Introduction to computer networks and Cloud Computing

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Computer Netwoks

- A *computer network* is a set of independent computer systems that are connected by a communication link with the purpose of sharing information and resources.
- The individual computer systems in the networks are called: hosts, nodes, or end systems.

Comm. link

- In the old days the physical link used to connect the computers was the phone line (dial-up). In that instance the transmitted data was converted from digital to analog in one end and converted back to digital at the other end.
- Modems (from modulation/demodulation) alter the properties of the electrical wave (amplitude/frequency)) that travels through the circuit to encode/decode the information (bit pattern) that is being transmitted by the computer system.
- *Bandwidth* is a measurement of bit-rate of available or consumed data communication resources expressed in bits per second or multiples of it (bit/s, kilobit/s, Megabit/s, Gigabit/s, etc.)

Comm. link

- *Broadband*: The terms generally refers to any communication link with a transmission rate exceeding 256 Kbits/s.
- *Digital subscriber line* (DSL): It uses the same wires as the phone, but a different set of frequencies and it transmit a digital rather than an analog signal. In DSL the data signal does not interfere with the voice signal and is usually asymmetric (i.e., not the same transmission speed for download and for upload direction).
- *Cable modem*: It uses the wires used to deliver cable TV. Thus some of the capacity used to provide the cable TV signals is allocated to transmit data.

Comm. link

- *Ethernet*: It was developed in the 70's by Xerox. Originally it used coaxial cable, but now it uses either coaxial cable, fiber optic cable, or twisted-pair copper wire. Through times several standards for Ethernet had been adopted by the IEEE.
- *Wireless Fidelity* (Wi-Fi): It is used to connect computers that are in the range of an access point (approx. 150-300 feet).
- *Bluetooth*: It is used to connect devices that quite close to each other (typically 30-50 feet).

Comm. link

Line Type	Speed
Dial-up phone	56 Kbps
DSL line, cable modem	2 Mbps
Ethernet	10 Mbps
Fast Ethernet	100 Mbps
Gigabit Ethernet	1 Gbps
Ten-Gigabit Ethernet	10 Gbps

Local Area Network (LAN)

- It connects hardware in "close" proximity.
- The owner of the computers owns the means of communication.
- Wired LAN's can be constructed using different interconnection strategies:
  - Bus topology: nodes are interconnected to a single shared comm. line.
  - Ring topology: nodes are interconnected in a circular fashion.
  - Star, etc.

Local Area Network (LAN)

- The most widely used connection technology used for LAN is Ethernet.
- Ethernet uses a bus topology. There are two ways to construct an Ethernet LAN.
- One way is called the shared cable. In that case a wire (twisted-pair or coaxial) is used and users tap into it using a *transceiver*. There is a limited number of users that can connect t o a cable.
- Two or more cables can be joined via repeaters (it amplifies and forwards a signal), and/or bridges (also called switches. Switches have knowledge of the location of nodes in separte networks.

Local Area Network (LAN)

- In the other way, rather than a single cable a box called a hub is. The hub contains a numbers of ports, with a wire leading from each port to an Ethernet interface in the wall of a room in a building. Note that in this case the shared cable or bus is inside the hub.
- In a LAN the messages are broadcast on the shared channnel (link).

Wide Area Network (WAN)

- It connects devices that are not in “close” proximity. (Across town, across country, etc).
- The unit of transmission in aa WAN is a packet. A packet is an information block with a fixed maximum size that is transmitted in the network as a single unit.
- Most WAN use packet-switched technology.
- Messages longer than a packet are chopped into packets and sent through the network.

Overall Structure of the Internet

- Real-world networks, like the Internet, are a complex mix of LAN's and WAN's.
- Individual networks are connected by *routers*. Like bridges, routers transmit messages between networks, but in contrast to bridges the network the networks do not have to be of the same type.
- The internet is a "network of networks" with a hierarchical structure.
- Internet service providers (ISP) provide conectivity to clients through their private networks.

Communication Protocols

- In networking a protocol is a mutually agreed upon set of rules.
- The protocols that govern the Internet are setup in a hierarchical fashion.
- The Internet protocol hierarchy (also called protocol stack) has 5 layers. This hierarchy is also called TCP/IP, after the name of the most important protocols.

Communication Protocols

Layer	Name	Examples
5	Application	HTTP, SMTP, FTP
4	Transport	TCP, UDP
3	Network	IP
2b	Logical Link Control	PPP, Ethernet
2a	Medium Access Control	Ethernet
1	Physical	Modem, DSL, Cable Modem

The 2a and 2b layers are the Data Link Layer.

Communication Protocols

- The *physical layer* creates the bit pipe.
- The *data link layer* solves the problem of error detection and error correction, and the framing problem (to identify the start and end of a message).
- The first two layers of the protocol stack enable us to transmit messages between nodes that are connected by a physical link.

Communication Protocols

- The *network layer* (Internet Protocol, IP) enable us to deliver messages from the site of origin to the ultimate destination.
  - It creates an universal addressing scheme for all network nodes (IP adresses).
  - It delivers messages between any two nodes in the network.
  - A special application called Domain Name System (DNS) converts symbolic host names to 32-bit IP adresses.
  - The process of delivering messages end-to-end, is a complex problem. This are solved by routing algorithms that seek to determine the shortest path in a network (e.g. Dijkstra shortest path algorithm).

Communication Protocols

- Several applications can be running in a host. The IP assigns a unique address to each host, but how a message is delivered from application to application? That problem is solved by the *transport layer*. The transport layer assigns to each application a port number.
- The IP is inherently unreliable because it ises a "good faith" transmision model. Now, the transport layer, also creates a high-quality, error-free, end-to-end delivery system.
- On the Internet the primary transport protocol is the Transport Control Protocol (TCP). Other important transport protocol is the User Datagram Protocol (UDP).

Communication Protocols

- The *application layer* are the rules for implementing end-to-end services provided by the network. These services are the reason that networks exists in the first place.
- Examples are: HTTP (access web pages), SMTP (send email), POP3 (receive email), IMAP (receive email), FTP (file transfer protocol), TELNET (remore acces terminal), SSH (secure shell), sFTP (secure ftp), etc.

A bit of the history of the Internet

1. ARPANET in the 1960's. This included department of defense instalations and some university campuses associated with the DoD.
2. NSFNET in the 1980's and decomisioned in the 1990's.

Cloud computing I

- Cloud computing refers to the practice of replacing computing resourses that might be provided locally with services provided over the Internet.
- Two categories of cloud computing include:
  - Software as a service (SaaS). It refers to software made available by a third party online.
  - Utility computing. This include platform as a service (PaaS).
- Some organizations develop their own private clouds.

SaaS I

- Firms using SaaS products can dramatically lower several costs associated with the care and feeding of their information systems, including software licenses, server hardware, system maintenance, and IT staff.
- SaaS offerings also provide the advantage of being highly scalable.
- The largest concerns with SaaS involve the tremendous dependence a firm develops with its SaaS vendor.
- SaaS systems depend on a reliable network connection.
- SaaS service provider may allow employees to access a corporations systems and data assets from a remote location, this raises concerns about abuse and infiltration.
- Firms with unique needs may find SaaS restrictive.

Utility computing I

- Sometimes a firm develops its own software but wants to run it somewhere else. That is ehat utility computing is all anout.
- In the scientific community this is nothing new. Think about supercomputing or high performance computing in general.
- In this model, a firm replaces computing hardware that it might otherwise run on-site with a service provided by a third party online.
- Users pay only for the amount of processing, storage, and telecommunications used.

Utility computing II

- Cloud vendors that provide a more complete platform (e.g., hosting hardware, operating system, database, and other software), which clients use to build their own applications are providing what is called platform as a service (PaaS).
- Another alternative is called infrastructure as a service (IaaS). In IaaS, clients can select their own operating systems, development environments, and underlying applications, whereas the cloud firm usually manages the infrastructure (providing hardware and networking).
- Hardware clouds and SaaS share similar benefits and risk, and as our discussion of SaaS showed, cloud efforts arent for everyone.

Virtualization I

- Recall that an operating system (OS) is software that always is running in a computer, and that serves as an intermediary between the different hardware components of a computer and the users of a computer (the users might be humans or other software).
- Virtualization refers to software that serves as the operating system of other operating systems. That is, it is a piece of software that is running on a computer but that mimics a machine with no OS, it is a virtual machine. You can run any OS on that virtual machine. Moreover, you can have several virtual machines running on a physical machine.

Virtualization II

- The increased efficiency due to virtualization means cost savings in hardware, staff, and real estate.
- It can also power down servers until demand increases require them to come online.
- Companies like VMware and Virtual Box offer virtualization software.
- It has some disadvantages. Inasmuch as the virtual machines are running on a physical machine, what happens if the virtual machine fails?