E-V^{2}oIP Conferencing and Streaming using Real Time Interactive Learning Systems over SSL IPv6 for Next Generation Network

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ABSTRACT: *This paper presents the development of next generation e-learning systems for real-time video, voice conferencing and streaming technology over secure socket layer (SSL) IPv6 in campus environment. Development of the V2oIP e-learning systems has contributed a significant value to distance learning. The aim of this study is to design real time interactive learning systems over SSL IPv6 for next generation network. This study shows the process and development of e-learning systems with V2oIP technology. Based on the results of this study, it is successfully develop e-learning systems with V2oIP technology over SSL IPv6 for distance learning system. From the result analysis, there is no significant difference between V2oIP SSL IPv6 and V2oIP SSL IPv4 performance issues. It also shows that IPv6 with difference Operating System (OS) has generated low usage RAM and CPU performance. The advantages of using V2oIP e-learning system to the universities are: i) able to manage students' industrial training remotely; ii) postgraduate supervision from other region; iii) reduce operational costs; iv) manage to conduct research activities remotely and v) to provide an element of security (SSL) over IPv6 technology. Therefore, implementation of V2oIP e-learning system over SSL IPv6 (next generation network) is able to create mobility and a secure environment for undergraduate and postgraduate students.*

Keywords: Delay, Jitter, Voice over IP, e- learning, SSL, RAM, CPU, IPv6, V2oIP

Received: 13 August 2013, Revised 2 October 2013, Accepted 9 October 2013

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1. Introduction

This study is to develop e-learning system with innovative technology in education learning system, for example, enabled V2oIP, Secure Socket Layer (SSL) and IPv6 features for next generation e-learning system. The objective of this study is: i) To develop e-learning system with video conferencing, voice communication and streaming over IPv6 for real time functionality; ii) to enable security element in IPv6 platform; iii) to analyze the performance of e-learning server based on number of users access into e-learning application with different network operating system; iv) to predict which network operating system that can provide outstanding performance by the e-learning application. This study is extension from the previous work that discussed and focused on high and low server specification performance [1]. E-learning is very important to the higher educational institutes today. Generally, e-learning system is being used for distance education. E-learning system can be

accessed by students from Internet and Intranet campus environment. Distance education strives to provide a rich, near-classroom experience to non-classroom students. Studies of the many facets of distance education have become increasingly common, and within recent years many universities have experimented with various formats in an effort to determine their effectiveness.

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Tool or Technique	**Generally Synchronous**	**Generally Asynchronous**	**Can be both**
General Web presence		X	
Web Tutorials		X	
Frequently asked Question List		X	
Shared Calendars		X	
Common Data space		X	
Electronic Mail		X	
IP video and audio	X		
IP Audio Only/VoIP	X		
White board Applications	X		
Shared Applications	X		
Shared Desktops	X		
Instant Messaging	X		
Web meeting Spaces (WebEx, Web Office, PlaceWare, Presentanytime, WebTrain)			X
Course Management Tools (WebCT, Blackboard)			X
Live Broadcasting over the web (tools include camera, elmo, whiteboard, writing pad)	X		

Table 1. E-learning system: Synchronous and Asynchronous Approach

Development of the e-learning system with V2oIP technology and support video conferencing functionality is different with others e-learning system. Students have an optional to communicate via video or voice or both environments. In addition this e-learning next generation will operate over SSL IPv6 platform. The benefits that Universities can gain from implementation of e-learning applications with V2oIP (real time basis) features are:-

i. Student industrial training – Supervisor from University will able to communication with their students all the time and all information can be updated within a day.

ii. Postgraduate supervision – Supervisor from University will be able to supervise their students remotely all the time at any place and location.

iii. Cost effective – development of this approach will reduce travelling costs for both parties (student and supervisor).

iv. Attending conference - Faculty members can keep in touch with students while away for a week at a conference.

v. Research activities – Researcher can collaborate and communicate with other institutions on a regular basis without traveling.

vi. Theses defend for distance learning - Faculty members can participate in a thesis defense at other institutions.

2. Related Works

E-learning is the most recent way to achieve distance education, carried out by distributing learning material and processes over the Internet [10]. E-learning (EL) has become an increasingly popular mode of instruction in higher education due to the continual advances in Internet and multimedia technologies [11]. Figure 1 shows the evolution of e-learning process and infrastructure. E- learning system is using two approaches such as synchronous and asynchronous. Table 1 provides a summary of the synchronous and asynchronous approach in e-learning system.

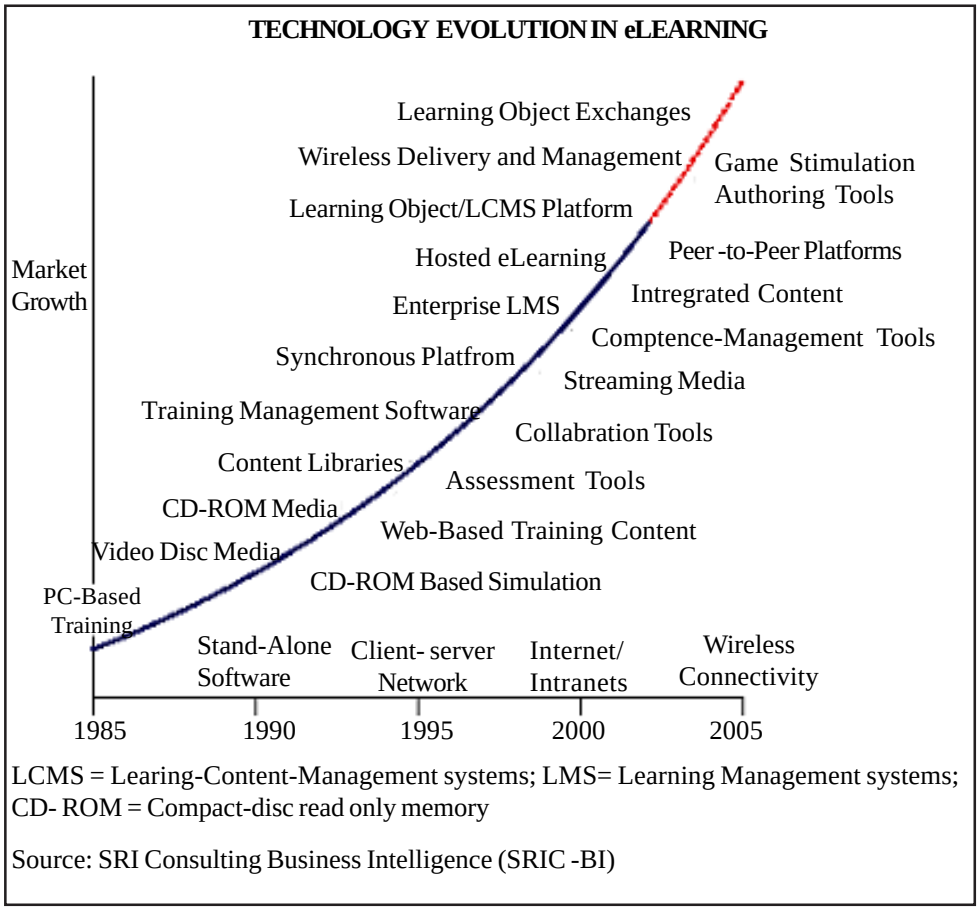

Figure 1. Evolution of E-learning Technologies

An e-learning system is used to deliver educational material and manage interaction between students and tutors. E-learning system can be open source, commercial or developed in-house by the universities. Tools like audio/ video conferencing, streaming, social software, RSS feeds, can be incorporated into the e-learning or can be subsequently added to the learning system as individual modules [12], [13].

Today, video and voice application is very important in e-learning system. There are three approaches to incorporating video over IP in the classroom, be it a pure distance learning class or an enhancement to a traditional class. Figure 2 shows these three types: Live streaming video, interactive video, and video-on-demand. In a technologically advanced setting, video over IP and collaborator tools allow activities that take place in the traditional classroom to occur in the distance learning environment. To deliver live real-time streams, a media server is required. For on-demand archived files, either a media server or an Internet server can be used. The hardware requirements are modest. For live real-time delivery a small server has more than enough capacity. Other consideration during implementation of e-learning system is bandwidth issue. Campuses may have high-speed Internet/Intranet access. However, off campus locations still suffer from lack of bandwidth. Virtual class caters to people with all kinds of Internet connection speeds as low as dial-up.

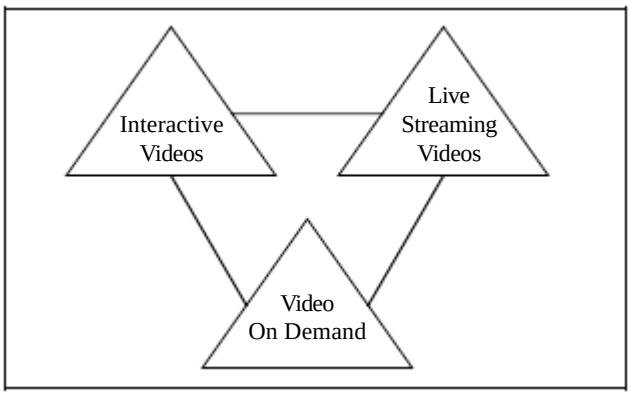

Figure 2. E-learning video services

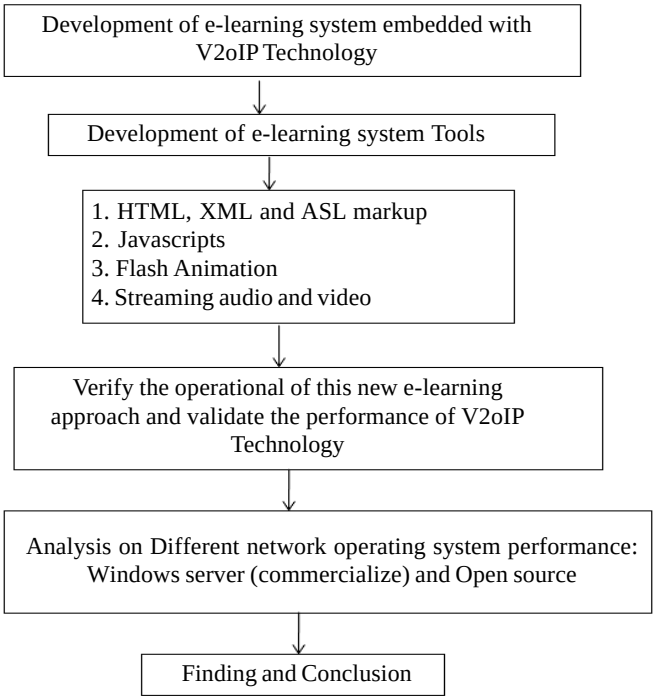

Figure 3. Development of E-learning system with V2oIP Technology

3. Methodology

This study involved three phases as follows: i) development of e-learning system with V2oIP technology; ii) e-learning system implementation with IPv6 SSL approach; iii) design and analysis.

The First phase of the study has developed e-learning system that able to support all the functions based on Figure 2. Figure 3 shows the development of e-learning system that has supported V2oIP technology architecture.

Second phases, Figure 4 shows the process of the communication between HTTPS, RTSP and RTMP protocols.

Process 1: RTSP (Real-Time Streaming Protocol)- Establish and control the media sessions between end points.

Process 2: RTMP (Real-Time Messaging Protocol) - Propriety protocol developed by Macromedia for streaming audio, video and data over the internet, it works between flash player and server.

Process 3: HTTPS (Hypertext Transfer Protocol Secure)- It is networking protocol for distributed, collaborative, hypermedia information systems. HTTPS is the foundation of data communication for the World Wide Web.

The scenarios are based on audiovisual coding systems and network protocols using TCP, UDP and RTP (refer to Figure 4).

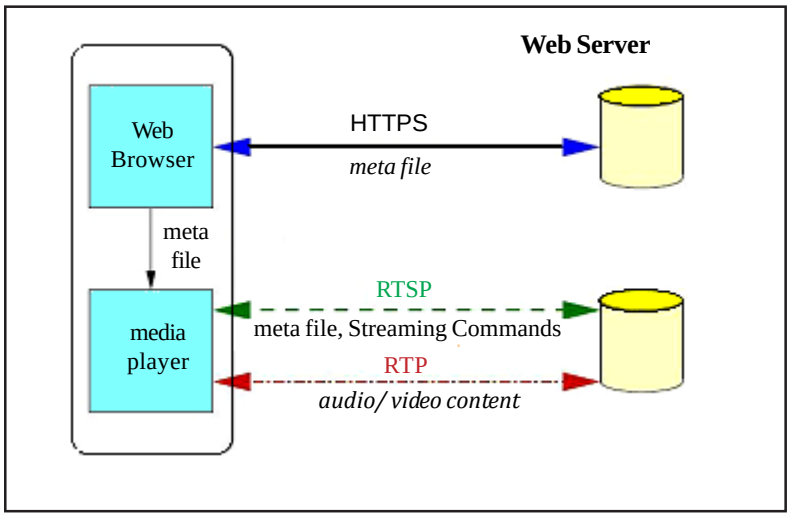

Figure 4. Control Streaming Media Servers and V2oIP Technology

The third phases of this study have setup a real V2oIP e-learning system to validate and verify the performance of: i) e-learning server over different network operating system over IPv6 and IPv4; ii) SSL over IPv6 and IPv4. This study posits several research questions: i) What is the performance level of the V2oIP e-learning server over SSL IPv6?; ii) What is the predicted number of students accessing V2oIP e-learning server over SSL IPv6?. Figure 5 shows e-learning network framework over SSL IPv6 to analyze the performance of e-learning server.

4. Purpose Of E-Learning Development, Analaysis Performance And Result

This section has shown the development, analyzing, measuring and comparison of e-learning server performance with different network operating system.

4.1 Development of e-learning system and V2oIP design interface

This e-learning system with V2oIP, SSL and IPv6 technology is developed based on following standard:

i. Ease of use and GUI

ii. Enable voice chat

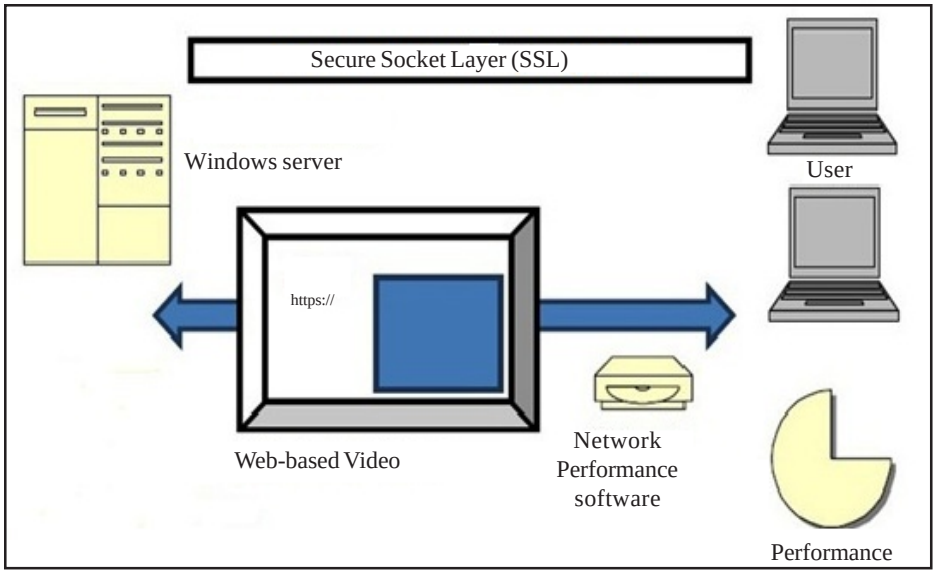

Figure 5. Analysis Design Framework for E-learning System with SSL over IPv6

iii. Enable video and voice chat

iv. New communication and innovation technologies have been used in the e-learning system. User can access video and voice via computer or mobile phone (supported with camera functionality).

There are several components that have being created using movie clip object under videoconference live stream section Flash CS4 software. The components are:

1. **VideoConference:** Use as platform for all other object (see appendix B for source code).

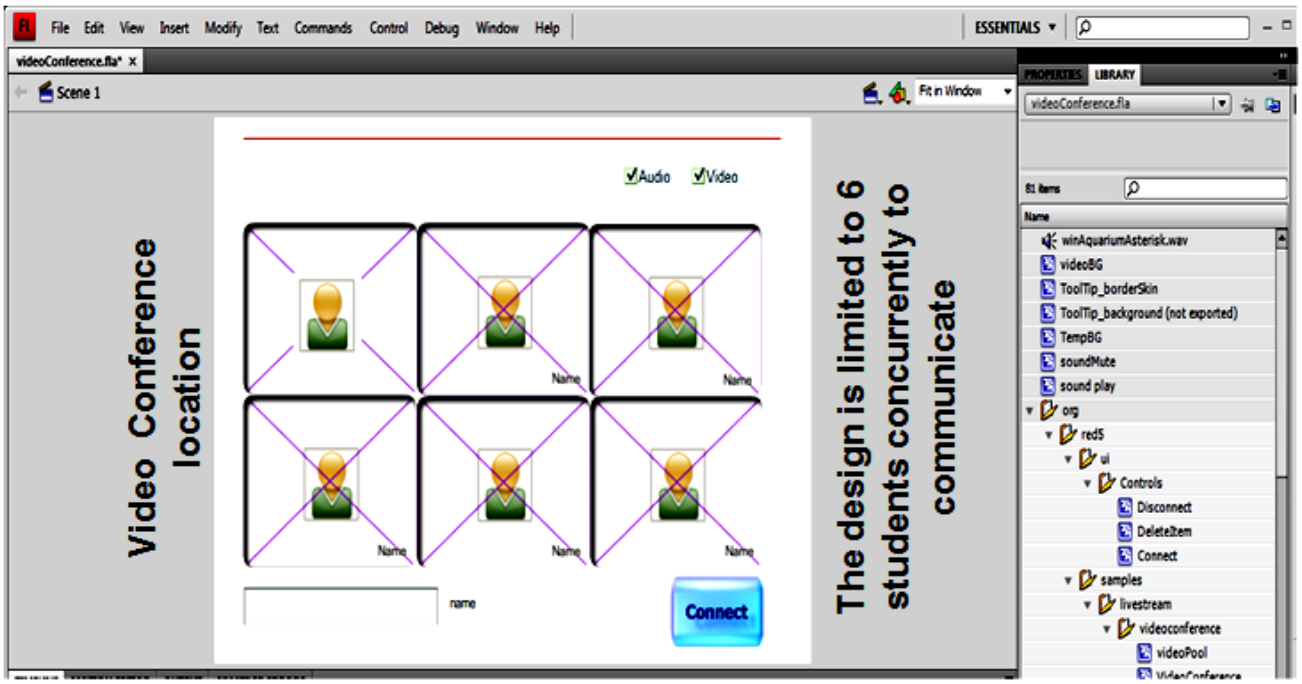

Figure 6. Video Conference Design for V2oIP Technology in E-Learning System

2. **Broadcaster:** Use for broadcast video which display back what a person's camera will see.

3. **Subscriber:** Use for subscribe other webcam client that cannot support with videoconference functionality.

4. **VideoPool:** Contain all subscriber video and being compile with the same instruction coding (see appendix B for source code).

5. **Connector:** For button instruction and open/close stream connection. This area must set server internet protocol and IP address.

Figure 6 shows the position of video conferencing design layout to support V2oIP technology in e-learning system. This e-learning system with innovative technology (V2oIP functionality) is limited to 6 subscribers that can communicate concurrently. Figure 7 shows the design of on/off video and voice menu button and communication link menu button. Figure 8 shows the overall video pool subscriber design layout. Table 2 shows software requirement that used in developing of e-learning system with V2oIP technology.

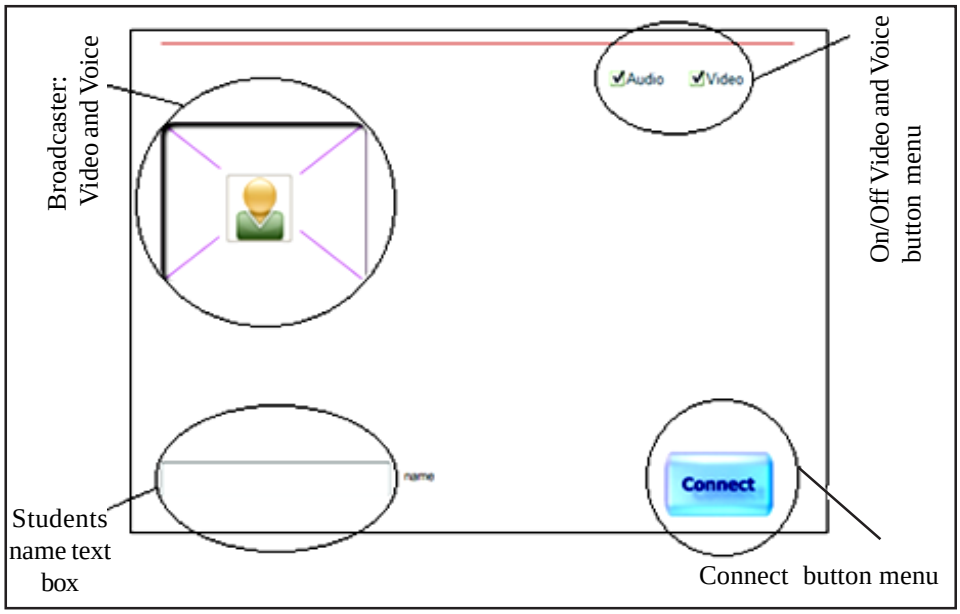

Figure 7. Video Conference Broadcast Site Layout Design for for V2oIP Technology in E-Learning System

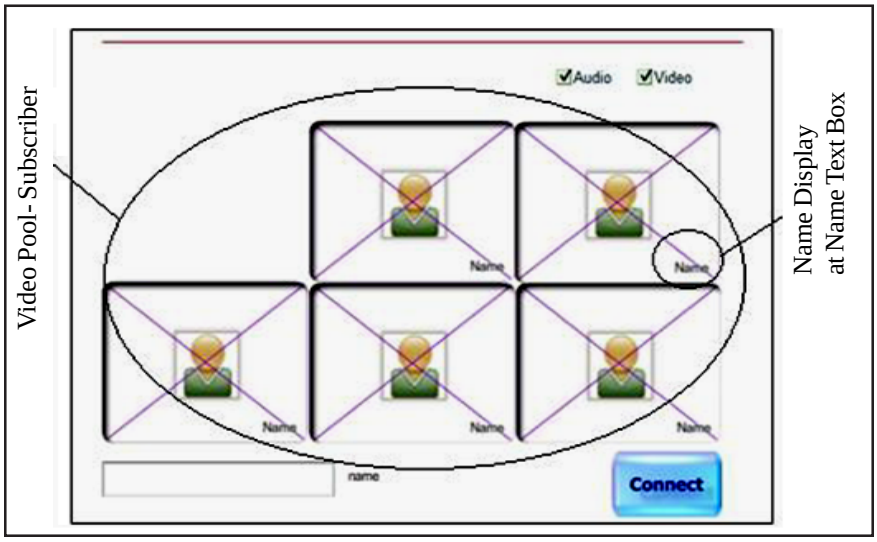

Figure 8. Subscriber Site Layout for Video Conferencing Design

Software	Description
Operating system - Windows based (Windows server 2003) and Open source based (Ubuntu 10.10)	Using different Operating System , Windows and Open Source platform that support Conference application
Web Browser	Application for accessing the Internet and make a call for MoIP from web page
Java eclipse, JRE, JDK 1. 6	Application for accessing the Internet and make a call for MoIP from web page
Flash CS4 with Actionscript	OOP Programming use to build the system

Table 2. Software Requirement for E-learning Development

Finally, figure 10, figure 11 and figure 12 show the V2oIP e-learning system has been successfully develop over SSL IPv6. The advantages of using this approach are: i). Students still can communicate with their supervisor if they do not have any web cam functionality; ii). Students can still use voice functionality because this system supports V2oIP technology compare to previous video conference technology.

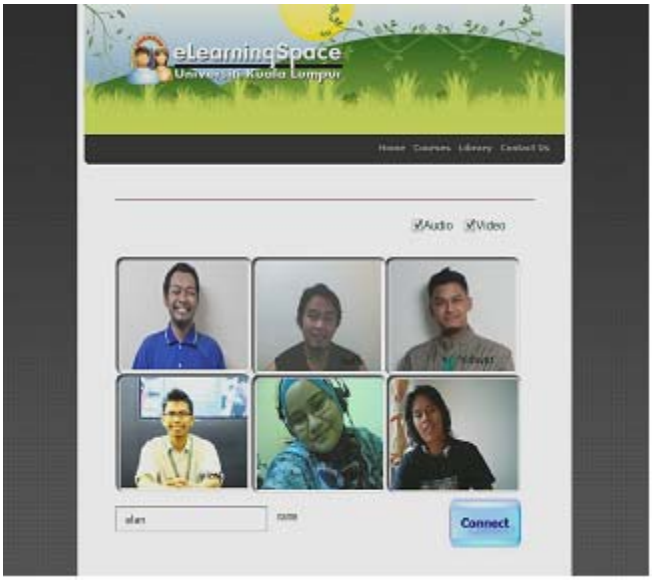

Figure 9. Output - Web-based E-Learning Video Conference Page using V2oIP Technology

4.2 Analysis Performance Design and Results

This section discussed network operating system on V2oIP e-learning over SSL IPv6 technology performance. In order to determine the quality assurance of the analysis, several methods of testing are suggested to be used. There are:

4.2.1 Comparison of two different servers used with SSL over IPv4 and SSL over IPv6

The analysis has been tested using different network operating system: Windows server and Linux server to analyze the performance of the SSL over IPv4 and IPv6.

4.2.2 Comparison of number of user used

The analysis has been tested with two different approaches: low volume of traffic which run only one conference at a time and

high volume of traffic which run more than one conference at a time. Figure 13 shows the implementation of V2oIP e-learning system in real network environment. The e-learning server is connected via UTP CAT 6 using Intranet of University of Kuala Lumpur. This e-learning with V2oIP can access via mobile phone with IP camera. Figure 14 shows the network design for SSL over IPv6 environment.

Figure 10. Output: Streaming over SSL IPv6 Technology

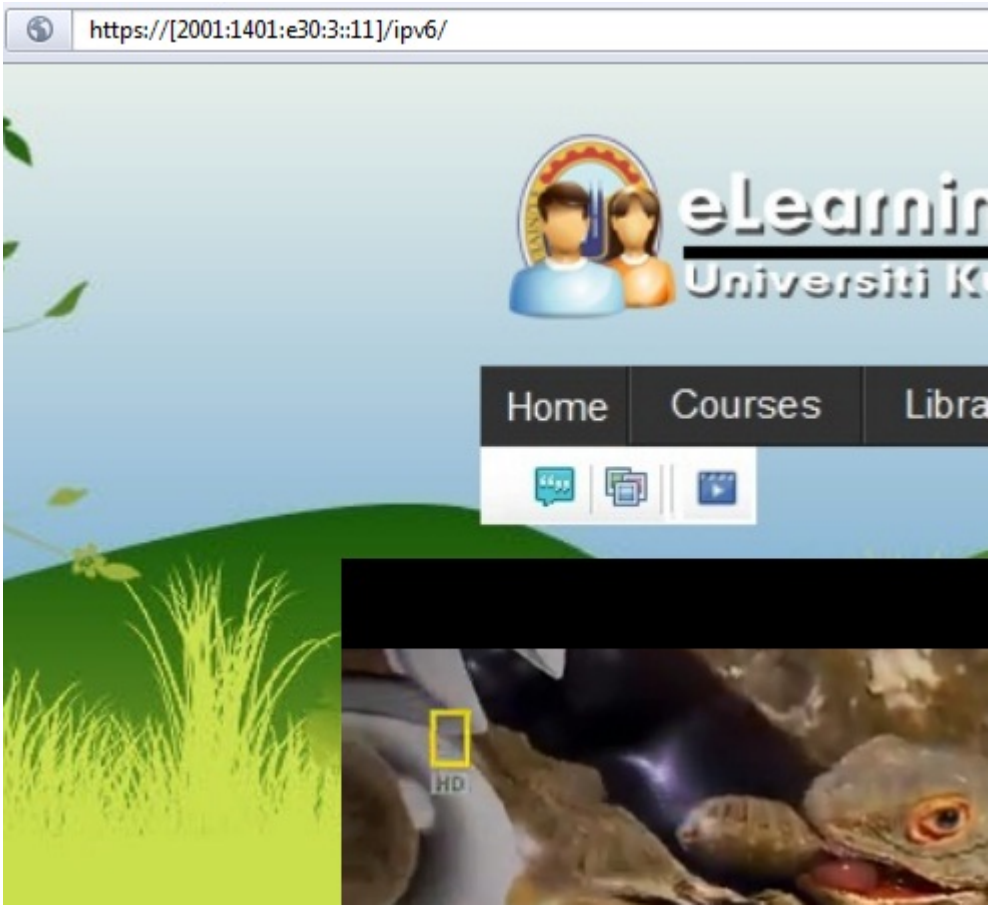

Figure 11. Output 2: Streaming over SSL IPv6 Technology

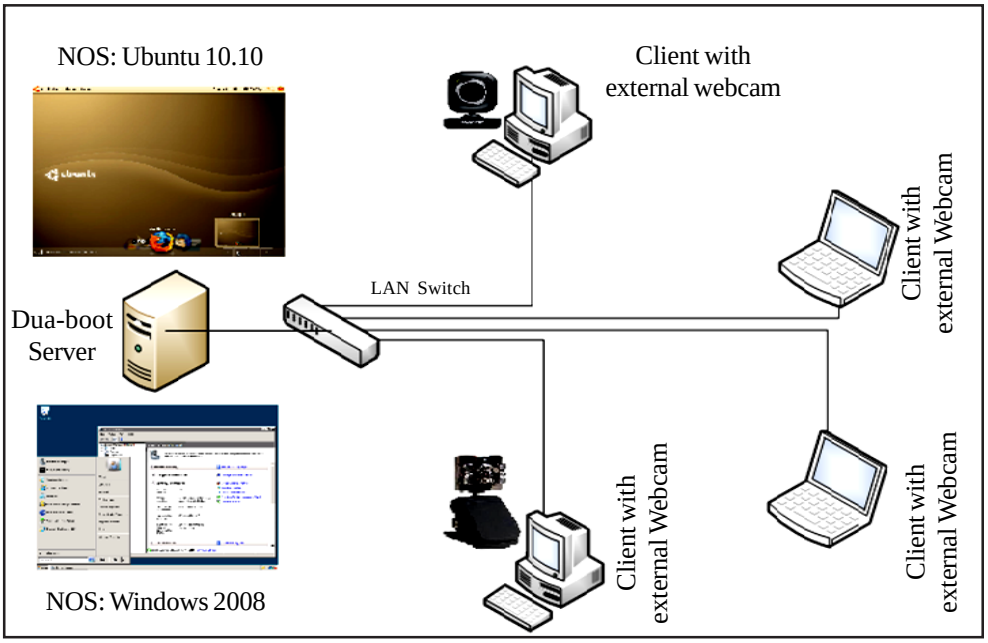

Figure 12. Implementation of E-learning System with V2oIP Technology in Real Network Environment

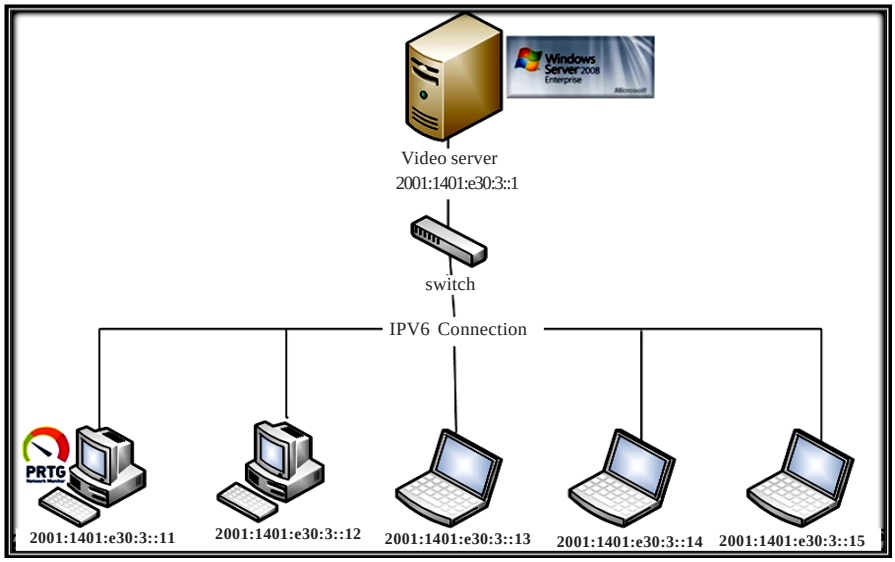

Figure 13. Network Design for SSL over IPv6

Both network operating system such as commercialize product (Windows server) and open source (Ubuntu/Linux) are using similar server specification, refer to Table 3.

There are several types of video resolutions available that must be defined in e-learning system with video functionality as follows: 600×400, 320×240, 240×160, and 160×110. Therefore, in this study, the e-learning system was setup with the following requirements:

i. Video: 160×110 resolutions

ii. Audio: Client's default frequency setting

This video resolution (160 × 110) setting is the smallest video size but it is good enough to communicate with students for long distance learning (undergraduate and postgraduate) over SSL IPv6. This setting is able to reduce and minimize the usage of RAM and CPU. The VQ manager application is used to monitor the performance of V2oIP e-learning system over SSL IPv6 technology as follows:

i. Latency

ii. Jitter

iii. Packet loss

iv. Mean Opinion Score (MOS)

v. RAM and CPU usage

In this study, three network management tools have been used to monitor and analyze system performance of e-learning system with V2oIP, SSL and IPv6 technology. Tools that are being used are as follows:

i.VQManager: To monitor delay, jitter, packet loss, and mean opinion score, MOS.

ii. Chrome Task Manager: To monitor memory and CPU usage of the flash-webpage.

iii. System monitoring console: To monitor packets send and receive and bandwidth utilization.

Hardware	Description
Intel Central Processing Unit (CPU)	CPU Intel Core 2 Duo 3.0 GHz
Kingston Random Access Memory (RAM)	3GB DDR2
Network Card	TP/Link 100mbps
Motherboard	MSI 220 appendices system build in VGA card

Table 3. Server Specification

The study has selected 6 students to use V2oIP e-learning system and they accessed into e-learning server concurrently. All students are divided into different network operating system in e-learning system. The duration for all students' activities is limited to one hour (60 minutes) only. Figure 15 and Figure 16 show the sample of V2oIP raw data performance that have been generated and captured using network management tools for commercialization of network operating system. While, figure 17 and figure 18 show the sample of V2oIP raw data performance generated by open source network operating system for video conferencing based on the number of students' access.

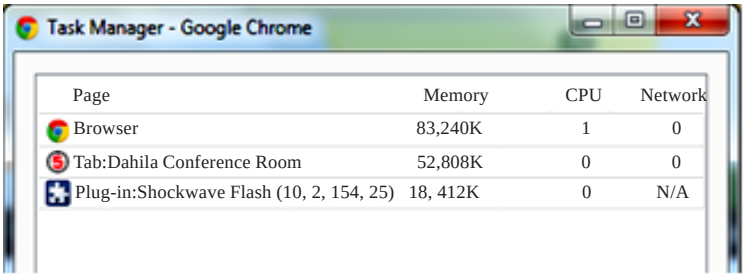

Figure 14. V2oIP performance for One User – Commercialize Network Operating System

4.3 CPU Usage

In this section, we will estimate and evaluate CPU usage based on number of current and future students access into e-learning server with V2oIP over SSL IPv6 environment. As a result, low server specification (CPU Intel Core 2 Duo 3.0 GHz) shows that 6 students with V2oIP (with voice functionality only) and access concurrently into e-learning server will consume low CPU usage approximately 2.5% to 2.80 % for both network operating system environment (refer to Table 4 and

Figure 19). Based on the graph analysis, it shows that commercialize network operating system can achieve a good performance result compare to open source network operating system but this result will not obviously effect the performance of e-learning system with V2oIP (voice functionality) (refer to figure 19) .

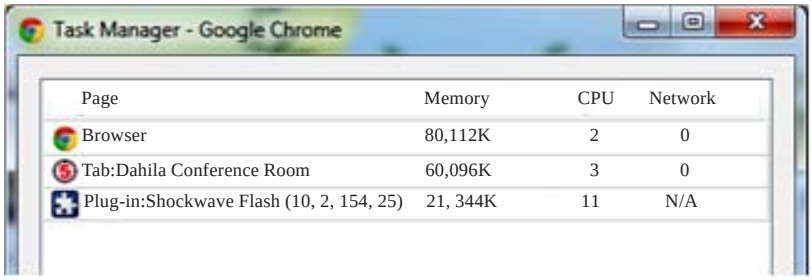

Figure 15. V2oIP Performance for Three Users – Commercialize Network Operating System

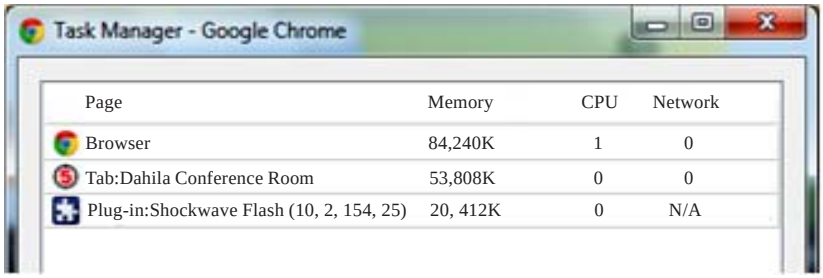

Figure 16. V2oIP Performance for One User – Open Source Network Operating System

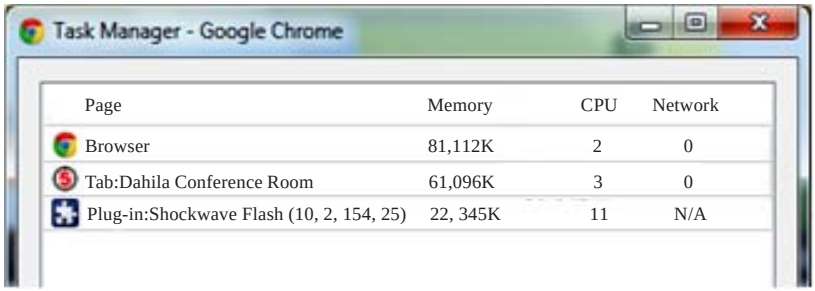

Figure 17. V2oIP Performance for Three Users –Open Source Network Operating System

Table 5 shows that experiment result performance with video conference via SSL IPv6 and IPv4 have slightly higher with SSL IPv4 but the result still in the acceptance range.

Users	Windows Percentange	Ubuntu Percentange
2	1.02%	1.48%
3	1.46%	2.12%
4	2.25%	2.4%
6	2.55%	2.82%

Table 4. Analysis of CPU Utilization – E-learning System with V2oIP (Voice Functionality)

In addition, server specification (CPU Intel Core 2 Duo 3.0 GHz with 3GB DDR2 RAM) has generated low utilization of RAM for both network operating system (refer to Figure 20). High RAM specification is able to achieve a better performance with

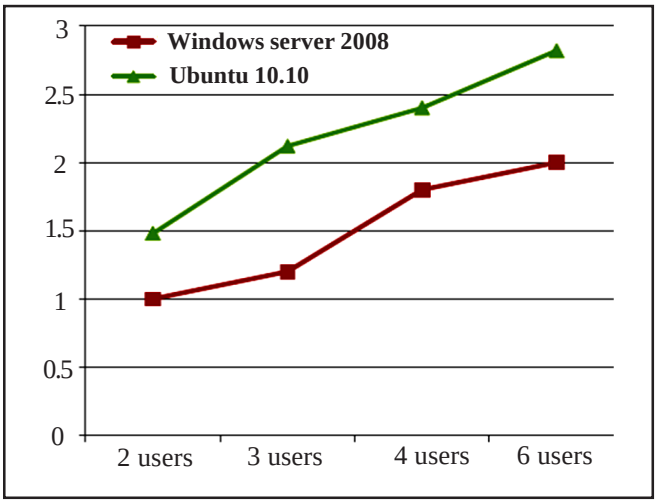

Figure 18. Comparison of CPU Utilization (Voice Functionality) – Commercialization and Open Source Network Operating System

Category	CPU Usage (%)
Windows Server 2008 without SSL Ipv6	51
Ubuntu 10.10 without SSL Ipv6	58
Windows Server 2008 with SSL (IPV4)	89
Windows Server 2008 with SSL (IPV6)	95

Table 5. V2oIP (Video Conference) with SSL IPv6 and IPv4: CPU Usage for 6 Students Access Concurrently

high number of student' access into e-learning server concurrently. Based on the graph analysis, the result shows that commercialization network operating system still achieves a good performance result. Open source network operating system is slightly higher compare to commercialization network operating system but it will not affect the performance of the e-learning system with V2oIP functionality (video and voice) (refer to figure 20). Figure 21 shows that V2oIP (video and voice) conference with SSL IPv6 and IPv4 have a higher memory usage compare to SSL IPv4.

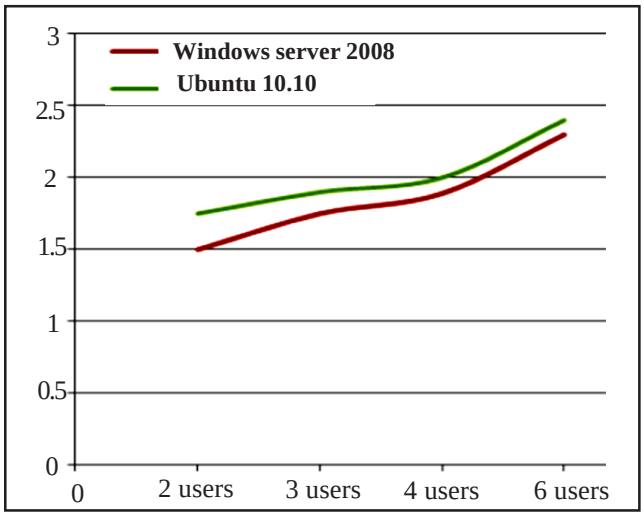

Figure 19. Comparison of RAM – Commercialization and Open Source Network Operating System (Video and Voice)

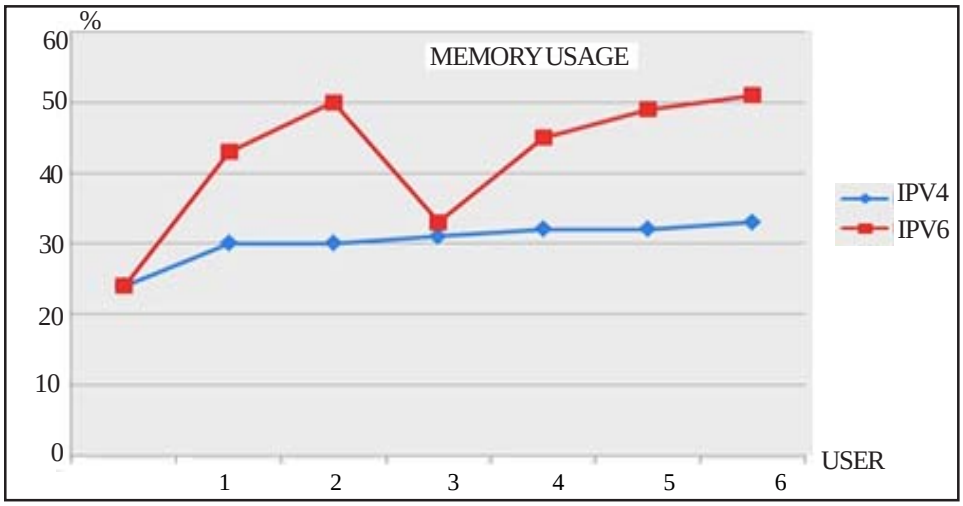

Figure 20. V2oIP (Video and Voice Conference) with SSL IPv6 and IPv4: Memory Usage for 6 Students Access Concurrently

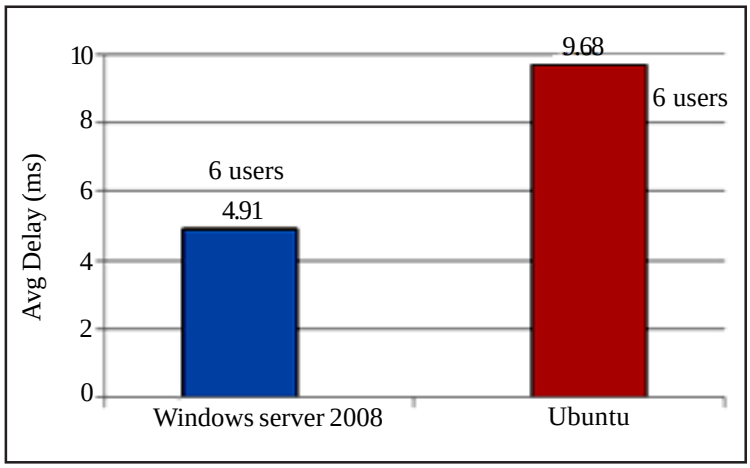

Figure 21. Delay Analysis - Average of 6 Students for 1 hour Activities with V2oIP over SSL IPv6

Milliseconds	Description	Range in Milliseconds
0-150	Acceptable for most user applications	0-50
150-400	Acceptable provided that administrations are aware of transmission time.	150-400
Above 400	Unacceptable for general network planning process	Above 400

Table 6. ITU Standard – VoIP Delay Performance

4.4 Packet Loss, Delay, Jitter and MOS

In this section, we will estimate and evaluate the packet loss, delay, jitter and MOS usage based on the number of students access into e-learning server with V2oIP (video and voice) functionality over SSL IPv6.

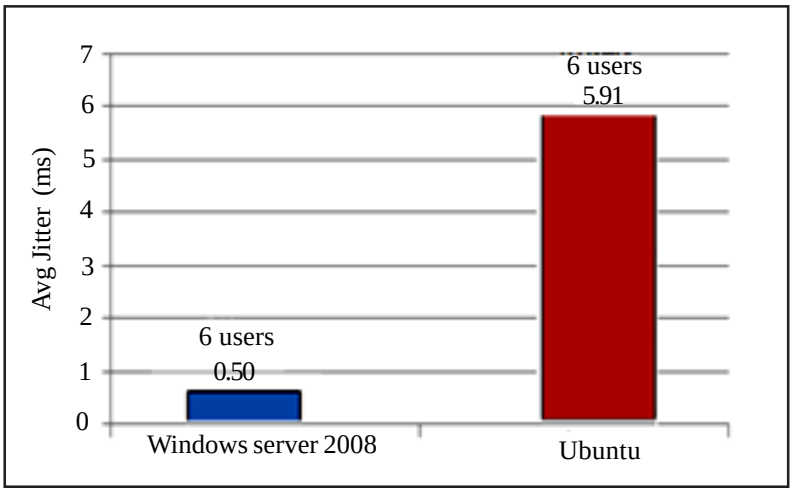

Figure 22. Jitter Analysis - Average of 6 Students
for 1 hour Activities with V2oIP over SSL IPv6

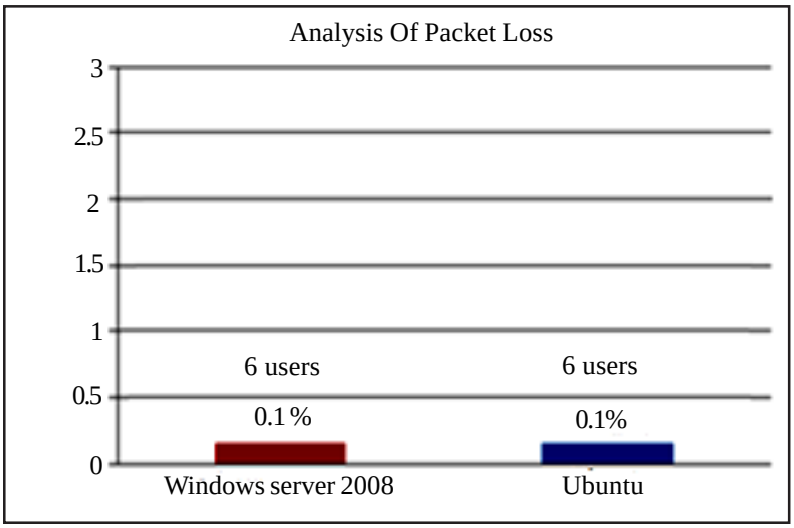

Figure 23. Packet Loss Analysis - Average of 6 Students
for 1 hour Activities with V2oIP over SSL IPv6

Based on the trends and results analysis, open source network operating system (9.68 ms) achieve higher delay compare to commercialization network operating system (4.91 ms) (refer to figure 22). The result analysis conducted on jitter performance shows that open source network operating system (5.91 ms) still achieve a bit higher jitter compare to commercialization network operating system (0.50 ms) (refer to figure 23). Then, the analysis continued with packet loss, the result shows that both network operating systems generate a low percentage of packet loss during video and voice conferencing activities (refer to figure 24). Based on ITU standard (refer to Table 6), delay, jitter and packet loss analysis result under acceptable range for both network operating system. ITU standard has defined, delay with 400ms above and more than 5% packet loss under unacceptable range for VoIP quality.

Finally, the analysis will end up with mean opinion score (MOS) testing to average the V2oIP (without SSL IPv6) performance over e-learning system. Mean Opinion Score (MOS) indicate that commercialization network operating system achieved scale rate 4.40 compare to open source network operating system achieved scale rate 3.55 (refer to figure 25). Based on ITU standard (refer to Table 7), commercialization network operating system has achieved rating 4, it means the speech quality over video transmission is good. While open source network operating system has achieved rating 3, it means the speech quality over video transmission is fair. Based on result finding (refer to Table 8), implementation of SSL technique will degrade V2oIP service. The overall performance for V2oIP over SSL IPv4 commercialization network operating system is able to achieve better performance rate compare to SSL IPv6.

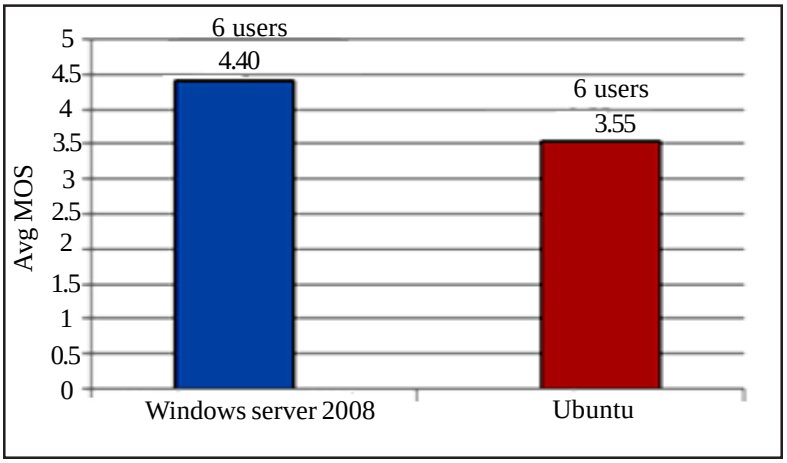

Figure 24. Most Opinion Score (MOS) Analysis - Average of 6 Students for 1 hour Activities with V2oIP (Video and Voice) without SSL IPv6

Rating	Speech Quality	Level of Distortion
5	Excellent	Imperceptible
4	Good	Just perceptible but not annoying
3	Fair	Perceptible and slightly annoying
2	Poor	Annoying but not objectionable
1	Unsatisfactory	Very annoying and objectionable

Table 7. ITU Standard – Scale Rate for V2oIP

Category	MOS (ms)
Windows Server 2008 without SSL (video conference)	4.4
Ubuntu 10.10 without SSL (video conference)	3.5
Windows Server 2008 with SSL (video streaming)	4
Ubuntu 10.10 with SSL (video conference)	3.0

Table 8. MOS Analysis between SSL IPv6 and IPv4

5. Conclusion

This study shows the success of V2oIP e-learning systems over SSL IPv6 development for next generation network. This study has focused on the performance of e-learning server based on six elements as follow: i). delay; ii) jitter; iii) packet loss; iv) CPU usage; v) memory consume; vi) MOS.

Based on the analysis result, the performance of V2oIP e-learning system over SSL IPv6 and IPv4 can be summarized as follows: i) both network operating system did not show any significant impact on packet loss, CPU and RAM usage; ii) commercialization of network operating system has achieved slightly a good delay and jitter performance result compare to open source network operating system but it does not show any significant improvement; iii) MOS indicate that commercialization of network operating system has achieved high performance result compare to open source network operating system.

Based on our findings, we conclude that development of V2oIP e-learning system over SSL IPv6 and IPv4 using processor CPU Intel Core 2 Duo 3.0 GHz with RAM 3GB DDR2, the number of maximum students can access into e-learning server is not more than 20 students concurrently. However, server with higher specification is able to support more students (more than 20 students) to access V2oIP e-learning system concurrently.

Therefore, implementation of V2oIP e-learning system over SSL IPv6 (next generation network) is able to create mobility environment for undergraduate and postgraduate students. For future work recommendation, researcher should develop a simulation model that is able to predict and evaluate the performance of V2oIP e-learning system over SSL IPv6 based on theoretical approach.

References

[1] Mohd Nazri Ismail. (2011). A Case Study: Server Performance Measurement for E-Learning System in Campus Environment. Journal Annals. Computer Science Series, Romania, V. 9, Fascicula I-a, p. 9– 30.

[2] Andrusyszyn, Mary, A., Soeren, Mary, V., Laschinger, Heather, S., Goldenberg, Dolly, DiCenso, A. (1999). Evaluation of Distance Education Delivery Methods for a Primary Care Nurse Practitioner Program. J. Dist. Edu, Retrieved from http://cade.athabascau.ca/vol14.1/andrusyszyn_et_al.html.

[3] The Rights Stuff: Ownership in the Digital Academy. (1999). Retrieved March 5, 2003 from http://thenode.org/ltreport/ip.

[4] Thompson, Herb. (1999). The Impact of Technology and Distance Education: A Classical Learning Theory Viewpoint. Education Technology & Society, Retrieved from http://ifets.ieee.org/periodical/vol_3_99/herb_thompson.pdf.

[5] Models of Distance Education. (1997). University System of Maryland, Institute for Distance Education Web site: http://www.umuc.edu/ide/modlmenu.html

[6] Distance Education at a Glance. (2003). University of Idaho, Engineering Outreach Web site: http://www.uidaho.edu/eo/distglan.html

[7] Herman Koppelman, Harald Vranken. (2008). Experiences with a synchronous virtual classroom in distance education. ITiCSE '08: *In*: Proceedings of the 13th Annual conference on Innovation and technology in computer science education, 4 (3) 194-198

[8] Michael Massoth, Roman Korn. (2008). The IP multimedia subsystem with an e-learning management system and integrated video conferencing. *In*: Proceeding IIWAS'08 Proceedings of the 10th International Conference on Information Integration and Web-based Applications & Services, p. 655-658.

[9] Valter Roesler, Ronaldo Husemann, Carlos Haas Costa. (2009). A new multimedia synchronous distance learning system: the IVA study case. SAC '09: *In*: Proceedings of the 2009 ACM symposium on Applied Computing, p.1765-1770.

[10] Costabile, MF., Lanzilotti, R., Ardito, C. (2007). On the importance of the user interface for e-learning systems quality Source, International Association Of Science And Technology For Development, *In*: Proceedings of the Second IASTED International Conference on Human Computer Interaction, Chamonix, France, p. 193-198.

[11] Sawai, S., Donyaprueth, K., Nicholas, JD., Paul, H. (2006). The study of e-learning technology implementation: A preliminary investigation of universities in Thailand, Education and Information Technologies, 11 (2) 137 – 160.

[12] Laura, GC., Ovgu, D. (2007). Drag and drop streaming: the next revolution in e-learning. User Services Conference, *In*: Proceedings of the 35th Annual ACM SIGUCCS conference on User services, Orlando, Florida, USA, p. 139 – 142.

[13] Iasmina, E., Diana, A., Radu, V. (2009). Study cases on elearning technologies used by universities in Romania and worldwide, WSEAS TRANSACTIONS on COMMUNICATIONS, 8 (8) 785-794.