What Online Gamers Really Think of the Internet?

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ABSTRACT

The Internet has provided a network infrastructure with global connectivity for the games industry to develop and deploy online games. However, unlike the document interface paradigm of the World Wide Web (WWW), these online games have more stringent requirements that are not fulfilled by the Internet's best effort service model.

A key characteristic of online games is the possibility of having multiple participants share the same experience. Consequently, the volatile nature of the Internet can affect the enjoyment of all, or at the very least a few, of the users. To ameliorate the impact caused by network problems that may arise during game play, game developers have adopted adaptation techniques in the design and implementation of online games. However, little is known of how the user perceives these mechanisms.

This paper presents 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. One of the main results is to demonstrate that the existing mechanisms fail to maintain the utility of the game at all times, leading to frustration on the part of the users. In spite of this, users are not willing to pay for any service guarantees**.**

Categories and Subject Descriptors

A1 [**Introductory and Survey**]

General Terms

Human Factors.

Keywords

Keywords are your own designated keywords.

1. INTRODUCTION

"Hiro is approaching the Street. It is the Broadway, the Champs Elysees of the Metaverse. […]It does not really exist. But right now, millions of people are walking up and down it."

"*Developers can build their own small streets feeding off the main one. They can build buildings, parks, signs, as well as things that do not exist in Reality, such as vast hovering overhead light shows, special neighbourhoods where the rules of three-dimensional spacetime are ignored, and free-combat zones where people can go hunt and kill each other."*

The word 'Cyberspace' has reached the mainstream and its semantic meaning is already overloaded. In this article, the meaning of the word is best illustrated by the above pair of excerpts from "Snow Crash" [18], one of the hallmarks in the cyberpunk literature. The vision described is an alternate reality that the senses perceive as real and that is shared amongst many simultaneous users.

Although "Snow Crash" belongs to the realm of science fiction, the world described is gradually becoming a reality as Virtual Reality merges with the Internet. The most popular networked applications, however, continue to be constrained by interfaces with two dimensions, such as the World Wide Web (WWW) and its web page paradigm. The addition of depth to the user interface brings forth additional functionality that would be otherwise unfeasible, thus promoting the emergence of a new genre of networked applications, such as the military simulations that allowed ground troops to coordinate their efforts before Operation Desert Storm, or the recent virtual "handshake" across the Atlantic where geographically-distant people were able to emulate the sensation of touching each other [10]. Although the high-end technology remains restricted to the military and various research institutes, the paradigm of 3D interfaces has made the Internet come alive with the emergence of online games.

The remainder of this paper is structured into 4 additional sections, with the next one describing the two categories of the online games considered for the survey. In section 3, we present the arguments

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concerning network Quality of Service (QoS) in online games. The results of the survey aimed at evaluating the user's[1] perception of network QoS and its impact on their enjoyment is covered in Section 4. Finally, we draw some conclusions in Section 5.

2. GAME CATEGORIES

Until the games industry realised the potential of the Internet, most games were confined to single player mode. In some cases, the games would extend beyond this and support a few more players. The number of additional players, however, was always very small, due in part to the fact that the supporting architecture was peer-to-peer, with total replication of the game database.

With the evolution of Internet-based games, client/server architectures became mainstream in game development, so much of the workload associated to the mechanisms responsible for sharing the experience was shifted from the client to the server. This centralised approach simplified issues concerning scale, consistency and security.

Although there is a wide proliferation of online games, this paper focuses on those games that fit in one of the two following genres:

- **First Person Shooters (FPS).** This genre encompasses all of the games where the user has a first person perspective of a small environment. The main objective of the game is to eliminate other players, whilst avoiding the same fate. Although users may roam the environment alone, another alternative is for users to band together as teams with the purpose of eliminating opposition. Traditionally, the number of users is restricted to a small number due to computational and network constraints of the supporting infrastructure. The game is fast paced, with users frantically running around shooting at anything that moves and getting out of firing range of an opponent. As a result, user expectations are high in terms of real-time interactivity. Clear examples are Half-Life™.
- **Massive Multiplayer Online Role Playing Games (MMORPG).** This game genre transports users into large-scale environments where they may take on the role of characters. Normally, MMORPGs are set in the medieval ages, mingled with strands of magic. The majority of MMORPGs provide the user with a first person perspective. Unlike FPS games, the number of simultaneous players is far beyond the few dozen and may reach a few thousand. However, the interaction model is designed such that the pace of the game is slightly slower than in FPS games, so the user's expectations are more accommodating with regards to response times.

  The possibility of acting out an alternate life in a MMORPG has been highly appealing to the mass market. In Korea, for example, the MMORPG Lineage™ has a userbase of two million users [7].

These two genres were chosen because both provide the user with a first person perspective in a multi-user environment.

3. NETWORK QUALITY OF SERVICE IN GAMES

A fundamental requirement of both the FPS and MMORPG is to provide a shared experience that appears consistent across all the players. Consequently, with the network being the backbone of the infrastructure, the importance of the associated service model becomes apparent. The Internet's current service model is best effort, with no guarantees with regards to data transmission.

The Transmission Control Protocol (TCP) takes into account the limitations of the Internet's service model and provides First In First Out (FIFO) data delivery between a source and a receiver. However, much of TCP's internal behavior, such as congestion control, can be detrimental to meeting the real-time constraints associated with MMORPG and FPS games. The games industry remains oblivious to the necessity of TCP mechanisms to provide fairness amongst the many data flows on the Internet. In fact, Lincroft [8] writes that TCP is evil and should be avoided at all costs. Most games have therefore adopted the User Datagram Protocol (UDP), to avoid TCP-like fairness behavior, but without taking into consideration the possibility of congestion collapse [5].

Irrespective of the protocol used in the network infrastructure of the game, without any Quality of Service (QoS) guarantees, real-time performance remains an illusive goal to achieve. The Internet

[1] Throughout this paper, the words user and player will be used interchangeably.

Engineering Task Force (IETF) has proposed improvements in the shape of two main proposals:

- **Integrated Services**. IntServ [15] was designed to grant applications end-to-end QoS, by providing an explicit setup mechanism, such that routers can provide services to those flows that request them. For instance, flows could use RSVP to request resources, and the network could choose to accept or reject the flow depending on whether its requested resource requirements could be met. As state is required to set up and monitor each flow, IntServ is unlikely to scale to widespread usage.
- **Differentiated Services**. Instead of classifying per-flow, DiffServ [3] classifies packets into classes, depending on the value of the codepoint in the packet's IP header. DiffServ does not provide absolute guarantees, but instead each router acts on classes depending on a Per-Hop Behavior (PHB). Unlike IntServ, per-flow state and processing is not required, and so DiffServ should scale much better.

The limitations of either approach raise significant deployment barriers to making QoS available across the Internet. Another barrier, which is non-technical, concerns who will pay for these service guarantees. It certainly will not be the players, as we conclude when discussing some of the results from our survey.

Another approach to accommodate the limitations of the service model is for developers to take network problems into account in the system design, and integrate adaptation techniques that maintain the user's perceived QoS. Some of the most common techniques are described in the following subsections.

3.1 Less is More

With the exception of audio/video streams, the movement updates of a user constitute the majority of the data traffic generated by a game. It is necessary for the local host to inform remote hosts of the current state of the user within the virtual environment. However, as the early networked version of the Doom™ FPS game showed, it is not appropriate to send every keystroke to the network, or the network will be inundated by traffic. Moreover, any loss in data can result in significant inconsistencies.

One solution to reducing the sample rate is dead reckoning, where every client predicts the next position of the remote clients via a simulation model. When an error is verified, a correction sample is generated [16]. To avoid the teleporting effect that can result from errors, the prediction model is complemented with convergence to smooth the inconsistencies. Nevertheless, if the perceptual threshold is exceeded, the user is likely to notice that something is wrong.

3.2 Buffering

A technique [4] that can reduce the effects of latency is to use a time buffer processing mechanism. Each element of the buffer corresponds to an interval of time when all events are processed. Naturally, this implies that all clients are synchronized according to the same clock. The essence of this approach is to avoid immediate processing of local events and to add an artificial delay similar to the latency that remote clients will experience when receiving the event. This is feasible so long as the artificial delay introduced does not reduce the perceived responsiveness of the user interface.

In [11], it was shown that users could adapt to latency provided that it remained consistent. Buffering also reduces the effects of latency jitter.

3.3 Prediction

A wide range of infrastructure architectures exist to support a VE. With a client/server architecture, all processing of the world is carried out at the server, based upon the updates received from clients. In turn, the server then communicates client state to all of the clients. Although client/server architectures enforce consistency due to the central nature of the database, they also introduce additional latency that may be detrimental for real-time interactivity.

Current online games have attempted to counter these problems by delegating some processing to the clients by means of Client Prediction [1] techniques. These methods are based on the assumption that the client may proceed with an operation because the server will most likely validate it. If this is not the case then the server will inform the client and it will have to do a rollback. In distributed architectures, client prediction may be used to determine lock ownership transfer [23].

3.4 Time Distortion

Several adaptation techniques exploit the notion of time, either by expansion or contraction as is deemed necessary. A simple example may be found in the 2D ping-pong game involving two users. Each user controls a paddle and tries to hit the ball back across the field towards the opponent. Although the ball's trajectory is deterministic according to physics, determining its exact position in time taking into account two different reference points is non-trivial. This is due to the existence of network latency. A possible solution [6] is to render the ball in real-time according to the user that will interact with it, while simulating it with a certain delay for the other user. The ping-pong scenario works due to the imposed constraints that limit the degrees of freedom. In a VE, it is not feasible to constrain the users in similar fashion, thus the need for generalization [14] based on relativity.

Another way of distorting time is by making consistency roll backs [22] in the VE database to a well-known synchronization point whenever inconsistencies arise due to latency problems. However, this approach results in disconcerting experiences to the users as the Half-Life™ game clearly demonstrates by the coined term of "shooting around the corner" [1]. This phenomenon typically occurs when clients have disparate latency times. The usual example is when a user scores a hit on another one whose client experiences much lower network latency. This results in the victim having the impression of being shot even though they were already around the corner, as the firing event is received with sufficient delay for the target user to have moved elsewhere.

4. SURVEY

Network adaptation techniques are an integral part of an online game system, but little is known of the success of these mechanisms in terms of user's perceptions.

Most surveys targeted at the gaming user community aim to characterize the user population and understand their motivations for playing. The objective of our survey was instead to provide insight to what users really thought of the Internet and its impact on their playing experience. The results would indirectly imply the success or failure of the network adaptation techniques.

The survey of 23 questions was made available online [19] via a World Wide Web (WWW) server and advertised on several game servers and various mailing lists of the online gaming community. As described in Section 2, the target population was users playing FPS and/or MMORPGs. Taking into account the main objective of the survey, the questions were structured in such manner as to avoid any need to discriminate the respondents regarding which genre did they prefer playing. This was verified in the pilot phase where we had respondents that were either avid players of FPS or MMORPGs.

After filtering of erroneous and invalid entries, a total of 335 unique responses via the website was available for analysis.

The majority of the questions were based on a Likert scale, between 1 and 7. The lower-end of the scale normally corresponds to when the respondent has a negative opinion to the question, whilst the upper-end of the scale indicates that the respondent has a positive response to the question. We adopted a qualitative approach in the design since our concern was the users' perception of the issues raised and not their quantitative assessment.

When doing a percentile comparison, we aggregated the responses into three classes:

- **Negative**. This class corresponds to when the respondent has a negative opinion concerning the question. We aggregate 1, 2 and 3 together.
- **Neutral**. Normally, people adopt the middle of the scale when indecisive or if they do not have a strong opinion on the question. This is corresponds to 4.
- **Positive**. This class corresponds to when the respondent has a positive opinion concerning the question. We aggregate 5, 6 and 7 together.

4.1 User Profile

The aim of the questions pertaining to the user's profile (Fig. 1) was to characterize the population sample in terms of how dedicated the respondents were to their gaming experience. This approach was taken for we knew that the sampling would not be random, and consequently not representative of the entire population that plays FPS and/or MMORPGs. Therefore we wished to target the "hardcore" gamers.

1. For how long have you played online games?
2. On average, how many hours a week do you play online games?
3. How much do games influence your purchases of new computer hardware?
4. Overall, how proficient are you as a player?

Fig. 1 - User profile questions

We have clumped together the answers to the first two questions, resulting in Fig.2. As evidenced, the sample relates to non-casual gamers, who dedicate a reasonable amount of their time to playing online games. The responses indicate 75% of the respondents have played for more than a year and that weekly time expenditure with gaming was found to be significantly higher (Q3 – the median response was 5-10 hours) than in previous studies [20] that targeted a more general population (1 hour).

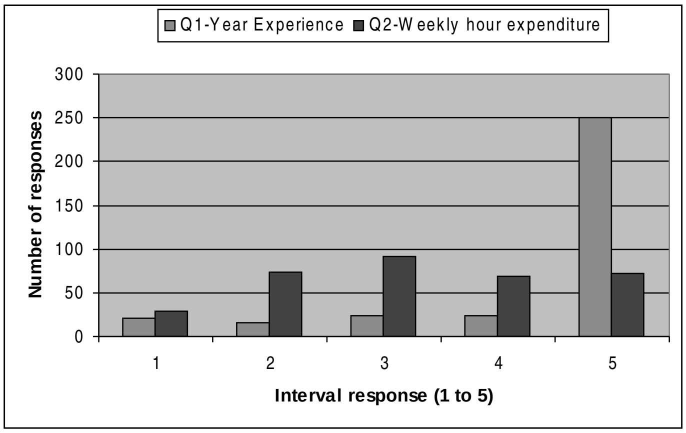

Fig. 2 – Years of experience with monthly intervals of (<1, 1-3, 3-6, 6-12, >12) and weekly hour expenditure with hour intervals of (<1, 1-5, 5-10, 10-20, >20)

The remaining two questions of the group indicate the monetary commitment of the respondents, and their perceived proficiency status. These questions used the Likert scale and the results are depicted in Fig.3.

Considering only the upper scale of the responses, we see that 68% determine the purchase of their PC hardware according to the system requirements of games. In addition, 73% of the respondents consider themselves to have better than average playing skill.

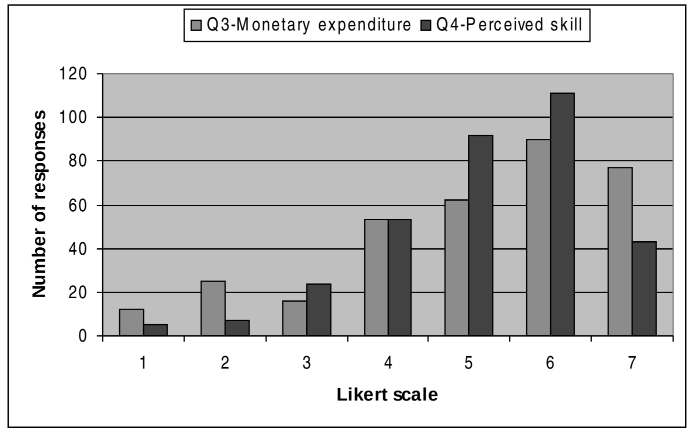

Fig. 3 - Monetary expenditure and respondents' perceived player skill

The main result of the user profile is that the respondents represent a sample of players that are "hardcore", meaning that significant time and monetary expenditure is poured into the experience of playing games. This sample of respondents has the highest expectations from an online game and demands an elevated QoS to match their investments.

4.2 Immersion

When users play online games such as FPS and MMORPGs, they expect to interact with an alternate reality during a particular period of time. This "feeling" of being somewhere else is known as Immersion and has two main components to it, Presence [2] and Co-Presence [13]. The former measures how much a user feels being in the alternate reality, whilst the latter corresponds to how much the user feels that they are sharing the environment with other users. Research [17] has demonstrated that Co-Presence reinforces Presence.

The questions in Fig. 4 aim to assess the perceived sense of Presence and Co-Presence of the respondents when playing.

5. When you are playing a game, to what extent are you aware of your surroundings (ie.: world outside the computer)?
6. How much do you have a sense of being in the game world?
7. Do you have a sense of being in the same space with other players?
8. How often do you notice disruptions in the game (excluding external disruptions such as telephone, people interrupting, etc)?

Fig. 4 – Immersion questions

The responses are aggregated together in Fig.5.

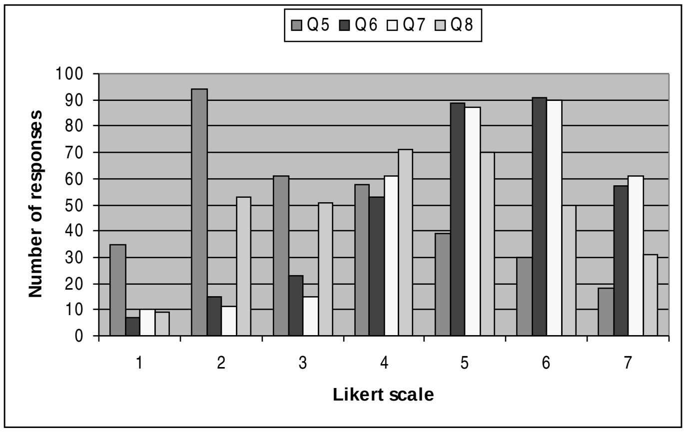

Fig. 5 - Player immersion in the gaming experience

As can been seen by Q5, players are able to abstract themselves from their surroundings and become immersed in the alternate reality. In fact, only 26% responded not being able to abstract themselves from their surroundings. This is supported by the responses to Q6, where 70.7% of the respondents claim to have the sense of being in the alternate reality of the game.

It appears that the resilience of the illusion, when confronted with the onslaught of disruptions from the real world, depends on the individual, since there was a mixed response to Q8.

In response to Q7, 71% of the respondents admitted to experience a sharing of the same space with other users whilst playing the game.

4.3 Perceived Network Impact

As discussed in Section 3, most developers adopt adaptation techniques to ameliorate the negative impact on the game by network problems.

The questions in Fig.6 are targeted to evaluate the success of the approach of isolating the user from the network state. The responses depicted in Fig.7 reflect the perceived impact of network problems on user's satisfaction.

9. What proportion of game disruptions do you think are due to network problems as opposed to software problems?
10. How annoying are game disturbances that result from the network problems?
11. Do you become more aware of your physical surroundings when network problems occur?
12. Do network problems disrupt your sense of being in the same space with other players?
13. When you abandon a game, how often are network problems the main cause?

Fig. 6 - Perceived network impact questions

The majority of the users (73%) attribute the majority of game disruptions to network problems which 86% of the respondents consider annoying.

When asked how network problems affected their sense of being in the game world (Q11), only 13% claimed that they continued to feel immersed in the alternate reality. In the same fashion, users were asked how network problems affected their sense of sharing the space with others, and a low percentage (16%) again responded that they did not experience any disruptions.

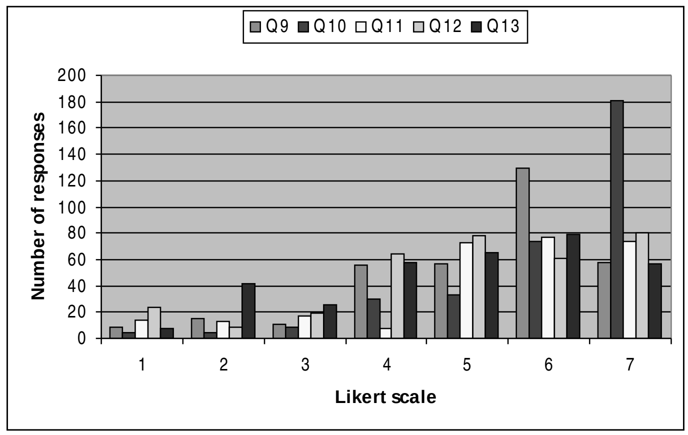

Fig. 7 - User perception of the impact of network problems on their gaming experience

Also in response to Q13, 60% of the respondents conceded that network problems would be the main cause for abandoning a game.

4.4 The importance of network delay

Network problems in games typically manifest themselves in the form of network delay, or "ping" as it is more commonly referred to in gaming circles. Questions 14-17 (Fig.8) were designed to look at the effects of delay in determining a user's decision to play the game.

14. How significant are ping times in choosing a game server?
15. How annoying is it when you have a much higher ping time than other players?
16. How often do you check your ping time (status) during a game?

17. Do you prefer servers where everyone has similar ping times to you?

Fig. 8 - The importance of network delay

As reflected in Fig.9, our self-selecting "hardcore" user sample appears to consider network effects when choosing a game server; 69% of the responses to Q14 are 6 or 7.

A similarly high proportion of respondents (60%) find a network-related disadvantage to be an annoyance (Q15), and would prefer servers where such network effects could be equalized across the userbase (Q17 – 85% responded > 3.5). Not all users, however, check the value of their network delay during a game (Q16 has an interquartile range of 3), which suggests that delay is only used as part of the selection process to choose the potential server that will provide the most enjoyment.

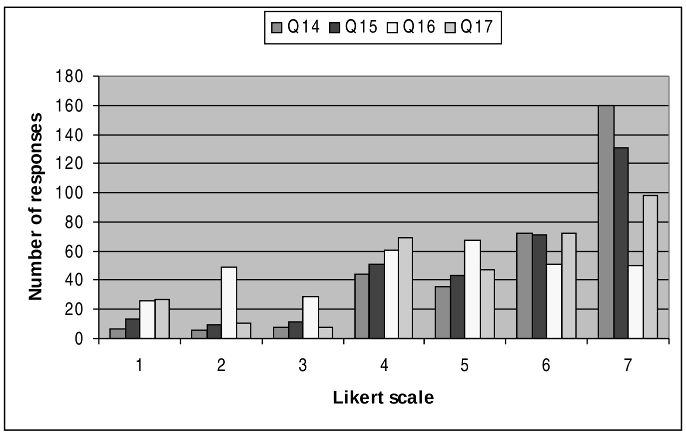

Fig. 9 - How relevant is knowledge of network delay at different stage of the game play

4.5 Social Issues

People are social beings, and it is therefore un surprising that social structures emerge both within and outside online games. These structures facilitate the grouping of users to come together to play. The questions in Fig.10 attempt to assess the relevance of the social acquaintance.

18. How often do you play games with people you already know?
19. How often do you meet new players in games and play with them in future sessions?

Fig. 10 - Social issues questions

As illustrated in the responses of Fig.11, the majority (58%) of the users play against acquaintances. Only 49% of the respondents, however, claimed that meeting new players implied planning future gaming sessions together.

Although it may be argued that the social properties inherent in the chosen game genres (FPS and MMORPGs) diverge, the questions are not targeted at how people interact whilst playing. In fact, offline communities surrounding particular games are common to both FPS and MMORPGs, which game providers encourage since it develops customer loyalty.

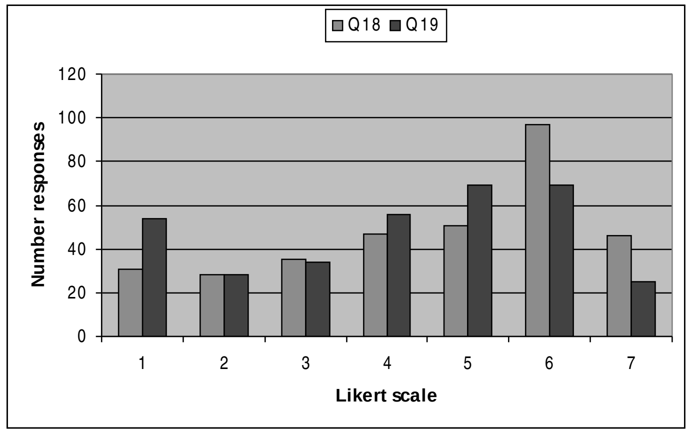

Fig. 11 - How social acquaintance affects game sessions

4.6 User Adaptation

It is true that network delay can have a negative impact on the user experience. However, studies [21] have demonstrated that if the delay is predictable then users may develop their own strategies to accommodate the network problem. The questions in Fig.12 aim to assess whether users are able to adapt.

20. Can you adjust your game play in the presence of network problems?
21. Does learning to anticipate network problems affect your game play?

Fig. 12 - User adaptation questions

As illustrated by Fig.13, a significant percentile of users (Q20-26%; Q21-32%) is not able to give either a positive or negative assessment (response 4 on the Likert scale).

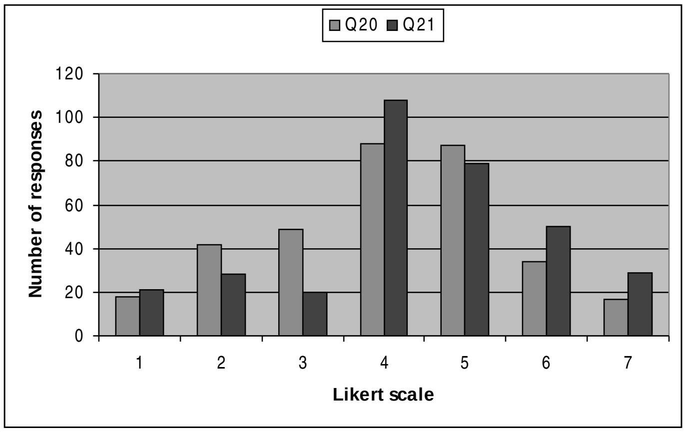

Fig. 13 - The success of user adaptation in the presence of network problems

There is no clear majority regarding the perceived user capability of adapting to the network delay. A likely cause is the difficulty of adaptation when in presence of jitter. Without the delay consistency, it becomes difficult to devise adaptation strategies.

4.7 User Requirements

Question 22 determines the importance to the user of having feedback of the current network state.

22. When network problems occur, how would you prefer to know about them?

Fig. 14 - User requirements question

The responses in Fig.14 yield an interesting conclusion illustrated in Fig.15. The majority (85%) of the respondents want to break the paradigm of user isolation from the network, and desire some feedback mechanism.

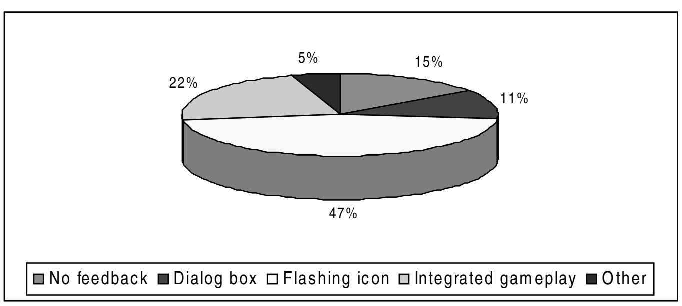

Fig. 15 – Various user requirements concerning feedback of the network state

Within the 85% of the respondents, 46% prefer a flashing icon, just to signal that the network is experiencing problems.

Although only 22% of the respondents wished for the network state to be integrated into game play, we surmise that this number could change if users were presented with examples of how it could be done. In fact, during the pilot phase of the survey, respondents would have changed their response if they were informed of possible scenarios where the game reflected the network state in an integrated way.

4.8 Payment for QoS

If users do not incur a cost, then network QoS is impractical – it would be in a user's best interests to select the highest available level of QoS for all their flows, if such a selection is free. One way to ensure that users do incur a cost is to charge them for the ability to provide certain applications with higher QoS. The final question in our survey was designed to ask users whether such a charge would be acceptable.

23. Would you be willing to pay for a service that reduced network problems in games?

Fig. 16 - Payment for QoS

As Fig.17 illustrates, the responses seem mixed (median = 4, interquartile range = 4). Moreover, there was little correlation between users who already spent additional money on their gaming habit (Q3) with a willingness to pay for better network QoS.

Comments from respondents indicate that additional charges might not be popular:

- "Couldn't someone else pay i.e. like the game developers, or maybe pay through advertising"
- "I'd like the ISP's [*sic*] to reimburse us for network problems"
- "Am willing to pay for a better connection, am using adsl but i refuse to pay extra online fees"
- "pay enough for my connection already"

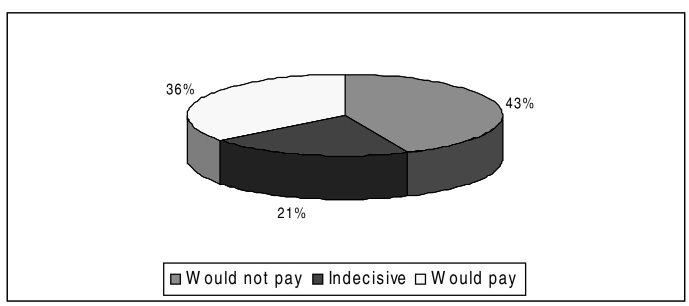

Fig. 17 – User's opinion concerning their monetary contribution to guarantee network QoS

5. CONCLUSIONS

The results of the survey clearly indicate 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.

Assuring specific network QoS for an online game would be a possible solution to improve the gaming experience of the users, but the issue is who will pay for the service.

The fact that network QoS is not a tangible product or service makes it harder to justify additional costs to a gamer. From the user perspective, they already invest money in assuring the best computer platform for the purposes of gaming, pay for the network connectivity and pay a subscription fee to play. Therefore, users will not incur the cost directly.

Another approach to ameliorate the impact of network problems is to integrate network compensation techniques in the game engine. This approach does not incur any additional costs to the user since it is part of the product when purchased. However, the survey's results clearly demonstrate the inefficiency of existing techniques, with 85% of the users requesting that the game provides additional information regarding the network state. Consequently, until users concede to pay for network QoS, it is necessary to find new system design paradigms for QoS in distributed applications with real-time interaction.

6. ACKNOWLEDGMENTS

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