Action specific Massive Multiplayer Online Role Playing Games traffic analysis: Case study of World of Warcraft

Mirko Suznjevic
University of Zagreb, FER
Unska 3, Zagreb, Croatia
mirko.suznjevic@fer.hr

Maja Matijasevic
University of Zagreb, FER
Unska 3, Zagreb, Croatia
maja.matijasevic@fer.hr

Ognjen Dobrijevic
University of Zagreb, FER
Unska 3, Zagreb, Croatia
ognjen.dobrijevic@fer.hr

ABSTRACT
In Massive Multiplayer Online Role Playing Games (MMORPGs) players can perform various actions in the virtual world. We try to answer the question how is generated network traffic, and to what extent, dependent of the action that player performs and overall context/situation in the virtual world. We have divided action types in four major categories: questing, trading, raiding, and player versus player (PvP) combat. We have carried out action-specific measurements of the network traffic for the World of Warcraft (WoW) game and gathered 1.28 GB of data on which the analysis was performed. The traffic analysis included network bandwidth usage, packet payload size, percentage of data packets in the total traffic, packet rate, and packet interarrival and interdeparture times. While the category of PvP combat has highest overall demands on the client side traffic, raiding imposes highest demands on the server side. Trading showed lowest demands on the both sides in almost all categories of the analysis.

Categories and Subject Descriptors
K.8.0 [**Personal Computing**]: General – *Games*; H. 4.4.3 [**Information Systems Applications**]: Communications Applications

General Terms
Measurement, Virtual World

Keywords
MMORPG, Network Performance Measurement.

1. INTRODUCTION
Massive Multiplayer Online Role Playing Games (MMORPGs) are networked virtual worlds offering big digital environments in which players interact with each other and the environment in real-time. In a MMORPG, a player controls a virtual character (avatar) and his/her actions. We have classified types of player actions into four major categories and have performed measurements for each category to determine the relationship between user's actions in the virtual world and the generated network traffic.

There is a lot of recent work related to MMORPG traffic. In [3] authors analyze the traffic generated by WoW and notice that the delayed ACK algorithm of the TCP protocol is a bad choice for a MMORPG because it brings additional delay into the communication. Traces captured on the server side of the MMORPG *Lineage II* were analyzed and one of the conclusions is that the major characteristic of the MMORPG traffic is asymmetry of upstream and downstream traffic [4]. In [1], authors show the analysis of Second Life traffic patterns which differ significantly from the traditional MMORPGs, especially in much larger bandwidth requirements. The authors have also noted that the traffic characteristics are highly dependent of the number of users in the vicinity and the action currently performed (i.e., walking, flying, or standing). Especially extensive research on traffic patterns of MMORPG game *ShenZhou Online* was done [2] and extended with the criticism of TCP as the base protocol for MMORPGs [5]. Requirements of the certain types of actions in online games and other applications (e.g., telerobotics) have been a subject of previous studies but mostly in terms of latency requirements for successful execution of those actions and overall effects on user perceived quality [6][7]. Network dependency of context of the virtual world has been studied for Collaborative Virtual Environments (CVE) [8] in the late 1990s but since then virtual worlds have evolved significantly in number of users and overall complexity.

NetGames'08, Worcester, MA, USA Copyright 2008 ACM 978-1-60558-132-3-10/21/2008...$5.00

2. Activities in WoW
We have defined specific actions for WoW, but most of them are common to MMORPGs in general. Types of actions differ in number of active participants (players), rate of required player input and overall context of the virtual world (goal of the action, number of active non player characters – NPCs). Through *questing* players perform different sort of tasks that usually involve fighting with hostile NPCs (usual referred as mobs), gathering items, or interaction with friendly NPCs. *Instanced dungeons*, keeps, or other confined areas are parts of the virtual world that only a certain number of players can enter. Each *instance* is created for specific group of players (5, 10, 25, or 40) so they can fight computer controlled mobs inside the instance privately, without being interrupted or helped by the players outside their group. Larger groups of players (i.e., 10, 25, or 40) are commonly called *raids*. *Raiding* is an activity mostly done by large groups of maximum level players (i.e., raids) engaging in battle with very challenging and complex mobs. Through *professions* players can create and collect virtual items. Professions play an important role in upgrading the character and acquiring game money (i.e., gold). *Trading* can be done directly between two players, or through *Auction House* (AH) in which players can create auctions for virtual items and buy items from other players. *Player versus Player* (PvP) *combat* involves battling between players of opposing factions. Combat can occur in *Battlegrounds* and *Arenas*, as instanced battlefields, or in areas of virtual world which permit combat between players. For the purposes of this paper previously described actions are grouped

into four major categories: 1) questing (incl. five men instances), 2) raiding, 3) trading (incl. all profession-related actions), and, 4) PvP combat.

3. Measurement environment and analysis

We have used the software protocol analyzer Wireshark (http://www.wireshark.org) to capture incoming and outgoing traffic on client's side of six PCs using 10 Mbit/s LAN and ADSL access networks. The users were asked to indicate the (type of) activity they performed during the capture. We have obtained 1.28GBs of context specific network traces, and analyzed: (a) the size of data packets sent and received by clients, (b) bandwidth, and (c) traffic patterns for different activities.

The largest size of data packets sent by the client is in PvP situations, next highest payload size has category of raiding and then questing. Trading has the smallest size of client payload. In general, the client payload is very low. Average payload size of all action types is 36 bytes which is less than the typical overhead the TCP/IP protocol stack creates (40 bytes). Server packet size distribution is much wider than the client side. Average payload size varies from 163 bytes for trading, up to 616 bytes for raiding. The amount of data packets sent by the client side varies significantly, as PvP combat has double the number of data packets (58%) as opposed to trading (23%). Server side traffic has average value of 76% data packets with smaller variation than the client side, with highest portion of data packets sent for trading (86%), followed by other categories (values around 72%).

Bandwidth usage for different activities is shown in Figure 1. On the client side PvP combat generates the largest and trading the smallest load on the network. The server side shows greater differences, as raiding uses 20 times more bandwidth than trading. This is expected, since there is much more server-generated information to be handled in raiding compared to other types of actions (such as positions and actions of players and mobs).

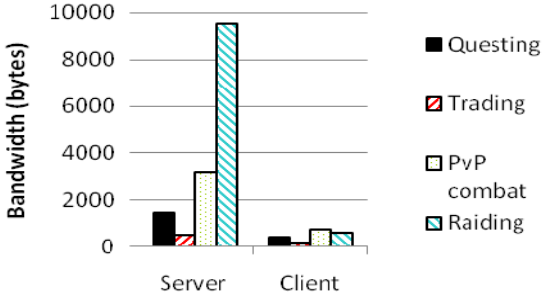

Figure 1 Bandwidth usage for various activities

Number of packets per second is low; average is 10 packets in both ways. It differs little among the client and the server side. Most packets are sent in raiding and PvP combat (10), while amount of packets sent when trading is 3 times lower.

Burstiness of client traffic is very dependant on the action performed as PvP combat has more frequent bursts and up to ten times higher spikes compared to trading. During PvP combat periodic high bursts on the client side almost reach that of the server side. Raiding and PvP combat have in general smaller gaps between sending new packets from the client side due to high rate of player actions. Up to 5% of the updates generated by the client in trading category have interdeparture times greater than 1 second, meaning that the client generating a single packet every second is enough for a realistic virtual experience.

Interarrival times of the server packets show fewer differences between specific actions than interdeparture times. Although a small amount of data is sent, and the overall number of packets per second is low, almost 50% of all the packets have interarrival times less than 0.1 second. This indicates high traffic burstiness. On the other hand, around 5% of the packets in trading category have 1 second and greater interarrival times. In this work we did not study latency, as dependencies of latency and the success rate of player actions are known from previous studies [6].

4. Conclusion

Questing had average values in almost all measured parameters when comparing all the categories. This can be explained by the variety of activities in which a player can engage while questing (e.g., collecting items, combating, resting, talking, or traveling). In terms of update rate, highly dynamic rate of actions and high mobility of the PvP combat situations have resulted in highest values of packets per second, bandwidth used, and the overall amount of data packets from the client side. On the other hand, raiding has the biggest demands on server side traffic. This can be explained with greater amount of data needed to be sent from the server. Trading category has the lowest demands on the network in terms of client side bandwidth, server side bandwidth, packets per second and packet size.

5. ACKNOWLEDGEMENT

Thanks to the characters of the EU Bladefist realm: Bothari, Aika, Belisarius, Divljak, and Naimed. This work was carried out within the research project 036-0362027-1639 supported by the Ministry of Science, Education and Sports of the Republic of Croatia.

6. REFERENCES

[1] Fernandes, S., Antonello, R., Moreira, J., and Kamienski, C., 2007. Traffic Analysis Beyond This World: the Case of Second Life, NOSSDAV'07 (Urbana, IL, USA, June 2007.)

[2] Chen, K., Huang, P., and Lei, C., 2006. Game traffic analysis: An MMORPG perspective, Computer Networks 50, 2006, 3002-3023.

[3] Svoboda, P., Karner, W., Rupp, M., Traffic Analysis and Modeling for World of Warcraft, IEEE International Conference on Communications, 2007, 1612-1617 (Glasgow, Scotland, June 24-28, 2007)

[4] Kim, J., Choi, J., Kwon, T., and Yuk, E., 2005. Traffic Characteristics of a Massively Multi-player Online Role Playing Game, NetGame'05, (Hawthorne, New York, USA October 10-11, 2005)

[5] Chen, K., Huang, C.-Y., Huang, P. and Lei, C., 2006. An empirical evaluation of TCP performance in Online Games, ACE 06 (Hollywood, California, USA, June 14-16, 2006.)

[6] Claypool, M., Claypool, K., 2006. Latency and player actions in online games, Communications of the ACM, Vol. 49, No. 11, (Nov. 2006.), 40-45

[7] Matijasevic, M., Gracanin, D.., Valavanis, K.P., Lovrek, I., 2002. A Framework for Multi-user Distributed Virtual Environments, IEEE Trans. on SMC-B, Vol. 32, No. 4, (2002) , 416-429

[8] Greenhalgh, C., Neford, S., Bullock, A., Kuijpers, N., and Donkers, K., 1998. Predicting network traffic for collaborative virtual environments, Computer Networks and ISDN Systems 30 (1998) 1677 – 1685