

# Introduction to Mesh Networking

7 May 2015

Jim Oberhofer KN6PE

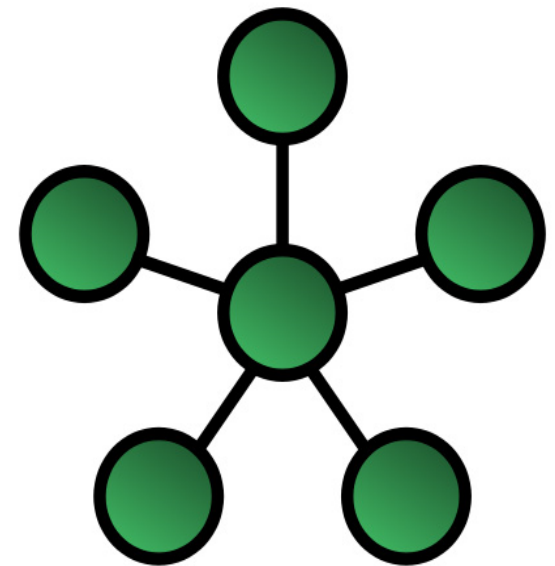
Cupertino ARES/RACES



# Computer Network basics

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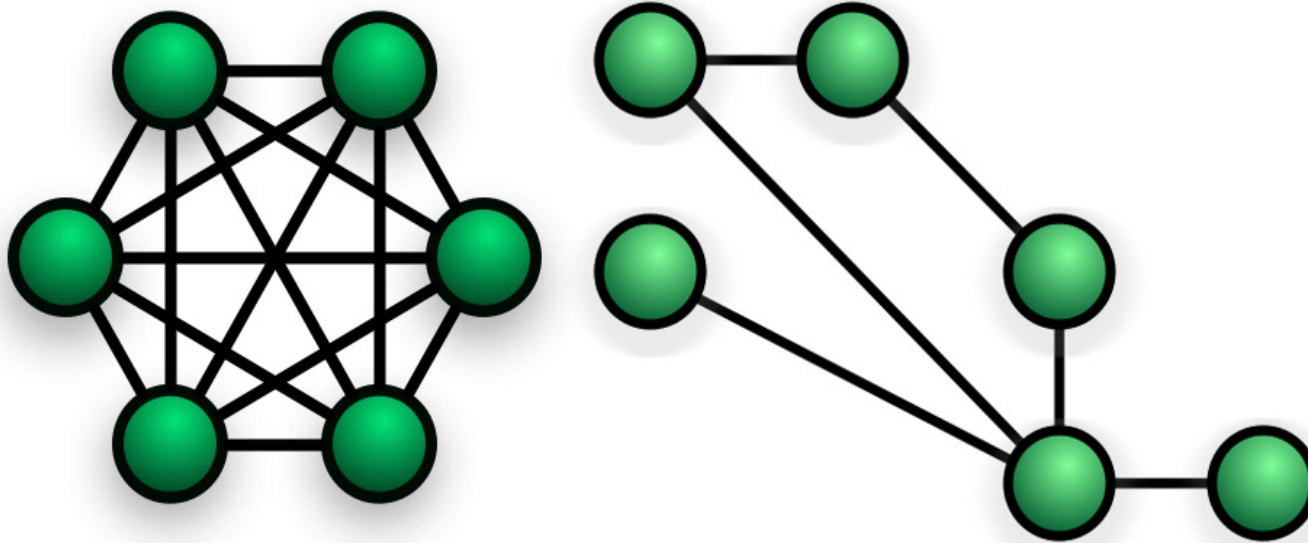
- **Topology** describes how the various members (nodes) of a network are connected together.
- Most small networks (your office, your home) use a *star topology*, with a central node (a switch/router) connected to a bunch of clients (your laptop, smartphone, Xbox, etc.).
- The ***Star Topology*** dictates that if one client wants to talk to another (say, you want to send a photo from your laptop to your Xbox), the data must go through the central point (the router).



# Computer Network basics

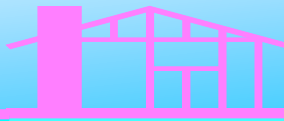
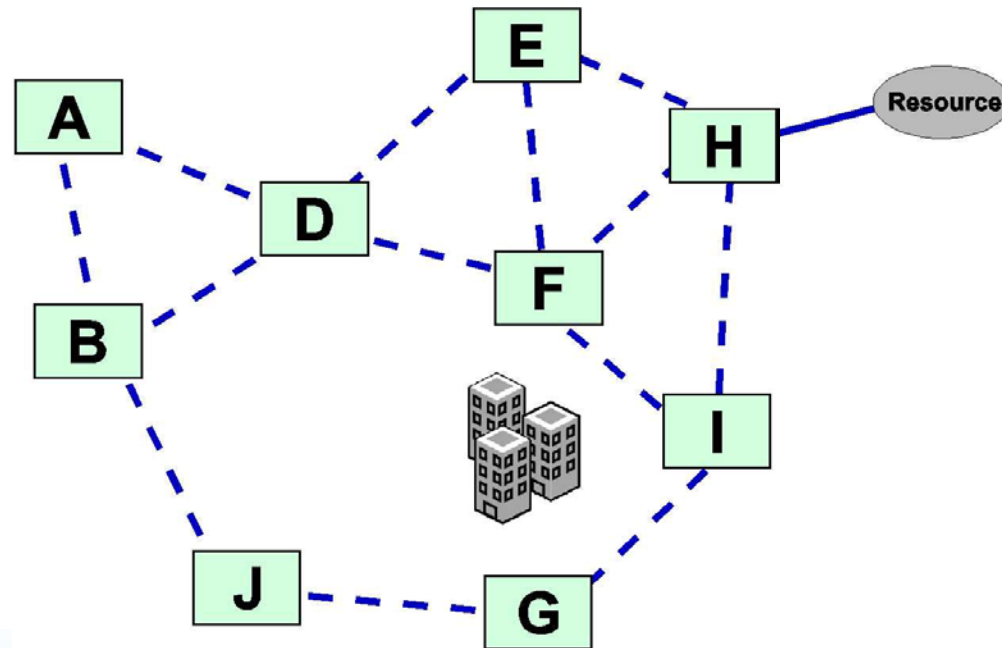
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- A **Mesh Topology** is when nodes are connected to multiple other nodes.
- Full-mesh is when every node connects to every other node (left picture).
- Partial mesh is something less than that, but more than a star topology.
- If a node goes down, there are other paths that can move the message along.



# What is a Mesh Network?

- Self discovering
- Automatically routes traffic
- Fault tolerant
- Automatically reconfigures itself as nodes join or leave
- Resources on any node can be shared by all nodes



# What is a Mesh Network?

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- Each Node is a radio
  - Manages the transmit and receive, typically on 2.4Ghz or 5Ghz band
- And, each Node is a router
  - Discovers and builds a routing table to track which nodes are connected
  - It knows how to send a message from one end of the network to another even if it cannot see the destination node.
  - If a node has resources (internet access, PBX server, webcam, file server, etc), then it can make them available to all network users.
- All nodes can be remotely managed.



# Why even consider Mesh networks?

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- We live in a digital world
  - Cell phones, tablets, apps
  - PDF files, excel spreadsheets, word docs, video clips
  - Email, Texting
- Our served agencies are used to that, and always connected is becoming an expectation.
- To keep up with this expectation, we may need to deliver communications services that supports their changing needs.
- High speed data networks – like Mesh – allow exchanging docs, text, images, chat, and voice to name a few.
- Mesh networking gives us a new tool to get the message (and data) through in support of our served agencies.



# Broadband-Hamnet™

## Mesh Networking Software

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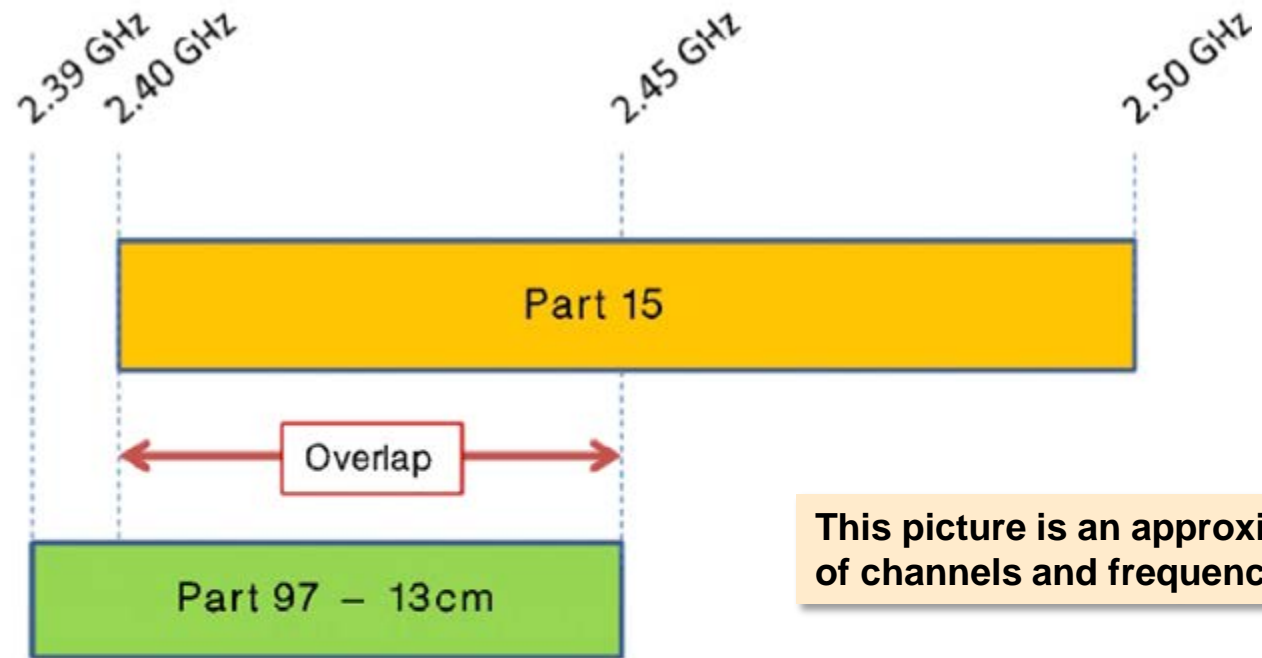
- The BBHN software creates a high speed, self-discovering, self-configuring, fault tolerant, wireless computer network.
  - It automatically discovers its neighbors.
  - It automatically determines which neighbors it can reach directly vs. which nodes must be reached through another neighbor.
- However, it does all of this on a shared frequency instead of collection of separate channels.
- While that makes it easy, it also means it is not as scalable like other mesh topologies. But for moderate traffic, it's proven to be "good enough".
- And, it operates on the **Ham Bands!**



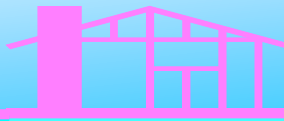
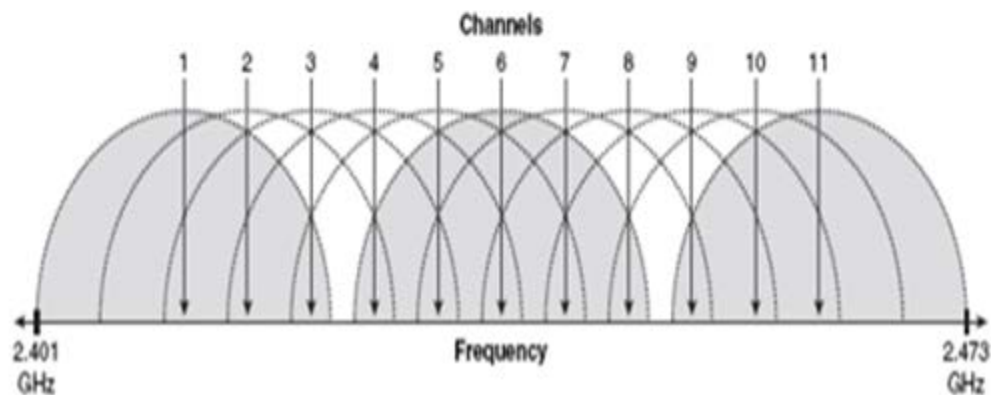
# Broadband-Hamnet™

## Mesh Networking Software

- WiFi Channels
- Channel 1 is the BBHN default



This picture is an approximation of channels and frequencies





# Broadband-Hamnet™

## Mesh Networking Hardware

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- **Linksys, WRT54G**

- Repurposed home routers; 2.4Ghz (13cm band)
- It's just a small Linux computer with a router and Wi-Fi built in.
- Inexpensive – around \$25 on eBay and readily available.
- But! You cannot buy the ones we need new (see the website for supported model and versions).
- 12 VDC Power
- Low power level (79 mW)
- Ideal for close-proximity multiple workstations where network end user phone support and information sharing is needed.
- Can use outdoors either during dry weather or when mounted in an enclosure.



# Broadband-Hamnet™

## Mesh Networking Hardware

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- **Ubiquiti** (<https://www.ubnt.com/>)
- Multiple frequency choices
  - M9 Devices - 900 Mhz (33 cm band)
  - M2 devices - 2.4 GHz (13 cm band)
  - M5 Devices - 5.0 Ghz (5 cm band)
- Multiple Models
  - AirGrid M2 (\$69)
  - Rocket M2 (\$79 + antenna)
  - BulletM2 (\$76 + antenna)
  - NanoStation Loco M2 (\$69)
  - NanoStation M2 (\$79)
- 24 VDC Power
- Higher power (Linksys=79mW Ubiquiti=600mW)
- Comes in a weather-proof package, no or minimal RF cable loss, relatively easy to mount.
- Readily available from multiple suppliers.



# Broadband-Hamnet™

## Mesh Networking Software

### Software Download

### Install the Software

- Find, download, and **FLASH** the correct firmware to the device.  
<http://www.broadband-hamnet.org/software-download.html>
- Be very careful to pick the correct download. Installing the wrong firmware may **BRICK** your device ☹️.

### Configure your node

- Once configured, you will discover, and be discovered by, other nodes.

#### Broadband Hamnet Software Download

[Linksys Firmware](#)

[Ubiquiti Firmware](#)

Please read this note about Linksys firmware support ending April 30th, 2015

#### Broadband Hamnet firmware

<a href="#">Release Notes</a>		Release Notes for this build. Please read as this document contains detailed information about this release.
<a href="#">bbhn-3.0.0-brcm-2.4-squashfs.trx</a>	2.9M	upgrade an existing mesh node md5sum: cce4619a7380287b6d464082d33ee077
<a href="#">bbhn-3.0.0-usr5461-squashfs.bin</a>	2.9M	firmware for a non-mesh usr5461 md5sum: 3da0c4df3ba19811b076edf78dcc09e4
<a href="#">bbhn-3.0.0-wrt300n_v1-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh wrt300n_v1 md5sum: c4a2e1a5ed8379d3c675ea6deb423079
<a href="#">bbhn-3.0.0-wrt54g-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh WRT54G and GL md5sum: ef84b833bedf4f04404b6540432ab194
<a href="#">bbhn-3.0.0-wrt54g3g-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh wrt54g3g md5sum: 8a94fb9bd437c4a54153f37be1fbf9b2
<a href="#">bbhn-3.0.0-wrt54gs-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh wrt54gs md5sum: 123f6c834288d0583eb09c855da337d6
<a href="#">bbhn-3.0.0-wrt54gs_v4-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh wrt54gs_v4 md5sum: cc6fed5aba61e82dba755c109384e455
<a href="#">bbhn-3.0.0-wrt54gs-2.4-squashfs.bin</a>	2.9M	firmware for a non-mesh wrt54gs md5sum: 8836e686f0523f5445cf230c1d30fbc3

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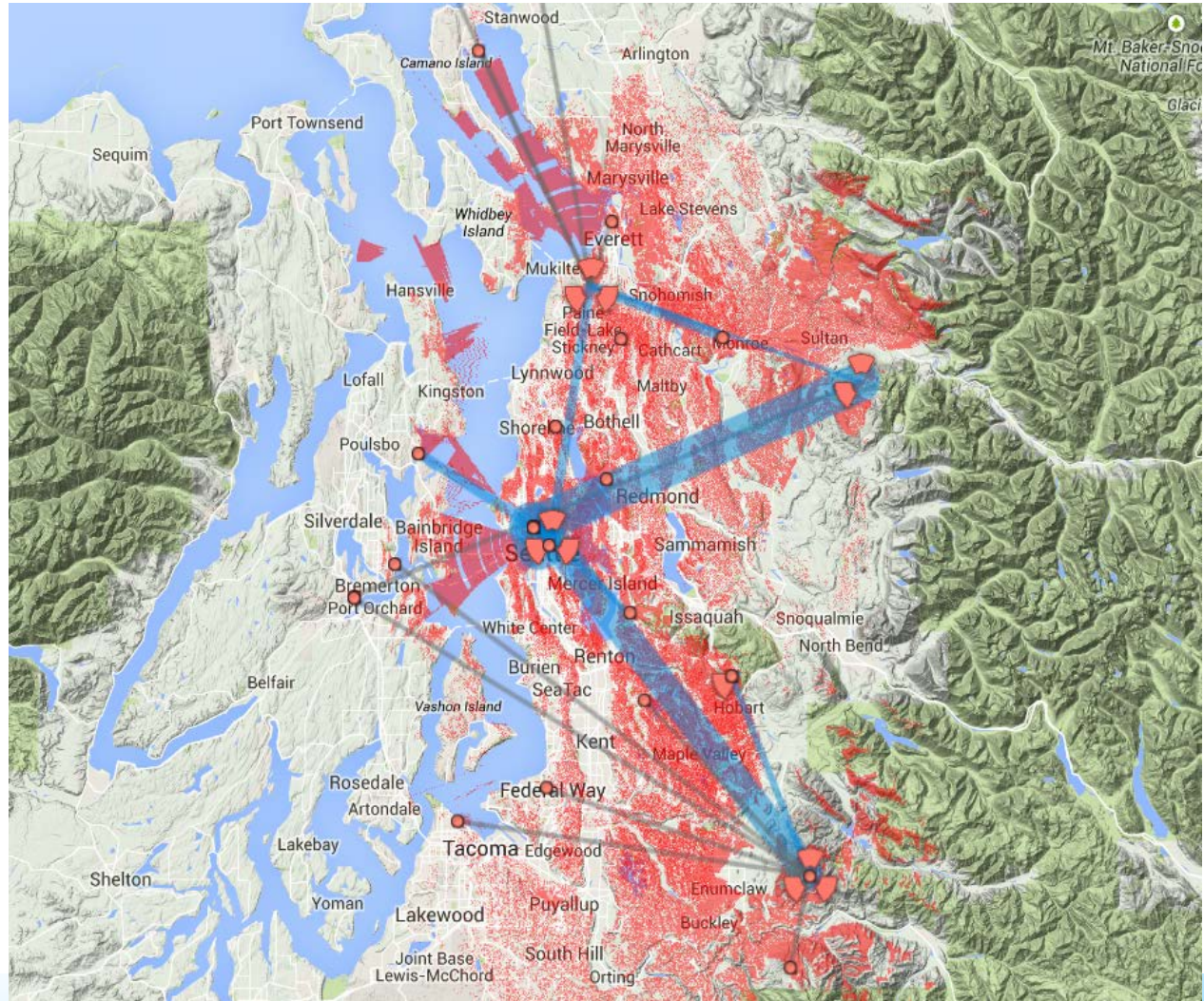
- Austin Texas





# Is anyone using Broadband-Hamnet™?

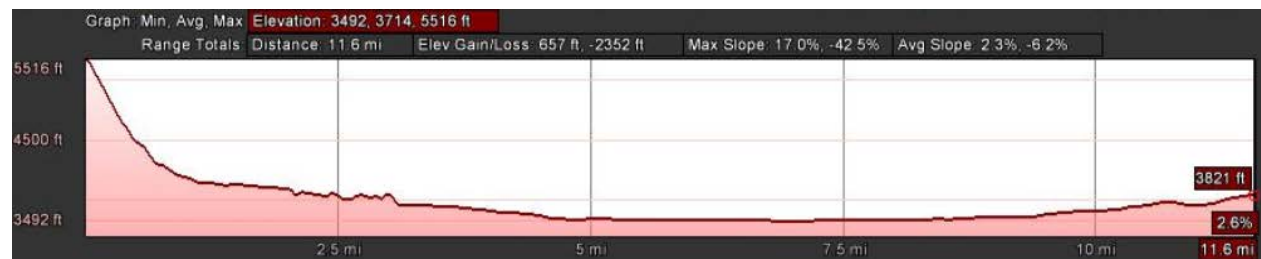
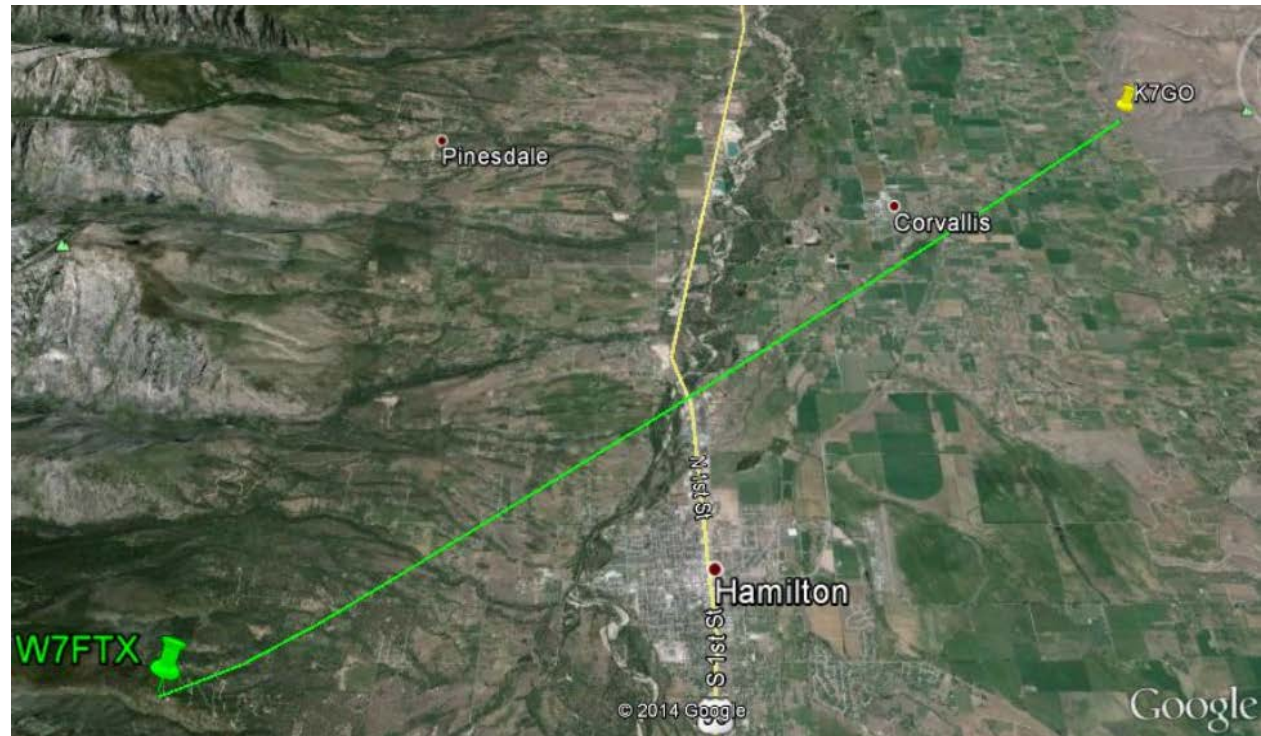
- Greater Seattle WA (NW MESH Amateur Networking Project)
- HamWAN cells have been deployed to four sites.
- Each site is inter-connected with 5.9 GHz modems with full routing.



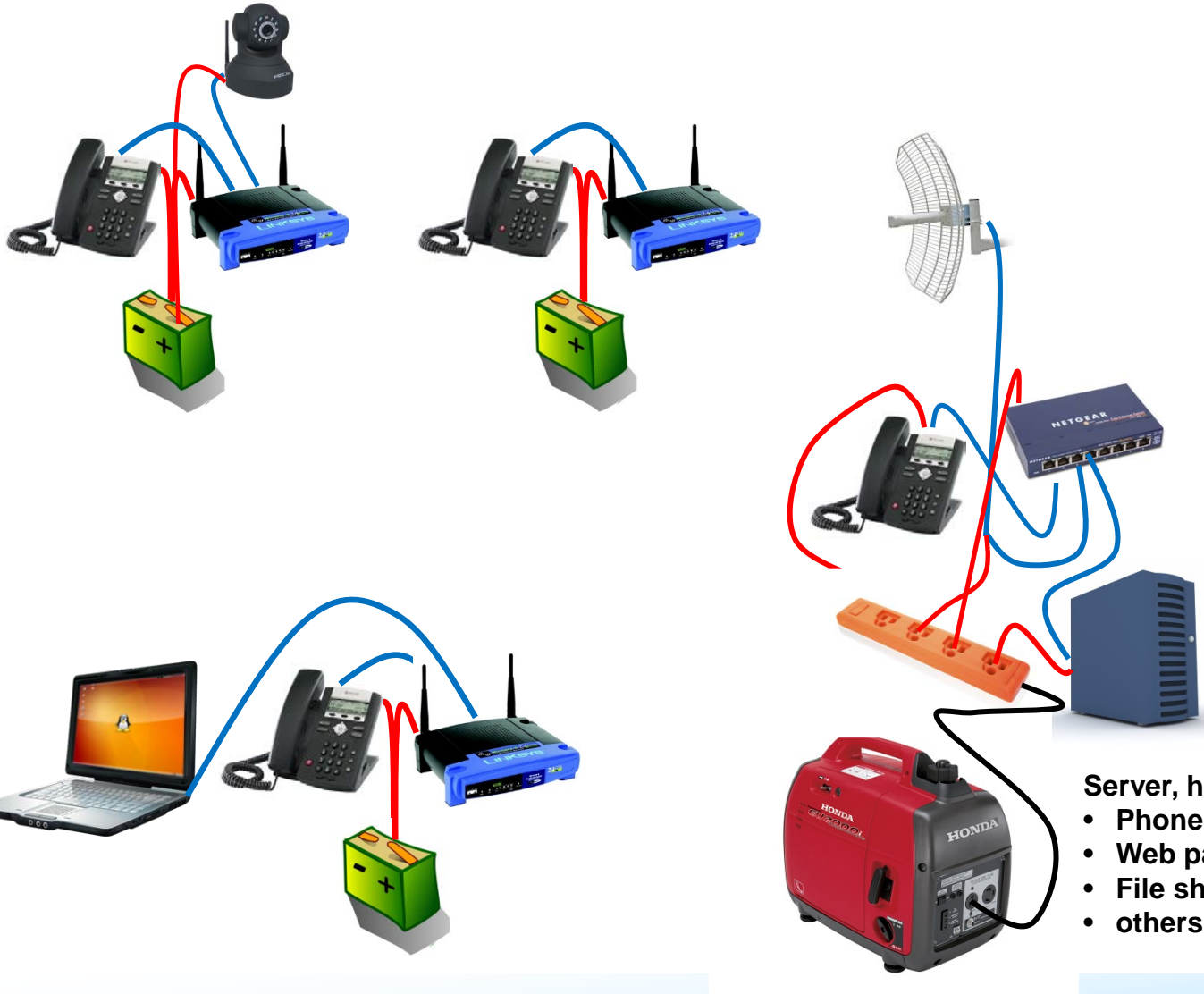


# Is anyone using Broadband-Hamnet™?

- Montana Mesh Project



# Putting it all together



## Considerations

- Power -- Batteries, generators; need 5vdc, 12vdc, 24vdc
- Radios – Linksys vs Ubiquiti
- Server-side: Services include phone, website, file shares, others?
- Packaging – portable, self-contained, speed of deployment

### Server, hosts....

- Phone Server
- Web pages
- File shares
- others



# What's next?... A few suggestions

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1. Host a hands-on Mesh Workshop for CARES members; early June
2. Deploy what we have during Field Day (27-June)
  - Test out: voice, webcams, open field distance between nodes, others?
  - Critique... what worked, didn't work
3. Look at deploying a Mesh Network at the Sheriff's heroes run (November)
  - What would be useful to support the event?
  - What equipment would we need to build or buy?
4. What else?





# Thank you

*Any Questions?*

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