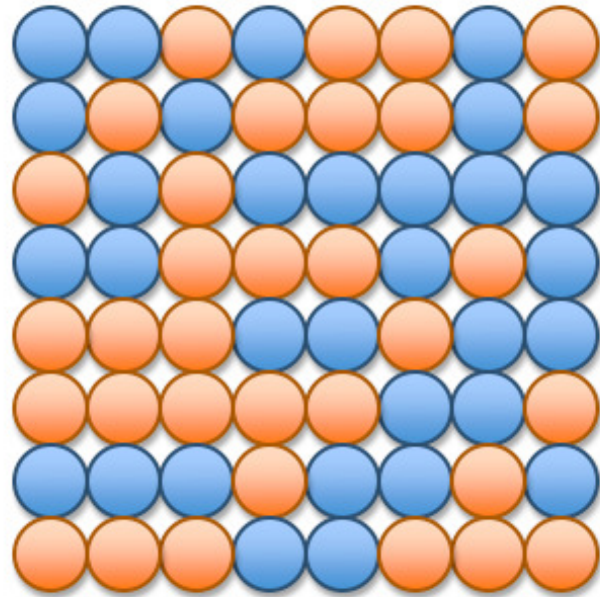




UNIT 11B

The Internet ctd...

Last Lecture

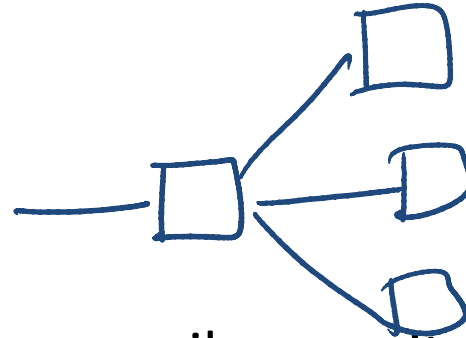
- Internet system
 - Hardware
 - protocols
 - IP addresses
- Servers
 - What do they do?
 - How to configure them?
- Emails
 - How they work

Questions?

- Who owns the internet?

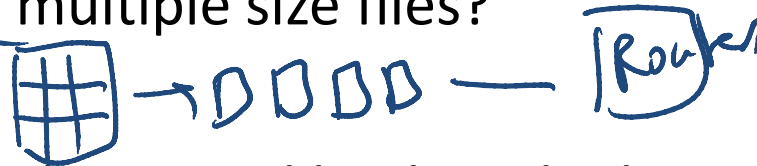
No one

- What is the purpose of a router?



- Does a router know you are sending email or a picture?

- How does internet handle multiple size files?



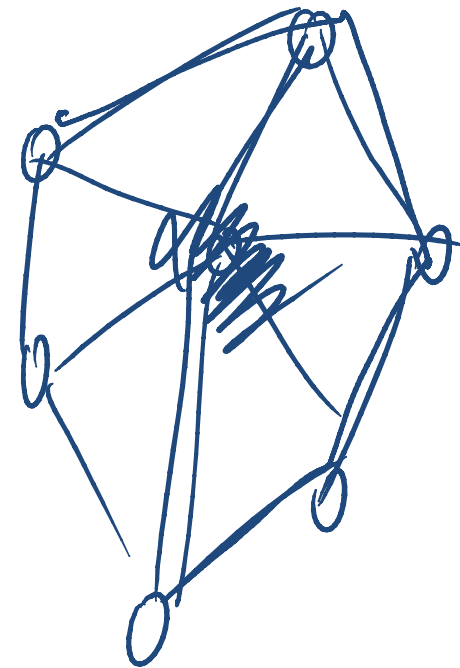
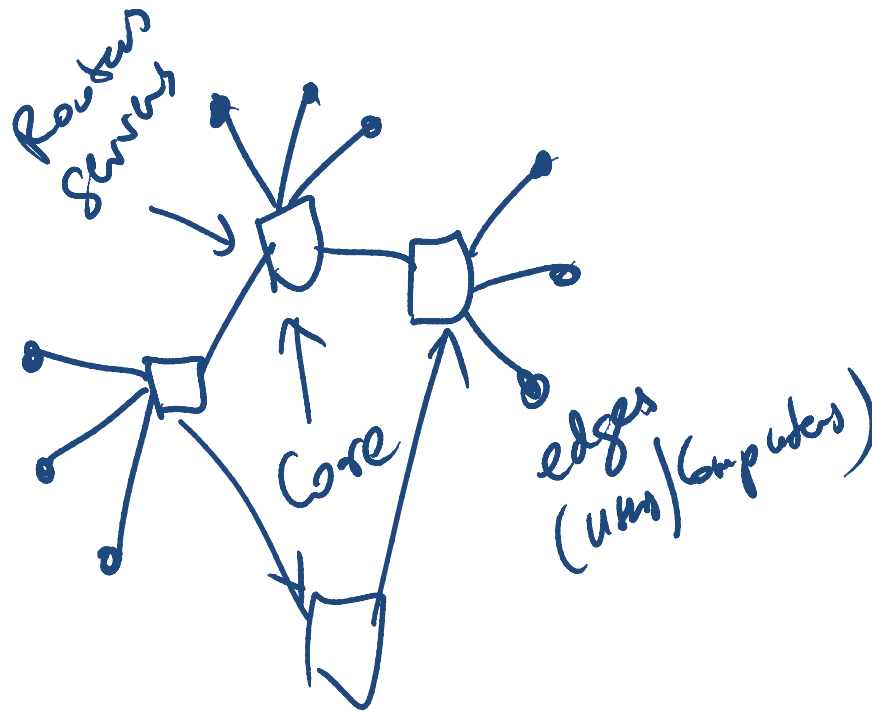
- Is the internet a circuit-switch system like the telephone system?

Internet as a packet switched system

- Design internet as a packet switched system
- Capacity of the internet is only limited by data traffic
- Limit the size of a packet to n bytes ($n < 1500$)
- Packets don't have to arrive in sequence or at the same time or even the same route

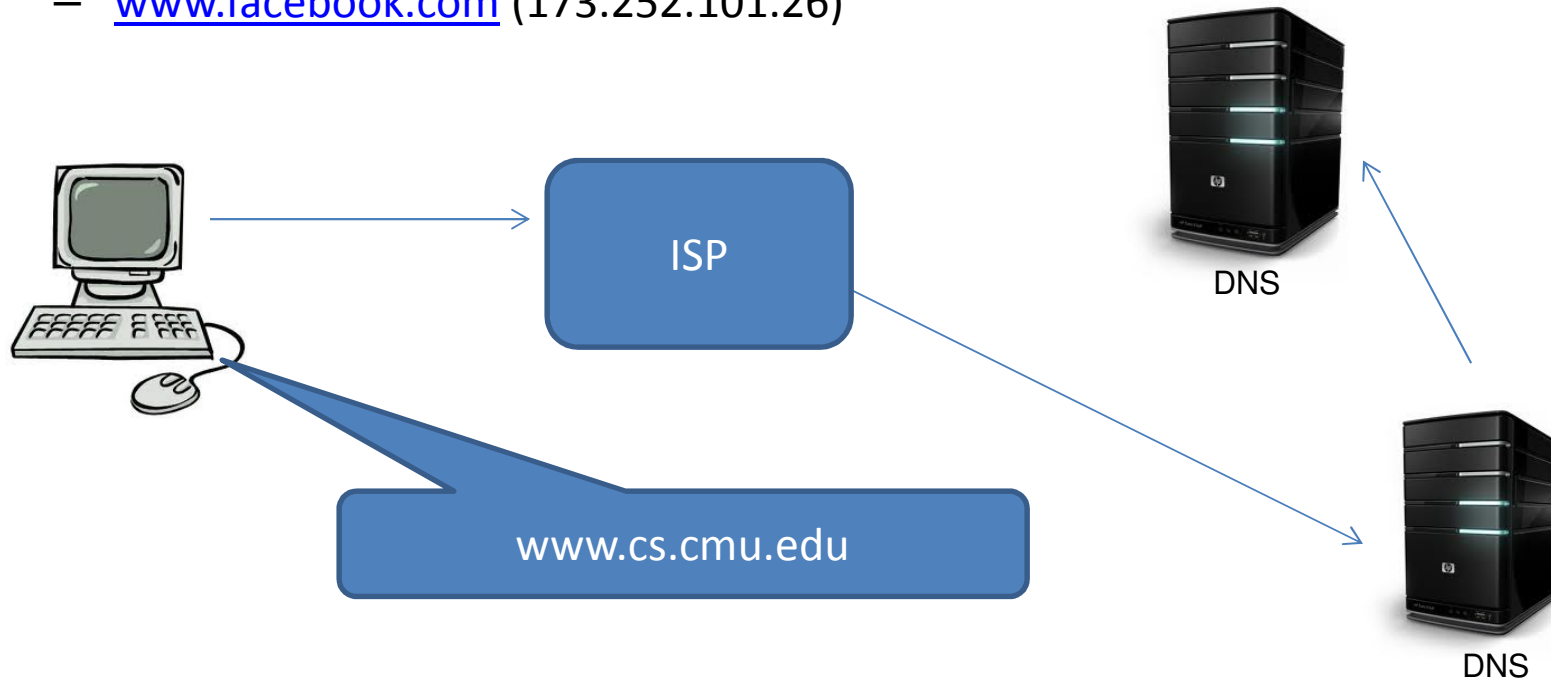
Internet as a system

- Core elements and edge nodes

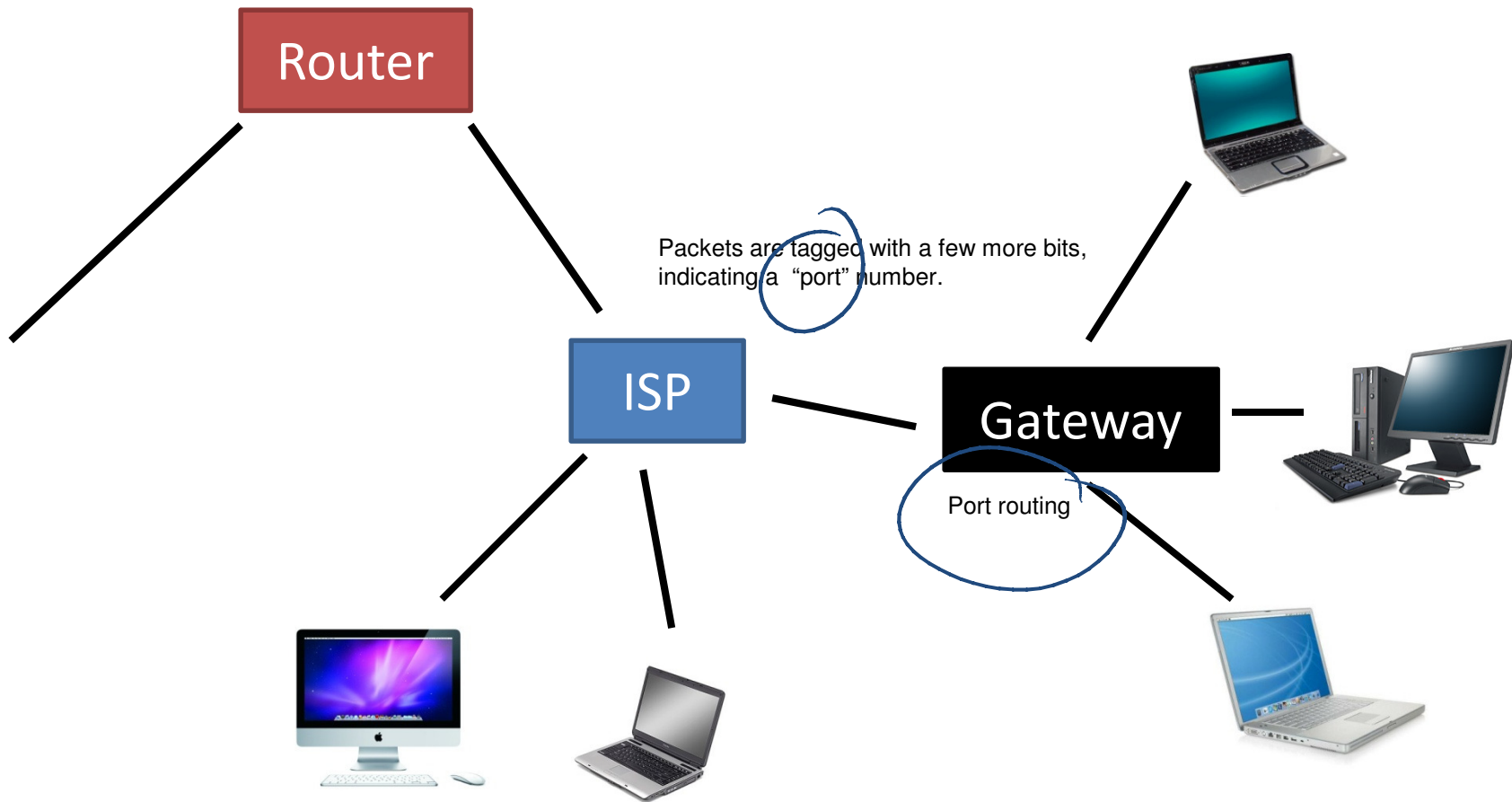


Domain Name servers

- The service that ties domain names to IP addresses
 - www.cmu.edu (128.2.42.52)
 - www.google.com (173.194.75.147)
 - www.facebook.com (173.252.101.26)



Network Address Translation (NAT)



Passing packets

Routing messages

- Routers do not know anything about the packets they are passing
- Routers can check the integrity of a packet by testing for errors in the packet
 - Missing bits
 - What can router do if it detects an error? *Resend*
- Routers can also “buffer” packets
- Packets are formatted according to Internet Protocol (IP)

Protocols

Protocols

- Agreement between communicating parties
 - Web (HTTP, SSL)
 - Email (SMTP, POP3, IMAP)
 - File Transfer (FTP)
- protocols
 - define format
 - order of messages sent and received among network entities
 - actions taken on messages receipt

Quiz

- Who controls the internet?

No one

- Can anyone join internet?

yes

- Is it possible that an email message can get lost?

Maintaining Reliability

- Use a higher level protocol to deliver messages reliably
 - Individual packet delivery may be unreliable
- Transport Control Protocol (TCP)
 - Higher level protocol to assure reliability
- TCP/IP

Reliable Communication with TCP

- Suppose Alice and Bob are the TCP implementations of two computers.
 - Alice is asked to send a message to Bob.
 - Alice breaks the message into several packets.
 - Each packet includes parity information, so Bob can check it for accuracy.
 - Packets are sent via IP.
 - Bob receives the packets.
 - If Bob is missing a packet or receives a corrupt packet, he can request retransmission.
 - If the packet is OK, Bob sends an acknowledgement.
 - If Alice doesn't get an acknowledgement, she will retransmit.
 - Bob assembles the incoming packets in order and provides the message to the appropriate application.

Other protocols

- Live streaming of data
 - Video
 - VoIP
- User Datagram Protocol (UDP)
 - a simple transmission model with a minimum of protocol mechanism
 - No “handshaking”
 - Error checking is not necessary or done by the application

quiz

- Can entire internet fail for some reason?
- Can it stands a nuclear attack?
- Can your computer fail to send a message?

How web pages work

Hypertext Transfer Protocol(HTTP/S)

- Retrieves documents(in HTML and other formats) over TCP using port 80
- Can also send form data to the server
- Support multiple requests per connection
- HTTPS = HTTP + TLS/SSL (secure socket layer)

Example: Web page Delivery

- A Web page is identified by a Uniform Resource Locator(URL)
- protocol://host address/page
- An HTTP Request
 - <http://www.cs.cmu.edu/~15110/index.html>

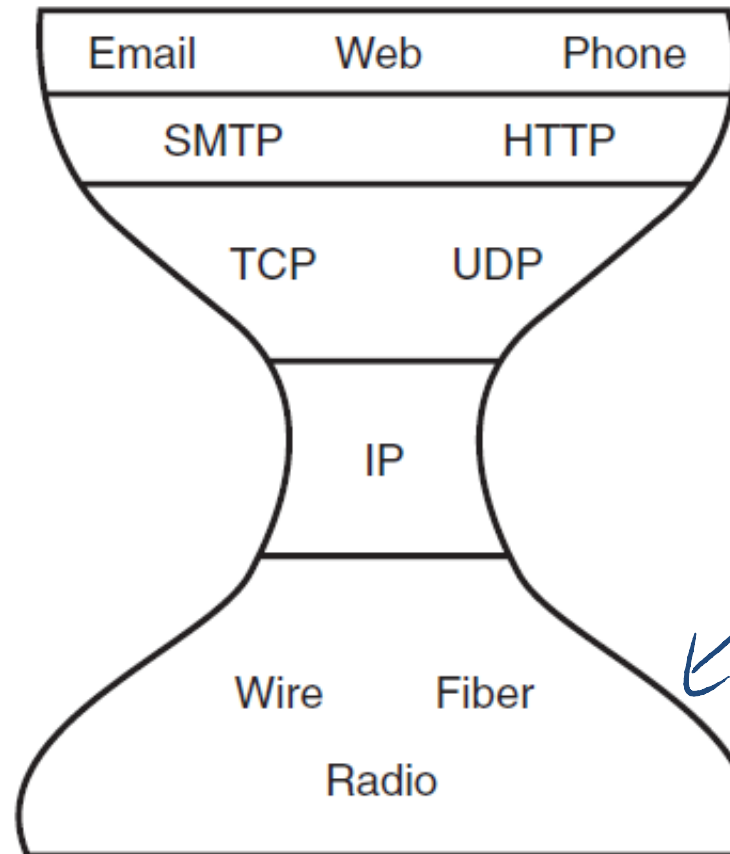
Example: Web page Delivery

1. Web browser extracts the name of the machine and gets it translated to an IP address (e.g. 128.2.217.13)
2. Establishes a TCP connection to port 80 at 128.2.217.13
3. Constructs a message
GET /~15110/index.html HTTP/1.1
4. Sends the message to server using services of TCP/IP
5. Web server locates the file and send a response back to browser using services of TCP/IP
6. The connection is terminated.

Email protocols

- Email protocols governs the communication between mail servers and clients
- SMTP
 - user-level client mail applications typically use SMTP only for sending messages to a mail server for [relaying](#)
- POP3
 - allows email client software to retrieve email from a remote server
- IMAP
 - newer protocol and oriented toward a "connected" mode of operation

Internet architecture



Innovator

techie

Source: blown to bits

Back to IP Addresses

IP Addresses (IPv4)

- Computers on the Internet are assigned an IP Address consisting of four numbers between 0 and 255 inclusive

____ . ____ . ____ . ____

Example: 128.2.13.163

- This means that each part of the address is an 8-bit value, and an IP address is 32 bits. Hence, it supports up to 2^{32} computers on the network at the same time.
- ISPs can reassign IP addresses dynamically.

IPv4 Address Assignment

- The original IPv4 had several classes of addresses that could be decomposed into a network and host part
 - Class A **0** + 7-bit network + 24-bit address
Accommodates up to 2^{24} unique IP addresses in a company or location.
 - Class B **10** + 14 bit network + 16-bit address
Accommodates up to 2^{16} unique IP addresses in a company or location.
 - Class C **110** + 21-bit network + 8-bit address
Accommodates up to 2^8 unique IP addresses in a company or location.

IPv4 Address Assignment

- In 1993, the Internet switched to classless internet-domain routing.
- In this scheme, the network part is an arbitrary length prefix of the address, such as 10.10.1.32/27, which has a 27-bit network part and a 5-bit host part (so there can only be 32 machines on that network).

New IP (IPv6)

- IPv6 uses 128-bit addresses, which implies 2^{128} (3.4×10^{38}) unique computer addresses, (4.8×10^{28} addresses per person)
- Allows for many more devices (cell phones, video game machines, appliances, automobiles, etc.)
- Designed to deal with the approaching use of all available addresses in IPv4.
- IPv6 also follows classless routing, but the standard subnetwork size is 64-bits.

Questions?

- Can entire internet fail on its weight?
- What would be an alternate model?
- How has internet changed humanity?
Opportunity?
- How do we define intelligence?

Bonus Slides

You will not be tested on these slides

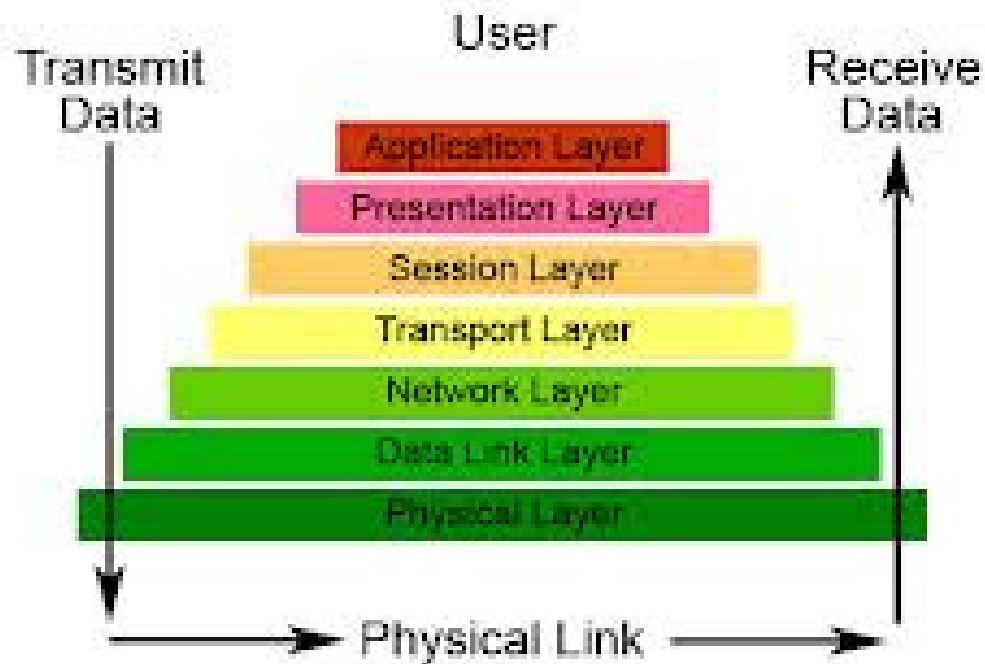
Internet layers

Layering Abstractions

- It is often useful to divide large systems into layers
 - Higher layer uses a lower layer as a service
 - Lower layers are implemented independently from higher layers
 - Interface between two layers needs to be specified
- Example: Dice game uses `roll`
 - `roll` uses `rand`
 - `rand` uses some LCRG method

Open system interconnection

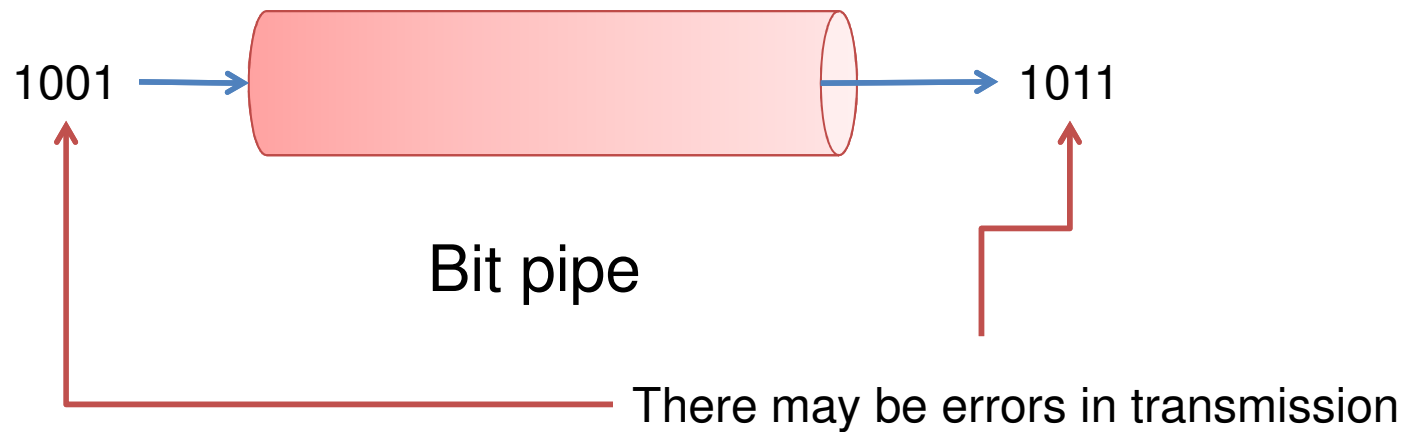
The Seven Layers of OSI



Source: Washington.edu

Link Layer

Physical Links



Link Layer

Data Links



Network Layer

- The link layer enables us to transmit messages from node A to node B, only if these two are connected by a physical link.
- In networks other than LANs, majority of nodes are not directly connected.
- Network layer is responsible for delivering messages from their source to destination.
- Key functions:
 - Create a universal addressing scheme for all network nodes
 - Deliver messages between any two nodes in the network

Transport Layer

- Internet Protocol (IP)
 - Delivers packets to IP address
 - Best effort delivery
- Transport Control Protocol
 - Creates a reliable bi-directional stream (source address/port and destination address/port)
 - acknowledgements, resend, reassembly in correct order,
 - error detection
 - connection must be opened and closed
 - flow/congestion control

Transport Layer

