Scalability Analysis on QoS of Video Conference Sessions in Adhoc Learning Environment

Kalamullah Ramli, Ari Raptino, Andi Faridz
The Center for Information and Communications Engineering Research (CICER)
Department of Electrical Engineering, Faculty of Engineering, Universitas Indonesia,
Kampus Universitas Indonesia, Depok 16424, INDONESIA
Tel. +62-856-9009843, Fax: +62-21-7270050, e-mail: k.ramli@eng.ui.ac.id

Abstract

We develop pervasive learning environment which allows the learning sessions and materials be accessed anywhere, anytime and on-demand. To enable anywhere access the environment employs adhoc network technology. For the purpose of verifying the usability of the system and observing the level of QoS a mobile learner perceived when running video conference session while traversing several adhoc network nodes we run some tests on adhoc network testbed with AODV routing algorithm. The number of nodes involved in the process is varied between two until five nodes. Parameters of the QoS used for the analysis are throughput, lost packet, delay and jitter. The results show that QoS is maintainable up to three nodes only. At four and five nodes jitter increases significantly and hence slow motion picture is resulted.

Keywords: *ubiquitous learning environment, mobile learning, QoS, AODV adhoc routing protocol, video streaming and video conference applications*

1. Introduction

We are developing pervasive learning environment which is aimed at allowing the learning materials and processes be accessed anywhere, anytime and on-demand. The environment is designed to support adhoc network notion which enables anywhere and anytime access to learning sessions and materials, and therefore support also the notion of mobile learning.

The paper describes continuation of our previous work in adhoc network [1], in which we use win-AODV routing algorithm within the testbed of two until three intermediate network nodes. The aim of our current work is to verify QoS perceived by mobile learners in case of incremental numbers of intermediate nodes involved in a video conference learning sessions. The effect is analysed by measuring the variation on QoS parameters at the moment client traverses more intermediate nodes while running such application.

2. AODV Routing Algorithm

Mobile adhoc network (Manet) can be defined as collection of mobile hosts which forms network anytime and anywhere, with neither centralized access network nor fixed infrastructure. Each host in this adhoc network functions as transceiver as well as router.

A routing algorithm has two basic functions namely route selection for source node and destination node, and message delivery to the correct node. For the latest purpose routing table and protocol variation are used.

Many routing algorithms have been proposed [2] and verified to deal with the dynamic nature of an adhoc network. Those algorithms modify conventional routing algorithm used by Ethernet such as link state, distance vector, source routing and flooding. In general routing algorithm for adhoc network can be classified into three types as listed in Table 1.

Table 1. Types of Adhoc Routing Algorithms

Table driven (proactive)	**On-demand driven (reactive)**	**Hybrid**
Destination Sequenced Distance Vector (DSDV)	Signal Stability Routing (SSR)	Zone Routing Protocol (ZRP)
Wireless Routing Protocol (WRP)	Dynamic Source Routing (DSR)	
Cluster Switch Gateway Routing (CSGR)	Temporary Ordered Routing Algorithm (TORA)	
Source Tree Adaptive Routing (STAR)	Multicast Ad hoc on Demand Distance Vector Routing (AODV)	
	Relative Distance Microdiversity Routing (RDMAR)	
	Associativity Based Routing Protocol (ABR)	

Table-driven (proactive) type represents an approach in which node searches route in periodical basis and therefore maintains the latest topology update in network. In On demand-driven (reactive) approach routing is built only when a node requests it and therefore an initialization phase is necessary. Hybrid mode combines the previous two approaches and uses hierarchical routing method in the implementation.

Adhoc On Demand Distance Vector (AODV) is the most widely developed in adhoc network research. This is a reactive routing protocol that develops routing table on demand. Each node is limited to maintain one route for one destination, to reduce overhead. The format of AODV routing table is as follows:

<*destination address, next hop address, sequence number, distance, precursor list, expiration date*>

AODV Uppsala University (AODV-UU) [3-4] is plug-in software on linux kernel that enables AODV routing run on adhoc network. AODV-UU run on user-space daemon and maintains routing table kernel. AODV-UU implements almost all functions of AODV routing algorithm. AODV-UU could be cross-compiled to be used at personal digital assistants such as HP iPAQ and Sharp Zaurus.

3. Video Transmission over Adhoc Network

By increasing bandwidth capacity on wireless networks and improving computing process on mobile devices it is expected that multimedia services such as video streaming and video conference session could be performed on wireless environment. However, streaming video on an adhoc network having more constrains than other wireless networks. This is mostly due to error proneness, node mobility, signal interference and infrastructureless factors.

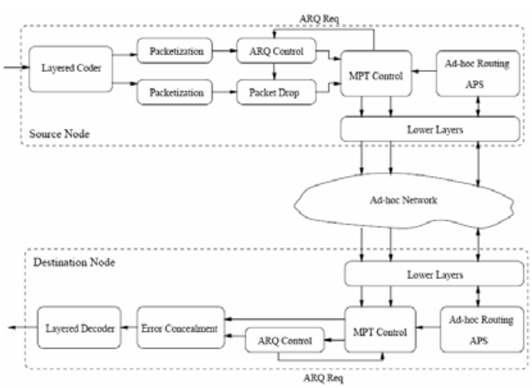

Figure 1. Video over Adhoc Network Architecture [5]

Forward error correction and automatic repeat request are two basic techniques usually employ on wireless network. FEC is however more appropriate for real-time multimedia delivery since it does not need feedback. A research in [5] has proposed the use of these techniques also for adhoc networks. The architecture is shown in Figure 1.

We develop adhoc network testbed with AODV routing algorithm to verify the level of quality of service mobile client perceived when running video video conference session while traversing several adhoc network nodes. The number of nodes involved is varied between two until five.

Parameters of the QoS used for the analysis are throughput, lost packet, delay and jitter. Throughput can be measured with Shannon theory as:

$$\textit{Throughput (bps)} = \textit{Bandwidth (Hz)} \times \log_2 [1+R]$$

Where R is signal power/ noise power (watt)

Delay can be obtained using the following equation:

$$D = \frac{1}{\mu} \times \frac{1}{1-\rho}$$

Where: D = average packet delay (s), μ = average packet processing capacity (packet/s), λ = packet arrival rate (packet/s), ρ = utilization (λ/μ)

Jitter might be counted through the following formula:

$$J = J' + \frac{1}{16}(D - J')$$

Where J = jitter (s), J' = previous jitter (s), and D = inter-packet delay (s).

4. Testbed Development

For the development of testbed and performance measurement we use softwares such as Fedora Core 4 operating system, AODV-UU 0.9.1, GnomeMeeting, and Ethereal and Iperf. GnomeMeeting is used as tool for video conference sessions and Ethereal is used for QoS parameter measurement. User interface of GenomeMeeting is depicted in Figure 2.

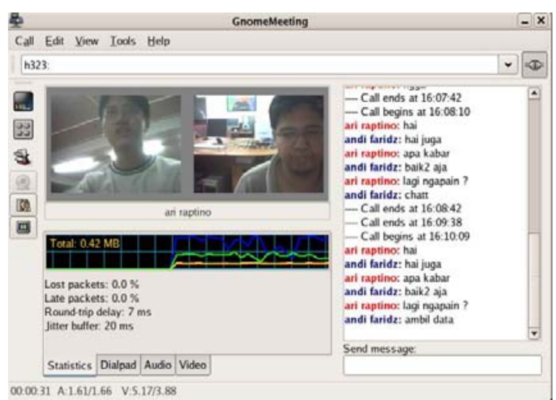

Figure 2. GUI of GnomeMeeting

Iperf is traffic generator application which is used to mimic variety of traffic density in measuring application jitter. A sample of Ethereal interface is shown in Figure 3.

Five scenarios are prepared for performance evaluation. In scenario one two nodes are connected wirelessly, and video conference session takes place between them by means of direct routing. In scenario two we use the same number of nodes but apply AODV routing algorithm instead.

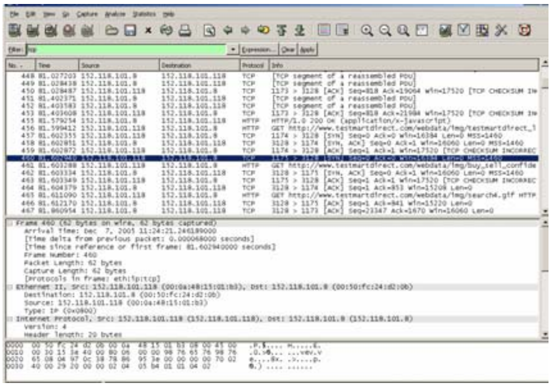

Figure 3. Ethereal Interface

One intermediate node is added in scenario three, and data is delivered through this node. IP tables are used. It is expected that the smooth delivery can be maintained although no direct connection is visible. The third node is added before the session started. The configuration of the three nodes is shown in Table 2.

Table 2. Wireless Configuration

	Node 1	Node 2	Node 3
IP Address	192.168.1.80	192.168.1.97	192.168.1.150
Netmask	255.255.255.0	255.255.255.0	255.255.255.0
Mode	Ad-hoc	Ad-hoc	Ad-hoc
Essid	Adhoc	Adhoc	Adhoc
Rate	11	11	11
Channel	1	1	1

Scalability is verified, starting in scenario four. Similar to the previous scenario three nodes are used. However, the introduction of the third node is performed on–the-fly. At the moment the receiver node moves outside the signal range of the transmitter and the third node comes in the range and becoming new router that connects transmitter and receiver. Handover process is unavoidable and therefore its effect on the QoS can be verified.

In scenario five and six the number of nodes are added and becoming four and five nodes respectively. Scalability aspect of adhoc network to support video conference sessions are in real tests in these two latest scenarios.

5. Results and Discussion

For round trip delay it is shown in Figure 4 that for two adhoc nodes aodv routing performs similarly with adhoc routing. At the moment of handover process the performance getting worse but it is still better than three-node adhoc network. Performance of five-node is six times worse than four-node adhoc networks. This creates question mark on the scalability of adhoce network in termas of round-trip delay, when the number of nodes exceeds four nodes, in particular for video conference applications.

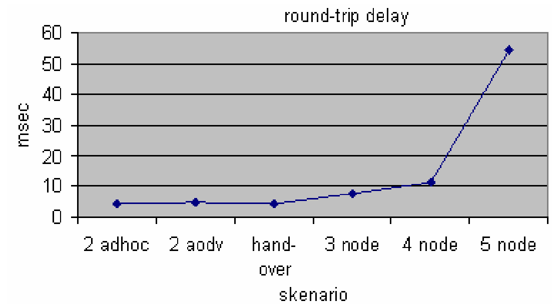

Figure 4. Round-trip Delay Comparison

It is interesting to see that the QoS of the session in terms of packet lost is much worse at the moment of handover process. This fact is shown in Figure 5. It is also obtained that there is no significant differences on the performance of two-node, three-node, four-node and five-node adhoc networks.

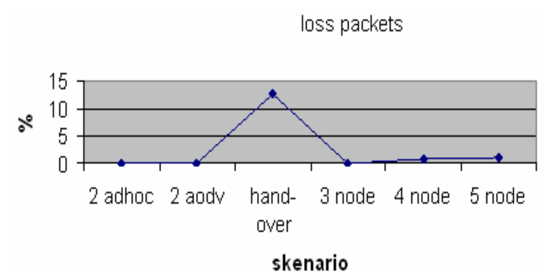

Figure 5. Ethereal Interface

For application jitter, QoS of video conference sessions are under big threat if the number of nodes involved is more than three nodes. This is depicted clearly in Figure 6. At four-nodes adhoc networks jitter reaches around 400 msec.

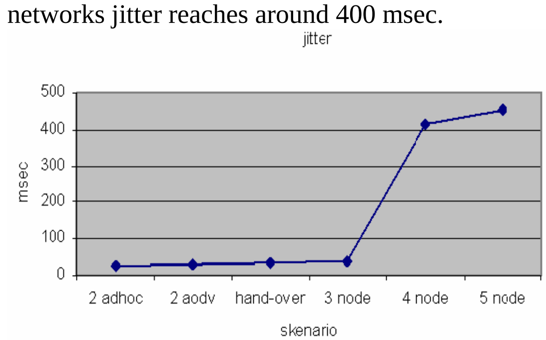

Figure 6. Ethereal Interface

Throughput of each scenario is compared and depicted in Figure 7. As the number of nodes increases the throughput decreases. Handover process gives slight effect on the throughput of the system.

For the first scenario the average data processing results for each of QoS parameters is as follows: throughput 0.150466667 Mbps, delay 0.011527 s, jitter 25.33333 ms and there is no lost of packet. For the second scenario the average QoS values are: throughput 0.13792 Mbps, delay 0.011273333 ms, jitter 38.66667 ms, and the lost of packet is 0.04 %.

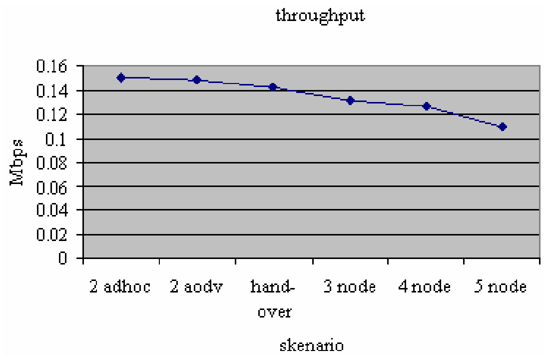

Figure 7. Ethereal Interface

The results for scenario three are: throughput 0.130866667 Mbps, delay 0.012166667 ms, jitter 93.33333 ms, with packet lost 0.02 %. For the latest scenario QoS parameters obtained are: *throughput* 0.141933333 Mbps, *delay* 0.011913333 ms, *jitter* 33.33333 ms, and the percentage of lost of packets is 12.64666667 %

6. Conclusions

The AODV protocol performs satifsfactorily. The QoS parameters such as round-trip delay, percentage of packet lost, jitter, dan throughput are getting worst as the number adhoc nodes increase.

Handover process reduces significantly the QoS of video conference sessions in terms of lost of packets. While for static node the lost of packet is only up to 1% for mobile adhoc networks the lost is up to 12.64%.

Our experiments show that Scalability of adhoc network to support QoS of mobile video conference sessions is maintainable up to three nodes only. Some of QoS paremeters perform fairly at four nodes, but not for jitter. At most the QoS paremeters the performance degrades significantly at the time five nodes involve in the adhoc network.

7. References

[1] Ramli, K., Natalia, Y., Indriati, D., “On Evaluating the Peformance of Multihop Communication on winAODV-based Adhoc Network”, submitted to Journal of Technology, July 2006

[2] Milanovic, Nikola et.al., *Routing and Security in Mobile Ad Hoc Networks*, IEEE computer society, Febuari 2004

[3] AdHoc@Uppsala University Portal of Implementation, core.it.uu.se/AdHoc/ImplementationPortal, last access on 14 Desember 2005

[4] Perkins, Charles E., Royer, Elizabeth M., *Ad-hoc On Demand Distance Vector Routing*, University of California, Santa Barbara, 1998.

[5] Shiwen, M., Shunan L., Shivendra, S. P., Wang, Y., “*Reliable Transmission of Video over Ad-hoc Networks Using Automatic Repeat Request and Multi-path Transport”*, Technical Report, Center for Advanced Technology in Telecommunications, Polytechnic University, NY, USA, 2002