

Digital Communications over Packet-Switched Networks

(ECE 446 – Lecture #5)

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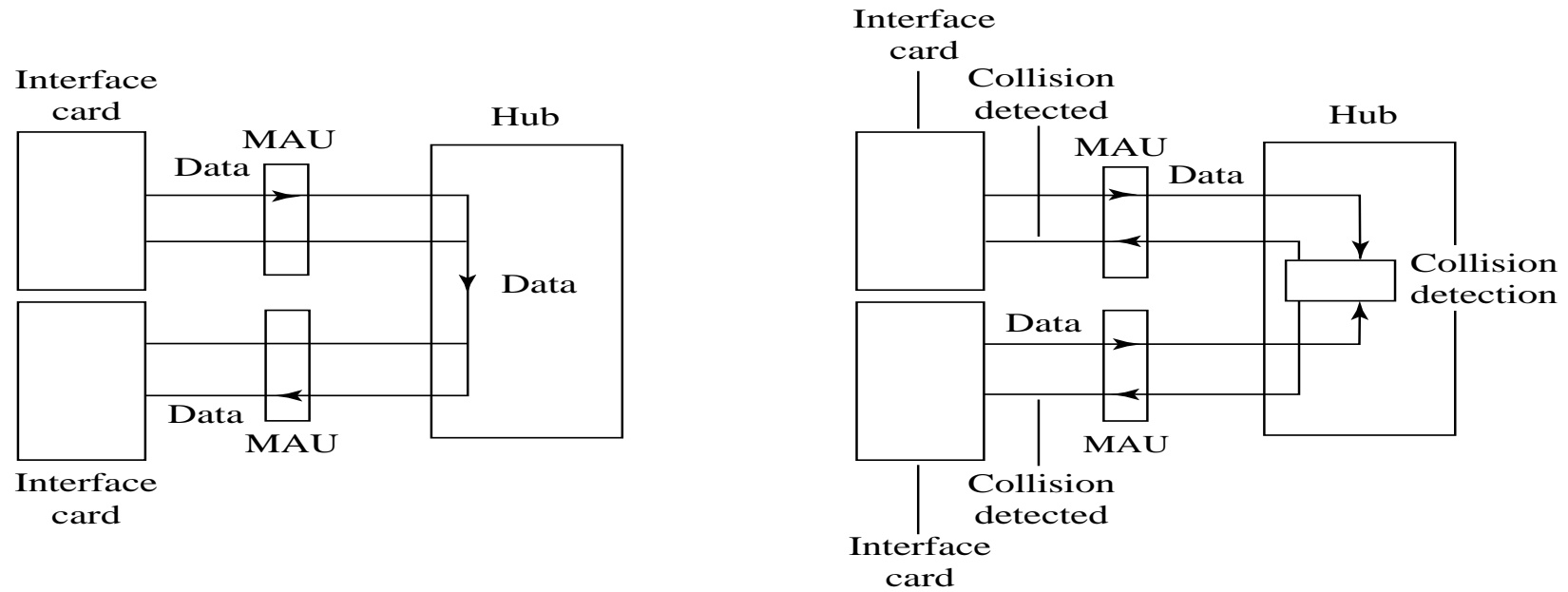
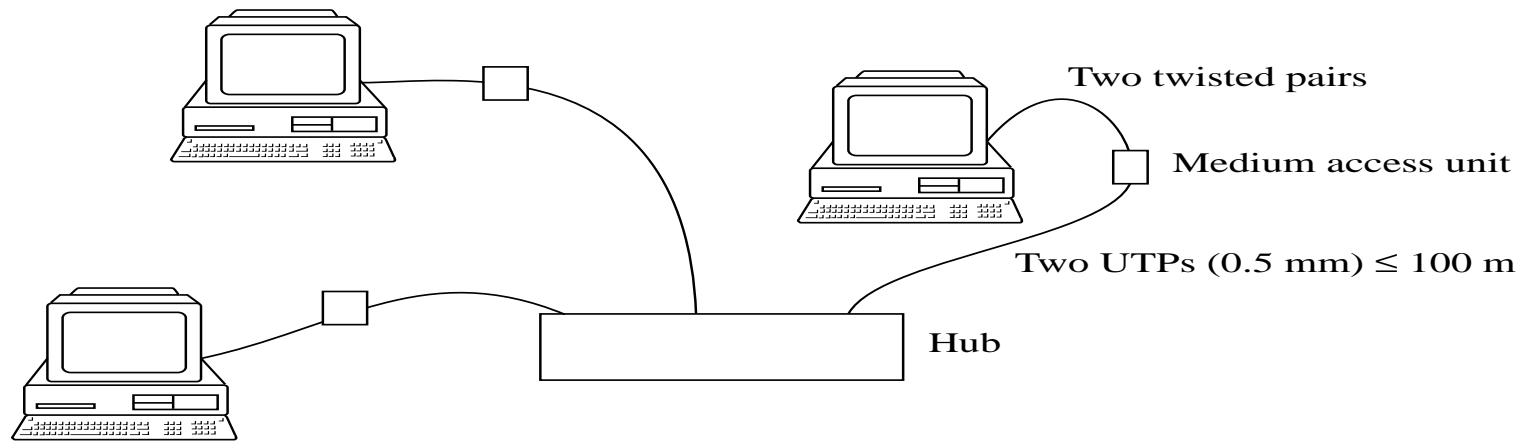
Outline

- Last time: the OSI model, layered network architecture.
- Today: Ethernet and Token Ring LANs.

Ethernet Local Area Networks – Layer 1

A variety of physical layer mechanisms:

- 10BASE-T
 - Same twisted pair cables used by telephone companies (popular).
 - Network interface: medium access unit with two twisted pairs to hub.
 - Hub \equiv repeater: broadcast from one port to all ports.
 - Connect hubs together with two twisted pairs, for larger networks.
 - Bits encoded at the physical layer as electrical signals with transition in the middle (0: low to high, 1: high to low).
 - Receiver uses transitions to synchronize.



- 100BASE-T
 - Same twisted pair cables used by telephone companies / 10BASE-T (even more popular: faster and using same wiring, easy to upgrade).
 - Other cabling supported: optical fiber, full duplex with two TPs, ...
 - Dual mode of operation (10/100 Mbps) also supported.

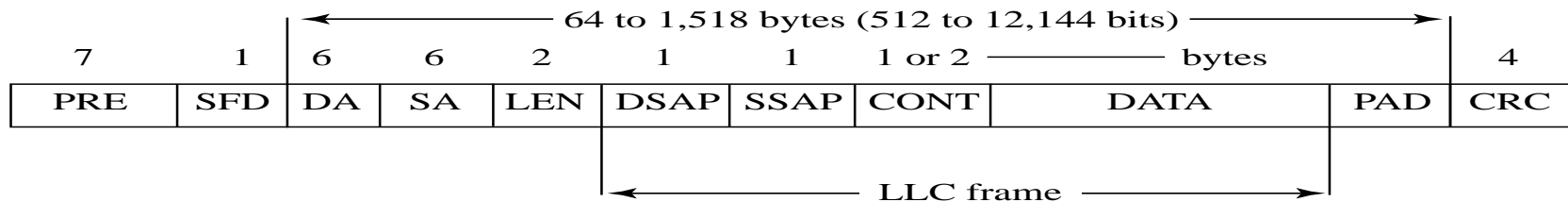
This is the prevalent standard today.

- 1000BASEx – Gigabit Ethernet.
- Wireless Ethernet – Instead of sharing a cable, share a radio channel.

All advances in this area depend on increasingly complex signal processing at the transmitters and receivers, to enable faster and more efficient use of the limited spectrum resource.

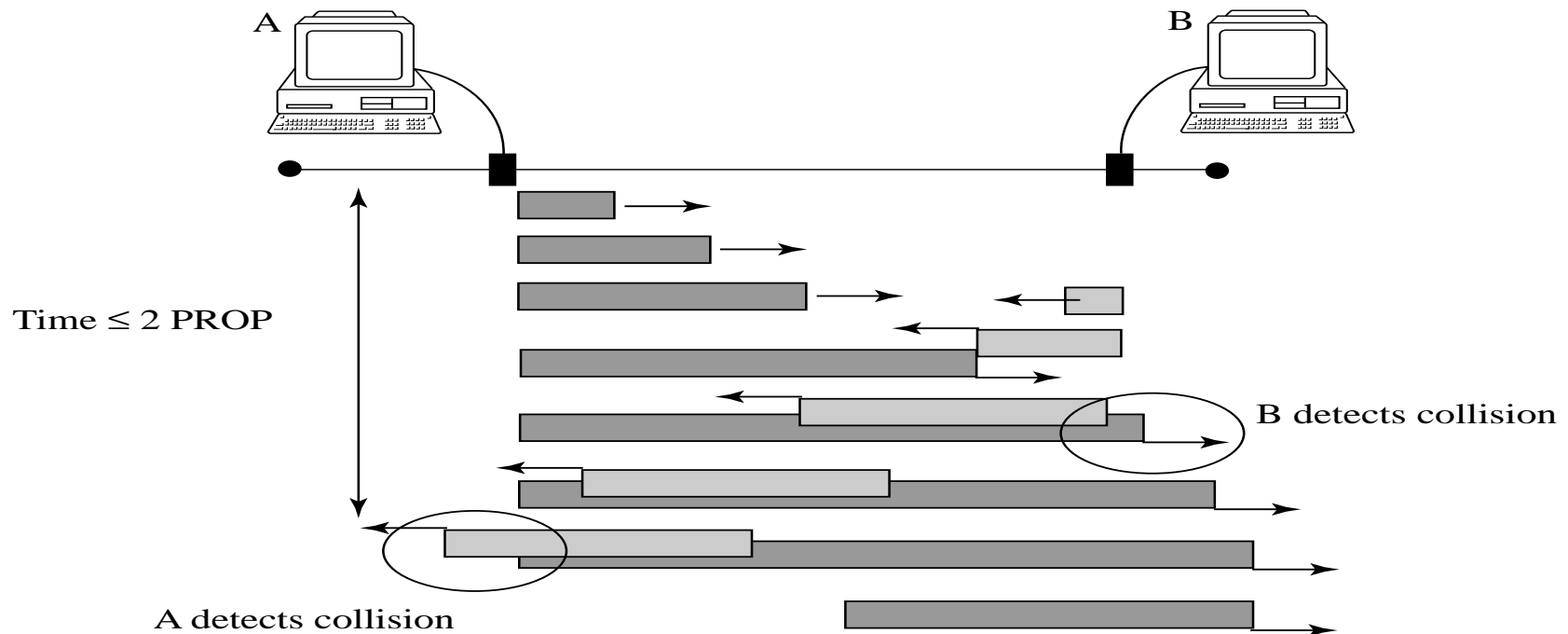
Ethernet Local Area Networks – Layer 2

- Format of an Ethernet packet:



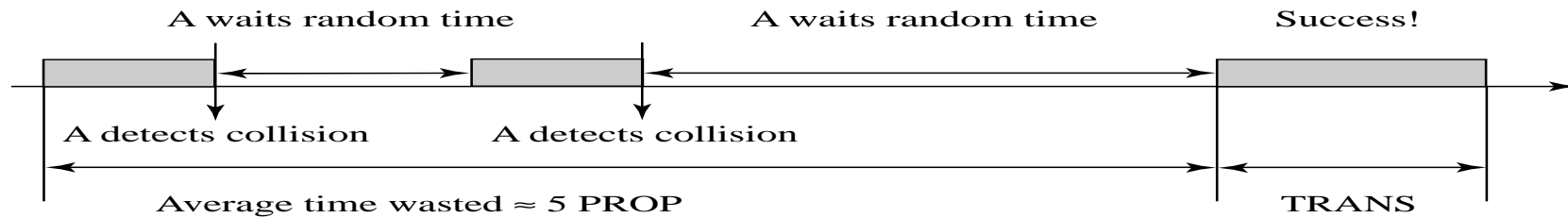
- PRE: Synchronization preamble.
- SFD: Frame start.
- DA, SA: MAC address of source/destination (unique 48-bits / NIC).
- LEN: frame length, 64-1518 bytes.
- DSAP, SSAP: source/destination service access points (ports).
- DATA: payload.
- PAD:
- CRC: parity bits for error detection.

- Carrier Sense Multiple Access with Collision Detection (CSMA/CD).
 - Wait until no transmission in progress (carrier sensing).
 - If two transmissions detected in progress, abort (collision detection).
 - If collision, wait for a random while then try again.

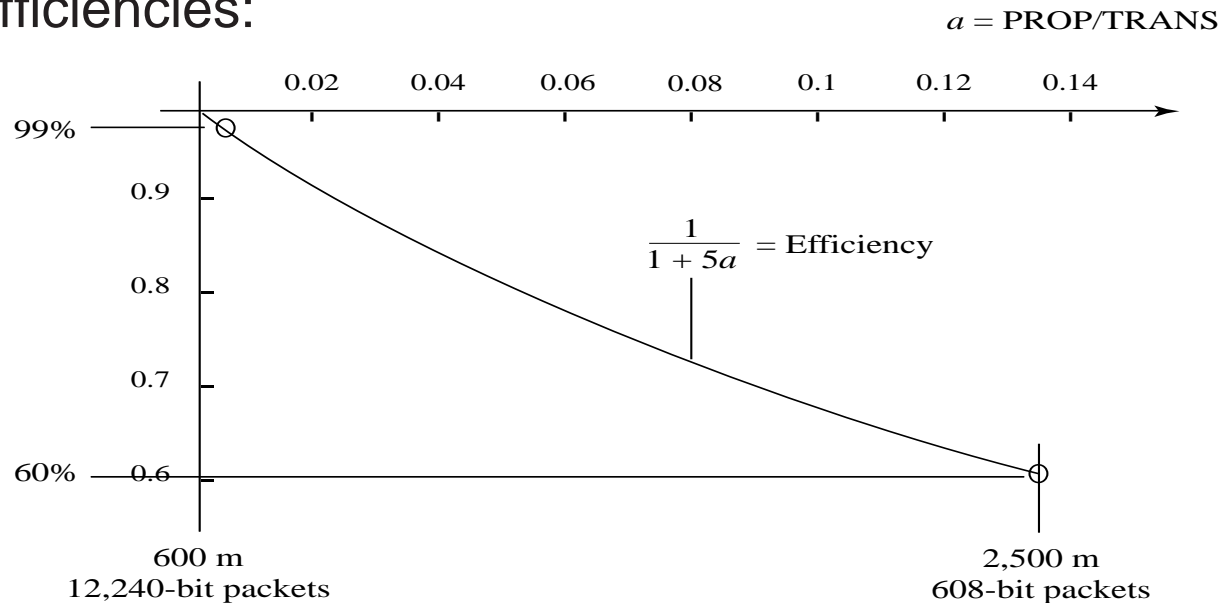


Packets must be long enough to allow collisions to be detected...

- A typical packet transmission:



- On average, it takes 5 attempts for a packet to go through successfully.
Typical efficiencies:

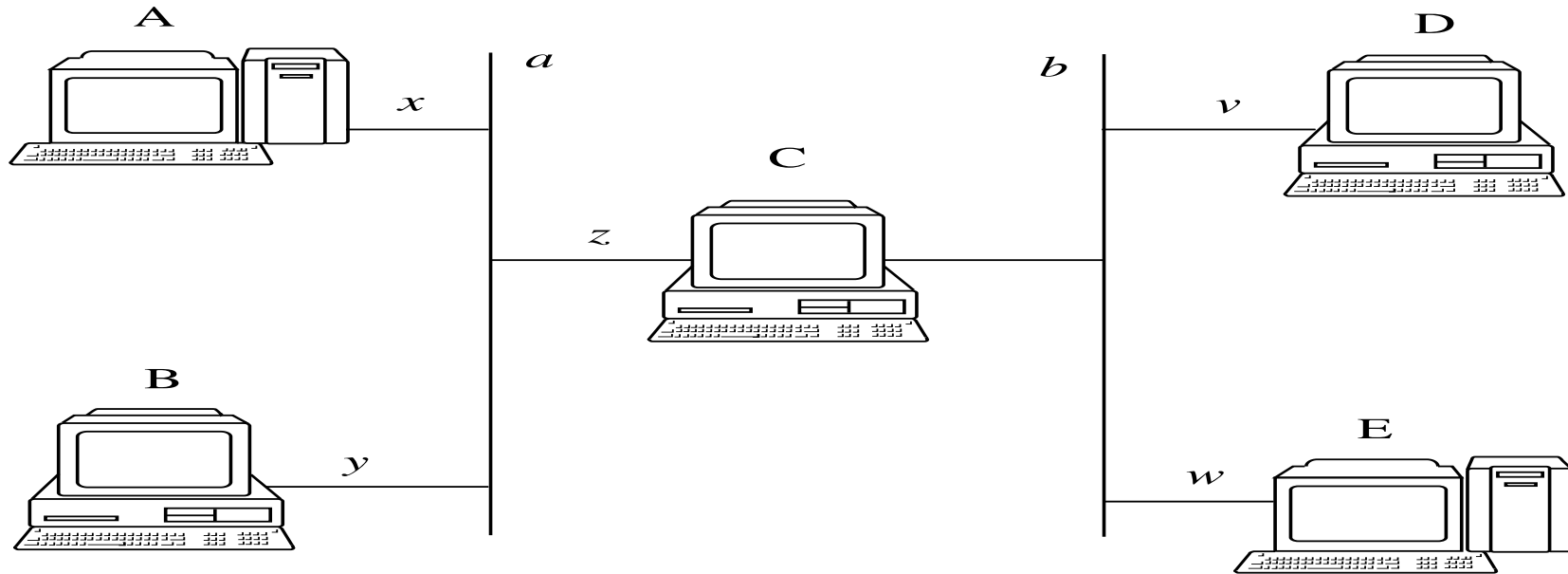


- LLC:
 - Connection-oriented or connectionless services (ack'd or not).
 - Multiplexing of transmissions differentiated by SAP – see headers.
 - Transparent routing across bridged network segments.
 - If connection oriented or ack'd connectionless, do error detection.
 - If connection oriented, use *go-back-N ARQ* to deliver packets.

Ethernet Local Area Networks – Layer 2 Interconnects

Three types: Hubs, Bridges and Switches.

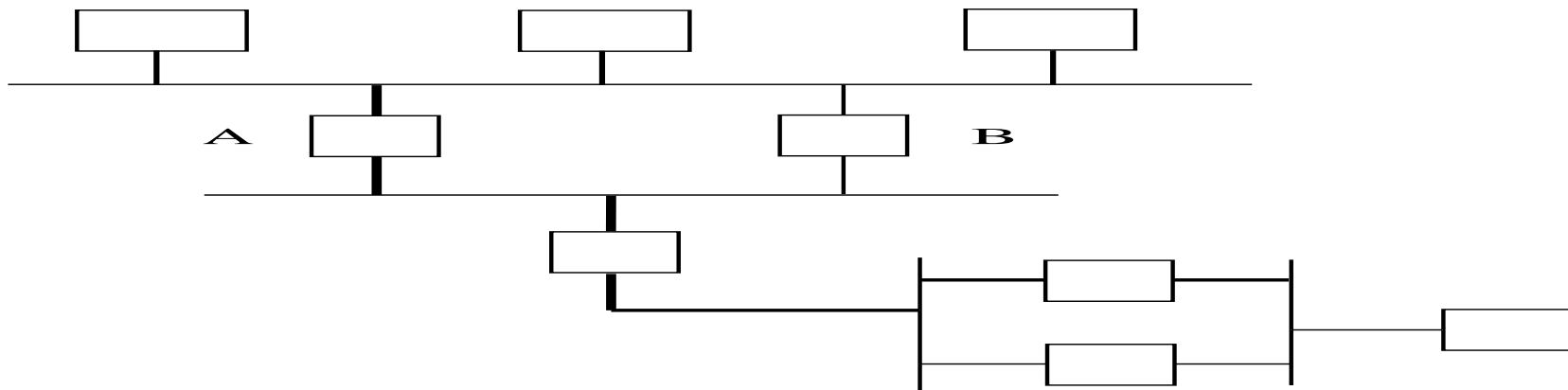
- Hubs: essentially repeaters. Two LANs sharing a hub become one.
- Bridges: implement transparent routing (selective forwarding).



The notion of transparent routing:

- Bridges must maintain tables of MAC addresses in each subLAN.
- Tables formed by recording MAC addresses of packets in subLANs.
- When bridge gets a packet not local, retransmits on the other subLAN.
- If error never mind – nobody will receive it, just wasted time.

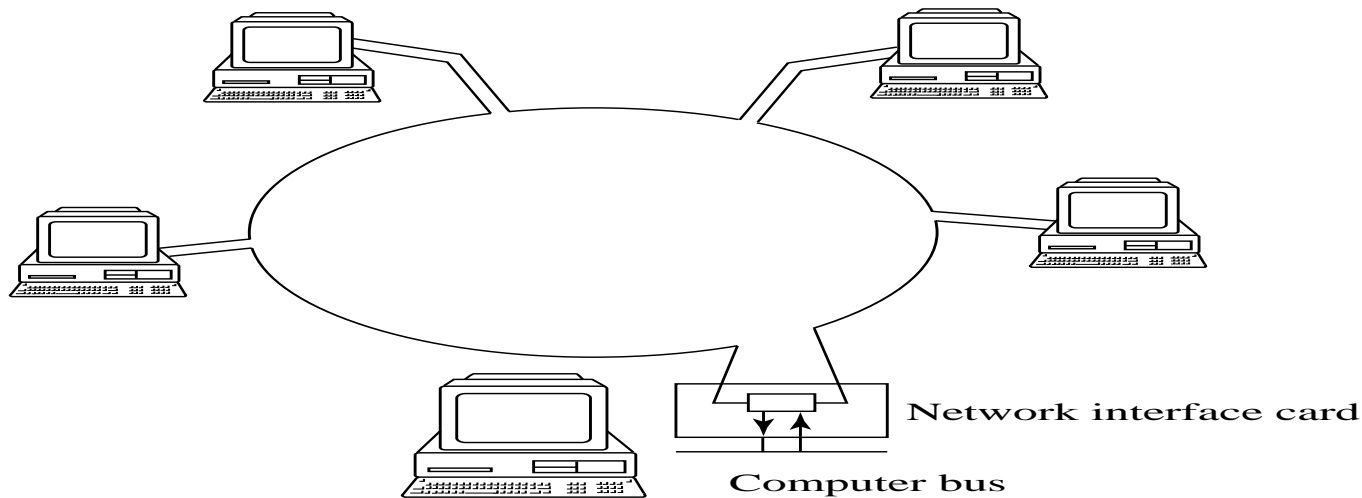
Problems with *careless* transparent routing: infinite loops.



Solution: build a *spanning* tree covering all nodes (but perhaps not all bridges – that's ok).

- Switches: multiport bridges, moving data across ports, one per subLAN.
 - Speedup over single shared LAN: output ports send concurrently.
 - Possibly different speeds across ports.
 - Buffers needed: packets for the same port, uneven port speeds.
 - Can be interconnected to form larger networks, like hubs/bridges.
 - Switching tables: MAC address \leftrightarrow switch port.
 - If MAC address not in table, broadcast.
 - Store-and-forward vs. cut-through switching.
- Virtual LANs (VLANs): segmented broadcast domains for LANs.
 - VLAN: subset of computers/ports within a switched LAN (e.g., cn).
 - Subset defined by administrative rules (e.g., all nodes in Sergio's lab).
 - Or by packet filtering (will see this for firewalls later).

Token Ring Local Area Networks – Layer 1



- Nodes interconnected by pt2pt cabling forming a ring.
- Repeater: incoming signal sent to outgoing link without processing.
- Open: own outgoing transmission, read and store incoming bits.

Token Ring Local Area Networks vs. Ethernet

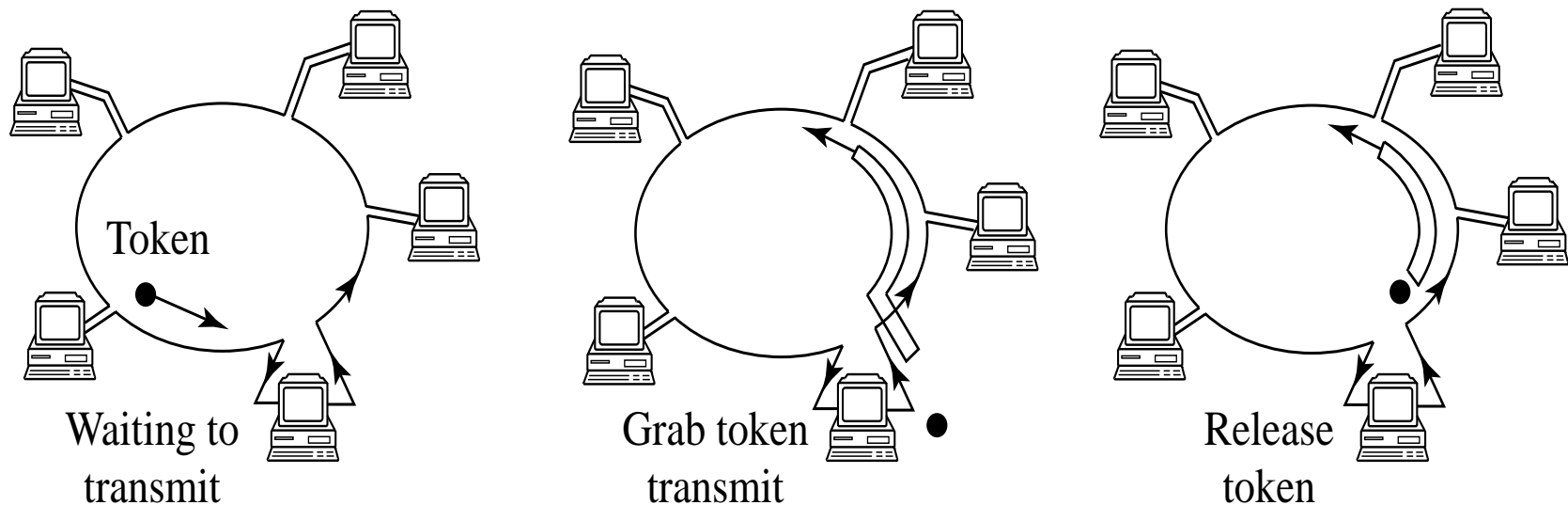
Key differences with Ethernet:

- Nodes guaranteed to be allowed to transmit by hard deadline.
- More efficient under high-load conditions.

LLC is identical.

Token Ring Local Area Networks – Layer 2

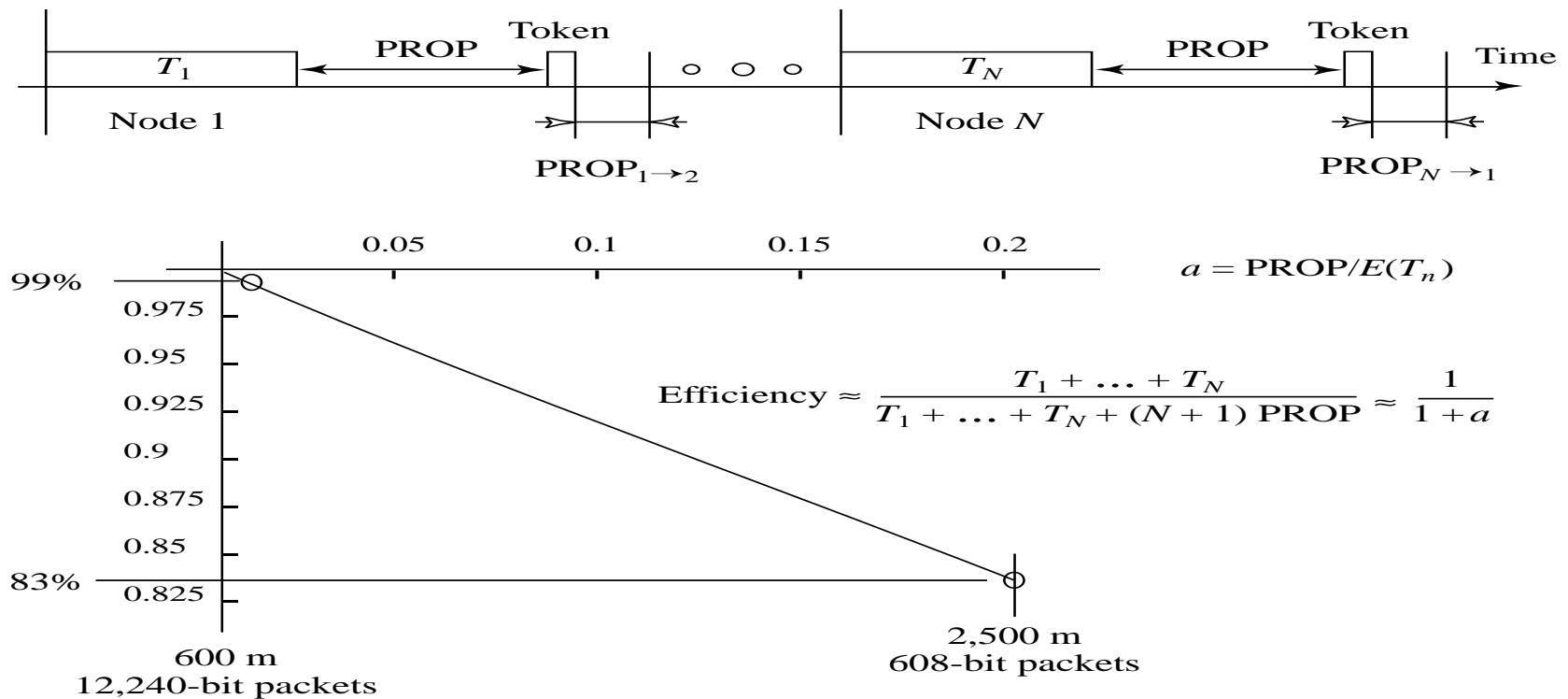
- Frame format similar to Ethernet.
- Special packet type: *token*.



Repeater/open states for NIC depend on whether have token or not.

Token Ring Local Area Networks – Layer 2

Efficiency of token ring LANs (compare to page 8 earlier):



What Next

- Complete reading up to section 3.3, browse the rest of chapter 3.
- Homework #2 due on Tuesday (9/20), solutions to hw1 available already.

Credits: the figures used in these slides are from our textbook.