

Broadband-Hamnet™



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An in-depth look at mesh networking using repurposed WiFi equipment in FCC Part 97 Amateur Radio spectrum.

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Introduction

What is Broadband-Hamnet™?

The Broadband-Hamnet website (<http://www.broadband-hamnet.org>) describes the system as the following:

“Broadband-Hamnet™ (formerly called HSMM-Mesh™) is a high speed, self discovering, self configuring, fault tolerant, 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. The focus is on emergency communications.

In its current form it is built using the Linksys WRT54G/GL/GS wireless routers and operates on channels 1-6 of the 2.4GHz ISM band, which overlaps with the upper portion of the 13cm amateur radio band. Other platforms and bands include several types of Ubiquiti equipment in the 900MHz, 2.4GHz and 5.7GHz band. Additional features let signals come in on one band and leave on another without additional configuration. All mesh nodes on all bands exchange data so long as they are within range. We will be adding support for Ubiquiti 3.4GHz gear as well.”

What is Amateur Radio?

Amateur Radio is a “service” as defined by the Federal Communications Commission. Also called Ham Radio, the service is a hobby, public service, and a method of emergency communications. Operators must be licensed through an examination process by the FCC. The FCC has granted amateur licensees use of different parts of the radio frequency (RF) spectrum ranging from 1.8 MHz to 275 GHz and beyond.

As a hobby, operators can communicate with each other on allocated frequencies both locally and internationally. Operators often try to contact others in as many counties, states, countries, or continents as they can. Methods can include voice, Morse code, and text-based modes.

As a public service, operators provide, free of compensation, communications for countless events across the country. Examples include bikeathons, marathons, charity walks, rowing events, car races, and countless others. Many of these events are held in areas where cellular phone service may be unreliable or nonexistent. Amateur radio is able to overcome this obstacle with ease.

As a method of emergency communications, amateur radio truly shows its mite. Many disasters disrupt conventional communication methods. Phone lines can go down, cellular networks can be overwhelmed, and power utilities can go down. Even police and fire radio systems can fail. What happens when a police or fire radio tower collapses? Amateur operators are ready and willing to step in regardless of the nature and severity of the emergency.

Capabilities of the Broadband-Hamnet

Science of 2.4 GHz

Broadband-Hamnet devices are typically used in the 2.4 GHz spectrum. This is because of the overlap of IEEE 802.11g wireless networks with an amateur radio allocation in the 13cm band. There are some considerations that have to be made when using this spectrum, though. First and foremost is the propagation of a signal at these frequencies. Unlike HF (3-30 MHz) signals, signals at 2.4 GHz, at the upper part of UHF (300 MHz to 3 GHz), cannot refract off of the Earth's ionosphere and travel long distances. As a direct result, the practical range of these devices is only up to about 30 miles in open space with no obstructions. However, this cannot be accomplished with stock equipment or without a tower. Standard WiFi antennas will only present up to a 6 dBi gain. Using specialized 'yagi' or parabolic dish antennas, a gain up to 23 dBi can easily be achieved. Using this model, a point-to-point link of two radio towers 30 miles apart with no obstructions and a perfect line-of-site can be achieved. A simple leaf on a tree can interrupt a signal at this frequency, so planning and calculation is a must.

Uses for Broadband-Hamnet™

A Broadband-Hamnet system is capable of countless uses for both everyday use and emergency use. The beauty of the BBHN system is that it is 100% internet, cellular, and telephone independent. These three systems have been known to be unreliable in major disasters. Since the BBHN is based on OpenWRT software, it supports any TCP/IP device. Here are a few examples of devices and services that can be networked over BBHN:

- Computers
- Servers
- VOIP phones
- Radio Repeater Linking
- IP Cameras
- Weather Stations

The system is capable of up to 54 Mbps bandwidth, so it is capable of handling most services that are needed, even live video.

Emergency Use

In a new modern era, even our emergency response requires a constant and stable stream of information. This presents many concerns to first responders. Their work is often one-sided, get in, get the job done, get out. In an era following disasters like 9/11, Hurricane Katrina, Superstorm Sandy, and many other disasters, we have learned that a proper and accurate response requires the availability of information. Using the recent and continuing events in Nepal as an example we can discuss some of the ways BBHN could be used in a critical emergency. Now close to three weeks after the initial earthquake,

internet and phone service is still unreliable. Search and rescue groups such as the Red Cross have massive databases with information on thousands of people. How does one access this information when existing infrastructure is down? A BBHN node consumes minimal amounts of power and can be effectively powered for a week on battery or indefinitely using solar panels. Why would response teams want to depend on an already-crippled infrastructure to transport such critical information? Let's look at another use – video surveillance. In disaster zones, medical facilities and food distribution are key to the mission of the area. The BBHN system can be used to serve video surveillance, monitoring the security of these locations and the accurate operation of these facilities.

Known Implementations

Through further research on this awesome system, it was discovered that it is widely used across the US and Europe. Most of these systems are used for the services discussed above. Below are just a few of few known implementations in the US. Dozens more exist around the world, but many are not publicized.

Heart O' Texas Amateur Radio Club (HOTARC) – HOTARC maintains one of the largest known mesh networks using BBHN. The mesh covers Waco, Texas and some surrounding towns. This system has also served as a development platform for BBHN for a number of years.

Phoenix HSMM-MESH – This is a mesh in the Phoenix, Arizona area. This group is comprised of hobbyists and is not affiliated with any groups.

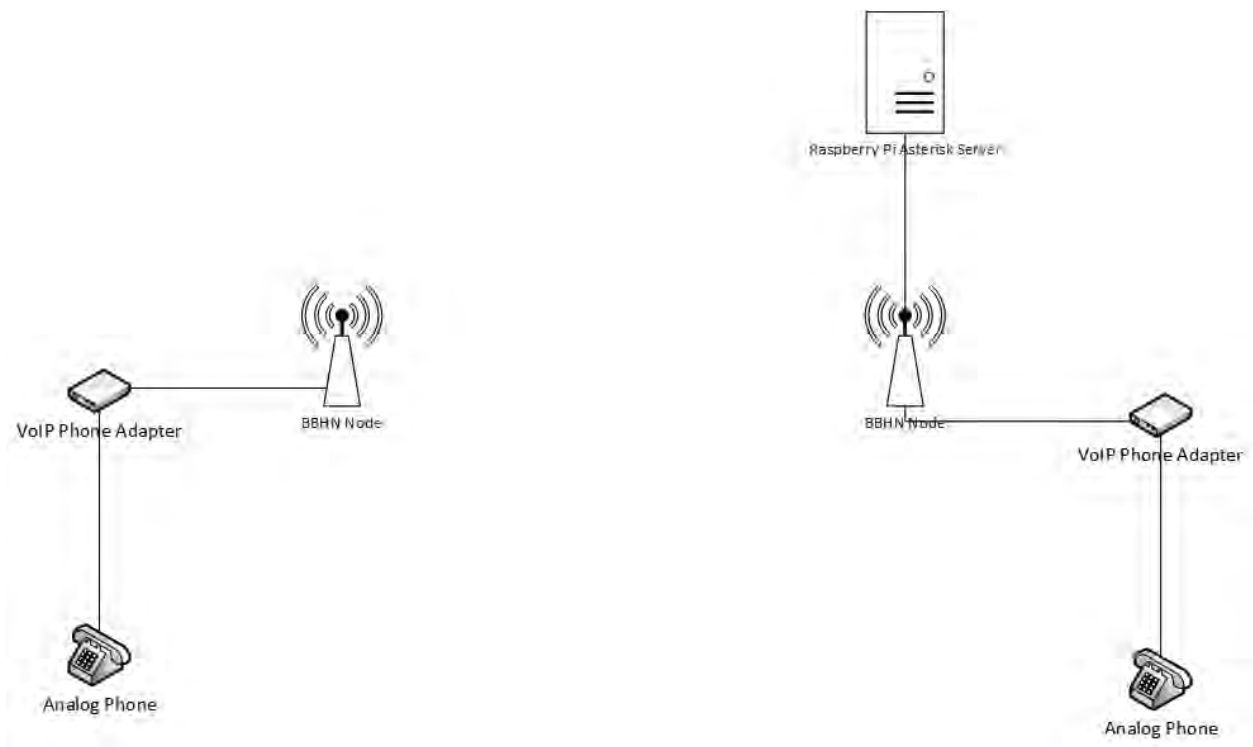
RI Mesh – This mesh is appears to also be unaffiliated. The mesh is centered around Providence and Pawtucket, Rhode Island.

Hands-On With Broadband-Hamnet

I spent a couple months working hands-on with Broadband-Hamnet and have documented my findings.

BBHN is extremely easy to use for anyone familiar with setting up wireless routers. I found that it takes about 10 minutes to get a node up and running. This includes flashing the firmware and configuring the settings as your mesh requires. The BBHN team has really great step-by-step instructions on how to get up and running. It's a very powerful system designed for use by the average person.

After getting 2 nodes configured and connected, I wanted to be able to assess their capabilities using a system that many BBHN meshes already use – Voice Over IP (VoIP). I setup a Raspberry Pi computer with an Asterisk phone server in order to get things rolling. Below is a graphic demonstrating the implementation.



I was concerned that the VoIP phone adapters would not be able to easily communicate with the server due to DNS difficulties, but there were zero problems with DNS or DHCP in BBHN. Again, this reinforces that this system is designed for the common person.

Next was voice quality, how would these calls sound? Would they sound like the other caller is in the same room or would it sound like a 1990s analog cellular phone in a tunnel? I was stunned with the quality and stability of the call. It was crystal clear. As long as the bandwidth is available and a good path can be made between the nodes, there should be no concerns with call quality.

Unfortunately, I did not have the capability to scale this test up using tower sites and greater distances. I was able to conduct a test with a 110 foot line-of-site. Again, I experienced great call quality. It's no wonder that so many mesh users like to use VoIP.

Continuing Work With Broadband-Hamnet

The conclusion of this course will not conclude my work with Broadband-Hamnet. I plan on continuing my study on the subject for the benefit of the amateur radio community. This will include a real-life implementation and a number of community publications. I strongly believe that the community can benefit from this system and improve our emergency communications capabilities.

The Future of Broadband-Hamnet

Citing current news from the BBHN website, the future of the system will be slightly altered. Recently, Linksys (a division of Cisco), announced the end of support for their WRT router series. These are the routers that BBHN was originally based on. BBHN support for these devices will not evolve beyond the current version. Future versions will only be supported by Ubiquity WiFi and mesh devices.

Updates will also only be released every 6 months. The reasoning for this comes from how BBHN works. Every node has to be on the same version of firmware in order to communicate. In order to have an emergency-ready, rapid deployment system, the need for updating should be limited as much as possible.

In the end, these devices are actually more inexpensive to implement and are designed specifically for outdoor installations. Instead of installers having to purchase cabling and an antenna, the Ubiquity devices are fully integrated and simplify the installation ten-fold. One user on the BBHN forums has already conducted a successful 32-mile point to point test with this equipment. I am confident that this is going to be a great direction for BBHN.

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