

All Things Digital

Amateur Radio for the 21st Century

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THE BROADBAND HAMRADIO [MESH] NETWORK (BBHN)—Part 1

What do hydro smart-meters, cellular phone systems and the BBHN have in common? They are all examples of wireless mesh (like fishing nets or gauze bandages) networks, very intelligent and autonomous but not quite “self-aware” like the “Skynet” (from the Terminator movies)—yet! Mesh networks are used everywhere and anywhere you need to provide wireless fidelity (Wi-Fi) or wireless local area network (WLAN) digital data communications.

NETWORKS: INTERNET VERSUS MESH

The Internet is a “hub-and-spoke” or “star” network (see Figure 1) because there’s a central hub (server) with “spokes” (like a wheel) that radiate out (like a star) to the individual users (clients). The spokes are combinations of transceivers, landlines, and other “black-box” technology connecting an Internet Service Provider (ISP) to your router (node).

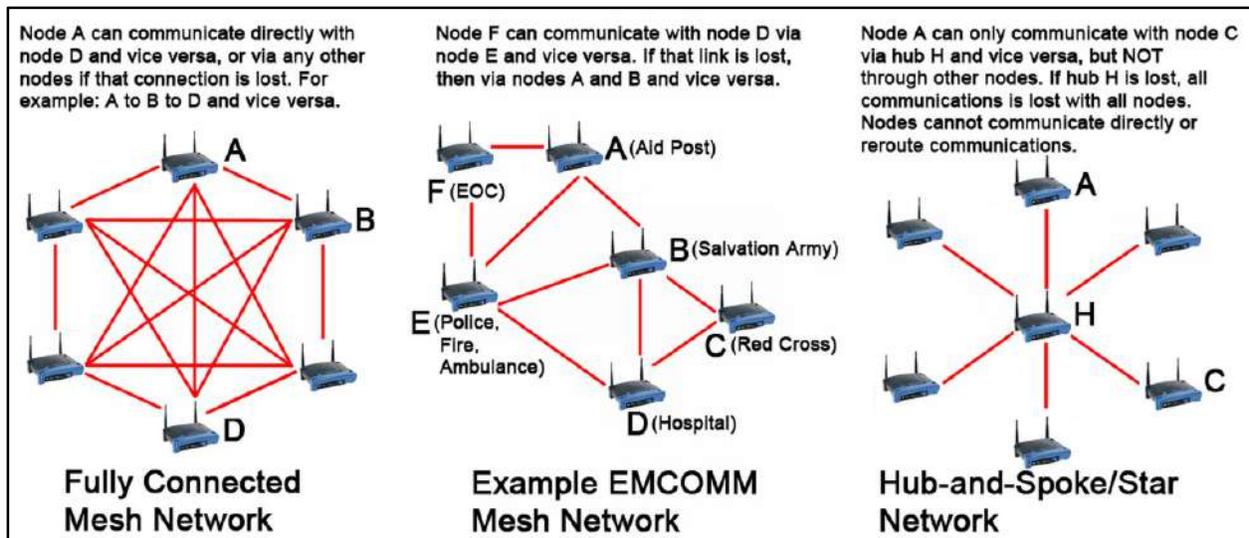
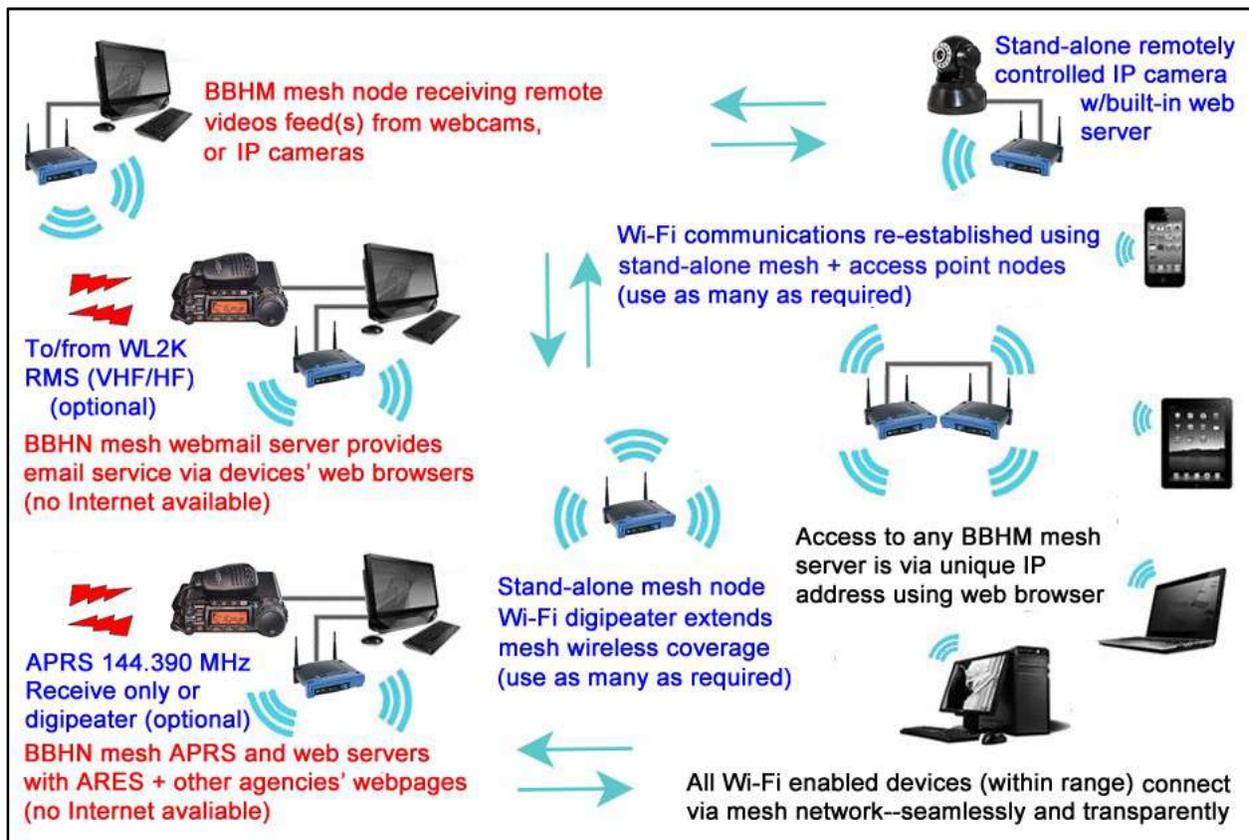


FIGURE 1: NETWORK EXAMPLES

Star networks are fixed in place and not very easy to move but they can exchange huge amounts of high-speed digital data between any node and vice versa, plus you don't have to worry about nodes affecting things as they come and go, but this is the 800-lb gorilla in the room—if the spoke between you and the ISP fails, you're cut off from Cyberspace—even worse—if the hub fails, everything, everywhere stops and all nodes are cut off!

On the other hand, a mesh network has no central hub or specific routing to/from nodes and is very portable and malleable. A commercial version was brought in after the 2010 Haitian earthquake to re-establish digital communications in the Port-au-Prince area.

FIGURE 2: TYPICAL BBHN [MESH] APPLICATIONS



A mesh network uses Open Shortest Path First (OSPF) routing whereby all nodes are in constant communication with each other to move any data (video, audio, pictures, text, email, files, etc.) efficiently and expeditiously (see Figure 2). More importantly, any node can act as an ad hoc server (e.g. a webmail server with Winlink 2000 (WL2K) radio email connectivity) or act as a stand-alone digipeater to fill-in wireless blind-spots, or paired with another node to provide a wireless Access Point (AP) to third parties who normally don't have access to a closed mesh (Amateur Radio based) network.

A mesh network is self-organizing and self-healing so if a node leaves or joins, the mesh automatically reorganizes the OSPF routing, and a node only needs to "see" its next node neighbour to have access to the entire mesh.

As long as you don't overload it (streaming high definition video isn't a good idea), a mesh network can move large amounts of digital data, but it has one major weakness because you need several nodes to establish it and more to expand it, however it's well-suited for specific and/or essential tasks such as public service events or emergency communications (EmComm) covering a local area when/where commercial systems are not available.

*Note: A node can also act as an Internet Gateway for the entire mesh but providing Internet connectivity is **NOT** the primary purpose of the BBHN since it's usually deployed when you don't have Internet access.*

THEN

The first wireless star network (ALOHAnet) was developed by Professor Norman Abramson [Hawaii, 1971] using UHF packet radio to connect seven computers, spread across four islands that communicated directly with a central computer. Shortly thereafter, Canadian Hams (first in BC, then in Quebec) developed the first Amateur Radio packet radio network systems to send/receive email and data files, well before the Internet came into existence!

Decades later, Dr. Winrich Roseheit [Cologne, 1997] created a new kind of [mesh] network called Digital Inter Relay Communications (DIRC) based on a different topology, more secure, intelligent, portable and less vulnerable to catastrophic failure. Soon, military DIRC networks evolved for tactical "command and control" of the battlefield. Mesh networks may have stayed in military/government or commercial use if it hadn't been for an unintended "Whoops!" committed by a company called "Linksys". In December 2002, it created and released the [now famous] WRT54G router (see Figure 3) supporting the new high-speed 2.4 GHz, 54 Mbps (802.11g) wireless protocol, and it didn't take long before cracker-jack hardware hackers stunned everyone by revealing that the router used Linux firmware which is open source (public domain) software!

Soon, many 3rd party firmware additions and enhancements followed quickly, including code written by Hams for Hams creating the “Hinternet” (Ham Internet) or HSMM (high-speed multimedia network). Later, Linksys reduced the memory and dropped Linux, so version 5 (and up) routers can’t be reprogrammed (“flashed”) with the latest BBHN firmware.



FIGURE 3: THE WRT54G (THE LITTLE ROUTER THAT CAN)

Initially, there was tremendous Hinternet/HSMM interest, but just as quickly as came into the limelight, it exited stage right because by the end of the 1990's the Internet buried most Amateur Radio packet radio networks (except APRS), so putting more money, time and effort to build short range microwave versions probably didn't appeal to most Hams—except for a dedicated few. Visit the BCWARN (British Columbia Wireless Amateur Radio Network) website and you'll discover a 21st century integrated network system!

Standard Amateur Radio operating rules apply (RBR- 4, former RIC-2 refers):

1. Station identification required (digitally transmitted at regular intervals).
2. No commercial or inappropriate use.
3. No (non-public) encryption methods to hide contents of transmitted data.
4. No interference to primary users or unnecessary interference to other users.
5. Use the minimum power needed to make and hold contact.

Note: IC documents RSS-Gen and RSS-210 refer to operation in this band segment, and I'm paraphrasing the regulations.

1. For licence-exempt, low-power wireless devices, the peak power to the antenna shall not exceed 1 watt with no more than 4 watts effective isotropic radiated power (EIRP), unless used as a fixed point-to-point link where EIRP can exceed 4 watts through the use of gain antennas but not increased peak power (RSS-210, A8.4 refers).
2. To use commercially manufactured external RF amplifiers with license-exempt, low-power devices, both of the following conditions must be met (RSS-Gen, 7.1.1 refers):
 - a. It must be certified for use with the device, and the amplifier-device combination can't exceed any of the limits specified for the device alone.
 - b. It must have the following statement on the packaging and in the user manual: *"Under Industry Canada regulations, this radio frequency power amplifier (insert Industry Canada certification number of radio frequency power amplifier) may only be used with the transmitter with which the amplifier has been certified by Industry Canada. The certification number for the transmitter with which this amplifier is permitted to operate is IC:XX...X-YY...Y."*

Note: Operating under Canadian Amateur Radio Service rules, the power limits don't apply because Hams can use higher peak input power with unlimited EIRP unless otherwise stated (as for the 60m and 30m bands), up to the maximums allowed by their Amateur Radio certificate class. However, IC pointed out Radiocommunication Act, section 9(1) (b): "No person shall (b) without lawful excuse, interfere with or obstruct any radiocommunication." Even if we can run higher power (peak input or EIRP) we must be very careful to not interfere with others, regardless if they are licensed primary or licence-exempt users.

GETTING MESHED

The Broadband Hamnet website has the latest BBHN information and firmware, and there are some excellent YouTube videos available. In hindsight, start with the videos first because they will save you a lot of wasted "meshing" around time!

THE HARDWARE

1. At least two flashed routers do a mesh network make. I bought mine on eBay (WRT54GL's and 54G's) but many such routers are collecting dust in Ham shacks or elsewhere.
2. One Windows (XP or later) or Linux based computer with a 10/100 Ethernet port connected to the router with Ethernet cable.

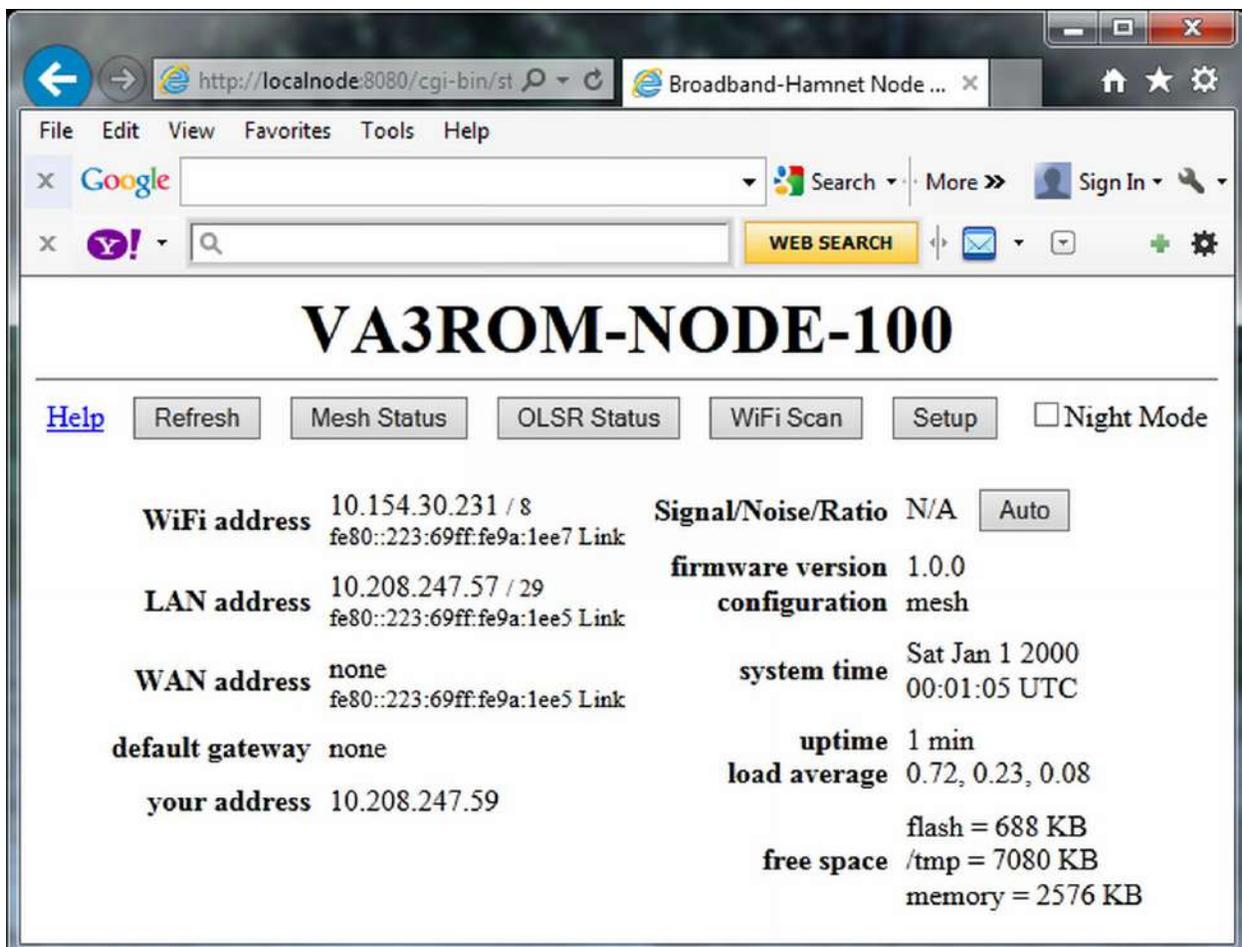
THE FIRMWARE

1. Download the specific router model firmware from the BBHN website.
2. Have a good read of the flash instructions—it's not easy to undo a "Whoops!"
3. Most importantly, always **turn off** your computer's internal wireless **before** you connect the router because it controls IP (Internet Protocol) addressing/routing and wireless connection to/from the mesh network.

ROUTER ACCESS & PROGRAMMING

Once flashed, you configure the router's mesh node operating parameters (callsign, SSID, type, etc.). See Figures 5 and 6. All nodes are accessible to each other using web browsers and you can remotely reconfigure/flash your own or someone else's node. To modify settings, you need the node's IP address, user name (always "root") and password (default "hsmm" or "admin"). *Note: Most Hams change the password to prevent someone from changing their node's settings.*

FIGURE 5: MESH NODE ROUTER MAIN MENU SCREEN



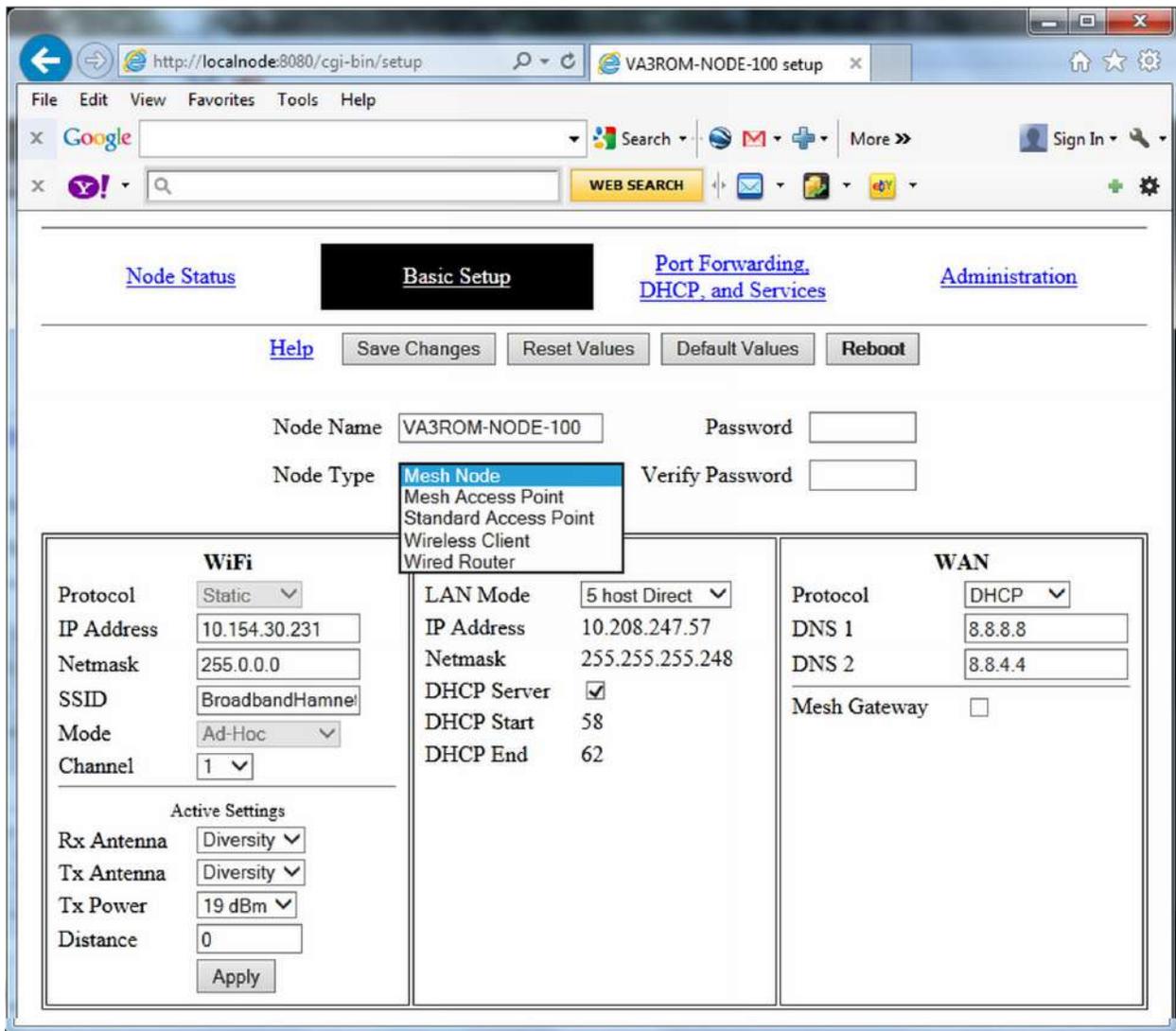
The screenshot shows a web browser window displaying the main menu for a mesh node router. The browser address bar shows the URL `http://localnode8080/cgi-bin/st`. The page title is "Broadband-Hamnet Node ...". The browser interface includes a menu bar (File, Edit, View, Favorites, Tools, Help), a search bar, and a "Sign In" button. The main content area features a large heading "VA3ROM-NODE-100" and a navigation bar with buttons for "Help", "Refresh", "Mesh Status", "OLSR Status", "WiFi Scan", "Setup", and a "Night Mode" checkbox.

WiFi address	10.154.30.231 / 8 fe80::223:69ff:fe9a:1ee7 Link	Signal/Noise/Ratio	N/A	<input type="button" value="Auto"/>
LAN address	10.208.247.57 / 29 fe80::223:69ff:fe9a:1ee5 Link	firmware version	1.0.0	
WAN address	none fe80::223:69ff:fe9a:1ee5 Link	configuration	mesh	
default gateway	none	system time	Sat Jan 1 2000 00:01:05 UTC	
your address	10.208.247.59	uptime	1 min	
		load average	0.72, 0.23, 0.08	
		free space	flash = 688 KB /tmp = 7080 KB memory = 2576 KB	

Normally, a node stays tethered to its host computer and is accessed by the host using IP address `http://localnode:8080` or `http://127.0.0.1:8080`. The “127.0.0.1” is the local (to you) network “phone” number and port “8080” the network “area code”.

When connected to the BBHN, nodes (tethered or stand-alone) transmit unchanging (static) mesh IP addresses starting with “10”, and this means you can always “dial” the same number (using your browser or 3rd party software) to access the same node.

FIGURE 6: MESH NODE ROUTER BASIC SETUP SCREEN



The BBHN is an open or public network and your firewall software must be set accordingly, especially when using 3rd party programs. Sometimes the firewall prompts you for access permission, but sometimes it just blocks a program without any notice, so check your firewall settings if you have connection problems.

MY FINAL

In part 2, we'll set up a BBHN webmail server with WL2K VHF/HF two-way connectivity because it's very useful for EmComm but not very easy (for most) Hams to setup. To help get you meshing, I've written three detailed tutorials (posted on my website) covering the easier to implement but very practical BBHN applications.—73

REFERENCES AND RESOURCES

2.4 GHz Wireless Channels

http://en.wikipedia.org/wiki/List_of_WLAN_channels

ALOHAnet

<http://en.wikipedia.org/wiki/ALOHAnet>

BBHN Website

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

BCWARN

<http://bcwarn.net>

Brown County ARES/RACES BBHN-MESH

<http://groupspaces.com/BCARES/pages/broadband-hamnet-bbhn-mesh-network-for-brown-county>

Mesh Networking

http://en.wikipedia.org/wiki/Mesh_networking

http://en.wikipedia.org/wiki/Wireless_mesh_network

WRT54G Router

http://en.wikipedia.org/wiki/Linksys_WRT54G_series

YouTube BBHN-MESH (HSMM) Introduction Videos

HSMM-MESH Networks <http://tinyurl.com/ndyuxpx>

Introduction to HSMM-MESH or Broadband-Hamnet <http://tinyurl.com/kxedh5n>

Getting your WRT54G series Ready for MESH <http://tinyurl.com/kxn89wx>

VA3ROM: All Things Digital

<http://tinyurl.com/og2acxq>