Mobile Learning: A QoS study on Video Conferencing over WiFi/WiMAX network

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Abstract: Mobile learning is the ability to obtain or deliver learning materials on personal pocket electronic devices such as mobile phones, PDAs or tablets. Mobile devices support multimedia elements, such as video conferencing and can be accessed by all learners via WiFi/WiMAX network. In this paper, we evaluate the quality of network traffic when video conferencing is being used by number of mobile devices over Wi-Fi/WiMAX network. A network testbed is designed with the E-Learning portal and PRTG is used to monitor the traffic; i.e. web traffic and multimedia traffic. The experimental result shows that the quality of traffic while using video conferencing in mobile learning is dependant on the number of users, accessing time & duration. It also shows that the technologies used are performing at desired level.

Keywords: Mobile learning, QoS, Video Conferencing, WiFi, WiMAX.

1. Introduction

Mobile learning (M-Learning) is defined as learning across multiple contexts, through social and content interactions, using personal electronic devices which allows users access to educational materials at any location and at any time of their convenience. In this paper, we focus on the quality of services (QoS) in terms of network traffic when video conferencing is being used in M-Learning and implemented in Wi-Fi / WiMAX network.

We examined the network traffic based on real-time data which are delay, jitter, packet loss and Mean Opinion Score (MOS) by using PRTG monitoring tool. The examination involved accessing video conferencing in electronic learning (E-learning) portal via mobile appliances over WiFi/WiMAX network.

This article is structured as follows: Section 2 presents background of this research. Section 3 describes the methodology used in evaluating the applications. Section 4 presents the testing done and the results achieved. Section 5 concludes the paper.

2. Background

1.1. Mobile Learning via WiFi/WiMAX networks

M-learning focuses on the mobility of the learner while interacting with portable technologies which is convenient and virtually accessible anywhere anytime. To share, access and update information, online networks are required, for example, WiFi/WiMAX networks. WiFi is local area wireless technology that allows an electronic device to participate in computer networking while WiMAX is sometimes referred to as "Wi-Fi on steroids" that can be used for a number of applications including broadband connections, cellular backhaul, and hotspots which enable usage at much greater distances. Therefore, an integrated WiFi access point has been used to provide the WiMAX Internet connectivity to multiple devices throughout the home or business network.

2.2 QoS in Video Conferencing

Quality of Service (QoS) refers to a broad collection of networking technologies and techniques which provide guarantees on the ability of a network to deliver predictable result of Internet applications such as VoIP, VoD, video conferencing and other consumer services [1].

The QoS metrics used in this study includes:

1) Delay: time span from the emission of the first bit of a packet at the source to the reception of the last bit of the same packet at the destination;

2) Jitter: end-to-end delay variation;

3) Packet Loss Rate: number of packets incorrectly transmitted in a given transmission;

4) Mean Opinion Score (MOS): a perceived quality numerical indicator of received media after compression or transmission. The value of the worst quality is 1 and the best quality is 5 [2], as shown in Table 1.

All these metrics are used in evaluating the traffic types which are web traffic (HTTP), file transfer (FTP) and multimedia traffic. For multimedia traffic, we evaluate it in two protocols which are Real-time Streaming Protocols (RTSP) that is used to control streaming media server between end points, and Real-time Messaging Protocols (RTMP) that is used for streaming audio, video and data over the Internet, between a flash player and a server. The correlation between these traffics is then analyzed.

Table 1. Mean Opinion Score (MOS) [3]

Quality Scale	Score	Listening Effort Scale
Excellent	5	No effort required
Good	4	No appreciable effort required
Fair	3	Moderate effort required
Poor	2	Considerable effort required
Bad	1	No meaning understood with effort

3. Related works

Saleh Abdallah-Salleh et al. (2011) used Emulator kernel to study on throughput, packet delays, packet loss and jitter during mobile video streaming over WLAN and WiMAX networks. Experimental results show the performance of mobile video streaming in different scenarios depending on the user's movement speeds [4].

Yang Can et al. (2011) studied mobile video/audio streaming system based on HTTP live streaming protocol in web portal cross platform. The system involved server component, distribution component and client software. In this study, by building a streaming system with Time-Shifted function, a new mobile streaming system can support better live broadcast, video on demand and others [5].

Tadafumi Hayakawa et al. (2012) studied on multimedia data management for streaming on a distributed E-Learning System. The system is implemented by Maglog, a Prolog-based agent framework. In this study, by considering on I/O timing division, this new method enabled smooth play of multimedia data [6].

Rubaiyat et al. (2012) studied performance of video streaming over Bluetooth network. The test bed network is concern on QoS, encoding method and packetisation. In this study, the video encoding method has been improved as it was directly related with performance parameters in Bluetooth Network [7].

Jing Chen et al. (2012) studied multi-streaming mobile learning platform via iPhone. The platform contains three stages; multi-streaming protocol, modules and interactive interfaces. In this study, a new platform which is more convenient and flexible has been introduced to supports live lectures and class recording for mobile learners through iPhone devices [8].

In studies [4], [5], [6], [7] and [8], the testing used different simulator, protocols, framework, parameters or mobile devices compared from our experiment. However, these studies are similar to our work in terms of being done on video applications while taking into considerations the QoS metrics, traffic assessment, networks or test bed.

4. Methodology

The integrated WiFi/WiMAX networks and a testbed was developed within the capability of the selected assessment and network provider. The selected assessments are based on traffic, web and multimedia traffic while the chosen network provider is YES 4G. Testbed was developed by using Moodle as website and content management (CMS) to monitor all the protocol used in the web server such as RTMP and HTTP; Figure 1 shows testing environment using YES 4G equipment which support WiFi/WiMAX network capabilities and testing equipment.

Table 2 shows assessment involved in testing environment; traffic assessment, web assessment and multimedia traffic assessment.

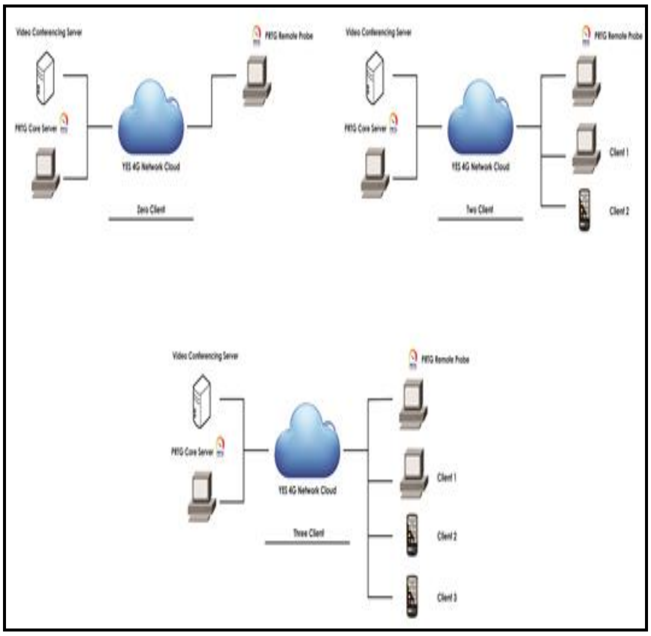

Figure 1. Mobile Learning architecture over WiFi/WiMAX network testing environment

Table 2. Network performance assessment

Assessment	Description
Traffic	• Using web server – side monitoring system • Using selected Passler routing traffic grapher (PRTG) as network monitoring system (NMS) tools • Traffic load simulated for various of activities over a specific time • Each traffic is filtered and captured using related sensor in PRTG
Web	• Using http advanced sensor • Monitors the source code of a web page using Hypertext Transfer Protocol (HTTP). • Captured the loading time and download bandwidth
Multimedia traffic	• Using QoS sensor • Monitors the relevant network parameters by testing network connection quality between two probes • Sends a series of UDP packets from the parent probe to remote probe and measures packet loss, jitter, MOS and packet delay

5. Testing and Result

During testing, the maximum numbers of mobile device users are 3 from which the raw data are collected in 1 hour consistently and all the traffic simulation is tested simultaneously. Figure 2, 3, 4, 5, 6 and 7 shows the related QoS metrics results in every 5 minutes.

Figure 2 and Figure 3 shows, the graph is synchronous with the raw data table for 0 client. The highest jitter time is 10ms and the lowest jitter is 2ms. The average for jitter is 6.41ms. As for delay, the highest delay is 87ms and the lowest delay is 19ms. The average for delay is 55.03ms. For MOS, the result is 4.4 which is fair result while packet loss is 0ms.

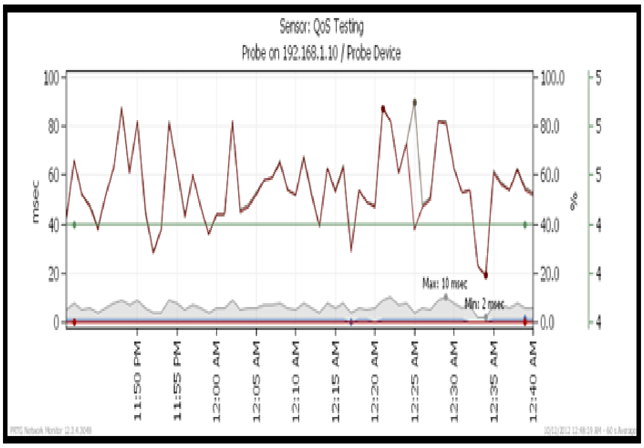

Figure 2. QoS graph for zero client

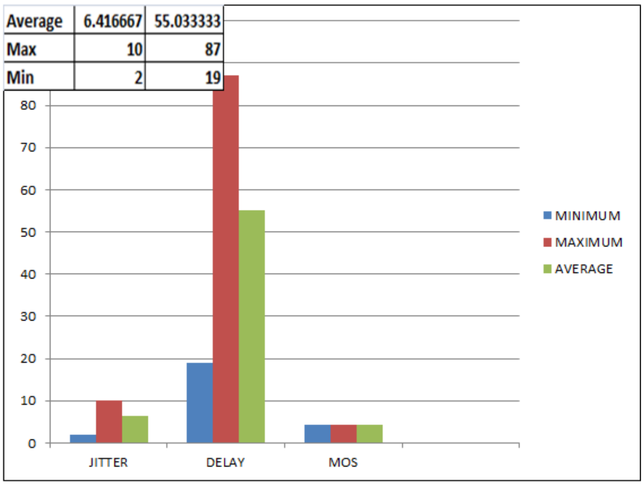

Figure 3. QoS graph summary for zero client

Figure 4 and Figure 5 shows, the graph is synchronous with the raw data table for 2 clients. The highest jitter time is 11ms and the lowest jitter is 4ms. The average for jitter is 6.13ms. As for delay, the highest delay is 89ms and the lowest delay is 29ms. The average for delay is 52.21ms. For MOS, the result is 4.4 while packet lost is 0ms.

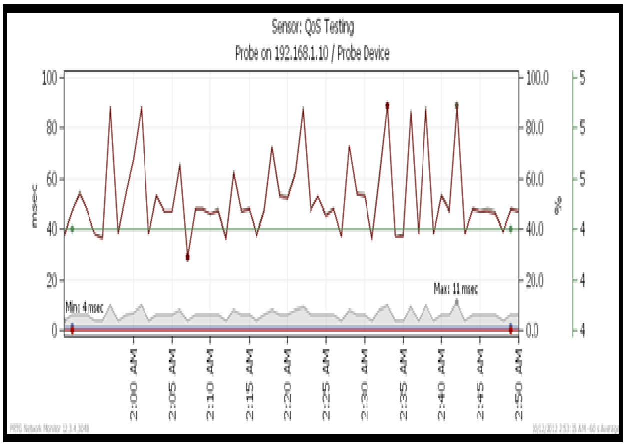

Figure 4. QoS graph for zero client

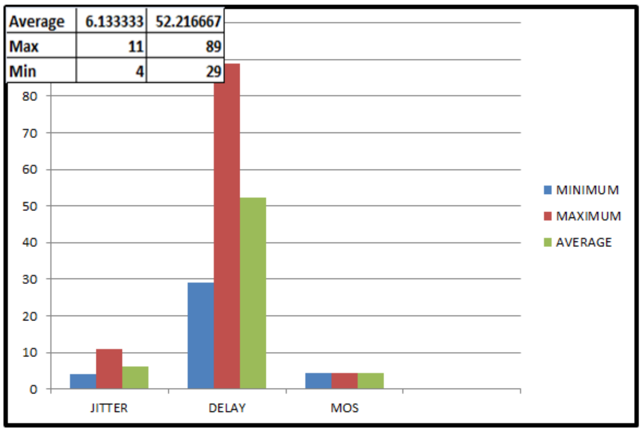

Figure 5. QoS graph summary for zero client

Figure 6 and Figure 7 shows, the graph is synchronous with the raw data table for 3 clients. The highest jitter time is 10ms and the lowest jitter is 4ms. The average for jitter is 6.5ms. As for delay, the highest delay is 87ms and the lowest delay are 28ms. The average for delay is 56.61ms. For MOS the result is 4.4 and packet loss is 0ms.

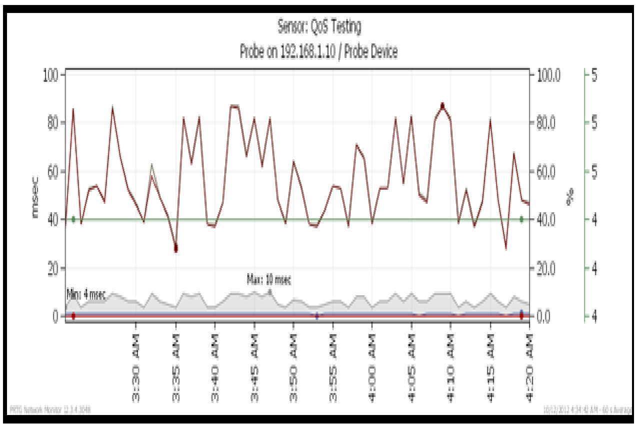

Figure 6. QoS graph for zero client

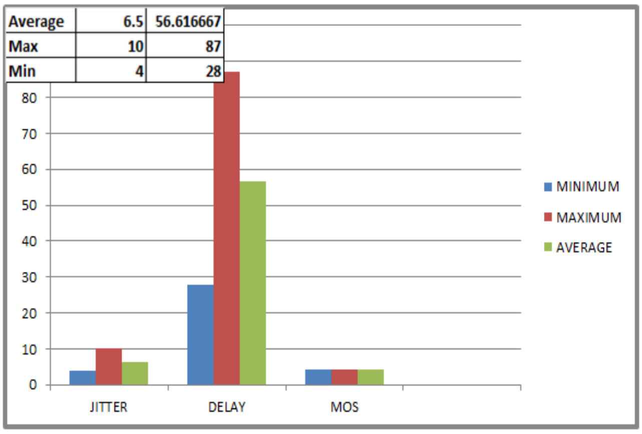

Figure 7. QoS graph summary for zero client

Table 3. Result Summary

No of Client (s) / Attributes	Zero	Two	Three
Average (ms)			
• Jitter	6.41	6.13	6.50
• Delay	55.03	52.22	57.5
• MOS	4.4	4.4	4.4
• Packet Loss	0	0	0
Download Speed (Mbps)			
• Server	7.54	7.89	8.37
• Client	10.12	11.42	10.83
Upload Speed (Mbps)			
• Server	2.52	2.34	2.68
• Client	3.52	2.67	2.63

Table 3 shows, when the number of mobile device users are increased:

- The average value for jitter and delay are larger
- More speed during server download and upload tasks is required
- Speed during client download and upload tasks are decreased
- Good voice & video quality (MOS)\
- No packet loss

However, due to testing hours during zero client session are conducted on different day, the result does shows:

- The average value for jitter and delay are larger
- More speed during server and client upload tasks is required.

From the studies in Section 3, the performance of mobile video applications may also depend on users' movement speeds, HTTP live streaming protocol, I/O timing division, video encoding methods and mobile devices capabilities.

6. Conclusions

In this article, E-Learning Portal had been embedded with video conferencing and used as part of Mobile Learning involving mobile devices. By using PRTG, the effect of traffic assessments in WiFi/WiMAX networks is analyzed. We concluded that based on our findings; HTTP traffic shows average loading time and RTMP traffic shows no packet loss, low in delay and jitter; and higher in MOS with up to 3 users.

Therefore, the study is useful in proving video conferencing can be embedded to enhance the E-Learning and M-learning features. Another line of work that may benefit from this research would be a comparison of the QoS implementations with other wireless network technologies by using different network performance tools, larger number of mobile devices, video applications, testing hours and time.

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