CSC 402 – Internet Technology

Recap

- Helper Application
- CGI
- CGI – How it works
- CGI – Get
- CGI – Post
- Servlets
- CGI vs Servlets
- Other Helper Application

Network

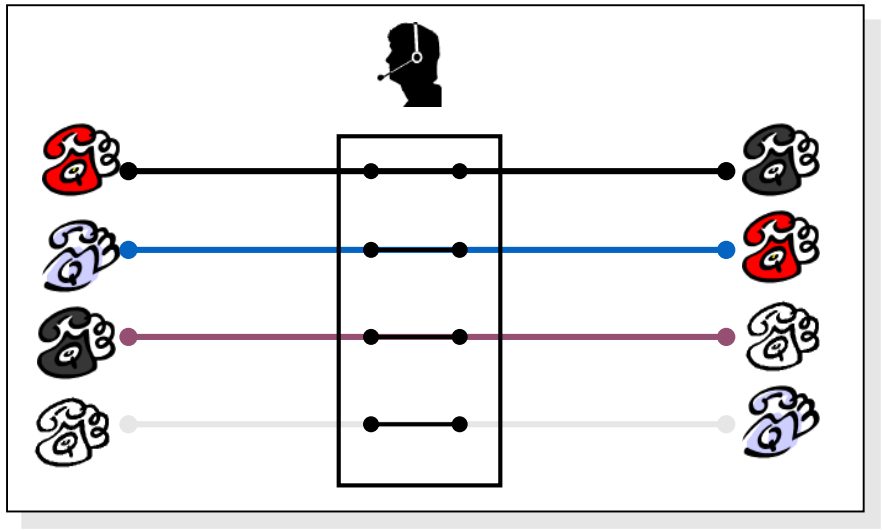
- Objective of Networks:
  - Communication between applications on different computers.
  - Must understand application needs/demands.
    - Traffic data rate.
    - Traffic pattern (bursty or constant bit rate).
    - Traffic target (multipoint or single destination, mobile or fixed).
    - Delay sensitivity.
    - Loss sensitivity.
- Networking can be summarized as:
  - Communicating across a link.
  - Connecting together multiple links (internetworking).
  - Finding and routing data to nodes on internetwork.
  - Matching application requirements.

Network

- Communicating across a link.
  - Creating a link between nodes.
    - Link: path followed by bits.
  - Medium: Wired or wireless.
  - Broadcast or point-to-point (or both).
  - Node: any device connected to a link.
- Switched Network
  - Switch: moves bits between links
  - 2 types: Packet switching and Circuit switching
- Packet switching mode:
  - **Unicast**: Transmission to single specific receiver
  - **Broadcast**: Transmission to all network nodes
  - **Multicast**: Transmission to specific subset of nodes
  - **Anycast**: Transmission to one of a specific subset of nodes
  - Difference in packet switching mode between IPv4 and IPv6, do you remember?

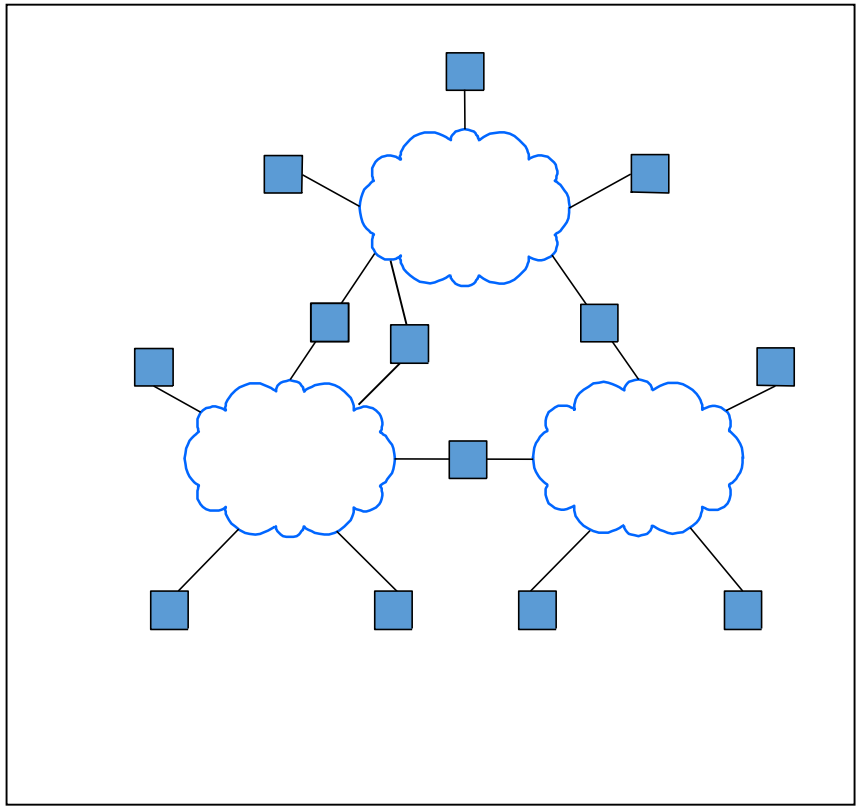
Network

- Circuit Switching: Back in those days as shown in the figure here.
- Benefits of packet switching:
  - Interleave packets from different sources.
  - Efficient: resources used on demand.
  - Statistical multiplexing.
  - Addition of queues, i.e. can handle more users at a single time.



Network

- Connecting together multiple links (internetworking)
  - A collection of interconnected networks.
  - Host: network endpoints (computer, PDA, light switch, etc).
  - Router: node that connects networks.
- Challenges faced while connecting networks
  - Address formats.
  - Performance – bandwidth/latency.
  - Packet size.
  - Loss rate/pattern/handling.
  - Routing.
  - How to translate between various network technologies.



Network

- Finding and routing data to nodes on internetwork i.e. how to find nodes.
  - Humans use readable host names. E.g. www.somewebsite.edu.np
  - Globally unique (can correspond to multiple hosts).
  - Naming system translates to physical address. E.g. DNS translates name to IP Address (e.g. 128.2.16.31)
  - Address reflects location in network.
- Each network technology has different local delivery methods.
  - Address resolution provides delivery information within network.
  - E.g., ARP maps IP addresses to Ethernet addresses.
  - Local, works only on a particular network.
  - Routing protocol provides path through an internetwork.

Network

- Forwarding tables at each router populated by routing protocols.
- Original Internet: manually updated.
- Routing protocols update tables based on “cost”.
  - An arbitrary value assigned by an administrator for the intersecting of networks.
  - Exchange tables with neighbors or everyone.
  - Use neighbor leading to shortest path.

Network

- Matching application requirements.
  - Reliability.
    - Problem: Data gets corrupted and packets lost.
    - Solution: Add checksum and timeout and retransmit.
    - Problem: Network overload.
    - Solution: Buffering and/or queueing.
    - Problem: Different network has different MTU.
    - Solution: Fragment data
  - Flow and congestion control.
  - We've discussed these before!!!

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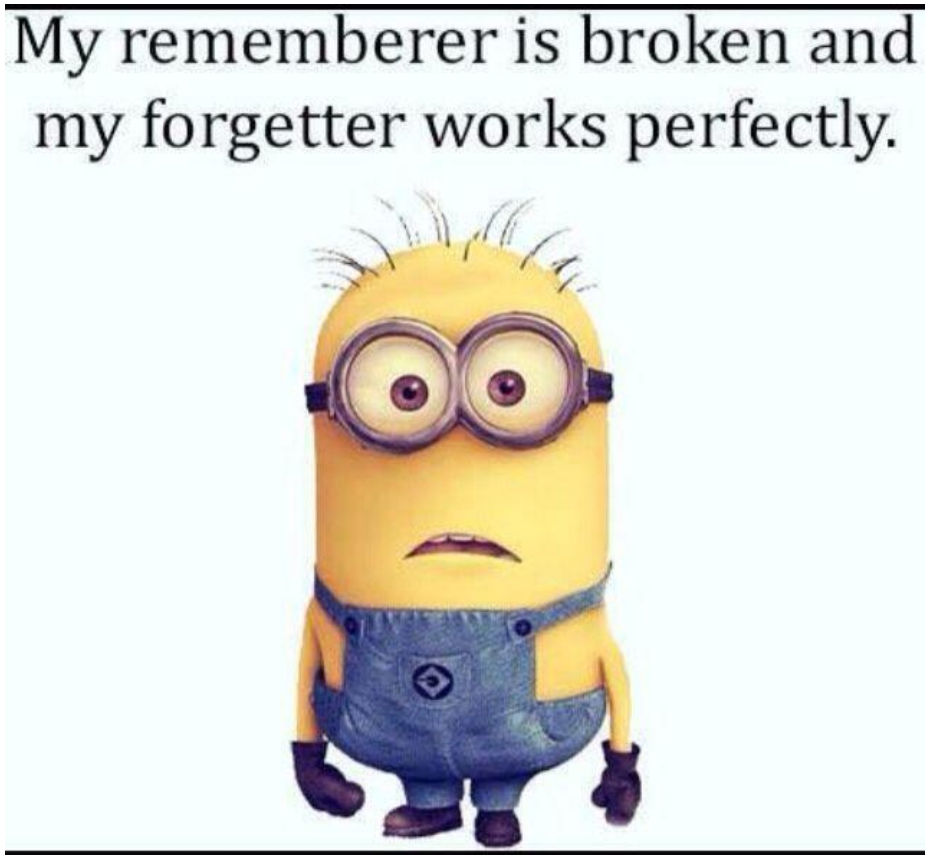


Internet

- History: discussed earlier.
- Today's Internet is arguably the largest engineered system ever created by mankind, with hundreds of millions of connected computers, communication links, and switches.
  - With billions of users who connect via laptops, tablets, and smartphones.
  - With an array of new Internet-connected devices such as sensors, web cams, game consoles, picture frames, and even washing machines.
- The network of networks.
- Internet jargons like hosts, end systems, packets, communication links, transmission rate, bandwidth, routers, switches, route, etc.

Internet

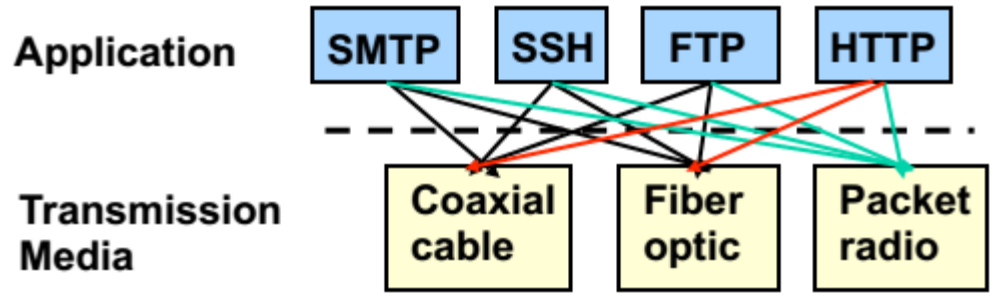
- Our discussions have identified many of the pieces that make up the Internet.
- But we can also describe the Internet from an entirely different angle—namely:
  - an infrastructure that provides services to applications.
- Applications include electronic mail, Web surfing, social networks, instant messaging, Voiceover-IP (VoIP), video streaming, distributed games, peer-to-peer (P2P) file sharing, television over the Internet, remote login, etc.
- Applications are said to be distributed as they involve multiple end systems that exchange data with each other.
- Internet applications run on end systems—they do not run in the packet switches in the network core.
- Although packet switches facilitate the exchange of data among end systems, they are not concerned with the application that is the source or sink of data.
- **Application Programming Interface** (API) specifies how a program running on one end system asks the Internet infrastructure to deliver data to a specific destination program running on another end system.
  - API are just set of rules.

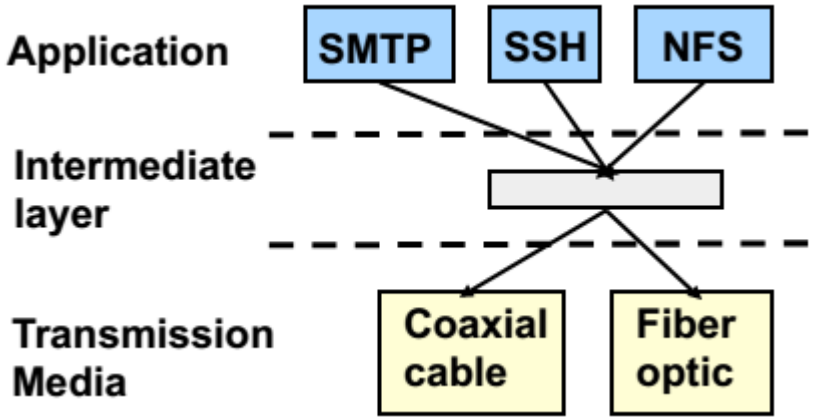
Internet

- Alice wants to send a letter to Bob (in a far away land) using postal service.
- Alice, of course, can't just write the letter (the data) and drop the letter out her window and reach Bob.
- Postal service requires that Alice put the letter in an envelope; write Bob's full name, address, and zip code in the center of the envelope; seal the envelope; put a stamp in the upper-right-hand corner of the envelope; and finally, drop the envelope into an official postal service mailbox.
- Thus, the postal service has its own "postal service API," or set of rules, that Alice must follow to have the postal service deliver her letter to Bob.

Network Architecture

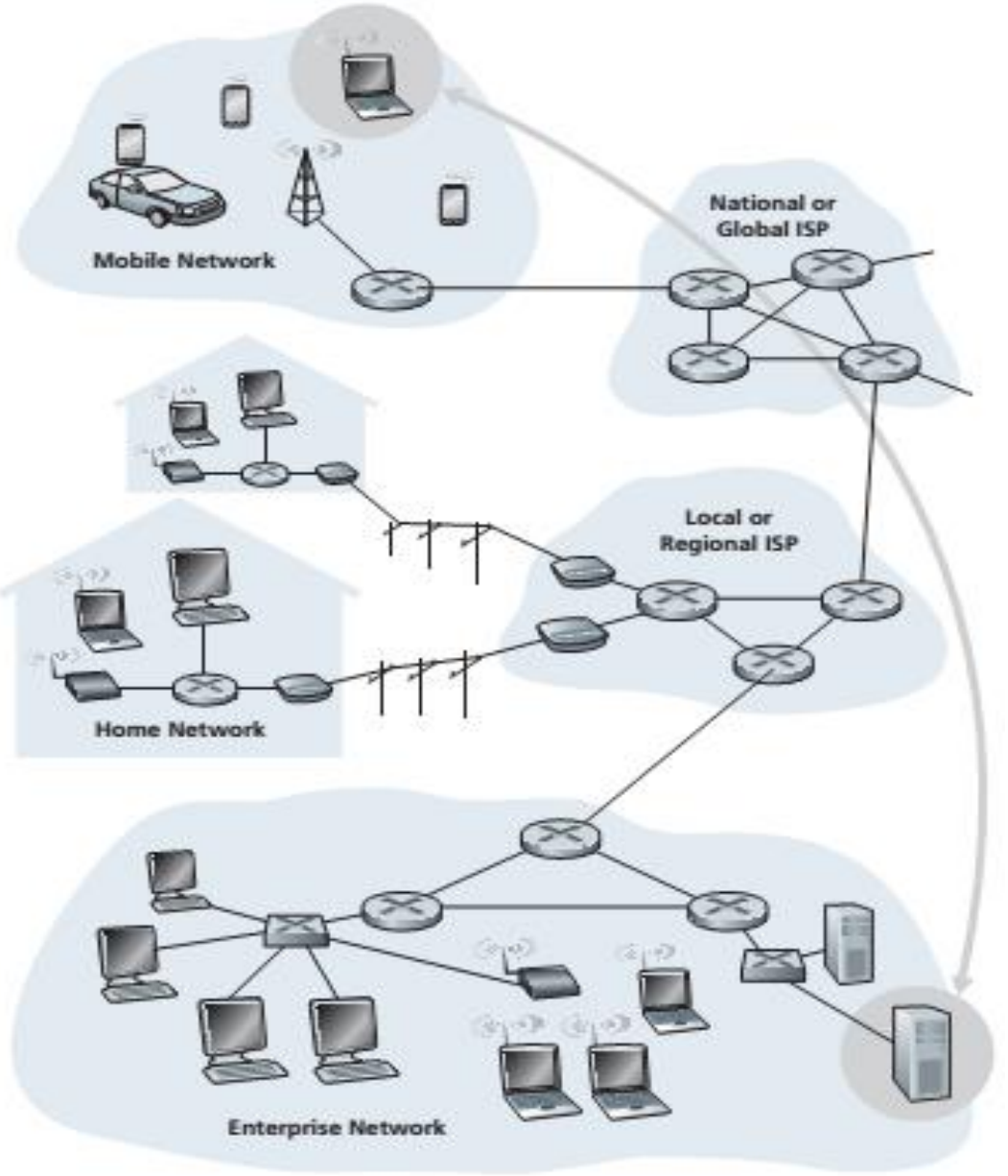
- From Layer 1 to Layer 7:
  - Different protocols.
  - Application has to interface to all existing media.
    - adding new application requires O(m) work, m = number of media.
  - Application end points may not be on the same media!
- Solution: introduce an intermediate layer that provides a single abstraction for various network technologies.
  - O(1) work to add app/media.
  - Indirection is an often used technique in computer science.
  - Remember the importance of Layering!!!





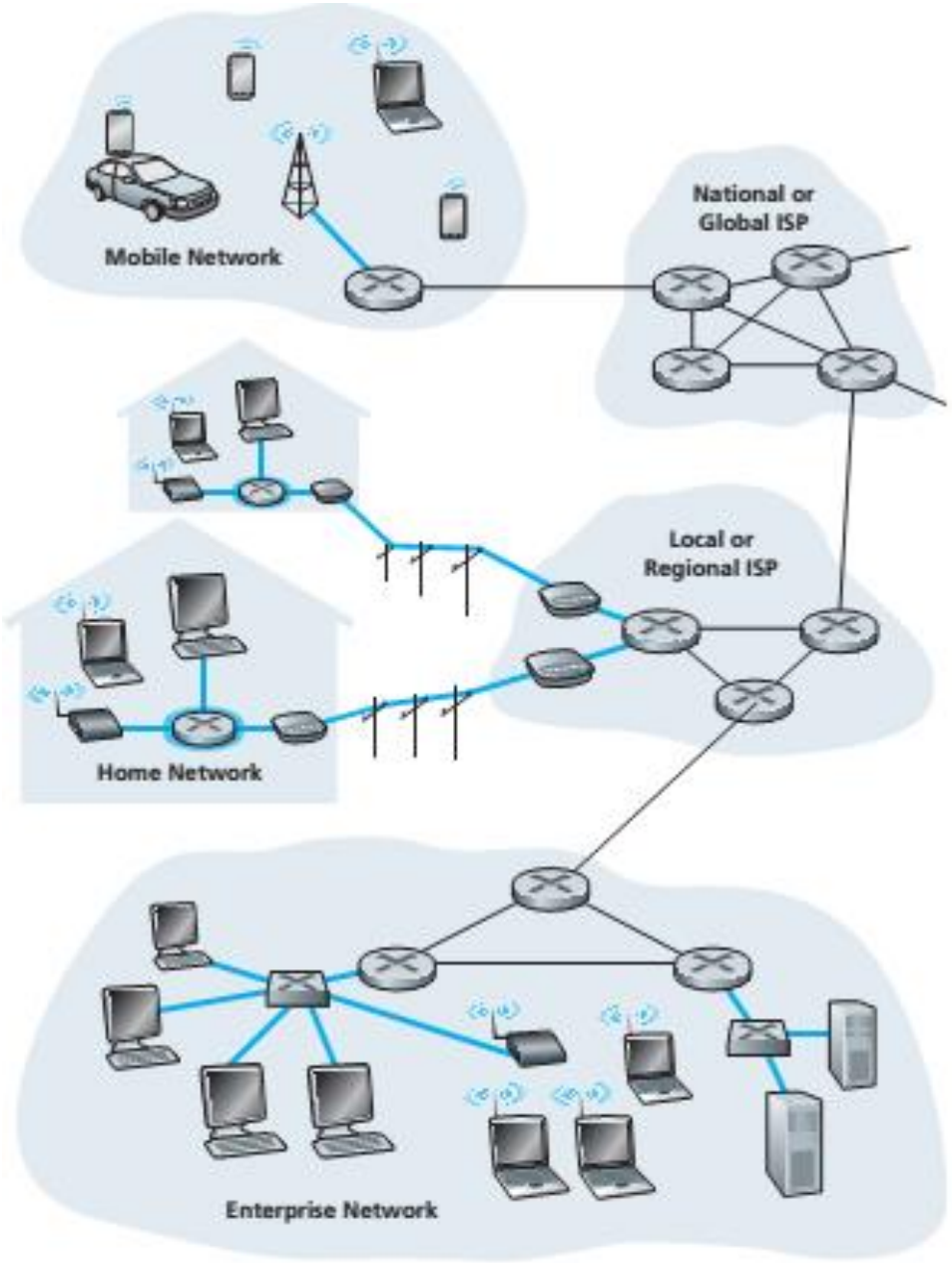
Network Architecture

- Network edge
  - Computers, smartphones and other devices that we use on a daily basis.
- Two main components
  - Network Edge
    - Access Networks
    - Physical Media
  - Network Core
    - Circuit Switching
    - Packet Switching



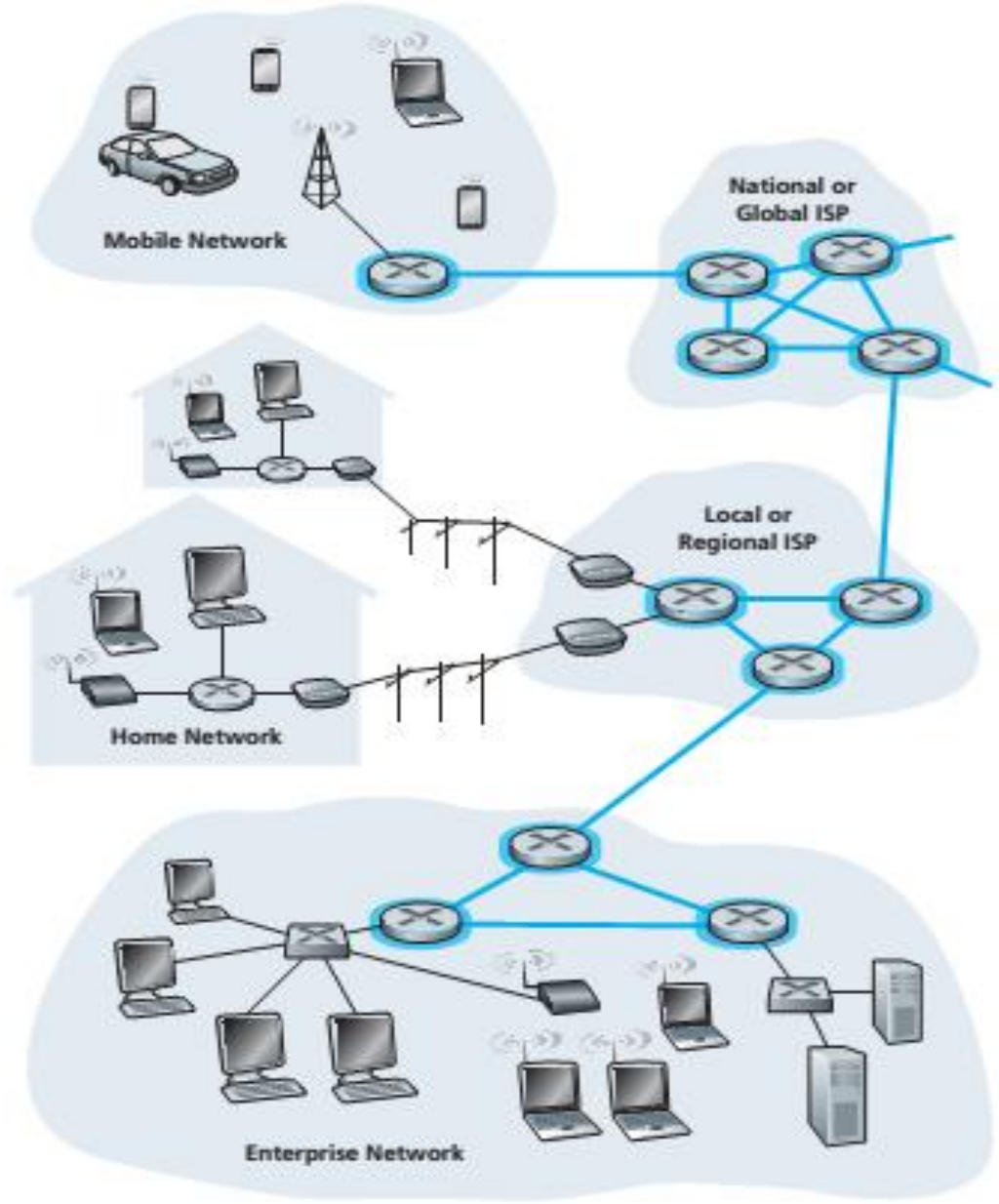
Network Architecture

- Access Networks
  - A.k.a “edge router”.
  - Network that physically connects an end system to the first router on a path from the end system to any other distant end system.
  - Represented by Blue lines.
  - The settings (home, enterprise, and wide-area mobile wireless) in which they are used.
- Physical Media
  - Twisted-Pair Copper Wire
  - Coaxial Cable
  - Fiber Optics
  - Terrestrial Radio Channels
  - Satellite Radio Channels



Network Architecture

- Network Core
  - Represented by blue shades.
  - The mesh of packet switches and links that interconnects the Internet's end systems.
  - A router will typically have many incident links, since its job is to switch an incoming packet onto an outgoing link.

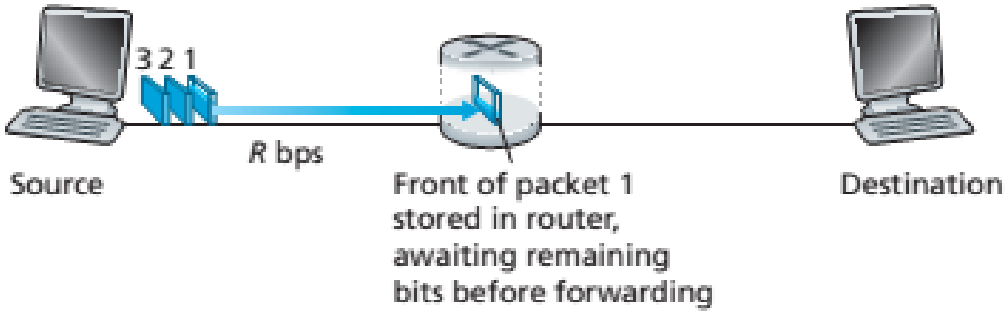


Network Architecture

- Packet Switching
  - In a network application, end systems exchange **messages** with each other.
  - To send a message from a source end system to a destination end system:
  - Source breaks long messages into smaller chunks of data known as packets.
  - Between source and destination, each packet travels through communication links and packet switches.
  - Packet switches are of 2 types, routers and link layer switches.
  - Packets are transmitted over each communication link at a rate equal to the full transmission rate of the link.
  - So, if a source end system or a packet switch is sending a packet of L bits over a link with transmission rate R bits/sec, then the time to transmit the packet is L/R seconds.
  - Most packet switches use store-and-forward transmission at the inputs to the links.

Network Architecture

- Store-and-forward transmission means that the packet switch must receive the entire packet before it can begin to transmit the first bit of the packet onto the outbound link.
- The router cannot transmit the bits it has received; instead it must first buffer (i.e., “store”) the packet’s bits.
- After receiving all packets from source, the routers starts transmitting.
- Queuing delays and packet loss



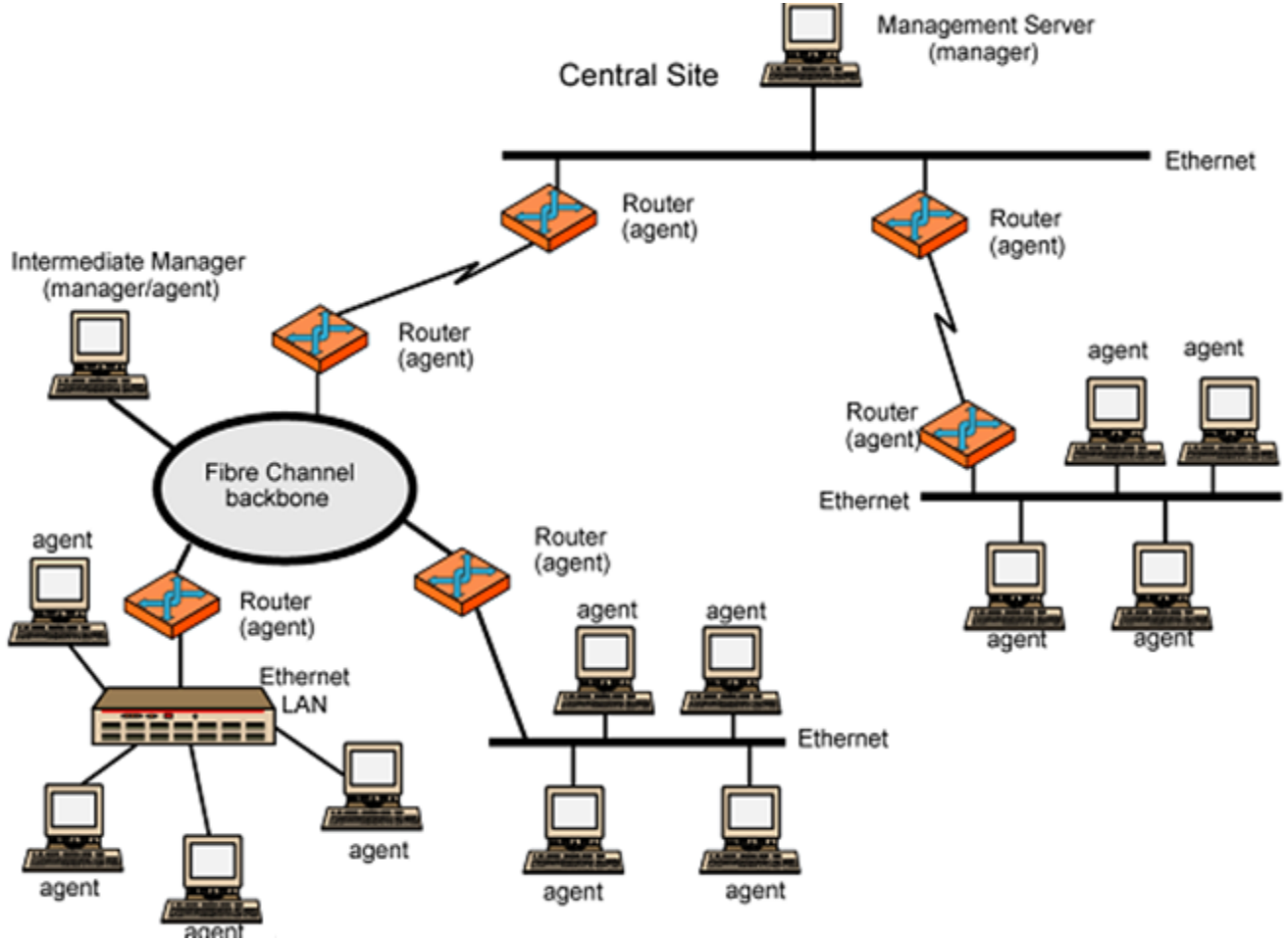
Network Architecture

- Refer the Network Core figure:
  - Each packet switch and routers have multiple links attached to it.
- For each attached link, it has:
  - **Output buffer** (also called an output queue), which stores packets that the router is about to send into that link.
  - If any attached link is busy, packets are stored in the output buffer.
  - When the link gets free, the packets are transmitted in the media to its destination.
  - Refer Store-and-forward transmission figure in previous slide.
  - This results in **Queuing Delays**.
- Since the amount of buffer space is finite, an arriving packet may find that the buffer is completely full with other packets waiting for transmission.
  - In this case, **packet loss** will occur—either the arriving packet or one of the already-queued packets will be dropped.

Network Architecture

- In circuit-switched networks, the resources needed along a path (buffers, link transmission rate) to provide for communication between the end systems are reserved for the duration of the communication session between the end systems.
- In packet-switched networks, these resources are not reserved; a session's messages use the resources on demand, and as a consequence, may have to wait (that is, queue) for access to a communication link.
- Circuit Switching
  - Telephony Service – Circuit Switching
  - Analyze the process to talk to another person on a phone.
  - Before the sender can send the information, the network must establish a connection between the sender and the receiver.
  - This connection is called **Circuit**.
  - Before the sender can send the information, the network must establish a connection between the sender and the receiver to guarantee the sender can transfer the data to the receiver at the guaranteed constant rate.

- Network Of Networks!!!



Choice of Platform

- "*That's how Dad did it, that's how America does it, and it's worked out pretty well so far.*“ – Tony Stark
- Software:
  - OS: Windows (IIS; Internet Information Services) and UNIX/Linux (Apache Web Server).
- Hardware:
  - Servers with high configuration regarding processor, memory, and storage.
  - RAID technology.
  - Dual SMPS.
- Servers in “Cloud”
  - Amazon Web Service, AWS: Instances and S3.