A Qos Oriented Congestion Control and Load Balancing Algorithms Under Various Mobility Conditions Over Wimax

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ABSTRACT
WiMAX is a wireless broadband solution that offers a rich set of features with lots of pliable in terms of deployment options and potential service offerings. Its main goal is to give good quality with cost effectiveness. WiMAX networks promise to offer relatively low- cost solution for the wireless broadband access. Current operating conditions, WiMAX will possible support traffic belonging to a range of broadband applications, and it claimed to give different among heterogeneous demanding flows. But Delivering QoS is more challenging for mobile broadband than for fixed. As TCP designed for wired networks, it looks at that all packet loss in the network is due to congestion. Wireless medium, uncovered all transmission errors and abruptly topological changes. So in this thesis work, we look into the effects of subscriber's mean speed on the performance characteristics of five representative TCP schemes, namely TCP-LP, TCP-Veno, Westwood, Compound and Cubic, in the WiMAX network environment, under the conditions of correlated lossy links, route failures and network congestion using ns2.

Keywords
QoS, WiMAX, TCP.

1. INTRODUCTION
WiMAX is basically a next-generation wireless technology that upgrade broadband wireless access. WiMAX, similar Wi-Fi, uses unregulated radio frequency spectrum, but not like Wi-Fi, it does not need line of sight and is not limited so clients are on per access point. WiMAX can distribute ultra-fast Internet access cover many miles. WiMAX is mainly built around broadband data, and not voice, where 3G is mainly built around voice, with support and keep up data services. WiMAX could prove disorderly to wireless carriers. WiMAX is also accepted to solve the problems of rural connectivity, as it is suitable for remote places that don't have a fixed infrastructure of power lines or telephone poles. WiMAX offers both better range and download speeds. It is a telecommunications protocol that gives fixed and mobile Internet access. Although initial WiMAX deployments are likely to be for well-fixed applications, the full potential of WiMAX will be realized only when used for innovative nomadic and mobile broadband applications. WiMAX comes in two varieties, fixed wireless and mobile. The fixed wireless version, known as IEEE 802.16d (2004), was designed to be a replacement or enhancement for broadband cable access or DSL. A lately ratified version, IEEE 802.16e (2005), also can support fixed wireless applications, but it allows for roaming among base stations as well.Thus, the two standards are usually known as Fixed WiMAX and Mobile WiMAX. WiMAX is produced to run in licensed bands of spectrum. Some of the most important features that deserve highlighting are as follows OFDM-based physical **layer**: The WiMax physical layer (PHY) is based on orthogonal frequency division multiplexing, an idea that suggests good resistance to multipath, and allows WiMax to run in NLOS conditions.

1.1 Scalable Bandwidth and Data Rate Support:
WiMax has a scalable physical-layer architecture that allows for the data rate to scale quick and easy with usable channel bandwidth. This scalability is supported in the OFDMA mode, where the FFT standard Fast Fourier transform size may be scaled based on the presented channel bandwidth.

1.2 Adaptive Modulation and Coding (AMC):
WiMax support number of modulation and forward error correction (FEC) coding schemes and allows the scheme to be changed on a per user and per frames, based on simply channel conditions. AMC is a successful mechanism to maximize throughput in a given time-changeable channel.

1.3 Quality-of-Service Support:
The WiMax MAC layer has a connection-oriented architecture that is designed to support a range of applications, including voice and multimedia services. The system offers support for constant bit rate, variable bit rate, real-time and non-real-time traffic flows.

1.4 Link-Layer Retransmissions:
WiMax has always supported automatic retransmission requests (ARQ) at the link layer. ARQ-enabled connections require on every transmitted packet to be acknowledged by the receiver; unacknowledged packets are pretending to be lost and are retransmitted. WiMax also optionally supports hybrid-ARQ, which is an effective hybrid between FEC and ARQ.

1.5 Support for Mobility:
The mobile WiMax variant of the system has mechanisms to support, secure, seamless handovers for delay-tolerant full-mobility applications, such as VoIP. The system also has construct-in support for power-saving mechanisms that extend the battery life of handheld subscriber devices.

2. WiMAX ARCHITECTURE
The mobile WiMAX user to user network architecture is based on an All-Internet Protocol (IP) platform and all packet technology. The end-to-end architecture makes the maximum possible use of the IETF, IEEE standards and protocols along with the adoption of commonly available standard equipment.

The open IP architecture provides network operators with high flexibility when selecting the solutions that work with legacy networks or that use the most advanced technologies, and in determining what functionality they want their network to support. The architecture gives permission modularity and flexibility to accommodate a wide range of deployment options such as small scale to large scale, urban, suburban and rural coverage, mesh topologies, flat, hierarchical and their variant and finally, coexistence of fixed, nomadic portable and mobile usage models. WiMAX forum includes the following:

- Handover.
- Authentication from side to side the proxy authentication, authorization, and accounting (AAA) Server.
- Radio resource management.
- Interoperability with different ASN's.
- Relay of functionality between CSN and different mobile station (MS),e.g. IP address allocation Base station (BS)

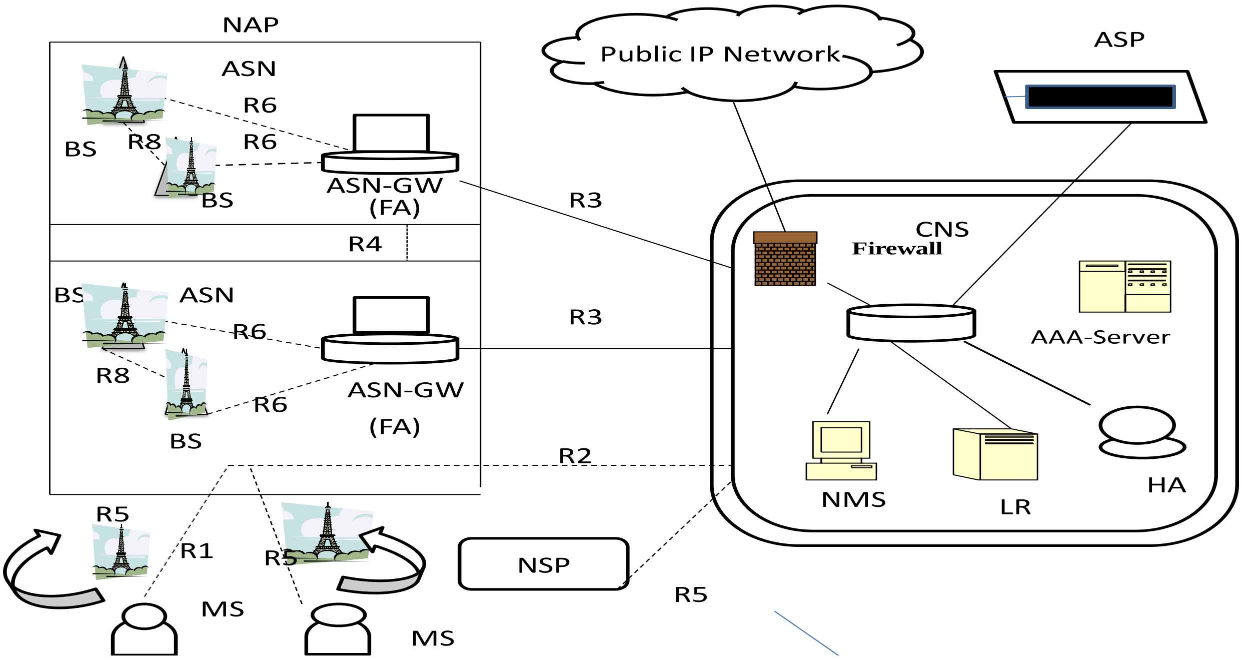

Figure 1. WiMAX Network Architecture

3. TRANSMISSION CONTROL PROTOCOL

TCP is the protocol that supports approximately all Internet applications. TCP is used by a large number of IP applications, such as email, Web services, and TELNET. TCP is a connection-oriented protocol, TCP ensures that data is transferred certainly from a source to a destination. For TCP, an adaptive retransmission mechanism is employed to accommodate the unreliable delays encountered in the Internet environment. The timeout parameter is arranged accordingly by monitoring the delay experienced on each and every connection. TCP also responsible for maintaining network buffer overflows. Since TCP is transparent to the intermediate mobile nodes, the sender has to not directly figure out network buffer overflows by keeping a timer that estimates the round-trip time (RTT) for TCP segments. If it does not receive an ACK packet before its time finish, a sender will assume that the packet was lost or misplace owing to network congestion and will resend the packet. The Concept of TCP sliding window mechanism allows the sender to send multiple segments before waiting for an acknowledgement (ACK). The window size

defines the number of packets the sender can send before it receives an acknowledgement ACK back. The window evenly slides open when wider acknowledgement (ACKs) is successfully returned and also keeping track of which segments sent are ACK ed and which are not.

3.1 TCP Congestion Control

TCP maintains network congestion. TCP maintains two variables that are a congestion window and a slow-start threshold. The congestion window decides the number of segments that is transmitted within an RTT. At the start of a TCP session, the congestion window is set to 1, and the transmitter sends only one segment and waits for an acknowledgment (ACK). When an ACK is received, the congestion window is doubled, and two segments are sent at a time. This process of doubling the congestion window continues to await it reaches the maximum indicated by the advertised window size or until the sender fails to get an acknowledgment before the timer finished. At this point, TCP verifies that the network is congested and start the recovery process by dropping the congestion window back to one segment. Resetting the congestion window to one segment allows the system to clear all packets in transit.

3.2 Versions of TCP

TCP's primary purpose to provide a connection oriented reliable data transfer service between different applications to be able to give these services on top of an unreliable communication system. TCP needs to look at data transfer, reliability, flow control, multiplexing, TCP segment, and congestion control and connection management. TCP versions are mostly based on the properties of wired networks. However, TCP congestion control algorithms may not perform excellent in different networks. The TCP protocol has been extensively tuned to give excellent performance at the transport layer in the conventional wired network environment. However, TCP in its present form is not well suited for ad hoc networks where the packet loss due to collapse routes can result in the counterproductive invocation of TCP's congestion control mechanisms.

3.2.1 TCP-Veno

TCP Veno is a combination of TCP Vegas and TCP Reno, which attempts to use the RTT-monitoring ideas of TCP Vegas while at the same time unexpended about as "Bellligerent" as TCP Reno in using queue capacity. TCP Veno has generally been represented as an option to address of TCP's lessee-link problem, rather than the high-bandwidth problem situation per se. A TCP Veno sender estimates the number M of packets possible in the bottleneck queue as M_{queue} = cwnd - BWE×RTT, like TCP Vegas. TCP Veno then change the TCP Reno congestion-avoidance rule as follows, where the parameter β, representing the queue-utilization value at which TCP Veno slows down and might be around.

$$If\ M_{queue} < \beta, cwnd = cwnd + 1\ each\ RTT$$

$$If\ M_{queue}\ \geq \beta, cwnd = cwnd + 0.5\ each\ RTT$$

The above scenario makes cwnd growth less aggressive once link diffusion is reached, but does remain to increase the cwnd until the queue is full and congestive losses occur. When a packet loss does occur, TCP Veno uses its current value of M_{queue} to attempt to distinguish between non-congestive and congestive loss, as follows:

$If\ M_{queue} < \beta,$ the loss is probably not due to congestion; set $cwnd = (4/5)^*$

$If\ M_{queue} < \beta,$ the loss phase probably been due to congestion; set $cwnd = (1/2)^*$ cwnd as usual.

In this idea the router queues have a total capacity greater than β, and loss with less than β likely does not represent a queue overflow.

3.2.2 TCP-Westwood

TCP Westwood creates no attempt to correct the problems of non-congestion packet loss in wireless networks like Veno, but rather to improve the efficiency of TCP in all different networks. It appraisals the network's bandwidth by correctly low-pass filtering and averaging the rate of returning acknowledgment packets per RTT. It then uses this bandwidth appraisals to adjust the ssthresh and the cwnd to a value close to it when a packet loss is experienced (adaptive decrease). In particular, when three DUPACKs are received, both the cwnd and ssthresh are set identical to the Estimated Bandwidth (BWE) times the minimum measured RTT (RTTmin); when a coarse timeout expires, the ssthresh is set as before, while the cwnd is set equivalent to one. The improvement of Westwood is a more realistic bandwidth estimation in comparison to TCP Vegas, which significantly increases TCP throughput over wireless links. TCP Westwood has also been checked in against handovers in simulated.

3.2.3 TCP-Compound

The key scheme is that if the link is under-utilized, the high-speed protocol should be forceful in increasing the sending rate to obtain available bandwidth more quickly. However the link is fully utilized, being forcefully is no longer good, as it will only cause problems like TCP unfairness. With the increase of the sending rate, queue is created at the bottleneck, and the delay-based flow continuously reduces its sending rate. The aggregated throughput for the communication also continuously reduces but is bound by the standard TCP flow. Compound TCP (CTCP), which desegregate a scalable delay-based element in the standard TCP congestion avoidance algorithm. This scalable delay-based element has a rapid window increase rule when the network is sensed to be under-utilized and gracefully decrease the sending rate once the bottleneck queue is created. With this delay-based component as an auto-tuning knob, Compound TCP can satisfy all three requirements:

a) CTCP can easily use the network resource and get high link utilization.

b) CTCP has similar or even enhanced RTT fairness compared to regular TCP. This is due to the delay-based component working on the CTCP congestion avoidance algorithm. It is known that delay-based flow.

c) CTCP has good TCP-fairness. By employing the delay based component, CTCP can lithely reduce the sending rate when the link is fully utilized. CTCP flow will not make more self-induced packet losses than a standard TCP flow, and therefore maintains and manage the fairness to other competing regular TCP flow.

3.2.4 TCP-Cubic

CUBIC is an advance version of BIC: it simplifies the BIC window control and enhances its TCP-friendliness and RTT-fairness. The window growth, function of CUBIC has been controlled by a cubic function in terms of the beyond time since the last loss event. TCP-cubic function gives a good stability and scalability. Furthermore, the real-time nature of this transport protocol keeps the window growth rate independent of RTT, which control the protocol TCP friendly under both short and long RTT paths.

4. RELATED WORK

Tuan Anh Le, Choong Seon Hong, and Eui-Nam Huh [1], the authors we propose an extended version of regular TCP Westwood for multiple -paths over wireless networks, called Multipath TCP Westwood (MPTCP) TCP Westwood (TCPW) uses the available bandwidth estimation technique to improve TCP performance in such environment. The performance regular TCP is very poor in wireless networks, where packet loss often is caused by frequent error rather than by network congestion as in wired networks. TCP Westwood (TCPW) uses the available bandwidth estimation technique to improve TCP performance in such environment. MPTCPW congestion control is designed as a coordinated control between paths which allows load-balancing feature between paths, fair sharing to regular TCPW at the bottleneck. The authors also conclude that MPTCPW can achieve stability, higher throughput compared with MPTCP, fairness to regular TCPW, and greater load-balancing than uncoordinated MPTCPW under various network conditions.

C. Chiang et al. [2], propose an Adaptive Split Ratio (ASR) scheme which adjusts the bandwidth ratio between DL and UL adaptively according to the current traffic profile, transport layer parameters and wireless interference so as to maximize the aggregate throughput of TCP based traffic. The authors study adaptive channel split ratio of uplink to downlink capacities in TDD-based IEEE 802.16 (WiMAX) wireless networks. ASR can also cooperate with the BS scheduler to throttle the TCP source when acknowledgements are transmitted infrequently, thus precluding either direction from becoming the bottleneck. The simulation results show that our adaptive scheme outperforms static allocations in terms of higher aggregate throughput and better Adaptivity to network dynamics.

L. Subedi et al. [3], compare the performance of various TCP algorithms in wireless and wired networks. Simulation results indicated that in wireless networks with signal attenuation, fading,withering and multipath, TCP Reno outperforms other congestion control algorithms in terms of congestion window size and file download response time. TCP Reno has larger congestion window size, shorter file download response time, and higher throughput than the remaining three TCP algorithms. These three networks are TCP Reno with SACK has the best overall performance.

F. Furqan Doan et al. [4], propose a mechanism, namely WiMAX Fair Intelligent Congestion Control (WFICC) to avoid congestion at the base station. WFICC assures that the traffic is scheduled in such a way that the base station output buffer operates on a target operating point, without violating the QoS requirements of connections. A detailed simulation study is performed in ns-2 to evaluate the effectiveness of the proposed algorithm to meet the QoS requirements of different Class of Services (CoSs). The results have shown that the offered WFICC algorithm enables the base station to avoid congestion and ensures the provision of QoS of different Class of Services (CoSs) in terms of throughput, fairness and packet delay.

M. Mathis, et al. [5], developed a Forward Acknowledgment (FACK) congestion control algorithm which addresses many of the performance problems recently observed in the Internet. In this paper, the authors have discovered that both FACK and SACK provide major performance improvements over existing Reno implementations, due primarily to the avoidance of retransmission timeouts. Reno users will perceive SACK implementations as having a significant advantage. This will provide incentive for the rapid widespread deployment of SACK in the Internet. The FACK algorithm has several benefits over Reno and SACK. The authors analyzed through simulation that FACK is more straightforward to code and less prone to subtle bugs than Reno and SACK.

5. RESULTS AND DISCUSSION

In this paper, we focus on TCP sender side mechanisms to handle higher offered load,random losses and retransmission. Timeouts in high delay networks in such a way as to keep congestion window as high as possible, while keeping the congestion under control and keep retransmissions to token.

The figure 2 shows the impact of network Mobility rates of subscribers' stations on the throughput over different mobility rates.

Table 1: Important Simulation Parameters

Parameter	**Value**
Simulation time	150 Sec
Simulation area	1800 m*1800 m
Antenna	Omni antenna
No. of nodes	50
TCP – Variant	TCP-LP, TCP- Compound, TCP- CUBIC, TCP-VENO
Modulation & Coding	BPSK ½
TCP Segment size	1024 bytes
Cyclic prefix	¼
Frame duration	10 m Sec
Mobility Rates	10,20,30,40

It is observed that the throughput of TCP-CUBIC and TCP-Compound is better than other TCP-Veno and TCP-Westwood. With the increase in network Mobility rates of subscriber stations, throughput decreases. The throughput is representative of the number of bytes received per second. Simulation results show that for low mobility rates, TCP-Compound shows poor performance as compared to other considered TCP variants.

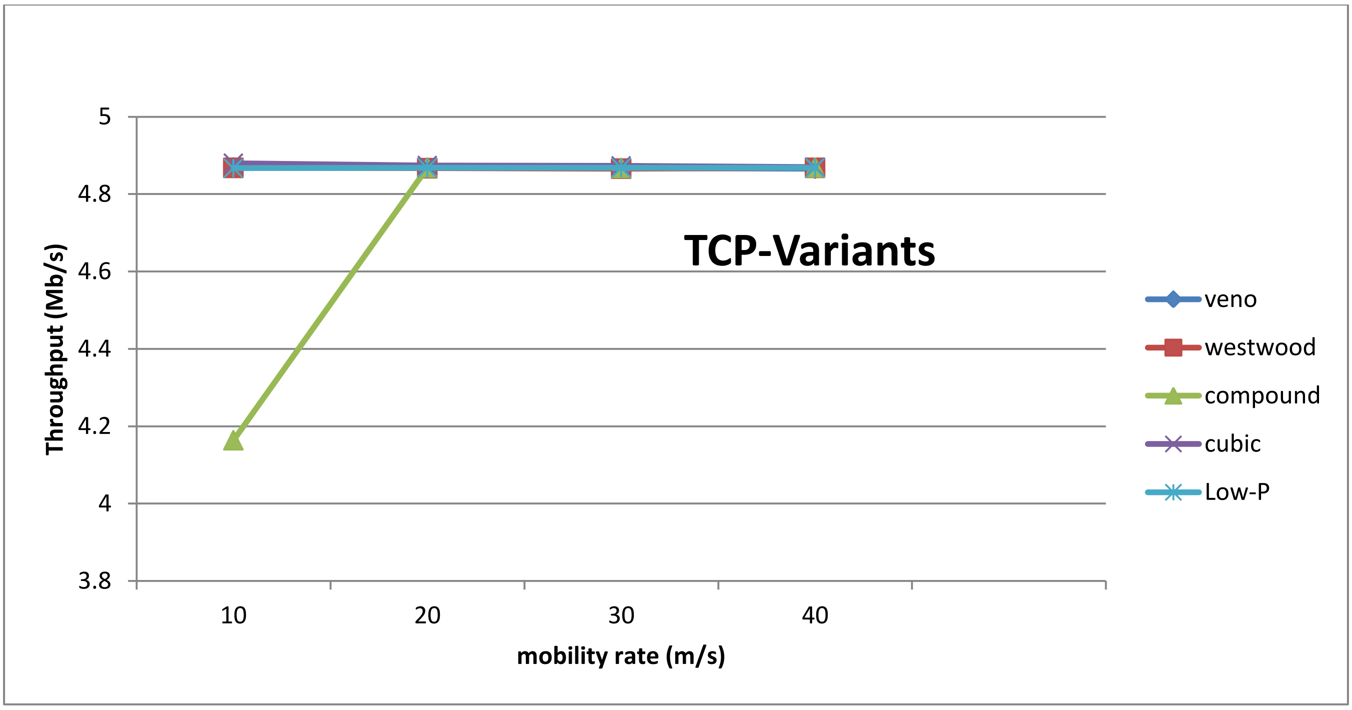

Figure 2. Throughput versus Mobility rates.

The figure 3 shows that the end-to-end delay of TCP-Westwood and TCP-CUBIC is better than other TCP-variant. TCP-CUBIC estimates the network's bandwidth by properly low-pass filtering and averaging the rate of returning acknowledgment packets per RTT. It then uses this bandwidth approximation adjust the ssthresh and the cwnd to a value close to it when a packet loss is received, as a result of which its end-to-end delay is comparatively smaller.

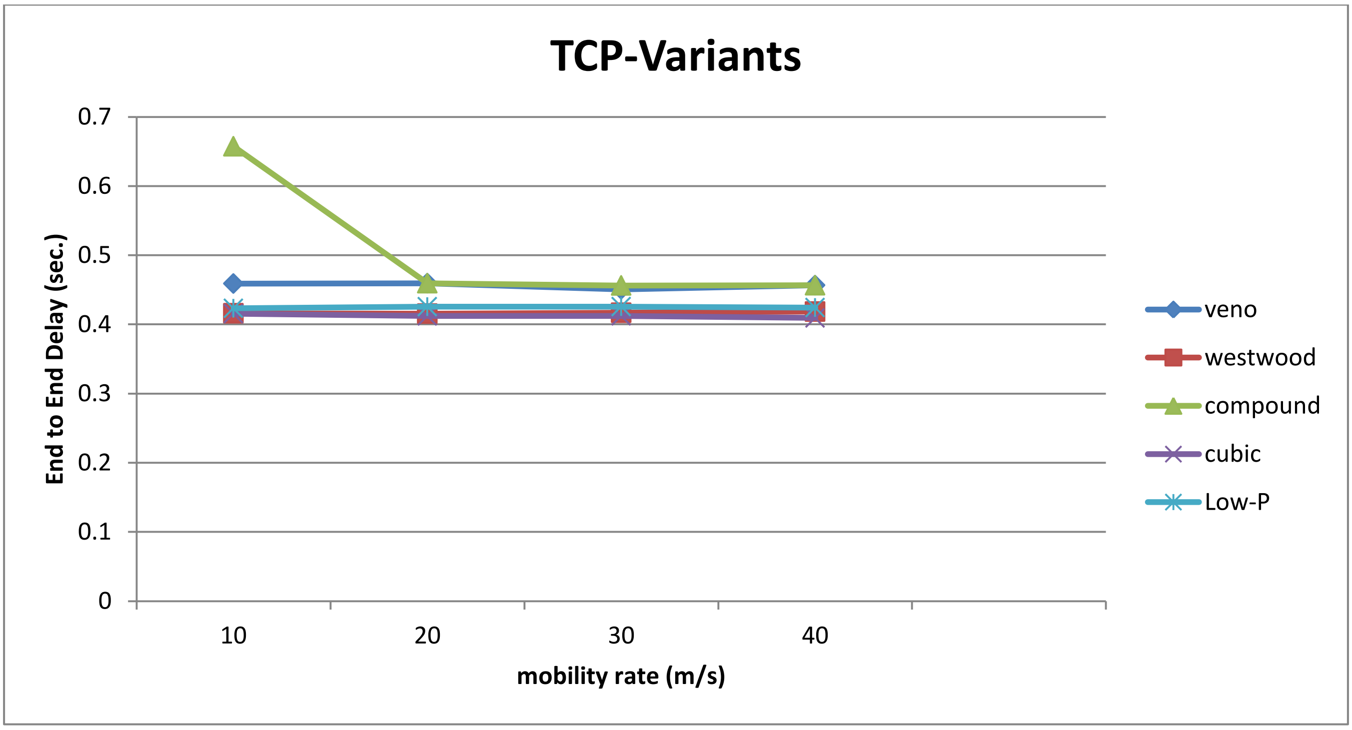

Figure 3. Average delay versus means speed.

The figure 4. Shows the impact of network Mobility rates on the routing load. It is observed that the routing load of TCP-Cubic and TCP-Compound is better than TCP- Veno and TCP-Westwood for higher Mobility rate scenarios. When the subscriber's station network Mobility rates is lower the routing load is smaller as Mobility rate increases.

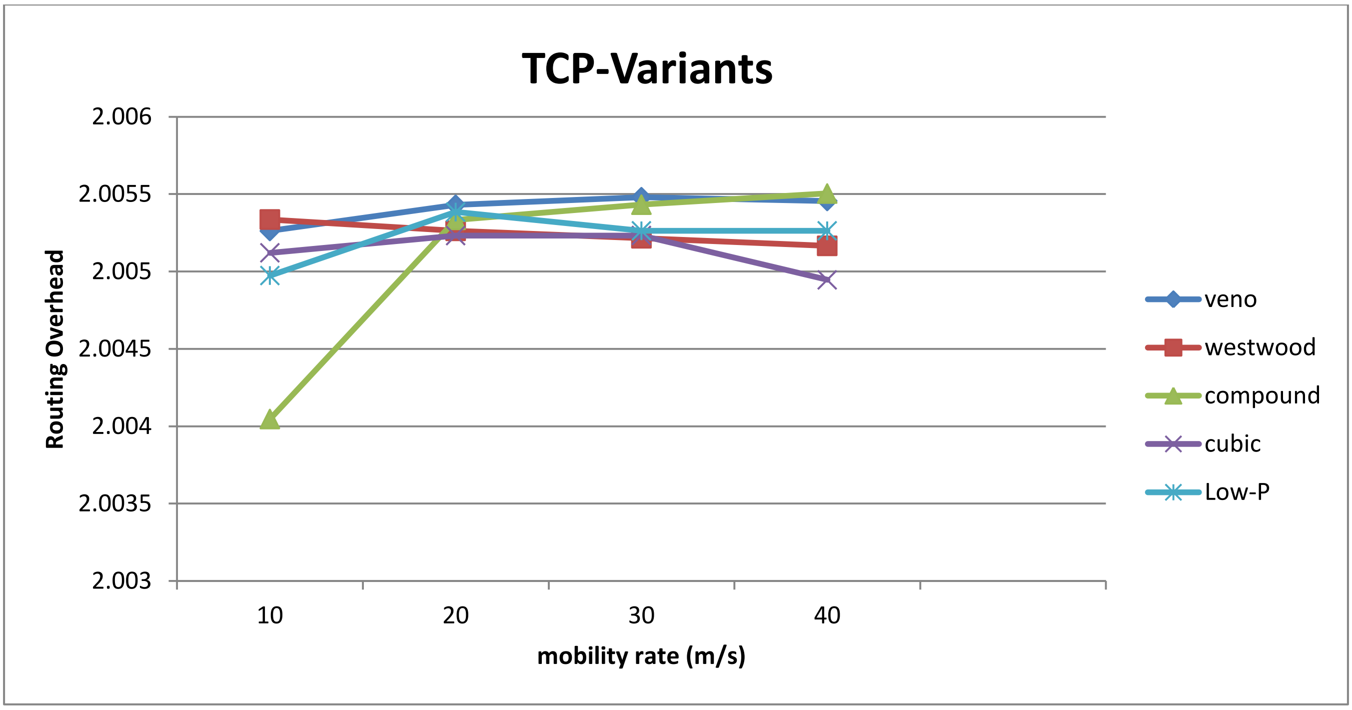

Figure 4. Routing Overhead versus mean speed

The figure 5 shows that PDF of TCP-Westwood and TCP CUBIC is better than other TCP-variant.

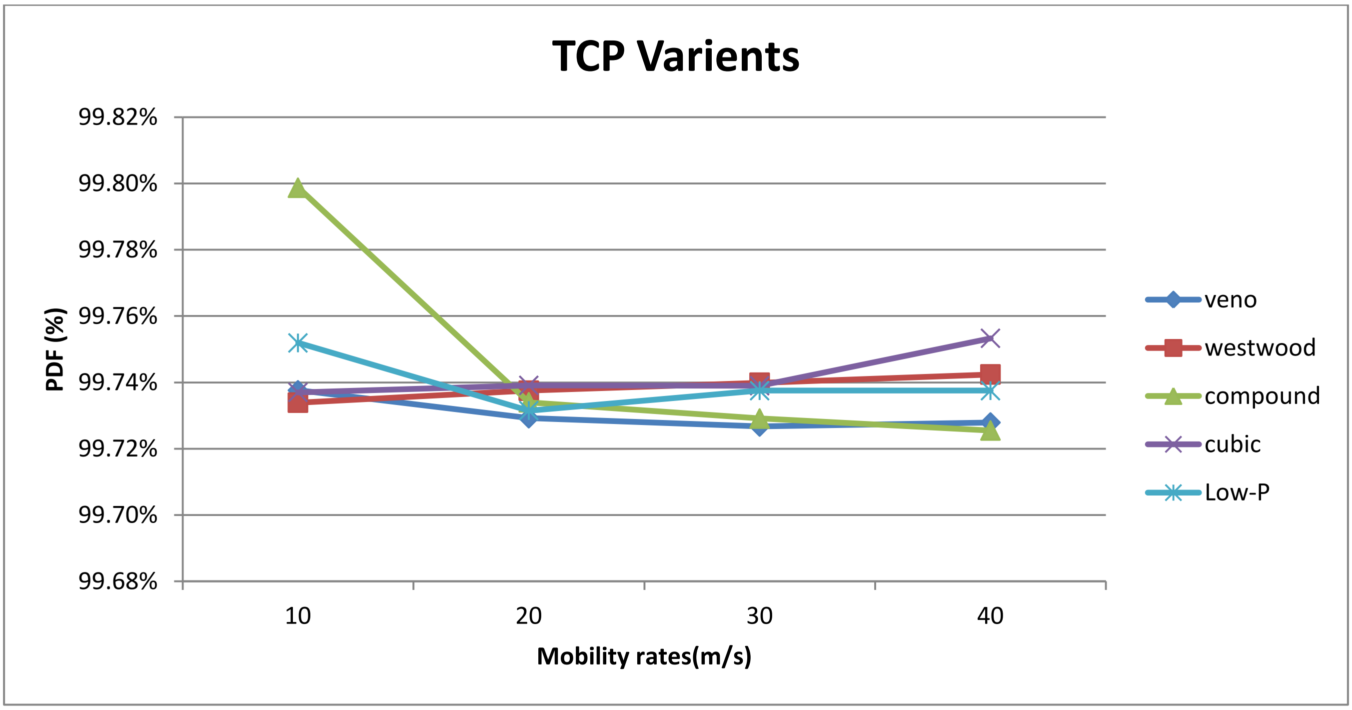

Figure 5. PDF versus means speed

6. CONCLUSIONS

A lot of research has been made so far, a goal at suggesting ways to get better efficiency of TCP in wireless networks. However, there are not extensive comparative studies of TCP performance in WiMAX networks. In this PAPER, we have reviewed that the lots of packet are random losses, correlated lossy links, route failures, and retransmission timeout that leads to network congestion. Since TCP has its variants, namely TCP-Veno, TCP-Compound, TCP-Westwood and TCP-CUBIC, we performed the comparison of TCP-Veno, TCP-Compound, TCP-Westwood, and TCP-CUBIC under different mobility scenarios. Through simulation, we noted that the TCP throughput decreases significantly when node movement cases link failures, due to TCP's inability to recognize the difference between link failure and congestion. However, from the view of average delay, TCP-Compound shows poor performance as compared to TCP cubic for lower mobility conditions, but with the increase in mobility speed or mean speed, it shows relevant results. From this analysis, we found that selection of TCP-CUBIC is better than other three TCP variants in case of increasing Random Packet Loss as well as in case of increasing mobility.

6.1 Future Scope

On the basis of the results obtained from simulation graphs and some trials in the literature, we can extend this work by improving TCP-cubic performance over WiMAX environment using QoS bandwidth allocation schemes, which is our interesting future work.

7. REFERENCES

[1] Tuan Anh Le, Choong Seon Hong and Eui-Nam Huh, 2012 "Coordinated TCP Westwood Congestion Control for Multiple Paths over Wireless Networks" International Conference on linformation Networking (ICOIN), IEEE.

[2] C. Chen, H. Wang, XinWang, M. Li, A.O. Lim.,2009, "A Novel Receiver-aided Scheme for Improving TCP Performance in Multi-hop Wireless Networks", in Proc. Of Int. Conference on Communications and Mobile Computing.

[3] L. Subedi, M. Najiminaini, and L. Trajković, 2009, "F Evaluation of TCP Tahoe, Reno, Reno with SACK, and NewReno Using OPNET Modeler", Proceedings of International Conference on Methods and Models in Computer Science.

[4] Fatima Furqan and Doan B. Hoang, 2013, "Performance E. ""WFICC: A New Mechanism for Provision of QoS and Congestion Control in WiMAX", The 10th Annual IEEE CCNC- Wireless Networking.

[5] Matthew Mathis and Jamshid Mahdavi,1996,"Forward Acknowledgment: Refning TCP Congestion Control", Computer Communication Review, ACM –SIGCOMM, vol. 26.

[6] Jeng-Ji Huang, Jin-Fu Chang, 2004, "Injong Rhee, and Lisong Xu ," CUBIC: A New TCP-Friendly High-Speed TCP Variant", SIGOPS, ACM, vol.- 42,2008."IEEE. Standard 802.16-2004. Part16: Air interface for fixed broadband wireless access systems.

[7] .Konstantinos Tsiknas,2012," A New Method to Improve the Performance of TCP SACK over Wireless Links",IEEE, 2003."Performance Evaluation of TCP in IEEE 802.16 Networks", Wireless communication and networking conference : mobile and wireless network.

[8] "A Compound TCP Approach for High-speed and Long Distance Networks" 25th IEEE International Conference on Computer Communications. Proceedings, INFOCOM, Dec. 2006. George Stamatelos," Kun Tan Jingmin Song Qian Zhang, Murari Sridharan.

[9] L. Subedi, M.Najiminaini, and L. Trajković, 2009, "Performance E Evaluation of TCP Tahoe, Reno,Reno with SACK, and NewReno Using OPNET Modeler" ,Proceeding fInternational Conference on Methods and Models in Computer Science.

[10] Md. Shohidul Islam, M.A Kashem, W.H Sadid, M. A Rahman, M.N Islam, 2009, "TCP Variants and Network Parameters: A Comprehensive Performance Analysis", Proceedings of the International Multi-Conference of Engineers and Computer Scientists.

[11] M. Rehan Rasheed.röhlich, B. and Plate, 2010," Performance of Routing Protocols in WiMAX Networks", International Journal of Engineering and Technology.