Introduction to Mesh Networking

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About Doug

Technician class in 1973

Repeater Committee for BARC in '70s

198? General class

Early Internet work at Ballistics Research Lab

2004 Advanced class 2004

Lots of IT infrastructure, networks to services

2011 Moved to Seattle

2012 - Discover MESH and PSRG!

Why Mesh? Why Now?

Our lives now revolve around data sharing

Amateurs need capable data infrastructure

Available equipment and software
Easily integrated
Easily modified and adapted

History

October 2003 - First RFC

2004 - Open source implementation

2007 - NRL release and olsrd-ng initiated

HSMM-MESH - Austin & Plano Texas

Various community networks across the world

2012 - NW-MESH initiated

Network Layers

OSI Model			
	Data unit	Layer	Function
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5. Session	Interhost communication, managing sessions between applications
	Segments	4. Transport	End-to-end connections, reliability and flow control (TCP, UDP, ICMP)
Media layers	Packet/Datagram	3. Network	Path determination and logical addressing (IP, Routing)
	Frame	2. Data link	Physical addressing
	Bit	1. Physical	Media, signal and binary transmission

Mesh networking operates in the bottom 3 layers, particularly layer 3 - its all about *routing*
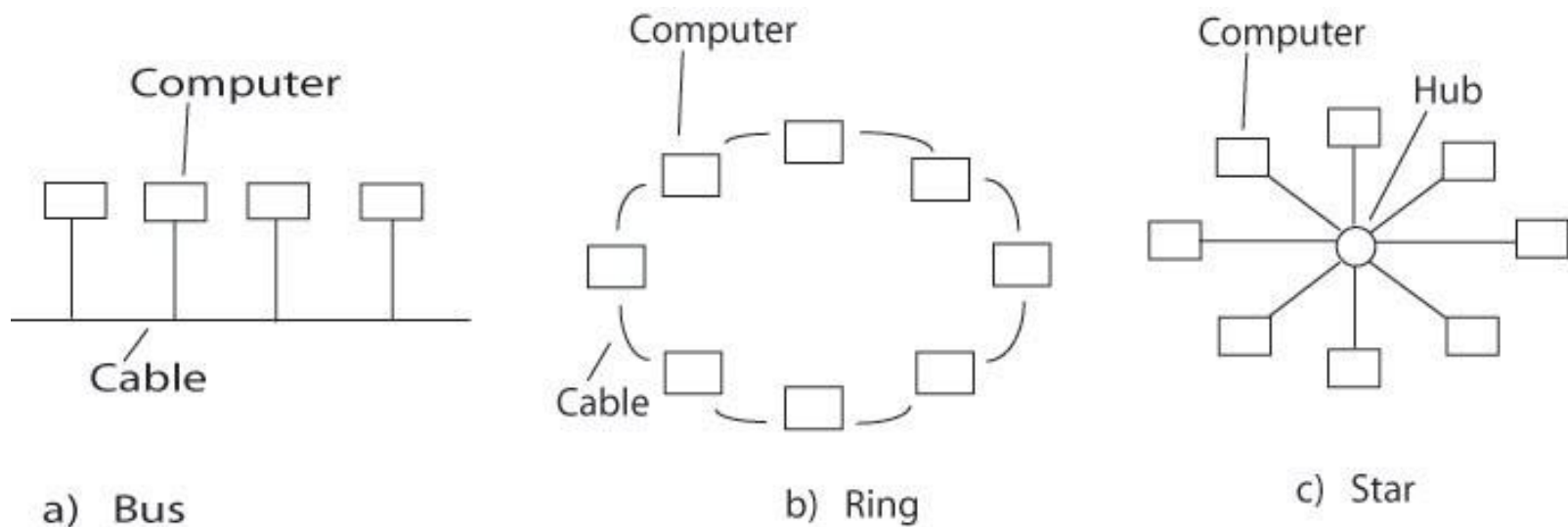
Basic Topologies
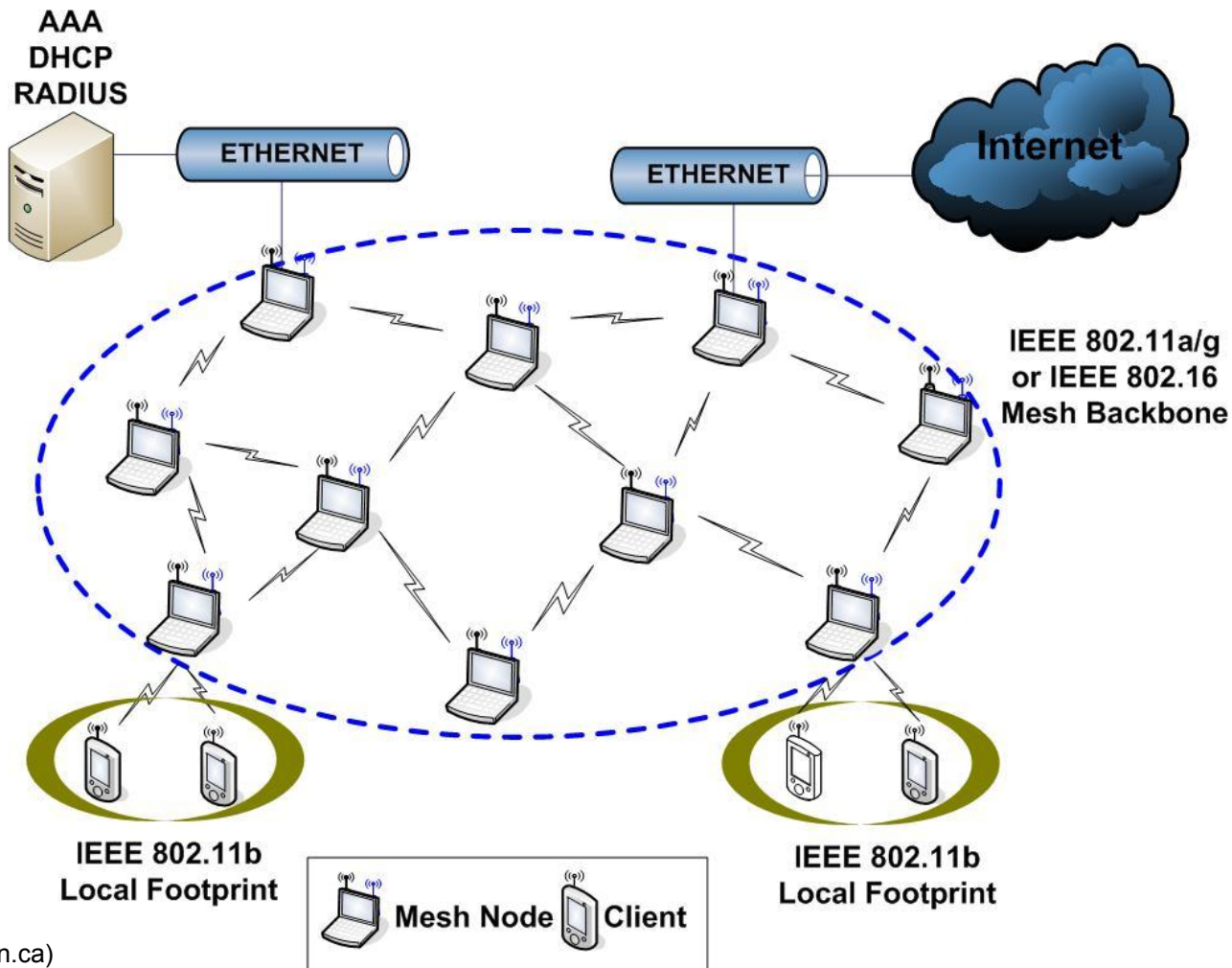
Universal access at link layer

Figure: Topologies commonly used in LANs.

Mesh Topology

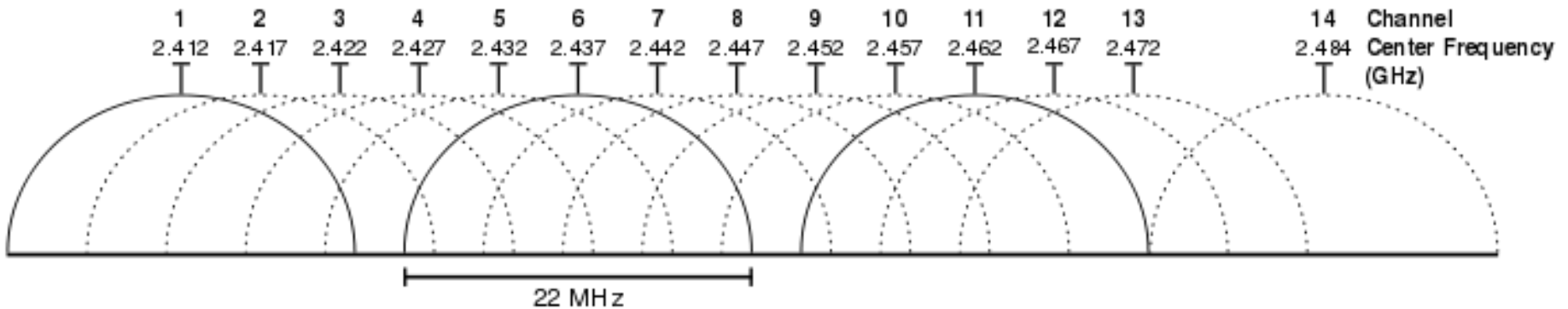(kunz-pc.sce.carleton.ca)

Mesh and WiFi

Frequencies overlap w/Part 15 and 97

- 2.4 Ghz (2390-2450 MHz)
- 5 Ghz   (5650-5925 MHz)

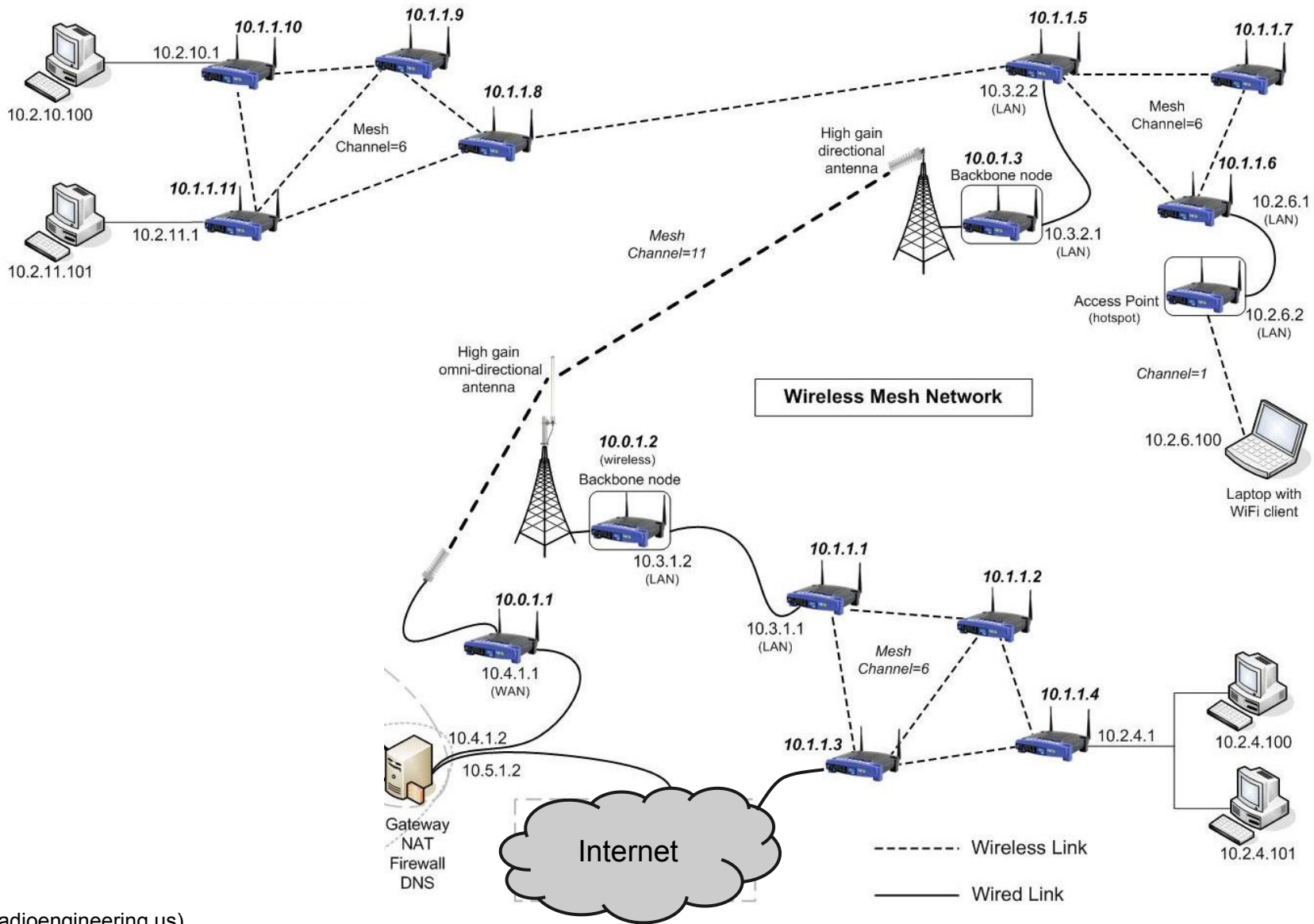Designed for mobile or unreliable nodes

Re-purposing WiFi Access Point equipment

- Standards based
- Open Source Platforms (Linux, OpenWRT)
- Useable Bandwidth
- Cheap

US WiFi allocation is 2402-2473 MHz
US Amateur allocation is 2390-2450 MHz

2.4GHz WiFI Channel Layout

10.2.10.100

10.2.10.1
10.1.1.10
10.1.1.9
10.1.1.5
10.1.1.7

10.3.2.2
(LAN)

Mesh
Channel=6

10.1.1.8

Mesh
Channel=6

10.1.1.11
10.2.11.1

10.2.11.101

High gain
directional
antenna

10.0.1.3
Backbone node

10.3.2.1
(LAN)

10.1.1.6

10.2.6.1
(LAN)

Mesh
Channel=11

Access Point
(hotspot)

10.2.6.2
(LAN)

Channel=1

High gain
omni-directional
antenna

Wireless Mesh Network

10.2.6.100

Laptop with
WiFi client

10.0.1.2
(wireless)
Backbone node

10.3.1.2
(LAN)

10.1.1.1

10.1.1.2

10.0.1.1

10.3.1.1
(LAN)

Mesh
Channel=6

10.4.1.1
(WAN)

10.1.1.4

10.2.4.1

10.2.4.100

10.4.1.2

10.5.1.2

10.1.1.3

Gateway
NAT
Firewall
DNS

Internet

10.2.4.101

------ Wireless Link

——— Wired Link

(www.radioengineering.us)

A complex mesh network

Network addresses

An IPv4 address (dotted-decimal notation)

172 . **16** . **254** . **1**

⬇ ⬇ ⬇ ⬇

10101100.00010000.11111110.00000001

One byte = Eight bits

Thirty-two bits (4 * 8), or 4 bytes

'Local Network' Addresses

Local Network Addresses (not routable)

10.x.y.z	16M addresses
172.16.x.y - 172.31.x.y	1M addresses
192.168.x.y	64K addresses

Reserved by IANA for local use (RFC1918)

Mesh Network Addressing

- Auto Assignment using MAC address
  - Take MAC address: 00:1b:63:9e:81:1b
  - Convert hex to decimal: 158, 129, 27
  - Address is 10.158.129.27
  - Pray for no duplicates (probably safe)

- Manual Assignment
  - Goto a registry and request a number of addresses
  - Assignments: nw-mesh@yahoogroups.com
  - E.g. 10.255.254.232/29 (232-239, 8 hosts)
  - Larger blocks available if needed

Mesh Routing - OLSR

OLSR - Optimized Link State Routing Protocol
- Designed for ad-hoc mobile networks
- Uses algorithms to minimize routing updates
- Actively manages host routing table
- RFC 3626 or read the Wikipedia article
- Demo of MPR flooding (Flash) and PDF

OLSR Terminology

Main Address

Neighbor Node
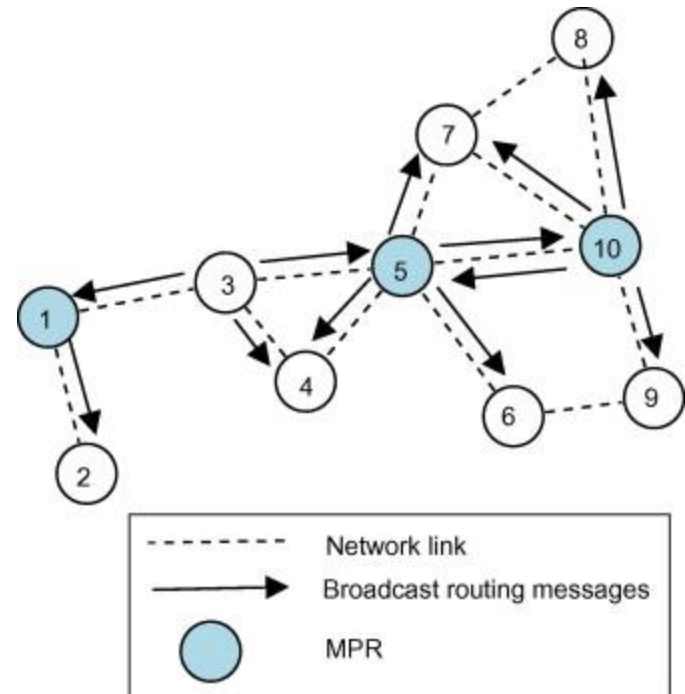
1 hop neighbors

2 hop neighbors

Multipoint Relays (1 or more)

Multipoint Relay Selector

Network link

Broadcast routing messages

MPR

(www.sciencedirect.com)

Radio propagation issues

Water is our enemy (fog, rain, trees!)

Line of sight

Power is limited

Potential radiation hazard (this is microwave)

Services

Chat

VOIP

File Transfer

Image Transfer

Websites

File Repository

Telemetry

Remote management

State of the Mesh

2.4GHz Channel: 1 (2412MHz)

2.4GHz SSID: NW-MESH-2412

   Use of the frequency in the frequency prevents "channel hopping". If using a different channel, change the frequency to match the channel.

New Backfire build for WRT54G's:
http://mesh.randomnotes.org

Open Questions

What band(s) to use?

What channels to use?

What protocol to use? (OLSR is not the only game in town!)

What services do we need?

Making services as reliable as network

Independence vs. Centralized Services

Getting Involved

- Join Yahoo! group NW-MESH
- Look for the next MESH workshop
- Start looking for good locations

Local Activists

These guys have been a great help to me:

Brian Heaton - KY9K

Steve Monsey - N0FPF

Bill Vodall - WA7NWP

Gerard Hickey - WT0F

Rob Martin - AE7EG

Wrap-up

Exciting Times for Amateur Radio

- Mesh data networks
- New Digital Modes (e.g. DSTAR)
- NBFM

Lots of evolving technologies

Protocol standards under active development

Much of this is still an experiment

Now's the time to join the party!

Questions

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Resources:

http://olsr.org

http://hsmm-mesh.org

Wikipedia: olsr, mesh networking

http://groups.yahoo.com/group/NW-MESH