MASSACHUSETTS INSTITUTE OF TECHNOLOGY
SLOAN SCHOOL OF MANAGEMENT

15.565 Integrating Information Systems:

Technology, Strategy, and Organizational Factors

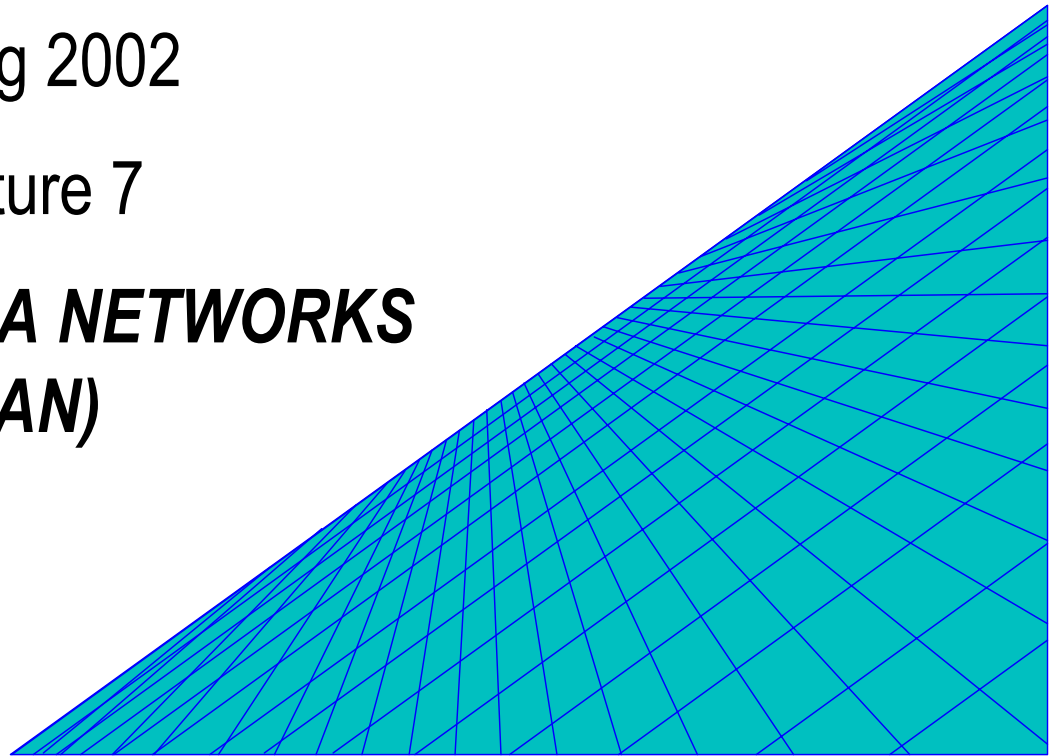
15.578 Global Information Systems:

Communications & Connectivity Among Information Systems

Spring 2002

Lecture 7

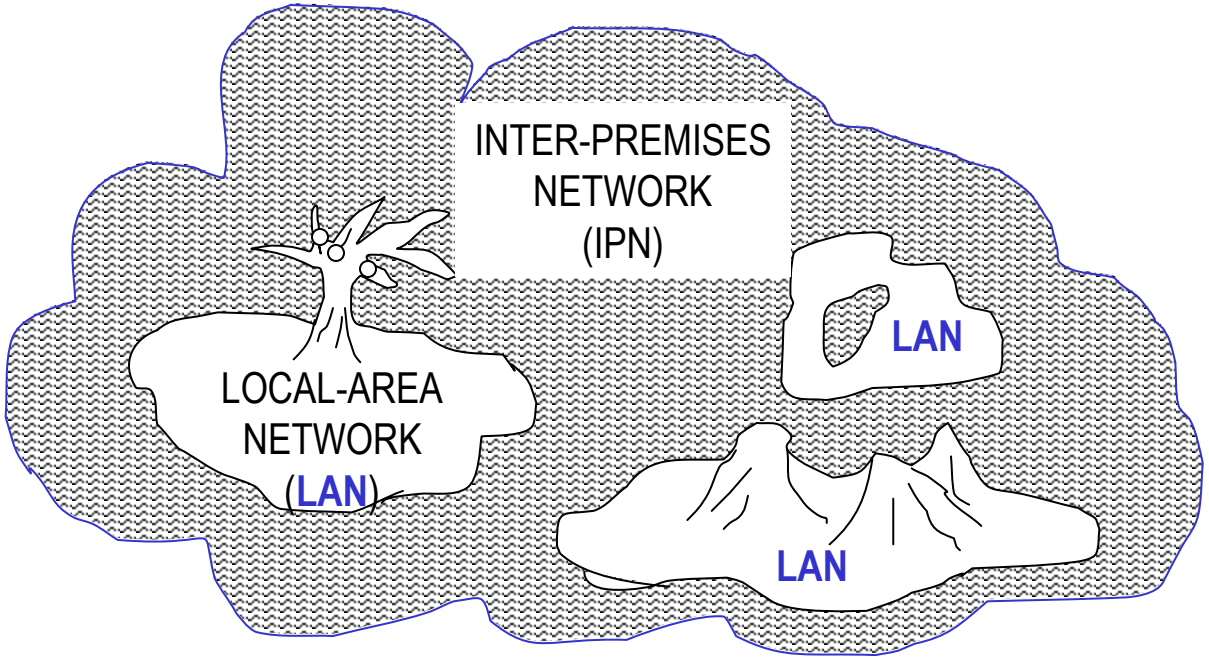
LOCAL AREA NETWORKS (LAN)



LOCAL AREA NETWORKS (LAN)

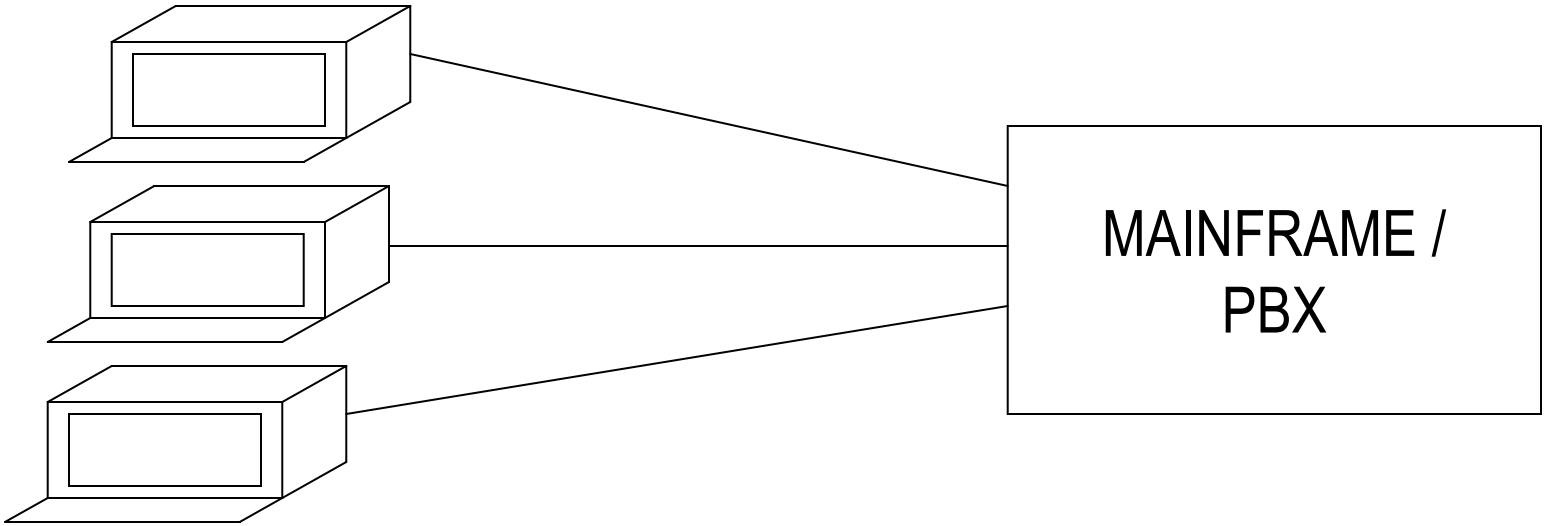
- CONNECTING BETWEEN INFORMATION ENTITIES IN CLOSE PROXIMITY
  - USUALLY ON COMPANY PREMISES
  - LOCAL AREA NETWORK (**LAN**)

- CONNECTING BETWEEN INFORMATION ENTITIES IN DISTANT LOCATIONS
  - INTER-PREMISES NETWORK (IPN) / WIDE AREA NETWORK (WAN)

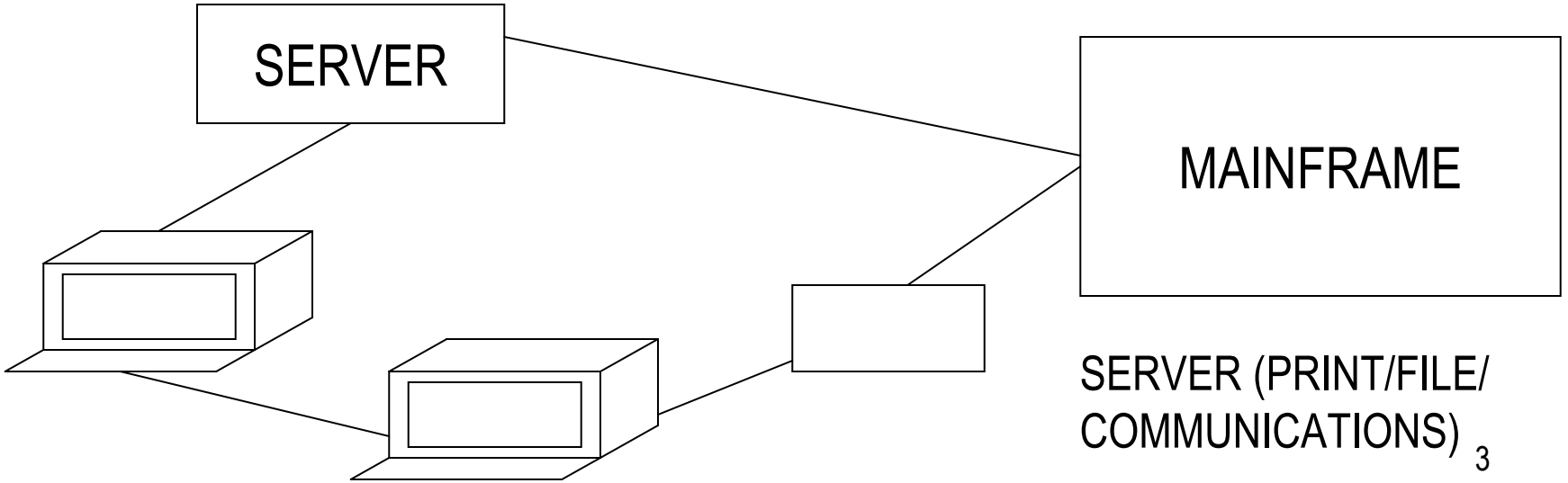


- LAN ENVIRONMENTS
  - GREAT DIVERSITY

TRADITIONAL "MASTER-SLAVE" LOCAL NETWORK



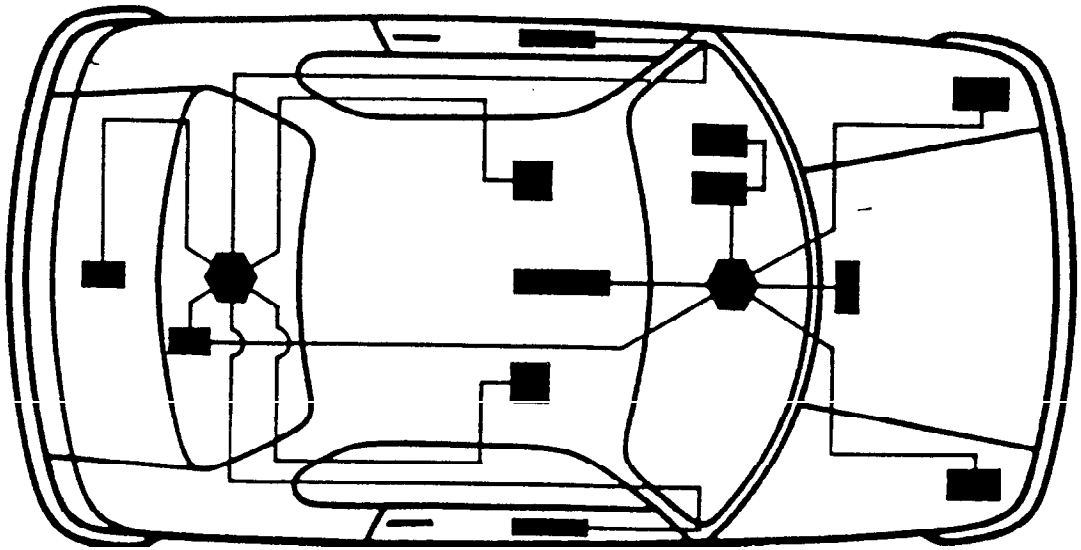
MODERN "PEER-TO-PEER" LOCAL NETWORKS



LOCAL AREA NETWORK CHARACTERISTICS

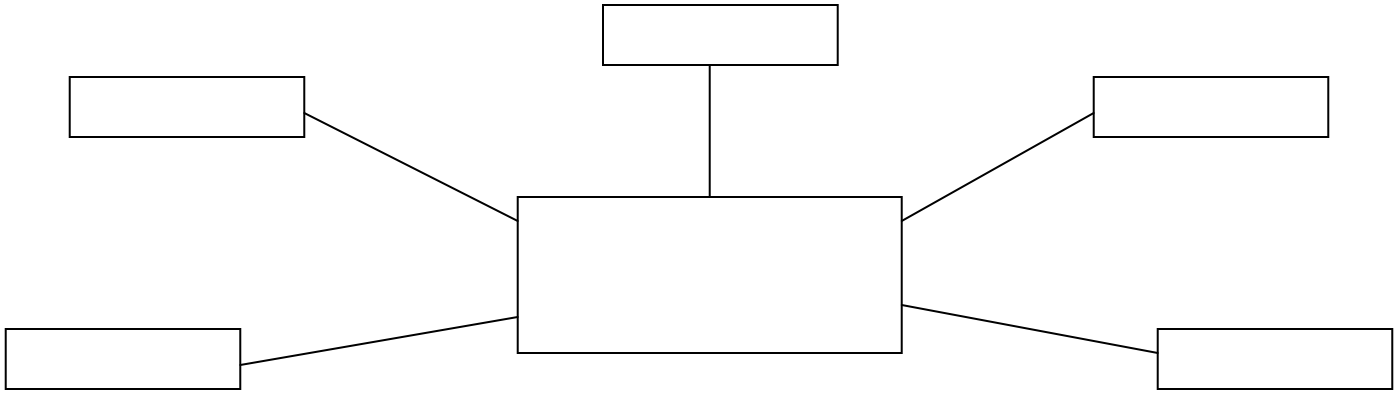
1. COMMUNICATE AMONG “INTELLIGENT DATA DEVICES”
2. SMALL AREA (USUALLY SINGLE BUILDING, UP TO 50 KM)
3. USUALLY PRIVATELY OWNED
4. HIGH DATA RATES (1--100M BPS)

NOVEL APPLICATIONS EMERGING

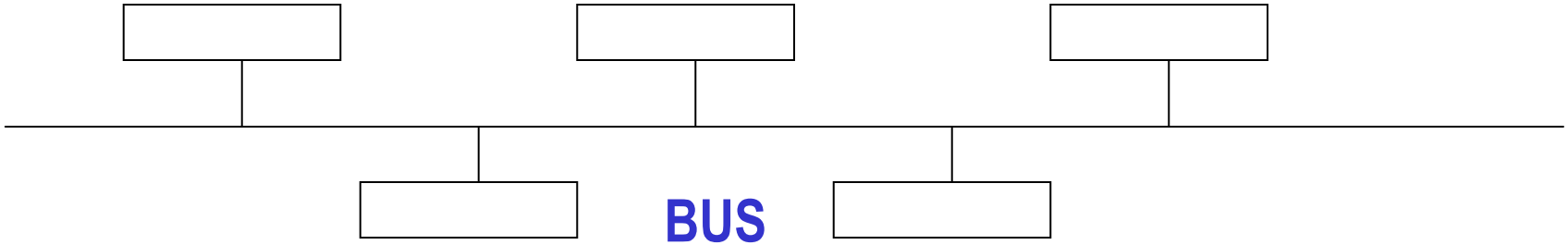


Topography of vehicle multi-plex system with central control, modules for the instrument readings, lights, doors, seats, centre console and central rear light unit.

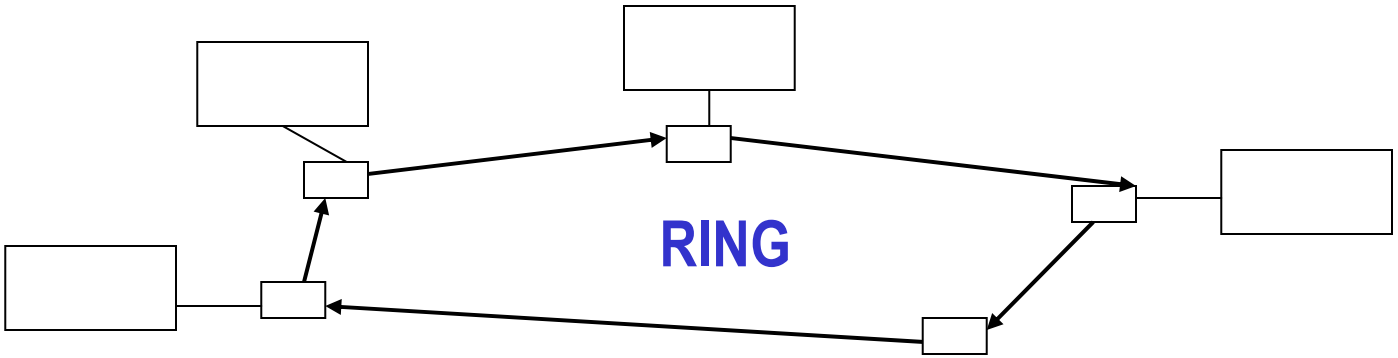
NETWORK TOPOLOGIES (LOGICAL VS PHYSICAL)



STAR

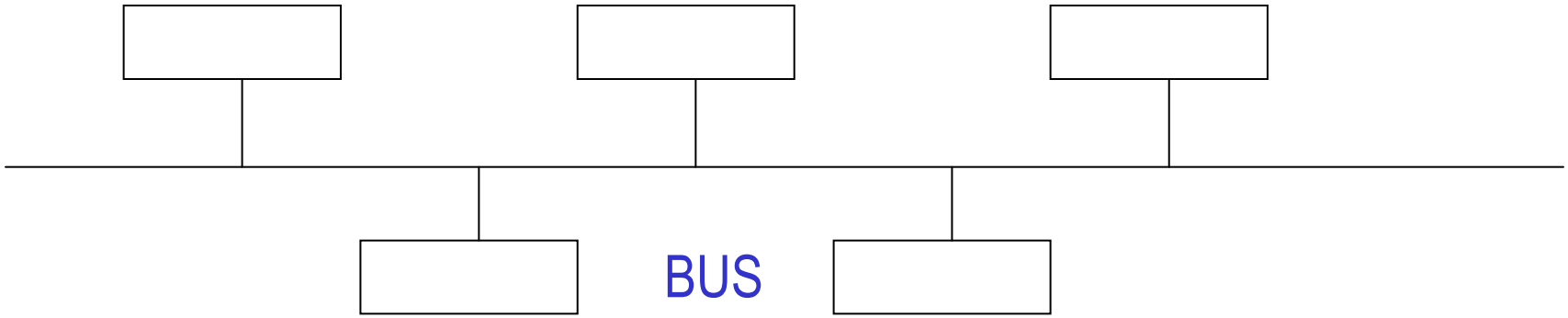


BUS



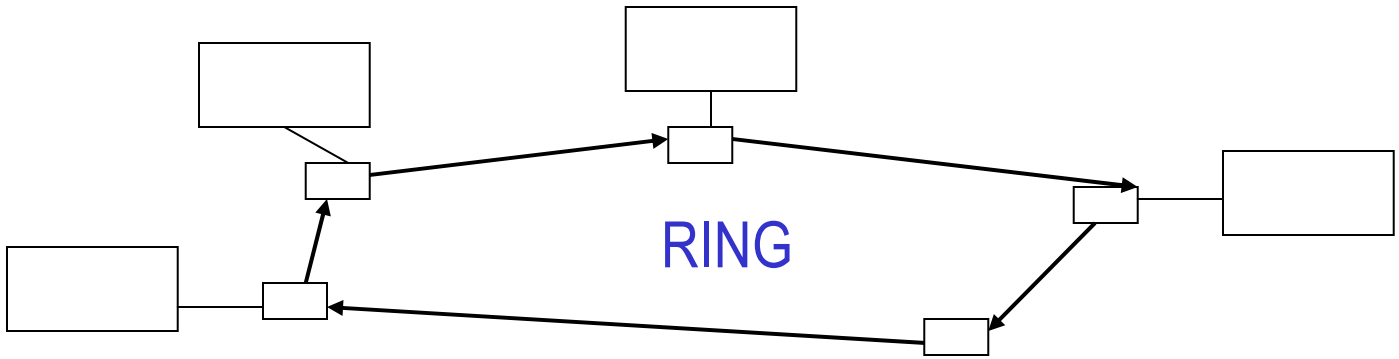
RING

MEDIA ACCESS CONTROL--BUS



- CARRIER SENSE MULTIPLE ACCESS WITH COLLISION DETECTION (CSMA/CD)
- **ETHERNET** (1972) AND IEEE 802.3
  - -- **COLLISION HANDLING**
    - IF COLLISION DETECTED, IMMEDIATELY STOP TRANSMISSION
    - WAIT RANDOM AMOUNT OF TIME, THEN RETRANSMIT (AMOUNT GROWS WITH EACH COLLISION)
  - -- **COLLISION DETECTION**
    - SIGNAL EXCEEDS VOLTAGE LIMIT (2 OR MORE TRANSMISSIONS)
    - LIMITATION ON MIN PACKET SIZE AND CABLE LENGTH TO GUARANTEE COLLISION DETECTION VOLTAGE (e.g., 500 METERS)
    - COLLISION MUST BE PROPAGATED ACROSS REPEATERS

MEDIA ACCESS CONTROL--RING



- TOKEN RING -- IEEE 802.5
  - -- STATIONS FORM LOGICAL ORDERED RING
  - -- CONTROL PACKET (TOKEN) REGULATES ACCESS
  - -- TOKEN PASSED IN STATION ORDER (LOGICAL)

- CSMA/CD VERSUS TOKEN RING

CSMA/CD

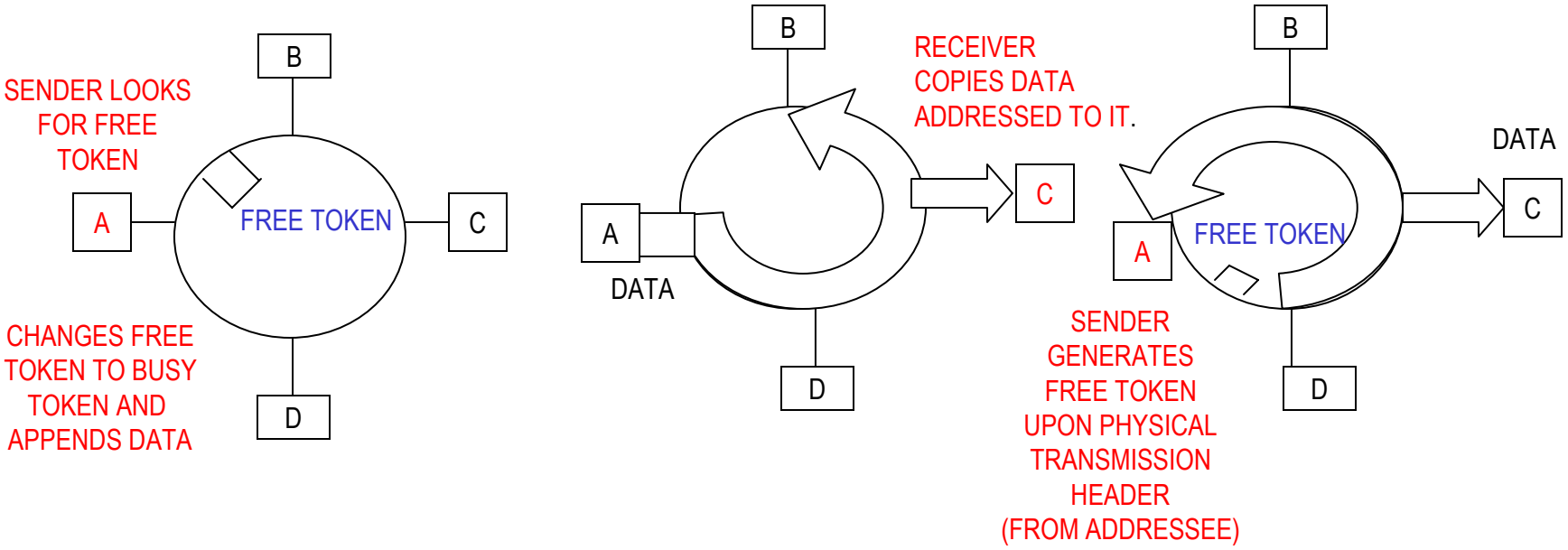
- SIMPLER
- NO TOKEN PASSING DELAY

TOKEN

- REGULATE TRAFFIC (HOLD PERIOD)
- "DETERMINISTIC" (?)

MEDIA ACCESS CONTROL--RING

- TOKEN RING--IBM AND IEEE 802.5
- EXAMPLE: "A" WANTS TO SEND DATA TO "C"



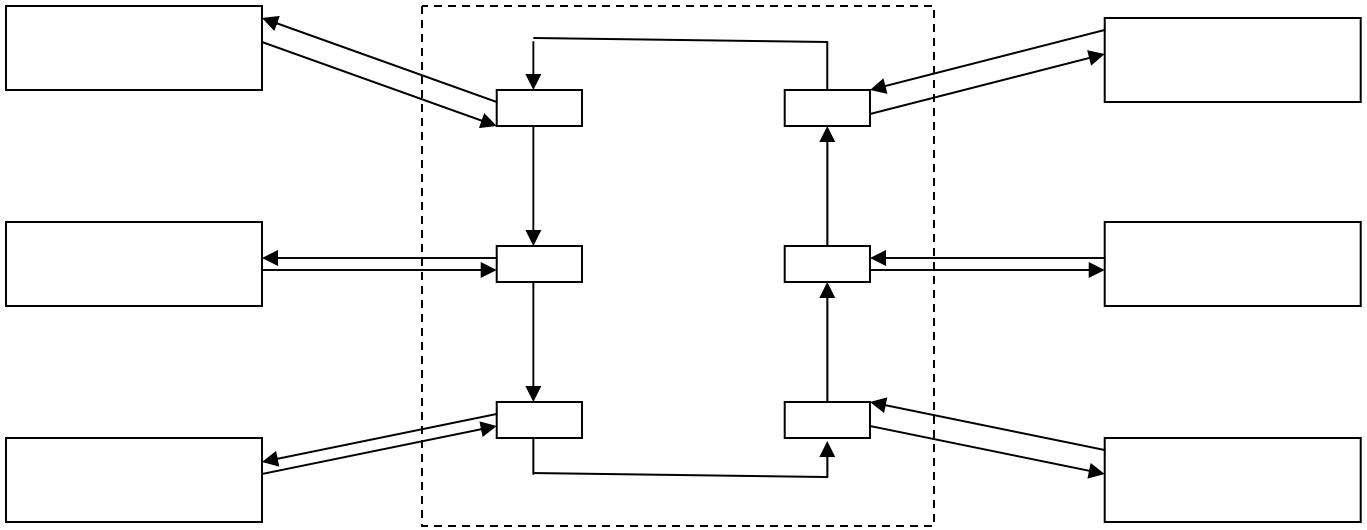
- BUSY TOKEN
  - -- DESTINATION STATION ADDS STATUS INFO TO TOKEN
  - -- SOURCE STATION REMOVES BUSY TOKEN (CHECK STATUS)
- "ACTIVE MONITOR" STATION
  - -- DETECTS LOST TOKEN USING TIME-OUT
  - -- DETECTS CIRCULATING BUSY TOKEN (VIA "MONITOR BIT")
- OTHERS STATIONS CHECK STATUS OF "ACTIVE MONITOR"
  - -- TAKE ON ROLE IF NECESSARY
- ADVANTAGES
  - -- TRAFFIC REGULATION
  - -- DETERMINISTIC, ALSO ALLOWS PRIORITIES
- DISADVANTAGES
  - -- TOKEN MAINTENANCE

BUS VERSUS RING TOPOLOGY

- BUS FAIRLY STRAIGHTFORWARD
- RING PROBLEMS (INITIALLY)
  - -- CABLE VULNERABILITY: SINGLE BREAK FATAL
  - -- REPEATER FAILURE: EACH REPEATER CRITICAL
  - -- FAILURE LOCATION DETERMINATION: EACH REPEATER MUST BE EXAMINED
  - -- INSTALLATION DISRUPTION: INSERTION OF NEW REPEATER NECESSARY
  - -- RECOVERY CONTROL: HOW ARE PROBLEMS HANDLED (E.G., FAULTY ADDRESS)
  - -- SIZE LIMITATION: EACH REPEATER ADDS TO DELAY AROUND RING

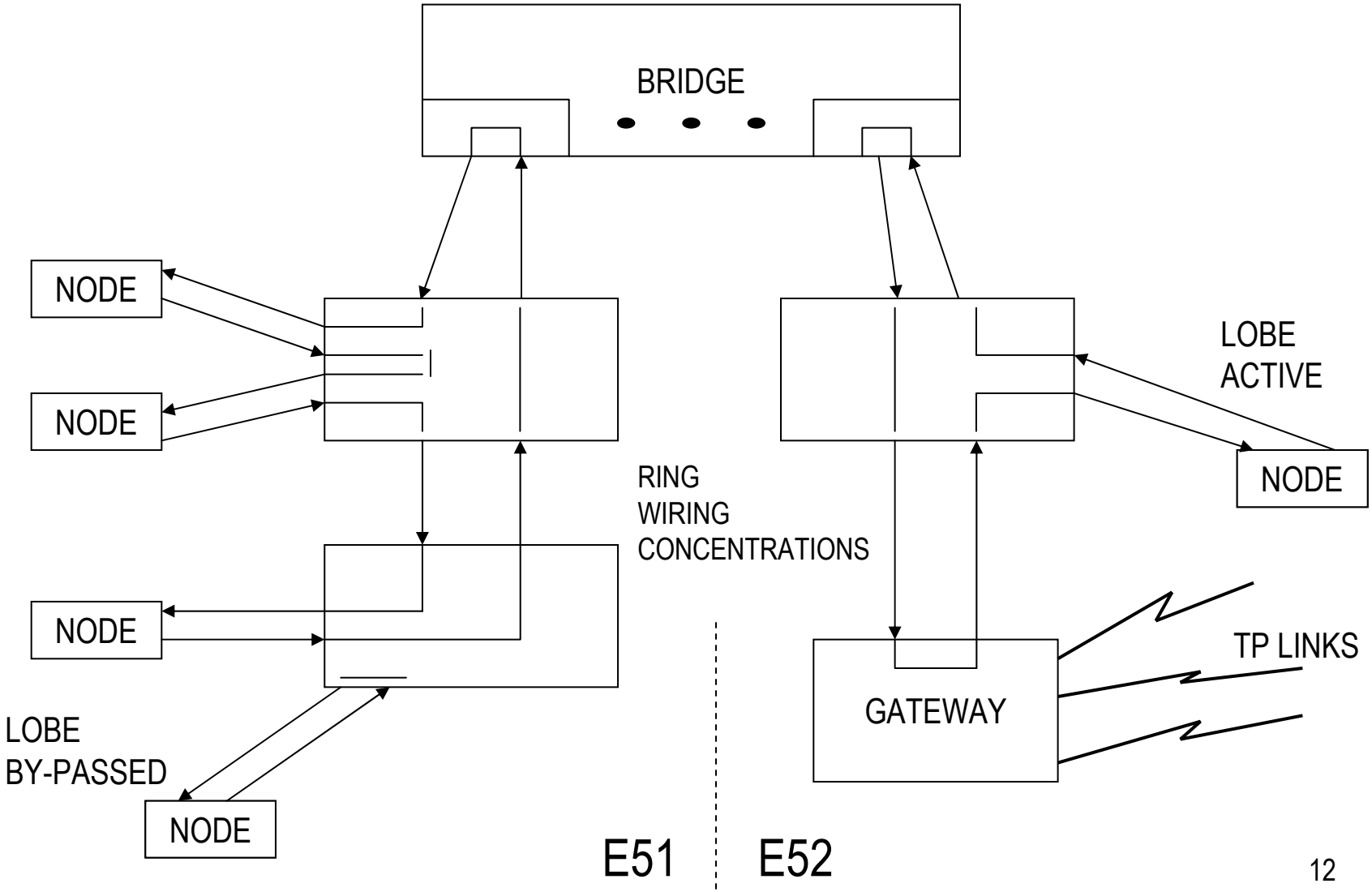
ENHANCED RING ARCHITECTURE

- CONCENTRATOR BOX -- CENTRALIZES REPEATERS



Multi-Station
Access Unit (MAU)

RING BRIDGES --
SPLITS LARGE RING INTO SMALLER RINGS



BUS VERSUS RING TOPOLOGY (REVISITED)

ADVANTAGES

- BUS
  - PASSIVE TAP
  - MEDIA FAILURE UNLIKELY
- RING
  - -- REGENERATED BIT MINIMIZES ERROR PROPAGATION
  - -- GREATER DISTANCES POSSIBLE (VIA BRIDGES)
  - -- FAULT LOCATION CENTRALIZED
  - -- SUITABLE FOR FIBER OPTICS

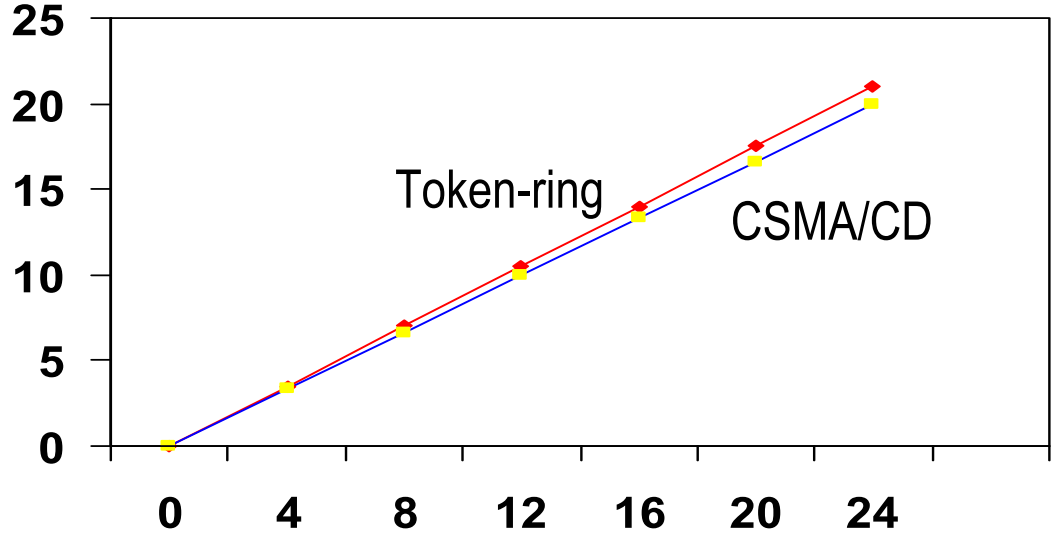
    [e.g., FIBER DISTRIBUTED DATA INTERFACE (FDDI)]

CSMA/CD BUS VS. TOKEN RING PERFORMANCE

- PERFORMANCE STUDY
  - -- LIGHT LOAD: 1 OUT OF 100 STATIONS BUSY
  - -- HEAVY LOAD: ALL 100 STATIONS BUSY
- RESULTS
  - -- SHORTER PACKETS FAVOR TOKEN RING
  - -- TOKEN RING LEAST EFFECTED BY LOAD
  - -- CSMA/CD DETERIORATES UNDER HEAVY LOAD
  - -- TOKEN RING HAS MORE DELAY UNDER LIGHT LOAD

CSMA/CD BUS VS. TOKEN RING PERFORMANCE

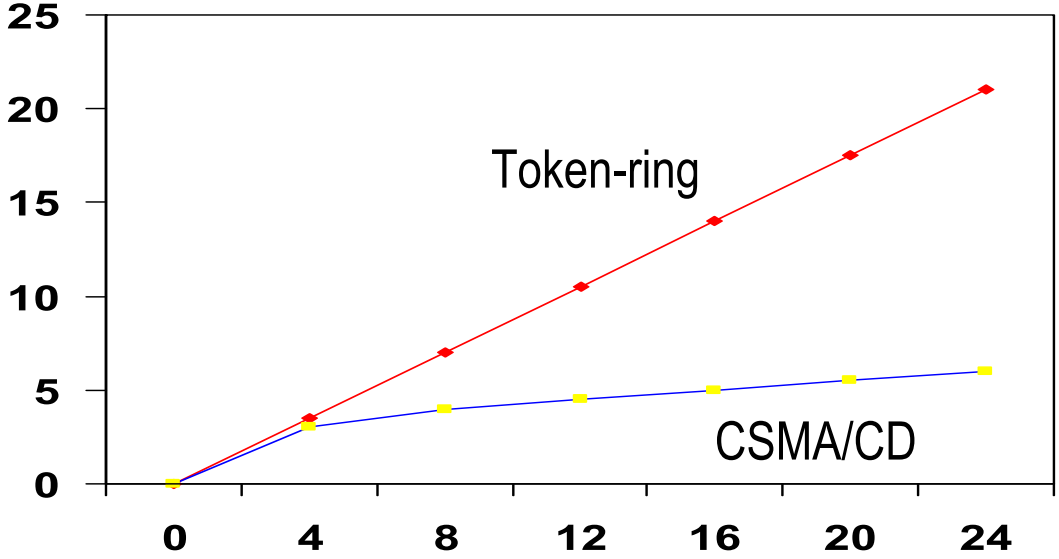
LIGHT LOAD: 1 station active out of 100 stations.



Comments:

- 2000 bits per packet
- Axis: Data rates (M bps)

HEAVY LOAD: 100 stations active out of 100 stations.



SUMMARY POINTS

IMPORTANT FACTORS

- WORKSTATIONS MORE POWERFUL & LANS PROLIFERATING
- FIBER COST DROPPING

LANS INCREASINGLY INTERCONNECTED (LOCAL & WIDE AREA)

- **HUB** - CONNECTS PARTS OF NETWORK, TYPICALLY DIFFERENT PARTS OF SAME LAN
- **BRIDGE** - CONNECTS TWO LANS, TYPICALLY USING SOFTWARE
- **SWITCH** - CONNECTS DIFFERENT LANS, TYPICALLY USING HARDWARE ONLY
- **ROUTER** - CONNECTS TWO NETWORKS THAT MAY OR MAY NOT BE SIMILAR AND ROUTES PACKETS APPROPRIATELY
- **GATEWAY** - CONNECTS NETWORKS THAT USE DIFFERENT PROTOCOLS

APPENDIX: INTERCONNECTING LANs – SOME TECHNIQUES

	Why use it?	What does it do?
REPEATER	• Extends cable longer than 500 meters (IEEE 802.3)	•Accepts signal and Amplifies it •Extend cable 2,500 meters (4 segments)
BRIDGE	• Connects two LANs using same protocols - but different medium -(e.g. twisted pair cable + coaxial cable)	•Interpret data link portion Determines to send to connected LAN •Operates at Data link layer of OSI model
ROUTER	•Network routing of packets •Routing between networks w/ different protocols •Isolates a part of a LAN (no access) •Can work as a level of security	•Sophisticated bridge •Chooses the best path for data transmission to avoid digital jams •Operates at Network layer of OSI model
GATEWAY	•Connection between LAN and WAN w/ different protocols	•Protocol converter •Operates at Network layer of OSI model