Amateur Radio Intranet
When All Else Fails…

FRRL Program

March 2014

AH6EZ

Cellular and the Internet

- Almost everyone uses them
  - Voice, text, video, pictures, social networks, browsing
  - Essentially for connectivity and information
  - Accustomed to high availability
- Designed for average loading
  - Not peak loading during disasters or emergencies
- Can be turned off or prioritized for Public Safety

Cellular Backup

- Major Cellular Carriers have Cell On Wheels
- Can be deployed fairly quickly
- May have lower capacity, user restrictions

Internet Backup

- Many ways to get to the Internet
  - Cellular, cable modem, telephone (DSL)
- Unless the electric utility power fails
- Any Amateur Radio solution needs backup power
  - Start with a few hours for most incidents
  - Then up to indefinite duration under your control
- Bridge from inside affected area to normal outside

Areas of Need

- Local emergencies
  - Nearby systems undamaged and provide coverage
  - Perhaps not as much need for Amateur Radio
  - Separate parallel network could avoid congestion
- Regional disasters
  - Nearby systems perhaps damaged, no coverage
  - Outer boundary connection by nomadic/mesh network
  - Amateur Radio RF spectrum variety very useful
  - More people affected, more time/resources to respond

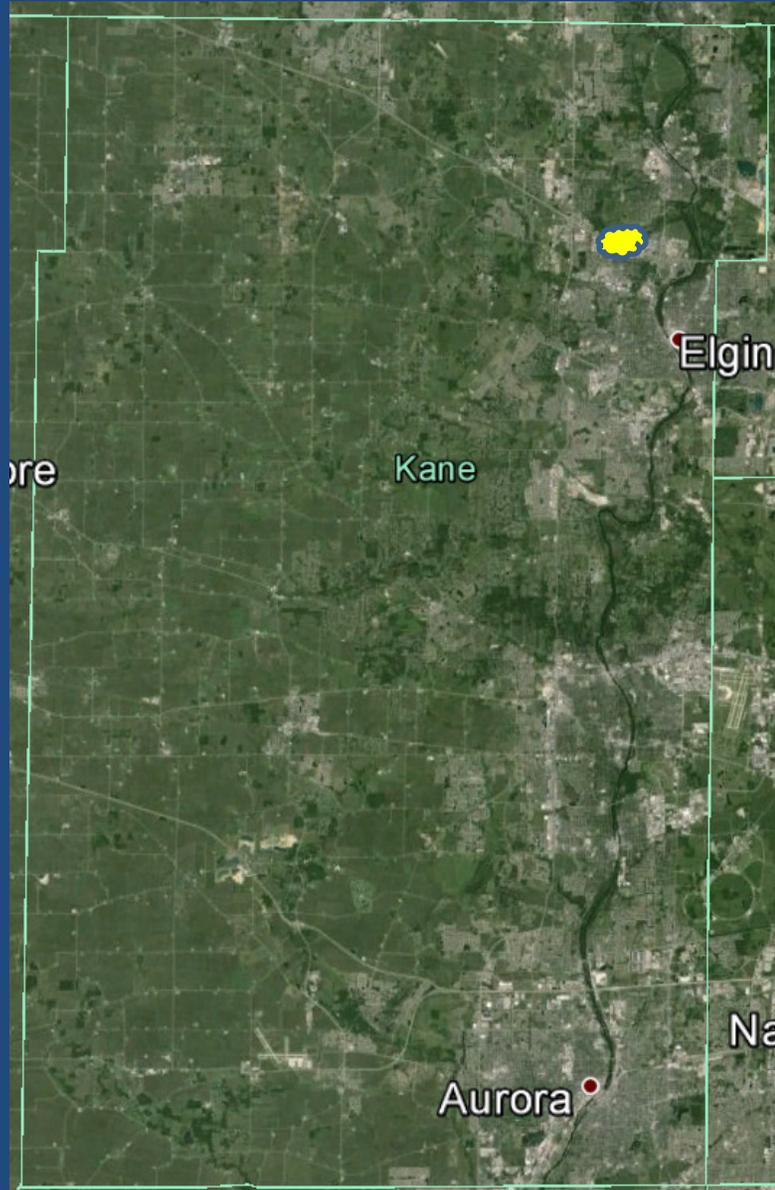# Illinois Earthquake Hazards
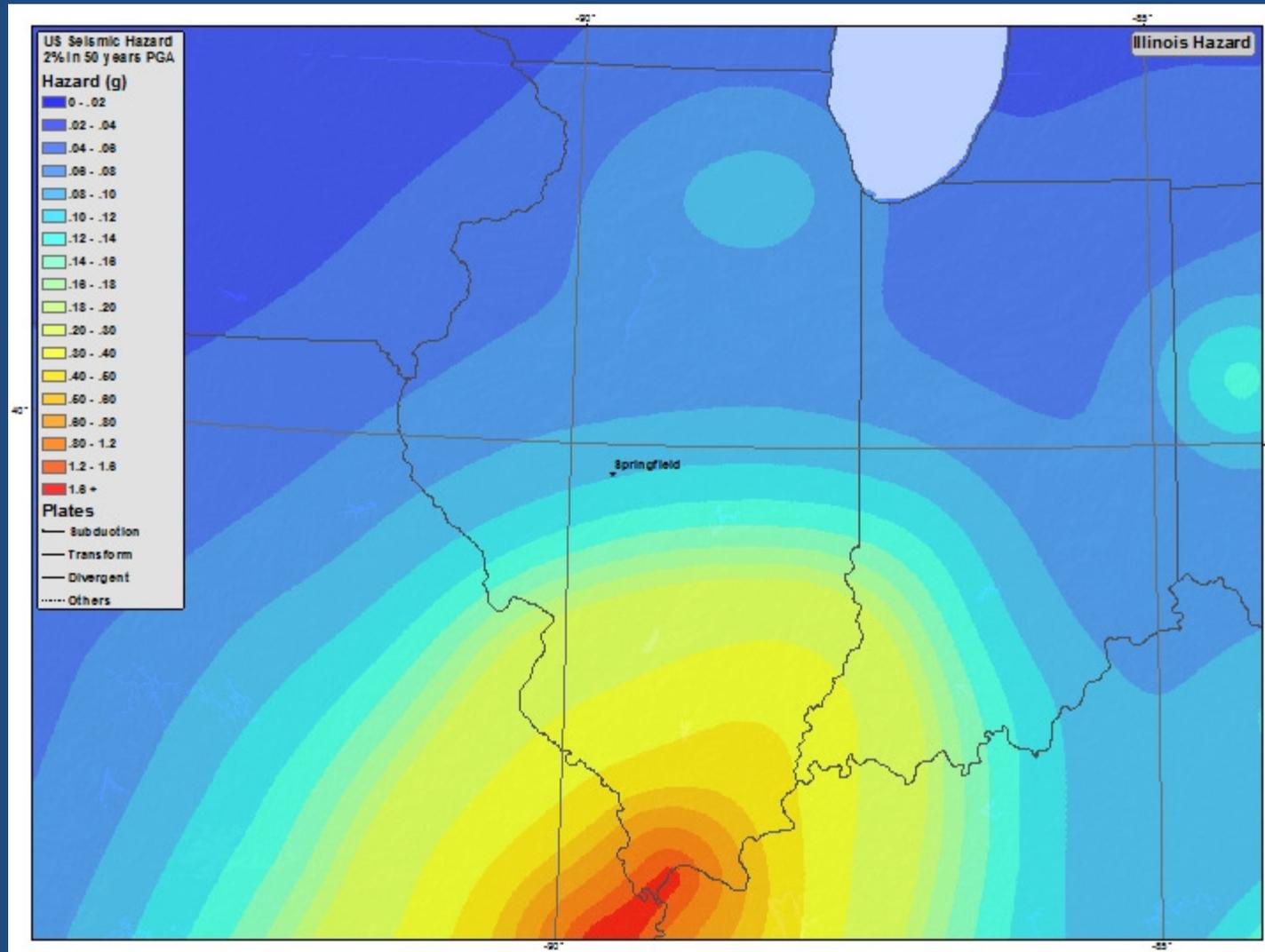
We have a .06-.08% chance in 50 years

Illinois Tornado History
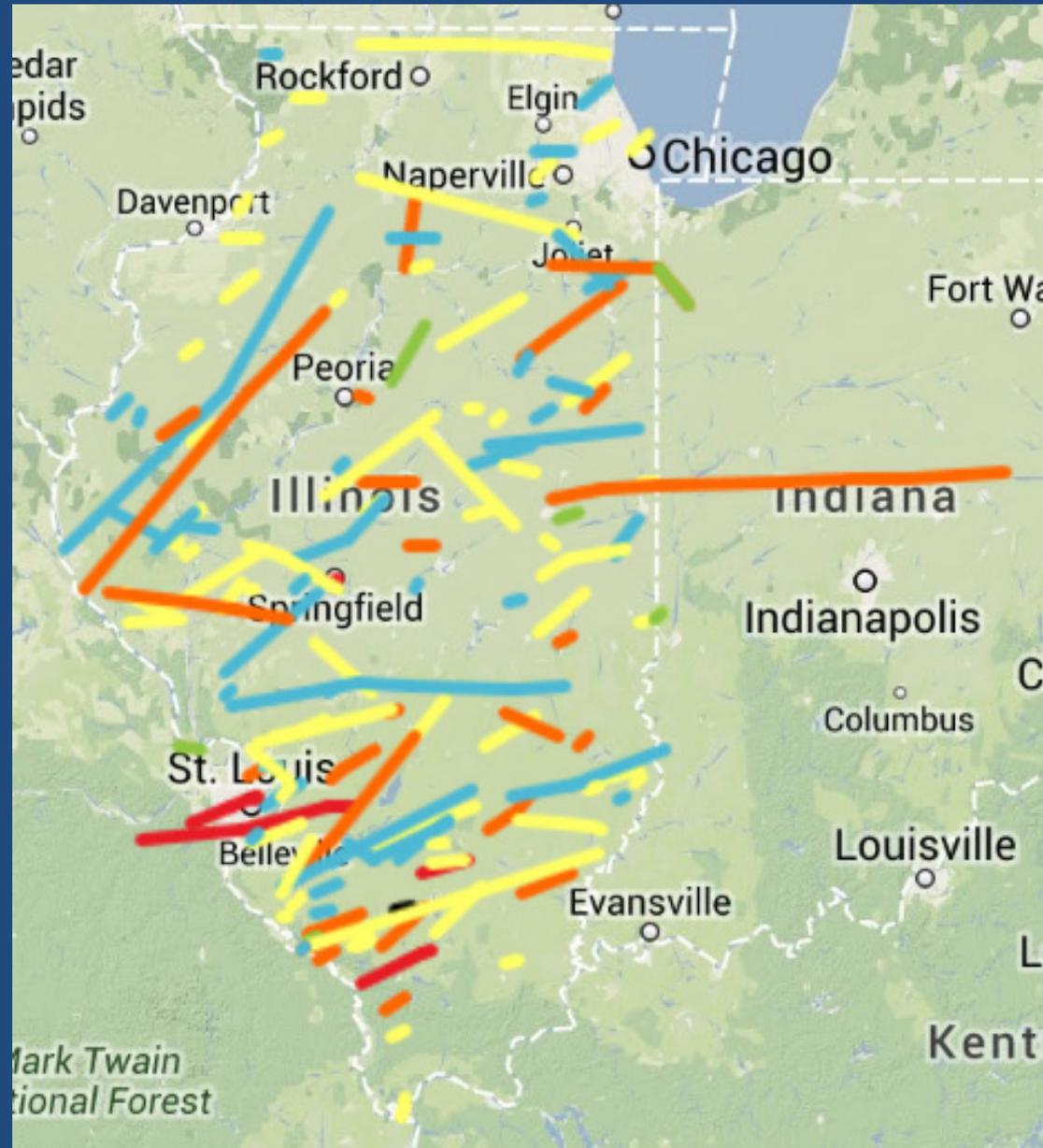
Kane County – Local Emergency

Cellular and Internet
Probably Still Accessible

Kane County – Tornado Disaster

Cellular and Internet
Might Not be Accessible
From Within Disaster Area

Gaining Attention of Served Agencies

- Show them applications <u>without</u> their Internet
  - Telephone voice with PBX (Asterisk-free)
    - Raspberry Pi can be an Asterisk pbx
  - Video Teleconference (iVisit free and no server)
  - PTT audio connections to external HF VHF/UHF radios
  - Electronic ICS/ARRL entry forms and error free xmsn
  - Bluetooth interface to their out of service SmartPhone
  - File storage and web servers

Public Safety Getting LTE data on 700 MHz

- Vehicular, handheld, USB user devices
- PTT Voice (also P25 integration), video, etc.
- 500Kb to 50Mbps adaptive data
- Presently stalled by FirstNet (new Federal Board)

Pure HSMM

- Mostly 2.4 GHz WiFi on Part 97 frequencies
  - Watch out for vegetation and building losses
  - .05dB/m at VHF and .35dB/m at 2.4 GHz
- Frequently mesh network
  - Fixed, mobile, and portable units
- May include PTP links to bridge coverage gaps
- 10 minute ID as normal
- NO commercial traffic (maybe no Internet access)
- Encryption allowed as long as there is public notification
- Authentication important
- Data speed is link loss adaptive
- End-to-end data speed through mesh is divided by number of hops

Hinternet or HSMM Activity

- SF Bay Area
  - South Bay – 40 nodes
    - Looks to be using mountain top sites and PTP/PMP links
  - Alameda ?
- Plano/Austin Texas – 48 nodes
- El Paso, TX – 10 nodes
  - IRC chat
- New York City ?
- Southern Puget Sound (Seattle), Washington
  - Can't use 420-430 MHz above Line A
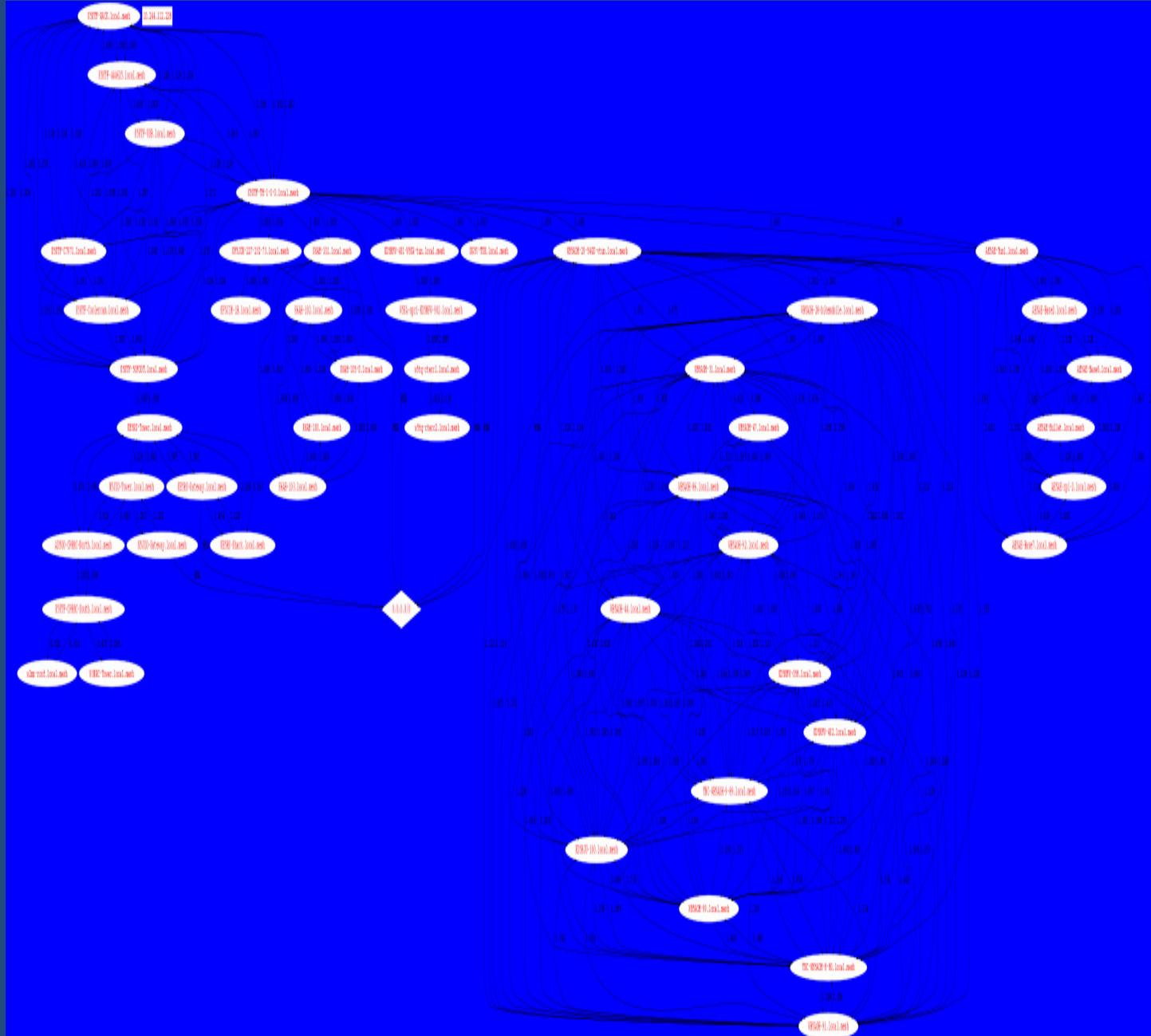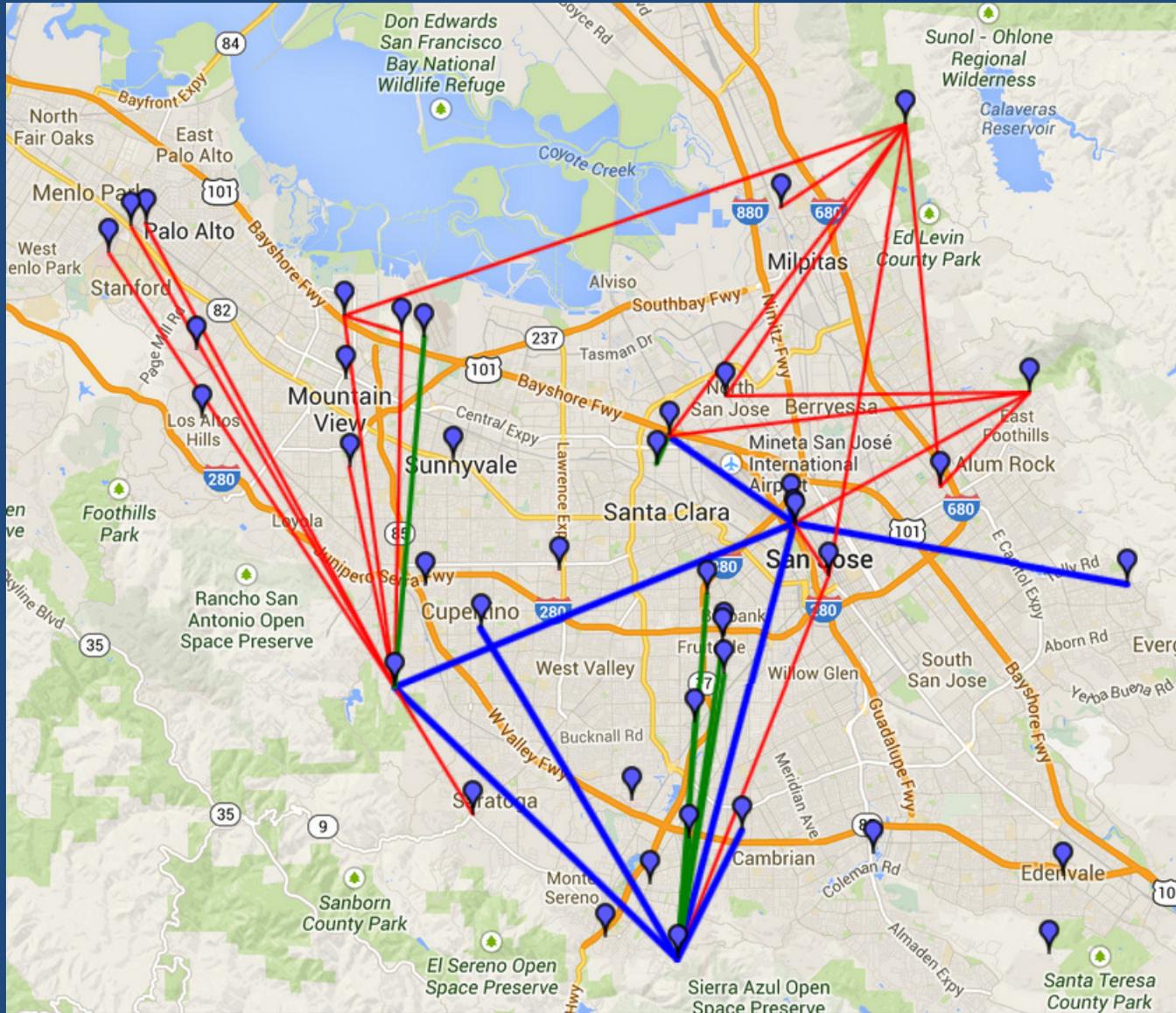- San Diego/Mexico per April 2014 QST
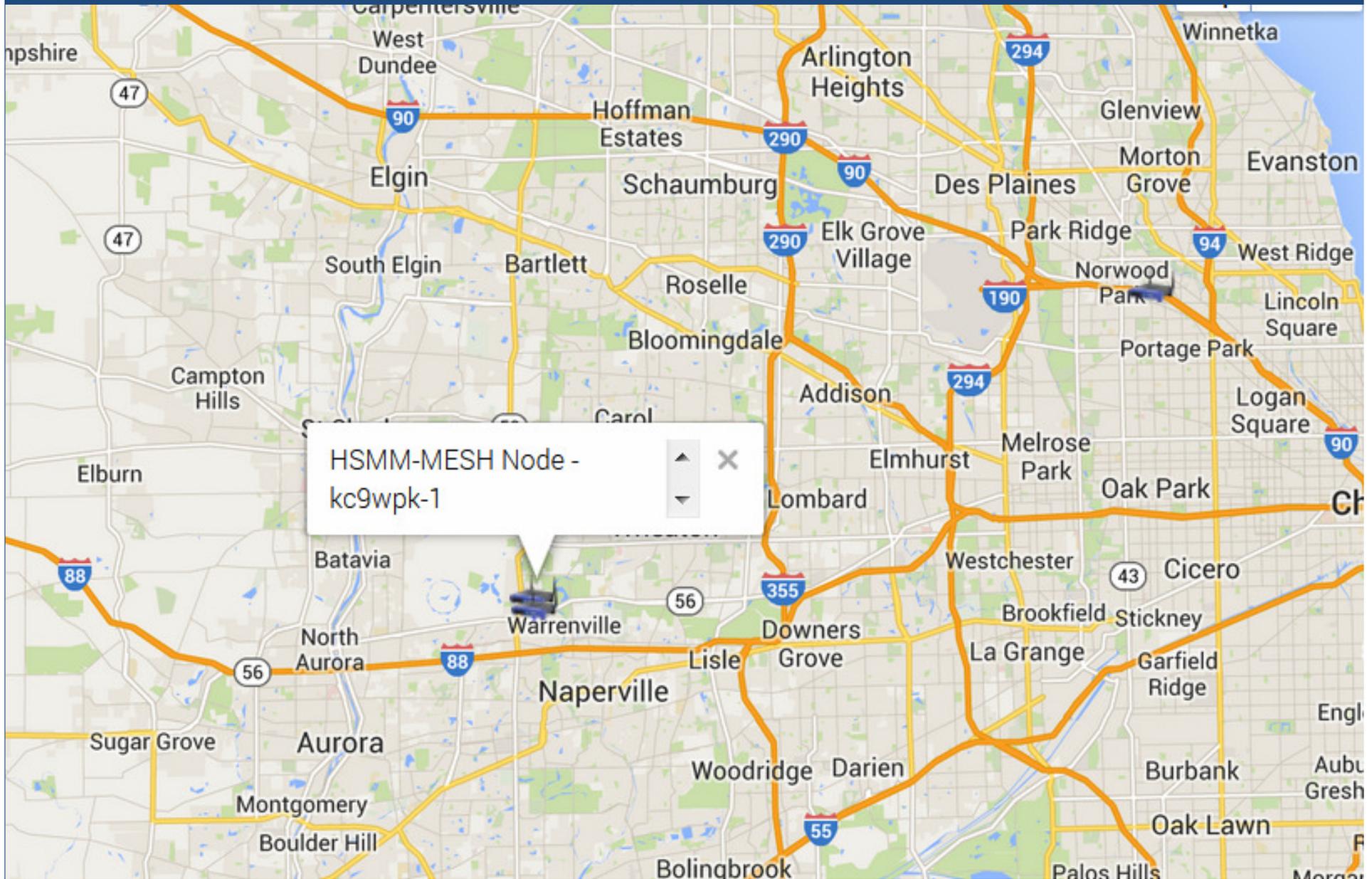
Global map of HSMM Nodes
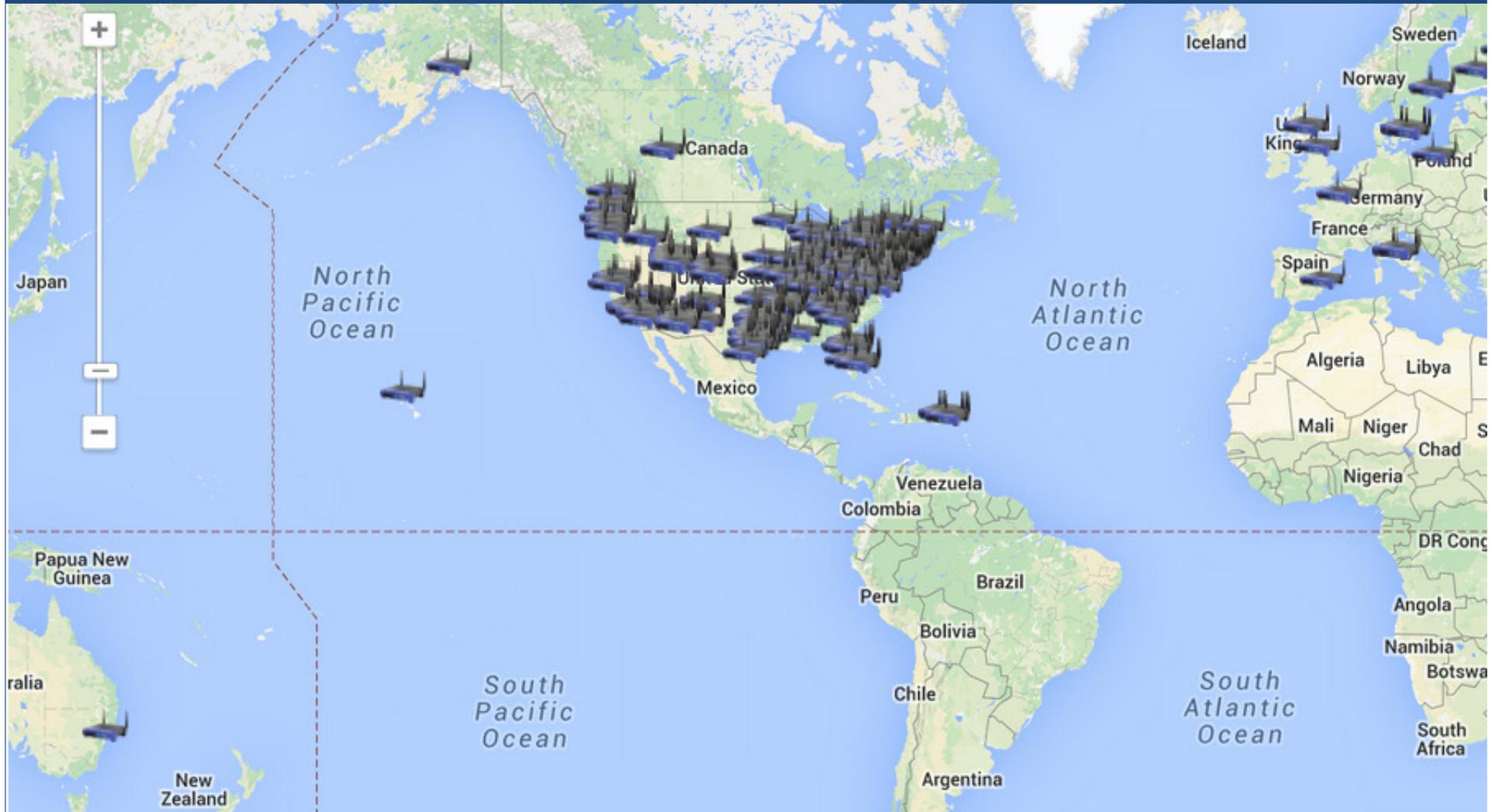
US Map of HSMM Nodes
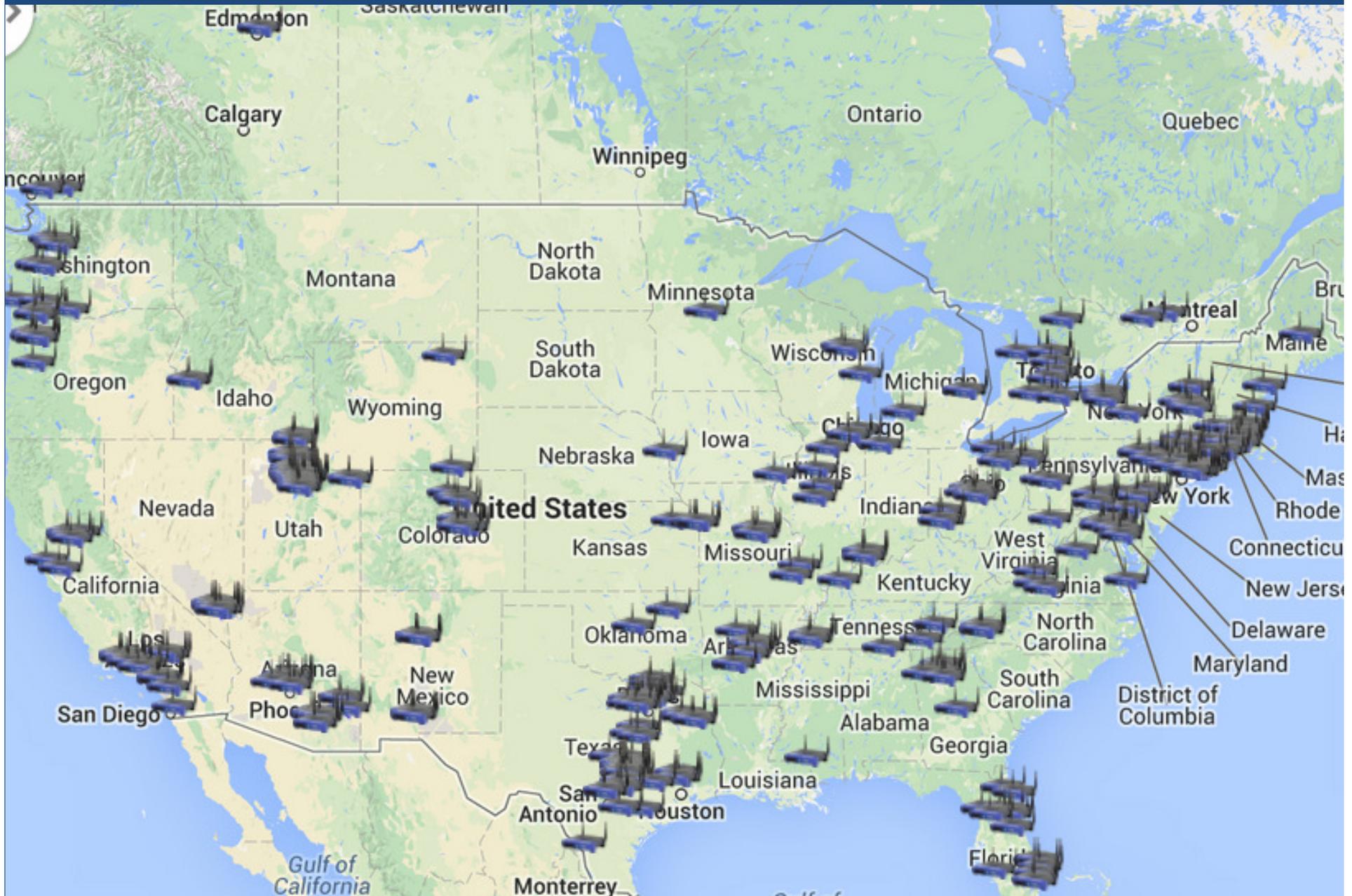
Austin TX HSMM Network

South SF Bay Area

"Registered" Northern Illinois Nodes

HSMM-MESH Node - kc9wpk-1

Amateur Radio Spectrum Flexibility

- HF – long distances, slow data speeds (300 bps)
  - Voice, Packet, AMTOR, RTTY, PSK, SSTV, CW
- VHF – County-wide
  - Voice Repeaters
  - D-Star 4.8Kbps text, APRS, 9.6Kbps packet data
  - Yaesu System Fusion 9.6Kbps data and still frame pictures
- 70cm (420-430 MHz)
  - Same as VHF, some vegetation losses, also 56Kbps data legal but few radios available
- 902-928 MHz
  - Most commercial equipment is 4W ERP, better vegetation penetration
- 1.2 GHz – Higher vegetation losses
  - D-Star – 128Kbps Data
- 2.4 GHz - WiFi Channels 1-6 are FCC Part 97 shared
  - Low power commercial meshable equipment available
  - Higher power can overcome some higher vegetation losses
- 3.4 GHz – Even higher vegetation losses
  - Some commercially adaptable equipment
- 5.8 GHz – Even higher vegetation losses
  - Some commercially adaptable equipment

Amateur Part 97 and Shared WiFi Frequencies

802.11b/g (13 cm)

Channel	Center Frequency	FCC Rules
−1	2.402 GHz	Part 97
0	2.407 GHz	Part 97
1	2.412 GHz	Part 97 & Part 15
2	2.417 GHz	Part 97 & Part 15
3	2.422 GHz	Part 97 & Part 15
4	2.427 GHz	Part 97 & Part 15
5	2.432 GHz	Part 97 & Part 15
6	2.437 GHz	Part 97 & Part 15

802.11a (5 cm)

Channel	Center Frequency	FCC Rules
132	5.660 GHz	Part 97
136	5.680 GHz	Part 97
140	5.700 GHz	Part 97
149	5.745 GHz	Part 97 & Part 15
153	5.765 GHz	Part 97 & Part 15
157	5.785 GHz	Part 97 & Part 15
161	5.805 GHz	Part 97 & Part 15
165	5.825 GHz	Part 97 & Part 15
169	5.845 GHz	Part 97
173	5.865 GHz	Part 97
177	5.885 GHz	Part 97
180	5.905 GHz	Part 97

Be careful of band edges
802.11b needs 20MHz

HSMM uses default of Ch 1

Power Limits

- 802.11a 5.8 GHz secondary shared use
  - OFDM: 1500 watts
- 802.11b 2.4 GHz secondary to Fed, primary to ISM
  - DSSS: 10 watts
- 802.11g 2.4 GHz secondary to Fed, primary to ISM
  - OFDM: 1500 watts
- 802.11n 2.4/5.8 GHz secondary to Fed, primary to ISM
  - OFDM: 1500 watts

FCC Part 97 frequency sharing

- 2300-2301 Note d,p
- 2390-2450 Note d,e,p
- 3300-3500 Note a,b,f,q
- 5650-5925 Note a,b,e,r (Region 2 North/South America)

a: Equality of right to operate with adjacent regions

b: No RFI to/from US Govt radio location

d: 3300-3400, 5650-5850 no RFI to other nation radio location

e: 2400-2450, 5725-5875 accept RFI from ISM users

f: 3332-3339, 3345.8-3352.5 no RFI to radio astronomy

p: 2305-2310 no RFI to/from aeronautical mobile or radio location

q: 3400-3500 no RFI to/from fixed satellite

r: 5650-5725 no RFI to/from other nations mobiles

   5850-5925 no RFI to/from other nations satellite
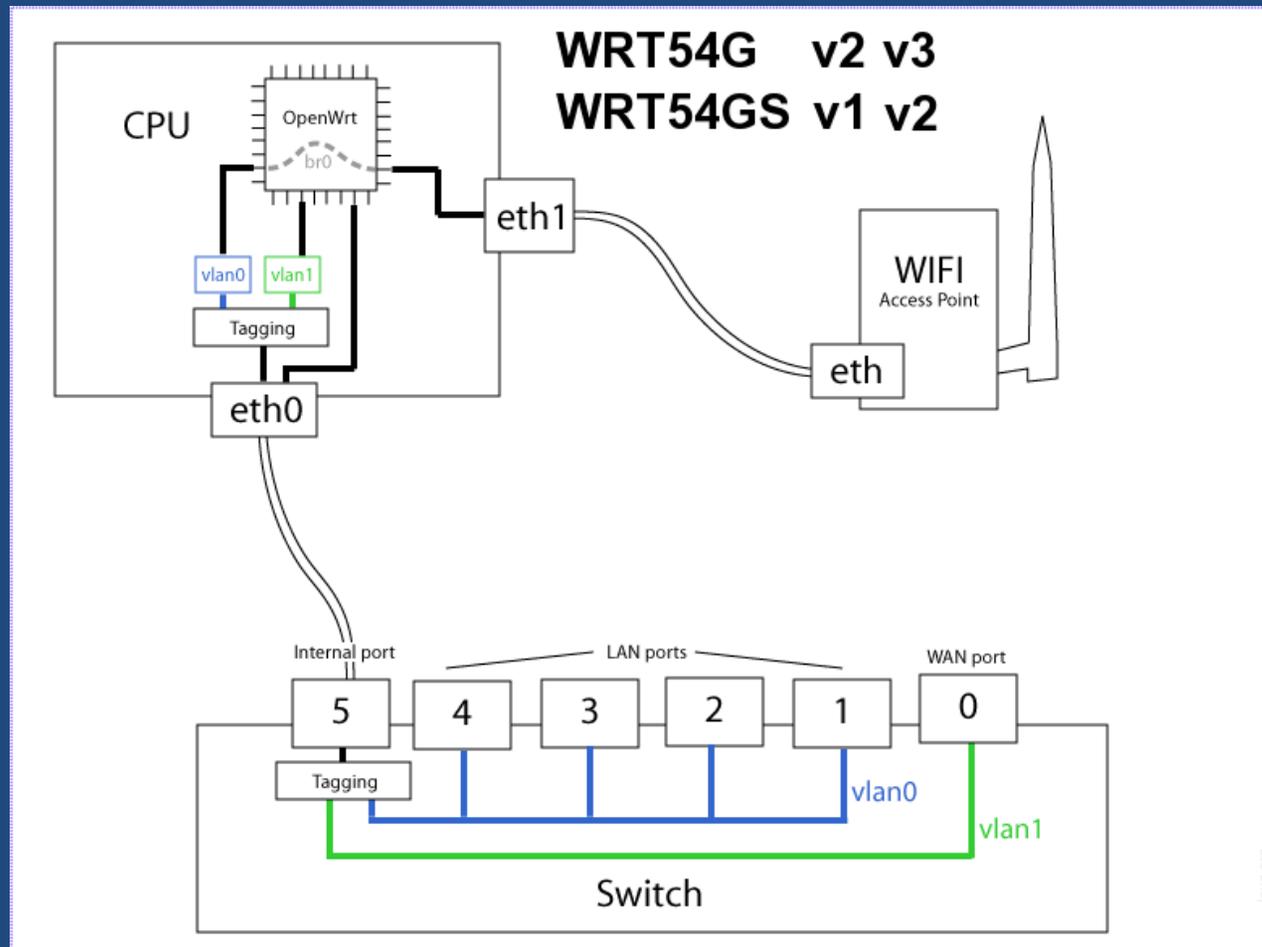
HSMM Software

- Open WRT
  - Use web browser to upgrade firmware
  - Stateful Packet Inspection
  - Intrusion Detection
- OLSR
  - Routing protocol that creates a mesh network
  - Linux software shows mesh topology w/graphviz and ImageMagick
- Linksys WRT54G/GL
  - Firmware to operate as HSMM on Part 97

Linksys WRT54

You can add SD card and USB port

WRT54G Internal Architecture

Linksys Shopping List

Simplified shopping list:

Model	Version	Comments
WRT54GS	1.0 – 3.0	Most memory (32/8) MB
WRT54GS WRT54G WRT54GL	4.0 1.1 – 4.0 1.0 – 1.1	16/4 MB
WRT54G	1.0	16/4 MB 5V DC power Warning - uses different supply voltage from all other models.

Higher numbered versions of each model are *not compatible* with Broadband-Hamnet™ firmware.

XAGYL
Communications

Wireless Communications.

HOME   PRODUCTS   ABOUT   CONTACT   DOWNLOAD   BUY

PRODUCTS

miniPCI Modules

- **XC420M**
- **XC480M**
- **XC555M**
- **XC630M**
- **XC750M**
- **XC900M**
- **XC900M-LW**
- **XC24M**

Military Grade miniPCI
Modules

- **XC900M-MG**
- **XC24M-MG**

Integrated Platform

- **WR24G30**

Made for
MikroTik

XAGYL XC900M 902-928MHz
1000mW miniPCI

The XC900M is a 1000mW TX power miniPCI radio module. It is designed for the 900MHz ISM License Exempt frequency band to support high value applications. The XC900M assures low EVM (Error Vector Magnitude) at higher modulation rates to maintain low packet errors and maximizes data throughput. The design uses highly linear output power amplifiers in balanced mode to deliver linear power even at 64 QAM radio modulations while maintaining an EVM below 4%. With better RX sensitivity and high SNR (specs stated in field conditions), the XC900M is specially designed to deliver best performance in long range outdoor applications. The industrial grade design and enhanced resilience to RF surges and ESD makes it ideal for deploying in harsh environments.

The noise level of XC900M is extremely low due to advanced filtering, careful component selection and improved RF receive chain design. It is designed to work in noisy environments, amid powerful GSM base stations, where other modules would be rendered non functional.

Applications

- Long range outdoor broad band wireless applications
- Access points and high performance CPEs
- Mesh wireless infrastructure applications
- Mobile applications

Ubiquiti now compatible

Ubiquiti firmware for the listed devices is available from the Software Download page, and properly interacts with BBHN 1.0.0 devices.

- Rocket M2 (w/GPS) $89

- Bullet M2 HP (PoE, no coax) $96

- AirGrid M2 HP

- NanoStation Loco M2 (NSL-M2) $79

- NanoStation M2 (NS-M2)

- Some models have two Eth ports (IP camera?)
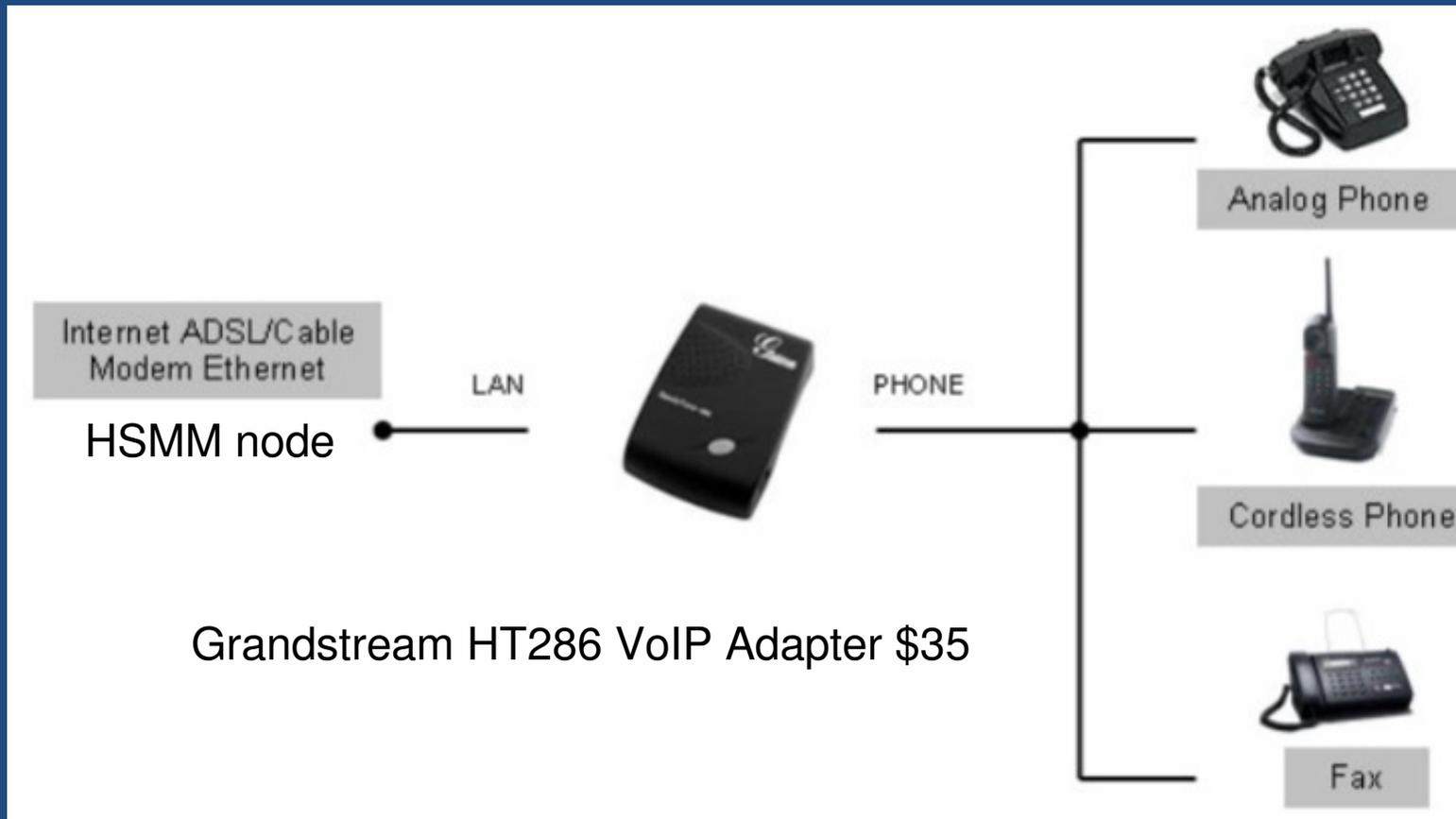
- Some models have built-in spectrum analyzers
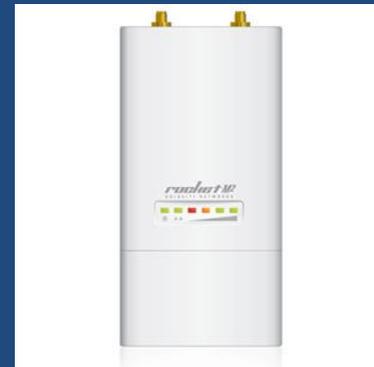
Ubiquiti NanoStation M2		
Link Calculation		
2.4 GHz		
TX Power	28.0	dBm
Antenna Gain	10.4	dBi
Path Length	5.0	miles
Path Loss	118.2	dB
Vegetation Distance	100.0	feet
Vegetation Loss	10.7	dB
Antenna Gain	10.4	dBi
RX Sensitivity (1-24Mbps)	-83	dBm
Fade Margin	2.9	dB
RX Sensitivity (54Mbps)	-75	dBm
Fade Margin	-5.1	dB

Another HSMM Application

Internet ADSL/Cable Modem Ethernet

HSMM node

LAN

PHONE

Analog Phone

Cordless Phone

Fax

Grandstream HT286 VoIP Adapter $35

Broadband-Hamnet™
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http://wndw.net/download/WNDW_Standard.pdf