13.1 Network Architectures & 13.2 Network Protocols-Reading

Notebook:	How Computers Work [CM1030]		
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Cornell Notes	**Topic:** 13.1 Network Architectures 13.2 Network Protocols	Course: BSc Computer Science Class: How Computer Work [CM1030]-Reading Date: December 28, 2019

Essential Question:

What are the different configurations of a network and the different protocols that govern its communication?

Questions/Cues:

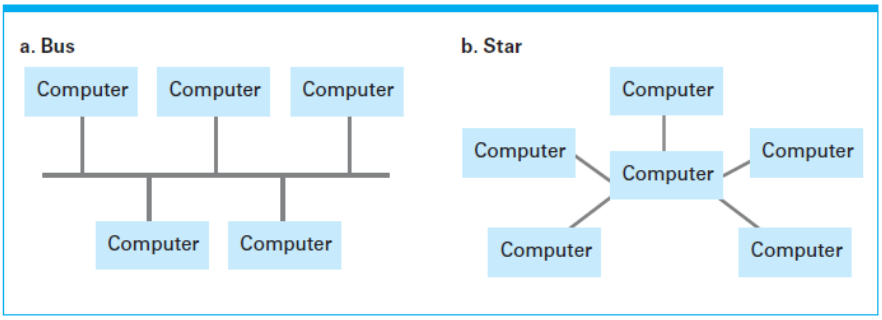
- What is PAN?
- What is LAN?
- What is MAN?
- What is WAN?
- What is a Open Network?
- What is a Closed Network?
- What is a Bus Network?
- What is a Star Network?
- What is a hub?
- What are Protocols?
- What is CSMA/CD?
- What is the Hidden Terminal Problem?
- What is a repeater?
- What is a bridge?
- What is a switch?
- What is a router?
- What is a forwarding table?
- What is a gateway?
- What is inter-process communication?
- What is the Client/Server Model?
- What is P2P?
- What are distributed systems?
- What is cluster computing?
- What is grid computing?
- What is cloud computing?
- What are tier-1 ISPs?
- What are tier-2 ISPs?
- What are tier-3 ISPs?
- What is a host?
- What is a hot spot?

- What is an IP Address?
- What is ICANN?
- What is a domain?
- What is a domain name?
- What are TLDs?
- What are Subdomains?
- What are Name Servers?
- What is DNS Lookup?
- What is VoIP?
- What is streaming?
- What is N-unicast?
- What is Multicast?
- What is on-demand streaming?
- What are CDNs?

Notes

- PAN(Personal Area Network) = used for short-range comms, typically less than a few meters such as between a wireless headset and a smartphone.
- LAN(Local Area Network) = consists of a collection of comps in a single building or building complex, for example the comps on uni campus
- MAN (Metropolitan Area Network) = network of intermediate size, such as one spanning a local community
- WAN(Wide Area Network) = links machines over a greater distance perhaps in neighboring cities or on opposite sides of the world
- Open Network = network's internal operation is based on designs that are in the public domain
- Closed Network (Proprietary Network) = network's internal operation is based on innovations owned & controlled by particular entity such as an individual or corporation; restricted by license fees & contract conditions
- Bus Network = machines are all connected to a common comm line called a bus; machines in network comm directly with each other over common bus. Sometimes, a bus network is created by running links from each comp to a central location where they are connected to a device called a hub.
- Star Network = in which one machine serves as a central focal point to which all the others are connected. Popular today in wireless networks where comm is conducted by means of radio broadcast and central machine called the access point(AP) serves as focal point around which all comm is coordinated; machines in network comm with each other indirectly through an intermediary central machine

Figure 4.1 Two popular network topologies



- Hub = little more than a very short bus. All it does is relay any signal it receives (with perhaps some amplification) back out to all the machines connected to it.
- Protocols = rules established by which activities are conducted to ensure network reliability
- CSMA/CD (Carrier Sense, Multiple Access with Collision Detection) = dictates that each message be broadcast to all machines on bus. Each machine monitors all the messages

but keeps only those addressed to itself. To transmit a message, a machine waits until the bus is silent, at this time it begins transmitting while continuing to monitor the bus. If another machine also begins transmitting, both machines detect the clash & pause for a brief, independently random period of time before trying to transmit again.
    - CSMA/CD is not compatible with wireless star networks in which all machines comm through a central AP, this is because a machine unable to detect that its transmissions are colliding with those of another.
- Hidden terminal problem = signals from different machines are blocked from each other by objs or distance even though they can all comm with central AP.
    - Result is that wireless networks adopt policy of trying to avoid collisions rather than trying to detect them, classified as CSMA/CA (Carrier Sense, Multiple Access with Collision Avoidance)
        - In CSMA/CA, when machine first needs to transmit and finds comm channel silent it doesn't transmit immediately. Instead it waits for a short period time and starts transmitting if channel has remained silent throughout that period
        - If busy channel is experienced during this process, machine waits for randomly determined period before trying again. Once period is exhausted, machine is allow to claim a silent channel with hesitation
    - To solve HTP some WiFi networks require that each machine send a short "request" message to AP & wait until AP acknowledges that request before transmitting an entire message. If AP is busy because it is dealing with "hidden terminal", it will ignore request & requesting machine will know to wait. Otherwise, AP will acknowledge request & machine will know it's safe to transmit. Note all machines in network will hear all acknowledgements sent from AP & thus have a good idea of whether AP is busy at any given time even though they may not be able to hear the transmissions taking place

Figure 4.2 Communication over a bus network

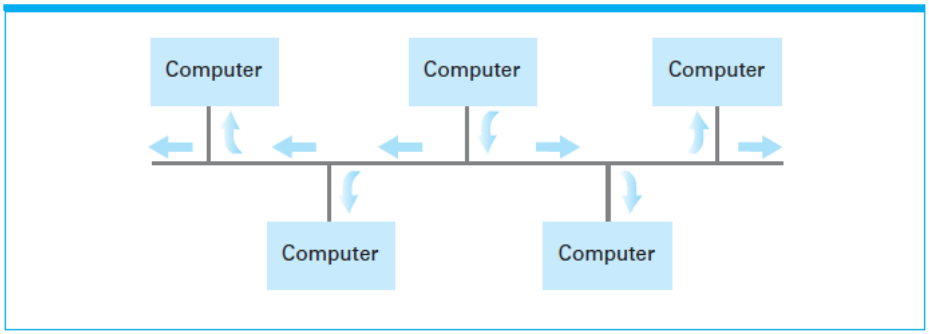
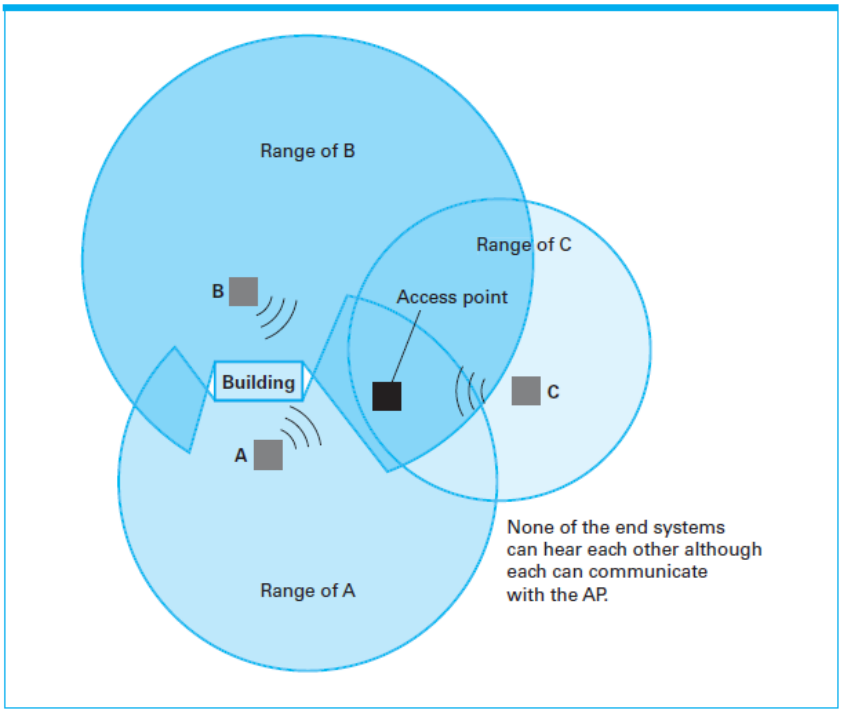
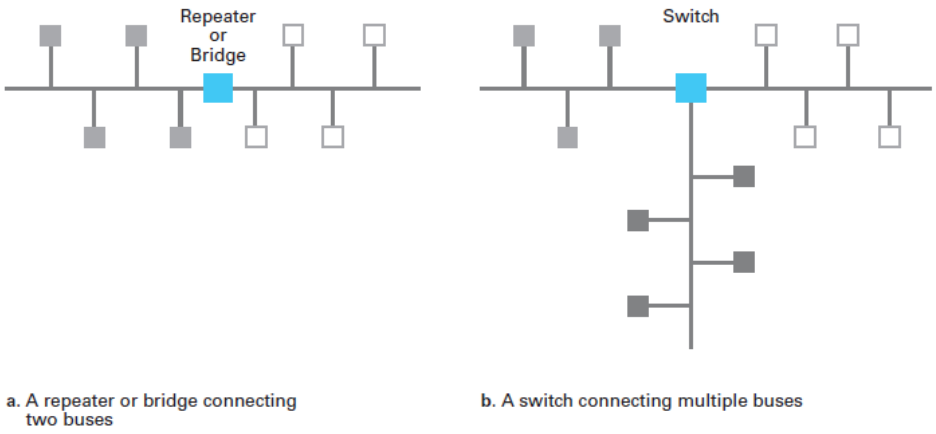


Figure 4.3 The hidden terminal problem



- Repeater = a device that passes signals back and forth between the original buses (usually with some form of amplification) without considering the meaning of the signals
- Bridge = Like a repeater, it connects two buses, but it doesn't necessarily pass all messages across the connection. Instead, it looks at the destination address that accompanies each message & forwards a message across the connection only when that message is destined for a comp on the other side. Thus, two machines on the same side of the bridge can exchange messages without interfering with comm taking place on the other side.
- Switch = is essentially a bridge with multiple connections, allowing it to connect several buses rather than just two. A switch produces a network consisting of several buses extending from the switch as spokes on a wheel. Like a bridge, a switch considers the destination addresses of all messages & forwards only those messages destined for other spokes. Moreover each message that is forwarded is relayed only into the appropriate spoke, thus minimizing the traffic in each spoke

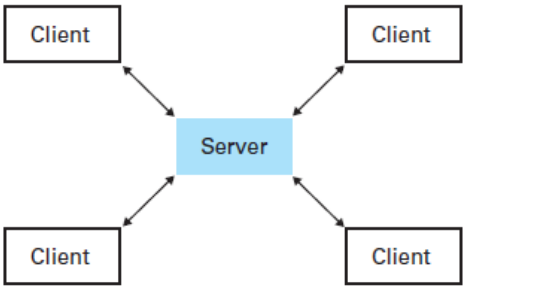
Figure 4.4 Building a large bus network from smaller ones



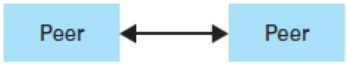
- Router = special purpose comps used for forwarding messages. Routers provide links between networks while allowing each network to maintain its unique internal characteristics

- Forwarding table = contains the router's knowledge about the direction in which messages should be sent depending on their destination addresses.
- Gateway = "point" at which one network is linked to an internet is often called a gateway because it serves as a passageway between network & outside world.
- Inter-process communication = various activities(or processes) executing on different comps with a network (or even executing on the same machine via time-sharing/multitasking), communicating with each other to coordinate their action & to perform their designated tasks.
- Client/Sever model = defines basic roles by processes as either a client--which makes requests of other processes or a server--which satisfies the requests made by clients
    - Early app of C/S model was in the office with a single printer acting as a print sever with all other machines acting clients making requests to the printer
    - Another app of C/S model was where one machine was equipped with high-capacity mass storage that contained all of an organization's records. Other machines requested access to records as needed. The machine with mass storage acted like the file server and other machines acted like clients that requested access to files stored at file server.
- Peer-to-peer (P2P) model = involves processes that provide service to & receive service from each other. P2P model usually involves process that execute on a temporary basis. Examples include instant message and playing competitive interactive games.
    - Swarm distribution is where one peer may receive a file from another and then provide that file to other peers.

Figure 4.6 The client/server model compared to the peer-to-peer model



a. Server must be prepared to serve multiple clients at any time.

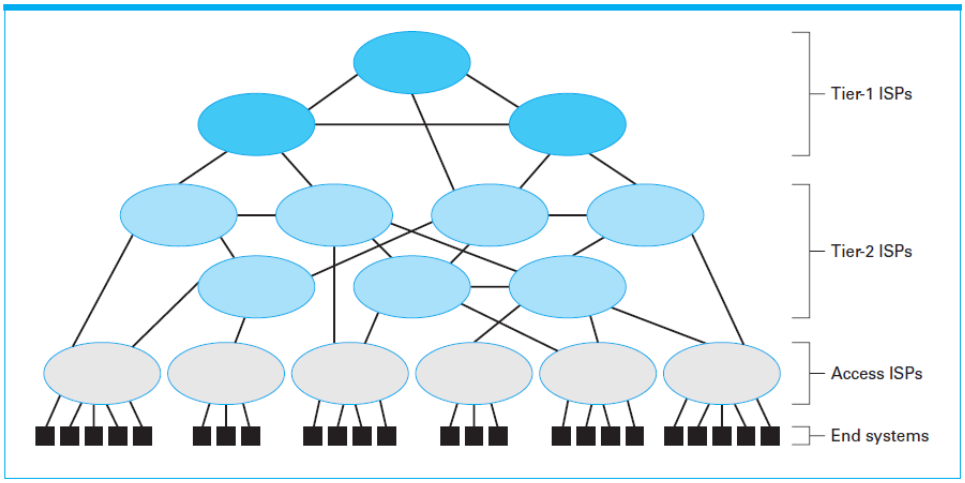


b. Peers communicate as equals on a one-to-one basis.

- Distributed systems = consist of software units that execute as processes on different computers.
- Cluster computing = a distributed system in which many independent comps work closely together to provide computation or services comparable to much larger machine
    - Cost of individual machines + high-speed network to connect them is cheaper than higher-priced supercomputer, higher reliability & lower maintenance costs
    - Such systems used to provide high-availability--at least one member of cluster will be able to answer request, even if other cluster members break down or are unavailable. Secondly, such systems also provide load-balancing--workload can be shifted automatically from members of cluster that have too much to do to those that may have too little.

- Grid computing = distributed systems that are more loosely coupled than clusters but still work together to accomplish large tasks, can involve specialized software to make it easier to distribute data & algorithms to machines participating in a grid
- Cloud computing = huge pools of shared comps on the network can allocated for use by clients as needed.
- Tier-1 ISPs = very high-speed, high capacity, international WANs. These Networks thought of as backbone of the Internet. Typically operated by large companies that are comms business.
- Tier-2 ISPs = tend to be more regional in scope and less potent in their capabilities. Typically also operated by large companies that are comms business.
    - Tier-1 & tier-2 ISPs are essentially networks of routers that collectively provide the Internet's comm infrastructure; they are core of the Internet.
- Tier-3 ISPs (Access ISPs) = Intermediary that provides access to core of Internet. Access ISP is an independent internet, also called an intranet, operated by single authority that is in business of supplying Internet access to individual homes & businesses

Figure 4.7 Internet composition



- End System or Hosts = devices that individual users connect to the access ISPs
- Hot spot = Area within the AP or group of AP's range
- IP Address = unique identifying address to a comp on the Internet. IP short for Internet Protocol. Originally, each IP address was a pattern of 32 bits
    - IP addresses traditionally written in dotted decimal notation in which bytes of the address are separated by periods & each byte is expressed as an integer rep'ed in traditional base 10 notation
- ICANN(Internet Corporation for Assigned Names and Numbers) = corp established to coordinate Internet's operation
- Domain = a "region" of the Internet operated by a single authority such as a university, club, company, or government agency.
    - Each domain must be registered with ICANN, a process handled by companies called registrars that have assigned this role by ICANN
- Domain Name = a mnemonic DN which is unique among all domain names throughout the Internet. Domain name are often descriptive of the organization registering the domain.
- Top-level domains (TLD) = For example, the edu suffix for "educational" is considered a TLD. Others are com for commercial institutions, gov for US government, org for nonprofit & info for unrestricted use.
- Country-code TLD = two-letter TLD for specific countries such as ca for Canada.
- Sub-domain = multiple extensions are used as a means of organizing the names within a domain. SDs often rep different networks within the domain's jurisdiction
- Name servers = essentially directories that provide address translation services to clients. Collectively, name servers are used as an Internet-wide directory system known as the domain name system (DNS).

- DNS Lookup = The process of using DNS to perform a translation is called a DNS lookup
    - for a machine to be accessible by means of a mnemonic domain name, that name must be rep'ed in a name server within the DNS
- Voice over Internet Protocol(VoIP) = Internet infrastructure is used to provide voice comm similar to that of traditional telephone systems.
- Streaming = transporting audio & video across the Internet in real-time
- N-unicast = single sender involved with multiple unicasts. For example, establishing a server that would send program messages to each of the clients who requested them in case of a Internet radio station.
    - Unicast refers to one sender sending messages to one receiver
- Multicast = server transmits a message to multiple clients by means of a single address and relies on the routers in the Internet to recognize significance of that address & to produce & forward copies of the message to the appropriate destinations
- On-demand streaming = end user expects to view or listen to media at an arbitrary time of their choosing
- Content delivery networks (CDNs) = groups of servers distributed strategically around the Internet that specialize in streaming copies of content to nearby end users in their network "neighborhood"

Summary

In this week, we learned about the different configurations of networks, different types of distributed computing, different tiers of ISPs, the DNS & domain names, and finally what streaming is & various technologies involved in making it possible.