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Intelligent Ad Hoc Marketing within Hotspot Networks

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ABSTRACT
In recent years, the growth of *Mobile Computing*, *Electronic Commerce* and *Mobile Electronic Commerce* has created a new concept of Mobile Electronic Marketing. New marketing models are being explored and used by small businesses and merchants to target mobile users in ever-changing ad hoc environments. Utilization of network infrastructure like hotspots networks can assist these small businesses and merchants in addressing challenges of local advertising in theses dynamic environments. This paper proposes a framework, called ***eNcentive***, which addresses issues of dissemination of promotional information in ad hoc environments within hotspot networks. Our framework employs an intelligent peer-to-peer marketing scheme, by providing users the capability to collect promotional information disseminated by hotspots on behalf of small businesses and merchants. Users can propagate these sales promotions and discounts to other users in the ad hoc network. Participating users benefit from such circulation since merchants and small businesses that originally created the promotions reward the active distributors with additional promotions and other compensations. Participating businesses and merchants benefit from this promotion distribution as they effectively reach a wider set of potential customers in their local neighborhoods. Our framework also offers merchants and businesses a mechanism for targeted promotions, which help them customize promotions accordingly.

KEYWORDS: Mobile commerce, hotspot networks, collaborative eCommerce, mobile computing, mobile electronic marketing, intelligent software agents, mobile middleware

INTRODUCTION

Mobile commerce is becoming a new way of doing business in the fast evolving mobile environment [1].With the explosion of wireless technologies, mobile computing is slowly but surely becoming a dominant new culture [2]. People are quickly getting hooked onto the flexibility and autonomy that mobile devices provide. Many mobile users no longer imagine their lives without their mobile phones, PDAs, MP3 players, digital cameras, etc. This nonstop evolution is fueled by new hardware, new software and new services that are being developed and broadly used. However, this transformation of user environments is not as smooth as on would hope. Mobile devices have smaller screens, limited interface capabilities, restricted computational power and relatively short battery life [1]. Mobile users are less tolerant of irrelevant information and frequently have shorter attention span. The demands of nomadic users also changed. They are looking for services that are context and location aware, personalized, address privacy and security [1,2,17]. M-commerce businesses, service providers and content providers must address these emerging issues in intelligent and creative ways. Small and large businesses are starting to acknowledge and accept new culture of m-commerce, applications and services. However, regardless of all the technological progress, the basic needs of merchants, businesses and service providers remain the same. They need to advertise and market their goods and services in order to attract customers. Clearly, this marketing information needs to be delivered in new intelligent ways so that the mobile users find the information interesting, helpful and rewarding with minimal costs imposed

on them and their devices. New marketing business models need to address individual user's personal preferences, user's location and temporal context along with privacy [18] and security issues [16,17].

Current mobile marketing and adverting approaches use SMS (Short Message Service), MMS (Multi-media Messaging Services) and EMS (Enhanced Messaging Services) messages sent by merchants to the user's mobile phone. This type of marketing requires relatively complex collaboration between multiple service providers and is too expensive for small businesses. In essence, mobile advertisement service provider have to take care of the preparation of the ad. Owners of the customer database have to define customer target groups. Mobile operators then have to select customers that fit into the target group. The customer has to give the permission in advance to receive ads from the mobile operator. This is a long and complicated way to reach the consumers. Privacy violations could occur when users provide personal preferences to the content provider. Also preferences can change form hour to hour. They also depend on the user's context. It would be hard to maintain this dynamic preference list on remote database. Privacy and preference management would be clearly simplified if personal preferences were stored on the user's device (such preferences and profiles can be represented in DAML [4], RDF [5] or XML). However, this would complicate things for advertisers. Once user's preferences are moved to mobile device, the advertisers (in order to reach the customers) would have no other choice but to flood the network with advertisements sent to random customers. This is clearly ineffective and not scalable. It is also clear that this flooding model will not be successful even in a sort term. Other communication and marketing mechanisms need to be explored.

This paper proposes a use of alternative wireless infrastructure to distribute promotional and marketing information to mobile users. This infrastructure in the form of base stations and hotspots is already available in many popular areas like Starbucks and Borders Bookstores. Several projects are underway to commercialize this notion of creating islands of high-speed network connectivity that are spread throughout a metropolitan region [20]. In addition, there is growing popularity in terms of community wireless networks [19]. Such community networks aim to offer network connectivity to mobile devices in metropolitan areas. In addition to that, there is also a variation of hotspot networks called infostation networks. In essence, an infostation is a base station coupled with an information server such that the base station provides the network connectivity while the information server handles the data requests. Infostation networks [21] have often been suggested as a viable alternative to meet the needs of mobile applications. Specialized data link protocols have been suggested for allowing devices to communicate with such infostations[22].

Often hotspot and infostation networks are characterized by pockets of network connectivity (close to the access point) surrounded by regions of no network access. Basically, these networks offer high-speed discontinuous coverage, which is inherently low cost. Network access is available to users that are passing in close proximity. A mobile device thus experiences areas of connectivity (when close to a infostation or a hotspot) and areas of disconnection (when there are no infostations or hotspots nearby). Clearly, this inconsistent and short range connectivity limits the adverting capabilities of businesses. This paper proposes use of peer-to-peer communication mechanism in mobile wireless environments where there is not hotspot connectivity. Frameworks like Numi [3,8], MoGATU [9] and Proem [7] explore issues of peer-to-peer communications. Technology like Bluetooth [10], UPNP [11] and JINI [12] can facilitate device and service discovery (many devices like PDAs and mobile phones come equipped with Bluetooth). Marketing information can be injected in to such environments by services providers and marketing information distributors that are operating hotspots that are broadcasting promotions and advertisements. This broadcasted marketing information would be picked up by mobile devices that will come in range of the base station. The devices will consult with user's profile before storing the promotions and advertisements. Thus, the promotions and advertisements will be transferred to the user's device in a private no intrusive matter. The problem with this approach is that broadcasts by a few

basestations can reach only a small number of mobile users. Nevertheless, we believe that this problem can be solved by employing intelligent marketing model.

To address these issues we have developed a framework called ***eNcentive*** that facilitates peer-to-peer electronic marketing in mobile ad hoc environments within hotspot networks. ***eNcentive*** employs a intelligent marketing scheme by facilitating users with mechanism that allow collection of promotional information distributed by hotspots managed by merchants. Sales promotions and discounts are propagated to other mobile users in the neighborhood. Active distributors of promotions are rewarded by merchants; thereby deriving benefits when those other users utilize this information. In essence, mobile users participating in distribution are rewarded accordingly to the success of the dissemination of these promotions.

Typical Application of eNcentive Framework

Consider a business like a restaurant, a cafe or a bookstore that is participating in hotspot network. Essentially, this business in addition to it's main core services also facilitates it's customers with a high-speed Wi-Fi wireless Internet access. The wireless basestations and other equipment that provides this access can be owned and maintained by a third party specializing in Internet access services, similar to T Mobile Hotspots Services[20]. In addition to this basic Internet access service, this business is also running an advertisement service (on top of basic Internet access service). This advertisement service broadcasts promotions, advertisements and coupons for the core services that the business is offering to it's customers. Customers using Internet access service are given an option to receive these promotions (advertisements are not forced like much hated popup advertisements). Promotions and coupons are very relevant to the users that are already using the core services, which this business provides. For instance, promotions can contain coupons and discounts on coffee, books, etc.

Consider a consumer equipped with a PDA running ***eNcentive*** framework traveling though a geographical region populated by businesses (restaurants, cafes and bookstores) that are actively broadcasting coupons, advertisements and other promotions to attract extra business. As the user passes by these businesses or visits these businesses, the ***eNcentive*** framework running on the user's PDA actively collects/caches these coupons and promotions. These advertisements and coupons can be redeemed by this user at a later time at that business location or at any other service provider who honors those promotions. Alternatively, the user can employ the ***eNcentive*** platform to become a distributor of these coupons, promotions and advertisements. In this case, the platform starts to actively advertise coupons to other ***eNcentive*** peer platforms that the user passes by along the way. The peer platforms can cache these distributed advertisements and later redeem them with the business that honors these advertisements or likewise become another distributor. Thus, a coupon can be pass from a user to another to yet another user before it is redeemed. To keep track of this chain, every promotion contains a list of platform IDs of every ***eNcentive*** platform that ever distributed this coupon. When a user decides to redeem a coupon and presents it to the business, the business after honoring the coupon stores the list of the platform IDs for future reference. Every participating business can choose to reward its most effective distributors with additional discounts or other rewards. For example, when a user redeems a coupon, the business can check its list of recently redeemed coupons and see how may times that user's ***eNcentive*** platform ID appears in those lists. The business can then reward the ***eNcentive*** user with additional discounts or upgrade the product or service the user was buying. This collaboration thus is mutually beneficial to both the businesses and the users that distribute coupons on behalf of these businesses. To personalize the promotions and add flexibility to their design, we have also developed targeted promotions. Targeted promotions provide mechanisms for merchants to customize the discounts to address needs and demands of a particular group of potential consumers. For example, consider merchant that is facing competition form neighboring businesses. Also, consider a user that is willing to disclose his or her route which includes the regions that host this merchants competition. The merchant

can offer this user a more lucrative promotion that is clearly more attractive to this user. In return, the user will distribute these promotions in the aria populated with competing businesses. This form of targeted advertisement is clearly beneficial to both consumers and service provides. There are clearly issues of violation of consumer's privacy and even merchant's privacy. However, if the benefit outweighs the risks both parties might be interested in use of this mechanism. Other protocols can be added to improve privacy and security [17].

In the following sections, we discuss related work, a set of application scenarios and features and functionalities of promotions and reward mechanisms. We also present ***eNcentive*** - agent based framework that we built as a prototype to demonstrate the feasibility of proposed approach. We conclude this paper by description of future work and summary and conclusions of work.

RELATED WORK

In recent years, a number of attempts were made to address marketing and advertising in mobile environments. In particular, there has been some work that targeted mobile phones. One such attempt was made by the Japanese video rental company, Tsutaya[15]. Tsutaya collected and maintained a database of its customers' musical and video preferences. With customers' consent, Tsutaya delivered highly personalized messages to the customers' mobile phones. The preferences where used to notify customers on their mobile phones of a release of new movies or new musical albums that matched customers' preferences. Tsutaya also sent out other promotional information like discounts on rentals and concert announcements that matched customers' personal preferences. Though very effective, the approach taken by Tsutaya has several draw backs. One of them is possible privacy concerns. Customers' explicitly supply their personal information and personal preferences to the company. A valid concern of users for this sort of a model could be that this personal information is now at the full disposal of the company and can be used and even misused by it for unwanted spamming. Another drawback is that a user's preferences can change over time. In this model, it is up to the user to update the database to continue receiving relevant information. In addition, this approach does not address context awareness; a user might be disturbed at some inconvenient time or location.

Another advertising model that was adopted by a number of companies like Go2.com [13] involves adding advertisement information to the content that is being requested by the users. For example, if a user is requesting information about local restaurants he or she is presented with a wide spectrum of information including promotions. Users using Agents2Go [2] can receive static information like restaurant's address, phone number and menu along with frequently changing information like today's specials, waiting time and other restaurant promotions like coupons. This marketing approach has a great potential since, it takes into account users' context including time and location. It can also be personalized by asking users for their preferences ahead of time or even during the content delivery. However, along with the quality of information can come a concern of privacy again since the user's preferences are being sent to the server operated by the content provider. Also, it is going to be more difficult for smaller, less established businesses as passing users are not going to trust them with their personal information.

In October of 2002, an advertisement company Aerodeon[14] conducted a mobile marketing campaign for a popular confectionary brand in the UK. The campaign targeted UK teenagers though SMS messages. The promotions provided teens with the opportunity to become "squad leaders" and to create a unique "squad" name. Teens could invite as many friends as possible to join using SMS text messages. Each invitee in turn received a branded text message from the confectionary company asking them to recruit friends to join their unique "squad". UK's biggest "squad" won a year's supply of confectionaries. This marketing model actively engages users by necessitating collaboration and recruitment. However, success of this model is directly tied to the characteristics of the target groups and the type of promoted products. Active manual recruitment can, at times be intrusive and can violate privacy of both sending

and receiving users. Scalability of the model can also be a major factor. Both sending and replying requires direct involvement of the users. Since users manually propagate the promotions to each other, they can be easily overwhelmed by active marketing environments. However, if the burden of solicitation, collaboration and marketing is shifted to devices like PDAs and mobile phones, the scalability and privacy problems can be avoided. If our personal devices are entrusted with our preferences and interests then they can make majority of evaluation and decisions our behalf.

In contrast to the above presented work, the ***eNcentive*** framework also addresses issues of privacy. Our framework allows users to store their profiles locally and does not require submission of any personal information to any centralized location. This inherently makes the framework privacy aware and more secure. Decisions, effecting the acceptance of the promotional information, can be made locally. The frameworks' management component can be tied to the context monitoring component and to the personal preferences component. As a user's preferences evolve over time, the decision of information acceptance is automatically adjusted to reflect the new preferences. Thus, there is no need to maintain a remote profile for the user. This is especially very important to users' who depend on multiple content providers that are not linked and are not cooperating with each other. An argument can be made that locally storing profiles can be a factor for users with nonrestrictive profiles on mobile devices with limited computing capabilities. Mobile devices of such users could occasionally be weighed down by the incoming marketing information. We believe that using device profiles along with the user preferences can solve this problem. Another benefit of the ***eNcentive*** framework is that it also addresses location awareness since only neighboring peer devices are propagating information. It is logical to assume that the majority of the devices participating in information distribution are from that local geographical region and contain information that is relevant to the current location.

TYPICAL SCENARIOS

Basic Scenarios

Consider a small business ***Jazz Café*** which is participating in has a hotspot network and running an advertisement service**.** The management of ***Jazz Café*** notices that in recent weeks they are getting fewer customers during evening hours. After some analysis, they come to the conclusion that this is a temporary phenomenon that can be overcome by distribution of additional advertisements. In attempt to attract to increase the repurchase rate, ***Jazz Café*** issues electronic promotions. The promotion offers 10% off a cup of coffee bought after 5pm.

The promotions are broadcast by the hotspot inside the café. ***Jazz Café*** also has a set of loyal customers that are always are on the look out of promotions. One such customer is Bob. Bob, like many of us, is attached to his PDA (***MH1***) and carries it with him at all times. Bob's PDA is running ***eNcentive*** framework. During Bob's morning visit to ***Jazz Café***, Bob's ***MH1*** receives and caches ***Jazz Café's*** e-promotion advertised by the café's hotspot. Once he leaves the café, ***MH1*** starts actively advertising this promotion to peer devises that it passes by. During the day, as Bob travels through the neighborhood, he passes by Suzan who is equipped with a PDA (***MH2***) running ***eNcentive***. ***MH2*** receives Bob's broadcast and requests the promotion from ***MH1*** as it matches Susan's drinking preference. ***MH1*** signs the promotion with Bob's ***eNcentive*** ID and passes the promotion to Susan's ***MH2***. Once Susan's PDA is out of Bob's range it starts actively advertising ***Jazz Café's*** promotion. In the afternoon, as Susan is traveling thought the neighborhood, she passes by Jeff who is caring ***MH3***. ***MH3*** receives ***MH2*** broadcast and requests the promotion (since Jeff is a coffee drinker). ***MH2*** signs the promotion with Susan's ***eNcentive*** ID. At 6pm, Jeff decides to take advantage of the ***Jazz Café*** promotion and visits the cafe. He presents his 10% off e-promotion as he purchases his cup of coffee. ***Jazz Café*** accepts the promotion and stores it in its ***eNcentive*** database.

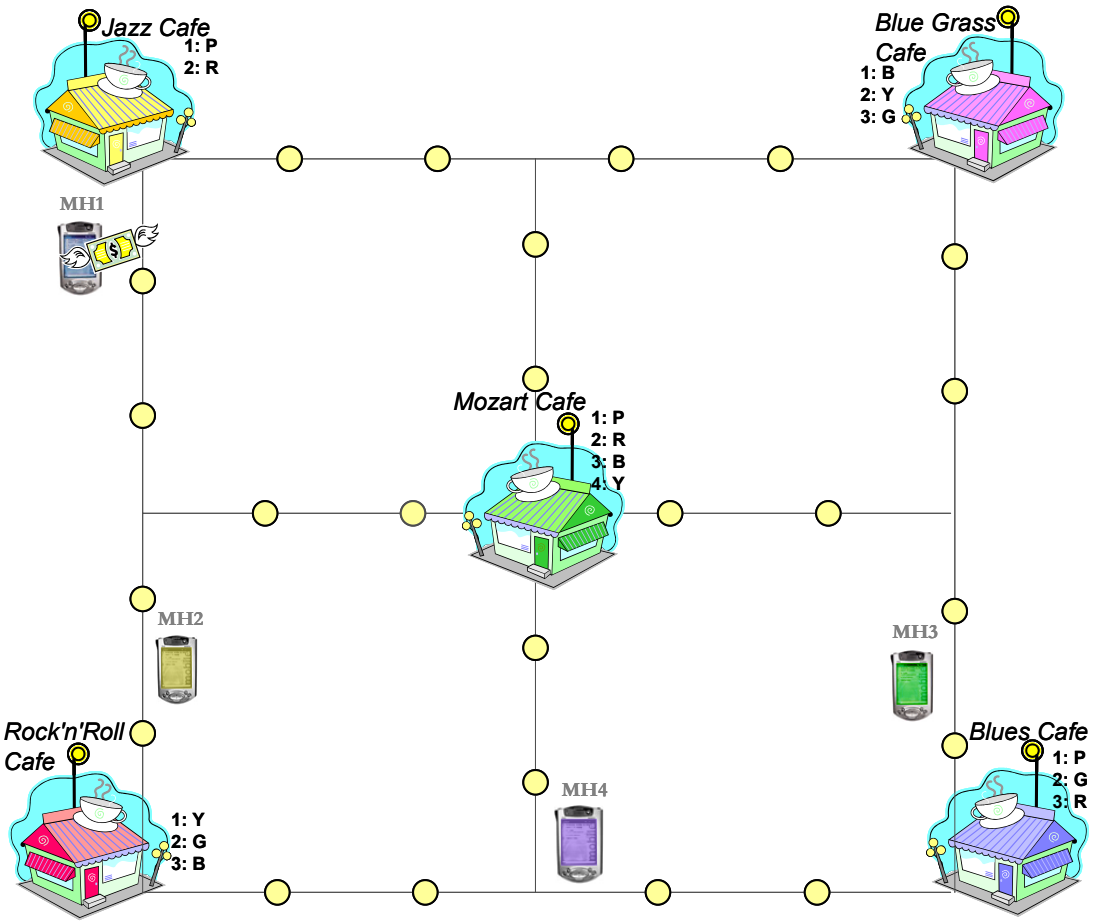

Figure1. Typical Application Scenario Map

Along with promotion, ***Jazz Café*** stores the ***eNcentive*** ID's of all the people that assisted in distributing this e-promotion. At 7pm, Susan also visits the café. She uses her e-promotion to get the discount. Like Jeff's promotion, Susan's e-promotion is stored in the database along with the ***eNcentive*** ID's of the distributors. In addition to that, as she presents her promotion the ***Jazz Café***, the ***eNcentive*** Server checks the ***eNcentive*** database and notices that she successfully assisted in distribution of one e-promotion (to Jeff). To reward Susan for her assistance, ***Jazz Café*** gives her 2% off in addition to the 10% off from the original e-promotion and 10 minutes of free internet access through the ***Jazz Café's*** hotspot. So Suzan's final discount is 12% off coffee and 10 minutes of internet access. At 8pm, Bob stops by ***Jazz Café*** to get his usual evening cup of coffee. He uses his e-promotion and receives additional 5% off on top of 10% guaranteed by e-promotion that he picked up in the morning. He also receives 15 minutes of internet access through the ***Jazz Café's*** hotspot. Bob's final discount is 15% off coffee and 15 minutes of Internet access time since Bob ***eNcentive*** ID was present in Susan's and Jeff's e-promotions. At the end of the day, all parties have benefited in this interaction. ***Jazz Café*** has succeeded in attracting more customers through its promotion and because others distributed its promotions, the promotions were able to reach a wider audience, even those that were not in range of the café. Susan and Bob benefited through their additional discounts and Jeff now has found a new previously unknown coffee shop that is convenient and offers him discounts.

Targeted Promotions Scenario

Suppose the management of ***Jazz Cafe*** concludes that their business is facing intense competition form other coffee shops in the neighborhood. In particular, ***Rock'n'Roll Café*** and ***Blue Grass Café*** are its

greatest rivalries. To address this competition problem, ***Jazz Café*** management creates a promotion that is specifically destined to target potential customers of ***Rock'n'Roll Café*** and ***Blue Grass Café***. Such *targeted promotion* for example could guarantee a generous discount for a popular coffee drink that is unique to ***Jazz Café*** and also assure a more generous reward to the active distributors. ***Jazz Cafe*** management feels that these *targeted promotion* are not for general distribution and should be given out mainly to potential customers of the competition. It is clear that the greatest concentration of such potential customers is in the areas near ***Rock'n'Roll Café*** and ***Blue Grass Café***. To reach these customers, ***Jazz Cafe*** needs to insure that *targeted promotions* are being advertised in these arias. This can be done by selectively giving *targeted promotions* to customers that are heading to the targeted arias. Thus, in addition to usual broadcast of *generic promotion*, ***Jazz Café*** starts selectively passing out *targeted promotions* to the users that are willing to provide there travel routes. Note that user's rotes can either be explicitly entered into the mobile device or they can be learned over time. Other applications on the device (like organizer or scheduler) can be used to learn route information.

So, in Bob's case, when ***MH1*** receives a *generic promotion* form ***Jazz Café's eNcentive*** Server (that is being indiscriminately broadcasted to all customers) ***eNcentive*** framework on ***MH1*** check with Bob's local personal profiles. From the profiles, the framework determines that Bob does not mind sharing his current route with neighborhood coffee shops. ***MH1*** sends Bob's route to the ***Jazz Café***. ***eNcentive*** Server in ***Jazz Café***, form that route, determines that Bob will pass by ***Rock'n'Roll Café***. Since ***Rock'n'Roll Café*** is a competitor, ***Jazz Café*** supplies Bob with *targeted promotions* that are specifically destined to target potential customers of ***Rock'n'Roll Café***. So, Bob actually received both *generic promotions* and *targeted promotions* (with a better discount and a generous reward for distribution). As Bob travels though the neighborhood, ***MH1*** starts advertising the *targeted promotions* which are picked up by other devices in the neighborhood. Clearly, it is in Bob's interests to distribute *targeted promotions* rather then *generic promotions* since *targeted promotions* promise a more generous reward for the distribution. Since the promotions have expiration time, ***MH1*** will distribute the promotions only for a limited time. Thus, the *targeted promotions* will be contained with a certain radius around the competition. Other mechanism of constraining distribution are possible (described below). These *targeted promotions* are picked up and identified by users' mobile devices. The collection of such promotions influences user's purchasing decisions and thus brings extra business to ***Jazz Café***. So, as the users redeem the coupons, ***eNcentive*** Server in ***Jazz Café*** keeps track of the distributors of the promotions. During the next visit Bob can use his *targeted promotion* and get that coffee drink that is unique to ***Jazz Café*** and also get extra generous reward.

Clearly, in *targeted promotion* scenario, the customers should have a number of privacy concerns related to revealing their travel route to any entity. However, we feel that a user might be willing to disclose this information if he or she is adequately motivated by high discounts and generous reward (discussed below) for the active distributors. Also, we feel that since a user is given a choice to disclose or not to discourse personal information he or she will have enough flexibility to handle privacy related concerns. Thus, if the user is willing to trust the businesses not to misuse the information this user can get a grater benefit and better discounts. Various trust mechanisms can be used to regulate the consumer information.

Obviously, consumers are not the only party at risk in this scenario. Businesses are also in danger of misinformation form the consumers. Businesses have no way of verifying that the information provided by the consumers is valid. For example, a rogue consumer a can provide false route (in hopes of obtaining a greater discount). There is not faultless solution that will eliminate or prevent such misinformation form happening. However, some steps can be taken to minimize it. For example, business can start a frequent-customer club. Only the members of this club can be trusted. Unfortunately, the price of this trust mechanism is a limited number of trusted consumers. Other trust mechanism are also possible.

Another concern that rises from *targeted promotions* scenario is that the competing businesses are also able to receive the *targeted promotions* and thus will be able to counteract the promotion campaign. However, this completion is a not very different from the other competitions that happen in a regular (not electronic or mobile) commerce.

PROMOTIONS AND REWARD MODELS

The ***eNcentive*** promotions are the central part of the framework design. They provide powerful yet flexible scheme for businesses to advertise and promote their services and goods. Each e-promotion contains the *name of the service provider* which specifies the name of the business that is offering this promotion. E-promotions also contain *discount information*. This information essentially is a text that specifies the promotion details of goods and services offered by the service provider. It is mainly used by the consumers to identify the details of the proposed deals. For example, promotion from ***Jazz Café*** can advertise "10% off of any cup of coffee". E-promotions also specify *promotions creation time*, *promotions start time* and *promotions expiration time*. In addition, each promotion contains a list of the distributor IDs that handled the promotion. Initially, when the promotion is created this list is empty. As the promotion is passed from a consumer to consumer, the list gets filled with the consumer IDs. To protect the privacy and the identities of the consumers, the IDs can be encrypted. Each promotion also has a *replication policy*. This policy specifies the number of times the promotion can be duplicated. If this number is set to zero, the promotion can not be replicated. Thus, consumer can only give this promotion away (to other consumers). As a result of that, the consumers are more likely not to distribute such promotions and keep them for themselves. The consequence of such behavior is limited promotion distribution. Zero replication policy also results in the number of promotions in the neighborhood not increasing. If the promotion's replication policy specifies a number greater then zero then the promotion can be replicated (specified **number of times**). In addition to the listed above features, each e-promotion also describes the *reward model* (also referred to as *incentive model*) that is used to reward distributors. *Reward model* is essentially a function that maps the number of assists of distributions to the percentage of additional discount. For instance, ***Jazz Café*** e-promotion can reward distributors like Bob with additional 1% off (on top of already guarantied 10% off) for every 15 people that will cite this user as part of their reference chain. The creators of the promotion (restaurants, cafes and other businesses) have flexibility of selecting this *reward function*. This function can have different speed of growth: linear growth, polynomial growth, exponential growth, etc. Threshold functions can also be used. The choice of growth function depends on the effect that the creators are trying to achieve. Aggressively growing functions will result in greater distribution of promotions, which will both increase consumer demand and number of rewards. This modular design of e-promotions provides businesses with flexibility to generate promotions that have of custom start and expiration time, **custom** replication policy, custom promotion information and custom reward function. These flexible settings provide powerful tools to businesses. The promotions can be distributed indiscriminately to every interested consumer or, they can be selectively distributed to a specific targeted population of consumers. The consequence of issuing targeted promotions is that same of the consumers that are in search for better promotions will be willing to alter their behavior patterns such as travel routes in hope of better discount. Thus, in effect, a consumer might be persuaded by a service provider (with generous discounts) to take an alternate route thought the neighborhood to deliver a promotion into the region of the neighborhood that the business is trying to target. Similarly, in search for better deals, a consumer that is aware of the targeting practices of service providers might chose a particular route in hope of acquiring a targeted promotion. This mobile consumer behavior can stimulate neighborhood economy by motivating service providers to develop new good s and services that are personalized to the needs of the community.

eNcentive FRAMEWORK

The ***eNcentive*** framework is an agent based framework. By abstracting functionality into distinct agents, our framework is highly modular and loosely coupled. ***eNcentive*** was built as an application on top of an

agent framework Numi [3,8]. Numi was built to address data management needs of mobile devices moving through a geographical region offering hybrid wireless support (combination of infrastructure based and ad hoc wireless technologies). The Numi framework envisions mobile devices moving through a geographical region populated with islands of cheap high-bandwidth network connectivity, close to access points, surrounded by regions of no connectivity or very expensive WAN connectivity. When mobile device are in range of an access point they are able to use the infrastructure and access information thought the high-speed connection. When devices are away form access points they have to rely on other neighboring peer devices for their data needs. Numi acts as a perfect underlying framework since it provides a communication layer for ***eNcentive*** that can seamlessly work for both infrastructure based and ad hoc wireless networks. ***eNcentive*** reuses much of the existing functionality provided by Numi. Device and infrastructure discovery, location management, data communication and messaging, application management and logging are provided by Numi framework agents. ***eNcentive*** is implemented as an application running on top of the Numi runtime.

The ***eNcentive*** framework runs on both mobile devices and advertisers' portal (portal are access points managed by application servers). There are two configurations for the ***eNcentive*** framework: *eNcentive Mobile Node Configuration* and *eNcentive Advertiser Configuration*. Our modular design allows us to reuse same agents to implement these functionalities in both configurations.

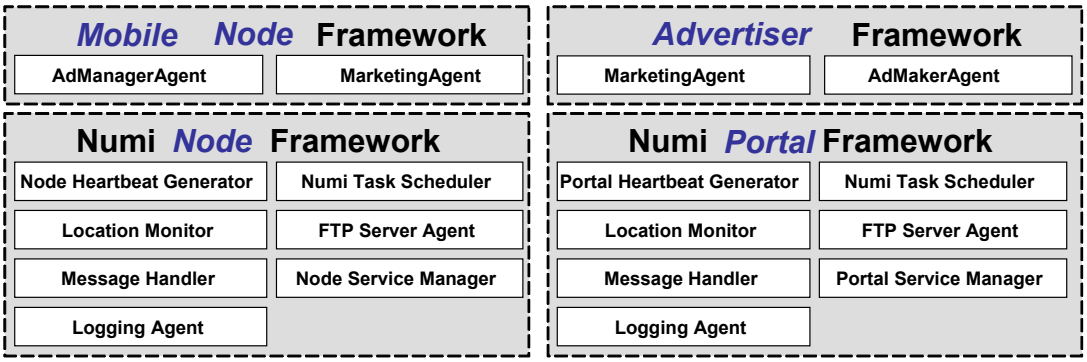

Figure2. *eNcentive* Framework Configurations

eNcentiv Advertiser Configuration

The *Advertiser Configuration* is set up at the location of the business involved in marketing. It can be set up at the individual stores and shops or it could be used by an aggregate of multiple businesses. For example, a shopping mall could run a single instance of this configuration on behalf all participating stores in that mall. The configuration consists of two ***eNcentive*** agents: *eNcentive Ad Maker Agent* and *eNcentive Marketing Agent* running on top of Numi *Portal Configuration.*

The *eNcentive Ad Maker Agent* provides advertisers with interfaces that allow them to create promotions and coupons. Promotions in ***eNcentive*** are objects or intelligent agents that encapsulate marketing details like discount information, *promotion creation time*, *start time*, *expiation time*, *replication policy* and a *reward model* that will be used as an incentive to active participants. The *eNcentive Ad Maker Agent* facilitates creation of e-promotions. It is also responsible for setting of replication policy. Once an e-promotion is created, it is given to *eNcentive Marketing Agent.* This agent is responsible for scheduling of advertisement release. The *Marketing Agent* is essentially in charge of the advertising policy. It specifies how frequently an e-promotion should be broadcasted by the advertising platform. This allows periodic and controlled injection of marketing information into the network. The *Marketing Agent* is also responsible for determining which targeted advertisement should be supplied to the users interested in targeted promotions.

eNcentive Mobile Node Configuration

Broadcast advertisements and promotions are picked up by the mobile devices running *eNcentive Mobile Node Configuration.* This configuration consists of two ***eNcentive*** agents running on top of Numi *Node Platform*: *eNcentive Marketing Agent* and *eNcentive Ad Manager Agent.* To reuse the modular functionality of ***eNcentive,*** we utilized the *Marketing Agent* used in *eNcentive Advertiser Configuration*. The job of *Marketing Agent* running on *Mobile Node Configuration* is to distribute advertisements that are approved by the local *Ad Manager Agent*.

The *eNcentive Ad Manager Agent* performs a number of tasks on the mobile node. This agent collects, organizes and maintains promotions. The collection function of the agent is linked to the user profiles and current user context. Once Numi platform notifies *Ad Manager Agent* about incoming advertisements, the agent consults the user profiles and makes a determination whether to collect or to ignore the advertisement. Current implementation of our framework employs relatively simple profiles described in XML. We are currently working on a more sophisticated implementation were profiles are implemented in RDF[5]. The *eNcentive Ad Manager Agent* also maintains and organizes already collected promotions. The promotions are kept in a lightweight data structure that is linked to the user interface. The promotions are also categorized based on their start and end times. Our data structure also insures that the information is displayed in the appropriate order. The *Ad Manager Agent* also is able to organize promotions by location. In particular, the *Ad Manager agent* can notify users that he or she is in range of a business that accepts the coupons held by the user. Thus, if the promotion is about to become valid, a user has a choice of remaining in his current location and being able to take advantage of the promotion. The *eNcentive Ad Manager Agent* is also in charge of responding to the peer requests. That is, if a device ***A*** is interested in the promotion that is being advertised by the device ***B*** then *Ad Manager Agent of* ***A*** request the *Ad Manager Agent of* ***B*** to forward the promotion. When the request is granted the *Ad Manager Agent of* ***B*** inserts ***B's*** platform ID into the requested promotion and then forwards this to ***A***.

Current design of the ***eNcentive*** framework employs a *push* model. The advertisements are actively broadcast through out a network. This is clearly not the only model that can be used. A *pull* model can also work well in mobile peer-to-peer environment. Mobile devices that are interested in the marketing information can query other peer device in the neighborhood. Other hybrid approaches are also possible.

PROTOTYPE IMPLEMENTATION

As a demonstration of our proposed approach, we have developed a working prototype. We have implemented our prototype using Java programming language. Our platform is installed on three PCs and three iPAQs. The PCs run the ***eNcentive*** *Advertiser Configuration* on top of Numi *Service Portal Platform* and the iPAQs run ***eNcentive*** *Mobile Node Configuration* on top of a Numi *Mobile Node Platform*.

All devices used were equipped with 802.11b wireless LAN cards. The iPAQs were running the Jeode Embedded Virtual Machine. Each *Advertiser* was also running a Tomcat Apache Servlet Engine. To simulate the mobility of the devices (moving in range and out of range of each other) we divided each an imaginary geographical region into non-overlapping cells. Each cell has a unique cell ID. Mobile nodes were able to communicate with each other only if they are in the same cell. Numi platform filtered out all messages that did not match a device's cell ID. By using this notion of cells, we are able to simulate neighborhoods and by changing a device cell ID; its neighborhood could be changed thereby simulating movement. We have developed an additional simulation component called the *Mobility Coordinator* (Figure 3). Using this, control messages can be sent to any device to change its current cell ID.

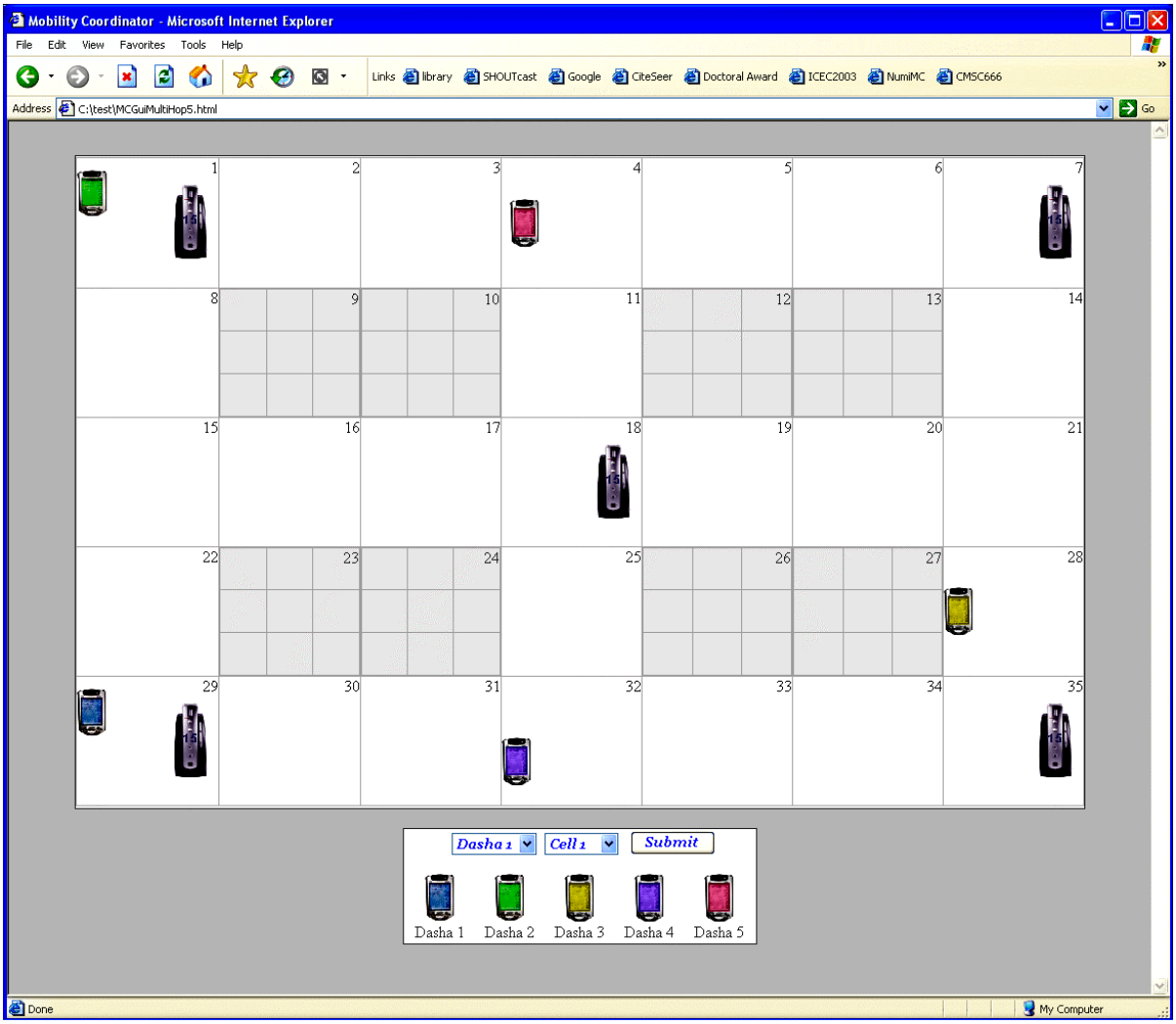

Figure 3. Mobility Coordinator Interface with five Portals, five Mobile Hosts and 35 cells.

Prototype Setup

We have set up three *Advertisers* (PCs): ***Jazz Cafe***, ***Rock'n'Roll Café***, ***Blue Grass Café***. All three advertisers were periodically (every 15 seconds) broadcasting coupons with discounts. All *Advertiser* used a set of *reward models.* Exponential reward model is described by the formula and graph in Figure 4. This *reward model* allowed gradual growth of rewards for up to 70% off. Simple *threshold reward model* and *linear reward model* were also used to create a diverse set of promotions. *Threshold model* settings are: for the first ten references, users got 5% off; for the ten to thirty references, users got 10% off; and for thirty and up user got 20% off. *Linear reward model* settings are: 1% for each reference, up to 40%.

$$f(x) = \frac{1}{1 + e^{-\sqrt{x}}} - 0.3$$

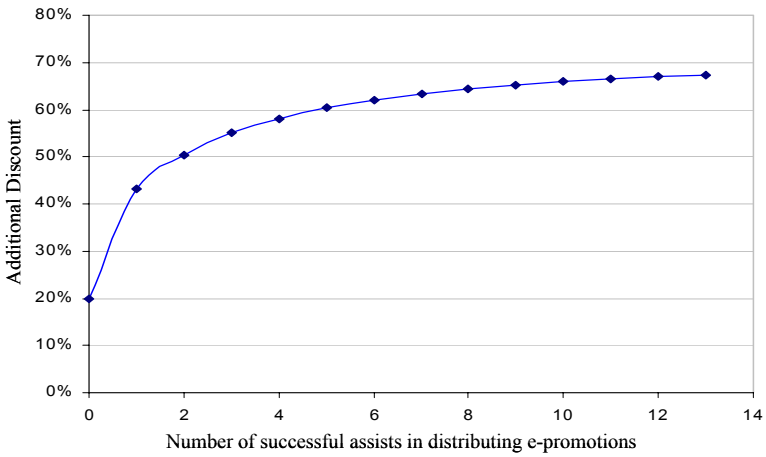

Figure 4. Example of *eNcentive Reward Model* Used by Marketers

Three iPAQs: Node1, Node2 and Node3 were running ***eNcentive*** *Mobile Node Configuration*. Node 1 was put into range of Jazz Cafe Advertisers. Once Node1 picked up a coupon form the *Advertisers*, it was moved out of its range. Node 1 then was then put in range with Node2. Once Node2 heard the café promotions from Node1, it requested this promotion. Before the promotion was transferred, Node1 inserted its ***eNcentive*** ID into this promotion. Then Node2 was put in range with Node3. Node3 requested the promotion from Node2. Once the promotions became valid (promotions had start and stop time), nodes were one by one moved into range of the advertiser.

Figure 5. Web Interface for *eNcentive Mobile Node Configuration*

The coupons were redeemed and active participants (Node1 and Node2) were rewarded with extra discounts. Node1 was the greatest benefactor since it referred Node2 and Node3. Node 3 received no additional discounts on top of the original promotion. Targeted promotions were also distributed by ***Jazz Café.*** They were given to any customer that reviled their route and was traveling towards ***Rock'n'Roll Café***. The discount of targeted promotions was: "30% off a cup of ***Jazz Café's*** jazz latte".

CONCLUSION AND FUTURE WORK

In this paper, we have presented a novel model for intelligent marketing in the mobile environments within hotspot networks. We have built a prototype framework that allows users, equipped with mobile devices, to collect advertisements, promotions, coupons and other marketing information that is being broadcast by hotspots on behalf or businesses and merchants. Mobile devices, later, can rebroadcast these advertisements to other peer devices. Each time an advertisement is passed from a device to another peer device, the platform ID of the broadcasting device is inserted into the advertisement. When the advertisement or promotion is presented as a form of payment for a good or a service, the business application server stores the IDs of all the devices that were involved in distributing this promotion. The owners of these devices are rewarded at a later time. *Reward models* can vary; however, it is clear that users and devices should be rewarded in accordance with the success rate that they have achieved in effectively distributing the advertisements and promotions. We have also developed a variety of e-promotions including *targeted promotions* which allow businesses and merchants to customize advertisements to better match users' needs. We are currently working on expanding functionalities our framework. We are developing promotions that are capable of adapting the discount to user's immediate interests. We are also looking into creation of intelligent composite promotions. We are adding more sophisticated device and user profiling. We are also experimenting with interfaces for collecting user preferences locally on their mobile devices. In particular, we are looking at possibilities of the device learning user's preferences over time. We are also looking into making the framework more location and context ware by linking it with a user's calendar.

We believe this form of distribution of marketing information can be very effective in mobile environments. Proposed approach provides powerful yet flexible mechanisms that allow businesses to boost the repurchase rate of occasional customers and to increase the set of loyal regular customers. Individuals can choose to collect the advertisements that are of most interest to them and in the same time, they can profit from such collection by redistributing the advertisements to their peers. This form of marketing is, flexible, personalized, private, location and context aware. It lets businesses to promote their goods and services in the location aware manner It also lets consumers be in control of information coming in and out if his or her device.

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