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# Packet Switching

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# PACKET SWITCHING

- PUBLIC / PRIVATE DATA NETWORK
- PSDN - AN INSTRUMENT FOR PUBLIC POLICY, BUSINESS & EMPLOYMENT.
- PSDN -- SWITCHING, LEASED LINE
- DESIGN FOR DIFFERENT KIND OF USERS & TERMINALS
  - synchronous / Asynchronous, Packet Mode
  - interworkability
  - CCITT standards

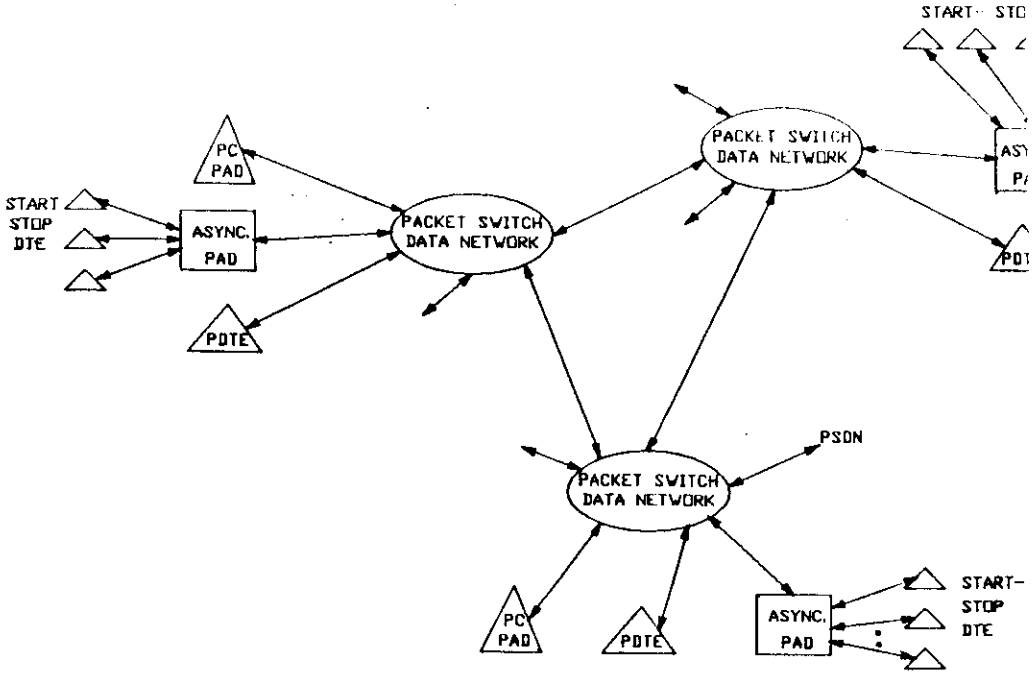



*FIG.1 : PACKET SWITCHED DATA NETWORK*

# DIGITAL SWITCHING

- CIRCUIT SWITCHING
- MESSAGE SWITCHING
- PACKET SWITCHING

## CIRCUIT SWITCHING

- SWITCHING AS IN TELEPHONE NETWORK.
- CIRCUIT ESTABLISHED FROM ONE SUBSCRIBER TO ANOTHER
- CIRCUIT BEING HELD FOR DURATION OF CALL

## MESSAGE SWITCHING

- MESSAGES - MOVED FROM NODE TO NODE
- MESSAGE SWITCH AT A NODE
- STORE AND FORWARD MECHANISM.

## PACKET SWITCHING

- MESSAGES - BROKEN INTO LIMITED SIZE PACKETS
- TRANSMITTED SEPARATELY THROUGH THE NETWORK
- PACKETS - RECONSTITUTED FOR MESSAGES.

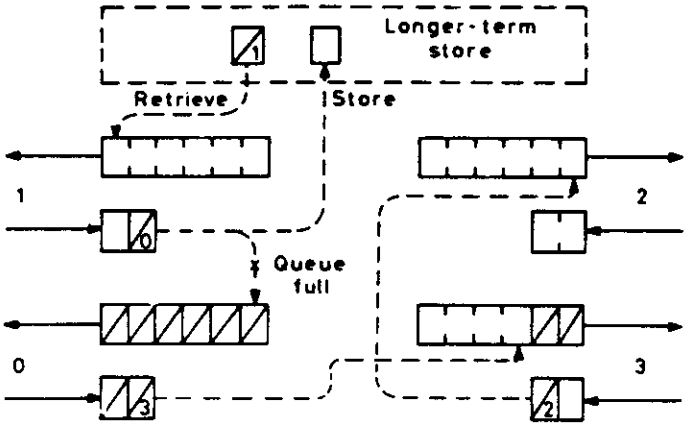



Figure 2.5 Queueing system of a message switch

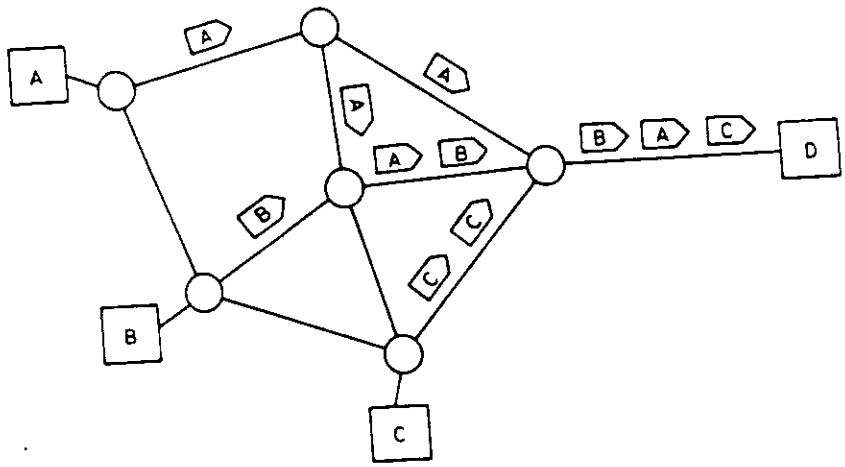



Figure 2.8 Packet switched network as a demand multiplexer

| CIRCUIT SWITCHING | MESSAGE SWITCHING | PACKET SWITCHING |
|---|---|---|
| e equivalent of a<br>e connects the<br>bscribers | No direct electrical connection | No direct electrical connection. |
| eal time interaction<br>possible | Two slow for real-time interaction | Fast enough for near real time interaction |
| Messages are not<br>tored | Messages are filed for later retrieval | Messages are stored until delivered but not filed. |
| ..e held for entire<br>ransaction | Route established for individual message | Route for every packet |
| elay in call set up<br>o delay in transmission | substantial delay in message delivery | less delay in call set up<br>moderate delay in packet delivery |

| CIRCUIT SWITCHING | MESSAGE SWITCHING | PACKET SWITCHING |
|---|---|---|
| ect of over load<br>- Blocking<br>- No effect on establi<br>-ed connection | - increase delivery delay | increased delivery delay (short)<br>blocking on saturation. |
| of messages-<br>nd user Responsibility | Network Responsibility | some protection-<br>end user protocol. als |
| Speed or code<br>version | Can do speed and code conversion | can do |
| nomical with low<br>ffic volume | moderate traffic | High traffic volume. |

Advantages of Packet switching

- Two different aspects
  - switching & Routing
  - storage & message manipulation by interface computer.

switching & Routing

- Fast response time
- High availability due to distributed routing
- High speed burst & low speed requirment can be handled.
- No blocking except when the network storage is entirely flooded.

Advantages of interface computer

- protocol converters
- buffering enables different speed computer.
- End to end protection against error and message loss.
- the network technique is can be made transparent to the host computer

cost

- High speed lines are needed. to meet large burst, fast response time etc.
- Distributed network are needed for reliability criteria
- Hence, expensive but attractive for high volume
- Telenet charges $0.60 for 1000 packets access port charge $0.9 to $1.4 / hour.

# TERMINALS

- Packet switch meant for bursty traffic
- Not suited for simple terminals
- Terminal handler / protocol convertors.
- packet mode terminals (PDTE)
- need for PAD, & PAD characteristics
- PC based PADs.

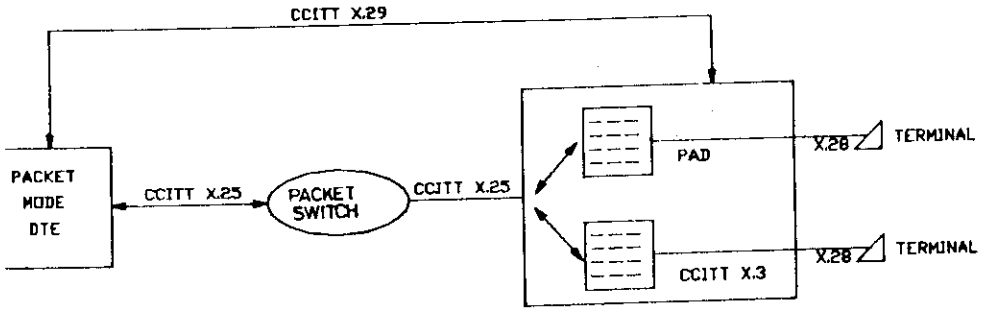



*FIG. 3: PACKET ASSEMBLER & DISASSEMBLER*

Basic functions of PAD

- Assembly of characters from the terminal into packets for the PDTE
- Disassembly of Packets in to characters for start-stop terminals
- setting up, interrupting, resetting and clearing of virtual calls.
- generation of service signals for the character terminal
- Forwarding of Packets on buffer full, time out etc.

Packet Switched Communication System

Objectives

- Single entity
- well defined simple interface to user
- Transparant to user
- Rapid and reliable delivery of Packets.

Design features

- NETWORK STRUCTURE
  - usually mesh structure
  - Distributed connection
  - More fault tolerent & reliable
  - Node & sub node concept for MINIMUM disturbance.

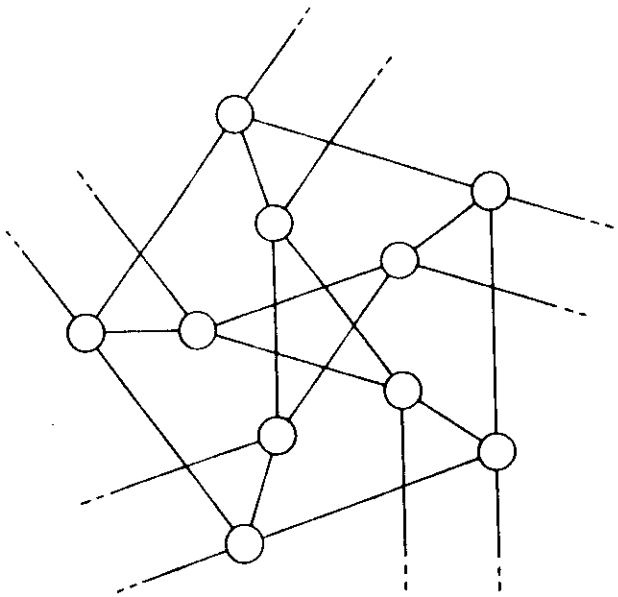
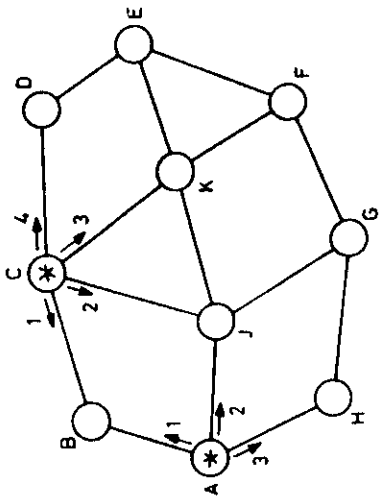


Figure 2.10 Internal structure of a multiple node

## Addressing & Routing

- Packet header has destination address – forms the specification of route.
- Routing decision at node
- Routing table with failure node and alternative routing node.
- small network - collection of alternative route stored.

- Adaptive method of calculating routing table is generally followed.




Routing table at A

| Destination | Route | Alternative |
|---|---|---|
| B | 1 | 2 |
| C | 1 | 2 |
| D | 2 | 1 |
| E | 2 | 1 |
| F | 3 | 2 |
| G | 3 | 2 |
| H | 3 | 2 |
| J | 2 | 3 |
| K | 2 | 3 |

Routing table at C

| Destination | Route | Alternative |
|---|---|---|
| A | 1 | 2 |
| B | 1 | 2 |
| D | 4 | 3 |
| E | 4 | 3 |
| F | 3 | 4 |
| G | 2 | 3 |
| H | 2 | 1 |
| J | 2 | 3 |
| K | 3 | 2 |

Figure 2.11 Examples of routing tables

## FLOW CONTROL

- store and forward enables terminals with different speed.
- Flow of data packets from sender mismatches with receiver.
- Good design is full utilisation of full capacity without congestion.

## MESSAGE ASSEMBLY

- Message divided to packets, which may be transmitted / delivered before the complete message is loaded.
- ARPA has a packet of 1024 bits, 8 packets per message
- one message at a time in transit at the Network for better flow control.

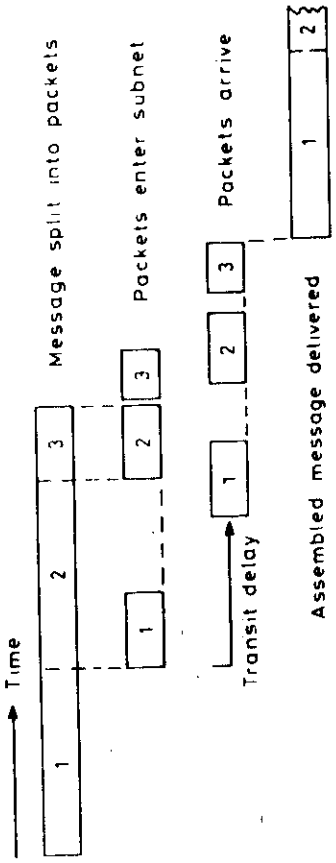



Figure 2.12 Message splitting and reassembly



- packets arrival out of their true sequence
- Restoring correct sequence is to be [illegible] at user/network level.
- private network - user's responsibility
- Public network resulted in [illegible] virtual circuit

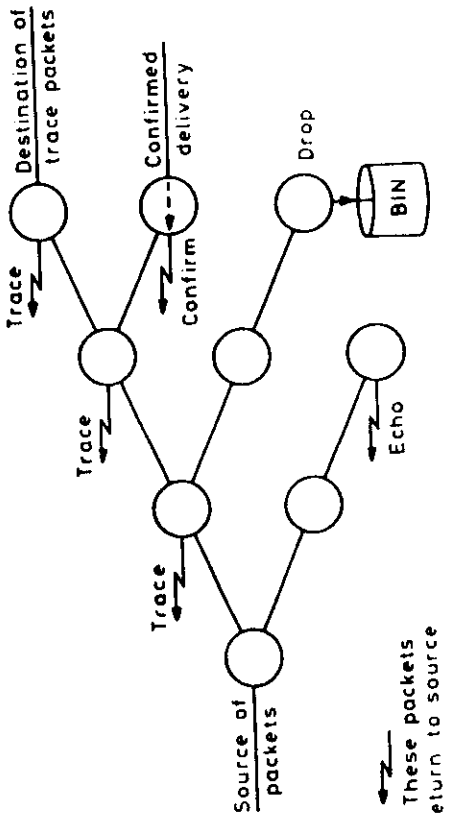



Figure 2.15 Special network features

special Features in Network

- **Delivery** confirmation
- **Trace** packets
  - Diagnostic tool. all node involved
- ECHO
  - Loop back facility
- DROP
  - Load test mainly on transmitter procedure.
- Network statistics
  - traffic levels
  - occupancy of queues
  - used Buffer space
  - error rate, redundancy, etc.
- **Network** diagnostic centre.

| Message from PDTE to PAD Type/Parameters | Action taken by the PAD | Message from PAD to PDTE Type/Parameters |
|---|---|---|
| Set/none | Reset all parameters to the initial profile | None |
| Set/parameter nos. and values | Set selected parameters to values given | None or error/parameter nos. in error |
| Set and read/none | Reset all parameters to the initial profile | /list all parameters and current values |
| Set and read/nos. and values | Set selected parameters to values given | /list selected parameter and current values |
| Read/none | None | /list all parameters and current values |
| Read/parameter nos. and values | None | /list selected parameter and current values |
| Invitation to break | Informs s/s DTE | |
| Invitation to clear | Clears call when data has been sent to s/s DTE | Clear/clearing cause |

Figure 8.21 Some PAD control messages and responses

X.29 specifications



| Message | Meaning |
|---|---|
| RESET DTE | Remote DTE has reset the call |
| RESET ERR | Call reset due to local procedural error |
| RESET NC | Call reset due to network congestion |
| PAD | Identification service signal (further study) |
| ERROR | Identification of an incorrect command |
| COM | Call connection |
| CLR | Call cleared—qualified as below |
| -OCC | Called number engaged |
| -NC | Network congested |
| -INV | Invalid facility requested |
| -NA | Access barred |
| -ERR | Local procedural error |
| -RPE | Remote procedural error |
| -NP | Not obtainable |
| -DER | Called number out of order |
| -PAD | Cleared by PDTE |

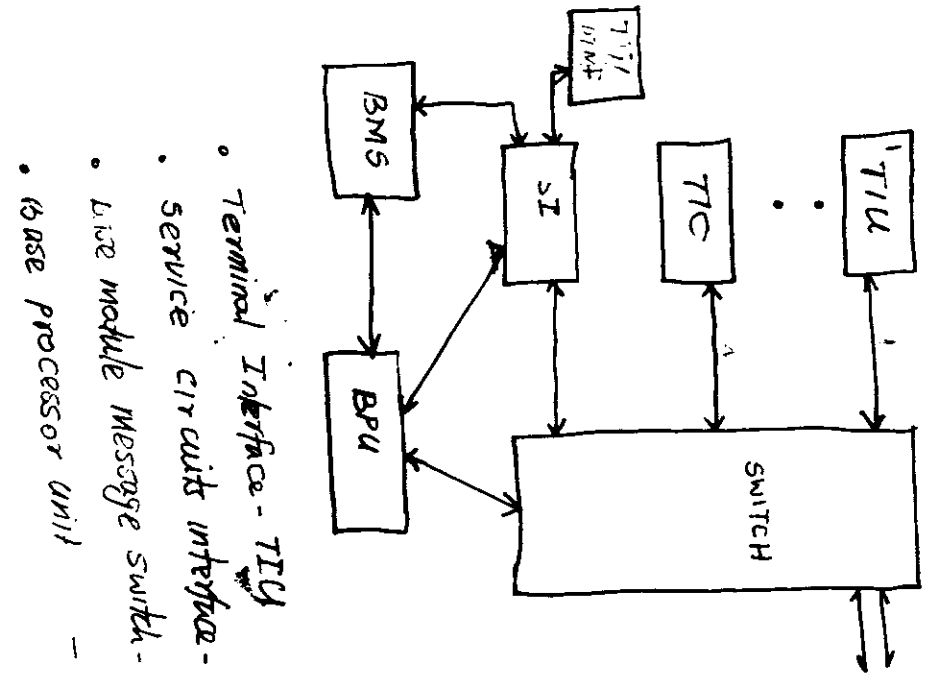
Figure 8.20 Additional messages from the PAD

| Terminal commands | Purpose | Response from PAD |
|---|---|---|
| STAT | Requests status of call to PDTE | FREE or ENGAGED |
| CLR | Requests PAD to clear down a call | CLR CONF or CLR ERR |
| PAR? (list) | Requests values of parameters listed | PAR (lists & values) |
| SET? (list & values) | Requests a change to values given & a reply | PAR (list & values) |
| PROF (identifier) | To give standard set of parameters | — |
| RESET | To reset the call to a PDTE | — |
| INT or INTD | To interrupt the call to a PDTE | — |
| SET (list & values) | Requests a change without a reply | |
| Selection command | To set up a call to a PDTE | — |
| Break signal | Out of band signal to recall command level | — |

Figure 8.19 Terminal commands and PAD responses

X.28 defines the interface and protocol between the start. stop DTE and the PAD.

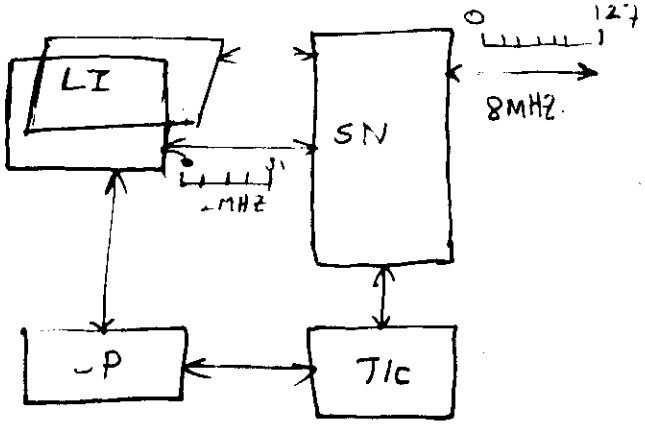
- four sections a) Establishing connection b) initialisation
  c) exchange of characters d) exchange of commands.




- Terminal Interface - TIU
- service circuits interface - SI
- Line module message switch - BMS
- 16 bit processor unit - BPU

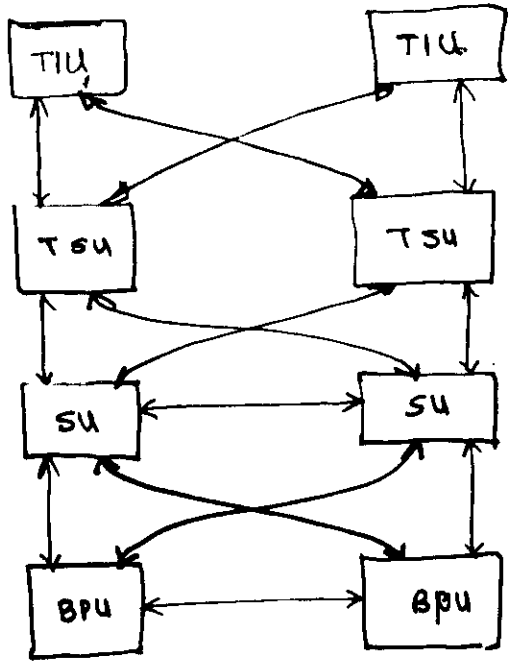
ARCHITECTURE OF CDOT 512 P EXCHANGE

Terminal Unit interface




- Line Interface - LI
- signal processor - SP
- Terminal interface controller - TIC
- SWITCH network - SP

Redundancy scheme




- Base processor unit
- service unit
- Time Switch Unit
- Terminal Interface Unit

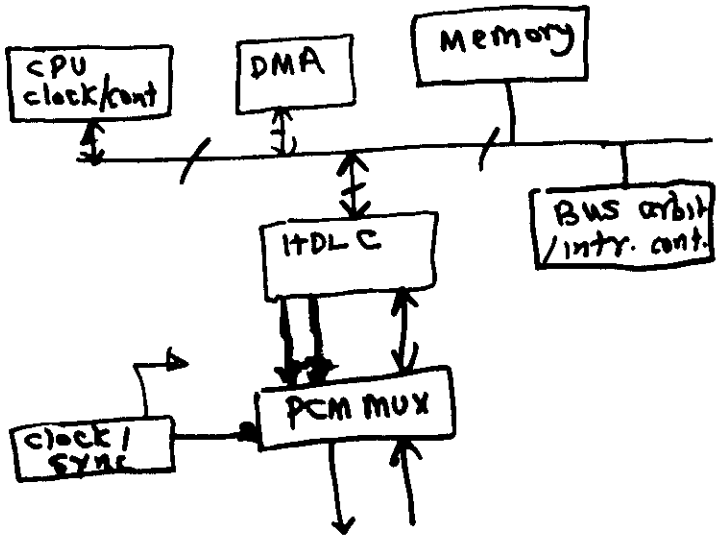
## Message switch

- Message handling mainly for
  - signalling on telephonic events.
  - Diagnostic and reconfiguration
- 32 ports - synchronous links each operating at 64 kps. Protocol used skeleton version of X.25.
- 16 bit processor for message handling.
- Real time transfer of messages Through DMA.
- Sufficient buffers for message handling.
- watch-dog for duplication monitoring.

## Message switch -(cont)

- implemented as three cards, two card types
- Message switch controller (MSC) - one unit
- Message switch device card (MSD) - Two units.
- MSC has the processor, memory bus arbitration, interrupt, control, etc along with six HDLC with 3 DMA
- MSD has all ~~HDLC~~ other 16 HDLC components with 8 DMA channels. in each card.
- All links operates at 64 kps, Multiplexed to form a 2 Mbps 32 channel PCM High way - to be connected to · Terminal interface

Message switch Architecture.




## Functional Block

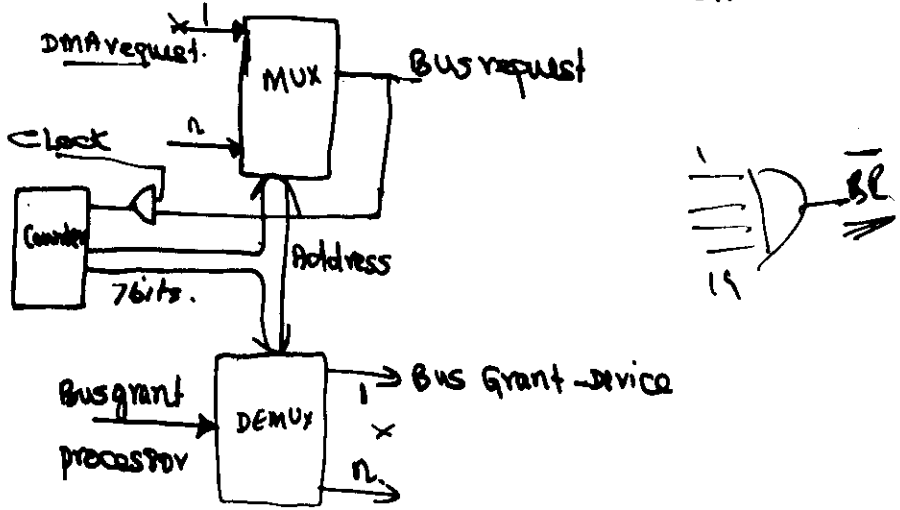
- Processor, control and memory
- Link controllers
  - Characterstic of HDLC
  - Total no of HDLC - need for faster service
  - Error handling. Abort, overrun frame error etc.
- Interface details
  - Processor interface
  - DMA interface
  - Modem & link interface

- DMA Controllers.
  - characterstic of DMA - number of channels, registers, priority of Service,
  - Speed of DMA - byte Transfer.

- Interface details
  - Processor interface

Bus arbitration

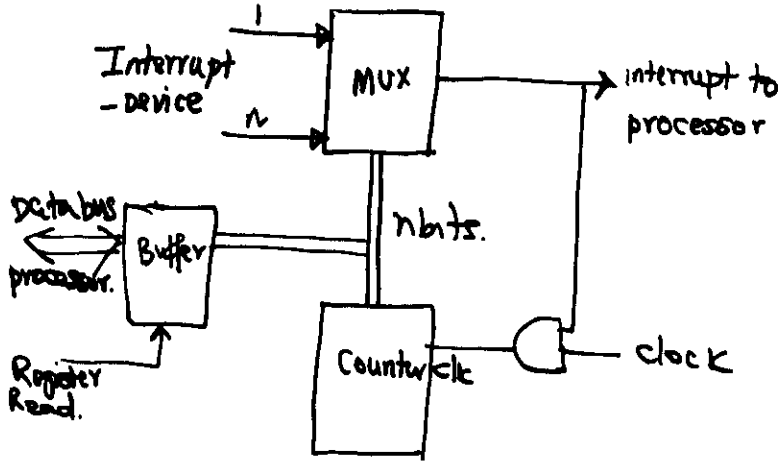
- Too many bus masters.
- Round Robin priority scheme
- Multiplexing of Bus Request and Demultiplexing Bus Grant.
- Bus mastership with DMA till the last channel is serviced.








- Interrupt logic
  - Faster service on interrupt - especially on receiver.
- Too many interrupts to handle
- scanning interrupt - status not possible
- Address of HDLC/DMA - interrupting is hardware generated.



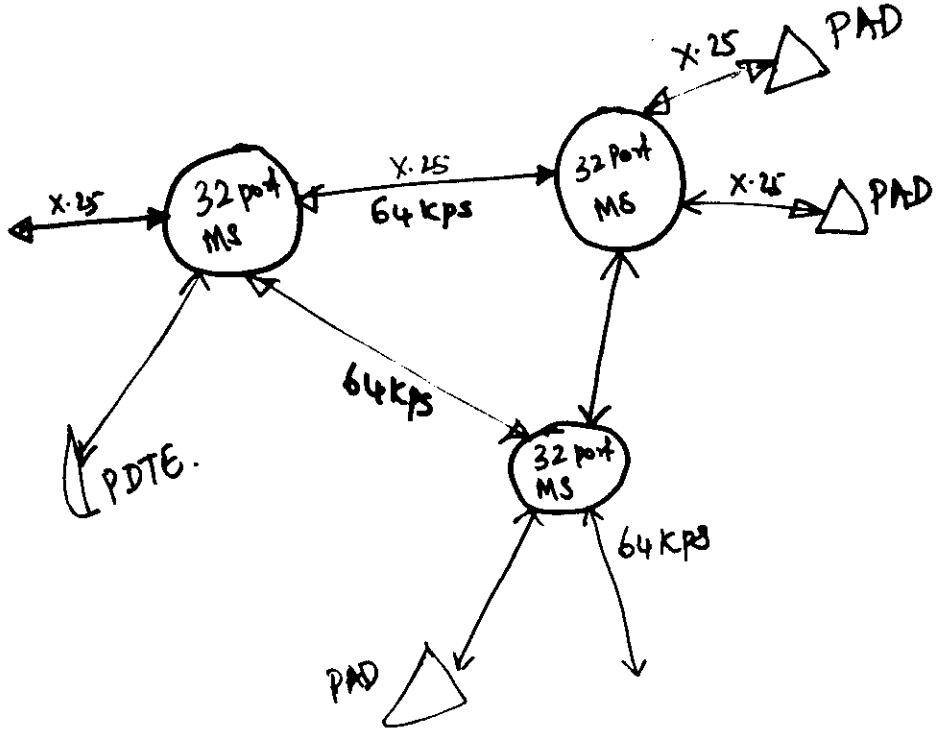
## Packet switch implementation

Two approaches

- Use of 32 port message switch as node
- Use of message switch in 512 circuit switch and get 512 port packet switch.

## Approach 1

- sufficient for immediate use
- Good for software development and experiment it in field.
- limited users and limited inter-node connectivity.



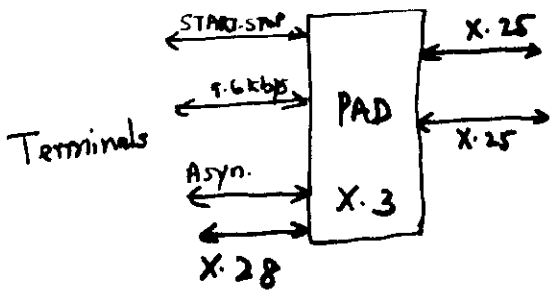
APPROACH II

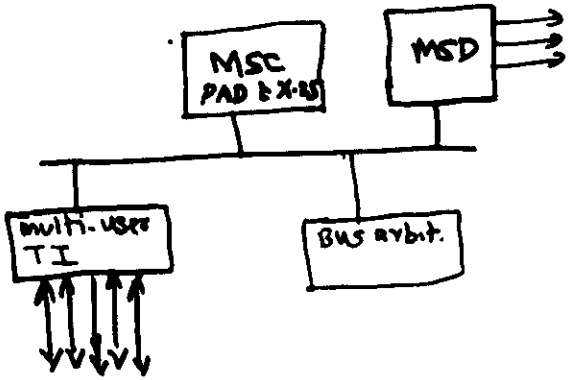
- Design of a 128 port Terminal Interface unit using message switches
- message switch compiler consists of four cards 1 MSC - 3 MSD
- 32 ports serial synchronous links at max 9.6 Kbps.
- 16 ports serial synchronous links at 64 Kbps towards the Terminal Interface switch
- Four such terminal interface units for 512 ports switch
- One time slot in each unit for signalling.
- PAD and PDTE connection for ...H MODEM RS232 RS422 option

APPROACH II (cont.)

- X.25 protocol on message switch
- Call processing software on RPCI
- inter exchange connection is through MODEM or PCM high way 64 Kbps / 2M bps.
- Administration software and Maintance software in RPU as on now.

PAD design

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