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Introduction (Contd...)

*Networking: A Top Down Approach Featuring the Internet,
Jim Kurose, Keith Ross*

Physical Media



Bit: propagates between transmitter/rcvr pairs

physical link: what lies between transmitter & receiver

guided media:

signals propagate in solid media: copper, fiber, coax

unguided media:

signals propagate freely, e.g., radio

Twisted Pair (TP)

two insulated copper wires

Category 3: traditional phone wires, 10 Mbps Ethernet

Category 5:
100Mbps Ethernet
1Gbps Ethernet



Physical Media: coax, fiber



Coaxial cable:

two concentric copper conductors

bidirectional

baseband:

- single channel on cable
- legacy Ethernet

broadband:

- multiple channels on cable



Fiber optic cable:

glass fiber carrying light pulses, each pulse a bit

high-speed operation:

high-speed point-to-point transmission (e.g., 10's-100's Gps)

low error rate: repeaters spaced far apart ; immune to electromagnetic noise



Physical media: radio



- signal carried in electromagnetic spectrum
- no physical “wire”
- bidirectional
- propagation environment effects:
 - reflection
 - obstruction by objects
 - interference

Radio link types:

terrestrial microwave

e.g. 45 Mbps channels

LAN (e.g., Wifi)

11Mbps, 54 Mbps

wide-area (e.g., cellular)

e.g. 3G/4G: hundreds of kbps

satellite

Kbps to 45Mbps channel (or multiple smaller channels)

270 msec end-end delay

geosynchronous versus low altitude

Types of Computer Networks



Spread, size, inter-node-distance and purpose based classification:

Personal Area Networks (PANs): Often Wireless: WPANs

Local Area Networks (LANs): LANs & Wireless LANs:
WLANs

Metropolitan Area Networks (MANs): Wireline and
Wireless MANs

Wide Area Networks (WANs): Wireless, Fixed / Mobile,



Types of Computer Networks

Intranet: Completely private network of networks

Wireline

Wireless

- Fixed

- Mobile

The Internet: Global public network of networks

Wireline

Wireless

- Fixed

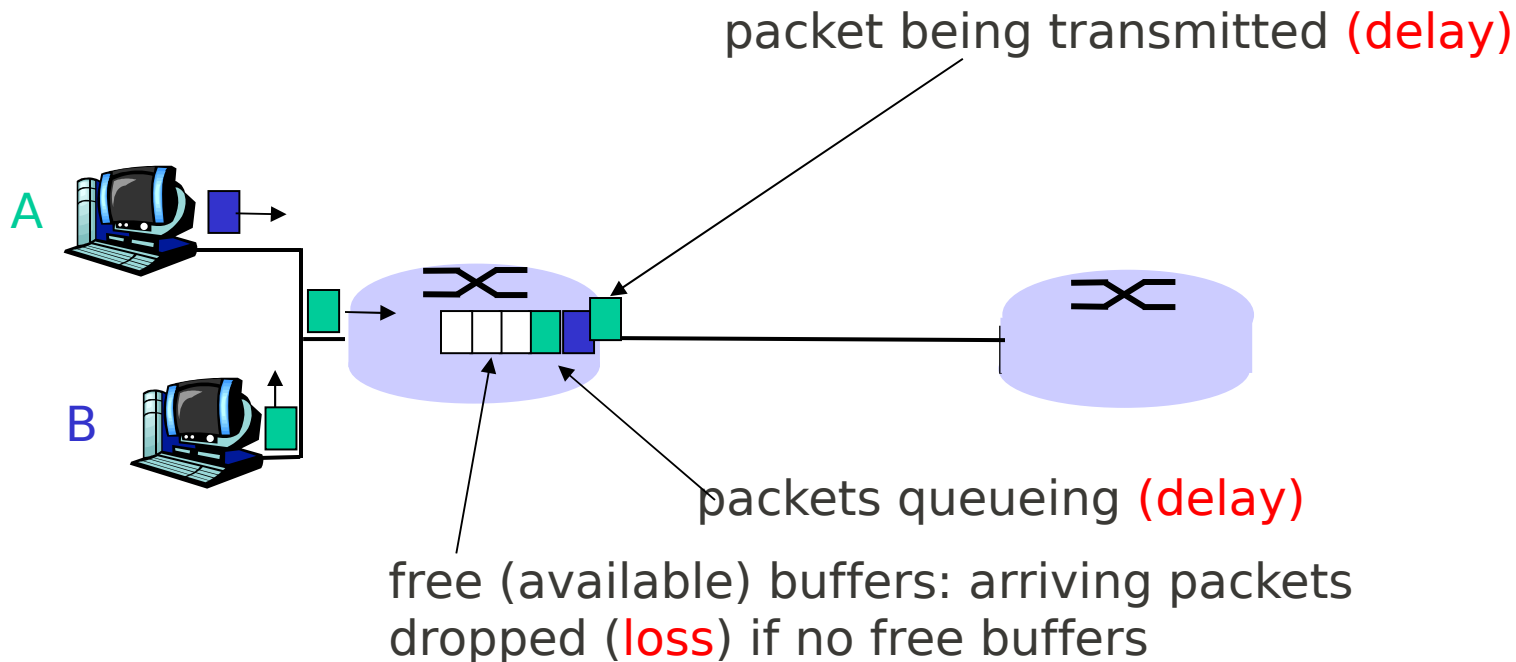
- Mobile

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

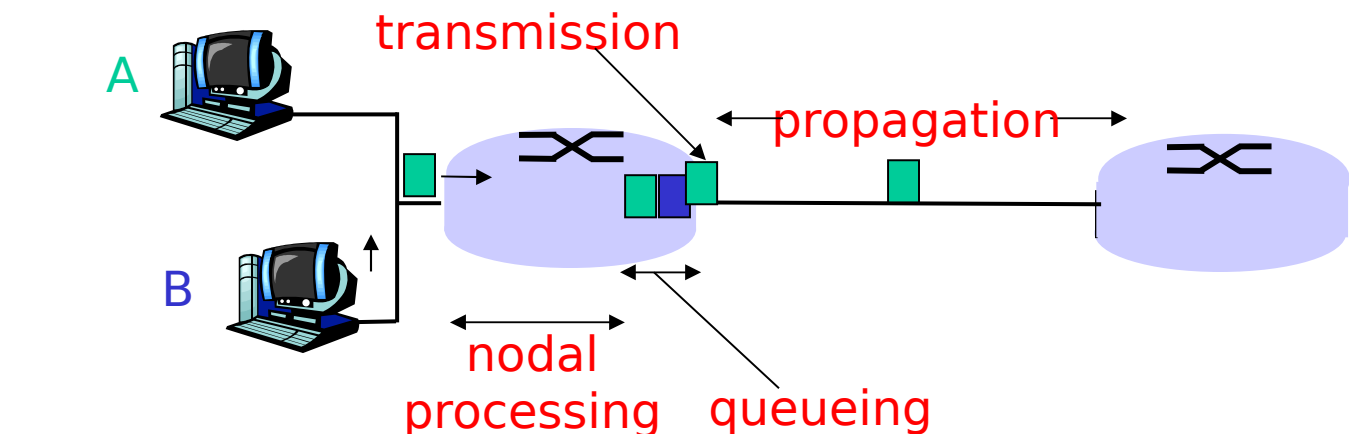


nodal processing:

- ❖ check bit errors
- ❖ determine output link

queueing

- ❖ time waiting at output link for transmission
- ❖ depends on congestion level of router



packet delay (contd..)

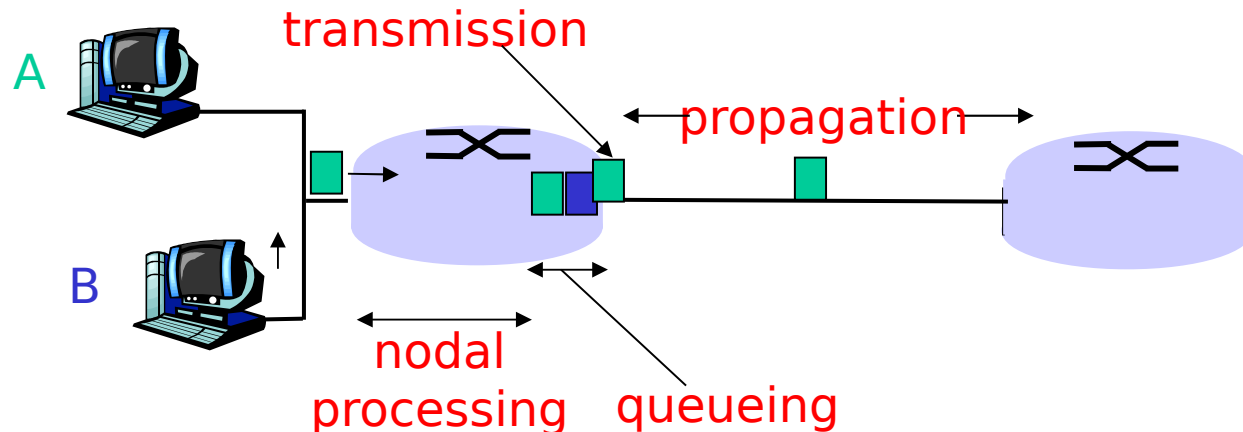


Transmission delay:

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

Propagation delay:

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

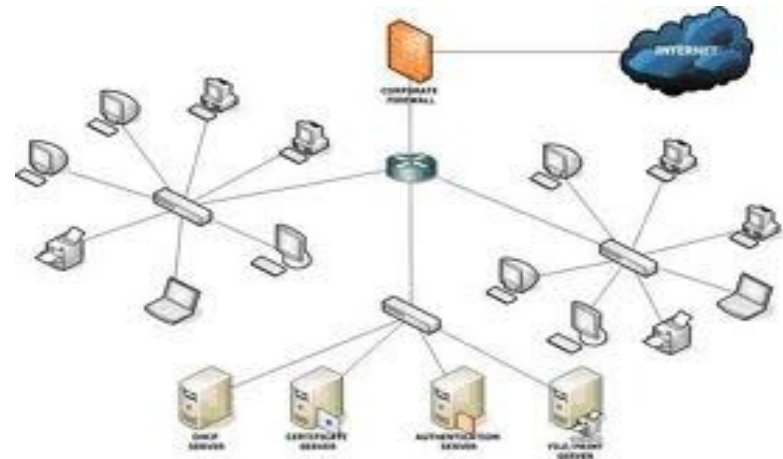




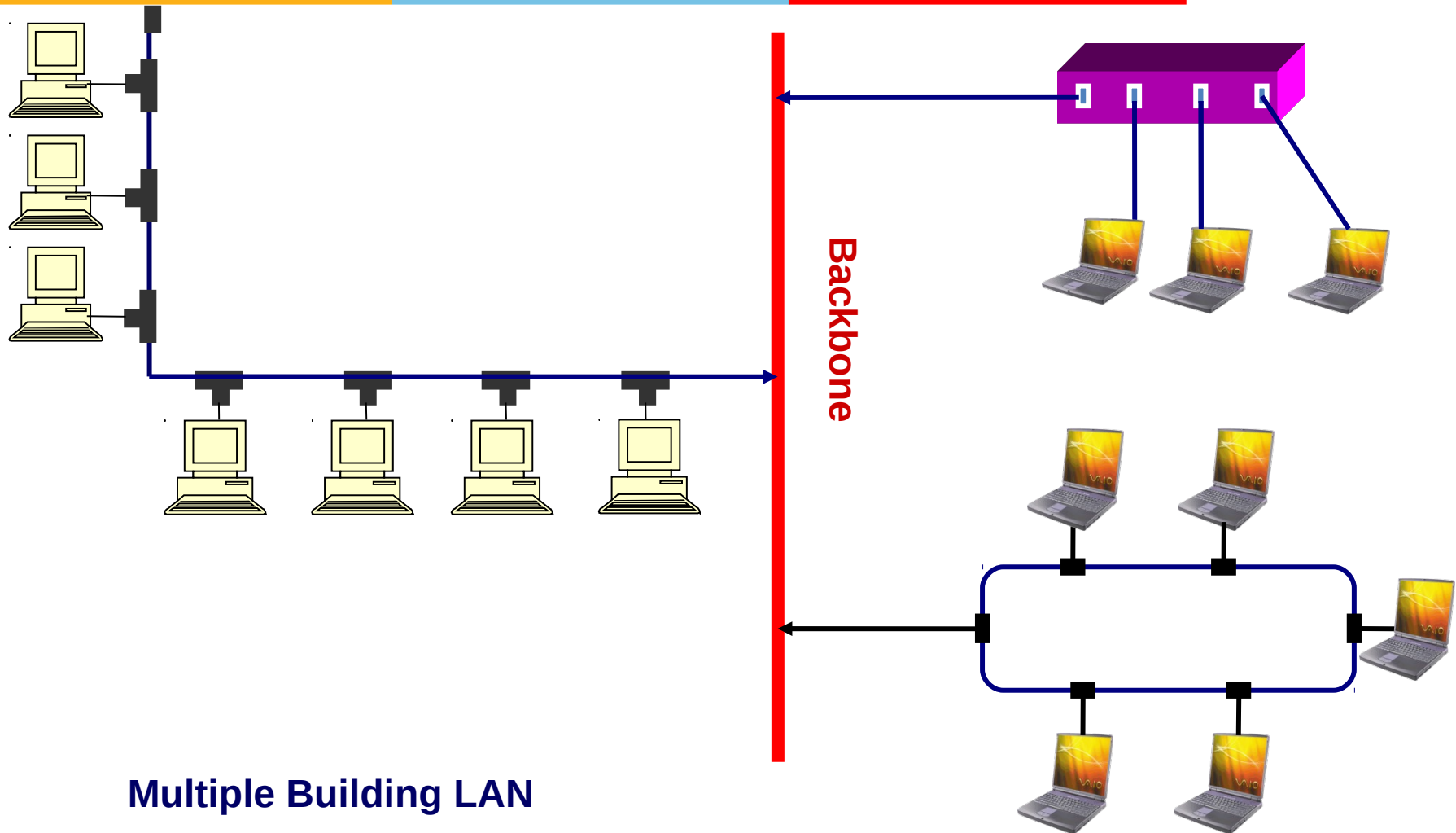
Topologies & Network Devices

Local Area Networks (LANs)

- Generally a privately owned network within a single office, building or campus covering few kms
- Shares disks, printers, programs & data
- Has data rates of hundreds /Thousands of Mbps



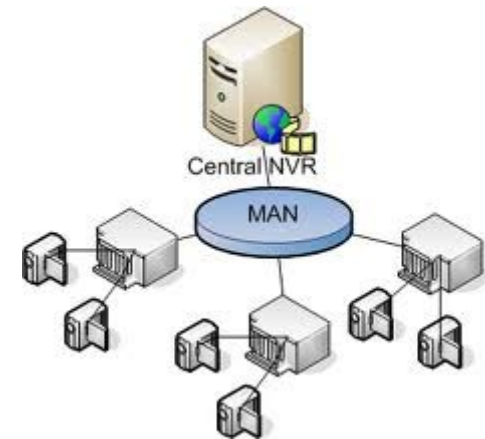
Inter connected Network



Metropolitan Area Networks (MANs)



- A network that is designed to cover an entire city
- Example - cable network & organizations connecting its offices in the city



Wide Area Networks (WANs)



- Bigger compared to LAN and MAN
- WAN - made up of LANS connected to each others to form a big networks of networks.



Elements involved in a Network/ Internetwork



Nodes

- Regular computing nodes
- Network extension / interconnection devices

Network Interfaces

- NICs / On-board Chips
- Wireless interfaces

Links

- Wireline links
- Wireless links

Strategies, Algorithms & Protocols:

- Hardware, Software,

Network Topologies



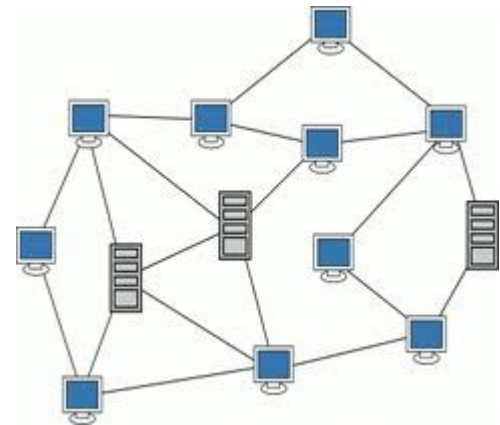
Network topology is the layout pattern of interconnections of the various elements (links, nodes, etc.) of a Computer Network

Classification

- Physical
- Logical.

Other Classification

- Static
- Dynamic



Network Topologies



Physical

The mapping of the nodes of a network and the physical connections between them – i.e., the layout of wiring, cables, the locations of nodes, and the interconnections between the nodes and the cabling or wiring system

Logical

Logical topology refers to how data is actually transferred in a network as opposed to its physical design.