ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

Context Aware Mobile Marketing: The case of markets in Ethiopia

By

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Advisor: Dejene Ejigu (PhD)

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Dedicated To

My Beloved

Acknowledgment

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Acronyms

CAMM	Context Aware Mobile Marketing
LBA	Location Based Advertisement
LBS	Location Based System
MMA	Mobile Marketing Association
SMMART	System for Mobile Marketing: Adoptive peRsonalized Targeted
PDA	Personalized Digital Assistant
HPS	Human provided service
FOAF	Friend Of A Friend
SOA	Service Of A Friend
ISP	Internet Service Provider
DB	Database
KB	knowledge base
AVD	android virtual device

Abstract

The idea of mobile marketing covers a broad range of marketing or commercial communication that can be accomplished through mobile phone. Despite the fact that, the marketers are able to address the majority of the audiences easily through mass communication, in the traditional mobile marketing, the mechanism for delivering marketing information or advertisement dictates, the mere delivery of information while neglecting the users preference and/or context.

In order to overcome such problem, we propose a context aware mobile marketing (CAMM) architecture that utilizes the user preference and context information of the user. The architecture is composed of two components which reside in the client mobile device and a server. The client side components are responsible for capturing user preference and context so as to infer users marketing preference and send a request to the server. Whereas, the server side components are responsible for processing the request received from the client and deliver marketing information that match the user context. In order to map the relationship between the context, market preference and user characteristics and identify the preferred user preference, we also utilized ontology based user preference modeling on the CAMM client.

As a means of evaluating the proposed architecture, we develop a prototype that implements the core components of the proposed architecture on android based mobile phone. We also evaluate the implementation on sample preferences and location data. Results from the experiment show the proposed architecture is promising to provide a context aware mobile marketing for smart phone mobile users.

Chapter One – Introduction

1.1. Background

The rapid growth of wireless technology coupled with the technological advancement in portable devices, such as PDA, cellular phones and smart phones, led to the fundamental change in the computing power of the devices, resulting an increase usability of the gadgets and as well as ubiquity of the environment. One of the basic deriving factor for the realization of ubiquitous computing, also called, pervasive computing is the growth in the area of mobile computing [4].

Mobile computing refers to the idea of using devices in non-static environment. Mobile computing, as of J.B. Zimmerman, is defined as the use of computing devices which usually interact in some fashion with a central information system. This implies that, mobile computing enables to create, access, process, store, and communicate information without being constrained in to a single location [9]. The device‘s mobility has improved efficiency by saving time, reducing waste, cutting cycle time, reducing rework and enabling business reengineering [9]. Among the number of tasks benefited from this opportunity, one is the area of marketing.

Marketing, in general, is an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders [1, 10, 12]. Due to the dynamically changing trend in marketing competition, marketers are always looking for acceptable methodology that allows them to success marketing campaigns. Therefore, in order to take the advantage of getting their customers any where any time, coupling the idea of mobility with marketing result the emergence of mobile marketing [8,9].

Mobile marketing covers a broad range of interaction with the audience through a mobile phone [8]. It is the distribution of any form of marketing message and/or sales promotion activity aimed at adding a value to the customer while enhancing revenue for the firm [12]. To achieve this goal, mobile marketing appears in different formats which can be grouped under four terms as, message based, browser based, voice based and emerging [8]. Mobile marketing is the best practice for an improved and cost effective marketing campaign delivering, which allows addressing a wide range of customers easily. The report on, _the MMA Primer on Mobile Analytics‘ of Mobile Marketing Update 2012, states that- for most mobile users, the time they spent on their mobile considered as precious and they are task focused in using their device and as result being contextually relevant is basic requirement in their mobile environment.

Even though, the ubiquity of mobile services and the capability of the mobile devices provide a great opportunity in the mobile marketing trend, yet the marketers believe that pushing content to the users/ audiences might not be enough. This causes the requirement for incorporating the idea of context [10] in their mobile marketing campaigns and services which lead to the need for integrating mobile marketing with context aware computing.

Context aware computing, first introduced in 1994 by Schilit et al., is one of the major study areas in pervasive computing. It is defined as ―software that adapts according to its location of use, the collection of nearby people and objects, as well as changes to those objects over time" [6]. Context aware features use context to present information and services to users, automatically execute services to the user and tag information for the user to support for later retrieval [5]. When it comes to mobile phones, as the context aware services need to react to their current context, they have to be able to adopt the rapidly changing environment. Here, the context for usage situation can be captured through either software sensors, which detect information about the networked virtual world, or through hardware sensors, which detect information about the physical world [5]. Hence, the most commonly used forms of context includes, location, time of a day, day of a week, identity of a user, proximity to other peoples or device, action of the user and social interaction.

The contextual information in the world of interest can be modeled either by conceptual approach through considering the characteristics from the real world abstraction, conceptually, or by context modeling through mapping context in to the context modeling representing contextual information [3]. As it is stated in Schmoh et al., the conceptual context can be modeled in different ways namely, key valued, mark up, graphic, object oriented and logic model. The most expressive context representation of the current time called ontology model [8, 36, 46].

Beside modeling, the architectural view of context aware application requires three levels of abstractions [2, 5] to be addressed. The first one is context discovery for the discovery of locations, information related specific context. The second one is context interpreter, for the purpose of addressing the interpretation, inference and fusion of context. The last one is, context aggregator, for collecting all context related information.

Even though, context aware applications retain complexity in their behavior [5], the risk in the usability aspect can be alleviated through the design of appropriate user interface that considers the human aspect. In addition, the level of interaction can also be modeled as of personalized where users specify the settings as how the application behave, passive context aware where application present updated context to the user and leave the user as how to use it, and active context aware where application automatically change according to the sensed information (context).

In addition, user location context can be captured through positioning systems: GPS (global positioning system) and GSM (Global System for Mobile Communications) tower based positioning which are suitable for mobile devices. GSM is the most widely accessible, fast and zero energy positioning offering area-wide coverage with very low power consumption. Whereas, GPS is highly accurate to pinpoint a user's current location, but with major drawbacks like, not all mobile phones have it and high power-consumption [15].

To sum up, mobiles are considered as personal gadgets where the users prefer to get information which is contextually relevant to them [10]. Context Aware Mobile based marketing try to address such kind of issues related to a personalized information access and delivery. Beside the discovery of user location, to deliver content to the audience, other contexts such as time and some other personalized factors should be address to provide well-qualified context relevant information/ services to the user.

1.2. Problem statement

In the competitive free market environment, the successfulness of a business mainly relay on different strategies that the company is employing. Currently, companies have realized that empowering their business depend, not only by the quality they try to address in their products but also in the way how they try to communicate with their customers, which implies their marketing strategies, and due to this they are investing substantially for it. To address this issue of marketing, marketers use various channels to establish communication, the most common ones are, TV, radios, internet, mobiles and others as a supplement.

With the rapid proliferation of telecommunication services and advancements in the functionality of mobile devices, the numbers of mobile users are growing considerably. As per the report of Buddecomm, a global independent telecommunication research and consultant company, the number of mobile users in Ethiopia tripled from its start in the year 2011 where in 2012 the estimated mobile market penetration is that of 26% [13]. This rapid growth of mobile usage and it‘s characteristics like, interactivity and ubiquity create a door way for mobile commerce triggering mobile communication to become an important channel for marketing various services. The common mobile marketing media paths used in mobile campaigns include SMS, MMS, mobile E-mail, voice interaction, mobile search and mobile web app‘s [10]. Where, SMS based marketing is the commonly utilized one in our country through the telecommunication industry.

Even though, the trend of mobile marketing in our country is in its embryo stage, marketing industries in the foreign countries adopted the idea of using mobile medias for communicating commercial contents. As an example, leading international brand manufacturers such as BMW,

McDonald, and Nike have already launched campaigns using mobile phones as means of conveying commercial contents [14].

Despite the fact that, the marketers are able to address the majority of the audiences easily through mass communication, like SMS, the growing success of mobile marketing and its acceptance reaches at a saturation point due to certain crucial factors, which are:

- mobile marketing services, such as, mobile advertising, doesn‘t consider some audiences issues like, personalization and interactivity
- intimate and personal nature of mobile device, which means, users need more intimate and personalized content in their device and
- the negative attitude of _spam messages‘, i.e. messages that are non-relevant and non-contextual, by the general population.

As a result of being unable to address such issues, marketers target in winning marketing campaign‘s fail.

Therefore, in order to alleviate the above mentioned problem, mobile marketing should take context in to account.This study intend to design a context aware mobile marketing system that adapt to users context beyond that of geographical location so as to captures and utilize users context such as, time and user preference, calendar activity to produce context aware mobile marketing communication.

1.3. Objective

1.3.1. General

The general objective of this thesis is to develop context aware mobile based marketing system which utilizes user context as means to deliver personalized marketing information based on Ethiopian market trend.

1.3.2. Specific

a. Review the current thesis in context aware computing, mobile computing and their intersection with marketing.
b. Study the characteristics of current mobile marketing trend in Ethiopia.
c. Identify context parameters that are relevant to the task.
d. Model and design context aware mobile marketing system suitable for mobile phone users.
e. Design a mechanism for capturing and utilizing context as well as for forwarding the appropriate context relevant marketing information to users‘ phone.

f. Develop a prototype for the proposed system.
g. Collect sample spatial information for market specific locations for testing purpose
h. Test the validity of the proposed system.

1.4. Scope and limitation

This thesis is intended to develop a context aware mobile marketing system which can be a broad concept. However the study is delimited focusing around the following aspects:

- Identifying the current context of the mobile user and using either through push or pull method, delivering contextualized marketing information to the mobile phone user
- Even tough, the implementation of such system is crucial to have it in all kind of mobile phones, in this study we choose to utilize an open source development environment, and as a result, android based mobile phones are the focus for the implementation of the application.
- The prototype implemented as a proof of concept do not consider showing the map for the user

1.5. Methodology

In order to meet the objectives of this study, the following techniques are adopted by the researchers:

1.5.1. Literature review

This thesis on context aware mobile marketing touches a number of areas, related to marketing strategies, mobile computing, mobile programming, context aware computing, human computer interaction, location based services, mobile tracking, context representation, discovery and utilization. Therefore, literatures related to the ideas mentioned above and any other relevant literatures that help to enhance the study will be reviewed and if necessary will be adopted.

1.5.2. Data collection

The following data gathering methods can be used to enrich the thesis,

- Interview and questioner: an interview and questioner will be prepare and used to understand user context factors and find any context parameter relevant to marketing
- Collect relevant spatial and non-spatial information

1.5.3. Prototyping

After the relevant data is collected and organized, it will be analyzed so as to draw the requirements. Then after, the necessary tools required for the implementation will be collected. Based on the analysis result and result from review on the relevant literatures, the context aware mobile marketing system will be modeled and a prototype will be constructed using android programming language for the client side implementation and java programming for the server side programming.

1.5.4. Testing and evaluation

After the successful completion of the thesis and development of prototype, an experiment will be performed to test the functionalities of the system, especially on, context discovery, context utilization, content discovery and content delivery. In addition, the prototype performance will be evaluated.

1.6. Application of the study

Mobile based services, as an emerging technology are trying to address different applications to their users in different perspective, such as, based on users location or personalized factors. Among the many services, one is marketing. Augmenting the idea of context aware computing together with mobile based services, this context aware mobile marketing can be used as a better way to success marketing campaigns.

This application gives better marketing service that would increase marketers‘ revenue and customer satisfaction by:

- Consider the place, promotion and product factors of marketing world through contextualized factors of each concepts in mobile based marketing
- allowing marketers to explore target audiences suitable for their market which are not located at the place where they plan to perform marketing campaign
- allow marketers to identify locations where to perform marketing campaign
- allowing markets to communicate with the targeted audiences through contextualized advertisement
- enabling marketers to consider the need of customers by addressing context related aspects namely, who, what, where, when and how, during establishing marketing communication
- inducing customers to engage in pulse marketing, for example, by informing customers that there is a new product at a point-of-sales

- enabling customers to decide on how to engage marketing communication addressing both push and pull aspects
- creating transparent marketing channel for the stakeholders by by giving priority to customers need and
- relieving customers from receiving non relevant marketing information

This study can be applied to provide near real-time, time relevant, personalized marketing information for customers and marketers.

In addition, this application can be applied to empower location based marketing services through contextualized content delivery and communication with audiences.

1.7. Thesis organization

The rest this report is organized as follows. Chapter two covers literatures reviewed so far. Chapter three presents the existing works that are related to this thesis. Chapter four discuss the design of the of the proposed context aware mobile marketing system. Where else, in chapter five we discuss on the implementation of the proposed system. The test and experiment of the system are discussed in chapter six. Finally, the conclusion made on the thesis result, the contribution of this research work and recommendation on possible future work related to the thesis are presented in chapter seven.

Chapter Two – Literature Review

In this chapter, we try to address detailed review on the concepts related to marketing, mobile computing and the intersection of these concepts with regard to mobile marketing and also issues that lead us for the consideration of context awareness in the area of mobile marketing. The concepts reviewed in the papers are organized in to different topics like, concepts related to mobile marketing, classification viewpoints of mobile marketing and concepts related to mobile marketing.

2.1. Mobile Marketing

The idea of mobile marketing covers a broad range of marketing or commercial communication that can accomplished through mobile phone. There isn't any conventional definition given to it but some of definitions on different literatures are given bellow. The Mobile Marketing Association (MMA), the premier global non-profit trade association defines marketing as, "a set of practices that enables organizations to communicate and engage with their audience in an interactive and relevant manner through any mobile device or network" [26]. The "set of practices" is the first important idea in the definitions given by MMA and refers to the activities, institutions, processes, industry players, standards, advertising and media, direct response, promotions, relationship management, CRM, customer services, loyalty, social marketing, and all the many faces and facets of marketing. Whereas, "engage" is the other main idea addressed by the definition and it means to start relationships, acquire, generate activity, stimulate social interaction with organization and community members, and be present at time of consumers expressed need. As of FirstPartner, research and marketing agency premier report, Mobile marketing covers a broad range of interaction with the audience through a mobile phone [23]. Mobile marketing is a personal channel enabling spontaneous, direct, interactive and/or targeted communications, any time, any place [20]. It is also defined as, the using of interactive wireless media to provide customers with time and location sensitive, personalized information that promotes goods, services and ideas, thereby generating value for all stakeholders [21]. In different articles it is called by different names, such as, mobile/ wireless advertising or mobile marketing where advertising or marketing related messages are sent to a mobile phone. [19]

Even though, Mobile marketing and mobile advertising are interchangeably used by some literatures, others disagree on some of the issues which they try to imply. Tahtinen J. (2006), try to view both issues and put some clear demarcation between them. Based on the type of message, i.e. promotional content, they try to deliver to the consumer both mobile advertising and mobile marketing seems similar, but they also have some difference. Advertising is one way communication and defined as a paid, mediated, form of communication from an identifiable resource designed to persuade the receiver to take some action now or in the future. Based on its

nature, mobile advertising is subjected to consumer repetition, message coordination, cluttering and computing environment. In addition, it is subjected to failure if it is not designed considering the user perspectives, such as, personalization and interactivity. On the other hand, mobile marketing is the distribution of any kind of message or promotion that add value to customer while enhancing revenue for the firm. It is described by its nature of being personalized, interactive, dialogue oriented commercial communication via mobile device. It is much more general perspective referring to mobile marketing communication, that may serve as purposes encompassing to advertising, personal selling, public relationship, customer relationship management, and sales promotion.[12]

Mobile marketing, being a growing concept to the concept of marketing require careful consideration of different factors so as to derive consumers to be willing to interact to the market. Basher et al. [17], in their research investigate the impact of mobile marketing on consumer attitude towards purchase intention. The core issue of their study is to identify factors connecting consumer attitude, belief and purchase intention. In doing so, they use different variables to measure consumer perception and their impact on purchase intention. The variables used include, attitude towards extensive advertising in direct marketing, perceived usefulness of the message to be delivered, perceived entertainment degree of the message, personal use of the device, past reaction and trust. In their findings, consumers show positive response by buying a product after they receive a message through their mobile phone if they find it useful, entertaining, and if they give prior permission to receive such message. On the other hand, consumer decline to buy a product as well as receive a message if they are subjected to extensive advertising (or direct marketing) in their past and also if they have a belief that mobile phone(device) is personal. In addition, people having negative attitude towards direct marketing in their past and those subjected to exhaustive advertisements (promotions) are less likely to trust and share their personal information and engage in permission based marketing [17, 25].

Bauer et al., agreeing with Basher et al. state that, behavioral intention to wards using mobile marketing service attitude can be developed if the mobile marketing message are entertaining or if they have high information value and consumers permit the reception of data on their mobile by providing personal data for personalization of the message. On the other hand, users perceived utility mobile device, perceived utilization of contextual information, perceived control on the overall mobile promotion are found to be crucial factors for driving consumer willingness for accepting mobile based marketing [25].

As it is considered in different literatures [17, 18, 19, 20, 24], personalization of message/ promotion in mobile marketing is the gearing factor for its growth and powerful reason for it to become popular. Personalization require the consumer willingness to provide personal

information such as, who he is, where about, status…and personal view of the product, to the marketers, Whereas marketers are expected to be trustworthy. The conceptual framework stated in the work of Lai et. al. [20] show that, the level of trust that can be raised between consumer and marketers can be affected by two factors:

- Internal: which address issues from marketers and consumers relationship perspective such as customer past experience, interpretation on the company, goal and vision, controlling the type of received items
- External: which are related to the environment surrounding the relationship between marketers and consumer and address issues like reputability of marketers, intermediaries that could mediate the two entities, institutions that could provide high level of trust, and issues related to the mobile technology.

In a more general way, the impact of trust on the overall consumer acceptance over mobile marketing could be addressed by careful consideration of personalization issues, providing relevant information, using attractive and entertaining interfaces that could allow establishing close relationship with the customers [17, 19]. The findings of Lai e. al. illustrate that, a consumer having trust to marketers is more likely to rely on the information from marketers which in turn result the participation of the consumer on purchase activity.

Consumer utilization of the mobile marketing is highly subjected to users permission to use the service provided for the mobile user [17,18]. However, As of Unni et al. [22], mobile marketing service utilization can also be affected by issues related to users control over the consumption of information/ promotion which result to a two approaches to be considered, pull based or push based. Pull based refers to a promotion explicitly initiated by the consumer for a given product promotion specific to its location. On the other hand, push based refers to the scenario where consumer does not have a control over the promotion they receive for a given specific location. Even if push based promotions are quit known for triggering impulse buying, pull based promotion is much more preferred than push based [22], when we consider the users control over the consumption of the information.

2.2. Classifications in mobile marketing

Since the ideas, technologies and functional aspects utilized in mobile marketing are vast and diverse, it is critical to classify the system point views so as to understand the behavior and pinpoint their characteristic variation. Therefore, we classify the mobile marketing systems based on the following viewpoints:

- Degree of user involvement to receive content

- Criteria to be taken for initiation of delivering marketing info
- Possible forms of mobile marketing/ advertising techniques

2.2.1. Degree of user involvement to receive content

This refers to the situation by which user require to interact to the system in order to receive marketing information from the system or the system‘s requirement to initiate communication.

a. Pull based vs. push based

Pull based [32, 34, 40]: such systems send content to the subscribed user upon explicit request from the user. This implies the delivery of message to consumers mobile device occur only when it is explicitly requested or initiated by the consumer.

Push based [34, 34, 39, 40]: in such systems content is sent by or on behalf of marketers to a mobile device at a time other than when the subscriber requests it. In such systems, the initiation for content delivery trigger by context situation, such as a change in consumer's location and/ or match previously stated preferences and so on.

b. Reactive

These systems react to the changing situational context to generate content delivery without requiring any explicit user intervention. Such systems make use of current and historic contexts and also system settings dictating the adaptation on the changing context may either be hardcoded or explicitly defined by the user [38].

c. Proactive

These systems are capable of proactively pre-caching appropriate content (downloaded from a content server) on the user‘s mobile device through extrapolating future context (using specialized prediction models) resulting high responsiveness [34, 35, 38].

2.2.2. Criteria to be taken for initiation of delivering marketing information

a. Pull based mobile marketing

These refer to a type of system that requires 0% user involvement in order to initiate the delivery of the information. Traditionally, these refer the concept of mass advertisement and/ or mobile mass promotions [40] by marketers in order to create a demand for a brand. Such a system can be permission based, where a user is required to opt-in for the service.

b. Preference based mobile marketing

These refer to a type of system that require some setting in user profile in order to invoke the delivery of content to the user of mobile device. A profile refers to a set of features with their relative weights and characterizing the preference and the activity of customers. For example, a user may specify that whenever she is looking for a restaurant, she would like that the query processor take into account distance, price, rating, and dietary restriction while when looking for gas stations, the user wants to consider only the distance and the preferred gas company. [16, 45]

Basically there are two types of profiles, those that could be either explicitly stated or implicitly inferred. The explicit user profile is created through a short survey, in the application startup, denoting demographic information, constraints, preferences and user goals. The implicit users profile is fed as the user interacts with the system, thereby implicitly denoting preference upon certain items through interaction behavior/history. For example, SMMART [34] utilize the implicit profile by capturing, users shopping habits, past user schedules and activities in addition to the explicit profile in order to decide what content to deliver for the user.

c. Location based mobile marketing system

These refer to a type of marketing communication that uses location-tracking technology in mobile networks to target consumers with location-specific advertising on their cell phones [40, 42]. For most mobile value added marketing systems [34, 37, 39], location is considered as one of the primary context for the initiation of content delivery. For a pure location based marketing system [41], content delivery by the system is triggered when the user of the mobile device reach in to certain vicinity or location radius. Such systems are the earlier forms of context aware systems that relay only on location without including the remaining context parameters.

Examples of location based systems include: Woodapples [37], which is a system that push information to the user if they are in a special location and also having a match in their interest. While using location as the main context variable, **Woodapples** is designed to present a mobile marketing platform enabling the advertisement of services and offerings in mobile which are customized based on user preferences to deliver services based on social-network properties and human provided services. Another example include, Ad-me [39], which is a system designed to deliver a context sensitive advertising by incorporating services, that can be offered to the user, which are primarily determine by location. Ad-me is a location based application designed to deliver information to users based on location (outdoor) received from the GPS.

d. Context aware mobile marketing

These refer to a category of mobile marketing systems which are designed as an intelligent pervasive system having the ability to target user and personalize its services to adopt user need by monitoring different user context variable and deliver a content matching to the different context changes [34, 37, 39].

The context that can be utilized in for triggering content in context aware mobile marketing systems ranges from a single context usage [41], such as location as in the pure location based systems, to multiple context usage by combining two or more context variables [34, 37, 39], such as user location, user personal preference, social status, shopping habit and any other relevant context variables.

2.2.3. Possible forms of mobile marketing techniques

The traditional ways of marketing commonly use a wide range of mediums for commercial communication. These mediums can be places that are expected by the marketers as if they can take person‘s attention towards to the delivery of marketing promotion or advertisement. These mediums can be: television, radio, bill-boards, newspapers, flyers, web banners, franchises or banners attached to the sides of automobiles, stickers on products in supermarkets, additional messages on the back side of event tickets, bills, magazines, celebrity branding or word of mouth.

In recent days, mobile marketing is taking advantage over the rest medium as it is a device that has pervasiveness in its nature so that marketers can reach in to consumer any where any time. Due to its nature, on one side marketers are showing willingness to provide product promotion as long as users show interest in receiving the content [28]. And on the other side, it also found to derive consumers attention towards purchase decision [28].

Mobile marketing use the mobile phone and other mobile devices to interact with the end-user. In order to use this media as a means of delivering marketing information to the consumer, there are different forms mobile marketing that could be utilized. Some of the common ones are described below:

- Short message service (SMS)
- Mobile coupons
- Location based
- In-application

a. SMS

Short messaging service (SMS) is one of the primitive type of medium used in mobile marketing which is conducted by sending a short message to the mobile user. SMS is

capable of sending short message containing up to 160 characters having text, numbers and some symbols. It enables brands and enterprises to deliver their messaging/content and connect with consumers and also it is suitable to conduct marketing campaign. SMS can consider as one of the low cost, high impact communication medium that can be received by almost all mobile phone users [21, 42].

SMS can be sent from a phone to a phone as well as from a computer to a phone. Text messages are sent and received using SMS short codes [44]. An SMS short code is a 5 or 6 digit number, just like a phone number. Short codes are leased (not owned) on a monthly basis by companies or SMS service providers.

Many companies use SMS short codes to run their mobile marketing campaigns because they allow consumers to text back to any messages received. This facilitates customer interaction and two way communication, which builds relationships, customer loyalty and generates many opportunities for targeted mobile marketing. Sending _keywords' over these short codes allow SMS _Application Service Providers' (ASP) to generate specific responses and interactions to text messages transmitted via Short Codes.

b. Mobile coupons

Mobile Coupons (M-Coupons) are the electronic tickets that are de-livered to the consumer's mobile phone, so that they can be exchanged for a financial discount when purchasing a product or a service [16, 44, 31]. Instead of sending the message with general promotion, m-coupons created the value to message by offering monetary incentives to the consumers.

Typical coupons include discounts, trial packages or free-SMS/ MMS available on advertiser's website. Also discount tickets sent to the mobile phone, e.g. after a mobile payment, and collected in a virtual discount ticket book belong to the coupon standard type. M-coupons can be used in different ways, for example, promoting a new product by offering customers a free sample or discount with a mobile coupon Get customers in store quickly during both sale periods and slow times with a mobile coupon

Mobile coupons have two categories [16]: impulse coupons and pre-selected coupons: Impulse coupons are highly time sensitive coupons with the aim to increase impulse purchases. Particularly impulse coupons are sent to customers who have opted in but they don't know when they will receive them. In contrast, pre-selected coupons have been pre-selected by customers who have expressed an interest in specific products.

Beside dictating permission based marketing, m-coupons benefit by increasing sales, encourages customer loyalty, simple and cost effective (particularly for SMS coupons) [44].

c. Location based services

Location-based services (LBS) can be defined as services that depend on location and are enhanced by positional information of mobile device. Location-based services determine the location/position of the user using technologies such as Global Positioning System (GPS), Global System for Mobile Communications (GSM) and / or any other means and use the information to provide personalized applications and services. Mobile phones are always on the move and hence the information can be dynamically updated to provide meaningful information that the user is looking for.

The LBS can be either triggered or user-requested [40]. Triggered LBS refer to Push services, rely on an advance condition set-up by users. Such push services are activated by an event, which could be triggered if a specific area is entered or triggered by a timer. User-requested LBS which is referred as Pull services require that a user retrieves his/her position for location-dependent information.

Location based services can be integrated in to different application. While considering the mobile marketing, LBS services allow providing services customized to users current location. The primary issue that could be raised in LBS is that of privacy concern. Such issues could be alleviated by utilizing a permission based opt-in basis delivery of location based marketing information [42].

d. In-application marketing / advertisement

These are another form of mobile marketing/ advertising where the advertisements are integrated into the applications used on a mobile enriching the user experience. The applications can be either pre-installed and integrated by the mobile company or downloaded and installed in to the mobile device in order to provide mobile marketing [34, 37, 39].

In-application mobile marketing is capable of utilizing the various capabilities and features of mobile device, such as, location awareness, touch screen, profile data storage and so on. Besides taking the advantage of the mobile device capability, in-application mobile advertising can integrate the other forms of mobile marketing too: which are, SMS, mobile coupons and location based services.

2.3. Services offered by mobile marketing systems

Mobile marketing, yet as an emerging technology [27], is capable of providing different services to the user. The services seem similar due to the reason that some of the concepts overlap on one other. In this section, we will discuss the services that can be offered by mobile marketing systems:

2.3.1. Marketing campaign

Marketing campaign is targeted in conducting promotion for sales, service and/ or events that aims to stimulate quicker or greater purchase of a product or service. Mobile Marketing, in its nature, can allow marketers to directly interact with wide range targeted audience. This one to one interaction helps marketers to create consumers understanding towards products and services. Since marketers have a complete control over the content to be sent to the consumer, such as time, frequency and so on, conducting marketing campaigns through mobile phone offer a great opportunity for gaining consumer attention towards purchasing a given product. On the other hand, companies can ask for the acceptance of customers to be involved in a mobile marketing campaign by building a solid level of trust [29].

The common objectives of marketing campaigns are [16]: building brand awareness aims at the customers‘ ability to recognize and recall a brand in purchase and consumption, changing brand image aims to change the perception of the brand by the customers, and enhancing brand loyalty aims at consumers‘ commitment to repurchase the brand.

Mobile marketing campaigns can be contextualized [37] in such a way where service providers can setup campaigns with a specific budget, time span and a location radius. Such type of mobile campaigns allow marketing info to be published to people within a certain location area in a specified time span if they are interested in this information.

2.3.2. Product promotion/ advertisement/ recommendation services

This looks similar to marketing campaign described in the Section 2.3.1. Product promotion/ advertisement/ recommendation services, refers the functionality by which users receive information (promotion/ advertisement) related to a given product/ service or a set of information‘s recommended by the system. Such services has, psychological impact on customers toward the products being advertised, forcing customers to go through an emotional respond while thinking about product and be attracted toward product so as to make an inclination towards purchase [30].

Unlike the traditional marketing which consider every customer in the same way, mobile marketing can provide advertisement or product promotion which are personal touch, tailor

made to suit individuals, and hence cost effective [38]. Such advantage of mobile marketing could benefit both the advertising companies by allowing utilizing user context and the consumer by creating an opportunity to receive marketing information tailored to their interest, such as user context, profile, location and any other relevant context parameter [34, 35, 39, 41].

2.3.3. Customer relationship management (handling)

The other category of services that can be addressed by mobile marketing system is customer relationship management [30]. Customer relationship management (CRM) is a business strategies process that improves organization‘s competitive ability and it create successful strategies for understanding the customer‘s needs, promoting the emerging speed of organization and maintain customer in a high competitive market environment.

Unlike the traditional marketing, mobile marketing can provide an opportunity to establish a bilateral communication between the marketers and mobile device owner [29]. This allows the customers to interact with marketers through a feedback mechanism instantly when they receive product promotions.

On the other hand, marketers can handle their customers using value added marketing services by providing incentives, such as coupons, free tickets and so on [16]. Such personal relationship will lead to improved customer acquisition, loyalty and satisfaction, so that a better return can be achieved from the customer [30].

Therefore mobile marketing can be used as a driving force to successfully manage relationship with customers benefiting both marketers and customers by shaping customer‘s perception toward product purchase and increased satisfaction to the service provided respectively.

Chapter Three – Related Work

With growing need of having an application that provides marketing information, which is contextually relevant to the user through mobile phone, there had been different researches in different areas. In the following sub sections, we try to show the works that are directly related to our research:

3.1. SMMART: a Context-Aware Mobile Marketing Application: Experiences and Lessons

SMMART – System for Mobile Marketing: Adaptive, peRsonalized and Targeted [32, 34] is a context-aware, adaptive and personalized m-commerce application designed to deliver targeted promotions to the users of mobile devices. SMMART is designed for delivering narrowly targeted promotions to the users of wireless mobile devices, such as PDAs and smart phones, when they are in a close proximity or inside a retail store. It is designed as an intelligent pervasive system having the ability to target user, personalize its services and adopt user need by monitoring shopping habit and learning from user personal preference.

SMMART is designed as of a user-centric, context-aware pervasive system that deliver targeted marketing information to customers whose preferences match products that are currently on sale at retail stores so as to help the shopper navigate through many offers or promotions available and direct the user‘s attention to those products that match their interests. The researchers use two sets of context information for usage situation while developing SMMART application: ***location*** for identifying which store inventory to be searched at a time the user wish to use the app and ***user context*** which have user id and the shopping preference of the user, past experience and also browsing pattern.

The framework for SMMART, as shown in the figure 3.1, is designed following a client server architecture where the client and server communication is implemented using XML web service. SMMART framework consists: a Server installed at every participating retail location and clients for mobile wireless devices that pull information.

The anatomy of SMMART Client consists of two main components: SMMART Browser which enables user interaction with the SMMART framework by presenting relevant product promotion to the user preference as well as letting the user to explore over the product information. Preference module contains and manipulates the list of weighted keywords, having a time stamp, stored in XML format in Preference Data. In addition to this, the preference module contains a set of agents that are responsible for adding new keyword, editing keyword, detecting erroneous keywords and removing them as well.

On the other hand, SMMART server comprises of: An inventory database of a retail store which provides the basis for all data, a Product Manager which retrieves all relevant information about a specific product, a Promotion Manager retrieves all promotion information for a given product and Search & Match Agent which receives a list of keywords from the client ordered by their relevancy to the user‘s interests and finds all matching products, using simple Boolean matching model, that currently have a promotion and adds them to the result in the order of relevance to the user preferences and returned to the client.

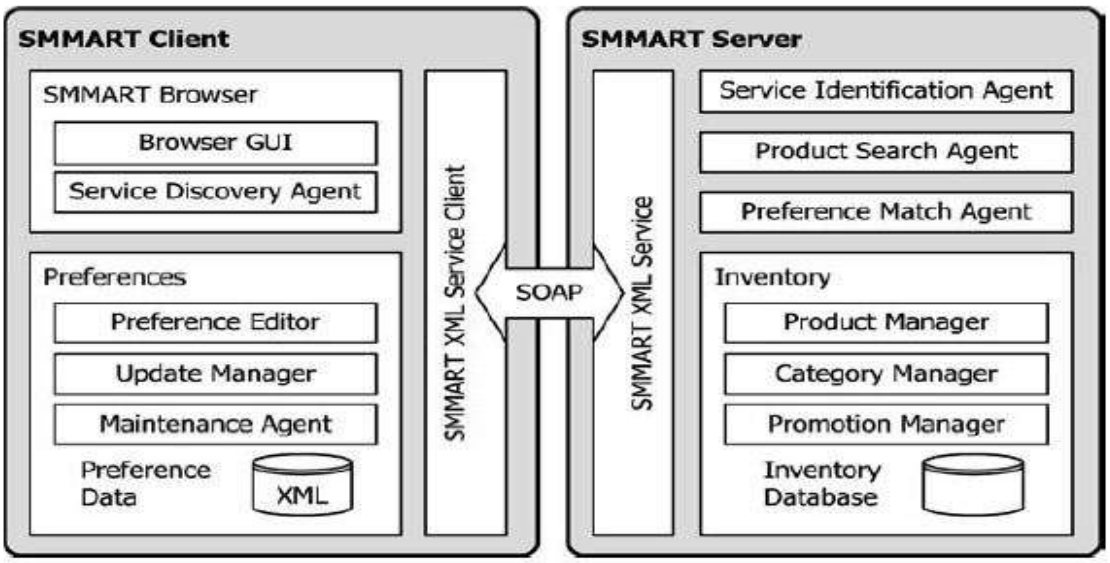

Figure 3.1: SMMART framework

SMMART is a system designed to provide services at retail stores only, therefore, it is unable to address potential customers outside the vicinity of the specified retail stores. In addition, the personalized factors of the user relay on the product to be purchased. As a result, SMMART is limited only in identifying customers with in the retail store using wireless technology and matching the items cusomers explicitly list in SMMART client application with the product list in the inventory database available in the store and find a matching product.

3.2. Context aware campaign in social network

Distributed Systems Group of Vienna University of Technology together with an innovative solutions company named as _TISCO‘ develop a framework named as ***_woodapples- information people love’*** that offers a set of APIs for creating a mobile context aware campaign [37]. ***Woodapples***, is a platform for mobile marketing which offer an advertisement platform such as Google Ads for mobile handsets where service providers can setup campaigns with a specific

budget, a time span and a location radius and publish marketing info to people within a certain location area in a specified time span if the user are found to show interest in the information.

The researchers believe that, the integration of humans and services into a common network structure, which referred as Service of a Friend (SOAF), can fosters the creation of Web service ecosystems [50]. However, difficulty rises in achieving this due to reasons related to infrastructure support. In order to address the challenge of the human/service integration the researchers employ the concept of Human-Provided Services (HPS) [1], so as to utilize the SOAF framework and allow users to be able to find any person who can deliver a human provided service (HPS) in a standardized, service-oriented manner.

Therefore, Woodapples is designed to present a mobile marketing platform enabling the advertisement of services in mobile markets and offerings which are customized based on user preferences to recommend services based on social-network properties and human provided services. This implies, it integrate the idea of SOAF to a location based application so as to filter and deliver information/ service that is recommended by a friend or by considering the social aspect.

The framework for context aware social campaign as depicted in figure 3.2, adopt the idea for solar middleware platform which consider clients only to subscribe to context changes in a central device (star), it come up with three layers namely: Woodapples Portal Layer, Woodapples Core Layer, and the SOAF Layer.

- The Woodapples Portal allows content subscriber the possibility to open an account for Woodapples so that the user will be able to get information and interact with the system through feedback.
- Woodapples Core is responsible for storing and retrieving the Content, Campaign Management, retrieving information of Social Networks and 3rd Party Content Delivery and recommendation.
- The SOAF layer of or proposed framework addresses issues concerned with network structures and in particular the integration of humans and services in a common network structure.

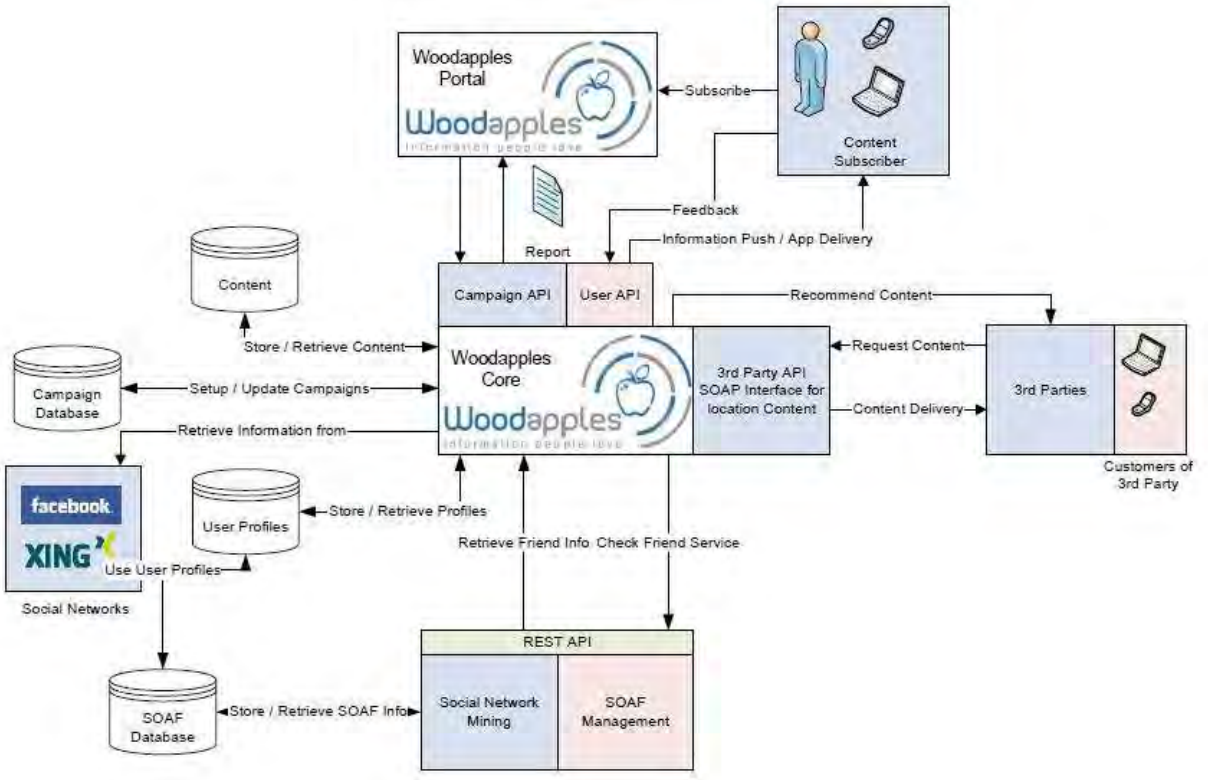

Figure 3.2: Woodapple of framework

Using location as the main context variable, Woodapples will push information to the user if they are in a special location and also having a match in their interest. The system, conduct marketing campaign to specific group of users called ***experts*** which opt-in for the service and also having high reputation, where the success factor of the campaign depend on the viral marketing that could be initiated, such as by recommending a service for a friend, and so on.

3.3. Ad-me: Intelligent Context-Sensitive Advertising within a Mobile Tourist Guide

Ad-me, is a system which is designed to deliver a context sensitive advertising by incorporating services, that can be offered the user, which are primarily determine by location [39]. The Ad-me system sits on top of a mobile tourist guide where the motivation and added value service offered to the user is that of context sensitive tourist services accommodated upon a Personal Digital Assistant (PDA) or cellular phone.

Beside the context sensitivity issue they try to address, the researcher of Ad-me define four specific problem domains which are specific to mobile device issues, namely interoperability, computational constraints, mapping technology and user localization through GPS receiver.

As it is depicted in the figure 4.2, the researchers follow a client server architectural framework during their development. The client side is responsible to collects information about the user location (from GPS receiver) and interface interactions, where the client browser made to be responsible for interpretation and execution of the received application. In the server side‘s technologies, the browser is only given the resulting HTML/WML page generated on the server.

The Ad-me system architecture is designed adopting the agent oriented approach with lightweight agents supporting real-time content retrieval, content presentation and user profiling, so as to utilized agent factory to distributed environment. In addition, the application environment is designed using PHP.

Ad-me utilizes a push technology through a context sensitive advertising agent so as to supply advertisement relative to user location and user perceived need which is captured from the profile database in the server. In addition, content relevant to places of interest located next to the users location presented

In general, Ad-me is a location based application designed to deliver information to users based on location (outdoor) received from the GPS.

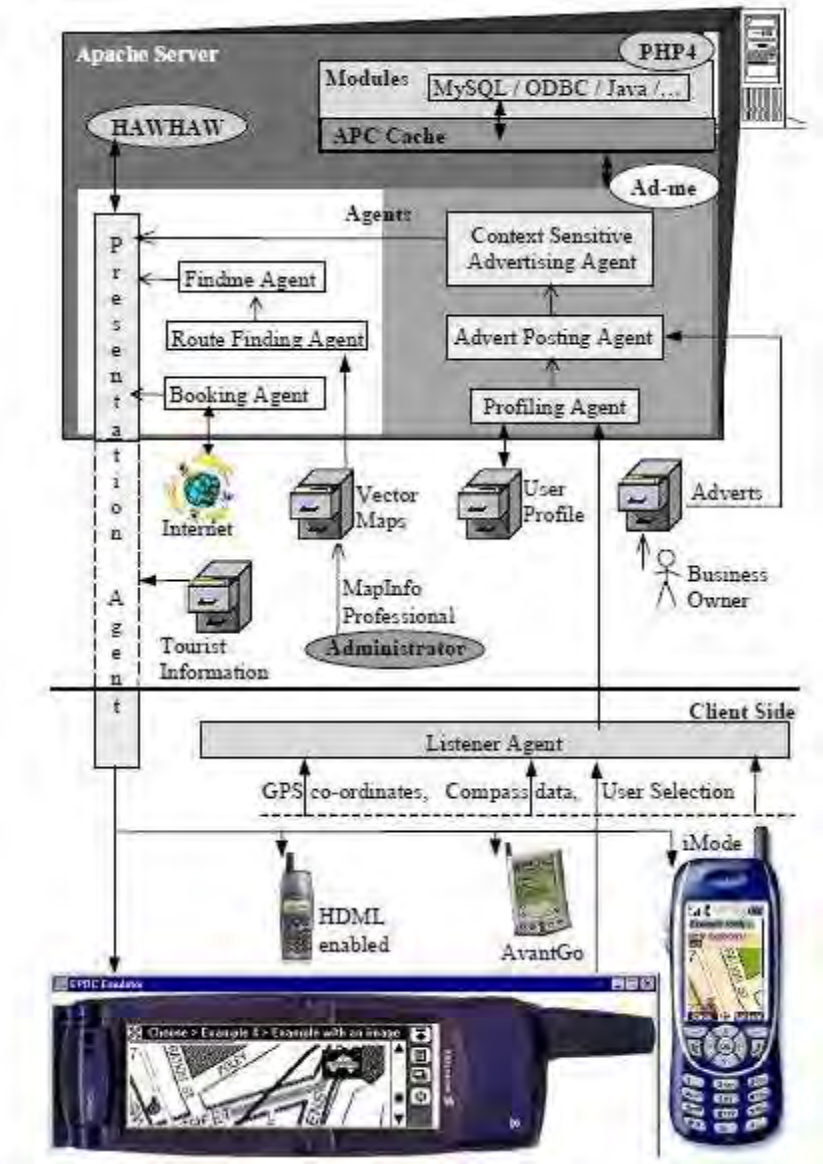

Figure 3.3: Architecture of Ad-me

3.4. Provisioning context aware advertisement to wireless mobile user

This paper presented an agent-based system for provision context-aware advertisements to wireless mobile users of J2ME and WAP device [38]. The system is built on top of system designed for personalizing services using mobile agents for location aware advertising and it add support for defining advertisements and provisioning them. In the system, rather than running in the user handled device, software agents are made to run on a remote server hosted by an Internet service provider or a cellular network service provider.

The researchers adopt a service oriented architecture framework so as to utilize a find bind execute paradigm where, content and value-added service providers register their services in a

public registry which in turn used by the system to find value-added services that match certain criteria so as to provide with a contract and an endpoint address for that service. As it is showed in figure 3.3, there are three main parts in this architecture: the clients, the Entry Server, and the Service Server. The Entry Server is responsible for the interaction between devices and the rest of the system. The Service Server hosts advertisements, services and service descriptions, and allows agents that migrate from the Entry Server to run there and select services and advertisements.

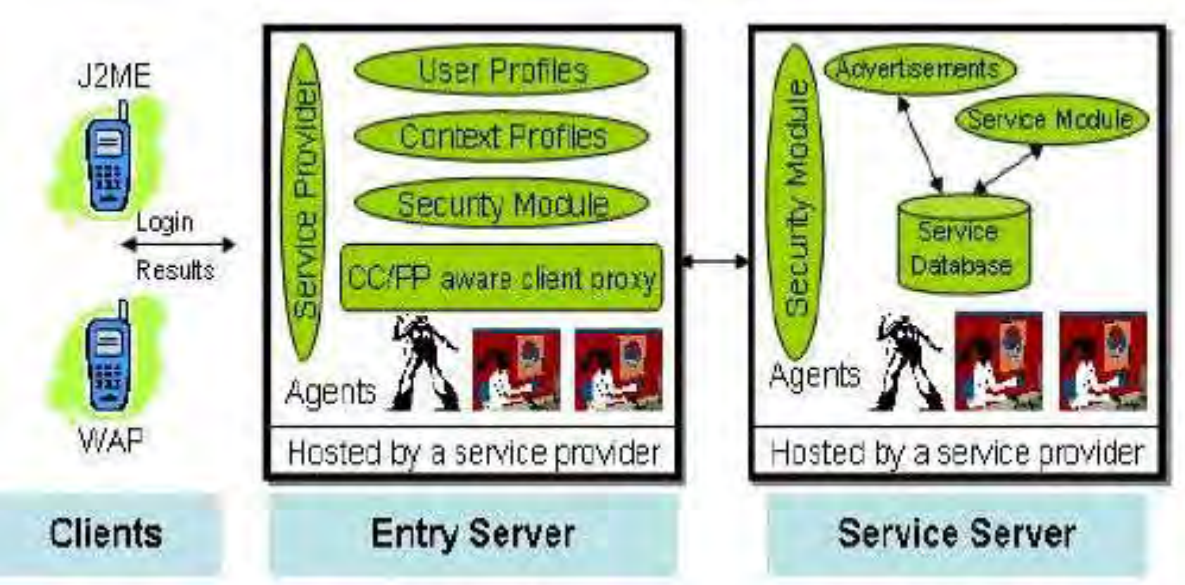

Figure 3.4: Architecture for context-aware advertisements to wireless mobile users

In this research, Service and content providers are made to register their products information through interfaces provided by Service Module, whereas, customers also must agree to accept mobile advertisements when they subscribe to value-added services; however, customers have control on how and when to receive advertisements. When considering the client side, the system is activated in either of the three ways which are: as a result of user request, incoming connection or scheduled alarm where user enter products they are interested in buying, and the system receives the request and dispatches agents to the service provider to find suitable products and services the user might be interested in, taking into account the users preferences, device capabilities, and the location.

There are two types of advertisements here, advertisements that can be pushed along with the results of a product search, or they can be treated as value-added services that mobile users subscribe. In general, this paper presented an agent-based system for provision context-aware

advertisements to wireless mobile users where location, time, and user preferences and device capabilities are used for defining the context.

3.5. Summary on related works

Here we present the summary over the reviewed related work. In doing so, we try to use nine different variables as a way to point out the ideas utilized with in each articles. Table 3.1 A and B show the summary over the related works:

Table 3.1: A. summary of related work

	SMMART	**WOODAPPLES**
Methodology	based on Keyword Boolean matching against the keywords available	Extend FOAF network structure and data model with service related information to include human provided information and provide information related to user interest
Attributes/ context utilized	• Location • Product preference	• Location • Preference
Architecture &/ framework utilized	Client server	• Client server architecture with • SOAF + HPS framework
Service type	LBS based over shopping preference	LBS and service of a friend
Marketing type	User initiated	User initiated
form of advert	In-application	Web based
Main context	Location and a keyword stating user shopping preference	Location and recommendation from focused groups called experts
Delivery type	Opt-in and Push based	Opt –in / PUSH
User action	Start the application and also fill in the shopping preference	Pooling location and register preference

Table 3.1: B. summary of related work

	AD-ME	**Provision of context aware mobile marketing**
Methodology	Use agents that query advertisement based on the profile stored in the server and user current location	based on the user's profile and context profile on the server dispatches mobile agents to search for these mobile advertisements
Attributes/ context utilized	• Preregistered user profile • Location	• Location • Preference • Time • Device capability
Architecture &/ framework utilized	• Client server • Agent factory framework	• Client server with a three layer for subscription on ISP • SOA framework
Service type	LBS	LBS
Marketing type	User initiated	User initiated
form of advert	In-application	In-application
Main context	Location	Location
Delivery type	Op-tin and Push	Opt-in and PUSH
User Action	Interact with the interface	Turn on the application

As it is described in the summary table 3.1 A and B, all the researchers utilize a reactive system which require the user to initiate the system and allow the system to capture user preference either by providing keyword or allowing the system to capture the location of the user where the a direct user preference is analyzed by the server in order to provide the appropriate information. However, besides utilizing only push type interaction through location as a major context parameter, the researchers do not consider to utilize concept base analysis over the preference and shopping interest that could be captured by the mobile phone. Hence, the proactivity aspect of context aware systems and also reasoning over the row data to infer some concept is not considered in all the scenarios. Therefore, considering this as a gap, this research work tries to address it by providing concept base inference over the user preference for the context aware mobile marketing system to infer and map users preference either to a market place or service providing centers.

Chapter Four – The proposed Context Aware Mobile Marketing System

4.1. Introduction

In the traditional mobile marketing, the mechanism for delivering marketing information or advertisement dictates, the mere delivery of information while neglecting the users need or preference [8]. Context aware mobile marketing (CAMM), as the name refers, it is a mobile based marketing system, which is expected to deliver marketing information to mobile phone users based on a predefined context parameters such as, location, preference, profile and time as a triggering condition for the adoption of the user need and/or preference as well as initiation of interaction between the user and the application.

As mobile phones always remain with the user, it has the potential to help learn users‘ preference and behavioral routine by considering concepts that could be captured through the mobile phone or with in the phone, such as, patterns of movement, activity and so on [36]. Using the information that could be captured by a mobile phone, user preference and behavior routine can be learned by using mechanisms such as Bayesian network [8] and ontology [8, 36, 46, 47].

The CAMM system provides a proactive service based on usage pattern of mobile phone and also environmental context of the user. The system, in the first place, requires to identify the relevant context parameter related to the user preference, map the user preference with a domain ontology so that it can infer an appropriate context, interpret the context and find a matching service (content) relevant to the context and deliver the content to the user mobile, i.e. targeted marketing information [20], to the user whose context matches to the content (service) available in the system.

The system requires two major components. The first one is, a client, implemented to run in android enabled mobile phones, so as to capture user context and preference, match the user preference with the domain ontology to infer the appropriate context for a request as well as present required information. The personalization effects are more shifted to the client side too to minimize the communication cost and allow users mobile phone store and process the user preference.

The second one is implemented in the server side and subjected to receiving the request from the client, processing and providing marketing information relevant to the user context. In addition, the server is also responsible for setting up marketing campaign and delivering it to a targeted group.

Therefore, in this chapter, we present and describe the architecture of Context Aware Mobile Marketing (CAMM) system by focusing on components involved on both the mobile client device and the server.

4.2. The proposed CAMM architecture

The general goal of CAMM system is to find marketing information for the mobile phone user based on his preference and inferred values from his activity. To achieve this task, the proposed architecture for CAMM system consists of two major components. The first one is a mobile device, which reside in the client side. In general, the client mobile device is responsible for capturing user preference, context and, taking this in to account, infer users marketing preference, send a request and also receive response from the server. The second one is a server handling the tasks of processing the request received from the client and deliver marketing information that match the user context. Figure 4.1 illustrates the generic architecture of the proposed context aware mobile marketing system.

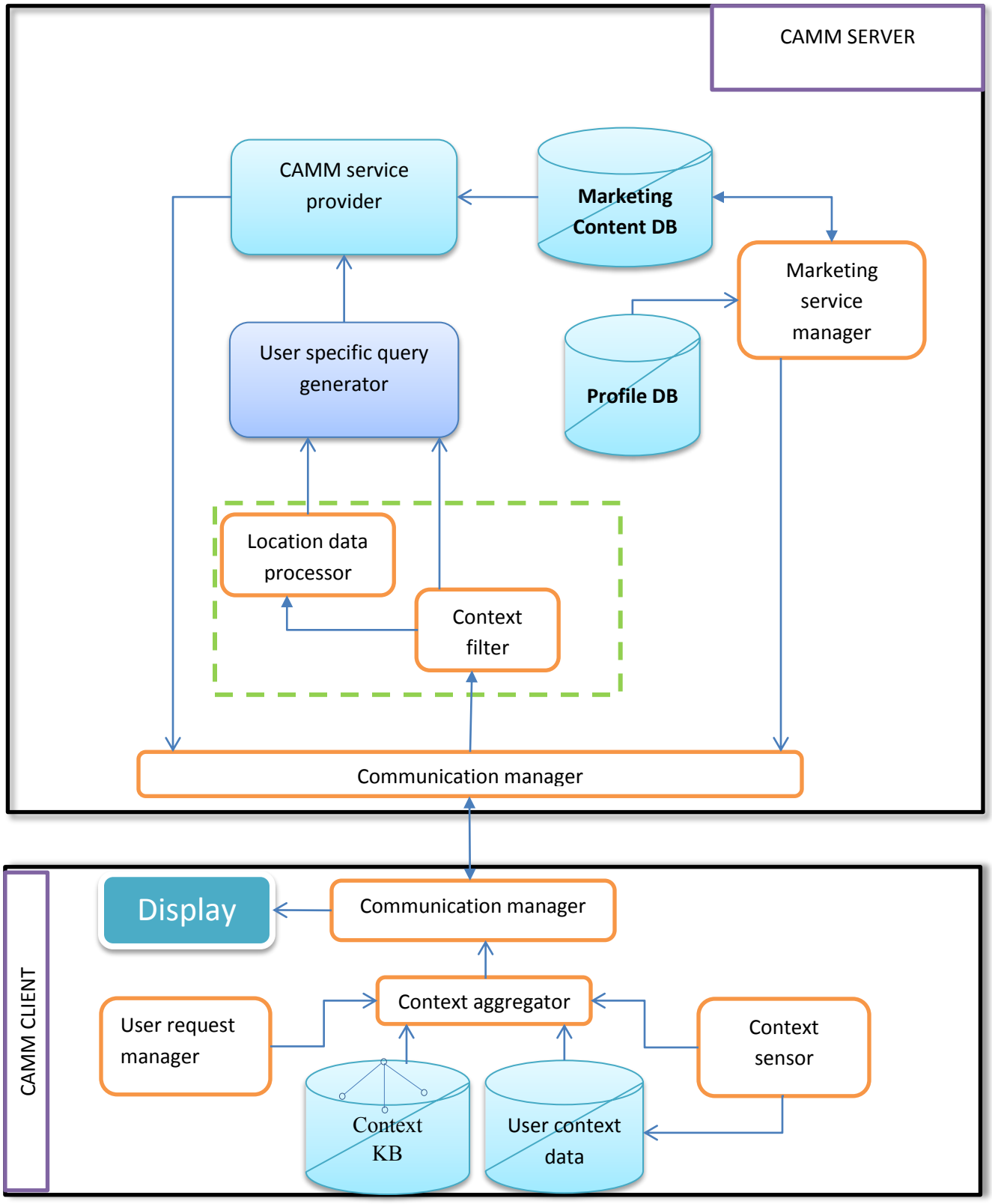

Figure 4.1: Architecture of context aware mobile marketing

Table 4.1 and 4.2 list and describe the core components as well as their purpose for both the server side and the client side components of the system as depicted in figure 4.1 the architecture of context aware mobile marketing system

Table 4.1: Client side components of the proposed architecture

Component name	Purpose
CAMM Client side components	
User request manager	Provide a means for the user to explicitly request for marketing information based on the his market preference
User Context Data	Store any relevant user context
Context KB (knowledge base)	Holds a marketing preference knowledge base
Context sensor	Extract user context from user phone and pass it to the context aggregator module. The tasks include, • Read about position of the phone • Scan for the current preference data • Scan for activity data (calendar) • Periodically trigger context aggregator and initiate client request
Context aggregator	• Use the knowledgebase and the rule model to reason on the received context of the user to infer the user preference that best suits the current context • Generate a query parameter for the context request • By using the context data received, create a request message to be sent to the CAMM server through the communication manager
Communication manager	Receive the parameters of a request and establish communication to the server and forward the request. In addition, it will receive a feedback from the server and forward it to the display unit
Display	Provide the application‘s UI to show the marketing information to the user

Table 4.2: Server side components of the proposed architecture

CAMM Server side component	
Component name	**Purpose**
Marketing service manager	Responsible for the registration and setting up of marketing campaign and also ensure the delivery of the marketing information to the right person based on profile context
Context filter	Received the context data from the client and perform operations to separate the location data and send it to location data processor module where on the other hand it pass the rest context data to context creator module
User specific query generator	Triggered by the context data received from context filter module and location data processor module, it formulates a user specific query string using a context model and pass it to the next module
CAMM service provider	Given user context information received from other modules of CAMM server, it retrieves and delivers context aware marketing to the client device
Location data processor	Receive the location data from context filter module and perform calculation for the current location of the client mobile device.
Communication manager	Receive a communication request from the communication manager of the client mobile device. It also serves as an interface for forwarding the marketing message from CAMM service provider and marketing service manager to the client
Profile database	A list of customers opt for marketing post where they provide a list of specific interest domain looking for marketing information related to their specific interest
Market content database	A database for the content regarding marketing information or advertisement

4.3. User context capturing

Capturing the context of the user is the initial task to operate the defined task for most context aware applications [34, 37]. It is commonly handled by the client mobile device in order to acquire the relevant information by accessing some kind of sensor equipment‘s available in the mobile device (physical sensors) and other mechanisms (software sensors). In this section we will describe the modules of the proposed system that are related to the task of capturing context of the user and related tasks.

4.3.1. Context sensor

A common way for capturing context information in context aware applications is using context information delivered from an array of diverse information sources such as context sensors [33]. This module is responsible for collecting user‘s context in their mobile phone. As shown in figure 4.2, the set of tasks and processes under this module are:

- Reading user location to position the client mobile device so as to locate the user in the geographical vicinity
- Reading activity calendar setting including the to-do list with time
- Reading user marketing preference if available

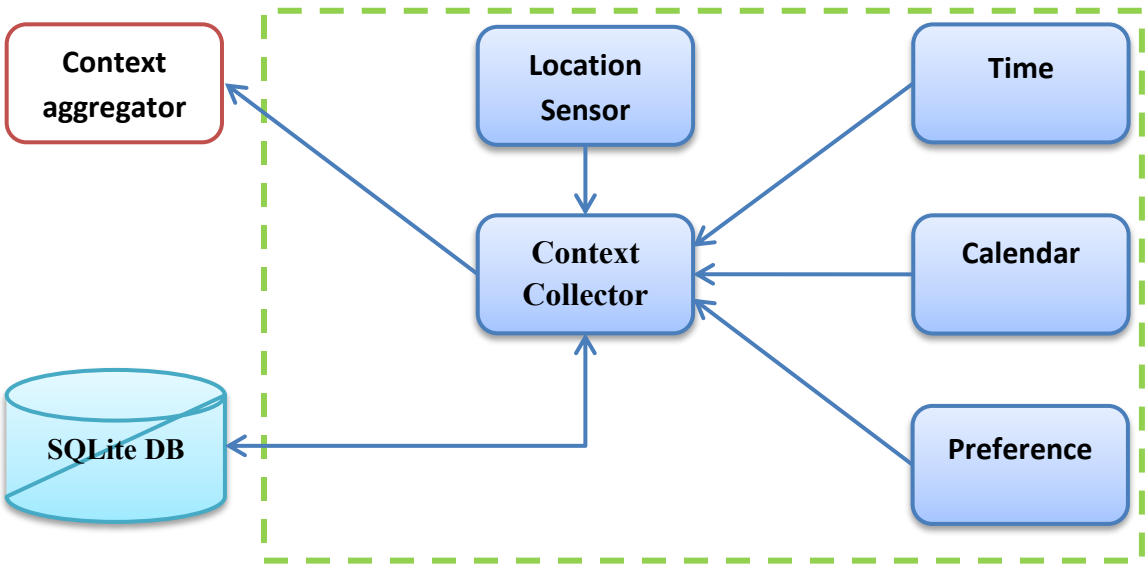

Figure 4.2: Components of the context sensor module

Beside capturing context changes that could occur with the mobile phone, this module is also responsible for the initiation of proactive services whenever a change in any of the defined context occur. This is achieved by triggering the next module in line which is the context aggregator. In addition to this, this module is also responsible to keep persistence of context changes that are captured by the sensor, by communicating to the small database that reside

within the mobile phone. As shown in figure 4.2, the context collector component is responsible for listening to changes in the user context as defined in the module.

4.3.2. User request manager

The main task of this module is to provide the user with a mechanism to request marketing information using the mobile phone. The module provide an interface in the mobile app to register clients interest in events such as listing out a set of items or services of their marketing interest and requests for subscription. This module is helpful for the user to reactively request for marketing information. The request made through this module is not a mere search task. Therefore, every request is processed through the context aggregator module in order to add the value of context awareness in the user request.

4.3.3. Context aggregator

Once the context changes are captured by the sensor module, the next task is to infer user interest towards marketing preference based on context parameter and a knowledgebase organized using domain ontology for user market preference. The context aggregator module is the major component of CAMM and has four subcomponents that are crucial for the system, namely:

- Context receiver
- User context reasoner
- Context notifier
- Context message creator

Figure 4.3 illustrate the process and interaction between components of the context aggregator module.

The tasks to be achieved in this module with respect to the components of the module are as follows:

Task 1: Context Receiving

- Achieved by the context receiver component
- Focus in receiving the captured context parameters from the context sensors and passing it to the next component inline
- Input: raw context value
- Output: context model

Task 2: Context Reasoning and Utilization

- Achieved by context reasoner component

- Use the knowledgebase and the rule and context model to infer the user preference that best suits the current context and generate a query parameter for the context request and pass the value to the next component inline.
- Input: context model, rule
- Output: inferred query parameter
- Component involved: domain ontology

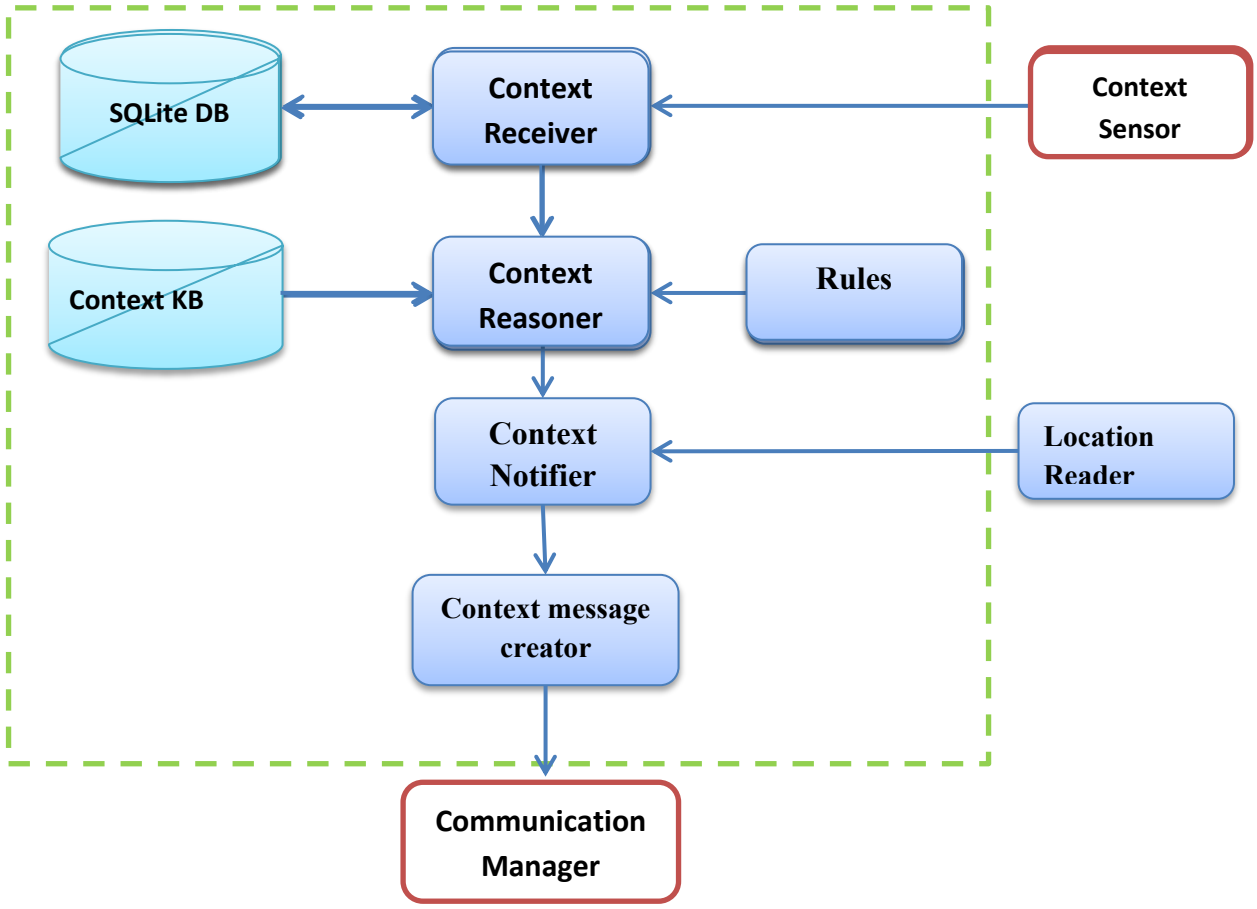

Figure 4.3: Components of the context aggregator module

Task 3: Context Notification

- Achieved by context notifier
- Receive inferred query parameter and initiate the location reader to capture current location of the user and notify it to the message creator component
- Input: location data, query parameter
- Output: location data, query parameter

Task 4: Request Message Creation

- Achieved by the context message creator component
- Create a request message from the context query parameter and code it in a way that utilizes the band width of the mobile internet connection and transfers the coded message to the communication manager where a request to the server is performed.
- Input: location data, query parameter
- Output: coded request message

The context aggregator is called whenever there is a change in the context of the client mobile device, which is derived by a call either from the context sensor (proactively) and / or the user request manager (reactively). Besides creating the context awareness, this module also benefits the system in reducing the communication cost. Algorithm 4.1 and 4.2 illustrate the process involved in the context aggregator module.

Algorithm 4.1 user context receiving

1. BEGIN
2. REPEAT
    a. Listen for context change
    b. IF context change occurs THEN
        i. Read context data
        ii. Preprocess context value
        iii. Create context model
        iv. Return context model
    c. ELSE
        i. Do nothing
        ii. Wait
    d. END IF
3. UNTIL user suspend process
4. END

Algorithm 4.2 context reasoning and notifing

1. INPUT
   - Context model // from algorithm 4.1
   - Rule
   - Ontology
2. CHECK for model
   a. IF model found THEN
      i. Load rule
      ii. Load ontology
3. Perform reasoning
   a. Reason on the model
   b. Infer new concept
   c. Return inferred concept
4. Initiate context notifier component
   a. Receive inferred concept //used as a query parameter
   b. IF concept found THEN
      i. Read current location
5. Create request message
   a. Code location data and query parameter
6. Send coded message

END

4.4. Device communication

4.4.1. Communication manager

As the name implies, this module is responsible for establishing a communication and persisting it between the client mobile device and the server. This module resides both in the client mobile phone and also the server.

The client side of this module is responsible to receive the request message sent from the context aggregator and initiate communication with the server. Both the client mobile device and server communication relay on this module. The module is also responsible for receiving information sent from the server and passes it to the display module.

The server side of this module always listens to communication request. The module handles two basic tasks. The first one is, it receives request message sent from the client mobile

device through the client side communication manager and pass it to the respective module in the server which is context filter. The second task of this module is, to receive the marketing information forwarded by the CAMM service provider and marketing service manager, and forward it to the mobile client application. In addition, this module is also responsible for initiation and keeping persistency of the communication between the client mobile device and the server.

4.5. Context and content processors

4.5.1. Context filter

This module receives request message coming from the client mobile device through the communication manager. The task of this module is:

- To receive and decode the request message that come from the client mobile device to a format usable by the user specific query generator module
- In addition to the task of decoding the request message, it also performs a preprocess operation in separating the location data from the rest of the context data and passes it to the location data processor for a further process, where the rest of the context data is sent to the next module in line

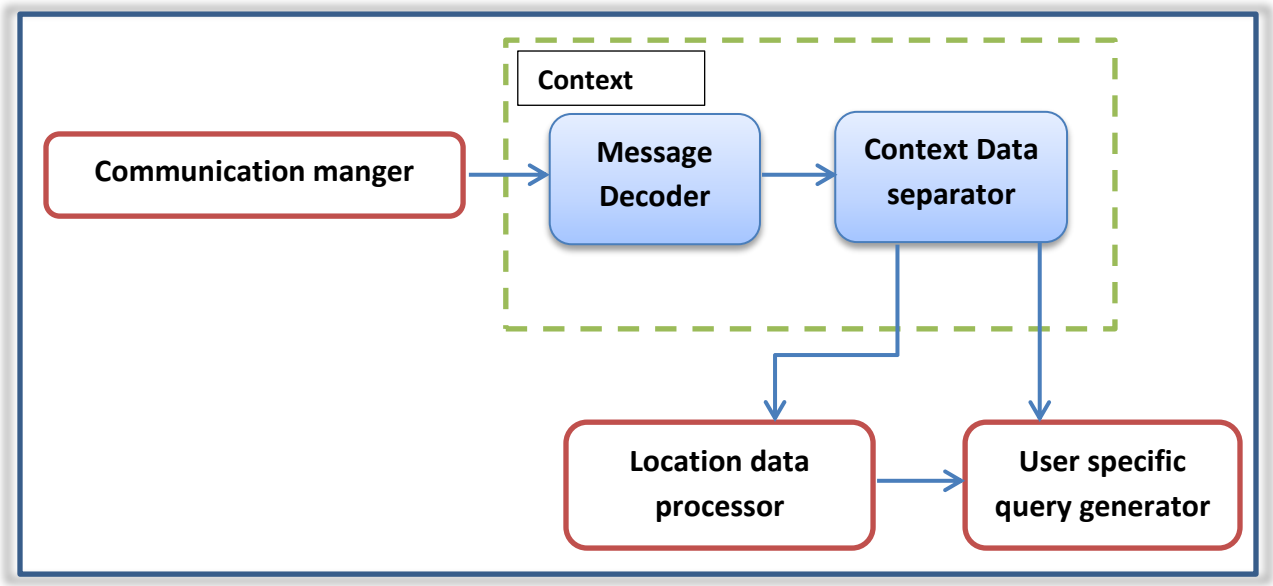

Figure 4.4: Context filter process and interacting components

As it is illustrated in figure 4.4, the request message from the client mobile received in the context filter is decoded by the message decoder and passed in to the context data separator. The context data separator sub component of the context filter module will separate the location data from the rest

context data and send the location data to the location data processor module and the rest context data to the context creator module.

4.5.2. User specific query generator

This module is triggered by the context changes received by the context filter and based on the context received it formulate a user specific query string using a context rule model and user profile data as an input and pass the result to the next module in line which the CAMM service provider,

As it is depicted in the figure 4.5, this module communicates with different components as described below:

- Context filter module: to access the context data for user query parameter and user location information sent from the client mobile device
- User profile: this components use to store a specific information on the individual user that are registered for the service. Therefore, the context creator interact with this component to read basic user information
- Rule model: to qualify query string and adding value to it, based on the information that reside in the user profile

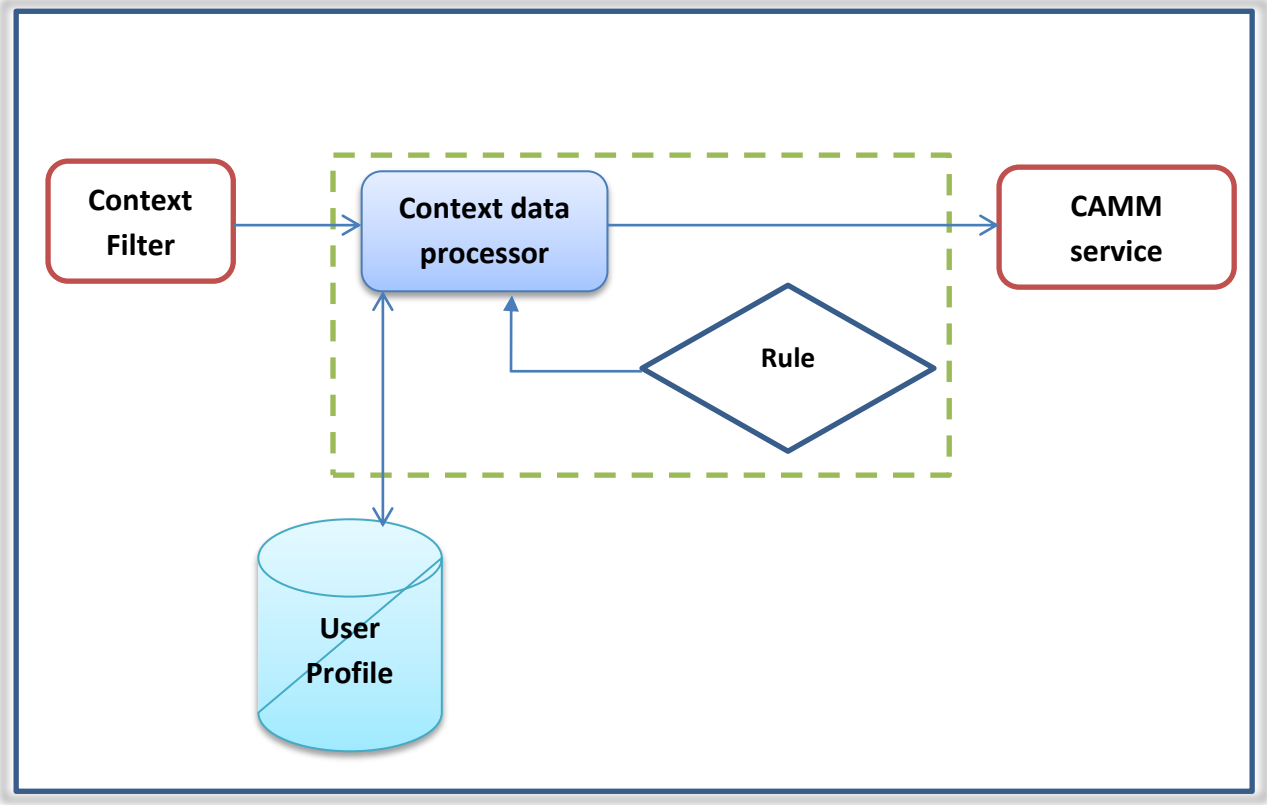

Figure 4.5: Context creator process and interacting process

4.5.3. Location data processor

Location is one of the crucial components of in the CAMM system. The task of this module is to receive the row location data from the client mobile device and then process (perform relevant calculation) in order to pinpoint the location of the mobile user with in a geographical vicinity and pass the result to the context creator.

4.5.4. CAMM service provider

The major task of this module is to ensure the delivery of relevant marketing information taking the context of the user in to consideration. In order to ensure this task the module interact with, the user specific query generator in order to receive the appropriate context query terms that used for retrieving the appropriate marketing content so as to send it to the user. The figure 4.4 illustrates the process of the CAMM service provider:

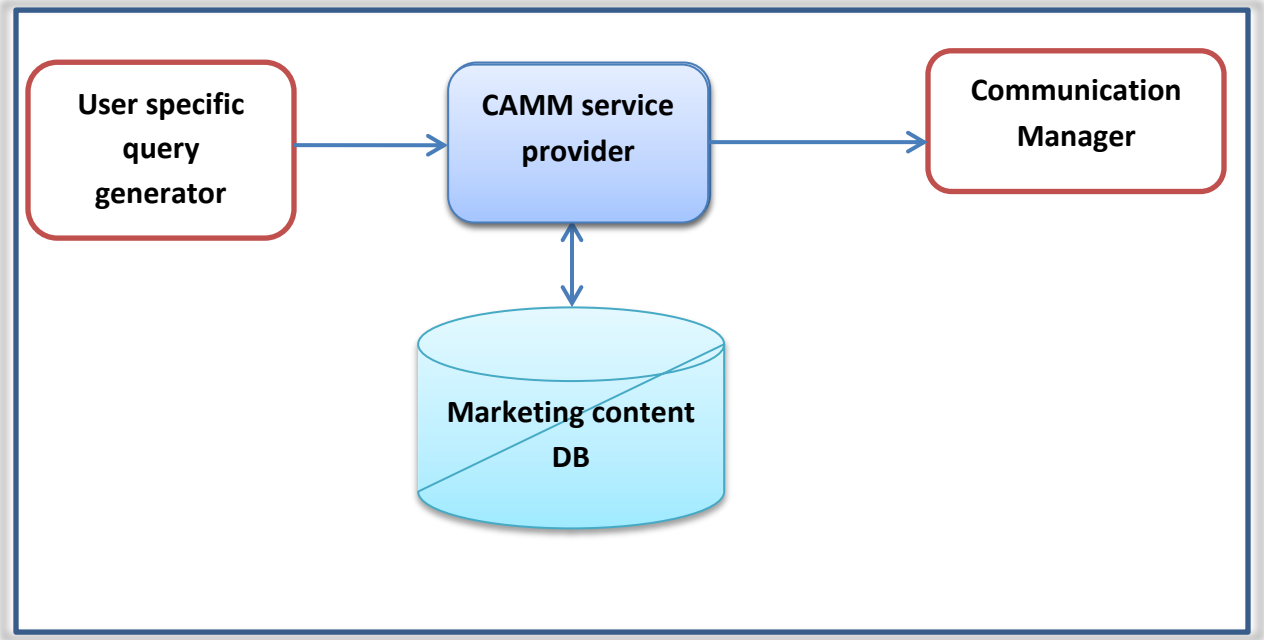

Figure 4.6: CAMM service provider process

4.6. Marketing service facilitator

The interaction between the client mobile device, whom provide a context as a request for a service, and the server, that subscribe for a context change to provide marketing content for the client, is triggered by a coming request from the client mobile device. Such kind of communication dictates pull based communication [40]. In order to perform marketing campaign, there must be a way where the marketers are able to initiate communication and push content to the user without violating the context parameters and holding users interest. Since, balancing the client mobile user interest and marketers need to push the marketing information

(contents) to those of the users is the attempt of the system. This can be achieved by marketing service manager module of the system.

4.6.1. Marketing service manager

This module resides on the server and targeted in initiating a communication from the server to the client. The module is responsible finding mobile clients that are subjected to a given context parameter and delivering or pushing marketing information to the client. In achieving this, the module will allow the marketers to conduct a marketing campaign by setting specific parameters and find a device that can fit to the predefined context parameter that are required to be adopted for the marketing campaign.

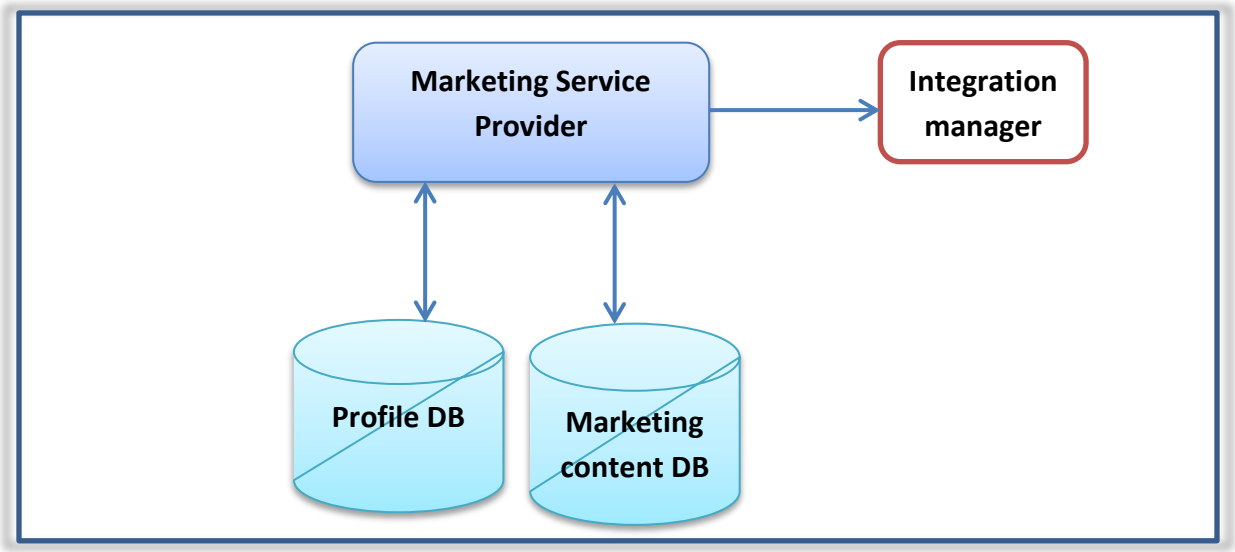

Figure 4.7: Marketing service provider module process

The module provides an interface where marketers can set up marketing campaigns in order to push marketing contents to client's mobile device. In order to achieve this, the module communicates with:

- ***Profile database***: to access the user profile that resides in the server. The user profile database used to store a general static information, like user interest in a certain aspects which are not specific to marketing and user identification number so as to id the user
- ***Marketing content database***: to access the marketing content to be delivered or advertised to the users
- ***communication manager***: to establish communication between the client mobile device and the marketing service manager

4.7. User preference modeling

Mobile devices have the ability to collect certain data that can reveal a given person patterns in his or her activity and this can provide a great opportunity for mapping such a data with the user preference. Since the mobile phones always remain with the user, beside analyzing location patterns like the way utilized in the LBS systems[14], it also can be used to capture user activity by modeling the information that the user fill in the phone in his/her day to day activity, such as to do list, calendar activity and events.

With regard to the task at hand, user marketing preference can also be traced through ―user personal marketing habit", activity logs that the user fills regarding his plan. In order to achieve this, we use ontology market preference for modeling and mapping user preference towards the need for marketing information.

There are several potential advantages for developing context models based on Semantic Web Ontology, such as its expressiveness, the capability of Knowledge Sharing and Knowledge Reuse; the support to various existing logic inference mechanisms, and lastly, its extensibility [36]. Ontologies also serve as metadata schemas, providing a controlled vocabulary of concepts that allow context aware systems share contextual information, Knowledge and to provide relevant services and information to users based on their situational needs [8, 36, 46]. Therefore, the design of the ontology in the proposed architecture focused on describing the semantic relation between the market information and user preference towards it so as to infer the appropriate marketing preference based on the user context. Figure 4.8 illustrate the screenshoot protégé OWL tool that we work on to develop the ontology.

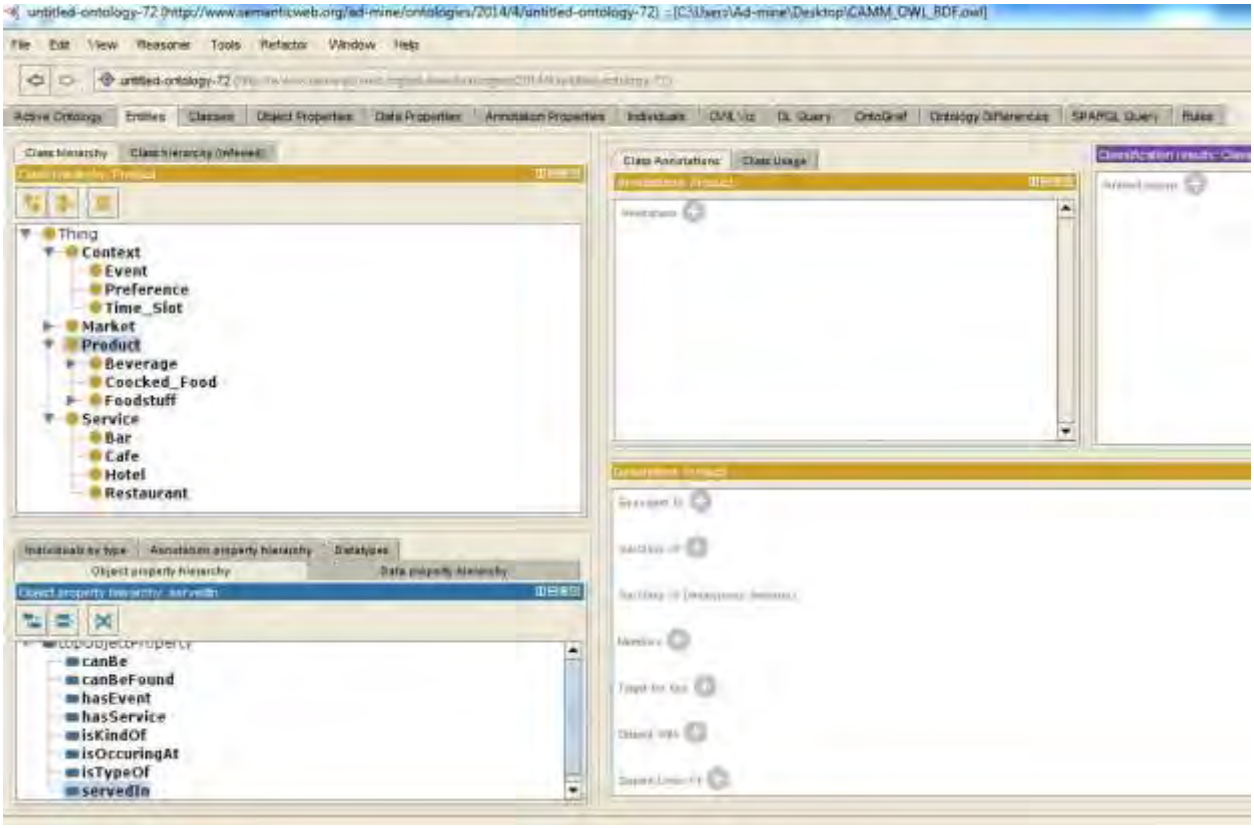

Figure 4.8: Protégé OWL tool diagram

By using OWL ontologies, we model the user preference with relation to market information need so as to infer on the user activities that could lead to a concept of a need towards certain specific marketing information. In this case user preference inference implies the process of taking current context of the user as captured by the mobile phone, as a proof and then calculating the preferred degree of the marketing information. This implies, the preferred user preference is defined by the relationship between the user contexts, market preference and user characteristics (such as user profile). On the other hand, context-aware computing takes personalization information as context information and this result in personalization information such as user preferences being taken as part of context data. Therefore, the concept to address in this study is related to the modeling of preference, extraction of the semantic concepts from preference words described by the user and issue the appropriate market preference. Figure 4.9 illustrate the assurted model of the owl ontology, as generated by –protégé OWL Viz tool".

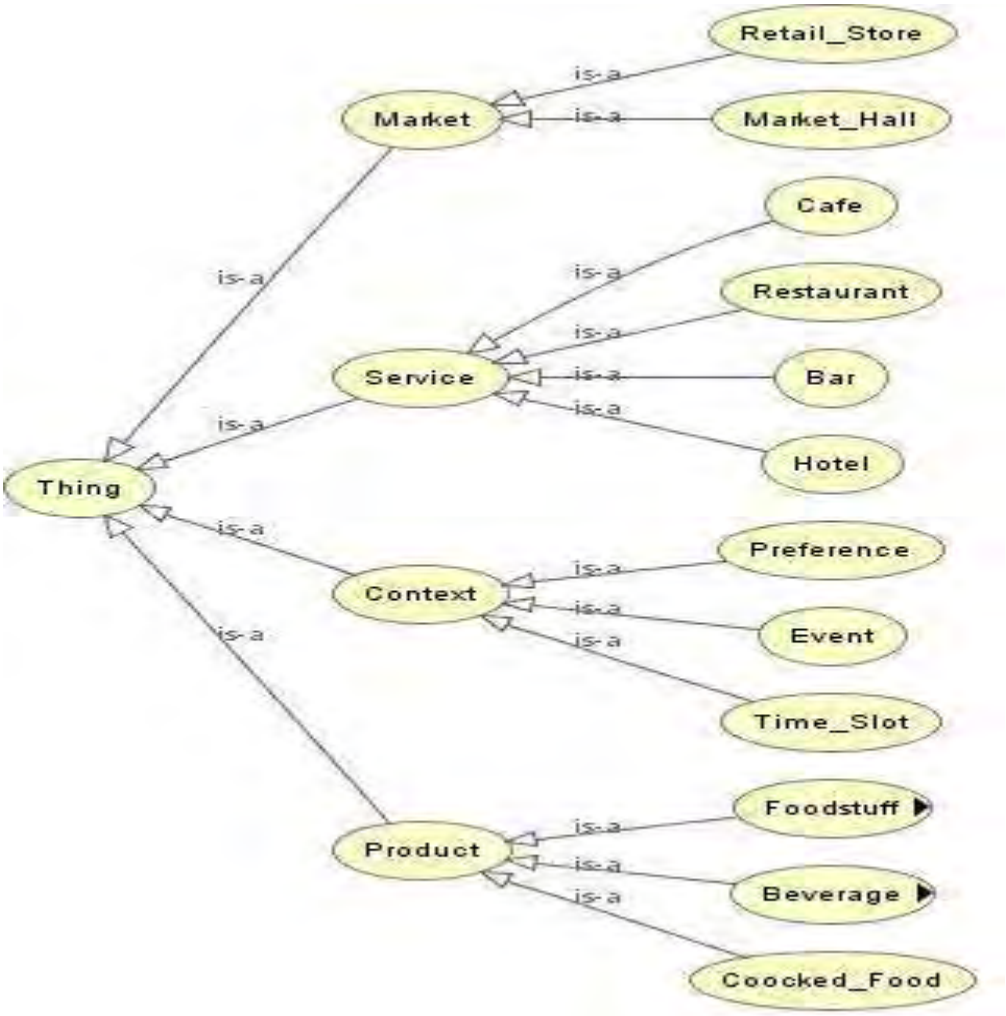

Figure 4.9: the asserted model of the user market preference ontology

In addition to figure 4.8, the figure in Annex A illustrate the ontology graph for the OWL ontology model, generated by ―protégé OntoGraph", illustrating the classes and the class hierarchy of the concepts modeled with in the owl user market preference ontology.

Since OWL language is not able to express all relations, we apply SWRL (sematic web rule language) rules to an ontology to add expressivity of the OWL ontology we design. Protégé OWL editor also supports SWRL rules. Annex B illustrates the screenshoot for the SWRL rules utilized with in the protégé OWL editer environment.

4.8. CAMM intraction layers

The proposed CAMM architecture is designed by focusing the delivery of marketing information, advertisements or product or service promotions. To assess the users persoption towards marketing through mobile we conduct questioner to selected mobile users and marketers as listed in the annex H and I section. This section illustrates the participating stakeholders and

their interaction for the functional operation of the CAMM system. The participating stockholders include:

A. **Customer (user)**: an individual who subscribe for a service by installing the client side application and registering it.
B. **Marketing information service provider:** is an endpoint where the users subscribe to get marketing information. It also serve as an interface between all service providers which include content provider, marketing service provider where they can deploy the marketing information content to be forwarded to the user.
C. **Content provider:** these are, in general, endpoints of the system where marketing information contents can be generated for CAMM system. Here, the marketing information content can be either system generated or can be generated by marketing service providers.
D. **Marketing service provider:** this include product providers, service providers or advertising agencies that are in need of delivering marketing information through the user mobile phone personalized to user's context and need.

Figure 4.10, illustrates the interaction between stockholders of the proposed CAMM system.

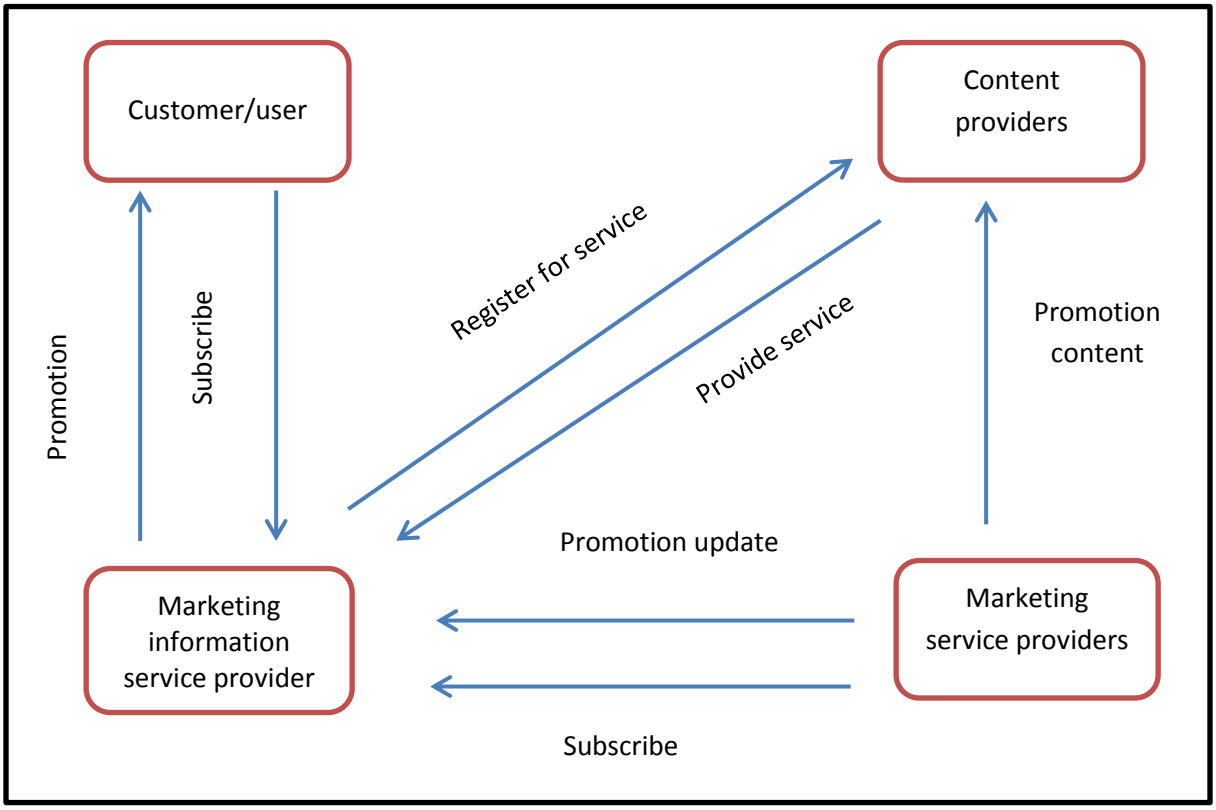

Figure 4.10: CAMM system users interaction

Chapter Five – Implementation and Validation

In chapter four, we describe in detail the design of the proposed context aware mobile marketing system. Following the concepts described on the design of the architecture for CAMM, we also develop a prototype. In this chapter we will discuss the implementation of the proposed architecture by presenting the prototype, tools utilized in developing the prototype and the implementation detail and the evaluation result.

5.1. Overview

The prototype developed in this study is purposed on checking the functionality of the proposed context aware mobile marketing (CAMM) architecture which is discussed in chapter four. Majority of the components in each modules of the architecture are implemented as per the theoretical specification and functionalities described during the design of the proposed system.

The prototype implemented utilizes market preference as it is inferred by the mobile phone to provide marketing information around the area (certain radius) where the user is located.

5.2. Tools and technologies utilized during prototype development

During the development of the prototype, a number of tools are utilized which are related to operation environment, programming, communication, database management, context (concept) modeling, representation, context reasoning. Lists of tools used are described below:

- Android 4.3 (Jelly Bean) software development kit (SDK) with API level 18 integrated with Eclipse IDE 4.2.0 for developing the client side
- Android virtual device (AVD) for API 18 to run and test the application
- Eclipse integrated development environment (IDE) version 4.3.0 for developing the server side.
- Java SE development kit (JDK) 1.6
- MySQL database server version 5.1.71 for data persistency in the server side
- Java Servlet application program interface (API) version 3.0 as a means of handling communication between the client and the server
- Apache Tomcat version 7.0 as a web container for Java Servlets
- Protégé for OWL Editor Version 4.3 with OWL API 3.4.3 for developing the user preference ontology
- Androjena 0.5 which is Android port of Hewlett-Packard's Jena Semantic Framework for processing the ontology in the prototype
- Jfact 1.2.0 which is android version of Fact++ reasoner for reasoning purpose

- ARQoid 0.5 is an Android port of Hewlett-Packard's ARQ SPARQL Query Engine for conducting semantic query over the ontology
- Microsoft Windows 7 (32 bits) operating system, a dual core @ 2.0 MHz, 2GB RAM and 230GB HD as an operating and development environment
- Galaxy s3 mobile device as a testing environment

5.3. Prototype setup

The prototype contains two components which run both in the client side and server side. Client side is implemented in android enabled mobile device using (AVD and Galaxy s3) where the server is implemented in windows 7 environment. The communication between the devices is handled by a standard hypertext protocol (HTTP).

On the client side the domain ontology, context sensor, the context interpreter, reasoner, request message creator communication handler and result viewer, request creator and request storage components are implemented.

On the server side, request listener and communication handler, context filter, location data processor, query organizer, CAMM service provider, marketing campaign creator and handler are implemented.

5.4. Implementation detail

Section 5.3 illustrates, the general set up of the prototype for the proposed architecture of CAMM. In the following sub section, we will describe the detail implementation of each modules incorporated both for the client side and server side

5.4.1. Client side modules

In general, the client side implementation, the development environment is based on an android programming language with a targeted SDK API level 18 (Jelly Bean) and minimum SDK with API level 8 (Froyo). Table 5.1 illustrates the detail on the implementation of the components which are found in the client side of the prototype.

Table 5.1 client side module implementation detail

Component name	Implementation detail
User request manager	• Implemented as android activity class running in the main UI thread • Provide an interface where the user input explicit request for product items or services • Annex A illustrates the android code utilized for the purpose of implementation
User Context Data	• Implemented using SQLite database in order to persist user request and any relevant user context
Context sensor	• Implemented as an android service class to periodically listen to context changes occurring in the mobile phone also o Read data for positioning the phone either GSM signal or GPS fix o Scan for preference and activity data over the calendar event and to do list • Annex B illustrated the code utilized for reading calendar
Context aggregator	• Implemented as a java class and all its components run as an Async task outside the main UI thread for performing reasoning and inference activity using the domain ontology and the rules provided • It is the main reasoning module • In addition it also receive and decode and pass the request to be made to the communication manager
Communication manager	• Implemented as a java class and perform HTTP request. • It receive the decoded message and pass it to the server over the established connection
Display	• Implemented as android activity class running in the main UI thread and use to view marketing information received from the server to the user

5.4.2. Server side modules

The server side module is designed with the Java programming language to take the language's advantages of machine independency and its ease in interacting with other open source tools. Table 5.2 illustrates the implementation detail for the modules that reside in the server.

Table 5.2: server side module implementation detail

Component name	Implementation detail
Marketing service manager	• Implemented as java servlet class • Its task is to set up marketing campaign and delivery of the marketing information to targeted audience
Context filter	• Implemented as java servlet class • It is responsible to separate the location data and send it to location data processor module where on the other hand it pass the rest context data to context creator module
User specific query generator	• Implemented as a java class • Responsible for creating a query string specific to a user that used by CAMM service provider for querying the Market content database
CAMM service provider	• Implemented as a java servlet class and it is used for fetching and delivery of context aware marketing information to the client device
Location data processor	• Implemented as a java class to process and map either the signal strength or GPS fix sent from the mobile to a geographical location to identify where the user is located
communication manager	• Implemented as a java servlet class so as to communicate with android client • It send and also receive HTTP response and request respectively to and from the android client
Profile database	• Implemented in MySQL server database to store basic information of the registered customers information
Market content	• Implemented in MySQL server database and use to store the

database	marketing information or advertisement content

5.5. Experiment

As it is mentioned in the beginning of this chapter, a prototype has been developed as a proof of the concepts described in in the architecture of CAMM. Therefore, in this chapter the test and experiments conducted to validate the proposed ontology based user market preference modeling for CAMM is presented. In order to conduct the test, an ontology specific to food product market and service domain is constructed and utilized during the experiment.

In order to test the system we have followed some form of procedures. The experimental platform, and the test scenarios and evaluation performed are described below.

5.5.1. Experimental platform

The service architecture for our experiment contains two parts, a CAMM client and CAMM server.

- The CAMM client: is set up to run on android based mobile device, mainly on Android Galaxy s3, and in light of absence of real device, an android virtual device (AVD), the emulator is utilized. The modeled user market preference ontology also resides in the client side mobile.
- The CAMM server is set up to run on laptop computer running Windows 7 operating system having dual core@2.0 and 2GB RAM**.** In addition to this, the marketing content database and also the user profile is also reside in the CAMM server

5.5.2. Scenarios

- Person ABC recently installed CAMM client in his android mobile device and opt-in for mobile marketing service by filling the necessary initial requirements, such as his profile and system preferences, context and events. Then ABC enters his preference for some item or service that he wants to get marketing information about and let the system to do the rest. Whereas, on the other hand the system periodically and proactively monitor context and checks marketing information that can suit to ABC‘s need which means, his shopping preference. Some of the possible the scenarios of ABC
    - ABC entered his preference for ―burger” before he leaves his home having in mind that he will have burger for his lunch. When the CAMM client reads for the preference item burger, it try to identify what burger means by consulting the domain ontology and try to find the related concepts to the item burger. Then CAMM client prepare a request and send it to the CAMM server to find restaurant

market information near to the vicinity of the user. CAMM server then respond to the request by sending the information. Where CAMM client receive and notify the ABC.

- ABC have a shopping calendar event on the next Saturday, CAMM client log the event and when the day come, request the CAMM server for Market or retail stores information that are relevant to user context and preference items listed in the user preference.
- ABC wants to find a market place to buy a cheese and use CAMM client to search for it. ABC starts the application and uses the available interface and sends a query for the item. CAMM server receives the request and look for market place around or on the neighboring places. Send the result back to the CAMM client where it will be displayed in the available interface.

5.5.3. Test and evaluation

Evaluating the design and implementation is a process of comparing the end result with our goals. To reach our goals we need our system to fulfill the requirements in the specification stated in the architecture of the CAMM system. First, we will identify appropriate test features. Then, we must determine what results we consider successful. We can then present the results of our tests and experiments with an evaluation.

5.5.3.1. Acceptance test

Acceptance tests are conducted on the final implementation of the proposed system prototype to determine whether the functionalities of the proposed CAMM architecture can hold. In order to check and confirm that CAMM deliver the functionalities as promised an acceptance test is conducted on a real life usage situation cases.

Case 1: In this case we are going to see if the CAMM is able to proactively discover the user context, interpret the context to appropriate concept, create a request for a service based on the concept identified and discover marketing information relevant to user context. In this case the user will set his preference,

Case 2: In this test case, unlike the first test cases, which check on the proactive functionalities of CAMM, this test case is conducted to prove on the reactive functionalities of the proposed CAMM.

Case 3: we conduct this test over the scenarios presented in section 5.5.2. We preparing samples for different preferences and context scenarios as described in the scenarios‘ conduct the test in each steps of the prototype implementation.

In all the three test cases, we will use the application under emulated test environments

Test Case 1: Proactive context awareness test

In this case, given a mobile phone installed with CAMM client where we set a profile, entered a preference and activate the context awareness. In order to emulate a location a module is added to the CAMM application that can generate a random mock location so as to simulate as different location. Annex E illustrates, some selectes location coordinates for market and service providers which are collected during data collection phase to build the test case. In order to conduct this test, we use features as it is depicted in table 5.3 and results are also illustrated.

Table 5.3 test case 1:

Features	Result	Pass/fail
Runtime Context identification and interpretation	In this case CAMM client is able to is able to identify the user context where the user preference, user location and time are identified and the results are interpreted to appropriate level	Pass
Concept generation	Given varied users preference provided, CAMM client is able to identify and map the user preference to high level concept as it is seen in the final out puts	Pass
Request creation	Once a concept is generated, proper request to the CAMM server is created and utilized. The request is created when a match between the predefined user preference and the current context of the user is found	Pass
Market information discovery	For every request made to the CAMM server, market information which is relevant to the user context is passed to the CAMM client.	Pass

Test case 2: Reactive context awareness test

In this test case, we are focusing to test the reactive functionality of the CAMM yet holding context awareness as basic criteria. A query is entered through the available interface for the item or service they are looking for. In order to conduct this test case, some features are selected as a test case considering example scenarios. Table 5.4 illustrate the test features and the experiment result.

Table 5.4 test case 2

Features	Result	Pass/fail
Find restaurant:- (Query term identification)	Given a query term (keyword), CAMM client is able forward the query to the CAMM server. Query result: Here as per the query term a list of available restaurants information is delivered	Pass
Find a restaurant near my location:- (Context capturing)	The reactive feature of the CAMM is supported with context awareness auto capture of the user location and other custom setting variables Query result: Here list of restaurant near to the user location is forwarded.	Pass
Burger :- (Query Concept interpretation)	A query term interpretation is performed so as to infer higher level concept generalized concept of the query Query result: Here the list of restaurant near to the vicinity of the user location is forwarded	Pass

Test case 3: Scenario test

We conduct this test as per the scenarios presented in section 5.5.2. We prepare samples for different preferences and context scenarios as described in the scenarios' and conduct the test in each steps of the prototype implementation. The test data set is prepared during the implementation period and conducted for each scenario cases. The results of the test are inline with the expected results for each of the scenarios.

5.5.3.2. Operational test

We conduct operational test experiment in order to check the functionalities of the prototype are in line with the modules of the proposed CAMM architecture. Table 5.5 illustrates the features selected, the test features and the results for the test. The features selected are derived from implementation modules of the of the prototype and the test features are the operations required to fulfill the operational functionalities.

Table 5.5 list of operational tests

Features	Test	Result		Note
		Pass	Fail	
Calendar	collect calendar events	✓		
	Log calendar event	✓		
	Use calendar event	✓		
Location	Location collected regularly	✓		
	GPS coordinates are exported	✓		
	GPS setting recognized	✓		
	Map generated from latitude, longitude		✓	A map component is not incorporated in the prototype
Custom setting	Auto observation of location	✓		
	Auto observation of preference	✓		

	Auto observation of calendar	✓		
	Custom setting	✓		
Model	Read model	✓		
	Write to model		✓	Model update is not incorporated
	Operate on model	✓		
Rule	Read rule	✓		
	Operate on rule	✓		
Database	Log to database	✓		
	Read from database	✓		

5.6. Demonstration

In the previous section, we describe the test and experiments conducted to validate the proposed mobile based ontology for user market preference modeling in CAMM. The experiments conducted illustrate that, the proposed approach for modeling user market preference with in the mobile domain allow to map user market preference to relevant market or service providers information. In this section we will present the demonstration for the final result by considering one of the scenarios illustrated in section 5.5.2

Consider the scenario bellow

- *ABC entered his preference for "**burger**" before he leaves his home having in mind that he will have burger for his lunch. When the CAMM client reads for the preference item burger, it try to identify what burger means by consulting the domain ontology and try to find the related concepts to the item burger. Then CAMM client prepare a request send to the CAMM server to find restaurant market information near to the vicinity of the user. CAMM server then respond to the request by sending the information. Where CAMM client receive and notify ABC.*

As illustrated in the scenario, once the user receive the a notification for the new market information which is based on the user need, he can start the application and view the market information, search and settings respectively as it illustrated in figure 5.1

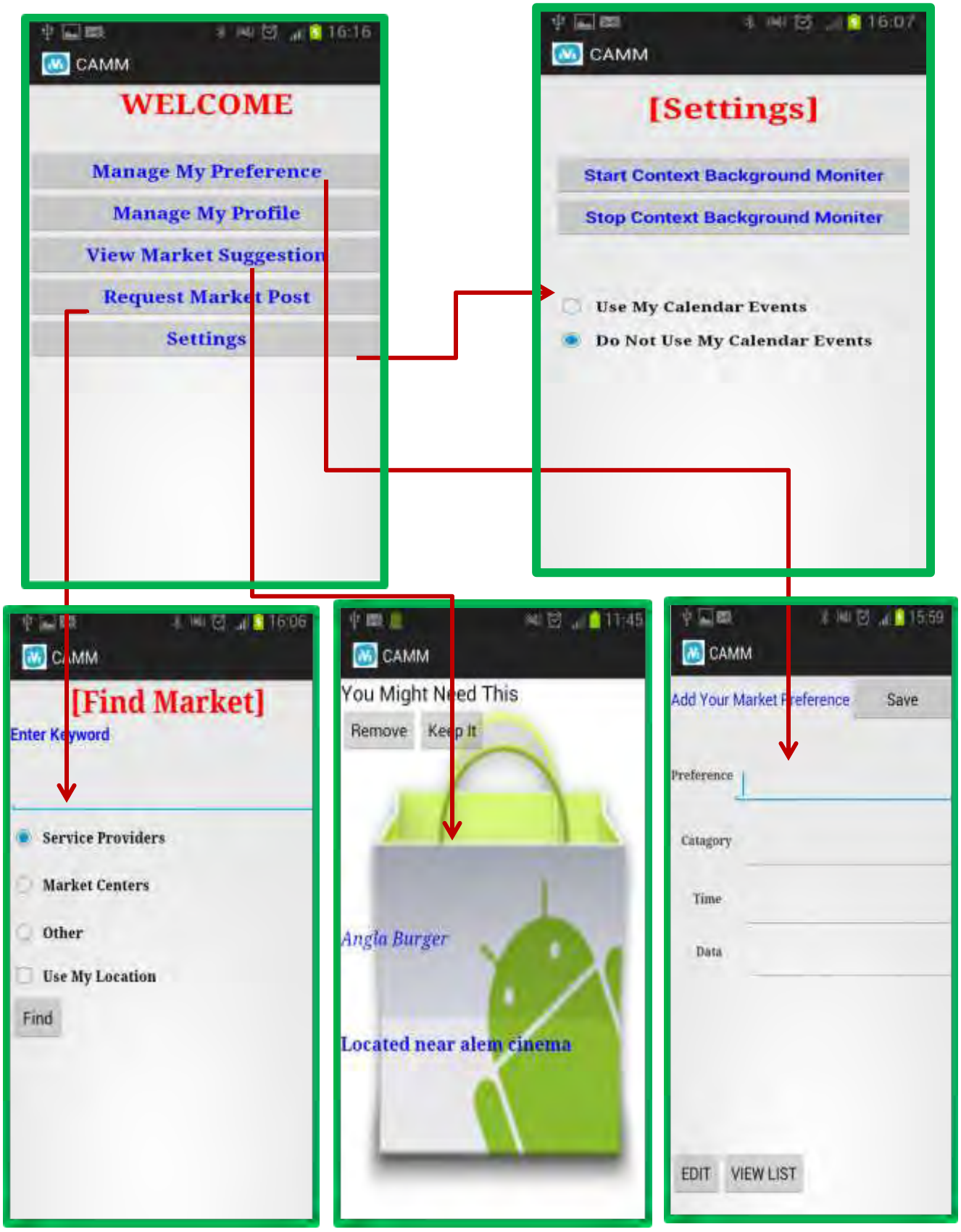

Figure 5.1: Main user interface of CAMM client and interaction flow

Chapter Six – Conclusion and Future Work

6.1. Conclusion and recommendations

The proposed architecture introduces a context aware mobile marketing that utilize user preference and context as a parameter. To address the problem of finding the appropriate market related entities, we design market ontology related user market preference.

Based on our ontology model, we created a context recognizer that utilizes user‘s explicit market need to infer appropriate market context. Inline with the task at hand, ontology based user market preference modeling is utilized as a mechanism to capture the preference at concept level. The ontology developed is utilized with in the mobile phone as part of the CAMM client.

The testes conducted with the prototype show that, our approach in utilizing ontology with in the mobile devices to create context aware application is an alternative to create personalized service with in a smart mobile phones environment.

During the process of the study we face some limitations during the implementation and as a result it also affects some of the test scenarios. The limitation we have faced include

- Lack of appropriate and flexible tool that can operate in the android environment in order to work on the ontology we design for the mobile based market preference modeling
- Lack of finding geospatial information for the GSM tower available and as a result we are forced to perform test using GPS data

Finally for future work we propose the following works that need additional investigation

- Implementation of this study in other smart mobile phones which operate in an environment different from android operating system
- Incorporate automatic construction of ontology suitable for android environment
- Dynamic ontology loading in order to consider multiple concept domain
- Utilize data mining algorithms over the logged user context with in the mobile environment to predict the user preference and update the model based on the result.

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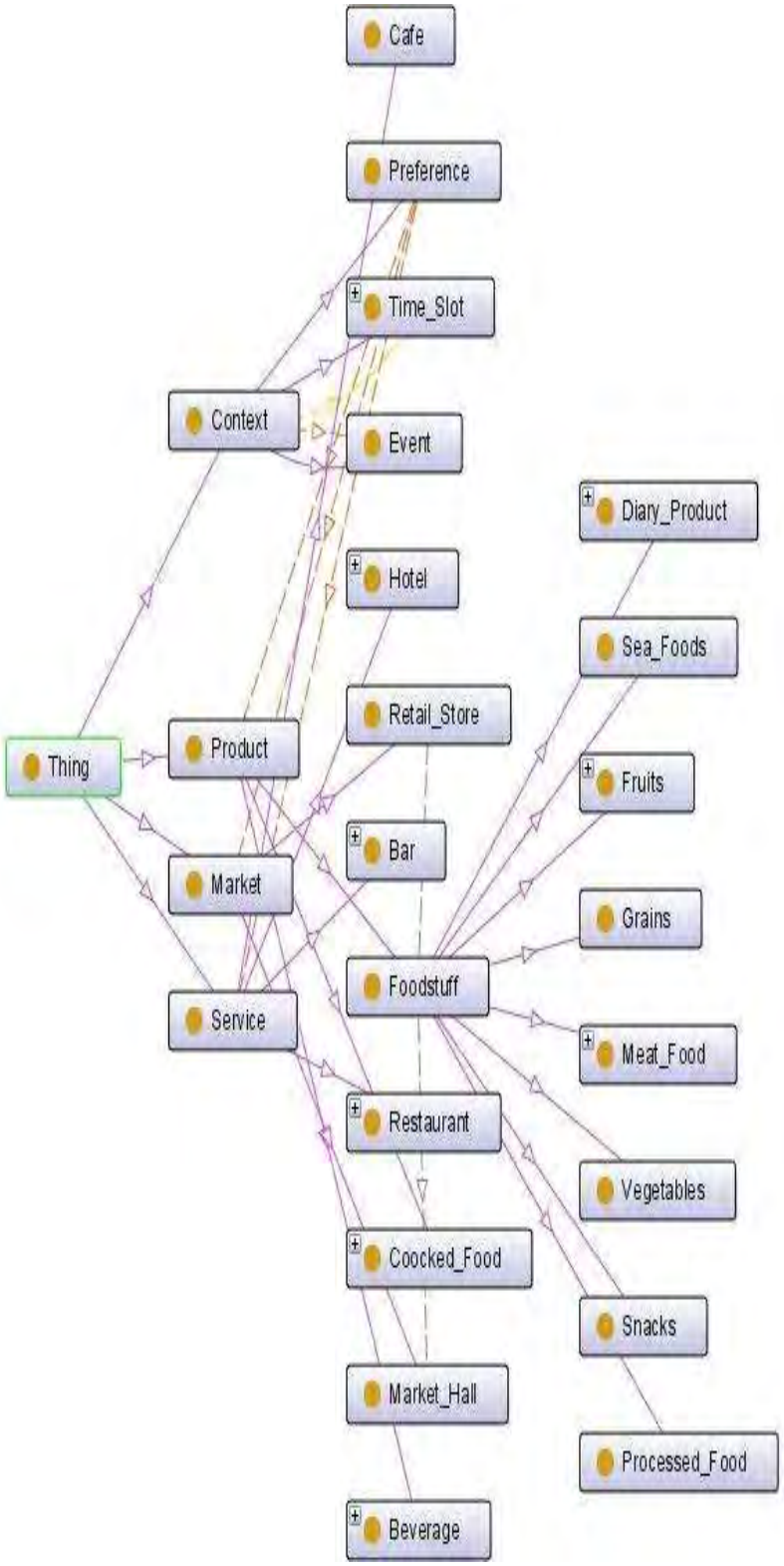
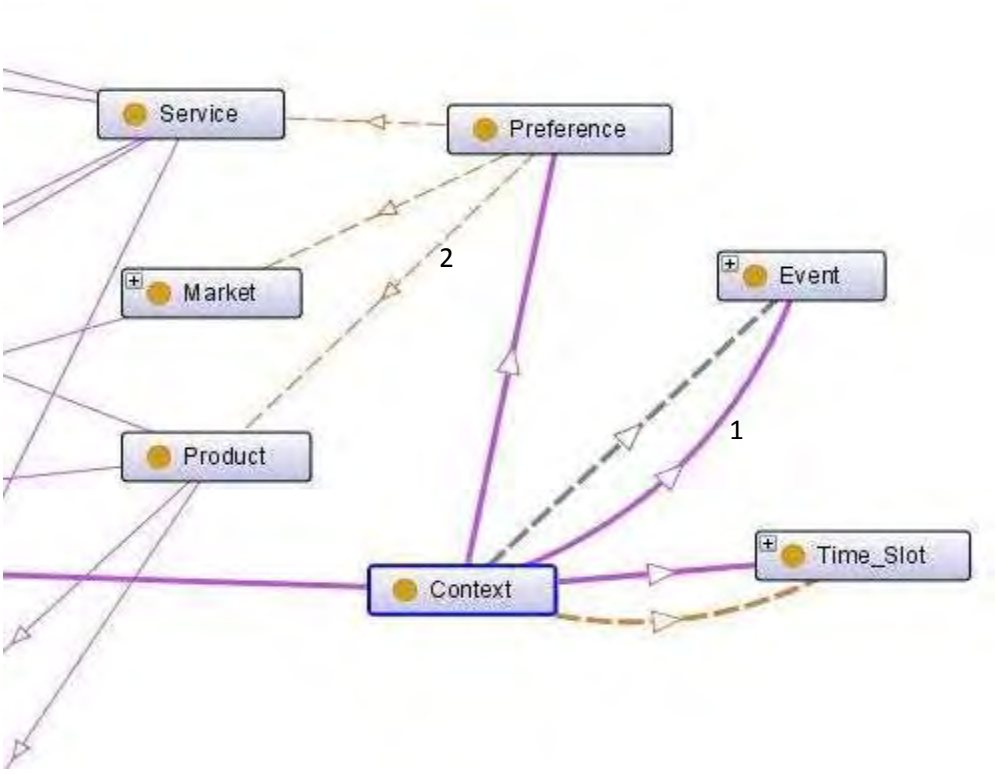
Annex

A. Ontograf generated by protégé owl



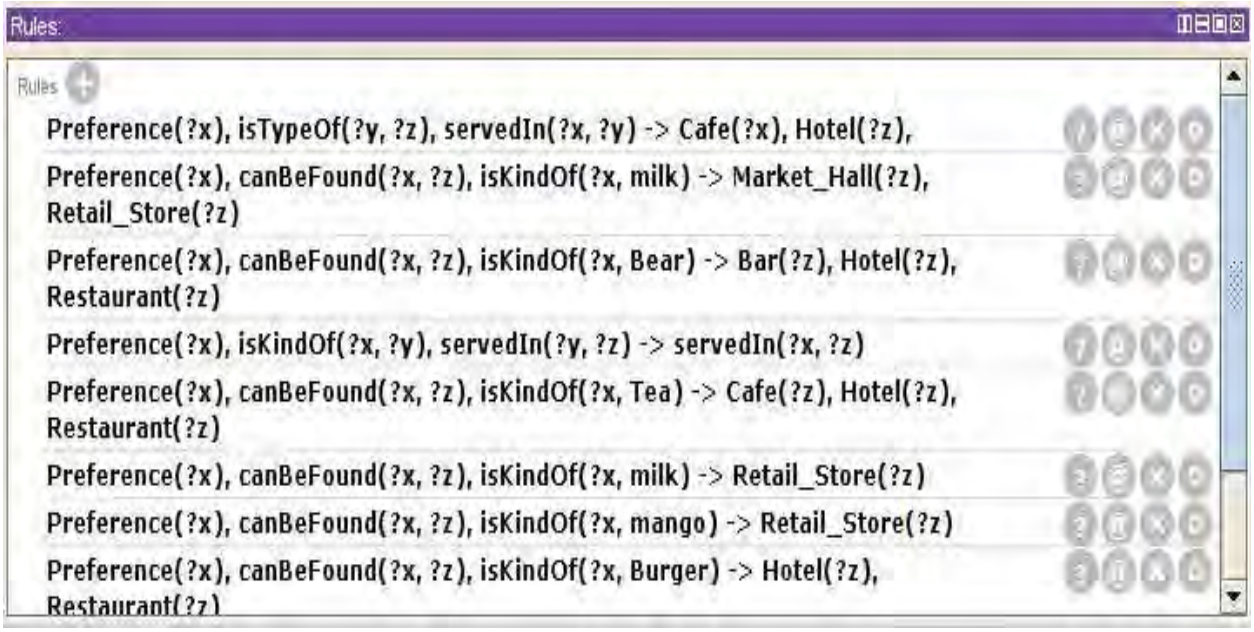
The figure in annex A, is an OntoGraf image generated by protégé OWL editor. OntoGraf gives support for interactively navigating the relationships of OWL ontologies. Various layouts are supported for automatically organizing the structure of ontology. Different relationships are supported: subclass, individual, domain/range object properties, and equivalence. Consider the section of the generated OntoGraf snippet figure bellow



As the figure illustrates, many type of axioms can be defined. Consider the labeled lines

Label	Meaning	Remark
1	Context -> has sub class -> Event	Use to describe sub class relationship
2	Preference -> canBe(Damon>Range)-> Product	Use to describe either data type property or object type property, where in this case it describes the object property

B. SWRL rules used in the ontology



C. Android code to perform marketig request from the mobile

```
public class RequestMarket extends Activity{
        private MyRequestReceiver receiver;
        EditText et;
        TextView outputValue;
        RadioGroup rg;
        CheckBox cb;
        Button find;
        @Override
        protected void onCreate(Bundle savedInstanceState) {
                // TODO Auto-generated method stub
                super.onCreate(savedInstanceState);
                setContentView(R.layout.request_market);

                outputValue = (TextView) findViewById(R.id.searchDisp);
                find=(Button) findViewById(R.id.Find);
                et=(EditText) findViewById(R.id.search);
                rg=(RadioGroup) findViewById(R.id.searchRadioGroup1);
                cb=(CheckBox) findViewById(R.id.LocationcheckBox1);

IntentFilter filter = new IntentFilter(MyRequestReceiver.PROCESS_RESPONSE);
      filter.addCategory(Intent.CATEGORY_DEFAULT);
      receiver = new MyRequestReceiver();
      registerReceiver(receiver, filter);

        find.setOnClickListener(new View.OnClickListener() {
                        @Override
                        public void onClick(View arg0) {
        getMarketInformation();
        hide the soft keyboard
InputMethodManager mgr = (InputMethodManager)
getSystemService(Context.INPUT_METHOD_SERVICE);
                 mgr.hideSoftInputFromWindow(et.getWindowToken(), 0);
                        }
                });
        }
```

```
        private void getMarketInformation() {
        String key = et.getText().toString();
        if(key.trim()==null){
       Toast toast = Toast.makeText(this, "Please enter Search Key!",
       Toast.LENGTH_SHORT);
           toast.setGravity(Gravity.TOP, 105, 50);
           toast.show();
        }
        else {
           Intent msgIntent = new Intent(this, JsonRequest.class);
           msgIntent.putExtra(JsonRequest.IN_MSG, "getMarketInfo");
           msgIntent.putExtra("idValue", key.trim());
           startService(msgIntent);
        }
     }

                //parse and display JSON response
    private void displayMarketInformation(String response){

       JSONObject responseObj = null;
       try {
          //create JSON object from JSON string
          responseObj = new JSONObject(response);
          //get the success property
          boolean success = responseObj.getBoolean("success");
          if(success){
             Gson gson = new Gson();
             //get the country information property
             String mktInfo = responseObj.getString("marketInfo");
             //create java object from the JSON object
             HostMarketInfo mrktinfo= gson.fromJson(mktInfo, HostMarketInfo.class);
             //set values from your country java object
             //Toast.makeText(this, mrktinfo.getHostName().toString(),
Toast.LENGTH_LONG).show();
```

```
            outputValue.setText("Search Resul:" + mrktinfo.getHostName().toString() + "   "  +
mrktinfo.getType().toString() + "  " + mrktinfo.getLocation().toString() + " " +
mrktinfo.getCity().toString());
            }
            else {

               outputValue.setText("not found");
            }

         } catch (JSONException e) {
            e.printStackTrace();
         }
      }
      //check if you have internet connection
      private boolean isNetworkAvailable(Context context) {
          ConnectivityManager connectivity = (ConnectivityManager)
          context.getSystemService(Context.CONNECTIVITY_SERVICE);
         if (connectivity != null) {
            NetworkInfo[] info = connectivity.getAllNetworkInfo();
            if (info != null) {
               for (int i = 0; i < info.length; i++) {
                  Log.w("INTERNET:",String.valueOf(i));
                  if (info[i].getState() == NetworkInfo.State.CONNECTED) {
                     Log.w("INTERNET:", "connected!");
                     return true;
                  }
               }
            }
         }
         return false;
      }
//broadcast receiver to receive messages sent from the JSON IntentService
public class MyRequestReceiver extends BroadcastReceiver{
public static final String PROCESS_RESPONSE =
"com.anteneh.cammclient.intent.action.PROCESS_RESPONSE";

         @Override
```

```
        public void onReceive(Context context, Intent intent) {
            String response = null;
            String responseType = intent.getStringExtra(JsonRequest.IN_MSG);
            if(responseType.trim().equalsIgnoreCase("getMarketInfo")){
                response = intent.getStringExtra(JsonRequest.OUT_MSG);
                 displayMarketInformation(response);
            }
            else if(responseType.trim().equalsIgnoreCase("getSomethingElse")){
                //you can choose to implement another transaction here
            }

        }
    }
}
```

D. Android class to Read and log user calendar event

```
public class CalendarService {

public static void readCalendar(Context context, int days, int hours) {

ContentResolver contentResolver = context.getContentResolver();

Cursor cursor = contentResolver.query(Uri.parse("content://com.android.calendar/events"),

                                        (new String[] { "calendar_id", "title", "description",
"dtstart", "dtend","eventTimezone", "eventLocation" }),null, null, null);

HashSet<String> calendarIds = getCalenderIds(cursor);

HashMap<String, List<CalendarEvent>> eventMap = new HashMap<String,
List<CalendarEvent>>();

for (String id : calendarIds) {

        Uri.Builder builder =
        Uri.parse("content://com.android.calendar/instances/when").buildUpon();

                long now = new Date().getTime();

        ContentUris.appendId(builder, now - (DateUtils.DAY_IN_MILLIS * days) -
        (DateUtils.HOUR_IN_MILLIS * hours));

        ContentUris.appendId(builder, now + (DateUtils.DAY_IN_MILLIS * days) +
        (DateUtils.HOUR_IN_MILLIS * hours));


        Cursor eventCursor = contentResolver.query(builder.build(),

                                new String[]  { "title", "begin", "end", "allDay"},
                                "Calendars._id=" + id,

                                null, "startDay ASC, startMinute ASC");
        if(eventCursor.getCount()>0)

        List<CalendarEvent> eventList = new ArrayList<CalendarEvent>();

     eventCursor.moveToFirst();

     CalendarEvent ce = loadEvent(eventCursor);

    eventList.add(ce);
```

```
while (eventCursor.moveToNext())
   {
    Toast.makeText(context, "inside loop", Toast.LENGTH_SHORT).show();
                                // Adds the object to the list of events
            ce = loadEvent(eventCursor);
            eventList.add(ce);
            Toast.makeText(context, "inside loop", Toast.LENGTH_SHORT).show();
                    Log.d("vales.....", ce.toString());
                    }
                       Collections.sort(eventList);
                       eventMap.put(id, eventList);
       System.out.println(eventMap.keySet().size() + " " + eventMap.values());
                    }
                    }
            }
            // Returns a new instance of the calendar object
            public static CalendarEvent loadEvent(Cursor csr) {
                    CalendarEvent calev = new CalendarEvent();
                    calev.setTitle(csr.getString(0).trim());
                    calev.setBegin(new Date(csr.getLong(1)));
                    calev.setEnd(new Date(csr.getLong(2)));
                    calev.setAllDay(!(csr.getString(3).equals("0")));
                    return calev;
            }
            // Creates the list of calendar ids and returns it in a set
            private static HashSet<String> getCalenderIds(Cursor cursor) {

                    HashSet<String> calendarIds = new HashSet<String>();
```

```
        try
    {
      if(cursor.getCount() > 0)
      {
        // Loop to set the id for all of the calendars
            while (cursor.moveToNext()) {

              long _id =cursor.getLong(0);//.getString(0);
              String displayName = cursor.getString(1);
              Boolean selected = !cursor.getString(2).equals("0");
             calendarIds.add(String.valueOf(_id));
             }
      }
    }
    catch(AssertionError ex)
    {
      ex.printStackTrace();
    }
    catch(Exception e)
    {
      e.printStackTrace();
    }
        return calendarIds;
  }
}
```

E . Mock GPS generator

```
public class MockGpsProviderActivity extends Activity implements
LocationListener  {
        public static final String LOG_TAG = "MockGpsProviderActivity";
        private static final String MOCK_GPS_PROVIDER_INDEX =
"GpsMockProviderIndex";
        private MockGpsProvider mMockGpsProviderTask = null;
        Random rand= new Random();
        private Integer mMockGpsProviderIndex = rand.nextInt(1000);
        @Override
        protected void onCreate(Bundle savedInstanceState) {
                super.onCreate(savedInstanceState);
                setContentView(R.layout.mock_gps_provider);
                /** Use saved instance state if necessary. */
      if(savedInstanceState instanceof Bundle) {
        /** Let's find out where we were. */
        mMockGpsProviderIndex =
savedInstanceState.getInt(MOCK_GPS_PROVIDER_INDEX, 0);

      }
      /** Setup GPS. */
      LocationManager locationManager = (LocationManager)
getSystemService(Context.LOCATION_SERVICE);
if(locationManager.isProviderEnabled(LocationManager.GPS_PROVIDER)){
        // use real GPS provider if enabled on the device
```

```
locationManager.requestLocationUpdates(LocationManager.GPS_PROVIDER
, 0, 0, this);
	}
	else
if(!locationManager.isProviderEnabled(MockGpsProvider.GPS_MOCK_PROV
IDER)) {
	  // otherwise enable the mock GPS provider

	  locationManager.addTestProvider(MockGpsProvider.GPS_MOCK_PRO
VIDER, false, false, false, false, true, false, false, 0, 5);

locationManager.setTestProviderEnabled(MockGpsProvider.GPS_MOCK_PR
OVIDER, true);
	}
if(locationManager.isProviderEnabled(MockGpsProvider.GPS_MOCK_PROVI
DER)) {

locationManager.requestLocationUpdates(MockGpsProvider.GPS_MOCK_P
ROVIDER, 0, 0, this);

	  /** Load mock GPS data from file and create mock GPS provider. */
	  try {
		// create a list of Strings that can dynamically grow
		List<String> data = new ArrayList<String>();
		InputStream is = getAssets().open("mock_gps_data.csv");
	  BufferedReader reader = new BufferedReader(new
	  InputStreamReader(is));
```

```
            // add each line in the file to the list
            String line = null;
            while ((line = reader.readLine()) != null) {
                  data.add(line);
            }
            reader.close();
            // convert to a simple array so we can pass it to the AsyncTask
            String[] coordinates = new String[data.size()];
            data.toArray(coordinates);

            // create new AsyncTask and pass the list of GPS coordinates
            mMockGpsProviderTask = new MockGpsProvider();
            mMockGpsProviderTask.execute(coordinates);
      }
      catch (Exception e) {}
   }
      }
      @Override
      protected void onDestroy() {
            // TODO Auto-generated method stub
            super.onDestroy();
            // stop the mock GPS provider by calling the 'cancel(true)'
method
      try {
            mMockGpsProviderTask.cancel(true);
            mMockGpsProviderTask = null;
      }
```

```
        catch (Exception e) {}

        // remove it from the location manager

        try {
LocationManager locationManager = (LocationManager)
getSystemService(Context.LOCATION_SERVICE);
locationManager.removeTestProvider(MockGpsProvider.GPS_MOCK_PROVI
DER);
        }
        catch (Exception e) {}
        }
        @Override
        protected void onSaveInstanceState(Bundle savedInstanceState) {
                // TODO Auto-generated method stub
                savedInstanceState.putInt(MOCK_GPS_PROVIDER_INDEX,
mMockGpsProviderIndex);
                super.onSaveInstanceState(savedInstanceState);
        }
        @Override
        public void onLocationChanged(Location location) {
                // TODO Auto-generated method stub
                TextView view = (TextView) findViewById(R.id.textView1);
                view.setText( "index:" + mMockGpsProviderIndex
                                + "\nlongitude:" + location.getLongitude()
                                + "\nlatitude:" + location.getLatitude()
                                + "\naltitude:" + location.getAltitude() );
```

```
	}
	@Override
	public void onProviderDisabled(String arg0) {
		// TODO Auto-generated method stub
	}
	@Override
	public void onProviderEnabled(String arg0) {
		// TODO Auto-generated method stub
	}
	@Override
	public void onStatusChanged(String arg0, int arg1, Bundle arg2) {
		// TODO Auto-generated method stub
	}

	/** Define a mock GPS provider as an asynchronous task of this
Activity. */
	private class MockGpsProvider extends AsyncTask<String, Integer,
Void> {
		public static final String LOG_TAG = "GpsMockProvider";
		public static final String GPS_MOCK_PROVIDER =
"GpsMockProvider";

		/** Keeps track of the currently processed coordinate. */
		public Integer index = 0;
		@Override
		protected Void doInBackground(String... data) {
			// process data
			for (String str : data) {
```

```
                        if(index < mMockGpsProviderIndex) {
                                index++;
                                continue;
                        }
                        publishProgress(index);

                        // retrieve data from the current line of text
                        Double latitude = null;
                        Double longitude = null;
                        Double altitude= null;
                        try {
                                String[] parts = str.split(",");
                                latitude = Double.valueOf(parts[0]);
                                longitude = Double.valueOf(parts[1]);
                                altitude = Double.valueOf(parts[2]);
                        }
        catch(NullPointerException e) { break; }            // no data available
                        catch(Exception e) { continue; }
                    Location location = new Location(GPS_MOCK_PROVIDER);
                        location.setLatitude(latitude);
                        location.setLongitude(longitude);
                        location.setAltitude(altitude);
                        location.setTime(System.currentTimeMillis());
                        Log.d(LOG_TAG, location.toString());
                        LocationManager locationManager =
(LocationManager) getSystemService(Context.LOCATION_SERVICE);
locationManager.setTestProviderLocation(GPS_MOCK_PROVIDER, location);
```

```
                        // sleep for a while before providing next location
                        try {
                                Thread.sleep(5000);
                                if(Thread.currentThread().isInterrupted())
                                        throw new InterruptedException("");
                        } catch (InterruptedException e) {
                                break;
                        }
                        index++;
                }
                return null;
        }
        @Override
        protected void onProgressUpdate(Integer... values) {
                // TODO Auto-generated method stub
                Log.d(LOG_TAG, "onProgressUpdate():"+values[0]);
                mMockGpsProviderIndex = values[0];
                //super.onProgressUpdate(values);
        }

    }
}
```

G. Sample location data for market and service centeres

latitude	longitude	place name	location	other info
9.005845	38.767705	Aberus Complex	Cherkos	
10.005845	39.767705	Adams Pavlien		
8.990713	38.783492	Angla Burger	Bole	Zimbabwe St,Addis Ababa,Ethiopia
9.015598	38.785041	DebreDamo Hotel	Haya Hulet	Haile Gebre Silase St.Addis Ababa,Ethiopia
9.004884	38.767063	Denbel City Center	Cherkos	Africa Ave,Addis Ababa,Ethiopia
8.997612	38.786738	ednamall	Bole	Cameron Street
8.98977	38.78618	Frendiship Buisness Center	Bole	
9.019339	38.816983	Holy City Center	Gurd Shola	
8.990305	38.725922	Lafto Mall	Mekanisa	Old Airport, Next to Bisrate Gebriel Church,S Africa St
9.015022	38.782173	Lex plaza	Haya Hulet	Haile Gebre Silase St.
8.996469	38.787661	Mafi City Mall	Bole	New Bright Tower,Cameron Street
9.037916	38.755272	Pizza Bell	Piazza	John Melly St,Addis Ababa, Ethiopia
9.036696	38.762695	Romina Restaurant and Café	Arat Kilo	King George VI Street, Addis Ababa, Ethiopia
9.01471	38.782897	Say Pastry	Haya Hulet	Haile Gebre Silase St.
9.001866	38.769142	Shewa Super Market	Bole	Bahar Bldg, Airport Rd
9.020553	38.800208	Zefmesh Grand Mall	Megenaya	Dispora Roundabout Kenenisa Ave
9.0271	38.76258	Lucy Restaurant	Amest kilo	National palace

H . survey item used for identifying user perception

Type I: questioner

The following questioner is prepared so as to identify the issues related to mobile marketing from consumer perspective.

1. Do you believe that a product should be promoted
   a. Yes b. no c. neither
2. Which type of promotion you prefer
   a. Traditional, using TV, Radio..
   b. New coming, using mobile or PDA
   c. Other
   _____
3. Have you ever receive a market/ product promotion through your mobile phone
   a. Yes b. no
4. Which one you receive
   a. SMS
   b. Other
5. What was your attitude towards mobile phone product promotions
   a) I found them useful
   b) I don‘t like them all
   c) Some of them are relevant for me
   d) All of them are irrelevant for me
6. What kind of marketing information you like to receive
   a) All kind
   b) Only a kind of information that I could probably use
7. Would you give marketers a permission to send you a marketing information of related to your interest/ preference
   a) Yes, any time I need to know that information
   b) Yes, but after I signaled request first
   c) No, I don‘t want
8. Would you give marketers a permission to send you a marketing information of which doesn‘t consider your interest/ preference
   a. Yes b. no
9. Have you ever bought a product that you get its promotion in your mobile phone
   a. Yes b. no
10. What do you prefer from marketers
    a. More choice in their information/ promotion
    b. Information/ promotion tailored to my choice

Type II: questioner

Give your attitude to the following question based on the scale provided. Put a tic mark for your answer

1 strongly agree
2 agree
3 neither
4 disagree
5 strongly disagree

	1	2	3	4	5
1. I did not like to recive marketing information or product promotion					
2. I like to receive marketing information/ product promotion					
3. I prefer, if I get marketing / product promotion through interface that allow me to browse through interactively					
4. I prefer, if I get marketing information through SMS					
5. I prefer if I get marketing information customized to my current location					
6. I prefer to ask for promotion of a given product first					
7. Mobiles can be used to deliver marketing information/ promotion					
8. traditional promotion method, such as TV, radio,…., are more effective methods than using mobile phone for promotion					

I . result of questioner collected to identify user perception

Collected data for questioner type 1

Measure	Source	Response
a product should be promoted	**100**	**71**
I like the idea of mobile promotion	**100**	**96**
I found mobile promotion useful if it consider my need	**100**	**86**
Some mobile promotion I receive are relevant	**100**	**81**
I like if mobile marketing of type personalized to my context	**100**	**86**
If personalized, I give permission to get market information any time	**100**	**83**
Questions for marketers		
Using mobile promotion is better from traditional	**30**	**27**
I like if I get customers that specifically need my service	**30**	**30**

Collected data for questioner type 2

	Strongly agree	Agree	Neither	Disagree	Strongly Disagre
I did not like to recive marketing information or product promotion	10	8	5	20	17
I like to receive marketing information/ product promotion	17	20	5	8	10
I prefer, if I get marketing / product promotion through interface that allow me to browse through interactively	35	17	8	0	0
I prefer, if I get marketing information through SMS	5	10	7	28	10
I prefer if I get marketing information customized to my current location	40	17	3	0	0
I prefer to ask for promotion of a given product first	30	14	14	2	0
Mobiles can be used to deliver marketing information/ promotion	30	20	10	8	2
traditional promotion method, such as TV, radio,…., are more effective methods than using mobile phone for promotion	0	7	11	23	19