

Cloud based E-Learning System



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Certified that work contained in this thesis titled “Cloud based E-Learning System”, carried out by ASC Muhammad Uzair, PC Abdullah bin Khalil, PC Muhammad Adil, ASC Sajjad Qazi under the supervision of Lec Amal Haider and Asst Prof Aimen Aakif for partial fulfillment of Degree of Bachelors of Electrical Engineering, in Military College of Signals, National University of Sciences and Technology, Islamabad during the academic year 2020-2021 is correct and approved. The material that has been used from other sources it has been properly acknowledged / referred.

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ABSTRACT

Nowadays, Internet of Things (IoT) and Cloud computing are becoming more and more popular due to the rapid advancements in the field of Information Technology. The demand and usage of E-Commerce and E-Learning systems have increased drastically in this decade. Due to the COVID-19 pandemic, which shutdown all the educational institutions to stop the spread of the virus, the E-Learning systems have become the need of the time. E-Learning systems were already becoming popular among the students and faculty but due to the COVID-19 pandemic their demand increased overnight, as there were no face-to-face interactions and classes and educational institutions needed to resume their academic activities. E-Learning systems are an innovative shift in the field of learning as it provides rapid access to the specific knowledge and information. Cloud computing is a hot topic now a days, it has attracted so many businesses, and institutions because of its reliable infrastructure, flexible tools, and easy access. Cloud based E-Learning system is a next step in the evolution of traditional learning methods. E-Learning system combined with Cloud infrastructure will eradicate the current restrictions of E-Learning systems. Many small institutions have felt the need of E-Learning systems, but they couldn't get their hands on any such system because of their high installation and maintenance costs. Cloud based E-Learning system is a low-cost E-learning system which will easily cater for the requirements of the small institutions. Cloud based E-Learning system will provide services like private cloud storage, secure file sharing, unrestricted access, full administration control and no storage limitations with a secure network interface to be accessed locally and publicly.

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CHAPTER 1: INTRODUCTION

1: INTRODUCTION

This chapter provides a comprehensive introduction of the project “Cloud based E-Learning System”

1.1 Problem Statement

Internet of Things and Cloud computing has witnessed rapid growth and influenced the human lifestyle tremendously through IT. Many organizations are adopting IoT and cloud computing particularly to overcome the current economic crisis. These technologies can provide different IT services including data-center service without investing huge money in a physical data center. Almost 31 billion devices are connected to the internet today. This has opened lot of opportunities for developers to bring their innovative solutions to the market. Many new software solutions are being developed and presented every day to replace the existing, traditional systems. For Example, consider the traditional learning method being used for centuries, which is classroom environment in educational institutions. There is nothing wrong in this practice, but it has some limitations e.g. limited resources, time restriction, physical location limitations, and many more. Moreover, the COVID-19 pandemic severely affected these practices as all intuitions were shutdown to stop the spread of this deadly virus.

COVID-19 highlighted the importance of having a digital platform for educational institutions where these institutions could resume their academic activities without having any direct human interaction. E-Learning usage is growing rapidly and being preferred over the conventional teaching-learning process in a big way. This revolutionary change is attributed to the advancement in digital technology. The transformation in digital technology has made the teaching-learning process flexible, easy, and convenient for effective knowledge transfer. Also, educational institutions required a platform where not only they could just share the educational resources but also, they could be able to interact with each other via chat boxes, emails and blogs, where they can share their experience, their academic problems and solutions. E-Learning system is a solution for such complications. Many service providers came forward with such solutions and many institutions opted for these solutions, but the problem was that these solutions were not feasible for smaller institutions and organizations as the proposed systems are costly and does not meet their requirements. Also, there is a factor of data-privacy and

confidentiality which affected the decision making of some sensitive institutions and organizations. E-learning systems are not only for educational institutions, but they are also being used by organizations to train their new employees, to share and store their files and documents. [1][2]

1.2 Evolution of E-Learning Systems

The teaching and learning methods have evolved over time. If we look back to the time when there was no internet, there was no concept of E-Learning or Distance Learning, instructors used chalk boards, hand written notes and books which would either be provided in the class by the instructor, or students had to walk to the far ends of the city to buy books from the stationary shops. But when the internet came, everything changed. With the introduction of e-books, Power Point presentations, video lectures and demos, all available online with a click of a button, this completely revolutionized the traditional teaching methods and techniques. In 1990's the trend of E-Learning emerged, and it rapidly attracted a large audience due to its convenient, comfortable and practical applications. Due to technical limitations of the time, the growth of E-learning systems was very slow, and it took nearly two decades to become what we see now. The upgraded technologies and software made E-Learning systems became more simplified and acceptable. Today, increased wireless access, online repositories, and content creation and management tools have made E-Learning systems more acceptable. We have divided E-Learning systems into three parts E-Learning, E-Learning 1.0, and E-Learning 2.0, to describe the advancements and achievements of E-Learning systems.

E-Learning involved different content creation tools like Power Point presentations, e-books, and e-notes (PDF and Doc files). These tools surely revolutionized the traditional method of teachings, but that was not enough. Such content still had to be shared via physically restricted storage and sharing tools like pen drives.

E-Learning 1.0 was a one large step in the advancement of E-Learning systems. Online repositories were introduced where all the learning content could be uploaded, which will be accessible to everyone via internet. E-Learning 1.0 removed all physical and geographical barriers and introduced online solutions, like E-learning repositories for the sharing of learning content worldwide. This provided opportunities to learn new skills and share knowledge with the outside world with no restrictions or limitations.

E-Learning 2.0 is the current phase of E-Learning systems. Many innovative services like real-time chat, discussion forums, video streaming platforms and conference calls were integrated to the E-Learning systems. E-Learning 2.0 is also referred as Distance Learning mode, because of the different user to user interaction services it provides. These services have enabled users to interact with each other, share their knowledge, discuss their problems and solutions to that problems. The newest feature of E-Learning system, commonly known as “Online Classes”, where all the students and faculty, joins a platform or a group via their internet devices and the instructors deliver their lectures online in real-time via video call, is the most notable achievement of E-Learning systems.

1.3 Proposed Solution

The impact of IT has been witnessed largely in various areas of human interactions like social, administration, and business. E-Learning has been significantly included in the business domain as well as in personal teaching-learning. E-Learning is the teaching and learning activities that carry on through Internet. E-learning is defined as “the effective learning process created by combining digitally delivered content with support and services”. An E-Learning system is an online digital platform for educational institutions, organizations, and businesses to share and store their academic content (Lectures, Video Lectures, Notes, Books etc.), businesses documents, and many other valuable documents. E-Learning systems also provides services like live chats, blogs, and emails for its users to interact with each other. E-Learning has grown into a widely accepted method of learning with the huge growth of its users, services, educational content, and resources. Until now the E-learning systems being used were web-based, Web-based E-Learning systems have their own limitations. Web based systems are costly to maintain, they provide limited services due to hardware restrictions, they cannot handle large number of users simultaneously and they have storage limitations. Many smaller institutions and organizations cannot afford to maintain these systems.

The alternative for web-based systems is Cloud based E-Learning system. Cloud based E-learning system is low-cost and easy to manage. It has become a new paradigm that has transformed the E-learning system to become more user-friendly. Cloud based E-Learning systems possess flexible tools and infrastructure which can be used to tailor the system and services according to the user’s requirements. Cloud framework allocates resources on demands,

which solves the dynamic requirements of the institutions. Cloud infrastructure is reliable and secure, it can serve large number of users simultaneously and due to its high scalability and virtualization it can counter any security threat to the its storage and infrastructure. It has become a new paradigm that has transformed the E-learning system to become more user-friendly. In the web-based E-Learning systems one Node failure is very common. Web based systems are cluster of networks and machines working as one system, if one network our machine is overwhelmed or encounter a set-back it will shut down the whole system whereas there is no such complications with cloud based E-learning systems. Cloud infrastructure provides the systems with mechanism to rebalance the workload it simply does not allow its systems to be overwhelmed and compromise the availability of the whole system. [3]

1.4 Project Overview

“Cloud based E-Learning System” is a personalized software/hardware solution for a large storage, user-friendly and secure E-learning system. It provides an effective file system to store and protect all type of data. It stores and manages files on the private storage connected to a private server. It provides a secure network interface that can be accessed via internet. Cloud based E-learning system can be accessed remotely from anywhere around the world. This system also provides chat, blogs, user profiles, notice board and email services. Cloud based E-Learning System is a cost-effective learning management system for the small institutions and organizations which cannot afford high cost E-learning systems like moodle, loop, learnamp etc. Cloud based E-learning system can be tailored according to the requirements of the users making it useful for smaller organization and businesses to share and save their data digitally which can be accessed remotely from anywhere.

1.5 Scope of Project

To develop a low-cost, user-friendly, secure, and reliable E-learning system to digitally deliver content along with interactive services. To develop a private cloud server to manage all the activity of the system. To make the system remotely accessible to upload/download files and to utilize other services without any restrictions or complications. To create a web app compatible with all operating systems and browsers. Web app will provide a unified platform to easily access all the features of the Cloud based E-Learning System. A user-friendly and innovative

web app ideal for all kind of audience. Lastly, a large storage with no file size limits so that users can upload/download all types of files without any limitations. The overall scope of this project includes, but not limited to:

- Computer Networks (TCP/IP Architecture)
- Security (Encryption, Authentication, MAC Filtering)
- Programming (Web, File System)
- Hardware (Interfacing, Wi-Fi connectivity)
- Operating System (Windows, Linux)

CHAPTER 2: LITERATURE REVIEW

2: LITERATURE REVIEW

This chapter deals with the literature review and an insight of the existing E-Learning systems offered worldwide. Flaws of existing systems and novelty of our project.

2.1 Literature Review

E-Learning systems have grown rapidly in the past few years. Many institutions have opted for E-Learning systems. Big organizations like Google, Microsoft, Moodle etc. have introduced their E-learning systems. These systems have their own limitations, first is the concerns regarding the privacy of user's personal credentials and confidentiality of the data shared and stored via these systems. Recently in April 2020, zoom data breach was reported, in which almost 500,000 Zoom accounts (Credentials like Login IDs, Passwords and Emails) were hacked, this caused serious concerns over the security of such systems. Also, the factor of third-party involvement in these systems compromises the credibility of such systems. Second, many of the existing E-Learning systems are offered on the basis of monthly and yearly subscription, these systems provide limited storage and file size limits and charges extra for other services like chat, emails etc. So, these systems become expensive for smaller institutions. Third, many of the existing systems does not give full administration control to their subscribers. They don't let their subscribers have full admin access of the E-Learning system they paid for. Cloud based E-Learning system addresses all these issues.

Cloud based E-Learning system is all-in-one product. It provides a private server to which you will have complete access. There is no storage and file size limitations, you can expand the storage if required in future. Cloud based E-Learning system have a secure authentication mechanism, it will only allow registered users with correct IDs and Passwords to access the cloud storage. It provides numerous services like chat, blog, notice board, user profiles, emails, and file system. It provides multiple directories to store data related to a specific subject in the subject's dedicated directory. This makes the management of data easier and makes the files easily accessible. The product can be customized according to the user's requirements. It is a one-time investment to avoid the long term, hefty subscriptions of other existing systems. This system comes with its dedicated hardware and can be placed anywhere user wants, let it be a school, tuition center or business office.

2.2 Existing Systems and their Limitations

2.2.1 Blackboard Learn

Blackboard is a leading educational technology company. It is known for Blackboard Learn, a Learning Management System for educational institutions. Blackboard provide software services to approximately 17000 schools in 100 countries. Blackboard is one of the largest and most expensive LMS in the world. Blackboard Learn system is a virtual learning environment. It is a web-based software which provides course management, customized architecture, and student information system. It provides different functions for communication and content sharing. Blackboard Learn's functions include:

- Course Content: Allow instructors to upload learning content.
- Calendar: Allow instructors to post important events like quizzes and assignments.
- Learning Modules: Allow instructors to post various online classes
- Assignments: Allow instructors to post assignments
- Assessments: Allow instructors to post quizzes.
- Grade Book: Allow instructors to post grades of students.
- Announcements: Allow faculty to post announcements.
- Discussion Board: Allow students and instructors to discuss new topics.
- E-Mail: Allow students and faculty to exchange emails.
- Chat: Allow users to chat in real time.

All these services provided by Blackboard Learn are not cheap. Blackboard is one of the most expensive E-learning systems out there. Blackboard Learn prices depends upon the services user want to avail. Sources suggest that for all the services mentioned above Blackboard charges approximately \$1200 per student per year. Which adds up to \$36000 per year for a class of 30 students. Also, the administration roles are managed by Blackboard itself. Blackboard doesn't give admin access to its users. [4]

2.2.2 Moodle

Moodle is one of the most popular customizable Learning Management System. Moodle provides free and paid plans. The free version of Moodle provides tools to develop, host and manage own Learning management system. Moodle provides customizable management features to create a personal website for online learning. Users can download the free version of moodle but user will have to design his own web app, than deploy and manage it himself. The paid plan includes packages for users to select from. These packages include different services and are charged accordingly [5]. The services provided by moodle includes:

- **Course Content:** Allows users to upload/download learning material
- **Assignments:** Allows instructors to post and collect assignments.
- **Assessments:** Allows instructors to post quizzes
- **Chat:** Allows users to chat in real time
- **Forums:** Allows faculty and student to discuss their ideas
- **Announcements:** Allows faculty to post news and announcements.
- **Feedback:** Allows faculty to collect feedback from students.

Moodle's Package prices are given on its official website (<https://moodle.com/moodlecloud/>). Their packages start from \$120 per year.

Showing prices in US dollars

Package	Price / year	Users	Storage
Starter	\$120 USD / year <small>May vary with exchange rate</small>	50 users ⓘ	250MB storage
Mini	\$220 USD / year <small>May vary with exchange rate</small>	100 users ⓘ	500MB storage
Small	\$390 USD / year <small>May vary with exchange rate</small>	200 users ⓘ	1GB storage
Medium	\$870 USD / year <small>May vary with exchange rate</small>	500 users ⓘ	2.5GB storage
Large	\$1,550 USD / year <small>May vary with exchange rate</small>	1,000 users ⓘ	5GB storage

Each package includes a "Buy now" button with a right-pointing arrow.

2.2.3 Learn Amp

Learn amp is one of the leading Learning Management System. Learn Amp is a fully featured LMS to serve different educational institutions and business organizations. Learn Amp offers learner portal, synchronous learning, and mobile learning. The feature of Learn Amp includes:

- Course Content: Allows faculty to upload course related material
- Assessments: Allows faculty to conduct online quizzes
- Assignments: Allows faculty to post assignments
- Surveys: Allows faculty to collect feedbacks from students
- User Profiles: Allows users to maintain their profiles.
- Chat: Allow user to chat in real time

Learn Amp prices depends upon the services and number of active users. Learn Amp provides monthly subscriptions. [6]

2.2.4 Wisetail LMS

Wisetail LMS is a cloud-based Learning Management System. Wisetail provides multiple services to its users all around the globe. Wisetail provides a built-authoring tool to its users to create custom courses and share course content. Wisetail LMS provides different packages to its users with different services and features. The features provided by Wisetail includes:

- Course Content: Allows users to upload/download learning material
- Course Creation: Allows users to custom create new courses.
- Assignments: Allows instructors to post and collect assignments.
- Assessments: Allows instructors to post quizzes
- Chat: Allows users to chat in real time
- Forums: Allows faculty and student to discuss their ideas
- Feedback: Allows faculty to collect feedback from students.

Wisetail charges its users on monthly and yearly bases. The pricing of Wisetail packages depends on the services user choses. Users complained about the complex and slow web application of the Wisetail. Its web application is not much user friendly. [7]

Existing System	Description	Cons
Moodle	Moodle is customizable E-Learning system. It provides services like file sharing and file storage. It has limited storage and charges more for extra storage. Moodle plans starts from \$275 USD/Year for 1000 users.	<ul style="list-style-type: none"> • Expensive • Limited Storage • Charges for customizable packages
Blackboard	Blackboard is a Learning management system. It is one of the largest and most expensive learning systems in the world. Their pricing start at \$35000 per year. Their pricing plans are dependent on the requirements of the users.	<ul style="list-style-type: none"> • Expensive • Charges extra for more users.
Learn Amp	Learning Management System which charges according to the features and storage. Poor customer services reported by its users.	<ul style="list-style-type: none"> • Expensive • No single platform for all services
Wisetail LMS	Wisetail is a Learning Management System. Its pricing depends upon the features and number of users. Its desktop application is not much user friendly.	<ul style="list-style-type: none"> • Expensive • Complex Desktop Application • No Administration control
Loop	Learning management system. User friendly desktop application. Pricing starts from \$299 per month	<ul style="list-style-type: none"> • Expensive • Limited Users and Storage

Table 2.1: Summary of different E-Learning Systems

2.3 Cloud based E-Learning System

Cloud based E-Learning system is a low-cost, personalized Learning Management System. It is specifically designed for small educational institutions and business organizations. Cloud based E-Learning system provides almost all the services provided by management systems discussed above (Section 2.2) but at low cost. CBEL is a perfect solution for organizations which are data sensitive and are not comfortable with sharing their data with a third-party. Cloud based E-Learning system is a one-time investment with no future costs other than maintenance. CBEL gives full ownership and full administration access to the user. CBEL maintains a private cloud server with private storage present on the physical premises of the owner, making it immune to any outsider's direct access. CBEL provides multiple file systems to maintain dedicated course directories. CBEL possess a flexible infrastructure and it can be tailored as per users requirements. CBEL can be used for different applications, like it can be deployed as an Online Library, containing e-books, video documentaries, articles etc. It can also be deployed as a secure data repository in offices to share and store their daily documents. Features and Services provided by Cloud based E-Learning system are given below:

- Private Cloud Server: It provides a private server configured with users own domain name and it has its own private data storage to store all the data.
- Extendable Storage: The data storage of CBEL can be extended anytime in the future if required, it can also be deployed with custom provided data storage.
- Course Content: Allows faculty to upload course related content in its dedicated directory.
- Security: It deploys certain security measures like authentication, encryption, and mac filtering to protect the system and data from unauthorized users.
- Announcements: Allows faculty and admins to post announcements of upcoming events.
- User Profiles: Allows users to view and edit their profiles containing their personal details like passwords, contact details, usernames etc.
- Chat: Allow users to chat in real time
- Discussion Forum: Allow users to discuss latest trends and ask their queries.
- Email: Allows users to send Emails.

2.4 Novelty of Cloud based E-Learning System:

E-Learning systems provided by Blackboard, Moodle, Wisetail etc. have certain limitations. These systems are popular around the world but are not much feasible for many institutions and business organizations. Firstly, these systems are very expensive. These systems offer monthly and yearly subscription packages with limited services. Small institutions like tuitions and vocational training centres don't have very large budgets and they require low-cost E-learning systems with appropriate services. CBEL is a one-time investment, cost effective and scalable solution which can be tailored to accommodate users requirements. Secondly, existing E-learning systems do not provide complete ownership and complete admin control to the user but CBEL provides user with a private server, private storage, it gives complete ownership and full admin control to the user. Due to its personalized hardware and software, CBEL is more secure than other systems. All the data on CBEL is stored in a private storage, whereas on other systems data is stored on their own storages raising concerns over third-party access to the users private data. CBEL provide a unified web app compatible with all operating systems. CBEL Web App provide all the features and services of CBEL on a single platform. CBEL also offers multiple file systems to arrange all the data on cloud storage according to its respective course/subject in its respective directory. The storage capacity of CBEL can be extended when ever required. CBEL puts no limitations and restrictions on minimum or maximum file sizes. Data of any format (pdf, doc, txt, mp4, mkv, mp3, etc.) can be uploaded to the system. CBEL offers a secure authentication system to authenticate and authorize valid users to access and utilize the services and features offered by the system. CBEL also allows admins to limit the access of any user to limited services, like not allowing students to upload and modify announcements and course content files.

Cloud based E-Learning system offers the following features:

- Unified Communication
- Complete Ownership
- Automated and user-intuitive GUI
- Extendable Storage
- Cost effective and Indigenous Scalable solution

2.5 Objectives

The Objectives of Cloud based E-Learning system are:

- To come up with a personalized hardware and software solution for sharing data, storing, and retrieving data on and from multiple file systems.
- To develop a user-friendly, interactive, and secure web application for client's access to services provided by CBEL.
- To come up with a low-cost E-learning solution for smaller institutions and organizations.
- To secure the CBEL's server with popular security techniques like Authentication and MAC filtering.
- To provide a secure cloud storage with no file size restrictions and no upload/download limits.
- To develop one platform for all the services.
- To divide and limit users access into different categories like Admin, Faculty and Student.
- To track and record all the activity of the system.
- To develop multiple file systems, each dedicated to one subject or category of data.
- To secure all the data on the cloud storage via encryption and hashing.

CHAPTER 3: TECHNOLOGICAL REQUIREMENTS

3: TECHNOLOGICAL REQUIREMENTS

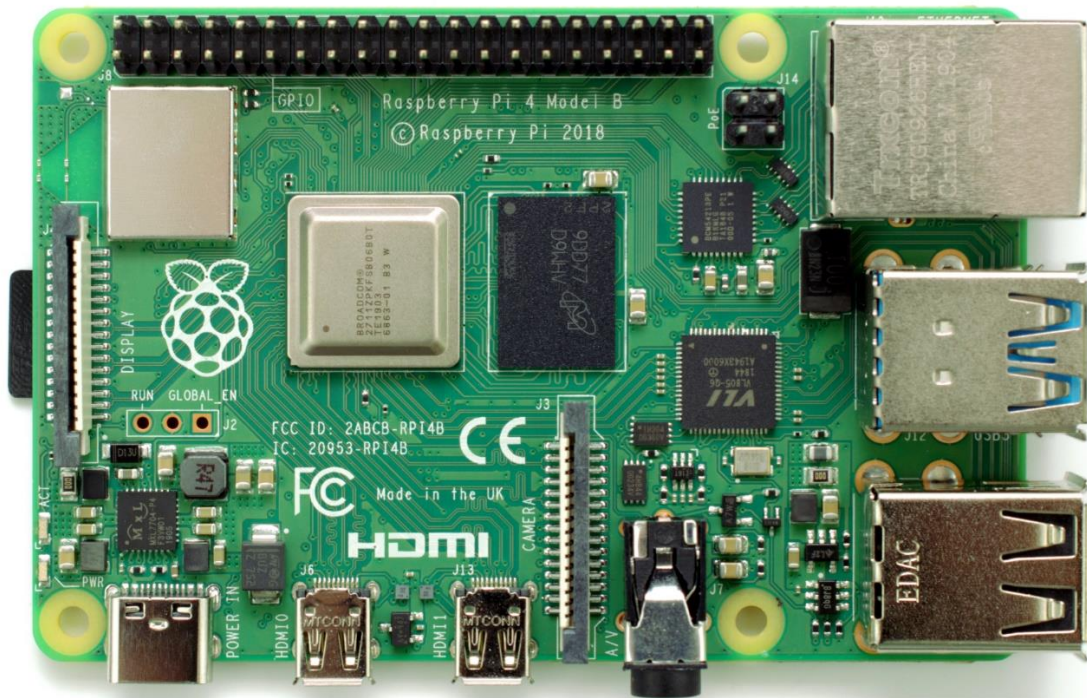
This chapter provides comprehensive details about the technical requirements of “Cloud based E-Learning System”

3.1 Hardware:

The hardware components required for the implementation of Cloud based E-Learning system include:

3.1.1 Raspberry Pi

A small single board PC that is powerful enough to run a server and carry out multiple tasks.



Minimum required specification for the Raspberry pi are:

- 1.2 GHz clock frequency
- Up to 2 GB RAM
- Wi-Fi
- USB 3.0 ports

3.1.2 External Storage

External media storage of up to 256 GB is required.



3.1.3 Power Supply

A good quality 3A power supply to keep the pi running.



3.2 Software Requirements

Cloud based E-Learning system's software requirements are mentioned below:

3.2.1 Python

Python v3.8 is utilized throughout this project.

The libraries used are mentioned below:

- **Django:** Django is a python-based free and open-source web framework to create web-applications. Django can work with any client-side framework and can deliver content in almost any format (including HTML, XML, JSON, etc.).
- **SQLite3:** SQLite3 is easy to use database engine. It is self-contained, serverless, zero-configuration and transactional. The Python Standard Library includes a module called “sqlite3” intended for working with this database. This module is a SQL interface compliant with the DP-API 2.0 specification. It creates databases to record user account details including hashes of every file synced with our server.
- **OS:** It commands to walk through our system locating files and returning their paths.
- **Hashlib:** It is used to hash and message digest by returning hash of chosen files.
- **Threading:** It is used for carrying out background processes without interrupting the current ongoing processes.

3.3 Operating System Requirements

The operating system requirements for running the Cloud based E-Learning systems are given below. These are the minimum requirements of this project; higher clock frequency and RAM will make this product more efficient.

- 1.2 GHz clock frequency or more
- Up to 256 GB external SSD
- Up to 2 GB DDR2 RAM or more
- Wi-Fi connection
- USB 3.0 ports

3.4 Setting up Working Environment

3.4.1 Installing OS

Raspberry Pi OS, Raspbian is installed through following steps [8]:

- Download Raspbian Image
- Download Etcher
- Format and Flash the USB with Raspbian Image using Etcher
- Connect the USB to Raspberry Pi
- Turn on the Raspberry Pi and sign in with default username and password.
- Install 'pip' to get libraries

3.4.2 Installing software

- Install latest version of Django using PIP command [9]
- Install Virtual Environment [10]

3.4.3 Setting up Django Working Environment

Step 1: Update your Python. Use latest version of python.

Step 2: Create and Activate virtual environment for your Django project using following commands:

```
# pip install virtualenv
# virtualenv -p <directory for creating virtual env> <name of the directory>
# ./Scripts/activate
```

For deactivating the virtual environment use the command

```
# deactivate
```

Step 3: Install Django using pip

```
# pip install Django
```

Step 4: To start a Django project use the following command

```
# python manage.py startproject <name of the project>
```

Step 5: After successfully executing this command you will see a folder with project name in the virtual environment directory with project's files (settings.py, urls.py ,manage.py).

3.4.4 Installing NGROK

Step 1: Search for NGROK on internet and download it. Our server is Linux based so our NGROK should be Linux version. [11]

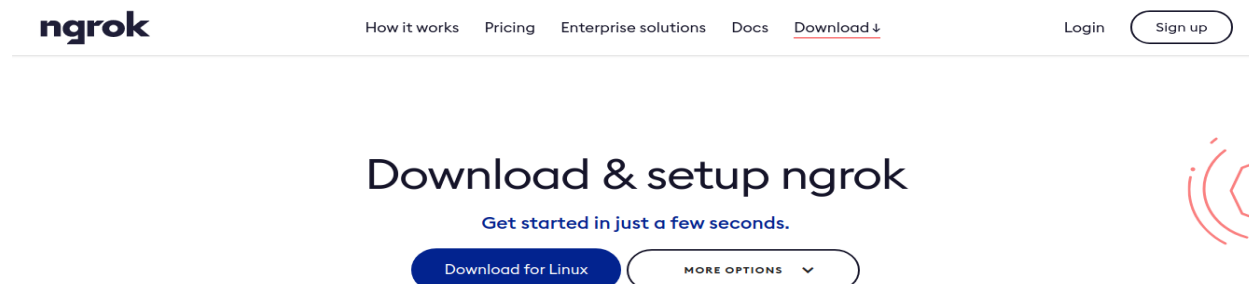


Figure 3.1 NGROK

Step 2: Unzip the downloaded NGROK file using command line or manually.

```
# unzip /path/to/ngrok.zip
```

Step 3: Add your Authentication token to your ngrok file with the command

```
# ./ngrok authtoken <your authtoken>
```

Step 4: After successfully installing NGROK, use 'ngrok help' command to explore all possible port forwarding examples.

```
(root@kali)-[~]
└─# ./ngrok help
NAME:
  ngrok - tunnel local ports to public URLs and inspect traffic

DESCRIPTION:
  ngrok exposes local networked services behinds NATs and firewalls to the
  public internet over a secure tunnel. Share local websites, build/test
  webhook consumers and self-host personal services.
  Detailed help for each command is available with 'ngrok help <command>'.
  Open http://localhost:4040 for ngrok's web interface to inspect traffic.

EXAMPLES:
  ngrok http 80 # secure public URL for port 80 web server
  ngrok http -subdomain=baz 8080 # port 8080 available at baz.ngrok.io
  ngrok http foo.dev:80 # tunnel to host:port instead of localhost
  ngrok http https://localhost # expose a local https server
  ngrok tcp 22 # tunnel arbitrary TCP traffic to port 22
  ngrok tls -hostname=foo.com 443 # TLS traffic for foo.com to port 443
  ngrok start foo bar baz # start tunnels from the configuration file
```

Figure 3.2 NGROK Tunnel examples

3.4.5 Setting up NGROK

Step 1: We run ngrok on port 80 of our server. NGROK gave us a random url which is forwarding all http and https requests to our local host port 80.

```
ngrok by @inconshreveable (Ctrl+C to quit)
Session Status      online
Account             Muhammad Uzair (Plan: Free)
Version             2.3.35
Region              United States (us)
Web Interface        http://127.0.0.1:4040
Forwarding           http://3436d18aeb5e.ngrok.io → http://192.168.100.6:8080
Forwarding           https://3436d18aeb5e.ngrok.io → http://192.168.100.6:8080

Connections         ttl    opn    rt1    rt5    p50    p90
                   0      0      0.00  0.00  0.00  0.00
```

Figure 3.3 NGROK port forwarding

3.4.6 Starting Django Project

We used Python Django as a backend to manage our web application. Django will receive different requests and it will give various responses accordingly. The responses will vary from storing data on Database, edit data from Database, authentication, Hashing and Encryption.

We set different routes for different services, like moving from one webpage to another, choosing a file for uploading etc. all accessible from one interactive navbar. The routes we use are:

/login: to authenticate users

/profile: to get profiles of signed in users

/course_content: to access, upload or download the files

/email: to send emails (only for admins and faculty)

/chat: to open group chat portal

/blog: to post and view blogs

/noticeboard: for posting announcements

3.5 Confidentiality, Integrity, & Availability (CIA)

Confidentiality, Integrity, and Availability, also known as CIA triad, are three most important aspects of Information of Security. CIA triad is an information security model which define the security policies of any system, which are protect the data stored in the system, protect identity of its users, and deliver the system resources only to the authorized users. Today information security has become the most important feature of any digital system. Protection of system data and reliable availability of system resources are the trademarks of each system. Cloud based E-Learning system deploy certain security measures and techniques to fulfill the standards of CIA triad. CBEL protects users data, it delivers systems resources to authorized users and it block and prevent unauthorized access to the system. The security policies and techniques incorporated by CBEL are:

Confidentiality: Confidentiality means the protection of system data, objects, and resources from unauthorized viewing and access. CBEL employs techniques like MAC filtering, authentication, and encryption to protect the system resources from unauthorized access. MAC filtering and authentication allows the authorized users to connect to the system and it blocks all unauthorized devices and users to access or exploit system resources. Data stored on the CBEL is encrypted and can only be decrypted by an authorized user.

Integrity: Integrity means the protection of data from unauthorized manipulation. In E-Learning systems, authenticity of data is most important. CBEL defines explicit user roles which prohibits the unauthorized users to manipulate the data. E.g. Only Admin and Faculty have the authority to upload, edit and delete course content files and announcements. Students can only view and download these resources; system restrict the access of students and proscribe students from manipulating these resources.

Availability: Availability means the access of resources only to authorized users. Authentication play a big part in the availability of system. All access permissions and user roles are defined via Authentication. Admin have complete access to all the resources of the system. Only admin can add and assign roles to new users. Admin define intelligible roles for each user, and restrict the user's access to system resources according to his role. Moreover, only the authenticated users can access the services of the system. Secure login IDs and passwords are given to users, only users with valid login credentials will be allowed to access system resources.

CHAPTER 4: METHODOLOGY

4: METHODOLOGY

A brief description of the architecture of 'Cloud based E-Learning system. Methods and procedures, we used to set up this system. This chapter includes the basic structure of backend software. It also includes a brief introduction to all the features provided by this system. This chapter gives the overall idea of 'Cloud based E-Learning system', its working and its services.

4.1 Architecture of Cloud based E-Learning System

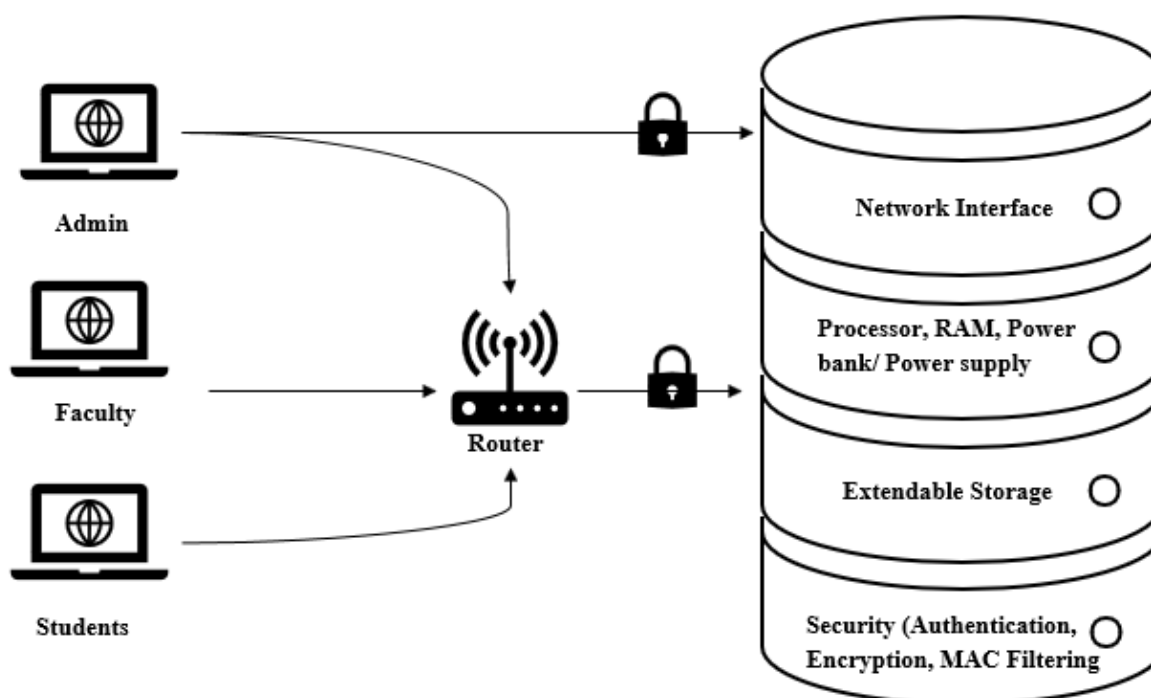


Figure 4.1 Architecture of Cloud based E-Learning system

Cloud based E-learning system can be accessed via web-app from any browser. Certain security measures have been implemented to the system, like authentication, to allow only authorized users, Encryption, to encrypt the database and all the data stored on the system storage and mac filtering to lock out untrusted users to connect to our system. An extendable storage is connected to the server. All the Databases containing user credentials and file hashing are stored at server side. Cloud based E-Learning system provides 3 types of logins, Admin, Faculty and Students. All three categories have their own defined roles and they have access to the system according to

their defined roles. All users can access the system via web application by entering their correct login credentials. Some basic roles of Admin, Faculty and Students are given below more user roles will be discussed further in the chapter.

Admin:

- Can upload, download, and delete files
- Can add new users
- Can set permission for other users
- Can send emails
- Can post notifications

Faculty:

- Can upload and download files
- Can send emails
- Can post notifications

Students:

- Can only view and download files
- Can only view notifications

4.2 Application Overview

The web app of the Cloud-based E-Learning system can be accessed from any browser. It is a platform for CBEL's users to access all the content and services available on the system. Users will have to enter their correct assigned Username and Passwords to access all functions of the app. When user enters its credentials on the '*login*' page of the app, then the usernames and passwords are sent to server to authenticate if these credentials are correct, after the authentication user will be allowed to proceed. Only admin can add new users by assigning them unique usernames and passwords. Admin will also set permissions for the users. For services like file system, noticeboards, and emails only admin and faculty have permissions to upload files, post announcements and send emails. Students can only view these portals. Group chat and Blog portal are specifically designed for students to interact with the systems community, so they have full access to use these services. Students can post blogs and comment on other users blogs.

Admin can perform all his duties from an '/admin' portal. This portal is only accessible to admins, not even faculty can access this portal. Admin can also track and view the activity of other users like when did they last signed in and what functions they perform when users signed in from this portal. Each service of the system has its own web page/ portal to avoid complexity. All these portals are accessible from an interactive dashboard and navigation bar. CBEL's web app is a responsive web app to develop a better user experience on different devices. Responsive web app renders web pages according to the user device or screen size with minimum to maximum display size.

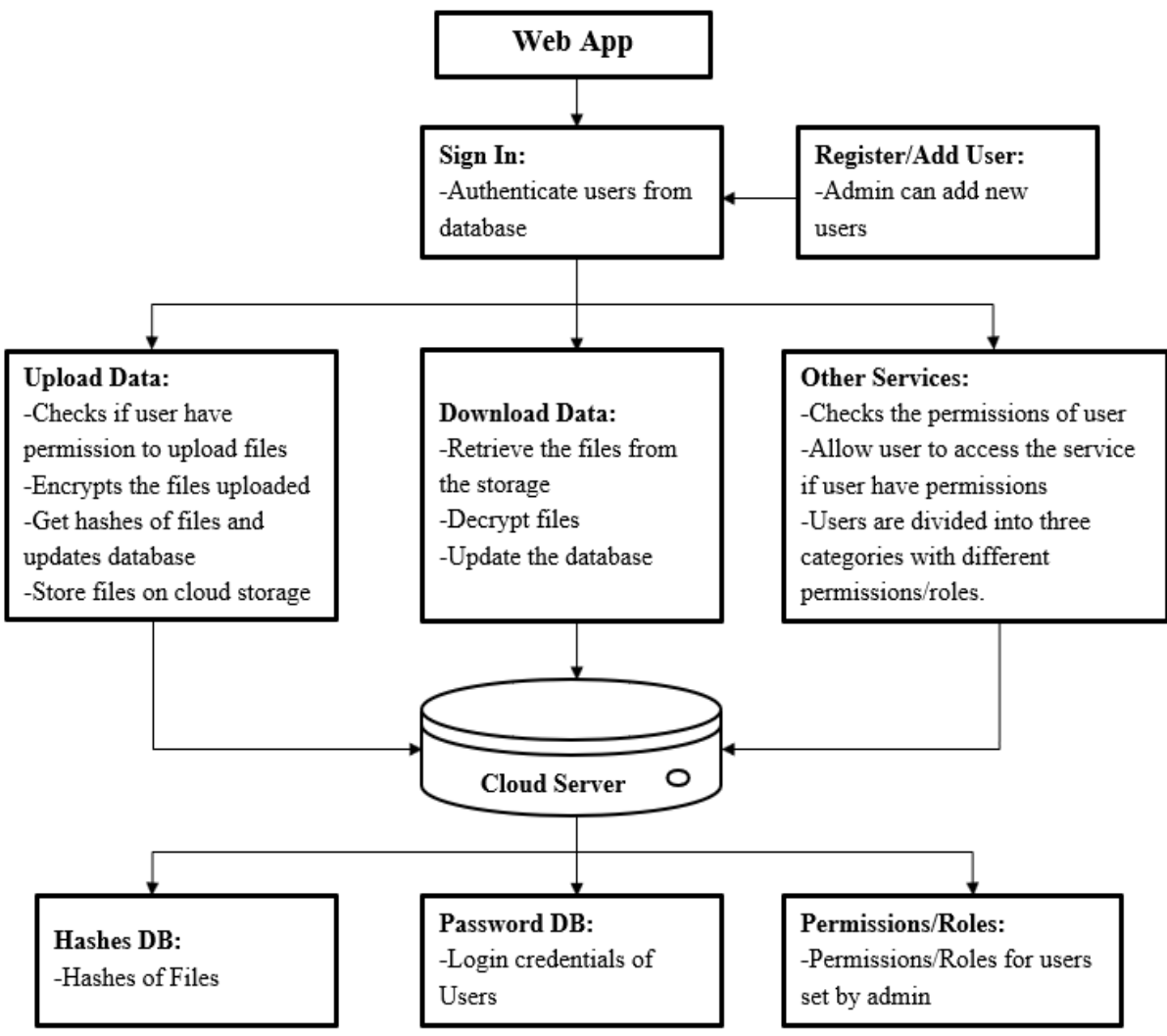


Figure 4.2 Application Overview

4.3 Authentication

Authentication is the most important part of Cloud based E-Learning system. Delivering specific content to a particular audience is the key principle of E-Learning systems. An Authentication mechanism for Cloud based E-Learning system was developed using python Django framework. Whenever a user tries to access the CBEL system, a login page will appear asking for user's login id and password as shown in Figure 4.3. User can also access this page from the Web app's dashboard.

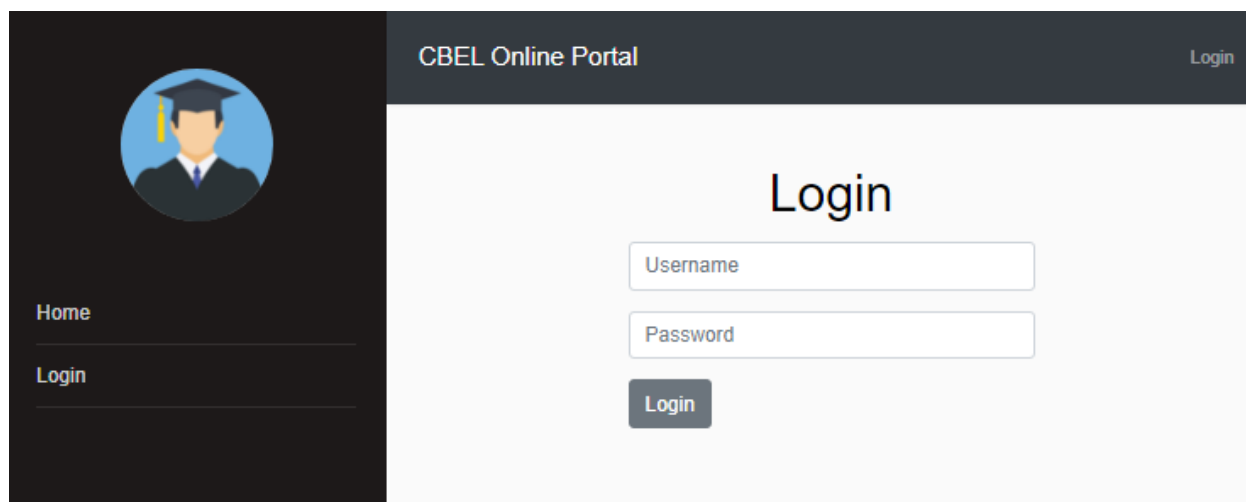


Figure 4.3 Login Page

When user enters his correct username and password and click login, the POST request is generated, and user's credentials are sent to the server for authentication. Server looks for the username in the database, check for user's password, if username and password are correct, server authenticates the user else it will send an error message. New users cannot register themselves, only admin have the authority to add new users. As such systems are designed for institutions and organizations so only admin will add new users. Admin will also define roles or permissions for the users. Afterwards when user tries to access any service from the app, it will first check user's permissions and will act accordingly. As in this system only faculty are allowed to upload files, students can only view those files. Adding new users and setting up permissions will be done from the admin panel of the web app, shown in Figure 4.4. Admin panel can be accessed by appending *'admin'* to the URL of server. On the admin panel, admin will assign a unique username and password to the user, admin will push those credentials onto

the database so when the user tries to login, his credentials can be authenticated. Certain conditions are added for password to create a strong password for users. Users can change their password after logging in.

Add user

First, enter a username and password. Then, you'll be able to edit more user options.

Username:

Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.

Password:

Your password can't be too similar to your other personal information.
Your password must contain at least 8 characters.
Your password can't be a commonly used password.
Your password can't be entirely numeric.

Password confirmation:

Enter the same password as before, for verification.

Save and add another Save and continue editing SAVE

Figure 4.4 Add User

System diagram of working Authentication module is given in Figure 4.5.

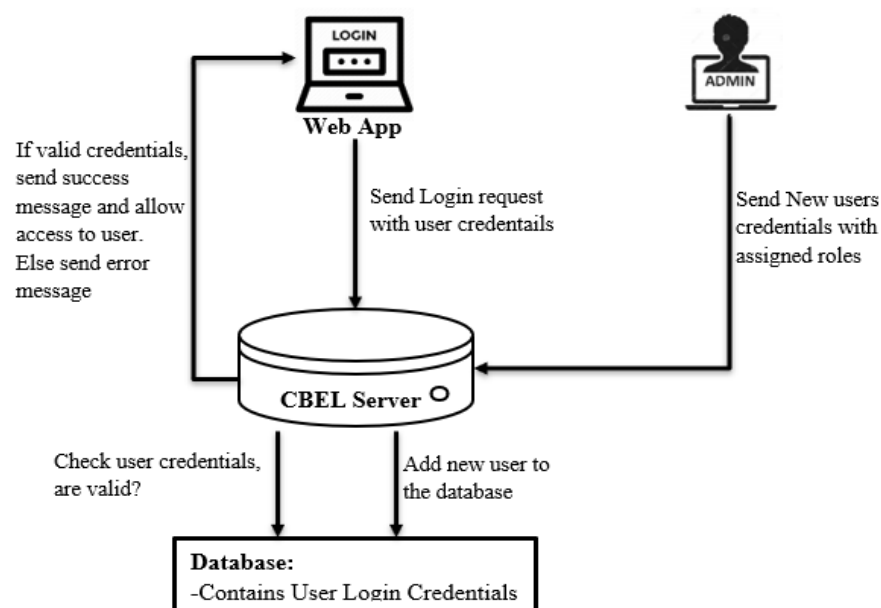


Figure 4.5 System diagram of Authentication module

4.4 File System

Once the user has logged in, user will be redirected to the home page of the app. On the home page user will see multiple file systems (for our project we only created three). Each file system is for one specific subject or category of data. In simple words one file system represent one separate directory. Purpose of multiple file systems is to organize data of one course or category on its respective assigned directory. Only Admin and Faculty are allowed to upload the data to the file systems. Students can only download the data from the subject's assigned archive. All the data uploaded will be encrypted. CBEL's File system supports all kinds of data. Any type of file, docx, pdf, text, ppt or any video/audio files mp3, mp4, mkv etc. also exe files of software required for lab tasks can be uploaded. Also, there is no file size limit on the CBEL's file system, large files can be uploaded. CBEL's file storage is extendable, it can be extended according to the requirements in future if needed.

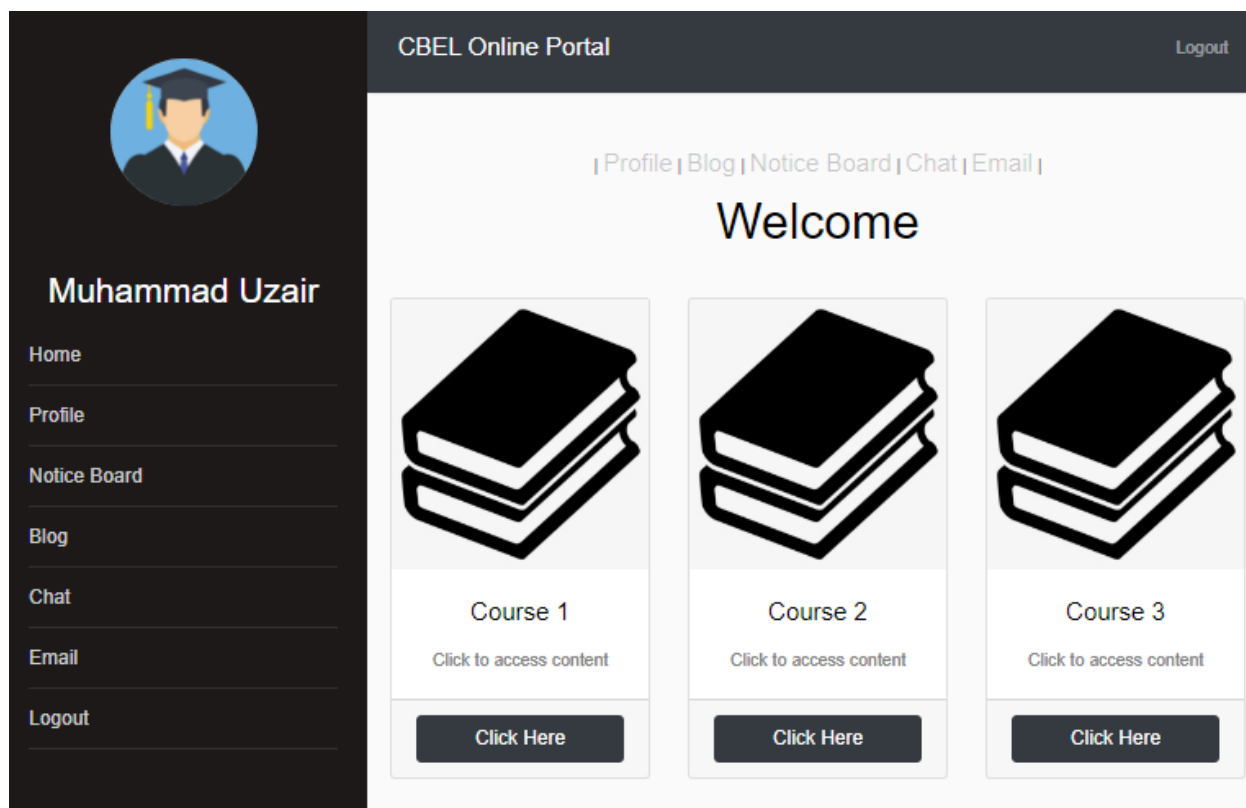


Figure 4.5 File System

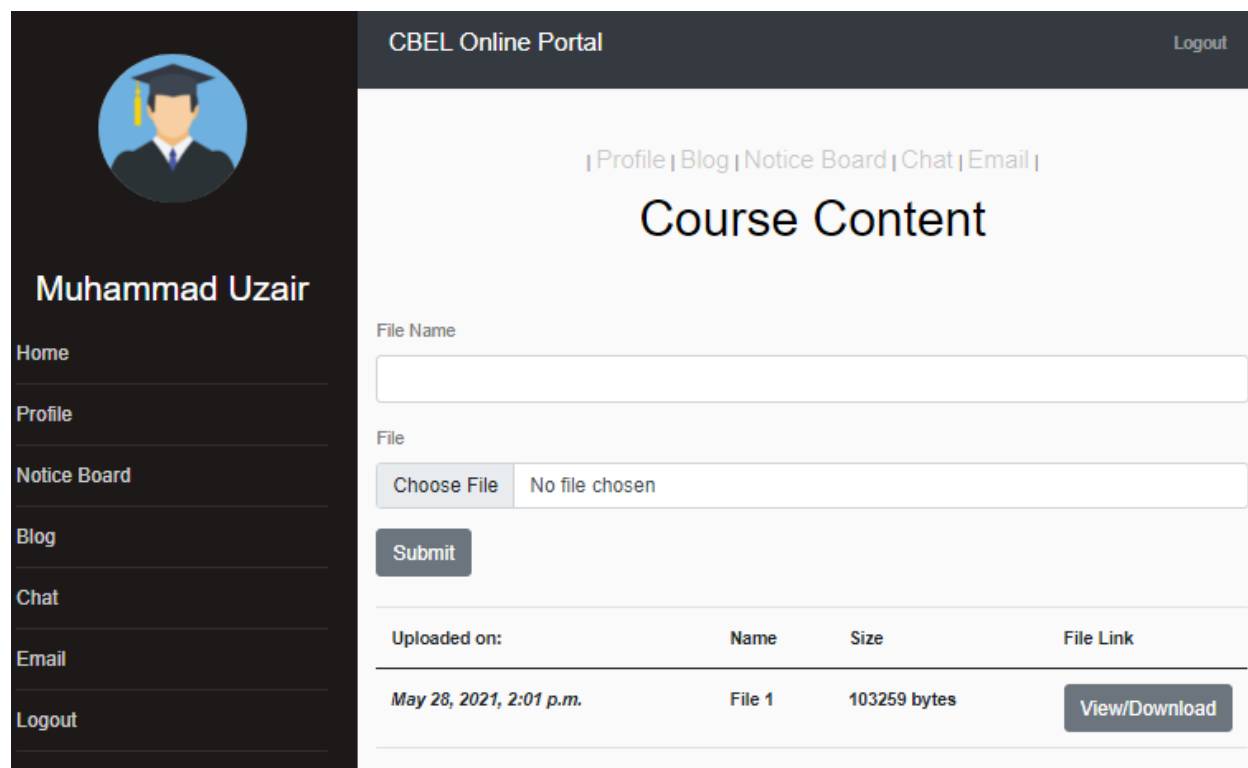
As discussed before only admins and faculty can upload the files on CBEL so the file uploading option will only be visible to admins and faculty. So, when authorized user wants to upload file following steps will be followed:

Step 1: First system will check the permissions of the user. If the user is authorized, then the uploading form will be visible to the user.

Step 2: For uploading a file, System will ask the user to enter File Name then select the file user wants to upload and click submit.

Step 3: After submitting the POST request will be sent to the server with file name, file, user id and the file system id as a query set.

Step 4: Server will encrypt the file, update its hash along with the file name, user id and file system id on database. File system id will specify the file system from which the file was uploaded, and the file will only be then accessed from the same file system it was uploaded from.



The screenshot displays the CBEL Online Portal interface. On the left is a dark sidebar with a user profile for Muhammad Uzair and navigation links: Home, Profile, Notice Board, Blog, Chat, Email, and Logout. The main content area is titled "Course Content" and features a file upload form with fields for "File Name" and "File", a "Choose File" button, and a "Submit" button. Below the form is a table of uploaded files.

Uploaded on:	Name	Size	File Link
May 28, 2021, 2:01 p.m.	File 1	103259 bytes	View/Download

Figure 4.6 Upload/Download Files

Step 5: After the completion of uploading procedure, system will update the entry of new file on file system's panel for students to view and download the file. File Name, size and file link will be updated on the system.

Step 6: When user clicks on Download button, the GET request will be sent to the server. Server will check for the file hash in its database, it will get the file from the media directory, decrypts it and send to the user.

System diagram of the file system modules is given in Figure 4.7.

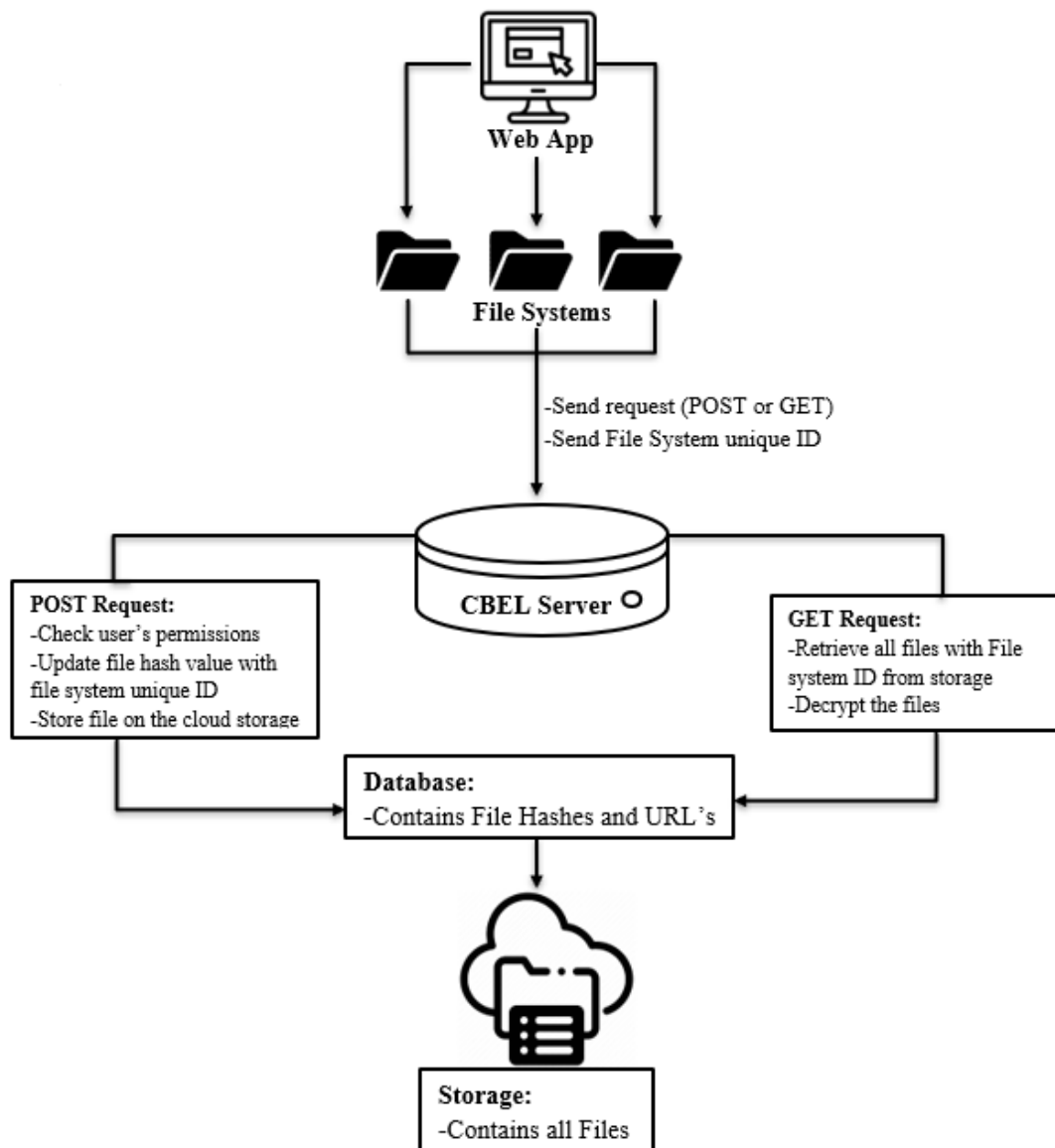


Figure 4.7 System Diagram of File Systems

4.5 Miscellaneous Services

A detailed overview of the miscellaneous features of Cloud based E-Learning system.

4.5.1 User Profiles

User Profiles contain some important credentials of users like username, password, user's first and last name and email address. More fields like user's qualification, status etc. can be incorporated according to the requirements. On user profiles platform, users can edit their contact details and passwords.

The screenshot shows the 'CBEL Online Portal' interface. On the left is a dark sidebar with a user profile picture of a person in a graduation cap, the name 'Muhammad Uzair', and a menu with items: Home, Profile, Notice Board, Blog, Chat, Email, and Logout. The main content area has a top navigation bar with 'CBEL Online Portal' and a 'Logout' link. Below this is a breadcrumb trail: '| Profile | Blog | Notice Board | Chat | Email |'. The main heading is 'Muhammad Uzair's Profile'. The profile details are as follows:

- Username: admin1
- First name: Muhammad
- Last name: Uzair
- Email: admin@cbel.com

Below the email field, there is a link: 'Click here To change your Password'. At the bottom of the profile section is a dark button labeled 'Edit Profile'.

Figure 4.8 User Profiles

User login passwords are the most critical information of the user which must not be compromised [15]. User passwords are not stored as raw passwords on the user model in Django. User passwords are stored as a hash on the database so they cannot be manipulated directly. So, for changing the password user have to first enter his old password so that his identity can be confirmed by checking password hash, then for new password a new hash will be updated to the data base replacing the old one.

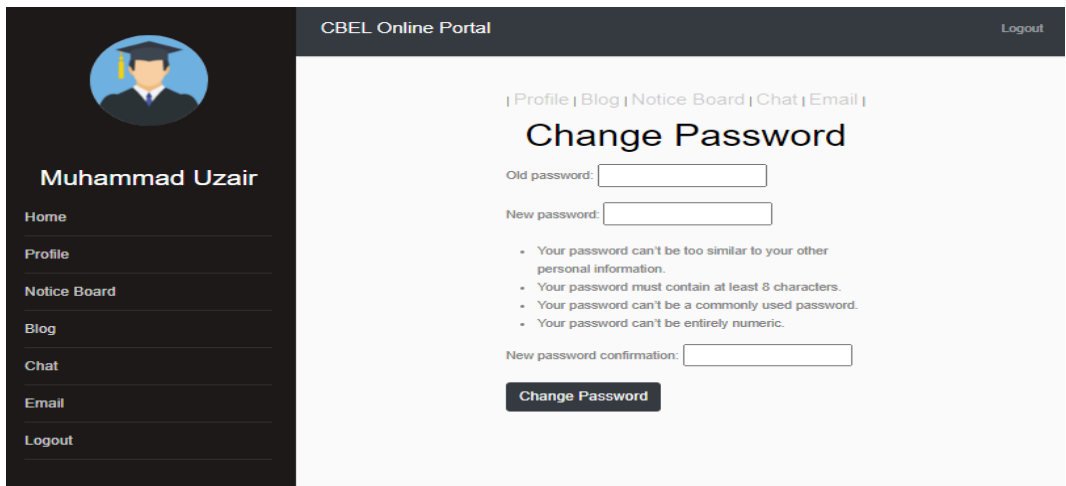


Figure 4.9 Change Password

System diagram for updating user profiles is given in Figure 4.10.

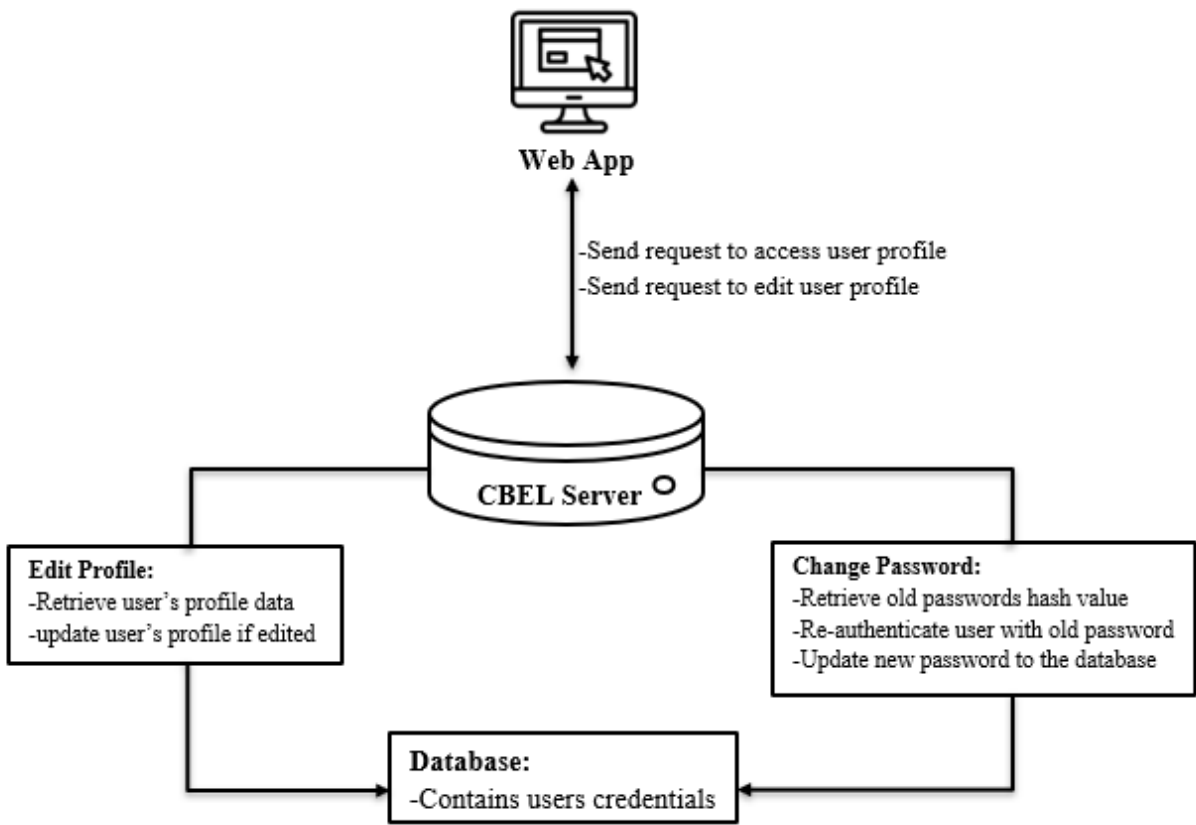


Figure 4.10 System diagram of User Profiles

4.5.2 Notice Board

Notice board is a must feature for every E-Learning system. Notice board is where admin and faculty can post announcements of the upcoming events. Only Admins and Faculty are authorized to post, edit and delete announcements. Students can only view these announcements.

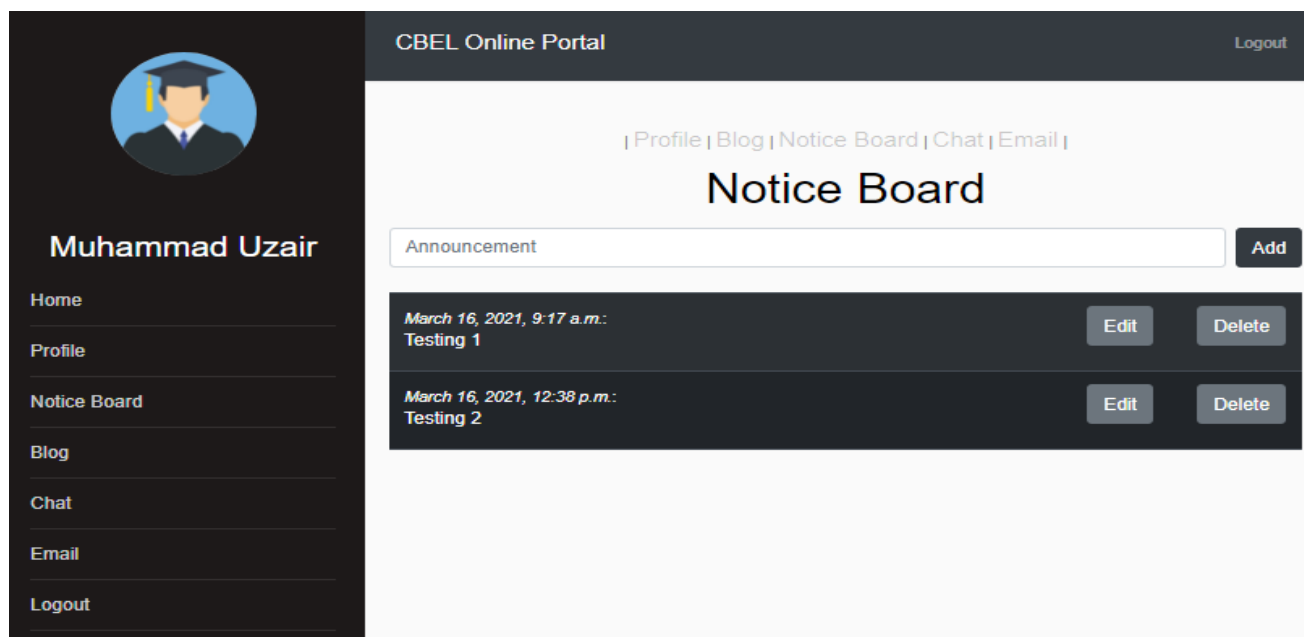


Figure 4.11 Notice Board

4.5.3 Blog

Cloud based E-Learning system have a Blog portal accessible to all users. Users can write about their academic experience; they can share their ideas and can seek help for their academic activities. Blogs will be visible to all users and all users can comment on the blog.



Figure 4.12 Blog

Every blog on CBEL is saved with a unique blog ID. When a user wants to view the blog, that blog is retrieved from the database with its specific ID. The comments for all blogs are posted with the blog ID and are only visible on the intended blog post. The system diagram for Blog and Comment posts is given in Figure 4.13.

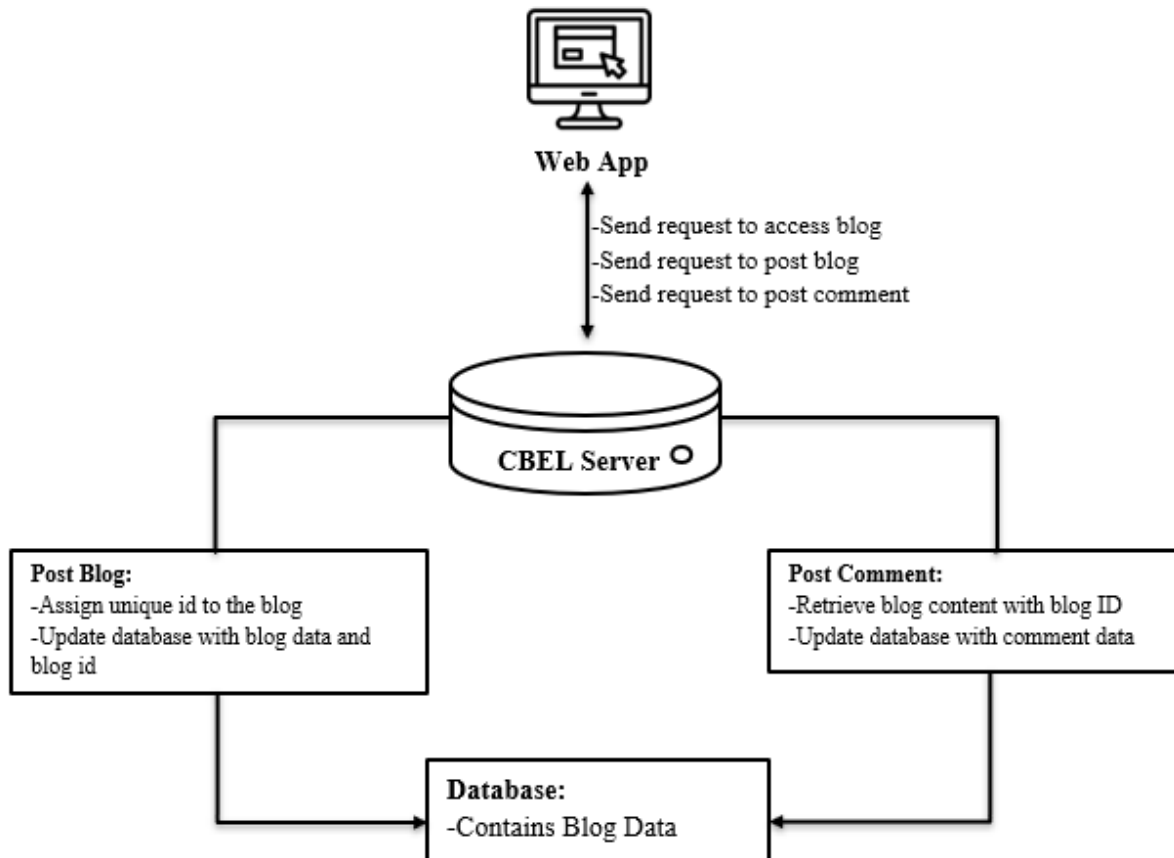


Figure 4.13 System diagram of Blog Module

4.5.4 Chat

A simple group chat application allows users to send and receive messages. Once a user clicks on chat on dashboard, user will be redirected to the chat app where user can send and receive messages. When the user clicks on send button a POST request will be sent to the server, the server will update the message on group chat window for other users to see and reply.

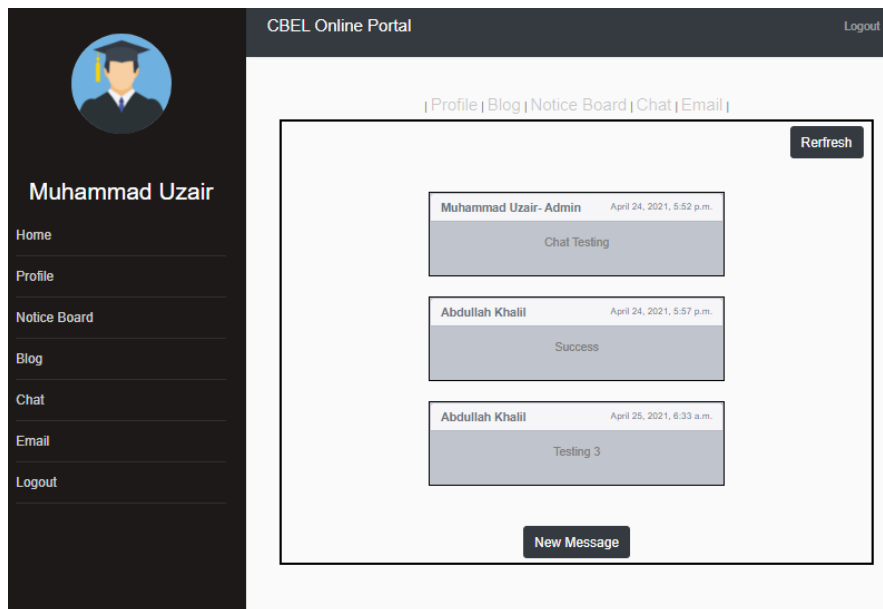


Figure 4.14 Chat

4.5.6 Email

Python Django provides a mail sending interface via `smtplib` module [12]. Mail uses SMTP host and ports specified in the Django settings. Django uses SMTP server to send emails. For setting up Django email server following configurations are required in Django settings file.

```
EMAIL_BACKEND = 'django.core.mail.backends.smtp.EmailBackend'
```

```
EMAIL_HOST = 'smtp.gmail.com'
```

```
EMAIL_PORT = 587
```

```
EMAIL_USE_TLS = True
```

```
EMAIL_HOST_USER = '<Email Address>'
```

```
EMAIL_HOST_PASSWORD = '<Email Password>'
```

[EMAIL_BACKEND]: is the built-in Django smtp module for sending emails

[EMAIL_HOST]: is the host for sending emails, for this project we used gmail as a host to send email.

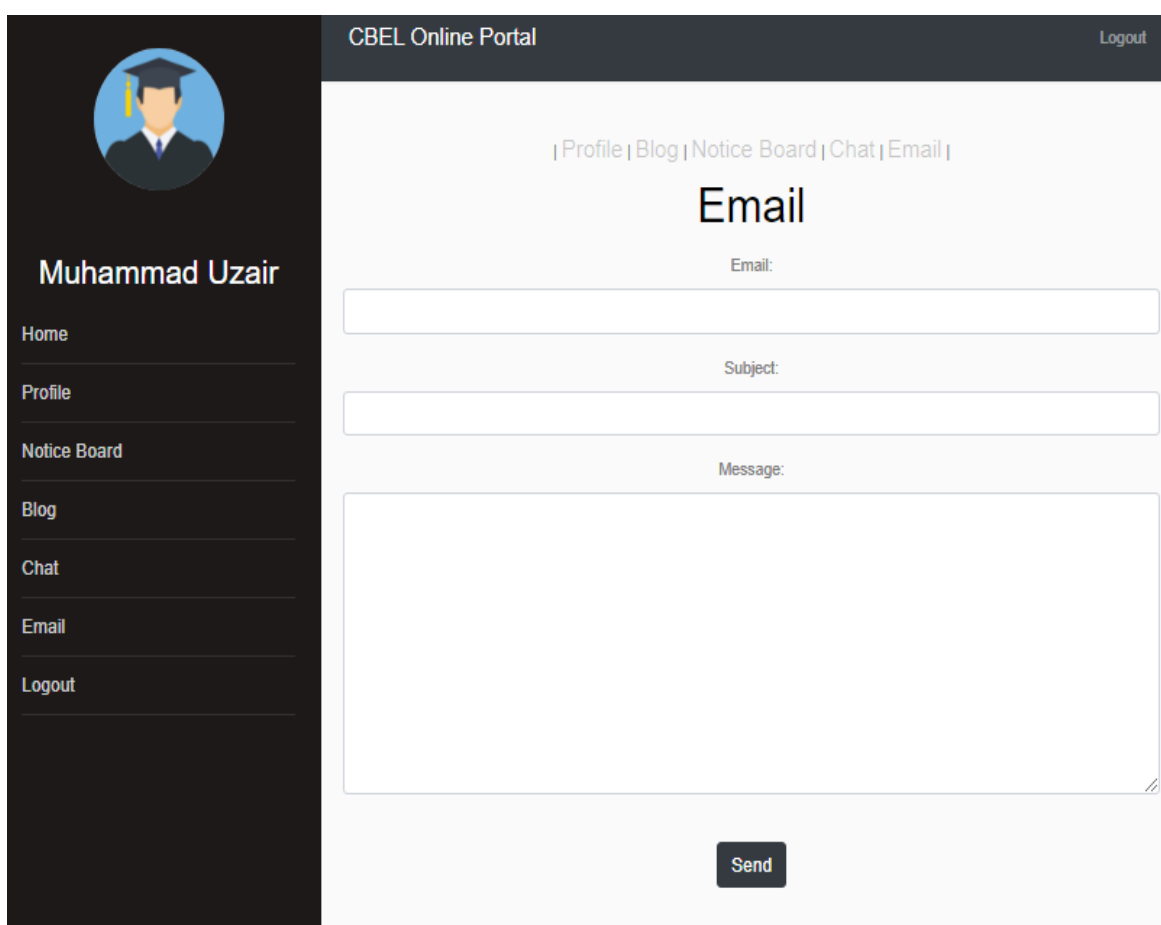
[EMAIL_PORT]: is port to use for SMTP server to send emails

[EMAIL_USE_TLS]: to use secure connection for sending emails

[EMAIL_HOST_USER] and [EMAIL_HOST_PASSWORD]: Host email address and password.

After the Django configuration, we also have to set gmail account settings to let Django send emails using gmail account, for that turn on gmail's 'Allow less secure apps' feature on.

Now for sending email from CBEL's web app, user has to enter receiver's email address, subject of the email and body and click send. Once the user clicks on send, a POST request will be sent to the server with the receiver's email address, subject and message. Server will forward that request to the smtp server, and smtp server will then send the email from the email address mentioned in [EMAIL_HOST_USER].



The screenshot shows the 'Email' form in the CBEL Online Portal. The page has a dark header with 'CBEL Online Portal' and a 'Logout' link. A navigation menu on the left lists 'Home', 'Profile', 'Notice Board', 'Blog', 'Chat', 'Email', and 'Logout'. The main content area is titled 'Email' and contains three input fields: 'Email:', 'Subject:', and 'Message:'. A 'Send' button is located at the bottom of the form.

Figure 4.15 Send Email

The system diagram for sending emails from the CBEL is given in Figure 4.16.

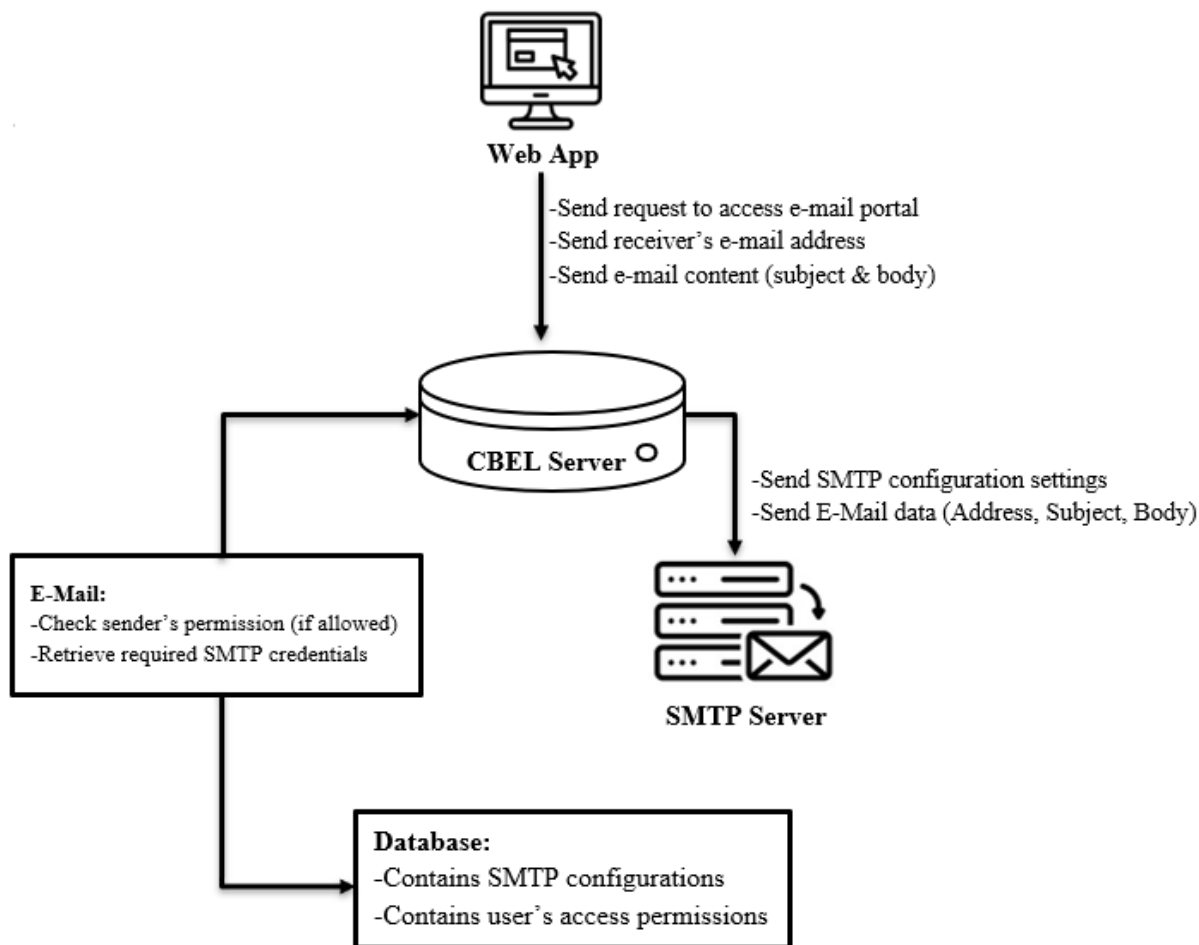


Figure 4.16 System diagram of E-mail module

4.6 MAC Filtering

We use 'IP Tables' module on our Cloud based E-Learning system to filter packets according to the mac addresses [13]. Using IP tables, we can accept and drop packets from mac and ip addresses. We can block untrusted mac and ip from accessing our system by defining ip table rules. We used linux CLI commands like:

```
iptables -A INPUT -p tcp -dport <port> -m mac ! --mac-source <mac address> -j DROP
```

Using above command, we can block mac address from our HTTP server.

To block IP address, we use the following CLI command:

```
iptables -A INPUT -s <IP address> -p tcp -dport -j DROP
```

This command will block the untrusted ips and will add an extra layer of security.

4.7 Integration of System Apps (Software & Hardware)

Software:

Web App of Cloud based E-Learning system is developed with Python Django Framework. Django is a model-template-views architectural pattern. It maintains sqlite3 database to manage user passwords, credentials and urls of uploaded files. Django provides built-in libraries and modules to manage all kinds of data. It supports multiple formats for sharing of data. Django supports secure end-to-end encrypted channels which were used to develop a group chat app. Django also supports smtp protocols to manage E-mail server of our system.

Hardware:

Raspberry Pi is a small, portable mini computer, a perfect device to run and manage our system. An Https server is set-up on the Raspberry Pi which manages all the traffic and data on our system. Raspberry pi a low-power, low-cost and low-maintenance mini-computer with multiple ranges of RAM (for this system RAM is 2GB) and a powerful processor to keep our server running. An external storage is attached to the Raspberry Pi which holds all the system files and all the data uploaded to the system. The storage is extendable and can be upgraded anytime if required. Storage have multiple file systems to manage and organize the data according to its category. All the data stored is encrypted via Advanced Encryption Standard (AES)

Network:

To make our system remotely accessible, we configured our system to run on local network by opening a port our server will listen to and forwarding it. Django by default uses port 8000 but it can be configured to use another port. Certain security measures like authentication and mac filtering were deployed to make our connection secure. For cross-network access an open source tunneling tool called 'NGROK' was make a network tunnel from the system to the public internet so that it can be accessed remotely from another network. NGROK provides secure tunnels and have an interactive GUI for users to inspect all the packets and traffic on the system. NGROK also provides tools to block untrusted ips from accessing and exploiting the CBEL system.

CHAPTER 5: RESULT AND ANALYSIS

5: Result and Analysis

This chapter gives a brief overview of the project, its block diagram and how things are working in the backend.

5.1 Block Diagram

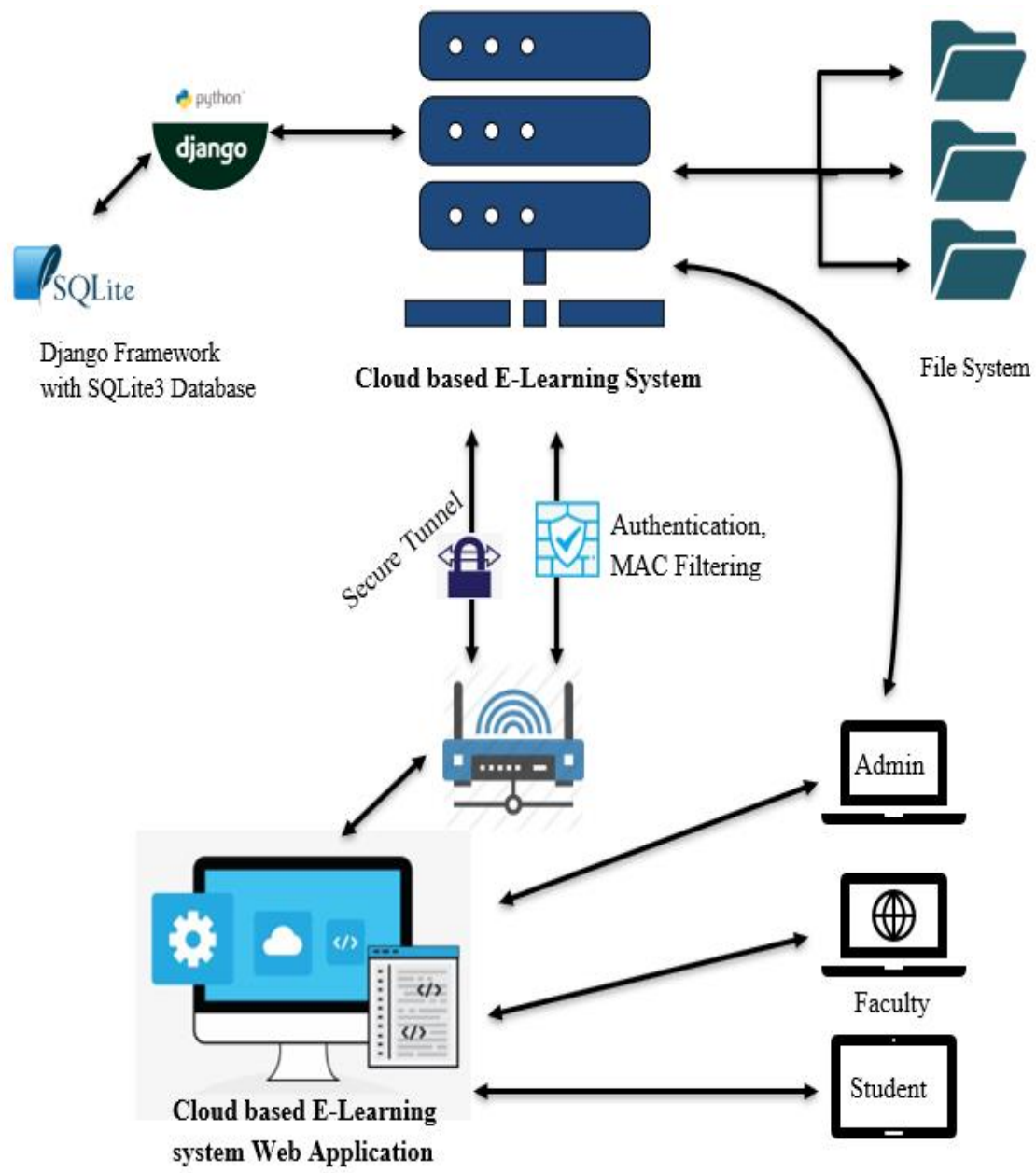


Figure 5.1 Block Diagram

Cloud based E-Learning system is a hardware product running an HTTP server, with its own private storage. Cloud based E-Learning system supports multiple file systems, it encrypts all the user's data and database. CBEL uses Advanced Encryption Standard (AES). AES is the most secure encryption standard in the world. All the data on CBEL is encrypted via AES encryption standard. CBEL supports multiple logins simultaneously and can handle more than adequate traffic on its server. CBEL's server and client-side software is developed using Python Django Framework, it is a high-level, most popular framework being used for rapid development and clean pragmatic designs. Django comes with built-in libraries for developing an efficient and secure server and client-side applications. Django provide built in libraries to encrypt user data and update data on database using hashing. CBEL can be run on the local network. It can also be exposed to the public internet through secure tunnels. CBEL uses ngrok http and https tunnels to expose the server to internet. Certain security measures are added to the system, more can be added with time. CBEL authenticate and allow only authorized users to access the services, Encryption techniques are used to encrypt user's data before storing it on the cloud storage, and mac/ip filtering to filter-out and block untrusted macs and ips (discussed in Chapter 4).

CBEL have an interactive, user friendly web app for its clients, CBEL's webapp can be accessed from any internet browser. It provides an interactive dashboard to access all the features of the system. CBEL supports three categories of logins, Admin, Faculty and Students, their roles are clearly defined in CBEL's configuration ([discussed in Chapter 4](#)). CBEL limits the user's access according to its category of login. Admins can perform their activities remotely and via connecting physically (by cable). All users first have to authenticate with their usernames and passwords to access the CBEL's system. CBEL is a low-cost e-learning and training solution for the smaller organizations. CBEL possess a flexible software and hardware infrastructure which can be tailored anytime to comply with clients requirements. CBEL can be used for multiple purposes and can be configured accordingly. The Hardware of CBEL only contains a server and storage connected to it. The server and storage both can be updated to handle large no of users and data. The better the hardware is, more efficient and reliable will be the system. Currently CBEL server is running on a minicomputer (Raspberry Pi; specification discussed in Chapter 3). CBEL can also be configured to use custom domains and custom defined port forwarding methods. CBEL uses smtplib to send emails, smtplib is a built-in Django module, it provides the necessary Django configurations to send emails from Django app.

5.2 Applications

Cloud based E-Learning system is a low-cost, personalized hardware and software solution for securely sharing, storing, and retrieving data from multiple file systems. CBEL employs custom built authentication mechanism to authenticate and authorize its users. It is specifically designed to cater for the needs of small educational institutions and organizations which need such systems but cannot afford the existing expensive systems. CBEL is a one-time investment and the buyer will have full ownership of its software and hardware rather than paying monthly and yearly subscriptions for lifetime. CBEL have multiple applications. It can be used by small educational institutions like tuition centres, vocational training centre for sharing their learning content. It can also be deployed in business organizations for securely sharing and storing their sensitive and important documents on CBEL's private storage. CBEL also provides communication modules like, chat, blogs, noticeboard, and emails for secure communication among different departments and organizations. Its multiple file systems allow the institutions and organizations to manage and organize their data into different categories. One file system dedicated to one category. Some applications of Cloud based E-Learning system are given below:

- **Educational Institutions:** Cloud based E-Learning system is a learning content management system, it can be deployed in educational institutions for sharing their learning content like e-books, notes, lectures etc.
- **Digital Libraries:** Cloud based E-Learning system can also be used as a digital library, where users can upload e-books, documentaries and users can discuss popular topics and share new via its communication modules.
- **E-Skill Center:** Udemy, Coursera and SkillShare are types of E-skill center where admins upload tutorials for users to learn different skills. CBEL can be used as an E-Skill Center to share different tutorials and discuss solutions to different technical problems.
- **Tuitions & Vocational Training Institutions:** There are millions of tuition and vocational training institutions all over Pakistan. These institutions don't have much large user and system requirements. CBEL can be deployed in such institutions as it is low-cost and can cater the tuition centre requirements.

- **Organizations:** Many business organizations, during this pandemic, required an online system to facilitate their work from strategy by providing them with a file sharing system. Such organizations also want a secure system and cannot afford the third-party interference which can possibly compromise their sensitive document. CBEL is a personalized, secure file sharing solution for such organizations.
- **Inter-Organization:** Cloud based E-Learning system can be deployed on temporary basis, where two different organizations are working on a same project. It can be used for secure and effective communication among these organizations.

CHAPTER 6: CONCLUSION AND FUTURE WORK

6: Conclusion and Future Work

This chapter gives a brief idea of what is Cloud based E-Learning system? why is there a need of Cloud based E-Learning system? And What makes the proposed Cloud based E-Learning system different and unique from other E-Learning systems. When we talk about the world technologies, there is always a room for improvement, this chapter also include some ideas which can enhance the performance of Cloud based E-Learning system.

6.1 Conclusion

In conclusion, Cloud based E-Learning system is a low-cost content management and secure file sharing system. The basic services of Cloud based E-Learning system includes, Private Cloud Server, Multiple File Systems, and Secure Data Storage. Additional services provided by CBEL are Noticeboards, Group Chat, Blog, User Profiles and Emails. All the features of CBEL are accessible from one unified web app, which can be used from any internet browser. There are no minimum or maximum file size limits for uploading files on the CBEL, users can upload files of all sizes and all formats. CBEL have multiple file systems for managing and organizing data according to their category in their respective directories.

The need of E-Learning systems arises when the world was struck by COVID-19 pandemic. Although the E-Learning systems were already becoming popular before the pandemic but during this time-period the demand for E-Learning systems rapidly raised. The reason was that all the institutions and organizations were shutdown to minimize the spread of virus, which halted all academic and business activities all around the world. Many educational institutions chose the E-Learning system to resume their academic activities, where the learning content can be shared with the students online. Many businesses also required similar systems to resume their business activities by adopting a strategy of working from home. Businesses required a secure and reliable E-Learning system for sharing their sensitive content without being subjected to any security risk.

There are large corporates like Blackboard, Zoom, Moodle and many more that are offering E-Learning systems. These systems have their own limitations. These systems are offered on monthly and yearly subscriptions. These systems have limited storages and they charges extra for more storage, same is the case with other services. Also, the data uploaded via these systems is

stored on their storages which compromises the integrity of sensitive data because of a third-party involvement. Such systems are not feasible for small educational institutions and small organizations, which need a low-cost, secure, and reliable E-Learning system which can cater for their requirements. Cloud based E-Learning system is a personalized E-learning system with private server and extendable storage, connected to internet via secure ngrok tunnels. CBEL's infrastructure is designed to be as flexible as could be so that it can be deployed for multiple purposes. It can be used as a Learning Management System in educational institutions, Secure File sharing and Management system in business organizations and can also be used as a digital library ([Detailed description is given in Chapter 5](#)). CBEL employ's security measures like Authentication, Encryption and MAC/IP Filtering to protect the data and integrity of the system.

The features of Cloud based E-Learning system are:

- Encrypt all data on CBEL's storage.
- Provide secure connection for file sharing.
- Multiple file systems for organizing and catalogue data
- No File size and format restrictions
- Notice board
- Group Chat, Blog and Email
- Encryption of all the messages being shared via Chat, Blog and Email
- Divide users into three groups, Admin, Faculty and Students
- Define rules and permission for different users to limit their access according to their defined roles.
- Deployment of CBEL on local network and on public internet using NGROK tunnels.

6.2 Future Work

There are certain parts of Cloud based E-Learning system which can be improved to make CBEL more user friendly. Enhancements to the code and hardware of the CBEL can significantly improve its performance. Certain upgradation to the system can improve its security. More features can be integrated into the system to make it more interactive and innovative.

6.2.1 Hardware Enhancements

Efficiency and Latency are the key factors defining the performance of Cloud based E-Learning system. More active users, multiple services and large data transfers can make CBEL slow if sufficient RAM is not provided. Even some extra line of codes can affect the performance of any system. Therefore, CBEL's hardware needs continuous maintenance. As the hardware part of CBEL consists of only a Server and storage, an advanced server with more processing power and RAM can be used to run CBEL's services. As discussed in the above chapters CBEL's storage can be extended anytime in the future. So, whenever a need arises, CBEL's storage can be extended to cater large data storage requirements.

CBEL's hardware is not 100% threat proof, with the advancements in the field of networking, the security threats are also becoming more and more relevant. Some threats are countered by CBEL via MAC/IP Filtering, but a more efficient approach is required for the protection of the systems. Attacker can spoof their MAC and IPs, making CBEL vulnerable to attacks. Some router and hardware firewalls can prevent that. They would also help to detect network intrusions and provide a much safer and secure environment. [12]

6.2.2 Software Enhancements

At this stage CBEL support multiple filesystems to manage and store the data. Only Admins and Faculty have access to upload data, but more similar portals can be developed for students to upload their assignments and quizzes online. More services can be integrated into the system like, Feedback forms, private chats, attendance, event calendars etc. Existing services can be improved, adding more fields to user profiles like user qualification, experience etc. Improving chat portal by adding private inbox chat feature.

We can also improve the security of the system by further adding multi factor authorization. [13] Android app can also be developed to further improve the user experience. Video conference calls can also be integrated into the system after carefully considering the hardware requirements.

APPENDIX A: SYNOPSIS FORM

Cloud based E-Learning System

Extended Title: Using Cloud Computing Platform for developing an effective E-learning system.

Brief Description of The Project / Thesis with Salient Specifications: Cloud based E-Learning system is a low-cost alternative of Web-based E-Learning with better efficiency, scalability and availability. Cloud based E-Learning system will also cater the problem often faced in Web-based system 'Node failure'. Using cloud computing this system will detect and exclude the node failure without effecting the normal operation of the system.

Scope of Work: To develop a Cloud based E-Learning system to allow faculty and students to share all learning resources. To build a website from where students, faculty and administration staff can access the cloud database. To provide security to the cloud to avoid the tampering of data. To remove the third-party involvement by providing user with a private cloud.

Academic Objectives: To provide a cheaper, reliable and effective E-Learning system. To resolve the Node failure using cloud technology. To provide all the required services on the single platform to make it easy to use for users. Also to enable the user to expand the data, storage if required in future, without effecting the normal operation of the system. To add security like authorization and data encryption to the cloud.

Application / End Goal Objectives: Cloud based E-Learning system can be implemented in educational institutions for Distance learning. This system can also be implemented in organizations to train new employees. Also this system can connect multiple campuses for secure and reliable sharing of resources.

Previous Work Done on The Subject: The platforms like Microsoft Teams and Zoom are providing E-Learning services to many institutions. These platforms provide its users services like sharing of lectures, notes and e.t.c, chat, and video call. But the problem with these systems are that the data shared via these platforms is stored on their own clouds which can be tampered.

Material Resources Required: Raspberry Pi

No of Students Required: 4

Group Members: Abdullah Bin Khalil Muhammad Uzair Muhammad Adil Sajjad Qazi
Special Skills Required: <ul style="list-style-type: none">• Python• Django• Linux

Approval Status **Supervisor Name & Signature**

Supervisor: Lec Amal Haider

Co-Supervisor: Asst Prof Aimen Aakif

Assigned to: _____

HoD Signature _____

R&D SC Record Status **File #** _____

Coordinator Signature _____

APPENDIX B: USER MANUAL

CLOUD BASED E-LEARNING SYSTEM

The user manual for each user (Admin, Faculty & Student), describing core features of the system. Clear instructions on how to fully utilize all the features of CBEL.

Admin/s:

Append '/admin' to the URL of the CBEL portal to access Admin portal.

User/s Management:

Add User:

1. From admin portal, select 'Users > Add user' to add new users.

Home > Authentication and Authorization > Users > Add user

2. Enter unique login username and password for new users
3. Click 'Save' to add user

Add user

First, enter a username and password. Then, you'll be able to edit more user options.

Username:	<input type="text"/>
	<small>Required. 150 characters or fewer. Letters, digits and @/./+/-/_ only.</small>
Password:	<input type="password"/>
	<small>Your password can't be too similar to your other personal information. Your password must contain at least 8 characters. Your password can't be a commonly used password. Your password can't be entirely numeric.</small>
Password confirmation:	<input type="password"/>
	<small>Enter the same password as before, for verification.</small>
<div style="text-align: right;"> <input type="button" value="Save and add another"/> <input type="button" value="Save and continue editing"/> <input type="button" value="SAVE"/> </div>	

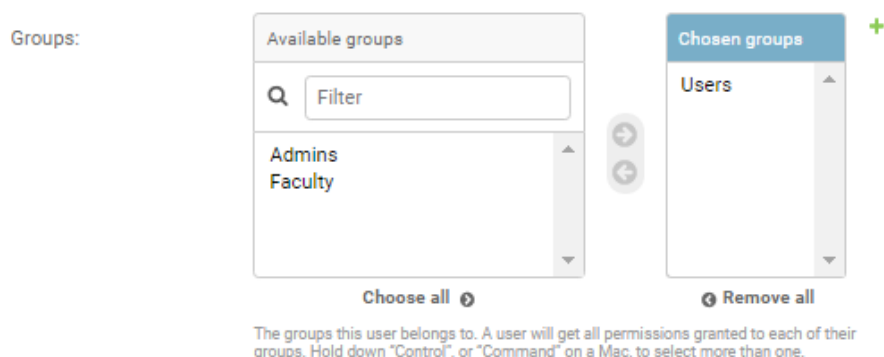
Similarly to Delete Users:

1. Select user from 'Users'

2. Click 'Delete' to delete user.

Assigning user to a specific group:

1. Select user from 'Users'
2. Scroll Down to the Groups.
3. Add/Remove user to the groups



Creating new Groups:

1. Select 'Groups > Add group'

Home > Authentication and Authorization > Groups > Add group

2. Name the Group and Select permissions for the Group.

Add group

Name:

Permissions:

Available permissions

Filter

- Announcements | list | Can add
- Announcements | list | Can chan
- Announcements | list | Can delet
- Announcements | list | Can view
- admin | log entry | Can add log e

Choose all

Chosen permissions

Remove all

Hold down "Control", or "Command" on a Mac, to select more than one.

Save and add another
Save and continue editing
SAVE

3. Also to assign individual permissions, Select user, scroll down to permissions and assign permissions to the user.

Manage Apps:

Admins have full control of the CBEL system, they have special permissions to delete and modify course files, announcements, blogs, and E-mails.

Delete/Modify course files:

1. Select the course and then select the file
2. Now change name, change file, or Delete file

Change file_upload HISTORY

File name:

My file: Currently: PE_Lecture_1.pdf
 Change: No file chosen

3. To check related history of File click 'HISTORY'

Edit/Delete Announcements and Blogs:

1. Select the entry to edit or delete
2. Make changes and click 'SAVE'
3. Or delete the entry

Add Announcements/Blog/Email:

1. Select the App (Announcement, Blog or Email)
2. Click 'Add', Fill the form.
3. Click 'SAVE'

Add file_upload

File name:

My file: No file chosen

Faculty:

Course Files:

1. Access Course from Home Page
2. Enter File Name and choose File to upload
3. Click 'Submit' to upload file

The screenshot shows the 'Course Content' page. At the top, there are navigation links: Profile, Blog, Notice Board, Chat, and Email. The main heading is 'Course Content'. Below this, there is a 'File Name' input field. Underneath is a 'File' section with a 'Choose File' button and a text area that says 'No file chosen'. A 'Submit' button is located below the file selection area. At the bottom, there is a table header with columns: 'Uploaded on:', 'Name', 'Size', and 'File Link'.

Announcements:

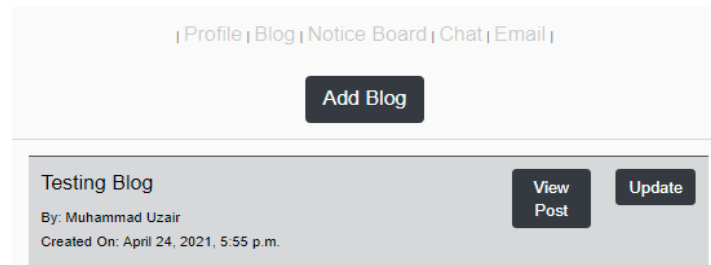
1. Select 'Notice Board' from Sidebar or Nav-bar
2. Enter Announcement and Click 'Add'

The screenshot shows the 'Notice Board' page. At the top, there are navigation links: Profile, Blog, Notice Board, Chat, and Email. The main heading is 'Notice Board'. Below this, there is an 'Announcement' input field and an 'Add' button. Below the input field, there is a dark grey box containing the text 'March 16, 2021, 9:17 a.m.: Testing 1' and two buttons: 'Edit' and 'Delete'.

3. To Edit announcement, click 'Edit'.
4. To Delete announcement, click 'Delete'.

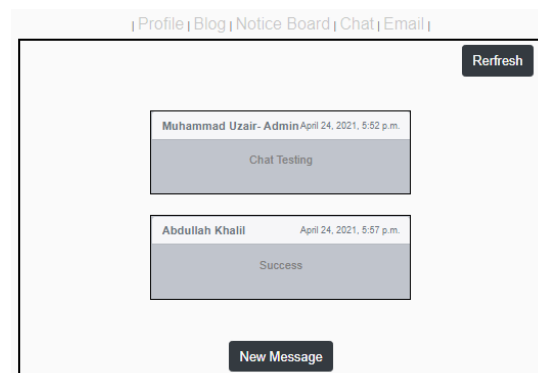
Blog:

1. Select 'Blog' from Sidebar or Nav-bar
2. To write new blog, click 'Add Blog'
3. To view existing blog, click 'View Post' from the desired blog.
4. To edit blog, click 'Edit Blog' (Only available if you created the blog)



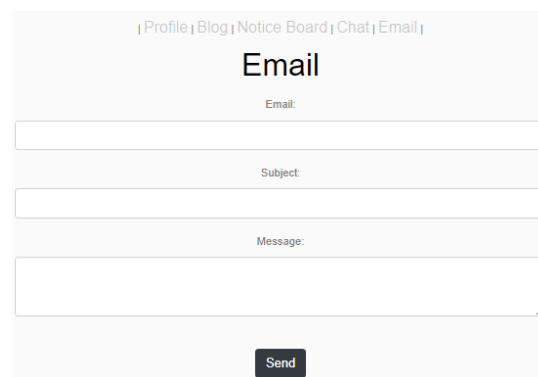
Chat:

1. Select 'Chat' from Sidebar or Navbar
2. To send message, click 'New Message'
3. To refresh for new chats, click 'Refresh'



Email:

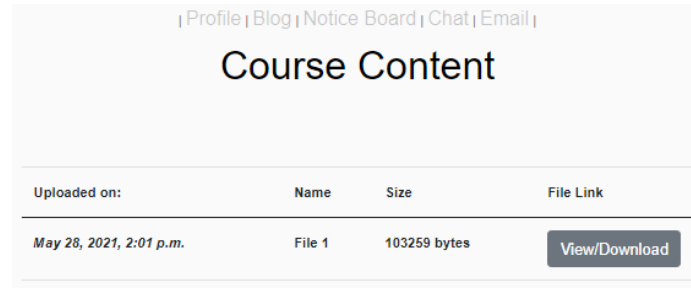
1. Select 'Email' from Sidebar or Navbar
2. Enter Receiver's Email address, Subject of Email and Body.
3. Click 'Send' to send Email



Admin's have all Faculty plus Admin Privileges and can perform all faculty tasks if required.

Student:**Course Content:**

1. Access the desired course from home page.
2. Download the file by clicking 'Download' button.

**Profile:**

1. Select 'Profile' from Sidebar or Navbar
2. Edit profile

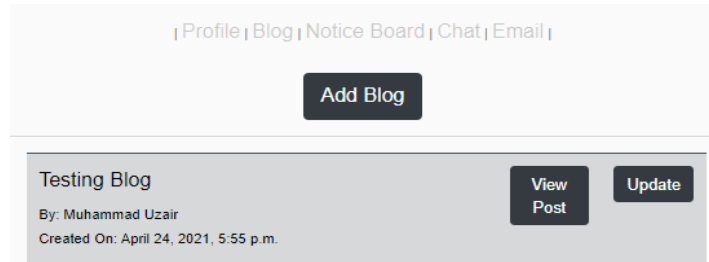


3. To change the password, click the link 'Click Here' at the bottom of the profile.

Blog:

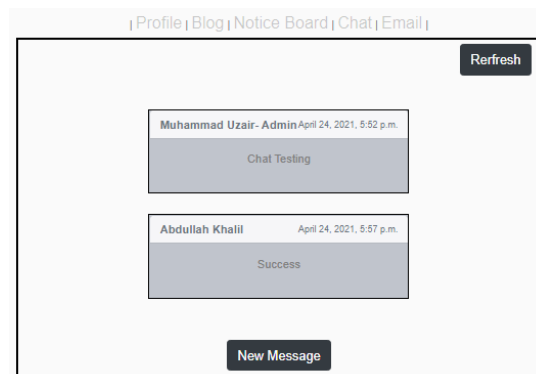
1. Select 'Blog' from Sidebar or Nav-bar
2. To write new blog, click 'Add Blog'
3. To view existing blog, click 'View Post' from the desired blog.

4. To edit blog, click 'Edit Blog' (Only available if you created the blog)



Chat:

1. Select 'Chat' from Sidebar or Navbar
2. To send message, click 'New Message'
3. To refresh for new chats, click 'Refresh'



Students can only view 'Announcements' and cannot send 'Emails'

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