COMPUTER COMMUNICATION NETWORKS

Department of Electronics and Communication Engineering

COMPUTER COMMUNICATION NETWORKS

UNIT 1: INTERNET ARCHITECTURE AND APPLICATIONS – Class 3 – Network Core

Department of Electronics and Communication Engineering

COMPUTER COMMUNICATION NETWORKS

UNIT 1: INTERNET ARCHITECTURE AND APPLICATIONS – Class 3 – Network Core – Text book reference – Section 1.3 – Pages 52-56,64

Department of Electronics and Communication Engineering

Class 3 - Network core

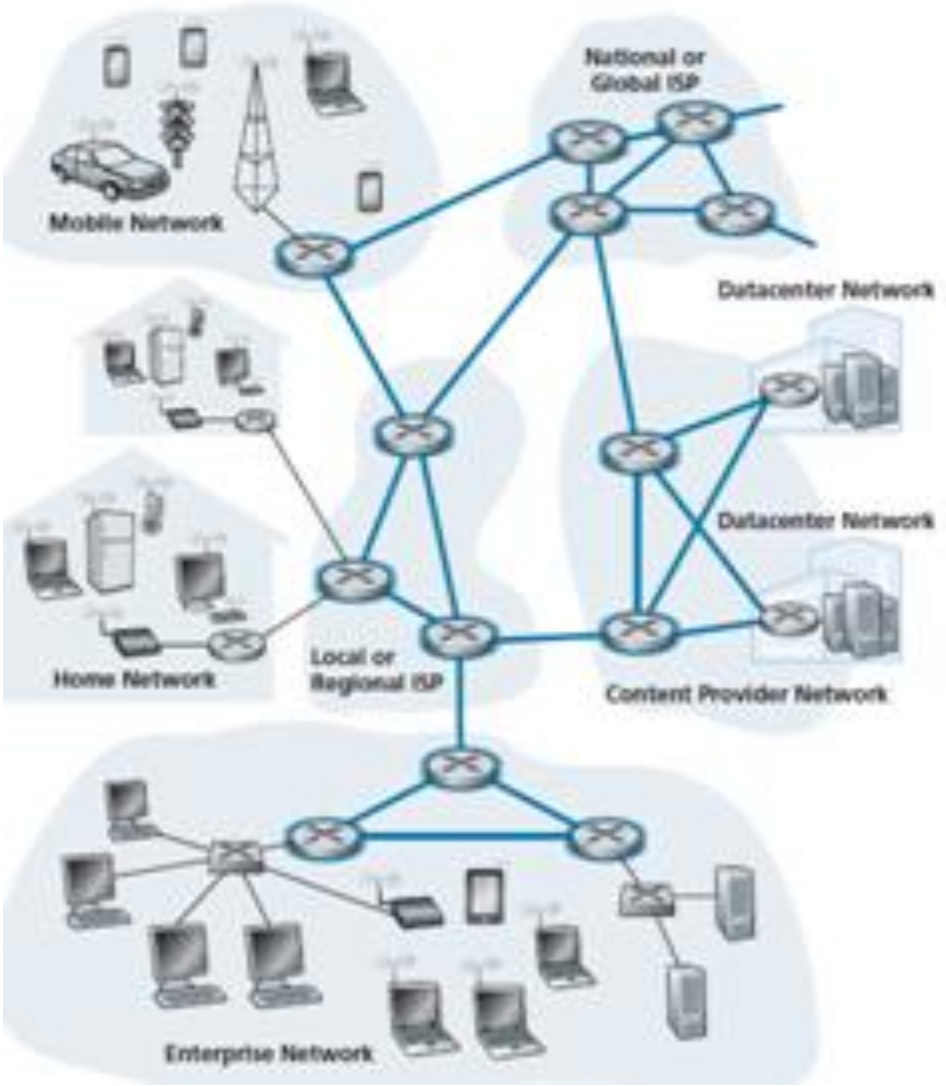
- Also known as backbone network
- Consists of high speed routers and high speed links (Gigabit Ethernet/optical fibers)

Cisco NCS6000 router

D-Link Cloud

DIR-600L Wireless N 150
Home Router

Class 3 - Network core



- Network core is part of the internet which is composed of high-speed packet switches and high-speed communication links
- Network core is constructed using the interconnection of ISPs
- The packet switches (routers) perform store and forward operation

Class 3 - Network core

- Traffic from access ISPs are aggregated using multiplexers
- Multiplexers are interconnected to more distant switches through a backbone network
- Network core follows mesh topology with lot of redundancy
- Some design problems in network core include:
  - Satisfy delay and reliability constraints
  - Routing
  - Assigning capacity (Flow maximization problem)
  - Cost improvement

Class 3 - Network core

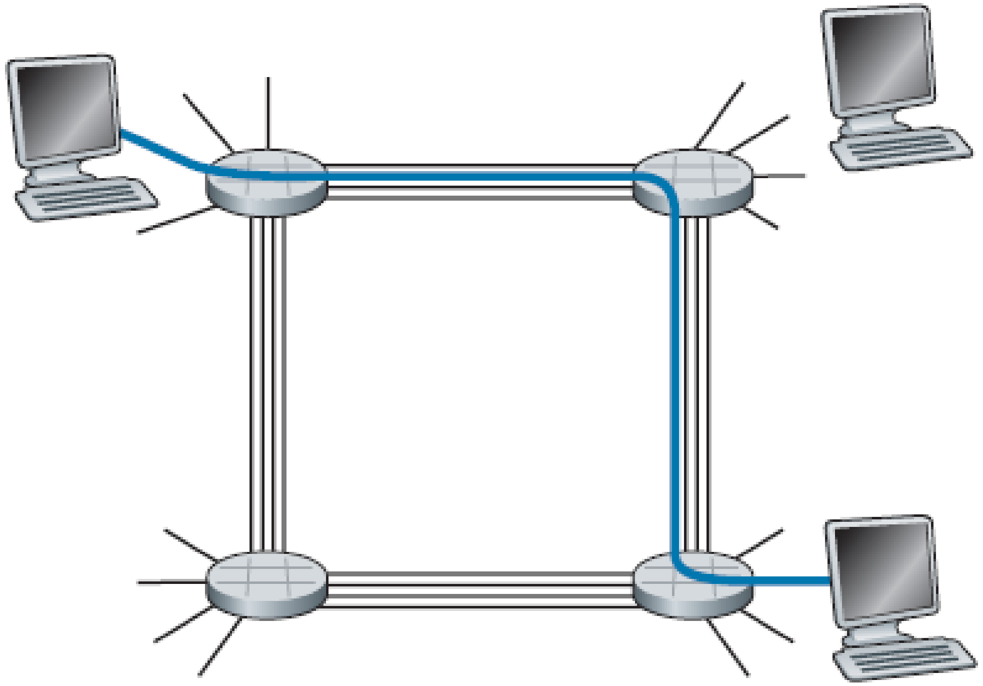
- Routers in the network core perform switching
  - Routers have several links on which packets arrive and depart
- Switching involves transfer of an incoming packet from one link to an appropriate outgoing link based on IP protocol
  - The switching operation can be done by hardware and/or software
- Different types of switching performed in the network core
  - Circuit switching
  - Packet switching

Class 3 - Network core

- Circuit switching:
  - Requires connection establishment before data transfer
  - Resources are allocated by every intermediate switch/router between the source and destination hosts
    - Resource example: Fixed link bandwidth, internal memory
  - In telephony, when a path is established between the source and destination we can say **a circuit is formed**
  - After data transfer, the circuit is closed by releasing the reserved resources at each intermediate router
  - No waiting time and no loss of data at intermediate routers
  - Throughput reduces with resource sharing

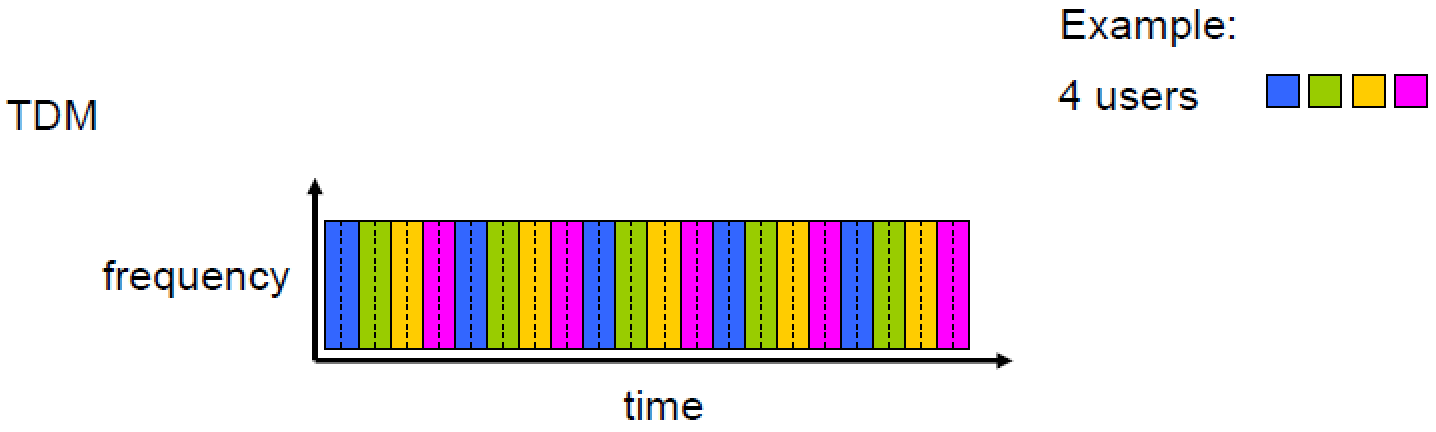
Class 3 - Network core

- Circuit switching:
  - A circuit in a link is established either by **frequency division multiplexing (FDM)** or **time division multiplexing (TDM)**



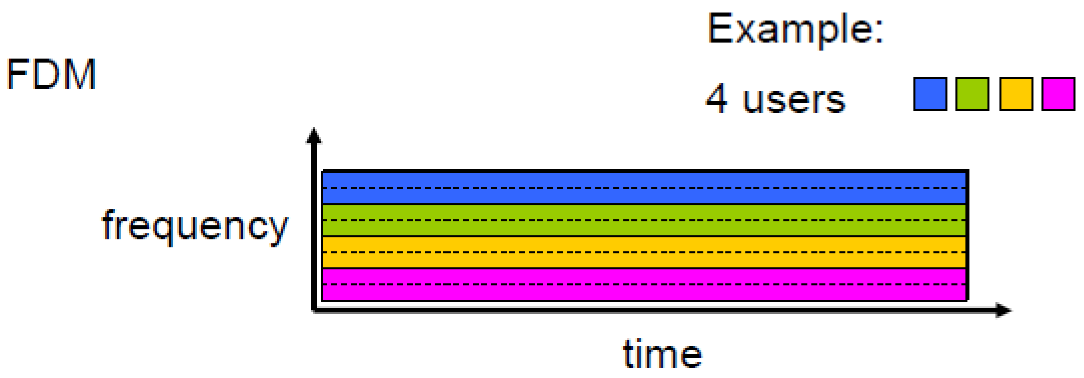
Class 3 - Network core

- TDM- Time division multiplexing:
  - Time is divided into frames and frames into slots
  - Slots in a frame are reserved for the transmitting hosts
  - Each slot ends with a guard time to prevent ISI
  - Duration of frame, slot, guard time are fixed



Class 3 - Network core

- FDM- Frequency division multiplexing:
  - Bandwidth is divided into channels
  - All channels reserved for transmitting hosts in a fixed slot time
  - Channel reservation done slot-by-slot-basis
  - Channels separated by guard band to prevent adjacent channel interference



Class 3 - Network core

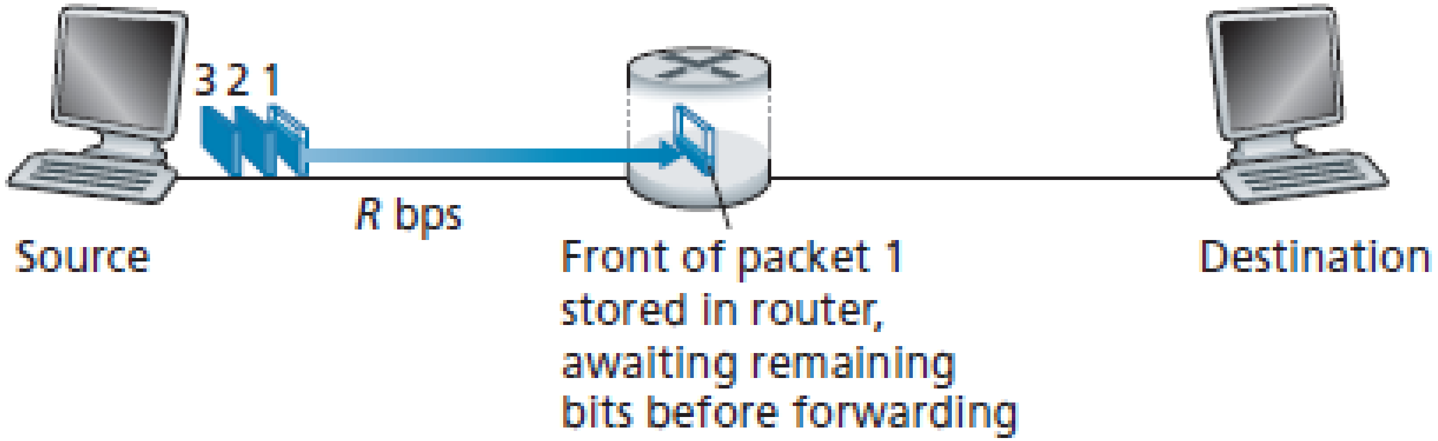
- Numerical #1:
  - How long does it take to send a file of 640,000 bits from host A to host B over a circuit-switched network?
  - All links are 1.536 Mbps
  - Each link uses TDM with 24 slots/sec
  - Guard time is equal to $(1/8)^{th}$ of the slot time
  - 500 msec to establish end-to-end circuit

Class 3 - Network core

- Numerical #2:
  - How long does it take to send a file of 640,000 bits from host A to host B over a circuit-switched network?
  - Available link rate is 1.536 Mbps
  - Link rate is distributed across 10 channels of 200 kHz
  - Guard band of 50 Hz is used
  - 500 msec to establish end-to-end circuit

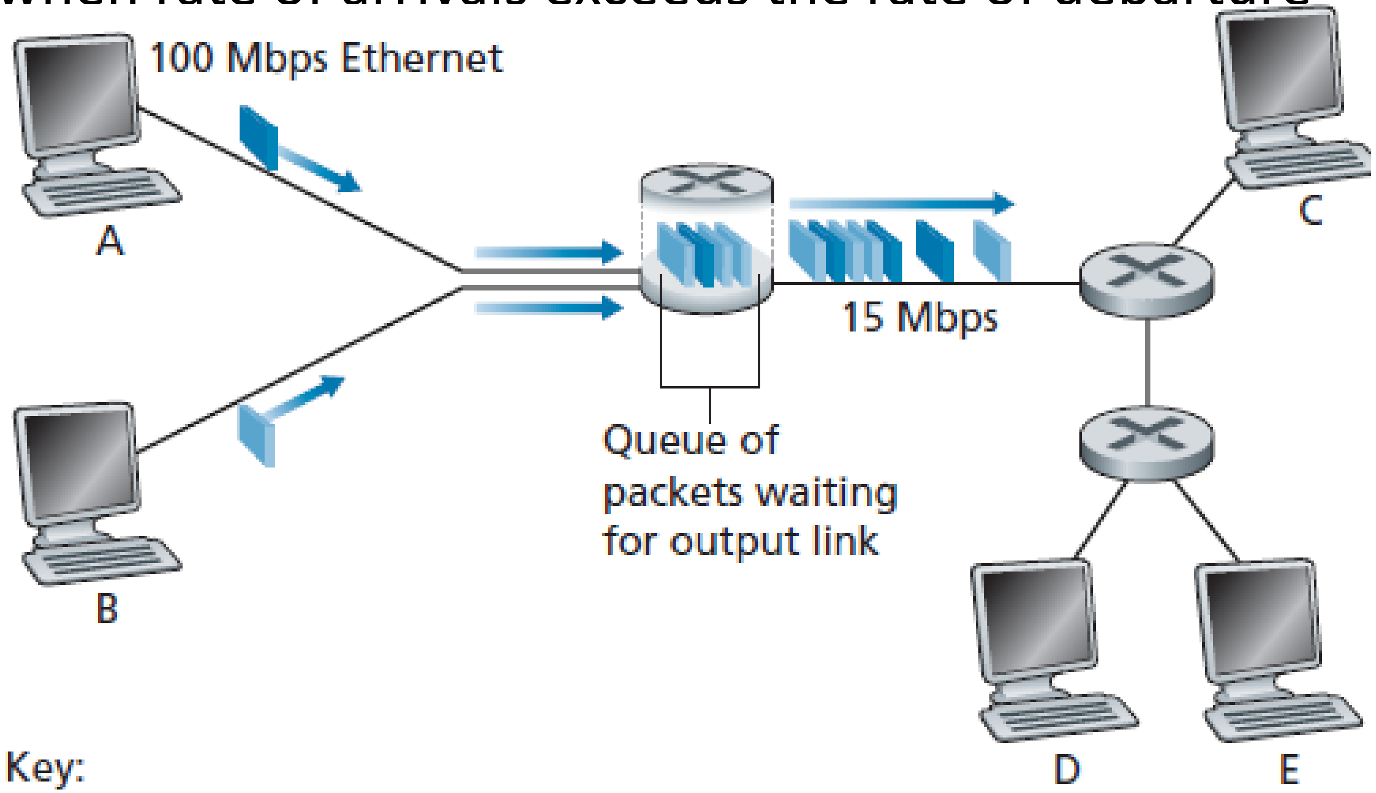
Class 3 - Network core

- Packet switching:
  - Data broken into smaller chunk called packets
  - No reservation of resources
  - Suited for bursty traffic
  - Better link utilization
  - Packets are stored in buffer and then forwarded one at a time
  - Requires protocols for link access and reliable packet delivery



Class 3 - Network core

- Packet switching (contd.):
  - Packets may suffer queuing delays and get lost at the routers
  - This happens when rate of arrivals exceeds the rate of departure



Class 3 - Network core

- <u>Packet switching versus Circuit switching – Case 1:</u>
- Suppose users share a 1 Mbps link. Also suppose that each user alternates between periods of activity when a user generates data at a constant rate of 100 kbps, and periods of inactivity when a user generates no data. Suppose further that a user is active only 10 percent of the time.
- With circuit switching, 100 kbps must be reserved for each user at all times. For example, with TDM, if a one-second frame is divided into 10 time slots of 100 ms each, then each user would be allocated a one-time slot per frame.
- Thus, the circuit-switched link can support only 10 (= 1 Mbps/100 kbps) simultaneous users.

Class 3 - Network core

- <u>Packet switching versus Circuit switching – Case 1:</u>
- With packet switching, the probability that a specific user is active is 0.1. If there are 35 users, the probability that there are 11 or more simultaneously active users is approximately 0.0004.
- When there are 10 or fewer simultaneously active users (which happens with probability 0.9996), the aggregate arrival rate of data is less than or equal to 1 Mbps.
- When there are more than 10 simultaneously active users, then the aggregate arrival rate of packets exceeds the output capacity of the link, and the output queue will begin to grow.
- Thus, packet switching performs same as circuit switched TDM but serves more than three times the number of users.

Class 3 - Network core

- <u>Packet switching versus Circuit switching – Case 2:</u>
- Suppose there are 10 users and that one user suddenly generates one thousand 1,000-bit packets, while other users remain quiescent and do not generate packets.
- Under TDM circuit switching with 10 slots per frame and each slot consisting of 1,000 bits, the active user can only use its one-time slot per frame to transmit data, while the remaining nine-time slots in each frame remain idle. It will take 10 seconds
- Under packet switching, the active user can continuously send its packets at the full link rate of 1 Mbps, since there are no other users has packets for transmission. In this case, it will take 1 second

THANK YOU

Department of Electronics and communication engineering