



# HSMM-Mesh <sup>TM</sup>

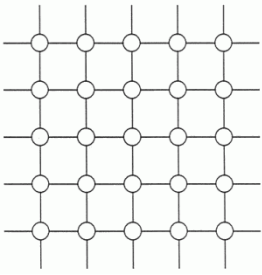
Part 1 – The Technology (tonight's Presentation)

Part 2 – Applications (coming soon!)

CCARES/BPRA Ham Basics – 19 November 2011

Gary J Takis – K7GJT

Don Peter – ND7P



# What is HSMM-Mesh?

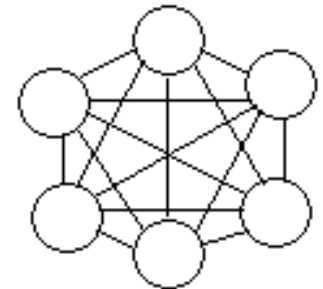
**MESH...** *Noun.* The topology of a network whose components are all connected directly to every other component.



Amateur Radio for the 21st Century

# How do we do it?

# Why would we want to?



# Subjects to cover

- Digital Systems
- History
- HSMM-Mesh Defined
- How does it work?
- The Hardware
- What about Power?
- The Topology
- What can we do with it?
- What is OLSR? Daemon?
- The Client Software
- My thoughts on a local Strategy

# Digital Systems

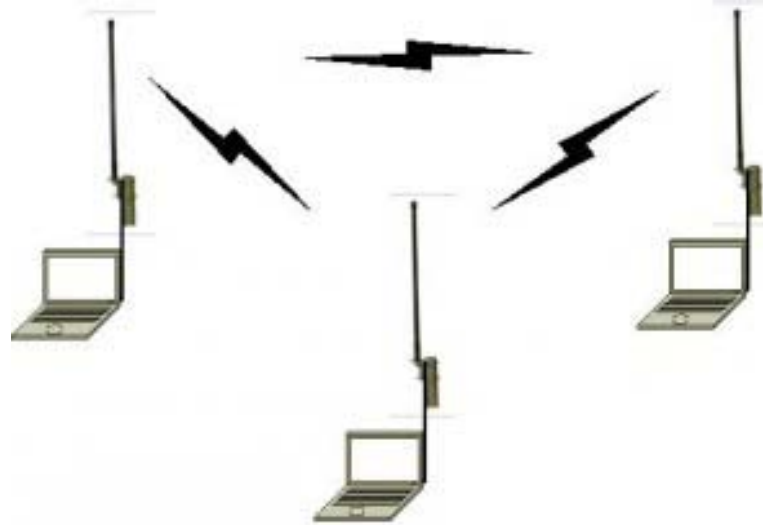
- [Project 25 TIG](#)
- [ICOM IDAS™ – NXDN](#)
- [Kenwood NEXEDGE™](#)
- [MOTOTRBO™](#)
- [TETRA Trunked Radio](#)
- [ICOM DSTAR](#)

# Digital Linking Systems

- High Speed Multi Media



- HSMM-MESH



# History

- ARRL HSMM Working Group created in 2001 to develop high speed (faster than dial-up modem) digital networks for the Amateur Service
- Started out as “ARES-MESH”
- ARES is an ARRL trademark!
- Now HSMM-MESH tm (yes trademarked!)
  
- Channels 1-6 of the FCC Part 15 802.11B/G wireless band are completely within the FCC Part 97 2.4Ghz ham band

# HSMM-Mesh Defined

- “**H**igh **S**peed **M**ulti-**M**edia **M**esh”
- HSMM-MESH is a automatically configuring, fault tolerant Ham radio wireless network.
- HSMM-MESH uses off-the-shelf commercially available hardware that has its internal software changed to perform completely different from a Wifi router.
- PACKET can do 1.2Kb/sec or 9.6Kb/sec
- 802.11b wireless routers can do 10 Mb/sec
- 802.11g wireless routers can do 54 Mb/sec

# Frequencies & Power

## **HSMM 802.11(a),(b),(g) under FCC Part 97.311**

**802.11(a) 12 Channels Non-Overlapping**

**5.650 – 5.925 GHz OFDM 1500 W PEP**

**802.11(b) 8 Channels Overlapping**

**2.390 – 2.450 GHz DSSS 10 W PEP**

**802.11(g) 8 Channels Overlapping**

**2.390 – 2.417 GHz OFDM 1500 W PEP**

**OFDM : Orthogonal Frequency Division Multiplexing**

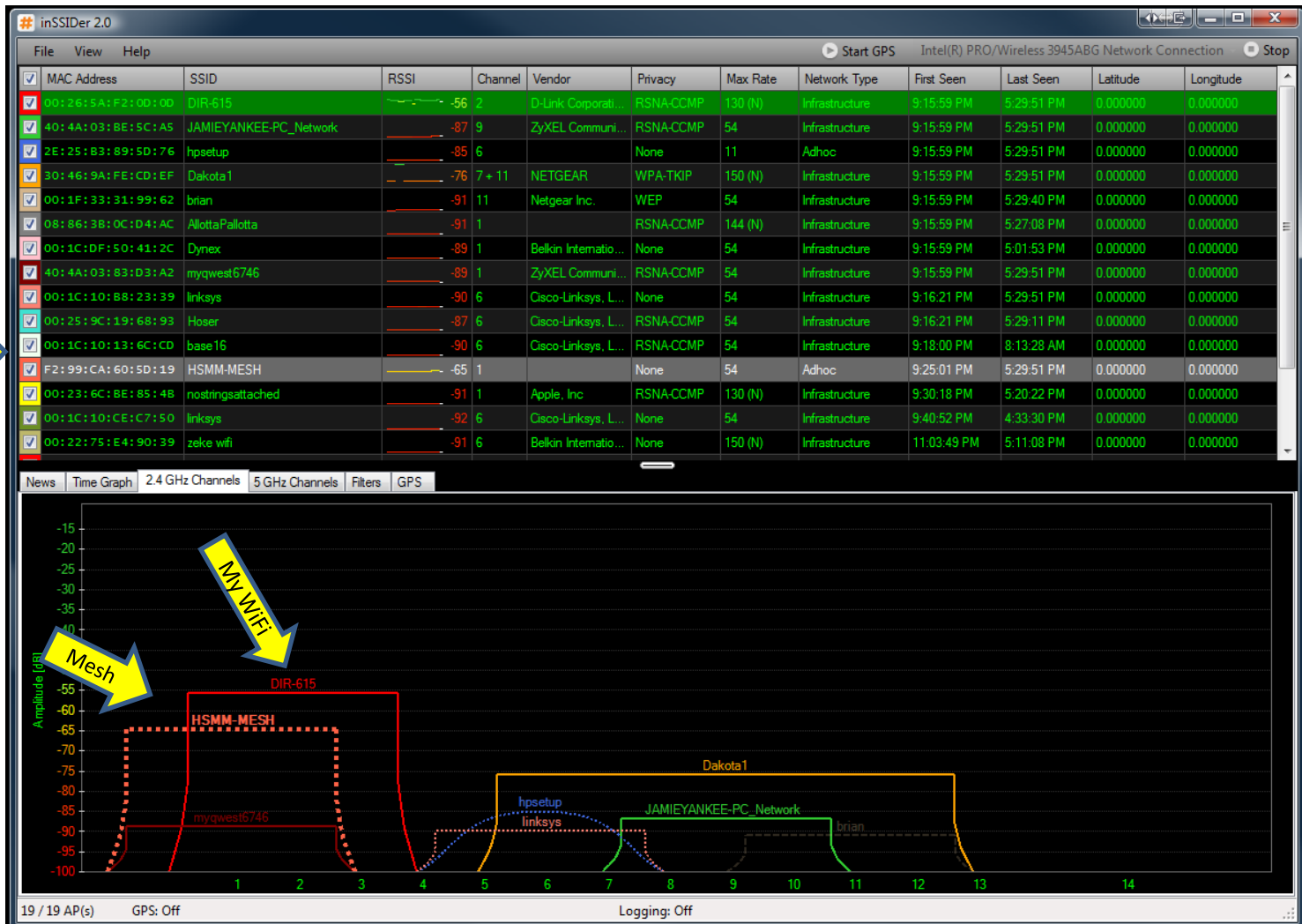
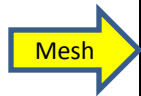
**DSSS : Direct Sequence Spread Spectrum**

# How does it work?

- An HSMM-MESH node is an endpoint connection AND a repeater.
- If one endpoint cannot see its desired destination, but CAN see nodes in between, the data will hop from one to the next until the final connection is made. Completely automatically.
- If one repeating node falls out, the software automatically re-routes traffic through other available nodes.

# Uses Ch 1 of the 802.11 WiFi band

Using  
“inSSIDer”



# The Hardware

- Router:
- LinkSys WRT-54G (version 1-4)
  - 12VDC @ 1A
  - Uses “RP-TNC” antenna connector
- Antenna Options
  - Typically Use ‘RP-SMA’ and ‘N’ connectors



Circular, Rectangular or Flat Panel = 8-24Dbi




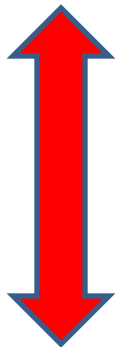
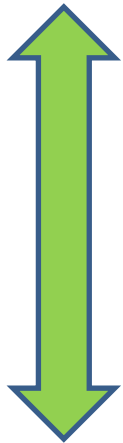
12 EI beam = 20Dbi  
16 EI beam = 24DBi



Verticals  
8 Dbi  
12 Dbi  
15 Dbi

# Not just any WRT54G router!


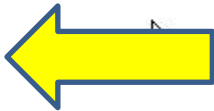
		(!) Please contribute to this list. (!)	OpenWrt	
Model	S/N Prefix	Stable White Russian	Development Kamikaze	
WRT54G v1.0	CDF0 or CDF1	(./)	(./)	
WRT54G v1.1	CDF2 or CDF3 or CDF4	(./)	(./)	
WRT54G v2	CGN10 (Canada)/CDF5	(./)	(./)	
WRT54G v2.2	CDF7	(./)	(./)	
WRT54G v3	CDF8	(./)	(./)	
WRT54G v3.1 (AU?, DE, FR, UK and SE)	CDF9	(./)	(./)	
WRT54G v4	CDFA	(./)	(./)	
WRT54G v5 *	CDFB	{X}		{X}
WRT54G v5.1*	CDFC	{X}		{X}
WRT54G v6 *	CDFD	{X}		{X}
WRT54G v7	CDFE	{X}		{X}
WRT54G v8	CDFE or CDFG	{X}		{X}



# Ease of Programming the Router

- Using one of the 4 Ethernet ports, update the original router firmware with appropriate HSMM-MESH binary (\*.bin) file with a normal internet browser
- Login to your new mesh node
- Give it a node name (e.g. “K7GJT-100”)
- Change the password
- Save & reboot
- Get one within range of another
- CONNECTED !

# Router Basic Setup

<a href="#">Node Status</a>	<b>Basic Setup</b>	<a href="#">Port Forwarding, DHCP, and Services</a>	<a href="#">Administration</a>	
<a href="#">Help</a>	<input type="button" value="Save Changes"/>	<input type="button" value="Reset Values"/>	<input type="button" value="Default Values"/>	<input type="button" value="Reboot"/>
	Node Name <input type="text" value="K7GJT-200"/>	Password <input type="text"/>		
	Node Type <input type="text" value="Mesh Node"/>	Verify Password <input type="text"/>		
<b>WiFi</b>		<b>LAN</b>		
Protocol	<input type="text" value="Static"/>	LAN Mode	<input type="text" value="NAT"/>	
IP Address	<input type="text" value="10.51.227.226"/>	IP Address	<input type="text" value="172.27.0.1"/>	
Netmask	<input type="text" value="255.0.0.0"/>	Netmask	<input type="text" value="255.255.255.0"/>	
SSID	<input type="text" value="HSMM-MESH"/>	DHCP Server	<input checked="" type="checkbox"/>	
Mode	<input type="text" value="Ad-Hoc"/>	DHCP Start	<input type="text" value="5"/>	
		<b>WAN</b>		
		Protocol	<input type="text" value="DHCP"/>	
		DNS 1	<input type="text" value="8.8.8.8"/>	
		DNS 2	<input type="text" value="8.8.4.4"/>	
		Mesh Gateway	<input type="checkbox"/>	

# Node Status

## K7GJT-200

[Help](#)

Refresh

Mesh Status

OLSR Status

WiFi Scan

Setup

Night Mode

**WiFi address** 10.51.227.226 / 8  
fe80::213:10ff:fe33:e3e2 Link

**LAN address** 172.27.0.1 / 24  
fe80::213:10ff:fe33:e3e0 Link

**WAN address** none  
fe80::213:10ff:fe33:e3e0 Link

**default gateway** none

**your address** 172.27.0.5

**Signal/Noise/Ratio** -69 / -92 / 23 dB

**firmware version** 0.4.2  
**configuration** mesh

**system time** Sat Jan 1 2000  
00:01:57 UTC

**uptime** 1 min  
**load average** 0.14, 0.11, 0.04

**free space** flash = 688 KB  
/tmp = 7064 KB  
memory = 2472 KB



# Mesh Status

My Portable  
Station

My QTH Station

## K7GJT-200 mesh status

Refresh

Auto

Quit

**Local Hosts**

**Services**

**Current Neighbors**

**LQ**

**Services**

K7GJT-200

[K7GJT-100](#)

94%

**Remote Nodes**

**ETX**

**Services**

**Previous Neighbors**

**When**

none

none

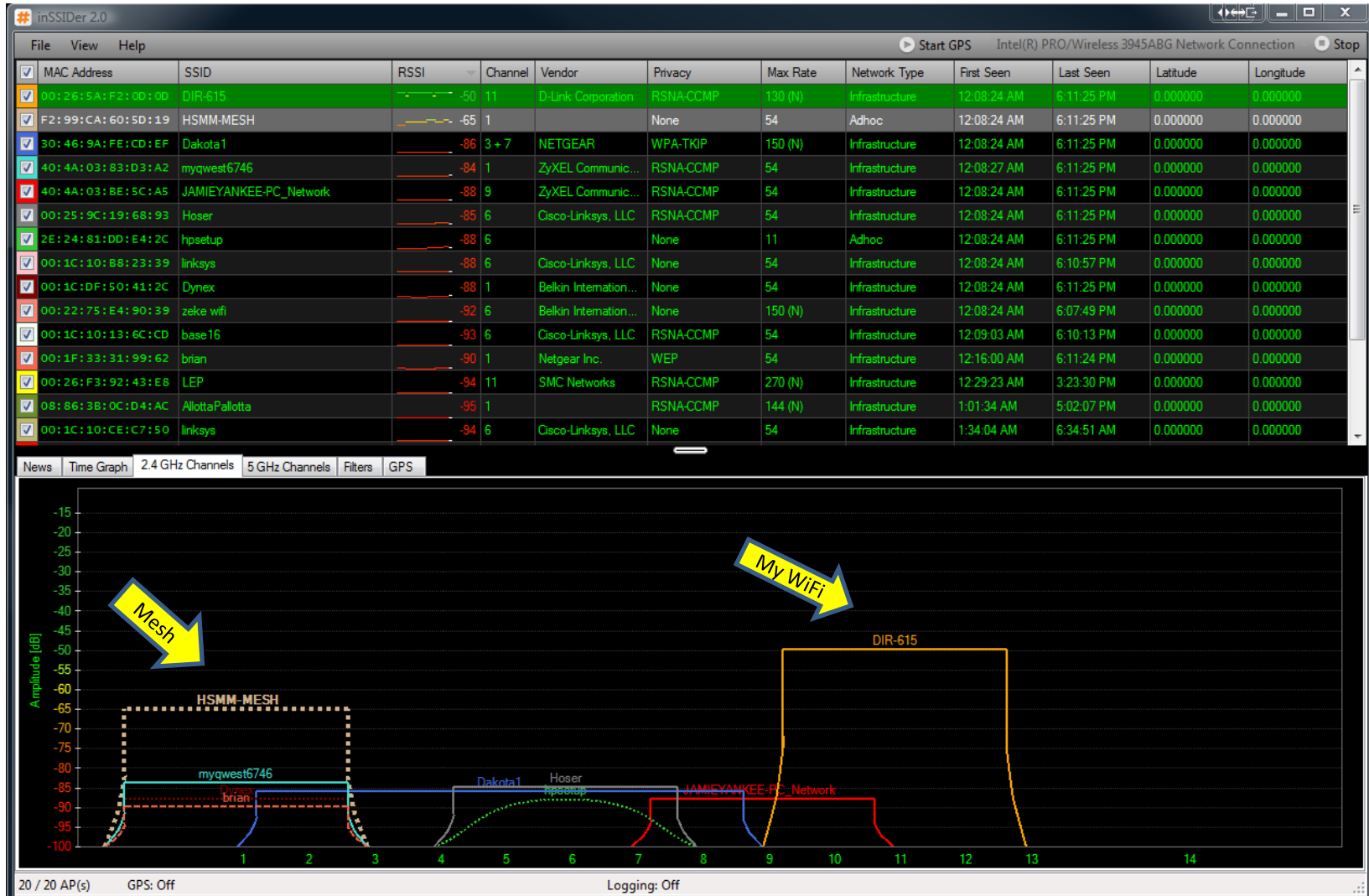
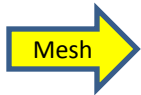
# WiFi Scan

## K7GJT-200 WiFi scan

Sig	Chan	Enc	SSID	MAC	Vendor
-64	1		HSMM-MESH	F299CA:605D19	Ad-Hoc
-69	2	*	DIR-615	00265A:F20D0D	D-Link
-75	5	*	Dakota1	30469A:FECDEF	Netgear
-81	9	*	JAMIEYANKEE-PC_Network	404A03:BE5CA5	Zyxel
-87	6		hpsetup	2E25B3:895D76	Ad-Hoc

My Home Network

# After moving my WiFi to CH 11



# The 'Night Mode' Display

**K7GJT-200**

[Help](#) Refresh Mesh Status OLSR Status WiFi Scan Setup  Night Mode

<b>WiFi address</b>	10.51.227.226 / 8 fe80::213:10ff:fe33:e3e2 Link	<b>Signal/Noise/Ratio</b>	-66 / -94 / 28 dB	<input type="button" value="Auto"/>
<b>LAN address</b>	172.27.0.1 / 24 fe80::213:10ff:fe33:e3e0 Link	<b>firmware version</b>	0.4.2	
<b>WAN address</b>	none fe80::213:10ff:fe33:e3e0 Link	<b>configuration</b>	mesh	
<b>default gateway</b>	none	<b>system time</b>	Sat Jan 1 2000 00:03:00 UTC	
<b>your address</b>	172.27.0.5	<b>uptime</b>	3 min	
		<b>load average</b>	0.16, 0.12, 0.04	
		<b>free space</b>	flash = 688 KB /tmp = 7064 KB memory = 2464 KB	

# What about Power?

- WRT54G wireless router needs 12VDC @ 1A
- AC Power Supply
- Battery
- Solar
- PoE (“Power over Ethernet”)
  - *When powering PoE devices there are two modes available, A and B. Mode A delivers phantom power on the data pairs of 100BASE-TX or 10BASE-T while Mode B delivers power on the spare pairs.*
  - Commercial PoE devices

# Typical Commercial PoE device

**TP-LINK®**

Power over Ethernet Adapter Kit  
TL-POE200

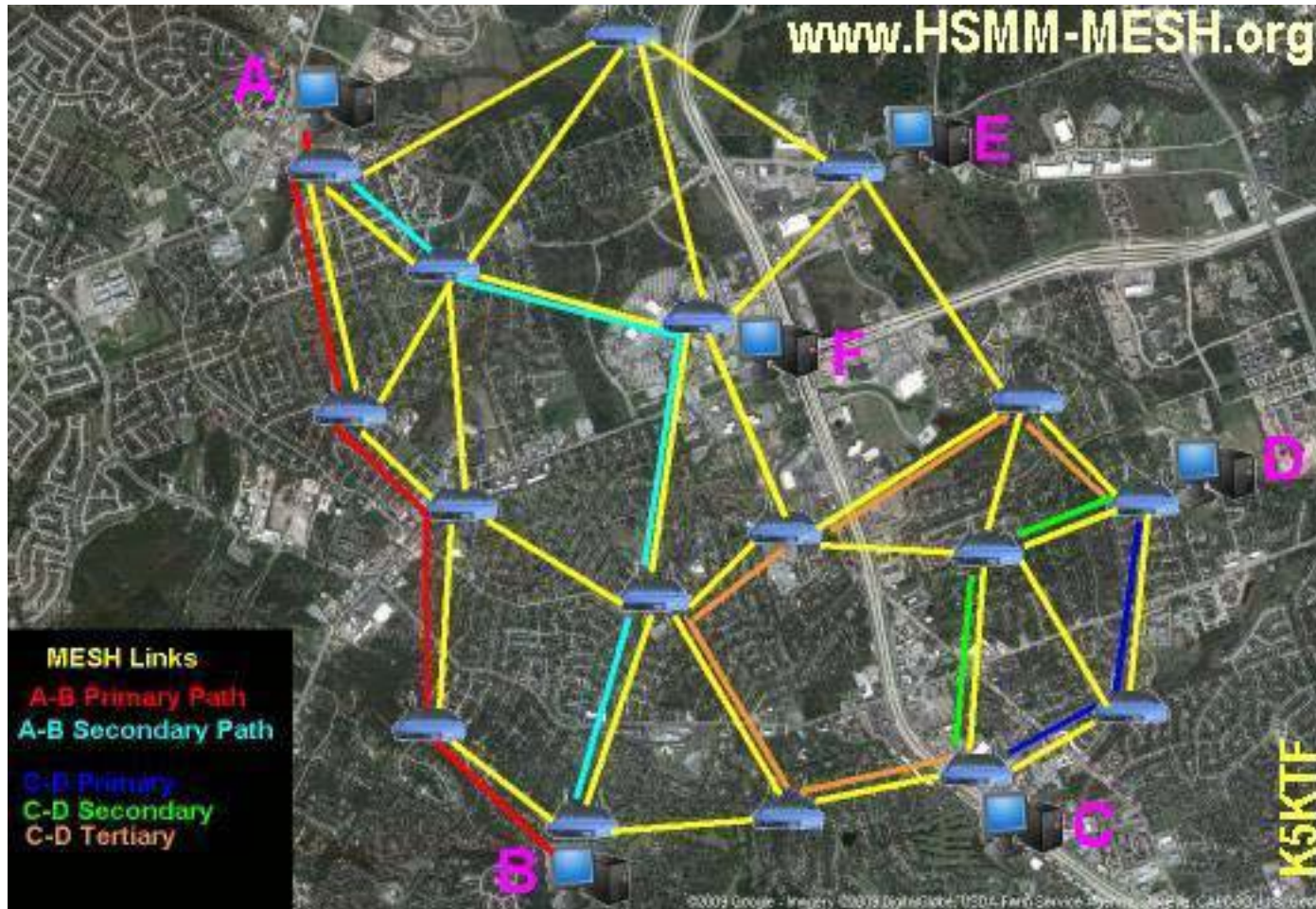


Voltage Output	DC 5V, 9V or 12V
Output Power	12V/1A, 9V/1.2A, 5V/2.3A

# The Topology

- “Nodes”
- “Clients”
- “Internet Gateways”

# The Topology



# The Range (*in TX*)

- With a node and 24dBi dish on each end:
  - 6 miles across South Austin between 2 parking garages-100% Link Quality.
- Secondary test: 1 dish + 1/2w Bi-directional Amp, and stock 3.5dBi rubber duckies on other end !
- With a dish and a small yagi: 10 miles from central Austin to South Austin
- Trees and structures present challenges

# What can we do with it?

- Connect two or more devices...
  - Computers (s)
  - Webcam(s)
  - VoIP phone(s)
  - Server(s)
  - Anything that 'talks' over a computer network
- An internet connection to *one node provides* the entire HSMM-Mesh network with internet access

# What is OLSR?

- The *olsr.org OLSR daemon* is an implementation of the [Optimized Link State Routing protocol](#).
- As such it allows **mesh routing** for any network equipment.
- It runs on any WiFi card that supports ad-hoc mode and of course on any Ethernet device.
- OLSR is next to [AODV](#) (*Ad hoc On-Demand Distance Vector (AODV) Routing - Nokia*) one of the main two internet standards for mesh networks.
- It is widely used and well tested.

# What's a *Daemon*?

- The term was coined by the programmers of [MIT's Project MAC](#).
- They took the name from [Maxwell's demon](#), an imaginary being from a famous thought experiment that constantly works in the background, sorting molecules.
- [Unix](#) systems inherited this terminology.
- [Daemons](#) are also characters in Greek mythology, some of whom handled tasks that the gods could not be bothered with.

# OLSR Protocol use

The OLSR protocol is used to route traffic between all nodes that can see at least one other node, thereby forming a mesh network and allowing all nodes to communicate with each other if a path exists between them

# Client Software

- 'Windows Explorer' for file transfer
- 'Filezilla' (less 'overhead')
- Video
- Voice over IP (VoIP)
  
- Whatever works across a WiFi net!!

# My thoughts on a local 'Strategy'

- Use the [www.hsmm-mesh.org](http://www.hsmm-mesh.org) website for critical files and information
- Coordinate and Document locally
  - Using new “[CC-HSMM-Mesh](#)” Yahoo! Group
- Help each other where ever possible
- Build the mesh
  - Opened to any licensed ham in Clark County (1600!)
  - Promote to any/all ham radio groups (CCARC ~300!)
- Identify the potential users
  - CCARES/RACES
  - Medical
  - Etc.

# HSMM-Mesh on a van



# A Typical Portable Omni- directional Node



# A Typical Portable Uni- directional Node

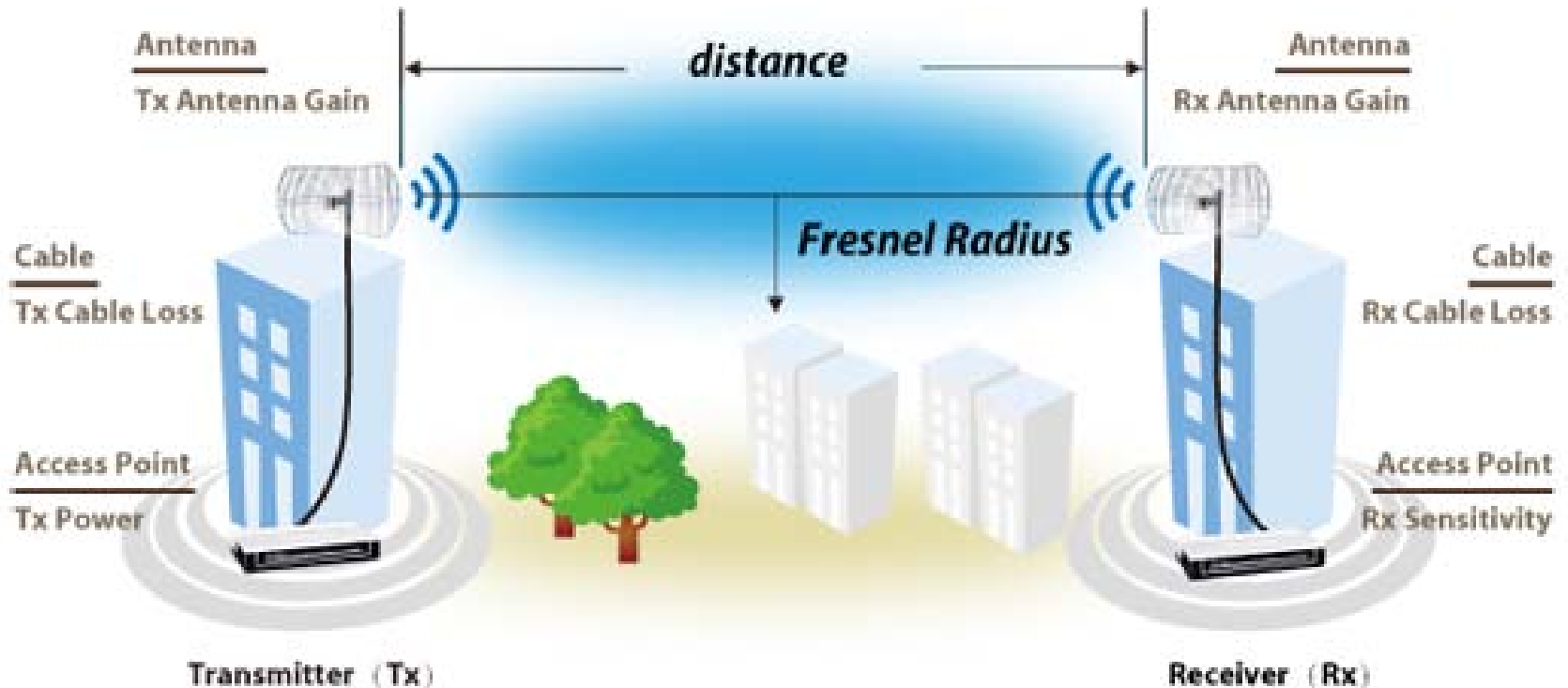




# HSMM-Mesh in a Backpack



# What about Distance?



<http://www.tp-link.com/en/support/calculator/>

# Ant = 2x24Dbi & Cable Length = 0

Signal Rate(bps)	Distance(km)	Distance(mile)	60% Fresnel Zone Radius(m)
<b>IEEE 802.11b</b>			
1M	59.566	37.229	25.886
2M	37.584	23.49	20.562
5.5M	34.277	21.423	19.636
11M	30.903	19.314	18.645
<b>IEEE 802.11g</b>			
6M	35.481	22.176	19.979
9M	33.497	20.936	19.412
12M	31.623	19.764	18.861
18M	25.119	15.699	16.81
24M	18.836	11.772	14.557
36M	10	6.25	10.606
48M	5.495	3.434	7.863
54M	4.169	2.606	6.848

# Ant = 2x24Dbi & Cable Length = 2x3M



Signal Rate(bps)	Distance(km)	Distance(mile)	60% Fresnel Zone Radius(m)
<b>IEEE 802.11b</b>			
1M	35.892	22.433	20.094
2M	22.646	14.154	15.961
5.5M	20.654	12.909	15.243
11M	18.621	11.638	14.473
<b>IEEE 802.11g</b>			
6M	21.38	13.362	15.508
9M	20.184	12.615	15.068
12M	19.055	11.909	14.641
18M	15.136	9.46	13.049
24M	11.35	7.094	11.3
36M	6.026	3.766	8.233
48M	3.311	2.069	6.103
54M	2.512	1.57	5.316

# Ant = 2x15Dbi & Cable Length = 2x3M



Signal Rate(bps)	Distance(km)	Distance(mile)	60% Fresnel Zone Radius(m)
<b>IEEE 802.11b</b>			
1M	4.519	2.824	7.13
2M	2.851	1.782	5.663
5.5M	2.6	1.625	5.408
11M	2.344	1.465	5.135
<b>IEEE 802.11g</b>			
6M	2.692	1.683	5.503
9M	2.541	1.588	5.346
12M	2.399	1.499	5.195
18M	1.905	1.191	4.63
24M	1.429	0.893	4.009
36M	0.759	0.474	2.921
48M	0.417	0.261	2.166
54M	0.316	0.198	1.886

# Learn more about it at:

- [www.HSMM-MESH.org](http://www.HSMM-MESH.org)

## User Documentation

Title Filter

Display #  ▼

#	Article Title	Author
1	<a href="#">Using a Rootenna enclosure</a>	Rick Kirchhof, NG5V
2	<a href="#">HSMM-MESH and Digital Encryption</a>	Jim Kinter, K5KTF
3	<a href="#">Using the MESH (aka Examples how to move stuff over the mesh)</a>	Jim Kinter, K5KTF
4	<a href="#">HSMM-MESH Design Philosophy</a>	David Rivenburg, AD500
5	<a href="#">Firmware Installation Instructions</a>	David Rivenburg, AD500
6	<a href="#">Firmware Change Log</a>	David Rivenburg, AD500
7	<a href="#">What is a mesh node?</a>	David Rivenburg, AD500
8	<a href="#">How to use the web interface</a>	David Rivenburg, AD500
9	<a href="#">Using Failsafe Mode to reset a forgotten password</a>	David Rivenburg, AD500

<http://wiki.openwrt.org/>

Router Linux firmware site



## Who's Online

We have 10 guests and 1 member online

- K7GJT

### Main Menu

- Home
- Web Links
- HSMM-MESH™ Forums
- Just starting? Read this

### Resources

- Administrator access
- Contact the Webmaster
- Active Mesh Nodes
- Which hardware to use
- Software Download

### HSMM-MESH Info

- Under Development
- User Documentation
- Developer Documentation
- FAQ
- HSMM files
- Learn about OLSR
- Learn about Open WRT
- Learn about WRT54G
- Learn about WRT54GL

## HSMM-MESH

### New firmware released, click NEWS above



### First time visitor?



If you are new to the web site, take a moment to learn a bit about [how our firmware works](#).

Last Updated on Sunday, 07 August 2011 10:21

### Welcome to the HSMM-MESH™ web site



Written by Jim Kinter, K5KTF

Monday, 18 January 2010 23:34

Here we will try to enlighten and educate you all about the High Speed Multimedia MESH network HSMM-MESH™ currently being designed, developed and deployed as an amateur radio broadband communications system. It is being used in and around Austin, and Plano Texas, as well as other sites.

Glenn KD5MFW, David AD5OO, Bob WB5AOH and Rick NG5V are the

Last Updated on Sunday, 19 June 2011 10:14

[Read more... >>](#)

### General Disclaimer



Written by David Rivenburg, AD5OO

Saturday, 13 February 2010 14:18

In order to gain benefit from this system you must be fluent in TCP/IP networking or be a highly motivated self-starter who can independently acquire that fluency. At this stage there are

Last Updated on Sunday, 19 June 2011 10:12

[Read more... >>](#)

# Credits....!

Jim K5KTF

[Jim@k5ktf.com](mailto:Jim@k5ktf.com)

Glenn Currie KD5MFW

[kd5mfw@arrl.net](mailto:kd5mfw@arrl.net)

John Champa, K8OCL  
Silent Key, Oct 2010  
Original ARRL HSMM  
Working Group Leader

# ARRL QST & QEX Articles

- QEX Jan 2011 (Pg. 2) – HSMM Losses\*
- QST Nov 2006 (Pg. 96) – Non-traditional Field Day? You Bet! (HSMM)
- QEX Jan 2005 (Pg. 61) – HSMM Radio Equipment (Nov/Dec 2004) \*
- QEX Nov 2004 (Pg 3) – HSMM Radio Equipment \*
- QST Dec 2004 (Pg 21) – Bit bucket aids HSMM experiment
- QST Apr 2003 (Pg 28) – High Speed Multimedia Radio
- QST Apr 2003 (Pg 31) – Using APRS to Locate Amateur HSMM Stations
- QST May 2003 (Pg 24) – More on HSMM Radio

\* indicates article is not available for download

# Other Websites found to date...

- <http://www.n5oom.org/hsmm/>
- <http://www.mark-rodgers.com/hsmm-mesh-demo>
- <http://www.w5adc.com/HSMM.htm>
- <https://www.slvarc.org/all-articles/85-hsmm-mesh-my-first-experience>
- <http://ncocra.org/hsmm.html>
- <http://hsmm.info>

**“Several mesh nodes  
+  
one experienced ham operator  
=  
a portable, quick deployment,  
Swiss army knife of network services”**

# Questions?



Gary – [K7GJT@arrl.net](mailto:K7GJT@arrl.net)