AG6QO Mesh Net Project

Ad Hoc Broadband Networks
What is a Mesh Net?

• “A mesh network is a network topology in which each node (called a mesh node) relays data for the network. All nodes cooperate in the distribution of data in the network.”
  – http://en.wikipedia.org/wiki/Mesh_networking

• A mesh network can be designed using a flooding technique or a routing technique. When using a routing technique, the message is propagated along a path, by hopping from node to node until the destination is reached.

• To ensure all its paths' availability, a routing network must allow for continuous connections and reconfiguration around broken or blocked paths, using self-healing algorithms.
Network Flexibility

A fully-connected network

Every node is within range of every other node in the network and can therefore connect directly to every node.

If nodes leave or enter the range of other nodes, traffic automatically gets routed to its destination by the best route (self-healing).

How?
How do Amateur Mesh Nets Work?

- Most use a protocol known as Optimized Link State Routing protocol, OLSR, which provides:
  - Self-healing
  - Auto-routing
- Most operate in the microwave bands to provide high data-rates.
- Most support TCP/IP as their standard transport layer.
- Can be built with low-cost, low-power, readily available WiFi hardware.
- Add your own high-gain antennas or even amplifiers.
What is a “Broadband” Network?

- Refers to Bandwidth of the channel, which is directly proportional to its data-rate capacity.

- Broadband Ham Networks operate in the range of 2.4, 3.6, or 5.8 GHz, providing data rates in excess of 50 Mb/s!

- Permits VoIP, Video and just about anything you can do with internet bandwidth.

- Is NOT a replacement for or extension of the internet!
How can they be used?

• Anything a high-speed TCP/IP network can be used for.
• Remote monitoring and control
  – Video
  – Audio
  – Temperature/Weather
  – Repeater/Rig/BBS
  – Power Condition, Power Control (Cycle)
  – Web pages, ftp data, Any data!
• Anything allowed by FCC Part 97 (Amateur Rules)
• Nothing Commercial
• Nothing Encrypted (be careful !)
TCP/IP Networking Basics

- **TCP/IP** – Transport Control Protocol / Internet Protocol
- **TCP/IP Port** – Port numbers for IP devices
- **MAC address** – Media Access Control Address
- **WAN** – Wide Area Network
- **LAN** – Local Area Network
- **SubNet** – Sub-network
- **DHCP** – Dynamic Host Configuration Protocol
- **DNS** – Domain Name Server
- **Router**
- **Ethernet Switch**
- **Bridge**
- **Access Point** – WiFi access to a network
MeshNet Applications

- **Voice over IP** – 3CX using Asterisk; Other VoIP
- **Internet Relay Chat** – IRC
- **Video** – Tower Cam Example
- **POP Server** – Post Office Protocol
- **SMTP** – Simple Mail Transfer Protocol
- **FTP** – File Transfer Protocol
- **HTTP** - Web Server – lighttpd
- **Telnet** –
- **LDAP** – Lightweigh Directory Access Protocol
Selecting Hardware and Installation

• Questions to ask:
  • How far will the nearest hop be?
    • Can I get Outside?
    • How high can I get?
    • Do I have line-of-sight?
  • How much gain do I need?
    • Farther distance; Higher gain
    • Directionality vs. Gain
  • What frequency is optimal?
    • Higher frequency has higher loss through atmosphere
    • Lower frequency requires larger antennas
    • 2.4 GHz has lots of “noise”
    • 5.6 GHz is quieter but has higher losses
    • 900 MHz has lower losses but requires larger antenna
  • How much power?
    • Lowest to make the connection!
• What applications do I want to run?
  • What bandwidth do I expect
  • What reliability level do I need
Planning the Net

- Baseline Band: 2.4 GHz – readily available hardware
- Outdoor is best
- High Gain for long distances
- Avoid amplifiers – antenna gain is far preferable
- Location Location Location!!!
20dB Directional Antenna

Omni-directional Antenna

Programming Nodes

- How to Flash Ubiquiti Nodes
- How to Flash WRT54 Nodes
Configuring Nodes

- **Node Name:** MUST contain your callsign – this is used for legal station identification. Must be unique.

- **SSID:** MUST be identical to ALL other nodes in the mesh – otherwise they won’t communicate with each other! Leave at default setting!
Possible Node Locations

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<th>Latitude</th>
<th>Longitude</th>
<th>True Bearing TO</th>
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References

- http://ag6qo.com/MeshNet.html
- http://www.broadband-hamnet.org/
- Software download page
- https://www.hamwan.org/t/tiki-index.php
- http://hsmmpi.wordpress.com/page/3/
Initial Application

- **Web-page controlled remote power switch**

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**Diagram:**

- **Ubiquiti Mesh Node**
  - 5-10 Mb/s Microwave Mesh Net Link

- **Raspberry Pi 12V Power Switch**
  - 12 VDC In (40 A)
  - Channel A
    - 12 VDC Out (30 A)
  - Channel B
    - 12 VDC Out (30 A)

- **Hardwired 10-baseT Ethernet (Cat 5)**

- **USB 2.0**
  - USB 2.0
  - Example use: 2 Tb Hard Drive
Remote Power Control

QO CGI client and QO Daemon written in “C”

Browser (Any)

Web Server (lighttpd)

QO CGI client (qocgi)

QO daemon (qod)

Web data served over microwave link
Mesh net

All in dashed box runs on Raspberry Pi
Which can also serve files and other web pages over mesh net

Two channel relay ctrl (Rpi)

TCP/IP (http)

UNIX socket

Rpi GPIO

9/27/2014

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QO CGI Client

Any web browser:

- Without using encryption, a passcode matching method is used for security.
- Similar to the KPC3 remote sysop feature.
- Individual control of the two channels.
- Can be expanded to include display of monitored values, voltage, current, temperature, etc.
QO Remote Power Switch
Joe Who?

• Ham since 1974 – WN3YKP, WA3YKP, AA3YKP
• Extra since Nov. 2012 – AG6QO
• Profession – BSEE, M. Eng.
  – Computer / Controls Engineer – Robotics, Flight Controls, UAVs
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