

JARINGAN KOMPUTER 2

WIRELESS LAN

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Course Outline

- Introduction of Wireless Network
- IEEE 802.11 Architecture
- IEEE 802.11 Physical Layer
- Data Encryption Wireless
- Site Survey

Wireless?

- A wireless LAN or WLAN is a wireless local area network that uses radio waves as its carrier.
- The last link with the users is wireless, to give a network connection to all users in a building or campus.
- The backbone network usually uses cables

How do wireless LANs work?

Wireless LANs operate in almost the same way as wired LANs, using the same networking protocols and supporting the most of the same applications.

How are WLANs Different?

- They use specialized **physical and data link** protocols
- They integrate into existing networks through **access points** which provide a bridging function
- They let you stay connected as you **roam** from one coverage area to another
- They have unique **security** considerations
- They have specific **interoperability** requirements
- They require **different hardware**
- They offer **performance** that differs from wired LANs.

Physical and Data Link Layers

Physical Layer:

- The wireless **NIC** takes **frames** of data from the link layer, scrambles the data in a predetermined way, then uses the modified data stream to modulate a **radio carrier signal**.

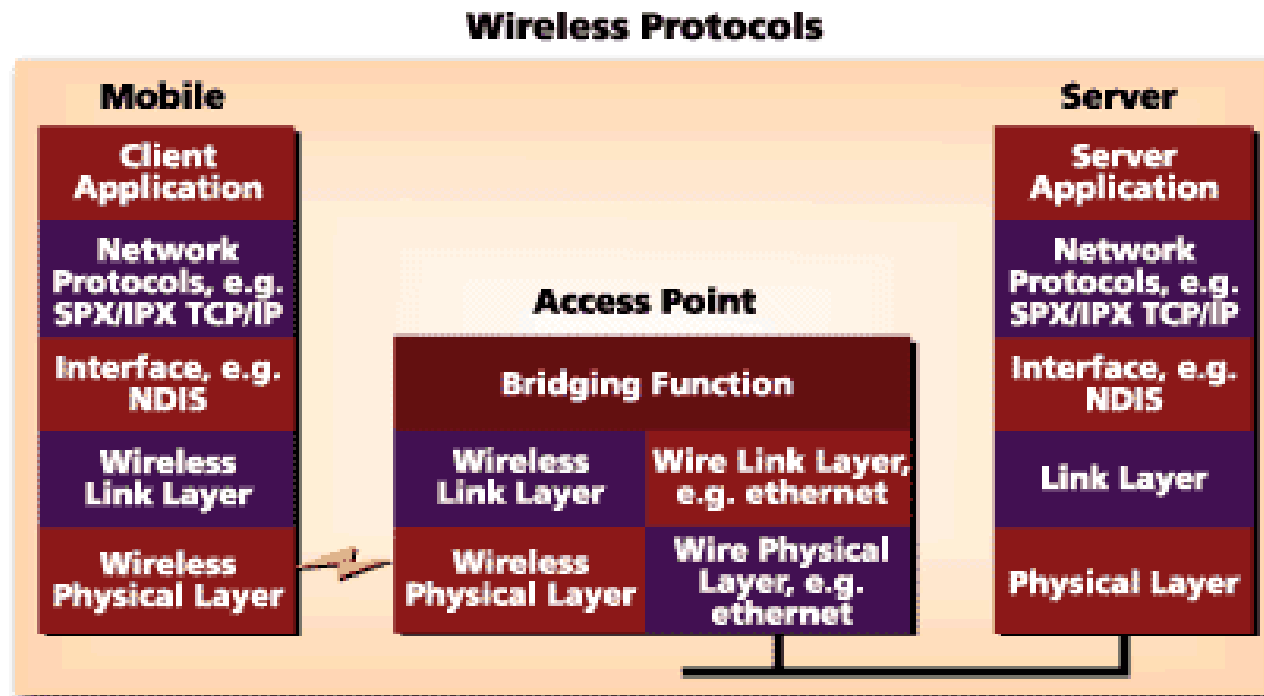
Data Link Layer:

- Uses **Carriers-Sense-Multiple-Access with Collision Avoidance (CSMA/CA)**.

Integration With Existing Networks

- Wireless Access Points (APs) - a small device that bridges wireless traffic to your network.
- Most access points bridge wireless LANs into Ethernet networks.

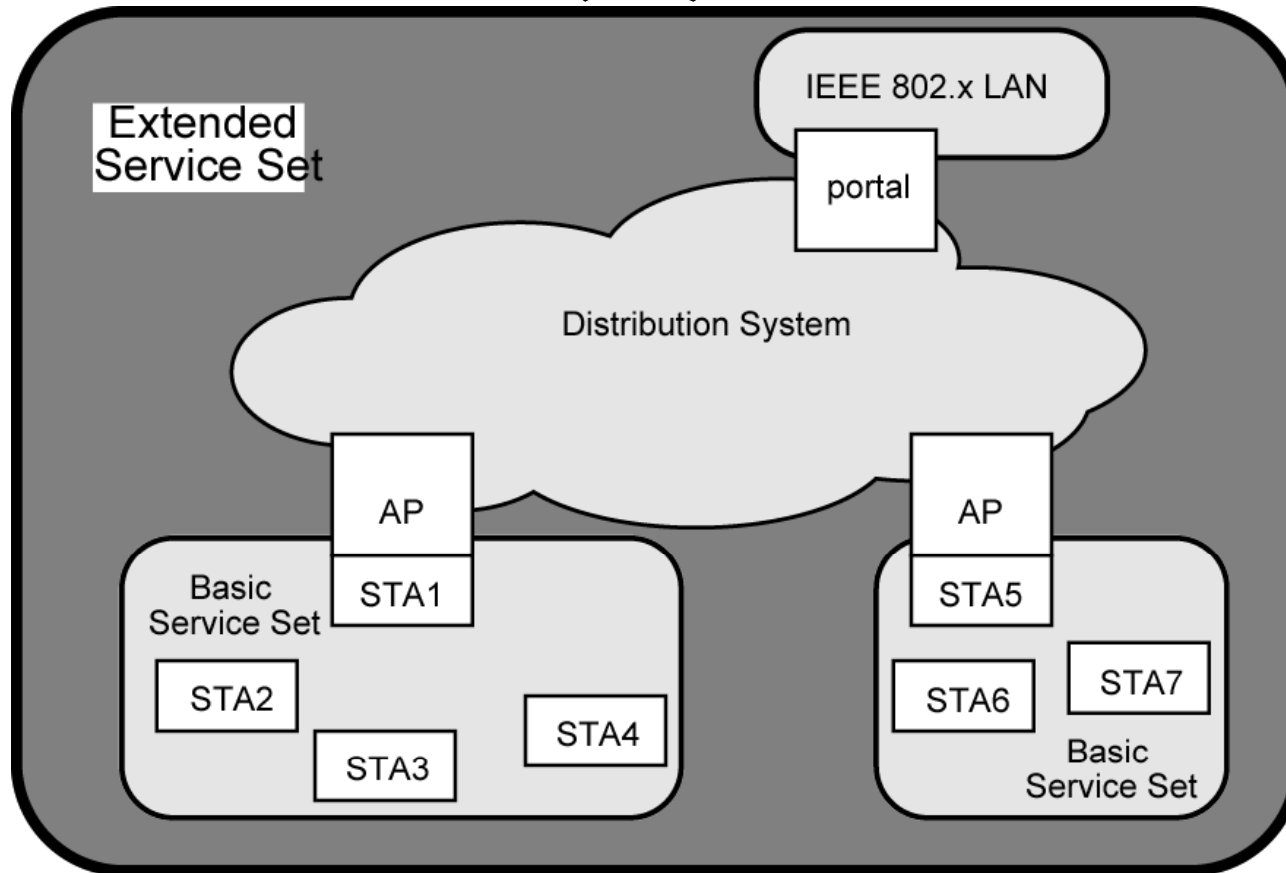
Integration With Existing Networks



IEEE 802.11 Network Architecture

Wireless network architecture :

1. Basic Service Set (BSS)
2. Extended Service Set (ESS)

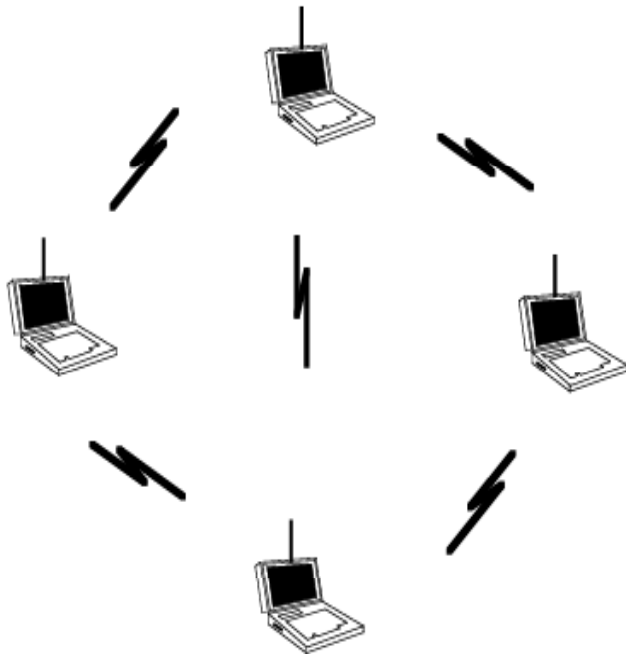


STA = station
AP = access point

Ad Hoc Networking

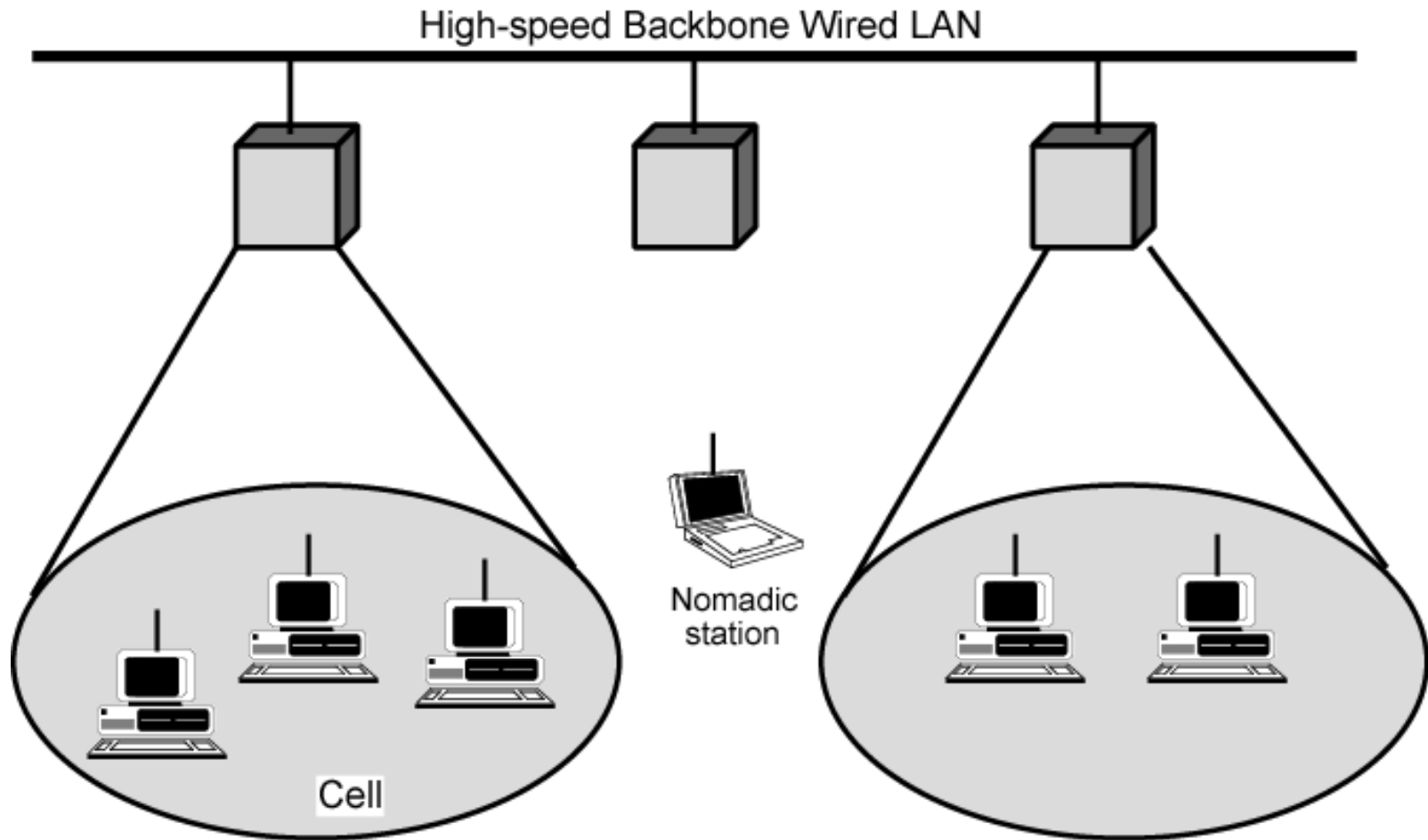
- Peer-to-peer network
- Set up temporarily to meet some immediate need
- E.g. group of employees, each with laptop or palmtop, in business or classroom meeting
- Network for duration of meeting

Add Hoc LAN



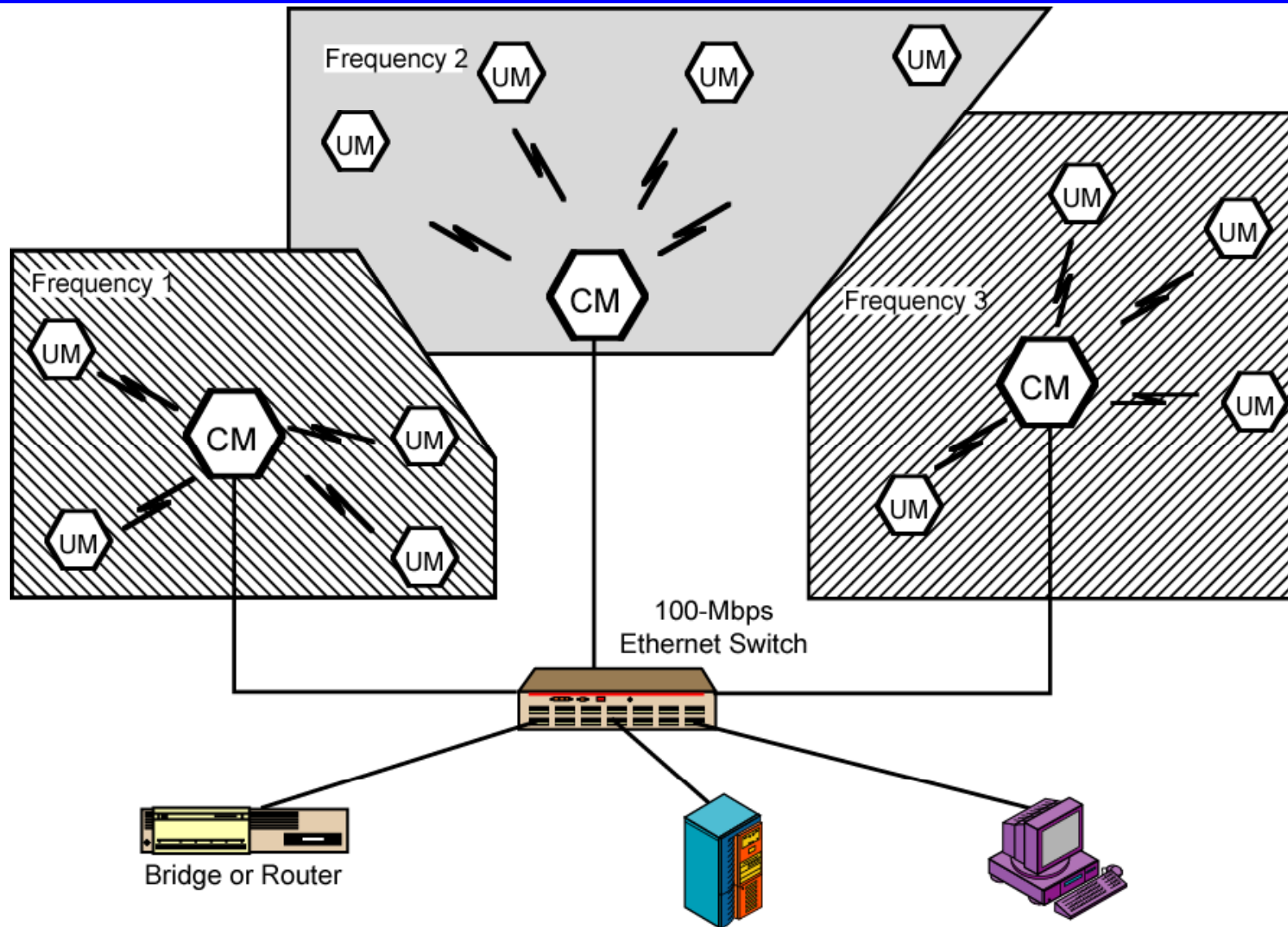
- A group of stations using the same radio frequency – Basic Service Set

Infrastructure Wireless LAN

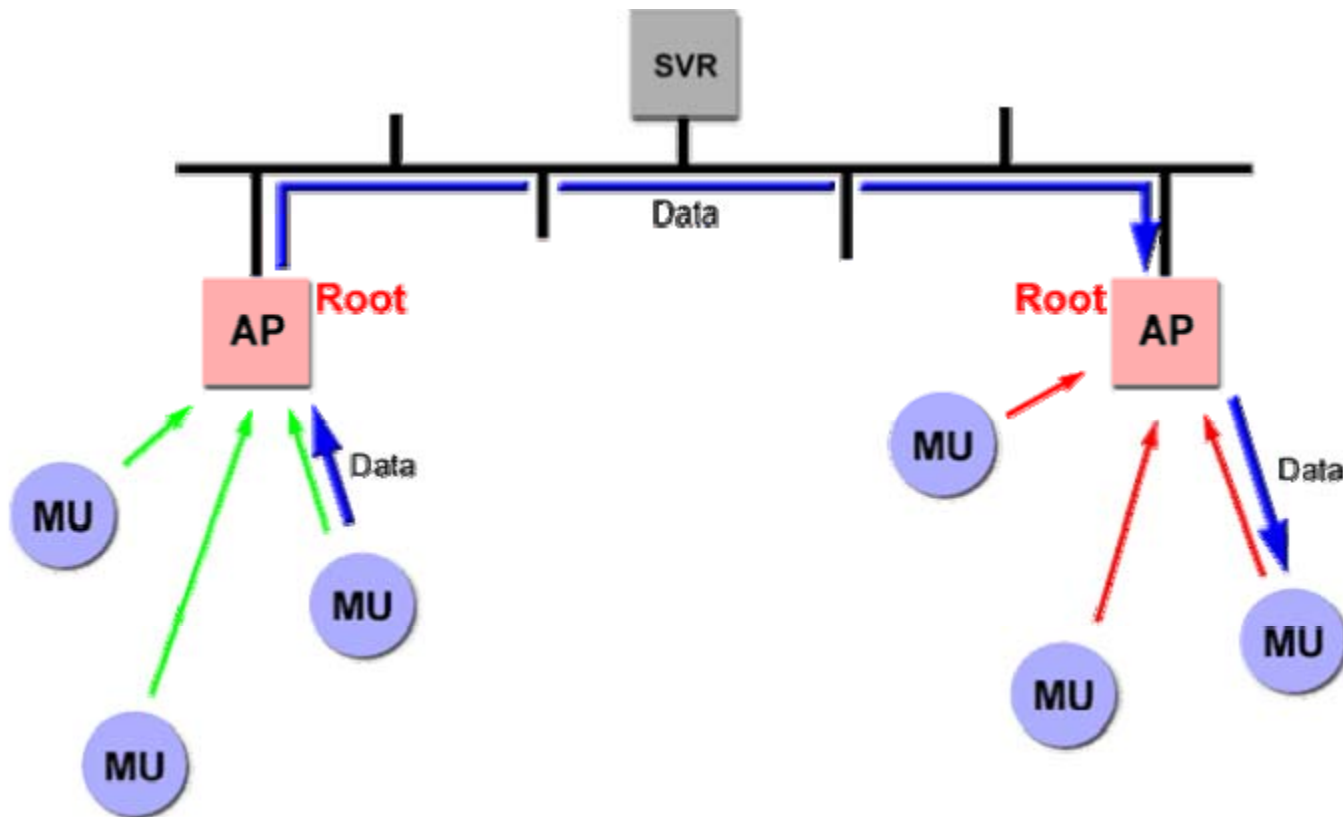


(a) Infrastructure Wireless LAN

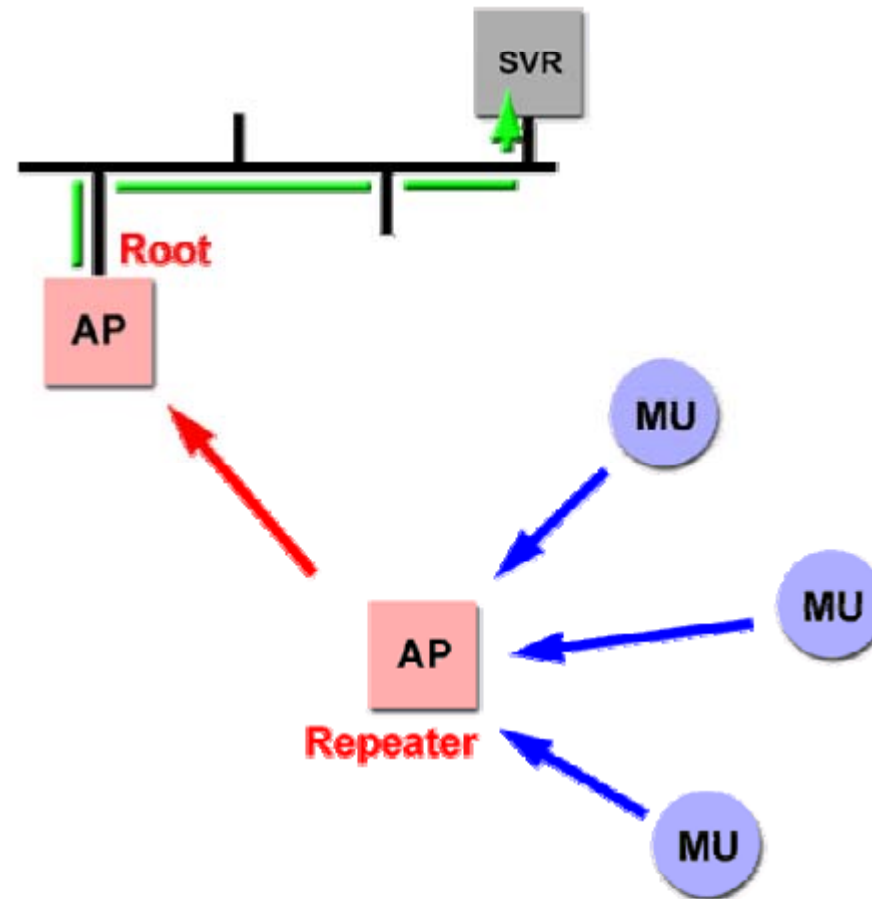
Multi-Cell Wireless LAN Configuration (Infrastructure Network)



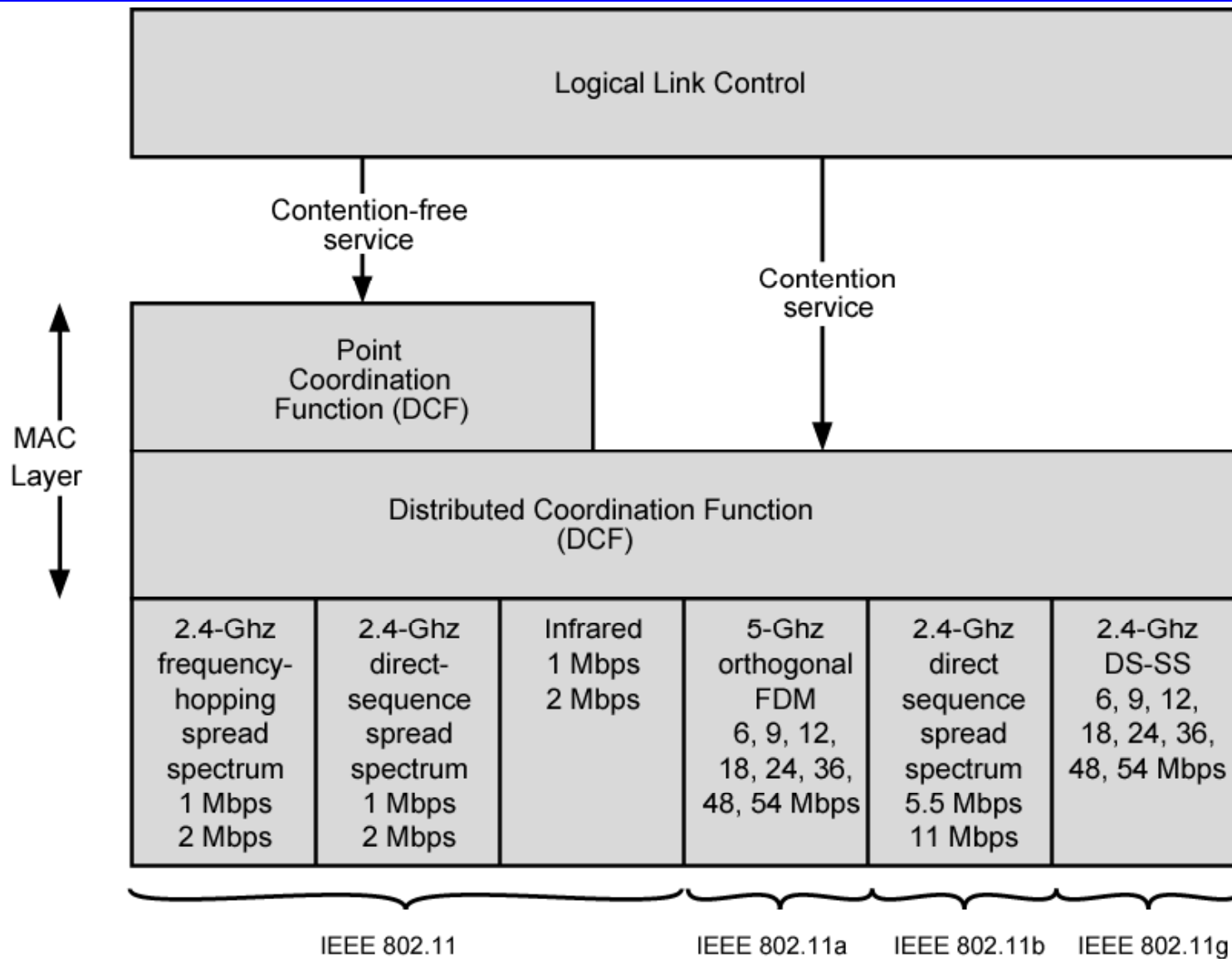
Access Point in "Root Mode"



Access Point in "Repeater Mode"















IEEE 802.11 Protocol Architecture



Why Choose? A vs B vs G

Wireless Technology Comparison Chart

Wireless Standard	802.11b		802.11a		802.11g	
Popularity		Widely adopted. Readily available everywhere.		New technology.		New technology with rapid growth expected.
Speed	11 Mbps	Up to 11Mbps (note: cable modem service typically averages no more than 4 to 5Mbps).	54 Mbps	Up to 54Mbps (5X greater than 802.11b).	54 Mbps	Up to 54Mbps (5X greater than 802.11b).
Relative Cost		Inexpensive.		Relatively more expensive.		Relatively inexpensive.
Frequency	2.4 GHz	More crowded 2.4GHz band. Some conflict may occur with other 2.4GHz devices like cordless phones, microwave ovens, etc.	5 GHz	Uncrowded 5GHz band can coexist with 2.4 GHz networks without interference.	2.4 GHz	More crowded 2.4GHz band. Some conflict may occur with other 2.4GHz devices like cordless phones, microwave ovens, etc.
Range		Good Range. Typically up to 100-150 feet indoors, depending on construction, building materials, room layout.		Shorter range than 802.11b & 802.11g. Typically 25 to 75 feet indoors.		Good Range. Typically up to 100-150 feet indoors, depending on construction, building materials, room layout.
Public Access		The number of public "hotspots" is growing rapidly, allowing wireless connectivity in many airports, hotels, college campuses, public areas, and restaurants.		None at this time.		Compatible with current 802.11b hotspots (at 11Mbps). Also, it is expected that most 802.11b hotspots will quickly convert to 802.11g.
Compatibility	OK 802.11b	Widest adoption.	OK 802.11a	Incompatible with 802.11b or 802.11g.	OK 802.11b 802.11g	Interoperates with 802.11b networks (at 11Mbps). Incompatible with 802.11a.

Benefits of A vs B vs G

802.11b

Wireless-B

- Lowest price
- Excellent signal range
- Coverage penetrates most walls
- Works with public hotspots

802.11a

Wireless-A

- Supports more users per room
- Unaffected by interference from 2.4GHz devices
- Can co-exist with B and G networks
- Coverage limited To one room

802.11g

Wireless-G

- Best value - only 10% premium for 5 times the speed of Wireless-B
- Compatible with Wireless-B networks and hotspots
- Excellent signal range
- Coverage penetrates most walls

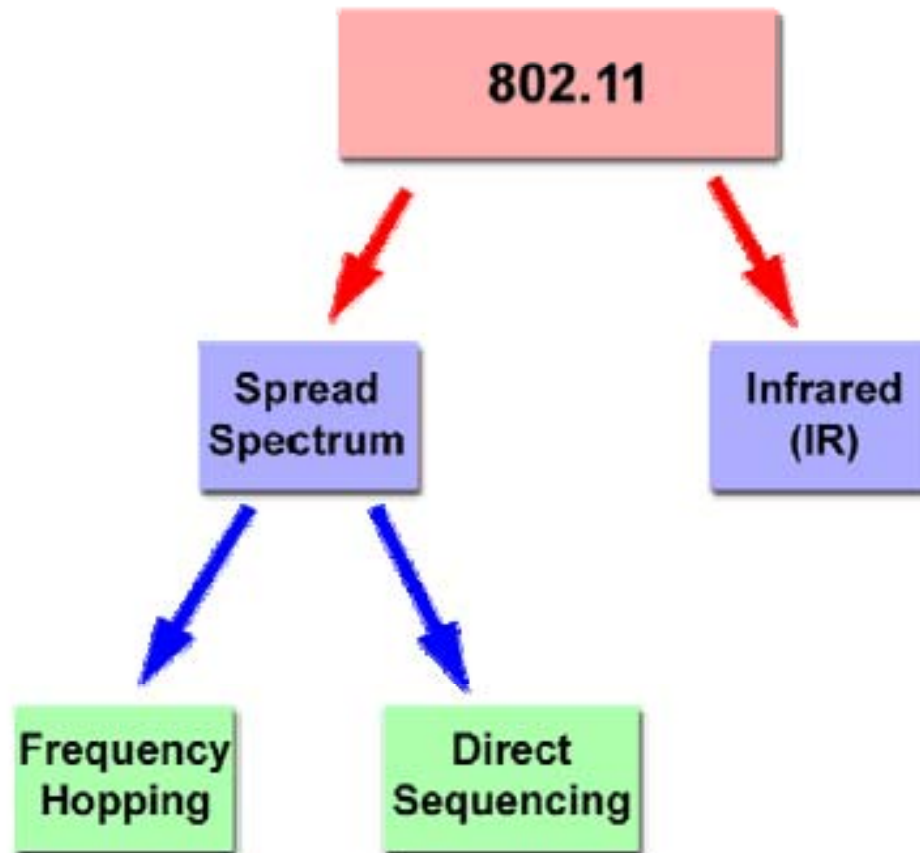
Table 1. IEEE 802.11 WLAN standards.

Standard	Spectrum	Maximum physical rate	Layer 3 data rate	Transmission	Compatible with	Major disadvantage	Major advantage(s)
802.11	2.4 GHz	2 Mbps	1.2 Mbps	FHSS/DSSS	None	Limited bit rate	Higher range
802.11a	5.0 GHz	54 Mbps	32 Mbps	OFDM	None	Smallest range of all 802.11 standards	Higher bit rate in less-crowded spectrum
802.11b	2.4 GHz	11 Mbps	6-7 Mbps	DSSS	802.11	Bit rate too low for many emerging applications	Widely deployed; higher range
802.11g	2.4 GHz	54 Mbps	32 Mbps	OFDM	802.11/ 802.11b due to narrow spectrum	Limited number of colocated WLANs higher range than 802.11a	Higher bit rate in 2.4-GHz spectrum

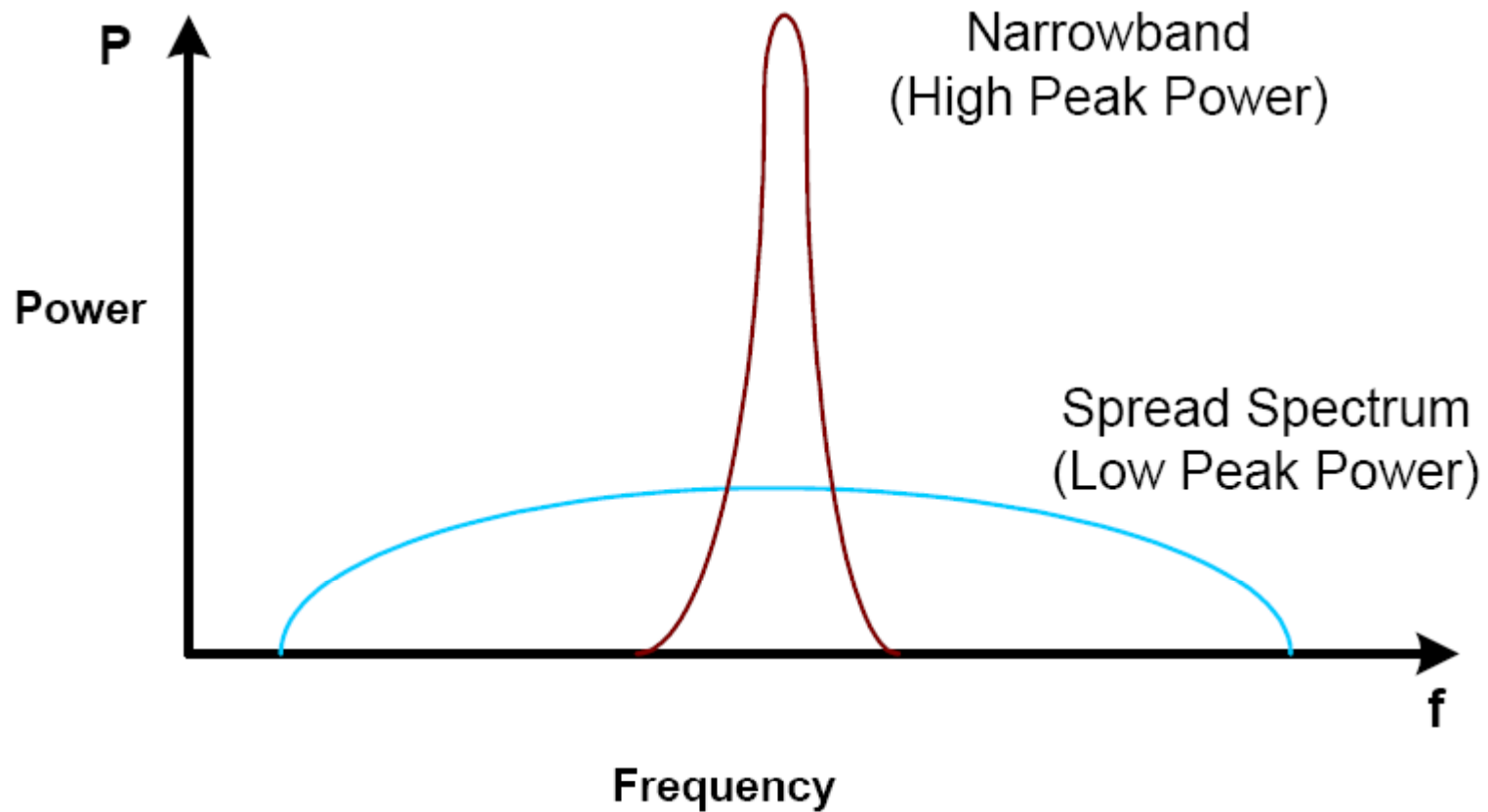
802.11 Physical Layer

- Issued in four stages
- First part in 1997
 - IEEE 802.11
 - Includes MAC layer and three physical layer specifications
 - Two in 2.4-GHz band and one infrared
 - All operating at 1 and 2 Mbps
- Two additional parts in 1999
 - IEEE 802.11a
 - 5-GHz band up to 54 Mbps
 - IEEE 802.11b
 - 2.4-GHz band at 5.5 and 11 Mbps
- Most recent in 2002
 - IEEE 802.g extends IEEE 802.11b to higher data rates

802.11 Physical Layer

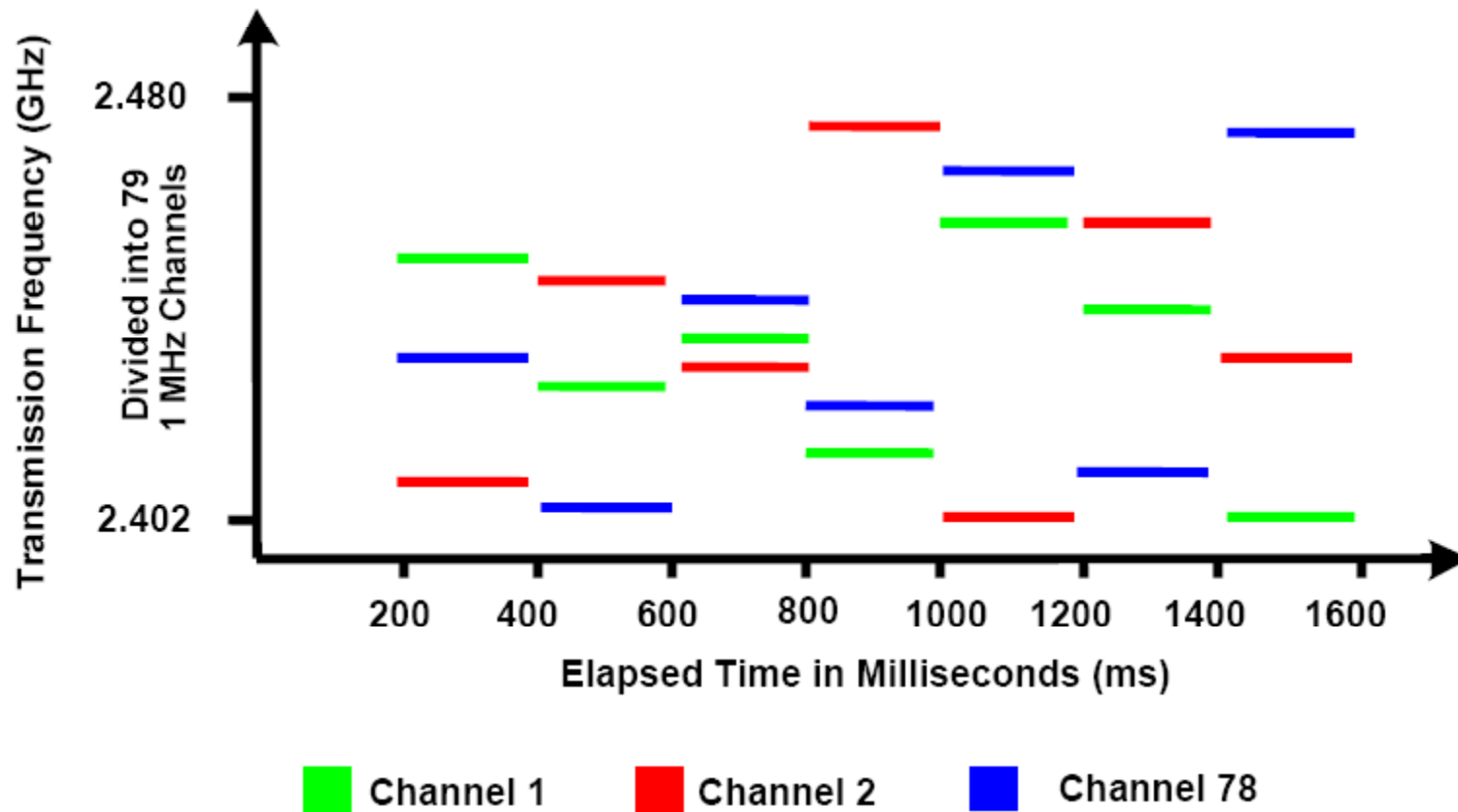


Spread Spectrum



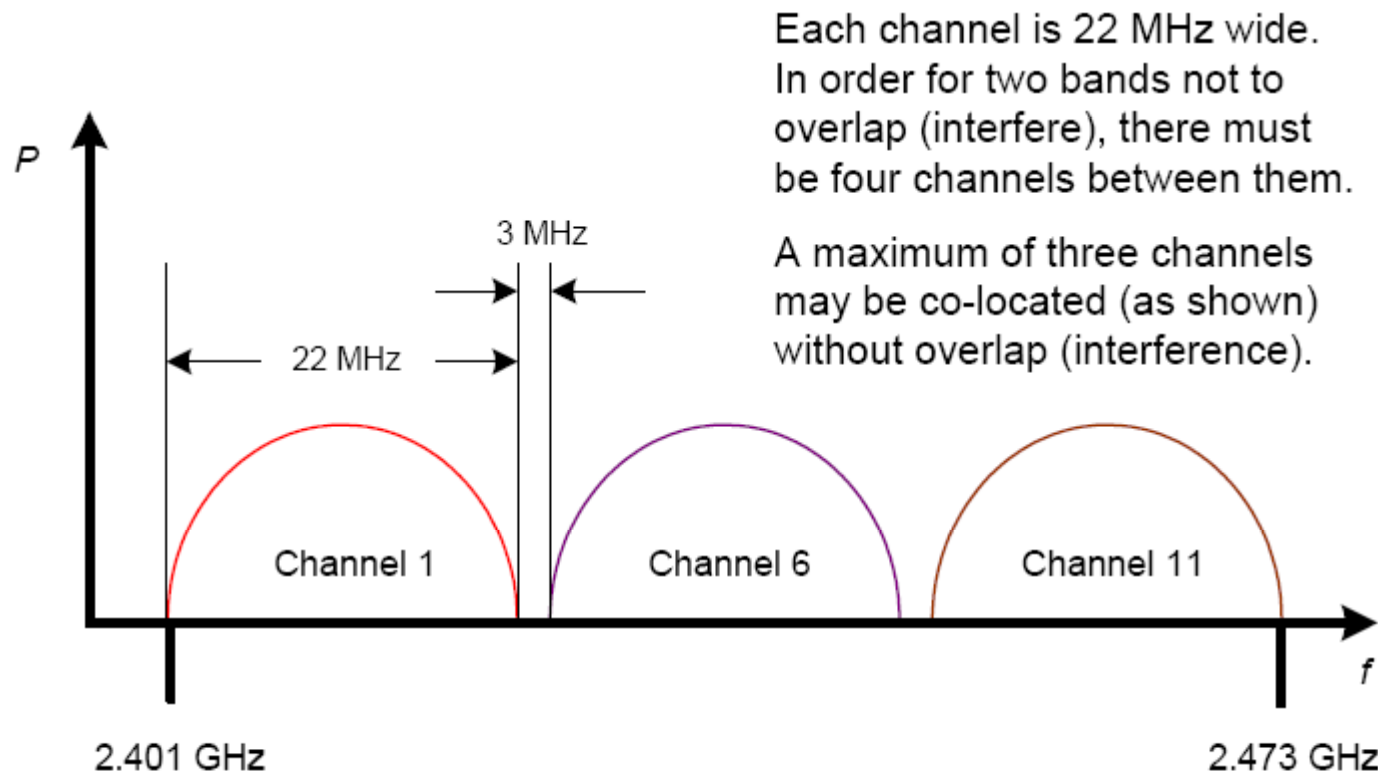
Frequency Hopping Spread Spectrum

An Example of a Co-located Frequency Hopping System

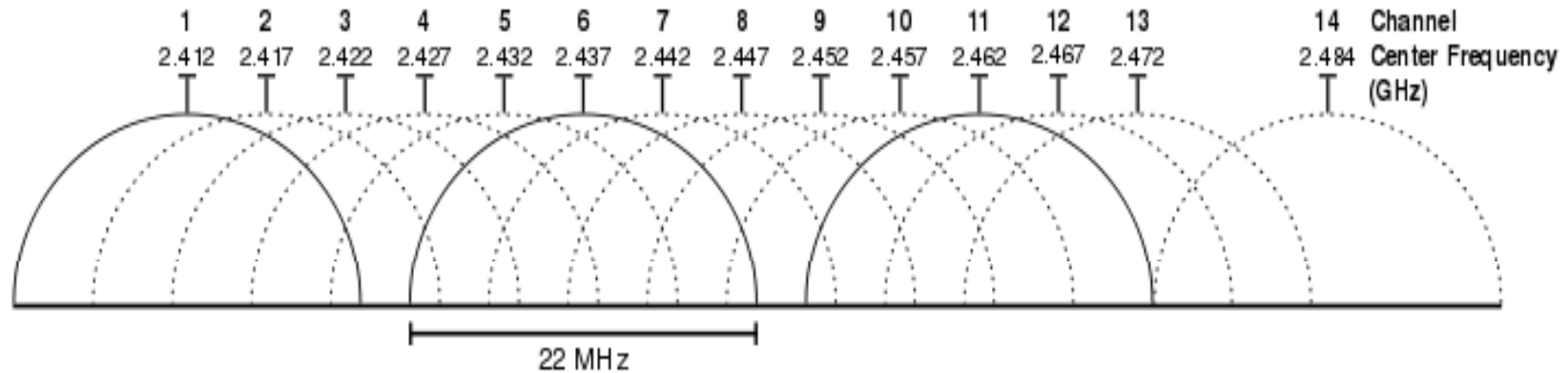


Direct Sequencing Spread Spectrum

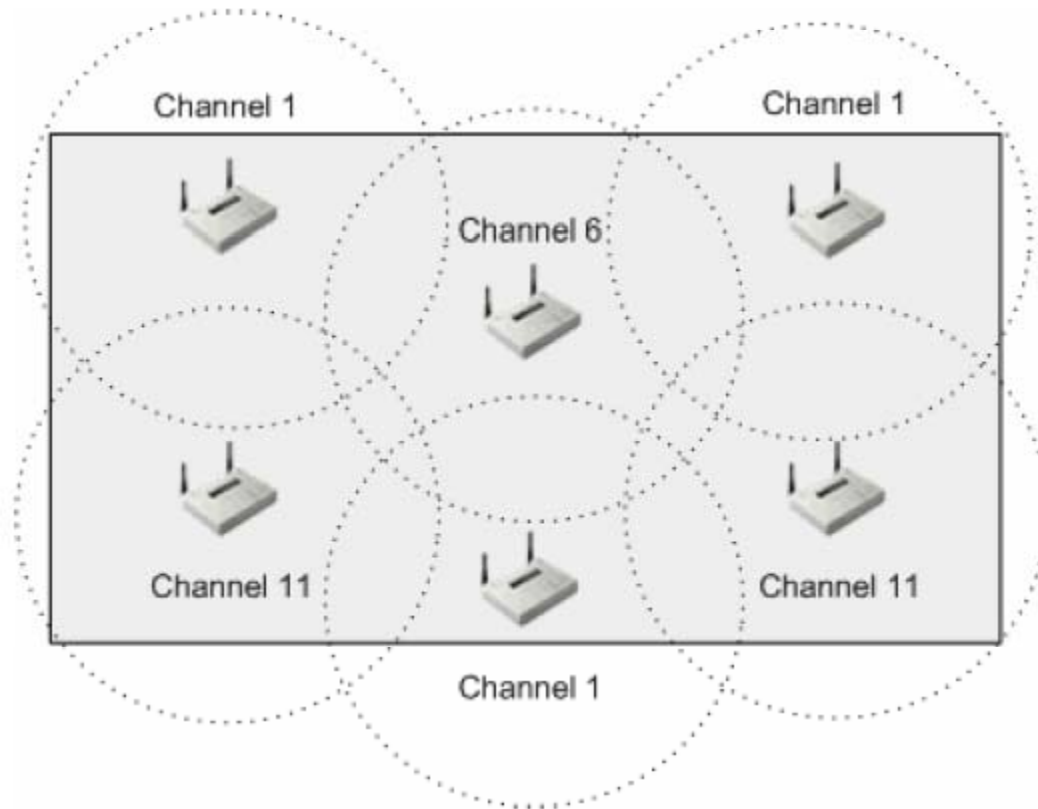
Channel Allocation and Spectral Relationship



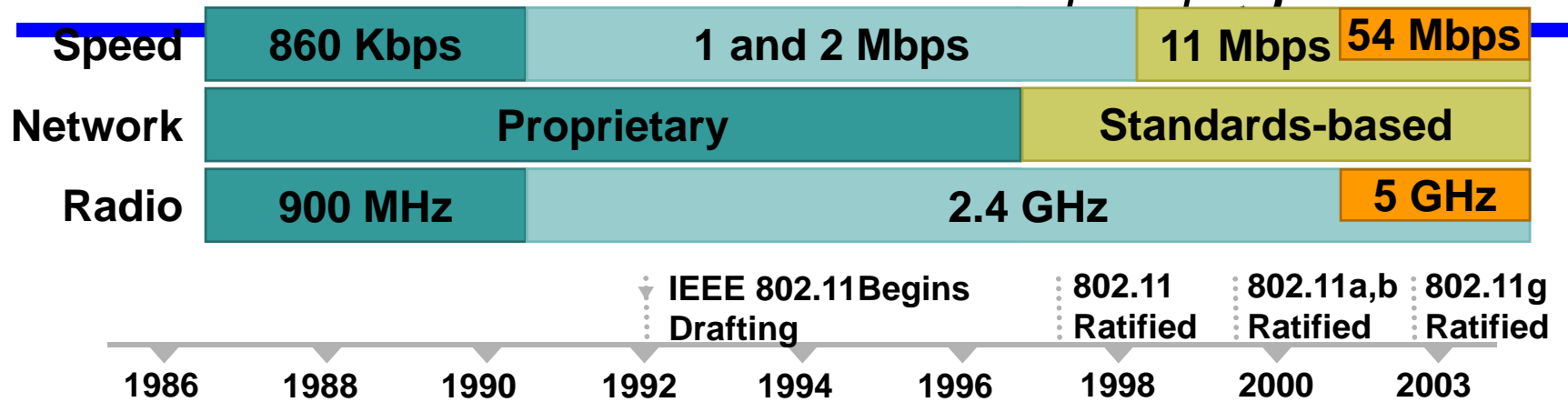
Graphical representation of Wi-Fi channels in 2.4 GHz band



Channel Reuse



Current Standards – a, b, g



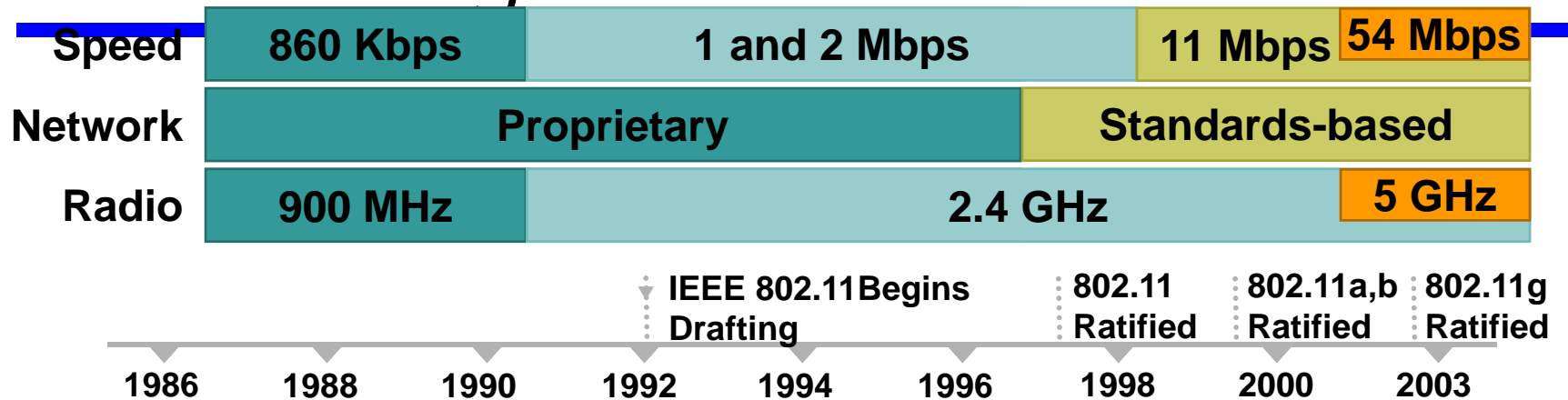
- **802.11a**
 - Up to 54 Mbps
 - 5 GHz
 - Not compatible with either 802.11b or 802.11g

- **802.11b**
 - Up to 11 Mbps
 - 2.4 GHz

- **802.11g**
 - Up to 54 Mbps
 - 2.4 GHz

802.11g is backwards compatible with 802.11b, but with a drawback (later)

802.11 PHY (Physical Layer) Technologies



- Three types of radio transmission within the unlicensed 2.4-GHz frequency bands:
 - Frequency hopping spread spectrum (FHSS) 802.11b (not used)
 - Direct sequence spread spectrum (DSSS) 802.11b
 - Orthogonal frequency-division multiplexing (OFDM) 802.11g
- One type of radio transmission within the unlicensed 5-GHz frequency bands:
 - Orthogonal frequency-division multiplexing (OFDM) 802.11a

WLAN Devices: Access Points

In-building Infrastructure

- **1200 Series (802.11a and 802.11b)**
- **1100 Series (802.11b)**



Wireless LAN Devices: Client Adapters

Clients (NICs)

- 350 Series (802.11b)
- 5 GHz client adapter (802.11a)



Drivers are supported for all popular operating systems, including Windows 95, 98, NT 4.0, Windows 2000, Windows ME, Windows XP, Mac OS Version 9.x, and Linux.

Wireless LAN Devices: Antennas

Antenna

- 2.4GHz Antennas
 - 5 GHz Antennas
- Indoor Vs Outdoor



Antennas

- Indoor and Outdoor
- WLAN and Bridging

- Outdoor
- Bridging

- 2.4 GHz



- 5 GHz



Dipole / Omni Antenna



Omni Ceiling Mount Antenna

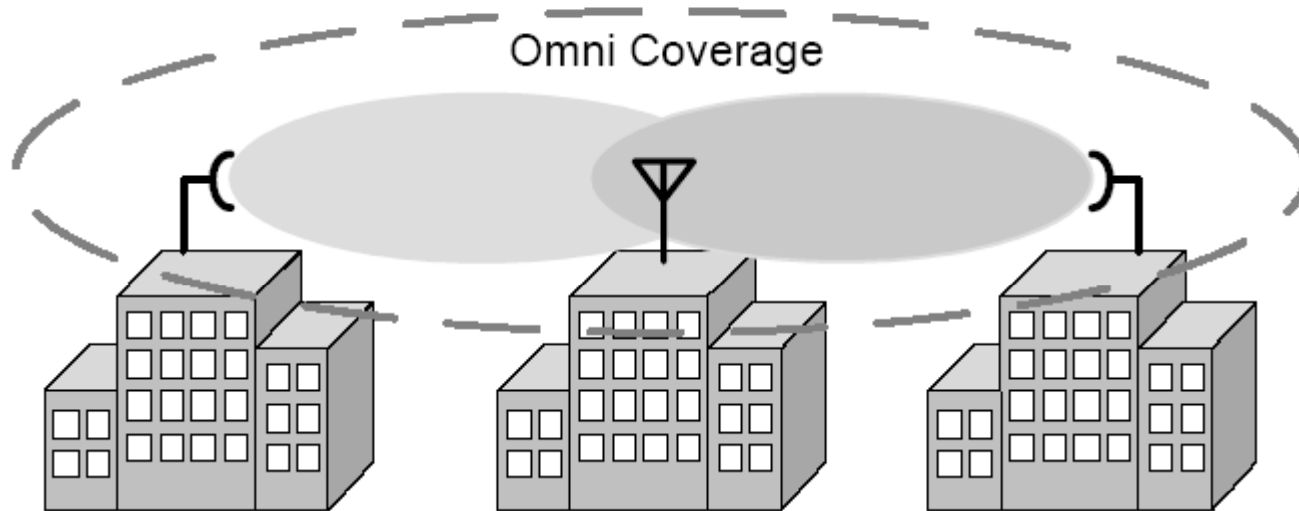


Omni Ground Plane Antenna

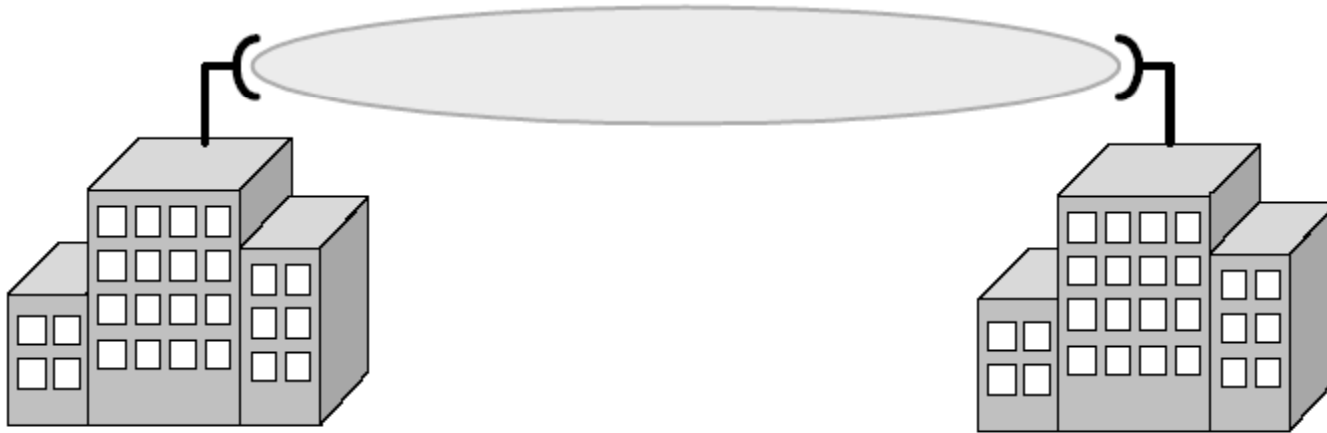


Omni Pillar Mount Antenna

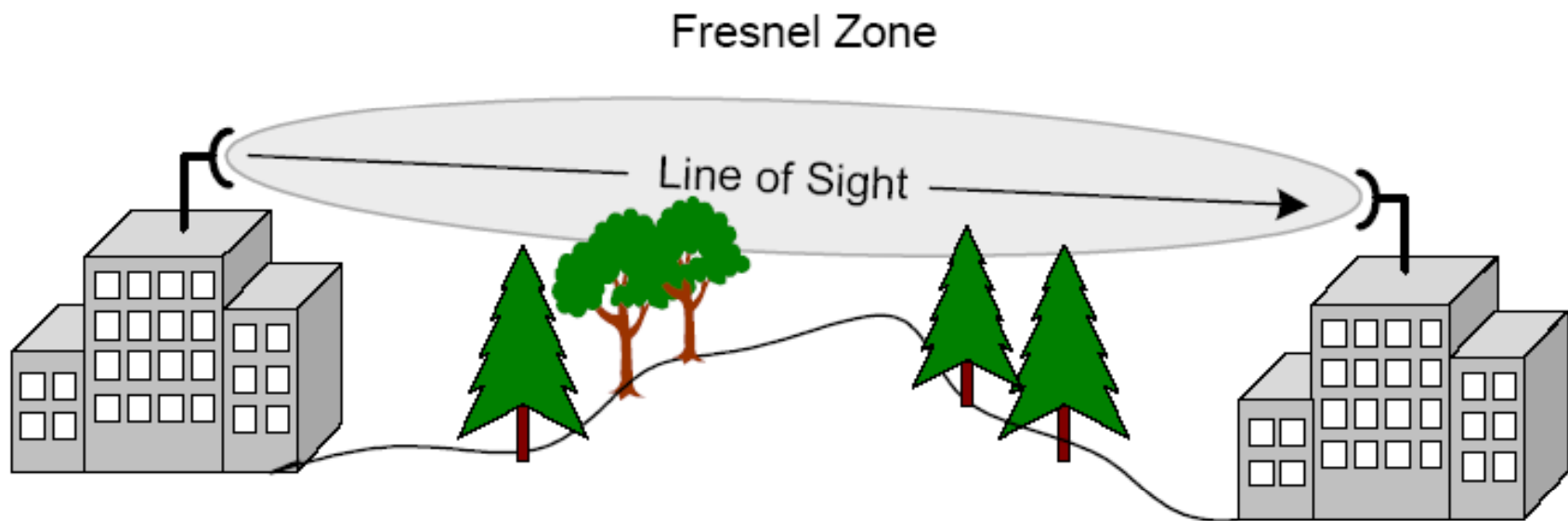
Point to Multipoint Link



Point-to-point Wireless Link



Antenna



Packet Analysis

AiroPeek - [Capture Lapc]

File Edit View Capture Statistics Tools Window Help

Packets: 11,085

Packet	Source	Destination	BSSID	Data Rate	Channel	Signal	Flags	Size	Absolute Time	Protocol
78	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	85%	▼	96	12:52:44.855178	802.11 Beacon
79	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	58%	▼	96	12:52:44.898153	802.11 Beacon
80	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	83%	▼	96	12:52:44.957640	802.11 Beacon
81	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	60%	▼	96	12:52:45.000548	802.11 Beacon
82	00:40:96:28:FC:30	01:40:96:00:00:00	00:40:96:28:FC:30	11.0	1	63%	▼	270	12:52:45.040507	SNAP-00-40-96-00-00
83	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	83%	▼	96	12:52:45.059972	802.11 Beacon
84	40:00:82:10:01:03	Broadcast	00:40:96:28:FC:30	11.0	1	63%	▼	82	12:52:45.067927	ARP Request
85	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	65%	▼	96	12:52:45.103060	802.11 Beacon
86	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	85%	▼	96	12:52:45.162379	802.11 Beacon
87	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	65%	▼	96	12:52:45.205366	802.11 Beacon
88	IP-0.0.0.0	IP Broadcast	00:40:96:28:FC:30	11.0	1	65%	▼	364	12:52:45.227588	UDP DHCP
89	00:10:DC:BD:3E:32	Broadcast	00:40:96:28:FC:30	11.0	1	65%	▼	82	12:52:45.240376	ARP Request
90	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	83%	▼	96	12:52:45.264704	802.11 Beacon
91	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	63%	▼	96	12:52:45.307823	802.11 Beacon
92	00:02:2D:09:F3:4E	00:40:96:28:FC:30	00:40:96:28:FC:30	2.0	1	100%	▼	28	12:52:45.308329	802.11 Data
93		00:03:2D:09:F3:4E		2.0	1	60%	▼	14	12:52:45.308603	802.11 Ack
94	00:02:2D:09:F3:4E	Broadcast	Broadcast	2.0	1	100%	▼	43	12:52:45.310041	802.11 Probe Req
95	00:40:96:28:FC:BD	00:02:2D:09:F3:4E	00:40:96:28:FC:BD	1.0	1	85%	▼	90	12:52:45.311146	802.11 Probe Rsp
96		00:40:96:28:FC:BD		1.0	1	100%	▼	14	12:52:45.311406	802.11 Ack
97	00:40:96:28:FC:30	00:03:2D:09:F3:4E	00:40:96:28:FC:30	1.0	1	63%	▼	90	12:52:45.312495	802.11 Probe Rsp
98		00:40:96:28:FC:30		1.0	1	100%	▼	14	12:52:45.312756	802.11 Ack
99	00:02:2D:09:F3:4E	Broadcast	Broadcast	2.0	1	40%	▼	43	12:52:45.320616	802.11 Probe Req
100	00:02:2D:09:F3:4E	Broadcast	Broadcast	2.0	1	100%	▼	43	12:52:45.334960	802.11 Probe Req
101	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	83%	▼	96	12:52:45.367181	802.11 Beacon
102	00:02:2D:09:F3:4E	Broadcast	Broadcast	2.0	1	80%	▼	43	12:52:45.387250	802.11 Probe Req
103	00:02:2D:09:F3:4E	00:40:96:28:FC:30	00:40:96:28:FC:30	2.0	1	100%	▼	20	12:52:45.402144	802.11 PS-Fail
104		00:02:2D:09:F3:4E		2.0	1	65%	▼	14	12:52:45.402396	802.11 Ack
105	00:40:96:28:FC:30	00:03:2D:09:F3:4E	00:40:96:28:FC:30	11.0	1	65%	▼	28	12:52:45.403816	802.11 Data
106		00:40:96:28:FC:30		11.0	1	100%	▼	14	12:52:45.403039	802.11 Ack
107	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	70%	▼	96	12:52:45.410142	802.11 Beacon
108	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	85%	▼	96	12:52:45.469501	802.11 Beacon
109	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	65%	▼	96	12:52:45.512618	802.11 Beacon
110	00:00:F0:32:41:EF	Broadcast	00:40:96:28:FC:30	11.0	1	68%	▼	82	12:52:45.536718	ARP Request
111	00:40:96:28:FC:BD	Broadcast	00:40:96:28:FC:BD	1.0	1	85%	▼	96	12:52:45.571902	802.11 Beacon
112	00:40:96:28:FC:30	Broadcast	00:40:96:28:FC:30	1.0	1	68%	▼	96	12:52:45.614937	802.11 Beacon

Packets / Nodes / Protocols / Conversations / Size / Summary / History / Log

For Help, press F1

Data Encryption

Secure Transmission of Information

- Physical layer
 - Physical security of data transmission is gained by using spread spectrum technology which makes it less vulnerable to interference
- MAC (Medium Access Control) layer
 - Encryption algorithm is called Wired Equivalent Privacy (WEP)
Use static encryption key.
 - Wi-Fi Protected Access (WPA)
WPA uses a Temporal Key Integrity Protocol (TKIP), which changes keys with every data packet.

The Site Survey

- Helps define the coverage areas, data rates, the precise placement of access point.
- Gather information: diagramming the coverage area and measuring the signal strength, SNR (signal to noise ratio), RF interference levels

Site Survey

