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Simulated performance of TCP, SCTP, DCCP and UDP protocols over 4G network

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Abstract

Forth Generation (4G) network support for wide geographical locations proves its use as a more advanced wireless technology. The Long-Term Evolution (LTE) is a 4G mobile communications standard set by International Communication Union (ITU), specifically ITU Radio communication Sector (ITU-R). At the moment, video traffic and telecommunications grow under the expansion of LTE, which is considered as the actual motivating access technology of 4G network. Throughout the deployment of LTE, various transport protocols are advised and broadly experimented, for instance, TCP, SCTP, DCCP and UDP that may execute differently on 4G networks subject to the network scenarios and parameter settings. Even though the deployment of LTE is swiftly enhanced, there is a lack of performance evaluation of its protocols. Hence, a widespread scrutiny is required for the evaluation of the operation of numerous protocols for high-end applications such as multimedia. Adopting these applications with flexible quality of service constraints with improved usage of resources is a challenging task. In this paper, the output results of different transport protocols for multimedia streaming applications, e.g., video, through extensive simulations are analyzed. The performance of an MPEG-4 video streaming is evaluated using NS-3. The performance metrics used are delay, jitter, throughput, and packet loss. These metrics are evaluated at the base station via TCP, SCTP, DCCP and UDP protocols over the 4G-LTE technology. The obtained results show that the DCCP performs the best in throughput improvement with the minimization of delay and jitter as compared to UDP, TCP, and SCTP.

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Keywords: 4G; LTE; TCP; SCTP; DCCP; UDP; MPEG4; NS-3.

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1. Introduction

Wireless communication networks are becoming a common service because of its flexibility in access and utilization for offering high transmission rate every time and everywhere[1]. These kinds of networks have been designed from an expensive technology for limited selected individuals of the existing ubiquitous systems, which are used by a huge number of masses in the world. Wireless technology may be divided into four different generations, that is, First Generation (1G), which was the analog radio systems; Second Generation (2G), which was the earliest digital wireless system; Third Generation (3G), which was the foremost wireless system that provides broadband communication; Fourth Generation (4G) famous for Long-Term Evolution (LTE)[2,3].

As a result in the development of wireless communications, the network traffic is being increased, particularly with the increase in the number of network nodes. LTE delivers higher transmission rate and meets the growing demands for multimedia transmission[4]. In the current era of telecommunications, video traffic is growing rapidly and simultaneously with the advancement of LTE, which is famous for the true fundamental access technology of 4G networks[5]. During the deployment of LTE, four protocols of the transport layer are the most encouraged and broadly reviewed, named Transmission Control Protocol (TCP)[6], Stream Control Transmission Protocol (SCTP)[7], Datagram Congestion Control Protocol (DCCP)[8] and User Datagram Protocol (UDP)[9]. The transmission rate is considerably motivated by the performance of the transport protocols, which is used in the scenarios of wireless networking[4].

While the implementation of LTE is promptly paced, there is a lack of performance evaluation of its protocols. Therefore, a broad assessment is indispensable for the performance evaluation of several protocol suits for high end applications such as multimedia and so on. The challenging behaviors of the three mentioned transport protocols for the transmission of multimedia applications need emphasizing the positive and negative aspects of their performances[7]. The present comparison reports do not reflect the performance of TCP, SCTP, DCCP and UDP protocols for the transportation of videos under the LTE access networks. The best transport protocol for the transmission of video data is even not illustrated due to the conflicted inferences. So, presenting an important investigation of the performance of the mentioned protocols for the LTE environment may help researchers and academicians in selecting the accurate protocol for the transmission of video applications.

In this study, the transport layer protocols that are used for video streaming are analyzed. Furthermore, through simulation results, performed in NS-3, the strength and weaknesses of TCP, SCTP, DCCP and UDP are presented that may give the idea of selecting the best protocols for the LTE environment. In addition, this performance evaluation can also provide base which protocol can be better for which metrics among the four, i.e., end to end delay, throughput, packet loss, and avarge jitter.

2. Previous works

Currently, a variety of the multimedia applications are using TCP, SCTP, DCCP and UDP as primitive transport layer protocols. In the existing available research, various studying works cope with their protocols under different network environments. However, the current works do not enfold their presentation in the environment of LTE, despite its essential principle in accelerating video traffic in the current telecommunication. The functioning of these protocols is a significant portion to be calculated in the assessment of any kind of network environments.

Nor *et al*., studied the performances of standards and TCP in coexistence with the DCCP over short and long delay link network. In their study the topology for simulation has six network nodes. While the evaluating results have four metrics, namely, jitter, delay, throughput, and packet loss. The results in their paper showed that packet pacing improves the TCP flow if it comes to jitter and bandwidth for long delay links, whereas the performance of standard TCP flow performs quite good with the paced TCP flow for short delay links. Moreover, they have also presented that the TCP pacing is merely appropriate for implementing on a network link with long propagation delay[10].

In the simulation results of Hofmann et al.[11], the performance testing of UDP and TCP over voice in a static wireless multi-hop network is investigated through extensive simulations. Measurements are done in a network containing eight nodes while the IEEE 802.11b standard is used as an interface in a ring topology. The outcome of packet size, hop count, and collision avoidance mechanisms are studied.