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Intelligent Delivery of Multimedia Content in Mobile Environment

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Abstract: Process of delivering multimedia learning objects such as text, video, images, audio, and animation requires real-time streaming of multimedia content from the M-learning systems to the mobile users. With enhancing the integration methods of the mobile devices into the learning systems, we have possibility to allow easy storing, recording and delivering of multimedia contents to the students in real-time. In this paper, we will present an intelligent mobile learning (M-learning) system for delivery of multimedia content depending of the context-aware conditions. This paper considers the significance of high QoS requirements for applications that are essential to achieve higher continuity of real-time multimedia contents. In this research, we have considered the best queuing packet delivery algorithm to provide appropriate multimedia contents to improve required bandwidth for user's communications.

Keywords: Multimedia Computing, M-learning, Quality of Service, User Profile.

1 Introduction

The existing perspective for mobile learning (M-learning) consists of presenting a lecture or e-books with lot of pages of text and graphics [1], delivered on a very small screen. However, with the introduction of new mobile information technology [2] and pervasive expansion of wireless technology, these conventional techniques will be replaced the brand-new mobile learning [3]. In recent years, mobile learning is a field which combines mobile computing and electronic learning (e-learning) [3], have provided more interactive and personalized instruction based on the learner's context [4] and learner cognitive profile [5]. Content adaptation [6] provides the most suitable applications according to students' computing context [7], referred to devices, network, location, and time, which affect students' mobile access of learning content [3]. In particular, network layer Quality of Service (QoS) parameters, that have huge influence on the bandwidth allocation in the process of multimedia content delivery [8] are lower start up delay and reduced end-to-end delay. M-learning systems deliver an interactive environment [9], through the right tools and support, research given in [10] and [11] show that students can retain significantly more and achieve a greater level of skill and performance. In order to reach higher endurance of multimedia, this creates new challenge in the area of content management and content delivery [12]. The process of continued delivery of multimedia content is highly dependent from efficient communication channels in M-learning systems in order to ease the transfer of multimedia content to the mobile users. In this paper we have researched the use of different queuing packet delivery algorithms that will provide interactive communication and personalized multimedia content for the mobile clients. This paper is organized as follows: Section II presents our proposed intelligent M-learning system architecture. Section III presents the simulation results of delivery of multimedia content in M-learning environment. Finally, Section IV concludes the paper.

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2 Intelligent M-Learning System Architecture

The proposed architecture of intelligent M-learning system is presented in Figure 1. The scenario is consisted of two similar laboratories for M-learning that have wireless access point router and mobile clients. This way all the students using different mobile devices (smart phones, tablets and mobile phones [13]) can easy connect, through the wireless router, to the multimedia streaming server [14].

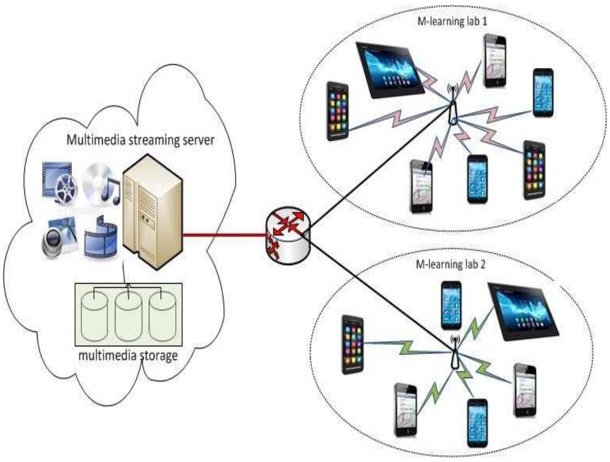

Fig. 1: System architecture of intelligent M-learning system

From the presented architecture we can determine that the bottleneck for multimedia delivery is from the multimedia streaming server to the switch. This happens because of the increased heavy load of multimedia data that needs to be delivered to the two M-learning laboratories in the same time. In order to estimate the bandwidth congestion in the presented architecture we have conducted experiments by modeling the proposed network and defining possible scenarios using software simulation tool. Therefore, the simulation is a brilliant tool for studying performance and identifying the Quality of Service (QoS) factors that have influence on multimedia contents delivery.

3 Simulation Results for Delivery of Multimedia Content in M-Learning Environment

The proposed system architecture of intelligent M-learning system is been developed in the OPNET IT Guru simulator, see Figure 2. Because it provides a comprehensive development environment with a full set of tools including model design, simulation, data collection, data analysis and support on the modeling of communication networks [15]. We have used the Discrete Event Simulation (DES) [16] because it enables modeling in a more accurate and realistic way. It creates an extremely detailed, packet-by-packet model for predicting the activities of the network. Multimedia streaming server (application configuration) is configured for streaming real-time audio, video and multimedia data [22](text or images), similar like in the real M-learning systems [18]. Existing research have discovered the Interaction is one of the most significant factors in assessing the quality of e-learning [9]. In order to simulate the M-learning laboratory we have configured two subnets that contain wireless access router and 9 to 5 mobile clients. The requests for multimedia content are streamed from the Multimedia streaming server to the mobile clients in the M-learning laboratory 1 or 2. Mobile clients using the profile configuration have been settled to three different cognitive learning skills: visualizer, verbalizer and bimodal users [19]. This way every mobile user depending of his cognitive learning style can receive appropriate multimedia content [20].

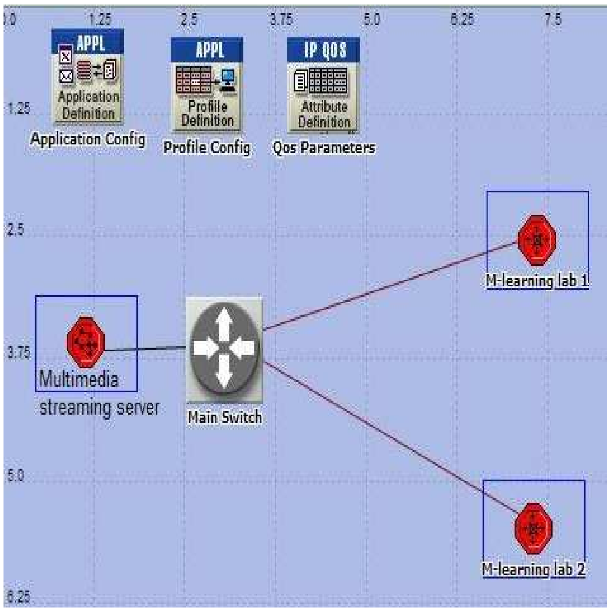

Fig. 2: Simulation of the intelligent M-learning system

From our preliminary simulations we have noticed that the bottleneck for multimedia delivery from multimedia streaming server is the communication link from the server to the switch. For that purpose we have established QoS parameters for the bottleneck link in order to improve the multimedia delivery. Depending of the used QoS queuing packet delivery algorithm we have formulated three different simulation scenarios. The first scenario is using First In First Out (FIFO) packet queuing algorithm [21] for the bottleneck link between the multimedia streaming server and the switch. The second scenario is using Priority Queuing (PQ) algorithm [22] to determine the delivery of multimedia packets. Finally, the third scenario is using the Weighted-Fair Queuing (WFQ) [23] algorithm for transferring of multimedia packets. The network simulator was configured to run one hour of multimedia content in the established M-learning system for the three different scenarios (FIFO, PQ and WFQ algorithms). The blue line represents the results from the FIFO packet queuing algorithm simulation, the red line represents the results from the PQ packet queuing algorithm simulation and the green line gives the results from WFQ packet queuing algorithm simulation. Analyzing the Wireless Local Area Network (WLAN) delay from the M-learning system in the three different scenarios, see Figure 3, we conclude that the FIFO packet queuing algorithm is generating the biggest delay. On the other side, the scenario with PQ packet queuing algorithm improves WLAN delay with 25% of total delay in comparison to the FIFO packet queuing algorithm. The lowest WLAN delay of 29% is accomplished with the scenario WFQ packet queuing algorithm in the M-learning system.

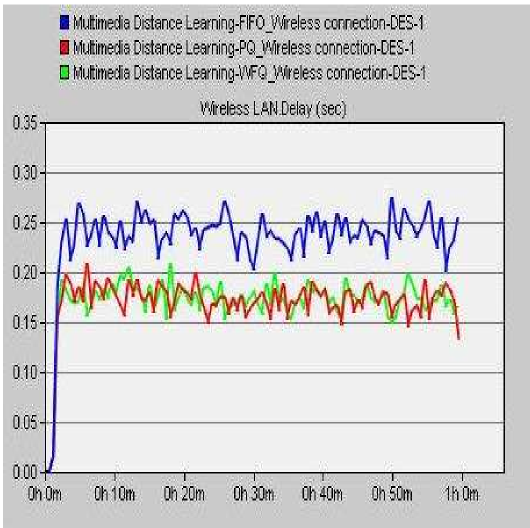

Fig. 3: Results from WLAN delay

The results from the Voice traffic QoS parameter, average packet delay, for the three different scenarios are shown in Figure 4. Considering the verbalizer cognitive perception, in the process of voice delivery we have discovered that the lowest average delay is in the scenario that uses WFQ packet queuing algorithm. By comparison of the WFQ scenario with the FIFO scenario, it enhances 37, 5% of the voice average packet delay. Nonetheless, the PQ packet queuing algorithm has shown also an enhancement of 31.25% in voice average packet delay compared with FIFO scenario. The results from the Video

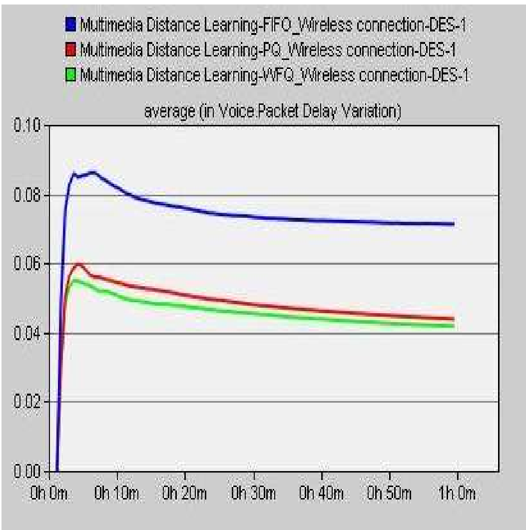

Fig. 4: Results from voice average packet delay

traffic QoS parameter, end-to-end average packet delay, for the three different scenarios are shown in Figure 5. The visualizer cognitive perception given by the video delivery has shown lowest average delay in the both of scenarios the PQ and the WFQ packet queuing algorithm.

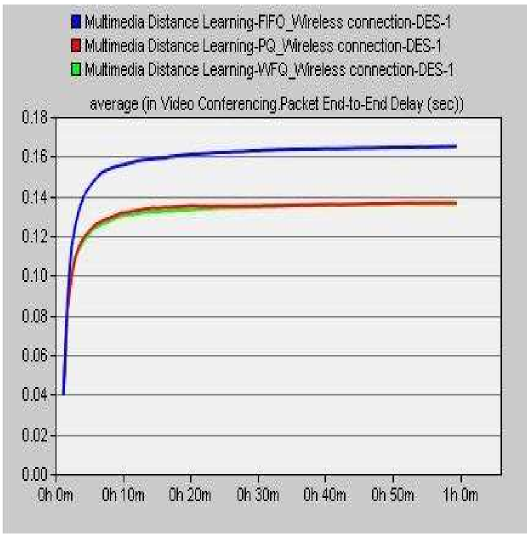

Fig. 5: Results from Video end-to-end average packet delay simulator

In conclusion we can see that almost the results are achieved for the both of scenarios the PQ and the WFQ packet queuing algorithm. While the FIFO algorithm for packet delivery that represents standard communication network has shown the poorest results for all of the monitored QoS parameters. Therefore, we can determine that the M-learning environment that is consisted with the existence of priority and weighted-fair queuing in the communication link have provided improved delivery of multimedia traffic.

4 Conclusion and Future Work

In conclusion the PQ and the WFQ packet queuing algorithm scenarios have shown decreased delay that has led to improved collaborative response to the mobile clients. Eventually, this means efficient and increased learner perception and satisfaction from the M-learning system that will provide better quality of learning. Priority packet queuing delivery algorithm utilizes scalable video/voice to provide a graceful degradation of the multimedia content in case of bandwidth shortages. The results from this research can be focused on further promotion of potential for m-learning using the cloud computing for training students in the universities [24], [25].

Appendix A

A review of distributed Queue algorithm analysis presented by (Kobliakov et al.) in [26] appears below. We use the results presented by (Kobliakov et al.) in [26] for simulation and evaluation of intelligent delivery of multimedia content in M-learning environment. Let suppose that M-learning system has infinite queue of packets intervals sets that have autonomous similar distributed random variables. The proposed system is modeled with stable queue that has the following condition assigned:

$$\Lambda < \lambda \tag{1}$$

where Λ is the queue mean number of received packets in the interval through the M-learning system, in the duration $1/\mu$. The transmission rate was calculated as maximal value of λ, the λ max, by means of determining under which inequity (1) holds. Let the bottleneck interval is spitted into S and N slots during the operation of system. During the frame either one or none sets may arrive into the distributed queue, thus the arrival of one set is

$$\Lambda = P_r\{set\} = 1e^{-\lambda} - \lambda e^{-\lambda} + q_0 e^{-\lambda} + q_1 e^{-\lambda} \tag{2}$$

Let

$$T(x) = \sum_{k=2}^{\infty} T_k \frac{x^k}{k!} e^{-x} + T_0 e^{-x} q_0 + T_1 x e^{-x} q_1 \tag{3}$$

Where T_k is the mean number of frames needed to serve collision set consisting of$k(kgeq0)$ requests. It can be shown, that $\psi = 1/\mu$ can be computed in the following way

$$\psi = \frac{T(\lambda)}{1 - e^{-\lambda} - \lambda e^{-\lambda} + q_0 e^{-\lambda} + q_1 \lambda e^{-\lambda}} \tag{4}$$

From equations (1) - (4) we determine, that proposed queuing system is constant to deliver for such values of λ, as long as this inequity stands

$$T(\lambda) < 1 \tag{5}$$

Considering the equations (1) - (5), the transmission rate R is calculated as $R(S,N) = \lambda_{max}(S+N)$, where λ_{max} is the maximal λ under which the following holds

$$T(\frac{\lambda}{S}) < \frac{N}{2S} \tag{6}$$

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