

REAL TIME TELEMEDICINE HEALTH SYSTEM



THESIS REPORT

by

NC Rabia Sultan

NC Muhammad Riaz Ahmad

PC Iftikhar Ahmad

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CERTIFICATE OF CORRECTNESS AND APPROVAL

Certified that work contained in this project thesis “**REAL TIME TELEMEDICINE HEALTH SYSTEM**” carried out by Rabia Sultan, Muhammad Riaz Ahmad and Iftikhar Ahmad under the supervision of Dr. Col Fahim Arif for partial fulfilment of Degree of Bachelor of Software Engineering is correct and approved.

APPROVED BY

(SUPERVISOR NAME)

_____ **DEPARTMENT**

MCS

DATED: _____

In The Name Of Allah, the Most Benevolent, the Most Merciful.

DEDICATION

Dedicated to my father who helped me walk through the life. And to my great mother who loved me even when I was rough.

-Rabia

Dedicated To My Parents and Brother who brought me where I am today. And to my fiancé Dr Quratulain Aslam for her unimaginable support.

-Iftikhar

Dedicated To My Parents and Brother who always motivated me, and To My Wife Dr. Amna Riaz for her unending support and kindness thru every hardship of life.

- Riaz

ACKNOWLEDGEMENTS

“All and every kind of praise to be for Almighty Allah, Who guides us from darkness to light and help us in difficulties”

First of all, we are grateful to Almighty Allah, His Kindness and Compassion that he made us able to complete this project.

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We are thankful to a friend and guide Sir Faryaad who lead us thru many difficulties. We are also thankful to Sir Aftab Ahmad Khan who helped us understand many things in video domain.

ABSTRACT

This document describes the complete Java based application, Telemedicine health system RTMS (Realtime Telemedicine System), incorporating two practices of Telemedicine: realtime telemedicine and store and forward telemedicine. RTMS is a medical diagnostic and treatment system to be deployed in remote areas of Pakistan where medical facilities are not adequate. To help patients in remote areas to get medical advice and treatment remotely by doctors and physicians, a representative in each remote area will make appointments with doctor and patients can communicate with doctors on due time with the setup deployed in every site. Main focus of the project is on presenting a free and open source solution for Multi-point Video Conferencing for which an open source streaming server (Darwin Streaming Server) is used. 2-4 people can join Video conference as per the need. Server would be used for scheduling the meetings and connecting members for video conference. Java based server application is also developed to handle database requests and AAA(authentication, authorization and accounting) of application.

Thesis Report

Project Introduction

Literature Review

System Requirements Specification

System Design Specifications

System Implementation

Testing and Results Analysis

Conclusion and Future Work

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Chapter 1: **Introduction**

Telemedicine is the use of telecommunication technologies to provide medical assistance electronically. It involves various mechanisms including the transfer of electronic medical data like high resolution images, sounds, and live video and patient records, from one location to another. This transfer of data utilizes a variety of technologies which includes telephone lines, the internet, CD-ROMs and voice response systems. Telemedicine is utilized by health providers in a growing number of medical specialties like dermatology, oncology, radiology, surgery, cardiology, psychiatry, gynecology and home health care.

1.1 Background

Need of Telemedicine System:

People living in rural and remote areas face very hard time to access timely, quality specialty medical care. Residents of these areas have little or no access to specialty health care, primarily because health facilities and machines are difficult to manage in these locations and specialist physicians are more likely to be located in areas with a more concentrated population.

Telemedicine in Pakistan:

Thus, the concept of Telemedicine is highly essential in developing countries like Pakistan that lack basic health care infrastructure. Pakistan is one of the highly densely populated countries in the world, yet the number of doctors is inadequate when compared to the number of patients. The doctor to population ratio is 1: 1,436 in Pakistan as compared to the 1: 500 in developed countries. In the case of a specialist, the figures in Pakistan are even worse, 1:12,800. Keeping in mind these health scenarios in Pakistan, no one can deny the importance of Telemedicine in providing specialized health services to the people of remote areas who have long been neglected, especially, the women and children who often sacrifice their health care.

To provide specialty care for the people living in remote areas of the country, there are

2 possible solutions:

1. The first is to build new hospitals and to then equip them with the latest medical equipment. This idea requires time, finances and effort. Moreover, it has been tried several times in past with little or no success.
2. The second solution is to adopt the Telemedicine concept, which means connecting already established health centers and advanced medical

establishments to localities where such institutions do not exist. This is done by using existing health care facilities and therefore is more feasible to setup.

1.2 Problem Addressed

Because of limited availability of service providers, both are very expensive solutions. All video conferencing softwares are under proprietary license. For a telemedicine system, no system with EMR and integrated video conferencing exists.

1.3 Goals and Objectives

To provide complete, indigenous & optimal multi-point video conferencing solution for real time telemedicine System.

To achieve this, our system will provide following solutions thru technology:

1. Multipoint video conferencing software for real-time diagnosis of patient's problems
2. Store and forward problem and diagnosis using patient's profile

1.4 Deliverables

- SRS + Literature review (current document)
- Architecture
- Design document
- Project documentation + code
- User manuals
- Quality assurance document
- Final Report

Chapter 2: Literature Review

2.1 What systems already exist?

2.1.1 Existing Video Solutions

There are many Systems for video and audio conferencing which already exist. They can be categorized as

1. **Online hosted paid services:** None of them are open source.

- 1-Nefsis Online
- 2-Cisco WebEx Meeting Center
- 3-MegaMeeting
- 4-Polycom HDX video conferencing solution

2. **Online hosted free services:** GTalk, Skype

3. **Self hosted systems:** No system available as such that application can be installed and hosted on own servers

2.1.2 Existing Telemedicine Solutions

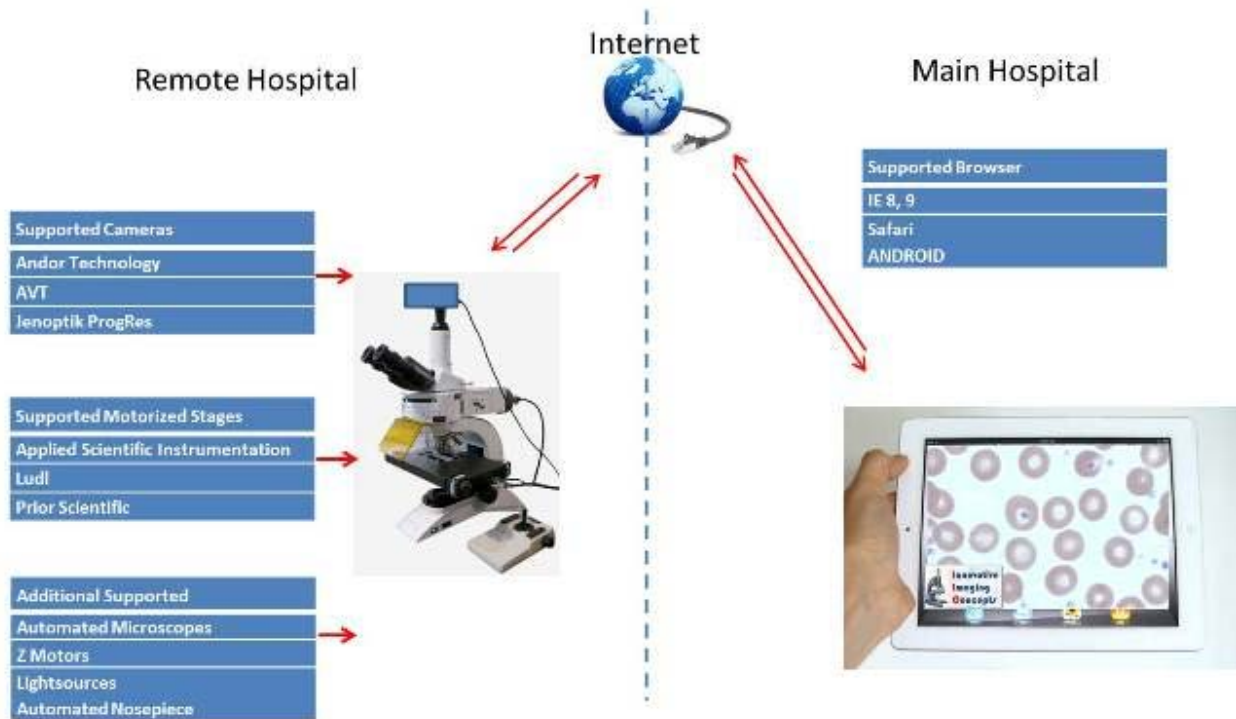
Self Hosted System OpenMRS is an open source system which has the source code available to install and maintain complete server functionality.

Other extensions:

Telepathology: The first telepathological system was developed in the 1960's at the Massachusetts General Hospital. However, it was not explored and used until the late 1990's. Telepathology is basically the viewing of pathological specimens on monitor and is successful in alleviating the maldistribution of pathology throughout the United States.

There are two main types of telepathology. The first is Dynamic Imaging Telepathology and the second is the Static Imaging Telepathology. In this form, pathologists select images, store them on a computer, and upload the image to other pathologists.

Telepathology is the practice of pathology at a distance



Primary Care Systems

Telemedicine, in today's health care, is most often associated with primary care. Basically, primary care is the, "basic level of healthcare that includes programs directed at the promotion of health, early diagnosis of disease or disability, and the prevention of disease." (Telemedicine: Theory and Practice)

Often times, rural areas have a difficulty in attracting physicians to practice in their area. This may be due to a number of reasons, some being the lower incomes, dispersed population, lower insurance levels, and lower reimbursement rates. However, if telemedicine can be implemented in rural and underserved areas, it can be extremely beneficial. Firstly, it can reduce professional isolation, provide medical education, improve contact with research facilities, increase continuity of patient care, and increase the physician's income. This can be accomplished by video consultations. Secondly, telemedicine can increase the percentage of patients that can be treated at local community hospitals instead of being transported to urban hospitals.



2.2 What are the shortcomings/issues?

Band width:

In the remote areas, bandwidth can be biggest issue to provide such services. Also to stream multiple videos, quality of video will be compromised to great extent due to bandwidth.

Congestion:

In video streaming, congestion can cause packet loss which can reduce video quality to great extent.

Signal latency:

Signals can have high latency because of low bandwidth in far off areas. The information transport of digital signals in many steps needs time. In a telecommunicated conversation, an increased latency larger than about 150–300 ms becomes noticeable and is soon observed as unnatural and distracting. Therefore, next to a stable large

bandwidth, a small total round-trip time is another major technical requirement for the communication channel for interactive videoconferencing.

2.3 What issues your project will resolve?

There is no open source video conferencing is available so our project resolve this issue. There is no such telemedicine system in which video conferencing is attached with Electronic Medical Record System so this issue is resolved by our system.

Despite every availability, RTMS is a unique system prepared as per the business requirements of a real client and incorporated every small level requirement of a telemedicine. Also it can be extended further to add more telemedicine options.

Chapter 3: **System Requirements Specification**

3.1 Functional Requirements

3.2 Nonfunctional Requirements

3.3 Design and Implementation Constraints

3.1 Functional Requirements:

System can be divided into three Modules:

1. User Accounts management
2. Meeting Centre
3. Written prescriptions

1. **Generate notice/alert:**

System must generate alert for all new events every time user logs in. For doctors end alerts for meeting invitation and all new patients since last login must appear as alerts. For paramedic staff, all new scheduled meetings and new prescriptions must appear as an alert.

2. **User Accounts:**

a. **Account creation:**

System has to provide mechanism to create new user accounts. User must provide username and password to access the system.

Stimulus/Response:

1. Select signup option from login screen. System will direct the user to a new page with a signup form.
2. User enters credential including username and password and requests an account.
3. System will direct user to a new page with a message that account shall be confirmed

b. **Authentication:**

System has to provide authentication mechanism to identify the authorized uses. User must provide username and password to access the system.

- a) On home screen, user will give username and password
- b) For authenticated users, their accounts with home screen shall appear. Unauthenticated will get a response to re-enter data again.

c. Authorization:

Authenticated user can access only those system features for which he has the appropriate privileges.

3. Video Conference:

a. Schedule meeting:

Doctor after reviewing the patient's profile may feel the need to have a live inspection of patient. So doctor can schedule the meeting at any time. Paramedic staff will get meeting's notification and inform the patient about the meeting.

b. Start meeting:

Any paramedic staff/doctor can initiate meeting and wait for others to join in.

c. Join meeting:

In an ongoing meeting, others doctors who are invited can join the meeting.

d. Leave meeting:

Anyone in conference can leave meeting at any time he/she wants.

4. Patient records management:

a. Generate patient number:

System must generate a unique number assigned for every patient.¹

b. Create new profile:

Paramedic staff can create new patient's profile and forward it to a doctor. He/she will have list of doctors and he would know which doctor is assigned to him.

Assumption: staff knows which doctor is assigned to him²

c. View profile:

¹ Patient number must have area code/remote station ID for identification.

² To keep system adaptable, initial scenario is assumed that staff knows which doctor is assigned to him/her. In later versions of system, System manager would be able to allocate doctor to remote stations so only available doctors will appear in their list of doctors.

Doctor can view the patient's profile.

5. Write prescription:

Only doctor assigned to that patient can write prescription. In store and forward mechanism style, doctors can write prescription/advise medicine to patient based on his opinion from symptoms entered by staff.

3.2 Nonfunctional Requirements:

Performance Requirements

Response times

Response time is very important for live video stream module because if there will be less response time then the end user can view the live video stream without long delay. Response time should be less, so the doctors can view the live video stream. If the response time is large then doctors will not be able to view the video on time as the video stream would have delay factor in that scenario.

Jitter & frame rate:

For the video streaming software, jitter would be minimized while maintaining 30fps as frame rate.

Safety Requirements

Lag/Delay in video stream can cause possible loss or harm. This delay may occur due to slow internet connection. Due to this delay the doctors may not be able to see the video in a convenient manner. Hence, the doctors can experience some problems while doing surveillance and important information may get lost. To solve this issue we are going to use an efficient video streaming server, which will reduce this delay issue.

Security Requirements

- a) Users will get login only by their own username & password.
- b) Only assigned doctor can write prescription to patient. More than one doctor can view profile.³

³ When doctors are invited on meeting for a specific patient, inviter may share profile of patient for whom all doctors are invited so they can check symptoms before meeting.

Software Quality Attributes

Adaptability

Our system will be adaptable that is easy to understand and use. Proper friendly interface will be provided for all type of users without any special knowledge.

Availability

It shall be available or properly functioning whenever needed. Streaming and web server will run 24 hours for providing streaming to all users over the web any time. Any user having this application on his pc can live stream his video on the web server.

Correctness

The whole system should perform properly involving proper user sessions handling by streaming servers, providing quality live streaming.

Flexibility

Our system should be flexible enough to overcome low and varying bandwidth problems by using necessary buffering and efficient compression and coding algorithms. The user interfaces should be flexible enough for the user to pass their information without any hurdle. It should be flexible to accommodate any additional feature required specifically on the web end.

Robustness

This term will deal with the stress handled by the software in extreme conditions. Extreme conditions with our software can be related with slow internet connectivity. Live up to date video stream should be provided to the user even if the internet connection is slow. To incorporate these, depending on connection speed at user end video quality may increase or decrease.

Testability

In testability we have to check the live video stream from the pc to streaming server and to the web end. Also testing will be done to check that the video stream reaches the user at the right time on the web user interface.

Business Rules:

According to the operating scenario of the System, patient's data of the specific patient shall be shared with the doctor with whom profile is shared.

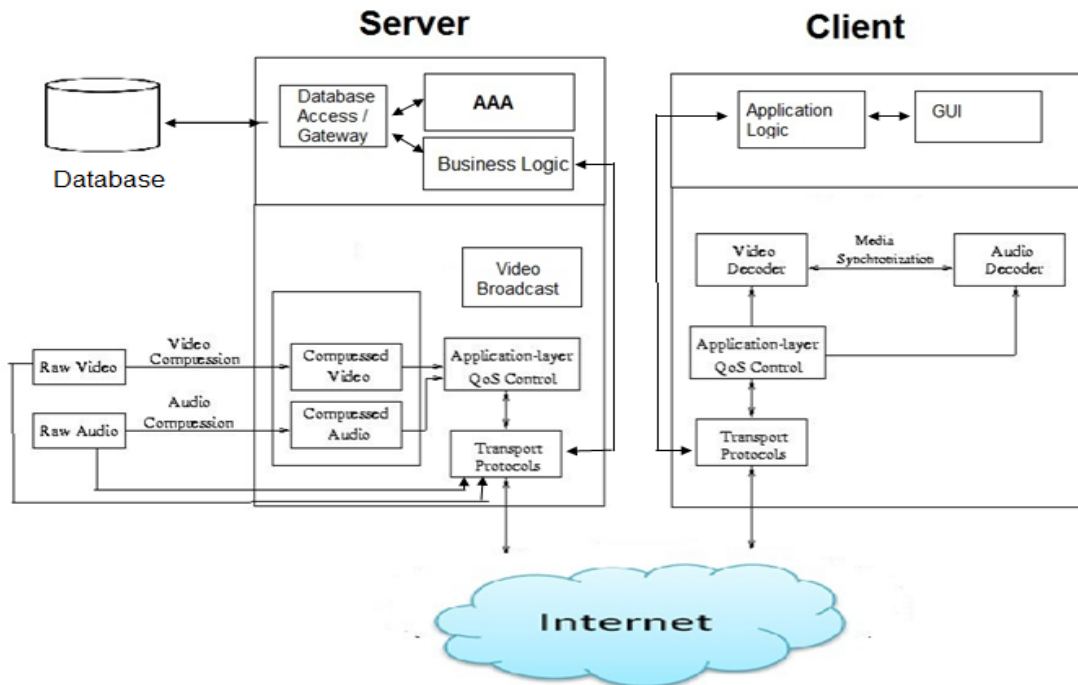
3.3 Design and Implementation Constraints

1. The main constraint in this system is timings for the transmitting and receiving patient data.
2. Free standards for video compression & transfer.
3. Band width should be high for real time video conferencing and communication it must be greater than 256MB.
4. Connectivity is the basic problem for the integration of the gadgets.
5. Transfer rate
6. Bandwidth available
7. Third party resource: Streaming server
8. Compression techniques and standards for specific video type and then video type Capability with the browsers
9. Time

Chapter 4: **System Design Specifications**

- 4.1 Architecture Design**
- 4.2 Implementation View**
- 4.3 Class Diagram**
- 4.4 ER Diagram**
- 4.5 Usecase Diagram**
- 4.6 Sequence Diagram**
- 4.7 DataFlow Diagram**
- 4.8 Activity Diagram**
- 4.9 GUI**

4.1 Architecture Diagram:



Description of Architecture diagram:

System uses Client/Server architecture model. On server end, Video received in real time is compressed and broadcasted. On Client end, video is decompressed assembled with audio and displayed.

Application Layer QoS Control: It helps in video quality maintenance on both client and server end. Switching of quality is done in these blocks/components.

4.2 Implementation View

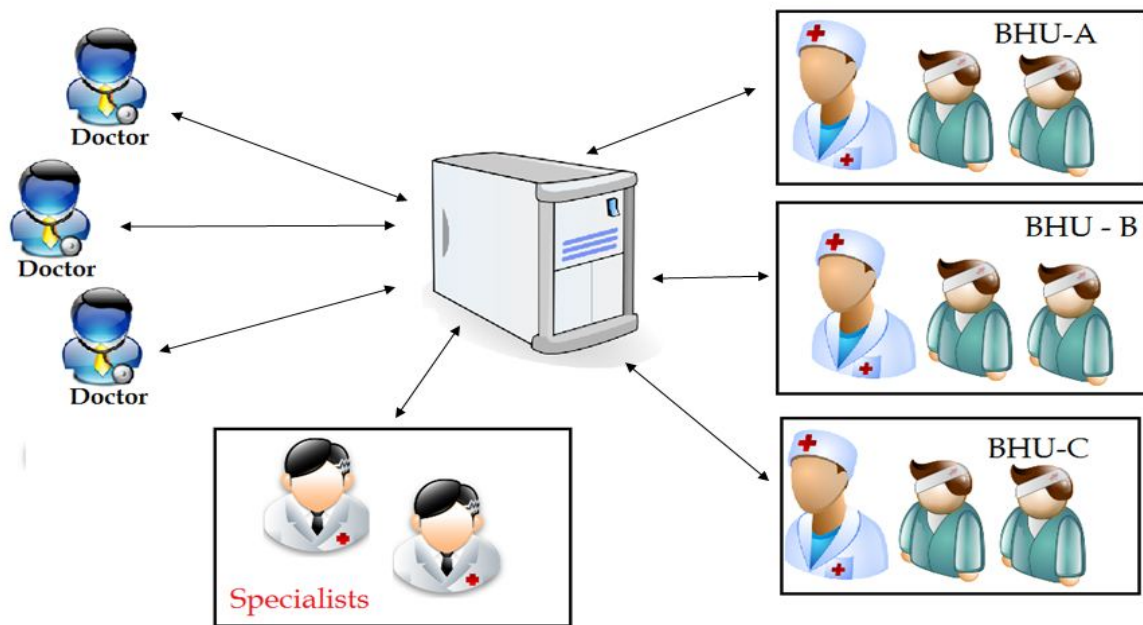


Figure 1: System View

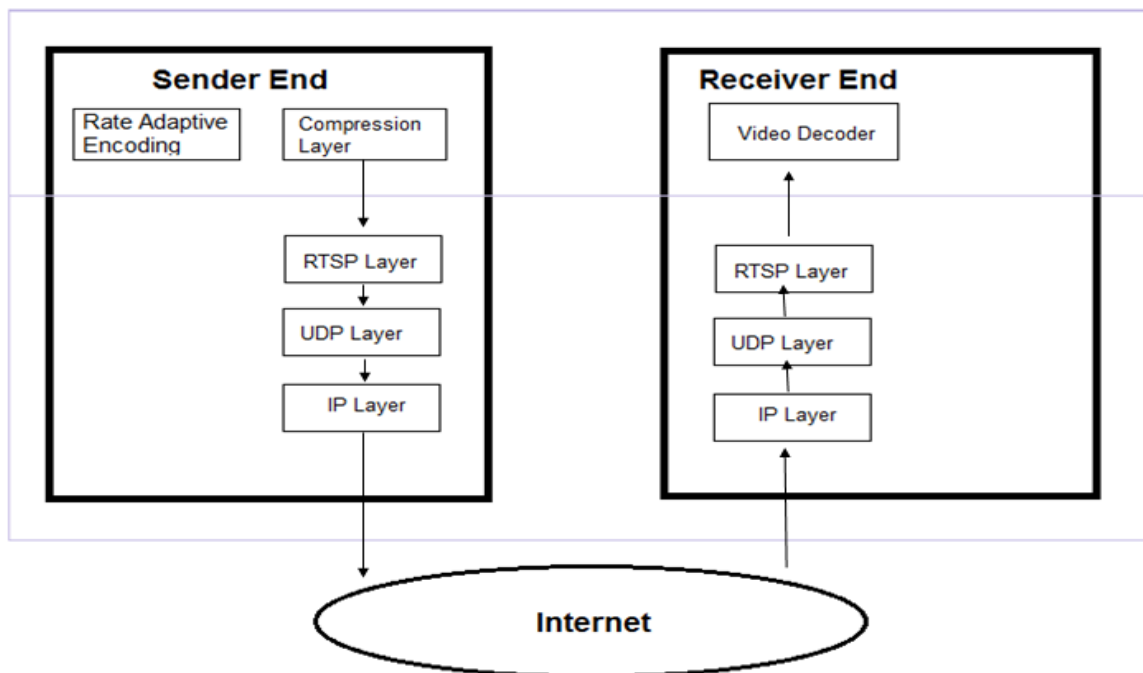


Figure 2: Protocol Stack

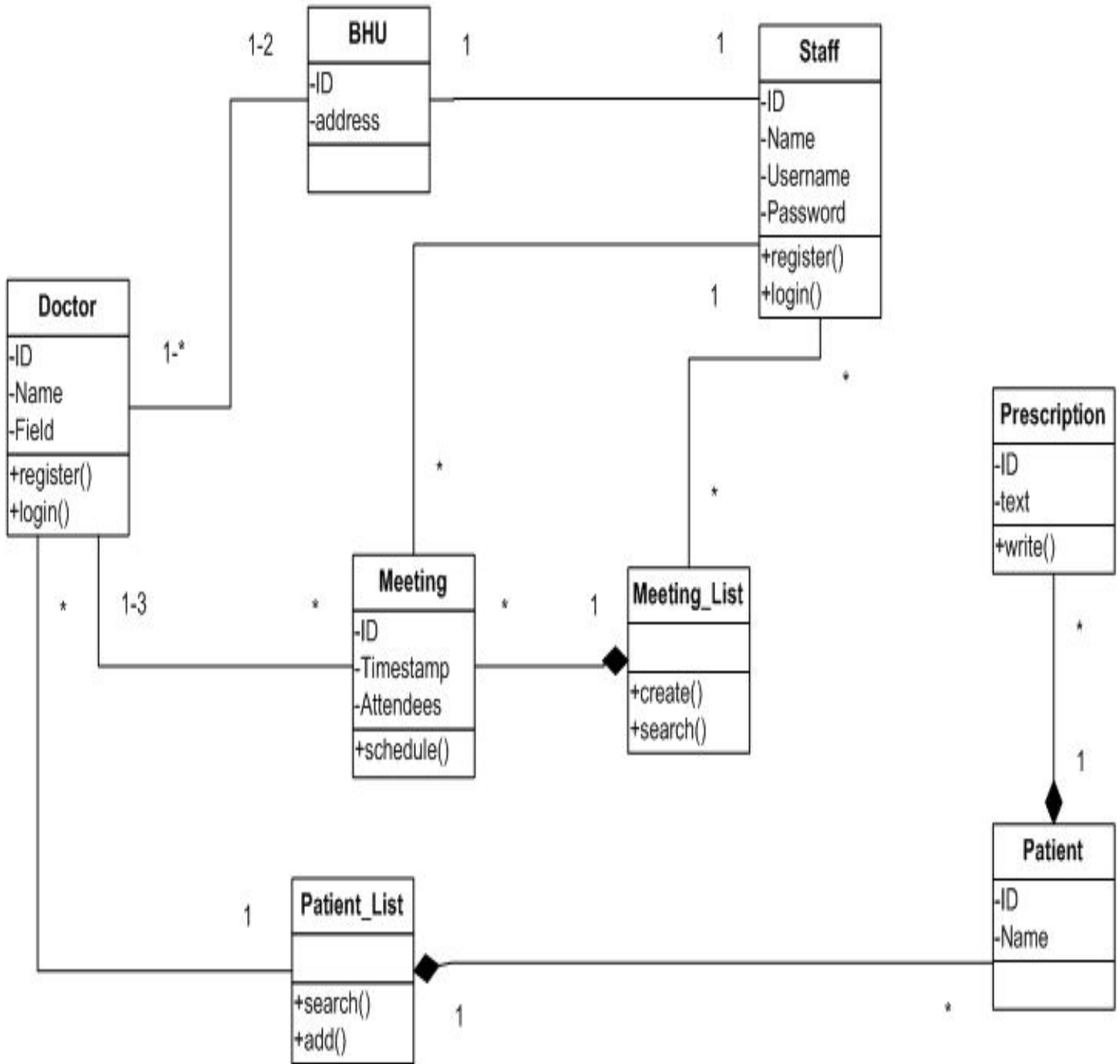
Description of Implementation View:

Implementation diagram shows two views of the system. It. Then the other diagram is stack of protocols used.

System View: System vie describes the system component and all the object involved in operation. Every BHU (Basic health unit) will have one staff and one or more patients. Specialists can be consulted on special occasions and doctors regularly for all patients' symptoms.

Protocol Stack: This is a protocol stack that shows how video is transmitted through different protocols. From sender end, it first encounters all the video compression and encoding. Then it goes to the Real Time Streaming Protocol (RTSP). From there on UDP layer and then IP / Network. Same stack is repeated at the receiver end inverted. Compression and encoding is done above these.

4.3 Class Diagram:

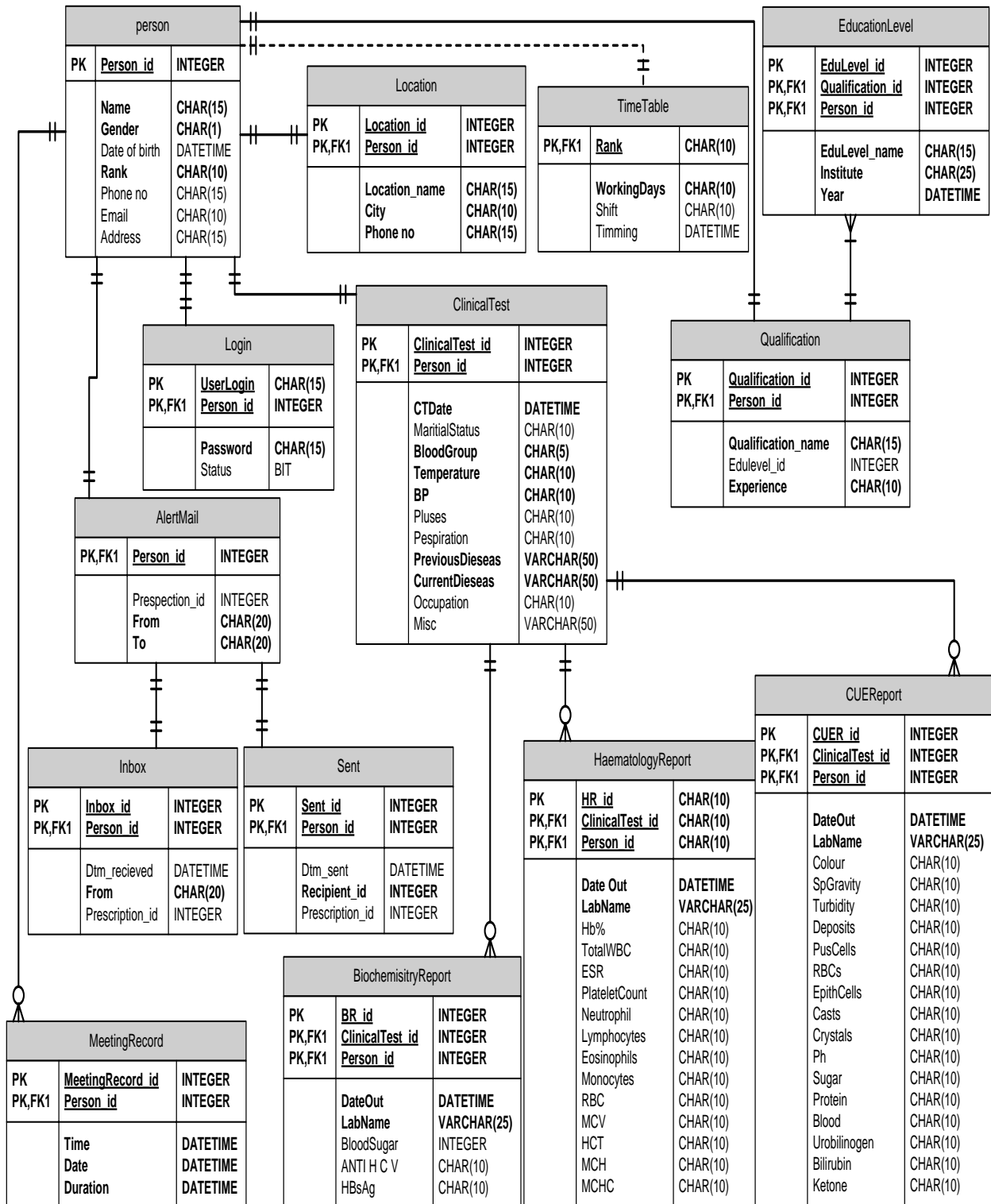


Description of class Diagram:

This class diagram shows classes involved in functional/operational works. Rest database ERD shows complete data models.

1. **Doctor:** This class contains simple data of doctor along with get and set methods and account details i.e. username and password.
2. **Staff:** This class contains simple data of staff along with get and set methods and account details i.e. username and password.
3. **BHU:** This class contains simple data elements along with get and set methods for the Basic Health Unit
4. **Patient List:** This class is important as it performs many important functions. It performs creation of new profile as it's composed of array/list of all patients. Searching is also performed by this class on the basis of patient id. It returns Patient from search method.
5. **Patient:** This class contains simple data of doctor along with get and set methods. Additionally it's composed of all the prescriptions every written to the patient. A patient can visit same BHU several times and as system records all the history so there can be more than one prescription.
6. **Meeting List:** This class is composed of all the meetings. It's important as it performs scheduling of new.
7. **Meeting:** This class contains data of meeting including associated patient, attendee doctors and staff.
8. **Prescription:** This class contains only the prescribed medicine along with recording patient, doctor and BHU's ID.

4.4 ER Diagram:

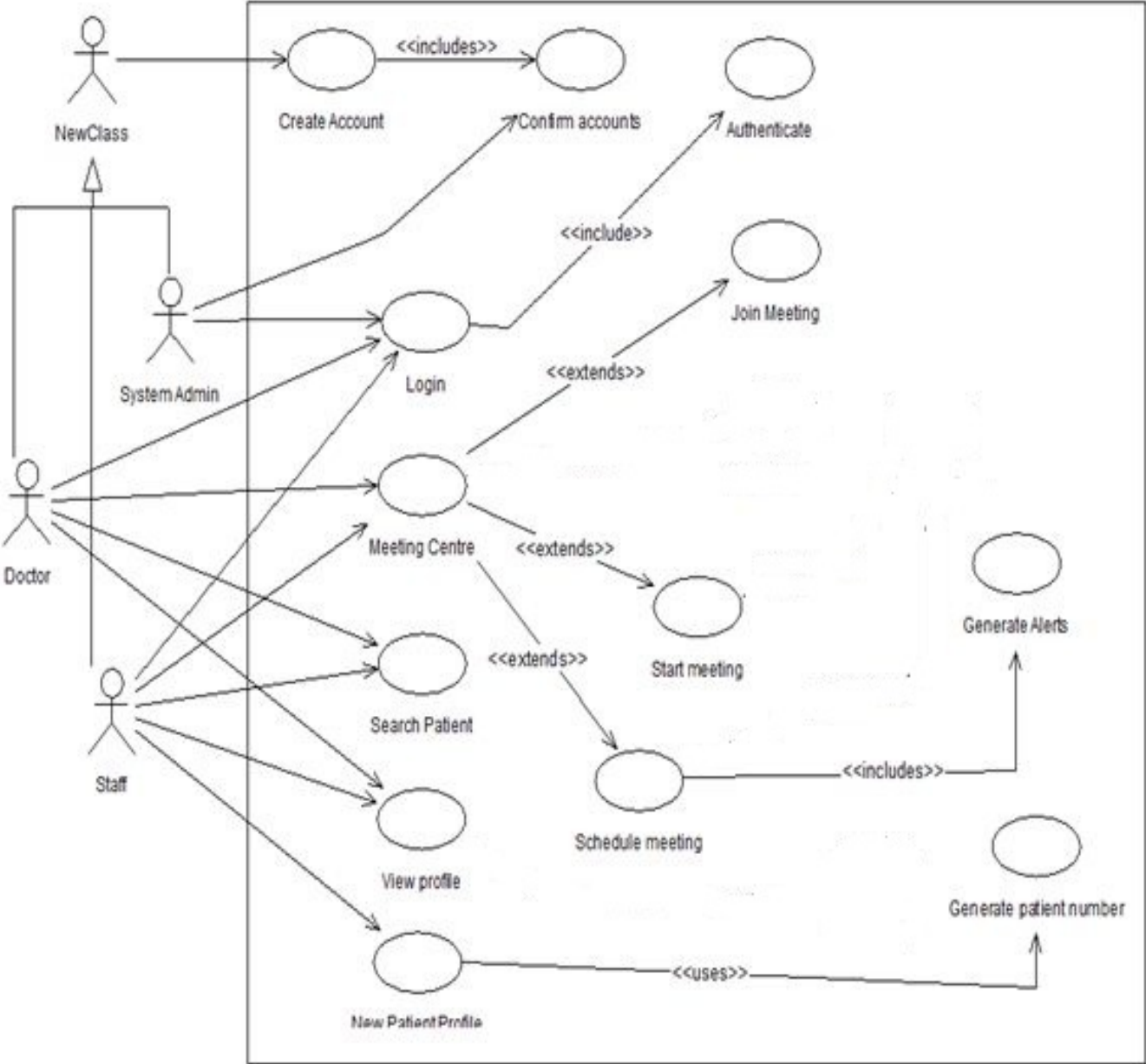


Description of ER Diagram:

After normalization we achieved the above mentioned ER diagram of our system. Its consists of 14 entities and the table below describes their description.

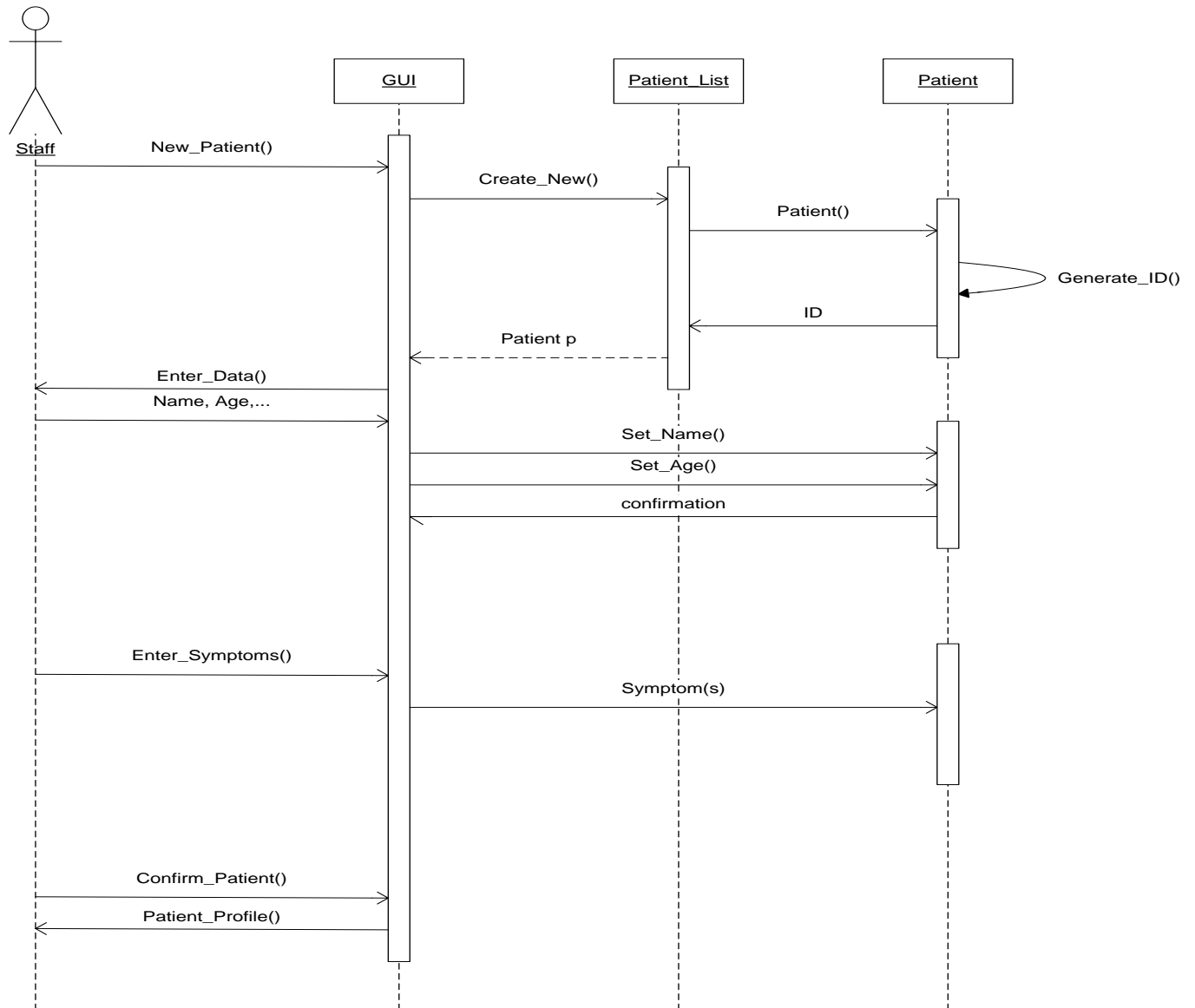
ENTITY	DESCRIPTION	PRIMARY KEY
Person	Patient table contain the general information of the person which can interacts with this system i.e. name,gender,rank,email etc.	Person_id
Location	Location Table only contain location information(city, phone etc.) of the paramedical staff and doctor	Person_id,Location_id
Timetable	Time table contain jobs timing and shifts type information related to PS and Dr's	Rank
Login	Login table contain account related information.	UserLogin,Person_id
Qualification	Qualification table is used for store information of education and experience of PS's and Dr's.	Qualification_id,Person_id
EducationLevel	Education Level table contain more defined information of PS's and Dr's.i.e bachelor degree info,masterdgree info and certifications.	EduLevel_id,Qualification_id ,Person_id
ClinicalTest	Clinical test table contain the general history of the patient which a paramedical staff examine real time and put it to Dr's	ClinicalTest_id,Person_id
BiochemsityReport	Biochemistry is more defined clinical test of patient which is specifically taken by some lab if doctor required.	ClinicalTest_id,BR_id, Person_id
HaemotologyReport	Hematology Test is also more defined clinical test of patient which is specifically taken by some lab if doctor required.	ClinicalTest_id,HR_id, Person_id
CUEReport	Complete Urine Examination is more defined clinical test of patient which is specifically taken by some lab if doctor required.	ClinicalTest_id,CUER_id, Person_id
AlertMail	Alertmail table contains the mail description record which is received by PS's and Dr's.	Person_id
Inbox	Inbox table contain the inbox record of PS's and Dr's.	Person_id,inbox_id
Sent	Sent table contain the Sent mail record of PS's and Dr's.	Person_id,sent_id
MeetingRecord	Meeting Record table contain the record of videoconferencing session of	Person_id,MeetingRecord_id

4.5 Use Case Diagram:



4.6 Sequence Diagrams:

Create Patient Profile

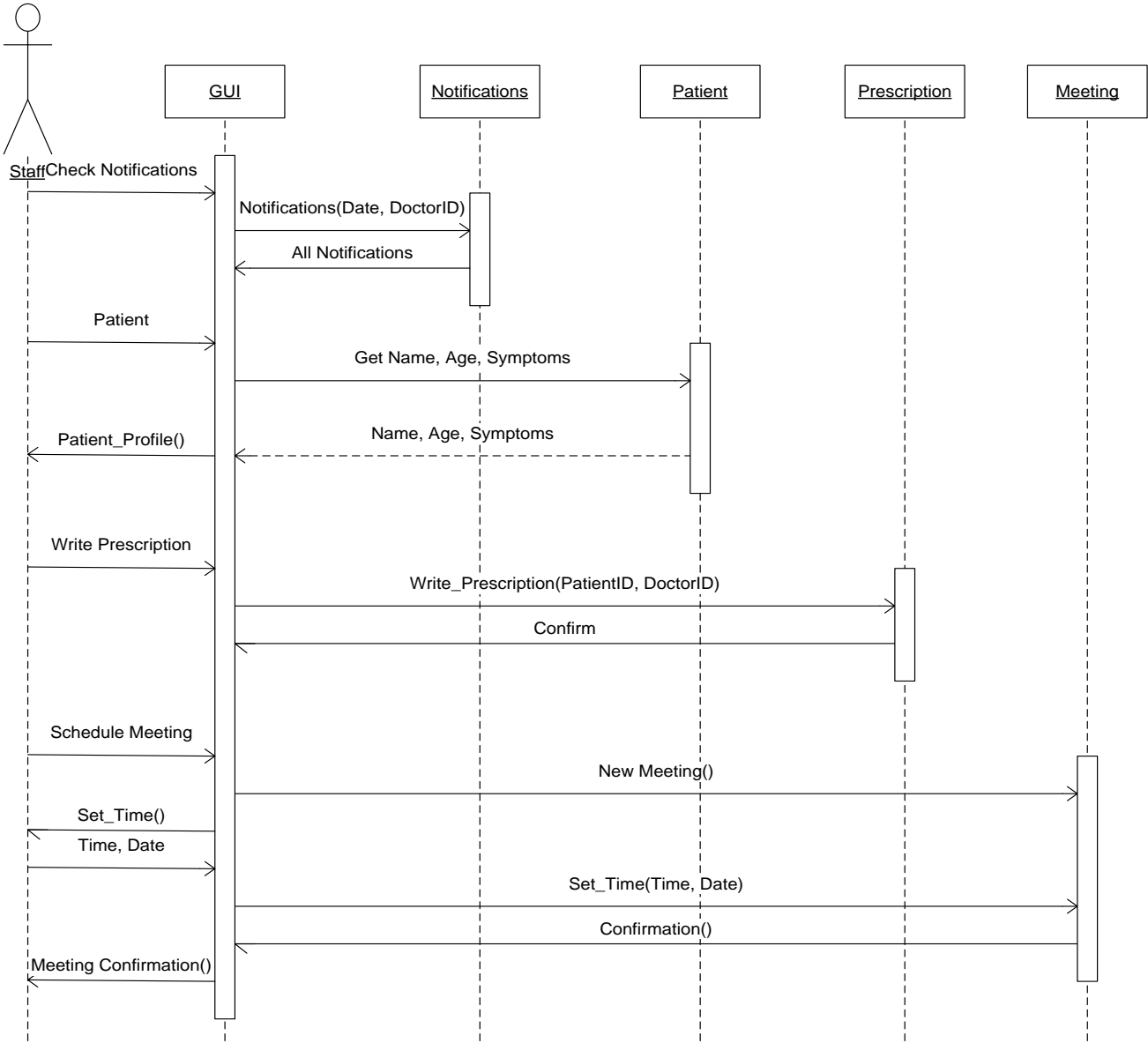


Description of Create Profile:

To generate new patient's profile.

1. As the paramedic staff wishes to create the new patient profile, he/she send command to GUI.
2. GUI contacts the Patient_List class to perform the function of composing another class.
3. Patient basic data along with symptoms are given to the system
4. System confirms the patient record.

Write Prescription/Schedule Meeting



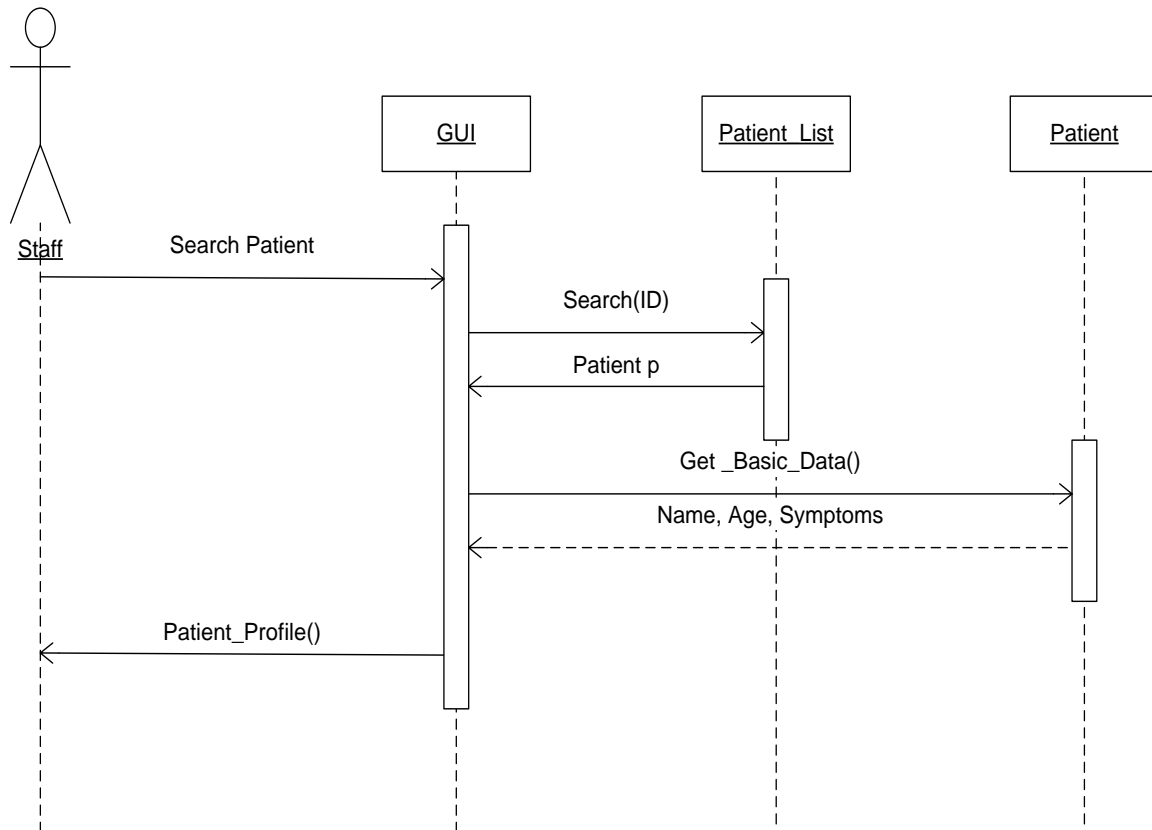
Write Prescription/Schedule Meeting:

This is combination of three use cases applied in sequence by the system i.e. Check notifications, Write prescription, schedule meeting.

1. As the doctor checks day's notification to find all the new cases.
2. Clicks on the specific notification/patient.
3. Looking at symptoms he/she can either choose to write prescription or schedule meeting with the patient.
4. For prescription, a prescription instance is created and set value along with doctor id and patient id.
5. For scheduling the meeting, doctor first sets the feasible time and then invites at max 2 specialists/doctors to the meeting.
6. System sends the confirmation as doctor finishes scheduling

Search Patient:

Search Patient



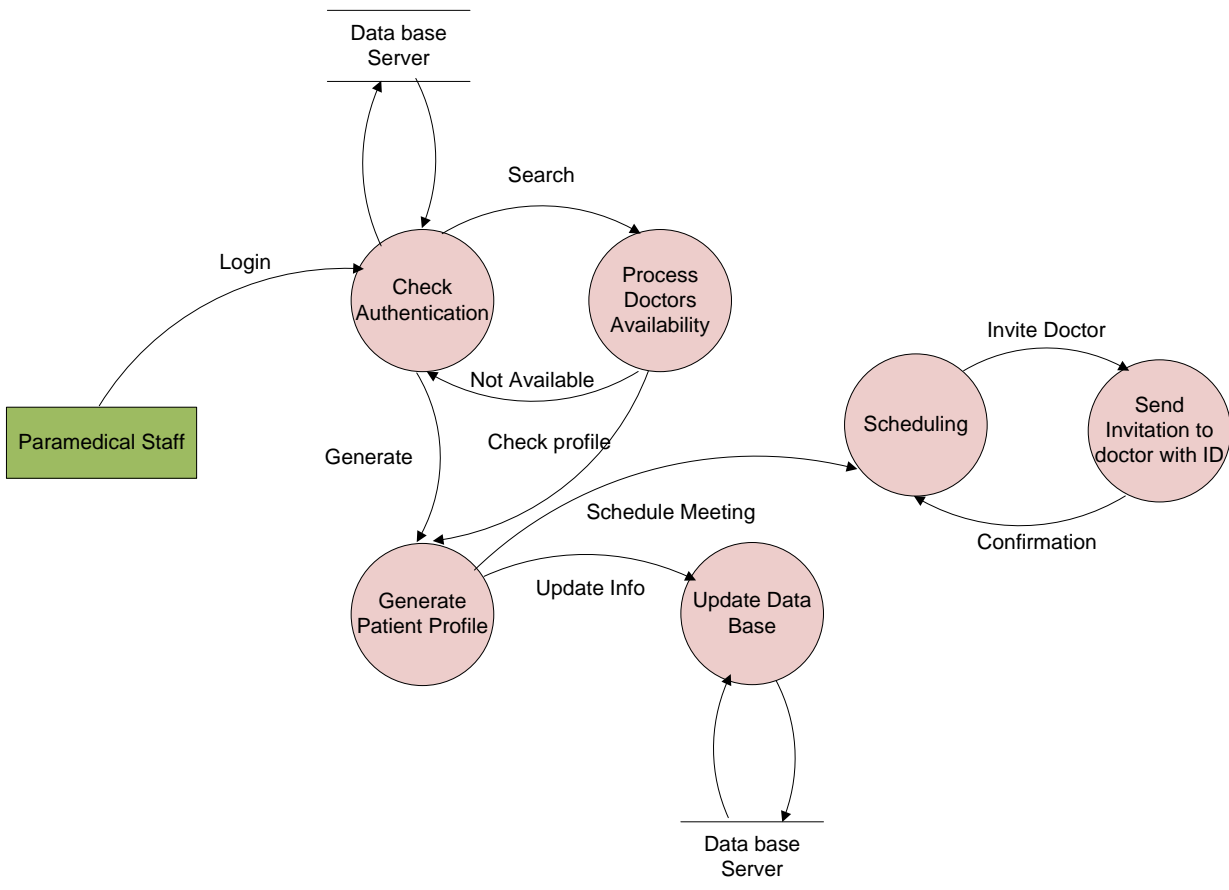
Search Patient:

Search use case, searches patient profile based on the patient ID assign automatically.

1. User commands for the search
2. System asks for the Patient ID to be searched.
3. Patient_List class searches the patient, gets basic data and give to GUI.
4. GUI generates the profile of user.

4.7 Data Flow Diagrams:

DFD of Paramedical Staff:



Description of Paramedical Staff:

Check Authentication: When paramedical staff will login to the system, System will check either it's a valid user or not by verifying from the data base server, if he is authenticated user he will be able to login the system otherwise system will generate error and will ask the user to enter valid user name and password.

Process Doctor Availability: In this process system will check either the specified doctor is available or not, if doctor is available paramedical staff can communicate with that doctor.

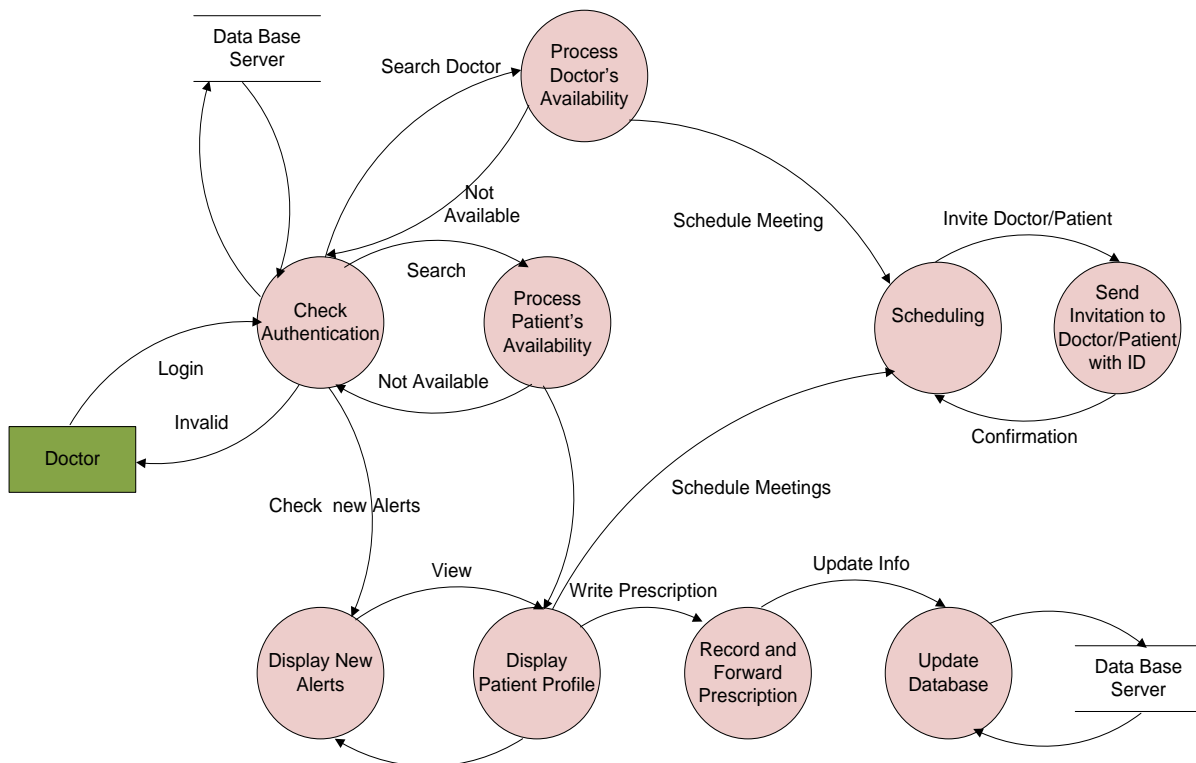
Generate Patient Profile: In this Paramedical Staff will generate the patient profile by checking the patient and by diagnosing patient disease.

Update database: After making the patient profile paramedical staff will save the profile in the database.

Scheduling: In this process paramedical staff will schedule the meeting with the specified doctor by sending him invitation.

Send Invitation to Doctor: In this process Paramedical Staff will send invitation to the doctor to do video conferencing, if doctor accepts the invitation then they can communicate otherwise paramedical staff should schedule the meeting with other doctor to do conferencing.

DFD of the Doctor:



Description of the Doctor:

Check Authentication: When Doctor will login to the system, System will check either it's a valid user or not by verifying from the data base server, if he is authenticated user he will be able to login the system otherwise system will generate error and will ask the user to enter valid user name and password.

Process Doctor Availability: In this process system will check either the specified doctor is available or not, if doctor is available doctor can communicate with that specific doctor.

Process Patient's Availability: In this process the doctor will check either patient is available or not to whom he wants to communicate, if the patient is available doctor will communicate otherwise not.

Display new Alerts: In this process all the new mails about the patients, patient profiles will be displayed to the doctor.

Display patient's profile: In this process all patient profiles will be available to the doctor to analyze, he can write the prescription or can arrange the meeting with that patient by reading profile.

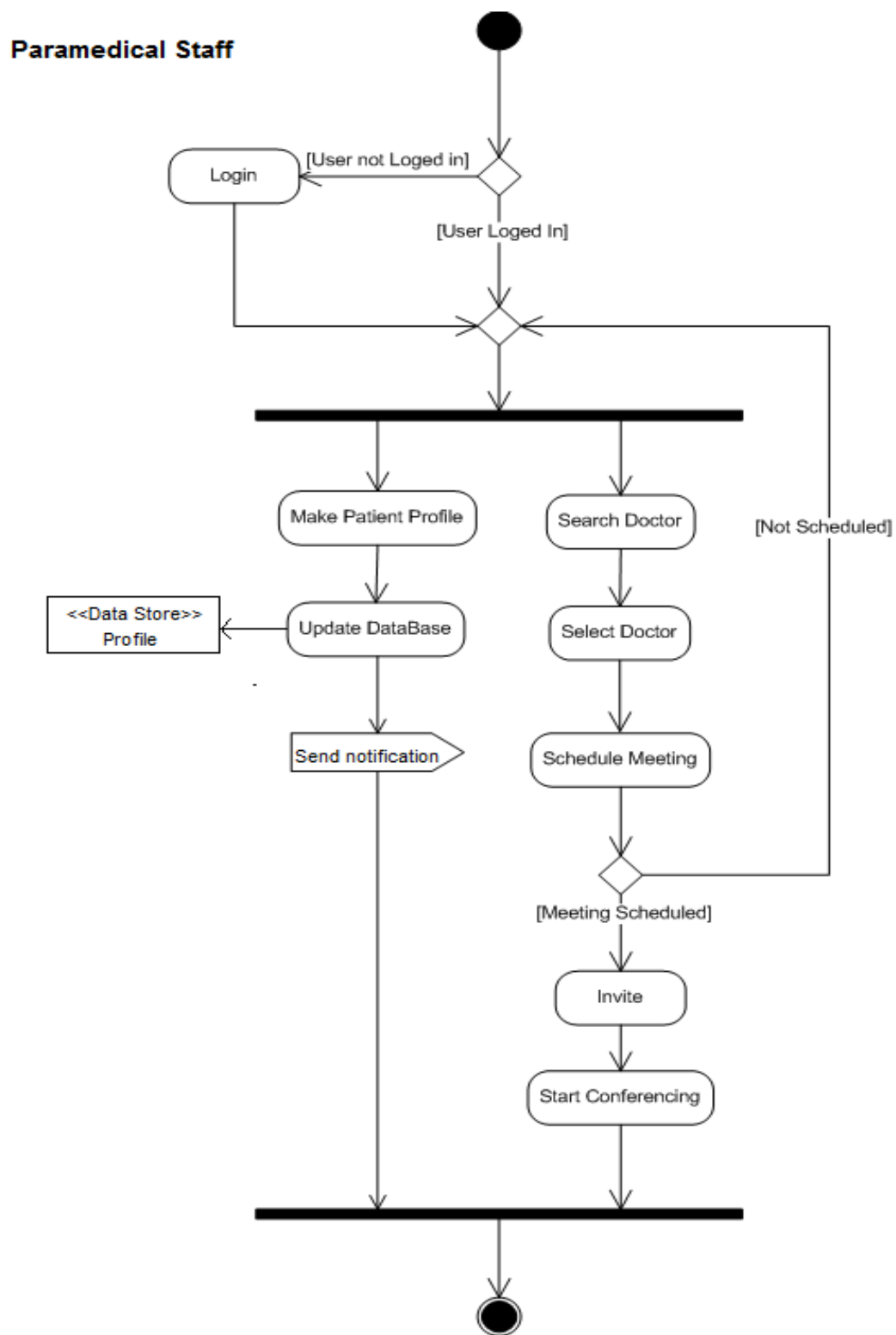
Scheduling: In this process doctor will schedule the meeting with the patient or with other doctor.

Send Invitation to the Patient/Doctor: In this processthe doctor will send invitation to the patient or to the doctor to do conferencing.

Record and Forward Prescription: In this process doctor can write the prescription on the profile and can store or forward to the patient.

Update database: After writing the prescription doctor will update the profile in the database.

4.8 Activity Diagrams:



De

scription of Paramedical Staff:

Login: Paramedical staff will login the system, if the user name or password is not correct system will generate error message and ask the user to enter valid user name and password to login the system.

Search Doctor: Paramedical staff after login will search the specialist doctor to start video conferencing.

Select Doctor: Paramedical staff will select the specific doctor who is specialist in that field which is required by the paramedical staff or who is concerned doctor.

Schedule Meeting: Paramedical staff will be able to schedule the meeting with that specific doctor; if meeting is not scheduled paramedical staff will search the other doctor again and will arrange the meeting to communicate with that doctor.

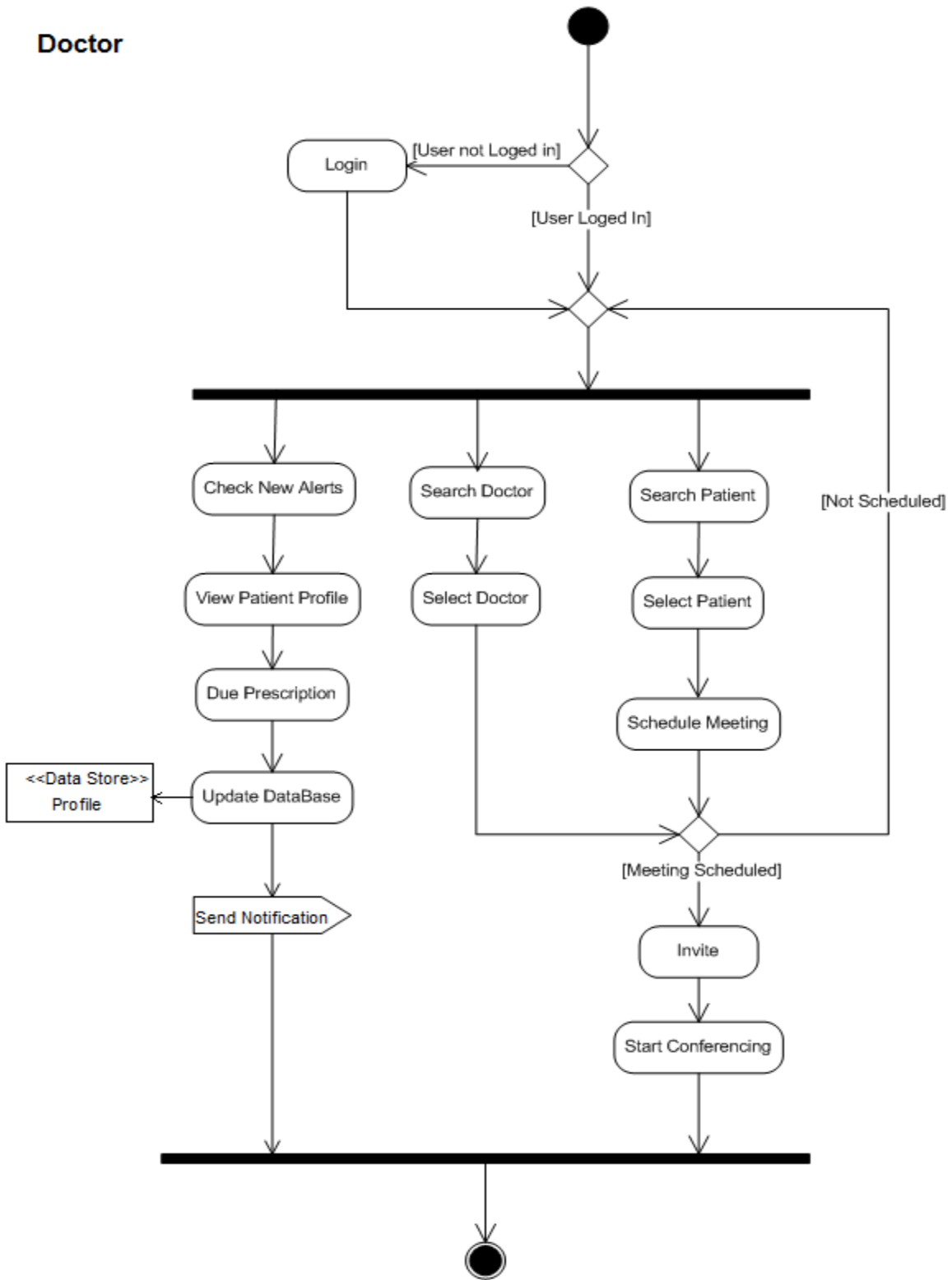
Invite: Paramedical staff will invite the doctor to communicate after scheduling meeting and will start conferencing with that doctor.

Make patient profile: Paramedical Staff will generate the patient profile.

Update database: Paramedical staff will update the database after making patient profile.

Send notification: Paramedical staff will send the notification to the specific doctor that patient profile is updated in the database.

Activity diagram of Doctor:



Description of Doctor:

Login: Doctor will login the system, if the user name or password is not correct system will generate error message and ask the user to enter valid user name and password to login the system.

Search Patient: Doctor after login will search the patient to start video conferencing.

Select Patient: Doctor will select the specific whose request he will receive.

Search Doctor: One doctor can also communicate with specialist doctor to get help, So he will search the other doctor who is online and who can help related to the problem

Select Doctor: He will select the other doctor who will help him.

Schedule Meeting: Doctor will be able to schedule the meeting with that patient; if meeting is not scheduled Doctor will search the other patient again and will arrange the meeting to communicate with that patient in the same way he will arrange the meeting with other doctors.

Invite: Doctor will invite the doctor to communicate after scheduling meeting and will start conferencing with that doctor or he will invite the patient with whom the meeting is scheduled.

Check New Alerts: Doctor will check the new alerts when he will login.

View Profile: He will be able to view the patient profile which is uploaded by the paramedical staff in the data base.

Due Prescription: It depends upon the doctor either he will arrange the meeting or he will write the prescription in the profile.

Update database: After writing the prescription in the patient profile doctor will update the profile and will store in the database.

Send notification: Doctor will send the notification to the specific paramedical that patient profile is updated in the database.

4.9 GUI:

Login Page:

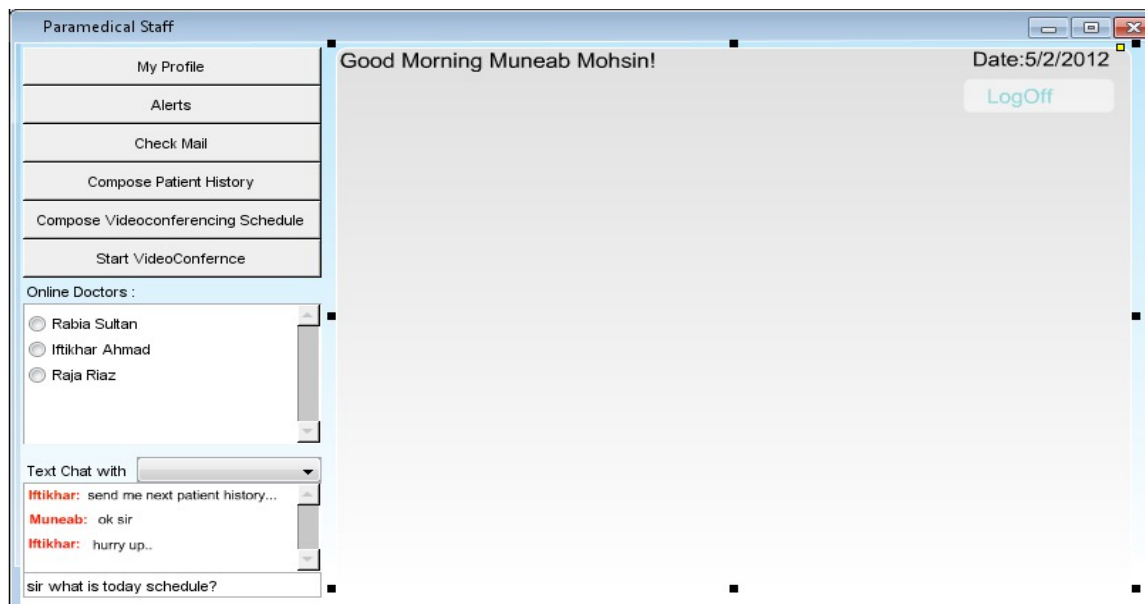


The screenshot shows a web browser window titled "Login". The main heading is "REAL TIME TELEMEDICINE SYSTEM" in a stylized, blue, blocky font. Below the heading, there are two input fields: "User name" and "Password". Underneath these fields are two buttons: "Login" and "Cancel". At the bottom of the page, there are three logos: on the left, a circular logo for "THE HIGHER COLLEGE OF HIGHER EDUCATION"; in the center, the "NEXSOURCE INTERNATIONAL" logo; and on the right, a circular logo for "PAKISTAN UNIVERSITY OF SCIENCE & TECHNOLOGY".

Description of Login Page:

In Login form user (doctor, patient and admin) has to enter username and password to login. After log in the user name and password is compared in database so according to this the next form will open.

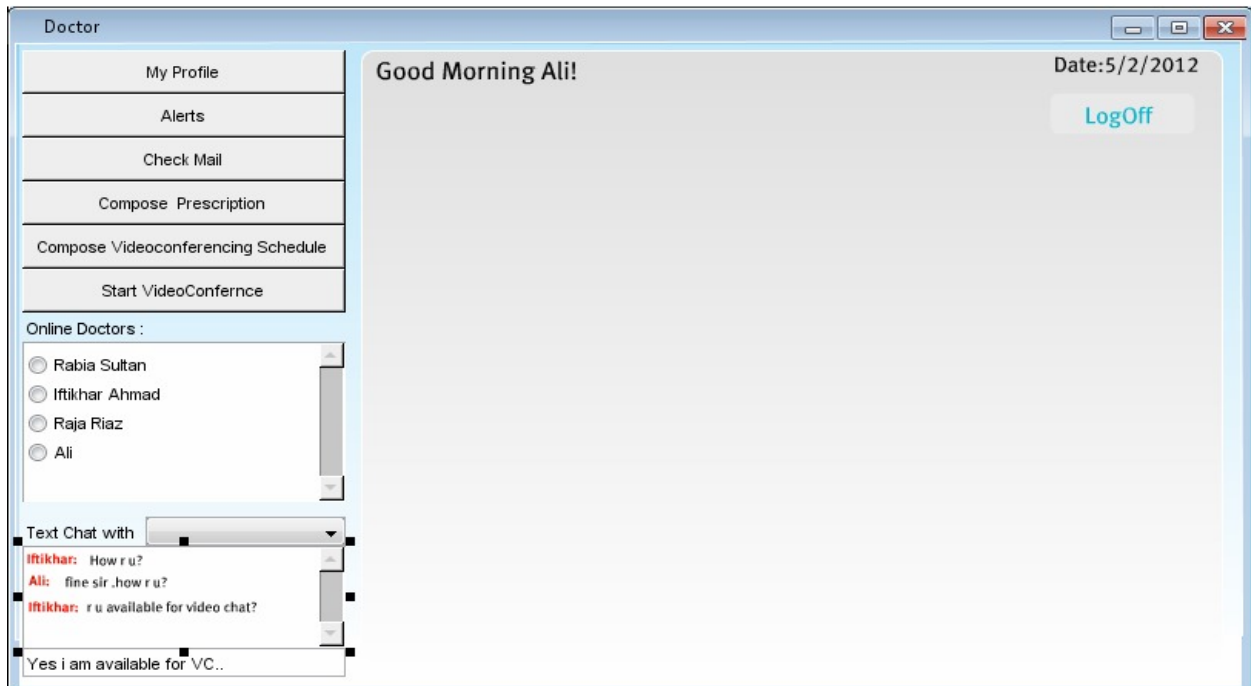
Paramedical Staff:



Description of paramedical Staff:

In paramedical staff form he/she can perform various tasks i.e. checking profile, checking alerts, checking mails, composing patient history, composing video conferencing schedule and starting video conferencing session. He/she can also view online doctors or PS's of the network and also able to text chat any of the selected person. In this form at upper right corner there is a logoff button so if user want to logoff he/she simply click on it.

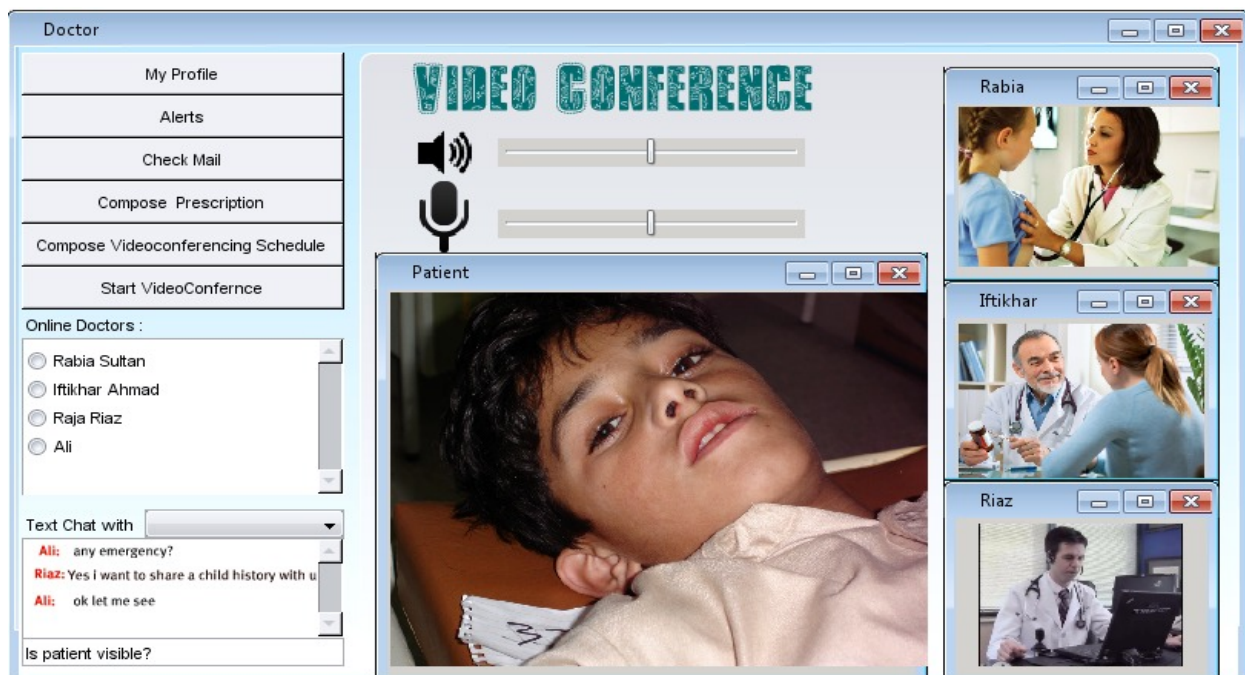
Doctor:



Description of Doctor:

In Doctor Form he/she can perform various tasks i.e. checking profile, checking alerts, checking mails, composing prescription for patient, composing video conferencing schedule and starting video conferencing session. He/she can also view online doctors or PS's of the network and also able to text chat any of the selected person. In this form at upper right corner there is a logoff button so if user want to logoff he/she simply click on it.

Video Conferencing:



Description video Conference:

If Doctor select to start video conferencing a video conferencing form will open in this form doctor can invite more than one doctors for video conference so doctor can now comfortably view patient (A comparatively large scale video screen form) and other linked doctors (A comparatively small scale video screen form) at a time. Setting of mike and speaker volume is also available in this form.

Chapter 5: Implementation

5.1 System Modules

5.2 Tools Used

5.3 Implementation Details

5.1 System Modules:

Application Modules:

1. **GUI (front end):** It includes all the interfaced (GUIs) implemented in Java. They call backend functions for any and every functionality.
2. **Chatting:** This module separates video conference from other system.
3. **Backend:** These classes call HTTP Requests and ask Servlets for any functionality.

Server

1. **Servlet** class implements functionality or service to be provided to the user. Name of main servlet class is to be made public so users can access it. It sees the request and
2. **Database Connectivity** class used Database drivers and fulfills the functionality desired by Servlet.

5.2 Tools Used

5.2.1 VLCJ

VLCJ version 1.2.2

VLCJ: Is a Java wrapper for VLC Media Player. It has the capability to capture the video and audio with different codecs and also stream them to any IP and write Session Description Protocol files.

The vlcj project, as its online website describes, provides Java bindings to allow an instance of a native VLC media player to be embedded in a Java AWT Window or Swing JFrame. Its not simple bindings but you also get a higher level API that hides a lot of the complexities of working with the vlc player library 'libvlc'.

The bindings can be used to build media player client and server software using Java - everything from simply playing local media files to a full-blown VOD(video-on-demand) streaming server is possible.

- To implement VLCJ, following libraries are used:
dna.jar, platform.jar, vlcj-1.2.2-test.jar, vlcj-1.2.2.jar, vlcj-1.2.2-sources.jar
- Program requires path of the vlc native library. It utilizes libvlc.dll

5.2.2 Servlets and Web Request:

JDK version: JDK-1.7.0_02

A Servlet is a Java class in Java EE that conforms to the Java Servlet API, a protocol by which a Java class may respond to requests. They are not tied to a specific client-server protocol, but are most often used with the HTTP protocol. So usually word "Servlet" is used in the meaning of "HTTP Servlet". Thus, a software developer may use a servlet to add dynamic content to a Web server using the Java platform. The generated content is commonly HTML, but may be other data such as XML. Servlets are the Java counterpart to non-Java dynamic Web content technologies such as PHP and ASP.NET. Servlets can maintain state in session variables across many server transactions by using HTTP cookies, or URL rewriting.

To deploy and run a Servlet, a Web container must be used. A Web container (also known as a Servlet container) is essentially the component of a Web server that interacts with the servlets. The Web container is responsible for managing the lifecycle of servlets, mapping a URL to a particular servlet and ensuring that the URL requester has the correct access rights.

5.2.3 DSS (Darwin Streaming Server)

DSS version used: Darwin Streaming Server 5.5.5

Darwin Streaming Server (DSS) is the first open sourced RTP/RTSP streaming server. It was released in March 16, 1999 and is a complete fully featured RTSP/RTP media streaming server capable of streaming a variety of media types including H.264/MPEG-4 AVC, MPEG-4 Part 2 and 3GP. It is the open source equivalent of QuickTime Streaming Server, Developed by Apple and is based on its code.

5.2.4 MySql

Version: 5.1.53

MySQL is the world's most used open source relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases. This tool is used to implement and maintain patient records and all data management.

5.3 Implementation Details

5.3.1 VIDEO STREAMING

Capturing & Streaming Video with VLCJ:

Adding this line at the start of programs, allows program to use VLC Native library:

```
NativeLibrary.addSearchPath(RuntimeUtil.getLibVlcLibraryName(), "C:\\Program Files\\VideoLAN\\VLC");
```

And to capture video, following LOC are written.

```
EmbeddedMediaPlayer localMediaPlayer;  
localMediaPlayer.playMedia(mrl, localOptions);
```

Where *mrl* defines the url to which stream will be sent. And *LocalOptions* describes the codes used.

```
":dshow-size=320x240                                     :no-dshow-config  
:sout=#transcode{vcodec=h264,vb=512,fps=25,scale=1,acodec=mp3,ab=128,channels=2}  
:rtsp{access=udp,mux=ts,dst=127.0.0.1,port=8000 }"
```

SDP (Session Description Protocol)

SDP is intended for describing multimedia communication sessions for the purposes of session announcement, session invitation, and parameter negotiation. SDP does not deliver media itself but is used for negotiation between end points of media type, format, and all associated properties. The set of properties and parameters are often called a *session profile*. SDP is designed to be extensible to support new media types and formats.

Every client, whose video is streamed, generates an SDP file on the server. This SDP holds the information of ports and media type. Any client who's allowed can pick the SDP from server.

Playing Multiple Stream:

As Multi-point video conferencing name suggests, there can be more than two users in the video call. In our case 2-4 users can do the call.

For this to work, user end plays the SDP using url like this from VLCJ Java code:

```
Mrl1 = rtsp://Server-IP:8000/stream1.sdp  
Mrl2 = rtsp://Server-IP:8000/stream2.sdp  
Mrl3 = rtsp://Server-IP:8000/stream3.sdp
```

```
remoteMediaPlayer1.playMedia(Mrl1, localOptions);
remoteMediaPlayer2.playMedia(Mrl2, localOptions);
remoteMediaPlayer3.playMedia(Mrl3, localOptions);
```

Where Remote Media Players defined here is of data type EmbeddedMediaPlayer (a built in data type of VLCJ to imitate VLC Media player functionality)

Video Attributes Used:

Name	Value
Video Codec	h264
Video bitrate	1024
Video width	320
Video height	240
Audio codec	mp4a
Audio bitrate	128
Samplerate	22050

5.3.2 USER DATA MANAGEMENT

Web Service Calling

HttpRequestPoster: is the class to post HTTP Requests from Java code. All services of application are called using this.

Other functionalities implemented as web-based service calls the Servlet service by sending following arguments e.g. Prescription writing is implemented as below:

```
String arguments = "process=prescription&session="+ session + "&pres="+
URLEncoder.encode(p) + "&pid=" +pid ;
String endpoint = Front.Main.endpoint;
HttpRequestPoster.sendGetRequest(endpoint, arguments);
```

Similarly process names for different functionalities are as below:

Functionality	Keyword
Authentication	process=login
New Patient Profile	process=newprofile
Writing New prescription New Alerts For Doctor	process= prescription

Database Connectivity:

Database driver used: com.mysql.jdbc.Driver

Servlet call database connectivity functions to further complete the application.

5.3.3 AUTHENTICATION AND SESSION HANDLING

Authentication And Session Handling:

RTMS handles sessions and authentication via HTTPRequestPoster

```
String arguments = "process=login&" + "username=" + URLEncoder.encode(user) + "&password=" +  
URLEncoder.encode(pass) + "&type=" + type;  
session = HTTPRequestPoster.sendGetRequest(endpoint, arguments);
```

This session variable's value is returned to the Main calling class.

Sessions are handled in the program such that, whenever user calls a service via Servlet, it sends session variable along. If session is active service is returned. Else not allowed.

Chapter 6: **Testing**

6.1 Black Box Testing

6.2 White Box Testing

6.3 Unit Testing

6.4 Integration Testing

6.1 Black Box Testing:

In Black Box Testing we have focused on inputs and output of the software system without looking at internal working of software.

Test case ID:	A 001
Test Description	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	1. Run Server Application 2. Run Telemedicine app. 3. Logged in on with incorrect username and password
Expected Result	error message
Actual Result	error message
Status	Pass

Test case ID:	A 002
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	1. Run Server Application 2. Run Telemedicine app. 3. Logged in on with correct username and password but incorrect user type
Expected Result	error message
Actual Result	Logged In
Status	FAIL

Test case ID:	A 003
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	<ol style="list-style-type: none"> 1. Run Server Application 2. Run Telemedicine app. 3. Logged in to system. 4. Check alerts when user is expected to have no alerts
Expected Result	No new alerts message
Actual Result	Alerts window opened with blank area for alerts.
Status	PASS

Test case ID:	A 004
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	<ol style="list-style-type: none"> 1. Run Server Application 2. Run Telemedicine app. 3. Logged in on with correct username and password. 4. Create new profile and leave few fields blank 5. Submit
Expected Result	error message: Fill all necessary fields
Actual Result	Profile Submitted
Status	FAIL

Test case ID:	A 005
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	<ol style="list-style-type: none"> 1. Run Server Application 2. Run Telemedicine app. 3. Logged in on with correct username and password. 4. Write new prescription 5. Submit
Expected Result	Submitted Successfully
Actual Result	Submitted Successfully
Status	PASS

Test case ID:	A 006
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	<ol style="list-style-type: none"> 1. Run Server Application 2. Run DSS 2. Run Telemedicine app. 3. Logged in on with correct username and password. 4. Select Video Conference
Expected Result	No conference can be started
Actual Result	Opens conference window but plays nothing
Status	Failed

Test case ID:	A 007
Test Description:	Project overall testing
Date	13/ 05/ 12
Environment:	Java app installed, Darwin Server running on Window Server 2003, Server Application & Mysql running
Test Execution:	<ol style="list-style-type: none"> 1. Run Server Application 2. Run DSS 2. Run Telemedicine app. 3. Logged in on with correct username and password. 4. Change Server IP to wrong one from settings 5. Start scheduled conference.
Expected Result	No video played
Actual Result	No Video Played
Status	PASS

6.2 White box Testing:

White box testing is done as a security testing method to validate whether code implementation follows intended design, and to uncover exploitable vulnerabilities.

Function Tested for several exceptions:

1. doGet method of Servlet is tested via browser giving urls like
<http://localhost:8084/auth/TelemedServlet/process=test&arguments=none>
<http://localhost:8084/auth/TelemedServlet/process=login&username=wrong&password=wrong>
<http://localhost:8084/auth/TelemedServlet/process=prescription&pres=take%20ponstan>
2. DBConnection method authentication, newSession, profile_insert are tested with all correct and wrong inputs.
3. HttpRequestPoster method sendGetRequest is tested for wrong endpoint address, port and method.

6.3 Unit Testing:

For unit testing, following units are tested independently before integration:

Video Conferencing: One, two, three, four videos are tested one by one on the system for single client.

Patient Data Management: All functionalities as a Doctor and Staff are tested in details.

6.4 Integration Testing:

Code for two modules are combined and unit tests are repeated on them.

6.5 Video Testing:

Testing Video Quality based on the following attributes gave following results.

No.	VCodec	ACodec	FPS	Resolution	Video bit rate	Audio bit rate	Delay	Quality
1.	H264	Mp4a	20	320x240	512	32	5-6	average
2.	H264	Mp4a	20	640x480	512	32	6-8	average
3.	H264	Mp3	25	320x240	1024	128	2-3	good
4.	H264	Mp3	25	640x480	1024	128	3-4	good
5.	H264	Mp3	30	320x240	1024	128	3-4	good
6.	H264	Mp3	30	640x480	1024	128	4-5	good

Chapter 7: **Conclusion and Future Work**

Video Delay:

The major problem in our project is the delay of the system during the video conferencing; in future this problem can be resolved by using many techniques.

Video Conferencing Extension:

Our system supports four users in video conferencing to communicate with each other, in future system can be enhanced for more than 4 users.

Patient Data Extension

In our system we get the basic information of the patient, store that information in the data base and forward to the server side, the system can be modified by introducing other new gadgets in the system like

1. Telecardiology
2. Teledermatology
3. Teleradiology
4. Telesurgery
5. Video Telephony
6. Teledentistry

Telecardiology

Telecardiology is a process of ECG waves being transmitted with the guide of wireless and telephone. A telecardiology system enables wireless transmission of electrocardiograph from the home of a patient. The ECG converts to sound waves along the frequencies which helps monitor patients with pacemakers. Telecardiology technology allows medical care in rural and remote areas. The benefits of telecardiology are being able to reach isolated communities and people in remote regions. The waves can travel wireless or through a telephone wire.

Teledermatology

One of the most common applications of telemedicine is teledermatology. Telecommunication technologies are used exchanging the patients medical information using audio, data, and visual communication about their skin conditions and tumors of the skin. It is practiced on two concepts, store and forward.

Teleradiology

Teleradiology is the travel of radiological images from one place to another for medical purposes. It improves patient care and allows radiologists to give a service without being at the location of where the patient is. It allows for a trained medical professional to be available 24/7 for diagnosing versus a medical profession only available only at certain times of the day. A teleradiology network is performed using up-to-date technology and software and transmits the images to the radiologists to be interpreted.

Telesurgery

Remote surgery (also known as telesurgery) is the ability for a doctor to perform surgery on a patient even though they are not physically in the same location. It is a form of telepresence. Remote surgery combines elements of robotics, cutting edge communication technology such as high-speed data connections and elements of management information systems. While the field of robotic surgery is fairly well established, most of these robots are controlled by surgeons at the location of the surgery.

Video telephony

At the dawn of the technology, video telephony also included image phones which would exchange still images between units every few seconds over conventional POTS-type telephone lines, essentially the same as slow scan TV systems. Currently video telephony is particularly useful to the deaf and speech-impaired who can use them with sign language and also with a video relay service, and well as to those with mobility issues or those who are located in distant places and are in need of telemedical or tele-educational services.

Teledentistry

Teledentistry is the use of information technology and telecommunications for dental care, consultation, education, and public awareness in the same manner as telehealth and telemedicine.

