

On The Battle between Lag and Online Gamers

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Abstract—Although online games have been an important Internet activity today, players inevitably suffer from lag from time to time due to the Internet’s non-QoS-guaranteed architecture. Here by lag we refer to the phenomena when a game fails to respond to user commands or update the screen in a timely fashion due to long system processing or network delays. Currently, little is known about how game players feel about lag and how they react when encountering lag during game play.

In this paper, we present an Internet survey that is designed to understand the following questions: 1) How do players perceive lag, 2) what do players think of the causes of lag, and 3) how do players react to lag. Our results show that game players often struggle with lag, because they are unable to identify the root cause. Therefore, they have to try any combination of possible solutions found on the Internet, blame game companies, or learn to cope. These findings manifest a strong demand for an automatic diagnostic tool that can identify the root cause of lag for gamers.

I. INTRODUCTION

In order to provide better QoE (Quality of Experience) for players, online game developers and network engineers endeavor to improve the performance and reliability of both game and network systems [11, 12, 15, 16]. Despite their efforts however, the Internet still sometimes does not guarantee QoS (Quality of Service), and online gamers inevitably suffer from lag from time to time. Here by “lag” we refer to the phenomena when *a game fails to respond to users’ commands or update the screen in a timely fashion*.

A number of studies have sought to investigate the impact of network quality on network gaming experiences. Among them, many try quantifying the individual impacts of network delay, jitter, and packet loss rate on gaming experience [1, 2, 4]. Others model the relationship between players’ satisfaction when gaming and network quality [3, 5, 7–10, 13]. Nonetheless, little is known about how game players feel about lag and how they react when encountering lag during game play.

In response to this issue, this paper presents an Internet survey designed to understand the following questions:

- 1) How do players *perceive* lag?
- 2) What do players *think of the causes* of lag?
- 3) How do players *react* to lag?

Note that the definition of lag above is *subjective* rather than objective. We did not give a precise definition of lag in our questionnaire for two reasons. 1) Even if we gave a

precise technical definition of lag, respondents may not be able to comprehend the definition correctly. 2) Respondents may *perceive* lag in different ways; that is, a situation in which one player detects lag may be completely fine for another player. Therefore, we purposely left the interpretation of lag up to the respondents, in order to gauge their direct feelings about the gaming experience.

Our questionnaire, which is listed in Table I, comprises four sections: player demographics, perceptions of lag, reaction towards lag, and solutions. The survey results indicate that, though network and system QoS provisioning have been extensively studied in academia, lag is still a headache to online gamers. Moreover, players often must struggle with lag because they are unable to identify the root cause. They may try any combination of possible solutions found on the Internet, blame game companies, or learn to cope. The results of our study indicate a strong demand for an automatic diagnostic tool that can identify the root cause of lag for gamers.

The remainder of this paper is organized as follows. Section II describes related works in the area of evaluating user perceptions of network and system QoS. In Section III, we depict the materials and methods of our survey. In Section IV, we analyze the results of the survey and reveal how significantly lag problems impact players’ gaming experiences. Finally, Section V offers our conclusions.

II. RELATED WORK

In a work closely related to this paper, Oliveira and Henderson [14] presented the results of a questionnaire targeted at the online gaming community, to provide insight into what users really think of the Internet and its impact on their playing experience. The main results showed that members of the gaming community do possess some network awareness. In fact, most users attribute the majority of the disruptions in their gaming experience to network related problems.

The research also demonstrated that although better network QoS for an online game offers a possible solution to improve the gaming experience, players are unwilling to pay for better service guarantees, because they have already invested money in assuring the network connectivity and the best computer platform for the purposes of gaming. On the contrary, 85% of players requested that online games should provide additional information regarding the network state for them.

III. METHODOLOGY

In this section, we present our questionnaire to investigate how lag problems impact players’ online gaming experience.

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TABLE I
QUESTIONNAIRE DESIGN

Section 1: Player Demographics	
Q1	What is your gender? (A) Man (B) Woman
Q2	What is your age? (A) 0–12 (B) 13–17 (C) 18–28 (D) 29–39 (E) 40+
Q3	How many years have you played single-player games including PC and video games? (A) 0-1 (B) 1-3 (C) 3-5 (D) 5-10 (E) 10+
Q4	How many years have you played online games such as FPS games and MMORPGs? (A) 0-1 (B) 1-3 (C) 3-5 (D) 5-10 (E) 10+
Q5	Which type of online games do you like to play? (multiple-choices) (A) Role playing (B) Real-time strategy (C) First-person shooter (D) Car racing (E) Casual games
Q6	How often do you play online games? (A) Rarely (B) Intermittently (C) 0–2 hours a day (D) 3–5 hours a day (E) 6+ hours a day
Q7	What time do you usually play online games? (A) before 9 AM (B) 9 AM–12 noon (C) 12 noon–2 PM (D) 2 PM–6 PM (E) 6 PM–10 PM (F) after 10 PM
Q8	What online games do you play now? (Write down their names)
Q9	Which Internet service provider do you use? (A) TANet (B) HiNet (C) SeedNet (D) APTG (E) TFN (F) Others (Write down the names)
Q10	How does your computer connect to the gateway? (A) Ethernet (B) WiFi (C) 3G (D) Don't know
Q11	How does the gateway connect to the Internet? (A) TANet (B) ADSL (C) Cable Modem (D) FTTB (E) 3G (F) Don't know
Q12	What is the downlink and uplink network bandwidth of your Internet access? (A) 2 Mbps / 512 Kbps (B) 4 Mbps / 1 Mbps (C) 8 Mbps / 640 Kbps (D) 3 Mbps / 768 Kbps (E) 10 Mbps / 2 Mbps (F) 20 Mbps / 2 Mbps (G) Don't know (H) Others
Section 2: Perceptions of Lag	
Q13	How often do you encounter lag during game play? (A) Rarely (B) Occasionally (C) Frequently (D) Always
Q14	How serious is the lag in general? (A) Slightly (B) Moderately (C) Seriously but tolerably (D) Intolerably
Q15	How long does the lag last? (A) Instantly (B) In a few seconds (C) In a few minutes (D) Intermittently (E) Constantly
Q16	In your opinion, what causes the lag you encountered? (multiple-choice) (A) Your PC (B) Access link bandwidth of your PC (C) Game client (D) Equipment of game servers (E) Access link bandwidth of game servers (F) Internet core bandwidth (G) Don't know
Q17	To what degree do you feel lag is related to the time of game play? (A) None (B) Weak (C) Moderate (D) Strong
Q18	To what degree do you feel lag is related to the number of avatars on the screen? (A) None (B) Weak (C) Moderate (D) Strong
Q19	Do you play more than one online games? (A) Yes (B) No
Q20	If you play multiple games, to what degree do you feel lag is the consequence of particular game(s)? (A) None (B) Slight (C) Moderate (D) Strong
Q21	In your opinion, what is the most decisive factor making different levels of lag in different games? (A) Game software (B) Equipment of game servers (C) Access link bandwidth of game servers (D) Don't know
Section 3: Reactions to Lag	
Q22	How do you generally react to lag? (A) Ignore them (B) Suffer and continue playing (C) Log out and retry immediately (D) Log out and retry later (E) Reconnect to the Internet and retry immediately (F) Reboot your PC
Q23	(Following Q22) If you choose to log out and retry later, how long do you wait before retrying? (A) A few minutes (B) Half an hour (C) An hour (D) Next available time
Q24	Do you check with your friends in the game when you encounter lag? (A) Yes (B) No
Q25	When you encounter lag, to what degree do you find your friends in the game also suffer the same problems? (A) None (B) Weak (C) Moderate (D) Strong
Q26	In general, to what degree does lag affect your game play? (A) None (B) Weak (C) Moderate (D) Strong
Q27	When you quit an online game, to what degree do you think lag is the main cause? (A) None (B) Weak (C) Moderate (D) Strong
Q28	Where or to whom do you usually complain about lag? (multiple-choice) (A) Internet forums (B) Your ISP (C) Game company (D) No public/formal complaints (E) Others
Section 4: Solutions to Lag	
Q29	Which of the following methods have you ever adopted to solve lag? (multiple-choice) (A) Upgrade PC (B) Upgrade access link (C) Optimize TCP/IP parameters (D) Use proxy server (E) Upgrade gateway (F) Switch to other ISP (G) None (H) Others
Q30	Do you use tools such as ping and traceroute to diagnose the root of lag? (A) Never (B) Seldom (C) Often (D) Always
Q31	If there is a software that can diagnose the root cause of lag, would you download and use it? (A) Yes (B) No
Q32	If there is a software that can mitigate lag, would you download and use it? (A) Yes (B) No
Q33	In general, is lag an issue to you in online game playing? (A) Yes (B) No

First, we design a structured questionnaire consisting of 33 questions. Then we post our survey on Internet forums to collect responses from Internet gamers.

A. Questionnaire Design

Our questionnaire comprises four sections: player demographics, perceptions of lag, reactions to lag, and solutions. The 33 questions are listed in Table I. Player demographics include Q1–Q12; perceptions of lag include Q13–Q21; reac-

tions to lag include Q22–Q28; and solutions to lag include Q29–Q33. Each section is explained in detail as follows.

- 1) *Player demographics*: The first section of the survey reveals the composition of online game players. Q1–Q8 ask for a player's profile, game play history, game play frequency, and time. Then Q9–Q10 ask details about a player's Internet access method and bandwidth.
- 2) *Perceptions of lag*: The second section of the survey targets perceptions of lag for online game players. First, players are asked Q13–Q15 on their perceptions of lag

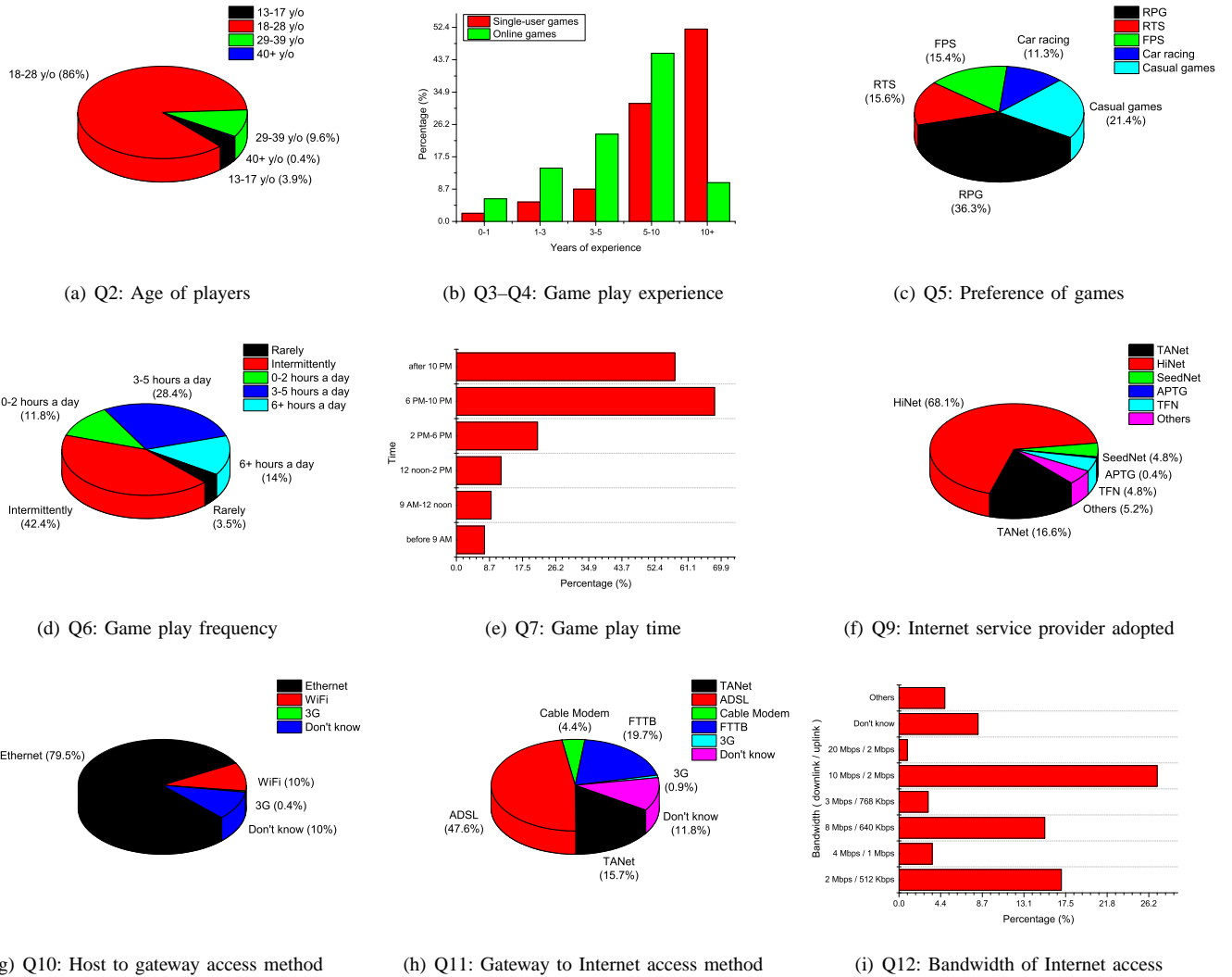


Fig. 1. Respondents' demographics

in their past gaming experiences. Then, Q16–Q18 ask players' belief (or their guess) of the reasons behind the lag they encountered. In Q19–Q21, players are asked about their experiences with lag across different games.

- 3) *Reactions to lag*: The third section of the survey shows how online game players react if they encounter lag. Players are asked Q22–Q29 to show their reactions to lag, including how players generally react to lag, how long players would wait and retry if they choose to log out, where or to whom players usually complain about lag, and so on.
- 4) *Solutions to lag*: The last section of the survey presents player demands for solutions to lag. First, players answer Q29 and Q30 to reveal their experience in fighting with lag. Then players are asked about their willingness to install tools to help them solve the lag problems in Q31 and Q32. Finally, players are asked to report whether lag is really annoying to their game play experience in Q33.

B. Procedure

We put our questionnaire on a free online survey web site, my3q.com. In order to increase visibility of the questionnaire, we also announced the survey on the largest BBS in Taiwan, PTT.cc¹, for three weeks. The announcements outlined the aim of the study, provided a hyperlink to the survey form, and as an incentive, rewarded each respondent 50 PTT dollars, which approximately corresponds to US\$ 0.05.

IV. SURVEY RESULTS

In this section, we examine the replies of 229 respondents to the questionnaire. First we analyze the player composition, and then investigate whether lag actually influences the gaming experience of players. We also present players' reaction to lag. Finally, we identify the solutions provided by the players themselves.

¹PTT can be reached via telnet://ptt.cc, which is one of the largest social network services in Taiwan, with an average of 800,000 daily logins.

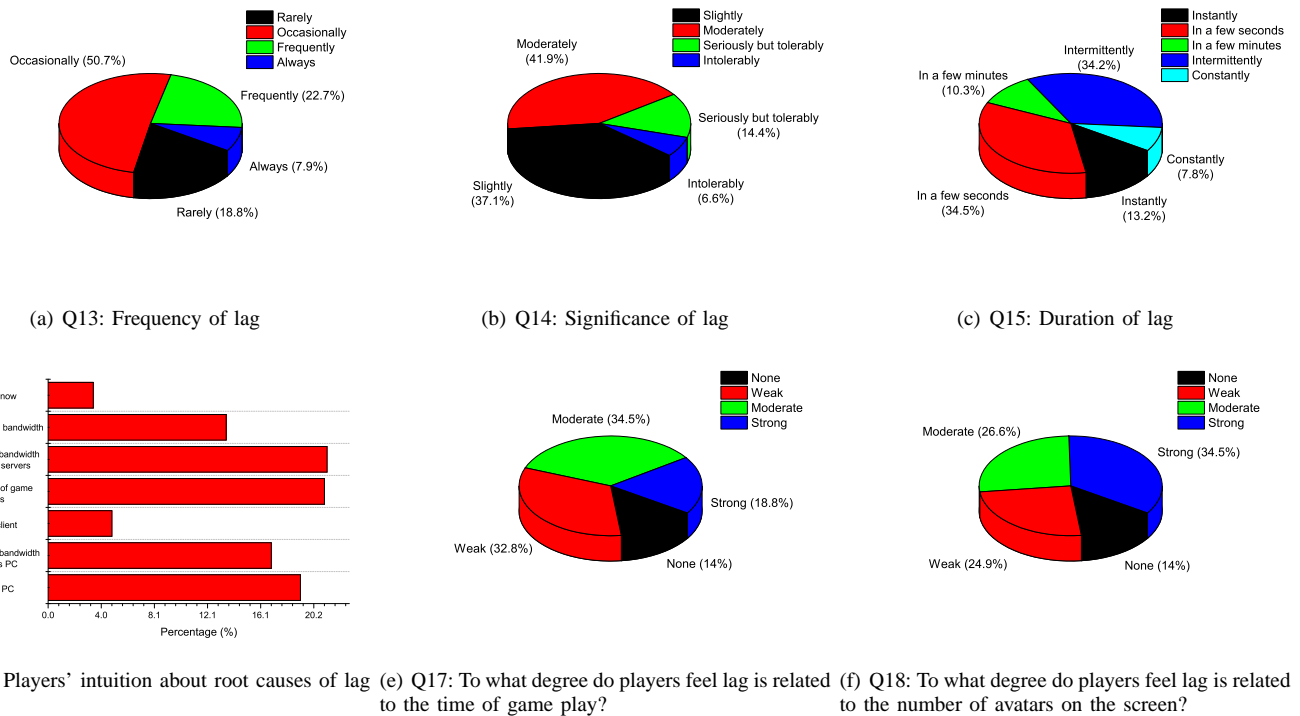


Fig. 2. Respondents' perceptions of lag

A. Player Demographics

First, the results present the composition of the sample, which consists of 76% males and 24% females. In Figure 1(a), the majority of respondents (86%) are between 18–28 years old. The results depicted in Figure 1(b) reflect that the sample is composed of “hardcore” players with rich experience of both single-user games and online games; roughly 52% of respondents have played single-user games for 10 years, and 45% of respondents have 5–10 years experience in playing online games. Player preferences in online games are shown in Figure 1(c). The most popular type of online game for players are role playing games (RPG) (36.3%), and most players like to play World of Warcraft. Figure 1(d) shows game play frequency. Most players do not play online games in fixed hours every day, and instead play intermittently (42.4%). In Figure 1(e), most players like to play online games from 6 PM to 10 PM or later.

The results also reveal Internet access methods and bandwidth. In Figure 1(f), 68.1% of players respond that they use Hinet ISP. Most players use Ethernet (79.5%) and ADSL (47.6%) as their main means to connect to the gateway and to access the Internet, as respectively shown in Figure 1(g) and Figure 1(h). In response to questions regarding their downlink and uplink bandwidth, Figure 1(i) shows that the majority of players use 10 Mbps / 2 Mbps, 2 Mbps / 512 Kbps, or 8 Mbps / 640 Kbps connections.

These results imply that the respondents in our sample are highly proficient online game players, and they access online games by using ADSL with sufficient bandwidth for online gaming [6].

B. Perceptions of Lag

Next, we investigate player perceptions of lag. In Figure 2(a), only a few players claim that they encounter lag frequently (22.7%); most players encounter lag occasionally (50.7%). Figure 2(b) shows that only 37.1% players regard lag as slight, with most players considering lag as serious (21%) or moderate (41.9%). Furthermore, most lag (Figure 2(c)) happens intermittently (34.2%) and lasts for a few seconds (34.5%).

Players were also asked to identify the most important factors leading to lag problems. In Figure 2(d), the results show that most players attribute lag to the access link bandwidth of game servers (21.2%) and server equipment (21%). Some players also consider their own PC (19.2%) and the access link bandwidth of their PC (16.9%). Moreover, the results in Figure 2(e) show that most players feel that lag is only moderately (34.5%) or weakly (32.8%) related to the time of game play, and in Figure 2(f) most players feel that lag is strongly (34.5%) and moderately (26.6%) related to the number of avatars on the screen. Only 31% of players play multiple online games now. When players were asked to what degree they feel lag is the consequence of particular games, most only responded moderately (36.2%) or weakly (30.4%). About 45.6% of these players think that the most decisive factor responsible for lag in different games is the access link bandwidth of game servers.

The results of lag perception conclude that 1) players are highly affected by intermittent lag, 2) players usually blame the access link bandwidth of game servers and server equipment for lag, and 3) players believe that lag is strongly

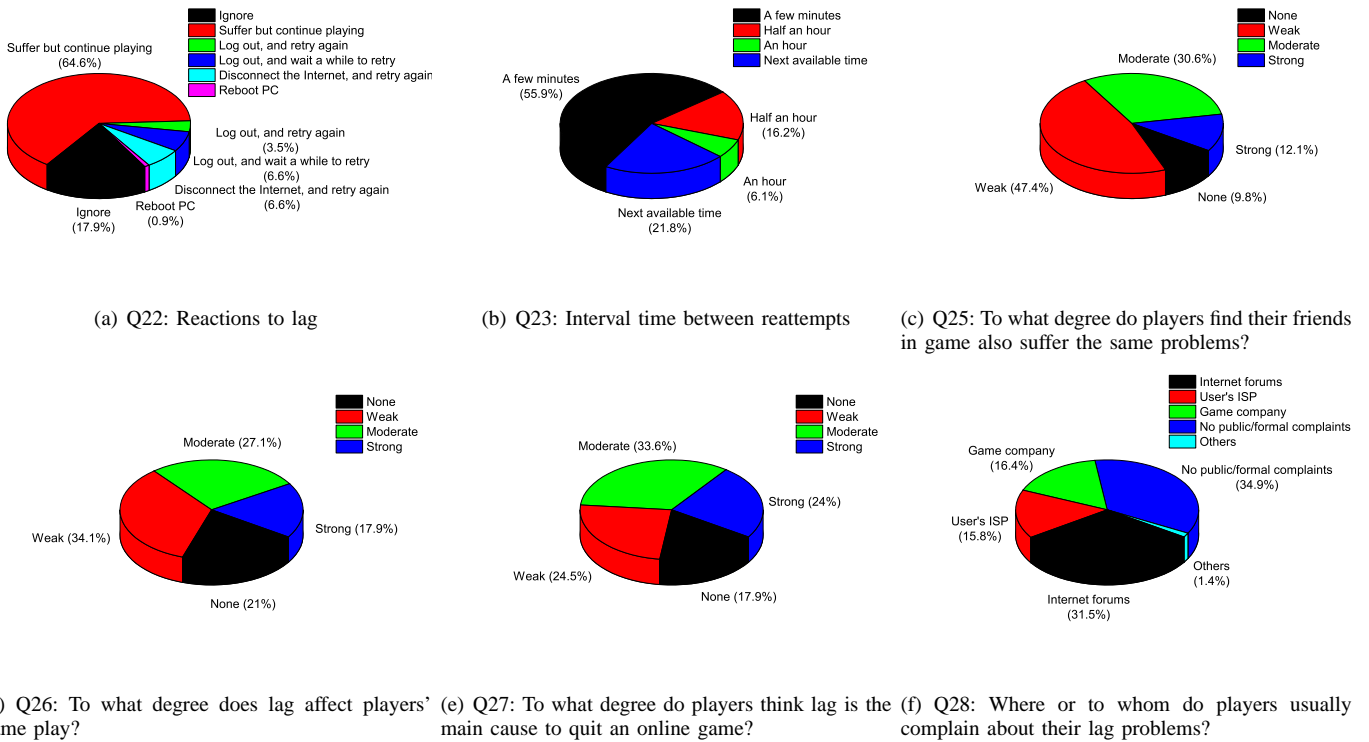


Fig. 3. Respondents' reactions to lag

related to their Internet usage time or the number of avatars on the screen.

C. Reactions to Lag

Next, we also reveal players' reactions to lag. When players encounter lag in Figure 3(a), most either suffer through lag (64.6%) or ignore lag (17.9%). Also, Figure 3(b) notes that if players leave the game because of lag, half of them (55.9%) try reconnecting after a few minutes.

The majority of players (76%) check with their friends in the game when they encounter lag. As shown in Figure 3(c), most players (47.4%) weakly find that their friends in the game also suffer the same problems. Furthermore, Figure 3(d) illustrates that although most players think that lag weakly influences their game play (34.1%), certain players claim that lag has a moderate (27.1%) and strong (17.9%) influence on their game play. If players are asked about the connection between lag and a game they decided to quit, roughly 57.6% of players say there is a moderate or strong connection in Figure 3(e).

When questions focus on whether players have reported lag to the responsible parties, Figure 3(f) displays that most players choose to keep silent (34.9%) or complain about their problems on Internet forums (31.5%). Only a few players contact their ISP (15.8%) or the game company (16.4%).

The results of lag reaction conclude that 1) players usually tolerate or ignore lag, 2) players wait a few minutes to reconnect to the server, 3) players check lag with other players, 4) players think that lag influences their game play, 5) players blame lag as the reason they decide to quit some online games,

and 6) players keep silent or complain in Internet forums when they encounter lag.

D. Solutions to Lag

Finally, we show solutions adopted and required by gamers to fight lag. As shown in Figure 4(a), when players are asked which methods they have adopted to solve lag, a plurality of respondents (23.6%) never adapt any method. The results also show that players usually increase their network bandwidth (23.6%) or upgrade their PC (23%) when they encounter lag. Furthermore, Figure 4(b) illustrates that about 41% of players have no experience in using network tools such as ping or traceroute to check network conditions when they encounter lag. Only 21.9% of players use network tools to detect lag.

To understand what kind of tools player demand to fight lag, they are asked whether they require root cause diagnostic software or lag mitigation software. The results show that players would like to download and use software that can either diagnose the root cause of lag (86%) or mitigate lag (93.9%) in Figure 4(c). In summary, 86% of players claim that lag is really annoying during game play.

Overall, our survey of requested solutions identified three points: 1) Most players have no technical background in using network tools to detect causes of lag, 2) players demand any software that can either diagnose the root cause of lag or mitigate lag, and 3) players really suffer from lag during game play.

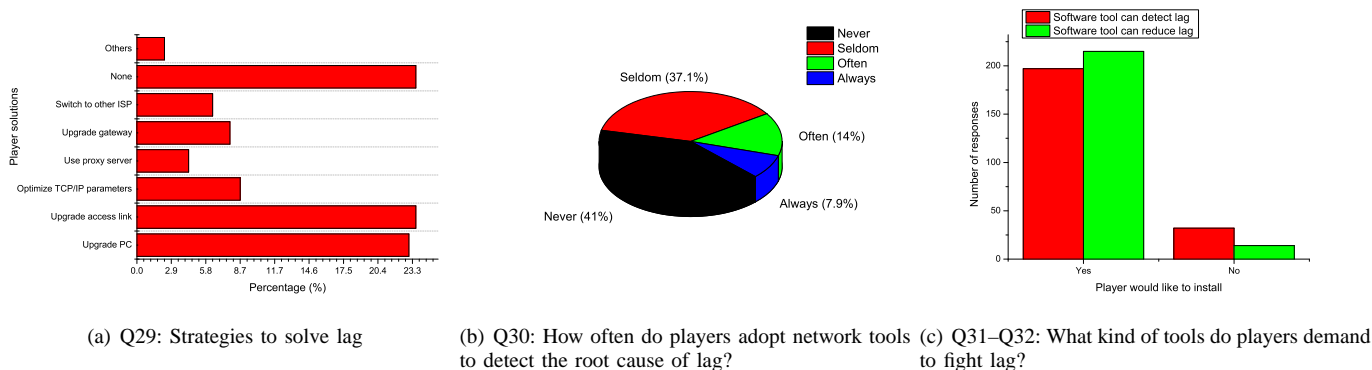


Fig. 4. Respondents' solutions to lag

V. CONCLUSION

In this paper, we present an Internet survey that aims to understand how players perceive of and react to lag. Our survey results indicate that players usually have no means to fight lag, as they lack the required technical background. Moreover, gamers are looking for solutions that can mitigate this problem. Thus, a diagnostic tool that can automatically infer the root cause of lag for gamers is urgently needed.

In the future, based on the above findings, we plan to develop a diagnostic tool to help gamers identify which part of the path between the game client and server applications generates lag. Such a tool will involve performance measurements of game clients, servers, and the network path between them. At the same time, we will pursue more understanding of how players define and interpret lag, in order to ultimately mitigate and even eliminate such problems.

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