FOSS IMPLEMENTATION OF AN EDUCATIONAL VIRTUAL OFFICE SUITE

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Abstract

Academic institutions and research organisations are fast becoming very corporate in the design and setup of the workspace. There is an ever-present need for readily available information and sophisticated means of communication. As a result, information and communication technologies are being deployed for application in various fields of endeavour some of which include virtual offices. A virtual office is essentially a simulated corporate environment that gives subscribers access to collaborative work related features, which act as a means of improving the way work is carried out in an organisation. Several organisations opt for the software services rendered by virtual offices because of their cost effectiveness and tendency to boost the collective productivity of these organisations. For reasons as such, the existence of virtual office software suites have become rampant, but the availability of its services are at a cost. This paper reports the design and implementation of an Educational Virtual Office using *Free and Open-Source Software* (FOSS) to relieve corporate organisations of the costly burdens of existing proprietary virtual office software. Tools used in achieving this feat are Drupal Web Content Management System (WCMS), readily available FOSS and a couple of other freeware, intelligently integrated to form a composite suite.

The developed educational virtual office suite was deployed in the Department of Electrical and Information Engineering of Covenant University. A usability (user satisfaction) test was conducted. Analysis of the test results showed that questions related to user satisfaction scored more "*Strongly Agree*" and "*Agree*" points than "*Disagree*" and "*Strongly Disagree*". This is a pointer to the fact that features such as the GUI of the web application and its navigation proved to have little or no challenges as at when the tests were carried out. Deployment of the developed educational virtual office suite has the significant advantage of low cost in comparison with proprietary virtual office suites with similar functionality. The fact that the suite was developed entirely using FOSS gives it all the attendant advantages that accrue from the employment of same from the system design bottom-Up. Such advantages as easy access to source code, which engenders easy upgrade of the component parts, come naturally.

Keywords: FOSS, Virtual Office, Drupal Web Content Management System (WCMS).

1 INTRODUCTION

1.1 Overview

In today's world, fast growing organizations have the tendency to want to expand the frontier of their services to other parts of the world. This may not only include regions in which they were initially set up, but also, the same state, country, continent and possibly, other continents also. As some organizations deem it fit, they may setup more than one branch office in a particular location so as to make attempts to satisfy the needs of the ever-growing population in that region. As these companies grow, the need to communicate also increases with respect to their growth margin even as they establish branch offices to suit the needs of their target populace. In this sense, it is obvious that there is an urgent need for organizations in such category to employ a means of communication that is readily available, dependable, flexible and easily deployable as their branch offices will also be opting for this solution.

The "virtual office" concept, if properly traced back, can be linked to Ralph Gregory, the founder of the company, *Intelligence Office* [1]. Established in the early '90s, the desire of the then new father to spend more time at home and less at work, but still be as proficient as when at work led to the establishment of the new business concept that could allow him to tap into the services available at his place of work [2]. As at this writing, several companies such as Compaq, Procter & Gamble, Hewlett-Packard, AT&T, IBM, etc. have in one way, completely adopted the use of virtual offices to manage

some area of their organization. Such areas, which are also related to telecommuting, include field sales and customer service [3].

1.2 Problem statement

There are several virtual office software, many of which fall under the licensed and/or free categories. Majority of them that require payment subscriptions before use provide a range of services that usually cover all that an organisation may require for collaboration on small and wide scale. On the other hand, majority of the software that fall under the free category offer good services also, but in most cases, of comparatively less quality than their proprietary counterparts. It is for this reason that as much as upcoming organisations tend to divert their mode of operation into using virtual office collaborative suites, they nevertheless, may not be able to utilise all the features that a virtual office collaborative suite has to offer due to financial and/or technical constraints. This project intends to create a basic FOSS structure that addresses this on which others may freely build.

1.3 Methodology

The features of the online virtual office web application in this project was realised using multiple FOSS. This enables several tests to be carried out on a large pool of FOSS and the probable best software to be selected for use. For the multiple FOSS to be embedded into an already existing web application, they will require some form of integration or the other. This integration feature was realised using web design tools that will be discussed later in this report. Fig.1.1 illustrates a simple block diagram showing the tools that were used to realise the online virtual office web application using FOSS.
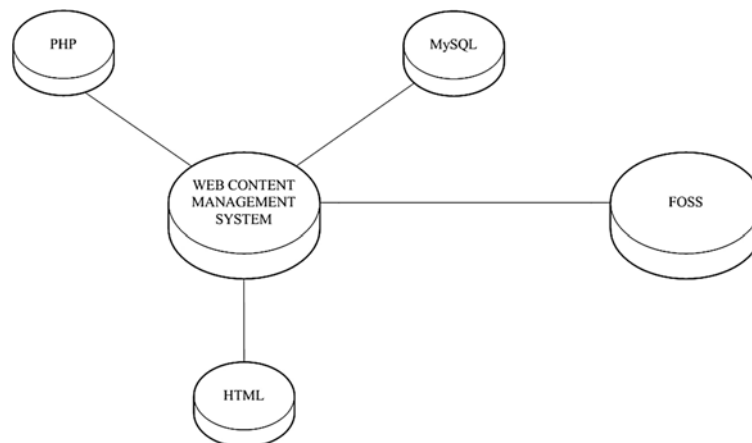

Fig.1.1: Online Virtual Office web application methodology.

As indicated in Fig.1, a Web Content Management System (WCMS) is used to realise the architecture of the primary web application in which the FOSS will be embedded. The WCMS builds the web application database using MySQL database management system, and PHP as the relational server-side language to interface the front-end HTML with the database.

1.4 The concept and history of virtual office

Virtual offices are traditionally defined as a rentable office space wherein firms that require such a service subscribe for with benefits that are attached to it. Such benefits may include the ability to work from home with the existence of effective and efficient internet technology that is paid for as part of services rendered by the virtual office provider firm [4], the availability of a business address to work with, email services, etc. Over time, entrance into the digital era has influenced the definition of virtual office. This new means of carrying out business activities emerged just as a concept with the entrance into this era, which started at about 1970 [5]. The digital era is characterised by the ability of several parties to give and receive information freely. This concept of being able to handle information freely is one that virtual offices are greatly characterised by today.

1.5   Review of existing virtual office software

There are several existing virtual office software that can collectively provide the services rendered by virtual offices as a whole. Enumerated below is a list (not exhaustive) of some popular examples:

- *AJAX WORKSPACE* – An online project management suite capable of managing real time web collaboration tools and content. It is an extensively integrated project management suite with easy to use features that helps in organizing tasks and projects, alongside managing their progress [6].

- SOCOCO TEAM SPACE – *Sococo* is a social company that majors in communications. They provide a virtual office simulation suite that illustrates an ideal office environment with solutions such as VoIP, conferencing and file management services.

- EPAZZ – This is a robust business collaboration suite with a set of compact features made available in groups. It is unique in that it focuses on administrative operating systems, development of applications, collaborative accounting solutions, and enterprise resource planning [7].

- FENG OFFICE – A very popular software suite, Feng Office was developed by a software development firm, Feng Office Collaboration Platform [8]. Its collaborative project which started as OpenGoo Open Source Project, Feng Office now stands as a fully hosted web based suite which allows for business collaboration, project management, billing, organization of meeting, and sharing of general information on a web based platform.

- ZOHO - This is a very rich cloud office suite that is very comprehensive for web programmers and businesses also. It focuses on cloud computing applications and their business related applications. ZOHO has launched more than 20 web applications, which range from project management suites to email applications and more.

- IBM LOTUS SOFTWARE – Another collaborative software suite that gives users the ability to optimize the way they work and still collaborate at the same time. It offers services such as email services with the ability of integrating these features with any web client or device. [9].

- MICROSOFT SHAREPOINT – A very popular software which operates using a web based platform, Microsoft SharePoint functions similar to a content management system with collaborative features. It gives users a customizable user interface with which they can make use of some of the Microsoft office tools over a web interface [10].

1.6   The open source initiative

The term Open Source is a notion that supports the distribution of already finished products and the documentation used in developing these products. With emphasis on software development, Open Source can be defined as free supplying of created software alongside their source code with a license that allows for explicit access and modification. This license has no restrictions on other software and must not be tied down to any specific software [11]. Generally, Open Source can be referred to as a method of developing software with the approach of making this software open for use alongside the source codes used in developing these software. The idea behind this is to make for more reliable and flexible software that are better in quality and are also available at relatively no cost. For software in this category, licensing is also made available and is attached to the software as an indicator to users and developers of what type software they are dealing with. Also, for software to be categorized as Open Source, they must meet certain standards. Some of these standards according to [12] are: 1) No Intentional Secrets, 2) All patents must be under royalty-free license, and 3) Availability.

2   SYSTEM DESIGN AND ARCHITECTURE

The OVO software built in the project is a web-based application. Like every other web-based application, it operates with protocols such as Hypertext Transfer Protocol (HTTP), Transmission Control Protocol (TCP), and was built using Hypertext Markup Language (HTML), which is the basic language used in building web-based applications and web pages.

2.1   Web design

For this project, the OVO was built using the most common and widely adopted web design technique illustrated in Fig.2.1.
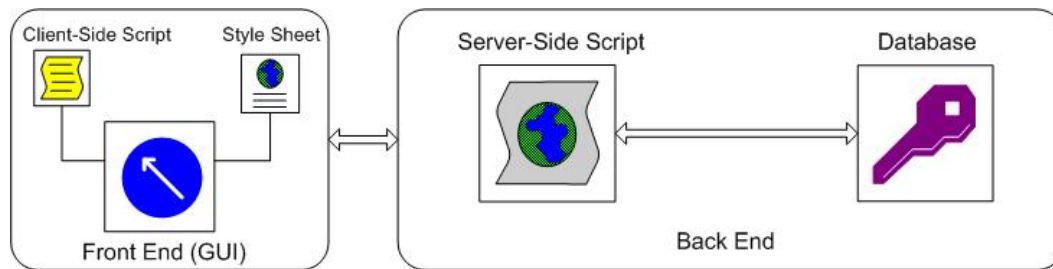
Fig.2.1 – Block diagram of a common web design technique.

2.1.1 Front end design

The front end of the OVO web-application was built using HTML and other client-side scripting languages. Just like every other web application, HTML was used to provide the basic information that users require to interact with the web-based application. It is with such information that the web users know what is required of them at different stages while navigating through the web pages of the web-based application. HTML was used to build the front end Graphics User Interface (GUI) for the application, which is the interactive portion of the site that users communicate with for one desired access feature or the other. When users are required to provide certain data, they do so using HTML as a guide regardless of what language format they feed into available fields on the application's web page. Another important aspect of the front end is the style sheet used. Style sheets are used to achieve certain desired features on front-end webpages. Such features include systematic arrangements of content, font types and sizes, page colour, font colour, etc. To achieve such requirements for this site, Cascading Style Sheet (CSS), which is a style sheet language used to describe the looks and format of documents written in markup languages [13] was used to achieve such features on the front end design of the web application. Other scripting languages that were used for the front end web design are Java Script (JS) and its free and open source cross-browser library, jQuery. JS is one of the most popular programming languages in the world [14].

2.1.2 Html i-frames

Another major aspect of the design of the OVO is HTML I-frames. A HTML I-frame, which can also be called "Internal Frame" is a HTML front end web design tag or tools that is used to allow a web browser window to be shared into several portions thereby allowing the possibility of viewing different web-sites or web content, either from the local site or externally, at the same time dependent on the availability of these sites at that point in time also. Since the development of this project gives liberty to use several FOSS, the possibility of embedding other hosted objects or sites that provide some of the features required by the OVO web application can be done in several ways, a few of which include using objects, applets (a basic computer program that can be transferred via the internet), as well as I-frames. The word embed here still refers to the same intention of an I-frame which is to load internal or external content using a web page and making it look like it was a part of the web page [15]. Such content that can be embedded into web pages include pictures, data (audio and video), macromedia flash documents, etc.

2.1.3 Back end design

In this project, the components of the back end design are the server-side script and the relational database. MySQL, which is an open source relational database management system was used. Since the OVO is a free and open source web-application that requires a database management system with full features, MySQL suits such needs as it is appropriate for applications that require a rapid structuring and storage databases, as well as being able to manipulate stored data with ease. Basic web applications require a GUI and a relational database for their operation but in every case, a server-side script is required to relate the database with the front end of the web application. This is a major requirement for the web application to render their functions completely as it enables a form of interaction with the front end and the database. This is the actual function of the server-side script. For building the OVO web-application, Hypertext Preprocessor (PHP), a server-side scripting language engineered specifically for the web, was used. PHP is a general-purpose scripting language particularly suited for web design and development [16]. It is particularly used for creating dynamic web pages which gives it the ability to be embedded into written HTML codes also; thereby making its integration into web-applications such as that of this project relatively beneficial.

2.2 Web content management system

For this project, the WCMS was the primary software used in building the web application. It is for this reason that all the tools used in developing the web application were tied to the functionality of the particular WCMS used. Although this does not obstruct the possibility of building the OVO web application using another WCMS, it only makes it possible to utilise the performance benefits of the WCMS used. For building the OVO web application, Drupal, which is a WCMS, was used.

2.2.1 Drupal content management system

Drupal is an open source based content management system. Content management systems allow users to manage the content of their website without little or no prior knowledge of computer programming. A CMS is also defined as a server based software that allows you manage website content through a web browser. Today, most web developers use PHP, Html and CSS web programming languages to develop their websites. Drupal's mechanics is dependent on this same languages but in a more user-friendly manner.
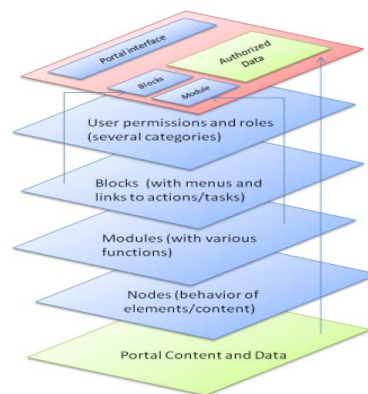
2.2.2 The drupal architecture

Fig.2.2 – Drupal Architecture (source:http://estrip.org/articles/read/tinypliny/52790/Drupal:-Hooks,-blocks,-modules-and-nodes.html).

2.3 Foss realisation of features

This portion of this chapter will be explaining each feature in this project, the software used to realise the desired feature, how they were integrated into the WCMS used in building the web application, and how they operate generally. Fig.2.3 shows a block diagram illustration of the particular software used to realise specific features required by the web application. Although some features did not require external FOSS to realise them, in the block diagram, no software was attached to these features because they were realised using the module platform provided by the WCMS used in developing the web application for this project.
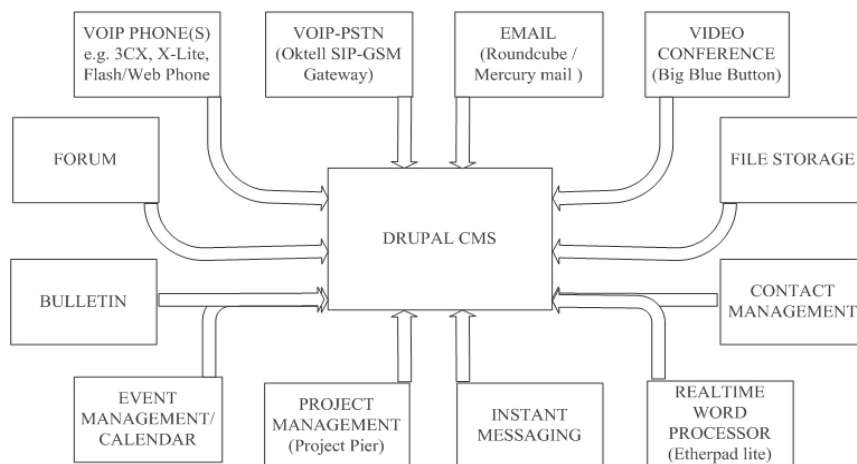

Fig.2.3 – Block diagram of FOSS realisation of OVO features.

For the OVO to maintain its stand as an independent functional web application, it should be able to operate such that all its features are accessible without its users having to carry out any installation of standalone applications.

2.3.1   VoIP Feature

The realised VoIP feature used in the OVO web application operates such that it can be implemented in a LAN, and also, for operations outside that LAN for possibilities of placing calls within and without a particular network. For this reason, it is obvious that for a fully functional VoIP network with office like features such as placing calls to several call extensions on the network even simultaneously with "call on hold" features, voice mail, caller groups for simultaneous office calls, the ability to interface with external gateways with respect to that which the gateway has to offer and many more, two basic nodes will be required. These nodes are the VoIP client and a tested and reliable VoIP server. Fig.2.4 shows the VoIP network architecture.
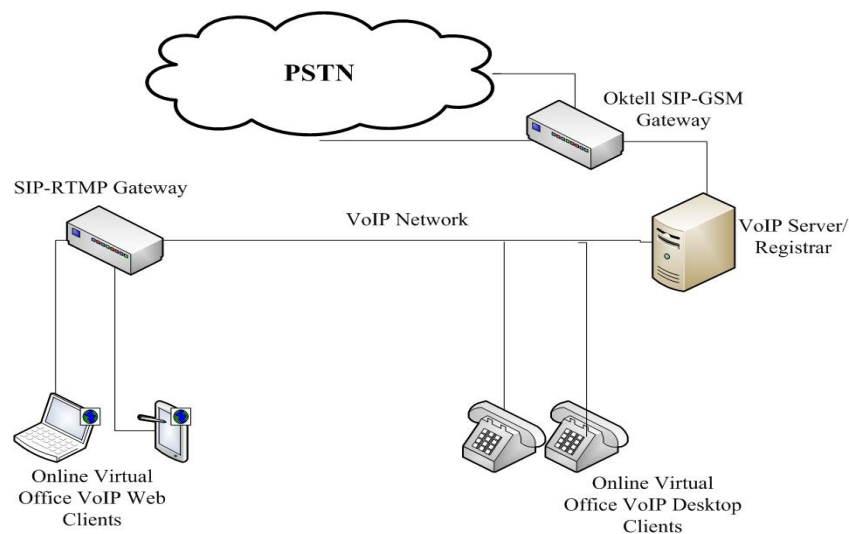

Fig.2.4 – Block diagram of OVO VoIP Architecture.

2.3.2   VoIP Client

The OVO being a web application requires all its features to be able to run completely with web browser capabilities; this also includes its VoIP client. Although this is a somewhat new feature being added to web browsers of late, very few FOSS give you complete access to their software to embed on a local web server for hosting purposes. To have a fully functional and interactive multimedia VoIP client working on a web browser, one primary requirement must be fulfilled; there must be a Real Time Messaging Protocol (RTMP) gateway to convey real time information from the web VoIP client to the VoIP server. SIP-RTMP VoIP Test Client, a VoIP-RTMP gateway test client is the VoIP client used in the OVO web application. It is a FOSS multimedia application developed using Adobe Flash which has capabilities of making multimedia calls from an Adobe Flash Player embedded on a web browser, to a Session Initiation Protocol (SIP) VoIP network and vice versa [17].

2.3.3   RTMP Gateway

As the name implies, RTMP gateways are used as intermediaries for real time web multimedia applications to interact with other applications, either web applications of standalone applications. They are mostly used in scenarios similar to that of the OVO web application whereas web multimedia applications such as server port testers, basic video broadcasters, real time chat applications, etc are used.

3   SYSTEM IMPLEMENTATION AND TESTING

3.1   Front end implementation

The implementation of the OVO web application will be illustrated from the perspective of the web administrator. This is because administrative access to the created web application covers every

aspect that was built and integrated into the web application, therefore, nullifying the need to create another subsection for the user implementation.

3.1.1 Home page / user registration and login

The OVO web application, just like several other web applications require one form of authentication or the other from users for them to gain access to the features that the web application offers. For this purpose, users will be required to authenticate themselves with a user name and a password before they can gain access to all the features the OVO web application has to offer.

3.1.2 User notifications page

The default location a user is taken to immediately after login is the news/update page, which can also be referred to as the general notifications page. On this page, general information that may be worthy of note to all the users of the OVO web application is placed here. Also, multimedia content such as pictures, audio files and videos are included for users to gain easy access to. Fig.3.1 shows a snapshot of the news/update page.
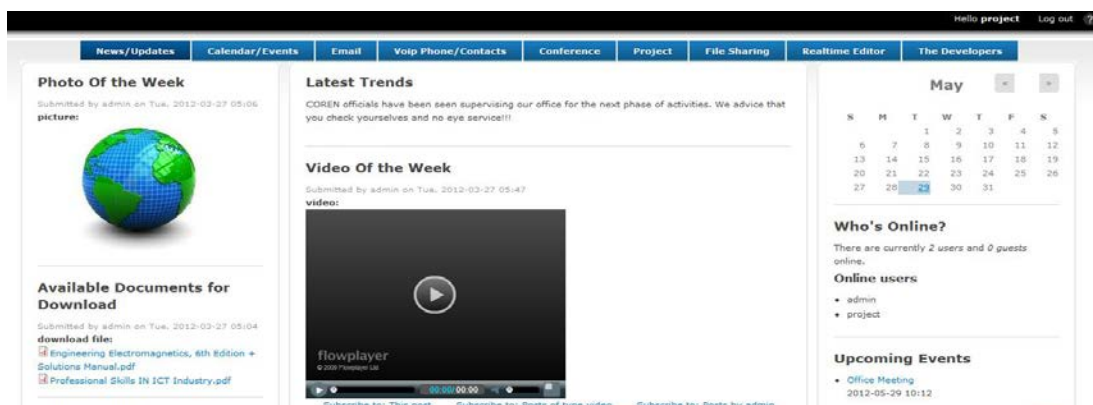

Fig.3.1 – Snapshot of the News/Update page.

3.1.3 VoIP Phone / office contacts page

In the OVO web application, the VoIP phone page has the office extensions and email addresses of predefined users on the network. This makes it easy for users on the network to place calls to existing extensions and also, send mails to existing email addresses without having to navigate away from the page.

3.1.4 Video conference page

For the OVO web application, access is given to all users to create meetings but only web administrators can gain access to the required field that send notifications to registered users on the web application. For the office administrator, the following steps are to be carried out in order to create a meeting and send a notification email to existent users.

3.1.5 File sharing page

On the OVO web application, authenticated users gain direct access to this page in order to send documents here for storage. This page is autonomously managed by the web administrator and is organised exactly like a file sharing application in the sense that authenticated users are given access to personalised folders that they manage themselves. These users can create subfolders in these parent user folders, and can share these folders with other existing users on the OVO web application. Fig.4.12 shows a snapshot of the file-sharing page.

3.2 Back end implementation

The portion of the backend that will be discussed here are those server side hosting features that are required to be functional before certain functions of the OVO web application can be functional. Some of these back end servers are the VoIP registration server, the real time word processor server, the RTMP gateway, and the SIP-GSM gateway.
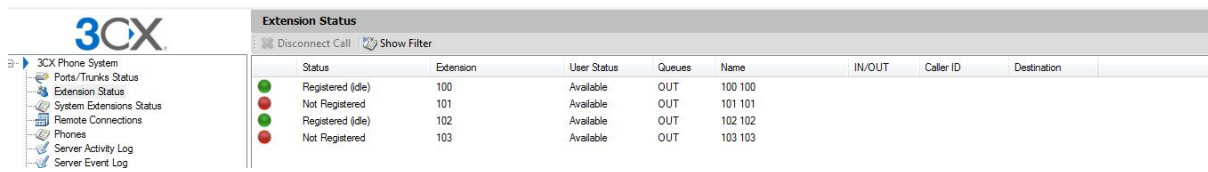
3.2.1 VoIP Registration server

Fig.3.2 – 3CX VoIP Registration Server.

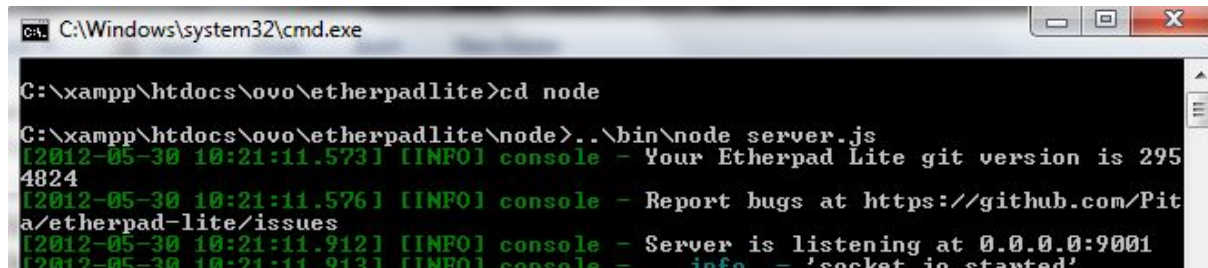### 3.2.2 Real time word processor server

Fig.3.3 – Snapshot showing the etherpad server.

3.2.3 SIP-GSM Gateway

Fig.3.4 – Snapshot of the SIP-RTMP Gateway.

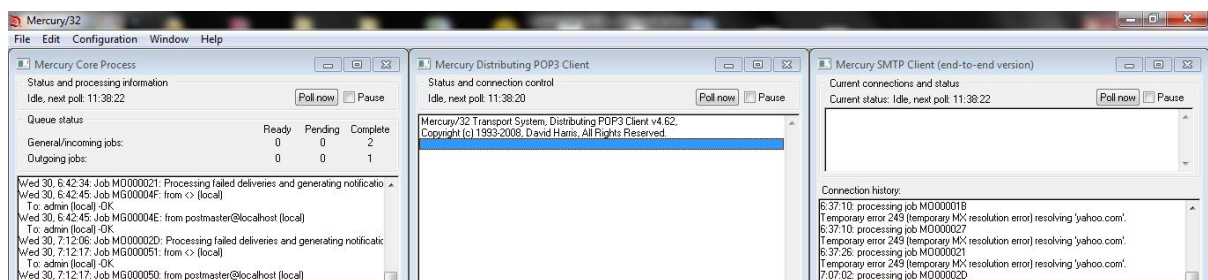### 3.2.4 Mercury mail transport system

Fig.3.5 – Snapshot of Mercury Mail Transport System.

4 TESTING

While developing the OVO web application, tests were carried out. Some of the tests were carried out to verify how user friendly the system was, bandwidth intensiveness of some features of the web application, the response rate of some of the features portrayed by the web application, etc. A few of these tests were carried out in a classroom session to verify how viable the video conferencing feature of the OVO web application is.

4.1 System Effectiveness Test

Parameter	Strongly Agree	Agree	Disagree	Strongly Disagree
I Was Able To Complete My Task Successfully And Correctly Using The Application	5 %	45 %	27 %	23 %
The System Did Not Show Error Message(s) While Using It	10%	60%	10%	20%
I Was Able To Recover From My Mistakes Easily	5%	50%	23%	22%
I Feel Comfortable Using The Application	10%	55%	15%	20%
The Voice Request/Response From The System Was Clear	0%	9%	50%	41%

4.2 System Efficiency Test

Parameter	Strongly Agree	Agree	Disagree	Strongly Disagree
Using The System Saves Me Time Of Learning	4%	32%	36%	28%
I Was Able To Complete My Task On Time	4%	54%	21%	21%
I Was Able To Navigate The VUI On Time When Using The System	7%	33%	40%	20%
I Didn't Have To Carry Out Too Many Difficult Steps Before Completing My Tasks	14%	61%	4%	21%
The Learning Content I Requested For Suited My Needs	0%	43%	25%	32%

4.3 User Satisfaction Test

Parameter	Strongly Agree	Agree	Disagree	Strongly Disagree
The System Was Easy To Learn	14%	71%	4%	11%
The System Was Easy To Use And Is User Friendly	14%	68%	7%	11%
I Am Satisfied Using The System	4%	50%	31%	15%
I Feel The System Met My Need	4%	40%	36%	20%
I Am Satisfied With The Performance Of The System In Accomplishing My Tasks	0%	44%	36%	20%

4.4 Analysis of user survey tests

After carrying out a graphical analysis of the test results, it was observed that questions related to user satisfaction scored more "Strongly Agree" and "Agree" points than "Disagree" and "Strongly Disagree". This illustrates that features such as the GUI of the web application and its navigation also proved to have little or no challenges as at when the tests were carried out. Nevertheless, as predicted, tests carried out under system effectiveness and system efficiency categories that were related to the nature of the service being proved inefficient as compared to that of the user satisfaction tests. This is as a result of the nature of the network the system was deployed on for testing purposes.

This is an indication that for an efficiency of the service provided by the web application, factors such as the nature of the network it is being deployed on should be put into consideration. Other tests carried out in the system effectiveness and system efficiency categories proved positive although one of the results which turned out to be negative was based on the nature of preference of the users on the type of service being rendered by the system.

5 CONCLUSION AND RECOMMENDATION

CONCLUSION - This paper, which focuses on designing and implementing an online virtual office web application using free and open source software aims at contributing to existent work done in the field of cloud computing, virtualisation and telecommuting. Although other virtual office software suites are already existent, the peculiarity of the created web application is positioned on the fact that open source software was completely used for the implementation of the web application, which is not quite popular in the virtualisation field. Other proprietary software are existent which serve this purpose, but as they stand proprietary, the demerits that are abound to subscribing to that category of software can be devastating especially for developing companies. This is one of the reasons firms move over to existing free and open source software to render the services they require for operation.

RECOMMENDATIONS – As much as the created web application in this project portrays majority of the features of an ideal virtual office software suite, certain areas as it relates to virtual offices were not touched and are being placed as recommendations for future enhancement of this project, and also, future works that can be carried out. Some of them are listed below: Short Message Service (SMS) Notifications to GSM number on the occurrence of events on the web application. Online Virtual Office mobile application for integration on mobile phones, tablet devices, etc using the android platform which is also free and open source. Development of the various FOSS used to build the virtual office web application for advancements geared towards virtualisation and cloud computing. Sourcing for several other FOSS to achieve new features that are or may be existent in the nearest future in fields of virtualisation and cloud computing.

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