

Introduction to Broadband-Hamnet™ Mesh Networks

(HSMM-MESH™)



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Broadband Hamnet – What is it?

Broadband-Hamnet™ is a high speed, self discovering, fault tolerant, self configuring ham network/wireless computer network that can run for days from a fully charged car battery, or indefinitely with the addition of a modest solar array or other supplemental power source. Its current focus is on emergency communications.

Broadband-Hamnet™ is being designed, developed and deployed as an amateur radio broadband communications system. It originated in Austin, Texas but has spread all across the USA and many other countries around the world.

This network is built using the Linksys WRT54G/GL/GS wireless routers and Ubiquiti Radios and operates primarily on channels 1-6 of the 2.4GHz ISM band (Industrial, Scientific and Medical), which overlaps with the upper portion of the 13cm amateur radio band.

This network is FAST! 802.11g wireless routers can do 54 Mb/s compared to 802.11b at 10 Mb/s and Packet at 1.2 or 9.6 Kb/s.

History of the Project

- In January 2001, the ARRL Board of Directors looked to develop High Speed Digital Networks for the Amateur Service. The group was called the **H**igh **S**peed Digital Networks and **M**ulti**M**edia Work Group, or **HSMM**.
- Due to rifts and disagreements, the ARRL Board decided to end the HSMM WG in 2006.
- Two Hams from Austin, started experimenting with a popular commercial piece of hardware, the Linksys WRT54G router, of which millions were sold for home and small office network use. They tested range and use with stock power but more directional antennae.
- OpenWRT, written for the WRT family of routers and OLSR (Optimized Link State Routing protocol), which actually creates and manages the "mesh", was customized and packaged to install onto WRT's for Ham radio.
- A monthly meeting in Austin called Digital Wednesday gradually morphed into the monthly meeting for HSMM- MESH™, the original project name, derived from the original ARRL Working group. Glenn Currie trademarked the name so that any device using that name would be able to talk to any other of the same name without problems.

- In December 2009, Glenn Currie was loaning his specialized remote TV van for a race as net control station for the volunteers. There he met Jim Kinter K5KTF who was coordinating the Hams for the race. Glenn told Jim about the project, Jim was instantly hooked and wanted to get involved. Since he owned his own consulting company and web servers, Jim came up with a website that the core group could log in and write articles, post files, correct errors, and easily provide information to the masses.
- January 26 2010 the web site went live, and as of this writing, the servers have served up over 1 million web pages and almost 81 Gigabytes of data just for this project. It now contains a forum section with various sections, from hardware and software to specific geographic areas that are working on building mesh networks. Also are videos produced by the group, or collected from around the web of others using Broadband-Hamnet/HSMM-Mesh. Articles range from the basic install and setup of the firmware, to hardware modifications and different application to use over the mesh network.

<http://www.broadband-hamnet.org/>

- In January 2013, a group from the Austin Amateur Radio Club (AARC) traveled to Big Bend National Park in South Texas to assist with a 50K footrace through the park. 4 Hams setup a 3-node mesh network, with an IP webcam at the finish line and a projector and screen at the other, and had live streaming video for the spectators of runners crossing the Finish line. With a collaborative effort, Lynn Jelinski AG4IU wrote an article about the race and use of the project, and submitted to QST. The article was featured as the cover story in the July 2013 edition, with the 2 page article inside.
- In January 2013, Dee Harrison KF5RLK, attended a Williamson County ARES (Amateur Radio Emergency Service) meeting, and observed a presentation about the project by Jim Kinter. In April 2013, she submitted a nomination of the project for the International Association of Emergency Managers 'Technology and Innovation Award'. On July 1 2013, the IAEM announced that Broadband-Hamnet had won for both the USA-Council and the Global awards.



Some Basic Concepts

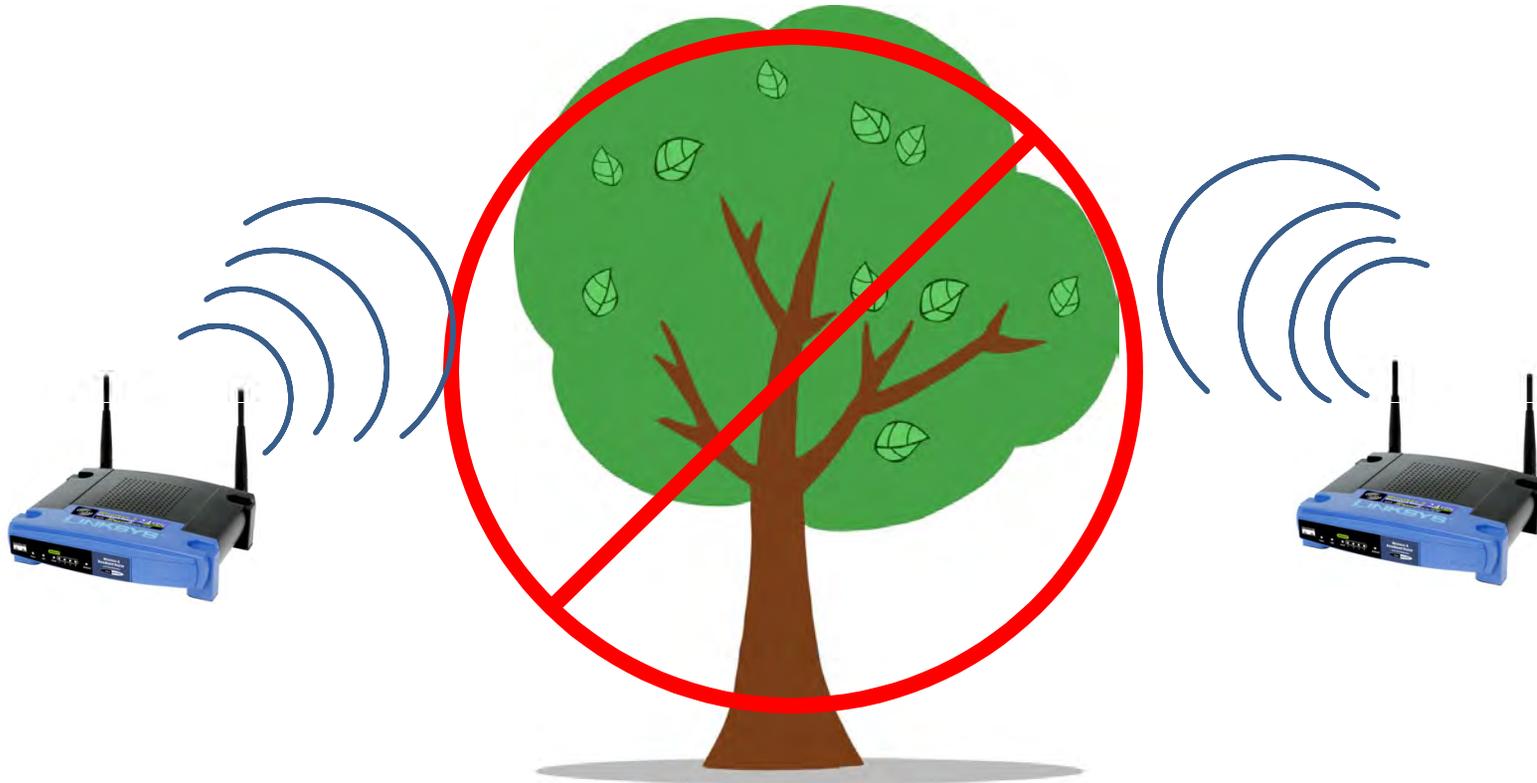
Broadband-Hamnet is a network, it is not application software. It is a special firmware build that transforms consumer wireless gear to a specialized ham radio function. It can use application software to transport your data from place to place, but you must provide the application software just like you do at your home or office.

A Mesh network is a highway over which data travels. Turning on two mesh nodes loaded with the Broadband-Hamnet firmware creates a data network. This highway carries your cargo (data), and allows your local computer to use information or applications stored in other locations.

Mesh nodes are originally consumer wireless routers but by updating the internal software the function of the device can be changed. They are a data network without the wires. Most tasks that you can do over a wired or wireless network at your home or office will work on a mesh node

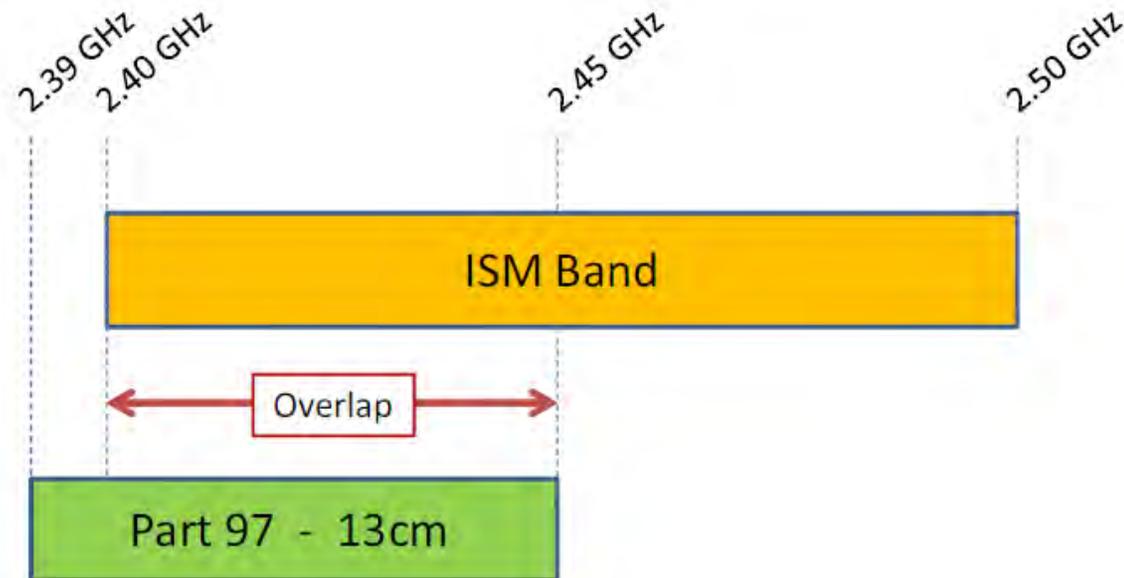
Mesh nodes only connect to other mesh nodes using peer to peer connections. This means each node can connect to all others it can directly reach. Mesh nodes are small, portable, low-power and inexpensive.

They are easily battery powered and can have a range of **10 miles or more** *using stock power* and gain antennas if you have **true line of sight**.



Channels 1-6 of the 802.11B/G wireless band are completely within the 2.4GHz ham band. Mesh nodes usually operate on channel 1.

802.11g Wireless Band



Mesh nodes on channels 1-6 use FCC part 97 rules instead of part 15. This allows big antennas, more power, other changes.

Mesh nodes talk to other nodes using RF (Wi-Fi).



To the Internet over the WAN port.

And to computers, servers, video cameras and other devices using the LAN ports.

Mesh nodes will create a network just by turning several of them on. They create portable, high-speed data networks in minutes.

Mesh nodes don't need any computer to be attached to pass data to other mesh nodes. Just plug one in, it will expand the mesh.

You don't need to physically attach to a given mesh node to make changes to it. You may "remote in" to configure it from anywhere on the mesh network

Data is data. It can be IP Video, VOIP, LAN traffic between computers, a web browser reading a situation briefing web page, downloading operating software or a radio manual by FTP, printing out something on a remote printer, keyboard chat, hop to the Internet, etc.

IP addresses exist but you interact with mesh nodes by using the node name. The names can be tactical but your ham call is still sent out frequently as a beacon packet.

Any mesh node within wireless range automatically joins the existing mesh and exchanges available routes with all others. If one mesh node has Internet access or contains a NTP (network time protocol) server, all mesh nodes will get a correct date/time in their display

As nodes join and leave the mesh your path between any two mesh nodes may be single or multiple hop and can/will change with no notice or impact to you. The data flows where it needs to flow because of the automatic routing delivered by OLSR.

A single node joining your mesh may add many other nodes if it can see other mesh nodes the first group can't reach. It does so by becoming a bridge to join the two separate groups of mesh nodes.

Mesh node owners from different parts of the country will join any existing mesh just by coming within range if it.

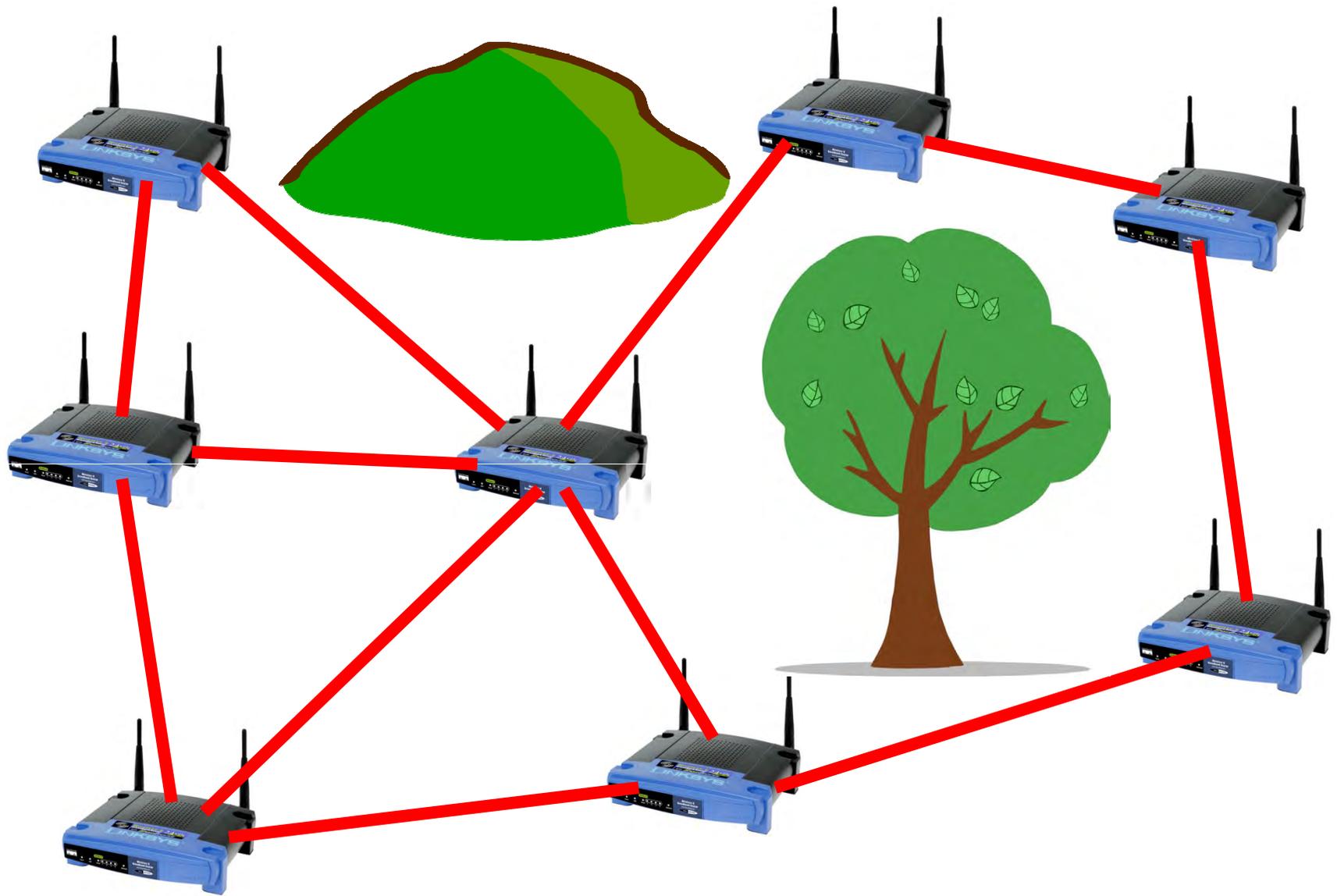
Several mesh nodes + one experienced ham operator = a portable, quick deployment, swiss army knife of network services

How does it work?

As long as one node can see another, devices on the network can talk to other devices on the network and each node can relay traffic between nodes. Between any 2 computers or devices, you can have multiple paths, giving redundancy in case one node goes down. Paths of different quality are automatically considered. If one path is worse than another, it gets less traffic.

If a node that is in use goes down, the surrounding nodes will automatically figure out an alternate route to pass traffic. Using OLSR (Optimized Link State Routing Protocol) the best route is automatically determined and used.

Items connected to nodes can be any network-enabled device, such as Computers, IP webcams, IP telephones, web, email, or file servers, RMS winlink nodes, network-attached-storage and other devices. Anything that can communicate over a standard TCP/IP network will work over Broadband-Hamnet™.





Hardware Required



Option #1

A Cisco Systems Linksys WRT54G \$15 - \$30 (19dbm/79mW) series consumer grade WiFi Router loaded with Broadband-Hamnet firmware (loading instructions can be found on the web at:

<http://www.broadband-hamnet.org/>)

It CANNOT be a version 5.0 or higher, all other versions are supported.
NOTE: WRT54G v 1.0 uses regulated 5v, all other devices use 12v.

For specific details please refer to this document:

http://www.broadband-hamnet.org/images/hsmm_docs/WRT54Shop.pdf

Option #2

A Ubiquiti Radio:



Rocket M2 \$80 - \$90
(24dbm/250mW)



Bullet M2 HP \$77 - \$101
(23dbm/200mW)



AirGrid M2 HP \$50 - \$139
(24dbm/250mW)



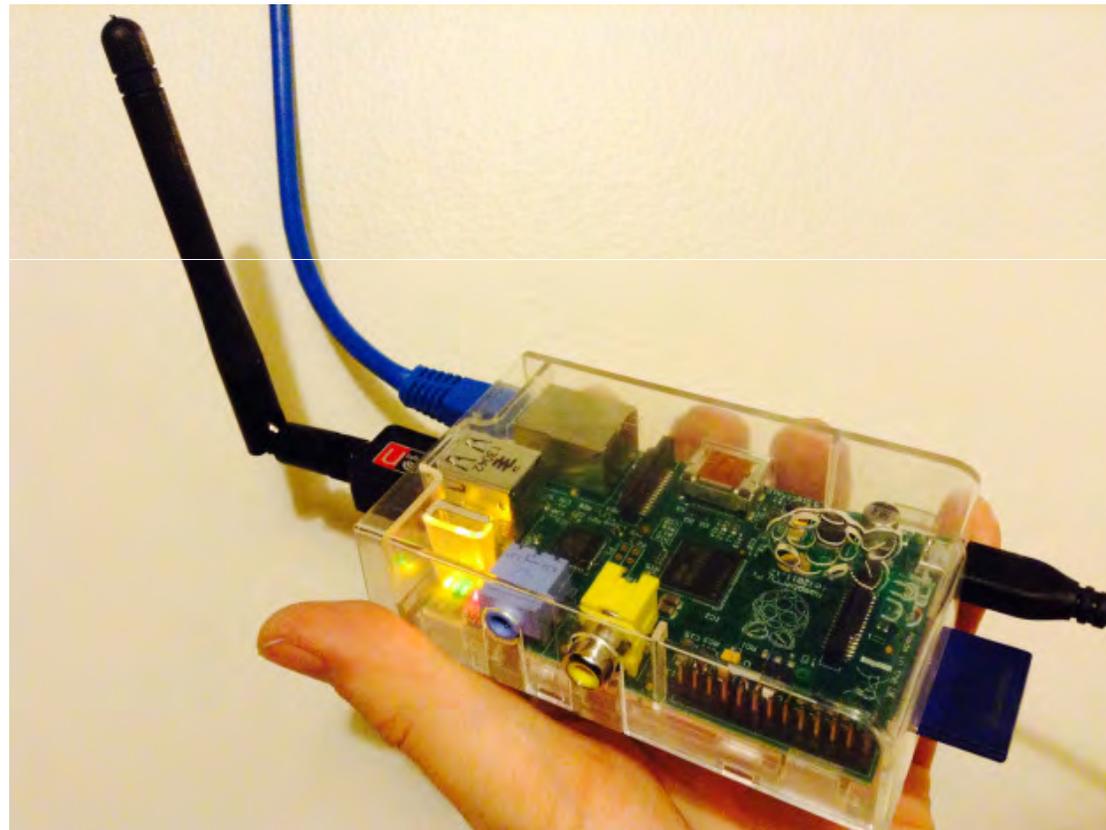
NanoStation Loco M2
(NSL-M2) \$45 - \$90
(23dbm/200mW)



NanoStation M2
(NS-M2) \$80 - \$90
(28dbm/630mW)

Option # 3

A Raspberry Pi computer running either HSMM-Pi or HSMM-Mesh software and any USB WiFi dongle



Antenna Options



Circular, Rectangular or Flat Panel = 8-24Dbi

12 El beam = 20Dbi

16 El beam = 24DBi

Verticals
8 Dbi
12 Dbi
15 Dbi

Effective Isotropic Radiated Power

With 79mW (stock) power from the node into a:

3.5dBi (stock rubber duck) .176W EIRP

9dBi (yagi/omni/dish) .62W EIRP

14dBi 1.9W EIRP

24dBi 19.8W EIRP

If you go with a 1/2W BDA (bi-directional amp--about \$60-\$80) into a:

3.5dBi (stock rubber duck) 1.1W EIRP

9dBi (yagi/omni/dish) 3.9W EIRP

14dBi 12.6W EIRP

24dBi 126W EIRP

And then, even a 2 watt BDA (\$60-?00's):

3.5dBi (stock rubber duck) 4.47W EIRP

9dBi (yagi/omni/dish) 15.8W EIRP

14dBi 50.24W EIRP

24dBi 502.4W EIRP

As you can see, no matter how many watts your pushing, having a better antenna ALWAYS helps out more than the amp, especially when you factor in cost.

Broadband-Hamnet is Low Power

Using Broadband-Hamnet, a Linksys WRT54G has a maximum power output of 79mW. That's 0.079W! It uses a standard 12V input (accepts from 4V to 16V).

Operating time on one time use alkaline batteries:

- 00:22 – 1x 9V
- 01:36 – 4x AA
- 05:15 – 8x AA
- 05:20 – 4x D
- 08:30 – 6x C
- 09:55 – 1x 6V Lantern

Operating time using rechargeable sealed lead acid:

- 2:30 – 1.3 Ah
- 32:00 – 7.5 Ah

A 55 Ah SLA battery with a 45W solar panel under suboptimal conditions can run a WRT54G indefinitely

Power can be supplied to the node via POE (Power Over Ethernet) adaptors from wall wart or battery.



Modifying the Linksys Router

1. Get the latest Broadband-Hamnet Firmware from:
<http://www.broadband-hamnet.org/download/firmware/index.html>
2. Using one of the 4 Ethernet ports update the original router firmware with the appropriate binary (.bin) file using a standard internet browser and the routers internal menu
3. Log into your new Broadband-Hamnet node
4. Give it a node name (i.e. KA8OAD-1)
5. Change the password
6. Save and reboot
7. Get it within range of another
8. CONNECTED!!

So What Can You Do with it?

- **File server – FTP (File Transfer Protocol)**
- **IRC server– Internet Relay Chat, runs right on the node!**
- **VoIP – Voice over Internet Protocol, phone calls over the mesh**
- **Video Camera – IP type, to keep an eye on things**
- **Web server – To host web pages accessible over the mesh**
- **Email server – For, you know, Email over the mesh**
- **Just about anything you can do over the internet**

IP Video



Typical omni-directional node



A typical portable uni-directional node



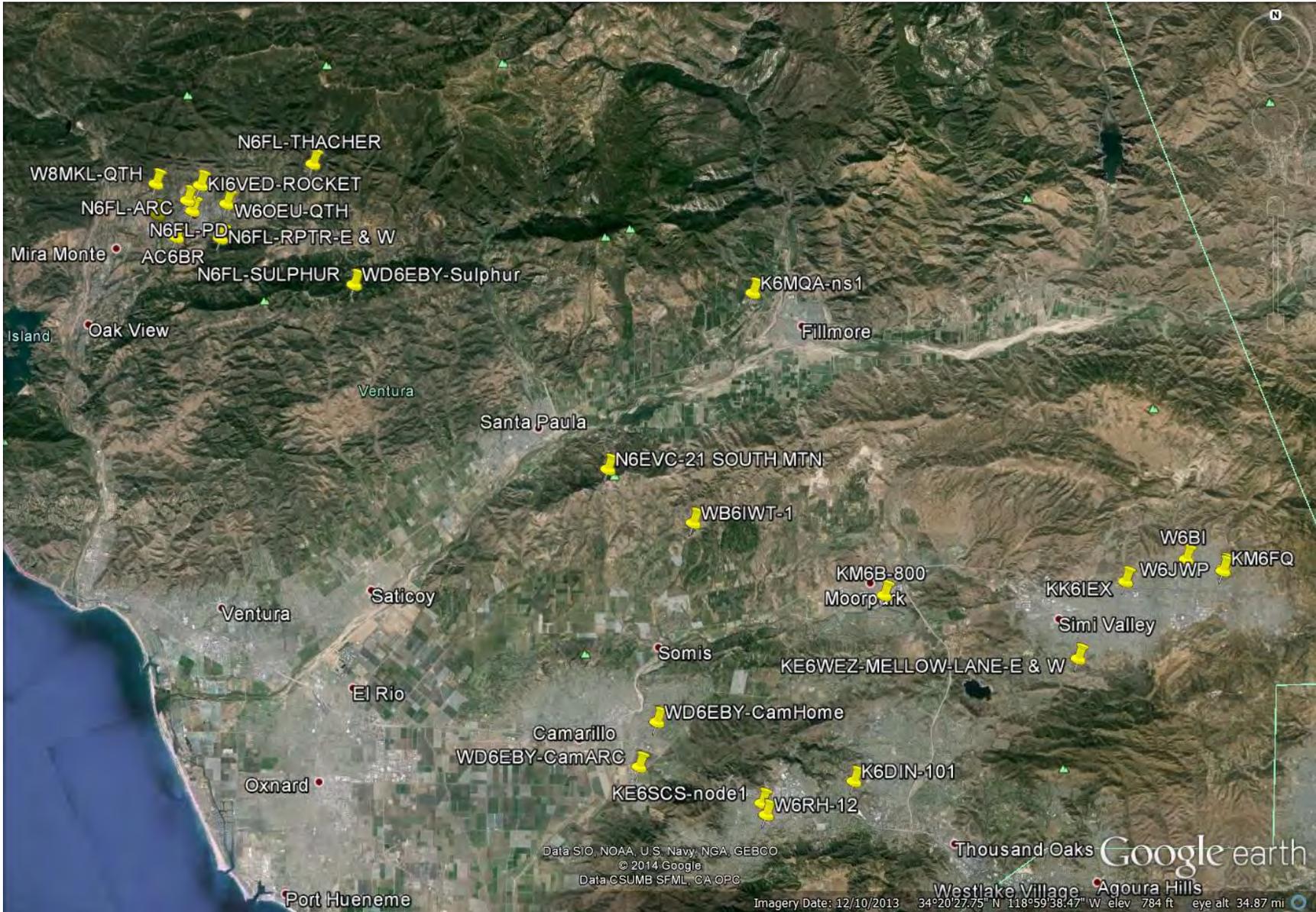
Broadband-Hamnet in a box



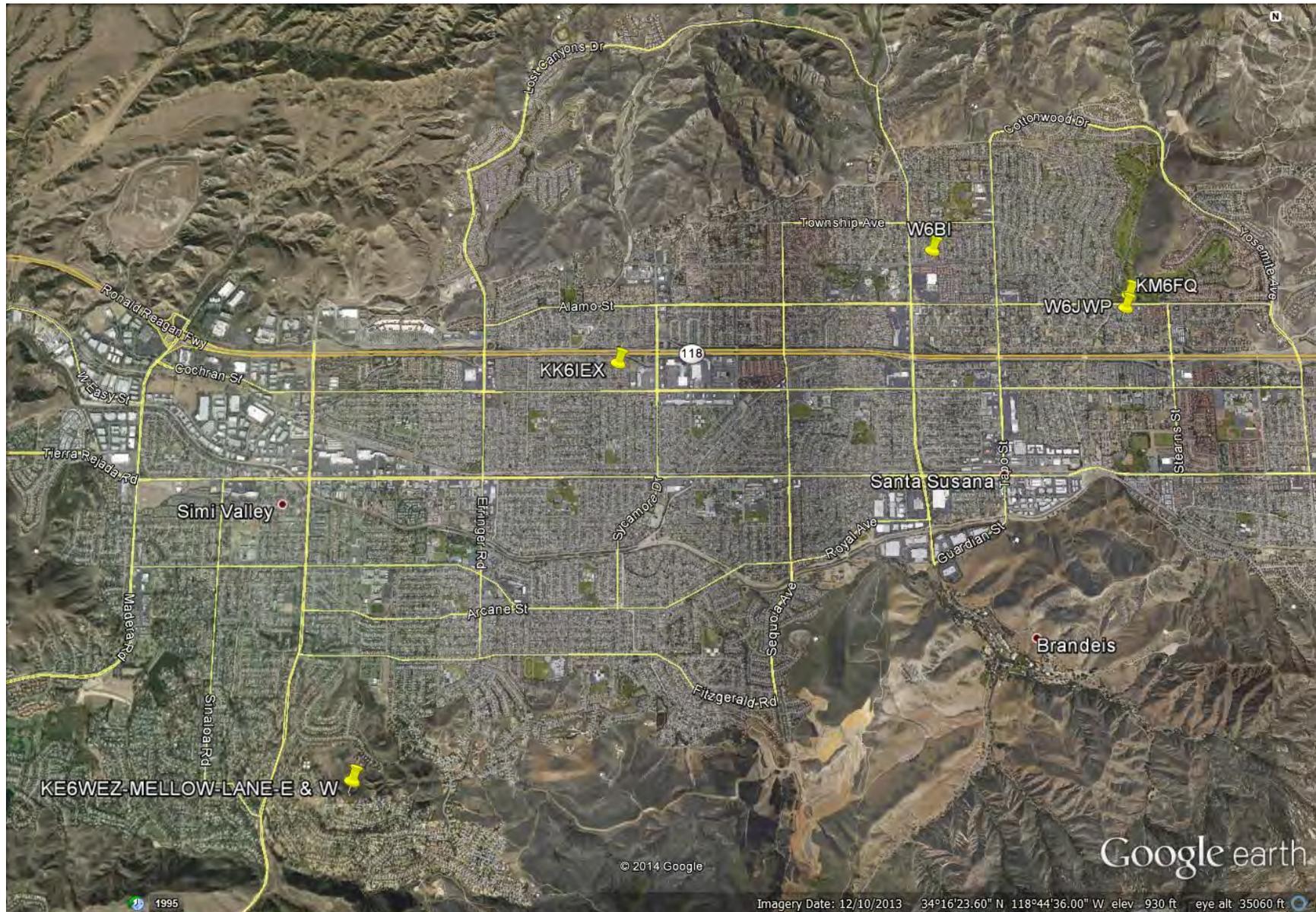
Voice Over IP



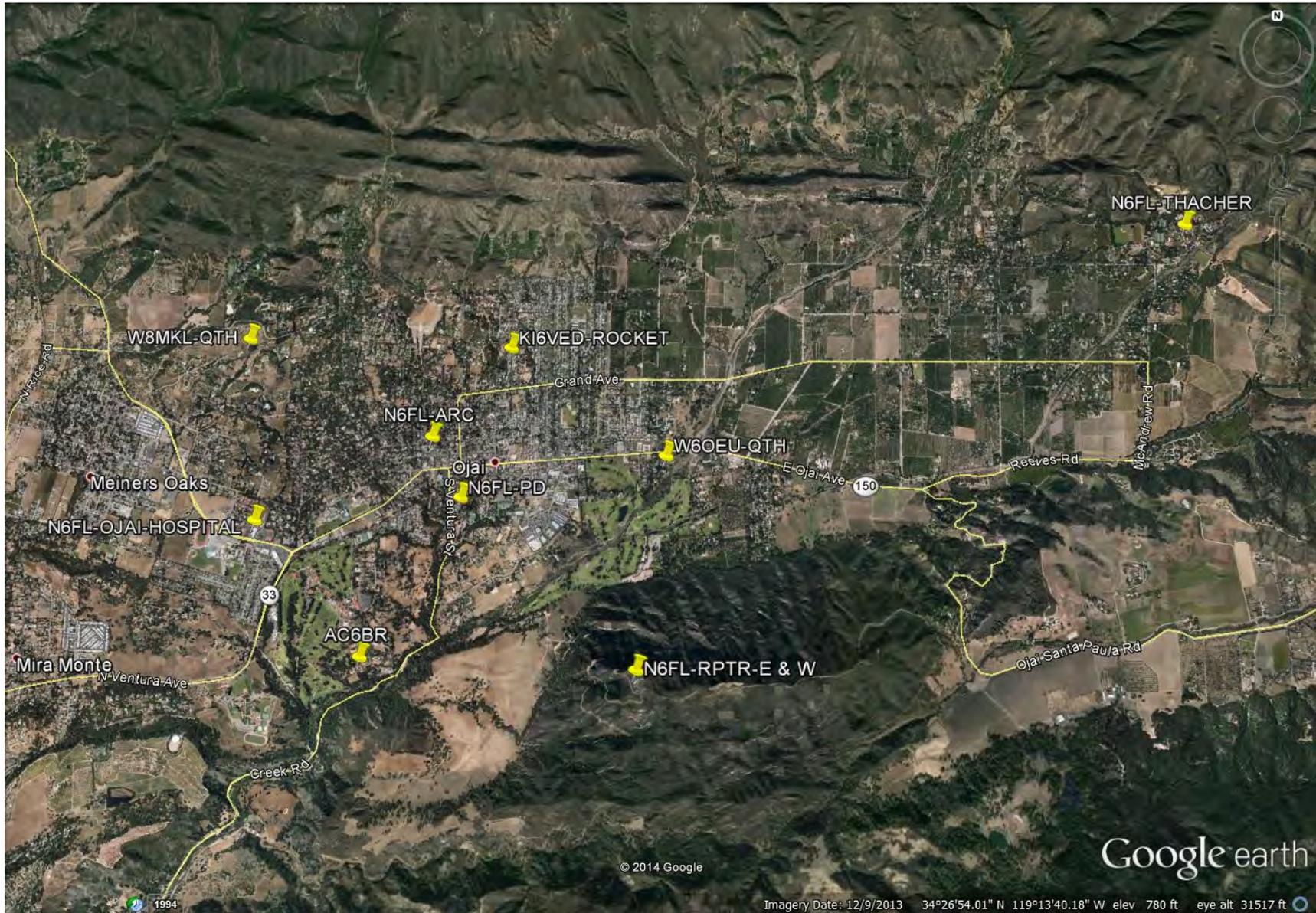
There are about 31 nodes in Ventura County



In Simi Valley we have 6 nodes



In Ojai they have at least 11





**High Speed
Multi-Media**

Amateur Radio for the 21st Century

Information from the following sources:

<http://www.broadband-hamnet.org/>

<http://www.wikifactory.org/w2wcr/projects/broadband-hamnet-hsmm-mesh>

<http://www.scc-ares-races.org/mesh/>

<http://www.wn8u.net/>

To keep informed on Broadband-Hamnet activity in Ventura County and Simi Valley
Consider joining:

https://groups.yahoo.com/neo/groups/VC_HAMMESHNET/info

https://groups.yahoo.com/neo/groups/SIMI_VALLEY_HAMMESHNET/info

With special thanks to:

W8MRC: <http://w8mrc.com/docs/presentations/HSMM-MESH-Web.pdf>