Introduction to Computer Networks

Lecture 2

Reference Models

- ISO OSI Model
  - International Standards Organization Open System Interface Model
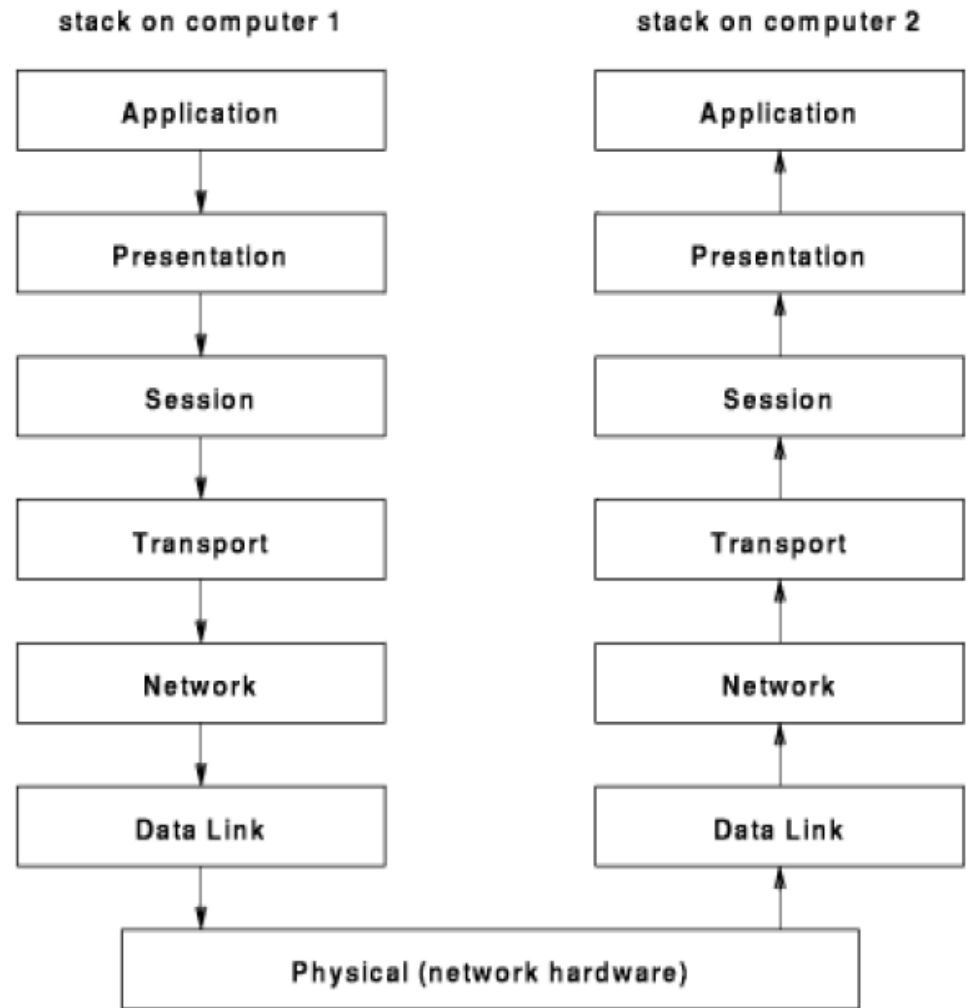
- TCP/IP Reference Model

ISO OSI Model

-International Standards Organization Open System Interface Model

- A standard and network architecture model
- Divides the many networking functions into seven different layers

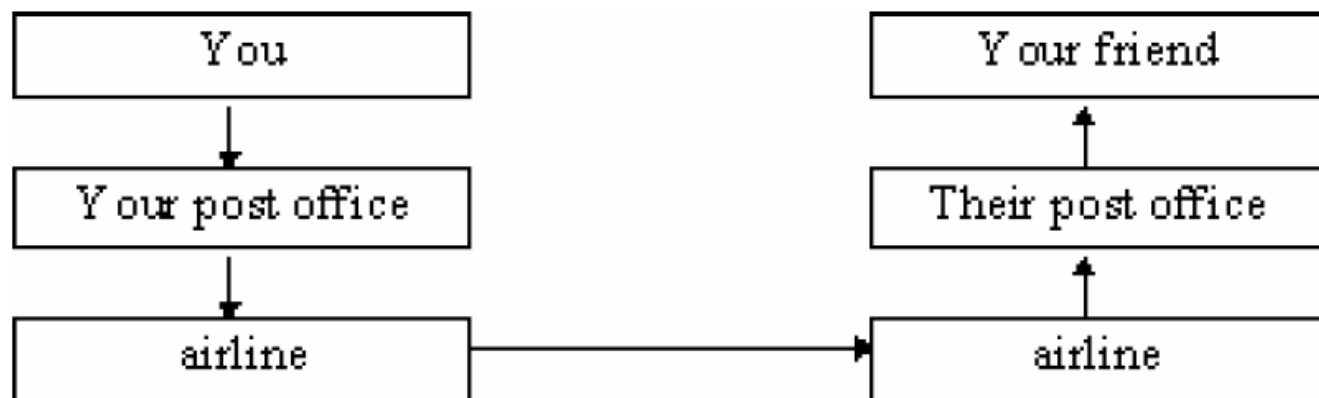| Layer	Description
Application	File transfer, Email, Remote Login
Presentation	ASCII Text, Sound
Session	Establish/manage connection
Transport	End-to-end communication: TCP
Network	Routing, Addressing: IP
Datalink	Media Sharing: Ethernet
Physical	How to transmit signal: Coding

OSI Flow Chart

- When a layer wants to send something to its peer layer in another computer, it calls a function in the layer below it to actually send the data

- Only the lowest layer actually sends bits to another computer

stack on computer 1

stack on computer 2

| Application |
| Presentation |
| Session |
| Transport |
| Network |
| Data Link |

| Application |
| Presentation |
| Session |
| Transport |
| Network |
| Data Link |

Physical (network hardware)

OSI (an Analogy)

- Ex: U.S. Mail

You		Your friend
↓		↑
Your post office		Their post office
↓		↑
airline	→	airline

- You do not have to worry about how to find your friends

- The post office does not need to know how to fly the airplane

- Each layer performs some particular functionalities

The Seven Layers of the OSI Model

- **Physical layer**
  - The lowest layer transmits raw bits over a communication channel. This is the only layer that actually sends bits to another computer
  - Examples: SONET, RS-232C
- Data link layer
  - Converts the raw transmission of bits into an error-free data communication channel
  - Provides media access control, flow control, network services
  - Examples: Ethernet, Token Ring

The Seven Layers of the OSI Model

- Network layer
  - Directs (routes) packets from source to destination host
  - Worries about congestion
  - Deals with addressing
  - Internet Protocol (IP)
- Transport layer
  - Directs packets to the correct user on a computer. It is the first *end-to-end* layer.
  - Deals with retransmitting data if the network layer fails to deliver it.
  - Deals with suppressing duplicates.
  - May also provide error correction.
  - Examples: TCP, UDP

The Seven Layers of the OSI Model

- ## Session layer
  - Provides a cleaner interface to the transport layer
  - Provides synchronization such as recovering from transport layer failure

- ## Presentation layer
  - Encoding data in a standard format
  - Encrypting data for privacy

- ## Application layer
  - Refers to the user programs themselves
  - Examples: email, HTTP, FTP

TCP/IP Reference Model

- TCP/IP stands for Transport Control Protocol / Internet Protocol

- Similar, but slightly different model than OSI

- A base set of protocols

- Protocols came first, where in OSI reference model, the model came first

- OSI is not widely accepted, especially in the U.S

- TCP/IP was already in wide use by the time.

- TCP/IP is not general. Ad hoc.
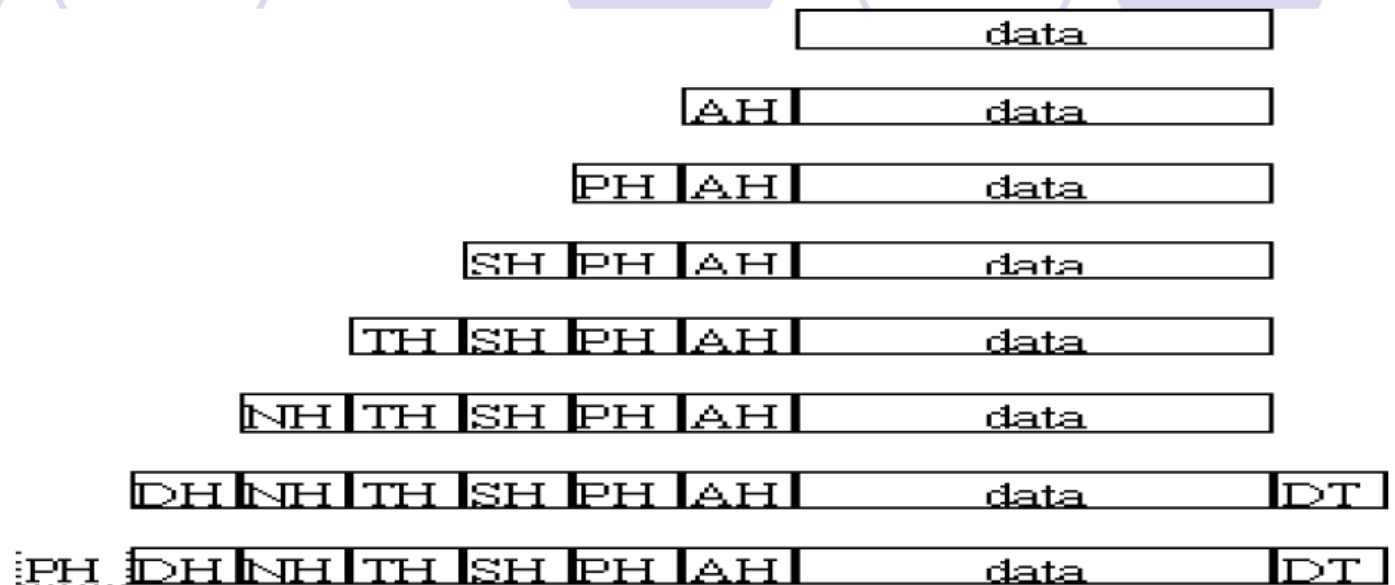
TCP/IP Reference Model

TCP/IP Ref Model	TCP/IP Protocols			OSI Ref Model
Application	FTP	Telnet	HTTP	Application
				Presentation
Transport	TCP		UDP	Session
				Transport
Internetwork	IP			Network
Host to Network	Ether net	Packet Radio	Point-to-Point	Datalink
				Physical

Nested Protocol Headers

							data	
						AH	data	
					PH	AH	data	
				SH	PH	AH	data	
			TH	SH	PH	AH	data	
		NH	TH	SH	PH	AH	data	
	DH	NH	TH	SH	PH	AH	data	DT
PH	DH	NH	TH	SH	PH	AH	data	DT

▸ Each layer communicates with its peer layer by prefixing the data from the above layer with a header

▸ The data link layer often adds a trailer to the packet that contains a cyclic redundancy check (CRC) to detect errors. The physical layer might, or might not, append a header or trailer to the packet

▸ When it is received at the other end, the headers are stripped off as the packet is passed up the stack to the user application

Transmission Media

- **Copper wire**
  - Unshielded twisted pair, Coaxial cable, Shielded twisted pair
  - They can carry digital or analog signals
  - Data rate is several M bps
  - They are usually used as local media, such as in a building, or a few rooms
  - Low cost

Coaxial and Fiber

Coaxial cable:

➢two concentric copper conductors

➢bidirectional

➢baseband:
  ★single channel on cable
  ★legacy Ethernet

➢broadband:
  ★ multiple channels on cable
  ★ HFC

Fiber optic cable:

➢glass fiber carrying light pulses, each pulse a bit

➢high-speed operation:
  ★high-speed point-to-point transmission (e.g., 10's-100's Gps)

➢low error rate: repeaters spaced far apart ; immune to electromagnetic noise

Wireless

> signal carried in electromagnetic spectrum

> no physical "wire"

> bidirectional

> propagation environment effects:

  ★ reflection

  ★ obstruction by objects

  ★ interference

Radio link types:

> terrestrial microwave

  ★ e.g. up to 45 Mbps channels

> LAN (e.g., Wifi)

  ★ 11Mbps, 54 Mbps

> wide-area (e.g., cellular)

  ★ e.g. 3G: hundreds of kbps

> satellite

  ★ Kbps to 45Mbps channel (or multiple smaller channels)

  ★ 270 msec end-end delay

  ★ geosynchronous versus low altitude