Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 2002 Proceedings

Americas Conference on Information Systems (AMCIS)

December 2002

DECOUPLING LOCATION AND PERSONAL INFORMATION IN LOCATION BASED SERVICES

Junwei Guan
Purdue University

Follow this and additional works at: http://aisel.aisnet.org/amcis2002

Recommended Citation
Guan, Junwei, "DECOUPLING LOCATION AND PERSONAL INFORMATION IN LOCATION BASED SERVICES" (2002). *AMCIS 2002 Proceedings*. 348.
http://aisel.aisnet.org/amcis2002/348

This material is brought to you by the Americas Conference on Information Systems (AMCIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in AMCIS 2002 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

DECOUPLING LOCATION AND PERSONAL INFORMATION IN LOCATION BASED SERVICES

Junwei Guan
Krannert Graduate School of Management
Purdue University
Junwei_Guan@mgmt.purdue.edu

Abstract

Location Based Service is one of the promising services in the M-Commerce arena. Although Location Based Service offers many conveniences and advantages, it also opens the potential for inferences to be drawn about consumers based on the knowledge of consumers' whereabouts. In this article, an analytical model is presented, and the findings from the model are discussed. We hope the model and the findings can offer some insights into the privacy issues in Location Based Services, and help both the sellers and consumers to enjoy the benefits offered by the new services.

Introduction

Location Based Service (LBS), as shown in Figure 1, is one of the new services enabled by today's mobile technology. Advances in mobile technology have enabled us to locate an item, or even a person, by great accuracy. There are generally two ways to collect the location information. In the first way, users will say they are in the vicinity of a certain location, such as a ZIP code or a city. In the second way, the information can be sent automatically using several location-detection technologies that are beginning to roll out. The technologies include Global Positioning System (GPS) phones, network solutions that use two cellular towers to describe the interconnection of signals with a users, and another method that relies on the time delay of the last transmission. By using the location information, a user can then receive weather, restaurant, travel and other information and services specific to that location.

The diffusion of M-Commerce is a bit slow in the states, but it is very popular in Japan. Japan has its own version of the wireless Internet – I-Mode. By using the fancy cell phones and other mobile devices designed for I-Mode, you can play games with your friends, read news, manage bank accounts, trade stocks and more. Europe is also much more advanced than the U.S. in terms of M-Commerce. For example, according to Doland (2002), cell phones can track down the nearest pub in Britain. Scandinavian teenagers can use them to find out where their friends are hanging out. A French company is even testing a dating service that will signal when available singles are around.

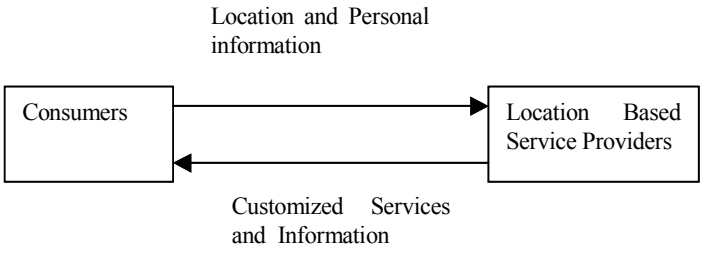

Figure 1. Location Based Services

Research Questions

One of the questions raised by LBS is the concern about privacy. The portability of mobile devices and the ubiquity of their applications coupled with their ability to pinpoint the location of individuals and reveal it to others could produce a system where the everyday activities and movements of individual consumers are tracked and recorded. The potential is there for inferences to be drawn about consumers based on knowledge of consumers' whereabouts.

Our suggestion to solving the touchy privacy problems is to decouple the location information and the personal information. By decoupling the location and the personal information, we can be sure there is no way to infer information about a user from his or her whereabouts, because we either do not know who the user is, or do not know where he or she is. However, at the same time, this scheme also makes it impossible for the users to receive customized information based on his location and personal information. Hence, in order to enjoy and benefits and convenience of M-Commerce, consumers may need the choice to reveal a combination of his location and personal information as well. Hence, this dilemma naturally leads to our research questions,

(a) How will the consumers reveal their location and/or personal information?

(b) What will be the socially optimal level of information revealing?

(c) How would the sellers like the information -- as accurate as possible, or a range will do?

In this article, a model of search and informative advertising is presented to study the problem. In the model, the consumers are looking for a certain product, and they give out personal and location information in exchange for customized advertisements about the products. The sellers provide those customized advertisements based on the information revealed by the consumers. Of course, M-Commerce is not limited to customized advertising, but M-Commerce. The rest of the paper is organized as follows: Section 3 gives the literature review. Section 2 presents the model and the analysis. Conclusions and discussions are presented in Section 4.

Literature Review

The literature on consumer search is extensive. Diamond (1971) shows that when the search costs are high, sellers have the incentive to set the price at the monopolistic level. A main observation of Diamond's model is that profits are discontinuous and jump to the monopoly price with a positive search costs. Rothschild (1974) offers a different search model by assuming buyers do not know *a priori* the price distribution. Instead, he uses a sequential search model in which buyers learn about the probability distribution while they search. He finds that in many instances the qualitative properties of optimal-search strategies are the same as in the simpler case when the distribution is assumed known. Salop and Stiglitz (1977) introduce heterogeneity into the search model by assuming some buyers are informed while others are not. They suggest that buyer heterogeneity will also lead to price dispersion in the market. Bakos (1997) models the role of buyer search costs in markets with differentiated product offerings. He finds that high search costs will result in market failure.

There is also a well-developed literature on informative advertising. Butters (1977) is the first to study the role of firms as suppliers of price information. In his model firms provide buyers with price information through purely informative advertising. Butters (1977) shows that because firms must bear the cost of providing the price information, a monopolistically competitive market has an equilibrium with firms advertising different prices with different intensities. Grossman and Shapiro (1984) adds heterogeneity to Butters' model by studying the role of promotional expenditures by sellers in a model of product differentiation in which advertising conveys full and accurate information about the characteristics of products. Stegeman (1991) modified Butters' model to allow buyers to have different reservation prices. He finds that in equilibrium, every firm on the continuous price distribution buys less advertising than is socially optimal.

The Model and the Analysis

Let us consider a market of a heterogeneous product with *n* buyers and *m* sellers. The market is represented by a unit circle, and the buyers and sellers are all uniformly distributed on the circle. Buyers each want to buy one unit of the product. A buyer may reveal his location information *l* and personal information *x* in exchange for customized advertisements from the sellers. The maximum level of personal information to reveal is $\bar{x}$. i.e., if $x = \bar{x}$, the buyer has given out all his or her personal information. When a buyer gets more than one advertisement, he or she will just randomly choose one of them. Buyers suffer a disutility from reading advertisements. Let us denote this disutility by $U(s_B) = as_B$, where a is a constant and s_B is the number of advertisements a buyer gets. Buyers also suffer anther disutility from revealing their location and personal information. For the ease of analysis, let us assume the disutility can be represented as $V(l, p) = \dfrac{b}{l + \bar{x} - x}$, where b and is a constant.

On the supply side of the market, let us use $A(s_S)$ to denote the cost of sending advertisement, where s_S is the number of advertisement a seller sends. Also for ease of analysis, let us assume $A(s_S) = cs_S$, where *c* is a constant.

For a buyer who is located at distance d_B along the unit circle and reveals his or her location information as *l*, he or she will receive advertisements from sellers located in $[d_B - l, d_B + l]$ whose products can satisfy his or her need. Let us use $\tau(x)$ to represent the fraction of sellers whose products can satisfy buyers who reveal their personal information as x or higher, and let us also assume that $\frac{d\tau(x)}{dx} < 0$. For the moment, we are looking at a symmetric equilibrium in which all buyers reveal their location information as *l* and personal information as *x*. Then the number advertisements a buyer gets is

$$s_B = 2ml\,\tau(x)$$

From the buyer's perspective, he or she will try to minimize his or her disutility as follows,

$$U(s_B) + V(l, p) = 2aml\,\tau(x) + \frac{b}{l + \bar{x} - x}$$

The first order condition equations are not tractable without further assumption on $\tau(x)$. For ease of analysis, we assume $\tau(x)$ is uniform, which means $\tau(x) = \frac{\bar{x} - x}{\bar{x}}$. Then, from the first order conditions, we get

$$l_1^* = \frac{1}{2}\left(\frac{b\bar{x}}{am}\right)^{\frac{1}{3}}$$

and

$$x_1^* = \bar{x} - \frac{1}{2}\left(\frac{b\bar{x}}{am}\right)^{\frac{1}{3}}$$

If a seller's product can satisfy buyers who reveal their personal information as *x* or higher, then the number of advertisements the seller sends is

$$s_S = 2nl$$

Then from the social planner's perspective, he or she will try to minimize the sellers' advertising costs and the buyers' disutilities as follows,

$$m\,\tau(x)A(s_S) + n[U(s_B) + V(l, p)] = 2(a + c)mnl\,\tau(x) + \frac{bn}{l + \bar{x} - x}$$

Also from the first order conditions, we get

$$l_2^* = \frac{1}{2}\left[\frac{b\bar{x}}{(a + c)m}\right]^{\frac{1}{3}}$$

and

$$x_2^* = \bar{x} - \frac{1}{2}\left[\frac{b\bar{x}}{(a+c)m}\right]^{\frac{1}{3}}$$

Comparing the figures, we find that $l_1^* > l_2^*$ but $x_1^* < x_2^*$. This implies that buyers are willing to reveal their location information more than the socially optimal level, but will reveal less personal information than socially optimal. Also from the expressions of l_1^*, l_2^*, x_1^*, and x_2^*, we can find $l_1^* > l_2^* > 0$ and $x_1^* < x_2^* < \bar{x}$, which means the buyers will never reveal their exact location information and full personal information in exchange for customized advertisements. Moreover, it is also never socially optimal to require the buyers to reveal their exact location and full personal information.

As for the sellers, they will try their best to lower the costs for advertising, which means they will try to minimize $2cml\tau(x)$. Also from the first order conditions, it is very easy to find that

$$l_3^* = 0 \text{ and } x_3^* = \bar{x}$$

The above result is quite intuitive. It actually means that the sellers would like as much location and personal information as possible. Hence, the sellers will support the revealing of consumers' information, and they will be willing to pay for it.

Conclusions and Discussions

In the previous section, an analytical model is presented to illustrate the privacy problems in M-Commerce. Although M-Commerce offers many conveniences and advantages, it also opens the potential for inferences to be drawn about consumers based on the knowledge of consumers' whereabouts. We argue that in order to protect the consumers, M-Commerce system should allow the consumers to decouple their location information from their personal information, which means the consumers should be allowed to only reveal their location information but keep their personal information private, or *vice versa*. In this way, no one can infer information about a consumer from his or her location.

Interestingly, our analysis shows that even when consumers are given the right to decouple their location and personal information, they may reveal a combination of his or her location and personal information in exchange for customized information and services. However, the consumers will never reveal their exact location or full personal information. Moreover, we also find that consumers may reveal their location information more than the socially optimal level, but they will reveal less personal information than socially optimal. The above findings suggest that consumers are willing to give out some private information for the conveniences offered by M-Commerce, but service providers cannot expect consumers to sacrifice all their privacies. Instead, the service providers should leave some room for consumer privacy, and provide services that do not require exact location and (or) personal information.

References

Butters, G. 1977. "Equilibrium Distribution of Sales and Advertising Prices," *Review of Economic Studies*, 44, 465 – 491, 1977.

Diamond, P. 1971. "A Model of Price Adjustment," *Journal of Economic Theory*. 3: 156 – 168, 1971.

Doland, A. 2002 "New Uses Coming for Cell Phones," *Yahoo! News*, Feb. 19, 2002.

Grossman, G. M. and C. Shapiro, 1984. "Informative Advertising with Differentiated Products," *Review of Economic Studies*, 51, 1:63-81, Jan., 1984.

Rothschild, M. 1974. "Searching for the Lowest Price When the Distribution of the Prices in Unknown," *The Journal of Political Economy*, 82, 4:689 –711, Jul. – Aug., 1974.

Salop, S. and J. Stiglitz, 1977. "Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion," *The Review of Economic Studies*. 44. 3:493-520. 1977.

Stegeman, M. 1991. "Advertising in Competitive Markets," *The American Economic Review*, 81, 1:210-223, Mar. 1991.

Strategy Anlysics, 2000. "Strategy Analytics Forecasts $200 Billion Mobile Commerce Market by 2004," *Wow-com*, Jan. 10, 2000.