TELE HEALTH SYSTEMS

History of Telemedicine and Communication Technologies

Telemedicine definition and history

Definition : The delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation and for the continuing education of healthcare providers, all in the interests of advancing health of individuals and their communities.

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              │  Communication   │
              │   Technology     │
              └────────┬─────────┘
                       ↓
┌──────────┐    ┌──────────────┐    ┌─────────────┐
│ Medical  │ → │ Telemedicine │ ← │ Bio medical │
│ science  │    └──────┬───────┘    │   Engg.     │
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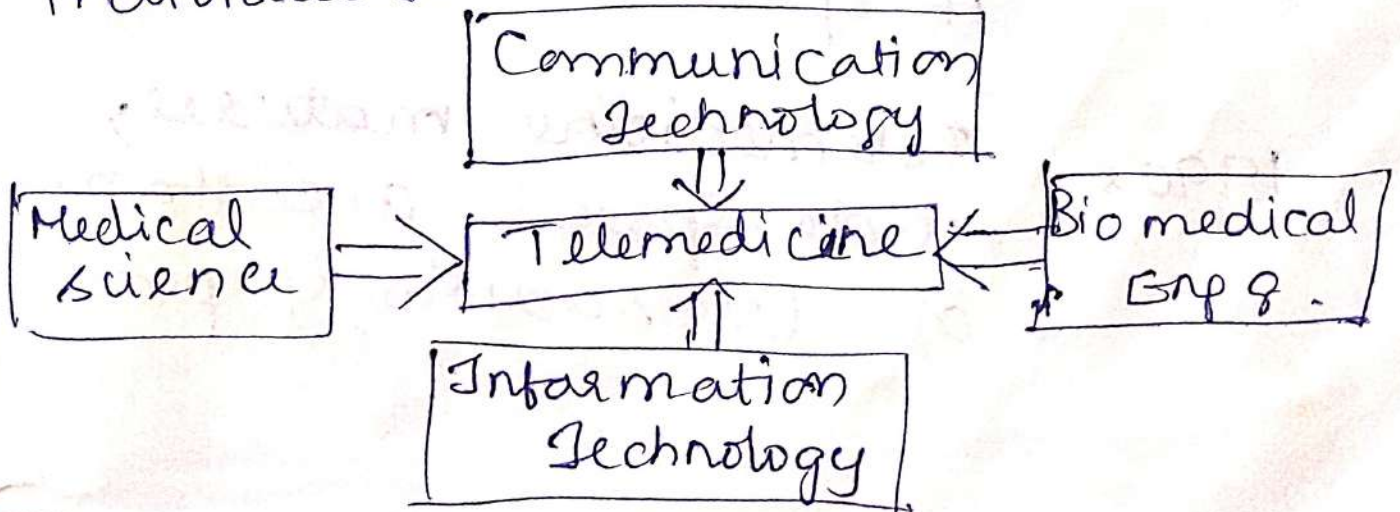
History of Telemedicine

Telemedicine is the remote delivery of healthcare services and clinical information using telecommunications technology.

This includes services using internet, wireless, satellite and telephone media

1905   William Einthoven transfers electrocardiograms electronically.

1960s   First used by NASA to monitor health of astronauts in space.

1990s   Telemedicine matures; wide-spread acceptance of tele radiology practices.

Now : Telemedicine seen as a viable means for improving access, decreasing costs.

Benefits (health care providers)

1) Improved diagnosis and better treatment management
2) Continuing education and training
3) Quick and timely follow up of discharged patients.
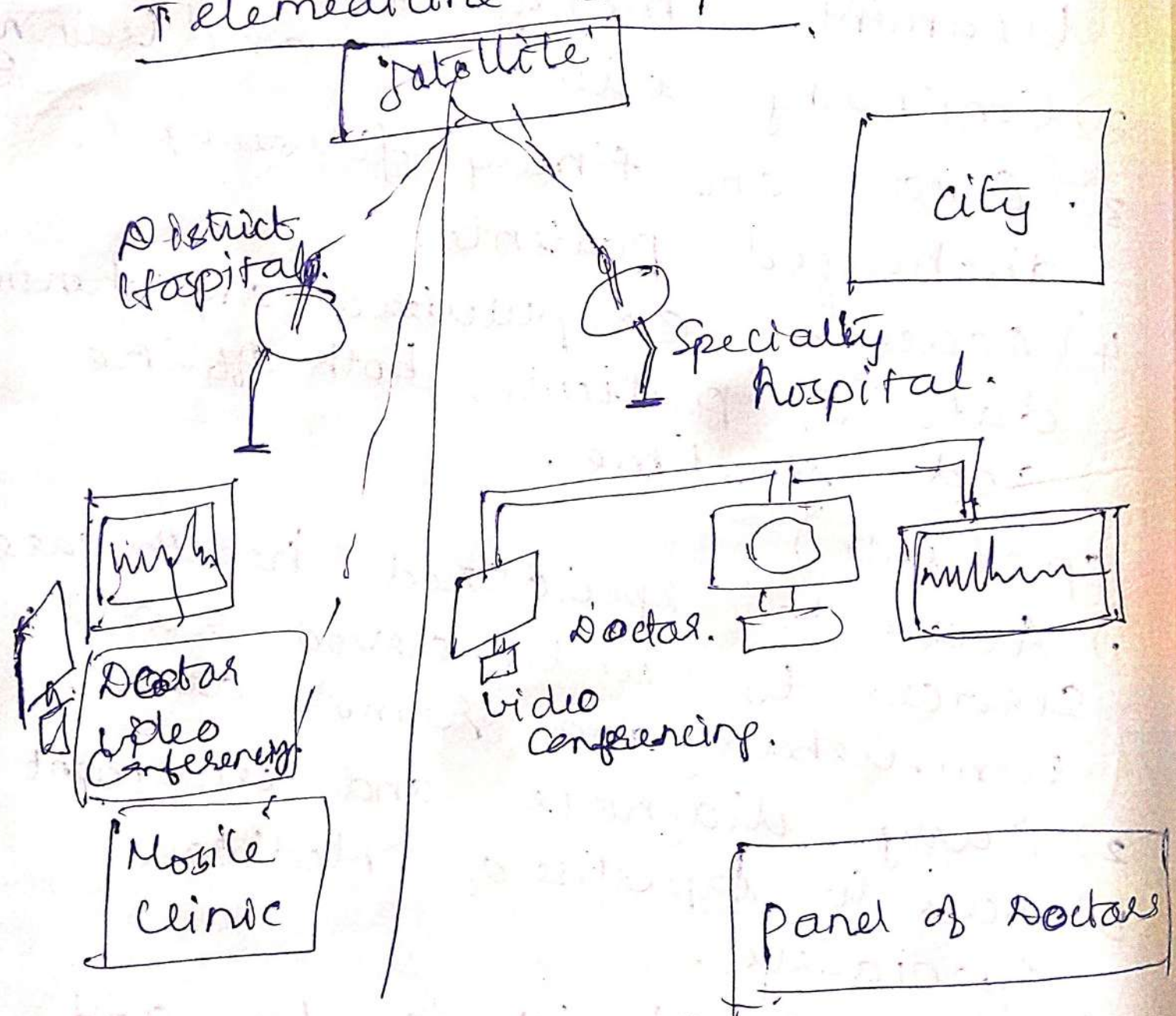4) Access to computerized comprehensive data of patients, both offline and realtime.

(patients)

1) Access to specialized health care services to under-served rural, semi-urban and remote areas.
2) Early diagnosis and treatment.
3) Access to expertise of Medical specialists.
4) Reduced physician's fees and cost of medicine.

5) Reduced visits to speciality hospital
6) Reduced travel expenses
7) Early detection of disease.
8) Reduced burden of morbidity.

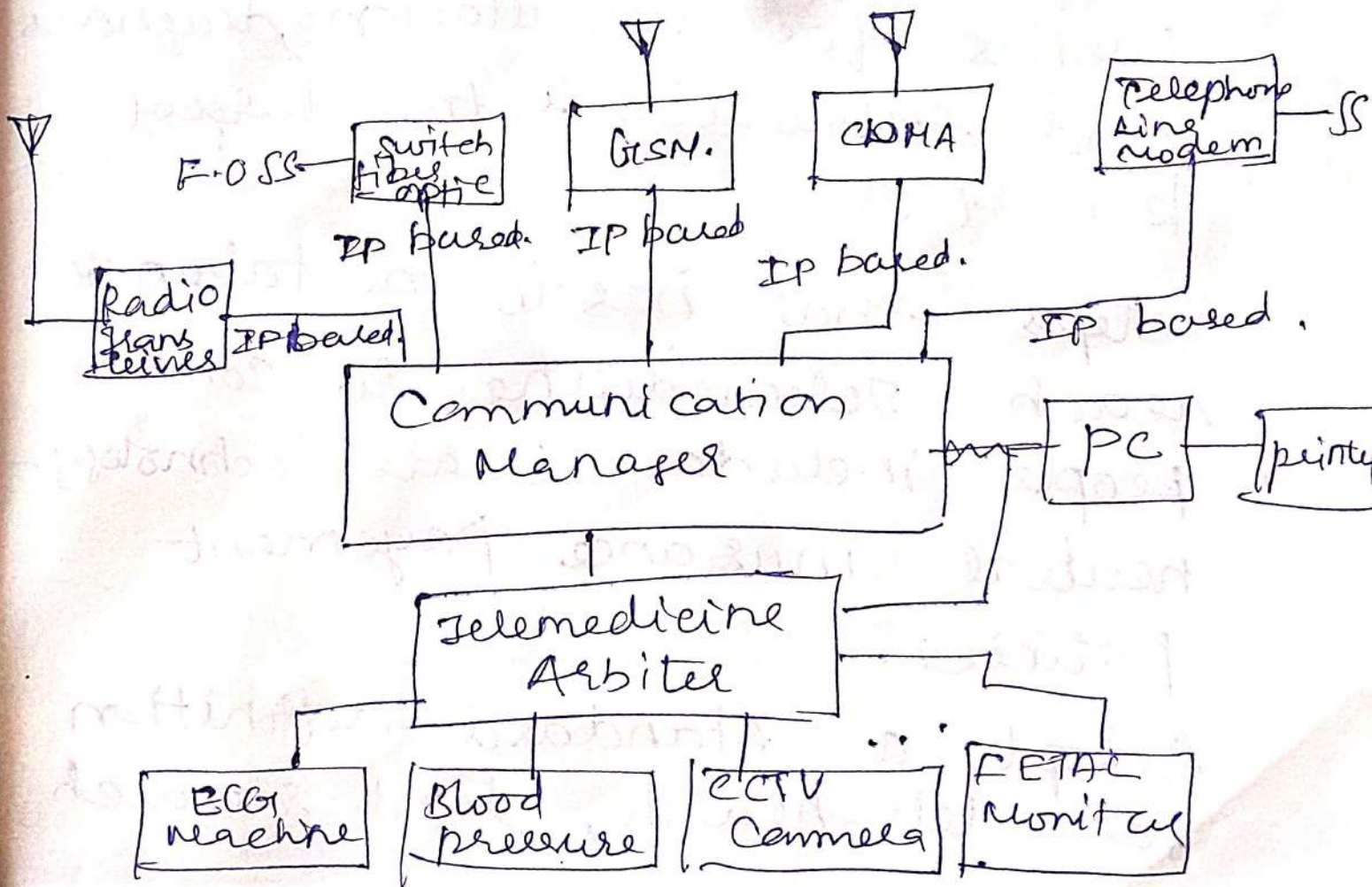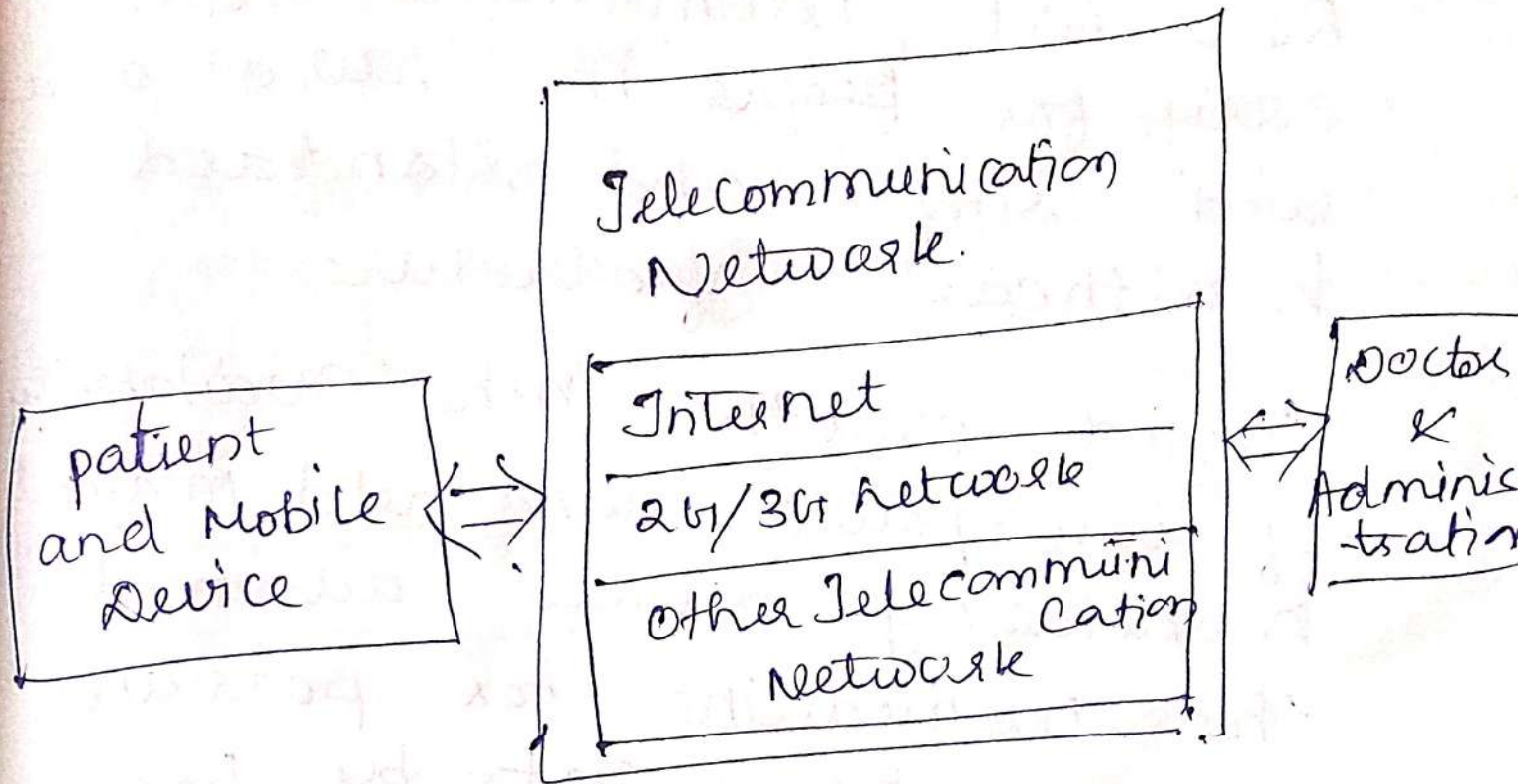(Government)

Telemedicine concept

Satellite

City

District Hospital.

Specialty hospital.

Doctor
Video Conferencing

Doctor.
Video Conferencing.

Mobile Clinic

Panel of Doctors

Block diagram

Block diagram showing patient and Mobile Device connected to Telecommunication Network (Internet, 2G/3G Network, Other Telecommunication Network) and Doctor & Administration. Lower section shows Radio transceivers, Switch Fibre Optic (F.O.S.S), GSM, CDMA, Telephone Line Modem connected via IP based links to Communication Manager, PC, printer, Telemedicine Arbiter, and devices: ECG machine, Blood pressure, CCTV Camera, FETAL Monitor.

Scope and importance of Telemedicine

Low cost Telemedicine made easy for people in rural area with simple and standard healthcare infrastructure

Rapid growth in the availability of low-power, hand-held medical monitoring devices advanced the telemedicine for poor and reduces travel costs by both parties for consultation, diagnosis and follow-up is the largest benifit.
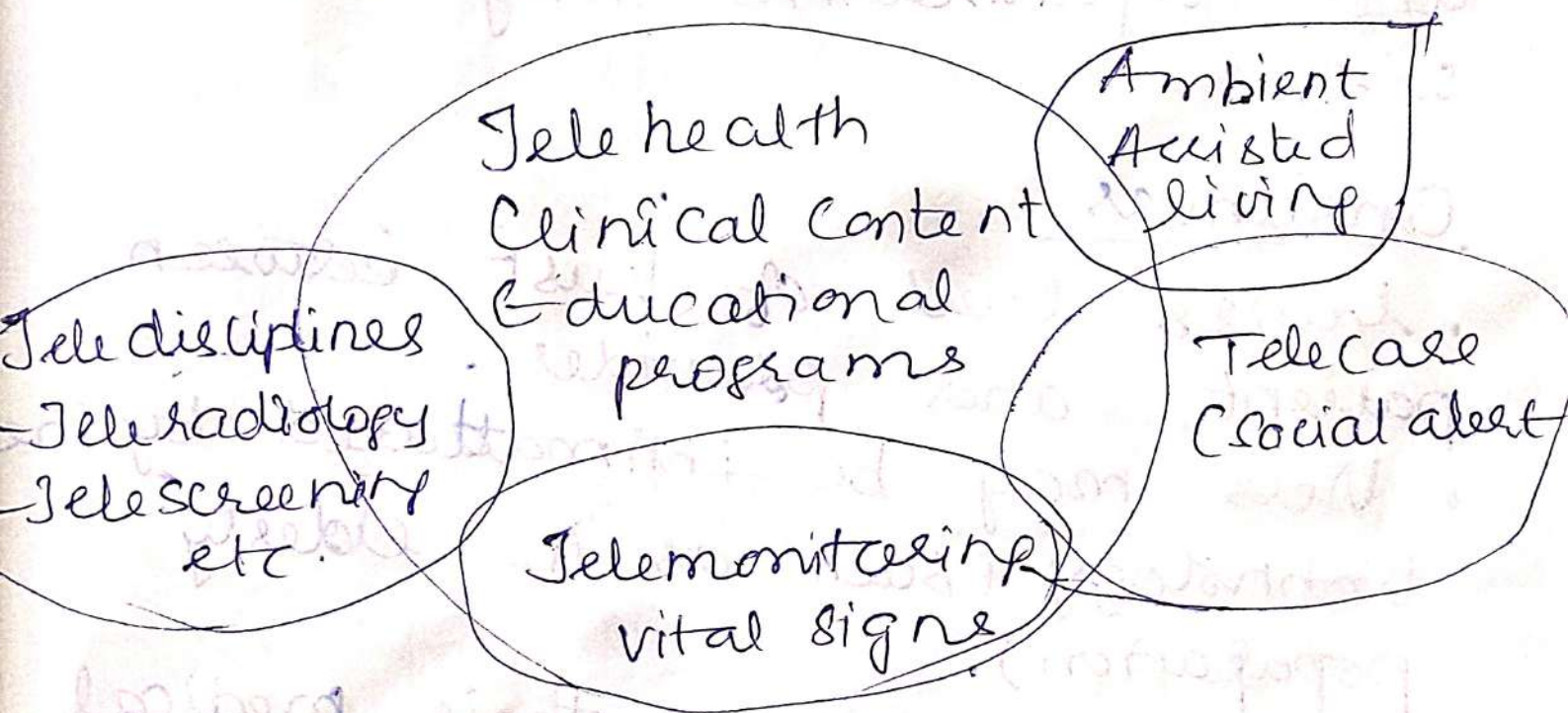
Steps that has to be taken to reach Telemedicine to common people include. Create technology-neutral insurance payement policies.

Adopt a standard-definition for tele-health, Fund research

to continually improve the
quality and lower the cost
of tele-health programs.

E-Health Economics concerned
with issues related to efficiency,
effectiveness, value and behaviour
in the production and consumption
of health and healthcare.

Telehealth
Clinical Content
Educational
programs

Ambient
Assisted
living

Tele disciplines
-Tele radiology
-Telescreening
etc.

Telemonitoring
vital signs

Telecare
(social alert)

Limitations of Telemedicine

While Three of the main limitations for telemedicine is the privacy of medical information, Relationship or lack of a relationship between patient and provider, and the associated liability for the providers and organizations they are affiliated with.

Consumers

- lowers level of trust between patient and provider.
- Users may be intimatdated by the technology (such as the elderly population).
- The uncertainity of their medical consultation and privacy.

Health care organizations

- requires to develop a telemedicine specific policies and procedures

- increased risk of liability.
- limited technological support in rural areas.
- the pace of development and capability of technology will force telehealth 'solutions' upon us.

It is crucial to understand some limitations and potential risks of the technology.

1. Geography :
   Bad outcome and want to file a grievance.
   You might be surprised to know standards haven't been set yet for physicians giving medical advice virtually or across state lines.

2. Malpractice:

3. Standard of care.

4. Deata breaches.
5. Fraud and abuse.

- This area of medicine is already complex, and grows even more complicated by adding the technological effects of telemedicine. for eg. bad audio.

3. ~~Stan~~. No established standard of care.
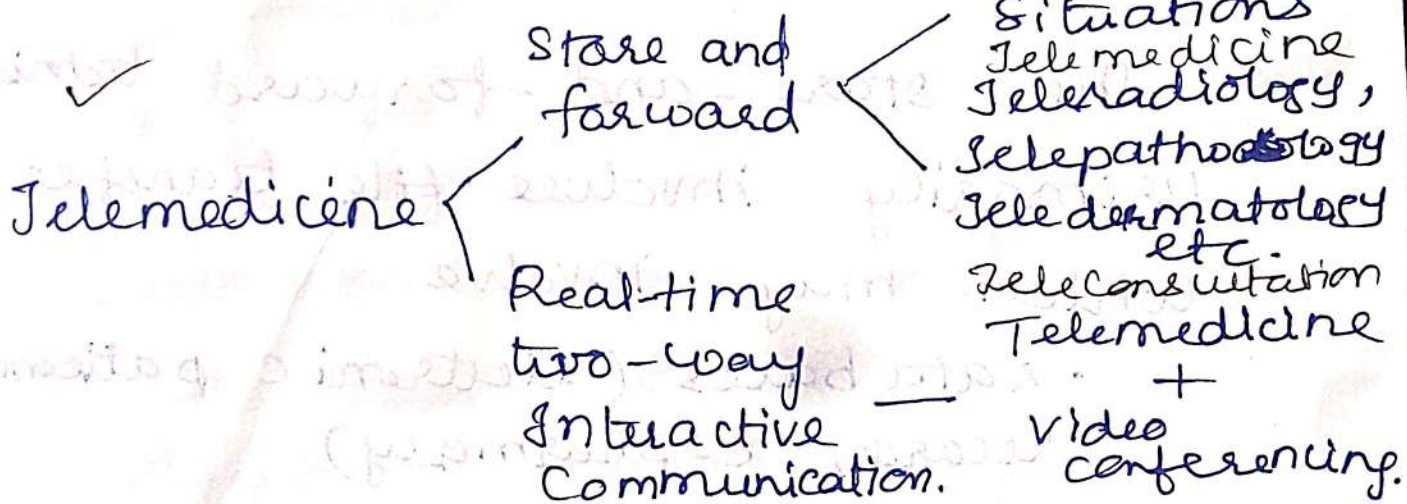
4. Risk of data breach with any internet-based Service.

5. No clear guidelines are set for telemedicine ~~in person~~ ~~evatrations~~

Delivery modes in Telemedicine

Store-and forward Telemedicine

The most common modes of delivery in telemedicine are store-and-forward (asynchronous) and real-time (synchronous).

Telemedicine
- Store and forward — For non-emergency situations Telemedicine Teleradiology, Telepathology Teledermatology etc.
- Real-time two-way Interactive Communication. — Teleconsultation Telemedicine + Video conferencing.

Store-and-forward Telemedicine

* (This technique involves collecting patient data, images and other clinical information and then forwarding it from one location to another location) This is typically used for non-emergent

situations, mostly for second opinion).

✱ Teleradiology ; Sending X-ray images, CT scans MRIs is the most common example of store- and -forward telemedicine technology.

2✱ (The store-and-forward technique primarily involves file transfer which may involve
  • Data bases (electronic patient record, e-pharmacy)
  • Radiology images (pathology, (x-ray, CT, dermatology etc MRI images)
  - Still image applications (pathology, dermatology, etc.)
  • Laboratory Investigations
  • Investigation results in the form of data (ECG, EEG, EMG)

The main applications of store-and-forward telemedicine are teleradiology, teledematology and teleconsultation.

3 * (In teleradiology, once digitised, images from radiographs and patient records are compressed, encrypted and stored in one file that is sent to the specialist centre as an attachment via appropriate telecommunication link.)

(The specialist receives the document and is able to give an instant opinion. ar at his convenience, depending upon the urgency of the case).

(The opinion is transmitted back generally through email ar fax/ telephone). the image for store-and forward.

4 * image for store-and-forward.
5 * The widespread availability of two key technologies has made store- and -forward telemedicine

a practical tool.

(i) The first is email system which allows digital files of all patient data and images to be attached and transmitted with the message.

(ii) Secondly, modern digital cameras have sufficient memory and ample resolution to capture and store clinical images.

6 */ Cost and Convenience are major Considerations in store - and - forward method of data transmission in telemedicine. The convenience is both for the patient as well as the consulting physician)(With the store- and -forward technique, the Consulting physician is able to view data from several patients at his Convenience)

7 * (In addition, the system requires only a personal Computer

or a laptop computer, a consumer grade video camera and Internet access. for its satisfactory operation.

Real-time Telemedicine

1 * (Real-time Telemedicine could be as simple as a telephone call as complex as robotic surgery.)

2 * (It requires the presence of both parties at the same time and a communication link between them that allows a real time interaction to take place)

2 * (physiological data can be transmitted in real-time across a standard telephone or digital network, radio, cellular or satellite phones.)

1 * * An example of real-time telemedicine is the transmission of ECG from the patient's home to a medical centre for diagnosis

of emergency condition and seeking support for delivery of pre-hospital care)

3 *(Telediagnostics is usually a real-time and live dialogue between the specialist and the doctor at the remote site with regard to the diagnosis of the patient's illness)

This is an online system that enables a consultation between the patient, primary care provider and specialist with a two-way interactive television) (The technique primarily uses video conferencing equipment at both locations)

This means that the patient does not have to travel to see

a specialist as live patient image
4* are available to him. (Almost all
specialities of medicine have been
found to be practical for this kind
of consultation)

5* (peripheral devices can also be
attached to the Computers or
the videoconferencing equipment
which can facilitate and assist
in an interactive real-time exami
-nation

(For example, a telestethoscope
allows consulting a remote
physician to hear the patients
heart beat.) on a teleo

6* (The medical specialties which
essentially require realtime
telemedicine include psychiatry
neurology and rehabilitation)

7* (The live picture transfer
includes all examination mater
<which is the output from a vide

pathology, ultrasound, surgery, endoscopies, psychiatry, etc., whereas realtime data transfer may be ECG from ambulances and EEG between hospitals).

Both types - store-and-forward and real-time telemedicine systems have their own advantages and disadvantages.

Video conferencing systems require the simultaneous presence of patient and the consulting physician at the two ends. This can be sometimes difficult to schedule. In addition, 8* (Video conferencing technology requires good video equipment, higher bandwidth, and good technical knowledge and expertise thereby making it a comparitively expensive technology).

In store-and-forward applications, the transmission time is not as important whereas in real-time applications, it is usually critical.

The choice of method between real-time or store-and-forward depends on what information needs to be transmitted, the availability of the appropriate telecommunication resources and the urgency of getting the response from the experts.

* Table 2.3

* Table 2.4.

TABLE 2.3 Feature comparison of store-and-forward (asynchronous) and real-time (synchronous) telemedicine systems (after Helen, 1999)

Parameter	Store-and-forward	Real-time
Virtual "hands-on" examination possible	No	Yes
Patient interactivity	No	Yes
Response time	Delayed	Immediate
Image quality	Higher	Lower
Bandwidth requirement	Lower	Higher
Cost	Lower	Higher
Scheduling requirement	Lower	Higher
Time requirement	Low	High
Convenience	Higher	Lower
Training	Lower	Higher

TABLE 2.4 Purpose and methodology of store-and-forward and real-time telemedicine

Purpose	Store-and-forward	Real-time
Clinical	Patient data and digital images sent via email direct to the specialist for diagnosis and management advice	Videoconferencing used for clinical consultations involving the patient, primary care provider and the specialist
Educational	Educational and training material sent by email in the form of tutorial notes, audio or video resources	Lectures transmitted via video-conferencing to multiple sites simultaneously
Administrative	Administrative information regarding meetings and other associated requirements may be mailed or sent by fax	Audio/video conferencing may be used for interactive discussions between participants

Types of Information (A.C. Norris)

Audio, video, still images, Text and data, and Fax.

• In a face-to-face consultation a physician use some combination of the five senses – sight, sound, touch, smell and taste to assess a patients condition.

In telemedicine, how the sensory data are first converted into electrical impulses for transmission to the remote physician. Touch, Smell and taste senses are still in the experimental stage. Hence, a teleconsultation relies primarily on the two senses of sight and sound.

(useful data)

The information, derived from these senses can be divided

into four types;
- text and data;
- audio;
- still (single) images;
- video (sequential images)

Typical examples of telemedicine
information

Source	type	Typical file size
patient notes	Text	<10kB
Electronic stethoscope	Audio	100kB
Chest X-ray	Still image	1MB
Foetal Ultrasound (30s)	video	100MB

Text and Data

Electronic documents such as reports, correspondence or medical records Containing ASCII or Unicode text and numerical information can be transmitted

Special sound cards that slot into a pc are available for this purpose and once installed no special equipment other than a suitable microphone is needed for teleconsultations.

Under the Windows operating system found on most PCs, audio files are held in a standard WAV format for easy transmission and reception.

Still images (Richard Wodton)

Two major classes of image are important in telemedicine-
~ those of unspecified quality and
— those where the diagnostic needs dictate a particular image quality.

* A low-cost digital cameras now provide very good imaging quality and may be adequate to capture an image of a skin

sion for teledermatology or a view down a microscope for telepathology.

* An inexpensive flatbed scanner can be used to digitize photographs or charts such as electrocardiogram (ECG) traces.

* If the scanner is equipped with the appropriate transparency attachment, then 35 mm slides or Xray films can also be scanned.

• A video camera that is specially designed for imaging documents is an inexpensive method to capture still images.

• Many diagnostic instruments now provide video output, for example Ultrasound scanners.

• A video capture card on a PC and a suitable screen capture program can be used to capture a still image.

• Modern diagnostic imaging devices are often equipped with digital outputs whose ~~cost is~~

provide high quality images.

Standard formats of still images
are : (Olga's book)

1. Analogue, codified in RGB Components

2. Digital Raster Format

JPEG

DICOM 3.X or MEDICOM with PAPYRUS ~~form~~ file format.

FIF (Fractal Image Format):
A format which is based on fractal's theory and that gives up to 200:1 lossy compression ratios.

GIF (Graphic Interchange File)

TIFF (Target Image file format)
" - B , Monochrome.
" - G , Grayscale.
" - P , palette based coding
" - R , RGB coding.
" - TT (Transport Independent (TIFF 6.0 version)

PNG (Portable Network Graphics)
Photo CD (Photo Compact Disk)
BMP   Microsoft windows
           Device Independent Bitmap
                    (DIB) format.

Types of Images for telemedicine
applications
        . Those suitable for _visual_
    perception
        . Those suitable for _computer_
    manipulation
(Norris)
Still image quality is defined by
the _size of a pixel_ in an image
and the _na. of grey or colour_
levels.
        Each pixel is allocated _a fixed_
number of bits to represent its
grey-scale level as _colour-_
usually upto _8 bits_ (or (255)
levels) for _greyscale_ and upto
24 bits (16.77 million levels) for
colour (depth).

when we use maximum no. of bits for a pixel. then the amount of computer memory or disk space needed to store a high-resolution image and the bandwidth and the time taken to transfer it will become high.

Video (Nacrils)

High Quality – higher the cost of the equipment & transmission

(i) Commercial video conferencing units provide the most straightforward solution to the problem of transmitting video pictures for telemedicine. A wide range available.

(ii) Broadcast television – more expensive which will give output of broadcast quality.

(iii) An important consideration for International teleconsultation

is the compatibility of the
analogue video signals, and
therefore the video equipment in
different countries.

formats: (Richard Wootton)

NTSC National television
standards committee adopted
in NA and Japan
525 lines / picture
framate rate of 30 pictures
per second.

PAL The phase Alternating Line
system used throughout
western Europe and Australia
625 lines / picture
25 PPS.

Sequential couleur a memoire
(SECAM) in France, Russia
Most modern television
receivers and video recorders
are able to convert signals
from one standard to another

The Common Intermediate Format (CIF) is a format introduced to provide capatibility between NTSC and PAL and offers a low resolution of 288 lines/pic 30 pps.

Compressing of video signals (R. Wootte

. Commercial video conferencing units all use compression techniques to reduce the quantit of data being transmitted, and therefore communication costs.

. The units at either end must be compatible i-e same compression and decompression algorithms must be employed

. To ensure that equipment from different manufactur are interoperable, international standards have been defined by the International Telecommun- catio

Union (ITU).

- provided that each telemedicine site has a system embracing the proper standards, it is possible to conduct videoconferencing sessions between the pieces of equipment supplied by different manufacturers.

- Equipment that does not adhere to transmission standards should be avoided.

    Camera Central data exchange between pcs.

Video conferencing equipment
    The axis of the equipment is the CODEC (Coder / decoder) which handles the compression of video signals prior to transmission and decompression of the received pictures prior to display.

Rollabout units are widely used (2 Mbits/s transmission).

- portable videoconferencing units in which all the components except display are into a single units.

    Such units along with a diemestic to form a good-quality videoconferencing system.

    Video conferencing functions become available from a plug-in card for PCs. Software CODEC implemented.

ITU protocols

Protocol	purpose
H.320	The oldest of the multimedia communication protocols. defines a video telephone operating on ISDN.
H.324	A newer protocol defining videotelephony for the PSTN, can also be used on ISDN.
H.323	A newer protocol defining videotelephony

for the LANs and the internet

T. 120 A family of protocols to allow computer-supported cooperative working in conjunction with video telephony.

Types of Communication and network (R.S. khandpur)

Telecommunication is a major component of a telemedicine system. Developments in telecommunication technology can be categorised into the following three eras:

First era — 1970s, Applications were dependent on broadcast and television technologies. Telemedicine did not make much use of these technologies.

Second era — Late 1980s. The digital technology led to the development of various communication mediums

Greater bandwidth allows more data to be transferred, which permits the transmitted information to provide a better image and video quality.

Multimedia, which simultaneously uses text, sound, images, colour and motion requires wide bandwidth for storage and transmission of data from one station to another.

Bandwidth may range from about 2000 bps for low end mobiles phones to more than 1000 Mbps when a fibre optic cable is used as a transmission medium.

The minimum n/w bandwidth requirement is dictated by the clinical information to be transmitted over the network. A variety of factors determine the amount of bandwidth required between telemedicine centres. These factors

include the availability of the
existing infrastructure at each
centre and the possibility of
having a communication link
between the centres through
local communication service
providers.

With rapid developments in
telecommunication technologies, the
operational costs of transmission
of telemedicine data has been
steadily falling.

"Advances in the associated
technologies such as data
compression are significantly reduce
transmission times and offer
enhanced capacity for sending
information.

Consultative committee for
International Telegraphy and
Telephony ITU.

Integrated Services Digital Network

- increasing improving Capacity of an analog network, transmission quality and range of services without replacing the n/w.

- Simultaneous transmission of voice, data and signalling using digital Connectivity. End-to-end

- provides higher speed and better quality than analog transmission.

- Access to ISDN service is performed by the use of standard and multipurpose user-to-n/w interfaces.

- Noise, distortion, echoes and cross talk normally present in POTs are virtually absent

- Integrated Services mean that ISDN allows any form of data from voices to faxes, and internet web pages to data files.

Implementation of an ISDN system is governed by a set of protocols that specify the setup and maintanance procedure, scheduling and completion of calls.

- ISDN preferred choice as a telecommunication modality for telemedicine purposes, because of the availability of higher bandwidth in the network.

- ISDN links are presently available between all the major cities in most of the countries.

- The n/w offers better security and good quality services

- For ISDN line, the interface units are available in the form a PC add-on card or as an external stand-alone unit.

Configuration of ISDN lines.

There are two basic types of ISDN services.

BRI - Basic Rate Interface
PRI - primary rate Interface.

B channel – voice & data information,
(Bearer)   64 kbps, 128 kbps is
required optically.

D (data) channel –   signaling & content
information,
16 kbps, or 64 kbps.

BRI :

Comprises two B channels,
64 kbps and one D channel
with a bandwidth 16 kbps.

(2B + D) configuration
total bandwidth – 144 kBps.

Meets the requirements of
individual users.

For telemedicine applications
requiring transmission of video
images, B channels of 64 kbps
to set upto 384 kbps bandwidth.

LT : Line termination
defined as the n/w end
of the line.   n/w Termination.

NT : User end of the n/w.

NT is small connection
box. The function of it is to

convert two lines coming in from the network (U interface) to four lines (S/T interface).

S/T interfaces can provide connections up to Eight terminal equipment, although only two are generally used at any given time.

The terminal equipment may be telephone, fax machine, computer or video conferencing equipment, etc.

BRI service can be accessed by subscribing to an ISDN phone line. However, the subscriber has to be within 5.5km of the telephone company facility. If BRI service is required beyond that, Repeater must be used.

Primary Rate Interface (PRI)

Intended for users Requiring higher bandwidth, and therefore, the PRI Configuration must provide a larger number of channels than the BRI.

Telemedicine system
patient end.

NT

ISDN line.

NT

ISDN line.

S.S.
speacialist end.
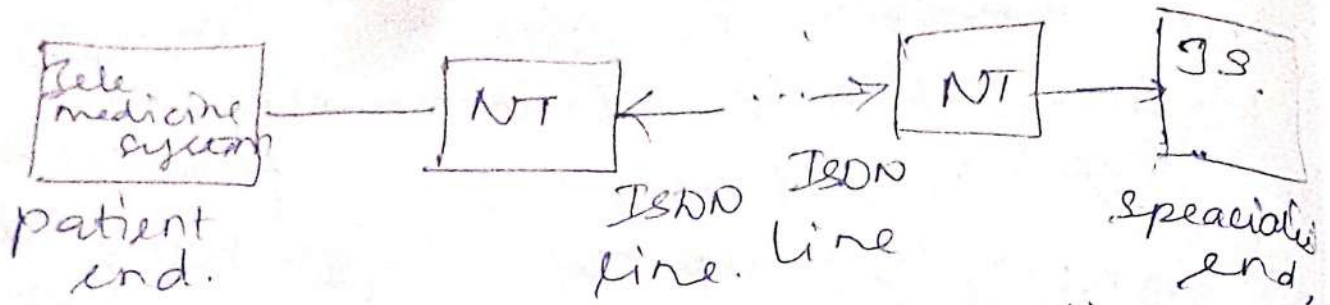
no. of B channel depending upon the necessary bandwidth and a D channel with a bandwidth of 64 kbps.

Two configurations

E1: In Europe and Austalia, a configuration of 32 channels at the speed of 64 kbps has been adapteds and is called E1. this provides a total data rate of 2.048 Mbps. 32 channel configuration includes 2 channels for IP. function. One channel reserved for signalling dwhile the other channel is for controlling.

T1: In NA and Japan a config of 24 digital channels is adopted and is called T1.

128
64
192
64
256

32×64
2048
Mbps

12
193
24

High speed data circuit with 4 wires, 2 of which for transmission 2 receiver

data rate 1.544 Mbps.
100 times faster than pc modem operating at 14.4 kbps.

- T1 Connection can support upto 200 and above users.
- capable of transferring good quality motion images.
- chest X-ray transmission around 40 min over an ISDN line, but but only 4 min over a T1 line.

- T1 and E1 not much different except for the no. of channels defined in their configure. not possible to provide this to individual residences.

- T1/E1 used AMI transmission protocol (Alternate Mark Inversion) which needs transceiver every 1000m from central exchange and every 2000m there after

25
12 2
24×64
536
1544
536
8
=
(1MB)

Advantages of ISDN

Speed: ISDN allows simultaneous operation of multiple digital channels through the conventional phone wiring system used for analog lines but offers a much higher data transfer rate capability. Time taken by an ISDN line to begin communication is typically half that of an analog line.

Multiple devices:

ISDN allows multiple devices to share a single line. It is possible to combine many different digital data services with no noise and interference since digital.

Signalling:

In the analog phone system, a voltage signal is sent for the bell to ring in customer premises whereas in ISDN, it is a digital packet on a seperate channel. It thus does not take any bandwidth

from the data channels and there is no disturbance to the established connection.

The signaling also enables call identification and type of call data voice.

ISDN has been overtaken by broadband Internet service such as ADSL.

Internet as Communication Medium

- We are accessing internet by using a modem and an ordinary telephone network.
- The system is almost universal availability.
- Convenient for everyone to access the desired site on the Internet at any time at any place.
- A clinician can have access to patient data from home through the Internet.
- Internet systems are particularly useful for remote areas where ordinary telephone lines are the only available Communication facilit

- Internet makes use of web servers for storing data which subsequently gets distributed to the users on demand.
- With the Internet, VPN (Virtual Private Network) can be established between two sites which can provide a private and secure connection.

Broadband Service

- A service that provides for high-speed transfer of data, voice and video over the Internet in a reliable manner.
- Broadband speed required for a particular application depends upon technology, geography or location and some other parameters.
- Broadband networks can be accessed through a variety of wired and wireless services.

* Each of them have their own specific and unique advantages in terms of speed,

affordability and reliability.

- Wired ~~and~~ or fixed broadband
  Services available through ADSL
  or Cable, etc. are faster than
  wireless alternatives,
- In certain geographically remote
  and difficult areas ~wireless
  can be the only practical approach.

Benefits of Broadband in Telemedicine

- play tremendously important
  role in health care services.
- If has enabled the Introduction
  and expansion of telemedicine Services
  which in turn can provide a no. of
  life enhancing, and potentially
  life saving benefits.

Expansion of healthcare provisions

- Healthcare services can be extended
  to remote and under-served
  Segments of a country.
- Help in
  ^Overcoming the problem of shortage
  of medical professionals in rural
  and remote areas.

Easier telehome care:

• Telehome care services greatly benefit from the expanding availability and increasing affordability of the broadband.

• Facilitate the establishment of efficient and effective in-home diagnostic, monitoring and treatment services.

• particularly beneficial for senior citizen who can avail more and better care at home.

Better healthcare administration

Broadband services can greatly help in streamlining healthcare administration especially in managing electronic health records, resulting in higher efficiency in back-office operations and consequently leading to substantial cost savings.

Healthcare providers and policy framers have always been

concerned over the rising cost of health care services and the worst sufferers are the patients.

Broadband-enabled telemedicine can offer an effective solution that can help in drastically reducing the costs and improve the quality of healthcare. especially for the population of senior citizens.

1) **Broad band Technologies**

- Fixed line broadband technologies depend upon a direct physical connection between the sites over some kind of terrestrial lines.

- Broadband technologies rely on a cable modem, XDSL (Digital Subscriber line) broadband or power line. for Communication

- Cable modem based broadband service employs available hybrid fibre-Coaxiable cable TV network

- The twisted copper pair generally used by POTS for voice transmission is utilized to carry
- In broadband power line technology the broadband signals are carried over the power lines which are used for supplying power to the subscriber's residence.
- There is an increasing trend to use home broadband for telecare projects to facilitate remote consultations.
- Wireless broadband networks offer advantages of mobility and convenience.
- There is a wide range of frequencies on which wireless broadband technologies operate.
- There is also a choice of making use of licensed or unlicensed frequency band.
- In general, higher frequencies offer several advantages over lower frequencies such as the possibility of getting more spectrum at those frequencies.
- Moreover, smaller antennas are

required at higher frequencies which are comparitively easier to instal.

. Most of the systems requiring high bandwidth generally operati above 10 GHz frequently.

. However, there are serious problems in working at high frequencies as the signals get severely attenuated under poor weather conditions.

. As a result there would be limitations on the distance over which such systems can be used.
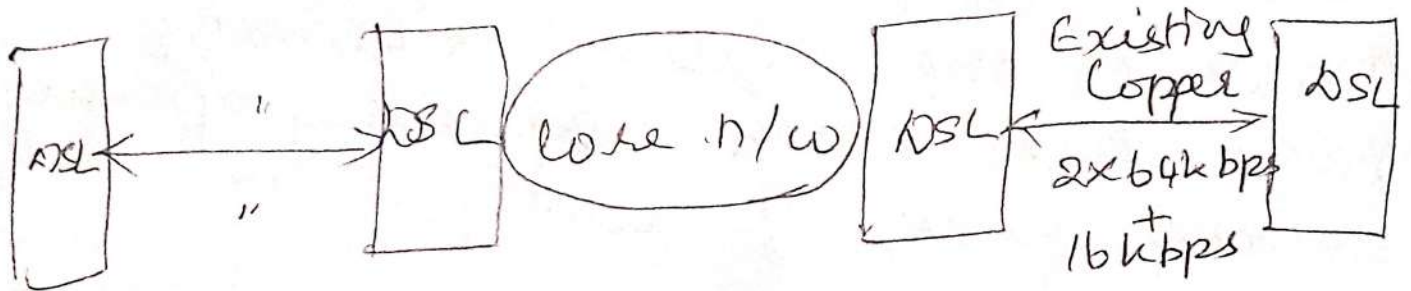
DSL (Digital Subscriber Line)

. DSL Technology, known by the name xDSL, is a broadband service to provide internet connectivity to the users.

. This Technology depends upon the use of existing copper telephone wire which is generally present in most of the places.

. This technology puts a limitation on the length of the facility to be about

5 km from the switch of the telephone company.

Digital Subscriber line modem for computer communication.

- DSL is basically a pair of modems
- The Data is transmitted by the DSL modem over copper lines in both directions simultaneously at the rate of 144 kbps.
- Types of DSL connections, High-bit-Rate Digital subscriber Line (HDSL), Single-line Digital subscriber Line (SDSL) and Asymmetric Digital subscriber Line (ADSL)

ADSL

- Is a popular technology that uses existing twisted-pair

telephone lines for high-speed data communications.

- can transmit upto 6 Mbps to a subscriber and as much as 832 kbps or more in both directions.

- ADSL has transformed the existing public information network which was limited to voice, text and low resolution graphics to a powerful and efficient system bringing multimedia, including full motion video, to subscriber's home.

- This technology has brought movies, television, video catalogs, video-on-demand, corporate LANS and the internet into homes and business premises.

- In ADSL the volume of data flow is greater in one direction than the other. Its operation is, therefore, asymmetric.

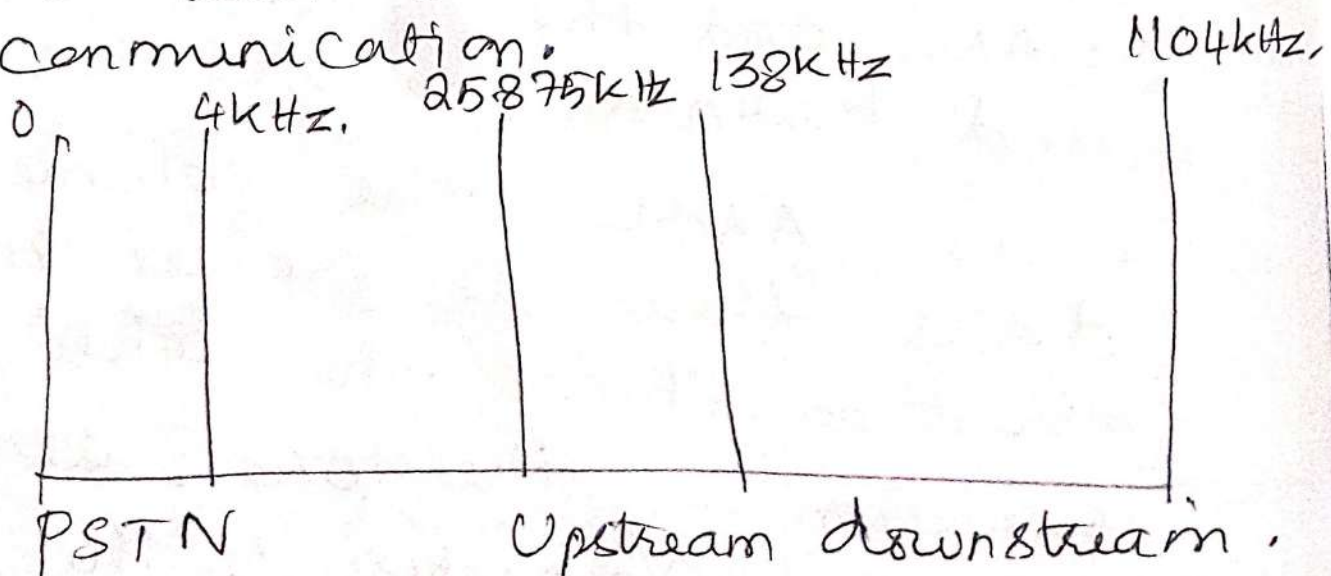- When connected to the internet ADSL enables to use the higher
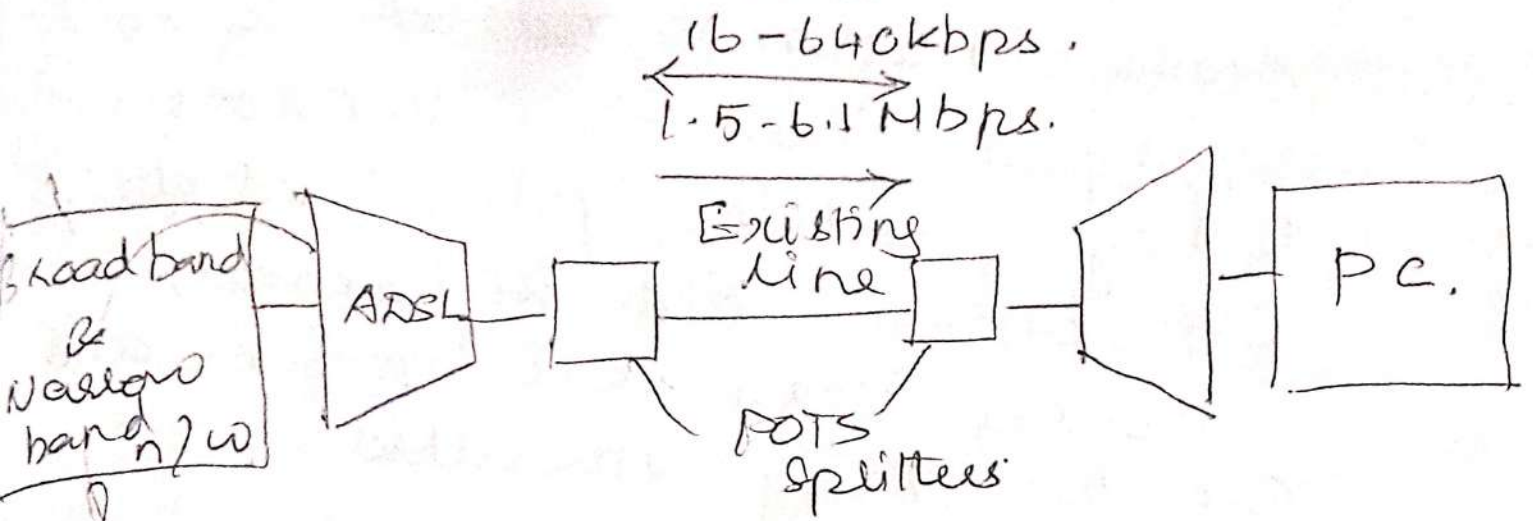
speed direction for the "download" from the internet.

- For ADSL, downstream rates generally start at 256 kbps and typically go upto 8 Mbps within 1.5 km of the central office or remote terminal. Upstream rates start at 64 kbps and typically go upto 256 kbps. They can even go upto 1024 kbps.

- ADSL uses two seperate frequency bands for upstream and downstream communication.

- The band from 25.875 – 138 kHz is used for upstream communication, while 138 – 1104 kHz is used for downstream communication.

0   4kHz.   25875kHz 138kHz   1104kHz.

PSTN   Upstream downstream.

16-640 kbps.

1.5-6.1 Mbps.

Broadband & Narrow band n/w — ADSL — [□] — Existing Line — [□] — P.C.
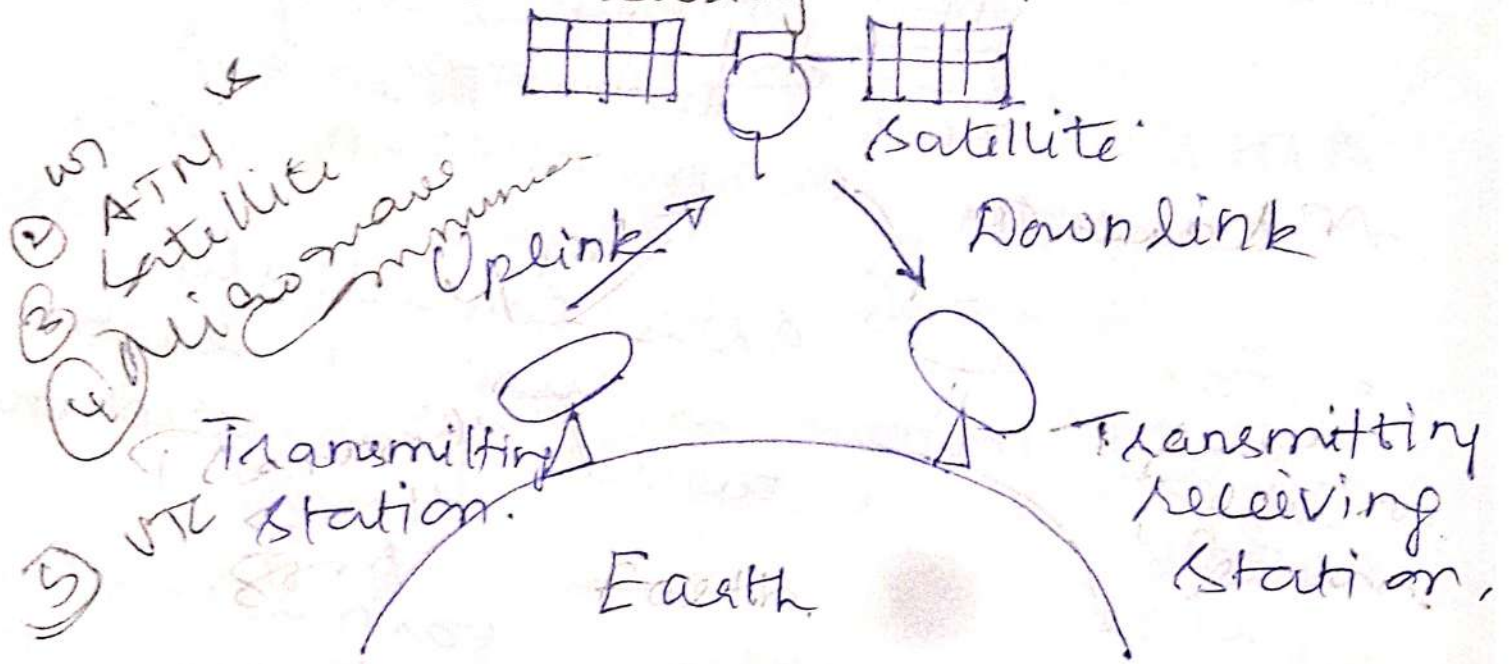
POTS Splitter

ADSL modem technology for computer Communication.
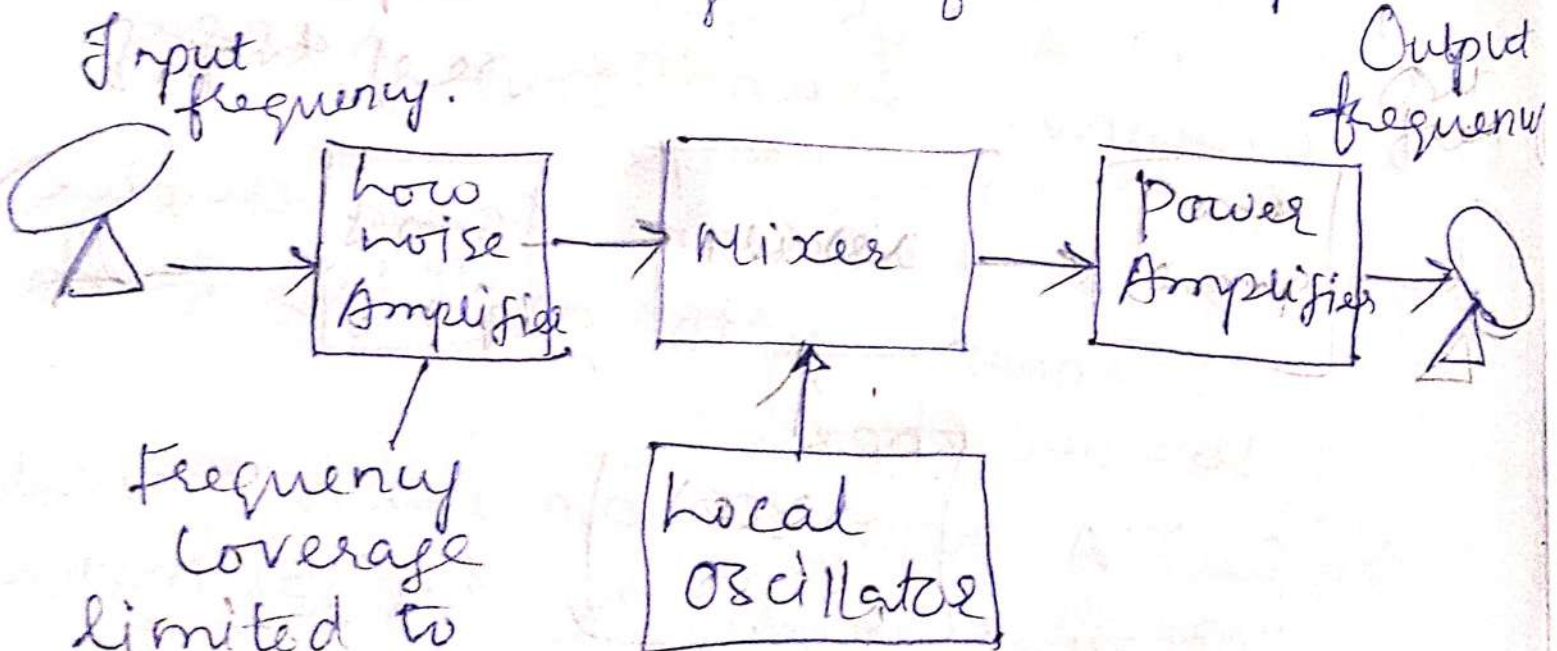
- For an ADSL Connectivity, an ADSL modem is used at each end of a twisted pair telephone line.

- It has three information channels spanning as a

i) A high speed downstream channel spanning a range from 1.5 - 6.1 Mbps.

(ii) A medium speed duplex channel with a range from 16 - 640 kbps.

(iii) A POTS or an ISDN channel obtained from the digital modem by using filters.

• ADSL modem market is so developed that the vendors today provide plug- and play equipment. Size is small, requires very low power and can be easily installed.

① w)
② ATM
③ Satellite
④ Microwave
⑤ VSAT Station

Uplink

Satellite

Downlink

Transmitting Station

Earth

Transmitting receiving Station.

Block diagram of a transponder.

Input frequency.

Output frequency

Low noise Amplifier → Mixer → Power Amplifier →

Frequency coverage limited to band width Required to be received.

Local Oscillator

Bandwidth

- The minimum network bandwidth requirement is dictated by the clinical information to be transmitted over the network.

- A variety of factors determine the amount of bandwidth required between telemedicine centers. These include the availability of the existing infrastructure at each center and possibility of having a communication link between centers through local communication service providers.

- With rapid developments, the operational costs of transmission of telemedicine data has been steadily falling.

- Advances in associated technologies such as data compression significantly reduce transmission times and offer enhanced capacity for sending information.

- The information carrying capacity of different telecommunication technologies is important because it affects the availability, quality and affordability of information in a telemedicine system.
- Important requirements of a telecommunication technology in relation to telemedicine are:
  - Audio : Sound fidelity
  - Still images : Image resolution
  - Video images :Completeness and quality of motion depicted
  - Amount of information transmitted in a given time: Transmission speed

Types of telecommunication Technologies

- P lain Old Telephone Service (POTS)
  - It is the low end of the spectrum and includes a voice by phone or radio.
  - Easy and cheap, it is generally sufficient for 30-40 percent of teleconsultations.
  - For telemedicine purposes line modems are required to provide digital communication interface between two points using telephone lines.
  - With POTS digital signals can be transmitted at data rates upto about 56Kbps.
  - This service is adequate for still images and hence for applications such as teledermatology and telepathology.
  - They can also be effectively employed for transmission of compressed images in teleradiology applications from digital modalities such as CT, ultrasound, MRI etc.

- Images from plain films can also be sent when compressed by enhanced JPEG and wavelet methods.
- POTS network is not suitable for real-time 30 frames per second video, even at very poor resolution.
- They cannot be used for PACS and uncompressed teleradiology applications due to their inability to handle large sized files
- POTS network has filters which put a limit on the banwidth to approximately 3.3KHz to make it more suitable for voice related applications.
- If there were no such filters , the same copper wires have the capacity to pass frequencies upto to MHz regions.

ASYNCHRONOUS TRANSFER MODE

- Increasing applications of multimedia data and their transmission.
- ATM – Universally preferred for Broadband Integrated Services Digital Network (BISDN).
- ATM has capability and capacity to handle multimedia data.
- ATM has good bandwidth flexibility.
- ATM is an ITU-T standard (International Telecommunication Union-Telecommunication standardization sector standard.
- ATM provide high speed data transmission due to the transmission of data as fixed sized cells with error correction protocols.

- "Asynchronous" refers to capacity of ATM to change bit rates and traffic patterns in accordance with the demand.

- "Transfer mode" refers to the multiplexing capabilities in transmission and switching multiple types of network traffic.

- ATM provides fast and reliable access to web-based applications and real-time transmission of multimedia content, hence preferred for telemedicine applications.

- ATM facilitates Virtual reality applications (VR)as may be required in telesurgery applications.

- ATM transmission has the advantage of operating at the rate of gigabits per second along with fiber optic cables.

- In spite of the several advantages of ATM, its use is not very common at the user level.

- The ATM network cost is very high that it tends to be prohibitive for most telemedicine applications.

- ATM networks hence have found only a few telemedicine applications directly.

SATELLITE COMMUNICATION

- Satellite technology has been widely used for implementing telemedicine projects to remote and isolated areas that lack terrestrial communication facility.
- It provides high bandwidth connectivity in shortest possible time.
- What are satellites?
- Height of the satellite above earth overcomes the problem of curvature of the earth's surface for communication over long distances.
- Telecommunication satellites uses: point-to-point telecommunication, mobile communication, direct broadcast which include relaying telephone calls and television signals.
- These facilities are of great significance for practice of telemedicine.

- Mostly used to implement telemedicine projects relating to mobile situations such as military units or ships in oceans.
- If the cost of satellite transmission reduce in future, they may become competitive with ISDN.
- A satellite functions as a repeater- uplinking and downlinking at different frequencies.
- Transponders in the satellite perform the function of receiver, frequency changer and transmitter.
- Need of filter?
- The signals are delivered by the carrier waves which are modulated by amplitude frequency or other methods.

- Transmitted signals are usually multiplexed.

- Several satellites operating on different bands are used to meet the enormous transmission requirements. Different satellites are distinguished by the beam width of the antenna.

- Satellites for Communication operates in the geo stationary orbits (36000Km above earth surface). Geostationary satellites?

- IUT guidelines- has to be separation of 2 degrees between two satellites. 180 satellites can operate at time in GSO.

- The satellite body is designed to carry a no of transponders or repeaters which determine the capacity of the satellite.
- INSAT series of satellites have typically 12/18 transponders in various frequency bands. Typical bandwidth of a transponder is 40 MHz.

Frequency band	Uplink(GHz)	Downlink(GHz)
C band	5.925 to 6.425	3.7 to 4.2
Extended C band	6.725 to 7.025	4.5 to 4.8
Ku band	14 to 14.5	10.95 to 11.7

- Internationally Ku Band popular and widely used, can support traffic with smaller antenna size compared to other frequency bands but susceptible to rain outages.

Worldwide Interoperability for Microwave access WiMAX

- A wireless broadband technology that delivers Wi-Fi type connectivity over a much higher operating range.

- A point-to-multipoint last-mile broadband wireless solution.

- WiM1ax name created by WiMAX forum which describes it as a standards based technology, an alternative to cable and DSL.

- Two types: LOS (Line – of - sight)and NLOS system.

- WiMAX is based on IEEE 802.16 standard.

- Objective is to improve the delivery capacity up to 75 Mbps/channel for fixed and portable applications in a typical cell radius of 3-9km.

- For mobile networks 15Mbps within a typical cell radius of upto 3km.

- A good choice for telemedicine providers in both fixed and mobile environments.

- Wi-Fi covers moderate to high speed data communication in a short range whereas WiMAX provide access over long range in outdoor environment.

Global System For Mobile Communication (GSM)

- Wide area second generation wireless standard
- Uses digital radio transmission to provide cellular communication.
- GSM is the name of a standardization group established in the year 1982.
- Most widely used cellular technology and has wide international coverage.
- Uses 200kHz RF channels which are time division multiplexed.
- GSM digitizes and compresses data.

- Privacy is assured by ciphering of the digitally encode speech.
- Its frequency bands are 900MHz, 1800MHz, and 1900MHz.
- Data rates upto 9.6kbps.
- Good speech quality, low cost, good spectral efficiency and international roaming.
- Specify the functions and interface requirements and not the hardware.
- Equipments from different vendors could be used.
- Subscriber Identity Module(SIM) can be used in any handsets.

Steps involved in video conferencing

i) Session at sending end:

Audio/video facilities, peripheral medical devices consulting physician and the patient.

ii) Codec process:

A device that codes and decodes the analog signals to and from the digital format. This process is needed so that images can travel in a digital format during transmission.

iii) Transmission of data:

ISDN lines,
coaxial lines,
satellite,
microwave/broadband
internet.

iv) Reconstruction of data:

A compatible codec on the other end to decode the video and other data for viewing.

(v) Session at receiving end :
Audio/video facilities for
interactive discussion and
actions .

ITU have formulated

H.320, H.323 and H.324 Umbrella
standards for videoconferencing
Systems .

H.323 IP VTC has become
more popular since it is
accessible to anyone with a
high speed Internet connection
such as DSL.

These technologies enable the
users to setup realtime
multimedia exchange facility
and have live interactions,
Collaborations and presentations
which are essential requirement
of a telemedicine system.

Basic Components of a video conferencing system

Requirements of a video conferencing terminal are:

Video input devices : webcam or video camera

Video output devices : computer monitor, Television or a projector.

Audio input devices : projection microphones.

" output " : Speakers.

Data transfer : Analog/digital telephone network, LAN or internet

. The quality, reliability and user-friendliness of the VTC depends on each of these components.

. Digital camera

A digital camera has a series of lenses to create an image of a scene or object.

- A sensor which is basically a semiconductor device records light electronically and converts into digital data.
- Image sensor an important component of the camera is characterised by the no. of pixels or dots that it can distinguish in an image, commonly called resolution.
- When a picture is to be taken, the shutter opens briefly and each pixel on the image sensor records the brightness of the light that falls on it by accumulating an electric charge.
- The more the light hitting the pixel, the higher the charge it would record.
- After the shutter closes, the charge from each pixel is measured and converted into a digital number.
- This series of numbers is then used to reconstruct the image by setting colour

and brightness of matching pixels on the screen.

- snapshots the view at 25/30 times/second.

640 × 480   web camera/CMOS sensor

720 × 480   NTSC.

720 × 576   PAL.

3 Megapixel - enough resolution.

CMOS / CCD sensor.

cheaper costly.

pan - tilt - zoom (PTZ) camera

- quality of camera decides quality of video.

- Features which determine the quality of image are:

i) wide angle vs narrow angle lens

ii) Manual focus vs auto-focus.

iii) Manual iris vs auto-iris.

iv) Auto_tracking.

v) Remote Control.

Video Sources commonly used in VTC systems are:

i) A CD or DVD player for sending pre-recorded video or multimedia information.

ii) Speciality cameras such as those integrated with microscopes or internal imaging systems.

iii) A document camera, for imaging documents, objects etc.,

iv) Document scanners.

A video mixer: Takes input from multiple devices, mixes it together and gives output as a single video stream. (IIIsurgery)

A typical for VTC system for telemedicine purposes may have the following cameras:

i) patient camera:

Skin, review of X-ray, Evaluation of motor skills,

camera is mounted on a tripod to obtain an optimal image. Three-chip CCD camera gives high quality pictures.

ii) Room camera: To obtain room view

iii) Document camera: To digitise ECG's, fingerprints, medications, CT scans, lab reports etc.

iv) Micro camera: A fibre optic camera which can be used with a variety of medical peripherals.

• voiced activated camera control system which automatically directs the camera towards the person who is speaking at a particular moment.

• Such systems will even zoom out when two people are in a dialogue at the conference table.

Unit-II

Medical data security

ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE

CONFIDENTIALITY, PATIENT RIGHTS AND CONSENT

- The guiding principle behind this legal perspective is the concept that information is to be held confidential if its release has the potential to injure a person either emotionally or materially.

- Irrespective of their legal system, most democratic countries now base their modern practice of patient confidentiality on the following three guidelines:

  – There exists a basic right of patients to privacy of their medical information and records.

  – Patients privacy should be observed unless waived in a meaningful way.

-Information disclosed should be limited to that information or portion of the medical record needed to fulfill the immediate and specific purpose.

- The legal force of these and additional guidelines may differ not only form country to country but also from state to state in federal nations like USA.

- Telemedicine creates special problems due to the involvement of non-clinical personnel in teleconsultations.

Videoconferencing system and multimedia data exchange

- Videoconferencing or Video Teleconferencing(VTC) system is a set of interactive telecommunication technologies which enable two or more locations to interact via two-way video and audio transmissions simultaneously.

- This is achieved through the use of cameras which capture, display monitors which display the received video, microphones to capture audio and speakers to play received audio along with the networking technology which carry out transmission and reception of data.

- Several models of video conferencing systems are commercially available.

- Videoconferencing technology revolves around three areas: Terminal equipment, data transfer systems and standards.

- Videoconferencing system based on PC, software data compression and broadband internet connectivity have become affordable at a reasonable cost.

- Continuous improvements in quality coupled with falling prices will make VTC an essential part of telemedicine.

- Any medical device that produces a digital signal can be used with VTC systems.

- These peripherals enable the specialist to examine the patient from a remote place.

- Electronic stethoscope, Ottoscope, general examination camera, dermascope, etc.,

- ECG tracings and video endoscopes can be used in conjunction with VTC equipment to transmit all types of digitized data about the patient.

- The analog video output from the echo-cardiograph machine can be directly connected to the videoconferencing equipment.

- The data transfer rate should be greater than 512kbps.

- Greater opportunities for value addition of continuing education programme using VTC technology.

Video Display

Two types of display devices: projectors, flat screens

Projectors: large view, large audience, cost less than flat screen display. There are problems of glare from windows and overhead lighting.

Flat screen LCD or plasma display: Can operate in varied light conditions, the effect of ambient light on image quality is insignificant. The viewers should be at a distance between 2 to 6 times the diagonal size of the screen. Displays with HD(high definition) are common now.

- In many cases, dual monitors are used.
  - One to display the incoming video.
  - Other for call control and data sharing related to the application.
- A video recorder should be included in the system for recording incoming video.

Types of connections which are used to connect the video images from the codec to the display determine the quality of the image are:

Composite video

- A composite video signal is the most commonly used analog video interface.
- Also referred as CVBS, which means color video blanking and sync or composite video baseband signal.
- It combines the brightness information, the color information and the synchronizing signals on just one cable. Has low video resolution(300+ lines on monitor screen)
- Yellow-video signal, Red and white – stereo audio signal.

- S-Video: Super-Video technology
- Video signals are transmitted over a cable by dividing video information into two separate signals: one for color and the other for brightness.
- Provides sharper images than composite video, as it provides higher resolution, usually 500 lines.
- S-video cable consists of 4 pins. Two GND pins, one for color and other for intensity.

Component video:

- Split the color information into three ways.
- It consists of luminance, Red- luminance, and Blue-luminance.
- Sync pulses for both horizontal and vertical are delivered on the Y-channel.
- Five cables: 3 for video and 2 for stereo audio.
- Higher resolution at 2000 lines.
- Mainly used for HDTV and DVD players.

HDMI (High-Definition Multimedia Interface)

- It is a Digital video/audio signal format which is more and more widely used.

- Video data together with embedded audio at extremely high bitrates

- Transmits uncompressed video/audio in digital form.

- High resolution video and high quality audio sound.

RGB format:

- Computer monitors are designed for RGB signals. Most digital video devices, such as digital cameras produce video in RGB format.

- They look better in computer monitor. When output on a television, they look better in S-video format than in composite format.

- Video frame rate common values are 1, 30, 60. VTC generally uses 30fps and 384 kbps bandwidth. Some brands use 60fps and 512kbps. This gives near TV broadcast quality pictures.

Audio components

- An important component in VTC system.

- Necessary characteristics for full duplex transmission are echo cancellation, noise suppression and audio mixing.

- They are influenced by the location, size and quality of microphones and speakers

- Loopback test commands available in VTC systems.

Audio mixers

- Multiple sounds combined into one or more channels, allows to adjust volume and tone (timbre)

- Three types: Analog mixers, digital mixers and powered mixers.

Microphones

- A transducer which convert acoustic energy into electrical signal.
- Several varieties available: based on physical design, size, shape and mounting method.
- Frequencies of audio signals are limited to 7KHz in VTC systems.
- Preferred types of microphones for VTC systems :

Personal video conferencing: headworn type and lapel type.

- Lapel type: mic fixed to clothings, headworn type attached to headgear.
- They isolate incoming and outgoing signal thereby eliminate echo or reverberation effect.

Room VTC systems:

- High quality omni-directional microphone is mostly preferred.

- They are flat in shape.

- They cover sound around a large flat surface like conference table.

- Several smaller directional microphones can be placed throughout the room.

- Wireless would eliminate cables running across and offer mobility.

Network Considerations For The Video Conferencing Systems

- VTC systems have been in existence since the introduction of the television technology.

- With the introduction of ISDN during 1980s, at a minimum assured bitrate of 128 kbps provide acceptable quality of video. But require highly expensive equipment, software and networks.

- Standards-based technology for use by general public at a reasonable cost available by 1990s.

- VTC systems depends to a large extent on bandwidth and data rates used for transmission.

Data security in Telemedicine systems

Points at which the data could be at risk include:

- Data capture stage : Wrongly identified participants in the telemedicine process, Lack of control to data access.

- Communication stage : Cross-talk on point-to point links, involvement of intermediaries such as internet browsers, problems in data management in store-and-forward mode of telemedicine.

- Data review and storage stage : Long term electronic and physical files (disc, tape, paper), Incidental information (cache memory, printouts).

Typical security risks when working with internet:

- Hacking: Refers to all activities that exploit weaknesses in software and computer systems. Intent may be to steal or alter data.

- Malware: A piece of software developed with the specific intention of attacking a computer. Include software like viruses, worms and Trojans.

- Phisher: Phishing is an attempt to play fraud on email to gain unauthorised access to secured information contained therein. This is done to target a specific group of people or an organisation.

- Spam: An Unsolicited advertising materials that are put on the internet. Result in wasting network resources such as bandwidth and storage space in mailbox with junk.

- Security is a fundamental requirement for telemedicine applications.
- Security strategies are designed to safeguard the privacy, authenticate, authorise, and maintain integrity of the data transmitted and received in a telemedicine system.
- Security elements include storage security, network security and data encryption.
- Security assessment in a telemedicine setup involves evaluation of as to who has been authorised for access to the system. This should include all the elements of the system such as computer terminals, servers, communication equipment, videoconferencing and network switching devices.

- In secure telemedicine system, it is necessary to establish the identity of the user by employing an authentication mechanism.

- The telemedicine system must then determine the rights of the user provided in the user profile.

- Based on this information, the user has to work with data under defined roles, e.g., create, add, view data etc., based on the identity of the user and the roles the user have.

- Health care information systems managers often face a challenge to ensure that there is easy and secure access to the data.

Components affecting the secure healthcare systems are as follows:

- Confidentiality :Applies not only to the transmitted data but also to data held by devices and that the information is made available only to those who are authorised.

- Authentication: Involves all parties in the telemedicine process to provide a means of proving their identity before they can get access to the system. The medical professional is validated before allowing access to patient data by using passwords, tokens, digital certificates or biometrics.
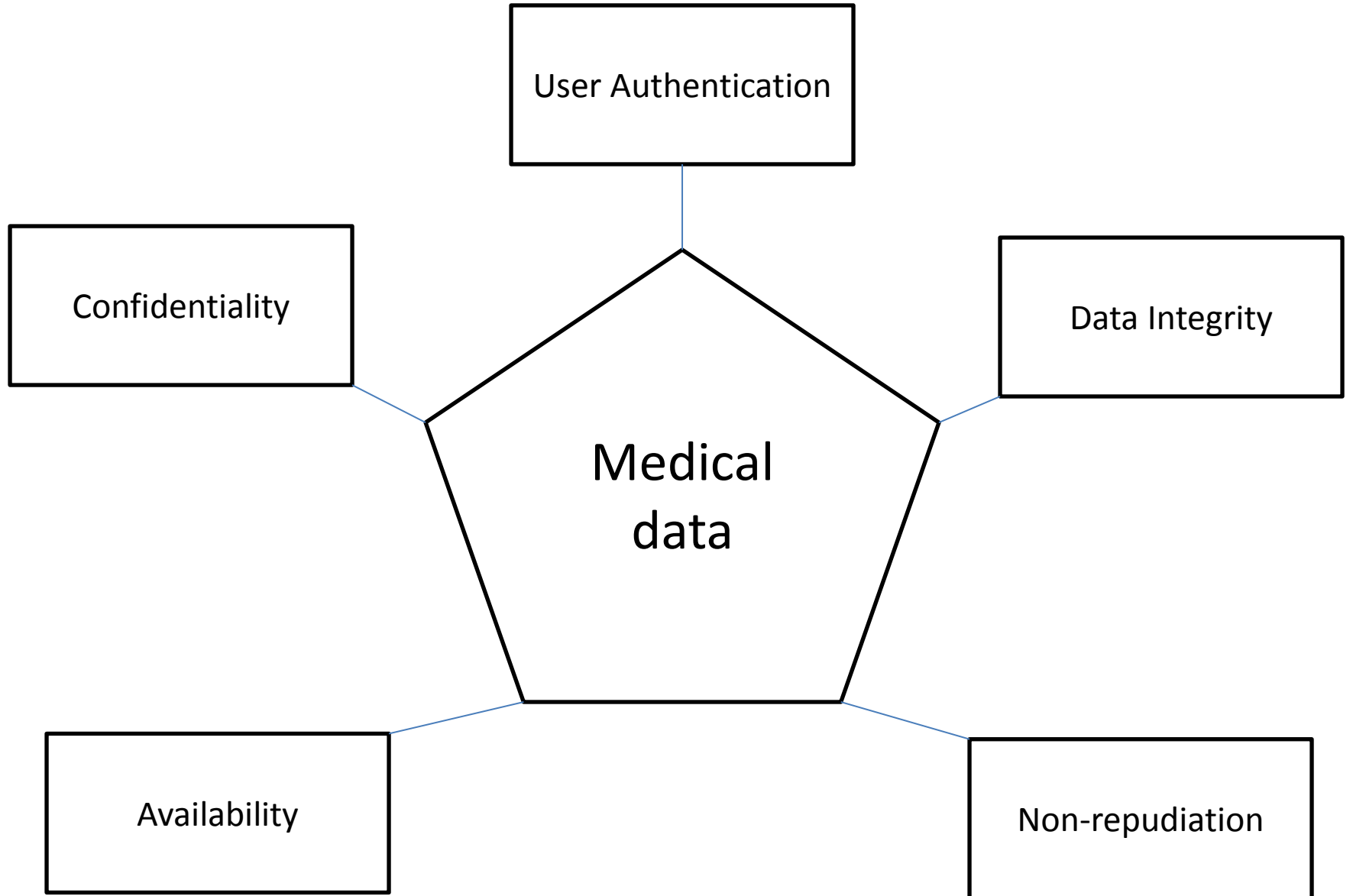
- Access control: control access data stored or transmitted, multilayer security, password, user ID.
- Firewalls: To prevent unauthorised users getting access to a private network, which are connected to the internet.
  - All messages entering or leaving the system pass through the firewall, which examines each message and blocks those that do not meet the specified security criteria.
  - Keeps track on the traffic going out from it.
  - There are several types of firewalls which include packet filtering, circuit level relay, and application proxy.
  - Use of firewalls result in slower performance.

- The usual focus of firewall is to prevent unintended external access to a network, but they can also prevent the unintended transfer of internal data to the external network.

- the application firewall configuration operates in the application layer. It operates by monitoring and potentially blocking the input, output and system service calls that do not meet the system policy of the firewall.

- There are two basic types of firewalls, network based, host-based application firewalls.

- Network based firewall is also known as proxy based firewall or proxy gateway.

- It inspects the traffic, blocking the specified content such as certain websites, viruses, or attempts to exploit known logical flaws in client software.

- It does it by comparing with the look up table and if it is not in the restricted list, then it is passed to the network.

- A host-based application firewall can only provide protection to the applications running on the same host.

Encryption

- Communication networks are viewed by a community of people. In contrast hospital records are meant only for a limited no. of authorised people.

- Cryptography is the art of protecting information by encrypting it.

- Encryption provides security for information while in transit or in storage by converting the plain text into unreadable format called cipher text.

- It is a scheme which scrambles contents of a message using mathematical schemes and algorithm.

- Decryption is the process of converting cipher text into plain text. This is done in conjunction with the use of secret keys.

- Only those who have the cryptographic keys (basically random numbers) can decrypt the message.

- Cryptographic keys : Public key ,Private key

- Public key- available to everyone via publicly accessible directory.

- Private key is kept confidential to its respective owner.

- With public key cryptography each person gets a pair of keys.

Any telemedicine application system must include the following security measures built in the system:

- List of persons including doctors, paramedical staff and others who are authorised to have access to patient's health related information.
- Security measures such as using password, fingerprint, and smartcard.
- Encryption used for storing medical and associated data.
- Encryption used for transmitting medical information over networks.

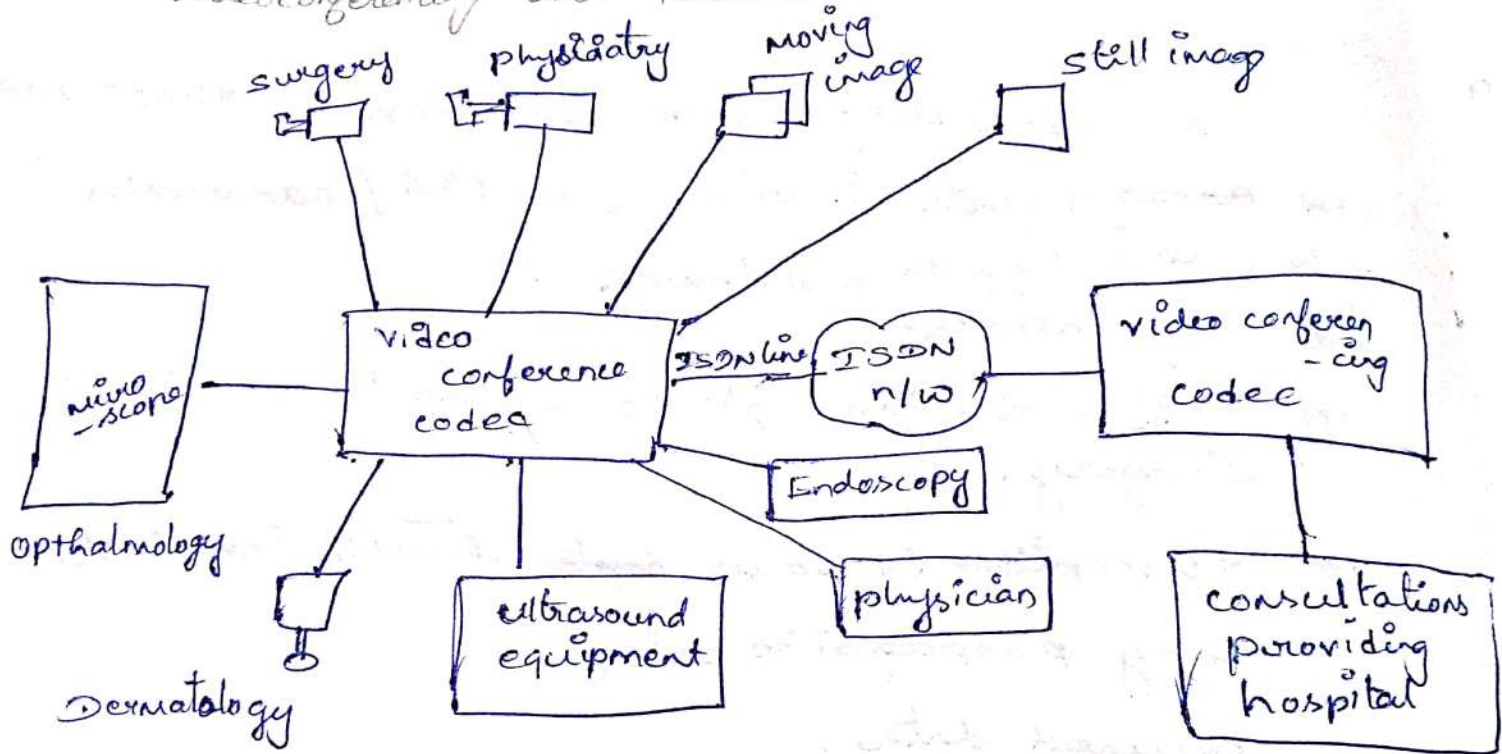Security and privacy of data can be ensured by the following measures:

- Physical security measures: These include access controls, private networks, firewalls, authentication, encryption, time-sampling.
- Specific measures: For securing email and web servers.

UNIT- 2

videoconferencing and telemedicine

surgery physiatry moving image still image

micro-scope

video conference codec — ISDN line — ISDN n/w — video conferen-cing codec

opthalmology

Dermatology

ultrasound equipment

Endoscopy

physician

consultations providing hospital

12/2/20

video conferencing system and multimedia data exchange:

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(*) This is achieved through the use of Cameras which capture, display monitors which display the received video, microphones to capture audio and speakers to play received audio along with the networking technology which carry out transmission and reception of data.

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(*) Electronic stethoscope, ottoscope, general examination camera, dermascope etc.

steps involved in video conferencing:

1) Session at the Sending end.
   - (*) Audio/video facilities
   - (*) peripheral medical devices
   - (*) consulting physician and patient

2) Codec process:
   - (*) codes and decodes analog signals to and from the digital format.

3) Transmission of data:
   - (*) ISDN lines/DSL lines
   - (*) co axial lines
   - (*) satellite
   - (*) Microwave/broadband n/w

4) Reconstruction of data:
   - (*) A compatible codec on the other end to decode the received data.

5) Session at the receiving end
   - (*) Audio/video facilities, physician.

ITU:

H.320

H.323 → more popular → accessible to anyone with high speed internet connection.

H.324.

Basic components of VIC systems:

video input device → webcam or video camera

video output device :

Audio input device .

Audio output device. :

Data transfer → Analog / digital telephone network
                              internet facility.

Digital camera:

(*) Has a Series of lenses

(*) Has a image Sensor which is basically a
Semiconductor device that records intensity
electrically and converts into digital data.

(*) This image Sensor is characterised by
The no of pixels it can distinguish in an image
commonly called resolution.

(*) when a picture is to be taken it opens a
Shutter briefly. and each pixel on the image
Sensor records the brightness. that falls on it
by accumulating an electric charge.

(*) Brightness higher charge higher

(*) After the Shutter closes the charge from
each pixel is measured and converted into
a digital number.

(x) This series of numbers are then used to reconstruct the data (image) by setting colour and brightness of matching pixels on the screen.

17/2/20

Features that determine quality of camera image:

i) Wide angle vs narrow angle lens
ii) Manual focus vs Auto focus
iii) Manual iris vs auto iris
iv) Auto tracking
v) Remote control.

Video sources commonly used in VTC systems are

i) A CD or DVD player for sending video or multimedia information.

ii) Speciality cameras such as those integrated with microscope or internal imaging systems.

iii) A document camera for imaging documents, objects etc.

iv) Document scanners.

Video mixer:

* Gets input from multiple devices, mixes

it together and gives output as a single video stream (telesurgery)

* A typical VTC system for telemedicine purposes may have the following cameras.

i) patient camera:

   To examine skin, review of x-ray, Evaluation of motor skills

ii) Room camera:

   To obtain room view

iii) Document camera:

   To digitize ECG, finger prints, medications, CT scans, lab reports etc.

iv) Micro camera.

   A fiber optics camera which can be used with a variety of medical peripherals.

(*) Voiced activated camera control system which automatically directs camera towards the person who is speaking at a particular moment.

(*) Such systems will zoom out when two people are in a dialogue at the conference table.

Composite video: Analog video interface

CVBs – Color video Blanking and Sync or
        Composite video Baseband signal (300+ lines/
                                                frame)

S·video – super video – 500 lines/Frame.

4 pins – 2 pin Gnd
           1 color
           1 intensity

component video:

    Luminance;

    Blue – B

    Red –

    Y-channel – sync pulses 2000 lines/frame.

Speakers:
————

i) Easier to select than microphones

ii) Head set or set of plain computer speakers
are sufficient

iii) Normal TV monitor sufficient for large rooms

iv) A separate sound system needed if the room
is of classroom type, comprising and amplifier, an
equalizer and speakers.

HDMI - (High Definition multimedia interface)

=> It is a digital video (Audio signal format which is more and more widely used

=> video data together with embedded audio at extremely high bitrates.

=> Transmits uncompressed video/audio in digital form.

RGB format:

* computer monitor are designed for RCB signals most digital video devices. such as digital cameras produce video in RGB format

* They look better in computer monitor. when output on a television they look better in S video format than in composite format

* video frame rate common values are 1, 30, 60. VTC generally uses 30fps. and 384 kbps. bandwidth.

* Some brands use 60fps and 512 KBPS.

Audio components:

* An important component in VTC system.

* Necessary characteristics for full duplex transmission are echo cancellation noise suppression and audio mixing

* They are influenced by location size and quality of microphones and speakers.

* loopback test commands available in VTC systems.

Audio mixer:

(*) Multiple sounds combined into one or more channels allow to adjust volume and tone. (timbre)

(*) Three types: Analog mixers, digital mixer and powered mixers.

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CODEC:

i) without codec very high bandwidth network will be required for VTC systems.

ii) Is responsible for real-time experience.

iii) Many types: Encoding techniques, bit rate, audio frequency spectrum, image resolution and frame rate.

iv) polycom, Tandberg and Sony.

v) Manufactures of codec.

Hardware codec:

* Dedicated processors use a designed algorithm to encode data.

* Faster and hence give real-time experience.

* video quality fixed.

* Inflexible.

Software codec:

* run on a pc or laptop.

* No need for any special hardware.

* usually less expensive and easier to install.

* flexible.

Network Consideration for video conferencing systems:

VTC is in existence since the introduction Television technology.

In 1980s with the introduction of digital telephony by ISDN & h.w. VTC systems were used But the cost involved is high.

In 1990s with the introduction of standards based communication technology VTC systems were available at low cost and for general public.

ISDN links at 384Kbps provide high Quality video for VTC systems.

Besides ISDN, LAN, WAN, internet, DSL, ADSL, SDSL, and VPN networks facilities were used for VTC systems.

All these n/ws have their own Strengths and weakness.

100 Nbps LAN with Switches and routers offer enough bandwidth to support desktop VTC systems.

LAN provides significantly higher bandwidth than ISDN.

Gigabit Ethernet (1000 Mbps) faster Switches, ADSL, SDSL and VPN have increased bandwidth.

Videoconferencing over internet:

 Bandwidth

 Pocket Loss

 Latency

 Jitter

Bandwidth:

 * Adequate bandwidth required for VTC system

 * ISDN video-conferencing use a bandwidth of 128 - 384 kbps.

 * IP based . H.320 – bandwidth 384 – 768 Kbps.

 * TV broadcast system bandwidth requirement is 6 – 20 Mbps for NTSC /PAL transmission.

 * For prerecorded HDTV and for line content display, bandwidth of 20 - 50 Mbps is required.

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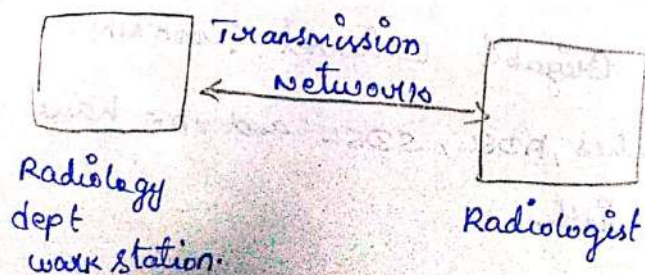
Network configuration:

 Point - to - point connection.

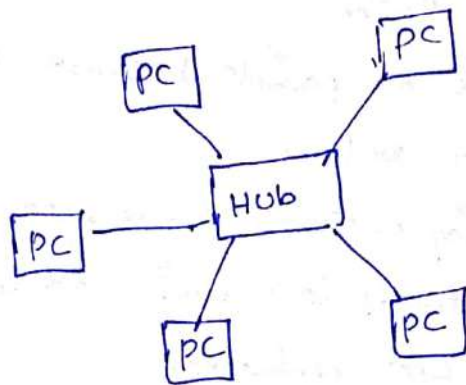 Local Area Network (LAN).

 Metropolitan Area Network (MAN).

 Wide Area Network. (WAN).

Point - to - point communication:

Radiology dept work station. ⟵ Transmission Networks ⟶ Radiologist

* To accomplish image/data transmission from one location to another by a dedicated network link.

* Sending and receiving stations are directly connected to each other.

Local Area Network:

* Provides networking capability to a group of computers which are in close vicinity to each other as in a hospital or a campus.

* Enables high speed data exchange between various telemedicine stations inside a medical facility.

* A LAN is useful for sharing resources like files, printers etc.

* Hardware requirements for implementing LAN is very simple and is just a network interface card (NIC).

* NIC can be an add on card or placed in the motherboard itself.

* A dedicated transmission network consisting of multiple sending and receiving stations.

* Only those delivers that are connected to the LAN can communicate with each other.

* LAN is usually wired through a hub which enables Any workstation to communicate with any other work station.

* High speed are possible because distance is limited to 10km or less.

* Networking protocols have been standardised at the international level which led to the wide spread use of LAN network.

* The standard governing LAN connectivity is IEEE 802.3 with a minimum speed of 10 Mbps.

Metropolitan Area network:

* covers area of a single city and is obviously larger than LAN.

* The range of MAN does not exceed 100km

* Comprises of a combination of ~~difficult~~ different hardware and transmission media.

* Many LANS may be connected together using radio waves as the transmission media

* some what slower.

Data Security in telemedicine.
systems:

points at which the data could be at risk include.

Data capture stage: wrongly identified participants in the telemedicine process, lack of control to data access.

communication stage: cross-talk on point to point between, involvements to intermediaries such as internet browsers problems in data managements in store and forward mode of telemedicine..

Data review and storage stage: long term electronic and physical files (disc, tape, paper) incidental information (cache memory, printouts)

Typical security risks when working with internet

Hacking: Refers to all activities that exploit weakness in software and computer systems winner May be to steal or alter data.

Malware: A piece of software developed with the specific intention of attacking a computer include software like viruses, worms and trojans.

phisher: phishing is an attempt to play fraud on email to gain unauthorized access to secured information contained there in This is done to target a specific group of people as an organisation.

spam: An unsolicited advertising materials that are put on the internet Result in waiting n/w resources such as bandwidth and storage space in mailbox with junk.

Security:

* security is a fundamental requirement for Telemedicine applications.

* security strategies are designed to safeguard the privacy, authenticate, authorised and maintain integrity of the data transmitted and received in a Telemedicine system.

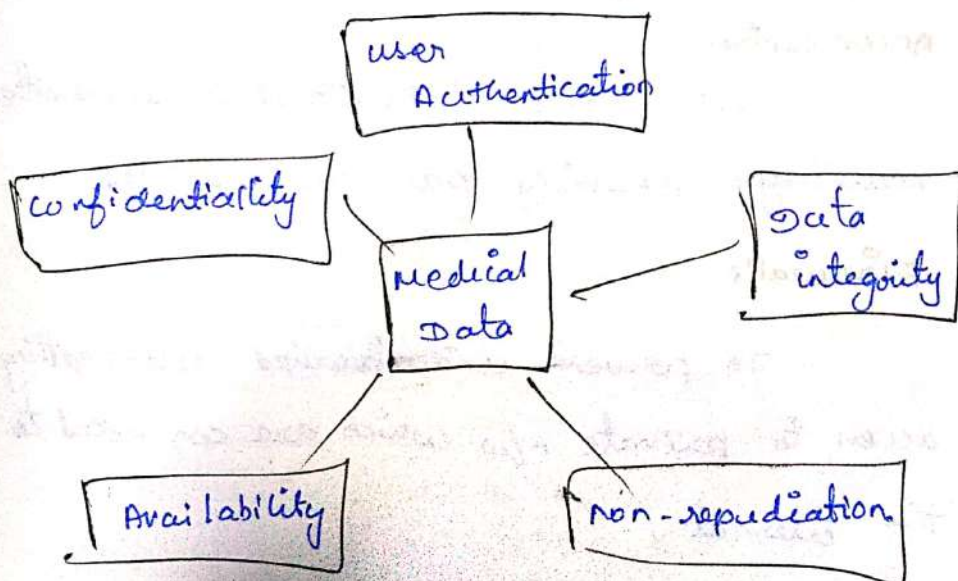* security elements include storage Security, network security and data encryption

* security assessment in a telemedicine setup involves evaluation of as to who has been authorized for accessing the system this should include all the elements of the system such as computer terminals, servers, communications equipments, video conferencing and network switching devices.

* In secure telemedicine system it is necessary to establish the identity of the user by employing an authentication mechanism.

* The telemedicine system must then determine the rights of the user provided in the user profile.

* Based on this information the user has to work with data under defined roles eg: create, add.

components affecting the secure healthcare systems.

| user Authentication |
| confidentiality |
| medical Data |
| Data integrity |
| Availability |
| Non-repudiation |

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Components affectiviting Security of healthcare system.

confidentiality:

Authentication involves all parties in the telemedicine process.

The medical professionals are validated before accusing patient data.

Data integrity:

(*) The accuracy of the transmitted and received data.

(*) This assures detection of any difference of the contents of transaction.

(*) This is carried out by algorithms to check that the data has been received unaltered.

(*) A digital signature may be employed to have a stronger test of integrity.

Non-repudiation:

A party involved may claim later that they did not participate in that particular process.

Availability:

This ensures that the system continues to perform its intended function without getting

disrupted by various technical reasons, which could
be latency in mobile data Service or quality of
Service problems.

Any telemedicine application system must include the following built in the system.

* list of persons including doctors, paramedical staff and others who are authorised to have access to patients health related information.

* security measures such as using password fingerprint and smartcard.

* encryption used for storing medical and associated data.

* encryption used for transmitting medical informations over n/w's

Security and privacy of data can be ensured by the following measures:

physical security measures:

Specific security measures: Email web pages

Access control:

control access data stored or transmitted multilayer security password user ID.

Firewall:

To prevent unauthorised users getting access to private n/w which are connected to the internet.

* All messages entering or leaving the system pass through the firewall which examines each messages and block those that do not meet the specified security criteria.

    * Keeps track on the traffic going out.

    * There are several types of firewall which include packet filtering, circuit level relay and application proxy

    * use of firewall result in slower performance

    * The usual focus of firewalls is no prevent unintended access in both directions

    * Many configurations of firewall are available

    * Application firewall: network based, host based.

    * Network based: Proxy outcome (gateway)

    * Host based: Monitor.

Written consent by the patient Provide Medical authorities a safety.

However, it is by no means certain that the patient's explicits consent would prevent healthcare Professional from facing prosecution for failing to Provide a duty of confidence.

In most circumstances the patients explicit consent is required to disclose identifiable health information.

This consent is normally obtained in writing for example: permission to release information for research purpose.

circumstances in which a patients refused to disclose can be overridden by the doctor..

when a patient medical condition posses a threat to the community at large.

mentally unstable and liable to injure others

However, telemedicine is no more prone to these circumstances than conventional medicine.

Access to medical records:
———— — ——.

A patient has an obivious interest is knowing what information is recorded in their medical record.

~~their medical record~~.

clinician prevent patients from ~~gaining~~ gaining access to this information.

The reasons offered for this denial range from unprofessional practice to the inability of patients to understand the information.

clinicians hide errors of medical judgement by refused to access.

~~By and large and accepted that they knew the best~~.

By and large the public trust doctors and accepted that they knew the best.

This has changed with the rise of consumerism in 1980s.

consumer rights encourages patients to claim access to this medical history and doctors respond positively to these requests.

Access to medical reports Act (1988) gives patients limited rights to control reports created for employment or insurance purpose.

The employer or insured must obtain patient's consent to disclosure prior to seeking medical report on this states.

The patient may consent to this request unconditionally or on the condition that they have access to the report.

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Disclosure of confidential patient information to an employer may carry risks for the patient where as non-disclosure may carry risks for the patient's fellow workers.

A teleconsulting doctor is obliged to draw a company's attention to condition that may adversely affect the health of his telepatients.

Access to health records Act (1990):

Gives patients access to health records made after 1st November 1991 and to earlier information if is it needed to make sense of the later information.

Patient's access right is subject to doctors. discretion possibley denying access when doctor belives that the information, may affect patients health.

Intellectual property rights:

To protect the designs and products from unscruputars.

Exploitation by others.

patents, licensing and copy right laws.

patent law: (UK patents Act (1977).

patents on products or processing can be applied for in several ways - British, European or international in scope.

scientific theories and Mathematical techniques are held to be in the public domain and are therefore not patentable.

Inventions against public interest are outside the scope of the Act.

Literary, asthetic and artistic works fall under the control of copy right laws.

A patentable item must satisfy the following key conditions.

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Access to health Records Act (1990)

- Gives patients access to health records made after 1 November 1991 and to earlier information if it is needed to make sense of the later information.

- patients' access is subject to doctor's discretion. The main grounds for exercising discretion, and possibly denying access are when the doctor belives that the information is deleterious to patient's health or when the release of information would jeopardise the confidentiality of other persons.

Intellectual property Rights

- To protect the designs and products from unscrupulous exploitation by others.
- patents, licensing and copy Right laws.

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- Scientific theories and mathematical techniques are held to be in the public domain and therefore not patentable.

- Inventions against public interest are outside the scope of the Act.

- Literary, aesthetic and artistic works fall under the control of copyright law.

A patentable item must satisfy the following key conditions:

- **Novelty**: the equipment is regarded as a new invention if its design has not previously been published or used.

- **Inventive Step**: An Invention must involve a design element which is not obvious to those familiar concepts. The step may have been published as used before but not patented.

Industrial Application: An invention must be capable of industrial application.

- If the authors of the patent meet the necessary conditions then they are granted a 20 year monopoly to exploit the patent.

- Legal copying with permission can be done.

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