



IEEE 802.11 Overview and Meshed Networking

ELEC6076 Computer Networks

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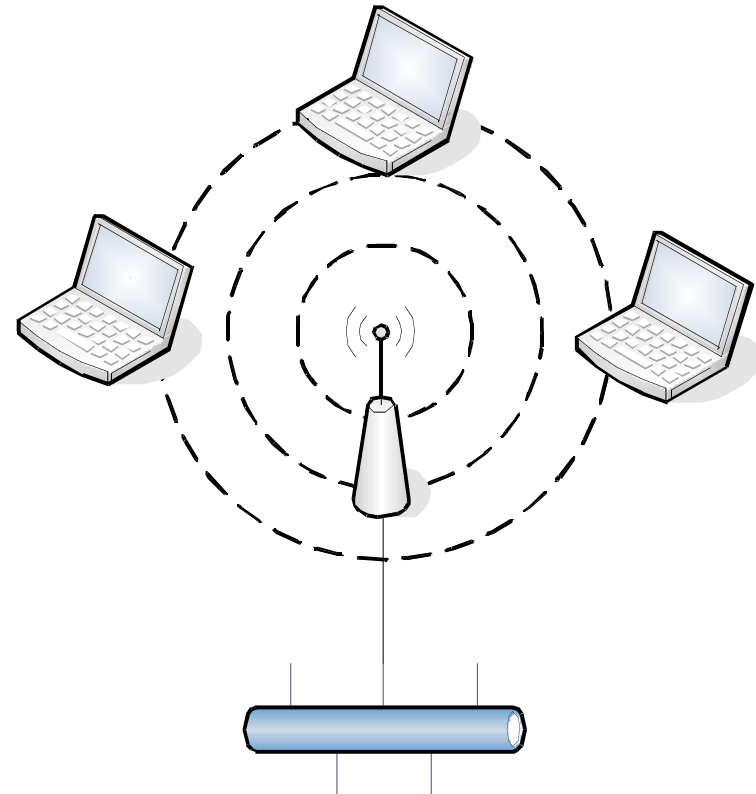


Overview

- IEEE 802.11
- 802.11b features and architecture
- The hidden node problem
- Issues with TCP over wireless
- Wireless security
- Meshed Networking Approaches and Issues

Wireless Networking (Wi-Fi)

- Data Link Layer (Layer 2) over radio frequencies
- Many standards
- Notably IEEE 802.11



Application Layer (e.g. HTTP, DNS)
Transport Layer (e.g. TCP, UDP)
Network Layer (e.g. IP, IPv6)
Data Link Layer (e.g. Ethernet, 802.11)



IEEE 802.11

- IEEE 802 – committee on LAN/MAN standards
- IEEE 802.11 – WG on Wireless LAN
- Network protocols
 - 802.11a, 802.11b, 802.11g
- Enhancements
 - 802.11i, 802.11e
- New work
 - 802.11n, ...

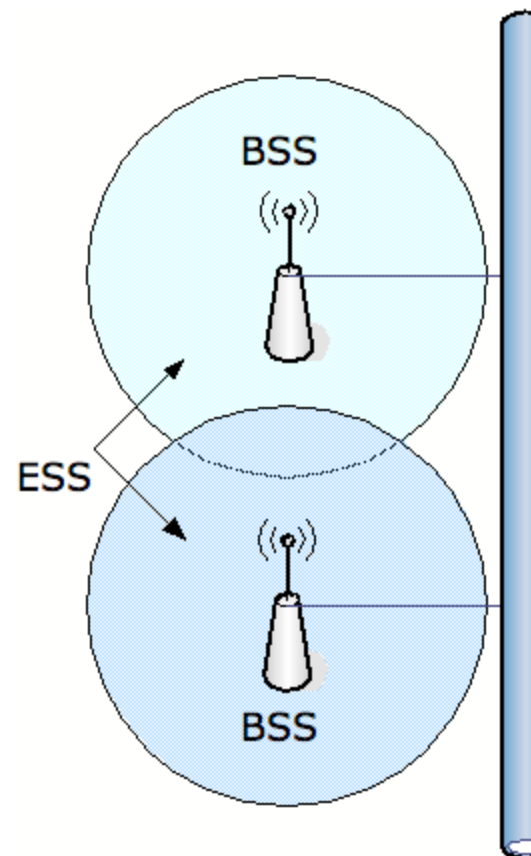


802.11b Key Features

- Speeds up to 11Mb/s
 - Scales down to 5.5Mb/s, 2Mb/s, 1Mb/s
 - About half speed taken with overhead
- Uses 13 × 22MHz channels within the IMS (2.4GHz) band in UK
- Omnidirectional range of ~50m
 - Directional, high-gain antennas can transmit over several km
- DSSS, CSMA/CA

802.11 Architecture

- BSS – Base Service Set
 - One cell from one access point
- ESS – Extended Service Set
 - Network of cells
 - Common ESSID
 - Cells linked by DS: Ethernet or wireless (WDS)



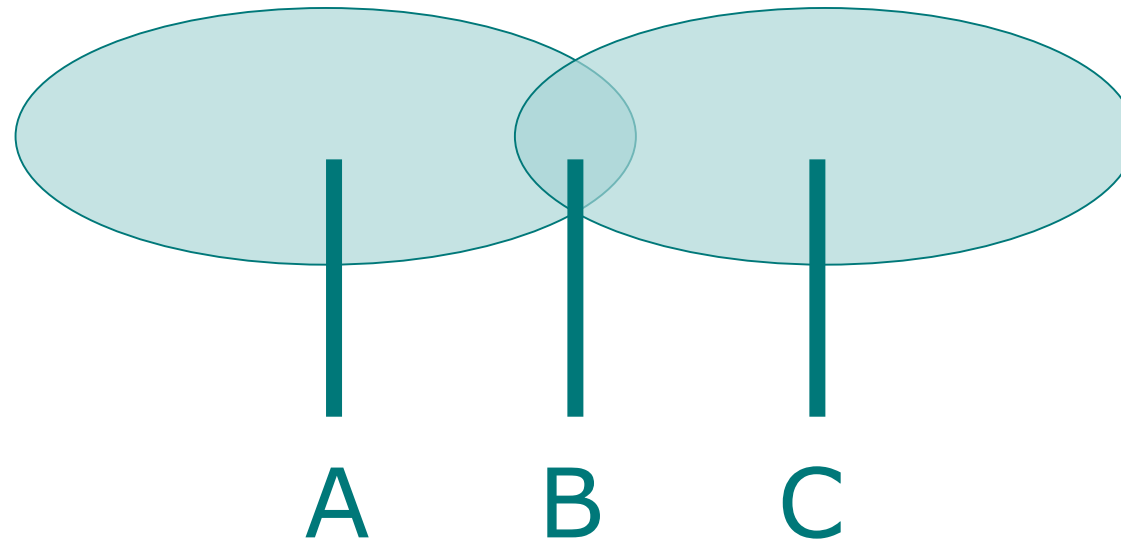


802.11b Layers

- Physical Layer
 - e.g DSSS for 802.11b
- Data Link Layer
 - Media Access Control – CSMA/CA
 - Logical Link Control – 802.2 standard

e.g. HTTP, DNS, SMTP	<i>Application Layer</i>
e.g. TCP, UDP	<i>Transport Layer</i>
e.g. IP, IPv6	<i>Network Layer</i>
802.2 LLC	<i>Data Link Layer</i>
802.11 MAC	
DSSS over RF	<i>Physical Layer</i>

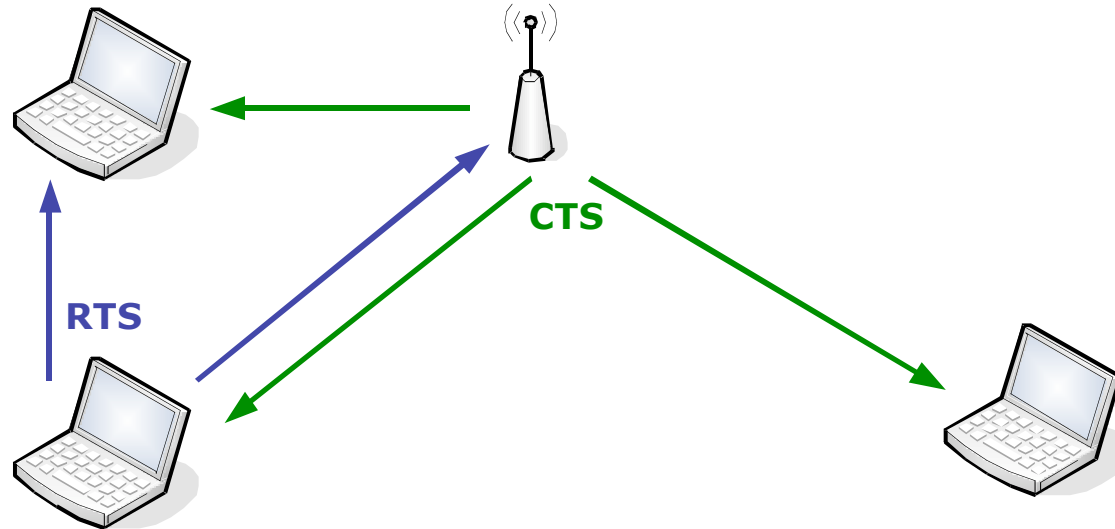
Hidden Node Problem



- A and C cannot see each other, B can see both

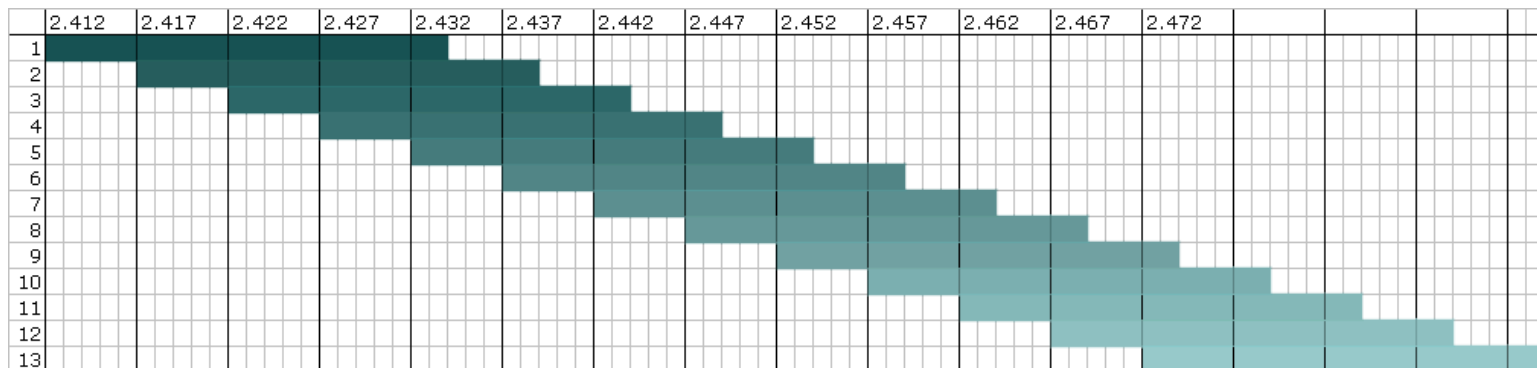
CSMA/CA

- Sender sends *Request to Send* (RTS)
- Receiver sends *Clear to Send* (CTS)
- Sender transmits for required time



802.11b Channels

- In the UK and most of EU: 13 channels, 5MHz apart, 2.412 – 2.472 GHz
- Each channel is 22MHz
- Significant overlap
- Best channels are 1, 6 and 11





TCP Over Wireless

- Wireless unreliable, prone to errors
- TCP will begin a slow start on errors
 - Designed to find optimum window size
 - Inefficient for wireless
- Improvements
 - Adding a threshold
 - TCP Reno – fall back to threshold
- Retransmission Timer
 - Doubles on every retransmission

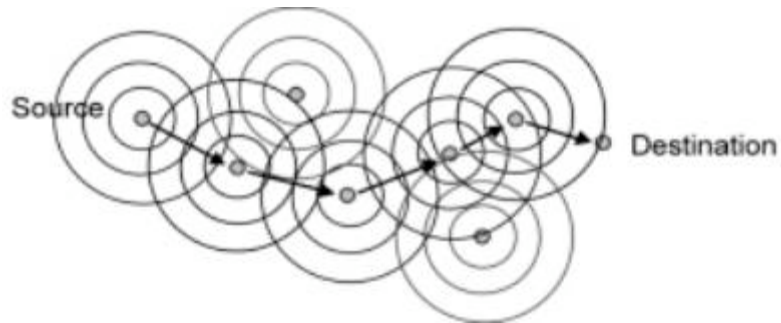


Security in 802.11b

- WEP
 - *Wired Equivalent Privacy*
 - RC4 and CRC32
 - Known vulnerabilities
- WPA
 - *Wi-fi Protected Access*
 - Larger, dynamically changed keys
- 802.1x
 - Port-based authentication
- 802.11i (WPA2)
 - Builds on WPA
 - AES (Rijndael)

Meshed Networking

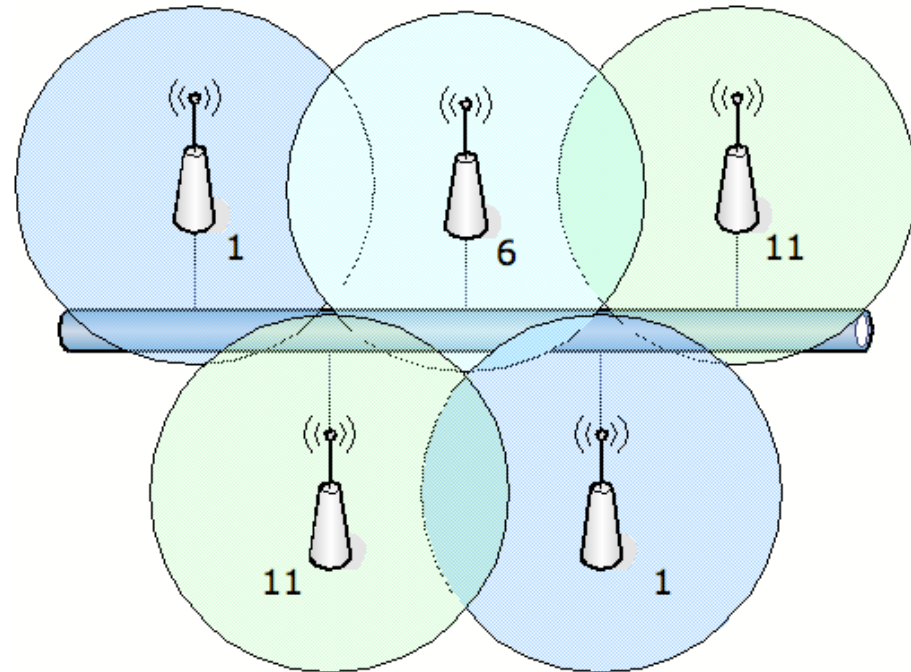
- Decentralised infrastructure
- Network of interconnected access points
- Peer-to-peer routing, often redundant



Source: Wi-fi technology forum

What's *not* a Mesh?

- The ECS Wireless LAN
- Multiple APs
- Different channels
- Same wired subnet



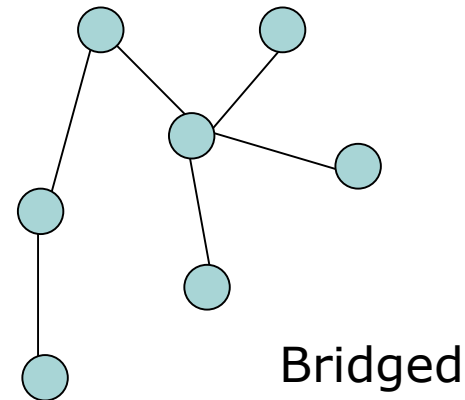
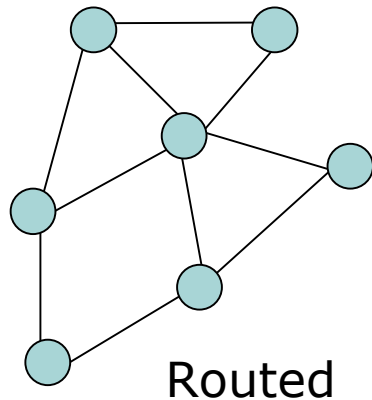


Mesh Approaches

- Ad-Hoc
 - No base station, all hosts are APs
 - Link-local between devices
- Bridging
 - Multiple APs, same subnet
- Routing
 - Multiple APs, multiple subnets
 - WDS links between nodes

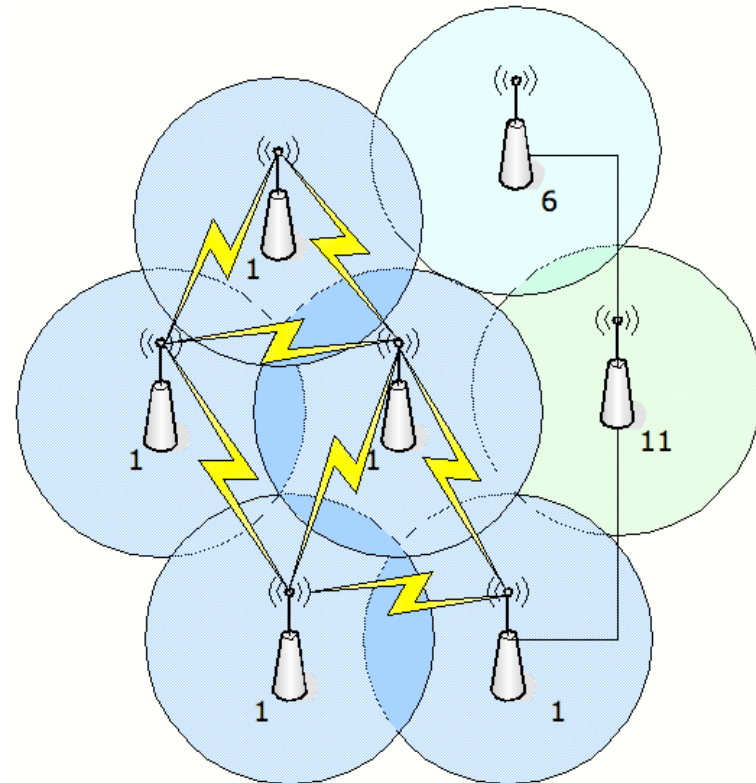
Bridging vs Routing

- Bridging gives one large subnet
- Routing permits multiple paths and external links, reduces bottlenecks
- Bridging permits easy mobility



Routed Mesh Networks

- WDS
 - Wireless Distribution System
 - Wireless links between APs, as opposed to wired.
 - All are on same channel.
- OSPF
 - Shortest path routing protocol



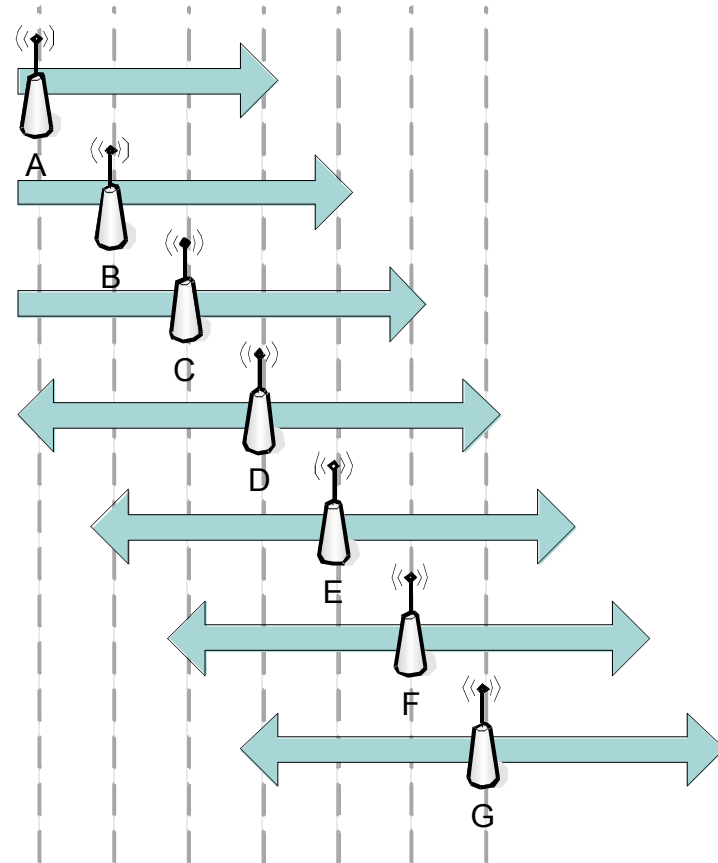


Mesh Issues

- Scale
 - Bridging does not scale well
 - Single-channel WDS does not scale well
- Distances
 - 1km+ distances are possible...
 - ...signal degrades, more users
- Congestion
 - Leads to decreasing performance
 - Colliding channels, hidden node

Mesh Throughput Degradation

- All meshed APs on same channel
- Data sent from A to G
- A – B, full throughput
- B – C, $\frac{1}{2}$ throughput
- C – D, $\frac{1}{4}$ throughput
- D – E, $\frac{1}{8}$ throughput
- A now out of range...
- E – F, $\frac{1}{8}$ throughput
- F – G, $\frac{1}{8}$ throughput



Source: Wi-fi net news posting



SOWN – A Real Mesh Network?

- For a time was a small mesh
 - Oakhurst Road to ECS via SUSU
- OSPF routing using Linux nodes
- Performance degrades very quickly
- Hidden node problems
- Backbone as a possible future solution
- Now just using point-to-point links
- Now going infrastructure-based
- Security implications



Summary

- Wireless networking is heavily in development
- 802.11b works on a small scale
- TCP not designed for wireless use
- Security flaws being addressed
- Many issues with meshing
- Large scale solutions are still to come



References

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- RFC2001
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