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Impact of Frame Duration and Modulation Coding Schemes With WiMAX Bandwidth Asymmetry in Transmission Control Protocol Variants

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ABSTRACT

WiMAX stands for Worldwide Interoperability for Microwave Access which is based on IEEE 802.16 specification and is considered as de facto standard for the broadband wireless data transfer over the internet. The different values of various WiMAX parameters for different TCP variants may affect the performance of the network. This article compares the performance of different TCP variants with bandwidth asymmetry, frame duration, and modulation coding schemes, along with the operating parameter namely number of wireless nodes. During the simulation study the performance was evaluated only for one-way data transfer. The finding suggests that the TCP New Reno performed better than other variants included in the simulation study for the comparison. The performance was measured on the basis of throughput, goodput and packets dropped.

KEYWORDS

Frame Duration, Medium Access Control (MAC), Modulation Coding Schemes, Transmission Control Protocol (TCP), Worldwide Interoperability for Microwave Access (WiMAX)

INTRODUCTION

WiMAX is based on IEEE 802.16 standard and employ Wireless Orthogonal Frequency Division Multiplexing (OFDM) technology that provides high throughput broadband connection over long distance. WiMAX network is an intelligent and agile communication system, capable of providing spectrally efficient and flexible data rate access. WiMAX technology provides high data rate and supports transmission control protocol for end-to-end delivery (Sharma et al., 2011). TCP Vegas is an extension of TCP variant Reno and is used often in research laboratories. It has been implemented in the Linux kernel, FreeBSD and other operating systems and reduces queuing and packet loss. In this paper, the performance of TCP variants has been evaluated under the bandwidth asymmetry with MAC and physical layer parameters along with the number of wireless nodes.

TCP relies on the timely arrival of acknowledgements (ACKs) to increase its congestion window and data sending rate. In normal network an ACK is duly received for packets sent and

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this helps increasing data sending rate at sender. The congestion is generally indicated by packet loss and TCP immediately decreases its congestion window, and again transmits the lost packets. The retransmission may aggravate the congestion. There are generally two ways to indicate the congestion or packet loss, the expiry of retransmission timer and Receipt of three or more duplicate acknowledgments.

In case of imperfect acknowledgement channel, the acknowledgement clocking is disrupted, that means the packets sent are not duly acknowledged. Consequently, the sender timer expires which TCP interprets as congestion and the congestion window plummets and the packets are retransmitted, even though these packets may have correctly reached to the receiver. This implies that the TCP throughput and goodput not only depend on the characteristics of the data sending channel, but also on the reverse channel used by ACKs (IEEE 802.16 Working Group, 2004).

Simulation studies performed by others on performance analysis of five TCP variants, namely TCP New Reno, Vegas, Veno, Westwood and BIC in WiMAX (and WLANs) networks, under the conditions of correlated wireless errors, asymmetric end-to-end capabilities and link congestion. The main purpose of evaluation is how the above conditions would affect the TCP congestion control and suggest the best schemes to be employed in WiMAX networks (Tsiknas & Stamatelos, 2012).

TCP Vegas implementation is a modification of Reno. This variant suggests an algorithm to resolve the problem of coarse grain timeouts which checks for timeouts in an effective and efficient manner. It also overcomes the problem of enough duplicate acknowledgements required to detect a packet loss and suggests a modified slow start algorithm which prevents the congestion of the network. It detects congestion even before the packet losses occur. However, it also retains the other mechanism of Reno and Tahoe, and a packet loss by the coarse grain timeout can also be detected even if all other mechanisms fail (Bandhu, & Vishwakarma, 2016).

THE THREE MAJOR CHANGES INDUCED BY VEGAS (BANDHU, & VISHWAKARMA, 2016)

New Retransmission Mechanism

Vegas extended the retransmission mechanism proposed by Reno. Vegas model keeps a track of all the segments sent. At the same time, it also keeps a record of time taken for the acknowledgement to receive and this is used in calculating an estimate of the RTT. Whenever a duplicate acknowledgement is received it is checked for retransmission. If the current segment transmission time is greater than estimated RTT then the segment is immediately retransmitting without waiting for three duplicate acknowledgements or coarse timeout. Thus, Vegas model gives the solution of the problem faced by Reno of not being able to detect lost packets when it had a small window and it didn’t receive enough duplicate ACKs. Vegas model also detects multiple packet losses and overcomes Reno’s shortcoming by reducing the congestion window multiple times.

Congestion Avoidance

TCP Vegas behaves differently during congestion avoidance from all other implementations. It does not use the loss of segment to signal the congestion rather it determines congestion by looking at the large queues at the router which gets build up due to decrease in sending rate compared to expected rate. Thus, whenever the calculated rate deviates too far from the expected rate transmission is increased to make use of the available bandwidth efficiently. And whenever the calculated rate comes too close to the expected rate the transmission is decreased to prevent over saturation of the bandwidth. Thus, Vegas deals with congestion quite effectively and doesn’t waste bandwidth which is a problem of other algorithms.

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