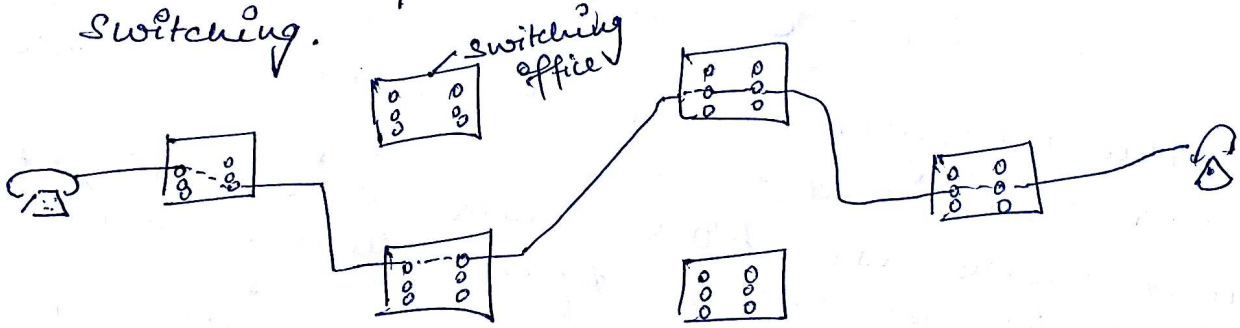
Switching

Many switching techniques are there:-

1) Circuit Switching
2) Message Switching
3) Packet Switching

Circuit Switching

- When we place a telephone call, the switching equipment within the telephone system seeks out a physical path all the way from our telephone to the receiver's telephone. This technique is called circuit switching.



- When a call passes through switching office, a physical connection is established between the line on which the call came in & one of the output lines.
- It requires end-to-end setup, reservation of bandwidth all the way from sender to receiver.
- All packets follow the same path. ∴ they can not arrive out of order.
- If switch goes down all circuits using it are terminated.
- No congestion
- If circuit is reserved for a particular user & it has no traffic then bandwidth is wasted.

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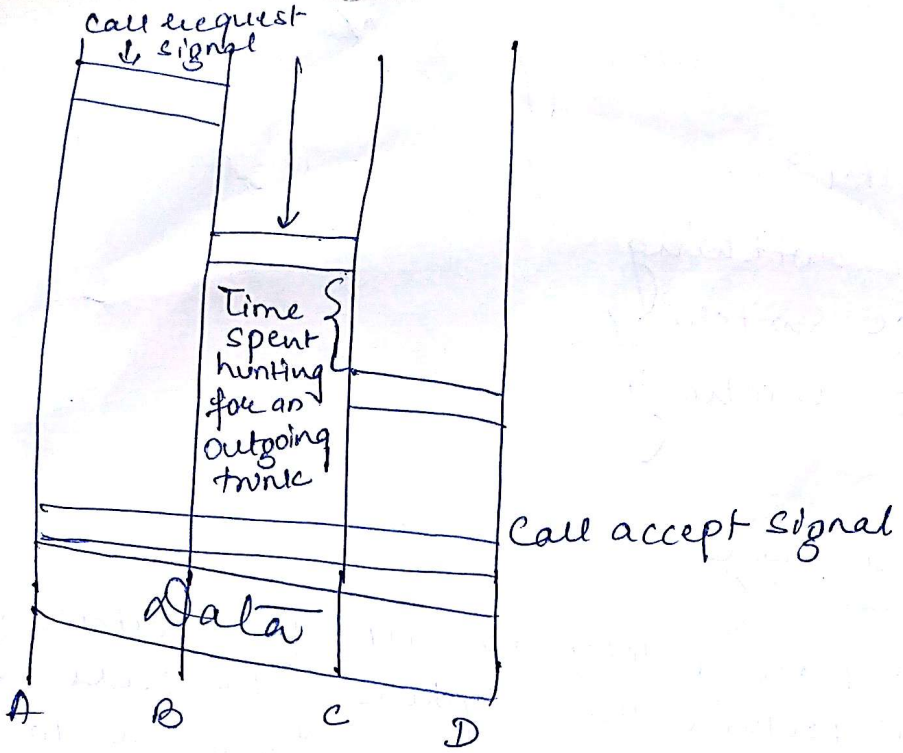
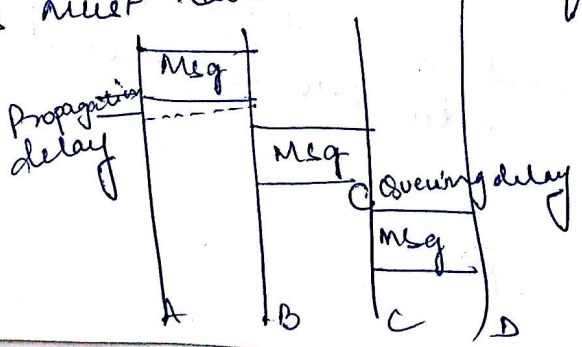


Message Switching

- In this no physical path is established in advance between sender and receiver
- when a sender has a block of data to be sent, it is stored in the first switching office & then forwarded later, one hop at a time
- Each block is received in its entirety, inspected for errors & then retransmitted - A network using this technique is called store and forward network.
- It is obsolete now adays.
- A single block tie-up router line for long time
- Not suitable for interactive traffic.
- No limit on block size
- Routers must have disks to buffers long blocks.



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Packet Switching

- Packet switching networks place a tight upper limit on block size, allowing packets to be buffered in router main memory
- Well suitable for interactive traffic.
- No user can block transmission line for long.
- Reduces delay and increases throughput.
- Computer networks are generally packet switched.
- Different packets follow different paths
- packets may arrive out-of-order.
- packet switching is more fault tolerant. ie packets can be routed around dead switches.
- No bandwidth is reserved.
- packets may have to wait for their turn to be forwarded.
- It doesn't waste bandwidth.

Difference b/w circuit & Packet Switching

Item	circuit	Packet
(1) call setup	Required	Not needed
(2) Dedicated physical path	Yes	No
(3) Each packet follows the same route	Yes	No
(4) Packets arrive in order	Yes	No
(5) Is a switch crash fatal	Yes	No
(6) Bandwidth available	Fixed	Dynamic
(7) time of possible congestion	At setup time	on every packet
(8) Potentially wasted bandwidth	Yes	No
(9) Store and forward trans	No	Yes
(10) Transparency	Yes	No
(11) Charging	Per minute	Per packet

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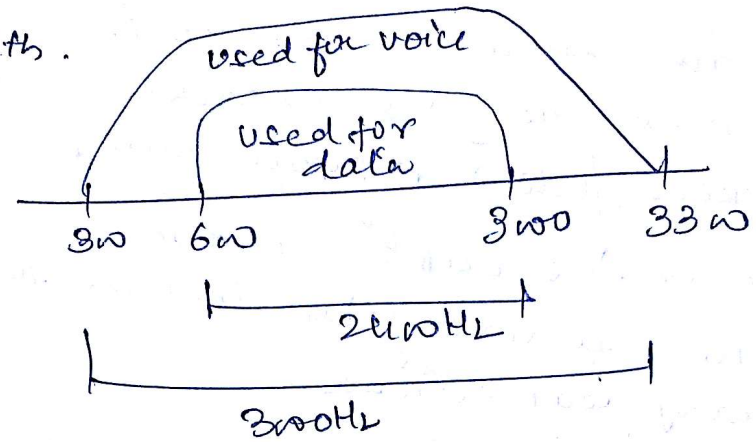
Dial-up Modems

- Telephone lines carry frequency between 300 - 3300
- Bandwidth of telephone lines is 3000 Hz (3300 - 300)
- Edges are not used for safety reasons.
- So signal bandwidth must be smaller than cable bandwidth.



- Modem refers to 2 functional entities
  (a) signal modulator
  (b) " demodulator
- A modulator creates a bandpass analog signal from binary data.
- A demodulator recovers binary data from modulated signal.

Modem Standards

- Most popular modem standards are V-series standards published by ITU-T

(1) V.32 : It uses combined modulation & encoding technique called Trellis coded modulation.
Trellis = QAM + a redundant bit.
Data stream is divided into 4-bit sections.
Value of extra bit is calculated from the values of data bits which is used for error detection.
It uses 32QAM & baud rate = 2400 ∴ datarate = 4×2400 = 9600bps

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(2) V.32bis :- It supports 14400 bps transmission. & uses 128QAM. It provides fall back and fall forward feature that enables the modem to adjust its speed upward or downward depending on the quality of the line or signal.

(3) V.34bis :- data rate is 28,800 bps

(4) V.90 :- Bit rate is 56000 bps. Also called 56K modems. They are asymmetric ie downloading rate is 56 kbps & uploading rate is 33.6 kbps. In downloading stream SNR ratio is higher & of no quantization error. In case of uploading the analog signal is sampled so quantization noise is introduced which reduces data rate.

Digital Subscriber line

- It provides higher speed access to Internet.
- various types are:-
  (i) ADSL (ii) VDSL (iii) HDSL (iv) SDSL

xDSL = {ADSL, VDSL, HDSL, SDSL}

ADSL (Asymmetric DSL)

- Provides higher speed in downstream
- less speed in upstream
- Bandwidth is unevenly divided
- Not suitable for business customers.
- ADSL is an adaptive technology ie its data rate is not fixed; it changes based on the condition and type of local loop cable.

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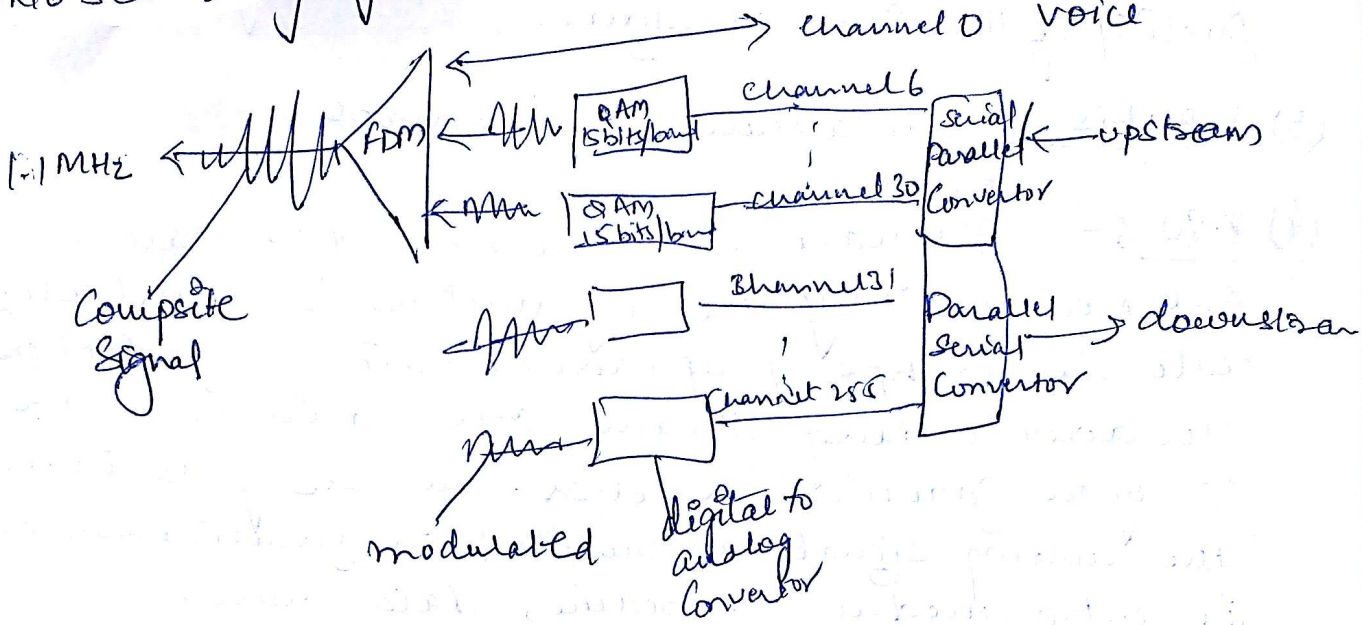
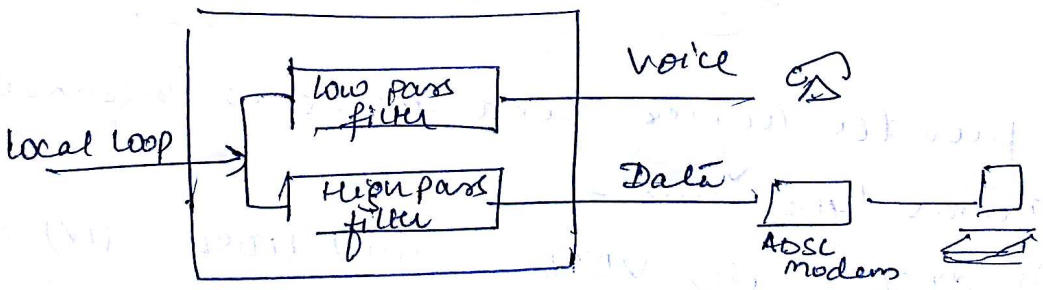
- The modulation technique used in ADSL is DMT (Discrete Multitone Technique)
- DMT = QAM + FDM
- No set way of dividing the bandwidth.



- Channel 1 to 5 are not used.



ADSL at customer site

ADSL Lite

- To avoid separate wiring for data line at customers ADSL lite is used. This technology allows an ADSL lite modem to be plugged directly into a telephone jack & connected to a computer.
- Max downstream rate is 1.5 Mbps & upstream data rate is 512 kbps.

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HDSL

- High bit rate digital subscriber line. It is less susceptible to noise/attenuation. Data rate is 1.544Mbps. without repeaters. It uses 2 twisted pairs (one pair for each direction) to achieve full duplex transmission.

SDSL

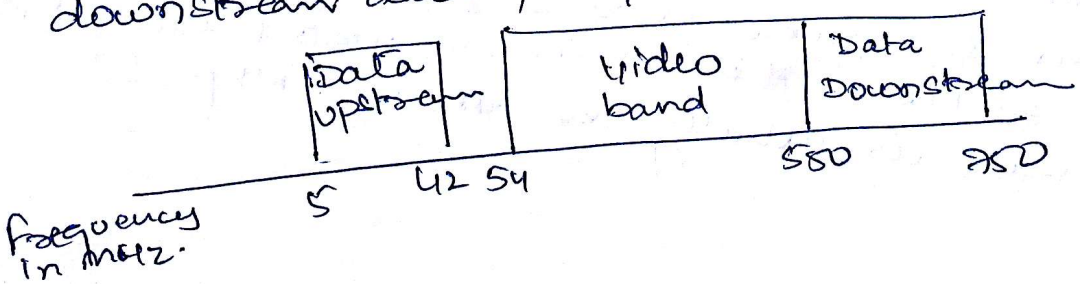
- It is symmetric DSL ie a one twisted pair version of HDSL.
- It provides full duplex symmetric communication ie 768 Kbps in each direction.
- Suitable for residential subscribers.
- Not suitable for business customers that send & receive large volume of data.

VDSL

- Very high bit rate DSL, It uses coaxial, fiber optics or twisted pair for short distances. Modulating technique used is DMT.
- Provides a range of bit rates ie 25 – 55 Mbps for upstream & 3.2 Mbps for downstream.

Cable TV for Data Transfer

- used for high speed data transfer.
- To provide Internet access, the cable company has divided the bandwidth into 3 bands :- video, downstream data & upstream data.



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- Downstream video band occupies 54 to 550 MHz for each TV channel occupies 6 MHz

$$\therefore \begin{array}{r} 550 \\ -\ 54 \\ \hline 496 \end{array} \qquad \frac{496}{6} = 82 \text{ channels.}$$

- Downstream data band

$$750 - 550 = 200$$

$$\frac{200}{6} = 33 \text{ channels.}$$

- Downstream data band are modulated using 64-QAM modulation technique.

64-QAM

$\downarrow$

$2^{(6)}$ i'e 6 bits/baud

- 1 bit: It is used for forward error correction
- 5 bits: of data

1 baud requires 1 Hz

$\therefore$ data rate = 5 bits $\times$ 6 MHz = 30 Mbps.

Upstream data Band

$$42 - 5 = \frac{37 \text{ MHz}}{6} = 6 \text{ MHz}$$

- upstream data band uses lower frequencies which is susceptible to noise & interference $\therefore$ QAM is not suitable. It is modulated using QPSK Data rate is usually less than 12 Mbps.

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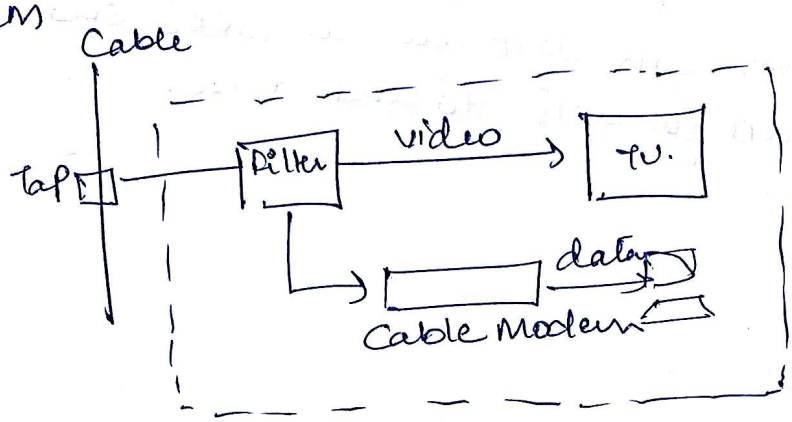
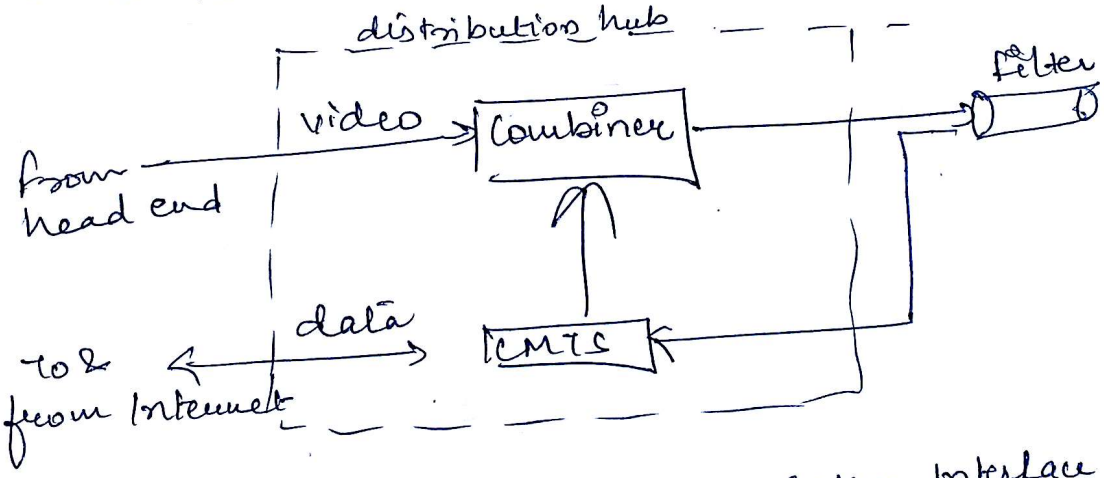
- to use a cable network for data transmission, we need 2 key devices:- a cable modem (CM) and a cable modem transmission system CMTS.
- Cable modem is installed on subscriber premises
- CMTS is installed inside the distribution hub by the cable company
- CM



- CMTS



DOCSIS Data over Cable System Interface Specification

- Steps in upstream communication

① CM checks the downstream channel for a packet sent by CMTS. which asks any new CM to announce itself on upstream channel.

② CMTS sends a packet to CM telling its upstream & downstream channels.

③ CM then starts a process called ranging which determines distance b/w CM & CMTS. This required

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for synchronization b/w CM & CMTS for slots in timestamp

(4) CM sends a packet to ISP, asking for the Internet address.

(5) CM & CMTS then exchange packets to establish security parameters

(6) CM sends its unique identifier to CMTS

(7) Upstream comm can start in allocated channel, CM can contend for slots to send data.

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