Can We Enjoy Internet MMORPG Games via WiBro/IEEE802.16e Network?

Xiaofei Wang†,Hua Cai§,Hyunchul Kim†,Taekyoung Kwon†,Yanghee Choi†,Sunghyun Choi§
†Multimedia & Mobile Communication Lab., School of Computer Science & Engineering
§Multimedia & Wireless Networking Lab.,School of Electrical Engineering and INMC
Seoul National University, Seoul, South Korea

ABSTRACT

The Massively Multi-player Online Role-Playing Game (MMORPG) is one of the most popular and profitable applications on the Internet. And currently players can enjoy it via Wireless Local Area Networks (WLAN) and Broadband Wireless Access (BWA). Investigating the quality of service for gaming via different accesses can help improve both gaming and networking techniques for better gaming experiences. In this paper we measure and analyze the traffic of MMORPG gaming via the WiBro/802.16e network.

1. INTRODUCTION

Wired-access Internet has long served for MMORPG games for more than 10 years. Recently, people also started enjoying these applications over Wireless Local Area Networks (WLAN) and Broadband Wireless Access (BWA). Online gaming performance has been evaluated for various network access systems, e.g. WLAN [1]. In this paper, we measure and evaluate online game playing accessed via the Korean 802.16e BWA network (WiBro), deployed by Korean Telecom since 2006. VoIP-over-WiBro performance has been evaluated in [2] [3] [4]. Besides VoIP, MMORPG game is also a representative real-time service, and since most MMORPG games are TCP-based, investigating the quality of real-time TCP performance over WiBro is currently of significant interest. To the best of our knowledge, no previous work has yet investigated the capability of BWA networks to guarantee the quality of service for real-time MMORPG game applications. In WiBro, the traffic for a subscriber station (SS) is handled by a base station (BS) in a best-effort service approach. For continuous connectivity, when a SS is moving out of the coverage of a BS into that of another BS, the SS performs a handover (HO) inducing an interruption delay which impairs real-time gaming performance.

2. MEASUREMENT PREPARATION

The application considered in this work is the popular game, World of Warcraft (WOW), running on a Macbook Pro laptop with Intel Core 2 Duo T8300 CPU, 2GB RAM, and Nvidia 8800GT video card. This configuration ensures that the hardware platform has no influence on the gaming performance. The computer accesses the WiBro network and then the Internet via the Samsung SWT-H200K WiBro modem. Data traffic is maintained by making the WOW character (avatar) to kill monsters consistently. The traffic is captured using the Wireshark. Two typical SS paths are selected within Seoul, Korea: 1) **subway**: subway line number 2, from Samseong station to Sadang station, with high commuter volume. At the subway, BSs are deployed inside stations, and repeaters are installed in the tunnels to relay data between SSs and BS. 2) **bus**: bus number 501 from Seoul National University to Seoul Station, a typical route passing near residential areas, a tunnel, a Han River bridge and a railway station.

PAM2009, April 1-3, 2009, Seoul, Korea.

3. ANALYSIS

Previous work [5] indicated that average game play time of users decreases significantly if the latency is higher than 250 ms, and also players are less tolerant to large delay variation than to high latency. Therefore, latency ultimately determines player's gaming experience. In order to investigate whether we can enjoy MMORPG game via WiBro, firstly we approximately model the MMORPG game latency as follows: An action of the avatar is sent to the WOW server as a TCP data packet, taking time of $T_{UL} + T_{Sys}$, where T_{UL} is the uplink delay of WiBro, i.e., from the client to the WiBro access router, and T_{Sys} is the system delay between the access router BS and the WOW server through the WiBro and Internet backbone. The WOW server instantaneously calculates the consequence by avatar's action and returns to the client, with updated ACK sequence ID, taking time of $T_{Sys} + T_{DL}$, where T_{DL} is the downlink delay of WiBro, i.e., from the WiBro access router to the client. Then the WOW client will acknowledge the WOW server, still taking time of $T_{UL} + T_{Sys}$. The WOW client utilizes the delayed TCP mechanism [6], which postpones an ACK's transmission for a specified period, $T_{DelayACK}$, to wait for the subsequent ACK, and then transmits them together if possible. So WOW client latency can be approximated as:

$$Latency = T_{Sys} * 3 + T_{UL} * 2 + T_{DL} + T_{DelayACK}$$

where, T_{UL} is about 80.1 ms and T_{DL} is about 25.5 ms [7], T_{Sys} is normally shorter than 10 ms as we traced the packet route and $T_{DelayACK}$ is bout 100 ms in average according to our measurements. Therefore the WOW-over-WiBro theoretical latency is expected to be 315.7 ms. In this paper, compared with the latency in WOW, we measure the round-trip time (RTT) of the TCP data packets at the client side, which is actually $T_{UL} + T_{Sys} + T_{Sys} + T_{DL}$.

In our measurements, each experiment is taken for five times, and we confirm that all plots follow the same pattern. In order to show the RTT variation corresponding to the SS movement, we present one representative real-time

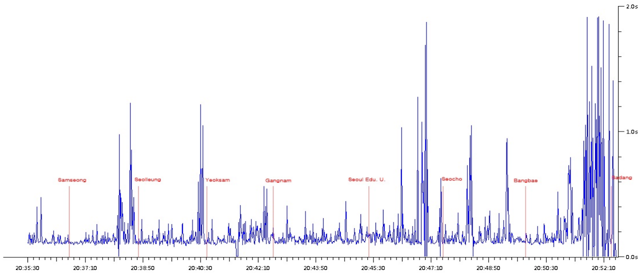

Figure 1: RTT for the subway case

RTT graph for the subway case in Fig. 1. The red lines indicate the arrivals at subway stations. We observe that every time before the train goes into a station, the RTT value increases significantly, since the SS performs a HO between the previous BS and this BS through repeater(s) in the tunnel. In some cases, several RTT peaks happen while the train is inside the tunnel, mainly because that the frames are relayed by repeaters inducing delay, and the changes of tunnel status may influence the signal quality, for example, another train is reversely passing by. At the Sadang station, corresponding to the right-most redline in Fig. 1, the RTT value fluctuates significantly, since Sadang is a very big transfer station and potentially many WiBro users exist potentially. Although WiBro access is not contention-based, when there are many users consuming high bandwidth for their applications, due to the best-effort service nature, they contend for bandwidth and packets are delayed if the BS is congested. The average RTT is 131.6±43.4 ms at stations and 144.6±56.4 ms at tunnels, since repeaters in tunnel relay frames inducing a small delay and HOs happen in the tunnel. Table 1 shows the effective RTT measurements, as well as the average latency in WOW.

Table 1: RTT value (ms)

Tests	AVG RTT	StDev	AVG Latency
Subway-station	131.6	43.4	301
Subway-tunnel	144.6	56.4	301
Bus	134.7	71.1	319

The real-time RTT in the bus case is shown in Fig. 2. Red numbers and lines indicate the bus stops, which are noted by the yellow pins geographically in the map. The RTT increases around bus stop number 5 because of a tree-covered hill between the BS and SS, where the signal quality may be degraded. The large RTT peak around bus stop number 8 is due to the signal fluctuation caused by tall apartment buildings. The large RTT increase in the tunnel between bus stop number 14 and 15 is probably due to a HO between the two tunnel-end BSs. On the Han River bridge, a HO may be performed between the two BSs at north and south banks. After the bridge, the RTT varies because the bus approaches the Yongsan electronics mall, where there are many tall buildings, as well as many WiBro products exhibited in the mall connecting to one BS. Around Seoul Station, the RTT value varies significantly still because of a larger number of WiBro users there. The average RTT value in the bus case is 134.7±71.1 ms. The standard deviation is higher than that in the subway case because the diverse outdoor environment impacts the WiBro link quality significantly due to the signal shadowing.

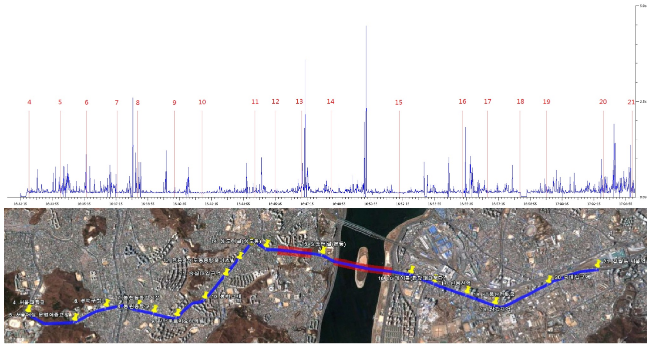

Figure 2: RTT for the bus case (with map)

Also as we measured, the average latency of WOW client is 301 ms for the subway case and 319 ms for the bus case shown in Table 1, which matchs our estimation well.

4. CONCLUSION

In general, gaming-over-WiBro quality is acceptable for most players, but they may suffer inconsistent latency and sudden lags. Nonetheless, turning off delay TCP will help to reduce latency to a satisfying level of 200 ms. Future work will aim at enriching the measurement from more aspects, and proposing practical optimization methods for both the game and the WiBro access scheme.

Acknowledgments

This research was partly supported by the Ministry of Knowledge Economy, Korea, under the Information Technology Research Center support program supervised by the Institute of Information Technology Advancement (Grant Number IITA-2009-C1090-0902-0006), and partly supported by Korea Research Council of Fundamental Science & Technology.

5. REFERENCES

[1] L. Caviglione. Traffic analysis of an internet online game accessed via a wireless LAN. *IEEE Communication Letters, 10(10), 2006.*

[2] H. Cai, Y.K. Choi, D.M. Kim, and S. Choi. A measurement study of VoIP over WiBro networks. *Proc. WBWF 2007.*

[3] D.M. Kim, H. Cai, M.S. Na, and S. Choi, Performance measurement over mobile WiMAX/IEEE 802.16e metwork. *Proc. IEEE WoWMoM 2008.*

[4] M.N. Han, Y.S. Lee, S. Moon, K. Jang, and D.Y. Lee. Evaluation of VoIP quality over WiBro. *PAM 2007.*

[5] K.T. Chen, P. Huang, and C.L. Lei, How sensitive are online gamers to network quality? *Communications of the ACM, Vol.49, No.11, Nov. 2006.*

[6] P. Svoboda, W. Karner and M. Rupp, Traffic Analysis and Modeling for World of Warcraft. *Proc. IEEE ICC 2007.*

[7] D.M. Kim, H. Cai, and S. Choi, Measurement and Analysis of One-Way Delays over IEEE 802.16e/WiBro Network. *submitted to IEEE VTC'09-Fall.*