

Lecture 02: Packets, Routing, and Performance

CS 326E Computer Networks

Mikyung Han

mhan@cs.utexas.edu



Please, interrupt and ask questions **AT ANY TIME !**

Pair Activity



Pick 2 from below and tell your neighbor about it



- 1 Difference between “routers” and “switches”
- 2 Is the wireless router at my house acting as a “router”?
- 3 What is access network and who provides it
- 4 What is IXP and why we need it
- 5 Why there are many layers in Internet Protocol Stack
- 6 Name one layer and tell (or guess) what it is for

Can not repeat what your neighbor already picked

Note: **Protocols** are horizontal, and **layers** are vertical

Example Protocols

Layers

Responsible for

FTP, HTTP, SMTP

Application

application specific needs

TCP, UDP

Transport

process to process data transfer

IP

Network

host to host data transfer across different network

Ethernet, WiFi

Link

data transfer between physically adjacent nodes

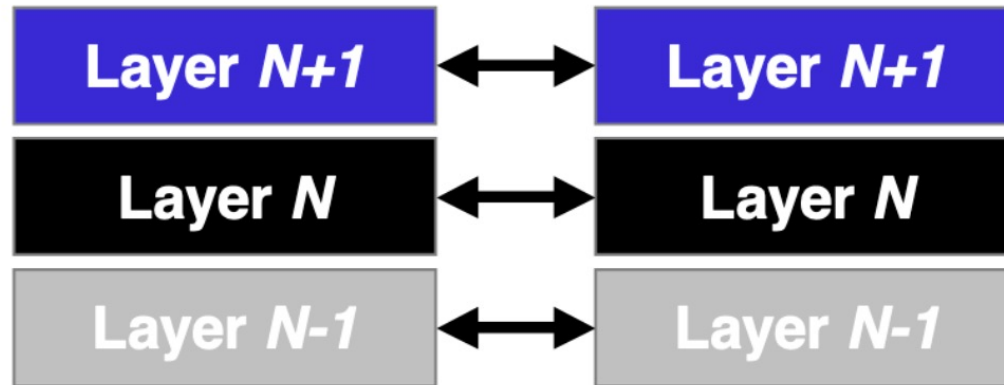
802.3 PHY

Physical

bit-by-bit or symbol-by-symbol delivery

Layer N provides service to Layer N+1
is serviced by Layer N-1


Protocols provides ways for peers to communicate **horizontally**



Protocol in layer N only interacts with peers in the same layer N

Outline

0. Administrivia and recap

-  1. **Goals**
- 2. Packet forwarding vs routing
- 3. Packet loss and delay
- 4. Sharing is caring: Packet switching vs circuit switching

Outline

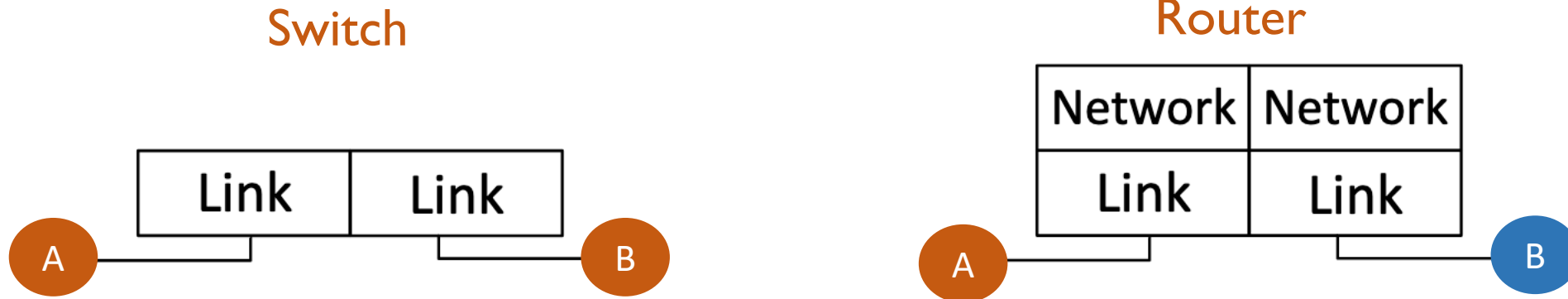
1. Goals

 2. Packet forwarding vs routing

3. Packet loss and delay

4. Packet switching vs circuit switching

Switches vs routers: Both do packet forwarding!

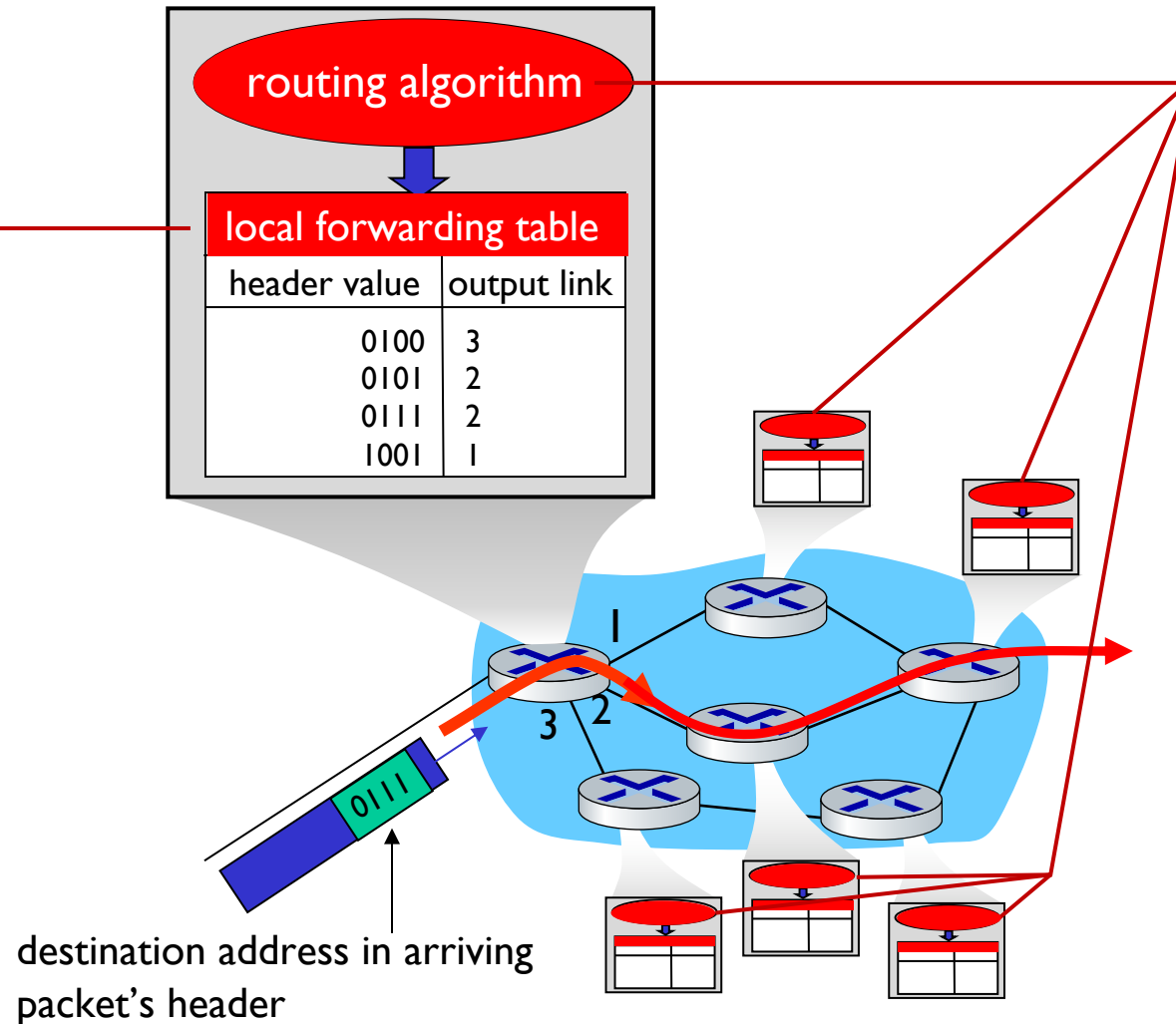


Switch forwards within the same network,
whereas routers forwards across different network

Forwarding vs routing

Forwarding:

- **local** action: move arriving packets to appropriate output link




Routing:

- **global** action: determine src-dst paths taken by packets

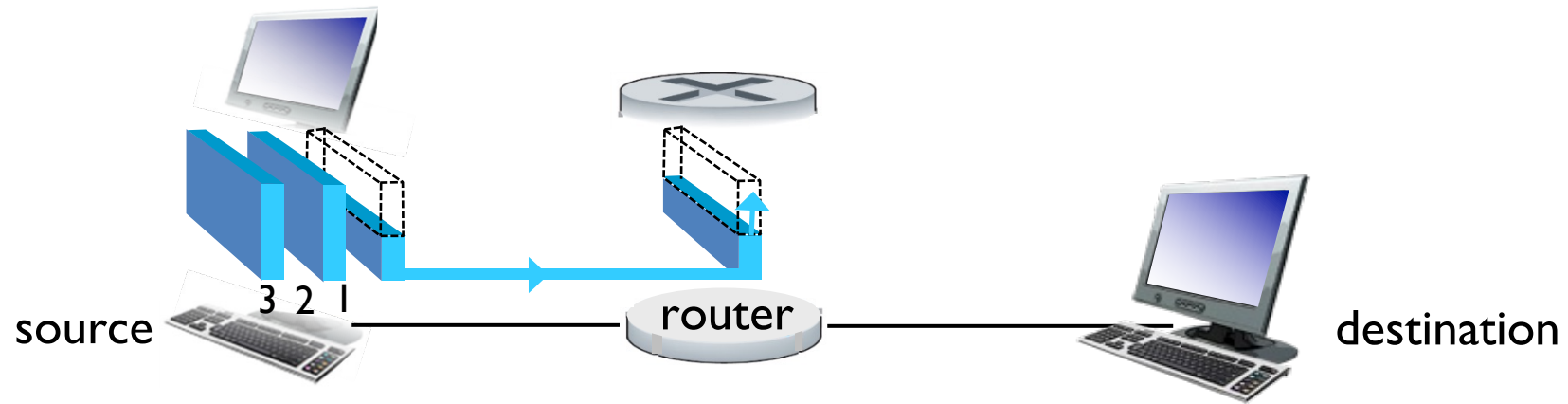




Outline

1. Goals
2. Packet forwarding vs routing
-  3. Packet loss and delay
4. Sharing is caring: Packet switching vs circuit switching

Store-and-forward: entire packet must arrive before it can be transmitted on to next link!



What happens if we don't?

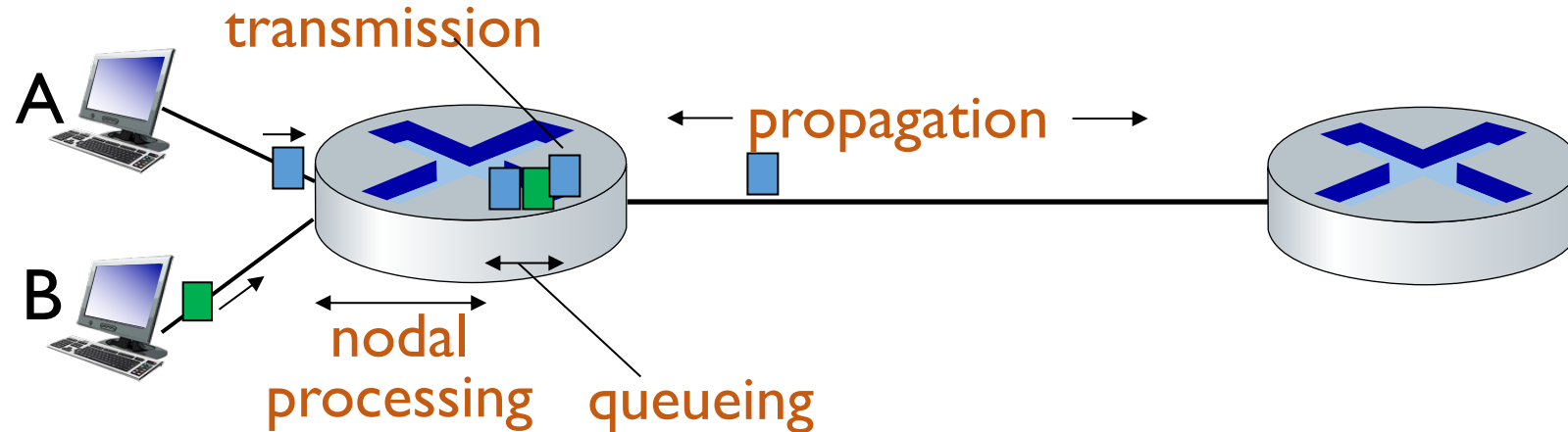
Where do packet delay occur?

- Packet delay:

The time it took for a sender to send out a packet and till it is received by a receiver

What could be the source of delay?

Packet delay: four sources



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

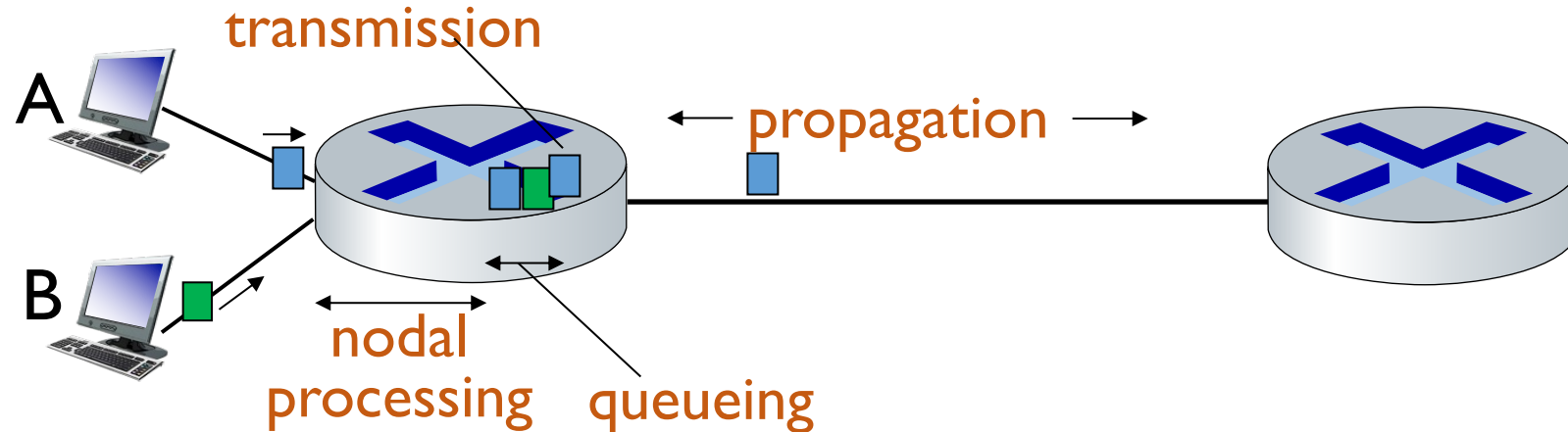
d_{proc} : nodal processing

- check bit errors
- determine output link
- typically < microseconds

d_{queue} : queueing delay

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

Packet delay: four sources



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

d_{trans} : transmission delay:

- L: packet length (bits)
- R: link transmission rate (bps)

▪ $d_{\text{trans}} = L/R$

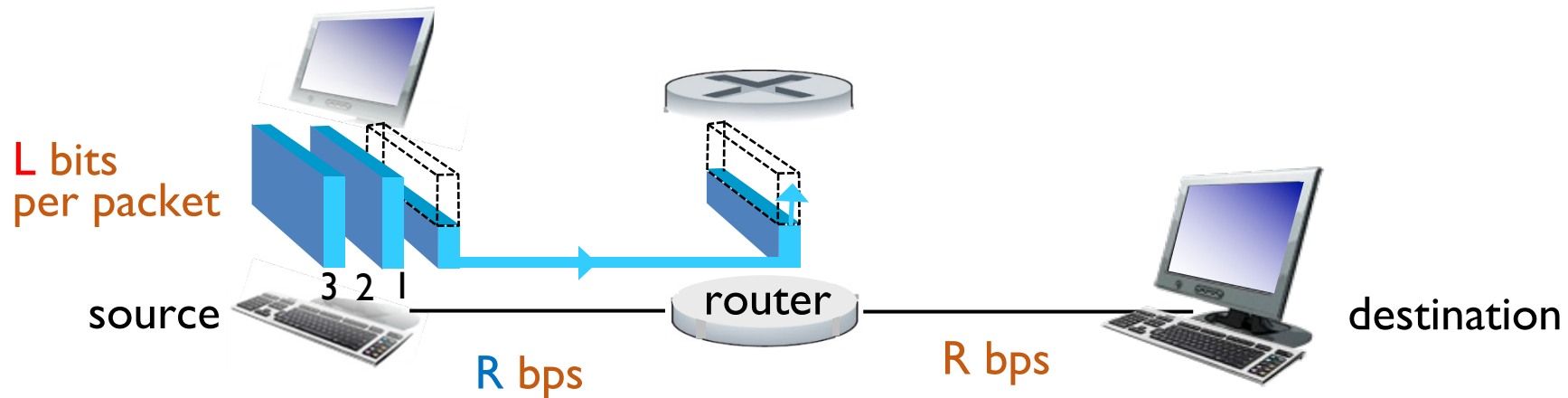
d_{prop} : propagation delay:

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

▪ $d_{\text{prop}} = d/s$

d_{trans} and d_{prop}
very different

Transmission delay vs Propagation Delay



- **transmission rate**: how fast data is pushed onto a link (in bits per sec)
- **transmission delay**: time to take to push all bits in the packet to the output link
- d_{trans} : L/R sec

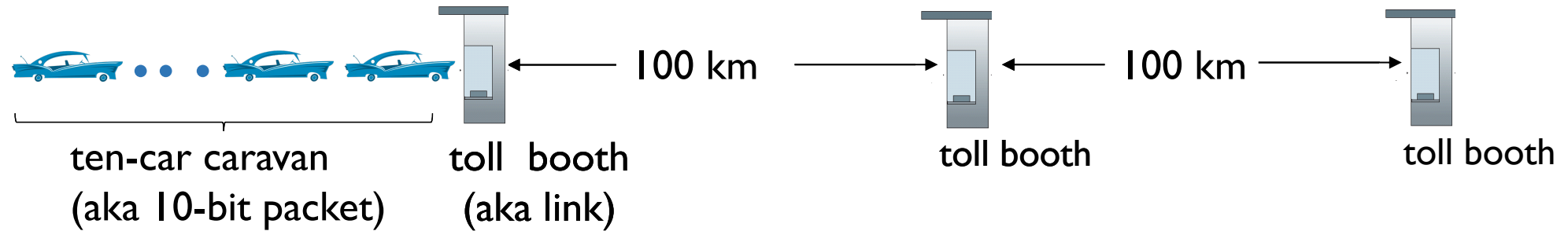
One-hop example:

- $L = 10$ Kbits
- $R = 100$ Mbps
- one-hop $d_{trans} = 0.1$ msec

Transmission delay vs Propagation Delay

- Depends on the **propagation speed** (**s** meters/sec) of the physical medium
 - Fastest is the speed of light (optical fiber)
- Depends on the **distance** of travel (**m** meters)
- **Propagation delay**: Time it takes for a bit in the beginning of the link to get to the next hop
- d_{prop} : **m/s** sec

Caravan analogy



- car \sim bit; caravan \sim packet; toll service \sim link transmission
- toll booth takes 12 sec to service a car (bit transmission time)
- “propagate” at 100 km/hr
- **Q: How long until caravan is lined up before 2nd toll booth?**
- time to “push” entire caravan through toll booth onto highway = $12 * 10 = 120$ sec
- time for last car to propagate from 1st to 2nd toll booth: $100\text{km} / (100\text{km/hr}) = 1$ hr
- **A: 62 minutes**

In-class activity



Take a screenshot of your Kahoot score

- Submit to Canvas!

Acknowledgements

Slides are adopted from Kurose' Computer Networking