Pricing of Mobile Peer-to-Peer application

20 March 2003
Yang Qiu
Helsinki University of Technology
yangqiu@cc.hut.fi

Abstract

This paper analyzes the pricing of fixed and mobile peer-to-peer application. In Fixed Internet the peer-to-peer application is very popular. In mobile Internet the peer-to-peer application has it own characteristics. Since the mobile set is personalized equipment, the mobile peer-to-peer application will concern something more personal. Defer from the peer-to-peer application of file sharing on normal Internet, the mobile peer-to-peer is more related to the Instant Messaging, Real-time caution and Gaming.

1. Introduction

Peer-to-peer is the most rapid developing application of Internet, despite the fact that the history of peer-to-peer technology is as long as USENET and FidoNet.

In Internet, the client-server architecture has dominated the network for almost 20 years. But the scarcity of bandwidth and disk space of server hinders the performance of wide-band access (ADSL, Cable modem and so on) users. The merging of peer-to-peer technology exhibits its decentralized technology. It allows the utmost utilisation of disk space and bandwidth of normal users are being upgraded, especially for users who are downloading data.

In mobile Internet, it is another story. Mobile Internet is charged by the volume (most of the GPRS operate), the price per bytes is much more expensive than the price of ADSL or Cable modem. There is no Advertisement any more, in consideration to the small screen of mobile set. So charging is more critical for mobile peer-to-peer application.

2. The Peer to Peer model

Most of peer-to-peer applications are file sharing, instant messaging and gaming.

File sharing

- Aimster:

Aimster (Note: Aimster is now called Madster and is now a subscription service.)

- FastTrack

KaZaA

- iMesh

iMesh

- Audiogalaxy

Audiogalaxy Satellite

- MFTP (Multi-source FTP)

eDonkey2000
eMule(client)

- NeoModus

Direct Connect

- Gnutella(serverless)

Acquisition
BearShare
Gnotella (no longer available)
Gnucleus
GTK-Gnutella
LimeWire
Mactella
Morpheus
Phex
Qtella
Shareaza
SwapNut (no longer available)
XoLoX

- OpenNap

WinMX

Instant Messaging

- MSN Messenger

- AOL Instant Messenger
- Yahoo Messenger!
- ICQ
- File sharing applications that contain the instant messaging.

Game server

There are so many game servers in the market.

With server or without

There are 2 kinds of peer-to-peer applications on the Internet, with server (e.g. napster and MSN) or without (e.g. Gnutella, Overnet). Lots of bytes will be sent during the initialisation process by the serverless peer-to-peer application, which will cost more if the ISP charging it by the volume. So serverless application could be no competition.

3. The Charging of normal peer-to-peer application

Since Napster could not afford the 2-cent copyright fee per download and shut down their service, more and more peer-to-peer file sharing applications changed to serverless. Since the owner of those applications gets money from the commercial advertisement on the application software, so this situation cannot be applied to the mobile peer-to-peer applications.

4. The principal agent model

Principal agent theory helps to identify the conditions under which the principal, can be understood through the establishment of a relationship with another party---the agent (Ross 1973, Bowie and Freeman 1992).

Principal agent relationship exists when the principal requires a task be performed, service be provided, or output be produced, for a variety of reasons, all these rely on the agent to complete the task, to provide the service or to produce the output (Holmstrom 1979) /**3**/. A principal agent problem arises when agents have hidden information about the outcome, are risk averse,

But it is not easy for the principal to monitor the agent. Principal agent theory seeks to understand real life problems of loss of control, information asymmetry, costs monitoring, and goals confusion in organizations. Essentially, principal agent theory suggests that both the principal and the agent exhibit self-interest behaviors.

To enhance sharing of goals with the agent, the principal can enforce certain conditions through a contract, or incentive scheme. The principal's goal is to devise an incentive scheme under which the agent will not shirk. At a minimum, the incentive scheme should satisfy two conditions. First, the agent must be willing to accept the incentive scheme. In other words, the incentive scheme must offer the agent at the minium as much utility (satisfaction) as the agent's next best alternative, or threshold wage, also known as the agent's reservation utility. This reservation utility is the compensation that the agent could receive by performing some other task rather than work for the principal. If the agent is not offered at least this amount, the agent will prefer to work for someone else. Secondly, the scheme should induce the agent to provide the level of effort that the principal desires.

The principal (P) wants to hire an agent (A) to perform a service. The output (x) depends on the agent's level of effort (a), and a random factor that the agent does not control. In Internet peer-to-peer technology, the random factor may cover a number of things such as a temporary shutdown of some Internet servers, connection problems due to heavy bandwidth, peers intentionally logging off and thus severing the connection, etc. The principal's goal is to devise an incentive scheme (I) that can maximize the utility

(UP) while ensuring that the agent receives a utility (UA) that is at least as much as the agent's reservation utility (threshold wage) K. Thus, following Holmstrom (1979) **/3/.**

The principal's problem becomes/**1**/:

max $E\{U_P(x-I(x))\}$ (1)

subject to $E\{U_A(I(x)\}\geq K$ (2)

subject to $E\{U_A(I(x), a\}\geq E\{U_A(I(x), a'\}$ for all $a'\neq a$ (3)

This indicates that (1) the principal wants to choose an incentive scheme I (x) to maximize her expected utility, subject to (2) the agent's utility must be at least as much as his reservation utility (or threshold wage), and to (3) effort level that is more desirable (results in at least as much payment) to the agent than any other effort level.

5. Application to Mobile peer-to-peer application

The most possible mobile peer-to-peer applications are Instant Messaging.

Some possible principal agent relationships in this area are the one between the mobile Internet user and the mobile Instant Messaging server.

In the principal agent paradigm, the principal's goal is to provide an incentive scheme under which the agent will not shirk. In other words, the users want the mobile Instant Messaging server to maintain a proper updated index (without broken links, flaky or malicious computers, etc).

Simply, we assume that the mobile peer-to-peer application server can either exert a high level of effort (a=1) or a low level of effort (a=0). We can define a high effort level (a = 1) as effort required to maintain the index properly in addition to providing messaging storage (if the user is unavailable) and send SMS to ask the callee to login. Low effort level (a = 0) can be defined, as the minimum effort required maintaining the index. In this example, let the outcome be x = 1 if the desired information is found and connected with caution or gaming, and x= 0, if it is not.

Outcome Probability	Outcome (x=0)	Outcome (x=1)
Effort (a=0)	0.5	0.5
Effort (A=1)	0.25	0.75

Table 1, Outcome Probability

From the Table it is assumed that 50% users are not login the Instant Messaging server. 50% un-login users can login if they received the SMS.

About the saving of Instant Messaging user, limiting our discussion for simplicity, we assume that a SMS costs 10 cent, the mobile Instant Messaging user stands to save the expense is f (X)=10N - vN cent (N is the average number of messages been sent in a dialog, v is charging of sent one message's volume in GPRS) for saving, if the connection is established successfully. For more simplicity we can assume v = 1 cent, N =11, then f (X)=100cent. Thus, when outcome x = 1 (connection is established successfully), the agent's output f (x=1) can be seen as 100 cent. On the other hand, when outcome x = 0, the agent's output f (x=0) is 0 cent.

But charging 100 cent is unacceptable. Then we use the incentive scheme I (x) to courage user to use this application. Then the income of the Instant Messaging server is U_A (X) = f (x)-I (x).

Power functions can be used in this situation to express the server utility, U_A

(X) = BX^{α}/α /**1**/. Here, we use B = 0.5, X = I (x), α = 0.5. Thus U_A (x) = $0.5I(x)^{0.5}/0.5 = (I(x))^{0.5}$. We assume that it costs Instant Messaging server 5*p cent (p is probability of a user logoff from the Instant Messaging) to ask the callee login. The server utility (the profit for user) is U_A (x) – V (a), can be represented as $(I(x))^{0.5}$ – (5*p/f (1)) a, p=0.5, so finally U_A (x) – V (a) = $(I(x))^{0.5} - 0.025a$.

The K is the server reservation utility. K=0, which means no monthly fee. Because some user may initial thousands of SMS, it's unfair for other users. So no monthly fee is reasonable.

Given all this, we can now formulate the user-server relationship as a specific instance of principle agent theory:

$$\text{maximize } E\{f(x) - I(x)\} \quad (4)$$

$$\text{subject to } E\{((I(x))^{0.5}-0.025a\} \geq 0 \quad (5)$$

$$\text{subject to } E\{((I(x))^{0.5}-0.025a\} \geq E\{((I(x))^{0.5}-0.025a'\} \text{ for all } a' \neq a \quad (6)$$

To this, we can also include the conditions that the server's utility is not negative:

$$(I(x))^{0.5} \geq 0 \quad (7)$$

This shows that the Internet user wants to (4) maximize his utility, which is the money he saves from using Instant Messaging minus the payment to

Instant Messaging server, subject to the constraints that (5) Instant Messaging server's utility should be at least as much as the utility it currently receives (zero), and (6) exerting effort level a can yield at least as much utility to Instant Messaging server as any other level. At last, (7) ensures that the agent's utility for profits that cannot be negative (don't lost money).

If a high level of effort (a = 1) is desired, we can use the probabilities from **Table 1** to describe the specific problem:

$$\max\{0.75(1 - I(1)) + 0.25(0-I(0))\} \quad (8)$$

$$\text{subject to } (0.75((I(1))^{0.5}-0.025)+0.25((I(0))^{0.5}-0.025) \geq 0 \quad (9)$$

$$\text{subject to } (0.75((I(1))^{0.5}-0.025)+0.25((I(0))^{0.5}-0.025) \geq (0.5((I(1))^{0.5})+0.5((I(0))^{0.5}) \quad (10)$$

$$\text{subject to } (I(1))^{0.5} \geq 0 \text{ and } I(0))^{0.5} \geq 0 \quad (11)$$

In particular, (8) ensures that the principal's expected utility for a high effort level (a= 1) should be maximized, subject to the constraints that (9) server's expected utility is at least as much as that of its current fee, (10) exerting a high level of effort (a = 1)

We should provide server with at least as much utility as exerting a low level of effort (a = 0), and (11) server's utility is nonnegative.

The maximum can be reached when I(1) = 0.22 and I(0) = 0. Thus, for every file downloaded, the Internet user pays 22 cents to if it is successful connected to the callee and 0 cents if it is not. This gives the user an expected utility (or expected net savings) of 110-22 = 88 cent. The server receives an expected utility of 22 - 5 = 17 cents with the 75% possibility, but lost 5 cent with 25% of possibility.

Discussion

To calculate the utility of mobile peer-to-peer application of games and caution, are quite difficult. Cause there is no similar application that we can compare. And mobile peer-to-peer caution could provide the real-time caution. For example, one user want to sell his ice hockey ticket before the game begins, he could sell it with original price (or even higher, if the there is no legal problem, in some country it's illegal to sell ticket higher than the selling price), but if the game begins, he have to sell it with lower price. So this kind caution has its own value, we could not compare it with the normal web caution. For mobile peer-to-peer game, it is another scenario. Playing game is normally charged by the month. The monthly fee is from free to a few Euro per month depending on the kind of games.

For Instant Messaging, Microsoft has already introduced the MSN messenger into the PDA phone, but it only worked in Effort (a=0) module.

Reference

/1/ Pricing Napster and Other Internet Peer-to-Peer Application; Anya Kim, Lance J. Hoffman.

/2/ Ethics and Agency Theory; Bowie, N. E. and E. R. Freeman, Eds.

/3/ Moral Hazard and Observability; Holmstrom