

CS 372 Lecture #3 (Part 2)

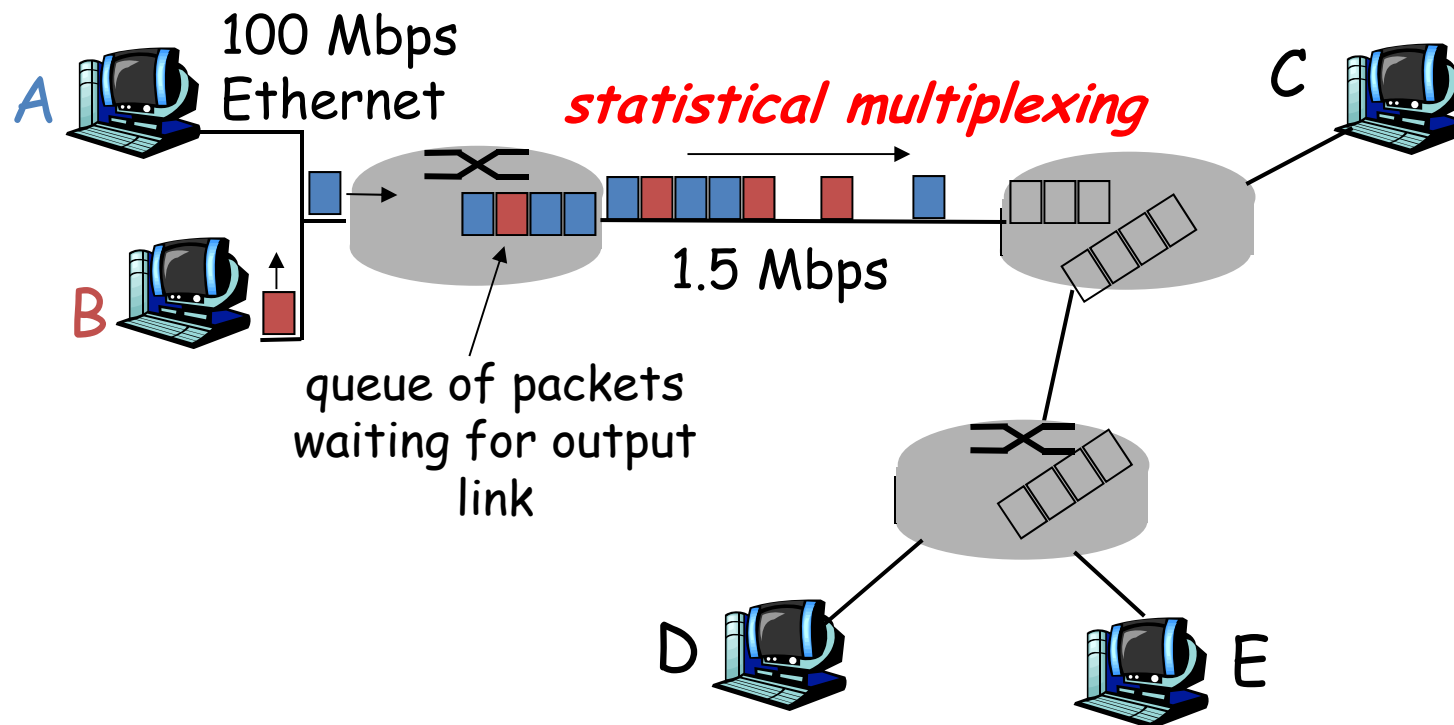
Overview of Networking:

- **Network core**
 - circuit switching
 - frequency-division multiplexing
 - time-division multiplexing
 - packet switching
 - statistical multiplexing
- **Utilization**

Note: Many of the lecture slides are based on presentations that accompany *Computer Networking: A Top Down Approach*, 6th edition, by Jim Kurose & Keith Ross, Addison-Wesley, 2013.

The network core: Packet Switching

Statistical multiplexing



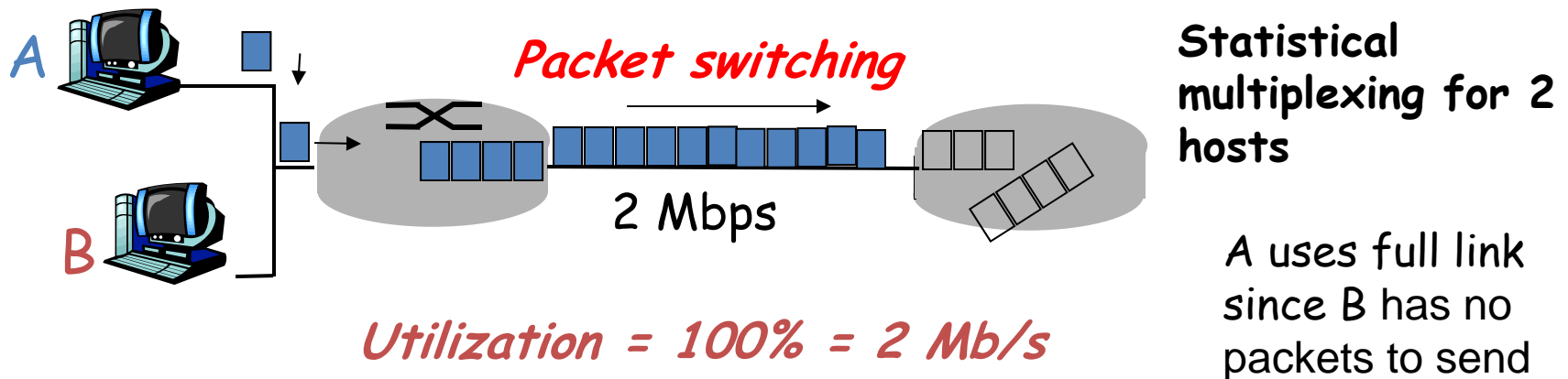
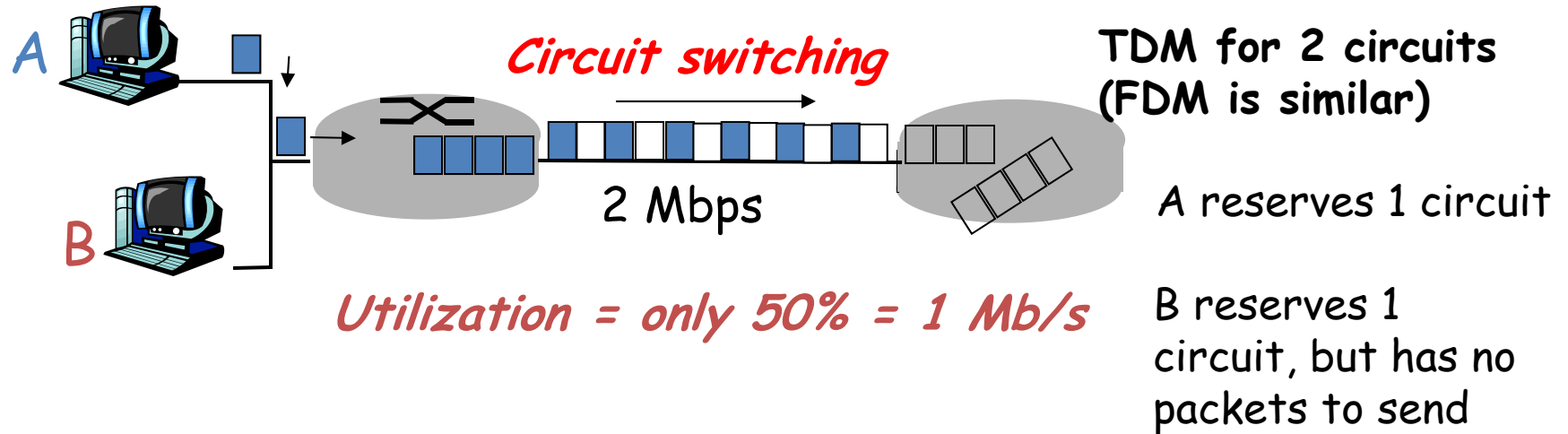
The network core: Packet Switching

Statistical multiplexing

- Sequence of A & B packets does not have fixed pattern
- Transmission medium is shared on demand.
 - if a host is idle, its bandwidth is available to others.
- Compare:
 - in **TDM**, each host gets same slot (periodically)
 - in **FDM**, each host gets same bandwidth (continuously)
 - with either TDM or FDM
 - a limited number of hosts get exclusive use of one slot or one channel
 - if a host is idle, its bandwidth is wasted.

The network core:

Circuit switching versus Packet switching



Note: Packet switching has some additional overhead

The network core:

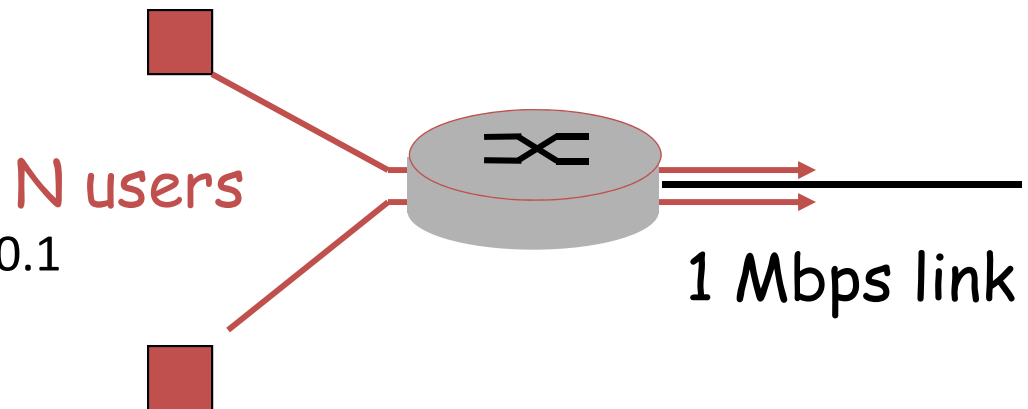
Circuit switching versus Packet switching

Utilization (average % of bandwidth used)

Circuit switching transmits at a constant rate.

Packet switching allows more users to use network! (better utilization)

- Suppose each user is active 10% of time
- **circuit-switching:**
 - with 10 users, each gets 0.1 Mbps when active
- **packet-switching:**
 - with **35** users, probability that more than 10 are active is less than .0004.
 - performance is nearly the same as **10** users with circuit-switching



Discussion question: how did we get value 0.0004?

The network core:

Circuit switching versus Packet switching

- Sometimes all (or most) users want to be active
- Packet switching is fine for data that is not time-critical
 - However ...
 - Excessive congestion causes:
 - packet delay and loss
 - "jitter"
 - packet construction creates additional overhead
 - protocols needed for reliable data transfer, congestion control
 - bandwidth guarantees are needed for audio/video apps
- Q: How to provide circuit-like behavior (constant rate or *appearance* of constant rate)?
 - still a research problem

- Definitions:
 - network core
 - circuit-switching, packet-switching
 - multiplexing
 - utilization
- Network core
 - composition (interconnected routers)
 - functions
- FDM, TDM
- Statistical multiplexing