Remote Delivery of Healthcare Services

Bindu Babu, S. Sudha, and S. Caroline Jebakumari

1 Introduction

The present healthcare system is a pioneer in providing only the basic needs for human beings in requirement. The foremost drawbacks of the currently available healthcare system are time and space. These drawbacks will be overshadowed in the upcoming years. The present facility provided by an ambulance is something which can be provided by a car too. Services offered to elderly people are not up to the mark to be very honest [1]. Due to the lack of medical treatment at the correct time in the ambulance, most of the patients die before reaching the hospital. The current healthcare systems are also poor or at times not able to detect real-time accidents. Due to the absence of accurate and precise framework and active offices, it's completely challenging to control the loss and pandemic issues. It is highly important and necessary foremost to develop a healthcare system like telemedicine which is intelligent. "The delivery of healthcare requirements, by all healthcare experts using data and transmission systems for the transfer of valuable data for education, treatment, and to avoid the spread of illness and damages, evaluate, research, and continuous knowledge of healthcare suppliers, with sole idea of improving the health of possibly and possibly every living being on Earth," according to the World Health Organization [2]. Telemedicine compiles real-time video conferencing, image transmission, e-health, which includes patient vitals, remote vital sign monitoring, continuous medical education, and medical call centre(s).

Telemedicine is a typical transmission of medical data that uses wired as well as wireless technology to send signals (biomedical), images, and data to a remote place for diagnosis [3]. This reduces the heat on medical professionals drastically, while it also compensates for the physical distance between patients and clinic/

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health centres fact. The first official instance of using telemedicine happened in the early twentieth century when the cardiograph data was transmitted through telephone lines.

Video communication in telemedicine is classified as video conferencing, which is a live, real-time, and interactive session between patients from various locations [4]. Using video conferencing, doctors will be connected with the patients who are technically far distant from them. Some examples of video conferencing include team meetings, tele-consultation, and education. In tele-presence, images of the field to be operated can be projected to the destination screen, which is at remote distance. By using telerobot, surgeons can perform operation without physically being with patients. Tele-robotics was first created with the intention of monitoring the wounds of soldiers on the battleground. Tele-presence surgery overcomes limitations of the operational manpower shortages in remote locations. Operational telemonitoring is an additional attribute for tele-presence telemedicine in which it provides access to display, provide instructions, command, and connect with another medical expert (e.g., a specialist) in an alternate location at a high time during an operation or clinical emergency.

2 Block Diagram of Telemedicine

Specific physiological signs should be recorded from people in their living surroundings during everyday activities and can then be used to identify any indications of medical distress or crisis circumstances [3]. Various research has been completed on considering various factors like types of sensors, type of information gathered, identifying gadget, and handling/clinical measurements and calculations. Biosignal sensors, which are mid-range units, raw information transfer networks, and importantly, a typical medical service centre are certain basic and ideal essentials for setting up an ideal telemedicine framework.

The biosignal sensors have the responsibility of gathering and moving raw information (the patient's important bodily functions) to the processing unit (signal) [5]. Each remote monitoring system's sensor layer is individually assigned with a handling gadget for signal compilation, maintenance, investigation, and formatting at an advanced speed. Following this, information is passed to the next layer, which is called correspondence layer. An ideal telemedicine framework's handling unit is simply a PC, or a cell phone, or even an implanted gadget (rare cases). In recent telemedicine consultations and results, many clinical measurements and calculations have been gathered and calculated to support patient health condition and early recognition of cardiovascular issues as shown in Fig. 1. Considering the fact that the pulse addresses an individual's condition of well-being, beat assessment has for some time been still the examination and exploration focal point of interest in the physiology field.

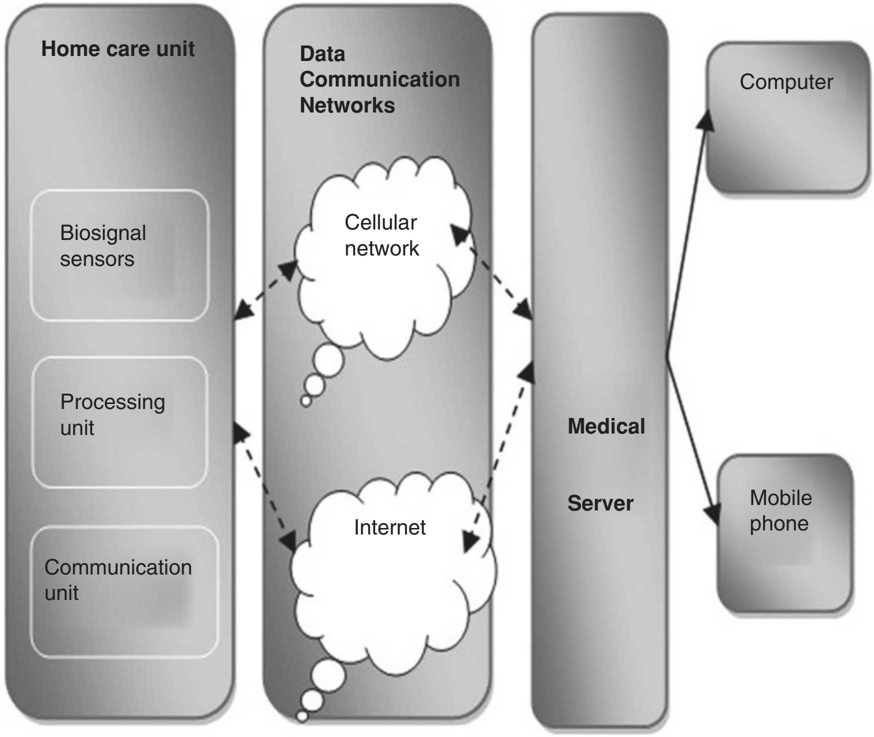

Fig. 1 Block diagram of telemedicine

3 Delivery Modes of Telemedicine

Telemedicine is mainly divided as (based on modes of delivery)

- *Store and forward mode (the asynchronous method)*: In asynchronous (store and forward method), patient's data, pictures, etc. are sent to another destination. This type of method is predominantly used for situations where a second opinion is required, and this includes methods like tele-radiology, tele-dermatology, and tele-consultation.
- *Real-time mode (the synchronous method)*: In this mode, patient's data is accessible at the server end itself, acquisition of data is done completely. It is mandatory that both patient and doctor are there at the same time and a communication portal that allows both of them to interact. It's an online module that allows a two-party interaction between the patient, treatment provider, and specialist doctor. The essential signs are communicated by mode of PC modules, cell modules, public phone modules, or satellite TV modules to the main server. The wired network, however, limits the level of opportunity for the same which is to be noted.

- *Hybrid Systems*: The combination of real time and store and forward together give hybrid systems. Which combines stored images or video with real time video conferencing [5].

4 Technology Used in Telemedicine

The information which is needed to be compiled and shared in telemedicine includes: (1) Personal information, data of physiological factors, disease and health history, payment for the corresponding, etc.; (2) Audio check-ups and compilation of data like typical heart sounds and sounds from/due to respiration, etc.; (3) X-ray, CT, MRI images, skin images, images of tissue and cellular specimens are considered as part of radiography.

4.1 HL7 (Health Level 7)

HL7 is a healthcare-compiled data shared between multiple computer systems/modules. HL7 is an abbreviation which is: health level 7. Level 7 is responsible for the application level of OSI model for medical condition. HL7 is a predominant protocol for electronic information sharing and performs transmission transactions for patient registration, patient insurance, patient billings, and patient orders.

4.2 Transmission of Images

The analogue images which contain large amounts of data should be digitized, as a result of which size of image is reduced to a smaller size so that sending and storing and managing will be economical, and this includes sharing of diagnostic images like X-rays, CT, MRI, histopathology slides, etc. Data stored in X-ray film is converted to a digital form ideally by a conventional scanner. Coupled devices which are charged and laser scanners are used in digitizing the film-captured images. Images from ultrasound, CT, and MRI devices are readily available as video, computer, or computer file format.

4.2.1 Standards for Still Images

Three still-image coding standards commonly used in telemedicine are as follows:

JPEG: Joint Photographic Experts Group (JPEG) is one of the most common compression standards for the sharing of images. JPEG uses DCT technique, in which, sampled data is in 8 × 8 pixel blocks which is then converted into component-based cosine functions using DCT (discrete Cosine Transform) technique as mentioned above. Non-detectable frequency to the human eyes is identified by the means of comparing the coefficients to that of a set coefficient. These frequencies are then re-assigned with zero value(s) as they will have no impact on the image quality even if they are lost. This results in a good and quality compression. The wavelet compression method works globally on the image and replaces the sequence of pixels with repeatedly assembled parts of much smaller wavelets. The performance of JPEG compression methods was examined based on an examination of tuberculosis X-ray data [6]. The method is found to perform good in low compression ratios. Both methods, fortunately, are useful in storing, maintaining, and sharing scanned images of the chest area (X ray). All shortened images are then shown to doctors and will be tested subjectively. The processed images were good and best in comparison to the unprocessed ones as a result of the testing process.

Digital Imaging and Communications in Medicine: Digital Imaging and Communications in Medicine is simply a simple facilitating processing and sharing of images and corresponding in the digital form. DICOM is the third version of a developed standard in 1983 transferring radiological images and other medical data from one computer to another. It allows diagnostics as well as usage of therapeutic equipment and systems from various manufacturers to communicate digitally and efficiently. In medical care, such availability is basic in terms of cost-effectiveness. Clients can capitalize on minimizing their expenses by making sure that the new equipment and frameworks are reliable. Additionally, clinical pictures are caught and shared all the more rapidly, permitting doctors to provide quick treatments and take decisions [7]. The objective of developing DICOM is to set a general standard that can be used and applied to all the images in the medical area and also to harness the development and expansion of PACS that interferes with other systems of hospital data. DICOM compiles the input of machinery such as workstations, central hubs into picture storage and communication units.

Picture Archiving and Communication System: The Picture Archiving and Communication System includes PCs. It is subjected for ability, recovery, conservability and show of medical images. PACS maintains pictures from different imaging ranges like radiography, ultrasonography, computed tomography, MRI, PET, and mammography. PACS is an electronic method for regular radiological filming: pictures are obtained, saved, shared, and displayed, as shown in Fig. 2. At the point when such a model is introduced all through the clinic, a filmless clinical condition results.

The first step in PACS is obtaining images like X-ray film or any other corresponding digital image. Images like X-ray film need to be digitized using a digitizer. The data connection between the various components of the PACS acts like a pathway for the complete system. The main functional unit (Brain) of the PACS is the sole database server, which keeps track of the data, images, image attributes/

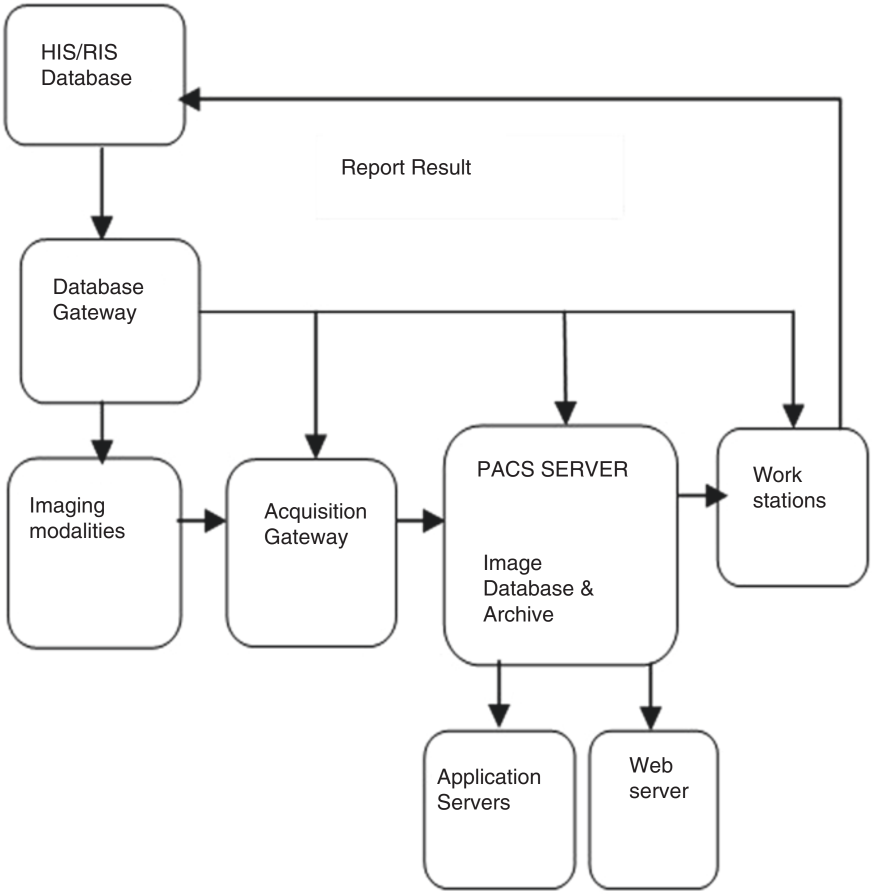

Fig. 2 Picture archiving and communication systems

conclusions, and image locations. The next important component is the Archival system, which electronically archives image information. The Radiological Information System maintains patient demographics, schedules, and interprets results based on corresponding examination. The display workstation provides a clear view of the image data to the clinician. PACS provides high efficiency due to electronic handling of data [8].

- When an image is acquired, it will never get lost or misplaced. It will be available all the time and can be accessed anytime.
- The images can be at different locations at the same time, which is not possible for a basic radiological film.
- Images stored in the PACS database can be easily retrieved as they are stored in sequential order, correctly arranged and labelled.
- After processing of images, computer tools can be used, which will enhance the view.

4.3 Transmission of Video

For proper diagnosis of the patient, it is mandatory to have the video data of the patient. In video, the bandwidth requirements must be multiplied with the video frame rate which will take up a lot of memory and hence video compression needs to be done before sharing the video.

In video compression, unwanted or repeating pixels are removed from each frame. A high rate of compression can be obtained if we are transmitting the difference between the frames. Video compression is performed using special ICs (Integrated Circuits) called codecs, which stand for compression and decompression. Video codecs mainly perform two functions:

- They convert the analogue video into digital form.
- Reduction in the bandwidth is obtained by compressing the digital data signal.

4.4 Transmission of Audio

Telemedicine has audio channels that are available in electronic stethoscope or Doppler ultrasound. The frequency response in an electronic stethoscope ranges from 20 Hz to 2 kHz, while it is from 100 Hz to 10 kHz for Doppler ultrasound. Audio signals are first digitized and then compression is done using ideal compression algorithm.

Audio compression methods for normal equipment and work have data rates ranging from 16 to 64 Kbps. In healthcare applications, where a high data rate of 120 Kbps is required to produce full audio frequency range from 20 Hz to 20 kHz over a range of 90 dB. Initially, Pulse Code Modulation (PCM) was used for the audio compression. Then, Adaptive Differentiable Pulse Code Modulation (ADPCM) was used for compressing the audio signal. In ADPCM, the difference between the two samples is sent which will reduce the data required for storing each sample.

5 Wireless Technology for Telemedicine

Wireless telemedicine is an emerging technology which connects the wireless technology with the medical and health systems for the ultimate well-being of the humans and other living beings on Earth. Wireless telemedicine has the ability to facilitate accurate diagnosis and examination, as well as the transfer of medical information, treatment history, medication details, test results, laboratory results, and insurance data. The availability of user-friendly, cost-efficient, and low-power consuming and portable wireless devices, patient treatment and care will be ultimately improved through better recording and observation of patient on the move.

And also, it supports patient health and treatment with full-time observation, timely health check-up, data, and follow-ups [4].

Multiple challenges are still there which are to be mentioned while using the wireless technology with healthcare instruments. Factors like reliability, low-power requirement, nodal failure, transmission reliability, power consumption, and for comfort of the patient, the wireless gadget must be small and lightweight, are the main difficulties to be considered while moving to smart wireless technology for telemedicine. While telemedicine is still in its early stages, there are a number of obstacles in the path, which includes license, reimbursement (if any damage), liability, and quality.

Technologies, such as mobile 4G, and the famous Wi-Fi, enable representatives to access important data from any place and any time in the formed networks topology. Radio-frequency identification, wireless sensor networks, ZigBee, and Bluetooth have been introduced only recently, but supporting the access of wireless communications as well as incorporation into delivery systems (health-oriented), we can make wonders.

5.1 Wi-Fi

Wi-Fi is routinely used in the home, office, and some commercial facilities to provide wireless connection; they also are widely used in telemedicine systems.

5.2 WiMax

IEEE 802.16 or simply the WiMax is good in wireless access solution that comprises basic attributes of spectrum flexibility that may be used elsewhere on the planet. The benefits of telemedicine are:

- Wireless access by broadband is available in fixed settings and in mobile setting.
- Bandwidth is significantly high, which minimizes the time it generally takes for high-quality photos to be sent.
- Telemedicine services, enabled by WiMax's network capacity, include various types of diagnostics, physical observation, medicine dosage management services, high-quality conversation and corresponding talk of a doctor and a patient, and talk with medical specialists.
- WiMax security features are found at the medium access control (MAC) layer which provides control for wireless telemedicine facilities.
- The 802.16e framework enables the smooth and effective transmission of medical data [9].

Table 1 shows the comparison of WiMax over WLAN set systems.

Table 1 Comparison of WiMax and WLAN technologies

Standard	Network	Band	Bit rate	Channel bandwidth	Bandwidth efficiency	Radio technique
802.11	LAN < 100 m	2.4 GHz	1 or 2 Mb/s	20 MHz	2.7 Mb/s/Hz	FHSS
802.11a	LAN < 100 m	5 GHz	6–54 Mb/s	20 MHz	2.7 Mb/s/Hz	OFDM
802.11b	High-rate LAN < 100 m	2.4 GHz	11 Mb/s	25 MHz	0.44 Mb/s/Hz	DSSS, CCK
802.11 g	LAN	2.4 GHz	22 Mb/s	20 MHz	2.7 Mb/s/Hz	OFDM
802.16	MAN, 1–3mi	10–66 GHz	32–134 Mb/s	20, 25, 28 MHz	5 Mb/s/Hz	QPSK, 16 QAM
802.16a	MAN, 3–5 mi	2–11 GHz	<70 Mb/s	20 MHz	5 Mb/s/Hz	64 QAM
802.16e	MAN, 1–3mi	<6 GHz	15 Mb/s	5 MHz	5 Mb/s/Hz	256 QAM

Table 2 Bluetooth power classes

Power class	Maximum output power	Typical range
1	100 mW (20 dBm)	100 m
2	25 mW (4 dBm)	20 m
3	1 mW (0 dBm)	10 m

5.3 Bluetooth

Bluetooth is seen to be the most promising technology for wireless communication with a short range of around 7–10 m. Bluetooth meets the following requirements, which include providing direct access to data, providing mobile information acquisition, providing the access to the usage of peripherals, and access to novel device architectures.

Bluetooth's most notable features include the ability to connect a maximum of up to eight devices and data transfer, which is normally available between 10 m and up to a maximum of 100 m. Bluetooth has low power and has also a short-range transmission system that operates in the scientific and medical frequencies range zones. It also supports data and voice communications and transmissions, as well as data for other short-range wireless gadgets, with a maximum and best data rate and potential range zones [10]. Table 2 illustrates the Bluetooth power classes with respect to maximum output power and range.

Bluetooth assures secure and reliable transmissions, reliable by using frequency-hopping spread spectrum algorithms and corresponding packet encryption methods and techniques.

Bluetooth Low Energy is a version of Bluetooth that uses less power consumption and is illustrated in Fig. 3. This minimizes the cost and size of battery, power consumption, and the chip design allows the technology to be included in small instruments without the requirement to significantly enclose the extensions. There are generally two types of Bluetooth low energy implementations: Small Bluetooth

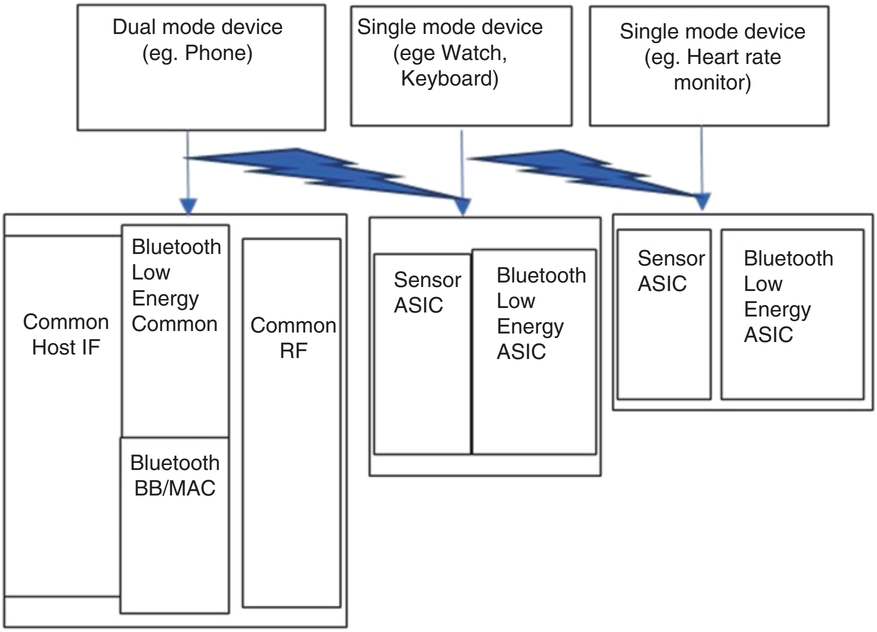

Fig. 3 Bluetooth low-energy devices

communication units that are generally incorporated into medical monitoring (wireless) with dimensions which are of just a few millimetres range comes under the category of single mode devices. Dual-mode devices are Bluetooth communication units that can be used both on mobile phones and personal computers [11].

5.4 *Zigbee*

Zigbee, which is a standard-based protocol, was established by using The Alliance, which was a non-profitable organization of enterprises, government regulatory bodies, and universities, which was specially assigned to facilitate multiple application environment. The IEEE 802.15.4 standard, which is predominantly embraced by the wireless sensor and networks community, decides the bottom layer of the ZigBee protocol.

5.5 *Ultra-Wideband Technology*

The Ultra-Wideband (UWB) is used in small-range communication, which has grown in popularity in recent past years. The UWB is the reason for reliable datarate (low data rate) sharing personal networks (WPANs), which is also accurate in range capabilities. Intrinsic noise characteristic is found in UWB signals. This makes it harder to check and prevents jamming, and hence possibly removing or eradicating the need for complicated encryption methods in devices. UWB acts as a communication interface in medical network topologies as a result of the mentioned qualities (WBAN).

Capsule endoscopy is a predominant application of UWB in terms of a wireless communication network. It is simply a camera which is in the form of a small pill that can be consumed to view the intestinal tract. They were ideally designed to send images of the intestinal tract to examine and identify problems.

UWB technology may be employed in healthcare systems in a variety of ways, including as a wireless communication network. The IR-UWB radar, for example, can detect microscopic motions inside the human body without causing any harm. As a consequence, monitoring cardiovascular physiological parameters is entirely feasible. Because of the architecture of the UWB radar, the same electronics may be used for radar detection and IR-UWB communications. Another possible application of UWB technology is used on the surface of and in-depth-situated tissues, such as for cancer treatment. This technology has the potential to replace X-ray mammography. The absence of negative effects from long exposure to ionizing radiation is a significant advantage of UWB.

6 Evolution of Wireless Communication

6.1 Zeroth Generation (0G)

The 0G was the first wireless phone, found during the World War days (predominantly World War II). In those pre-cell days, when there were only a few channels accessible, the calls were set up by the mobile provider. These phones do not support the handover function, which allows you to change the frequency of the channel. This generation of network refers to mobile communications technology from the 1970s, such as radio phones, which some individuals used in their automobiles before cell phones became ubiquitous. A mobile radio telephonic system underpins modern cellular mobile-telephony technology. These frameworks are known as 0G (Zero Generation) Systems, thinking of them as the precursors of cell phones.

6.2 1G (First Generation)

First-generation mobile systems were launched in the early 1980s. 1G was an outmoded analogue technology that could only handle the initial generation of analogue mobile phones at 2.4 Kbps. These analogue mobile phones were rather large and couldn't be carried in a pocket. The voice information was conveyed on a frequency-modulated carrier in these devices. Every one of the frameworks upheld changeover and meandering; however, the phone networks couldn't interface across borders (i.e. users could only make voice calls inside a single nation). The drawbacks of 1G mobile networks include restricted frequency, unsteady handoff, poor voice communication, and inadequate security; calls become vulnerable to spam calls.

6.3 2G (Second Generation)

Second-generation telephones were launched in the early 1990s and are based on digital technology to fulfil expanding capacity demands in a cost-effective way. On 2G, text communications, picture messaging, and MMS were all possible. In the 2G system, digital mobile access technologies are utilized to provide simpler signalling, reduced interference, and the integration of transmission and switching operations.

CDMA provides a unique code for communication, while TDMA separates the signal into time intervals. Furthermore, the 2G networks permitted global roaming, which allows connectivity all over the world. TDMA technology is used in GSM, PDC, iDEN, and iS-136.

GSM covers a vast region. GSM (Global System for Mobile Communication) is a technology that was developed in Europe in 1982. Today, GSM is the most commonly utilized cellular technology in the world, with extensive worldwide coverage. It employs digital radio transmission to deliver a wide range of cellular communication services such as voice, data, and multimedia communication. GSM cellular technology employs RF channels with frequencies of 200 kHz. The fundamental use of a GSM system is obviously to be used for voice or speech communication.

This is accomplished by digitally encoding the speech and afterwards decoding it with a coder. GSM, in addition to phone services, enables a wide range of additional data services. The data services are normally offered with user data rates of up to 9.6 Kbps per channel slot. SMS, Short Message Service, is one such data service. GSM has good subjective speech quality, is inexpensive, terminals are portable devices, the system permits worldwide roaming, and has high spectrum efficiency.

GPRS is a technique that enables existing 2G networks to provide packet-based services while also improving available data speeds. It offers mobile phone and computer customers' data speeds ranging from 56 to 114 Kbps as well as continuous Internet connection. It supports a wide range of multimedia services, but at a somewhat modest pace. Email may be sent using a GPRS-enabled phone [12].

Migration road to 3G Wireless System: In the near future, there will be a greater desire to blur the distinctions between fixed and mobile networks. The challenge for the 3G system, with assistance of new communication technologies, is the globalization and convergence of office and home applications and services. However, the issue is not clear. As previously noted, the enormous range of communication technologies accessible today spans numerous geographical locations, each with its own set of economic, political, legal, and social challenges, making it difficult to rise in bringing together to a single meeting point.

Significant investments have already been made, and creating standards from the ground up is extremely difficult, if not impossible. With this in mind, it has been recognized that a standard that permits current networks to remain backward-compatible, while simultaneously defining a common framework within which these networks may expand should be devised.

6.4 3G (Third Generation)

Third-generation mobile networks provide fast speeds in terms of data transmission, bandwidth is wider, and hence there is an increased wireless communication capacity. All of these variables contribute to the availability of new mobile phone services. Internet connectivity, multimedia apps, worldwide roaming, and so forth are examples of these services. Data transfer speeds range from 384 Kbps to 2 Mbps, with a maximum speed of 14.4 Mbps. As a result, this network provides mobile phones with services such as voice, video, and file transfer, Internet surfing, viewing TH and high quality videos, playing online games, watching live sports, and much more. In comparison to 2.5G and previous networks, 3G provides the following advantages:

- Streaming audio and video have been improved.
- Several times faster data transmission.
- Support for video conferencing.
- Higher speed web and WAP browsing.
- Support for IPTV (Internet television).

Figure 4 depicts a situation in which direct transmission of ECG signals is used for telemedicine through a wireless network. This system comprises a real-time acquisition of cardiac data using an ECG equipment, a 3G mobile phone functioning as a persona, a server, and a medical server with Internet connectivity. The detected signal is sent to the mobile phone using Zigbee or Bluetooth wireless technology, which then transmits it to the base station or over the Internet to the care provider or automatic monitoring and recording system. Future advances, such as 3G technologies, will allow more data to be sent while on the move, influencing the trajectory of the wired and wireless computing areas.

6.5 4G (Fourth Generation)

It's simple to see a future in which mobile phones, PCs, licences, charge cards, controllers, security gadgets, smart money, and so on—all consolidated into a single device. However, if a person is accessing the Internet via his mobile phone using

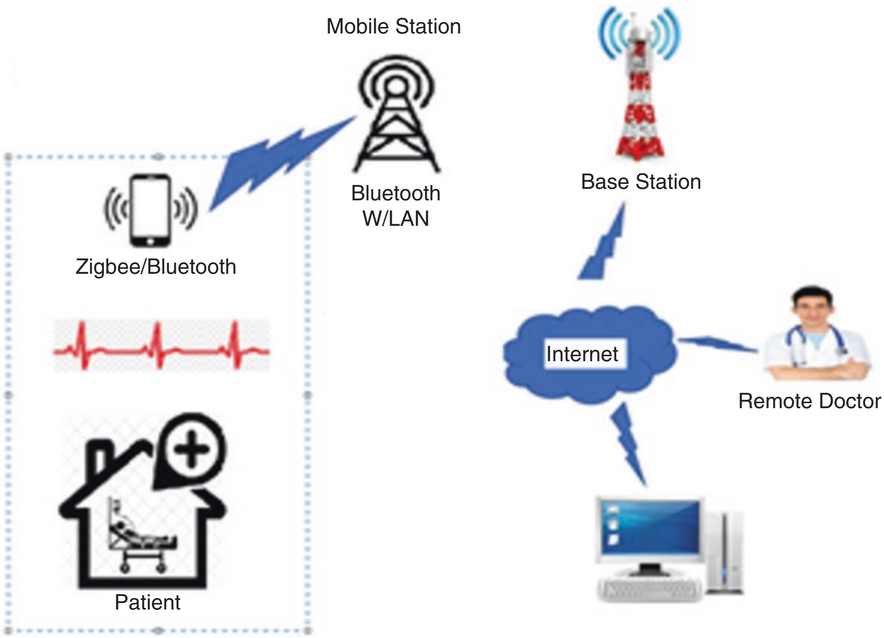

Fig. 4 Scenario of telemedicine system for cardiac applications based on 3G wireless network

any of the technologies such as Wi-Fi, WiMax, GPRS, EDGE, and is travelling to a region where network interoperability is not accessible, that user would be stranded. If the user has 4G, he can access the Internet while travelling from one area to another using any of the aforementioned technologies.

The following are some of the concerns that are expected to be handled in this 4G mobile technology:

- Larger data rate transmission and reception.
- 4G mobile technology has the capacity of downloading ten times faster than 3G.
- Call interference.
- LTE is designed to be integrated into 4G mobile LTE (Long-Term Evaluation) to provide high-level security as well as high-speed data transmission, avoiding delay.

6.6 5G (Fifth Generation)

Transmission speed is a milestone in 5G technology, with data transmission speeds of up to 10 Gbps. Aside from improved speed, 5G has low latency. Additional (far broader) frequency bands, as well as enhanced spectral bandwidth per frequency channel, are proposed for 5G technology. As of now, the predecessors (generations) of mobile technology have demonstrated a tremendous increase in peak bitrate. 5G has also progressed in terms of significantly improved peak data rate.

- Greater data volume.
- High capacity.
- Lower battery usage.
- Better connectivity, regardless of distance.
- A larger number of connectable devices.
- Infrastructure level development at very low cost.
- Communication quality is highly improved.

It's worth thinking about what 5G means for healthcare. Aside from speed Internet, telemedicine will benefit predominantly from trustworthy Internet access, which is needed for huge items and instruments, whose capacity is generally high. The most probable areas where 5G has a direct influence are virtual reality as well as augmented reality, with possible contributions for intelligent medicine as the technology advances [13].

Virtual reality and augmented reality are crucial for concise extremities rehabilitation and healthcare. Another sector that would gain from 5G would be telemedicine, as the reach of telemedicine would be expanded, and this could happen quickly. Precision medicine, on the other hand, is a conundrum that cannot be solved without the assistance of 5G technology. Bandwidth and data transfer speed have long been recognized as the most important limiting factors. The most crucial factors to consider are bandwidth and latency. This implies that a large number of devices have the ability to connect and communicate, clogging the topology. VR, no-delay response, and augmented reality result in a more engaging experience. The evolution from first generation to fifth generation in wireless technologies is showcased in Table 3.

Table 3 Evolution of wireless technologies from 1G to 5G

Generation	Speed	Technology	Key features
1G	14.4 Kbps	AMPS	Voice only services
2G		TDMA, CDMA	Voice and data
2.5G–2.75G	171.2	GPRS	Voice, data, mobile internet, low speed streaming services
3G	3.1 Mbps	EDGE	Voice, data, multimedia, support for smartphone applications
3.5G	14.4 Mbps	HSPA	All the services from 3G network
4G	300 Mbps	Wimax, LTE, Wi-fi	High speed, high-quality voice over IP, 3D gaming, HD video conferencing and worldwide roaming
5G	1–10 Gbps	NOMA	Superfast mobile internet, internet of things, security and surveillance, autonomous driving, smart health applications

6.7 6G (Sixth Generation)

Prospective technology will dominate the whole health industry by 2030 as a result of implementation of 6G. 6G governs the health business and a number of other industries as well. 6G is projected to transform several industries. In future, Healthcare will be run by artificial intelligence and 6G connection technology, affecting our notions of our life style [2].

Holographic communication and augmented/virtual reality will also aid intelligent healthcare systems. The terahertz (THz) wave will be utilized to transfer data in 6G. The THz signal boosts data rate and bandwidth. Furthermore, the bandwidth will be three times that of a 5G transmission, i.e. mm Wave. The THz signal boosts data rate and bandwidth. In addition, it will have three times the bandwidth of a 5G transmission. The 6G data rate will be one terabit per second (TBPS).

The 5G and B5G correspondence structures are 2D, but the 6G correspondence structures will be three-dimensional, taking into account time, space, and frequency. Because of AI, blockchain, this generation of mobile communication system (6G) will actually desire to provide 3D forms of aid. The 6G organization will be enormously broad and well-connected. 6G will provide more and more widespread inclusion and satellite networks. 6G comprises combining handling, routing, and detection into a single correspondence structure. In terms of security, this generation will encompass the safety, mysticism of big data created by many of dazzling devices and sensors. Regardless of which, there is a separation from intelligent gadgets, as shown in Fig. 5.

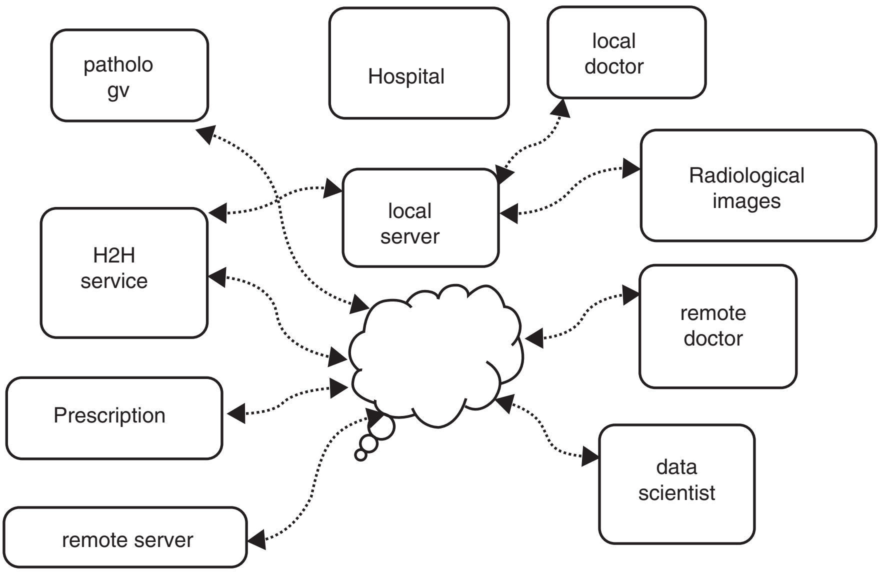

Fig. 5 Intelligent healthcare system

7 Mobile Telemedicine Systems

Service, including patient check-ups, and medicinal service providing can all be done from mobile telemedicine systems.

- *Emergency telemedicine*: Patients who are in need of emergency treatment, for example, in an unfortunate disaster, can make use of a mobile telemedicine system. It has the ability and capacity to significantly increase emergency survival rates of patients. The system shares signals (including BP, heart beat rate) and other information (such as pictures of injuries) to the hospital/clinic, allowing doctors to provide correct and timely suggestions and treatment.
- *Patient monitoring (mobile) and healthcare provision*: Patient monitoring with mobile patient monitoring is possible, which uses advanced and intelligent sensors to check on vital signs of patients so that doctors may treat remotely.
- *Treatment data (mobile)*: access (wireless) to all patient data and information is available. Patient's data with comparable symptoms can be searched in order to get data from previous experiences and better treatment can be given. Considering the patient's privacy, only medical data is available and accessible, which does not reveal the patient's identity. This medical information of patients can be accessed wirelessly by patients as medical experts.
- *Robotic systems (mobile)*: Medical experts can now use mobile systems to control highly sensitive and accurate medical instruments such as ultrasonic gadgets at the patient's side from remote location which is a revolution in the medical field. Medical surgeon can control equipment wirelessly, allowing them to precisely measure and provide accurate medical data while removing the need for patients to operate medical gadgets. This type of service is provided by tele-echography (mobile) using a very ultralight weight robot (OTERO). Raw communication and sufficient bandwidth for sharing high-resolution digital films and photos are required for robotic systems, and WiMax technology meets these criteria ideally.
- *Pre-hospital care*: In an ambulance, WiMax technology potentially improves treatment before getting into hospital. Ambulance members can use WiMax network to access the particular hospital's medical information and get the required medical information for patients at risk [R3]. The doctor in a hospital will be able to undertake and do the corresponding examination as well as diagnose, until the time that the ambulance reaches the hospital, using video conferencing and robotics technology.

8 Conclusion

This chapter has highlighted the improved telecommunication in medicine using telemedicine. Various technologies, especially PACS and the delivery modes used in the telemedicine, have also been explained. AI-driven medical services and innovations of medicine in 6G technology are also explained.

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