Chapter 6

Wired and Wireless Local Area Networks

Chapter 6: Outline

- 6.2 LAN Components
- 6.3 Wired Ethernet
- 6.4 Wireless Ethernet
- 6.5 Best Practice LAN design
- 6.6 LAN Performance

Dedicated Servers vs. Peer-to-Peer

- Dedicated server network
 - Server permanently assigned specific task
 - Majority of all LANs
- Peer-to-peer network
 - Computers act as both clients and servers
 - No dedicated servers
 - Cheaper than dedicated with less capability
- Nslookup -type=any
- > yahoo.com

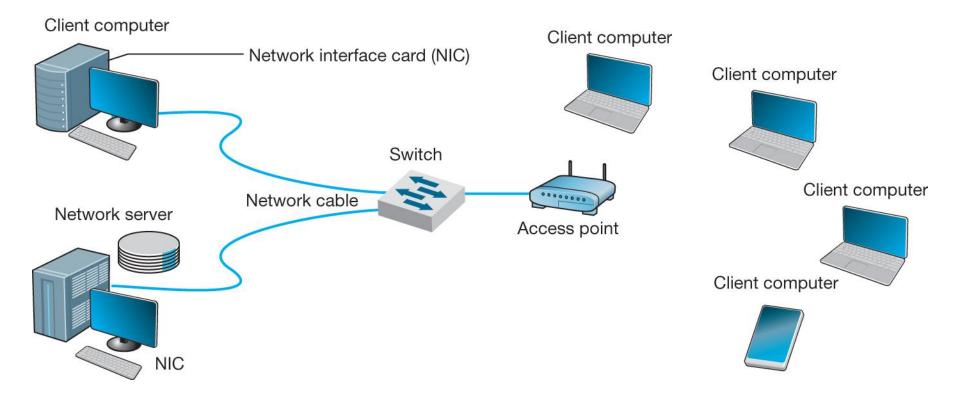
Dedicated Server Types

- Common server types:
 - Web
 - e-mail
 - DNS (name server)
 - SQL
 - DHCP
 - AAA (authentication, authorization, and accounting)
- Other Server Types
 - File servers
 - Print servers

Peer-to-Peer Networks

- Historically, more appropriate for small networks
- Advantage: Lower cost
 - No dedicated server
- **Disadvantage: Slower** than dedicated server networks
 - Each computer may be in use as a client and/or a server at the same time
 - Potentially, difficult to manage
- Which type of network is bit torrent?
- With IoT peer to peer utilization likely to increase...

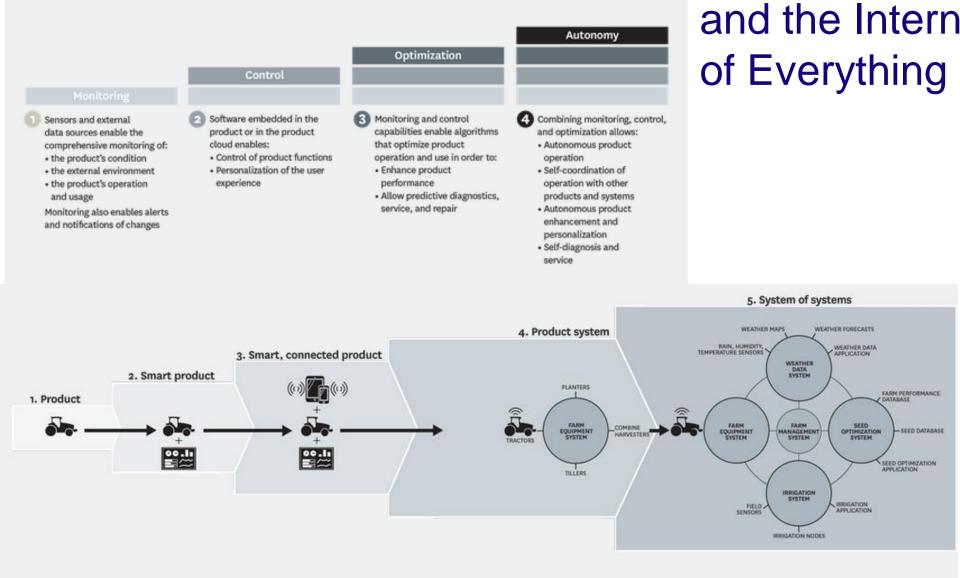
6.2 LAN Components



Now, you can also see storage components like Network Attached Storage (NAS) or Storage Area Networks (SAN)...

Capabilities of Smart, Connected Products

The capabilities of smart, connected products can be grouped into four areas: monitoring, control, optimization, and autonomy. Each builds on the preceding one; to have control capability, for example, a product must have monitoring capability.



Pervasive

<u>Communication</u>

Network Interface Cards (NICs)

- AKA network cards or adapters
- Physical and data link layer functions
 - Includes a unique data link layer address (called a MAC address), from manufacturer (& IEEE)
 - Organizes data into frames, sends them on to the network
- Now, usually built into motherboard
 - Makes it network interface chip rather than network interface card...
 - Also, external wireless NICs available with USB interface

Network Circuits

- Physically connect computers
- Cable types
 - Untwisted wire pairs (UTP)
 - Shielded twisted pair (STP)
 - Optical fiber
- Air...
 - Microwave
 - Radio
 - Laser
 - 802.11

Hubs & Switches

Functions:

1) Link cables from several networked computers

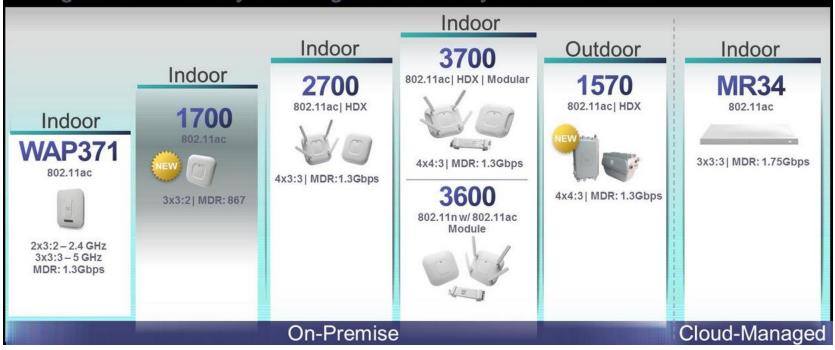
1) 4,8,16,24, or more ports



- 2) May allow connection of more than one media type, such as UTP and coax.
- 2) Repeats (reconstructs and strengthens) incoming signals
 - Extends the maximum LAN segment distance
- 3. Hubs: level 1 devices
- 4. Switches: level 2 devices

Wireless Access Points

Improve Wireless Performance Everywhere Gigabit Wi-Fi for Any Size Organization / Any Business Model

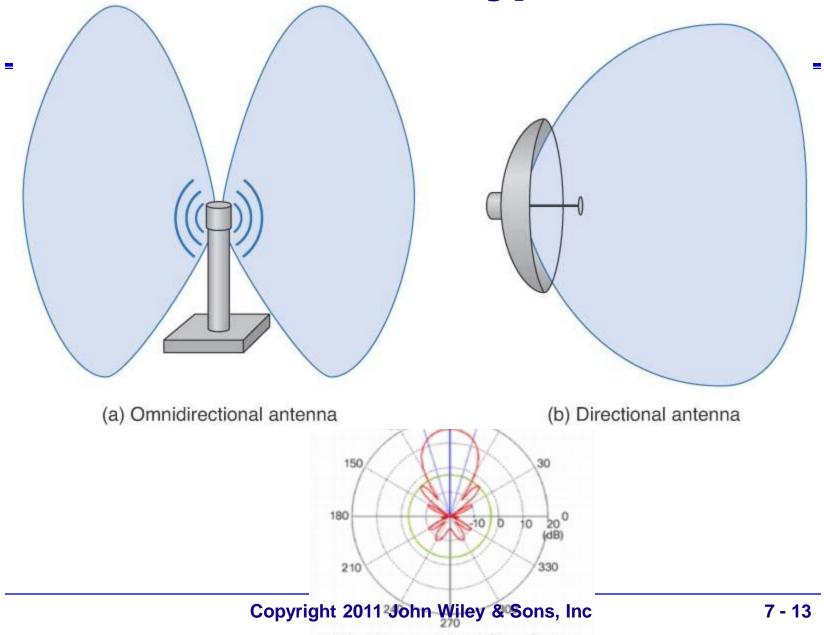


- Act as repeaters (hubs)
 - Must be able to hear all computers on a WLAN
 - Level one devices...

Three WLAN Antenna Types

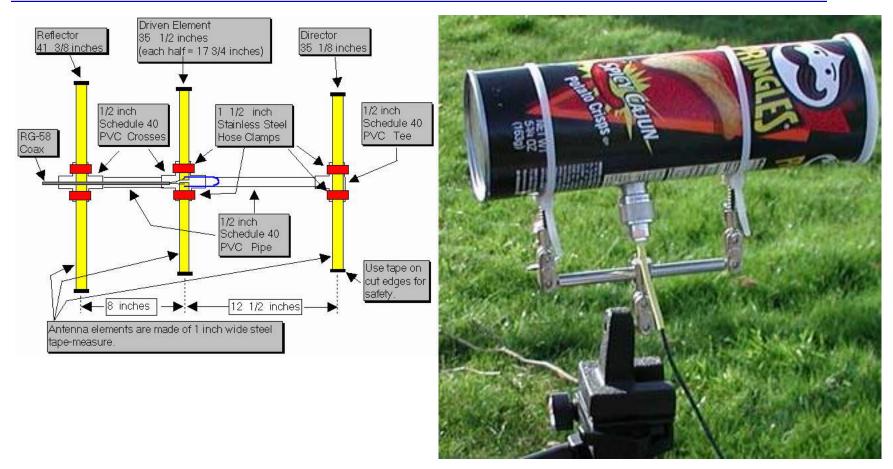
- Omni directional
 - Most common...
 - Dipole antenna
 - Transmits in all direction
- Directional antennas
 - Project signal primarily in one direction
 - Focused; stronger signal; farther ranges
 - Most often used on inside of an exterior wall
 - May reduce security vulnerabilities
- Yagi Antennas
 - Can also be made from Pringles, etc. cans
 - Called "Cantennas" (<u>www.cantenna.com</u>)
 - Older outdoor TV antennas were also Yagis....

Antenna Types



⁽c) Yagi Antenna Azimuth Plane Pattern

Yagi Antenna



Special purpose...

Network Operating Systems (NOS)

- NOS Components
 - Server software
 - Client software
- Directory Services
 - Provides information about LAN resources
- Network Profiles
 - Specifies what resources are available for use by other computers and which devices or people are allowed what access.

NOS Directory Service

- Provides LAN resource information
 - Yellow Pages
- Example: Microsoft's Active Directory (AD)
 - AD servers, or domain servers, act as Domain Name Server (DNS)
 - Organizes resources into a tree, each branch contains a domain (a group of resources)
 - A domain has a server (domain controller)
 - » Responsible for resolving address information (textual name of resource → network address)
 - » Responsible for managing authorization
 - Uses Lightweight Directory Service Protocol (LDAP) to interact with client computers

Profiles

- Network Profiles
 - Reside on servers
 - Specify resources available for use by other computers
 - Include data files, printers, etc.
 - Configured when LAN is established, and updated
- User profiles
 - One profile for each user
 - Describe what each user on a LAN can access
 - Includes access codes assigned to devices and users
 - Only user with a correct code can use a specific device



Wireless Ethernet

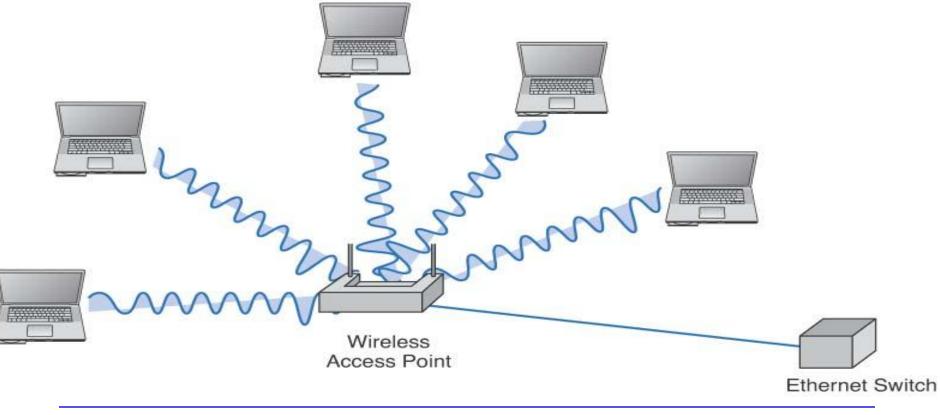
Uses radio frequencies

- Transmits through air
 - 802.1x Standard Family (aka, Wi-Fi)
- Wi-Fi popularity
 - Eliminates cabling
 - Facilitates network access from multiple locations
 - Facilitates mobile workers
 - Used in 90 percent of companies
 - Enables user to communicate when and where they want...

WLAN Topology

Same as Ethernet

- Physical star
- Logical bus



WLAN Media Access Control

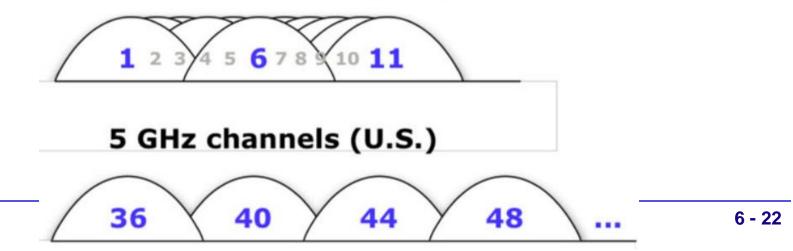
- CSMA/CA Media Access methodology
 - CA \rightarrow collision avoidance
 - Before sending anything, a station waits until another station is finished transmitting plus an additional random period of time

Association with an AP

- Scanning- searching for available APs
- May be active or passive
 - Active
 - NIC transmits probe frame on all active channels
 - AP responds with association info
 - Passive
 - NIC listens on all channels for beacon frame
 - NIC can use info in beacon frame to associate with AP

WLAN Characteristics

- Two frequency ranges
 - 2.4 GHz
 - 5 GHz
- Distance 100-150 meters
- Channels used to reduce interference 2.4 GHz channels (U.S.)

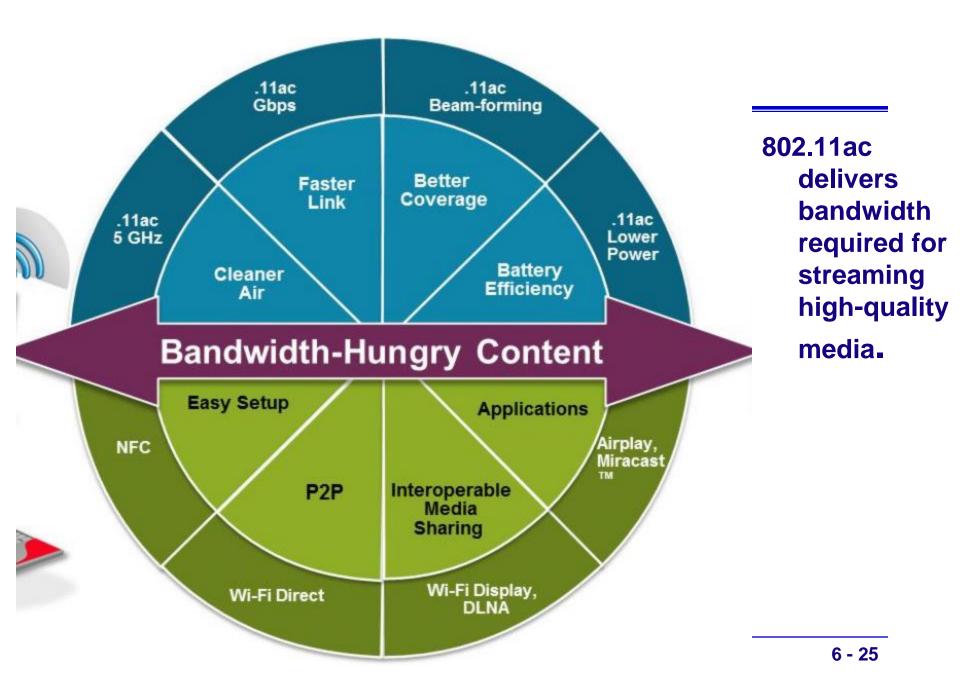


Popular Wireless Ethernet Standards

		THE EVOLUT	TABL	E I 802.11 STAN	DARDS		
Protocol	Year Introduced	Maximum Data Transfer Speed	Frequency	Highest Order Modulation	Channel Bandwidth	Antenna Configurations	
802.11a	1999	54 Mbps	5 GHz	64 QAM	20 MHz	1×1 SISO	
802.11b	1999	11 Mbps	2.4 GHz	11 CCK	20 MHz	1×1 SISO	
802.11g	2003	54 Mbps	2.4 GHz	64 QAM	20 MHz	1×1 SISO	
802.11n	2009	65 to 600 Mbps	2.4 or 5 GHz	64 QAM	20 and 40 MHz	Up to 4×4 MIMO	802.11ac Gigabit Spee
802.11ac	2012	78 Mbps to 3.2 Gbps	5 GHz	256 QAM	20, 40, 80 and 160 MHz	Up to 8×8 MIMO; MU-MIMO	5 9
						802.11n 450 Mbps	CWIFICI
				802 11b 11 Mbps	802.11g/a 54 Mbps		
			11 2 Mbps	2 nd Generation	3 rd Generatio	4 th Generation	
		Copyr	¹ Generation 1997-1998	1999-2001	2002-2006	2007-2011	6 - 23 Today!

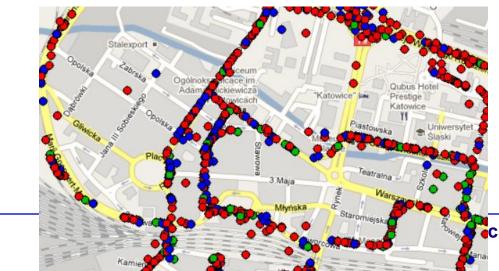
IEEE 802.11n

- Backward compatible with a, b, and g
- Disadvantage: one laptop using a, b, or g slows down access by all other laptops (even when they are using n)



WLAN Security

- Anyone within range can an use unsecure WLAN
- Finding a WLAN
 - Use special purpose software tools to learn about WLAN you discovered
 - Wardriving reconnaissance



Types of WLAN Security

- Service Set Identifier (SSID)
 - Required by all clients in every packet
 - Included as plain text
- Wired Equivalent Privacy (WEP)
 - Requires that user enter a key manually (to NIC and AP)
 - Communications encrypted using this key
 - Short key (40-128 bits) \rightarrow Easy to break
- Extensible Authentication Protocol (EAP)
 - One time WEP keys created dynamically after login
 - Requires a login (with password) to a server

Types of WLAN Security, cont'd

- Wi-Fi Protected Access (WPA)
 - new standard
 - longer key, changed for every packet
- 802.11i (WPA2)
 - EAP login used to get session key
 - uses AES
- MAC address filtering
 - Allows computers to connect to AP only if their MAC address is entered in the "accepted" list

Wireless Recommendations:

- Pick newest one that cost permits
 - 802-11ac
- Placement of APs a design consideration
 - So is likelihood of furniture moving

Physical WLAN Design

- Design begins with a site survey that determines:
 - Feasibility of desired coverage
 - Measuring the signal strength from temporary APs
 - Potential interference sources
 - Most common source: Number and type of walls
 - Locations of wired LAN and power sources
 - Estimate of number of APs required

Wireless Auditing

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Elapsed Time	2m 33s		asa-test.noc.iu.edu	TE	eLinks 0B:D1:40		0.130	49,647	1,227	1,870	49.96
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Identifying Network Bottlenecks

- server vs. circuit
 - Network server
 - Network circuit (especially LAN-BN connection)
 - Client computer
- How to find it
 - Check the server utilization during poor performance
 - If high >60%, then the server is the bottleneck
 - If low <40%, then the network circuit is the bottleneck
 - If between 40% 60%, both the server and circuits are the bottlenecks

Improving Disk Drive Performance

- Consider Redundant Array of Inexpensive Disks (RAID)
 - Replacing one large drive with multiple drives
 - Can improve performance and increase reliability
 - Can increase redundancy so a single drive failure does not result in data loss
- Also consider NAS or SAN

