Chapter I

INTRODUCTION TO DISTRIBUTED SYSTEM AND ITS ROLE IN HEALTHCARE COMMUNICATION

1.0: Introduction

It is seen that, the organizations have been interested in the decentralization of processing while achieving the integration of the information resources with in their geographically distributed systems of database, applications and users. Web based systems and applications (called WEBAPPS) have evolved into sophisticated computing tools that not only provide standalone function to the users, but also have been integrated with corporate databases and real world applications.

The world is changing at fast pace and it is the need of the time to connect all the rural and remote places with the help of wireless technology. i.e. Internet using mobile phone. Survey shows that the e-health [S. Soegijoko, 2009] is Internet based or electronic health system which is not available in rural areas in India [Sting Jarle Fjeldbo, 2005]. It is seen that the wireless technology is not implemented at large scale in these areas.

Primary Health Centers (PHC) are dispersed through out the region and it is observed that, the communication techniques used today are not optimum and having lot of limitations. It is observed that, the Health Care (HC) environment in rural areas are inadequate in all aspects and the HC practitioners are more involved in collecting, preparing requisite reports rather than consulting the patients which is their main role. Due to their more involvement in administration, it is difficult to provide better services, consultation and provision of basic HC. Hence the Distributed Web Based model (DWB) be setup for such organizations in India. So we treat each PHC as one client node and we can design & develop distributed system models for such system. We expect, these models will be useful. The models can be user friendly, portable, and self computing clients with server using network.
Today in healthcare system, telemedicine provide the good role. The advantages of telemedicine are providing improved health care to the underprivileged in inaccessible areas. It reduces cost and improve quality of health care. It mostly reduces the isolation of users viz. Specialists, nurses and allied health professionals. The term tele-medicine [S. P. Sood and J. S. Bhatia, 2005] refers to the use of telecommunications and computer information technologies with medical expertise to facilitate by providing information for remote health care delivery, medical services to remote areas or across great distances on the globe [Jabir S. Aziz, Osama Abbas Hussein, Amer Naaom, 2009]. We found that, Telemedicine has various limitations [P. S. Pandian, K. P. Safeer, D. T. Shakunthala, Parvati Gopal and V. C. Padaki, 2007]. The major limitations is it is hazardous if consulted by unauthorized staff.

The recent advances in the growth of medical sciences, engineering studies, communications and information technologies have been supported by the growth of internet technology. Internet technology provides us effective, efficient and improved health care information about the patients and their health related problems. In healthcare field, the face-to-face meetings between users viz. patients and doctors, doctors and doctors are essential and important. The situations where face-to-face meetings are not possible, the designed models plays a vital role for obtaining information about better treatments.. It also covers any form of communication between users : health workers and patients through electronic equipment from remote locations. So we proposed to develop distributed system.

The major objectives of the research work are:

1) Designing of various distributed systems based on Network Based Technology and Wireless Network Based Technology
2) Designing of Hyper Terminal and Data Logger Based Distributed Systems
3) Designing of Web Based Distributed System (DWB Model)
4) Study of access of distributed System for DWB model
5) Study of Performance of various Distributed System and their comparative study

All the research topics are concerned with ‘Distributed system’, ‘Wireless Technology’, ‘Software Engineering’, ‘E-commerce’ & ‘Internet Technology’.
1.1: Computer Networks, Networking Devices, Data Transfer Mode and Distributed System

Data transfer can be performed by making use of carriers called as communication lines. Computer systems are connected by making use of carrier lines which forms Computer networks as per Tannenbaum A. S., 2007. The computers on the network works as Transmitting unit (Sender Computer) for data send operation and Receiving unit as receiving computer. There are various types of the topologies for the computer communication. The various medias are used as communication carriers, channels are categorized as wired and wireless networks as stated by Williams Stallings, 2006. The first Distributed System invented is Local Area Network such as Ethernet, during 1970.

Distributed Computing is a branch of computer science that studies the Distributed Systems. It refers to the use of Distributed systems to solve computational problems. Here the problem is divided into multiple tasks, and each task is solved by one computer.

Distributed System consists of multiple autonomous computers that communicate through a computer network. These computers interact with each other in order to achieve a common goal. The computer application or program which runs on a distributed system is called distributed program. The process of writing the distributed program is called Distributed Programming.

Distributed system is a system where the information processing is distributed over several computers rather than confined to a single machine. Distributed systems are the Internet based applications where there are two types of computer systems: Server node and Client node. Simply Distributed System is a computer system which works by using the various computers connected by the computer networks.

Applications:

Distributed Computations have several applications. Following are the applications of Distributed Systems as stated by George Couloris, Jean Dollimore, Tim Kinderberg, 2004.

1. Telecommunication network Based Distributed System:
2. Wide Area Network Based Distributed System (Wired and Wireless)
   - Multiplayer online games.
   - Distributed databases and Distributed Database Management Systems.
   - Network files systems.
   - Distributed information processing systems for commercial applications such as Banking Systems and Airline Reservation Systems.

3. Internet
4. Intranet
5. Resource sharing with WWW

1.2: Traditional Systems versus Distributed Systems for Communication

Early database systems moved towards centralization and resulted into complex databases. The database systems are single user, multi user with centralized computing at server side only. These systems are traditional systems viz. Single tier or host systems and Two tier Architecture viz. Traditional systems having no. of limitations. Today the needs of the users are not limited and not based upon single location but the user wants to have the global information access and he wants to update regularly. User want to access the information from the remote locations or units which can be connected through wired or wireless technology. In the traditional systems, information is only read by the users. In these, Client Side Computing environment can not be made available logically to Server side through networks globally or remotely.

1.2.1: Traditional Systems

Traditional systems are Database Management Systems, Relational Database Management Systems. These systems are centralized systems, which doesn’t support Internet applications for the data processing and decision making tasks.
Hence these systems can’t share the resources globally for healthcare communication.

There are some limitations of traditional systems.

- Very expensive hardware wise.
- Difficult to share information.
- Software applications tend to be extremely high.
- Installations are time consuming and difficult to coordinate.
- Separate licensing is not economical.
- Upgrades and new installs are both very tedious and difficult.
- Read operations are allowed only from client terminals.

These are non Distributed Systems which are two tier systems. The block diagram of the Traditional System: Two Tier Architecture as per George Porter, Ramdy Katz, 2006 is shown in Fig. 1.1 (a).

![Fig. 1.1 (a): Two Tier Architecture](image)

In the view of above limitations of traditional systems, we felt the need to apply the Distributed Web Based Systems: DWB model (i.e. Internet Applications) to improve the health care facilities at remote locations as mentioned by Zipping Walter and George Scott., 2006. We also felt that to improve overall performance of data transfer, its processing and decision making activities at the right time, there is need of another system [Mauro Andreolini, Michele Colajanni, Riccardo Lancellotti, 2005; Adekunle Afolabi and Bayode Ijagben]. So we felt that the Distributed system is the good solution.
1.2.2: Distributed Systems

Distributed systems are the web based applications or the systems. These are supported by the Internet. These systems share the resources locally as well as globally. Today Internet is a fastest growing technology for the data transfer operations. The Client Server Architecture of Distributed system is shown in Fig. 1.1 (b)

![Client Server Architecture: Three Tier Architecture](image)

Advantages and Disadvantages:
The important advantages of Distributed Systems are:
- Resource sharing
• Openness
• Concurrency
• Scalability
• Fault tolerance

The important disadvantages of Distributed Systems as per Somerville Ian, 2004 are:

• Complexity
• Security
• Manageability
• Unpredictability

1.3: Architectures of Distributed System

The architectures of the Distributed systems are of the following type:

1. Peer to peer Architecture (P2P)
2. Client Server based Architectures

Fig. 1.2 and 1.3 shows the Peer to peer Architecture (P2P) and Client Server based Architectures of distributed system respectively.

Fig. 1.2: Peer to Peer Architecture

Fig. 1.3: Client Server Architecture
In addition to the above architectures, there are other types of architectures such as Multi processor architecture, Distributed Object architecture and Inter organizational Distributed Computing as per George Couloris, Jean Dollimore, Tim Kinderberg, 2004.

But presently, we have used Client Server Architecture for DWB model and P2P architecture for DLBDS and all wired and wireless NBDS. Here the model follows the hierarchical database structure. Client Server Technology is a computer architecture where there are two types computers: Client (Requester/sender/sending terminal) and Server (Provider/receiver/ Receiving Terminal) which uses standard communication methods such as TCP/IP for the sharing of information [Richard W. Boss, 2002].

1.4 : Case Study : PHC and Role of existing networks in case study

The case study selected by the researcher is healthcare domain or application area in the real world. The domains are of different types where computers can be useful or its research aspects should be studied.

We have been visited at the various Primary Health Centers (PHC), which are located at villages. PHC provides guidance for health care related problems and provision of information about healthcare and related services. The PHC is located in a village or in sub centers. Sub centers are the villages which are the branches of the PHC units. The PHC authorities in addition to the routine work, submits the monthly reports to the subsequent higher authorities: THO, DHO shown in the Fig. 1.4. It is seen that, there is lack of use of Electronic and Information Technology. But in many countries electronic systems and computer systems have played the important role in these area [Marco Eichelberg, Thomas Aden, Jorge Rosemarie, Asuman Dogac, Gokcc Lakeci, 2005]. The computer system can play a very important role in health care at remote location [Vishwanath Anantraman, Tarjei Mikhelsen, Reshma Khilnani, Vikram Kumar, N. Rao, Machiraju, Alex Pentland, Lucila Ohno Machado].

The topic selected by the researcher as case study is based on Client Server based architecture. The clients are the computer nodes where the THO’s and DHO’s are submitting their data. The server is
office. DHO is supposed to work as the Administrator but in some cases he also work as a client.

**DHO:** District Health Officer in Zilla Parishad is posted at District level as responsible user – Authority or Administrator for decision making type of the health and related activities.

**THO:** Tahsil Health Officer - Authority at Panchyat Samiti is posted at Tahsil level as responsible user for decision making type of the health and related activities.

**PHC:** PHCs are located at villages or sub centers where mainly Medical Officers (MO) are responsible for the health and related activities.

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**Fig. 1.4 : Health Care Communication in the District**

It is observed that the healthcare authorities in district are as :

- DHO : District Health Officer
- THO : Tahsil Health Officer
- PHC : Primary Health Centers
Healthcare Administration in State - Maharashtra:

The Hierarchy of the Health scenario and services at state level: e.g.

Maharashtra State Government is shown in Fig. 1.5

![Healthcare Hierarchy (At State Level)](image)

The researcher has been observed the computing and electronic communication facilities available at various PHC, THO and DHO offices. The various offices visited are in the Districts of Western Maharashtra Viz. Satara, &
Sangli. We visited many PHCs, THO offices: Panchyat Samities (Health Section) and DHO offices: Zilla Parishad (Health Section). We observed that, mostly the communication between PHCs, THOs and DHO is averagely as mentioned in Table: 1.1.

Table 1.1: Present communication mode for Data Transfer

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Region</th>
<th>Units/ Offices</th>
<th>Communication mode for Data transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rural</td>
<td>PHCs to PHCs</td>
<td>Manually</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td>PHCs to DHOs</td>
<td>Manually</td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td>PHCs to THOs and vice-versa</td>
<td>Manually</td>
</tr>
<tr>
<td>4.</td>
<td>Urban</td>
<td>THOs to DHOs</td>
<td>By using CDs in Excel format, By using E-mail</td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td>DHOs to THOs</td>
<td>By using E-mail</td>
</tr>
</tbody>
</table>

It is seen that, most of the PHC units are scattered in remote areas. These units are not linked to each other for the effective co-ordination and efficient working by using modern technologies for communication.

Survey shows that, the current operations of health services are grossly inadequate due to lack of communication facilities between them. Also the, present data recording procedures in most of the Health Centers leave much to be desired. Manual systems employed are inaccurate, it requires more time, space and cost.

We felt that, there is a immense need of modern communication systems which reduces cost and wastage of resources. It also supports needs of a wide range of users. A well-designed system could have a substantial impact on the cost and quality of service (QoS) in health care [Ravi Duggal, 1992]. PHC’s are working in villages where they have approximately 4000 population as the work area. A PHC structure is shown in Fig. 1.6
It is seen that, activities of PHC, THO and DHO are as:

- To consult & perform check up of the patients and maintain the record.
- To supply the medicines, doses and other health care facilities to the people and send reports to the higher authorities.
- To visit each family in the villages and make the inquiry about the various diseases or any other problem related to health care and support accordingly.
- The identified cases to be checked and consulted, operated and follow up of the patients till the patient recovers from the disease/s using his back history (data).
- If the cases can not be handled well due to some reason i.e. lack of medicines, equipments or any other reason such cases can be referred to Tahsil hospital, District hospital with his all record (data).
- To plan for immunization, vaccination programme and conduct it and provide the necessary data to the THO (Tahsil Health Officer).
- THO’s have to collect the reports from PHC’s and forward these reports (data) to DHO (District Health Officer).
- DHO performs consolidation of data and maintain the data received from THOs in the requisite form. DHO has to forward these reports (data) to
the Deputy Director (DD) – health ministry of State Government and DD sends it to Director.

- Director has to send the **reports (data)** to the State Government - Secretary.

- The **reports** are to be sent by PHC regularly to the THO office in Panchyat Samiti office and directly to the DHO whenever required.

- Similarly DHO sends **reports (data)** to PHC directly.

  *The above structure shows that, a large data has been transmitted from one office to another office. So it requires a strong Computing and Communication System.*

**1.5: Why Distributed Computing at PHC, THO and DHO units?**

We observed the following drawbacks in the present healthcare communication which is carried out manually and electronically.

- Presently Information generated is inadequate.

- The recording procedures are paper based which are rigorous and time consuming for maintaining past history: medical data.

- Rural or remote units are not linked, communicated and updated timely with latest schemes or information.

- The present user’s i.e. Medical Officers are mostly involved only in collecting the patient’s information about immunization, vaccination schemes, programme, statistical data etc. rather than providing services to the patients due to lack of computing facilities.

- It is found that, the reports are paper based and are communicated to higher authorities by traditional methods which are time consuming process.

- In emergency situation, due to lack of requisite information, it is difficult to consult, communicate or operate the needy viz. patients due to lack of good communication system.

- Various Government and Non-Government agencies, which need the important information that cannot be made available in time.

- Each PHC unit is reporting to its higher authorities at different levels (e.g. from PHC to Tahsil) by using traditional way which is time consuming process.
Reporting medias and communication channels (e.g. Excel data sheets, e-mails, CDs) for data submission are weak and require more time hence we feel that they are not safe to maintain confidentiality.

Privacy is not maintained neatly for data. Telemedicine is hazardous if consulted by unauthorized staff [David Forslund and David Kilman, 1996]. Faxed data reports cannot maintain security for office recording purpose using present systems.

The healthcare units comprises with complex processes which are dispersed among the diversified users [Kewafor Anyanwu, Amit Seth, Jorge Cardoso, John Miller, Krays Kochut, 2003].

In addition to the above limitations or drawbacks, there are several functional issues in healthcare sector [Jadhav B. T., Patil P P, Renushe H. N, 2009]. These limitations are:

- Lack of awareness about PHC wise disparities in access of people to PHC
- Most of the PHCs are having worst picture of availability of drugs, staff and peripherals. The officers which are working at various levels are unknown about recent HC related practices & problems. This is due to lack of linkages with modern communication technology and its use for HC development [Sundeep Sahay, Eric Monterio, Margunn Aanestad, 2007].
- It is seen that, overlapping & duplication of similar functions at Directorate, division, district & PHC Level that need to be reduced.
- Medical education to the staff is not feasible for every PHC due to shortage of staff and long distance from PHC and training place.

In the view of above stated limitations and other limitations, there is need of application of Distributed Computing for performing data transfer efficiently [Patel Neesha, 2005]. We feels that the DWB model can be developed to reduce above limitations. We also feels that, the model can be user friendly, portable and becomes Self Computing client i.e. Ubiquitous Computing [Heng-Shun Chen, 2007]. As researcher knows that, Primary Health Centers are playing a vital role in developing state as well country, still most of the Primary Health Centers are not computerized.
and as a result, the officers at various levels are not getting actual information about health centers in time [Krishna Nandiminti, Marcos Dias, Rajkumar Buyya].

So we proposed to design and development of Distributed Web Based Model by using Wireless Technology and its performance evaluation.

1.6: Important Processes of Healthcare and Use of Distributed Systems

It is observed that, the information is collected on paper and used at healthcare centers viz. PHC, THO & DHO units and its allied units. The important processes carried out at each unit has been listed as follows:

**PHC Processes:**

PHCs are located at villages. The PHC is a small hospital cum healthcare assistance office.

**Important responsibilities of PHC’s are:**

- To provide information as the help assistance by using healthcare record.
- To store past history in the form of medical records.
- To communicate the information for implementation of schemes for healthcare development.
- To provide the data related to the medical schemes to THO office
- To conduct the healthcare related campaigns and implement the same for the development of the rural community.
- To conduct awareness programmes for prevention of diseases before the commencement of seasons viz. rainy, winter and summer.
- To perform medical checkups and maintain records of patients in the vicinity of PHC.
- To educate, motivate and train the villagers about best practices for prevention of diseases.

*Distributed System is helpful for all the information, processing and data transfer operations.*

**THO Processes:**

THO is an important office authority who is working at Panchyat Samiti at Tahsil level. THO works as the mediator between PHCs and DHOs for the rural development. He represents the whole Tahsil for the effective implementation of healthcare activities.
Important responsibilities of THO’s are:

- To collect, compile, record and maintain various datasheets submitted by PHCs.
- To implement the schemes at Tahsil level and promote different healthcare related schemes.
- To visit the PHC centers and take overview of the activities and record them.
- To monitor the healthcare activities in the Tahsil and provide better environment for the citizens by giving some important hints.
- To communicate the data and information received from DHO’s and vice versa.

The jobs done by the THO is information collection, analysis and communicate to higher authorities. For all these activities, Distributed System does the better job.

DHO Processes:

DHO is an important office authority which is working at Zilla Parishad at District place. The authorities works as the mediator between THOs and Divisions for the healthcare development. DHO represents the whole District for the effective implementation of healthcare and related activities.

Important responsibilities of DHO’s

- To collect, compile, record and maintain various data sheets submitted by THOs and PHCs.
- To implement the schemes at District level and promote different healthcare related schemes through THO and PHC.
- To visit the Tahsil health offices and PHC centers and take overview of the activities and record informative data.
- To perform monitoring of the activities within District and provide better environment for the citizens by giving hints.
- To communicate the data and information received from Divisional offices, State Governments and vice versa to THO and PHCs..

In the view of role and responsibilities performed by the PHC, THO and DHO authorities, we feel that, DWB model in the form of Distributed Web based System is one of the suitable computing solution which is helpful for creation of database,
insertion of newly added data, modifications with in the existing data, searching specific data items, deletion of data items and printing of selected data items in the different formats.

1.7: Literature Review

The researcher have been reviewed the following literature:

**Heng-Shun Chen. [2007]**, in his Ph. D work titled “From Rural telemedicine to ubiquitous healthcare”, stated three dimensions of e-health systems development as i) Information Communication Technology (ICT) infrastructure ii) health system iii) Healthcare setting. In his Ph. D. work, he has explained, how does ICT can be used in healthcare sector for rural users and their development by means of information processing and availability and its timely usage towards patients consultations i.e. User care in remote areas. He also mentioned about the decision making and the implementation of Govt. schemes, resources available at PHC. But his work is only limited to telemedicine which has many drawbacks.

**Mihai Jalobeauni**, a professor of Western University, Romania stated in his research paper titled “Internet –A Virtual Laboratory for Distributed Computing”, that how does the distributed computing can be done by using the internet as a virtual laboratory for database management tasks. He also explained about, how does the different resources can be used globally for various applications? This gives the idea of the Distributed System for healthcare.

The internet downloaded article by **Obi Igbokwe** titled “Wireless Technology and Healthcare” explained major issues for building effective healthcare system by using wireless technology which include needs of standards: data privacy, confidentiality and security, challenges of data entry and difficulties associated with the integration wireless technology based systems with other information resources in the area of healthcare setting. He has also stated the need and importance of wireless technology in the field of medical sciences. The paper also suggests how does the medical education – as a science, has provided a rich area for research in computer science, telecommunications and several basic computing insights and different methodologies have been identified and used in medical computing research.

**Francesco FEDELE. [1995]**, Cambridge University, UK stated in his paper titled [ANSA works 95] “Healthcare and Distributed System Technology”
suggested the need of Distributed Hospital Environment (DHE) where he covered the importance of model and its internal connectivity amongst departments. He also covered the need of advanced healthcare using Information Technology as distributed system in the different views: **Technological, Operating and Organizational**. But it is useful for one organization and not interlinked with the other healthcare organizations.

**V. Cardellini, E. Casalicchio, M. Colajamni, P. S. Yu. [2002], “The state of the art in locally distributed web server system”,** ACM Computing Surveys, Vol. 34 No. 2 June 2002 : focused on web system architecture that consists of multiple server nodes distributed on local areas, with one or more mechanism to spread client requests among the nodes. Using new system solution in the form of web based distributed system. Cardellini & his team have solved many problems concerning with multiple server architectures for web sites. Instead of new system solutions routine mechanism & policies they classified & described main mechanism to split the traffic load among the server nodes. The authors suggests both the alternative architecture & load sharing policies using DWB model. He focused on architecture, internal routines, mechanisms & dispatching request algorithms for designing & implementing scalable web server system under control of one content provider. This work is helpful for design of DWB model.

But, these techniques are not fulfilling the current requirements of multi user.

**Mauro Andreolini, Michele Colajanni, Riccardo Lancellotti. (2005), “Impact of technology trends on performance of Web-based services”,** International Journal of Web Services Practices (IJWSP), No.1, Dec. He has also given some ideas related with performance evaluation of a web based system as well as he also explained difficulties in designing of web based system but researcher expect these difficulties can be overcome only when the proposed model will be developed.

**Michele Colajanni, (2005),** explained the impact of technology trends on performance of web based services. He suggested few techniques of performance evaluation. But suggested techniques are not satisfying the absolute performance characteristics. But the model suggested by researcher is user friendly, its performance can be tested easily and satisfy the absolute performance characteristics.
M. Sriram Iyenger and Mukesh Singhal, (2006), : had explained about how does the distributed systems are essential by using wired and wireless networks with in his research article titled “Effect of network latency on load sharing in distributed systems”, the paper published in Journal of Parallel and Distributed Computing listed the importance and how does the load is shared which implies for the need of web based distributed systems and its application in the remote area.

Sabastein Rumley, Christian Gaumier and Christopher Trefois, (2005), stated how does he complexity in the modern communication networks can be divided in to smaller solutions with in his research paper titled “Distributed and component oriented tools for communication networks using web services” Telecommunication laboratory Switzerland. His work also suggests, how does the needs of remote users can be fulfilled by using the web based tools, which indicates the necessity of the present model to be developed by the researcher.

Vicki McKinney and Mary Whiteside, (2006), with in his research article titled “Maintaining Distributed relationships” published in the Communication of the ACM revived the various communication modes like face to face, video, phone , email, letters fax and commented about how does these modes of data transfers and distributed relationships are important. They also stated complexity with in the distributed tasks. In the suggested model we attempt to minimize the complexity.

Pavol Bistak and Katarina Zakova, Dept. of Automation and Control University of Technology, Ilkovicova Slovak, stated with in his internet article about the need of Client Server applications. They suggested the importance of web applications for sharing of medical advice in the emergency using telemedicine’s. But the research work is limited and useful for the places where the internet connectivity is available.

Cathy Schoen and et. al. (2004), : stated in the “Primary Care and Health system performance : Adults Experience in five countries : Australia, Canada, New Zealand, UK and US”. The problems of primary care and health system in the different five countries and its impact on to the performance is mentioned. They covered issues about access to health care, coordination and communication as well as preventive care.
IBM – a global and world wide leader in technology stated the importance of implementation and usage of wireless devices (PDAs) with computers in the research article: “Transforming hospital care with next generation medicine”. The IBM suggests how does the Personal Digital Assistants can be useful for information transfer? The article also states why there is need of web based preventive disease management system. But we feel that, in India there is need of effective implementation of PDAs by using proper communication methods and internet technology.

Sue Whelton, Anu, Larson and Siaw and Siaw-Teng Liaw, (2005), in his article “eHealth, eLearning and eRources for rural health practice”, WMASH Sept. California USA, mentioned the importance of elearning and eResearch for the development of rural health practices by using Information Communication Technology (ICT) in Australia. The technique and standards used by the authors can be useful for the present work.


Jochen Schiller, (2004), in his Book Mobile Communication, Second Edition, stated the different wireless networks and their importance in Mobile Communication. Author also stated the need for research work in the mobile communication by using wireless and mobile computing. In our research work we are using mobile phones and wireless networks for the study of wired and wireless Network Based Distributed System and Data Logger Based Distributed System systems.

Bakim Patel, Lal Bihari Barik, (2004), in his book, Introduction to Web Technology and Internet, explained design and development of web technology based systems. In present study to design and development of Web Based Distributed System : DWB model, we have applied different programming techniques suggested by him. The authors also stated applications, current and future use of Mobile Internet connectivity which are helpful for research work.
George Couloris, Jean Dollimore, Tim Kinderberg, (2004), Distributed Systems – Concepts and Design, 7th Edition, Addison Wesley, Pearson Education. Authors described the importance of Internet as distributed system and how to perform distributed computing? The author also explains role of wireless networks, mobile devices in the spontaneous working. This helps us in the design and development of various distributed systems studied in the research work.

1.8: Orientation of Research Work

Many techniques in decision making and data processing in healthcare administration depends upon facts and figures. By the survey, it is seen that, information must be shared about different schemes and activities. The information about latest schemes and programmes need to be implemented by using modern computing technology and better communication medias for the development and better administration. There is need of some solution in the form of computing tool. Presently due to lack of awareness of medical related data, the users viz. villagers in remote and rural area are suffering badly. Due to lack of in time information, users and PHC Doctors are unable to update their knowledge and maintain about health care. This results in to that, patients can’t be well treated and they are forced themselves to take help of private hospitals or make use of home based treatments which are not affordable to the common man now a days. Many times such hospitals are not easily accessible in all the ways. The patients become victims of diseases or some times patients dead due to unavailability of healthcare and related information for prevention from diseases.

Due to lack of well computing facilities we feels, that the patients from rural areas will not be supported with correct information at right time. During last four years, survey had been carried out and observations are noted at various processes of many PHCs, THOs and DHOs offices. Also discussions are carried out with the healthcare staff, doctors, experts and govt. officers who are working actually at these units of healthcare. During the discussions and observations we understood that many processes depend upon human knowledge and skill. It has been seen that, there exists different problems in the present communication modes due to traditional way of working.

As a result, these processes suffer from one or more drawbacks as listed below:

• There is lack of security amongst data communication methods.
• Instant communication about the requirements is not presently available.
• Cost of present data communication & processing method is high.
• Decision making for further developments using available data becomes late.
  Due to the unavailability of current data and recent information about any
  government scheme or modern treatments.
• Present mechanism for data sharing and processing requires more time in
  healthcare system.
• Doctors can not share their views with experts from research laboratories and
  training institutions.

In order to dilute these drawbacks, we proposed to develop Distributed
system based on network technology, logger methodology and Web based
technologies. These systems support for wired and wireless technology used at PHC, 
THO and DHO centers as an application. The PHC unit works under the directions of
THO and DHO as stated. The villagers with certain health problems are well treated
as users with facilities and information about various schemes can be provided time to
time from PHCs. With this aim, we have developed the model which treats the
villagers with correct medicinal information as consultation. The research papers:

1) Andre Kushnirule, [2002], “Evaluation of the design of health
information systems: Application of approaches emerging”, Science
direct, Computer in Biology and Medicine, Vol. 32 Issue- 3 May.
2) Krishna Nandiminti & et al. [2006], “Distributed Systems and Recent
Innovations : Challenges and Benefits”, Dept. of Computer Science and
Software Engineering, The University of Melbourne, Australia.
3) Jabir S. Aziz & et al. [2009], “Design of telemedicine systems for rural
and urban areas in Iraq, ARPN Journal of Engineering and Applied
Sciences, Vol. 4 No. 2 April.

All these research papers inspired us to study the clarifications of processes
in healthcare sector and model them as Distributed system as an application for
healthcare system. For healthcare sector, important areas related to rural villagers of a
country may prove to be well modeled and helped for data transfer by using
Distributed applications.

So as evolutionary idea of developing Distributed System which works on
wired and wireless Network Based Distributed Systems, Data Logger Based
Distributed Systems and Internet Technology boiled in our mind while reading some outstanding research papers on applications of Distributed Systems to real problems and few books on specific aspects and agenda of Distributed Systems and applications [George Couloris, Jean Dollimore, Tim Kinderberg, 2004].

So we suggested and developed distributed Systems based on three different concepts - as a part of some important processes of PHC, THO and DHO health sections. The modules of the proposed model will be:

1. PHC day to day working module.
2. PHC, THO & DHO communication virtual module (virtual web) using wired and wireless networks.
3. Data Logger Based Distributed Systems module.
4. Web model.

The software tool or model comprises with group of programs called a module. We put a good time for development using modules as : PHC day to day administration module; PHC, THO & DHO communication virtual module (virtual web) using wired and wireless networks; DLBDS module and Web model of Distributed System and their performance study; Development methodologies and its applicability suggested to various disciplines.

We explored the possible and efficient use of Distributed Systems to the applications of PHC, THO and DHO processes to minimize their manual efforts and make their processes more efficient. We used .Net (dot Net) platform for the development of : PHC day to day working module, PHC, THO & DHO communication virtual module (virtual web) using wired and wireless networks and C language and Protis, VMware simulation software’s for the development of Data Logger Based System. For virtual internet model which will work on wired and wireless technology, we have used .net and other interrelated software applications.

For web model using wireless technology we have used software’s .Net platform with Microsoft Access tool for development. For all these systems the performance is measured by using performance tool of windows XP professional version 5.1 (Service Pack-2) operating system. The development of all distributed systems in the form of modules are illuminating concepts and underlying principles of Distributed Systems, Web design concepts and its applications.

We have developed the following distributed systems and measured performance for each system.
• Wired and wireless Network Based Distributed System
• Hyper Terminal and Data Logger Based Distributed System
• PHC day to day working model
• PHC, THO and DHO communication module as a Web Based Distributed System

First, we have designed the tables of PHC record containing data about certain schemes and kept in the database of three sizes as 1.6MB, 3.1 MB and 6 MB. The wired Network Based Distributed Systems are designed by using: LAN, Comport Network and Internet as communication networks and wireless Network Based Distributed Systems are designed by using: WLAN, Bluetooth, Wi-fi and Wi-Max and Wireless Internet as communication networks.

Here we have designed these systems by using the Peer to Peer mode of architecture of distributed systems. Each distributed system is designed, developed and its performance is observed by using the performance tool.

The performance tool is used from the control panel of windows operating system. The status of different performance parameters are observed and noted. Finally, the performance of each wired NBDS is compared with the other wireless NBDS system and noted the difference in the form of advantages and disadvantages. In the wired and wireless Network Based Distributed Systems, we found certain limitations in the various ways. Hence we felt the need to develop another tool as own distributed system.

In the second part, we have designed and developed Hyper Terminal Based Distributed System (HTBDS), Wireless Hyper Telephone Network Distributed System and Data Logger Based Distributed system (DLBDS). The DLBDS system is designed and programmed by using the C language. The two terminals are loaded with DLBDS system and the connection is developed by using the wired network as LAN. The three data files of size 1.6 MB, 3.1 MB and 6 MB are designed. The data file is text file containing data about PHC details which are selected for the experimental study.

As we have found certain drawbacks in the DLBDS system, we felt the need to design and develop Web Based Distributed System as DWB model. This model is designed and developed by understanding the requirements of PHC, THO and DHO
units. The web design and principles of distributed system are used for the construction of the tool. The tool is web based application which supports the internet which is a virtual Distributed System. The tool is useful for the hospital administration for PHC day to day activities. In addition to that, it can be accessed for communication between PHC, THO and DHO units. There are two major parts of the system which are: Clients and Server. The interfaces are designed and developed are briefly explained in the Chapter IV. The data is entered and Distributed System is tested by hosting the web application on to the Internet. We have measured the performance by accessing the tool by the different users such as PHC, THO and DHO. The various data reports useful for the PHC, THO and DHO administration are generated by using this tool.

After putting the system for the usage, we observed that, DWB model plays a vital role in connecting the rural PHC with the urban based THO and DHO units. When we compare this tool with DLBDS and different wired and wireless NBDS, we feel that, the performance of DWB model is always better and it is one of the global solution and resource for the information access and decision making activities.

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