

QUEEN CREEK AMATEUR RADIO CLUB (QCARC)

ELMER SERIES – MESH NETWORKING I

# What is a Ham Mesh Network – A Primer

Mesh Networking

**QCARC**

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## Mesh Networking

### Scope

Many amateur radio clubs (and individuals) are interested in building out a mesh network. A mesh network can support many amateur radio activities as well as a robust EmComm network. This primer has been created to afford members of QCARC the opportunity for a bit of self-learning prior to launching their own mesh project. Any questions that you may have can be submitted to the QCARC YAHOO Group at [queen\\_creek\\_hams@yahoogroups.com](mailto:queen_creek_hams@yahoogroups.com). You need to be a member of that Group prior to sending any email to it. Or, send an email to [queencreekarc@gmail.com](mailto:queencreekarc@gmail.com).

### Credits

Most of the information and graphics in this primer comes from the Pima County OEM website at [www.oemcomm.org](http://www.oemcomm.org). Additional information, additions, etc. have been provided by N2QOJ of QCARC.

### Definition

In simple terms, it's hams using our radio privileges to operate a private, self-contained wireless computer network. Anything that can be done on a regular network/internet can be done on this private Wi-Fi network. The HAM Mesh Network can use existing off-the-shelf Wi-Fi equipment or off-the-shelf Wi-Fi equipment that has been modified to permit equipment to be used on HAM frequencies under Part 97 rules. This means much higher power can be used, where needed, to establish links between wireless routers (Nodes in HAM Mesh lingo). Links between nodes can be achieved for miles and miles limited only by line-of-site.

### A Few Examples of Possible Uses of a HAM Mesh Network

- Field Day Logging (e.g., N1MM, N3FJP)
- Video (e.g., webcams, Stream)
- Phone (VoIP)
- File transfer (FTP)
- Chat
- Email
- Screen mirroring
- Web server (e.g., WX station, DX Cluster, Ham repository)
- Map server

## How does this technology benefit Amateur Radio?

The biggest benefit is to our emergency communications operations. During a large emergency or disaster there is always the risk that the normal infrastructure, electrical power, telephone service, cell service, internet, etc. will fail. Traditionally, this is where amateur radio is strong in being able to provide needed communications during these times of need.

By adding this suite of computing power to the mix, computer operations can also be established for the use of responders when the internet and cell networks are down. All the data can be processed locally than transferred when things return to normal.

An additional benefit of moving data via a mesh network is that the emergency amateur radio RF communications network is not loaded down with data communications which could easily saturate the network and compromise the voice communications.

In non-emergency situations, an established ham mesh network can serve as infrastructure for the ham community, providing access to amateur radio reference material, community video streams, club/group email servers, etc.

## Hardware Examples

(click on the image for a larger view)

**Sample Mesh Installation- Block Diagram**

**Linksys Routers: Quick Shopping List**  
*(Only those models will work for Hamnet Mesh.)*

Model	Version	RAM/Flash	Serial Nos. Prefix
WRT54GS	1.0 - 3.0	32/6 MB*	CDR,CDW1, .COM6
WRT54GS	4.0		CDW6
WRT54G	2.0-4.0	16/4 MB	CDP2,CDP3, .CDP4
WRT54GL	1.0-1.1		CLD1, .CLD2, & CLD3
WRT54G	1.0	16/4 MB	CDP, CDP1

**Ubiquiti Mesh Nodes**

- Bullet M2HP: Antenna "N", Ethernet/POE Connection
- NanoStation M2: Built-in Antenna, Ethernet/POE Connection
- Rocket M2: Antenna X2 RP SMA, Ethernet/POE Connection

**Linksys Example**

POE Injector, Ethernet Cable, POE Injector

**Linksys Router**

Internet, 1, 2, 3, 4, Power

REVERSE POLARITY! MAKE SURE TO ISOLATE "N" (Neutral) and Ground (GND) (Ground) Port on Power-Polarity! (See "Notes" on the bottom of the page for more information.)

NOTE: Cable lengths at 2.0GHz are indicative of maximum line loss. Please refer to the cable manufacturer's website for more information on cable loss.

Connect devices that you want to be part of the Mesh network to any of these 4 ports.

If you want an INTERNET connection, connect your ISP network here.

## Mesh Networking Lingo

### Access Point (AP)

A device that acts as the bridge between wireless clients and the wired network. Often abbreviated as AP.

### Ad Hoc Mode

A peer to peer mode of networking using Wi-Fi networking but no access point. Ad Hoc networks can include more than two devices.

### Beacon

A beacon is transmitted by an AP ten times per second, and advertises the existence of the AP on a particular channel or channels. It includes information needed by clients to associate and may include the ESSID, the supported channels and data rates, and whether it is open or requires authentication. In HAM Radio mesh networking, the owners ham radio call sign is also broadcast.

### Channel

A channel is the network path for wireless transmissions. Each Wi-Fi standard has numerous channels, each of which is a center frequency. There are 11 channels in 802.11b and g networks in the United States and Canada; 14 in most other countries. Channels have a bandwidth-the greater the bandwidth, the greater the potential throughput. Ham Mesh bandwidth can be set to 5 MHz, 10 MHz, and 20 MHz.

### Diversity

Using multiple antennae to reduce interference and improve both transmission and reception of signals. LinkSys nodes and some Ubiquiti nodes use two antennae in diversity mode for better link quality. This is also referred to MIMO.

### MIMO

Multiple Input/Multiple Output signaling that uses several transceivers and antennae to improve throughput and range of the wireless network. APs with more than one antenna uses MIMO.

### Node

A node is a device that was originally a wireless router that has been converted to transfer data between other nodes in the mesh network. Nodes are self discovering, self configuring, self advertising and fault tolerant.






### Peer to peer

In mesh networking, nodes are peer to peer devices. That is, if a node is within radio range of another node and they broadcast the same SSID, they will connect to each other.

### SSID

The Service Set Identifier (SSID) is the name of the wireless network. It is contained in the beacons sent out by the nodes.

## Mesh Networking Links

- [Antenna Basics](#) 
- [Parabolic Dish Antenna Theory](#) 
- [Offset Dish Antenna Theory](#) || [Offset Dish Antenna Specs](#) 
- [Patch Antenna Design](#) 
- [BroadBand-Hamnet](#)
- [Wasatch Meshers](#)
- [Taylorsville Hamnet](#)
- [Heart O' Texas Mesh](#)
- [Multipath and Diversity Mode](#) 
- [Link Path Profiler](#)
- [Amateur Radio IP Networks](#)
- [AE5CA](#)

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