Wireless LAN Networks

Updated: 5/10/2011

Introduction

- Refer to notes

802 Protocols

- The services and protocols specified in IEEE 802 map to the lower two layers
  - Data Link and Physical
  - IEEE 802 splits the OSI Data Link Layer into two sub-layers named
    - Logical Link Control (LLC)
    - Media Access Control (MAC)

http://en.wikipedia.org/wiki/IEEE_802

802 Protocols

name	description	note
IEEE 802.1	Bridging (networking) and Network Management	
IEEE 802.2	Logical link control	inactive
IEEE 802.3	Ethernet	
IEEE 802.4	Token bus	disbanded
IEEE 802.5	Defines the MAC layer for a Token Ring	inactive
IEEE 802.6	Metropolitan Area Networks	disbanded
IEEE 802.7	Broadband LAN using Coaxial Cable	disbanded
IEEE 802.8	Fiber Optic TAG	disbanded
IEEE 802.9	Integrated Services LAN	disbanded
IEEE 802.10	Interoperable LAN Security	disbanded
IEEE 802.11 a/b/g/n	Wireless LAN (WLAN) & Mesh (Wi-Fi certification)	
IEEE 802.12	demand priority	disbanded
IEEE 802.13		Not used (officially)
IEEE 802.14	Cable modems	disbanded
IEEE 802.15	Wireless PAN	
IEEE 802.15.1	Bluetooth certification	
IEEE 802.15.2	IEEE 802.15 and IEEE 802.11 coexistence	
IEEE 802.15.3	High-Rate WPAN certification	
IEEE 802.15.4	Low-rate WPAN certification	

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IEEE 802.15.4	Low-rate WPAN certification
IEEE 802.15.5	Mesh networking for WPAN
IEEE 802.16	Broadband Wireless Access (WiMAX certification)
IEEE 802.16e	(Mobile) Broadband Wireless Access
IEEE 802.16.1	Local Multipoint Distribution Service
IEEE 802.17	Resilient packet ring
IEEE 802.18	Radio Regulatory TAG
IEEE 802.19	Coexistence TAG
IEEE 802.20	Mobile Broadband Wireless Access
IEEE 802.21	Media Independent Handoff
IEEE 802.22	Wireless Regional Area Network
IEEE 802.23	Emergency Services Working Group

Wireless LAN Classifications & Implementations

- Remember what LAN is!
- LAN Classification according to transmission technology
  - Infrared (LAN)
  - Spread Spectrum
  - Narrowband Microwave
- Wireless implementation approaches
  - LAN Extension
  - Cross-building interconnect
  - Nomadic Access
  - Ad hoc networking

LAN Extension

- Wireless LAN linked into a wired LAN on same premises
  - Wired LAN
    - Backbone
    - Support servers and stationary workstations
  - Wireless LAN
    - Stations in large open areas
      - UM: User Modules (connected to CM)
      - CM: Control modules
    - Manufacturing plants, stock exchange trading floors, and warehouses

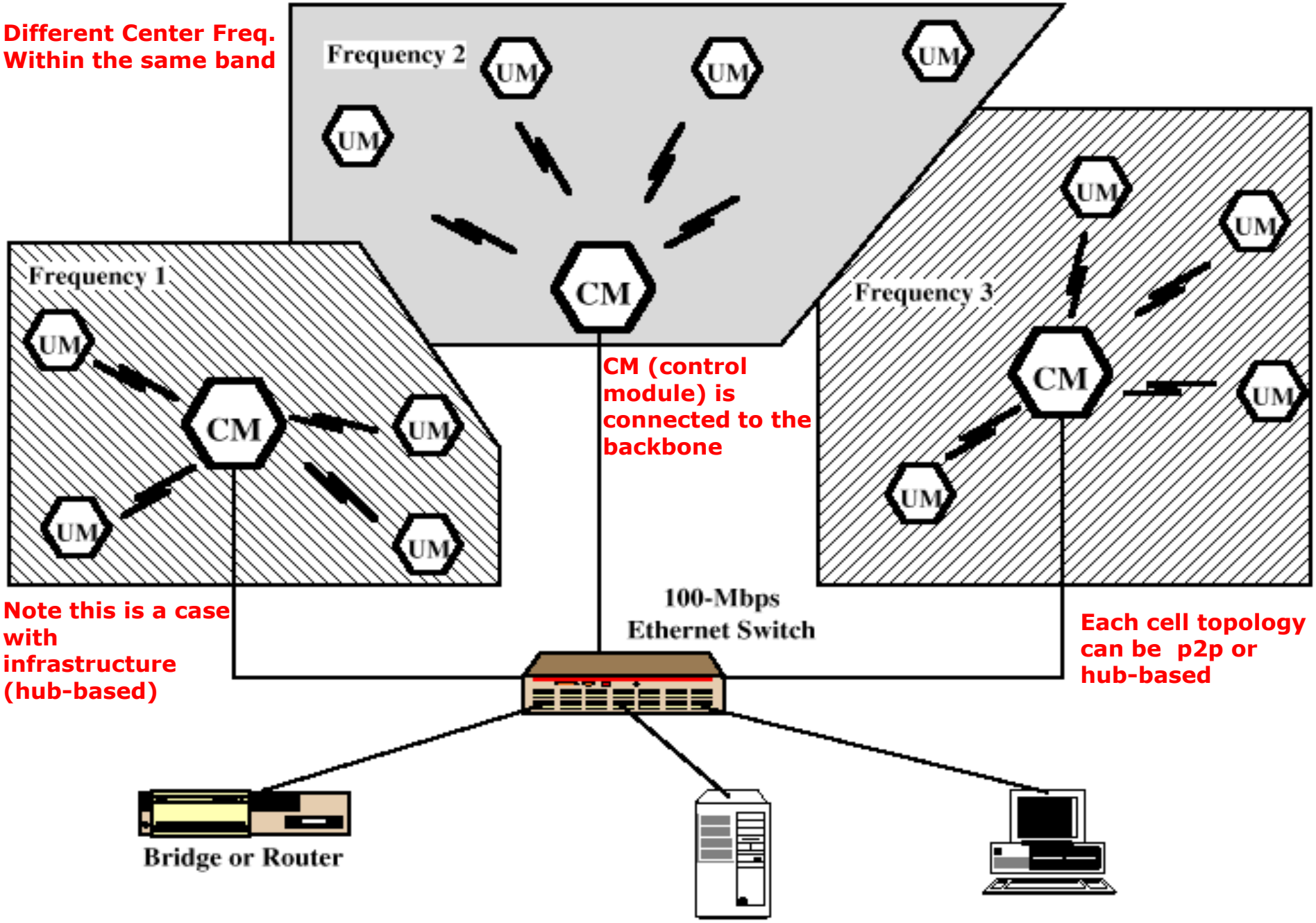


Figure 13.2 Example Multiple-Cell Wireless LAN Configuration

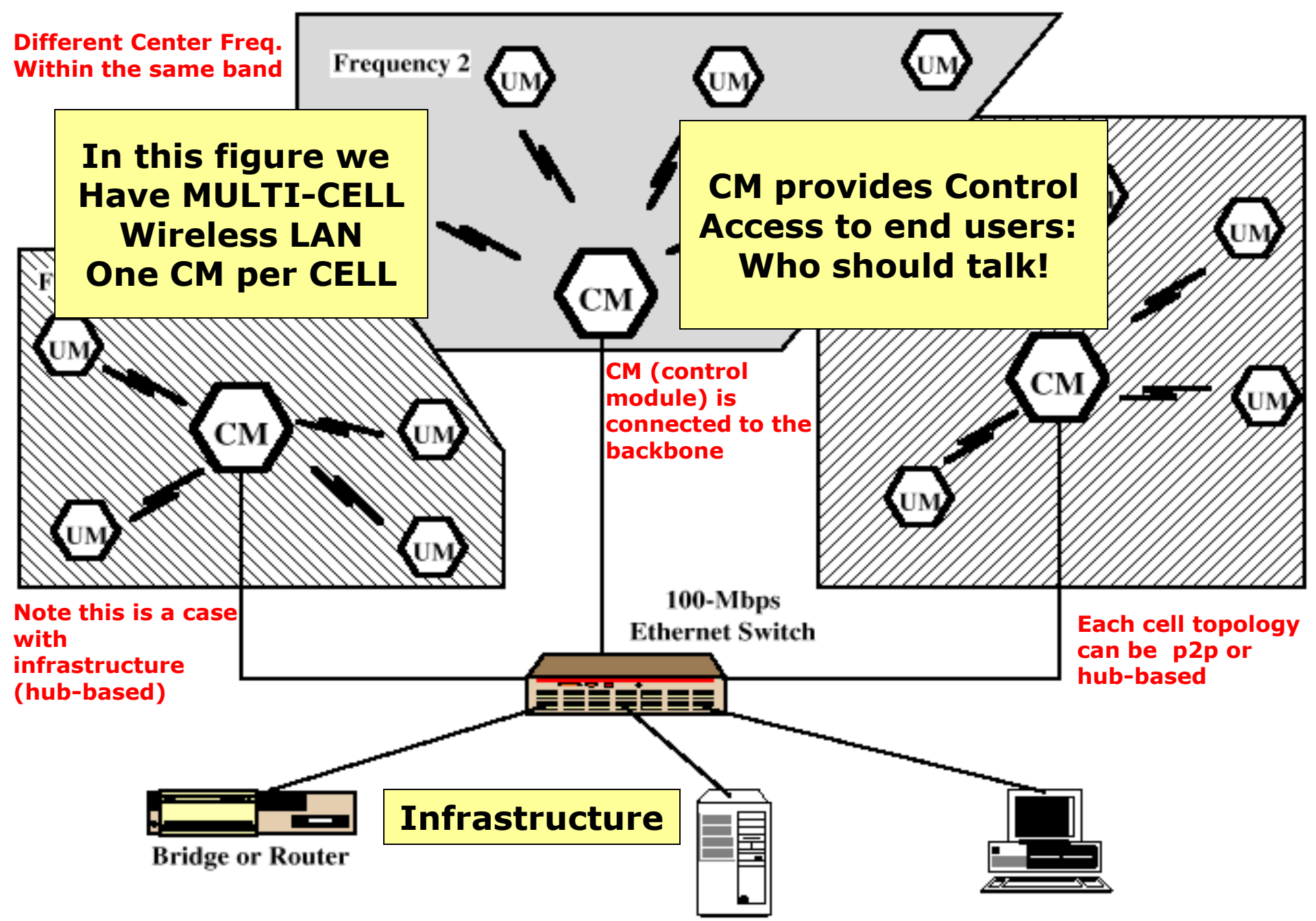


Figure 13.2 Example Multiple-Cell Wireless LAN Configuration

Cross-Building Interconnect

- Another wireless implementation approaches
- Connecting LANs in nearby buildings
  - Wired or wireless LANs
- Point-to-point wireless link is used
  - Devices connected are typically bridges or routers

Nomadic Access

- Wireless link between LAN hub and mobile data terminal equipped with antenna
  - Laptop computer or notepad computer
- In this case nomadic stations can move from one cell to another
  - The network has an infrastructure
- Uses:
  - Transfer data from portable computer to office server
  - Extended environment such as campus

Ad Hoc Networking

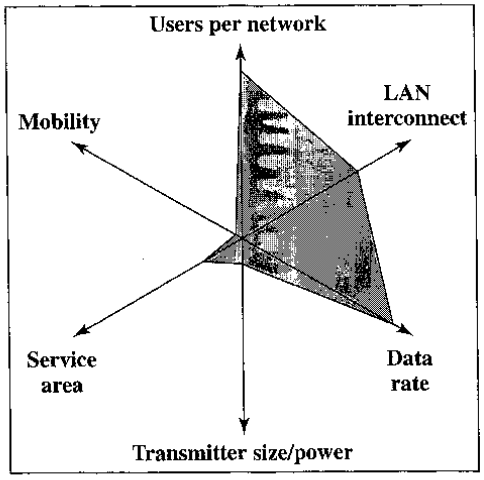
- Temporary peer-to-peer network set up to meet immediate need
  - No infrastructure
  - A peer collection of nodes dynamically configure themselves
  - There are no cells or control modules!
- Example:
  - Group of employees with laptops convene for a meeting; employees link computers in a temporary network for duration of meeting

Wireless LAN Requirements

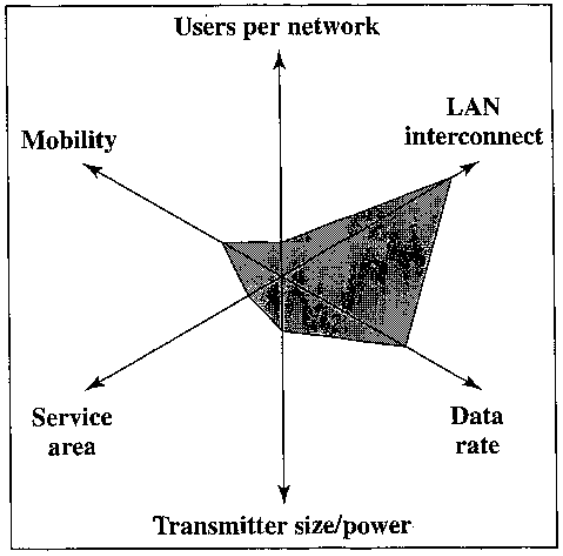
- Throughput
- Number of nodes
- Connection to backbone LAN
- Service area
- Battery power consumption
- Transmission robustness and security
- Collocated network operation (interface between LANs)
- License-free operation
- Handoff/roaming (Operated by the MAC)
- Dynamic configuration (automatic deletion, and addition)

In many cases these are conflicting requirements!

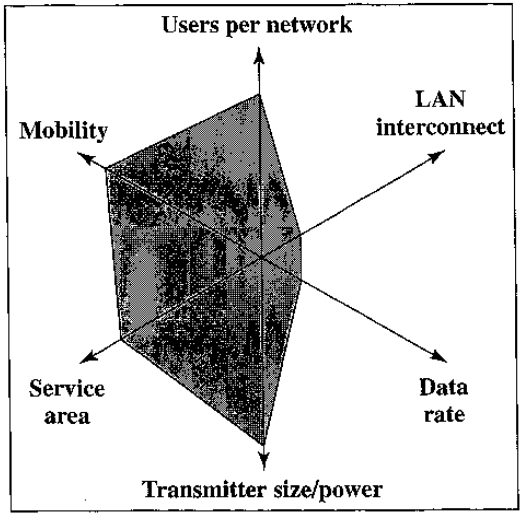
Kiviat Graph



(a) Wired LANs



(b) Wireless LANs



(c) Mobile data networks

Wireless LAN Categories

- Infrared (IR) LANs
- Spread spectrum LANs
- Narrowband microwave

Technology Comparison

	Infrared		Spread Spectrum		Radio
	Diffused Infrared	Directed Beam Infrared	Frequency Hopping	Direct Sequence	Narrowband Microwave
Data Rate (Mbps)	1 to 4	1 to 10	1 to 3	2 to 20	10 to 20
Mobility	Stationary/mobile	Stationary with LOS	Mobile	Stationary/mobile	
Range (m)	15 to 60	25	30 to 100	30 to 250	10 to 40
Detectability	Negligible		Little		Some
Wavelength/ frequency	λ: 800 to 900 nm		902 to 928 MHz 2.4 to 2.4835 GHz 5.725 to 5.85 GHz		902 to 928 MHz 5.2 to 5.775 GHz 18.825 to 19.205 GHz
Modulation technique	ASK		FSK	QPSK	FS/QPSK
Radiated power	—		<1W		25 mW
Access method	CSMA	Token Ring, CSMA	CSMA		Reservation ALOHA, CSMA
License required	No		No		Yes unless ISM

Carrier Sense Multiple Access (*CSMA*)

Strengths of Infrared Over Microwave Radio

- Infrared spectrum unregulated worldwide
  - Spectrum for infrared virtually unlimited
  - Possibility of high data rates
- Equipment inexpensive and simple
- Reflected by light-colored objects
  - Ceiling reflection for entire room coverage
- Doesn’t penetrate walls
  - More easily secured against eavesdropping
  - Less interference between different rooms

Drawbacks of Infrared Medium

- Outdoor environments experience infrared background radiation
  - Sunlight and indoor lighting
  - Ambient radiation appears as noise in an infrared receiver
  - Transmitters of higher power required
    - Limited by concerns of eye safety and excessive power consumption
  - Range limitation

IR Data Transmission Techniques

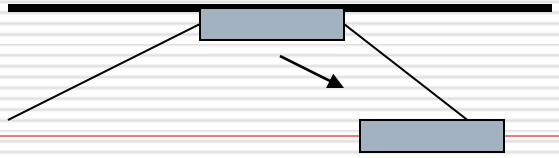
- Directed Beam Infrared
- Ominidirectional
- Diffused

Directed Beam Infrared

- Used to create point-to-point links
- Range depends on emitted power and degree of focusing
- Focused IR data link can have range of kilometers
  - Cross-building interconnect between bridges or routers

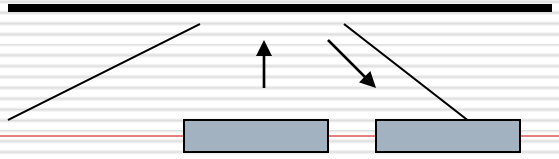
Ominidirectional

- Single base station within line of sight of all other stations on LAN
- Station typically mounted on ceiling
- Base station acts as a multiport repeater
  - Ceiling transmitter broadcasts signal received by IR transceivers
  - IR transceivers transmit with directional beam aimed at ceiling base unit



Diffused

- All IR transmitters focused and aimed at a point on diffusely reflecting ceiling
- IR radiation strikes ceiling
  - Reradiated omnidirectionally
  - Picked up by all receivers



Spread Spectrum LAN Configuration

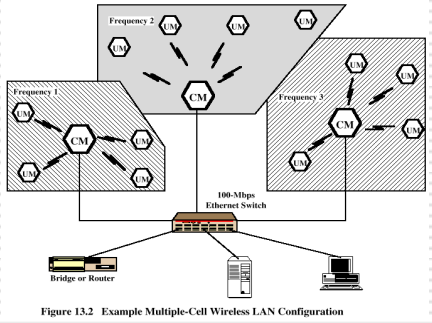


Figure 13.2 Example Multiple-Cell Wireless LAN Configuration

- Multiple-cell arrangement
- Within a cell, either peer-to-peer or hub
- Peer-to-peer topology
  - No hub
  - Access controlled with MAC algorithm
    - CSMA
  - Appropriate for ad hoc LANs

Spread Spectrum LAN Configuration

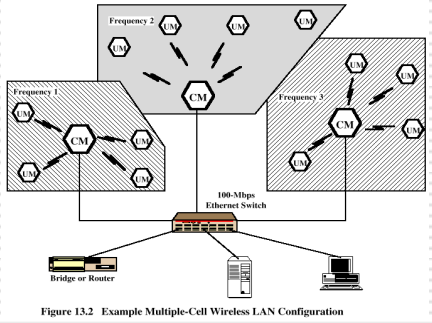


Figure 13.2 Example Multiple-Cell Wireless LAN Configuration

- Hub topology
  - Connected to backbone
  - May control access
  - May act as multiport repeater
  - Automatic handoff of mobile stations
  - Stations in cell either:
    - Transmit to / receive from hub only
    - Broadcast using omnidirectional antenna

Narrowband Microwave LANs

- Use of a microwave radio frequency band for signal transmission
- Relatively narrow bandwidth
- Licensed Narrowband
  - Controlled by FCC
- Interference free
  - Each geographic area has a radius of 28Km – 5 licenses / 10 frequencies
  - Motorola holds 600 licenses in 18-GHz band!
- Unlicensed
  - Low power / 2-5 GHz

Homework –

- Read Chapter 11: 329-348
- Read chapter 13
- Read the following papers and write one page summary for each (Note: the final-exam will include some of the issues discussed in these papers! Read them carefully)
  - **Wireless LAN design** alternatives **Bantz**, D.F. Bauchot, F.J. IBM Thomas J. Watson Res. Center, Yorktown Heights, NY;. http://pompone.cs.ucsb.edu/~wenye/majorexam/Communication/Bantz94.pdf
  - **Wireless Infrared Communications,** JOSEPH M. KAHN, MEMBER, IEEE, AND JOHN R. BARRY http://www-ee.stanford.edu/~jmk/pubs/proc.ieee.2.97.pdf (relatively old but you the idea)