



Lecture 18

Computer Communication

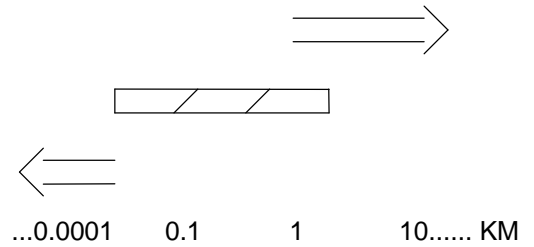
Sommersemester 2000

Leitung: Prof. Dr. Miroslaw Malek

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NETWORKS

- WAN's - Wide-Area Networks = Long-Haul Networks (e.g., Internet)
- LAN's - Local Area Networks (e.g., Ethernet)
- Computer System I/O Busses (e.g., Banyan)



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MOTIVATION

- **WIDE-AREA NETWORKS**
 - E-MAIL
 - WORLD-WIDE-WEB
 - SHARING OF LARGE COMPUTING RESOURCES WHICH ARE GEOGRAPHICALLY DISTRIBUTED
 - REMOTE COOPERATION
- **LOCAL AREA NETWORKS**
 - E-MAIL
 - COOPERATION-MANAGEMENT
 - SHARING OF LOCAL RESOURCES (HARDWARE & SOFTWARE)
 - SYSTEM ENHANCEMENT (GOOD QUALITY PRINTER, EXTRA INTELLIGENT TERMINALS)
- **COMPUTER BUSESSES**
 - INTERCONNECTING COMPONENTS OF ONE COMPUTER SYSTEM
 - HIGH-PERFORMANCE COMPUTING
 - RESPONSIVE (FAULT-TOLERANT, REAL-TIME) COMPUTING

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LAN - DEFINITION

- **SCOPE:** GEOGRAPHICALLY CLUSTERED SINGLE BUILDING OR PLANT NO LONGER THAN FEW KILOMETERS
- **OWNERSHIP:** SINGLE ORGANIZATION
- **ACCESS MECHANISM:** SIMPLE CONTROL MECHANISM
 - (e.g., CSMA/CD - Carrier Sense Multiple Access / Collision Detection; Token Passing Ring)
 - usually no routing
 - easily expandable
 - inexpensive attachment
- **TECHNOLOGY:** HIGH-SPEED LOW-COST TRANSMISSION MEDIUM WHICH USES SIMPLE ADAPTERS

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LAN

- MOTIVATION:
 - SHARING LOCAL RESOURCES (FILE SERVERS, MAIN-FRAMES, ETC.)
 - MAIL-SYSTEM
 - INTEGRATED SYSTEM FOR UNIVERSITY AND INDUSTRIAL ENVIRONMENT

BASIC ISSUES CONSIDERED

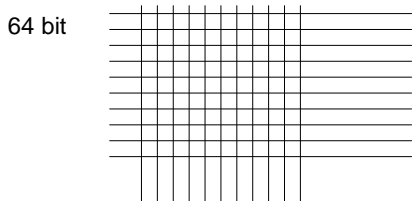
- SYSTEMS ARCHITECTURE
- HARDWARE ORGANIZATION FOR RELIABLE LOW COST HIGH SPEED COMMUNICATION
- ADDRESSING AND ROUTING
- PROTOCOLS FOR THE NETWORK
- INTERFACES
- WIRING
- INTERCONNECTING LAN's AND LONG-HAUL NETWORKS
- EASE OF EXTENSIBILITY

BUS

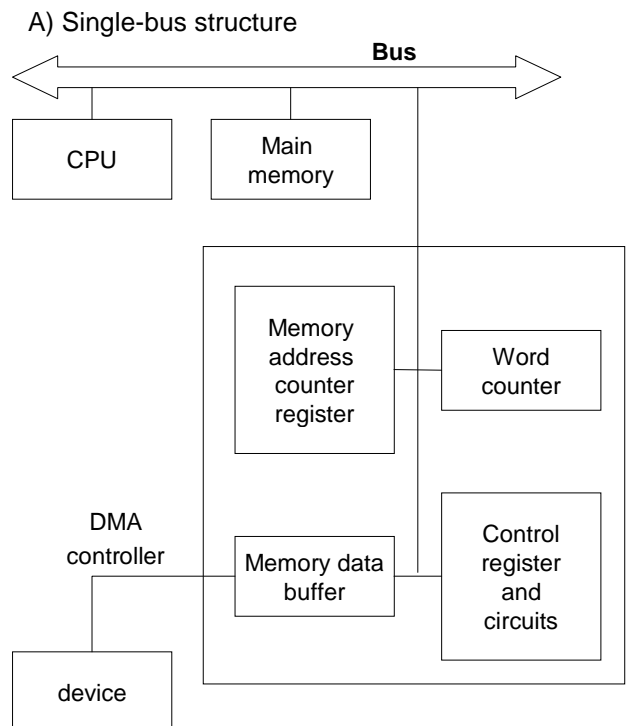
- SCSI - Small Computer System Interface, "scuzzy".

32	address bus
32	data bus
32	control bus
32	I/O bus

- VMEbus - (VersaModule Eurocard bus)

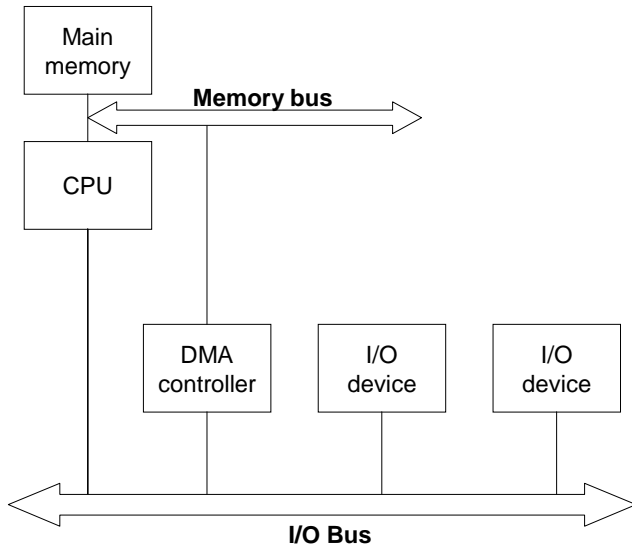


BUS ORGANIZATION FOR DIRECT MEMORY ACCESS



BUS ORGANIZATION FOR DIRECT MEMORY ACCESS

B) Two-bus structure with a "floating" DMA controller



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LOCAL AREA NETWORKS TRANSMISSION SPEED 1 Mbps-100 Mbps

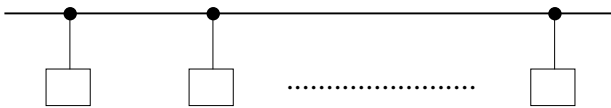
COMPONENTS OF LAN

- TRANSMISSION MEDIUM (coaxial cable)
- ACCESS (CONTROL) MECHANISM (HARDWARE PROTOCOLS)
- INTERFACE (ADAPTERS)
- SOFTWARE PROTOCOLS

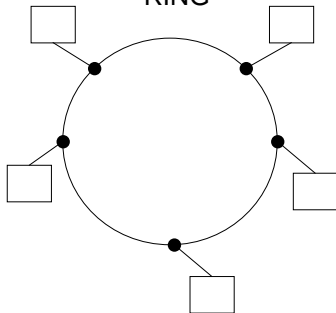
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LAN TOPOLOGIES

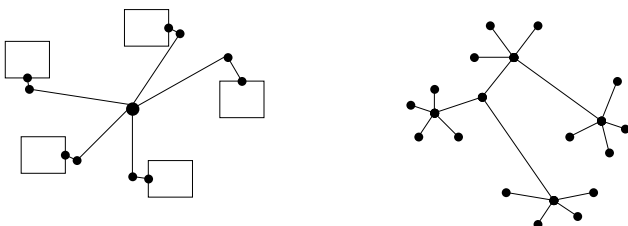
BUS



RING



STARS



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CONTROL OR ACCESS MECHANISMS WHO TRANSMITS NEXT?

CENTRALIZED:

- POLLING (PROBING)
- INTERRUPTS

DISTRIBUTED:

- CONTROL TOKEN (e.g., token passing ring)
- DAISY CHAINING
- MESSAGE SLOTS
- INSERTION BUFFERS (e.g., Pierce Loop)
- CONTENTION (e.g., CSMA/CD)
 - (A) DETECT COLLISION
 - (B) RANDOMIZE DELAY SACRIFICING BANDWIDTH TO KEEP ADAPTER SIMPLE

- (1) NOT LISTENING
- (2) LISTEN BEFORE TRANSMITTING
- (3) LISTEN WHILE TRANSMITTING

(COAX SIMPLE, RADIO NOT POSSIBLE)

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TRANSMISSION TECHNOLOGIES

BIT SERIAL TRANSMISSION ON

- (1) BASEBAND
- TWISTED PAIR
 - COAX
 - FIBERS (NO BUS)
 - ATM (ASYNCHRONOUS TRANSFER MODE, 155 Mbps MBITS/SEC on OC-3, up to 2,488 Mbps = 2.488 Gbps)

SIMPLE ADAPTERS 1-12 Mbps

- (2) BROADBAND
- CATV
 - FIBERS (NO BUS)

EXPENSIVE ADAPTERS ≈ 100 Mbps (VIDEO TRAFFIC)

- ULTRANET ≈ 1 - 2 Gbps

- (3) WIRELESS (e.g., RF signaling, infrared)

BROADBAND INTEGRATED SERVICES DIGITAL NETWORK (B-ISDN)

Level	North American	Europe	Japan
1	1.544 (DS1)	2.048	1.544
2	6.312 (DS2)	8.448	6.312
3	44.736 (DS3)	34.368	32.064

Digital Signal Hierarchies (in Mbps)

SONET - SYNCHRONOUS OPTICAL NETWORK

Level	Line Rate (Mbps)
OC-1	51.84
OC-3	155.52
OC-9	466.56
OC-12	622.08
OC-18	933.12
OC-24	1244.16
OC-36	1866.24
OC-48	2488.32

SONET Optical Signal Level Hierarchy

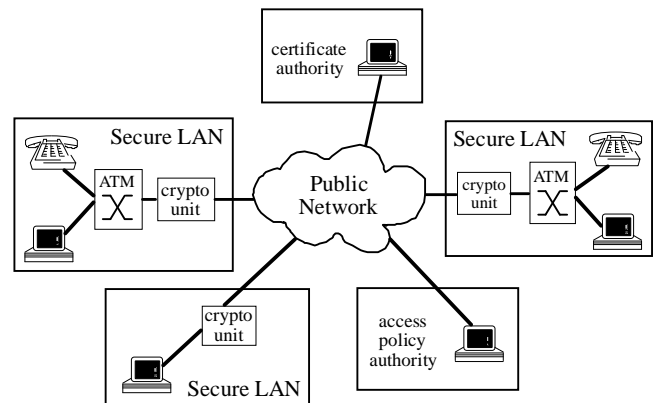
CHARACTERISTICS OF ATM LANs AND WANs

ATM LANs	ATM WANs
Small, cheap switches (10 -256 ports)	Large, expensive switches (> 1000 ports)
Need not be ultrareliable and fully redundant	Reliability and redundancy a must
Traffic policing is unnecessary, as the traffic sources are under local control	Traffic policing required
Transmission latency is not a major issue	Transmission latency is a major issue
Can have many slower links (e.g., 155 or 622 Mbps); every link need not operate a gigabit speeds	Must have gigabit links to handle aggregate traffic
The aggregate traffic is a very bursty arrival process	The aggregate traffic is a nonbursty arrival process

- ATM - Asynchronous Transfer Mode
 LAN - Local Area Network
 WAN - Wide Area Network

TRANSMISSION SECURITY

DATA PRIVACY REFERENCE UNIT

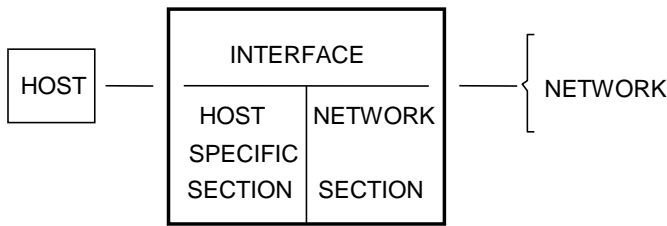


TRADEOFFS BETWEEN COMMON KEY AND PUBLIC KEY ENCRYPTION/DECRYPTION

COMMON KEY - SAME KEY FOR ENC/DEC FOR ALL USERS

PUBLIC KEY - SAME KEY FOR ENCRYPTION BUT A PRIVATE KEY FOR DECRYPTION

INTERFACE DESIGN

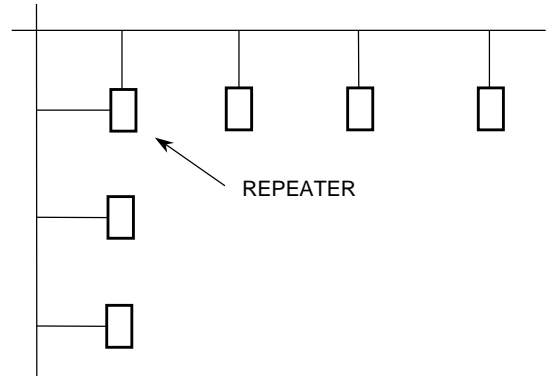
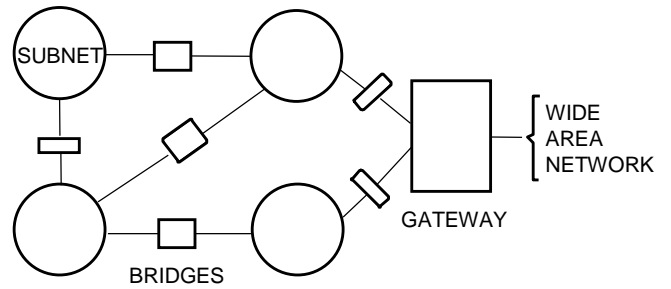


NETWORK SECTION:

- CONTROL OF RECEPTION
- CONTROL OF TRANSMISSION
- ADDRESS RECOGNITION
- SIGNAL CONDITIONING

NETWORK EXTENSION METHODS

- 1) REPEATERS
- 2) BRIDGES
- 3) GATEWAYS



REPEATER (simplest interconnection)

- NO CHANGE IN DATA RATES
- NO PROTOCOL CONVERSION

BRIDGES

- MAY CHANGE SIGNALING RATE
- MAY CHANGE ACCESS MECHANISM
- NO PROTOCOL CONVERSION
- NO FRAGMENTATION

GATEWAYS

- PROTOCOL CONVERSION
- FRAGMENTATION
- CHANGE SIGNALING RATE
- CHANGE ACCESS MECHANISM

NETWORKS SUMMARY

	WANS		LANS		BUSES	
	ARBITRARY	EXPLICIT	STRUCTURED (e.g., ring, star, tree)	IMPLICIT	BUS	IMPLICIT
TOPOLOGY						
ROUTING						
DATA TRANSFER	STORE & FORWARD (BUFFER PROBLEM)		CHECK & FORWARD		DIRECT	
TRANSFER MODE	SERIAL, PACKET BASED		SERIAL, MESSAGE BASED		PARALLEL, BYTE or WORD BASED	
INTERFACE	MODEMS, ISDN		CARDS (e.g., Ethernet)		NONE or CHANNELS	
PROTOCOLS	COMPLEX (incl. routing, e.g., TCP/IP)		SIMPLE (e.g., CSMA/CD)		SIMPLE	
COST	HIGH		LOW		MEDIUM	
RELIABILITY	FAULT TOLERANT, GOOD		VERY HIGH BUT NOT FAULT TOLERANT		VERY HIGH BUT NOT FAULT TOLERANT	