Downlink ratio impact on downstream traffic performances on WiMAX

J H T Simarata, S Suherman*

Electrical Engineering Department, Universitas Sumatera Utara, Medan, Indonesia

*suherman@usu.ac.id

Abstract. Worldwide Interoperability for Microwave Access (WiMAX) offers high speed data transfer with various quality of service (QoS) for different applications. One of the services is the downlink ratio adjustment. Theoretically, the parameter allows users to manage bandwidth for uplink and downlink direction. As there is no related work to proof this parameter adjustment, this paper examines the impact through network simulator for downlink streaming. With limited total capacity of the simulated network, by using 4 nodes with downlink traffics varied from 5 to 15 kbps, simulation proofs that by changing downlink ratio from 0.1 to 0.9, the downlink stream performance is increasing with delay decrement up to 5.34 ms, jitter decrement 9.1 ms and packet loss reduction about 97.62%.

1. Introduction

Worldwide Interoperability for Microwave Access (WiMAX) is standardized by IEEE as 802.16 providing high speed fixed and mobile radio which is able to cover 50 km distance, compared to 802.11 that reaches only 3 km. WiMAX can be used for internet access or dedicated network with various speeds [1].

Fixed WiMAX is fully depending in frequency spectrum in licensed and unlicensed bands of 3.5 GHz and 5.8 GHz. Meanwhile mobile WiMAX works on 2.3 GHz, 2.5 GHz, 3.3 GHz and 3.5 GHz [2]. WiMAX architecture contains a base station (BS) and subscriber stations (SSs). The physical layer and medium access control layer determine the standard variation [3]. WiMAX provides flexibility on scheduling that has been explored by many researchers to adapt the type of traffics and users of WiMAX intended for [4-6].

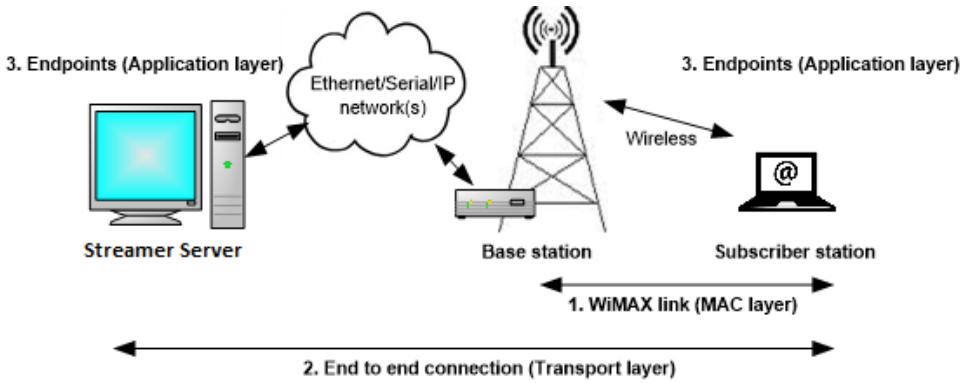
Downlink ratio is one of the adjustable parameters within WiMAX as comparison of downlink rate to total rates. The suggested ratio is 75% to 50%. However, it depends on user requirement. Setting up 50% means both directions have similar bandwidth. Since there is no study of the downlink ratio impact to downstream performances, this article examines the parameter impact to the streamed traffics.

2. Evaluation method

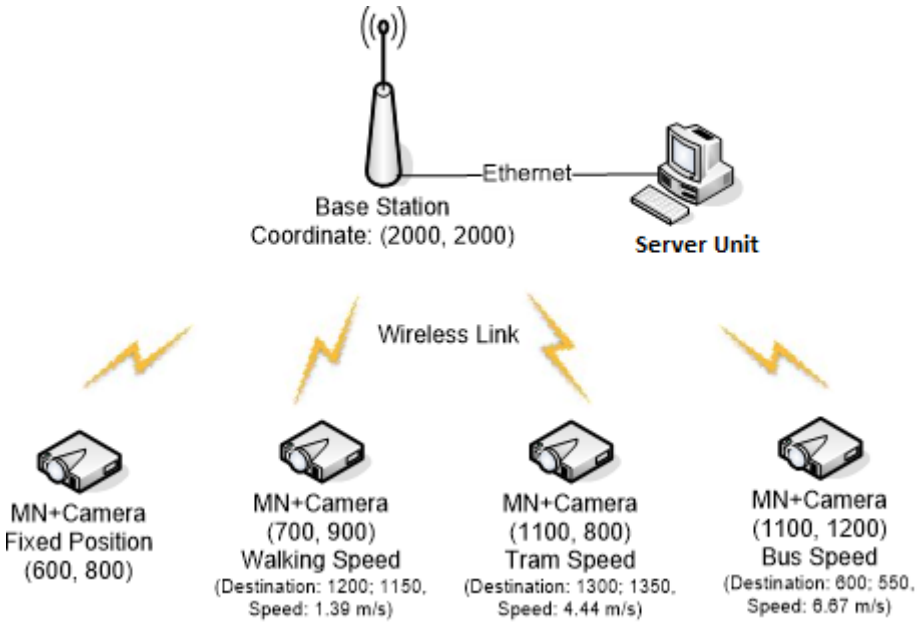
The assessed network is WiMAX for downstream application such as in Figure 1a. Server streams video to subscriber stations, where changing the downlink ratio within base station is expected to have positive impact on streamed videos. In order to model the assessed network, network simulator-2 (NS-2) [7] is employed as it provides WiMAX module in its mac libraries, and the module has been tested by the national institute for standard and technology (NIST) [8]. NS-2 is installed through virtual box into Ubuntu operating system, which runs on Asus GL552JX with hardware specification of processor intel® Core™ i7-4720HQ, CPU @

2.60GHz (8 CPUs), 2.59Ghz, memory 8192 MB RAM and running other operating system Windows 10 Home Premium 64 bit.

WiMAX is configured by using tcl script with point to multipoint configuration containing a single base station serving four subscriber stations with various speed: fixed (0 m/s); walking speed of 1.39 m/s; tram speed of 4.44 m/s and car speed of 6.67 m/s. The transmitter is set to cover 1000 m radius by using 64 QAM modulation and two-ray ground propagation model. The model is shown in Figure 1b.



(a) Assessed network



(b) Network model

Figure 1. Evaluation method

The evaluated traffic is set from akiyo_cif.yuv video trace with specification outlined in Table 1. Frame rate is number of picture frame per second, video codec is mpeg4 without voice in it, packet size is adjusted according to WiMAX packet size 1024 bytes. The evaluated performances are delay, jitter and packet loss. Delay is defined as the required time to send video packets to receiving end. Jitter is delay variation and packet loss is comparison between successful received packets to total transmitted packets.

Table 1. Video properties

Parameter	Detail
Video sequence	akiyo_cif.yuv
Frame rate and type	30fps IPP
Video codec	MPEG4
Video bit rate	5120 bps to 15360 bps
Packet size	1024 bytes

3. Evaluation results

After recording the repeated experiments of 2000 packets transmissions about 10 times and varied downlink ratio, the experiment results are averaged as in Table 2.

Table 2. Experiment results

Downlink Ratio	Delay (s)	Jitter (s)	Packet Loss
0.1	5.3402	0.009101	97.620%
0.15	3.2304	0.007200	93.480%
0.2	1.3239	0.002324	84.600%
0.25	0.7622	0.001379	73.510%
0.3	0.5689	0.001034	64.610%
0.35	0.4321	0.000997	53.530%
0.4	0.3623	0.001363	44.650%
0.45	0.3011	0.000882	33.560%
0.5	0.2649	0.000994	24.680%
0.55	0.2355	0.001279	15.800%
0.6	0.1999	0.000411	4.690%
0.65	0.0067	0.000004	0.010%
0.7	0.0052	0.000002	0.009%
0.75	0.0043	0.000002	0.008%
0.8	0.0033	0.000002	0.007%
0.85	0.0030	0.000002	0.006%
0.9	0.0027	0.000001	0.005%

Figure 2 shows delay performance changes to downlink ratio. The higher the downlink ratio, the lower the downlink packets delay. Delay decrement is exponential from about 5340,2 ms at downlink ratio 0.1 down to about 2.7 ms at downlink ratio 0.9. Delay 5340.2 ms is much higher than delay threshold for real-time communication, 150 ms. which means, downlink ratio 0.1 gives worst performance for downlink traffics. While 0.9 downlink ratio gives best performance.

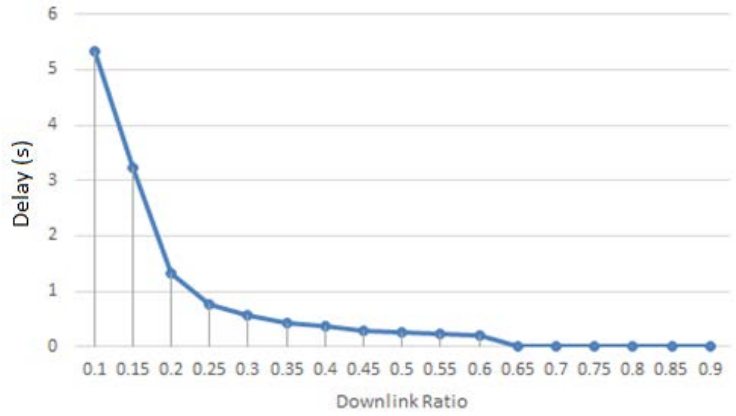


Figure 2. Delay performances

Likewise, jitter decreases exponentially to downlink ration increment as shown in Figure 3. Jitter is 9.1 ms when downlink ratio is 0.1. 9,101 ms down to only 0,001 ms for downlink ratio 0.9. This very small jitter shows that WiMAX is very best for video streaming as it gives almost constant delay for all signal components.

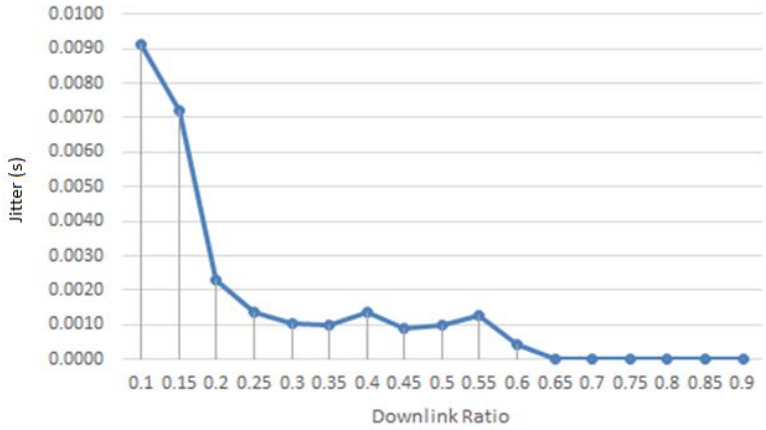


Figure 3. Jitter performances

Packet loss is also improving when downlink ratio increasing from 0.1 to 0.9. Packet loss drops from 97.62% to only 0.005%. Improvement is about 97.615%. Figure 4 plots the loss reduction.

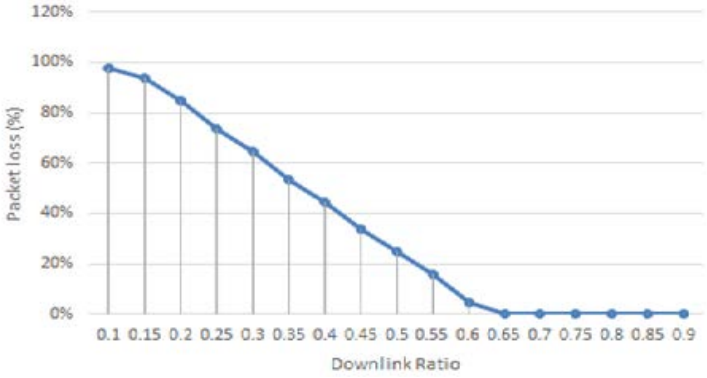


Figure 4. Packet loss performances

4. Conclusion

This paper examined downlink ratio impact to downlink traffic performances. Downlink ratio increment causes downlink bandwidth increases. This higher bandwidth allows traffics to flow more easily. The assessment shows that traffic transmission experience lower delay, jitter and packet loss as downlink ratio raised.

As downlink ratio climbs from 0.1 to 0.9, delay decreases from about 5340,2 ms at downlink ratio 0.1 down to about 2.7 ms at downlink ratio 0.9. Jitter drops about 9.1 ms and packet loss reduced about 97.62%.

References

[1] A.G. Jeffrey, G. Arunabha, and R. Muhamed, 2007. “Fundamentals of WiMAX”, Prentice Hall, Massachusetts, Page 13-28.

[2] IEEE Std 802.16e-2005. Part 16: Air Interface for Fixed Broadband Wireless Access Systems – Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Band. IEEE, Dec.

[3] Suherman, S., & Al-Akaidi, M. (2013). Adjusting WiMAX for a dedicated surveillance network. International Journal of Electrical and Computer Engineering, 3(4), 492.

[4]. Ahmed, Z., Hamma, S., & Nasir, Z. (2019). An optimal bandwidth allocation algorithm for improving QoS in WiMAX. Multimedia Tools and Applications, 1-40.

[5]. Naik, D., Dora, S., & De, T. (2019). Normalized Uplink Bandwidth Scheduling Algorithm for WiMAX Networks. In Advances in Computer, Communication and Control (pp. 311-325). Springer, Singapore.

[6]. Suherman, S. (2018). Delay reduction of transmission control protocol in WiMAX by prioritizing the acknowledgement packets. In MATEC Web of Conferences (Vol. 197, p. 11021). EDP Sciences.

[7]. K. Fall, K. Varadhan, The network simulator (ns-2) (2007), http://www.isi.edu/nsnam/ns

[8]. R. Rouil, The NIST WiMAX network simulator. NIST Technical Report (2007)