The Impact of Cyclic Prefix, Modulation Coding Scheme, Frame Duration, Two Way Transfer And Propagation Model With Network Asymmetry In Wimax Network using Tcp New Reno

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***Abstract*— The WiMAX technology support to different cyclic prefix, modulation coding scheme, frame duration, simultaneous two way data transfer and propagation model. The WiMAX network asymmetry is largely depends on DL: UL ratio.**
This paper investigates the effect of Cyclic Prefix, Modulation Coding Scheme, Frame Duration, Two way transfer and Propagation model in WiMAX network with network asymmetry using TCP New Reno. The performance of WiMAX network is evaluating by varying MAC layer parameter such as cyclic prefix, modulation coding scheme, frame duration, DL: UL ratio and physical layer parameter such as propagation model and full duplex mode of data transfer and other operating parameter such as downloading traffic (number of downloading and uploading wireless nodes) and these parameters really affect the performance of WiMAX network.
The performance of WiMAX network is measured in terms of throughput, goodput and number of packets drop.

***Index Terms*— World Wide interoperability for microwave access (WiMAX), Subscriber Stations (SSs), Downlink (DL), Uplink (UL), Medium access control (MAC), Transmission Control Protocol (TCP), OFDM, IEEE 802.16, Throughput, Goodput and Packet drop.**

I. INTRODUCTION

WiMAX is abbreviation `Worldwide Interoperability for Microwave Access', is a new wireless OFDM based technology that provides high throughput broadband connection over long distances based on IEEE 802.16 [6][7].

WiMAX network increasingly more intelligent and agile communication systems, capable of providing spectrally efficient and flexible data rate access [7].

Network asymmetry means that network characteristics in one direction do not match with the other direction [11].

Cyclic prefix, modulation coding scheme, frame duration, simultaneous two way data transfer and propagation model affect TCP performance along with Network asymmetry, since TCP relies on the timely arrival of acknowledgments (ACKs) to increase its congestion window and data sending rate. Under normal network conditions, an ACK is duly received for packets sent, and this helps the sender to increase the data sending rate. In the case of congestion, typically indicated by packet loss, TCP abruptly decreases its congestion window, and retransmits the lost packets [8][9]. The retransmission may aggravate the congestion. Normally, there are two ways to indicate the packet loss or congestion:
(1) Expiry of retransmission timer
(2) receipt of 3 or more duplicate ACKs
In the presence of an imperfect ACK channel, the ACK clocking is disrupted, i.e., packets sent are not duly acknowledged. Consequently, at the sender, the timer expires which TCP interprets as congestion, 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 depends on the characteristics of the data sending channel, but also on the reverse channel used by ACKs [11][5][1].

WiMAX provides the flexibility in cyclic prefix, modulation coding scheme [2], frame duration, propagation model along with simultaneous two way data transfer.

The rest of the paper is structured as follows. The system model for the investigation is introduced in Section 2. In Section 3, simulation scenarios are presented and the results are discussed. Finally, the conclusion is present in Section 4.

II. SYSTEM MODEL

This section present the system model used in investigation. The network setup is shown in Fig. 1. All subscriber stations are downloading stations (SSs).

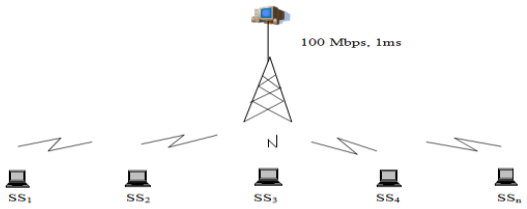

Fig.1 Topology

A. Simulation Environment

The performance analyzed through simulation by using network simulator *ns-2 (ns2.31)* and the WiMAX module from the National Institute of Standards and Technology (NIST) [3][4].
The simulation parameters are summarized in Table 1.

TABLE I. SIMULATION PARAMETERS

WiMAX and OFDM Parameters	
Channel bandwidth	20 MHz
Frame duration	5, 10 ms
Modulation & Coding	BPSK 1/2, QPSK 1/2, QPSK 3/4, 16QAM 1/2, 16QAM 3/4, 64QAM 2/3,64QAM 3/4
Cyclic prefix	1/2, 1/4, 1/8, 1/16
Contention size	5
Propagation Model	TworayGround, FreeSpace, Shadowing
Traffic Source and Other Parameters	
TCP version	New Reno
TCP segment size	960 Bytes
No. of DL WL Nodes	5,10,15,20,25
Delayed ACK factor	2 s
TCP start time	20 s
Simulation duration	300 s

B. Performance Metrics

The performance studied by means of three metrics:

1) *Throughput* that measures the amount of raw bytes sent by a source.
2) *Goodput* that measures bytes that are sent and success-fully acknowledged.
3) *Number of Packets drop.*

III. SIMULATION RESULTS

Several scenarios are considered to evaluate the performance of TCP New Reno in WiMAX network for different DL: UL ratio.

A. Scenario 1: Effect Cyclic Prefix

In this scenario the performance of TCP New Reno in WiMAX network is evaluated using cyclic prefix in bandwidth asymmetry, shown in fig. 2 and 3.

Fig. 2 shows that, whenever the cyclic prefix increases the throughput and goodput decreases. The higher cyclic prefix has low throughput and goodput due to extra overhead of cyclic prefix and lower cyclic prefix has higher throughput and goodput.

The maximum throughput and goodput obtained for cyclic prefix 0.3125 with DL:UL ratio 0.90.

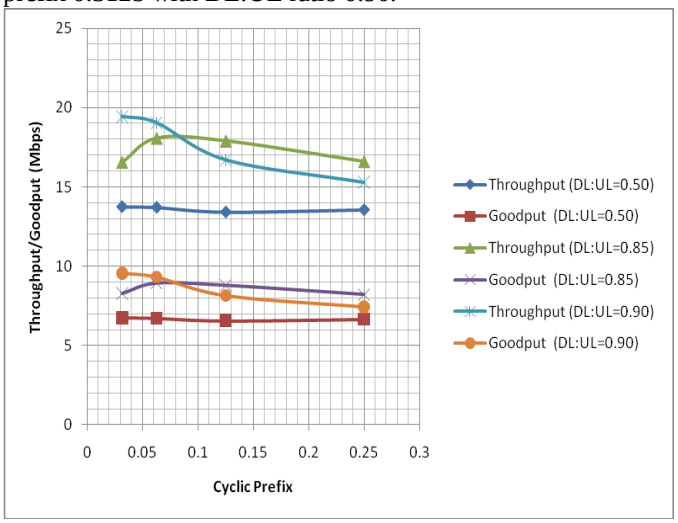

Fig. 2. Throughput & Goodput for different Cyclic Prefix by cosidering DL:UL ratio

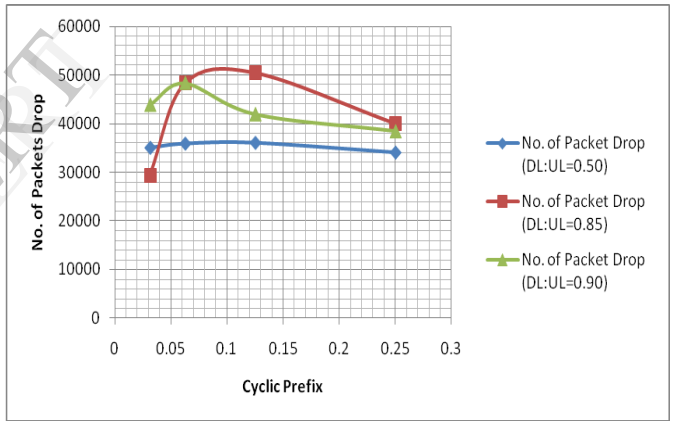

Fig. 3. No. of Packet drop for different Cyclic Prefix by cosidering DL:UL ratio

The number of packets drop is higher for low cyclic prefix due to echo and interference in multipath propagation. The low cyclic prefix increases the echo and interference in multipath propagation due to this packet drop increases which is shown in fig. 3.
The maximum number packet drop obtained for cyclic prefix 0.3125 with DL:UL ratio 0.90.

B. Scenario 2: Effect of Modulation Coding Scheme

The fig. 4 shows the throughput, goodput and fig. 5 shows the number of packets drop in different modulation coding scheme for different DL:UL ratio.

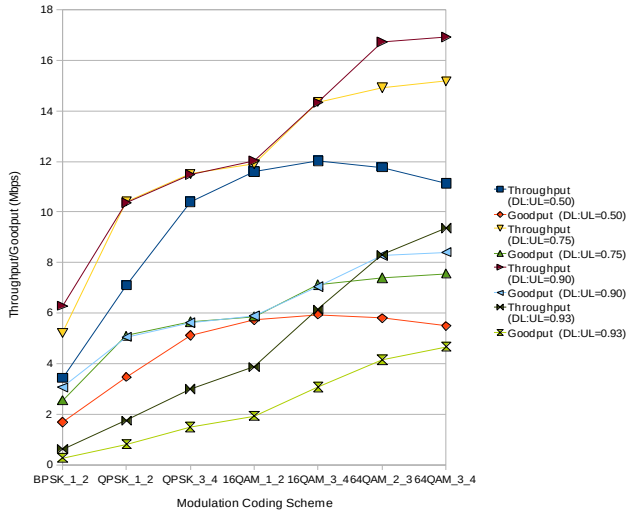

Fig. 4. Throughput & Goodput for different Modulation Coding Scheme by cosidering DL:UL ratio

The throughput and goodput for DL:UL ratio 0.90 is higher as compare to other DL:UL ratio for modulation coding scheme 64QAM3/4 due to large number of time slots in higher order modulation coding scheme as compare to lower order modulation coding scheme shown in fig. 4. The higher order modulation coding scheme support higher data rate over long distance.

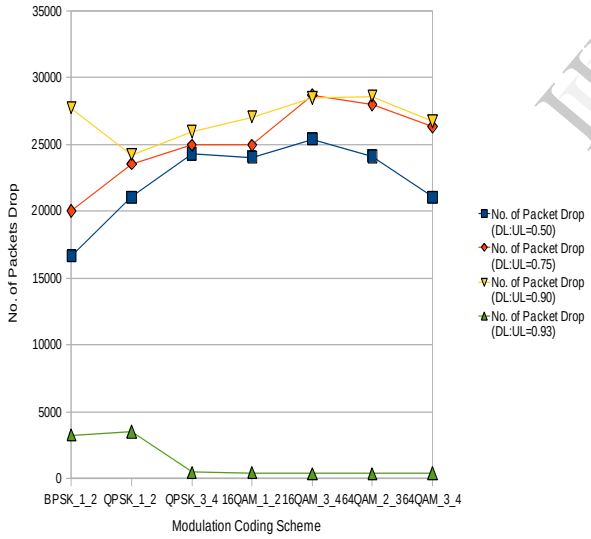

Fig.5. No. of Packet drop for different Modulation Coding Scheme by cosidering DL:UL ratio

The number of packets drop is higher for DL:UL ratio 0.90 with 64QAM3/4.

The number of packets drop increases because the higher order modulation coding scheme support to high data rate over long distance but signal become poor due to long distance so that the start packet drop which shown in fig. 5.

C. Scenario 3: Effect of Frame Duration

The fig. 6 represent the effect of frame duaration in terms of throughput and goodput and fig. 6 shows effect in number of packets drop.

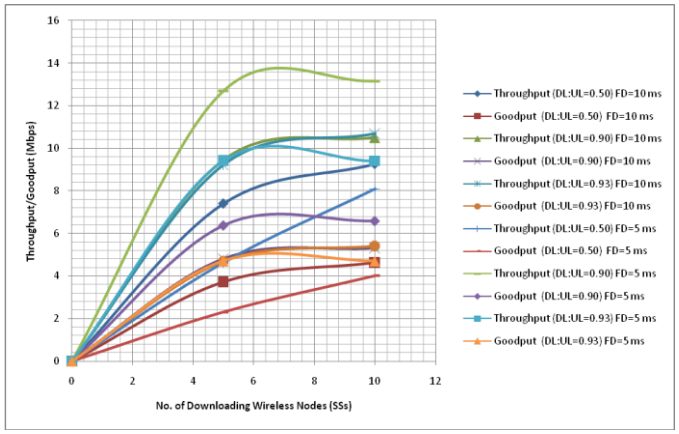

Fig. 6. Throughput & Goodput for different Frame Duration by cosidering DL:UL ratio

The fig. 6 shows that the throughput and goodput for DL:UL ratio 0.90 with frame duration 5ms is higher as compare to 10ms. When Frame duration increases the throughput and goodput decreases due to the less number of frame present in channel per unit time.

The throughput and goodput for DL:UL ratio 0.93 is less for frame duration 5ms and 10ms as compare to DL:UL ratio 0.90 for 5ms and 10 ms due to grater bandwidth asymmetry. If DL:UL ratio is 0.50 then there is no bandwidth asymmetry.

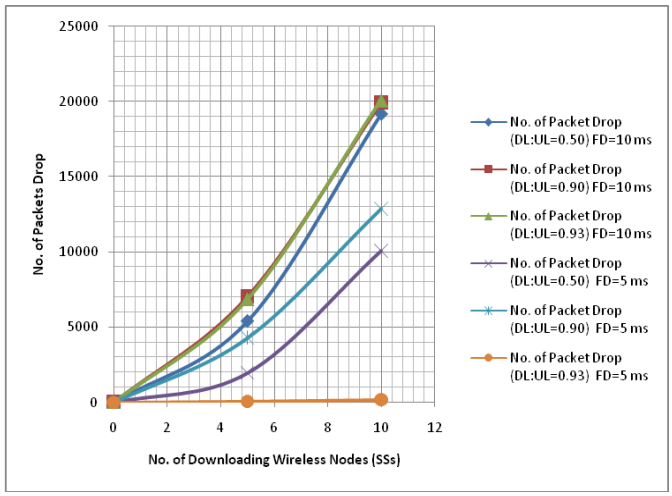

Fig. 7. No. of Packet drop for different Frame Duration by cosidering DL:UL ratio

The number of packets drop is larger for DL:UL ratio 0.90 with 5ms frame duration because of large number of packets in channel per unit time, shown in fig. 7. Large frame duration reduce the packets drop rate.

D. Scenario 4: Effect of Simultaneous Two Way Transfer

Fig. 8 and 9 shows the effect of simultaneous two way data transfer.

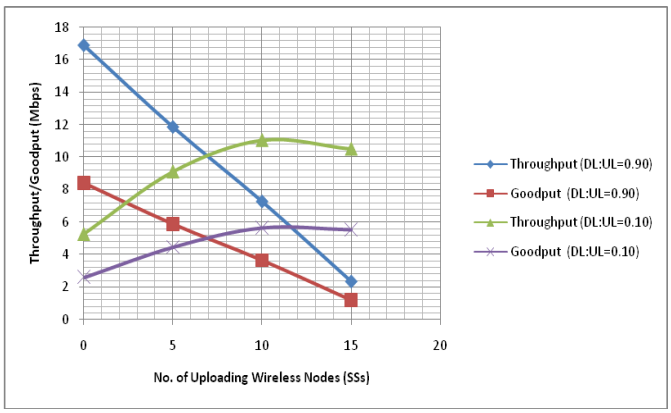

Fig. 8. Throughput & Goodput for Simultaneous two way transfer by cosidering DL:UL ratio

The fig. 8 represent the throughput and goodput for DL:UL ratio 0.90 and 0.10. Whenever the number of uploading nodes increases the throughput and goodput goes down due to portion alloted to UL is 0.10 which is not sufficient to handel large number of uploading nodes.

Similarly the throughput and goodput is increases when the number of uplaoding nodes increases due to portion allotted to UL is 0.90 which is capable handle large uploading traffic.

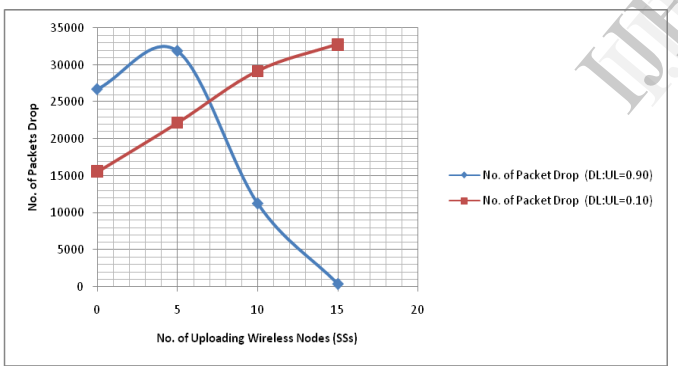

Fig. 9. No. of Packet drop for Simultaneous two way transfer by cosidering DL:UL ratio

The number of packet drop is increases for DL:UL ratio 0.10 (UL=0.90) due to large traffic in uploading and number of packet drop decreases when DL:UL ratio 0.90 (UL=0.10) due to low traffic in uploading shown in fig 9.

E. Scenario 4: Effect of Propagation Model

The impact of propagation model is measured by three performance matrices throughput, goodput and number of packets drop shown in fig. 10 and 11.

The throughput and goodput is slight higher for Shadowing propagation model than TworayGround and FreeSpace for DL:UL ratio 0.90, shown in fig. 10.

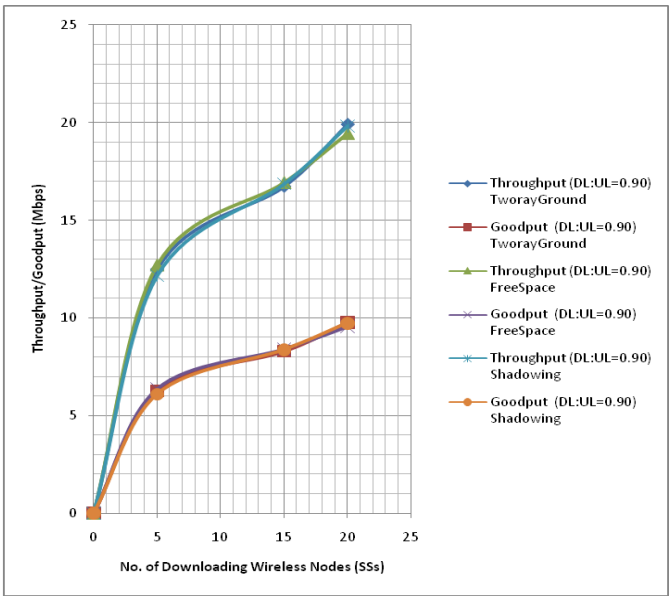

Fig. 10. Throughput & Goodput for different Propagation model by cosidering DL:UL ratio

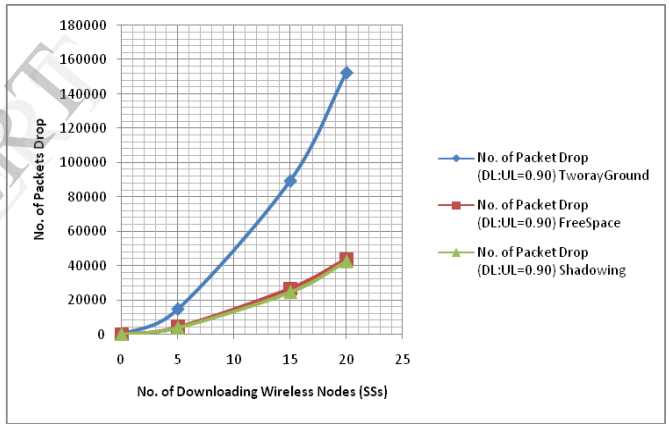

Fig. 11. No. of Packet drop for different Propagation model by cosidering DL:UL ratio

The number of packet drop is higher with DL:UL ratio 0.90 for TworayGround propagation model due to reflection and refraction and this will be reason for weak signal strength, which is shown in fig. 11.

IV. CONCLUSION

This paper investigates the impact of cyclic prefix, modulation coding scheme, frame duration, simultaneous two way data transfer and propagation model in WiMAX network with bandwidth asymmetry using TCP New Reno.

It is observed in simulation study that the higher cyclic prefix reduce the data rate also reduce the packet drop.

The higher order modulation coding scheme provides higher data rate and higher packet drop.

It is also observed that lower frame duration enhance the data rate and number of packet drop.

In simultaneous two way data transfer higher DL:UL ratio reduce data rate and packet drop for large uploading nodes and lower DL:UL ratio increase the data rate and packet drop for large uploading nodes.

The shadowing propagation model provide high data rate and TworayGround propagation model provide large packet drop.

REFERENCES

1. Konstantinos Tsiknas and George Stamatelos "Comparative Performance Evaluation of TCP Variants in WiMAX (and WLANs) Network Configurations" Hindawi Publishing Corporation Journal of Computer Networks and Communications Volume 2012, Article ID 806272, 9 pages doi:10.1155/2012/806272.
2. Pratyush Sharma, Abhishek Sharma, Kailash C. Bandhu "Performance Evaluation of Adaptive Modulation Techniques and Offered Load in OFDM based WiMAX Network by Considering Cyclic Prefix" International Journal of Scientific & Engineering Research Volume 2, Issue 11, November-2011 ISSN 2229-5518.
3. Network Simulator Ns-2, 2010, http://www.isi.edu/nsnam/ns.
4. R. Rouil, "The NIST WiMAX Network Simulator," NIST, Tech. Rep., 2007.
5. K. Xu, Y. Tian, and N. Ansari, "Improving TCP performance in integrated wireless communications networks," Computer Networks, vol. 47, no. 2, pp. 219–237, 2005.
6. IEEE Standard for Local and Metropolitan Area Networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems, 2004.
7. Air Interface for fixed broadband wireless access systems, Oct. 2004.
8. M. Gerla, R. Bagrodia, L. Zhang, K. Tang, and L. Wang, "TCP over Wireless Multihop Protocols: Simulation and Experiments," IEEE ICC 1999
9. M. Gerla, K. Tang, and R. Bagrodia, "TCP Performance in Wireless Multihop Networks," IEEE WMCSA 1999
10. V. Bharghavan, "Performance Analysis of a Medium Access Protocol for Wireless Packet Networks," IEEE Performance and Dependability Symposium 1998.
11. H. Balakrishnan, V. Padmanabhan, and R. Katz, "The effects of asymmetry on TCP performance," in Proc. 3rd ACM/IEEE Intl. Conference MOBICOM, 1997.