Why MMORPG players do what they do: Relating motivations to action categories

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Abstract: This paper presents an analysis of relations between player motivation and behavior in a Massively Multiplayer Online Role-Playing Game (MMORPG). We examine player behavior in terms of when, how much, and what they do in the virtual world. Player motivation is measured in terms of percentile ranks of motivational components for MMORPG players defined by Nick Yee. Player behavior is described through previously defined action categories for MMORPGs (*Trading, Questing, Dungeons, Raiding, Player versus Player (PvP) Combat, and Communication*). We conduct a player survey and perform measurements on the client side for a group of 104 players of a popular MMORPG – World of Warcraft (WoW), and discover that there are strong patterns in player behavior and significant relations between specific motivational components and players' actions in the virtual world. Additionally we examine the importance of both voice and textual (chat) communication in MMORPGs, note that communication makes a significant portion of average player's playtime, and that voice communication is used by a large portion of players. Through understanding of the relations between player behavior and generated network traffic we can describe and anticipate the traffic better, on the scale of one, as well as a large number of users. We believe that the results of this study may be used for improving the models and prediction of MMORPGs' network traffic.

Keywords: MMORPG; Player motivation; Player behavior; Session Characterization; Session patterns; Action categories; VoIP in games;

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1 Introduction

Massively Multiplayer Online Role-Playing Games (MMORPGs) have been evolving rapidly in the past decade. Virtual worlds in which these games take place have became more and more complex, with increasing array of possible actions. Also, the number of players participating in MMORPGs has increased greatly in the past years, reaching 22 million active subscriptions (www.mmodata.net, 2010). Although it has been shown that online games traffic has certain properties such as large, high periodic bursts of very small packets with predictable long term rates (Maier and Herzog, 2010), due to the increasingly large number of users and different behavior of those users, MMORPG traffic – especially in the upstream direction – is difficult to predict and model. We aim to model the MMORPG traffic not just on the packet level by describing the statistical properties of observed traffic, but on the source level, further and in more detail analyzing the sources of the traffic. In order to better model a source of the MMORPG traffic we need to understand the relations between generated traffic and the context of situation in the virtual world, and behavior of the players which caused such a situation. This approach requires a better insight into *what, when,* and *why* players do what they do in the virtual world. In this paper we aim to provide an answer to those questions and provide a basis for the traffic modeling for MMORPGs based on players' behavior. As a case study we use World of Warcraft (WoW), a highly successful MMORPG. This work is an extended version of our previous work (Suznjevic et al., 2009a).

In our previous work (Suznjevic et al., 2009b, 2008), we have tried to find an answer to the question *what* players do in the virtual world. We have defined five categories of user actions for MMORPGs: *Questing, Trading, Dungeons, Raiding,* and *Player versus Player combat*. These categories have been defined based on several parameters such as number of players, input characteristics, mobility of the players' characters, etc. We have also introduced and investigated another action category, termed *Communication*, to determine how important is the social aspect of the game, and how much players communicate with each other by using text or voice (Suznjevic et al., 2009a). By measuring the traffic on client side we have identified network traffic characteristics for each of the defined categories.

In order to answer the question *when* we continue examining quantitative properties and time dependencies of a specific action category (daily, weekly, and in

the whole time period). Our goal is to determine the patterns of players behavior. We are using a player sample of 104 players and also, a different time frame in regard to our previous measurements (Suznjevic et al., 2009b, 2008). Those measurements were taken at the time when the game was just updated with a new expansion ("Wrath of the Lich King") which brought a large amount of new content. Measurements taken for this work were in a stationary period as related to the game release, where by "stationary" we mean a time period in which the players have, in general, become familiar with the current game content and new content has not been added recently. Our monitoring period was from May 5, 2009 to June 21, 2009, and the last previous content patch was applied on April 14, 2009. Measurements of player behavior were taken on the client side by using WoW Session Activity Logger (WSA-Logger), our WoW add-on. The add-on is available, as open source, on our web site (Suznjevic, 2010) for use under GPLv3 license.

MMORPGs are not played just by teenagers, but by people of every age and gender (Williams et al., 2008). As MMORPGs offer many options to their players, different people are attracted to different things in these games. In order to answer the question *why*, we need knowledge about what motivates players, and how do these motivations reflect on their actual behavior and through that on the network traffic they generate. We examine existing models of psychological motivation for MMORPGs and try to perform a mapping to our action categories. Measurements of players motivations were performed through an existing online survey (Yee, 2010), which participating players filled in and reported their results (i.e., percentile ranks on each motivational component). The difference in motivation can explain very variable behavior of individual players and lead to a more precise modeling of the generated traffic on a level of a single player (e.g., player highly motivated for *Raiding* will have more frequent and longer sessions consisting of that action type).

Another important phenomenon which occurs in the current MMORPGs is voice communication through various Voice over Internet Protocol (VoIP) clients (inbuilt in MMORPG clients and independent alike). Characteristics of VoIP traffic have already been thoroughly studied, and they represent a significant load on the network when compared to regular MMORPG traffic. This is also why it is important to know how much players communicate in MMORPGs, by what means, and when. The participating players filled in a survey regarding their use of voice communication, and in-game text communication was measured through WSA-Logger. Measuring the amount of communication is also an empirical way of determining how important is the social aspect of the MMORPGs, and how much that aspect contributes to their popularity amongst players.

Results of this work can be useful for game design (creating adaptable games which will offer different options based on player motivations), network engineering (predicting the load), and also for design of servers hosting virtual worlds (geographical distribution of the avatars and load, based on action categories e.g., *Raiding* is done in only specific areas of the virtual world). The remainder of the article is organized as follows. In the Section 2 we discuss the related work, followed by description of motivation components and action categories in Section 3. In Section 4 we describe the methodology. In Section 5 we provide the results and we conclude the paper in Section 6.

2 Related work

We now briefly summarize the findings in related research work in the areas of session characteristics, psychological motivations and social aspects of MMORPGs. Using a trace sample gathered for almost two years, Tarng et al. (2008) analyzed WoW player's game hours. Additionally, they investigated whether it is possible to predict player subscription time. Zhuang et al. (2007) calculated player availability, inter-arrival times, and geographical distribution of players in the virtual world from the dataset gathered for five months with the help of a WoW add-on. Pittman and GauthierDickey (2007) measured geographical distribution of players in WoW. Feng et al. (2007) have studied the trace of MMORPG EVE Online, which was provided to them by the publisher of the game (CCP). They focused on prediction of the workload and predictability of players' disinterest in the game. Chen and Lei (2006) studied player interaction its relationship with players' game time. Our approach to player session characterization differs from others as we determine exactly what the players do in the virtual world and for how long, as opposed to examining just overall session time. Also, we have higher precision, compared to related work (i.e., 1 second, as opposed to 10 and 5 minutes), as well as accuracy, since we determine the actions taken by a specific player regardless of his/her current game character. Another difference is that we inobtrusively collect data on players' computers as opposed to probing-based measurements which check the player population by having a single player run the polling scripts.

First description of player's motivation for Multi User Dungeons (MUDs) has been given by Bartle (1996). He divided the players into four major categories through a player interest graph with two axes: *players – world* and *acting – interacting*. Bartle further extended his categorization by adding a third *implicit – explicit* axis into the graph, resulting in a total of eight player types (Bartle, 2003). Also, he determined development tracks for players' evolution (switching between player types) during the course of the game. Bartle's original model was criticized by Yee (2007) who argued that each MMORPG player shows a number of different motivations for play, which are related to different types, and that players can not be categorized through types. Based on a 39-question survey taken on 3200 players of different MMORPGs, through the principal component analysis Yee has determined 10 distinct motivational subcomponents and grouped them into three major components: *Achievement, Social,* and *Immersion*. By combining the Big 5 personality test with items from Yee (2007), demographic information, and MUD type, van Meurs (2007) performed a study on 1741 players and designed a new model for Bartle types. In this work we have decided to empirically test Yee's model of players' motivations.

Social aspect of MMORPGs' has been studied intensively. Kang et al. (2009) study social support of guilds on and its impact on players' game flow and loyalty. Ducheneaut et al. (2006) study social relations and find that joint activities are not so prevalent, especially in the early game stages. To the best of our knowledge no work has been done in order to measure actual players' communication time and by that quantitatively describe the social component. Since the share of voice communication traffic in the overall network load of the MMORPG can be significant, we consider it important to determine how much and when players use voice communication.

3 Motivation – behavior relationship

In order to define a mapping between players motivations and their actual behavior we first formally describe the motivational components and the characteristics of action categories, on the basis of which we define several hypotheses which are later tested through measurements.

3.1 Motivational parameters

The motivational components and subcomponents defined by Yee (2007) which serve as a basis for our hypotheses about relations between player motivation and their actual in-game behavior are briefly described next. The model of player behavior consists of 3 major motivational components: *Achievement*, *Social*, and *Immersion*, which comprise a total of 10 subcomponents as follows.

- *Achievement* consists of three subcomponents:
  - *Advancement:* The desire to gain power, progress rapidly, and accumulate in-game symbols of wealth or status.
  - *Mechanics:* Having an interest in analyzing the underlying rules and system, in order to optimize character performance.
  - *Competition:* The desire to challenge and compete with others.
- *Social* consists of three subcomponents:
  - *Socializing:* Having an interest in helping and chatting with other players.
  - *Relationship:* The desire to form long-term meaningful relationships with others.
  - *Teamwork:* Deriving satisfaction from being part of a group effort.
- *Immersion* consist of four subcomponents:
  - *Discovery:* Finding and knowing things that most other players don't know about.
  - *Role-Playing:* Creating a persona with a background story and interacting with other players to create an improvised story.
  - *Customization:* Having an interest in customizing the appearance of their character.
  - *Escapism:* Using the online environment to avoid thinking about real life problems.

3.2 Action categories

In a typical virtual world of a MMORPG, the player controls a virtual character (avatar) which represents him/her in the virtual world. Players may perform a variety of actions, which can differ somewhat depending on the game content. Nevertheless, several key fundamental elements common for the most MMORPGs, may be identified: progression or advancement in player's level, power, social interaction, in-game culture, and character customization. In our previous work (Suznjevic et al., 2009b, 2008) we have defined specific action categories, with the focus on player progression. We do not attempt to model all possible player

actions, just the actions that lead to players progression in terms of character level, power or wealth (e.g,. we do not try to explain or model antisocial behaviors like "griefing" (i.e., purposely irritating and harassing other players)). These categories are based on a variety of factors, such as: the number of actively participating players, the number of active Non-Player Characters (NPCs), the dynamics of player input, mobility of the character, combat, cooperation required, and the communication aspect. We have used WoW as a case study to which these action categories have been defined, but they are considered to be applicable to other MMORPGs as well. We briefly summarize the properties of each category:

Trading: A single, or two-player activity consisting of the exchange of virtual goods between two players directly, or through auction system, and creation of virtual items. Characteristics are: low mobility, low player input rate, and low complexity.

Questing: Mostly single player activity consisting of solving different tasks given by NPCs for specific rewards (e.g., experience and virtual items). This is the most important progress category until a player reaches the maximum possible level of his/her character. It has been shown that each player tends to progress at his/her own pace, and only asks or tends to group with other players when the required task can not be done alone (Ducheneaut et al., 2006). Characteristics are: medium mobility, low to medium action rate, and low number of NPCs involved.

Dungeons: Primary a small group activity consisting of combat between small groups of players and hostile NPCs, in specific instances (i.e., isolated portion of the virtual world replicated for each group of players), which allow no interruption nor help from players outside that group. Characteristics are: limited player number, medium mobility, medium input rate, and medium number of NPCs involved.

Raiding: Fighting between large groups of players and more difficult and complex NPCs. Similar to *Dungeons*, but larger on all scales, so characteristics are: high number of players and NPCs, high input rate, medium mobility, and increased complexity of the task with high cooperation requirement on participating players. This is amongst the most challenging and complex tasks, so the value of the prizes for players is the highest.

PvP combat: Combat between players in instanced or non-instanced battlefields. Characteristics are: almost no NPCs, high mobility, high input rate, as well as high complexity of the tasks. Player count may vary significantly, from only few players to hundreds of players involved. Highly competitive, best ranked players earn highly valued rewards.

Communication: This category is not reflecting player behavior, but the amount of time they spent communicating with each other. It is the only category which can occur concurrently with other categories. Other categories are strictly distinct (e.g., player can be communicating and *Raiding* at the same time, but can not be in *PvP combat* and *Dungeons* simultaneously). In *Communication* category we only consider time periods in which the messages are sent through the inbuilt chat client. We do not consider the player as communicating when just receiving chat messages, as the players can be "joined in" many chat channels, in which they may (or not) actually participate.

Additionally, in our previous research we have identified parts of the data log which remain uncategorized and for that data we introduced an *Uncategorized* action category. Within this action category we further identify: 1) the time spent

inactive, or Away From Keyboard (AFK), and 2) actions not belonging to any other category. The latter include actions of continuous killing monsters for profit (commonly know as "grinding"), gathering virtual items (e.g., ore for smelting, or herbs for potion making), or chasing achievements (i.e., records of specific tasks being completed, e.g., gathering and eating one hundred chocolates).

3.3 Hypotheses

As *Raiding* and *PvP combat* are two action categories which yield the most in terms of character improvement at the maximum level, we assume that the players highly motivated by *Advancement* will spend a greater (than average) amount of time performing them. *Questing* is the prime activity for obtaining experience and therefore the leveling process and it is positively associated with this motivational subcomponent in the early stages of the game in which the players have not reached the level limit, but we do not assume such as association as the time when the measurements took place most of the players have already reached level limit. *PvP combat* is a highly complex activity. To perform well, players need to have a deep knowledge of not only the functions of their own character, but the functionalities of other players, and also to anticipate their moves. Therefore, we assume that it will be positively associated with the knowledge about mechanics of the game. Also, the highest competition is in the *PvP combat* action category, as players can actually be ranked in comparison with other players and this information is visible in the game, as well as through the player rankings on the game's web site, so we assume a positive dependency.
Socializing and *Relationship* are motivational components which are hardly mapped to our action categories. We assume that these kind of human interactions are mostly realized through communication between players. In this way, we foresee that amount of communication between players will be increased for those who score highly on these two motivational components. *Teamwork* is connected to a group effort, therefore the players more motivated by this subcomponent should perform more group based actions such as *Dungeons* and *Raiding*. As for the *PvP combat* category, it is difficult to assume the latter, as players often perform *PvP combat* "alone in the group". They join PvP battles through the help of the game mechanics, and often actually do not try to perform as a part of a group or in cooperation with others (e.g., a typical player entering a battleground in WoW is assigned to a random group of players).
Exploration in WoW is mostly done through *Questing*, as some tasks encourage players to go to areas of the world they have not yet explored. Motivational subcomponent *Role-Playing* is more focused on role-playing in terms of acting out characters in unscripted situations such as in an improvisational theater (e.g., player only speaks from the point of his/her character). This kind of role-playing is supported on dedicated role-playing (RP) servers. *Customization* and *Escapism* can not be mapped on our action categories, as players can escape their real-life problems by doing any of the defined actions, and customization is rather limited in WoW and it has not been taken into account. On the basis of given descriptions, the following nine hypotheses were formed:

- *H1. Advancement is positively associated with Raiding*
- *H2. Advancement is positively associated with PvP combat*

- *H3. Mechanics is positively associated with PvP combat*
- *H4. Competition is positively associated with PvP combat*
- *H5. Socializing is positively associated with Communication*
- *H6. Relationship is positively associated with Communication*
- *H7. Teamwork is positively associated with Dungeons*
- *H8. Teamwork is positively associated with Raiding*
- *H9. Discovery is positively associated with Questing*

4 Methodology

We applied several measurement procedures to obtain all required data. Motivation of the players was evaluated through the online motivational assessment designed by Yee (2010). Each of the participating players also filled in a questionnaire about the use of voice communication. Players' actual in-game behavior was measured through the use of our add-on for WoW named WSA-Logger (Suznjevic, 2010). WSA-Logger is developed using ACE3 framework (www.wowace.com, 2010) and Blizzard Entertainment's WoW Application Programming Interface.

All measurement were done through a student project which granted the participating students part of the credit for the course. The task of each student was to involve five or more WoW player volunteers who would agree to participate in this research by installing and using the WSA-Logger. Students used various means to find volunteers, such as asking on several WoW Internet forums, finding fellow students who played WoW, or asking friends in the game since some of participating students were already WoW players. No personal data about participating players, other than age, was gathered. This method of obtaining the player sample resulted in an (on average) younger player sample than the general population of MMORPG found by Williams et al. (2008), as shown in Table 1 (average age 24 compared to average age 33, respectively). Students needed to collect and organize data gathered by the add-on and percentile ranks obtained through motivational assessment, as well as to perform a voice communication survey on their player sample, and to write a report summarizing their findings. The total number of participating players was 104. We acknowledge that the sample size is relatively small compared to other works in the area, but in compensation we examine the behavior of every player in much more detail. The limiting factor on the player base was drawn from the fact that players need to volunteer to participate, to download and turn on the WSA-Logger on their

Table 1 Players' sample age comparison

Age range	Our sample	Williams et al.
Teens 12-17	6.73%	6.45%
College-age 18-22	43.27%	12.40%
Young adult 23-29	38.46%	26.27%
Thirties 30-39	8.65%	36.39%
Forties 40-49	1.92%	12.40%
Fifty or older 50+	0.96%	4.80%

computers, and submit the gathered data. Other works in the area used a single character which would take note of all currently active characters in the virtual world. By using this method we made a trade-off between involving a high number of players and the level of detail of gathered information. The biggest issue with distributing the add-on was the trust of the players who feared for the safety and privacy of their accounts.

4.1 Motivational assessment and voice communication questionnaire

The *Motivations Assessment* designed by Yee (2010) is a survey consisting of 39 multiple-choice questions with answers offered in form of 5-point Likert scale. This is an example of the question form used in the assessment: "*How important is it to you to be well-known in the game?*", with following possible answers: "*Not Important At All, Slightly Important, Somewhat Important, Very Important, and Extremely Important*". At the end of the assessment, player's percentile ranks in the 10 motivation subcomponents against a sample of 3200 original respondents are shown in several graphs. Each participating player filled in the assessment and reported his/her percentile ranks on every motivational component. As indicated by Yee (2007), the descriptions for each motivational subcomponent emphasize what it means to score high on the specific subcomponent. Scoring low on these subcomponents reveals that a player is not interested in those motivators. Therefore, while testing our hypotheses we have looked only at the players with score rank over of 80 out of 100 in a particular motivational subcomponent. Also, for the negative relations we have looked at the players who scored lower than 20. These limits were determined in several tests as setting the 90/10 limit resulted in too few players to perform the analysis on. Setting the bars to 70/30 and lower would be in contrast to the definition of the motivational components. Each of the hypothesis relates one motivational subcomponent to one action category. The algorithm for testing each hypothesis is as follows:
1) Extract the players with rank score over 80 and rank score below 20 in specific motivational subcomponent (N_{high}) and (N_{low});
2) For each of the extracted players compare the time spent in the target action category with the average value of the whole sample (these values are determined through the analysis of the data obtained with WSA-Logger);
3) Observe the number of players with higher than average time spent in the targeted action category in the player group with rank score over 80 (M_{high});
4) Observe the number of players with lower than average time spent in the targeted action category in the player group with rank score below 20 (M_{low});
5) Calculate the percentage of players conforming to the hypothesis in the following way $(M_{high} + M_{low})/(N_{high} + N_{low})$.
The questionnaire we used consists of 5 multiple choice questions regarding the frequency of voice communication usage throughout action categories, with answers offered in form of 5-point Likert scale. The form of the questions conforms to the example: "*How often do you use voice communication while in Raiding instances?*" with following possible answers: "*Always, Often, Sometimes, Rarely, Never*". Also, we investigated the general use of VoIP while playing and popularity of common VoIP applications (i.e. "*Do you use a VoIP program for voice communication while playing, and if yes, which one?*").

4.2 Data gathering: WSA-Logger

The WSA-Logger records the events fired by the WoW API when a certain action is performed in the virtual world. For example, the *Bank_Frame_Open* event is fired once the bank interface is displayed and the WSA-Logger notes the date, time, and player action type as *Trading*. We have tracked only events that could be classified as action specific (e.g., entering a battleground instance for *PvP combat*). As an output add-on generates a log file which consists of the chronological list of all events that were collected during the monitored period. By analyzing this event list we can extract the data about player behavior in terms of specific categories (i.e., retrace all relevant player actions).
Compared to the previous version (Suznjevic et al., 2009b), the functionality of WSA-Logger has been extended in order to track communication. WoW client has simple and effective chat mechanisms. There are several chat commands which enable communication amongst players. Communication command */say* is used to communicate with people who are nearby in the virtual world, */yell* is a similar command allowing the people on a larger virtual territory to see the message. Players joined in a guild can always communicate with each other, no matter what their position in the virtual world is through a specific, guild-only channel. Players can also use private chat channels to talk to each other. In general, there are many channels and players can easily create new ones. In addition to text messages, there are "emotes", messages which are done by the virtual character (e.g., */wave* causes the character to wave). All of these types of outgoing messages are tracked. The downside of message tracking is that the log files generated by the add-on have significantly increased in size. The second modification was made in order to increase the precision of the add-on. The previous version tracked time based only on *GetGameTime()* method from WoW API, which only returned time in hours and minutes. By using an additional library (www.wowwiki.com, 2010), we have increased the precision to one second. The only disadvantage of the library is that for the very first minute of the session, seconds are not tracked. Compared to other work in this area, this is currently, as of June 2010, the highest achieved event monitoring precision.

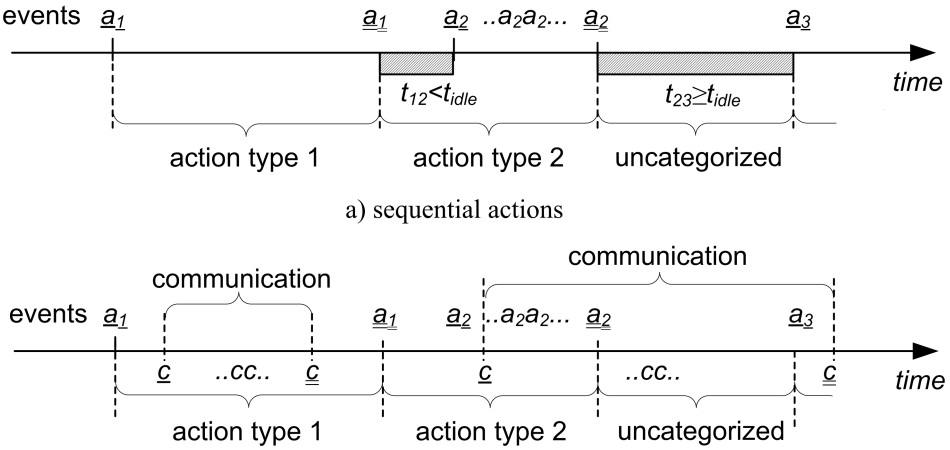
4.3 Data analysis

For the analysis of the log files provided by the add-on, we developed a log file parser in Java. The monitored session characteristics include overall session duration and player activity within a session (i.e., player behavior in terms of action performed). As for the session duration, we define it as the time interval between the time when the player logs in to the game and the time of the corresponding logout from the game. In respect to our previous work (Suznjevic et al., 2009b) we have refined the definition of a session. In the previous version of the parser, we observed the time between login and logout of a specific character as one session. Through this change we wanted to alleviate the effect of "alts" phenomenon. Alts or alternative characters are most often used as a storage space for the primary (main) characters, or for trading and crafting purposes. These characters are most often used just for a brief while (e.g., for creating several

items and transferring them to the main character) which results in very low session duration values. With this change, a player could switch between characters (during the maximum timeout period of 5 minutes) and the elapsed time would be recorded as a single session. Additionally, this approach solved the problem of disconnecting, so that the player reconnects within the timeout period the session is considered uninterrupted.

We define a "session segment" as a part of the playing session in which the player performs only actions from a specific category. Session segments of *Dungeons*, *Raiding*, and instanced *PvP combat* are labeled with their start and end time (there are specific events labeling entrance and exit from the instanced areas), and segments of *Questing*, *Trading*, *Communication*, and non-instanced *PvP combat* are noted as a chain of events. So, one *Raiding* segment is represented with the time between entrance and exit of the raiding instance. If a player enters a raiding instance subsequently, it is treated as one *Raiding* segment. For non-instanced categories, such as *Trading*, an action specific session segment is defined as the time between the first and the last event in the chain of events of the same category. Time between two events of different categories is labeled as belonging to the second category, as we assume that the change of context occurs when the player performs last action in the sequence of actions of one type (Suznjevic et al., 2009b). If the time between two events of a specific category is larger than the timeout period of 5 minutes, it is labeled as *Uncategorized*.

Action category *Communication* differs from the other five categories as it happens concurrently with other actions and it is thus monitored in parallel with all other actions, by collecting outgoing messages. If the time between sending two messages is shorter than 5 minutes, it is added to the ongoing communicating session, and if it is longer, it is discarded as a given *Communication* session is considered to end when no messages are sent for five minutes. Figure 1 illustrates how the duration of a specific action category within a session is determined. Part a) shows sequential actions. The following example illustrates the relationship between events in WoW API and action categories. Players enter the instance ($\underline{a_1}$) of *Dungeons* category (action type 1 in the figure). After defeating the opponents and exiting the instance ($\underline{\underline{a_1}}$), players go into town to perform some *Trading* actions (action type 2). They repair equipment ($\underline{a_2}$), sell unneeded items (a_2), and store the needed ones in the bank ($\underline{\underline{a_2}}$). The time period between exiting the instance and repairing is shorter than the timeout period, so it is assigned to the latest action category. After storing the items in the bank, the player rests for a while. The time between him starting the next action ($\underline{a_3}$) turns out to be longer than the timeout period and it is thus labeled as *Uncategorized*. Part b) shows Communication as an interleaved action. For example, while in a dungeon [$\underline{a_1}$–$\underline{\underline{a_1}}$], the players encounter a hard NPC opponent and are discussing the tactics to defeat it [$\underline{c}$–$\underline{\underline{c}}$]. This time period is assigned to *Communication* while at the same time being a part of *Dungeons*. Later, while in town, the players start to chat and that initiates the second communication segment (another *Communication* period in parallel to action type 2 and beyond).



a) sequential actions

b) interleaved actions

Legend:

a_i – *any observed event of action type* i
$\underline{a_i}$ – *first observed event of action type* i
$\underline{\underline{a_i}}$ – *last observed event of action type* i
t_{ij} – *time interval in-beween the intervals assigned to action types* i *and* j
c – *any observed event of communication*
$\underline{c}$ – *first observed event of communication*
$\underline{\underline{c}}$ – *last observed event of communication*
t_{idle} – *threshold for assignment of* t_{ij} *to either action or uncathegorized*

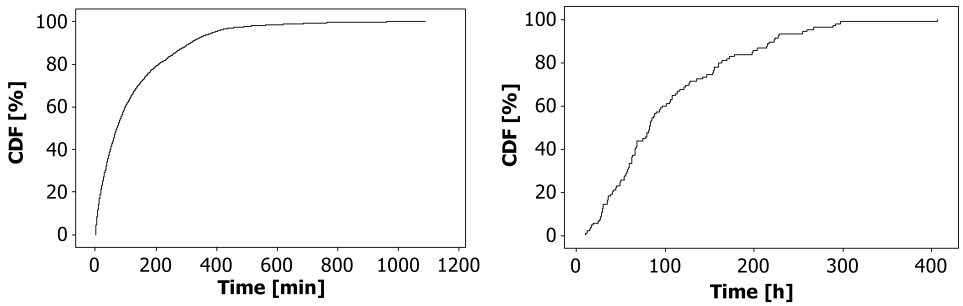
Figure 1: Determining the duration of a specific action within a session

5 Results

From the data we gathered with WSA-Logger we extracted the statistical characteristics of all action categories, the session duration time, and the behavior of players during the day, during the week, and during the whole monitored period. From the data gathered throughout the survey we extracted the values about usage of VoIP clients and how often people use voice communication depending on the action category. In order to test our hypotheses the data gathered about the motivational parameters was compared with the player behavior tendencies gathered with WSA-Logger.

5.1 Session characteristics

We have established that the acquired data consists of 11775 individual sessions. First, we defined a session as comprising all events and player's actions during the time between login and logout from the specific character. This resulted in the mean session time is 56.17 minutes with the longest session lasting over 16 hours, which is consistent with the results of our previous research with average value of 54.92 minutes (Suznjevic et al., 2009b). The median is 25.41 minutes. Other researchers have established different medians of session length of 1.8 hours and 50 minutes, but with different measurement precision: 10 and 5 minutes, respectively (Tarng et al., 2008; Zhuang et al., 2007). Pittman and GauthierDickey (2007) found that more than 50% of sessions are shorter than 15 minutes, by using *friends* list to achieve granularity of approximately 30 seconds. The difference of the times



(a) (b)

Figure 2: CDFs of (a) session times and (b) monitored time per player

in the literature can stem from the precision of a particular measurement. In order to disregard the effects of disconnecting, reloging, and using alts, we adjusted our parser to treat all sequential sessions that lasted less than 5 minutes between player's logout and a new login as one session. By applying this method, the median time increases to 71 minutes. The CDF of the session times captured with these settings and the CDF of whole period of monitoring across players is presented in Figure 2. If we disregard all sessions lasting under 10 minutes, the median increases to 90 minutes. In our effort to better determine the time characteristics of a specific action category and decrease the effect of interleaving actions (e.g., handing in quests that yield honor points which triggers events belonging to *Questing (Quest_Finished)* and *PvP combat (Honor_gained)*), we have added some limitations to the minimum value of a specific category. Minimal values for *Dungeons* and *Raiding* were set to five minutes, as it is almost impossible to reach and defeat main NPC enemies in those instances in less time. Limits on other actions were set to one minute. Statistical time characteristics of a specific category can be observed in Figure 3. Related to our previous research (Suznjevic et al., 2009b), *Dungeons* tend to be shorter, probably because the game content is not new anymore, and players are generally more powerful (i.e., players

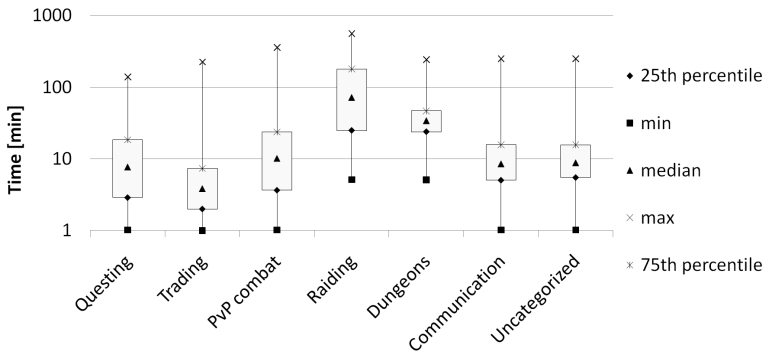


Figure 3: Statistics of time length for particular player actions

got better equipment), so they can complete tasks in less time. On the other hand, *Raiding* has longer duration. As players hit the level cap they can only improve through obtaining better equipment, first from dungeons and after that only through raiding, which results in longer raiding sessions. Also, game designers tend to add more *Raiding* instances which are increasing in difficulty during the life of the game. The rest of the activities have similar or slightly shorter times. The same relations amongst categories remain with *Raiding* as the longest activity, followed by *Dungeons* and *PvP combat*. As shown in Figure 4, we have successfully categorized more than 70% of the session time. The results show that players have spent most of their playtime in category *Raiding*, followed by *Communication*. By tracking text based communication we have recorded 456228 messages. Message sending is, in general, very bursty, as more than 50% of the messages have the time period between sending two subsequent messages of 20 seconds or less. According to the player survey results, voice communication is used by more than 94% of the participating players. Players were also asked which program they use for voice communication (multiple answers were allowed). The most popular program in the observed player group is Ventrilo (75%), followed by Team Speak (21%). Approximately 11% of players use Skype. Also, it is interesting to note that only 16% of the players use VoIP client that is inbuilt into WoW, the Voice Chat. This indicates that the Blizzard's VoIP solution is not well accepted among the players, although it was deployed in late September of 2007, almost a year and a half before our measurements were taken May/June 2009. One of the disadvantages of the inbuilt voice chat is that it is disabled when a player exits the WoW client, so if a player is disconnected from the game server during combat, the voice communication is interrupted as well. For players, it is often useful to maintain communication even when they are disconnected from the game server. Hence, most players tend to use independent programs, even at an additional cost. In our survey, the players were asked how often they use voice communication depending on the action category. The reported frequency of use of voice communication across action categories is shown in Figure 5. We can see that almost 70% of players "always" use voice communication while *Raiding*, followed by *PvP combat* with almost 15%. Many raiding guilds have voice communication as mandatory, which may be one of the reasons for such high use of it while *Raiding*. Players that

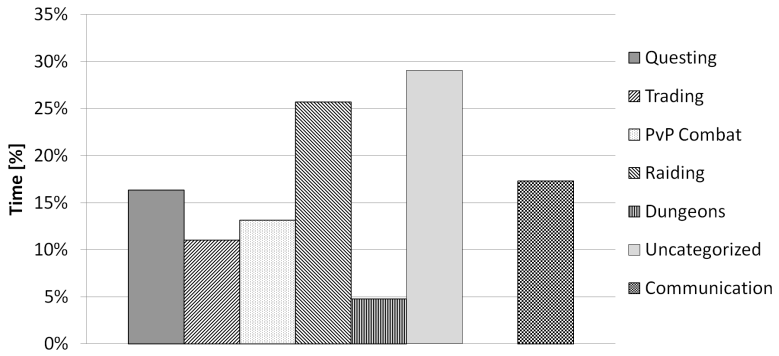


Figure 4: Percentage of time spent playing per category

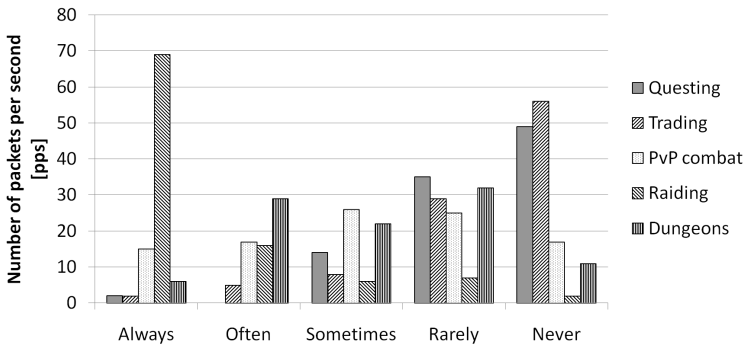


Figure 5: Usage of voice communication per category

participate in highly organized *PvP combat* (i.e., arena combat, or premade groups for battlegrounds) also often use voice communication for better coordination, which explains why *PvP combat* has second highest voice communication usage. *Questing* and *Trading* are simple and not group-based activities, which explains the fact that almost half of players "never" use voice communication in these situations.

5.2 Motivations – behavior hypotheses

In Figure 6, the statistical distribution of motivational subcomponents derived from the survey is shown. It is worth noticing that subcomponents of *Achievement* are the strongest motivators. Only *Teamwork* out of all other subcomponents, is close to *Advancement*, *Mechanics*, and *Competition*. Subcomponents of *Immersion* are the least significant in our player base. The age of the game might have an influence here, as the game was, at the time when the measurements were taken, almost four and a half years old, and most of the players were quite familiar with it (we can see the *Discovery* subcomponent is the lowest of all). Low amount of possible customizations may be the reasons for low score of the *Customizing* subcomponent. In our sample players mostly played on PvP servers (92), than on Normal servers (23) and only 4 of the players played on RP servers which may be accounted for low ranks on *Role-Playing* motivational subcomponent. Values shown in Figure 4 are representing average percentage of time spent in particular category which are referenced when the player behavior is tested (e.g., while testing H1 we first separate the players who scored over 80 in *Advancement* and than compare their time spent in *Raiding* category with the reference value which is 26%, also we separate the players who scored below 20 in *Advancement* and test did they spent in *Raiding* category less than the reference value). Results of the data analysis across all hypotheses is shown in the Table 1. In first column the percentage of players who conformed with the hypothesis (only players with extreme rank score in specific motivational component (i.e., over 80 and below 20) were tested). The second column contains Pearson's r coefficient, and the third column contains Kendall's $\tau - b$ coefficient derived from the whole player sample. Strength of the association is determined based on these parameters. Most of the presented correlation coefficients are rather weak, but confirm the trends shown by

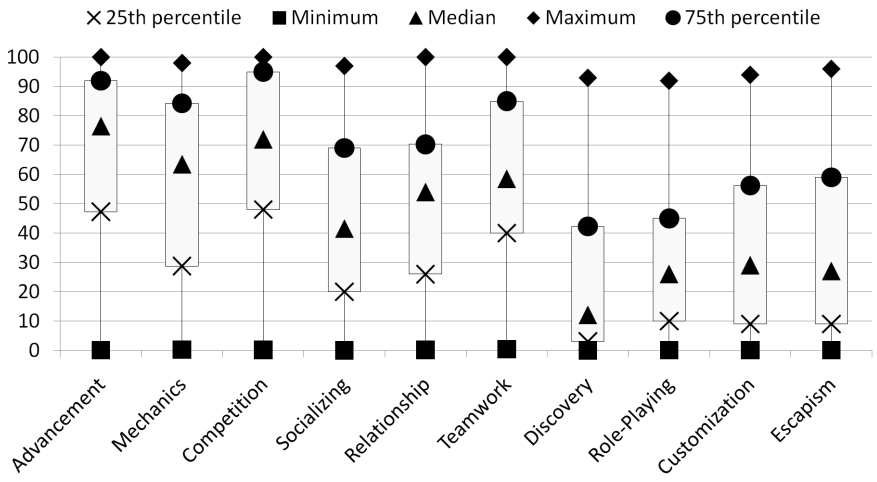


Figure 6: Statistics of the motivational subcomponents

the percentages.

As it can be observed from the Table 2 both hypotheses H1 and H2 are not strongly supported by the data. We tried to determine the relationship between players highly motivated by *Advancement* who have increased time spent in *Raiding* and those who have increased time in *PvP combat*. It has been shown that those two player pools are very distinct, meaning that players are either focused on "Player versus Environment" (PvE) or "Player versus Player" (PvP) aspect of the combat. As high as 89% of players who have high *Advancement* component have increased playtime in either *Raiding* or in *PvP combat*. The hypotheses H3 approved to be false as it is proved that increased knowledge of the game mechanics is not positively connected to the *PvP combat* category. H4 is only in which the the statistics suggest the opposite relationship, while the percentage of the players does not confirm the hypothesis, correlation coefficient suggest the different. The hypothesis H5 is weakly positive while H6 has a stronger positive association. This means that the *Social* component has an influence on

Hypothesis	Conforming players	Pearson's r	Kendall's $\tau - b$	Association strength
H1	61%	0.1079	0.0610	Weakly positive
H2	37%	-0.0335	-0.0008	Weakly negative
H3	38%	-0.1029	-0.0839	Weakly negative
H4	42%	0.2084	0.1631	Inconclusive
H5	56%	0.1315	0.0951	Weakly positive
H6	68%	0.1675	0.1160	Positive
H7	17%	-1617	-0.1028	Strongly negative
H8	77%	0.1684	0.1072	Positive
H9	62%	0.1231	0.0995	Weakly positive

Table 2 Statistical data about player's conforming to hypotheses

the amount of time players spent communicating, but it is not that significant. The amount of time players spend communicating by voice has not been measured, but only the percentage of players who use voice communication. These results showed that 100% of players who had increased *Social* subcomponent used voice communication while playing, though the number of players in the sample who used voiced communication was also very high - 94%. The explanation to very different results of H7 and H8 can be in the actual teamwork requirements of a small group and a large group activities within WoW. *Dungeons* are made as a content which is used in the process of obtaining the maximum level. As players reach the maximum level and make significant progress in the power of their characters in terms of character equipment (e.g., weapons and armor), *Dungeons* tend to become very easy, even trivial. This results in teamwork not being required in *Dungeons*. On the other hand, *Raiding* instances are made very complex to grant the best rewards. We showed that players most often use voice communication while *Raiding*, when the cooperation between them has to be very good. This is proven by the fact that only a portion of players can complete *Raiding* instances. The results have showed that H9 hypothesis has a weakly positive association with 62% of the players conforming to it.

5.3 Patterns of player behavior

Proportion of action categories during the day, during the week, and during the whole monitored period are shown in Figure 7. *Raiding* shows the strongest patterns as it requires a highest number of specifically designated and organized people. It is usually done by guilds (i.e., player organizations) which tend to be rather small, with average size of 16.8 and 90th percentile of the distribution of 35 players (Ducheneaut et al., 2006). Also, *Raiding* needs a group of 10 or 25 members (even 40 in original WoW without expansions) so that is how many people in the guild need to be present in order to start the raid. As opposed to *PvP combat* in which large groups of players are entering battlegrounds with the help of the game mechanics, in *Raiding* players need to organize themselves to play. As shown in Figure 7, *Raiding* shows a significant incline around 18:00 and starts to decline around 23:00, corresponding to the availability of players. This could be expected since the average player's age in our sample is 24, so it may be presumed that most of them work or attend classes during the day. While many previous works show that weekends have higher amount of time spent playing, we observed higher playtime only on Sunday and not on Saturday. This is caused by a specific weekly raiding pattern. Thursdays have highest *Raiding* activity, which has lower values on Fridays and Saturdays. Most of the raiding guilds do not raid on Friday and Saturday which can be explained by the fact that Fridays and Saturdays night are most often used for socializing in real-life, and especially by younger people. As our player sample is younger than the average player base, this phenomenon is even more emphasized. The rest of the activities are evenly divided across the days of the week. The weekly pattern is also easily discernible when we look at the whole monitored period. An interested reader can compare and see that this period is indeed "stationary" in terms of distribution of playing time across action categories, as opposed to the period we examined in our previous research (Suznjevic et al., 2009b).

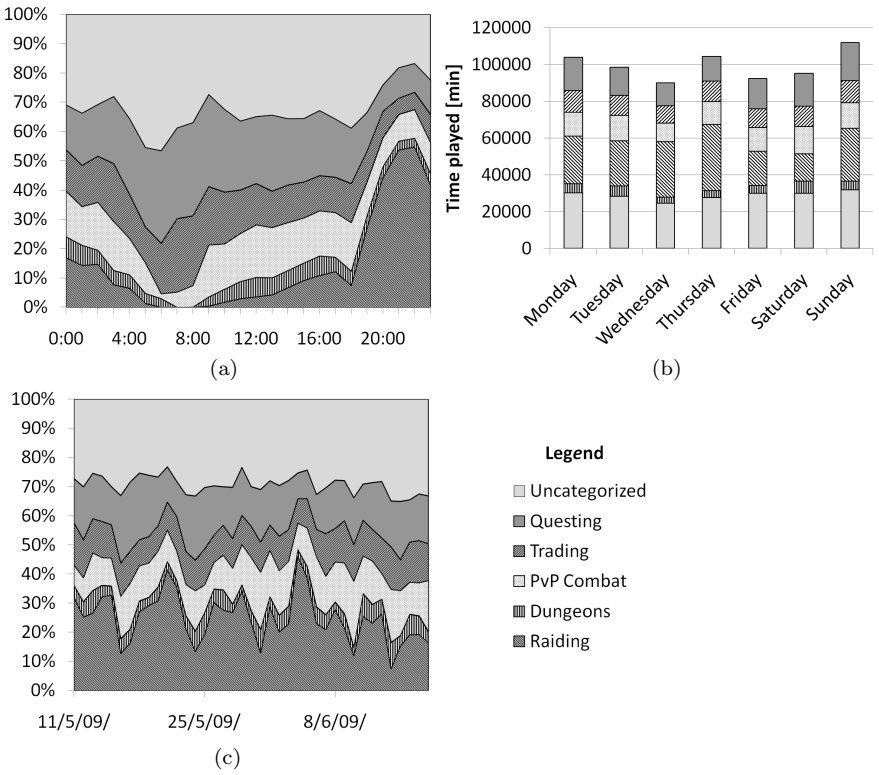


Figure 7: Proportion of (a) action categories through a day, (b) a week, and (c) whole monitored period

6 Conclusion

In our effort to better model the traffic of MMORPGs we aim to describe in more detail a player as a source of that traffic. In our previous works (Suznjevic et al., 2008, 2009b) we have determined that characteristics of generated traffic based on the action category differ significantly. In this paper we determine the patterns of player behavior and the causes of different player behavior by relating Yee's motivational subcomponents to actual in-game player behavior. Our summarized findings are as follows:

- Players were highly motivated by the *Achievement* component and *Immersion* showed to be the weakest motivating component.
- Players highly motivated by *Advancement* most often have increased time spent in *Raiding*. A very interesting fact is that two player groups highly motivated by *Advancement*, one having increased *Raiding* and other *PvP combat*, are very distinct.
- Motivational component *Social* has a weakly positive influence on how much players communicate.
- Importance of VoIP communication for players is high, which suggests the need for high quality VoIP solutions.

- Players more motivated by subcomponent *Teamwork* had increased time spent in *Raiding*, but not in *Dungeons*.
- Patterns in daily and weekly activities are evident which can be used to enhance already proposed (Ahmed et al., 2007; Morillo et al., 2006) virtual world partitioning mechanisms.
- Written communication statistics serve as a quantitative proof that the social component is an important parameter affecting MMORPG popularity.

These findings empirically prove that motivations have an impact on player behavior. As virtual worlds of MMORPGs are very large, with many possible player actions with different network traffic characteristics, player behavior must be taken into account while describing that traffic. In our future work we aim to incorporate player behavior into modeling a player as a source of the traffic. We aim to develop several player models, as one model can not describe behavioral diversity of players. We plan to verify these models by implementing a traffic generator and comparing the synthetic traffic with the real network traffic traces.

7 Acknowledgments

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