

INTRODUCTION NETWORKING CONCEPTS AND ADMINISTRATION CSIS 3723

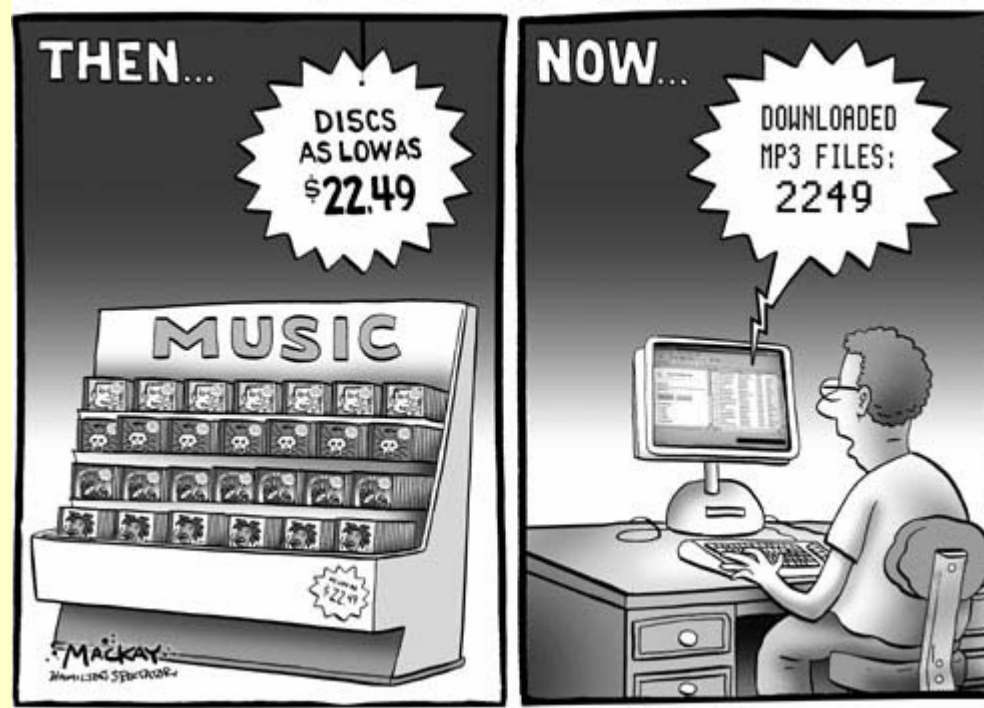
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Chapter 1: Introduction

Our goal:

- get “feel” and terminology
- more depth, detail *later* in course
- approach:
 - use Internet as example

Overview:

- what’s the Internet?
- what’s a protocol?
- network edge; hosts, access net, physical media
- network core: packet/circuit switching, Internet structure
- performance: loss, delay, throughput
- security
- protocol layers, service models
- history

Chapter 1: roadmap

1.1 What *is* the Internet?

1.2 Network edge

- end systems, access networks, links

1.3 Network core

- circuit switching, packet switching, network structure

1.4 Delay, loss and throughput in packet-switched networks

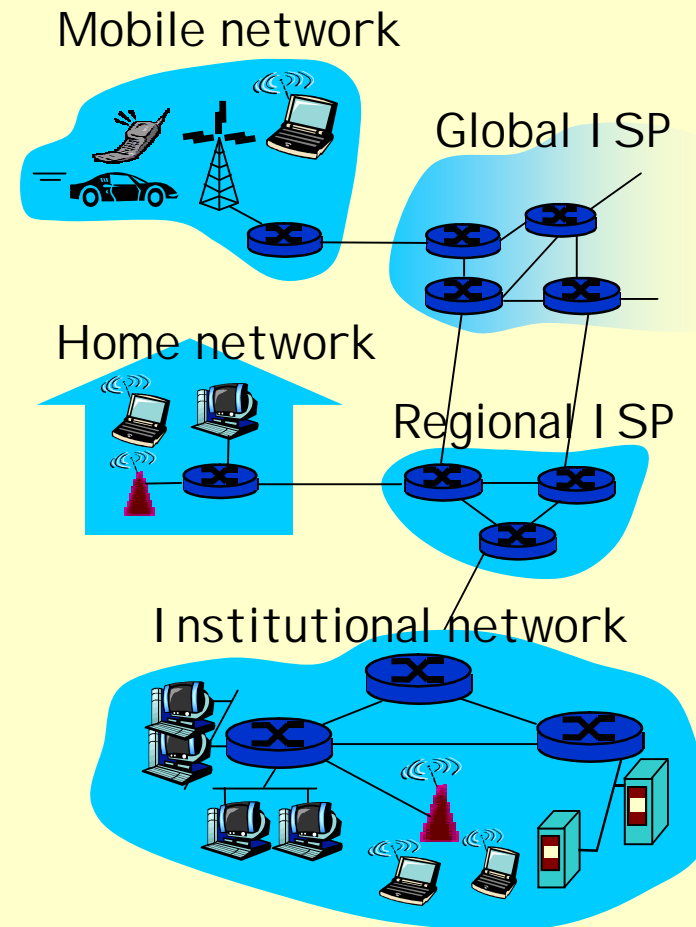
1.5 Protocol layers, service models

1.6 Networks under attack: security

1.7 History

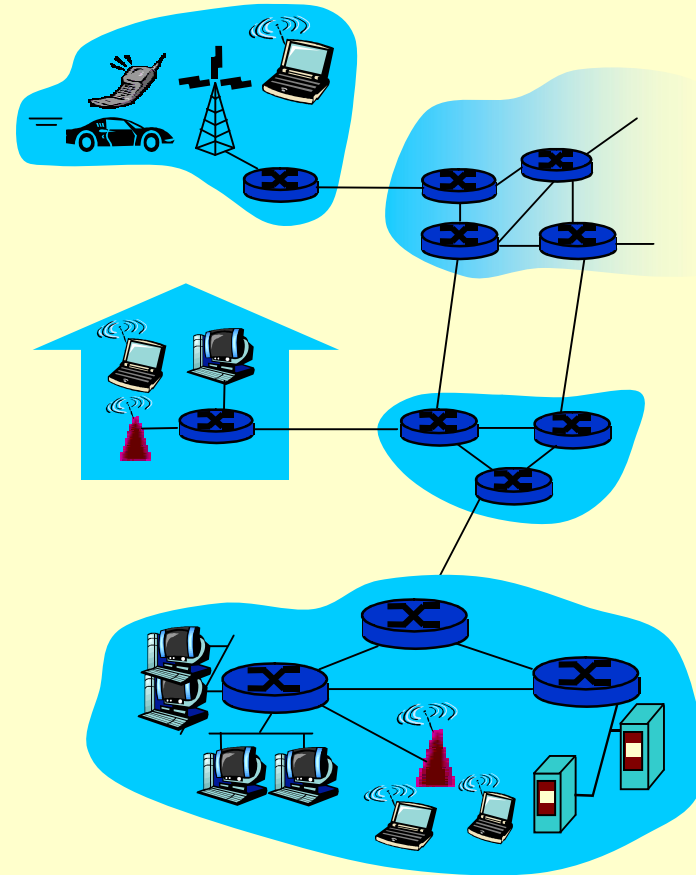
What's the Internet: "nuts and bolts" view

- **protocols** control sending, receiving of msgs
 - e.g., TCP, IP, HTTP, Skype, Ethernet
- **Internet: "network of networks"**
 - loosely hierarchical
 - public Internet versus private intranet
- **Internet standards**
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



What's the Internet: a service view

- **communication *infrastructure*** enables distributed applications:
 - Web, VoIP, email, games, e-commerce, file sharing
- **communication services provided to apps:**
 - reliable data delivery from source to destination
 - “best effort” (unreliable) data delivery



What's a protocol?

human protocols:

- “what’s the time?”
- “I have a question”
- introductions

... specific msgs sent

... specific actions taken
when msgs received, or
other events

network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

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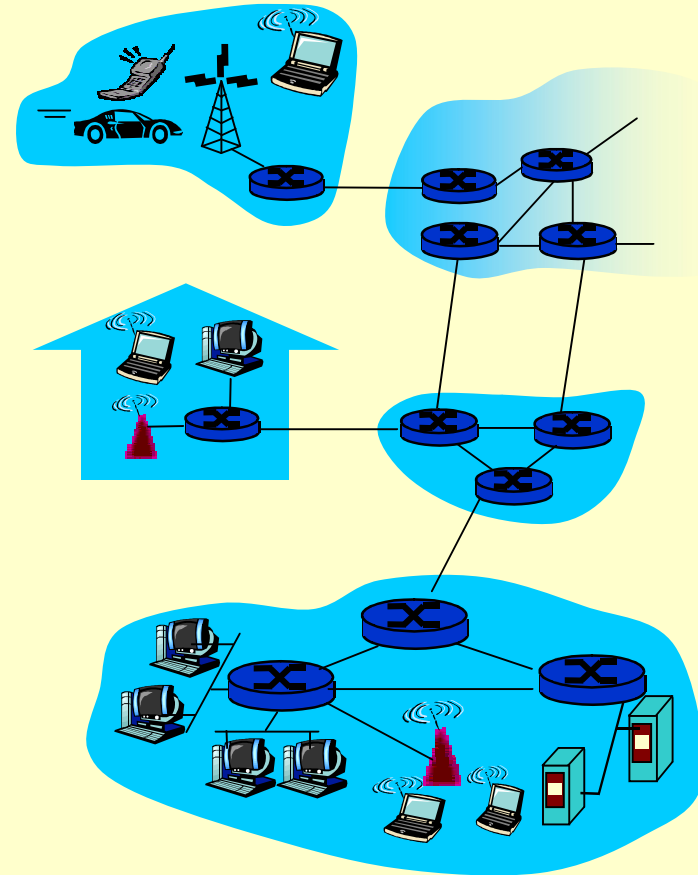
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A closer look at network structure

- **network edge:**
 - **applications and hosts**
 - **access networks,**
physical media:
wired, wireless
communication links
 - **network core:**
 - ❖ interconnected
routers
 - ❖ network of
networks



The network edge

- **end systems (hosts):**

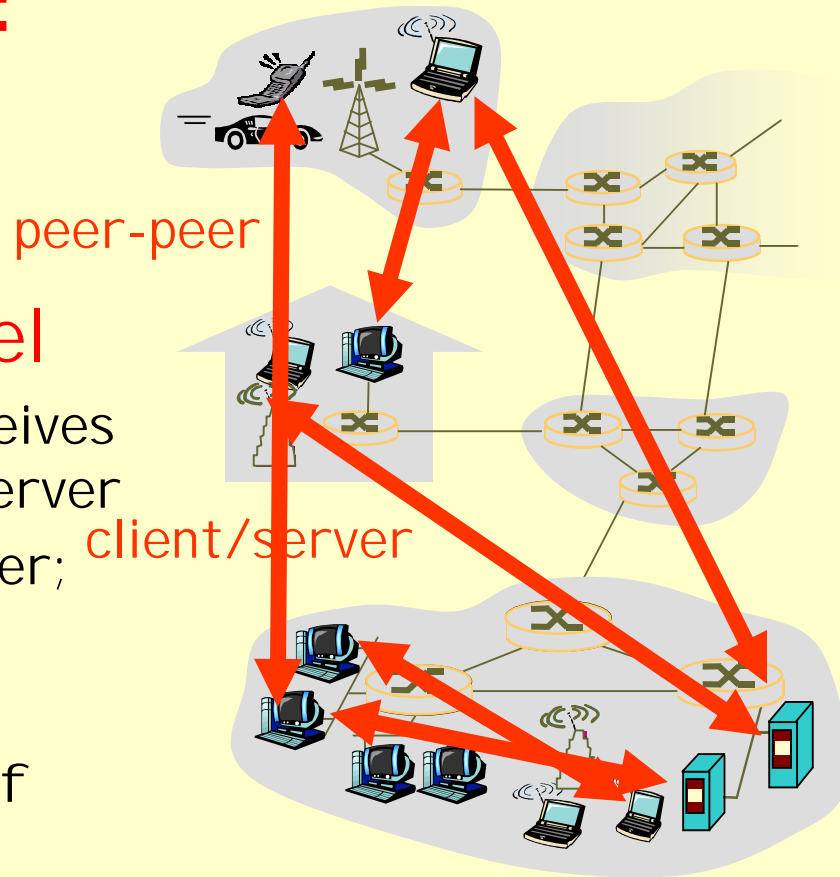
- run application programs
- e.g. Web, email
- at “edge of network”

- **client/server model**

- ❖ client host requests, receives service from always-on server
- ❖ e.g. Web browser/server; email client/server

- **peer-peer model:**

- ❖ minimal (or no) use of dedicated servers
- ❖ e.g. Skype, BitTorrent



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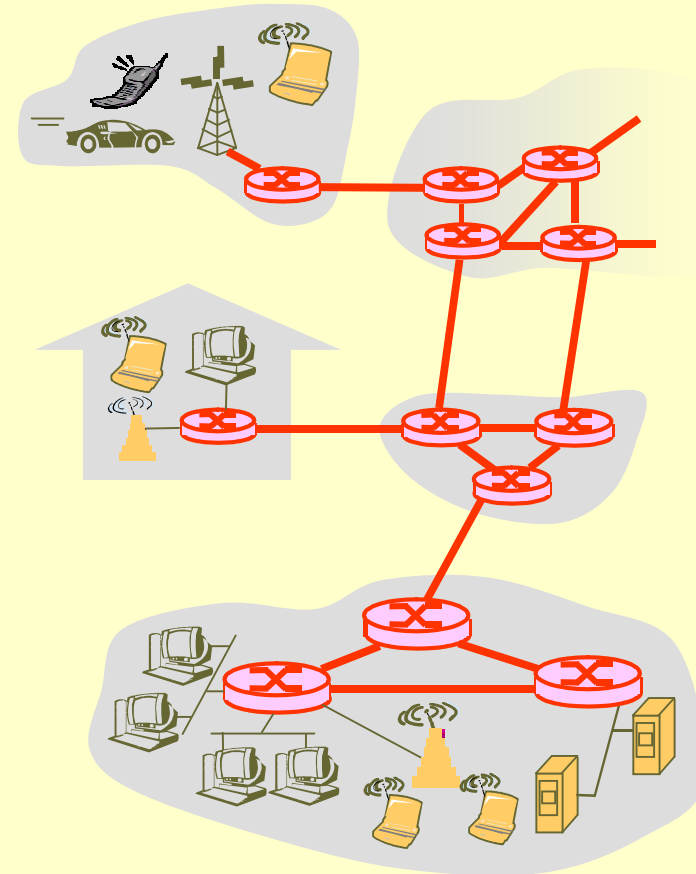
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The Network Core

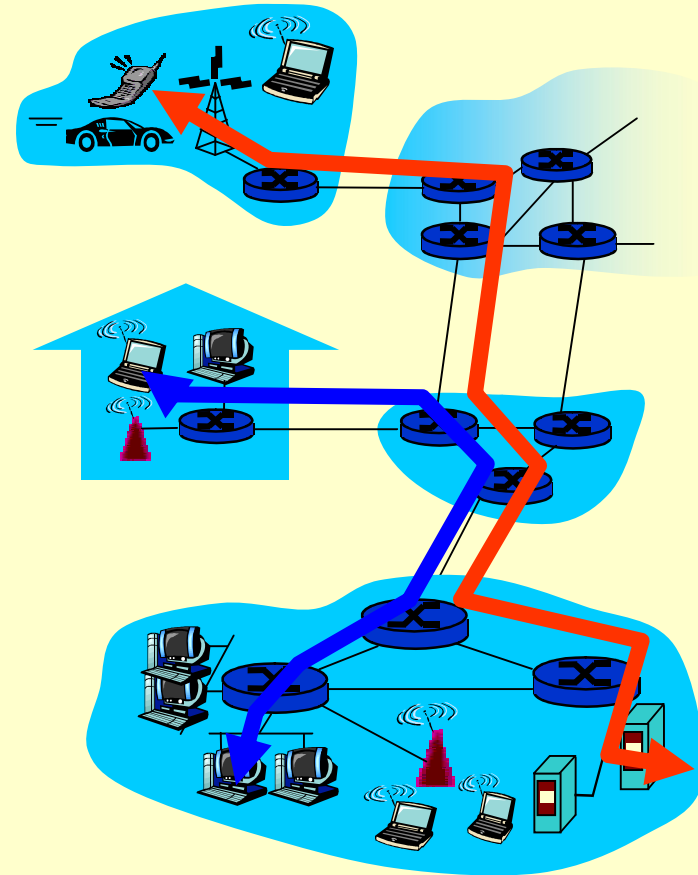
- mesh of interconnected routers
- **the fundamental question:** how is data transferred through net?
 - **circuit switching:** dedicated circuit per call: telephone net
 - **packet-switching:** data sent thru net in discrete “chunks”



Network Core: Circuit Switching

End-end resources reserved for “call”

- link bandwidth, switch capacity
- dedicated resources: no sharing
- circuit-like (guaranteed) performance
- call setup required



Network Core: Circuit Switching

network resources (e.g., bandwidth) **divided into “pieces”**

- pieces allocated to calls
- resource piece *idle* if not used by owning call (*no sharing*)
- dividing link bandwidth into “pieces”
 - frequency division
 - time division

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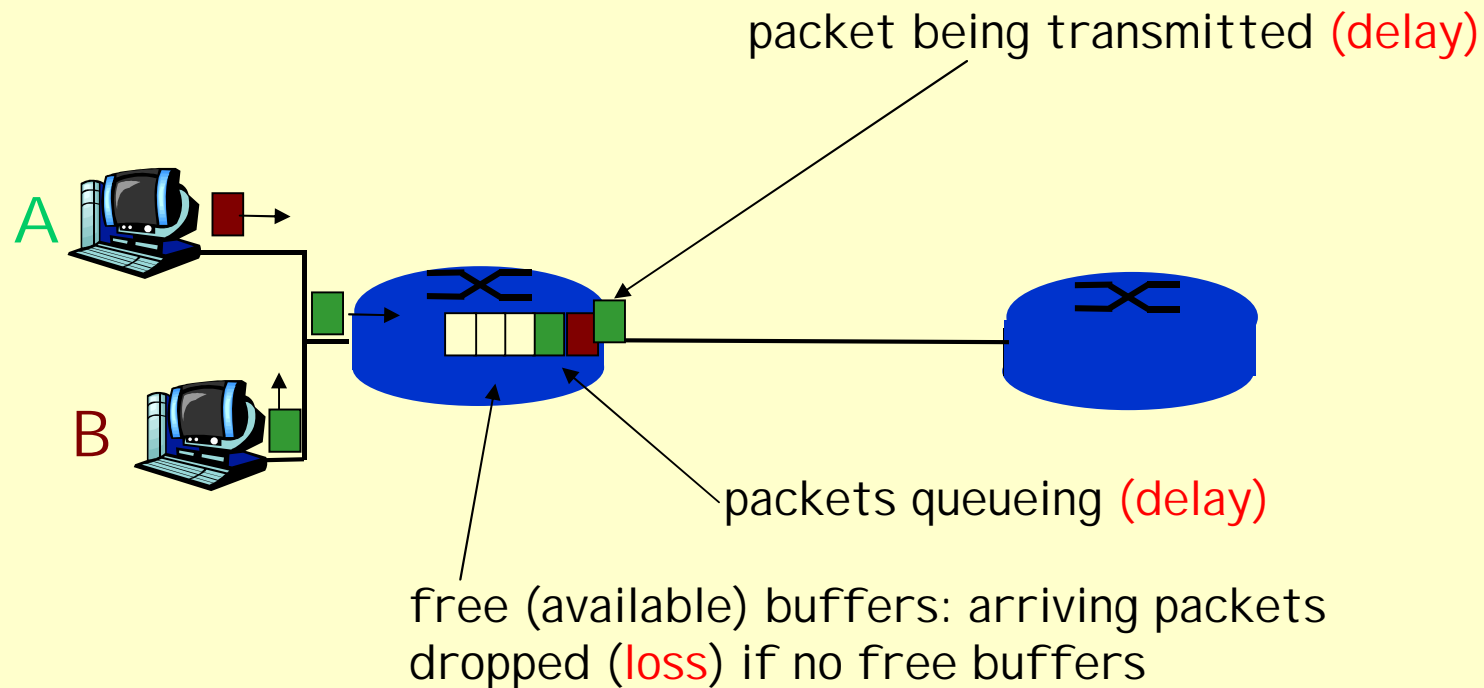
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How do loss and delay occur?

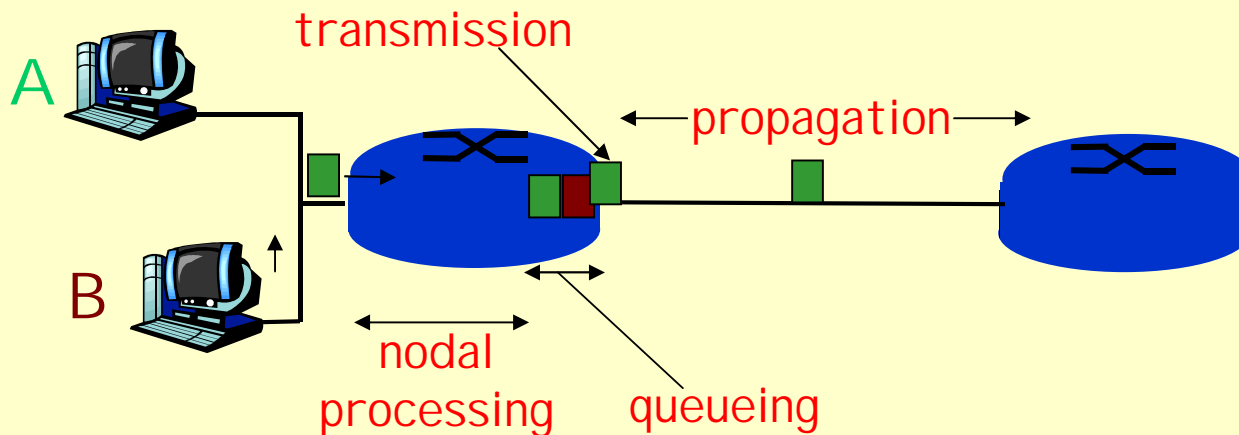
packets *queue* in router buffers

- packet arrival rate to link exceeds output link capacity
- packets queue, wait for turn



Four sources of packet delay

- **1. nodal processing:**
 - check bit errors
 - determine output link
- **2. queueing**
 - time waiting at output link for transmission
 - depends on congestion level of router



Delay in packet-switched networks

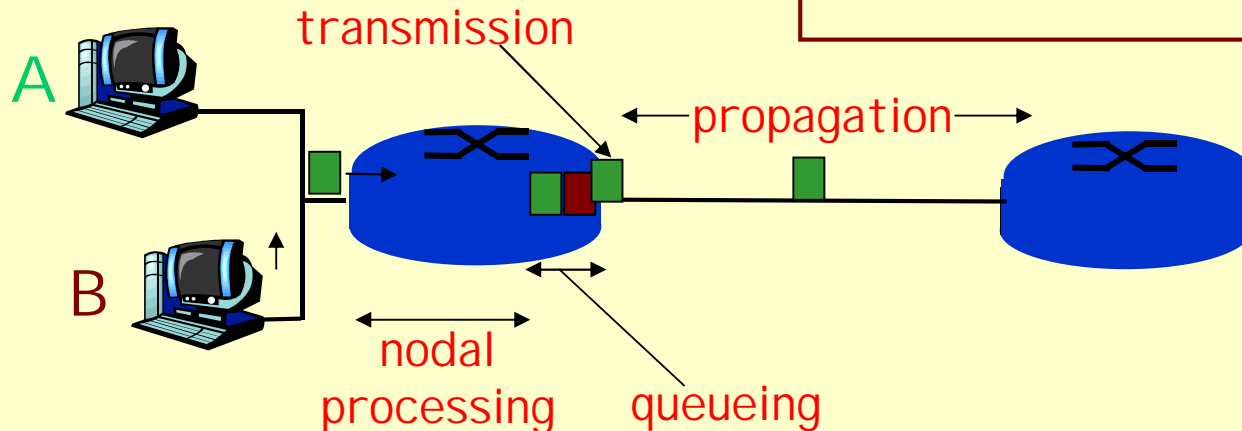
3. Transmission delay:

- R = link bandwidth (bps)
- L = packet length (bits)
- time to send bits into link = L/R

4. Propagation delay:

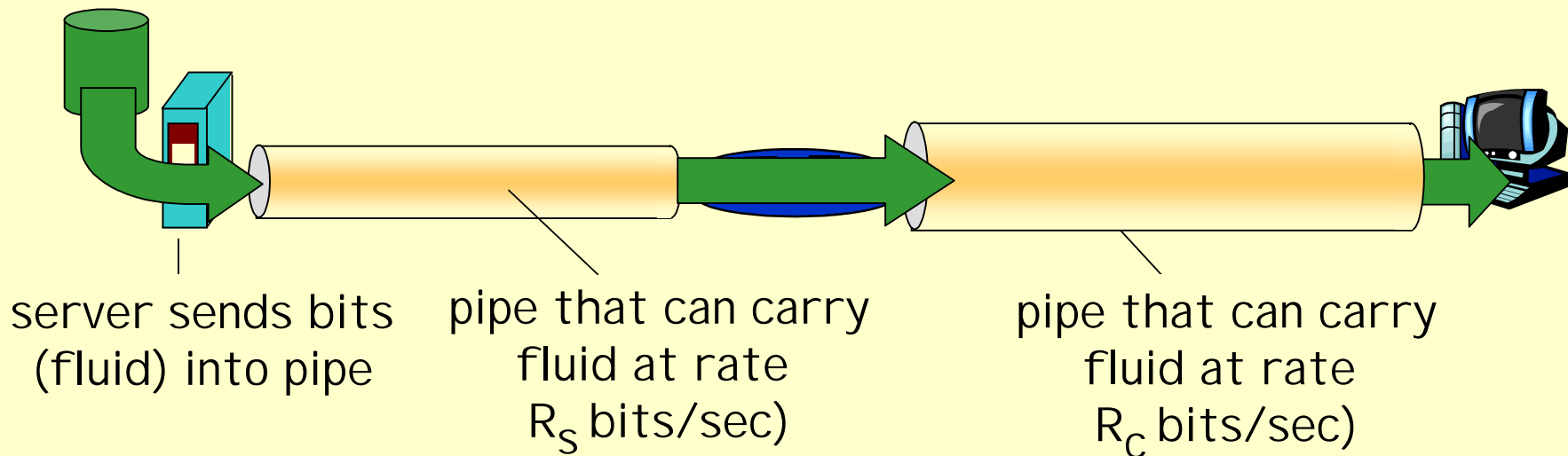
- d = length of physical link
- s = propagation speed in medium ($\sim 2 \times 10^8$ m/sec)
- propagation delay = d/s

Note: s and R are very different quantities!



Throughput

- **throughput:** rate (bits/time unit) at which bits transferred between sender/receiver
 - *instantaneous:* rate at given point in time
 - *average:* rate over long(er) period of time



Nodal delay

$$d_{\text{nodal}} = d_{\text{proc}} + d_{\text{queue}} + d_{\text{trans}} + d_{\text{prop}}$$

- **d_{proc} = processing delay**
 - typically a few microseconds or less
- **d_{queue} = queuing delay**
 - depends on congestion
- **d_{trans} = transmission delay**
 - $= L/R$, significant for low-speed links
- **d_{prop} = propagation delay**
 - a few microseconds to hundreds of msecs

Introduction: Summary

Covered material

- **Computer network (Internet)**
- **network edge, core, access network**
 - packet-switching versus circuit-switching
- **loss, delay, throughput**

NEXT:

- **context, overview, “feel” of networking**
- **layering, service models**
- **security**
- **history**
- **more depth, detail *to follow!***