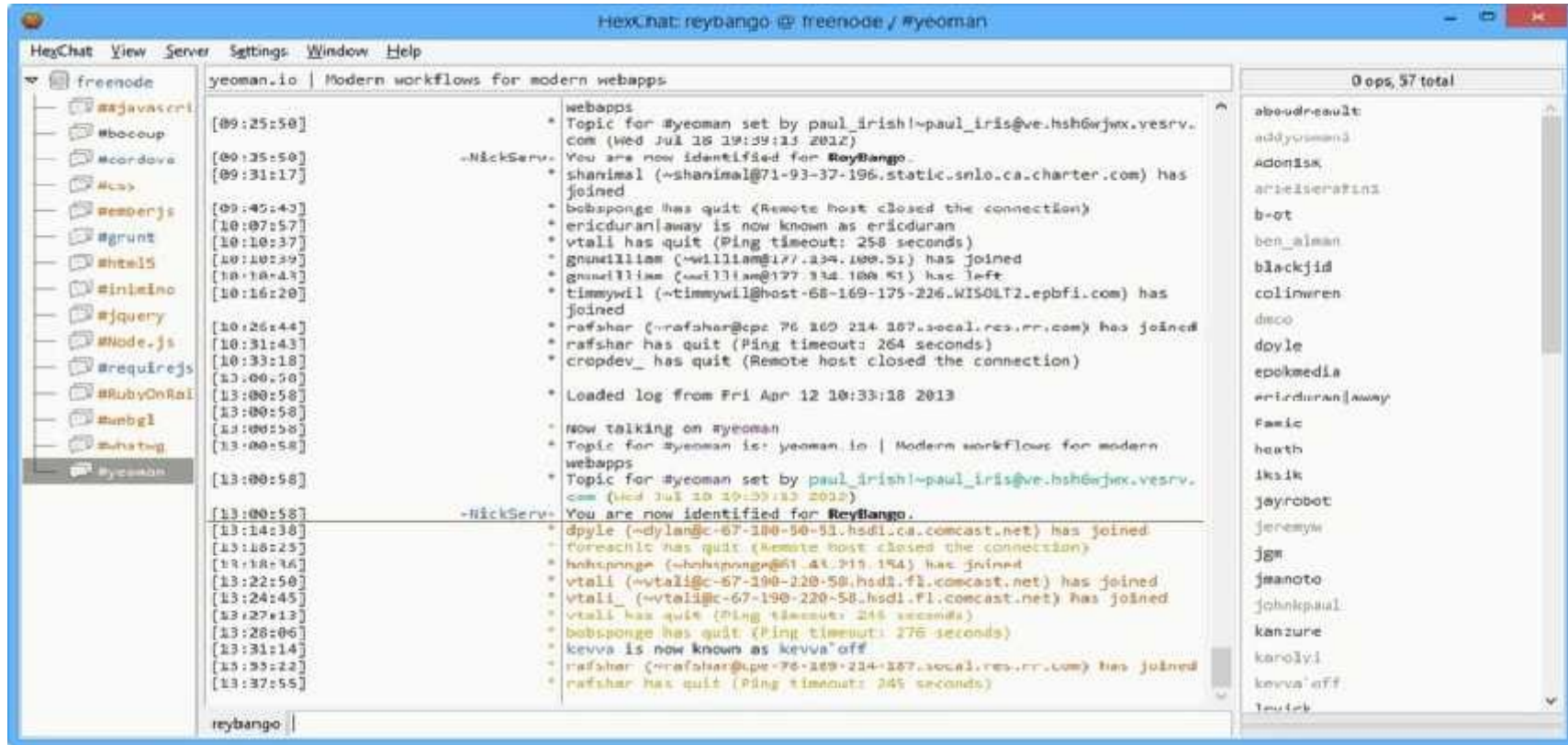
Mesh Networking Services

- Services = things you can actually use
 - Keyboard to keyboard (IM)
 - Voice
 - Video
 - Docs (like Google Docs)
 - Web servers / pages
 - Store and forward (email)
 - Repeater linking
 - Pretty much anything you can do on the Internet – subject to the Part 97 Regulations

Keyboard to Keyboard

- **IRC (Internet Relay Chat)**
 - Dedicated channels
 - Ad hoc channels
 - Ad hoc one-on-one chats
 - Minimal bandwidth required
 - Easy to use with minimal training
 - Geographically-separate servers can be linked together.
 - IRC Servers require some skill to set up and link together

IRC Example



Keyboard to Keyboard

- **MeshChat**
 - Automatically links to other MeshChat services discovered on network
 - Multiple channels (optionally)
 - Supports file upload/download (“Dropbox”)
 - Runs nicely on a Raspberry Pi

MeshChat

CHAT

FILES

STATUS

LOGOUT

Mesh Chat v1.0

Zone: LWMeshChat
Call Sign: K7FPV

Node: laytonwestdistrict
Updated: 14 seconds ago

Send a Message

New Message

Enter message here

Channel: Everything

SEND

Mesh Chat Users

1

Call Sign	Node	Last Seen
K7FPV	laytonwestdistrict	10/11/16 10:51 AM

Messages

Search:

Enter search

Channel: Everything

Time	Message	Call Sign	Channel	Node
10/11/16 10:50 AM	This is meshchat. It is a messaging and file sharing app for AREDN mesh networks.	K7FPV		laytonwestdist rict
	It is fully redundant and decentralized. It works with spotty links and requires very little bandwidth.			

VOIP (Voice Over IP)

Phone calls over the network



VOIP (Voice Over IP)



VOIP (Voice Over IP)

Voice Chat

- TeamTalk, etc.
- One to one
- Many to many (chat room)
- Can set up as many channels as necessary
- Multiple, simultaneous conversations
- Speaker/microphone or headset (HIGH quality audio)
- PTT (Push To Talk), VOX (Voice-operated Transmit) or open microphone
- Video, file sharing, desktop sharing – all available

VOIP (Voice Over IP chat server)



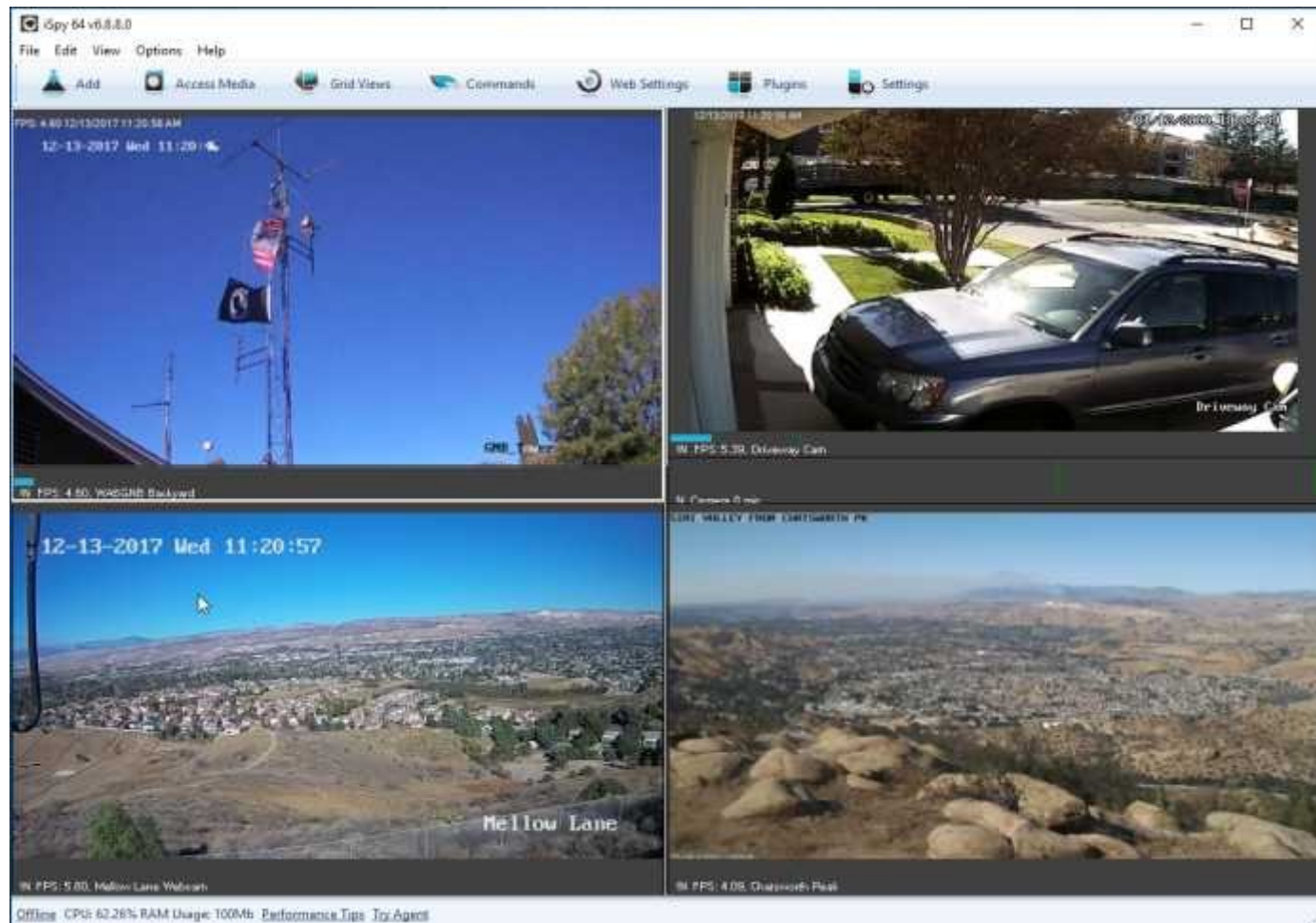
Video – Webcams

Webcam screenshot

Via mesh network - 3 hops on 2.4 & 5.8 GHz, about 40 miles total path length



Video - Webcams



Video - Webcams



Video - Webcams



Editable Docs

Etherpad - like Google Docs

- Concurrent editing by multiple authors
- Text & tables only

```
9 Yo
10 Hello?
11
12 A hoy hoy!
13
14 Neat! It seems like it's going in real-time.
15
16 Yes, it is! (AppJet has a scalable implementation of comet).
17
18 Nice. That's certainly something that's always a pain to try and get
19 right.
20
21 Yeah, and we went to great pains to make sure it works on IE6 and stuff.
22
23 Awesome. So this is all part of that .jar, then?
24
25 Not released yet. The .jar lets you run apps that currently can run on
26 appjet.com. Just 1-pagers basically.
27
28 EtherPad is the poster child for "project barmitzvah" -- wehre AppJet
29 comes of age :). We'll release the new version of AppJet for all
30 developers, open source, shortly afterwards.
31
32 Nice. So that big release is also happening next Wed.? (not necessarily
33 the Open Source release).
34
35 That's actually going to take a littl bit of time. Next wednesday is just
36 EtherPad and the announcement of the new platform coming. The new
37 platform (not sure what to call it yet, maybe JavaScript On Jets (I own
38 javascriptonjets.{com,net,org} :))
39
40 Ha, nice. Ok, so a three-stage release - Etherpad, then platform, then
41 open source platform.
42
43 Probably:
44 1. etherpad (next wed)
45 2. platform + open source to host yourself (a .jar basically)
46 3. ability to host any app on our servers, utility model
```

hide »


Connected Users

	John Resig	edit name/color 
24.61.14.106/Firefox3.0.3		
	aaron	
64.81.66.253/Firefox3.0.3		
	Aaron (laptop)	
64.81.66.114/Firefox3.0.3		
	jd	
64.81.66.219/Safari3.1.2		

[invite more people...](#)

Saved Revisions

[Save New](#)

 [Revision 1](#) *saved 5 hours ago by John Resig (24.61.14.106)*
[view](#) | [restore](#)

Options

- ☒ Highlight who typed what.
- ☒ Wrap long lines.
- ☒ Show line numbers.
- ☐ Use full window width & height.
- ☐ Highlight JavaScript syntax.

Feedback

Email

- Sendmail email servers
- RMS Express / Outpost / Winlink
- Citadel BBS

Old School – BBS!

Summary page for w6bi
Friday, 02/12/16

Language: en_US

 Dagoba  View tasks  Add new task  Skip this room  Go to next room

 Summary

 Mail

 Calendar

 Contacts

 Notes

 Tasks

 Rooms

My folders

Main Floor

 Aide

 Global Address Book

 Lobby

 Trashcan

 Online users

 Chat

 Advanced

 Administration

 Log off

Messages

Mail 0/1

Lobby 0/4

Tasks

(None)

Today on your calendar

(Nothing)

Who's online now

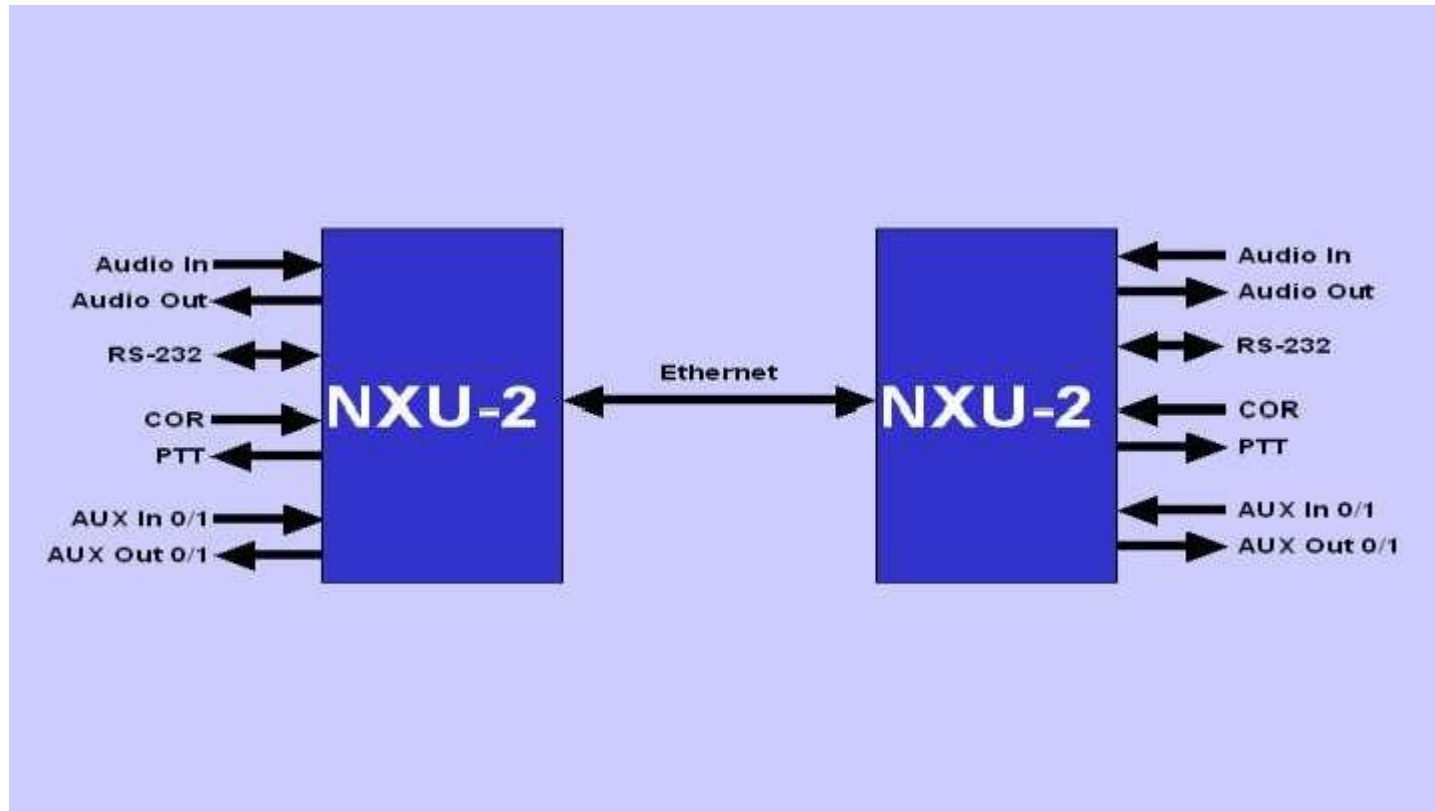
User name	Room
 w6bi	Tasks

About this server

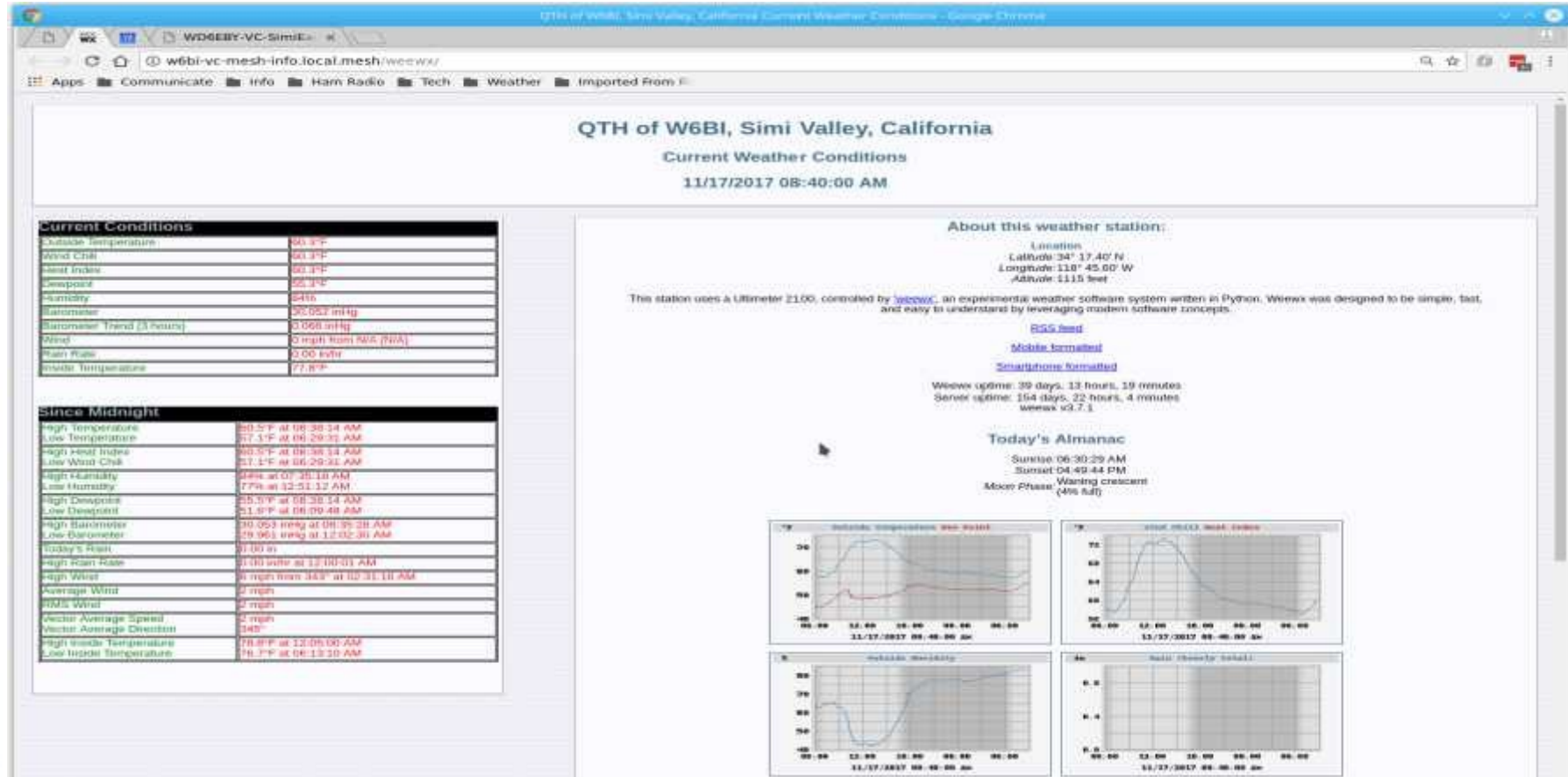
You are connected to SV Citadel Server, running Citadel 8.24 with WebCit 8.24, server build 8.24 and located in Simi Valley, CA. Your system administrator is W6BI!

RoIP Repeater Linking

JPS Communications, SkyMira, etc.



Weather Station



Equipment

What's out there??

Ubiquiti Access Points

- Available for four amateur bands
 - For outdoor use: weatherproof
 - Higher power - 28 dBm (most models)
- Built-in gain antennas in many models
- Sophisticated software-defined transceivers (dual chain!)
 - MIMO/802.11n (most models) - enhances throughput substantially
 - POE (Power Over Ethernet) - only one cable required to node.
- Like handie-talkies: low power, line of sight
 - Used mostly through hilltop relays

For the home:

Ubiquiti Nanostation M2/M5*



* ~ \$85/\$90 - Amazon

Ubiquiti PowerBeam M5*



*~\$115

Ubiquiti Rocket M2/M5*



- For the high-level access points: mountaintops & hilltops
- Requires external antennas

***\$77/85 - Amazon**

Ubiquiti Rocket M2/M5



On back of
MIMO sector antenna (\$85-125)



With MIMO
omni antennas (~\$160)

Other Mesh Station Requirements

- Shielded (per Ubiquiti) outdoor network cable (\$25-75)
- Dedicated computer for mesh (standalone network – no Internet access)
- Dedicated network switch (optional)
- Clear line of sight, because...

Line of Sight

***“Microwaves can
go 15 miles or
through one tree”***



Higher is better!



- Note Nanostation M2 at top of mast.

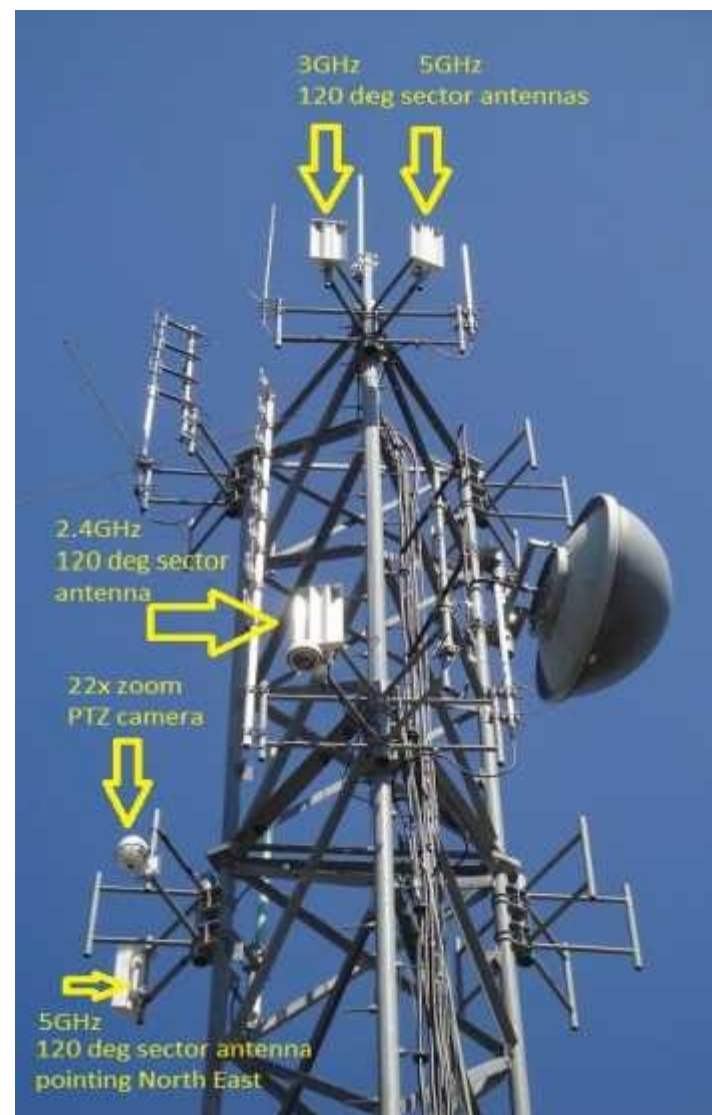


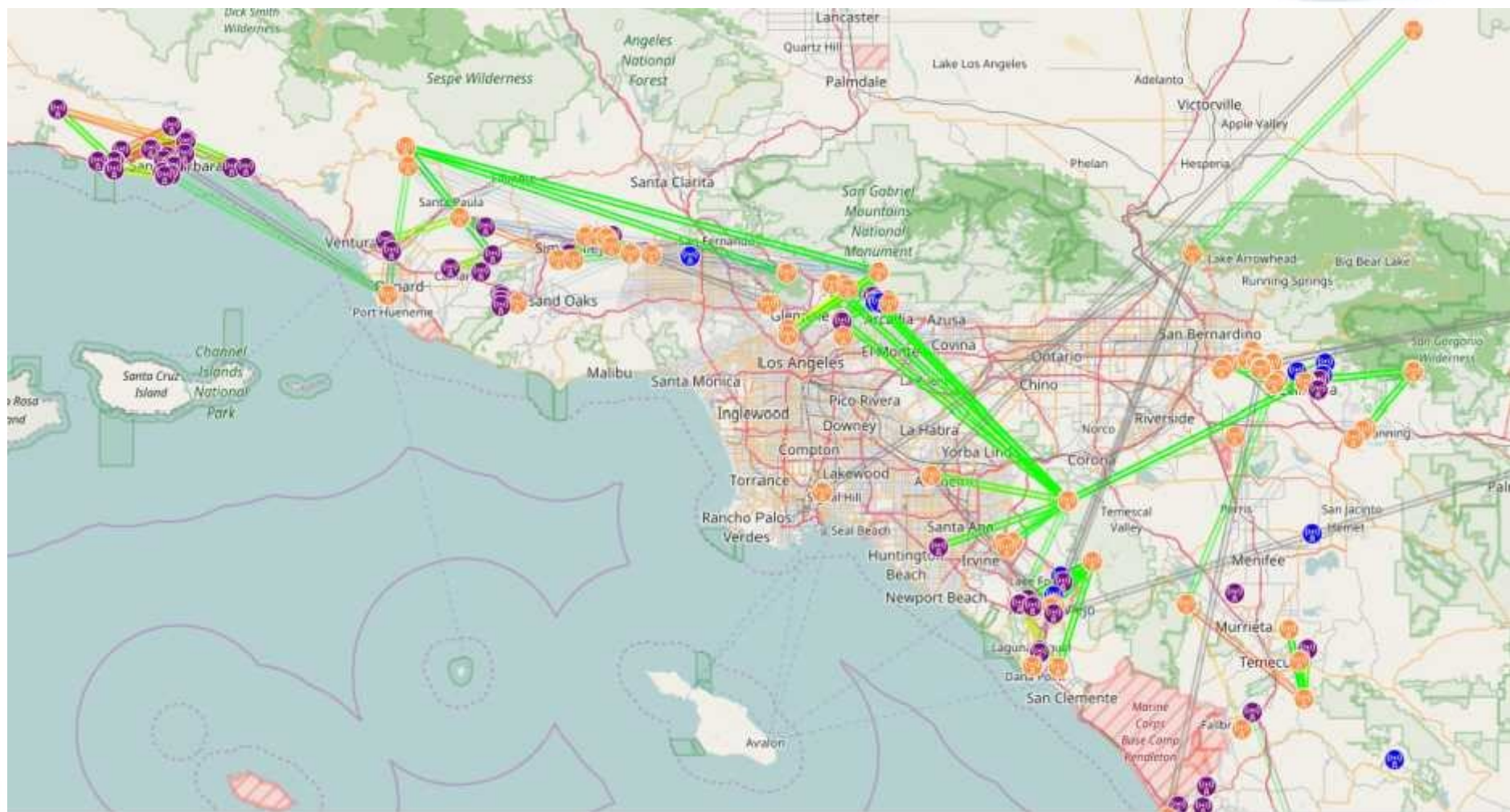












Ham Network Software Development Group

- Amateur Radio Emergency Data Network (AREDN)
 - <https://www.arednmesh.org/>
 - Software downloads
 - How-Tos
 - FAQs
 - Documentation
 - Forums

You Need a Ham License!

- Technician (entry-level) license is sufficient (Morse code no longer a requirement)
 - <http://www.arrl.org/getting-your-technician-license>
 - 35 multiple-choice questions
 - <http://www.arrl.org/question-pools>
- Tests administered locally by VEs (Volunteer Examiners)
 - <http://www.arrl.org/find-an-amateur-radio-license-exam-session>
 - Or contact your local ham radio club
 - Minimal cost for test
- Technician license also provides voice privileges on VHF & UHF bands, limited HF privileges

Questions?

The Ham Radio Internet

- orv.beach (at) gmail.com



An International
Association of Technology
& Computer User Groups