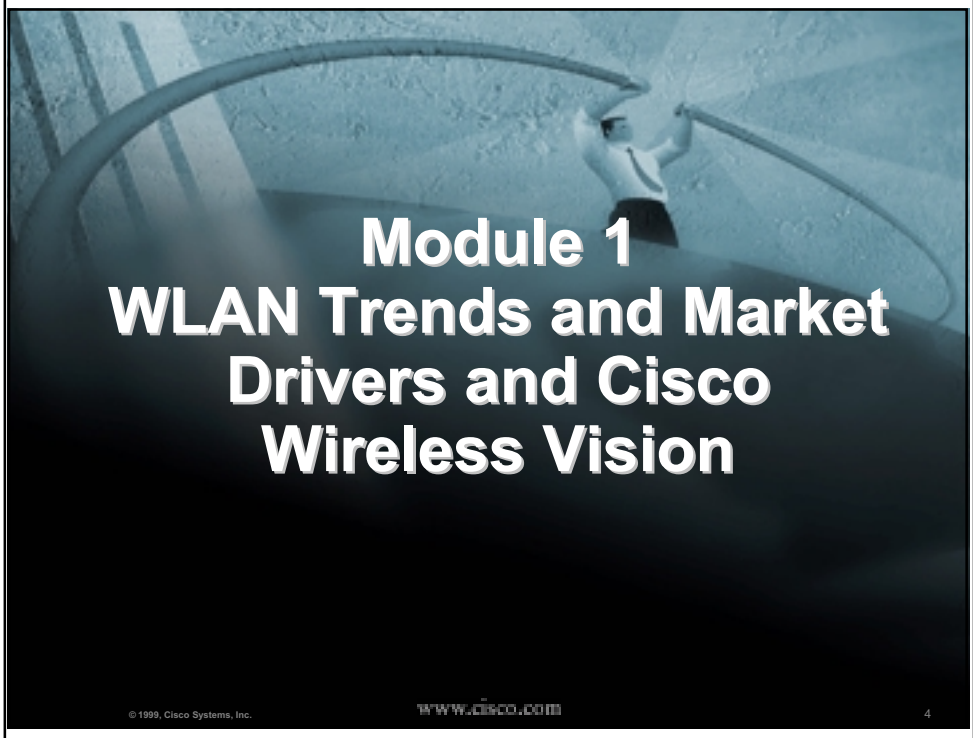
Course Agenda

- Module 1—Introduction to WLAN networking trends and Market Drivers and Cisco's Wireless Vision
- Module 2—Key WLAN Technologies
- Module 3—WLAN Products
- Module 4—WLAN Network Design

Course Objectives

- **Upon completion of this course, you will be able to:**
  - **List the emerging WLAN market trends and requirements and describe Cisco's wireless vision.**
  - **Describe the major WLAN technologies.**
  - **Define the functions and features of the Cisco WLAN products.**
  - **Describe WLAN network design issues, WLAN configurations and sample applications using Cisco WLAN products.**



Historical Market Inhibitors

- Positioning of wireless as a separate solution
- Immature technology
  - Low throughput speeds
  - Security concerns
  - Vertical marginalization of technology
  - Lack of standards
- Vertical applications solving specific problems
  - Manufacturing
  - Healthcare
  - Retail
  - Education

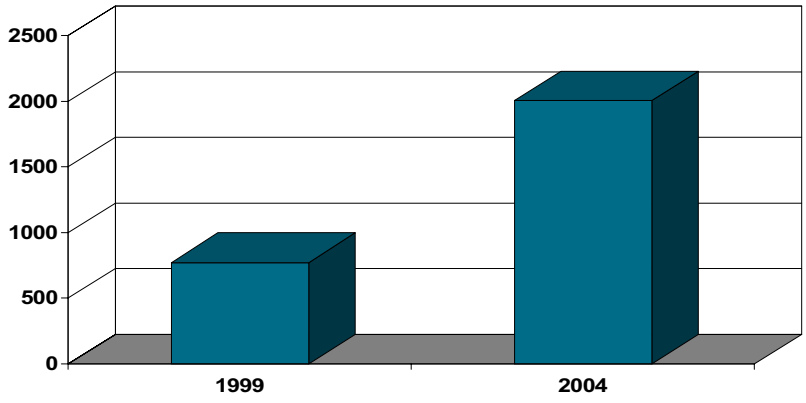
Market Materialization

- **Standardization**
  - IEEE 802.11b standards
- **Technological maturity**
  - Better security – 128-bit encryption
  - Longer range access points
  - 11-Mbps throughput speeds
- **Horizontal applications**
  - Extension of wired solutions
  - Connecting mobile workers

Key Market Drivers

- **Speed**
  - 11-Mbps throughput meets enterprise performance standards
- **Positioning**
  - Wireless completes the networking solution
- **Value**
  - Lower costs with acceptable performance
- **Ease of Implementation**
  - "Instant" solutions, excellent manageability, easy implementation

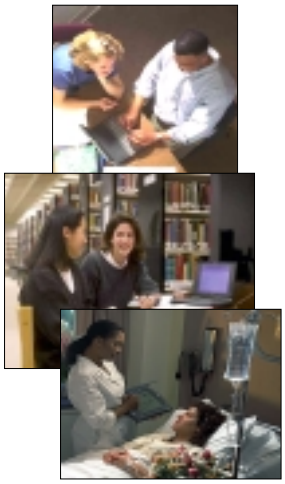
Projected Market Growth ($ millions)



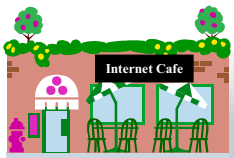
Source: Cahners In-stat Report

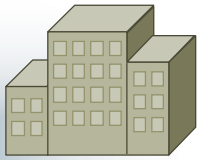
Diverse and Attractive Markets

- **Enterprise & Small/Medium Businesses**
- **Consumer/Home**
- **Education**
  - K–12 cost-effective network infrastructure
  - Dynamic class sizes in universities
- **Health Care**
  - Access and update patient data directly at the point of care



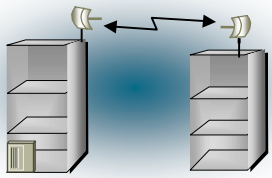
Cisco's Wireless Vision





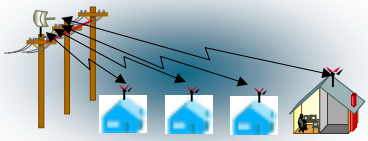
Ubiquitous, high-speed networking where you work, live, learn, & play

Cisco's Wireless Initiatives



Point-to-Point/Multipoint Wireless

Wireless LAN



Wireless Local Loop

Mobile Cellular Voice/Data Communications

Review Quiz - Market Trends

1) List the three of the four market drivers fueling the growth of the wireless LAN market.

2) Name the industry standard that has enabled the development of wireless LANs for horizontal applications.

3) Name the two primary ways in which wireless LANs can be used.

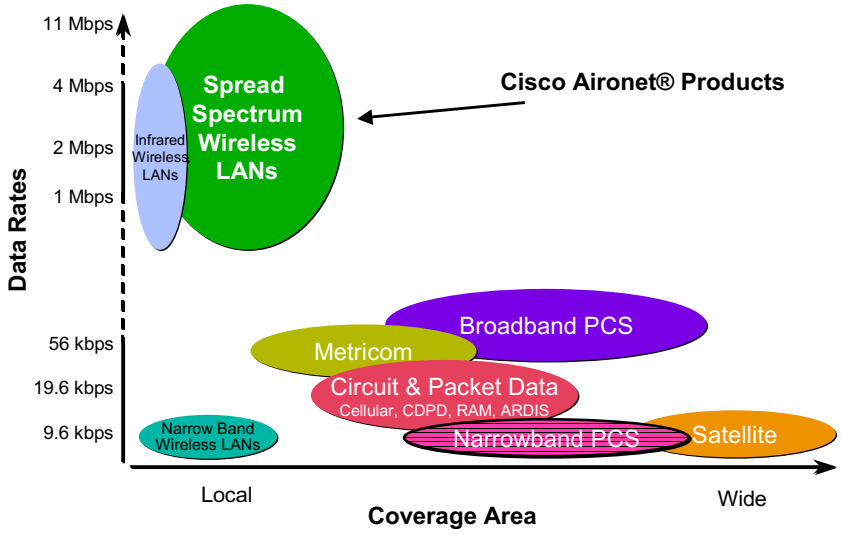
Cisco Systems

Empowering the Internet Generation℠

Module Objectives

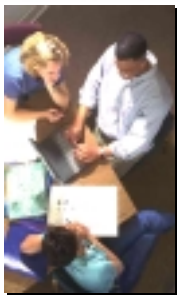
- **Upon the completion of this module, you will be able to:**
  - **Describe radio frequency (RF) spread spectrum technology.**
  - **Understand the basic fundamentals of RF technology.**
  - **Describe wireless LAN (WLAN) topology solutions that will work with WLAN technology.**

Overview of Wireless Data Network Offerings

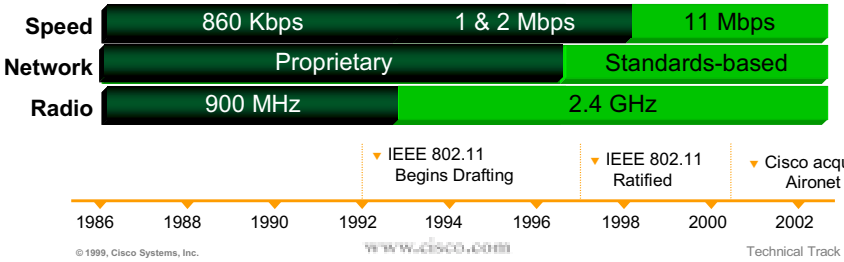


WLAN Evolution: 2000

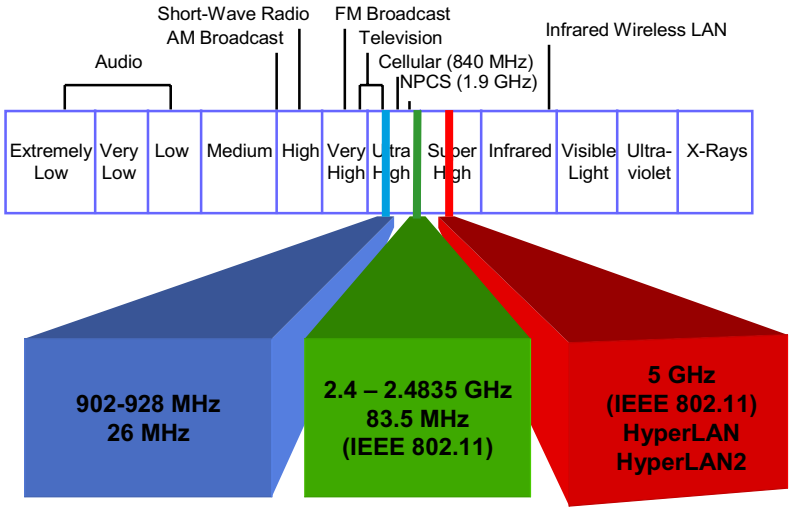
- Small and Medium Sized Businesses
- Small Office / Home Office
- Healthcare
- Education
- Warehousing
- Retail



- Home Networking



ISM Unlicensed Frequency Bands



900 MHz vs. 2.4 GHz vs. 5GHz

	900 MHz	2.4 GHz	5 GHz
Pros	Greater range than 2.4 GHz (for inbuilding LANs)	Global Market IEEE 802.11 Higher data rates (10+ Mbps)	Global Market IEEE 802.11 Higher data rates (20+ Mbps)
Cons	Maximum data rate 1 Mbps Limited bandwidth Crowded band	Less range than 900 MHz (for In-building LANs)	Much less range than 900 or 2.4 GHz Higher-cost RF components Large antenna required

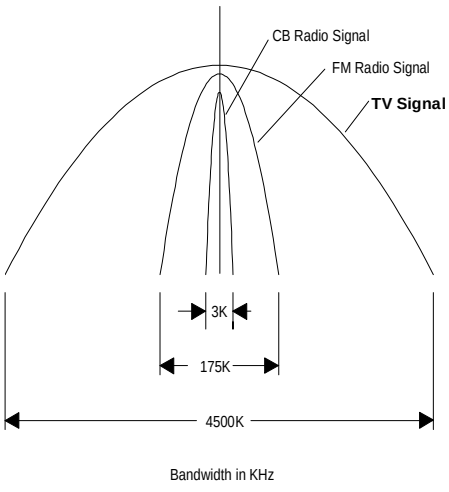
Frequency Hopping vs. Direct Sequence

- **Frequency Hopping**
  - Older technology
  - Designed for easy interference avoidance
  - Has been slower
- **Direct Sequence**
  - Throughput
  - Range
  - Reliable

Cisco WLAN Radio Technology

- **Spread Spectrum Radio**
  - **–Direct Sequence Spread Spectrum (DSSS)**
    - **•2.4GHz- ISM 11Mbps**

Radio Modulation

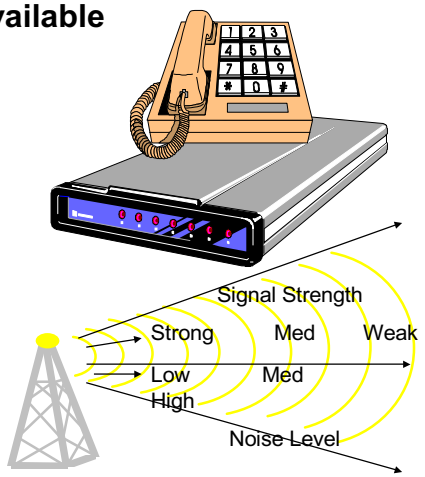


- More Information = More Frequency Spectrum Used

Modulation

- **Complex modulation requires better signal strength, therefore less coverage is available**

- **High speed modem compress the data to use the same line as an old 300 baud modem. This means the same bandwidth is available.**
- **56Kmodems require a better (quieter) phone line to communicate at the higher speed**
- **If there is noise on the line, the modem will drop down in speed to connect.**
- **More noise, less speed**



IEEE 802.11 Standard—Development

- **IEEE 802.11 became a standard in July 1997.**
- **Two technologies are defined:**
  - **DSSS - 2 and 11Mb**
  - **FHSS - 1 and 2 Mbps**
- **IEEE 802.11B became a standard in September 1999.**
  - **Only one RF technology was defined–DSSS @ 11-Mbps**
- **802.11 defines a high-performance radio.**
- **802.11 promises true vendor interoperability (over the air).**

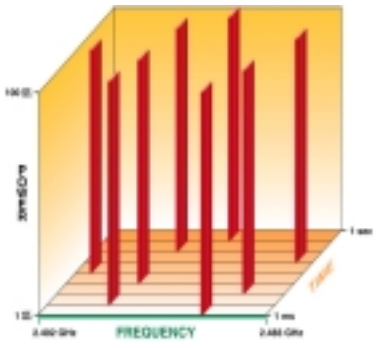
Cisco Radio Technology

Direct Sequence Spread Spectrum (DSSS)

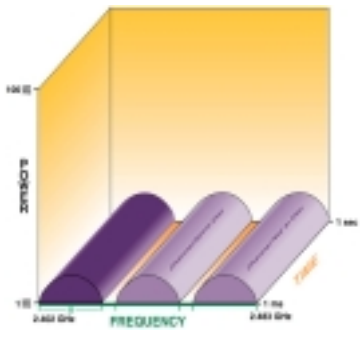
- 2.4GHz
- One piece PCMCIA radio product
- 1, 2, 5.5 and 11Mb
- 25 Mile bridge links
- Fully 802.11 Compliant at all speeds

Spread Spectrum Approaches

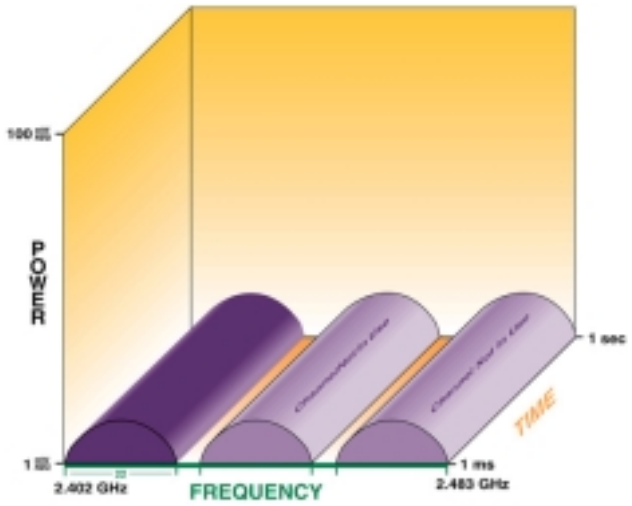
Frequency Hopping



Direct Sequence



Direct Sequence



Direct Sequence Modulation

- **Each data bit becomes a string of chips (chipping sequence) transmitted in parallel across a wide frequency range**
- **Minimum chip rate per the FCC is 10 chips for 1 and 2MB (BPSK/QPSK) and 8 chips for 11Mb (CCK) datarates.**

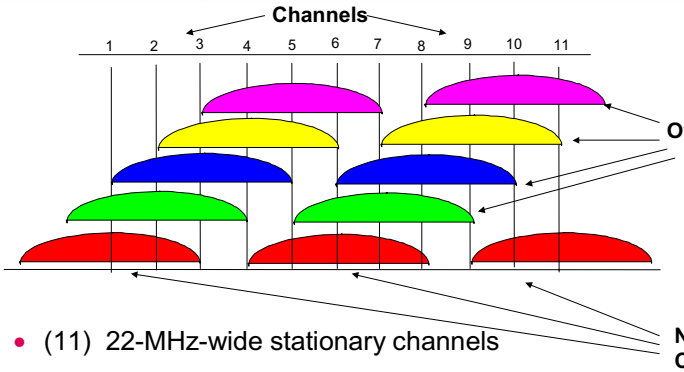
If the data bit was: 1001

Chipping code is : 1=00110011011 0=11001100100

Transmitted data would be:

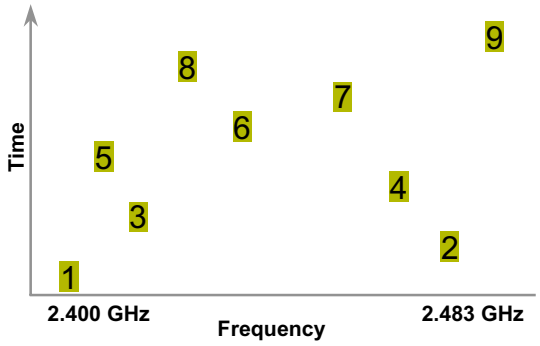
00110011011	11001100100	11001100100	00110011011
1	0	0	1

Channels—802.11 DS



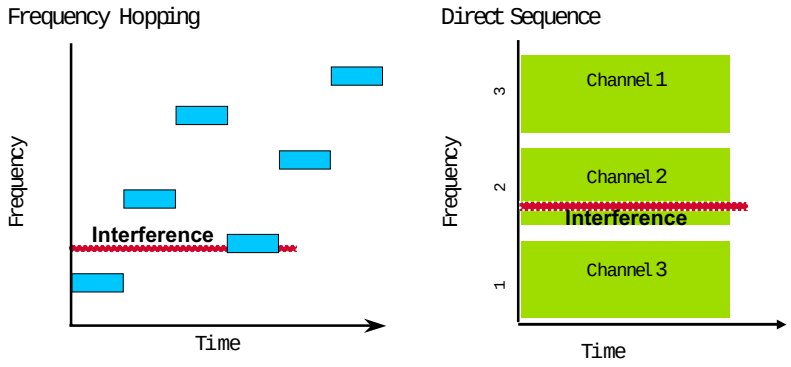
- (11) 22-MHz-wide stationary channels
- x “chips per bit”, means each bit is sent redundantly
- 11-Mbps datarate
- 3 nonoverlapping channels (1, 6, and 11)
- 3 APs can occupy same area - set at different frequencies

Frequency Hopping



- **79 Channels, 1 MHz Each**
- **Changes frequency (Hops) at least every 0.4 seconds**
- **Synchronized hopping required**

FH vs. DS: A Summary on Interference Handling



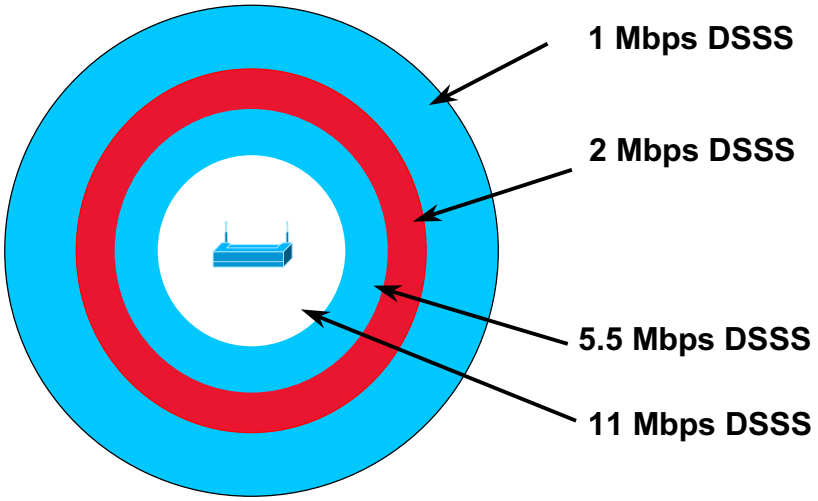
Data Rates DS vs. FH

- The “over-the-air” data rate at a given range and given similar implementation will favor DSSS by a factor of 2 to 1.
- A 1-Mbps DSSS system should have twice the range of a 1-Mbps FHSS.
- A 2 Mbps DSSS system will offer comparable range to 1-Mbps FHSS technology.
- For these reasons, the data-rate advantage goes to DSSS.

Range—DS vs. FH

- Range depends on a numerous implementation details, including:
  - Transmit power
  - Antenna system (including antenna gain, cable loss, and whether diversity is used)
  - Radio sensitivity
  - Processing gain (Processing gain results from the DSSS technique of redundantly transmitting bits.)
- Because of this processing gain, the DSSS technology will have more range than FHSS at a given data rate.

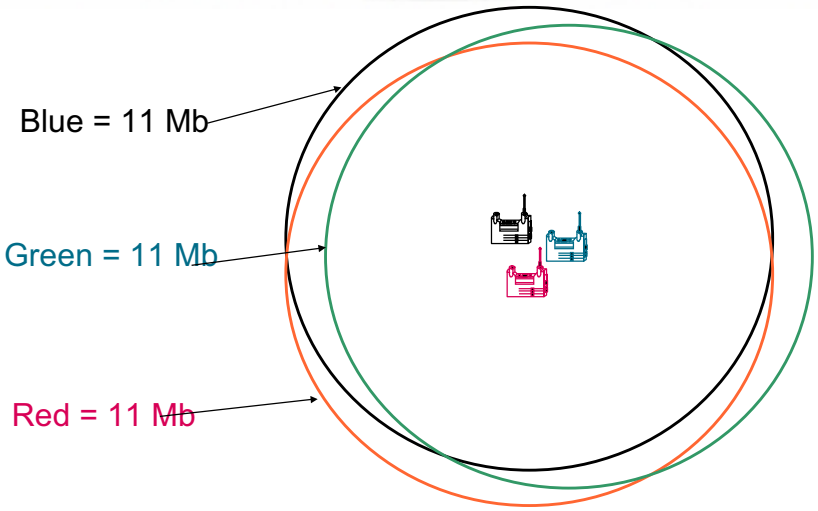
Access Point Coverage and Data-Rate Shifting



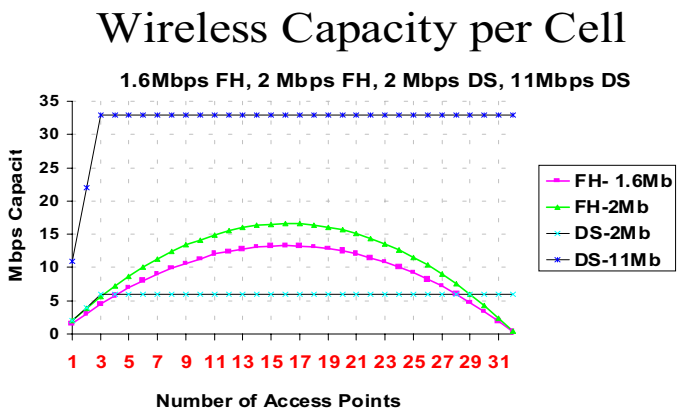
Scalability—DS vs. FH

- Scalability is the ability to locate more than one AP in the same area, increasing the bandwidth of that area for all local users to that AP.
- DS has a limit of 3 nonoverlapping channels, and therefore, limits the total AP number to 3.

Scalability with Direct Sequence



Scalability—FH Vs DS



IEEE 802.11 Impact

- Enables basic interoperability over the air
  - DS adapters from different vendors can interact
  - FH adapters from different vendors can interact
- System level interoperability requires more...
  - Vendor cooperation
  - Higher-level protocol agreement

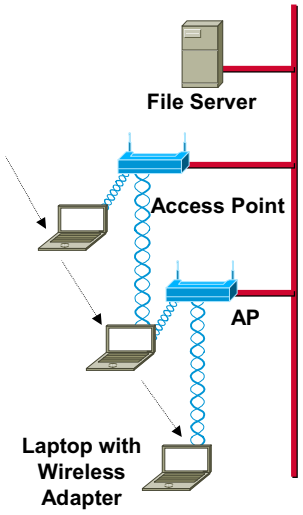
IEEE 802.11 Standard

- 802.11 incorporates many Cisco features such as:
  - Power management
  - Active scanning
  - Registering (association) with AP
  - Concept of roaming

802.11b–Higher Data Rate

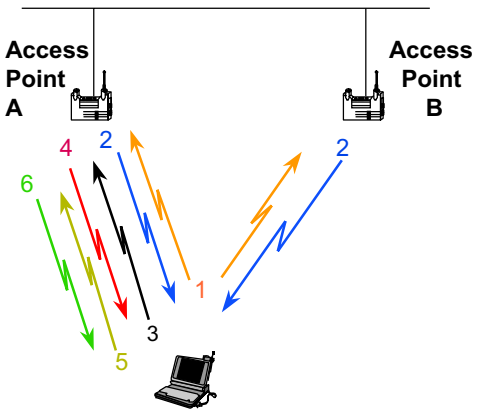
- With the need for a higher data rate, 802.11 decided to add more specifications.
- A 11 Mb specification was ratified in September 1999.
- This specification uses DS
- The standard uses Complementary Code Keying (CCK) modulation

Roaming and Options



- All Cisco wireless LANs deliver superior roaming
- More 802.11 options than anyone

Cisco Aironet Association Process—Passive Scanning



Initial connection to an AP

Steps to Association:

1 Client sends probe

2 AP sends probe response

Client evaluates AP response, selects best AP

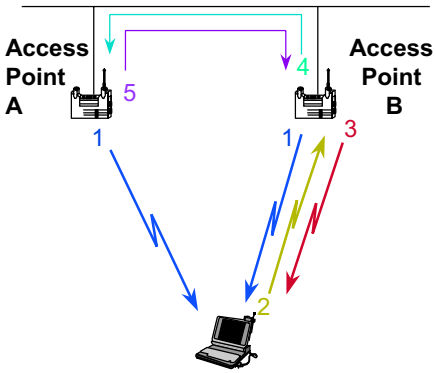
3 Client sends authentication request to selected AP (A)

4 AP A confirms authentication and registers client

5 Client sends association request to selected AP (A).

6 AP A confirms association and registers client

Cisco Aironet Reassociation Process—Passive Scanning

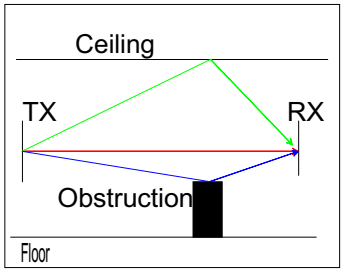


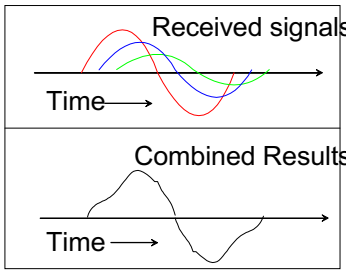
Roaming from AP A to AP B

Steps to Reassociation:

1. Adapter listens for beacons from APs. Adapter evaluates AP beacons, selects best AP.
2. Adapter sends association request to selected AP (B).
3. AP B confirms association and registers adapter.
4. AP B informs AP A of re-association with AP B.
5. AP A forwards buffered packets to AP B and de-registers adapte

Multipath Distortion

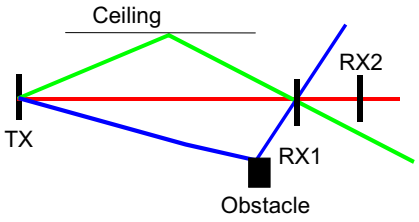




Diversity and Multipath

- In a multipath environment, signal null points are located throughout the area.
- Moving the antenna slightly will allow you to move out of a null point and receive the signal correctly.

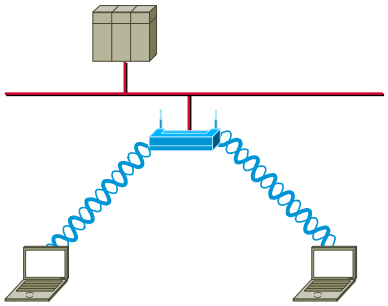
Dual antennas typically mean if one antenna is in a null, the other one will not be, thus providing better performance in multipath environments.



Two Different Implementations of Wireless LAN Technology

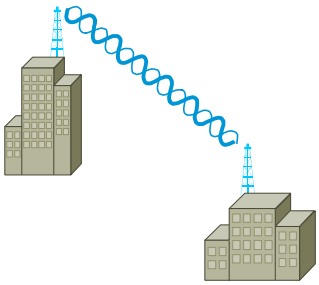
Wireless Networking

- Mobile user connectivity



Wireless Bridging

- LAN to LAN connectivity



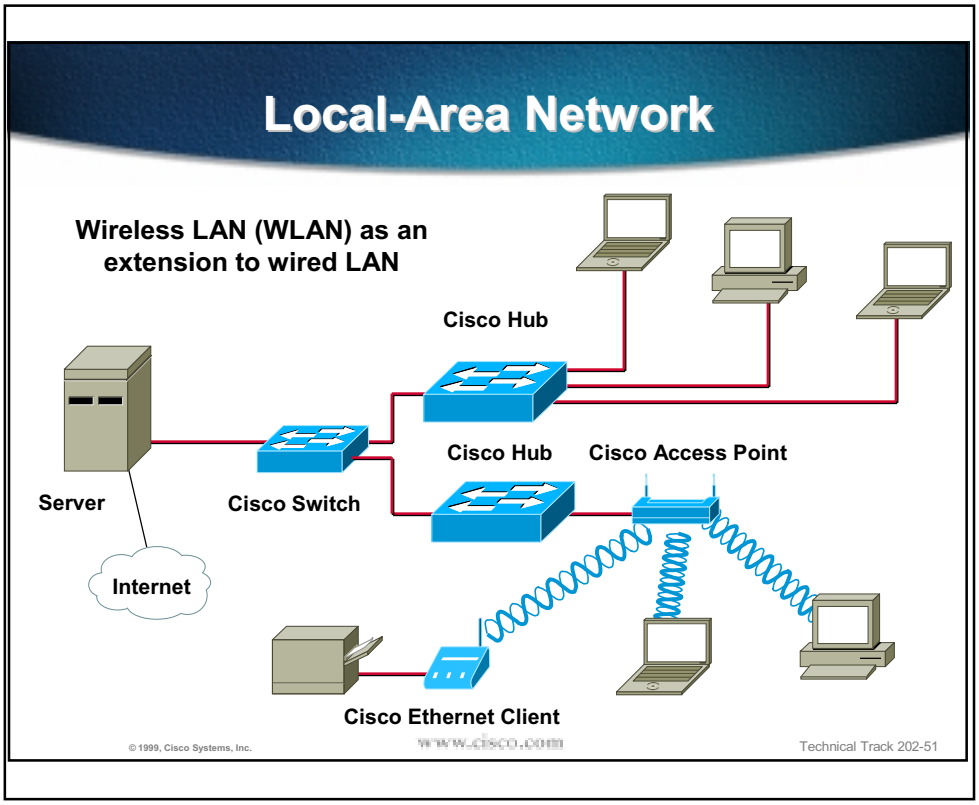
What Are Wireless LANs?

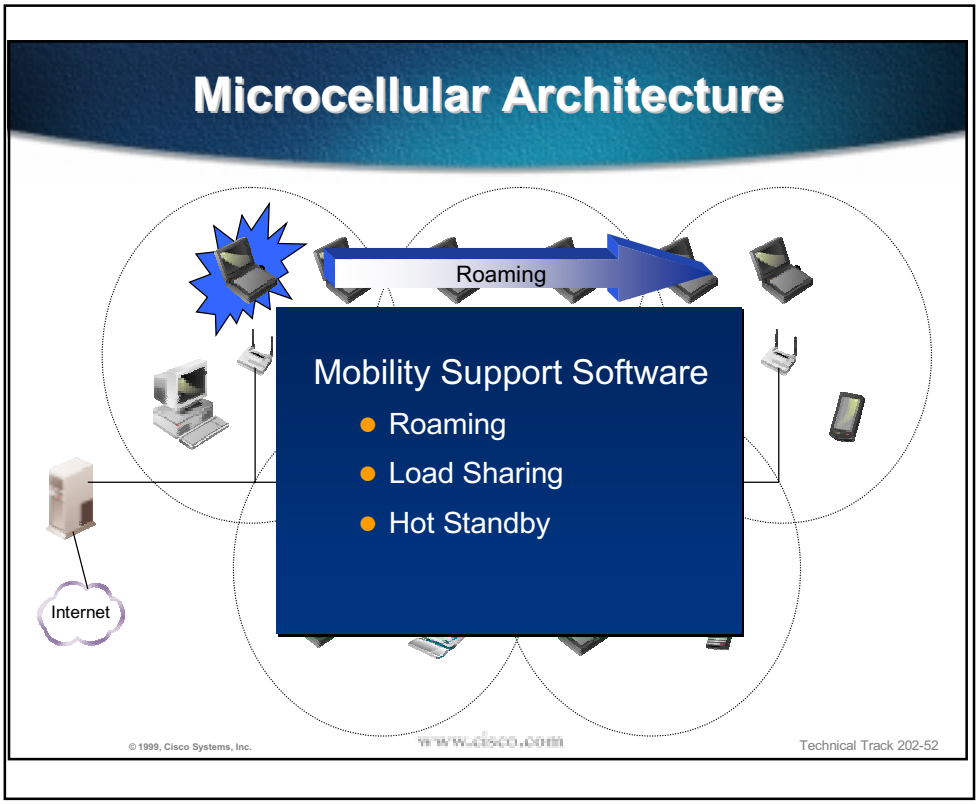
They are:

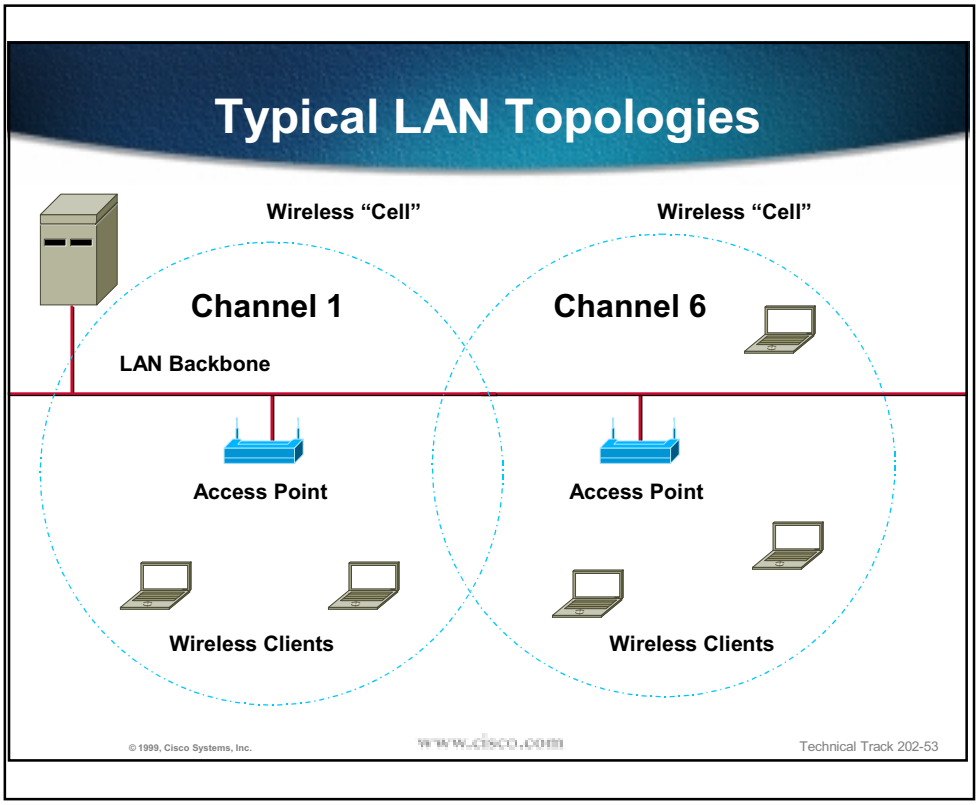
- Local, not wide area
- In-building or campus area coverage for mobile users
- Up to several miles for point-to-point (LAN to LAN)
- Radio or infrared
- FCC licenses not required
- Customer owns the equipment (no usage charges)

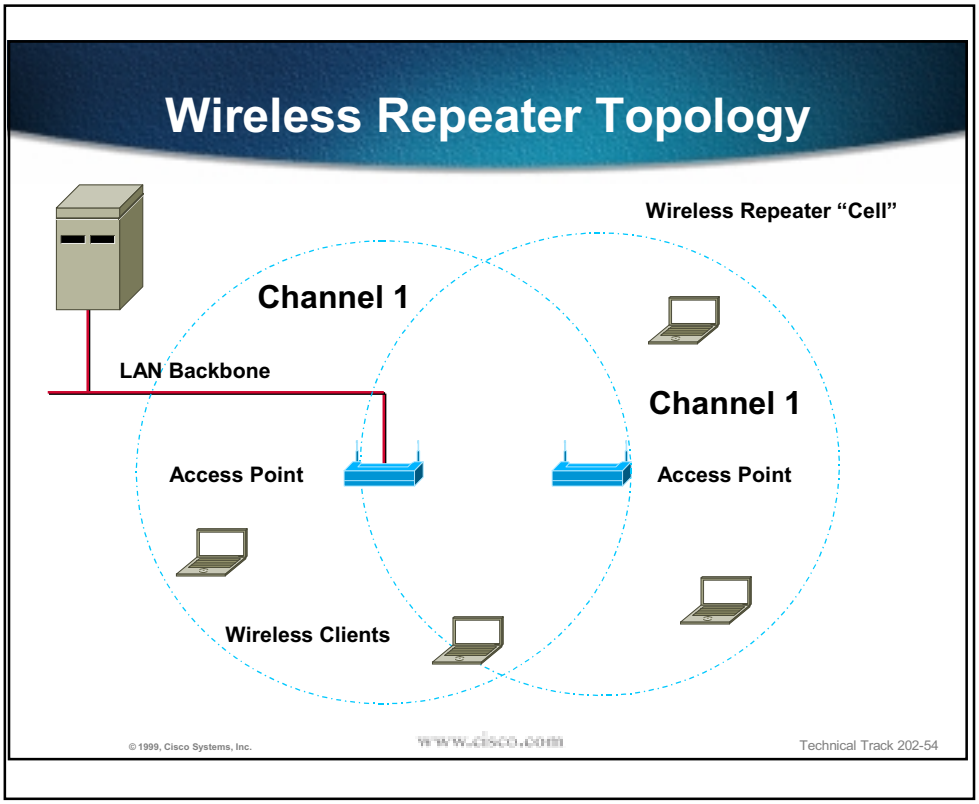
They are not:

- Cellular phones
- Pagers
- Packet Data
  - Ardis
  - CDPD
  - RAM Mobile Data
- PCS

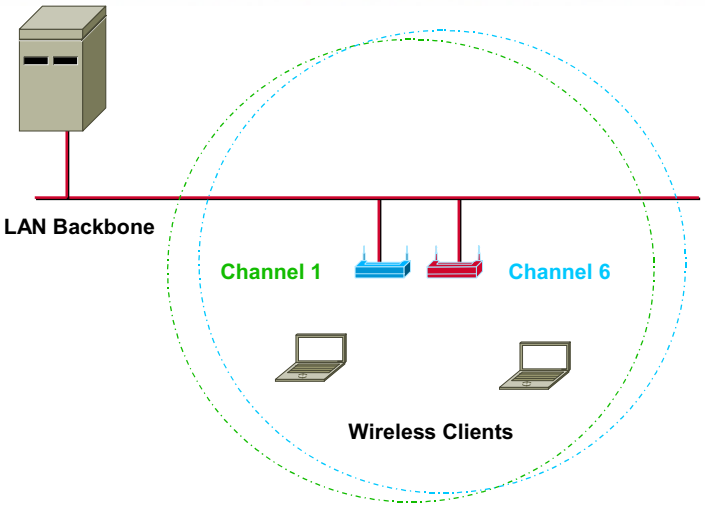




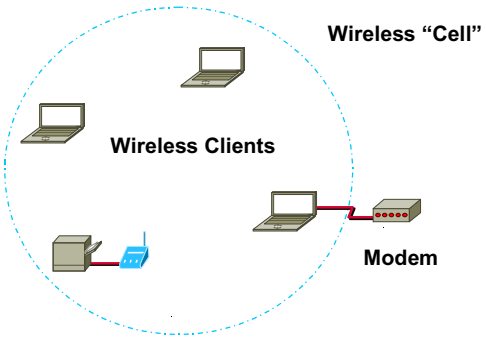




System Redundancy Topology

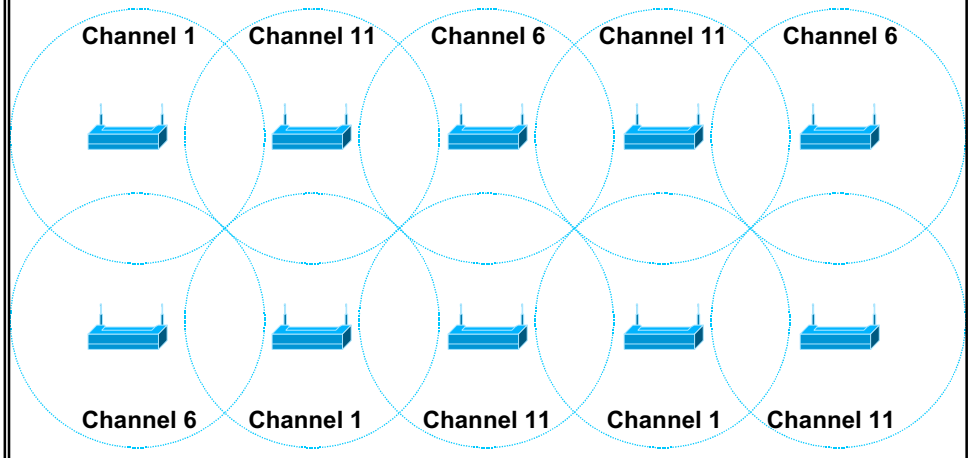


Alternative Peer-to-Peer Topology— Ad Hoc Mode



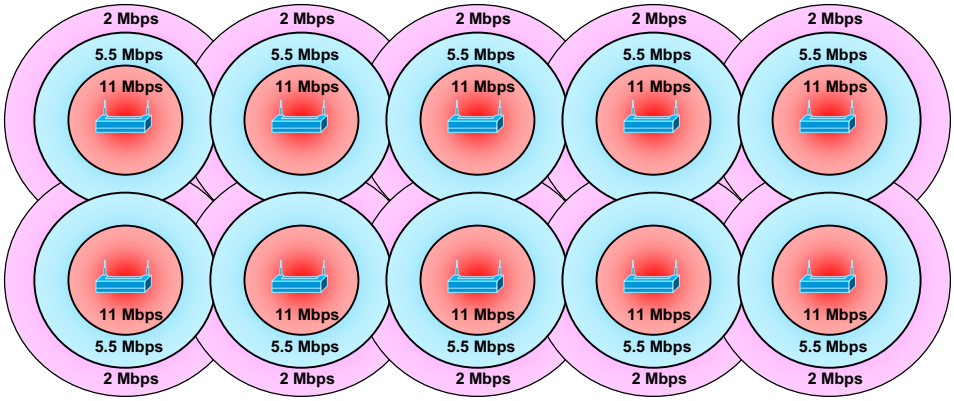
Channel Setup

Site Survey Channel Example



Multi-rate Implementation

Site Survey Bandwidth Example

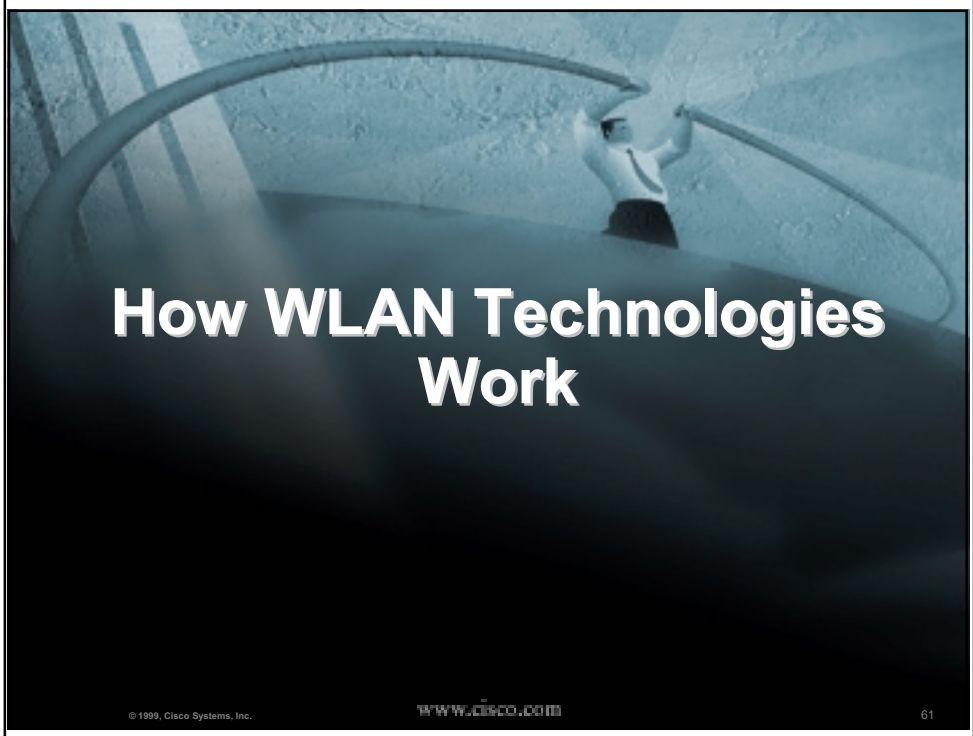


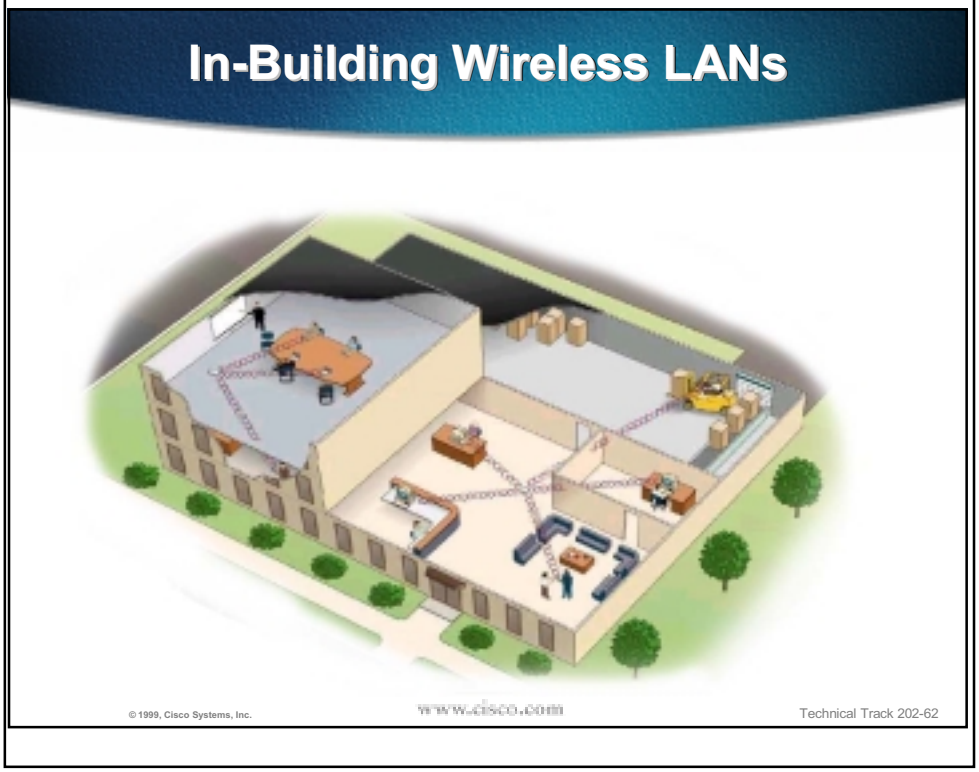
Some Rules for Wireless LANs

- All equipment must be on the same frequency (900 MHz or 2.4 GHz) and same type of modulation (FH or DS) to communicate.
- In order for wireless equipment from different manufacturers to work together, they must all be 802.11 compliant. Some performance issues may still arise, but as testing continues between vendors, these should be overcome in the near future. WECA will help with this.
- Performance is dependent upon many factors—"your mileage may vary"

Summary of Benefits of Cisco Microcellular Architecture

- Seamless roaming
- Superior power management
- Load sharing
- Wireless connected APs
- Wireless repeaters
- Fault tolerant systems
- Easy system configuration and expansion



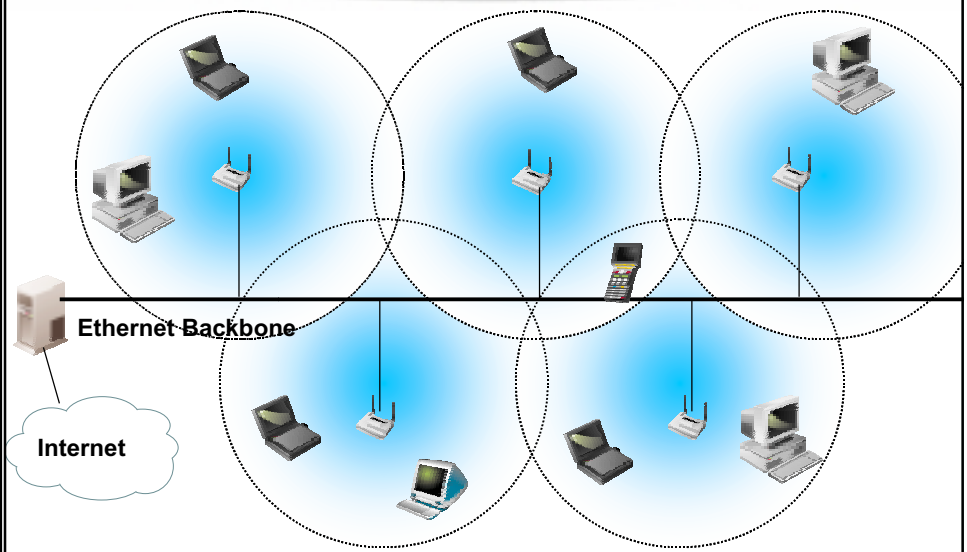


In-Building Wireless LAN—What it Is

Access points and client adapters working together to communicate data over radio frequencies

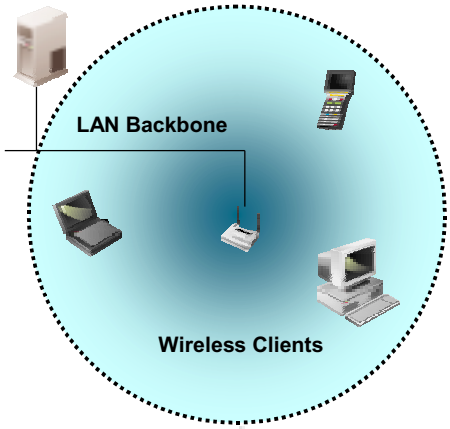
- **Overlay to existing wired networks**
  - **Enabling mobility**
- **Free standing network when wires aren't feasible**
  - **Enabling fast, flexible LAN's**

In-Building Wireless LANs—How it works



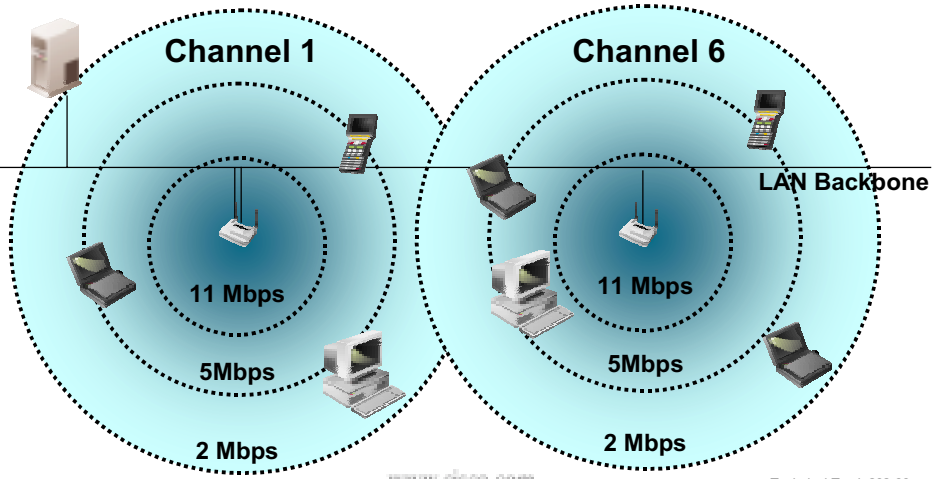
In-Building Wireless LANs—How it Works

Typical Single Cell Configuration



In-Building Wireless LANs—How it Works

Typical Multi-cell Configuration



Building-to-Building Wireless LANs

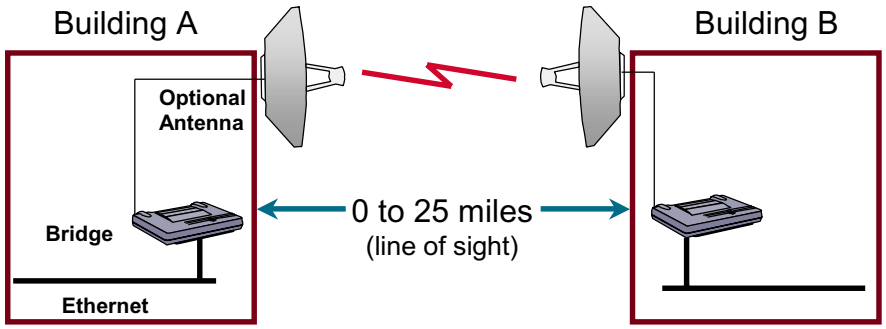
Building-to-Building Wireless LAN—What it Is

Wireless bridges and antennae communicating data between buildings over radio frequencies

- **Wireless building-to-building bridges**
  - **Connect separate LANs at high speed**
  - **Alternative to TI**
    - **No installation or recurring fees**
  - **Alternative to wired data infrastructure**
    - **Rapid deployment with lower cost**

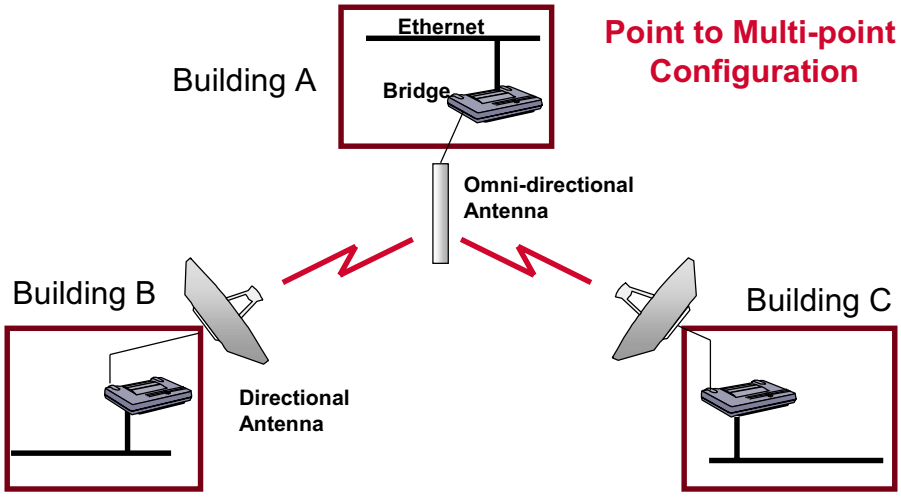
Wireless Bridge—How it works

Point to-Point Configuration



Wireless Bridge—How it works

Point to Multi-point Configuration



Review Quiz - Wireless LAN Topologies

1) Select the appropriate phrase to complete the following sentence. (More than one phrase may be correct.)

Wireless LANs...

A are local

B support the use of cell phones

C support the use of pagers

D provide in-building or campus coverage for mobile users

2) In-building LANs require bridges. True or False?

3) More Information = More Frequency Spectrum Used. True or False?