A Novel Peer-To-Peer Personalized Advertising Framework Using Ad Hoc Wireless Communication

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ABSTRACT

The proliferation of mobile devices and pervasiveness of wireless technology have provided a new environment for mobile commerce (M-Commerce). In this environment, mobile advertising will be playing an important role in mobile commerce marketing. Generally, mobile advertising can be defined as advertising a product advertisement or a service advertisement to the mobile users via wireless network. This paper discusses some issues in mobile advertising and proposes a framework for mobile advertising using peer-to-peer ad hoc wireless communications.

Keywords: *mobile advertising, peer-to-peer, ad hoc network.*

1.0 INTRODUCTION

The rapid increase in the usage of mobile devices especially in mobile commerce has lead to the growth of mobile advertising. Such a marketing model can create a lot of opportunities for the business owner. However, it does have some negative impacts to the mobile commerce user. Such impacts included information flooding, privacy concerns, etc. Therefore, our goal is to create a framework for personalized mobile advertising with three main advances: (a) to take advantage of peer-to-peer techniques in innovative ways in mobile ad hoc network environments; (b) to reduce or minimize the potential negative aspects of mobile advertising so the solution will be attractive for the general public; and (c) to propose a new business advertising paradigm in a specified and crowded location such as shopping mall. This paper introduces our proposed framework for personalized mobile advertising using peer-to-peer ad hoc wireless communications. We start this paper by discussing mobile ad hoc networks, current issues in mobile advertising, and some related work for peer-to-peer applications. Then, we will discuss the proposed framework design and features following by the implementation of the framework. Finally, we will discuss the time efficiency between the manual approach and the framework approach in distributing an advertisement to shoppers.

2.0 AD HOC NETWORK

Wireless ad hoc networks are self-organizing networks that are comprised of wireless nodes in order to dynamically establish communication. Any device with a microprocessor, whether highly mobile or stationary, is a potential node in an ad hoc network. Ad hoc networks have a number of advantages and characteristic compared to the traditional wireless cellular network.

Advantages and characteristics of ad hoc network
No infrastructure required
Ad hoc wireless network do not rely on wired base-stations and for that reason can be deployed in places without existing infrastructures. They can be created spontaneously on an "as needed" basis, because they require little configuration to setup compared to the traditional wired network.

Self-organization
The network topology of an ad hoc network is dynamic. We may assume that as soon as two nodes are within hearing distance of each other, a communication link between them is automatically formed. Consequently, the network topology of an ad hoc network reflects the relative distance of its nodes and is continuously reconfigured as nodes come within reach of each other.

Fault tolerance
The self-organizing nature of ad hoc networks has a better fault tolerance because they do not rely on the dedicated base station. In a traditional cellular network, a fault in the base station will impair all nodes in its cell. In ad hoc networks, a malfunction in one node can be easily overcome through network reconfiguration.

Note that in much of the literature, "mobile ad hoc networks" means multi-hop mobile ad hoc networks, where a sending node finds a multi-hop path to the destination node or nodes, either proactively or reactively (on an as-needed basis). For our application, we do not need to send advertisements only to specific nodes, and so we save battery life by not running complex routing algorithms. Instead, nodes simply interact with any other nodes that come into their transmission range to pass on advertising information.

3.0 CURRENT RESEARCH ISSUES IN MOBILE ADVERTISING

3.1 Personalized services
Information flooding is a recently emerging issue in M-Commerce, especially in mobile advertising. It happens since business advertisers think it is a good way to push information to the user. However, it can become an annoyance for a mobile application user who keeps receiving irrelevant advertisements from their mobile services provider. As a result, it may create a negative impact to M-Commerce. One of the

result is mobile users will stop using M-Commerce services. So, one approach proposed by some researchers to handle this issue is personalized services [1]. The objective of personalized services is to create a one-to-one relationship with the current customers and providing clients with uninterrupted relevant contents. With personalization, the amount of messages sent to the customers will be reduced. The users will no longer receive numerous irrelevant messages. With fewer messages, the users can view the message title, and hence select the interesting pieces of news, more easily. Consequently, it is likely that personalization can solve the problem of small screen display in M-Commerce.

3.2 Coverage

Another concern on which we have to focus when designing a mobile advertisement is the coverage of the advertisement. The author of the book "Creating location services for the wireless Web" [2] has highlighted that there are two sections of mobile advertisement coverage: one that is general and covers everything and another that is specialized and covers only the specific area where the store is located. Some questions such as do you want to draw users that are not in the vicinity to your store, or do you want to advertise it inside the vicinity of your store needs to be considered. Thus the type of advertisement coverage will affect the architecture used to design and develop a mobile advertising framework.

3.3 Privacy

Privacy is another concern resulting from personalization. The W3C and the WAP Forum held a workshop in 2000, discussing privacy for M-Commerce. The workshop agreed on a number of points. The most important point was that the user must be in control of personal information. Then there is a need for privacy tools and privacy architectures [3]. Privacy should not be seen as a technology or legal problem alone; rather, it is a societal issue, and technology and laws must work together to ensure the privacy of the user. Otherwise, the high level of trust that is required in the mobile environment will not be kept, and the opportunity of mobile network operators to become trusted agents for transactions will disappear.

4.0 RELATED WORKS FOR PEER-TO-PEER APPLICATIONS

4.1 Kazaa

Kazaa [4] is the most prominent example of a decentralized peer-to-peer system in the stationary-wired network. It was developed to provide capabilities similar to the file sharing network Napster and is mostly used for software, music, video, and image files. Unlike Napster, Kazaa uses peer-to-peer technology. This means that individual users connect to each other directly, without need for a central point of management. For example, Bob downloads Kazaa and installed it onto his computer. Alice also has installed Kazaa on her computer. Bob uses Kazaa to search for a file he is looking for and his Kazaa software finds the file on Alice's computer. So Bob can download the file directly from Alice. In order to encourage the collaboration between peers, Kazaa has implemented a reward scheme, which is the Peer-to-peer Participation Level. User who have better integrity rated in sharing or uploaded the share file to the other peer user will have a higher Participation Level and have better download priority and performance. However, Kazaa is primarily designed for traditional fixed networks, not mobile ad hoc networks.

4.2 Impromptu MP3 File List Sharing

Impromptu MP3 File Sharing is a peer-to-peer mobile ad hoc collaboration application developed by a group of researchers at the Department of Computer Science at University of Oregon U.S. [5]. The objective of this research is to promote the social relationship among co-located persons during chance encounters. In this collaboration, users equipped with Impromptu MP3 File Sharing platform can change their MP3 download list when their mobile device is within a close physical proximity. In this case, the authors have highlighted some design issues in developing this platform. This issue included the social context, usage context, and the technical context.

4.3 eNcentive

eNcentive is an intelligent marketing framework in mobile peer-to-peer environments [6]. The eNcentive framework is an agent-based framework. Each peer in the network is an agent for each other peer in passing the advertisement. As a result, some rewards or extra discounts will be given to the peer's efforts. eNcentive has solved the privacy issue in mobile advertising by having a user profile installed in the devices. Currently, eNcentive is using an active push model to push the advertisement to the peer devices. However, eNcentive lacks certain useful features like price comparisons and does not adapt to battery power levels.

5.0 FRAMEWORK DESIGN

There are few criteria needs to be considered in this peer-to-peer personalized mobile ad hoc advertising framework design.

5.1 Coverage

The objective of the proposed framework is to propose a smarter way to disseminate shop advertisements and promotions to shoppers in the shopping mall via mobile advertising. So the framework will apply a peer-to-peer architecture model in order to provide advertisement information coverage to targeted users.

5.2 Privacy

In peer-to-peer advertising mode, each user will have their own personalized advertisement category list

installed in their personal mobile device. This personalized list will maintain the specific category of advertisement, which the user wishes to accepted or download from the base station broadcast centre. This will address the privacy problem since this personal information is not maintain by the third party in the centralize database. Consequently, it will address the privacy infringements due to personalized information

5.3 Personalized update

This framework will allows user to customize their update advertisement from the base station broadcast centre via advertisement category or brand personalization. This will ensure that not all new advertisement will be downloaded to the mobile device every time users update their framework's advertisement at the base station broadcast centre.

5.4 Push model

This framework will apply the push model in disseminate the advertisements or promotions. The mobile node will actively broadcast or push the advertisement to its peers that are within its physical proximity. However, the user will have the option to either accept or reject the broadcasted advertisement from their peers.

5.5 Entomology and collaborative reward scheme

The advertising framework applies some insect communication analogies adopted from the entomology study. This communication analogy applied to the framework for advertisements dissemination among peers. One proposed communication analogy is the honeybees' communication analogy [7]. In this analogy, the scout bees will lead their peers to the location that provides nectar. This scenario can be representing that each mobile node in the network will act as an agent and try to distribute the advertisement. As a result, they get some rewards from a collaborative reward scheme.

6.0 FRAMEWORK FEATURES

6.1 Personalized list

A user personalized list or profile will be stated in the framework (inside the mobile device). A user can customize and maintain their preference type of advertisement, which they wish to receive and download from base station broadcast centre. This preference can be the product category of the advertisement or even more specifically the brand of a product. For instance, product category customization can be shoes and brand customization can be Adidas sport shoes. Mobile node who have a shoes category customization will receive the entire shoe advertisement from different brand includes sander, sport shoes, boot etc. However, mobile node that has the Adidas sport shoes customization will only receive the Adidas sport shoe advertisement. Such personalization type of advertisement will address the battery power constraint of a mobile device since not every advertisement push by the peer is downloaded into the mobile device.

6.2 Periodic advertisement broadcast

The framework will have a user-defined timer so that the broadcast activity will not drain up the mobile device's battery in a quick time. Thus, this is another solution for the mobile device's limited battery power constraint.

6.3 Referral

This framework will have a referral reward scheme to reward the advertisement distributor in the network. Each peer device or mobile device will have a unique framework identification number (IDNumber) provided by the framework. This IDNumber will be inserted into the advertisement message as the ReferralID when it is broadcasted to another peer device. Peer device that received this advertisement will have this IDNumber as the particular advertisement first referral. Usually, the broadcaster will be the first referral for an advertisement. This referral reward scheme can be passed up to maximum five referrals in one advertisement. Eventually, the shop owner can record down the referral's IDNumber and give them the reward to referrals if they are spending some money at the shop in the future. Usually, the first referral will have a better discount percentage compare to the rest of the referrals. Figure 1 shows the structure of the broadcasted advertisement.

Company/Category/Brand	Information	ReferralID

Figure 1: Structure of broadcasted advertisement

Here are some explanations of the structure elements.

Brand / Category: This data element will refer to the advertisement's category, the brand of the advertisement product or the company name that send out the advertisement.

Information: This data element will contain the advertisement details. Such information like discount percentage and valid time, shop location etc.

Referral ID: This is an array data element, which will add the peer's IDNumber to the message each time this advertisement is broadcast.

Figure 2 shows how the ReferralID pass from a broadcaster to a receiver.

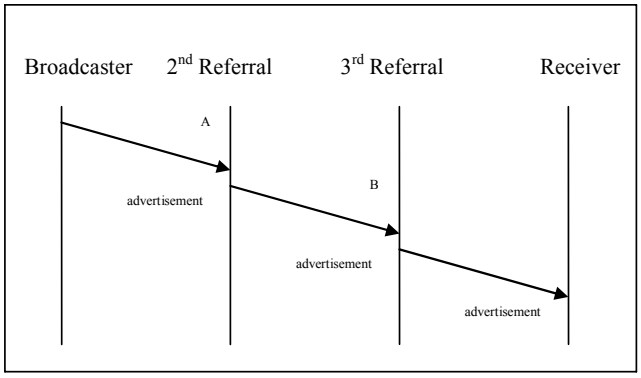

Figure 2: The ReferralID pass from the broadcaster to the receiver

A and B are the ReferralID list in the advertisement message.

A: Advertisement message broadcast from second referral will have the ReferralID list: ReferralIDList(Broadcaster, 2nd Referral)

B: Advertisement message broadcast from the third referral will have the ReferralID list: ReferralIDList(Broadcaster,2nd Referral, 3rd Referral)

Scenario of using peer-to-peer personalized mobile ad hoc advertising framework

The shop owner of ABC Feng Shui Crystal World notices that it is hard for them to attract the customer to visit their shop since the location of the shop is not strategic. After some analysis, they come out with a conclusion they need to send out more advertisements to attract the customer to visit them. One solution suggested is to send out mobile advertisement. They have put their advertisement at the information counter near the shopping mall main entrance. Usually, customer who has their mobile device (PDA) installed with this framework can download the latest promotion advertisement according to their shop preference or product preference. However, after a period of time, they noticed that there was no much effect on the advertisement that they had advertised at the information counter. Thus, they did some analysis and found out that their products are too specified (not a common product) and not many people have actually set it as the personalized download item and download it into their mobile devices from the information counter. So, they try to make use of other features of the framework, which is the advertisement broadcast via push mechanism, and the referral collaborative reward scheme. They have set up their own broadcast base station at their shop and actively broadcast their promotion advertisements. One day, Alice who carries a mobile device like a PDA passed by the shop. Alice's PDA is running the peer-to-peer personalized mobile ad hoc advertising framework platform. She will receive the broadcasted advertisement's header even though Feng Shui product was not her choice. However, she will have an option to whether to receive or reject the full broadcasted advertisement. Let's assume that Alice is attracted by the advertisement's promotion and select to download it to her device. Consequently, Alice has become the distributor agent for the particular advertisement. Alice can choose to broadcast this advertisement to her peer when she is walking in the shopping mall. We assume both Bob and Calvin is potential recipient for the Feng Shui product advertisement since they are within Alice's PDA physical transmission proximity. Both Bob and Calvin will receive the broadcasted advertisement header from Alice's PDA. Bob may reject the advertisement if he is not interested with it. However, Calvin may download it into his device. Thus Calvin becomes the second referral for that advertisement if he managed to pass the advertisement to David. As a result, ABC Feng Shui Crystal World will give Alice some credit to reward her contribution in the advertisement distribution. Thus, this reward can be some extra discount for Alice if she is buying some products from the shop in the future. Besides, Calvin can get the reward also if David spends some money in the shop. Figure 3 shows the scenario of using the proposed peer-to-peer personalized mobile ad hoc advertising framework.

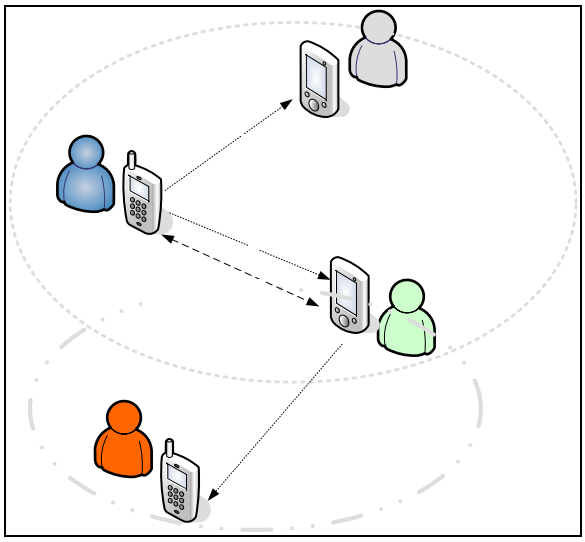

Figure 3: Scenario of using peer-to-peer personalized mobile ad hoc advertising framework

7.0 IMPLEMENTATION

A prototype version of the software implementation of the framework is being developed. We have deployed the framework in a wireless local area

network environment using few laptop computers with WLAN 802.11b ad hoc communication capability. The framework was implemented with Microsoft .Net Framework in the Windows platform. The prototype will have some features such as personalization list, active broadcast control by a timer, advertisement referral with an agent based collaborative reward scheme, chatting capability etc. Figure 4 shows a screen snapshot of the software prototype's interface.

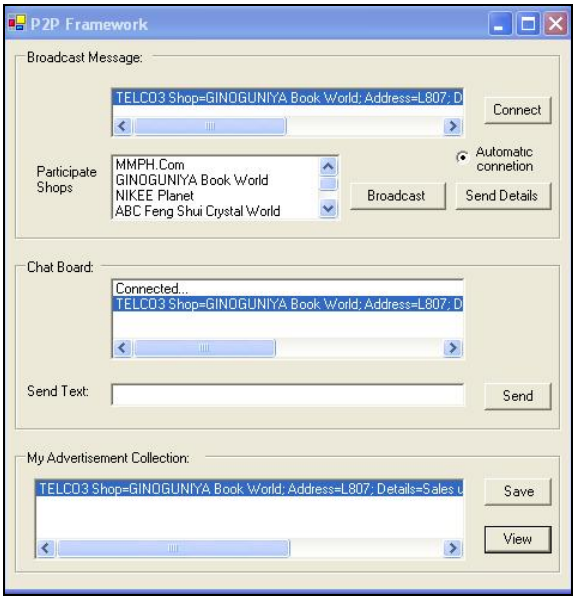

Figure 4: Snapshot of the software prototype interface

8.0 ANALYSIS AND EVALUATIONS

A study has been carried out to compare the time efficiency in distribute an advertisement to a fixed number of shoppers in the shopping mall. Two approaches have been tested out in the study. They are the manual approach and the framework approach. The manual approach will use manpower to distribute an advertisement to a fixed number of shoppers in the shopping mall. However, the framework approach will use the Peer-to-Peer Personalized Mobile Ad hoc Advertising Framework as a tool to distribute an advertisement to a fixed number of shoppers in the shopping mall. The distribution of an advertisement from one shopper to another shopper in the shopping mall building can be thought of as an epidemic that spreads from one person to another person in a country. "The common cold, for an example can be thought as a simple epidemic. A person is healthy but susceptible to a cold. A sick person starts infecting the healthy person when he or she coughs around the healthy person. The new infected person can cause infection to possible susceptible just as he or she was infected. However, the infected person may get recover and become the susceptible class of people. Thus, a person can flow from susceptible to infectious and back to susceptible status." [8]

Deterministic Model

The Deterministic Model is one of the standards modeling procedure that can be used to model the epidemic. Deterministic modeling considers a structured mathematical framework, where one takes the actual number of new cases in a short interval of time to be proportional to the number of both susceptible and infectious individuals, as well as the length of the time interval.

If in a constant population N is categorized into X as susceptible and Y as infected, then we can write the deterministic form of the SIS (Susceptible Infection Susceptible) model as follow.

$$X' = -\lambda X(Y/N) + \partial Y$$

$$Y' = \lambda X(Y/N) - \partial Y$$

Where

$\lambda = cB$

c is the average number of contacts per person unit time.

B is the probability that any one such contact will transmit infection.

∂ is the rate of recovery.

Figure 5: Deterministic Model

The deterministic model was chosen to model the framework's advertisement distribution time efficiency simulation. Advertisement distribution from one shopper to another shopper in the shopping mall building can use the epidemic spreading analogy where

Let assume that

$\lambda = cB$

c is the average number of people walk around the shopper who send out or broadcast the advertisement per particular shopper unit time

B is the probability that any one such contact will transmit or forward the advertisement.

∂ is the rate that the shopper (advertisement keeper) leave the shopping mall.

A side survey using questionnaire method has been carried out to collect relevant information for the framework approach simulation parameters. The result of the simulation is show in Figure 6.

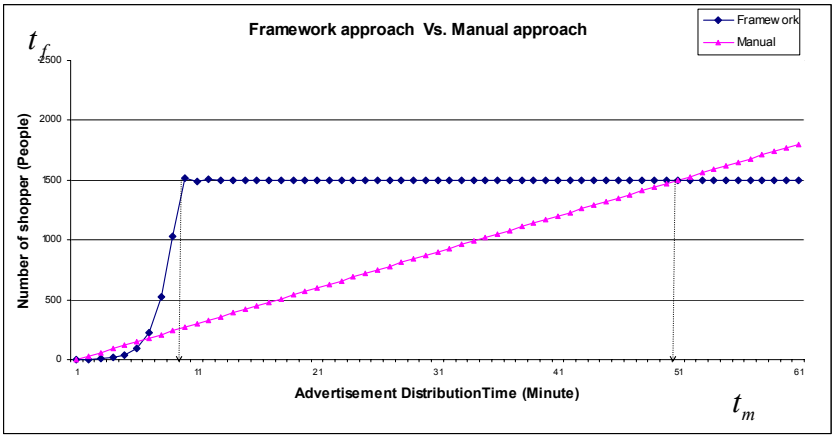

Figure 6: Simulation result to compare the time efficiency to distribute an advertisement to a fixed number of shoppers using the Framework Approach and the Manual Approach

Explanation

This simulation was try to compare the time need to distribute an advertisement to 1500 shoppers in a shopping mall that consists of 5000 shoppers between the framework approach and the manual approach. t_f is the time need to distribute an advertisement to 1500 shoppers using the framework approach. t_m is the time need to distribute an advertisement to 1500 shoppers using the manual approach. Consequently, we can save more time and effort to distribute an advertisement to a same number of shoppers if we use the framework approach.

9.0 FUTURE WORK

We will implement the framework in some Pocket PC in the future, both with Windows platform and Linux platform.

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