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TELEMEDICINE USING COMPUTER COMMUNICATION NETWORK

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ABSTRACT

Most of the Telemedicine Centers maintenance cost is very high. Mostly the Telemedicine centers have hierarchical structure of Network Model. Telemedicine Nodes are maintenance from VSAT to TM Foundation, TM division to TM Nodes. This hierarchical structure of maintenance cost is very high. My research work is proposed Telemedicine using computer communication Network by distribute network sharing structure, so all the TM nodes are act as a TM Foundation and the maintenance cost is very low that can implement to rural area. We need framework design of telemedicine network for low cost telemedicine network maintenance for Mode 1 is the communication control mode that is applied to set the client's communication status; Mode 2 is a point-to-point mode that makes clients able to have point-to-point communication; Mode 3 is a group working mode that provides the multipoint-to-multipoint communication. TM using computer communication network can be transmitted all Bio-signal of ECG, EMG, EEG, blood pressure, temperature and all images with high quality[1][2].

Index Terms: Telemedicine, Computer Network, Distributed Sharing.

1. INTRODUCTION

VSAT based telemedicine network is a hierarchical structure of telemedicine network. Mostly telemedicine used in rural area. but needs the following back ground.

- need network division.
- need License and agreements from Network foundation.
- need of V-Satellite Communication.
- need high frequency, bandwidth allocation with respect distance transmission.
- need high cost for maintenance for TM foundation or division.
- need high filter section circuit for transmission and receiving signal.

The fig 1. model is hierarchical structure of VSAT telemedicine networks model, If the patient 1 has to connect and discuss to Specialist Doctor 4, the following connectivity of single root path:

Patient 1 → Rural Hospital 1 → Telemedicine division1 → Telemedicine Foundation → Telemedicine Division 2 → Rural Hospital 4 (specialist 4). If failure link root between telemedicine foundation to telemedicine 2, Patient 1 is not link to Rural Hospital 4 of specialist 4. It has only one root path , if this root path failure cannot communication between patient 1 to specialist doctor 4.

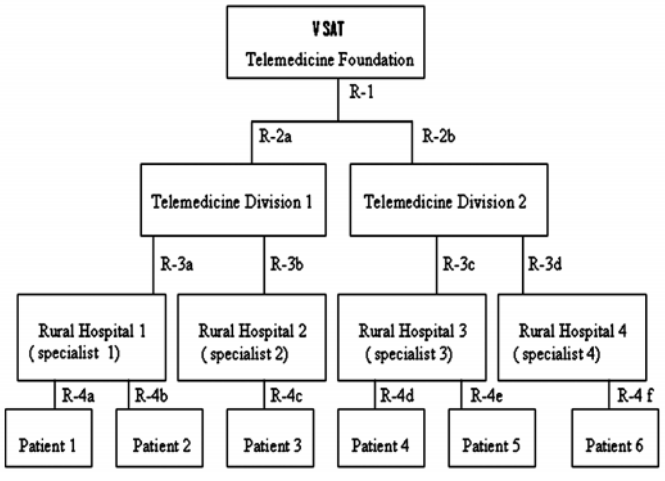

Figure 1: Hierarchical Structure V SAT Telemedicine Network

ISRO is providing free bandwidth through V SAT connectivity in India, they are also looking forward to defining a framework modal for a National Telemedicine connectivity GRID on hybrid model utilizing existing terrestrial fiber optic and upcoming wireless media

technology, this hierarchical structure of maintenance cost is high. This would look at utilizing bandwidth across different communication links depending on the application and the investment considerations. The specific structure of any particular telemedicine center of the network would depend on the geographic factors of the area that will be serviced by the network, and the type of local users there. They visualize the National Rural Telemedicine Network to be a tiered hierarchical structure. This would include:

- **LEVEL-1**: Primary Health Center (PHC)/ Community Health Center (CHC) *connected to a District Hospital*
- **LEVEL-2**: District Hospital *connected to a State Hospital / National Super Specialty Hospital*
- **LEVEL-3**: State Hospital / National Super Specialty Hospital *connected to each other*
- **LEVEL-M**: Mobile Telemedicine Unit covering few villages *connected to nearest PHC/CHC or directly to District Hospital*

Financial summary providing for defining a framework modal for a National Telemedicine of hierarchical structure. There are various varying components in the tentative budget provisions given the table 1, here the maximum value per unit is taken to know the extent of budget. Communication setup and running cost may change completely depending on the type of connectivity chosen finally.

Table 1
Financial Summary Providing for Defining a Framework Modal for a Indian National Telemedicine of Hierarchical Structure

Unit	*Fixed*	*Recurring*	*Qty*	*Total*
LEVEL-M	71,60,000	13,22,000	50	42,41,00,000
LEVEL-1	15,60,00	07,48,000	100	09,04,00,000
LEVEL-2	49,60,000	14,14,500	50	31,87,25,000
LEVEL-3	35,10,000	11,97,000	5	02,35,35,000
Total			205	85,67,60,000

The above hierarchical model of Telemedicine has the following problem in rural areas:

- The maintenance cost is very high.
- If the connectivity of foundation is failure depending upon the divisions and hospital specialists are not able to connectivity.
- need signal strength Antenna for signal transmission and receiving.

2. METHOD OF TELEMEDICINE USING COMPUTER COMMUNICATION NETWORK

My research paper is proposed Telemedicine using Computer Communication Network that is followed distributed sharing of network, this model overcome the rooting failure, if root is failure the other root is selected by routing algorithm.

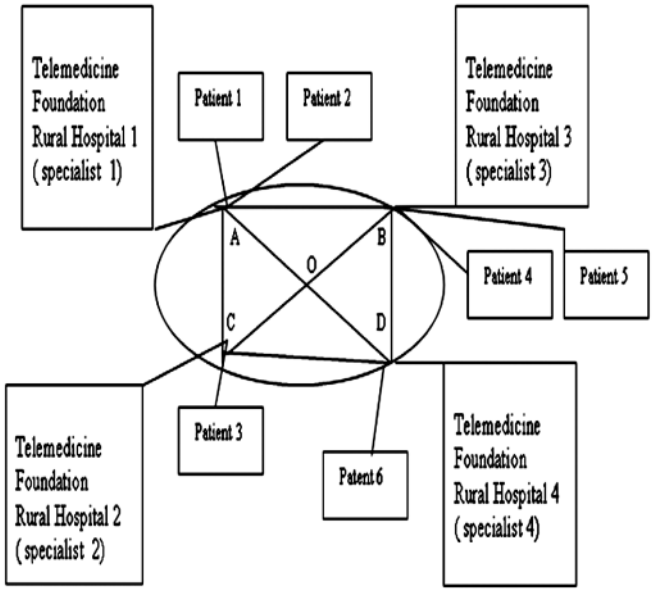

Figure 2: Model of Telemedicine using Computer Communication Network

If Same patient 1 connect and discuss to Specialist Doctor 4, link the following root paths:

Root 1: Patient 1 → Network Point *A* → Network Point *O* → Network Point *D* → (specialist 4)

Root 2: Patient 1 → Network Point *A* → Network Point *B* → Network Point *D* → (specialist 4)

Root 3: Patient 1 → Network Point *A* → Network Point *C* → Network Point *D* → (specialist 4)

Root 4: Patient 1 → Network Point *A* → Network Point *O* → Network Point *B* → Network Point *D* → (specialist 4)

Root 5: Patient 1 → Network Point *A* → Network Point *C* → Network Point *O* → Network Point D → (specialist 4)

Root 6: Patient 1 → Network Point *A* → Network Point *C* → Network Point *O* → Network Point *B* → Network Point *D* → (specialist 4)

Root 7: Patient 1 → Network Point *A* → Network Point *B* → Network Point *O* → Network Point *D* → (specialist 4)

In Distributed network sharing root paths have seven root paths for connective from patient 1 to Specialist Doctor 4. So one root path is failure other six root can use by Routing algorithm in Distributed network sharing.

Advantages of TM using Computer communication Networks:

- all TM nodes act as a telemedicine foundation.

- all small scale hospitals can be done Telemedicine center.
- no need Antenna with high frequency, Bandwidth allocation for signal transmission and receiving.
- no need high cost for making network foundation.
- mostly avoid filter section Circuit for transmitting and Receiving signal.
- not limited Channels.

3. CONCEPT OF COMPUTER COMMUNICATION NETWORK

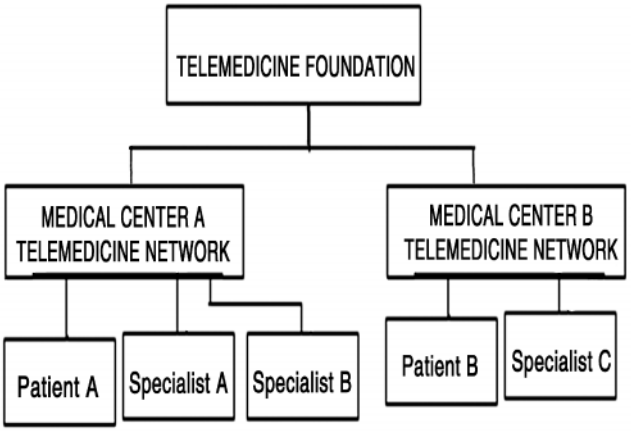

Figure 3: Hierarchical Structure of Telemedicine Network

In the application of telemedicine, the medical information usually needs to be distributed among medical doctors and display, archival, and analysis devices. For example in fig.3 is hierarchical structure of Telemedicine Network when Patient *A* is requested to send data to the medical specialists *A* and C, by using the traditional method, the patient has to send data to specialist *A* first and then the same data to specialist *C*. If a service in the Medical Center *A* was able to receive the data packages of Patient *A* and deliver the packages to specialists *A* and *C*, the patient's operation would not be simplified. Patient *A* send data to medical center *A* then send to Specialist *A*. then send data to Telemedicine foundation to Medical center *B* then deliver to Specialist *C*. The method requested by patients and served by a special application gives out a computer communication network structure. To meet communication requirement for telemedicine applications, we introduce the concept of a computer communication network that is able to provide the service of multipoint-to-multipoint communication and has a simple connection with its clients. The architecture model of the logical connections of telemedicine applications through this Computer communication network is presented by Fig. 4.

To make an effective service for all clients, a distributed sharing is adopted in this communication service model. The telemedicine users and participants, medical information display, archival, and retrieving systems are all clients to the distributing sharing communication Network. The communication among them are all under the control and through the services of the communication distributed network service as shown in Fig. 4. The basic function of the communication network service is to manage the communication between its clients, such as to receive, transfer, and distribute the medical information and to control the information exchanging direction, priority, and stream rate. Since such a network is able to exchange data packages with all clients, so each client is able to send to and receive information through the network. In the client's view, he or she has only one connection with the network and only needs to send the communication request in a data package to the network according to the hospital's protocol. To meet the special requirements in telemedicine applications, three operation modes are defined for the communication network as follows: Mode 1 is the communication control mode that is applied to set the client's communication status . Mode 2 is a point-to-point mode that makes clients able to have point-to-point communication; Mode 3 is a group working mode that provides the multipoint-to-multipoint communication.

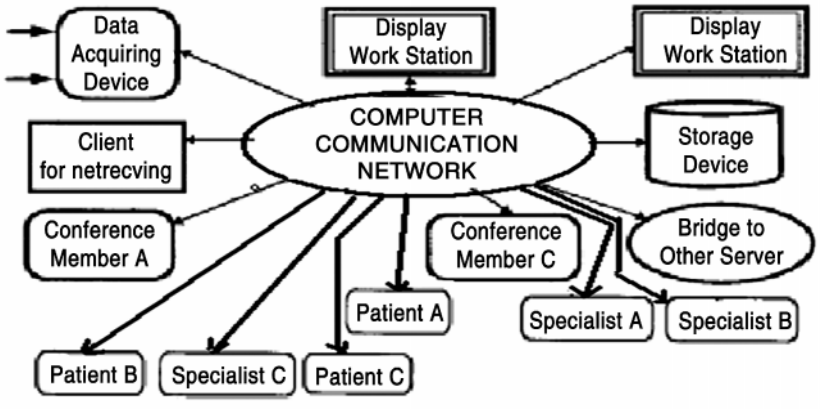

Figure 4: Telemedicine using Computer Communication Network

4. FRAMEWORK DESIGN OF TELEMEDICINE NETWORK

Framework design of telemedicine network for following services:

(i) Bio-Medical service

(ii) Information Technology service

(iii) Computer Communication network service

Framework design of Telemedicine network shown in figure 5.

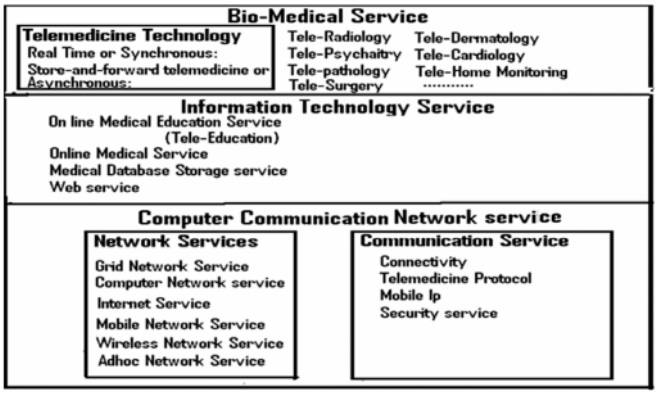

Figure 5: Framework Design of Telemedicine

4.1 Bio-Medical Service

The main Bio medical service application are Tele surgery, Tele-dermatology, Tele-cardiology, Tele–radiology, Tele-psychiatry, Tele-pathology, and Tele-home monitoring etc. Bio Medical service as shown in fig. 6.

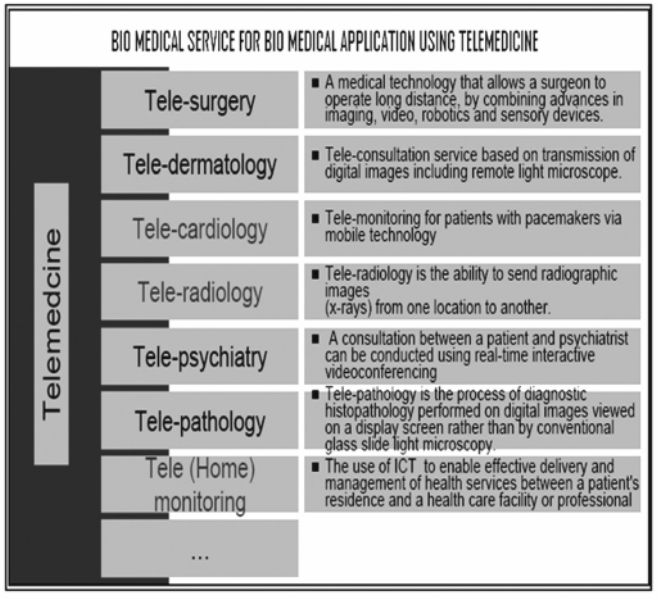

Figure 6: Bio Medical Service for Bio Medical Application using Telemedicine

4.2 Information Technology Service

The goals and activities of telemedicine and health IT are complementary and synergistic. Telemedicine is a method of delivering health care that makes use of health information technologies to accomplish its goals. Conversely, health information technologies (HIT) are an enabling component to the delivery of health services over distances, providing fundamental tools and systems.{3}{4}.

The base of health information technology supports the deployment and use of electronic health records, administrative applications consumer information services and core clinical services (of which telemedicine is one component in the delivery of those services). Relation between Health information technology(HIT) and Internet based Telemedicine as shown in fig. 7. And fig 8.

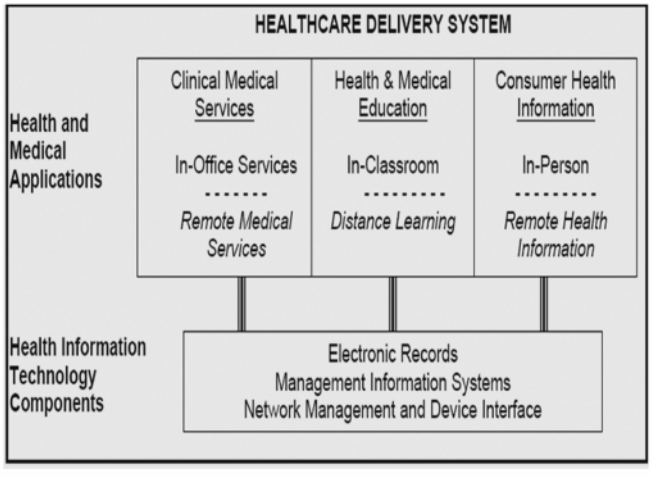

Figure 7: Relation Between HIT and Telemedicine

Tele-Medicine, Health informatics, using IT for Health for Prevention, curing, rehabilitation, Medical Education and accessing resources are the some of them.

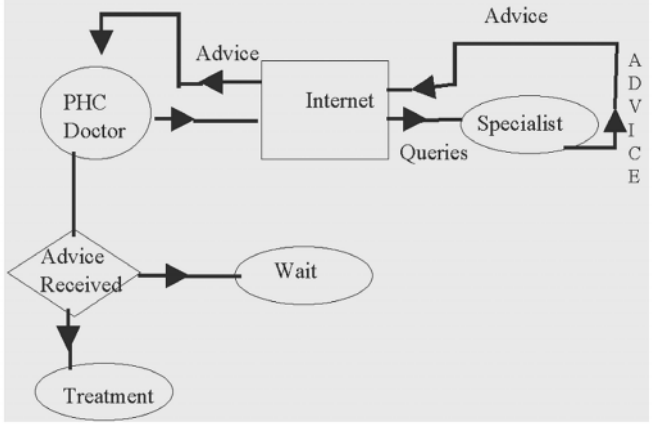

Figure 8: Internet Based Telemedicine

4.3 Mobile IP

The traditional way of IP address assignment to a node is network dependent. It brings problem in a mobile network environment. When a mobile node moves from one wireless network to other network, the IP address

must be changed accordingly, while ongoing connection must be maintained and the packets belonging to the connection must be delivered continuously.[5][6][7]. Mobile IP is the solution to this problem. Mobile IP users keep the same long-term IP address, ie home address, which has the same network prefix as a network called home network. When a Mobile Node determines that it is connected to a foreign network, it acquires a care-of address in addition to its home address. Care-of address is a forwarding address for a roaming mobile node. In mobile IP, packets destined for the mobile node are always sent to the mobile's home network. When a mobile node moves to a foreign network, it gets the care-of address from a router in the foreign network called foreign agent. The mobile node then registers the new location to a router in its home network, called home agent. The home agent captures packets meant for the roaming mobile node, encapsulates and forwards it to the foreign agent. The foreign agent then delivers the packets to the mobile node. Packets in the reverse direction from the mobile node can go directly to the corresponding host without going through the home agent. Mobile IPv6 simplifies the scenario by removing the foreign agent. The mobile node uses IPv6 address auto-configuration procedure to acquire a collocated care-of address Simple connection of telemedicine network as shown in Fig. 9.

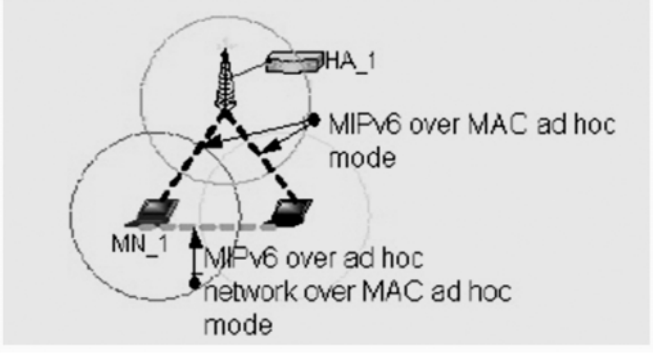

Figure 9: Simple Connection of Telemedicine Network

4.4 Telemedicine Protocol

In order to discuss about the protocol architecture, we need to examine the following case. When MN_1 is attached to its home network and located within coverage area of the AP, it has one hop to HA_1. MN_1 can use MIPv6 mechanism available from HA_1 to communicate with another node. In the mean time, MN_1 can also communicate directly to another node in a peer-to-peer fashion using ad hoc network based on medium access control (MAC) WLAN ad hoc mode. Therefore, that MN has two mechanism links over MAC WLAN ad hoc mode, namely MIPv6 over ad hoc mode and MIPv6 over ad hoc network The tele medicine MN specifications are defined in a protocol architecture describing the functionality of all layers. As illustrated in Fig. 10, the telemedicine protocol architecture consisting of fourth layer includes adhoc protocol network within the network layer[5][6].

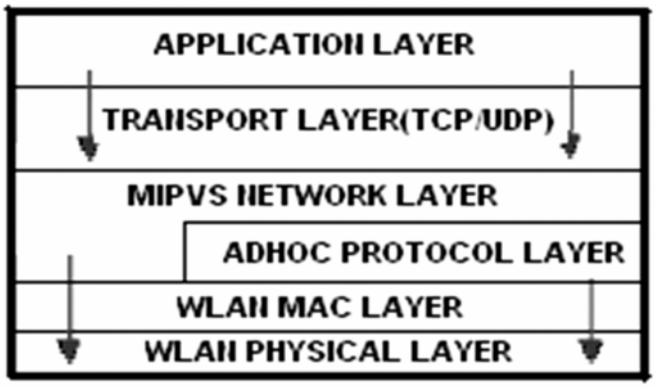

Figure 10: Telemedicine MN Protocol Architecture

If a MN communicates using ad hoc network, the ad hoc network layer is taken to provide ad hoc communications. With this architecture, the MN is able to handle two mechanism links as defined above. A mobile node such as MN_1 can move anywhere, anytime in the home network or move into foreign network as shown in Fig. 10. When MN_1 is attached to a foreign network, it obtains a care of address (CoA) and registers it with HA_1.

The HA_1 will know the current address and location of the MN_1. When a correspondent node (CN) such as the server in health care center sends packets towards MN_1's home address, the packets are intercepted in MN_1's home network by HA_1 and tunneled to MN_1's care-of address. When MN_1 sends packets to the CN, it uses its CoA as source address and puts its HoA in the Destination Options (home address

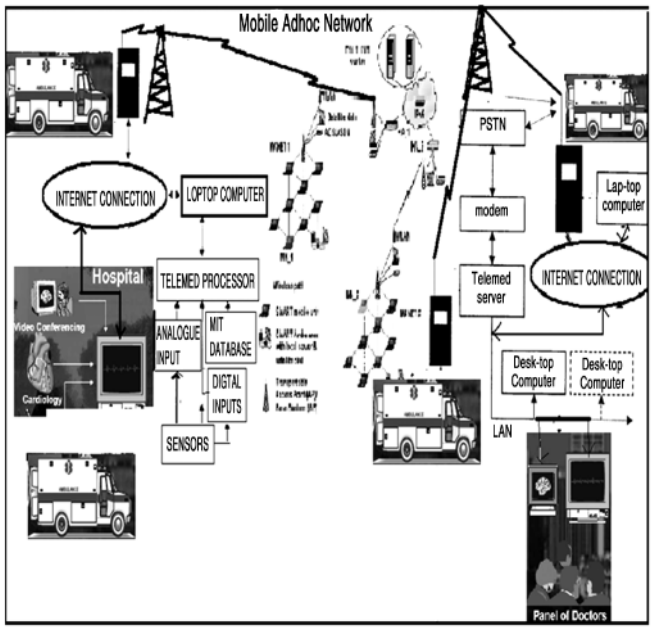

Figure 11: Mobile Telemedicine-Emergency with MIPv6

options). MN_1 informs the CN of its new CoA so that subsequent data traffic can be sent directly between MN_1 and CN, without tunneling process to the HA_1.

Upon the packet receive by CN; the HoA replaces the source address so that the applications in CN perceive that it is still communicating with the MN at its HoA. While the CN sends packets to MN_1, it puts MN_1's CoA in the destination field and the HoA in the type 2 routing header. The same processes are applied to MN_2 when it is moved and attached into a different sub networks. The macro mobility given by MIPv6 combined with MANET micro mobility within sub network provides seamless mobility for Tele-Emergency MN.

4.5 Mobile Ad Hoc Network

Ad hoc literally means "formed or used for specific or immediate problems or needs". Thus, MANET means a mobile network which can be formed or used for specific or immediate problems or needs. Mobile nodes in a MANET communicate to each other without base station, without the aid of any centralized administration hence it is also known as an infrastructure less wireless network. MANET employs its mobile nodes as a part of the networking system. Each node in MANET can act as an intermediate node, i.e. as a relay to forward packets of data and do routing functionality. In MANET, mobile nodes are free to move arbitrarily. It leads to an important property of MANET which is dynamic topology. MANET routing protocols can be classified into demand-driven routing protocols and table-driven routing protocols. Demand-driven protocols create routes only when the source node initiates a route discovery process. Examples of demand-driven protocols are Ad Hoc On-Demand Distance Vector (AODV) and Dynamic Source Routing (DSR). Table-driven protocols attempt to maintain consistent, up to date routing information in routing tables on every node. Examples of table-driven protocols are Destination Sequenced Distance Vector (DSDV) and Optimized Link State Routing (OLSR). command.

4.6 Grid Network Service

GRID network technologies could improve the management of Medical Information Systems, in order to enable a coordinate, flexible and secure sharing of diverse resources, including computers, applications, data, storage, networks and scientific tools across dynamic and geographically (at regional, national and international level) dispersed health structures and clinical communities (Virtual Organizations Healthgrid uses GRID technologies applied to health care information (at molecular level as genomic data, at individual level as medical record and imaging and at population level as epidemiological registers and database), in order to establish a distributed environment providing basic common services (web portals, computing resources) to the health professionals and biomedical researches located in various Hospitals, clinical and research centers grid network service as shown in fig.14 by grid service portal. The most important fields in which Grid technology is exploited for health purposes are Proteomics, Genomics, Bio-images analysis and transmission, simulations of biological events and clinical knowledge sharing, Neuroscience, Epidemiology[8].

Bio-informaticians are creating Grid Services Portals. These are actual service providers wishing to take advantage of the grid's computational power and data storage capacity. Grid service Portals may be used to run the presently existing algorithms as well as new grid-aware ones. Many biomedical service providers rely on web-based technologies to offer access to their databases and computational resources. Grid service Portal as shown in fig.12.

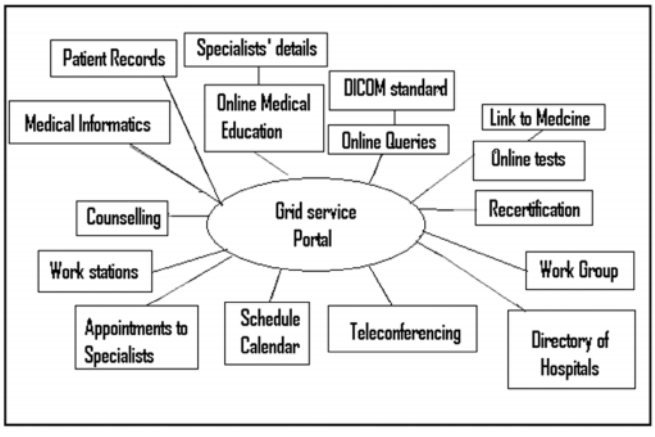

Figure 12: Grid Service Portal

4.7 Web Portal

Web portals offer users a unique access point to information, sites, web services with a common focus, and are organized in such a way as to make them easier to use. They can automate transactions, manage processes, provide access to information and reduce the time and money spent on financial and administrative operations.

5. APPLICATION OF GRID IN TELEMEDICINE NETWORK

The application of grid technology to healthcare explaining the concept of healthgrid. A healthgrid is an innovative use of information technology to support broad access to rapid, cost-effective and high quality healthcare. An emerging aspect of e Health, it is an environment where data of medical interest can be stored, processed and made easily available to the different actors of healthcare, physicians, healthcare centres and administrations, and of course citizens.

The recent emergence of grid technology opens new perspectives to enable telemedicine and medical research with developing countries, particularly for preparation and follow-up of medical missions as well as support to local medical centres in terms of teleconsulting, telediagnosis and patient follow-up. Indeed, grids mask the complexity of handling distributed data in such a way that physicians will be able to access patient data without being aware where this data is stored.

GRID technology opens perspectives to empower existing telemedicine services in terms of interactivity and access to data. It allows the exchange of patient data by Grid networks as fig 13.

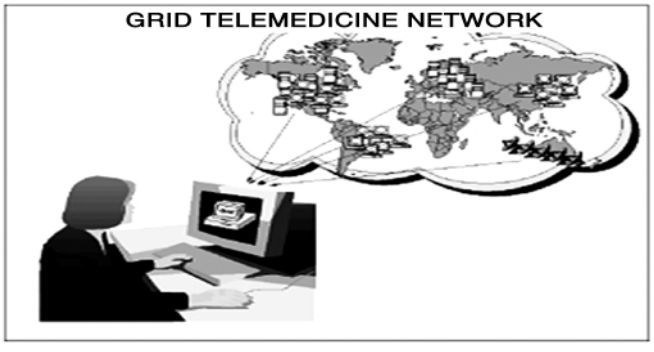

Figure 13: Grid Telemedicine Network

Benefits of Grid in Telemedicine network:

- The complicated and complex global environment leverages a multitude of open standards and technologies in a wide variety of implementation schemes.
- Grid computing adds infinite number of computing devices into any grid environment
- So better computing capability and problem resolution tasks within the operational grid environment.

The grid gather:

1. drug designers to identify new drugs
2. healthcare centres involved in clinical tests
3. healthcare centres collecting patent information
4. structures involved in distributing existing treatments (healthcare administrations, non profit organizations,…)
5. IT technology developers
6. Computing centres
7. Biomedical laboratories searching for vaccines, working on the genomes of the virus and/or the parasite and/or the parasite vector

A grid dedicated to research and development on a given disease should provide the following services:

1. large computing resources for search for new targets and virtual docking
2. large resources for storage of post genomics and virtual docking data output
3. grid portal to access post genomics and virtual docking data
4. grid portal to access medical information (clinical tests, drug distribution,…)
5. a collaboration environment for the participating partners. No one entity can have an impact on all R&D aspects involved in addressing one disease. Such a project would build the core of a community pioneering the use of grid-enabled medical applications. The choice of a neglected disease should help reducing the participants reluctance to share information. However, the issue of Intellectual Property must be addressed in thorough details.

6. DISCUSSION

Most of the telemedicine projects are designed to allow the exchange of information between two groups of healthcare professionals, in developed and/or developing countries. Such an exchange is very well fitted to provide a second diagnosis. However, the set-up of multipoint dynamic telemedicine networks where several teams could share patient data while respecting patient privacy requires the further strengthening of collaboration between healthcare professionals even within developing countries. In these networks, the medical teams in healthcare centres would be capable of sharing medical data on demand for second diagnosis [10]. This requires moving away from the present central web server approach towards the creation of a federation of databases where data is stored in the healthcare centres and made available for punctual enquiries whilst safeguarding patient privacy.

Such networks would be efficient tools to collect epidemiological data in relation to neglected diseases. Indeed, epidemiologists need to collect data from endemic areas to develop models of a given disease, to evaluate drug resistance, to monitor drug distribution, etc. The medical data available in hospitals geographically distributed in endemic areas is extremely relevant provided it can be consulted for epidemiological analysis. GRID technology allows the creation of such a federation of databases.

7. RESULT

The Bio-signal transmission of ECG, EMG, EEG and all image can be transmitted and receiving by digitally through distributed network sharing with live or store and forward method as shown in figure 14 and figure 15. We can avoids noise problem for transmission and receiving signal of biomedical signals and avoid noise problem by digital transmission of Bio-signal and all Image , The same quality of Image are received by digital

transmission. The IP address for connectivity of TM center are user friendly in rural area... All client act as a TM foundation. The maintenance cost is very less in my research. The small transfer delay referenced in table 20

Figure 14: Live Transmission and Receiving of ECG Signal by TM using Computer Communication Network

Figure 15: Receiving of ECG Signal by Computer Network of TM

Table 2
Data Transfer and Transfer Delay Time

Data	*Transfer rate*	*Transfer Delay time*
Physiological data	240 KB	0.5 sec
	3 MB	0.1 sec
	10 MB	0.04 sec
	22 MB	0.01 sec
Medical Image	240 KB	1.02 sec
	3 MB	0,1 sec
	10 MB	0.04 sec
	22 MB	0.01 sec

Table 2. shows Data transfer and transfer delay time of TM using computer communication network If we use above 2 MB speed of internet connection avoid transfer delay in network sharing of TM.

8. CONCLUSION

In future Computer communication based telemedicine will be implemented in rural area by very low cost for live or store and forward method of transmission and receiving. All the small scale Hospital can act as a TM foundation in rural area. The Mobile also can be implemented for TM node, some time it act as a TM foundation if we connected Distributed Network sharing through internet connection. The quality of transmission is very high in digital [9][10]. Grid technology of telemedicine network by sharing distributed by internet and support complicated and complex connection of telemedicine network.

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