Network View

17CS52 - CN: L04

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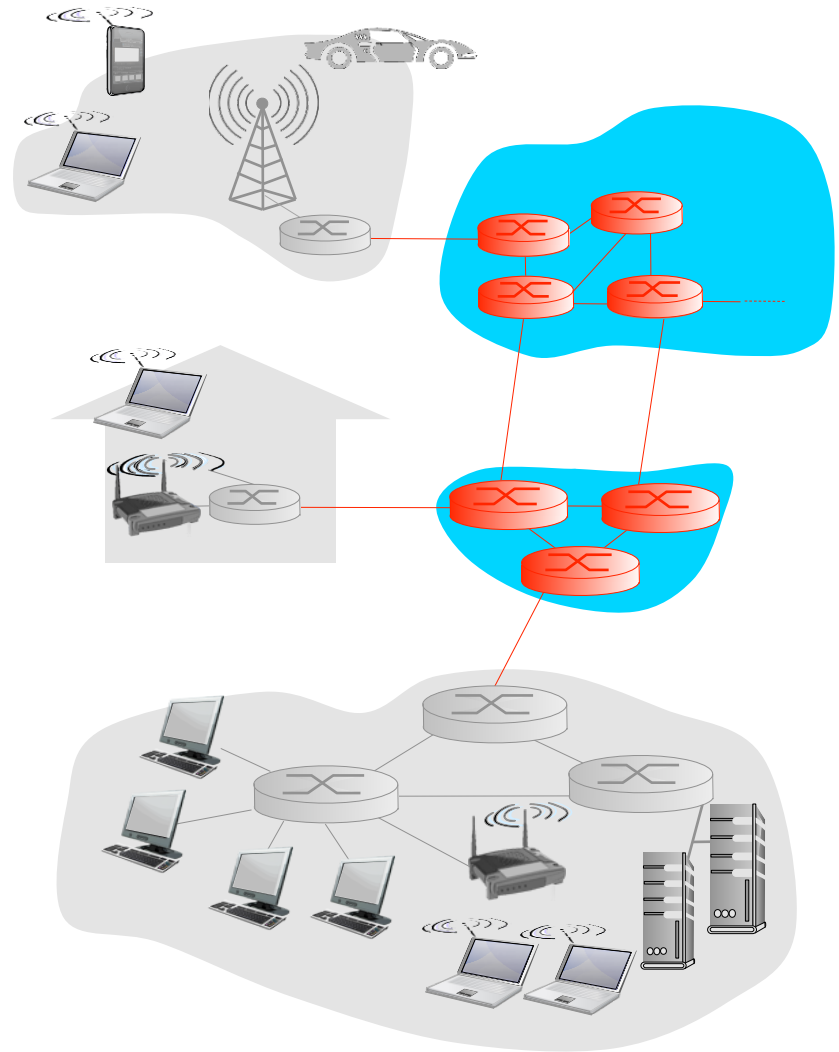
https://www.youtube.com/watch?v=BAZ7Bxn26c4

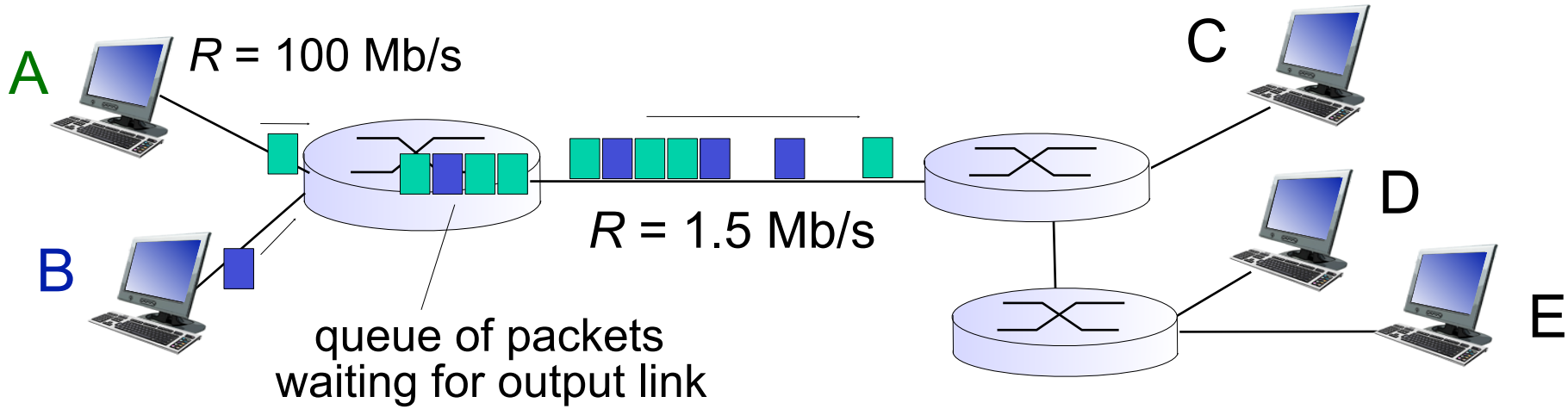
The network core

- Mesh of interconnected routers
- Packet-switching: hosts break application-layer messages into *packets*
  - Forward packets from one router to the next, across links on path from source to destination
  - Each packet transmitted at full link capacity
- Full-duplex and half-duplex links



src: Computer Network: A top down approach; Kurose, Ross

Packet Switching: queueing delay, loss



- queuing and loss:
- If arrival rate (in bits) to link exceeds transmission rate of link for a peri of time:
- packets will queue, wait to be transmitted on link
- packets can be dropped (lost) if memory (buffer) fills up

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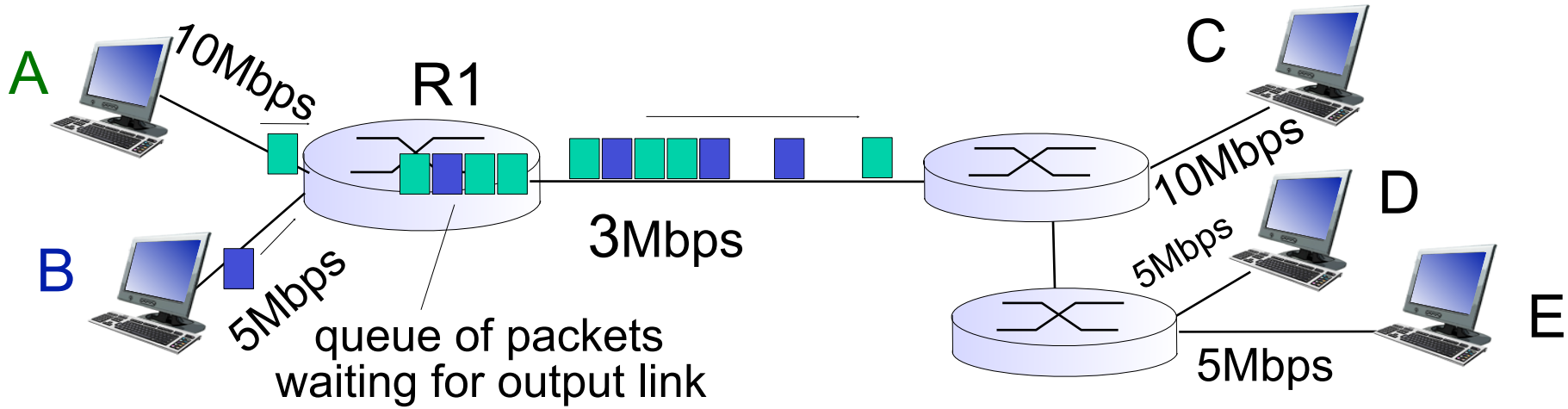
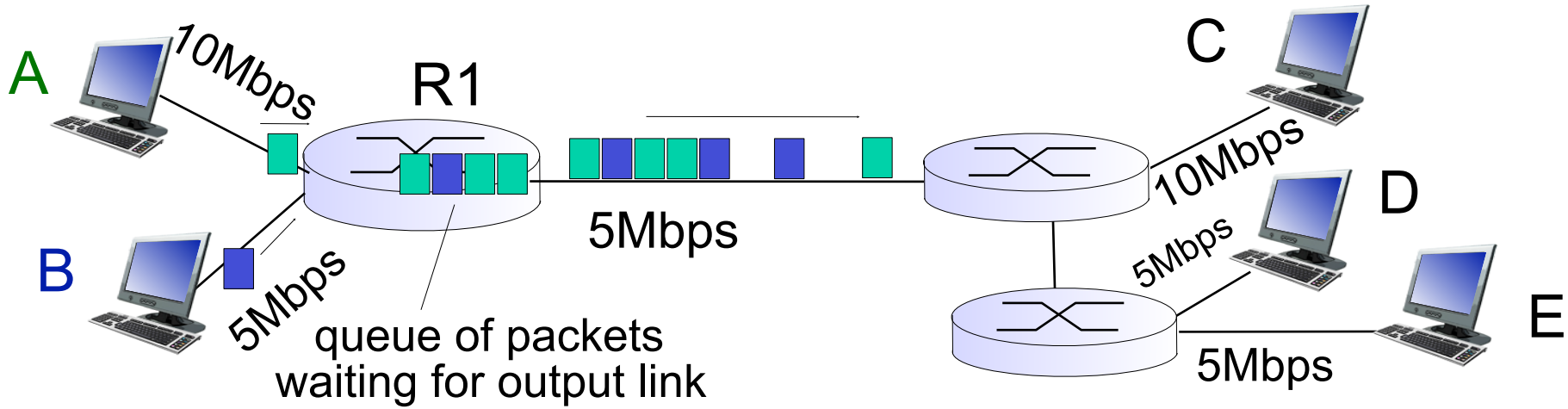
Example: queueing delay, loss



- In the above figure, assuming A pumps data to C at full bandwidth of 10Mbps (10 pkts each of 1Mbits), and B to E at full bandwidth of 5Mbps (5 pkts each of 1Mbits), and router R1 treats all packets fairly, then
- What would be the data rate at which C and E will receive packets?

src: Computer Network: A top down approach; Kurose, Ross

Case Study 01: queueing delay, loss



- In the above figure, assuming A pumps data to C at full bandwidth of 10Mbps, and B to E at full bandwidth of 5Mbps, and router R1 equal weightage (priority) to both A and B, what would be the data rate at which C and E will receive packets.

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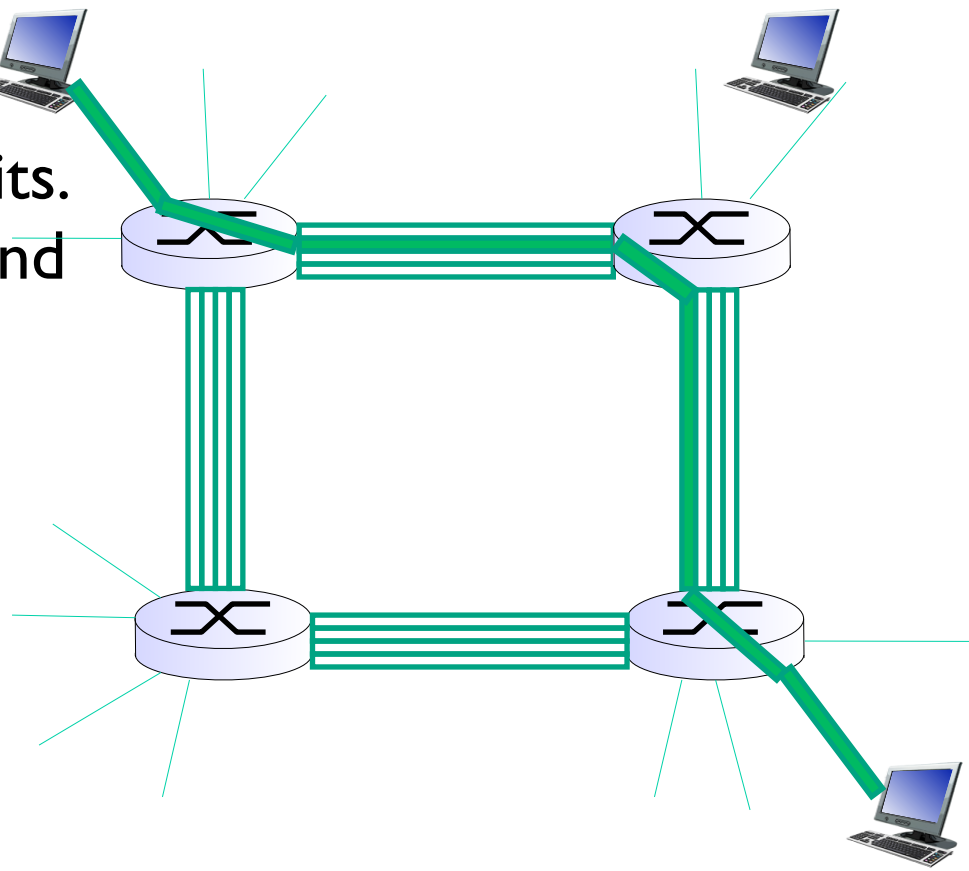
Alternative Core: Circuit Switching

- end-end resources allocated to, reserved for "call" between source & dest:
- In diagram, each link has four circuits.
  - call gets 2nd circuit in top link and 4th circuit in right link.
- dedicated resources: no sharing
  - circuit-like (guaranteed) performance
- circuit segment idle if not used by call *(no sharing)*
- Commonly used in traditional telephone networks

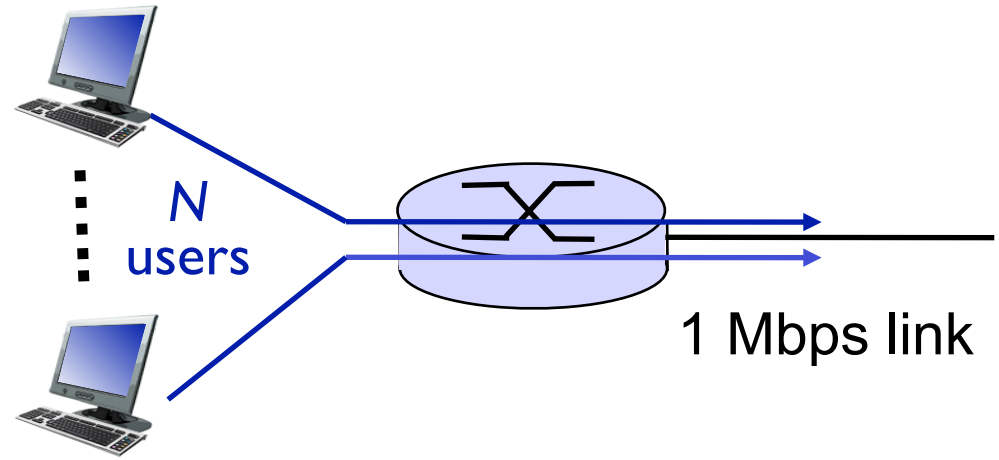


src: Computer Network: A top down approach; Kurose, Ross

Packet switching versus circuit switching

packet switching allows more users to use network!

- Example: 1 Mb/s outgoing link
- each user sends at the rate of 100 kb/s when "active"
- A user is active 10% of time and there are total of N users
- Q: Given N>10 user, how many users this router can serve when using *circuit-switching*:
  - 10 users



- Using *packet switching*:
  - Given 20 users, What is the probability that all users can be served by this router given that a user is active 10% time
    - Prob P_u of 1 user tranmitting=0.1
    - Prob of 1 user transmitting and other not transmitting: $(1-0.1)^{19}$
    - Prob of exactly k users transmitting
      - $^{20}C_k\,(0.1)^k * (0.9)^{20-k}$
    - Prob. of at Most 10 users xmitting

$$\sum_{0 \le i \le 10} {}^{20}C_i\,(0.1)^i * (0.9)^{20-i}$$

$$= 0.99999291$$

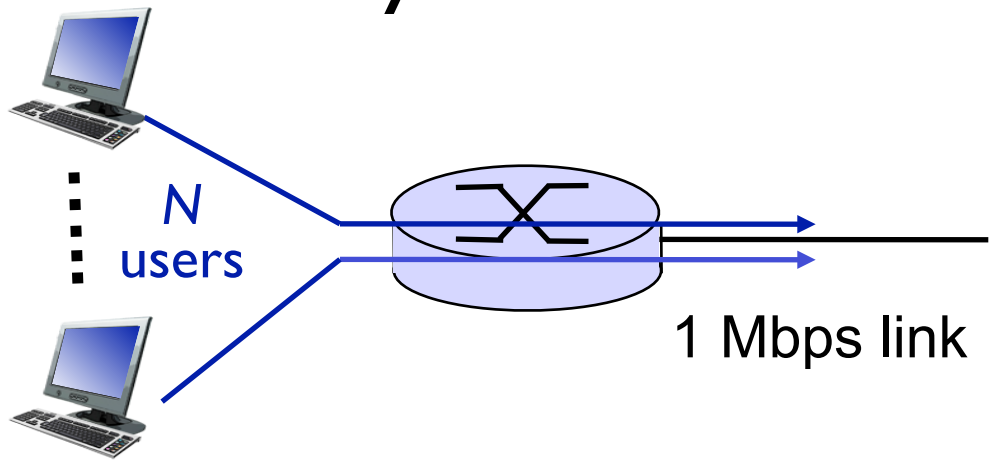
src: Computer Network: A top down approach; Kurose, Ross

Packet switching versus circuit switching

- Study the interactive exercise
  - http://gaia.cs.umass.edu/kurose_ross/interactive/ps_versus_cs.php

- Refresh your binomial distribution and probability theory
  - http://www.youtube.com/watch?v=O12yTz_8EOw

Case Study 02: Exercise Using Packet Switching



- Router has 1 Mb/s outgoing link, and each user sends at the rate of 100 kb/s when "active"
- Case A:
  - A user is active 20% of time and there are 30 users
  - What is the probability that all 30 users can be served
  - Ans: ?
- Case B:
  - A user is active 50% of time and there are 20 users.
  - What is the probability that all users can be served?
  - Ans: ?

src: Computer Network: A top down approach; Kurose, Ross

Packet switching versus circuit switching

Q: Is packet switching a "slam dunk winner?"

- Great for bursty data
  - Resource sharing
  - Simpler, no call setup
- Excessive congestion possible: packet delay and loss
  - Protocols needed for reliable data transfer, congestion control
- *Q:* How to provide circuit-like behavior?
  - Bandwidth guarantees needed for audio/video apps
  - till an unsolved problem

Q: human analogies of reserved resources (circuit switching) versus on-demand allocation (packet-switching)?

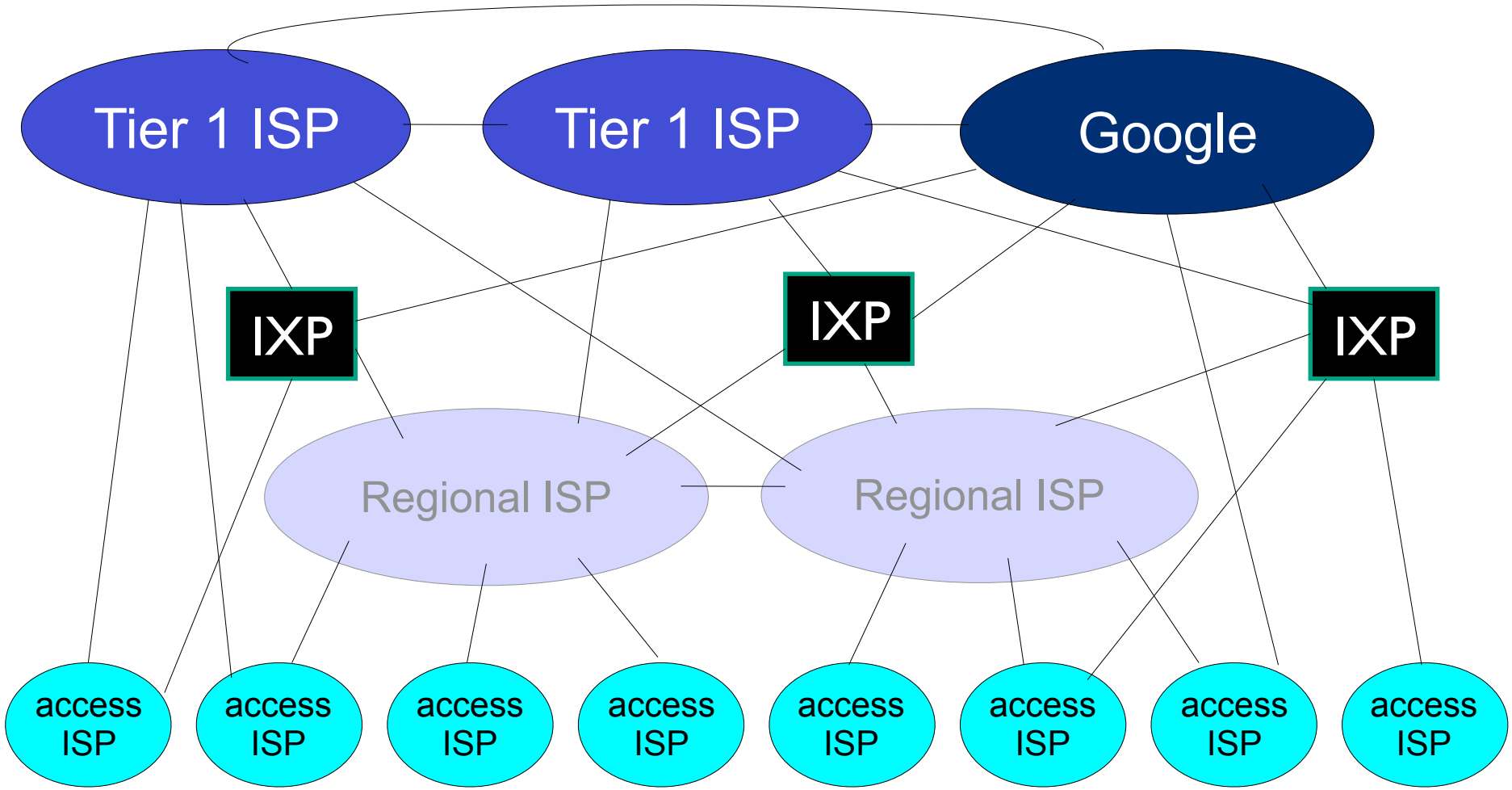
Packet switching versus circuit switching

- Recommended Reading
  - Molinero-Fernandez, ACM SITCOM CCR 2002
    - "Is IP going to take over the world of Communications"
  - http://yuba.stanford.edu/~nickm/papers/HotNets02-IP conquest of the world with authors.pdf

Internet structure: network of networks

- End systems connect to Internet via access ISPs (Internet Service Providers)
- Residential, company and university ISPs
- Access ISPs in turn must be interconnected.
- So that any two hosts can send packets to each other
- Resulting network of networks is very complex
- Evolution was driven by economics and national policies
- Let's take a stepwise approach to describe current Internet structure

Internet structure: network of networks



- at center: small # of well-connected large networks
  - "tier-1" commercial ISPs (e.g., Level 3, Sprint, AT&T, NTT), national & international coverage
  - content provider network (e.g, Google): private network that connects it data centers to Internet, often bypassing tier-1, regional ISPs

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Summary

- Internet Core
- Packet Switching vs circuit switching
- Internet structure