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THIRD COLLEGE ON MICROPROCESSORS:
TECHNOLOGY AND APPLICATIONS IN PHYSICS

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NETWORKS LAN'S AND WANS

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LECTURE 4

NETWORKS

LAN's + WANS

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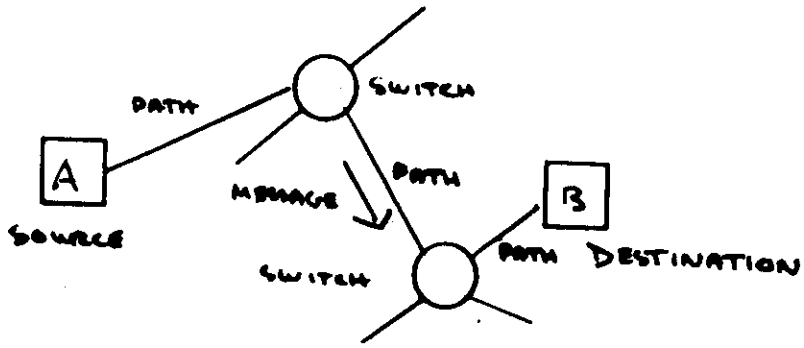
GENERAL COMMENTS ABOUT NETWORKS

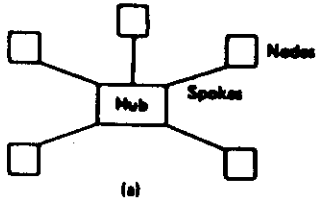
Lecture 4

- Consider any collection of computer systems interconnected to form a network.
- Processors are connected in various topographic structures and exchange messages via means of data communication paths and switches. Processors often called network nodes
- A message is a unit of information transfered between computers. It will be an address and a block (almost always) of data. ex) data block transfer.
- A path is the communications channel over which information is transfered
- A switch is an intervening, normally intelligent, device that routes a message between sender and receiver

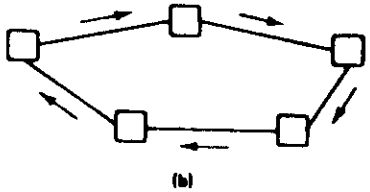


-et us look at some topographies

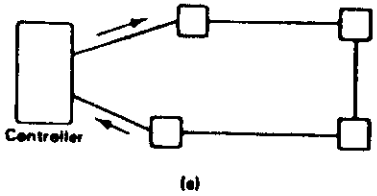
STAR. Hub acts as switch. Point to point links. LAN + WAN



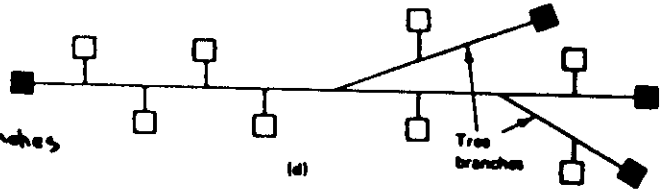
RING. All nodes connected together LAN. All nodes equal

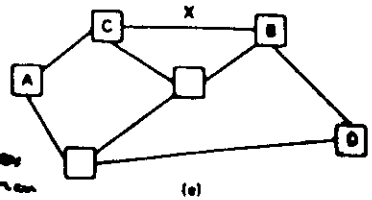


LOOP. All nodes connected together one always in control. LAN

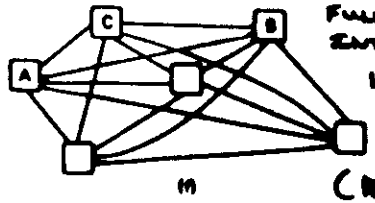


Bus. Shared ath to which ll nodes onnect. ee = Bus + branches LAN





re complex nterconnection AN (LAN)



Fully interconnected Highly fault tolerant (Military use?)

NETWORKS

WHY ???

- RESOURCE SHARING INDEPENDENT OF LOCATION
  (DATA/INFORMATION STORED IN MANY COMPUTERS)
- REDUNDANCY CONSEQUENTLY RELIABILITY
  (IF ONE COMPUTER GOES DOWN ANOTHER TAKES OVER)
- PRICE OF COMPUTERS VERSUS COMMUNICATION
  (COMPUTER (µP-BASED) ARE CHEAP CAN BE PLACED EVERYWHERE)

TENDENCY:

- BECAUSE µP ESPECIALLY µP-BASED COMPUTERS ARE CHEAP IT IS ATTRACTIVE TO CONNECT THEM TO INCREASE COMPUTING POWER AND TO SHARE EXPENSIVE PERIPHERALS
  (DISCS, PRINTERS, TAPES ETC)

RESULT:

DISTRIBUTED COMPUTER SYSTEM

(MULTIPLE) PROCESSOR SYSTEM
LOCAL AREA NETWORK

TENDENCY:

BECAUSE COMMUNICATION BECOMES CHEAP IT IS ATTRACTIVE TO CONNECT COMPUTERS AT DIFFERENT PLACES

RESULT:

COMPUTER NETWORKS

4 WIDE AREA OR LONG HAUL NETWORKS

LOCAL AREA NETWORKS

WIDE AREA NETWORKS

- SPEED TELEPHONE LINE SMALL (≤ 50 Kbits/s) COMPARED WITH SPEED NETWORK NODE
- CONSEQUENCE NODE CAN DO THE SWITCHING AND ROUTING (STORE AND FORWARD, HOP BY HOP)
- HAVE TO DEAL WITH PUBLIC TELEPHONE SERVICES (TRANSMISSION LINES ARE EXPENSIVE SO SHARING WITH OTHERS)

LOCAL AREA NETWORKS

- PROCESSORS NOT ANY MORE FAST COMPARED WITH SPEED TRANSMISSION LINES (≥ 1 Mbits/s)
- CONSEQUENCE HOP BY HOP REPLACED END TO END
- NO LIMITATION OF PUBLIC TELEPHONE SERVICES

CONSEQUENCES

- LOCAL AREA NETWORKS REPLACE FRONT-END AND BACK-END NETWORKS BY ONE DISTRIBUTED SYSTEM.

PROTOCOL HIERARCHIES

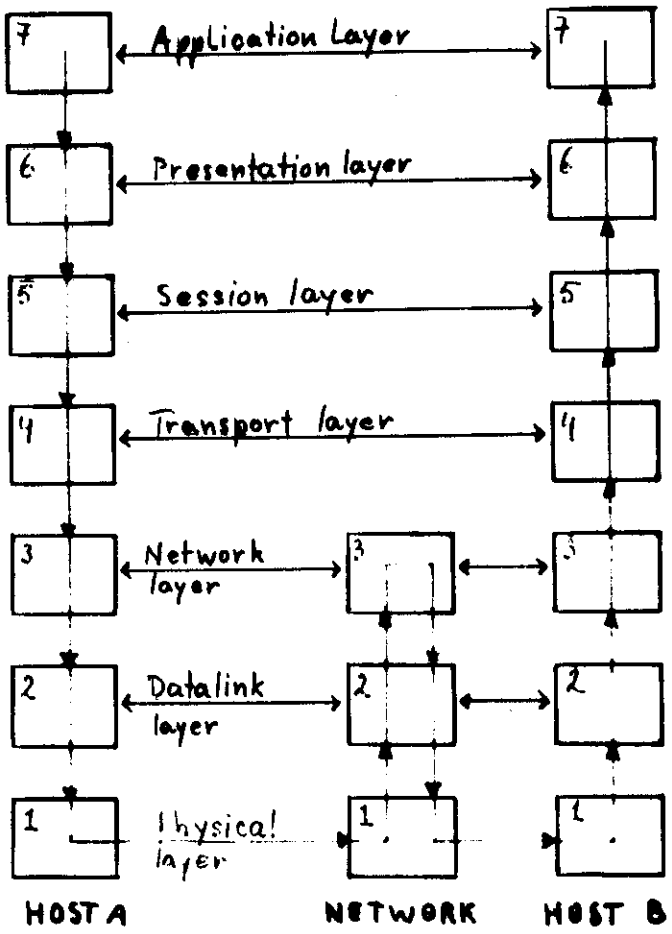
WHY ???

- TO REDUCE DESIGN COMPLEXITY OF NETWORKS
- NETWORK ORGANIZED AS NUMBER OF LAYERS OR LEVELS
- NUMBER OF LAYERS IN NETWORK DIFFER
- PURPOSE OF LAYER IS TO OFFER CERTAIN SERVICE TO NEXT HIGHER LAYER (SHIELDING OF DETAILS HOW LAYER IS IMPLEMENTED)
- LAYER n CARRIES CONVERSATION WITH LAYER n IN OTHER MACHINE
- RULES AND CONVENTIONS USED IN CONVERSATION ARE CALLED LAYER n PROTOCOL
- ENTITIES COMPRISING CORRESPONDING LAYERS ARE CALLED PEER PROCESSES (PEER PROCESSES COMMUNICATE VIA PROTOCOL)
- EXCEPT FOR LOWEST LAYER NO DATA IS DIRECTLY TRANSFERRED BETWEEN LAYERS
- EACH LAYER PASSES DATA TO HANDS LOWER ONE

COMMUNICATION:

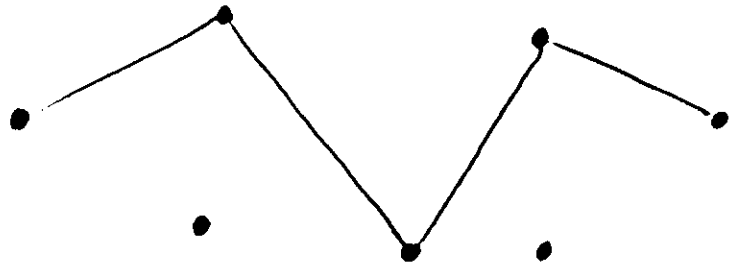
- PHYSICAL COMMUNICATION BETWEEN MACHINES AT LOWEST LEVEL
- VIRTUAL COMMUNICATION BETWEEN HIGHER LEVELS
- INTERFACE BETWEEN LAYERS
  - PRIMITIVE OPERATIONS
  - SERVICES

OSI model of ISO



Network Services:

- terminal traffic
- file transfer
- remote job entry/manupilation
- electronic mail
- central data bases
- interactive graphics
-



HOP BY HOP
ROUTING

Wide Area Network

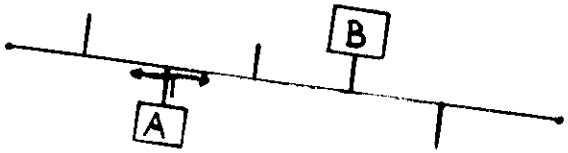
distance :

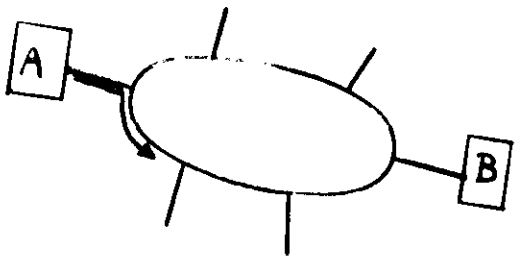
speed :

examples :
- public telephone
- Leased Lines
- public packet switched network

Local Area Network

distance : ≤ 2 km
speed : 1 - 10 Mbaud
examples : - Ethernet (CSMA/CD)
- Cambridge ring (free slot)
- IBM ring (token)



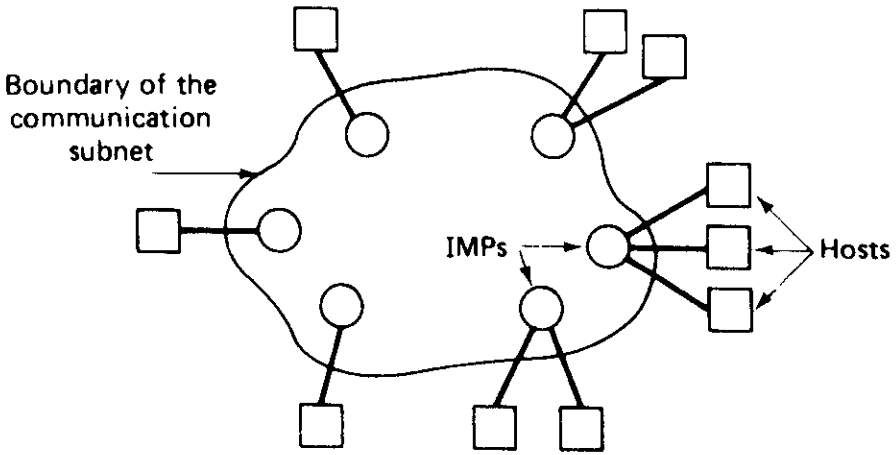


- FOLLOW TERMINOLOGY FIRST MAJOR NETWORK ARPANET.
- IN A NETWORK THERE ARE COMPUTERS RUNNING ALL TYPES OF USER SOFTWARE
  THESE MACHINES ARE CALLED HOSTS
- HOSTS ARE CONNECTED BY A COMMUNICATION SUBNET
  OR TRANSMISSION SYSTEM
- JOB SUBNET CARRYING MESSAGES FROM HOST TO HOST
  RESULT IS THAT COMMUNICATION NETWORK (SUBNET)
  HAS ABSTRACTED FROM APPLICATION (HOST)

COMMUNICATION SUBNET CONSISTS OUT OF TWO BASIC COMPONENTS :

- SWITCHING ELEMENT
- TRANSMISSION LINE

INTERFACE MESSAGE PROCESSOR



public telephone:

1. A calls B
2. PTT makes connection (hardware)
3. private line during CALL
4. disconnect

leased lines:

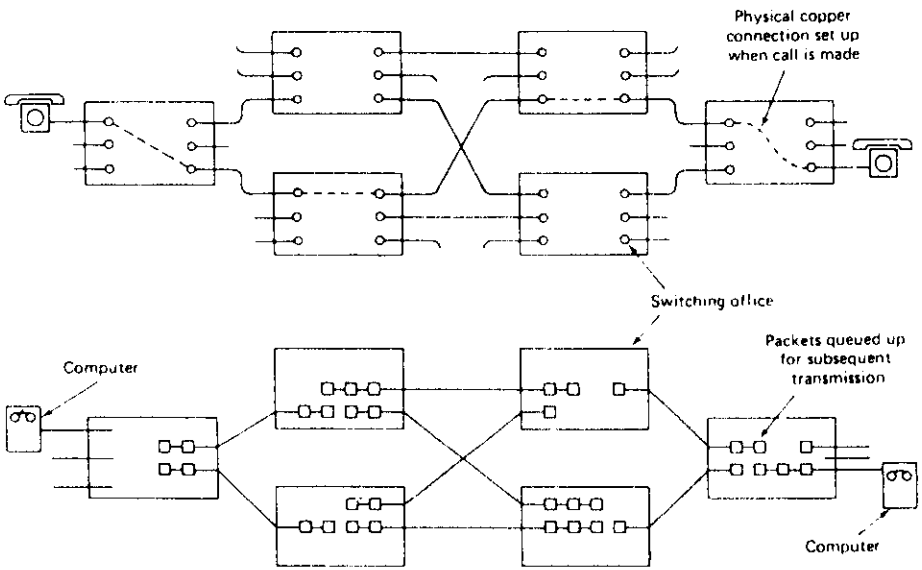
2. fixed connection between A and B
3. permanent private line

PPS network:

1. A calls B
2. PTT makes connection (soft/hardware)
3. private line during transfer of <u>one</u> packet of data.
4. disconnect

CIRCUIT SWITCHING

- FIRST CONNECTION MADE
- AFTER THAT ANALOGUE LINE ALL THE TIME AVAILABLE



PACKET SWITCHING

- PACKETS ARE ROUTED OVER DIFFERENT LINES
- AT THE END STATION ASSEMBLED INTO MESSAGES

WIDE AREA NETWORKS (PTT's — PPS NETWORKS)

- STANDARD X.25 COVERS: PHYSICAL, DATALINK, NETWORK LAYERS
- HOST INTERFACE: DATA TERMINAL EQUIPMENT (DTE)
- IMP INTERFACE: DATA CIRCUIT-TERMINATING EQUIPMENT (DCE)
- IMP IS CALLED DATA SWITCHING EXCHANGE (DSE)

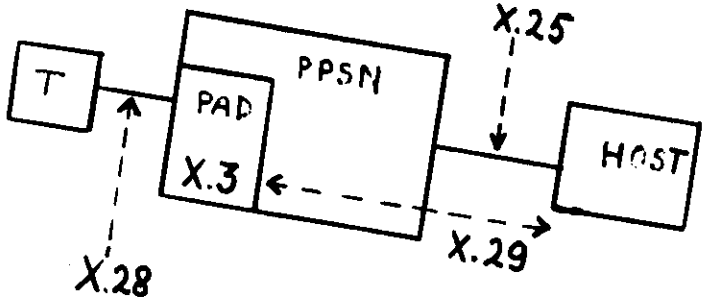
SOMETIMES WE ONLY WANT TO CONNECT TERMINALS TO X.25 NETWORK

PACKET ASSEMBLER DISASSEMBLER
THREE X 's

X.3 DEFINES PAD PARAMETERS
X.28 DEFINES TERMINAL - PAD INTERFACE
X.29 DEFINES PAD - HOST (DTE) INTERFACE

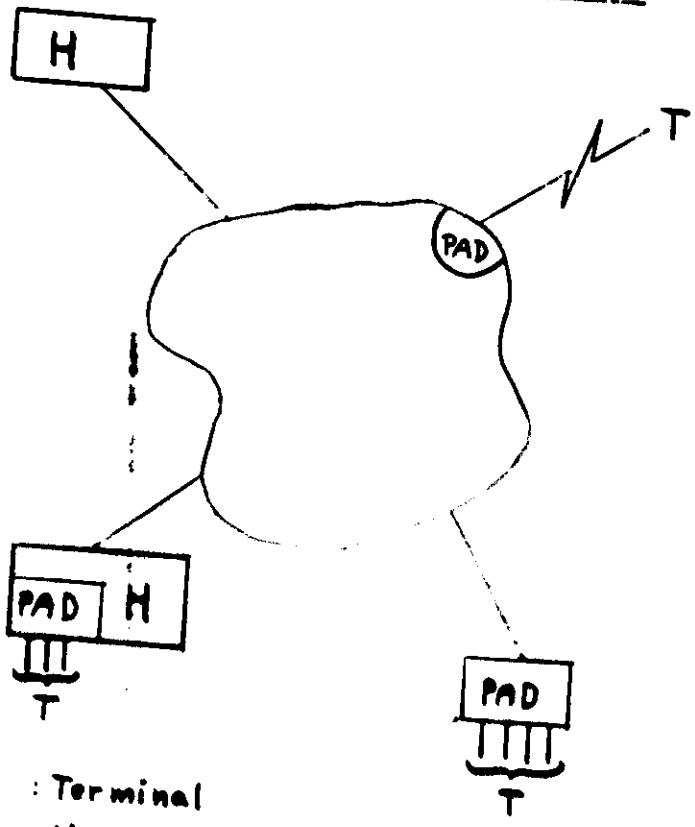
X SERIES PROTOCOLS

- terminal traffic



- file transport : no standard

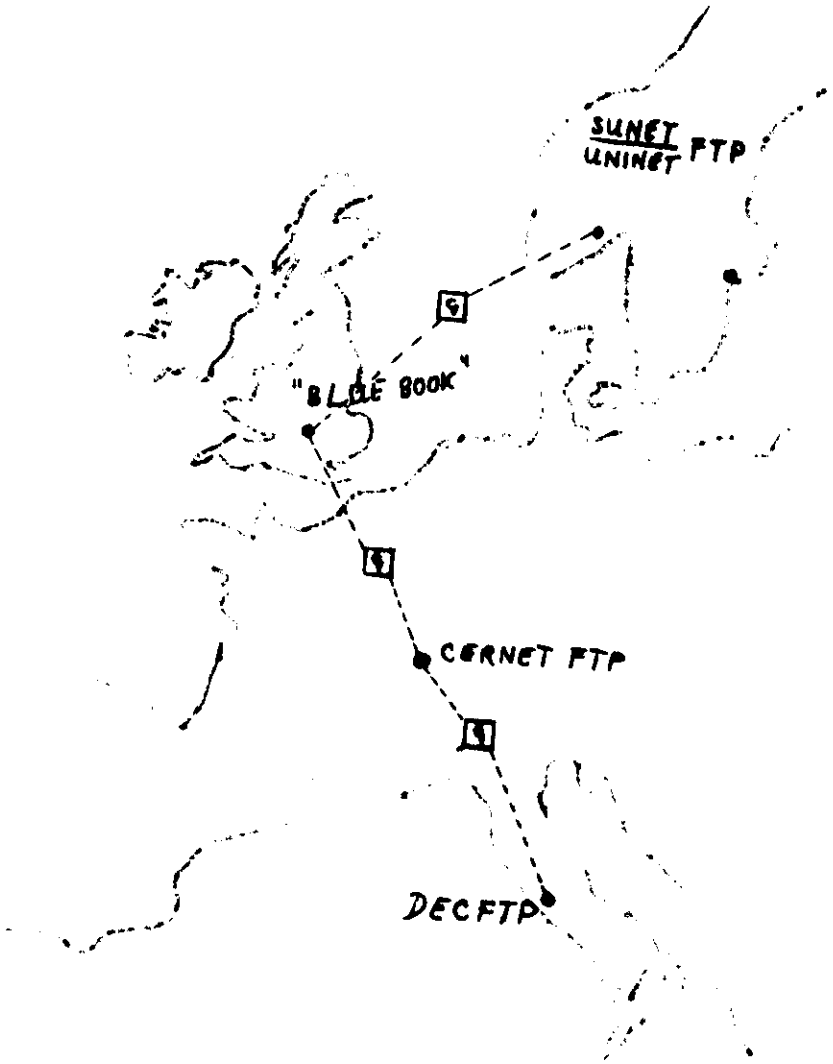
X25 PPS NETWORK



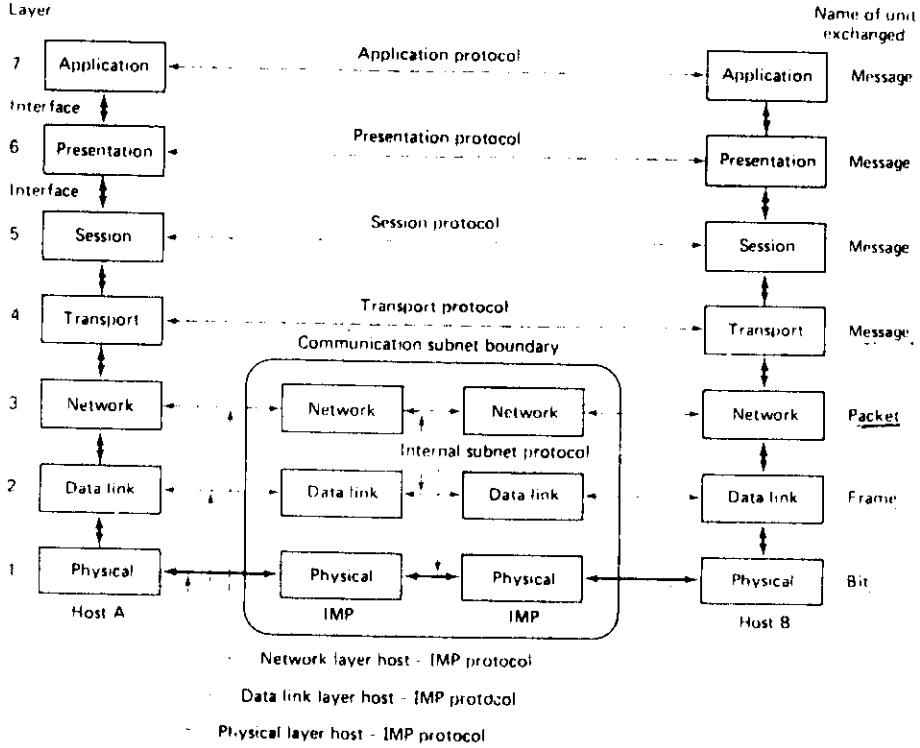
T : Terminal
H : Host
PAD : Packet Assembler/Dissembler

FTP

[G] GATEWAY



ISO MODEL AND INTERFACE MESSAGE PROCESSOR (IMP)



LANs

There are three topographies in common use

STAR

BUS

RING

We will emphasise bus and ring systems. This is what is fashionable at the moment.

Note a bus is a shared path. We met bus concept talking about computer system buses and instrumentation buses.

Beware of potential confusion!

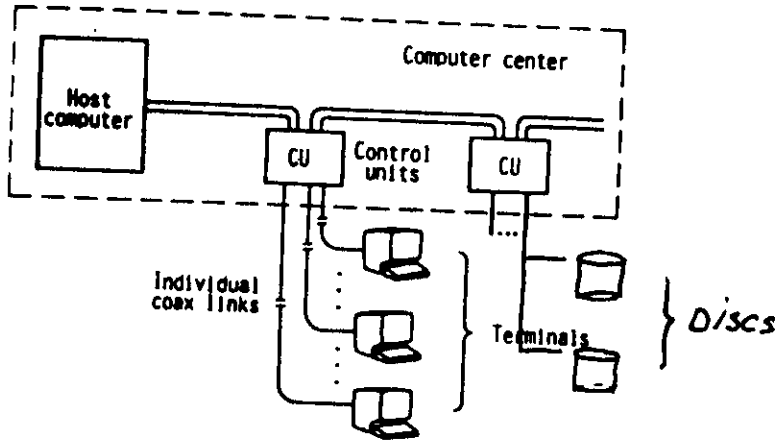
Computer bus	LAN bus
parallel	serial
read/write	"write" only
few words per transaction	normally data blocks

COMPUTER CENTRE (OLD)

- TERMINALS NO LOCAL INTELLIGENCE
- TIGHTLY COUPLED VIA I/O CHANNELS
- CONTROL UNITS (CU) PERFORM CONTROL FUNCTION

PROBLEMS / SHORTCOMINGS

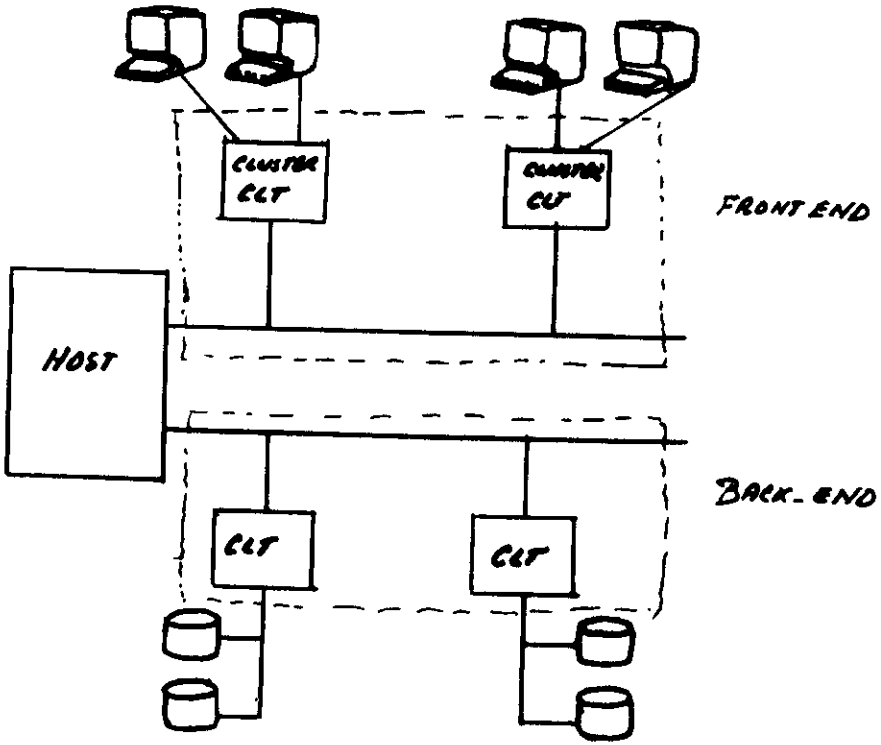
- CONTROL UNITS HAVE TO BE IN CENTRE
- INDIVIDUAL CABLES TO ALL TERMINALS
- TERMINAL SWITCHING FROM ONE COMPUTER TO OTHER DIFFICULT



CU'S COUPLED VIA PARALLEL CHANNEL

COMPUTER CENTRE (NEWER)

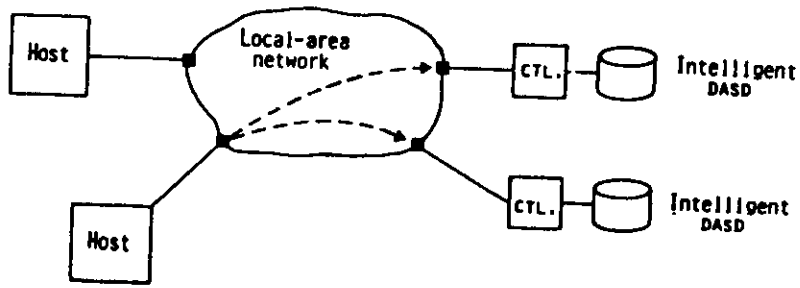
- DIFFENT PARALLEL BUSSES FOR TERMINALS AND STORAGE DEVICES
- ONLY TERMINAL CONNECTIONS SERIAL



- IF WE COULD MAKE PARALLEL CONNECTION SERIAL TIGHT COUPLING → LOOSE COUPLING (NETWORK)
- THE CONNECTION HAS TO BE FAST ESPECIALLY FOR BACK-END (32 MS / 16 BIT)
- POSSIBLE WITH LOCAL AREA NETWORKS 1 — 10 MBIT/S

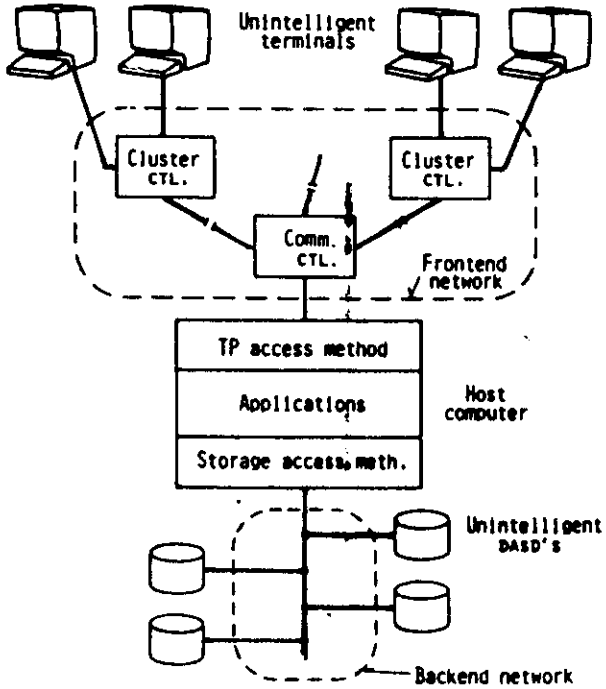
NETWORK

- DIRECT ACCESS STORAGE DEVICES (DASD) NEED INTELLIGENCE TO ACCESS NETWORK
- EACH HOST CAN COMMUNICATE WITH EACH DASD



COMPUTER CENTER (NEW)

- INTELLIGENT CLUSTER CONTROLLERS CONNECTED INTO FRONT-END NETWORK (CONNECTIONS SERIAL)
- MASS STORAGE DEVICES CONNECTED INTO BACK-END NETWORK (SERIAL CONNECTIONS)

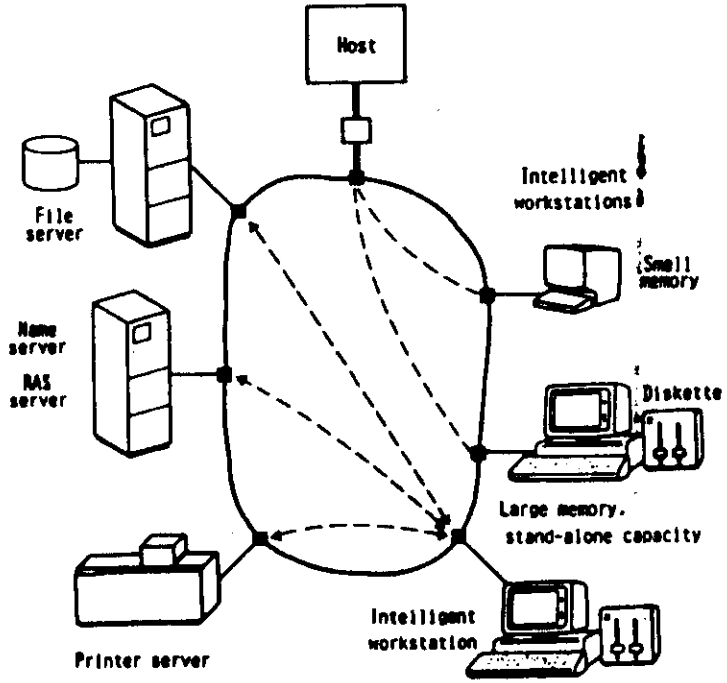


CLIENT-SERVER MODEL

- WORKSTATIONS (CPU, MEMORY, TERMINAL, SOMETIMES SMALL DISC) ARE CLIENTS

COMMUNICATE WITH

- INTELLIGENT PRINTERS, DISCS (FILE SERVER DATABASE) WHICH ARE CALLED SERVERS



STAR

Useful in cases where hub is providing service for nodes on its spokes.

Good for one to many relationship.

Not very suitable for many to many relationship. Central switch is vulnerable.

Not too convenient to add nodes. May be difficult to cable. Expensive too!

Main interest for LAN is when star implemented as PABX - private automatic branch exchange. High speed circuit switching as opposed to slow telephone relay switching.

CENTRALIZED MANAGEMENT WORKS WELL!!

BUSES

- Many of the ideas we developed when talking about computer buses are applicable.
- But we must find techniques that are applicable over kms instead of metres
- LAN buses are write only, serial and normally data block oriented.
- There is provision made to detect errors introduced along the transmission path

The focus of our attention will be how to allocate the bus to different nodes - arbitration. This is what differentiate different types of bus LAN.

ACCESS METODS

BASIC PHILOSOPHY

- EITHER ACCESS IS CONTROLLED AND NO COLLISION WILL OCCUR OR IT IS RANDOM AND COLLISIONS TAKE PLACE
- IN LAST CASE WE NEED RECOVERING METHOD

CONTROLLED ACCESS :

TOKEN PASSING RING

- ACCESS CONTROLLED BY TOKEN CIRCULATING IN RING IF NO MESSAGE TOKEN IS PASSED ON
- IF A STATION WANTS TO TRANSMIT IT FIRST HAS TO CAPTURE IT AND CHANGE IT TO BUSY
- BLOCK LENGTH MESSAGE ARBITRARY
- STATION SENDING MESSAGE HAS TO REMOVE IT FROM RING.

TOKEN PASSING BUS

- ADDRESSED TOKEN PASSED FROM ONE STATION TO THE OTHER
- CAPTURE OF TOKEN AS WITH RING
- AT THE END OF TRANSMISSION TOKEN IS PASSED ON BY TRANSMITTING STATION
- NO REMOVAL OF MESSAGES REQUIRED

PROPOSAL FOR STANDARDIZATION

- IEEE 802
- ONLY LEVEL 1 & 2 INVOLVED
- MAPPING OF TWO LAYERS OF ISO MODEL INTO THREE LAYERS OF 802 STANDARD

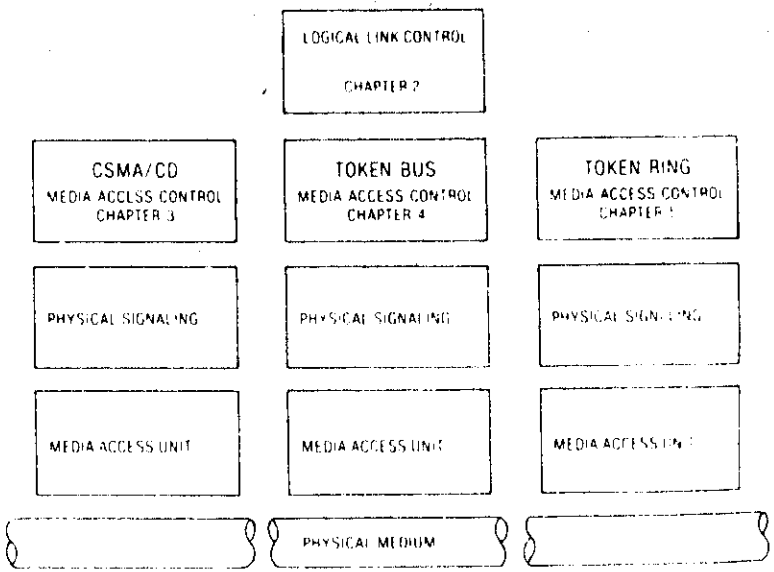
IN PROPOSAL STANDARIZATION

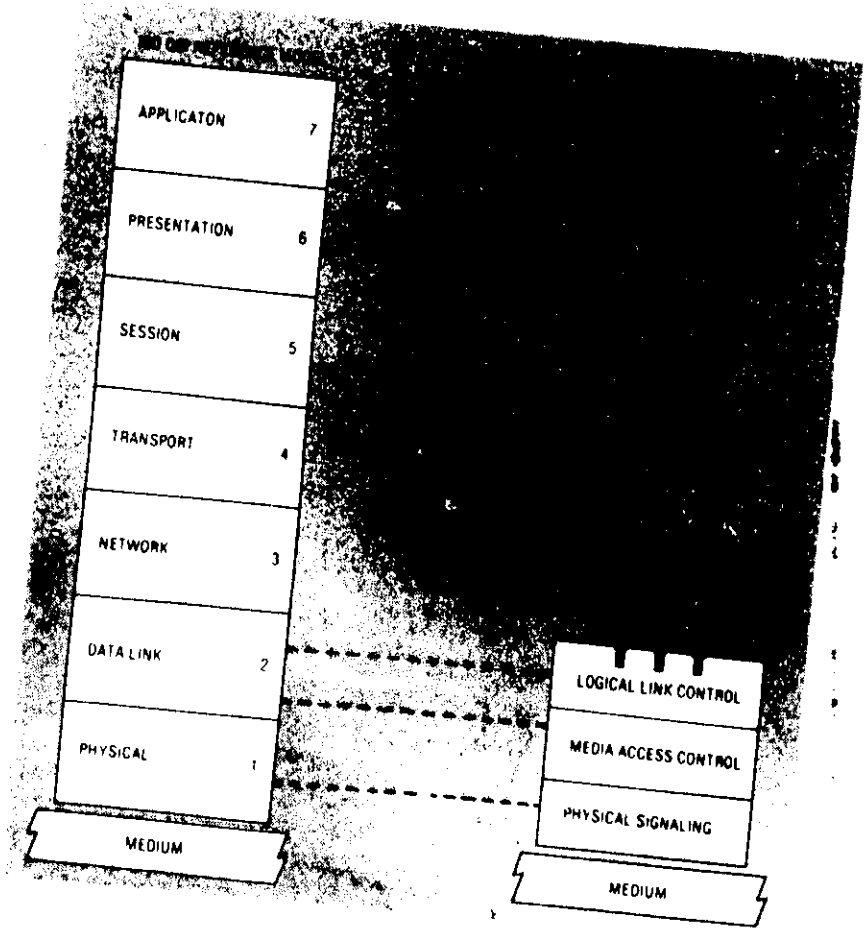
- LAYER SPECIFICATION EG. AWAY HOW LAYER IS IMPLEMENTED
- SERVICE SPECIFICATION EG. SERVICE PROVIDED TOWARDS NEXT HIGHER LAYER

MEDIUM ACCESS CONTROL

- DESCRIBES THREE PARALLEL LAYERS BECAUSE THE DIFFERENCES IN ACCESS
  - CARRIER_SENSE_MULTIPLE_ACCESS WITH COLLISION DETECT (CSMA/CD)
  - TOKEN BUS
  - TOKEN RING

802 PROPOSAL FOR CSMA,
TOKEN BUS
TOKEN RING





ETHERNET – IEEE 802 STANDARD

- Ethernet is a local area network standard endorsed by IEEE 802.
- It uses CSMA-CD principles.

It will become very important in the future especially when protocol chips become widely available and connection costs drop.

We will give some more details of Ethernet. There are other similar products around. Some with lower speed and cost.

Main features

- 1980 specification of commercial Ethernet published by Xerox (the originators), DEC and INTEL.

Very similar spec produced by IEEE 802 committee

- Is a 10MHz CSMA-CD bus

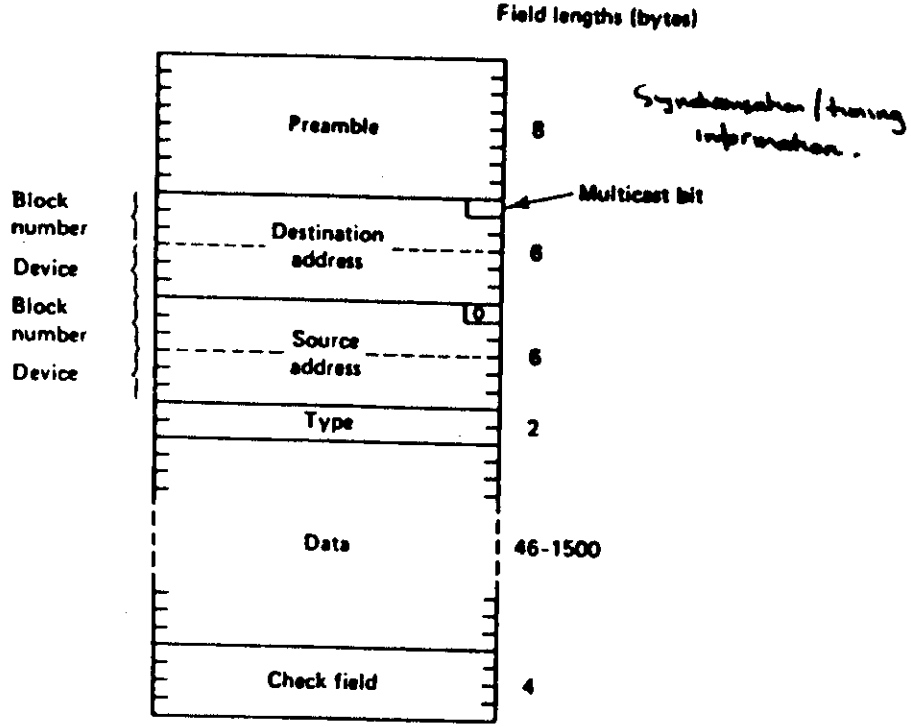
Transmission of information is bit serial.

Transmission medium is coaxial cable impedance terminated at each end.

Maximum separation for devices on Ethernet = 2.5 km

Maximum number of devices = 1024

Ethernet messages are sent as frame variable length 72 to 1526 bytes



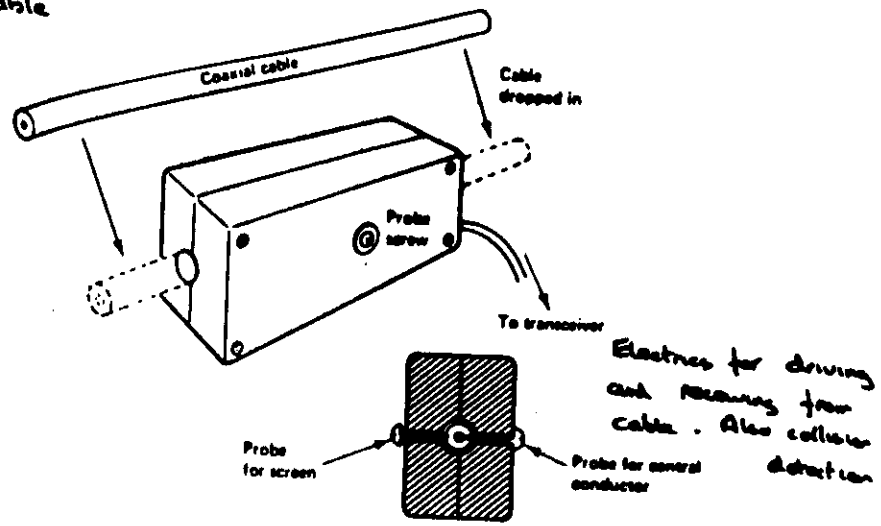
48 bit source and destination address

If first bit in destination address specifies frame is to be received by all devices

CRC sum for error detection

* CYCLIC REDUNDANCY CHECK

- Connection to Ethernet cable



Electrics for driving and receiving from cable. Also collision detection

Possible to tap into cable while network is operating. Slight disruption taken care of by normal error detection correction mechanisms

Advantages of Ethernet and other similar bus LANs

- medium cable totally passive, if down fault unlikely to bring down whole network
- relatively easy to attach new device
- good performance
- components now becoming readily and more cheaply available

Disadvantages

- quite a lot of intelligence and cost needed for a connection may be not too suitable for very dumb or cheap devices
- no automatic acknowledgement of rings
- no fairness built in, non deterministic time to get onto bus and transmit.
- Length limited to few km. Too short for some applications

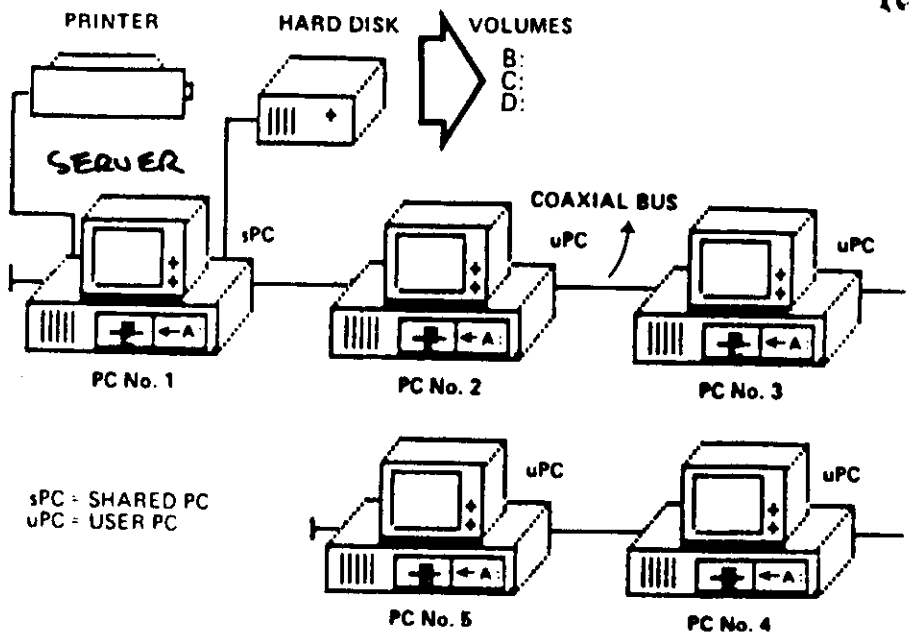


Figure 6–10. PCnet installation and components.

LANs for microcomputer systems

Usually bus systems but slower and cheaper than Ethernet. Speed 300 kbps ⇒ 1 Mbps.

IBM, Acorn, Apple and other manufacturers market cheap LAN eg) £300 per connection, or less

Many 3rd party products Hw + Sw available eg) PCnet as shown above.