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Distributed Multimedia System for Distance Education

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Abstract: A distributed multimedia system (DMS) come to play as a backbone of 21th century to provide sophisticated technology to realize such a modern distance education/ learning. In this paper, we describe distributed multimedia system for distance education that could be implemented at Kathmandu University and how this system interacts with other University i.e. Tribhuvan University. Proposed framework brings an abstraction and its infrastructure for multimedia materials storage, management, real time review of this multimedia on demand and a shared whiteboard on web browser to distance learner. For the design of the proposed system, it is necessary to consider different requirement and management of Quality of Service (QoS). This system is made available to only registered student/users through various networks i.e. Local Area Network (LAN)/Internet using university's own VPN user ID and Password. In addition, proposed system provides abstraction in which distance learner or student access lecturer presentation/notes on web browser and can review multimedia lecture's notes, presentation on demand. Student or people could have different reasons for attending distance education/learning such as constraints of time, distance, and finance etc. So, distance education system should reduce the distance gap between a student/participants and lecturer. This is done by quick response interaction between lecturer and student throughout the system. The main objective of this paper is to provide distance education platform while guarantying secure communication and user on demand multimedia access with the sophisticated QoS.

Keywords: Distributed Multimedia System, Distance Education, QoS Management, Multimedia Database System, Virtual Private Network, Local Area Network

1. Introduction

Distance education refers to all types of studies in which people or students are separated from teachers by space and/or time. For simple understanding, the distributed electronic classroom at the Kathmandu University overcomes separation in space by exchanging digital audio, video, and whiteboard information between two sites, *i.e.* Kathmandu University and Tribhuvan University via broadband networks. If the classroom involves in one of the University then student of other University can run the lecture from his computer in home, office using Internet. The main advantages of distance education are availability, reduced cost, flexibility and integration [2].

Distributed multimedia systems come to play as a backbone to provide technology to realize such modern distance education/learning. A distributed multimedia system (DMS) is an integrated communication computing, and information system that enables the processing, management, delivery, and presentation of synchronized multimedia information with guarantees of the quality of service [1]. A multimedia system is an interactive digital multimedia system which integrates audio, video, text data, and images *etc.* via computers and allows users to interact with such information according to their preferences. For examples, number of multimedia PC's or workstations interconnected with continuous media servers via broadband Internet that allows users to retrieve, browse, and manipulate video or audio.

The existing distributed systems are RM-ODP, CORBA, and DCE that mainly focus on discrete data transmission [3]. Distributed multimedia system should be able to provide integrated multimedia information such as audio, video, etc. with sophisticated quality of service (QoS) management. In traditional computing system, there is no guaranty of QoS. For instance, request for the particular service are either met or ignored. Distributed multimedia system should be able to provide the real-time synchronization of continuous media transmission. Through DMS, student or user can request the service any time and from anywhere and service allows users to have a complete control of the presentation. Student or people could have different reasons for attending distance education/learning such as constraints of time, distance, and finance *etc.* Distance education application/system should reduce the distance between instructor/lecturer and student. Virtual class room should be interactive. There would be variety of interaction while attending virtual class [7]. Some of the common interaction between lecturer and student would be:

- Viewing and hearing the lecturer, including gestures
- Monitoring arrival and departure of participants
- Slides, with ability to point or mark for emphasis
- 3D representation to make the lecture more realistic
- Spontaneous writing and drawing (as on blackboard)
- Student questions on lecture content, including ability to support another's question (e.g. nodding in class)
- Spontaneous questioning of students by instructor
- Process-related issues, such as level of comprehension (in a class, communicated publicly with comment or privately by facial expression)
- Discussion among students
- Demos or labs

The main objective of this paper is to provide distance education system or platform while guarantying secure communication and user on demand multimedia access with sophisticated QoS.

2. Related Works

Multimedia on demand for distance education is the systems that allow users to select and watch/listen to multimedia content i.e. audio, video, text data and images when they choose to, rather than having to watch at a specific broadcast time. Silveira, et al. [4] described the Multimedia on Demand (MoD) system developed at Polytechnic School of University of

Sao Paulo. MoD provides an abstraction for multimedia material production, storage, and management and on demand or real time distribution applied to distance learning. In this paper, author analyzed the requirement of each media and to specify the network infrastructure. They also considered QoS management and a secure mechanism for multimedia material distribution. They believed that the distance education would be very important way to transmit technical information and intellectual experience over the world.

Plagemann & Goebel [5] have presented measurement and analysis result of transport, application, user level QoS in the electronic classroom at two site of the University of Oslo and two sites in Norway to overcome separations in space by exchanging multimedia information via Norwegian academic ATM-based network. From the results, user level QoS accepted a relatively high error rate below 5% and 10% in video and audio streams with end-to-end delay 125ms. Zeng et al. [6] described a Multimedia Whiteboard (MMwb) tha is based on a commercial video conferencing engine. MMwb provides multimedia information to virtual conference room and allows a synchronized audio, video to be played back and interacted on participant's workstations simultaneously. Each student or member on conference room can play stop, rewind or otherwise control a motion-JPEG movie with text captions. The video with 20 frames per second requires about 4Mb/s bandwidth.

Sagias [8] proposed Virtual Blackboard (VB) project that contains components according to the nature of the lecture and content. VB integrates all the components in a user-friendly interface that can represent different content i.e. video, audio, HTML pages, Text, Whiteboard, Application sharing, 3D representation, still images, file transfer, email, chat, FAQ, participants list and question & answer in a single windows in computer. VB showed an innovative approach to distance learning by integrating technologies that facilitate different lecturing/ learning modes, including synchronous (on-lecture, off-lecture) as well as asynchronous (bulletin boards, forums) etc.

Min et al. [8] presented a platform-independent multimedia distance education system. They named as Global Virtual Academy (GVA) that provides lecture to remote student by means of multi-user interactive tools such as real-time full duplex voice talking, text chatting and a shared whiteboard on top of a browser. In GVA, self study abstraction provides student access lecture notes on the web and review previous lecture on demand accessible by the registered user through various network environment including LAN, ISDN (Integrated Services Digital Network), PSTN (Public Switched Telephone Network) and Internet etc. Goebel & Plagemann [9] discussed design consideration for the DEPEND (Distance Education for People with Different Needs) project which was under development at UNIK – Center of Technology at Kjeller, University of Oslo while considering synchronous that means lecture in an electronic classroom are distributed in real time to other classrooms and student workstation; & asynchronous in which students browse distributed hypermedia documents, including video clips from lecture, transparencies, exercise, and background material. Main goal of DEPEND was to flexibility and efficiently support these various user requirements with an integrated multimedia system.

3. Proposed Conceptual Framework

Proposed framework is composed of own Local Server (LS), media server, a teacher per session as an instructor in university and a number of students. Fig. 1 shows the architecture of the proposed system where teachers at university and student at home or office connected through several networks. Lecturer/teacher connects via university's LAN or high-speed bandwidth to transmit the large amount of data and students via various networks depending on their own system such as Broadband Internet or ADSL etc. I propose two server, i.e. local server that manages the university's network and media server that is common to both universities, i.e. Kathmandu University and Tribhuvan University. Data on the LS will be replicated to media server.

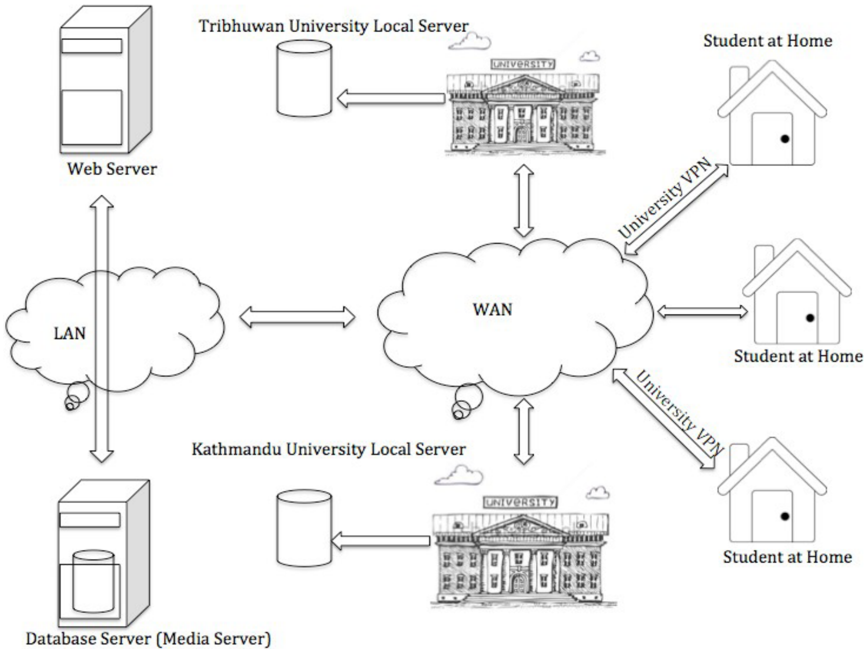

Fig. 1: Architecture of Proposed Framework

While managing real-time multimedia data, I propose four server threads namely; Controller Server (CS), Multimedia Coordinator Server (MCS), Post-Processing Server (PPS), and Multimedia Database Server (MDS) (Figure 2). All the servers are placed on Media Server. Main purpose of using different server is to share workload of components. CS controls the whole system. MCS controls the real-time lecture by opening, closing, and supervising sessions. Function of PPS is to provide reviews of past lectures, *i.e.* provide proper multimedia services according to students on demand requests. MDS provides storage and retrieval of data.

Lecturer and students to access class information, lecturer information, class materials, and student registration *etc.* while browsing web server main page. Upon registration, student will get the VPN (Virtual Private Network) username and password to access the university's resources, multimedia lectures. A VPN is a network that uses a public telecommunication infrastructure, such as the internet, to provide remote offices or individual users with secure access to their organization's network [10]. A VPN ensures privacy through security procedures and tunneling protocols such as Layer Two Tunneling Protocol (L2TP). Data is encrypted at the sending end and decrypted at the receiving end.

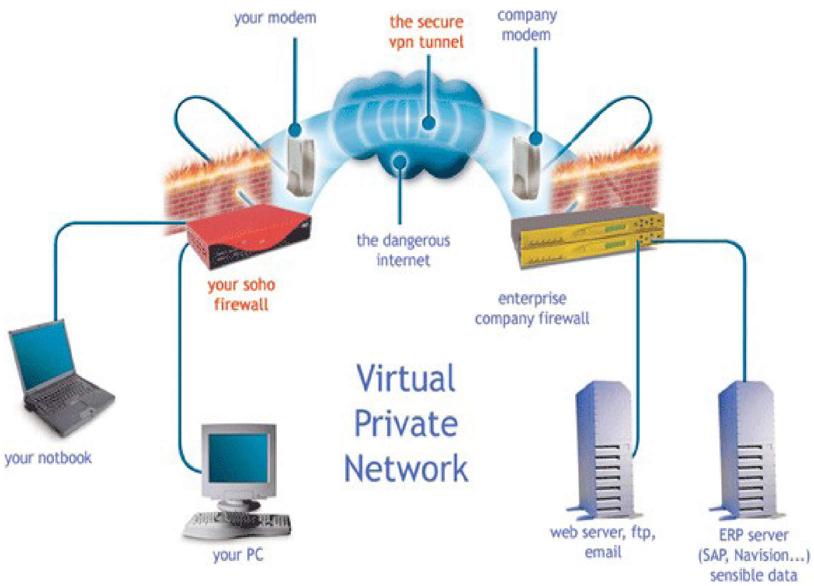

Fig. 2: Working of VPN (Source: http://techagelabs.com)

3.1 Detail Organization of Proposed Framework

It is already known that proposed framework is composed of media server that contains four servers, i.e. CS, MCS, PPS and MDS. In this organization, I describe function of each server in detail. Lecturer application is connected to the WAN (Wide Area Network) or Internet. Main purpose of using the local server is to keep record of student information, lecturer information, schedules etc. Lecturer application starts when lecturer login using his particular username and password of home page provided by web server. Student can login using their particular user ID and password provided by University. All servers are connected to each other and standby to perform their particular work. MCS is used to manage the lecture class. It handles lecturer login and student login and keeps the record of lecturer information and student information using local database. Lecturer loads his presentation material on whiteboard of lecturer application. So the student can see presentation slides while clicking page number. Lecturer can check the participants of his lecture. Student can also check status of the system and can see participants to the system. The whiteboard contains menu bar, chatting bar, URL, and help bottom for the participants. In lecture session, student can ask the question to lecturer using chatting tool or student can directly speak. MCS helps to store the lecture information in database to be used for on demand lecture service.

To build above system, there are several server are interacted with particular function. Communication of these servers should be transparent. Here CS is used to control the overall system. CS makes MCS create a new session according to given schedule. It manages MCS, MDS and PPS. Controller Server (CS) is used to manage the VPN in the network. Here main purpose of using VPN is for secure communication. Using this VPN user ID and password student can access the web server to get into the class. Multimedia Coordinator Server (MCS) manage session of lecture and provides session information according to the requests of CS. MCS starts when lecture login his user ID and password to lecturer application. While login lecturer application, MCS receives lecturer information, registered student information to start the class session and to display number of student or participants in the application.

Multimedia Database Server (MDS) provides information of user, lectures. MDS stores lecturer, student registration information and information of student participation etc. MCS communicates with MDS to authenticate users when lecturer and student request to join the session.

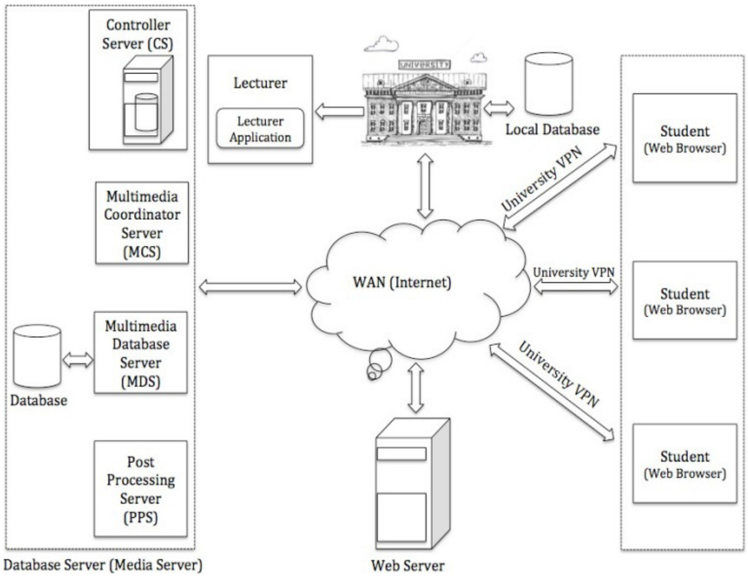

Fig. 3: Detail Organization of Proposed Framework

When student and lecturer want to check the status of the participants then database service provides stored information. There are two servers one is media server and another is local server. MDS stores separated multimedia data in separate folder i.e. audio, video, text and images. The real time lecture data is uploaded and stored into media server database and local server database. Once the lecture data is stored, students can review on demand lecture data via Post- Processing Server. Main function of PPS is to reply the old or stored lecture data when student or user demands. When the user/student wants to view lecture, first he should have to be registered user with VPN, then he gets access to PPS through main server. PPS manages multimedia data in real time format i.e. student can forward and backward the multimedia data such as audio video *etc.* MDS manages the stored data in different forms such as audio, video, images and text data. So synchronization of this data is needed with quality of service. Media synchronization is performed in local server when the user demands the multimedia access. Main purpose of real time synchronization in the Local Server is to overcome delay on network and server's performance degrades due to demands of many users. Real time data synchronization in media server in short period of time is difficult.

3.2 Key Requirements for Proposed Multimedia System

In distributed multimedia system for distance education, there are number of data types that can be characterized as multimedia data types such as text, images, audio, video and graphical objects. These are typically the elements for the building blocks of one generalized multimedia environments, platforms, or integrating tools. To handle these multimedia data in distributed system, there are different key considerations. Management of QoS is handled in Controller Server (CS).

3.3 Representation of Multimedia Data in Distributed System

Representation of multimedia data is important key requirement in distributed system. Multimedia data have spatial constraints in terms of their content. For example, video frame must have spatial relationship, *i.e.* on left, on right, next to *etc.* In case of audio representation, it is made up with chunks of audio frames representing amplitude. For example, audio chunks can be represented as 16 bit from of each. So then audio must be played back at same rate as it was sampled (e.g. 36100 Hz). Continuous multimedia data is maintained with its certain level of service, *i.e.* 30 frames/sec of video, 35100 Hz of the audio. This multimedia continuous data should be handled in their original form so that it can be played well. As we know that changes of one bit of frame can drastically destroy the multimedia data.

3.4 Multimedia Synchronization Support

Distribution multimedia system should support real-time multimedia synchronization. Multimedia synchronization preserves the playback continuity of media frames within a single continuous media stream and the temporal relationships among multiple related data objects [1]. In distributed multimedia system, there are different forms of real time synchronization [12].

- Intra media (e.g. maintain uniform time spacing of a single continuous media stream)
- Inter media: synchronization of video and audio stream (lip synchronization) and text streams (subtitles)
- Synchronization of distributed state (e.g. stop video operation should be observed by all within 400 ms)
- External synchronization (e.g. synchronization of time based streams with data in other formats, *i.e*. animations, white-boards, shared documents)

There are two types of synchronization mechanism:

a. The principle of explicit synchronization on the level of data units.
b. The principle of synchronization as supported by high level interfaces.

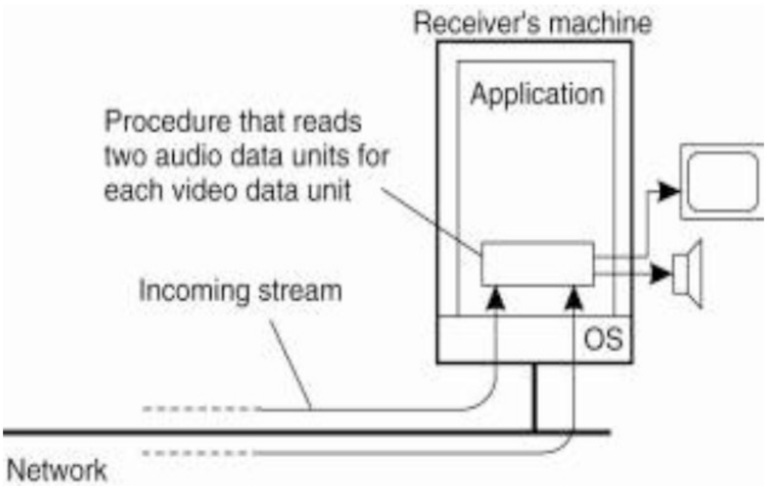

Fig. 4: Explicit Synchronization on the level of data units [12]

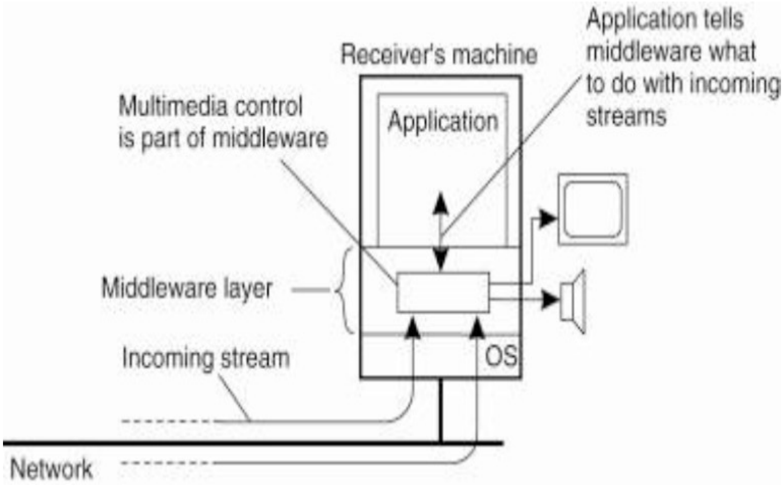

Fig. 5: Synchronization as supported by high level interfaces [12]

3.5 Consideration of Quality of Service (Qos) Management

QoS in distributed multimedia system is one of the most considered requirements of system. QoS guarantee that requested resource/service would be available in particular time with error free. In most traditional computing system, request for a particular service are either met or ignored.

According to Lu [4] and Verma & Singh [12], there should be major components in order to provide the QoS guarantees:

- **QoS specification:** A QoS specification is mechanism for creation of QoS contract specifying QoS requirements.

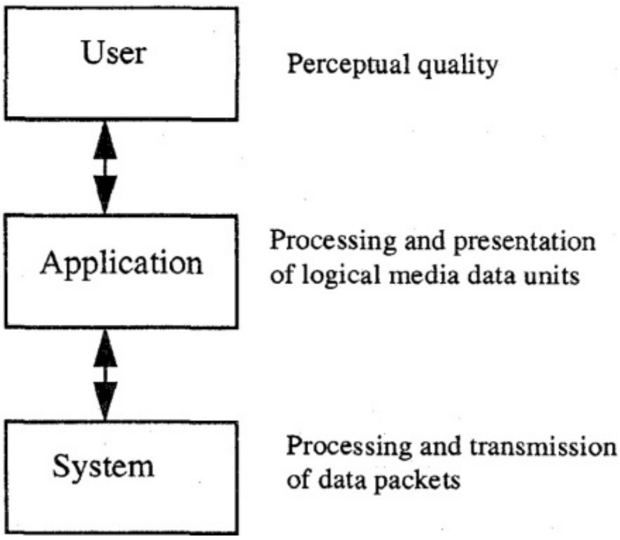

Fig. 6: Conceptual Model of QoS [11]

- **Admission control:** Admission control determines whether the new application should be admitted without affecting the QoS of other ongoing applications. It will perform the test to determine if the system can deliver the required service. If it finds all the resource is available for the required system then it allows using resource of the system. After then system should guarantee that the quality of service can be met.

- A **QoS negotiation:** QoS negotiation refers to achieving an agreement on the QoS contract between all involved parties. It establishes sophisticated quality of service for each of involved components.

- **Resource allocation and scheduling:** It is used to guarantee the desired service level to be met the QoS requirement of accepted applications.

- **Traffic policing:** It is used to make sure that application generates the correct amount of data within the agreed specification.

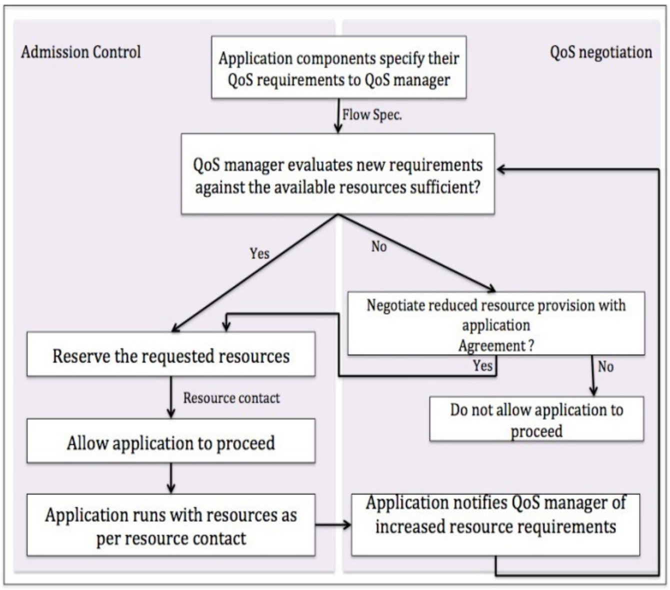

Fig. 7: QoS Manager's Task [3]

- **QoS Manager:** Quality of service manager performs different functions while guarantying sophisticated quality of service. QoS manager's task is defined below clearly. Quality of Service manager is handled in the controller server. Tasks of the QoS manager are well defined in Fig. 7.

3.6 Streaming Media & Compression Methods

Continuous multimedia data that are sent in compressed from over the Internet and received *i.e.* form media server to own local computer by the user as they arrive. When the user or student receives the continuous multimedia data while student application uncompress the compressed data. Compression techniques are important method to minimize the media file size which overcome the network delay or network traffic. In this case different compression techniques are considered i.e. MPEG, MPEG-4, MPEG-7, H.261 and H.264 etc. H.264 is an efficient and scalable compression standard providing extremely high quality in smaller files.

4. Discussion

As we can see in the above literature, there has been number of proposed model for distributed multimedia system for distance learning. But in the literature, I found that there is little consideration on QoS and less secure communication channel between distance education provider and user or students. In traditional system, when the students want to be connected distance learning system then they simply used their user ID or password provided by the system. But in this proposed system, I consider more secure communication between distance education provider and students while applying concept of Virtual Private Network (VPN). VPN provides more secure own private tunnel. Student can get informed about class information, lecturer information, and class schedule through direct web pages of distance learning/ education provider. In case of when student want to access or review lectures note, presentation, multimedia notes on demand then he should have VPN user ID and password. Lecturer application system or server system should be of high-speed broadband Internet connection, higher processor speed, operating system, working audio, video card, dual switchable cameras etc.

5. Conclusion and Future Implications

In this paper, we present distributed multimedia system for distance education at Kathmandu University and how this system interacts with other University i.e. Tribhuvan University while guarantying secure communication with student or distance learner using VPN and user on demand multimedia access with the sophisticated QoS. In this system, lecturer provides a lecture to remote student, i.e. student at home using distance education web application (web browser). From web application, remote student can interact with lecturer either directly voice talking or text chatting and shared whiteboard in student's web application. Using their VPN user ID or password provided by particular organization, university or distance education provider, student/participants could directly access to lecture notes and view previous lectures on demand. Currently, this proposed system is made accessible to only registered student using own particular organization, university or distance learning provider's VPN user ID and password through LAN/Internet. The proposed system is based on conceptual framework. This technology has yet to realize its full potential. At present, we have little understanding of appropriate conventions for different interaction classes. More research and developed is required.

References

[1] Eliassen F (2006). *Distributed Multimedia Systems,* Retrieved April 19, 2015, from INF 5040 autumn 2006. Retrived on March 16, 2016 from http://www.uio.no/studier/emner/matnat/ifi/INF5040/h07/ undervisningsmateriale/INF5040_WK46_DMMS.pdf

[2] Goebel V and Plagemann T (1996, November), Towards User-Centered Multimedia Systems for Distance Education. *ITA - Information, Telecommunications, Automata Journal.* Retrieved on September 18, 2018 from *https://pdfs.semanticscholar.org/557a/d63a368d653ce95c76960d05ab737873bbab.pdf.*

[3] Li VO and Liao W (1997, Distributed Multimedia System. *Proceedings of the IEEE,* 85.

[4] Lu G (1996), Quality of Service Management in Distributed Multimedia System. *IEEE*.

[5] Min D, Choi E, Han YT, Hwang D and Jung JH (1997), A Distributed Multimedia Conferencing System for Distance Learning. *IEEE*.

[6] Neal L (2016), Distance Learning. *ACM Conference on Computer Supported Cooperative Work*

[7] Plagemann, T and Goebel V (1999), Analysis of Quality of Service in a Wide-area Interactive distance learning System, *Telecommunication Systems,* 11, 139-160. J. C. Baltzer AG, Science Publishers.

[8] Rouse M (2007, May), V*irtual-private-network*. Retrieved on April 16, 2015, from *http://searchenterprisewan.techtarget.com/definition/virtu al-private-network.*

[9] Sagias YN (2017), Distributed and Online Distance Lecturing Environment (The Virtual Blackboard project). *Educational Technology & Society,* 5.

[10] Shadab (2015), H*ow-to-configure-vpn-networks-part-1*. Retrieved April 18, 2015, from http://techagelabs.com: http://techagelabs.com/how-to-configure-vpn-networks- part-1.

[11] Silveira R, Margi C, Gonzalez L, Favero E, Vilcachagua O and Bressan, G (2016), A Multimedia on Demand System for Distance Education, *LARC - Laboratory of Computer Architecture and Networks.*

[12] Verma, M and Singh A (2011), Concepts of Distributed Multimedia System. *International Journal of Computer Science and Technology,* 2 (2): 150-153.

[13] Zeng Y, Caron S and Georganas N (1997), MMwb: A Multimedia Whiteboard for Distance Learning Applications, *in: Proceedings of International Conference on Computer Communications (ICCC'97)*.