

Study To Evaluate The Scope And Nature Of WIT (Wireless And Information Technology) In Patient Health Monitoring Sector

Minakshi Hudda, Dinesh Kumar

ABSTRACT: Telemedicine is a new and emerging area in healthcare sector. Now everywhere in the world did Information Technology have a greater personal impact than in the delivery of health care? Energetic efforts are now being done all over the world to use IT for the improvement of quality of health care, provision of easy access to health care facilities and enabling the patients to improve their own health status. The aim of the research was to evaluate the scope and nature of wireless and mobile technology in health sector. The thrust for the research came from analysis of the information requirements in health sector and increasing demand of wireless technology, which incurs globalization and makes world interconnected. This paper covers wireless technologies that exist for telemedicine, the issues it meets against changing technology and evolution it will bring in today's world. Also it is meant for ongoing researches in telemedicine as a supplement to their knowledge and pays a small contribution to improve health care services in INDIA and rest of the world. Finally, during the study we have noticed, wireless remote monitoring is really an underdeveloped area today in the health care service. It will continue to become more and more important and revolutionizing for the way patients are treated in the years to come. Introducing technology that has the potential to bring healthcare out of the hospital and into the patient's home, replace nurses with technical devices, and collect sensitive information will bring many ethical considerations. These must be dealt with in order to ensure that any changes made in the health service are for the better for the patient.

Keywords: Telemedicine, GSM, GPRS, UMTS, WLAN, IT, WIT, TDMA, ISP

INTRODUCTION

In recent years, there has been a rapid growth in wireless technologies. They found their way into airports, campus, schools, offices, coffee shops and even hospitals, providing users with the freedom of using services in mobile environment. One can easily presume that the trend of wireless technology our society following will rapidly transit from wired to wireless environment, as there is an intense need of mobility in our day to day requirements. In early years nobody knew that how to implement wireless technology in health sector and what kind of operating system should be used but IT brings new era in health care and now wireless is rapidly growing in health sector. Telemedicine is one of the booming fields in health care industry. The health care industry traditionally known as laggard in the IT arena - is now emerging as a leading in adopting mobile and wireless technology. Most numbers of the health care organizations have already adopted or planning to adopt this technology. Wireless technology not only provides optimum efficiency to cure patients and improves quality assurance but also saves money and time. Time and distance has always been a major barrier between patient and their health service providers. People in rural area, physically disabled, patient at accident scenes have to physically present for their medical treatment. Telecommunication technology is the key tool to break the barrier of time and distance.

Use of wireless and mobile technology removes limitations on boundaries of support and can be used on various places like on a space shuttle flight, train, at accident scenes, in route to a hospital, in a submarine etc.

TELEMEDICINE

The term telemedicine consists of two parts. The first part, "tele", means "at a distance" so basically telemedicine is the practice of medicine at a distance. The evolution and emergence of various communications technologies, such as the telephone, television, computer network and wireless communication, have been enhancing the feasibility and diversity of telemedicine applications over the past few decades. In rural areas where commuting is a major problem telemedicine can perform effective results. By 2050 the approximate population of 60 or older persons would be 2 billion, telemedicine would be needed as a necessary phase of treatment. Telemedicine is proved fruitful in disasters like earthquake; flood etc. (Furht and Ilyas, 2003) Telemedicine is of two types: real time and store- and- forward. In real time the information transmitted in forms of data, audio, video, images and communication to patient site immediately. Real time interaction generally used in emergency purposes e.g. like consultation with remote doctor, ambulatory electrocardiogram (ECG) monitoring, exchanging critical information. High transmission is excessively required, which results high cost. Where store- and forward mode is concerned, it is relatively cheaper than real time mode. Acquired information is stored in servers and viewed later. So it doesn't require high rate of bandwidth.

TELEMEDICINE AREAS

Telemedicine applications reflect the spectrum of clinical specialties and subspecialties found in conventional clinical medicine. That is, telemedicine has been applied in practically all areas of clinical medicine. Therefore, clinical telemedicine is represented in the vast majority of medical

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specialties, although the stages of development and maturity vary substantially by specialty. Following is the list of vastly used telemedicine applications:

TELEMEDICINE APPLICATIONS

- Telecardiology
- Teleradiology
- Telepathology
- Teledermatology
- Teleoncology
- Telepsychiatry
- Tele – Homecare
- Tele –surgery
- Remote patient monitoring
- Teleconsultation

The major focus of the paper is to enlighten the impact and awareness of wireless technology in health sector among people. The research concentrates on formulating an approach to help health sector by providing the facts and figures gathered by conducting surveys and intensive research study based on current environment in the market of health care. Therefore with the above factors in the mind, research was conducted on the specific group of people. As people already worked or going to work in future in this field, would be able to provide more relevant information on the basis of their knowledge and experiences.

TECHNOLOGIES BEING USED IN TELEMEDICINE

Various technologies have been used in telemedicine but technologies like GSM, GPRS, Satellite, UMTS, and Wireless LAN are extensively being used by current health care systems.

GSM: The Global System For Mobile Communications (GSM) is the second generation of mobile communication

networks. GSM is a circuit- switched technology based on TDMA. Data transfer speed of GSM network is 9.6 Kbps. Through the years a new technique was introduced called High Speed Circuit Switch Data HSCSD. HSCSD is allowed for multiple time slots to be used in a single connection of data transfer up to 57.6 Kbps.' (MartynMallick, 2003).

GPRS: General packet radio system is upgrade to GSM and TDMA. Since it's upgrade to GPRS/TDMA so it can operate on same frequencies used by GPRS and TDMA. It provides cost effective upgrade over GSM and gives better user experience to stay online for extended periods on wireless networks. GSM so it counts as part of 2.5 generation of networks. It provides higher speed of data transfer speed with higher bit rates with improved technology of packet switch technologies for wireless networks. GPRS defined as a safe point between 2G and 3G so it counts as a part of 2.5 G which comes from GPRS and can be modified to further 3G technology.

UMTS universal mobile telephone system which is a 3rd generation mobile system based on W-CDMA (Wideband Code Division Multiple Access). UMTS officially forecasted in 2002 but publicly it was launched in 2005. It is capable of providing upto 2 mbps connection, which includes text, multimedia, voice, audio, video data packets transfer on wireless, Ethernet and Satellite connection.

SATELLITE COMMUNICATIONS: If telemedicine is practiced at places which are thousand miles away where wireless connection and wired connection can't be used, satellite communication is the only option left for internet access. For example in India 75% of population living in rural areas and more than 75% doctors living in urban areas, satellite communication is the only way to bridge the gap to provide services.

Type	Sub- Type	Frequency Band	Data Transfer Rates
GSM	GSM-900	900 MHz	9.6-23.2 Kbps
	GSM-1800	1800 MHz	9.6-43.3 Kbps
	GSM-1900	1900 MHz	9.6-43.3 Kbps
GPRS	GPRS	900/1800/1900 MHz	171.2 Kbps
WIRELESS LAN	IEEE 802.11a	5 GHz	20 Mbps
	IEEE 802.11b	2.4 GHz	11 Mbps
	Hiperlan 1	5 GHz	20 Mbps
	Hiperlan 2	5 GHz	54 Mbps
	Bluetooth	2.4 GHz	732.2 Mbps
SATELLITE	ICQ	C, S band	2.4 Kbps
	Globalstar	L, S, C band	7.2 Kbps
	Iridium	L, Ka band	2.4 Kbps
	Cyberstar	Ku, Ka band	400 kbps – 30 kbps
	Celestri	Ka band and 40-50 GHz	155 Mbps
	Teledesic	Ka band	16 kbps – 64 Mbps
	Skybridge	Ku band	16 kbps – 2Mbps

Wireless Communication Networks Standards

WIRELESS LAN: A wireless LAN (WLAN) is a flexible data communication system implemented as an extension to or as an alternative for, a wired LAN within a building or campus. "Using electromagnetic waves, W LANs transmit and receive data over the air, minimizing the need for wired connections." (pulseswan, 2006). W LAN technology is often used between a ward within a hospital and remote physician situated outside the hospital. Snaps shots, video streams captured by camera and converted into IP packets then send to remote physician using ISDN connection on 128 kbps speed. Besides being accessed by remote areas it can be accessed by multiple locations at same time and Local area network system gives an extra advantage to save retrieved images and store it for future purposes.

The Major Wireless Communication Networks Standards

Source: IEEE Antenna's and Propagation Magazine, April 2002

INTRODUCTION ON WIRELESS

Wireless technologies represent a rapidly emerging area of growth and importance for providing 24/7 access. It offers a wide range of telecommunications services, which helps us to communicate or exchanging data in terms of text, voice, images and data. Wireless communications is one of the most active areas of technology development in current. Mobile phones and pagers are the most commonly used mobile wireless device today, and many routine daily activities rely on the voice communications and messaging services supported by these devices. New technologies are emerging that will support wireless remote monitoring, wireless financial transactions, wireless Internet access, and wireless control of appliances and devices. This chapter will provide a brief back ground on history of wireless technology, general overview of mobile wireless technology available today and some benefits and issues against applications used in wireless technology.

HISTORY OF WIRELESS TECHNOLOGY

Wireless technologies invented more than hundred years ago. Guglielmo Marconi and Heinrich Rudolf are known as founder of wireless technology. 1899 was the first time when world's first telegraph message sent across the English Channel without using wires. Within three years of span it took a major turn and wireless devices being used sending and receiving messages across Atlantic Ocean. Early years it was used for military purpose only but due to its efficiency and speed of message sending receiving ability it became popular so quickly and 'by the 1920s, wireless technology had become a mass medium, and its popularity soared with the public discovery that it could send personal messages across continents. With the introduction of broadcast radio, wireless technology became commercially viable.' (Morrow. R, 2002)

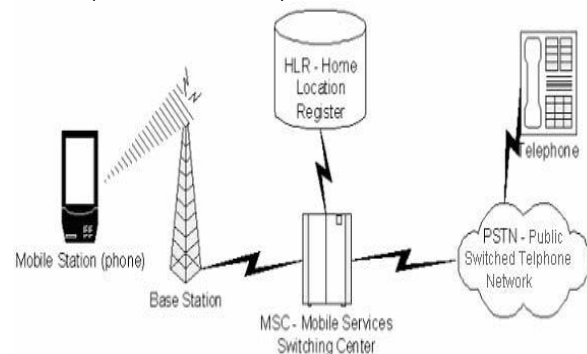
TECHNOLOGY TERMINOLOGY

This section will shed lights on major Wireless Technologies being used in Telemedicine and it is focused on GSM, GPRS, BLUETOOTH, UMTS, WIRELESS LAN IEEE 802.11 and SATELLITE COMMUNICATIONS technologies.

GSM

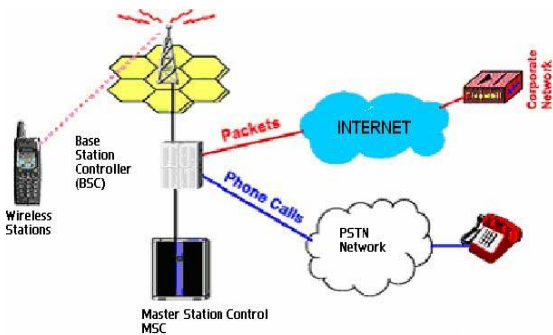
The **Global System for Mobile Communications (GSM)** is the most popular standard for mobile phones in the world. "A digital European cellular standard, based on TDMA technology, specifically developed to provide system compatibility across country boundaries. This compatible network enables GSM cellular users to use a single cellular phone throughout Europe, most of Asia, and parts of North and South America and have every call billed to one account. Countries have been rapidly building GSM networks, resulting in over 160 million fully working subscribers in over 125 countries." (Adaptivedigital, 29 Feb. 2004) GSM is a part of 2nd generation as its based on digital signals so it's an open standard to 3rd generation. GSM provides higher digital voice quality and low alternatives to making calls such as text messaging. And due to its open standard ability it allows inter – operability, which means GSM based devices, can be used all over the world. GSM uses TDMA air interface technology. It operates at 900 and 1800 MHz in Europe and 1900 in the United States. One of the key features of GSM is the Subscriber Identity Module (SIM), commonly known as a **SIM card**. The SIM is a detachable smart card containing the user's subscription information and phonebook. This allows the user to retain his or her information after switching handsets.

SECURITY From the outset, GSM has been a system designed with stringent levels of inbuilt security. With constantly enhanced transmission protocols and algorithms added to the flexible and future proof platform, GSM remains the most secure public wireless standard in the world. (Gsmworld, 2000)



GPRS

General Packet Radio Service (GPRS) is a packet based mobile service which is implemented over GSM Technology. As this technology also supports CDMA (3G) so it's also known as 2.5G. GPRS supports a wide range of bandwidths, is an efficient use of limited bandwidth and is particularly suited for sending and receiving small amount of data, such as e-mail and Web browsing, as well as large volumes of data.



Source:-Industrial Wireless Book issue 5:1, 2004

GPRS runs at speeds up to 115 kbps as compare to Gsm which is 9.6 kbps which is very higher. Its constant connectivity adds another advantage of having GPRS. GPRS provides many services which has been upgraded by Gsm:

- **Point-to-point (PTP) service:** Internetworking with the Internet (IP protocols) and X.25 networks.
- **Point-to-multipoint (PT2MP) service:** Point-to-multipoint multicast and point-to-multipoint group calls
- **Short Message Service (SMS):** Bearer for SMS.
- **Anonymous service:** Anonymous access to predefined services.
- **Future enhancements:** Flexible to add new functions, such as more capacity, more users, new accesses, new protocols, new radio networks. (Wikipedia, 2006)

SECURITY

The air interface ciphering in GPRS is at the same level as in an ordinary GSM network without GPRS. The encryption algorithm in GPRS is GEA. The strength of GEA is roughly equivalent of A5 used in ordinary GSM. The authentication process is also done in a similar fashion. (GPRS security-security remote connections over gprs, 2001)

2.3.3 BLUETOOTH

Bluetooth is a new wireless radio technology which uses for making transmission of signals over short distance between PDAs (Personal digital assistants) telephones, computers and other devices like printers, household appliances without the use of wires. Bluetooth name derived from the 10th century king of Denmark, Harald Bluetooth. Who 'engaged in diplomacy which led warring parties to negotiate with each other, making *Bluetooth* a fitting name for their technology, which allows different devices to talk to each other' (Bluetooth SIG, 2004) the name of the king in Danish in Harald Blatand and the Bluetooth logo is based on the H and B runes.

Benefits

- Globally Available
- Range of Devices
- Ease of Use
- Globally Accepted Specification
- Secure Connections

Bluetooth communicates on a frequency of 2.45 gigahertz which transmits data via low-power radio waves. It supports short range upto 10 meters and low speed up to 1mbps which supports both point to point and multipoint applications. Bluetooth can connect up to **eight devices** simultaneously with all of those devices in the same 10-meter (32-foot) radius. Bluetooth uses a technique called **spread-spectrum frequency hopping** that makes it rare for more than one device to be transmitting on the same frequency at the same time. In this technique, a device will use 79 individual, randomly chosen frequencies within a designated range, changing from one to another on a regular basis.

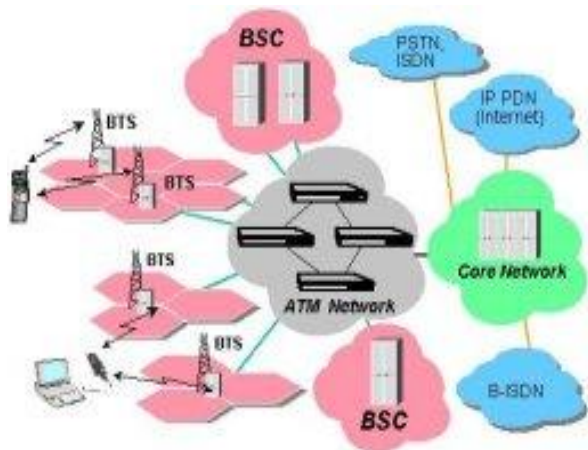
SECURITY

Bluetooth is extremely secure in that it employs several layers of data encryption and user authentication measures. Bluetooth devices use a combination of the Personal Identification Number (PIN) and a Bluetooth address to identify other Bluetooth devices. Data encryption (i.e., 128-bit) can be used to further enhance the degree of Bluetooth security. The transmission scheme, fast frequency-hopping spread spectrum (FHSS), provides another level of security in itself, allowing only synchronized receivers to access the transmitted data. (Mobileinfo, 2001)

UMTS

Meaning of UMTS - "Universal Mobile Telecommunications System", is a third generation digital mobile telecommunications standard. UMTS are designed in such a way so that It could be used in parallel with GSM technology which is second generation of communications. UMTS mobile phones can function in GSM networks as well as UMTS networks, so if in a region where UMTS is not yet available it can be used in GSM network. UMTS is specifically designed for high-speed data transfer and is "Internet Ready". The European implementation of the 3G wireless phone system, UMTS provides service in the 2GHz band and offers global roaming and personalized features; designed as an evolutionary system for GSM network operators, multimedia data rates up to 2mbps are expected. It uses W-CDMA as the underlying standard, is standardized by the 3GPP, and represents the European answer to the ITU IMT-2000 requirements for 3G Cellular radio systems. 'UMTS offers teleservices (like speech or SMS) and bearer services, which provide the capability for information transfer between access points. It is possible to negotiate and renegotiate the characteristics of a bearer service at session or connection establishment and during ongoing session or connection. Both connections oriented and connectionless services are offered for Point-to-Point and Point-to-Multipoint communication.' (umtsworld,2003)

UMTS Architecture



Source:- umtsworld, 2003 UMTS was basically developed for the countries where GSM Network is already enabled because these countries have agreed to free new frequency ranges for UMTS networks. Because it is a new technology and in a new frequency band, whole new radio access network has to be build. 'The advantage is that new frequency range gives plenty of new capacity for operators. 3GPP is overseeing the standard development and has wisely kept the core network as close to GSM core network as possible. UMTS phones are not meant to be backward compatible with GSM systems. (but subscriptions (=SIM card) can be, and dual mode phone will solve the compatibility problems, hopefully). UMTS also has 2 flavors FDD (will be implemented first) and TDD.'(umtsworld, 2003)

Current list of main vendors providing UMTS services:

- Alcatel
- Ericsson
- Lucent
- Motorola
- Nokia
- Nortel
- Siemens/NEC

SECURITY

'The security functions of UMTS are based on what was implemented in GSM. Some of the security functions have been added and some existing has been improved. The application of authentication algorithms is stricter and subscriber confidentiality is tighter.

The main security elements that are from GSM:

- Authentication of subscribers
- Subscriber identity confidentiality
- Subscriber Identity Module (SIM) to be removable from terminal hardware
- Radio interface encryption

Additional UMTS security features:

- Security against using false base stations with mutual authentication
- Encryption extended from air interface only to include Node-B to RNC connection
- Security data in the network will be protected in data storages and while transmitting ciphering keys and authentication data in the system.

- Mechanism for upgrading security features.' (umtsworld,2003)

WIRELESS LAN or IEEE 802.11

According to *proxim,1998* 'A wireless local area network (LAN) is a flexible data Communications system implemented as an extension to or as an alternative for, a wired LAN'. Using spread- spectrum technology based on radio waves enables communication between devices in a limited area. All the data transmits over the air which minimize the need of wired connections. Thus wireless LANs combine data connectivity with user mobility. Wireless LANs have been increasingly popular in various areas of markets, including health – care, retail, manufacturing, warehousing and academics. Today it's been commonly used for portable devices and hand held devices like laptops, PDAs (personal digital assistants) etc. WLANs are based on several technologies but most wireless LANs use wireless Ethernet technologies based on IEEE 802.11 standards. 802.11 wireless networks are also known as Wi-Fi (Wireless Fidelity). It comes from the testing and certification program run by the Wi-Fi Alliance. To ensure wireless products from different manufacturers comply with standards and are interoperable.

Current Standards

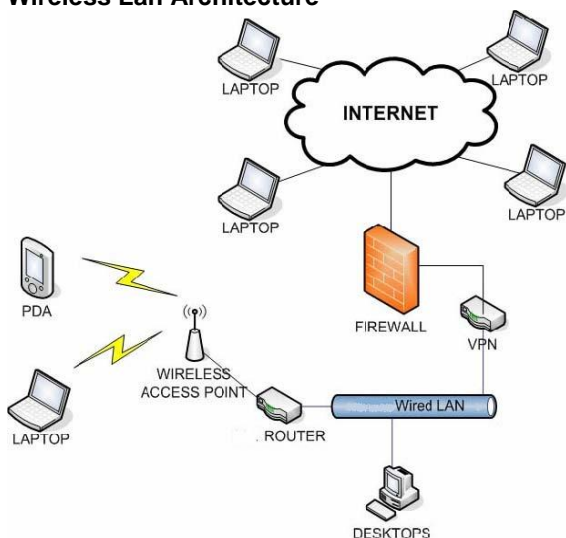
- IEEE 802.11b
- Wi-Fi Alliance (WFA)
- IEEE 802.11g
- IEEE 802.11a
- IEEE 802.11h

A WLAN can be configured in two basic ways:

Peer- to –Peer (ad hoc mode): An ad hoc network is peer-to-peer network (no centralized server) set up temporarily to meet some immediate need. This mode consists of two or more PCs equipped with wireless adapter control but with no connection to a wired network.

Client/Server (infrastructure networking): In infrastructure mode devices which communicate each other, first has to go through a point called Access Point (AP). Usually APs are connected to wired networks using normal Ethernet connections and they act as bridge between wired network and remote computers.

Wireless Lan Architecture



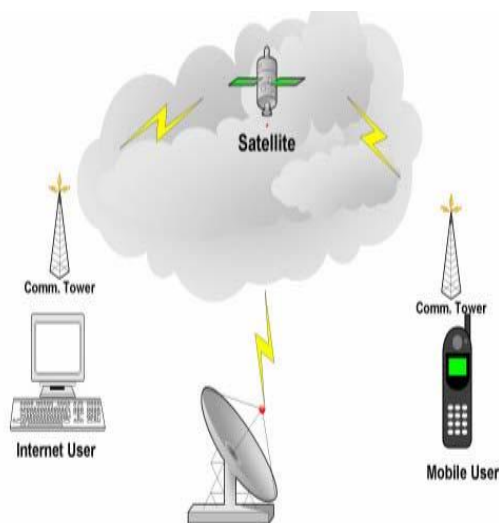
- 802.11 wireless LANs, WiMAX and 3G+ cellular networks offers global mobility, high bandwidths, quality of service and seamless integration with one another.
- Access to real-time information in conferences, meeting rooms to help with decision-making
- Freedom to access shared information from anywhere in a building, company or organization without being tied to a cable connection.
- Reduce overall network installation cost as no need to use wires and easy setup as compare to wired connections.

SECURITY

Two security services are specified in IEEE 802.11, the authentication service and the privacy service. 'The privacy service is provided by Wired Equivalent Privacy (WEP) algorithm. The authentication service provides two basic levels of security. The first, Open System Authentication (OSA) is mandatory, but provides essentially no security. The second is shared-key authentication that provides the highest level of security available and uses the WEP algorithm. OSA simply exchanges messages between a station and the wireless access point. Any station that can successfully send and receive compliant messages is permitted to associate with and enter the network.' (Intelligraphics, 2005)

SATELLITE COMMUNICATIONS

Communication Satellite is an artificial satellite which is stationed in space for telecommunication purpose. They can be used in planes, ships or any mobile areas where other technologies such as cable or impractical or impossible. A communications satellite interconnects many locations, fixed and mobile, over a wide area using radio signals.



Satellite Communication

According to Encyclopedia, 1998 "A radio relay station in orbit above the earth that receives, amplifies and redirects analog and digital signals contained within a carrier frequency. There are three kinds' communication satellites.

- Geostationary (GEO) satellites are in orbit 22,282 miles above the earth and rotate with the earth, thus appearing stationary. The downlink from GEOs back to earth can be localized into small areas or cover as much as a third of the earth's surface.
- Low-earth orbit (LEO) satellites reside no more than 1,000 miles above the earth and revolve around the globe every couple of hours. They are only in view for a few minutes, and multiple LEOs are required to maintain continuous coverage.
- Medium-earth orbit (MEO) satellites are in the middle, taking about six hours to orbit the earth and in view for a couple of hours."

CONCLUSION

Wireless history, wireless technologies and different characteristics of wireless technologies mainly used in telemedicine have been reviewed to provide foundation knowledge. In just a century, wireless technologies have made a significant progress but this revolution isn't stopped here it just keep moving with every day enhancement in technology growth. Bringing new technology in market and educate people about it would be slightly difficult task but as soon as people will come to know about it, it will bring awareness and encourage them to benefit from it.

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