An Open Platform for Context-aware Short Message Service

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An Open Platform for Context-aware
Short Message Service

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Abstract

Personalization has been recognized as an important feature of a successful m-commerce application and context-awareness is a promising approach to achieving it. The proposed platform reaches the mobile device users and bridges enterprise information systems with mobile network operators, aiming at supporting personalized short message service (SMS) in an open and generic way. Based on a rule repository and a rule matching engine, the service provider can offer personalized SMS according to customer’s contextual information (i.e. location and personal profile). Moreover, rather than a platform developed for a certain application only, it is used as the infrastructure of a short message broadcasting system and on the basis of which, customized systems for different commercial applications can be constructed.

Keywords

Short Message Service, Broadcasting, Context-aware, Mobile Commerce, personalization, collaborative filtering

Introduction and motivation

Mobile Commerce (m-commerce) has been witnessed a very high growth rate and is widely recognized to have an even bigger success in the near future. The short message service (SMS) is a mechanism of delivering short messages over the mobile networks (Gregory & Iftode, 2005). Besides the simplicity and fair compatibility, SMS doesn’t require the receiver to keep online, say, message can be stored and sent later, which result in the widely adoption of SMS and the booming of the market over the world - by 2012 global SMS revenues are expected to reach 67 billion USD (Jun Zhang et al., 2003; Report, 2007). The popularity of SMS makes it the most successful platform to support m-commerce and, such additional information services conveyed by SMS as news, entertainment, advertisement, coupon etc., boost the prosperity of m-commerce remarkably.
Basically there are two strategies to deliver short messages to the client, i.e., pull and push (Acharya et al., 1997). The pull approach is based on an “on demand” way to send information which requires clients to initiate requests explicitly. Thus from the view of the service provider; pull is a passive way of providing service, which unfortunately fails to deliver messages timely in many cases. Another strategy is push or, broadcasting. A broadcasting service delivers information to a client population according to a predefined broadcast schedule, without the receiving of any specific request. In a word, both of the two strategies are indispensable and furthermore, they are complementary to each other in terms of information delivery service. In such m-commerce applications as m-advertisement and m-coupon, however, broadcasting is actually a more common way because service providers tend to send information at the right time according to their business strategies. (Like SMS, some other emerging mobile message services such as the MMS, or Multimedia Messaging Service deliver information in the similar way, thus “SMS” indicates “any kinds of mobile message services” hereafter in this paper.)

In spite of the popularity of SMS, delivering short messages massively is not without its cost. Furthermore, short message sent at inappropriate time or place can even be regarded intrusive sometimes. Thus neither broadcasting short message to the whole population across the entire cellular network nor to random targets is preferred in most cases and, the deliberate selection of target receivers is absolutely necessary. This problem actually motivates the development of so-called personalization (Ho & Kwok, 2003). Personalization is a way of pushing information to the client in time but substantially constrains the population of receivers, aiming at delivering relevant content to the right people at the right time. Ho SY et. al (Ho & Kwok, 2003) and Varshney, U. et al (Varshney & Vetter, 2002) exhibit the empirical evidence that providing of personalized service is a key factor to the success of an m-commerce application.

Recent research on the “context-aware computing” has been widely recognized as a promising attempt to the enhancement of personalization, which accounts for user’s contextual information to determine his or her current statues (Bill et al., 1994; Schmidt et al., 1999; Stephen Shaoyi et al., 2004). A variety of context-aware frameworks are proposed and prototype systems are developed (Brown, 1996; Nitin & Schmandt, 1997; Schmidt et al., 1999). For most of current context-aware systems or frameworks, many types of contextual information are taken into account, such as position, velocity, temperature, humidity, noise level, heart beat rate and so on, however, there is still a long way to go before putting all those features into a real m-commerce scenario - it is still hard to imagine that a user is walking on the street, wearing a bunch of sensors and using his PDA to order a pizza in the meanwhile.

Apart from those systems, the platform proposed in this article has quite different design objectives:

1. This context-awareness-enabled platform aims at facilitating personalized SMS to support m-commerce. To make it practical, only two types of contextual information, location and user profile are incorporated at the current stage of the project. The former, which is normally regarded as the dynamic aspect of user context, is obtained via mobile positioning service (currently two telecommunication operators, say Sunday and Smartone offer the location positioning technology in Hong Kong). The latter including user’s demographic, personal preference, etc., which is relatively more static, is collected through customer surveys or previous rating records, or higher level knowledge generated by intelligent data analysis processes. These two kinds of information will be stored in a “user profile database” for identifying the “right” receivers.

2. Another design objective of the proposed platform is generality and openness. The proposed platform provides an interface to the existing information systems of the service provider (SP). The short message service can be triggered off once a specific condition is satisfied, which is specified by an SP itself according to some key business indicators from the existing information system. The trigger rules constructed by SRQL builder also include personalization constraints so as to determine target receivers and provide individually tailored service. (SRQL, Short message service Rule Query Language, is an SQL-like query language developed for this platform. SP can use the SRQL builder to construct customized rules so as to identify target subscriber based on user’s profile and location information.)

We organize this article as follows: the first section offers an introduction of the background in this area and introduces the motivation of this research. Section 2 provides a brief review of related works. Section 3 elaborates the overall system architecture and the functions of each component. In section 4, the prototype of an exemplar system will be demonstrated. Section 5 discusses the implication and future work.

Related Works

Context-aware system frameworks

The term context is defined as “Knowledge about the user’s and IT devices’ state, including surroundings, situation, to a less extent, location”(Anind et al., 2001; Bill et al., 1994) Contextual information can be position, velocity, temperature, humidity, noise level, and heart beat rate and so on.

Due to the potential of using context information, a variety of research projects (Anind et al., 2001; Brown, 1996; Nitin & Schmandt, 1997; Pascoe, 1997) have been carried out, aiming at creating supportive frameworks for context-aware applications. Among them the Context toolkit (Anind et al., 2001) by Georgia Tech is among the most representative which...
defines several software components to deal with different kinds of context. These works discuss context-awareness from the perspective of software architectures, strategies and principles. In contrast, we place the focus of this article on the implementation of a context-aware framework in order to support real world m-commerce application. This paper introduces the concrete implementation of a location-dependent short message broadcasting system, which is an example demonstrating how to apply contextual information to enhance the personalization of mobile service.

**Mobile Advertising Service and Location-based Services**

A line of research papers (A. Ranganathan & Campbell, 2002; Hassim Mohamed Yunos et al., 2003; Ngai & Gunasekaran, 2005) review recent progress on wireless advertising and advertising in ubiquitous environment. Some of the important issues as well as such challenges involved in this area as ads delivery approach, revenue collection, privacy and security, are proposed and discussed, providing a vision to the related research issues regarding mobile advertising. The Location-Based Service (LBS), which is defined as “services that integrate a mobile device’s location or position with other information so as to provide added value to a user (Schiller & Voisard, 2004)”, has been studied extensively from different perspectives. For example, Choi proposed a ubiquitous GPS-Web-enabled mobile search mechanism, in which fuzzy query technique is incorporated (Choi, 2005). Data management issues, value-added services and business implication are extensively discussed and applications are introduced (Easton, 2002; Jochen & Voisard, 2004).

Some of the representative existing systems that support location-dependent mobile advertising service are introduced as follows:

The SmartRotuaari (Ojala et al., 2003) service suggests that different functional context-aware mobile multimedia services in real end-user environment and provides a functional research framework for prototyping and empirical evaluation of context-aware mobile multimedia services, customer behavior and business models in real end user environment. The B-MAD (Aalto L et al., 2004)) is an implementation of a location-aware mobile advertising system, which is based on Bluetooth positioning and WAP Push. Empirical evaluation of the system is also provided.

The Vindigo System (vindigo, 2007) provides several different location-based services to PDA users. It delivers media content including news, local information, restaurants, movies, travel, restaurants, etc. It facilitates subscribers learn about movie to be shown, ATMs and parking lots nearby, etc. Similarly, the other two well-known systems AvantGo (avantgo, 2007) and Avesair (Avesair, 2006) strive to offer special “channels” on subscribers’ PDA or smartphone: news, weather, sports, stock quotes, maps, movie listings, and so on. In addition, the Mobile Bristol project investigates how mobile devices and pervasive information technology can be used to enhance the ways in which residents and visitors experience and interact with their surroundings.

To summarize, the major innovation of the proposed platform is two-fold. First, instead of a conceptual framework proposed from the perspective of software architecture and on the basis of which, system analysis and design process are still needed, the platform can be regarded as a concrete implementation of a personalization-enabled, location-dependent system. The system can be put into commercial use once the “connector” and “rule repository” are specified and the customer profile database is ready. Besides, it has the characteristics of openness and generality. Rather than those developed specifically for a certain business, it is proposed in a generic way and can work with the existing MIS, and based on context rules and matching engine, an enterprise is able to customize its own short message broadcasting service according to various business requirement as well as customer’s contextual information. On the other hand, existing collaborative filtering approaches (B.P.S. Murthi & Sarkar, 2003; Marko Balabanovic & Shoham, 1997; Raghu et al., 2001) which are developed and widely used in nowadays’ personalized web can also be seamlessly incorporated in the current framework.

It’s worth noting that research by Figge et.al. also introduces the concept of “contextualized personalization (in which it is called situation based profiling). (Figge 2003) proposes the business model of situation based profiling and (Figge 2005) discusses it from the technical perspective. Although the idea of “situation based profiling” presented in these two papers is similar to “contextualized personalization“, the main idea proposed in this article, they actually have different focuses. (Figge 2005) elaborates how to use Semantic Web and other IT standards to model and presents the problem of providing personalized mobile service, while this paper demonstrates the design of a concrete prototype system, in which a triggering mechanism allows service providers to combine both business requirements and user’s context to generate tailor-made mobile services to mobile customers.

**System Architecture**

In this section the processes of providing broadcasting SMS will be introduced, followed by the elaboration of each part of the platform.
The process of broadcasting SMS

Figure 1 presents the overall architecture to provide broadcasting SMS, which consists of four major parts, i.e., the service provider, the proposed framework, the network operator, and the mobile user respectively from top to down. The descriptions of them are listed in table 1.

Table 1. Description of 4 parts in the architecture
The procedure of providing SMS is as follows:
Mobile client may subscribe for the SMS from the service provider. For example, a movie theater can provide m-coupon service to subscribers in order to attract more customers go into the theater and thus decrease the vacancy rate. When a customer subscribes the service, s/he is asked to complete a questionnaire (can be on-line) so that the customer’s demographic data, preferred service type (e.g. ticket discount, free snack, etc.), preferred time to receive short message, personal hobbies, etc., can be gathered as the information for personalization use, which will be stored in the “user profile database”. User profile can be information primitively collected from customers or even higher level knowledge derived by a range of collaborative filtering algorithms (B.P.S. Murthi & Sarkar, 2003; Marko Balabanovic & Shoham, 1997; Raghu et al., 2001) which have been widely adopted in various recommendation systems.
On the other hand, the movie theater (or, service provider) uses the Rules Builder to create and maintain trigger rules, which defines when to invoke a piece of SMS request and who the target receiver will be. The former condition is composed on the basis of a number of key business indicators/critical values, i.e., the vacancy rate for a theater or stock turnover rate for a vendor, and so forth. The latter condition is composed according to the user profile as well as mobile clients’ location. These conditions can be regarded as a filter constraining target receivers so that services can be more specific to different segmentations of customer.
Once the conditions in a trigger rule is satisfied, the platform then identifies the target subscriber set and passes it to the network operator to perform broadcasting task on that tailored target subscriber set.
Finally, when a mobile client receives the message, s/he may reply a confirming message, access a certain WAP site, or do any other operations according to the instruction from the received message to complete the whole transaction.

**Components of the Framework**

- **Connector**

  *Input: Indicators from the enterprise information system*
  *Output: Indicators to the rule matching engine*
Indicators are data values in the enterprise information systems reflecting the current statues of the enterprise operation. For example the vacancy portion of a movie show could be an indicator in terms of a theater, which can be used as a referential value of launching an m-coupon promotion or not. The Connector, which works as an interface between the platform and the existing information systems of the enterprise, collects the values of a number of designated indicators and passes to the matching engine. The matching engine is in charge of making decisions by comparing the values of indicators with predefined “rules”.

To be coupled in the existing information systems, the connector needs to be implemented specifically according to the operation of an enterprise, where how these indicators can be extracted from the existing information systems and delivered to the next module need to be specified.

- Customer profile database

**Input:** Customer profile collected from each subscriber via questionnaire  
**Output:** Customer profile information to the broadcast generator

This component stores the profile of each subscriber (the “profile context”). There are basically three types of information sources can be used to profile a customer. 1) Demographic information (gender, age, nationality, etc.), preferred message types (e.g. coupon, ad., forenotice of the new fashion style, etc.), preferred time to receive messages, preferred discount rate to receive messages and so on. 2) Descriptive statistics results or facts that extracted from customer’s transaction data, such as the average purchase amount per transaction 3) On the basis of 1 and 2, higher level knowledge (e.g. structures and patterns) generated by employing recommendation approaches which have been extensively studied in the area of “recommendation systems”. All these information sources are literally preference/demographic related which provide a long-term and relatively stable description regarding the customer. The Broadcast Request Generator retrieves customer profile from this repository in order to identify the target receiver of the message.

- Rule building components

Two kinds of user’s contextual information are introduced into the platform, say, geographic position and customer profile to identify the target user set. We introduce two concepts to present the process of obtaining the final target set, i.e, the Basic Set Operations and Scoring Approach. The Basic Set Operations is an intuitive approach to limit the receiver population to a target set. The scoring approach uses weighted score to balance the location context and profile context. The process is formulized in the following paragraphs.

**Definition 1**
Suppose $S$ is the set of all registered subscribers of the service, called the population. $P = \{p_1, p_2, ..., p_m\}$ is the set of all profile items (for instance, $p_i$ can be the item “preferred message type”).

**Definition 2**
Suppose $2^S$ is the power set of $S$. A profile constraint is a mapping from $S$ to $2^S$, denoted as $pro_i : \{S\} \rightarrow 2^S, 1 \leq i \leq m$. In another word, each profile item is corresponding to a profile constraint, which maps the population $S$ to its subset. For example, $pro_i(S)$ can be a filter that constraints the age of target receivers to be “18 or above”.

**Definition 3**
A spatial constraint specifies the subset of the entire population which satisfies a certain geographic location condition that needs to deliver message, it is a mapping from $\{S\}$ to $2^S$, denoted as $spt : \{S\} \rightarrow 2^S$.

**Definition 4**
In terms of Basic Set Operations, the target receiver set $TR$ is the intersection of all profile constraint mapping and spatial constraint mapping on $S$, which can be represented as:

$$TR = spt(S) \cap \left( \bigcap_{i=1}^{m} pro_i(S) \right)$$

**Definition 5**
Suppose \( S = \{s_1, s_2, \ldots, s_N\} \) is the set of all registered subscribers. Let \( \text{score}_p \) be the profile scoring function on \( s_i \) for any \( i \in [1, N] \), which ranks the possibility of \( s_i \) ’s adopting a certain kind of service according to his/her profile. Let \( \text{score}_s \) be the spatial scoring function on the position of \( s_i \).

In terms of scoring approach, the target receiver set is defined as:

\[
TR = \left\{ s_i \mid w_p \cdot \text{score}_p(s_i) + w_s \cdot \text{score}_s(s_i) \geq \theta \right\}
\]

Let \( w_p \) be the weight on profile function and \( w_s \) be the spatial function. Suppose \( \theta \) is a predefined threshold. Thus the target receiver set is the population of subscribers whose score is no less than a given threshold.

Above processes are implemented by SRQL, which is an SQL-like language we developed for this framework. It allows to create any combination of spatial constraint and profile constraint. The SRQL also includes information about when to invoke the service request and what the broadcasting order is. The detailed definition of SRQL based on Backus normal form is given in the appendix of this paper. For brevity, only the first section of the definition is provided in below (table 2).

**Table 2. Process of rule matching**

<table>
<thead>
<tr>
<th>Rule statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATE RULE &lt;rule name&gt;</td>
<td>Creates a rule with the specified name</td>
</tr>
<tr>
<td>ON [TOP n] &lt;constraints clause&gt;</td>
<td>Specifies a constraint on the top n subscribers</td>
</tr>
<tr>
<td>WHEN &lt;trigger condition clause&gt;</td>
<td>Specifies the condition that triggers the rule</td>
</tr>
<tr>
<td>ORDER BY &lt;broadcasting order clause&gt;</td>
<td>Specifies the order of broadcasting messages</td>
</tr>
</tbody>
</table>

As is shown in the script in appendix section, “spatial constraints clause” and “profile clause” define the spatial constraints and profile constraint respectively. The “trigger condition clause” defines the condition that triggers the rule based on the indicators from the connector component. The “broadcast sequence clause” defines the order of broadcasting messages to different clients in the target receiver set (i.e. the probability of adopting the m-advertisement, the current distance from the shop, etc.)

Once a rule is composed, it will be analyzed by the rule parser and stored in the rules repository. By specifying its own trigger rules, the service provider is allowed to choose the right time and right customers to push message.

Worth notice is that there has been a great deal of work in the research area of geoinformatics and computational geometry for efficiently resolving location based queries (Jun, Manli et al. 2003; Wei-Shinn, Roger et al. 2005). Thus the definition of spatial constraint can utilize the results of a location based query which is capable of determining the result subset efficiently. On the other hand, the aforementioned spatial constraint mapping only accounts for the geographic coordinates and distance. As a matter of fact, a more powerful approach to exploit positional information is to employ spatial ontology. Ontology is defined as “machine-readable vocabulary that is specified with enough precision to allow differing terms to be precisely related (Eduardo and Illarramendi 2001)” and has been proved as an effective solution of intelligent software development. Ontologies with well defined spatial semantics facilitate intelligent system to reason about spatial contextual information and, can enrich the informativeness of a spatial constraint. For example, on the basis of spatial ontology, the system is able to acquire the knowledge that a certain area usually is currently in crowded traffic condition, thus to perform corresponding reasoning process to make the right decision.

Privacy issues will be caused when tracking user’s position, therefore the service provider needs to obtain user’s consent when s/he is subscribing the service. Another solution is, as suggested by (Figge 2003), to make the subscribers’ position data maintained by an arbitrary third party. However, privacy is out of the scope of this paper and interested readers can refer to many other researches.
The role of the matching engine is monitoring the updates of critical values and comparing them with the stored rules. Once a rule is found matched, the engine will send it to the Broadcast Request Generator.

Suppose \( R = \{r_1, r_2, \ldots, r_p\} \) is the set of all rules and \( \text{IND} = \{\text{ind}_1, \text{ind}_2, \ldots, \text{ind}_q\} \) is the set of indicators, the matching process can be described in table 3:

### Table 3. Process of rule matching

```
WHILE TRUE
    FOR EACH \( r_i \in R, \ 1 \leq i \leq p \)
        IF \( r_i.\text{TriggerCondition}(\text{ind}_1, \ldots, \text{ind}_q) \) THEN
            PUSH \( r_i \) to the Generator
        END IF
    END FOR
END WHILE
```

- **Broadcast request generator**

Based on the rule delivered from the matching engine, the request generator retrieves the customer profile database to identify those subscribers who satisfy the profile constraint. Subsequently their location information will be requested from the Location Service, and which will be used to identify the target subscriber set that satisfies both profile constraint and the spatial constraint. Once the final target set is determined, it will be passed to the SMS providers, specifying the subscribers who need to be delivered short message service. The processes of generating broadcasting request are described in table 4 (Basic Set Operation).

### Table 4. Processes of request generating

```
// Identify subscribers that satisfy the profile constraint
\( TR' = \bigcap_{i=1}^{m} \text{proj}_i(S) \)

FOR EACH \( s \in TR' \), request the location information of \( s \)

// Apply the spatial constraint
\( TR = \text{spt}(TR') \)

Send TR to the SMS provider, request for short message service.
```

**A Sample applications - The m-Cinema Short Message Service**

Based on the proposed platform, we build up the “m-Cinema” which is a sample application aiming at simulating the process of offering mobile service in the scenario of a movie theater. The prototype of the platform (GOSMP, Generic and Open Short Message Platform) implements the kernel parts – Rule builder and matching engine. Artificial Neural Network is employed as the profile filter module \( \text{proj}(\cdot) \) by employing a commercial mining module “Forecaster XL” (Alyuda 2006).

The design objective of the m-Cinema is to deliver personalized m-coupons to subscribers in order to attract users and provide additional value-added service. For example, the m-Cinema can send a piece of m-coupon to a subscriber and the subscriber can redeem in the cinema to get discount on buying tickets, foods, beverages, etc.
The advantage of m-coupons service is immediate. The m-coupon providers can push a piece of m-coupon at the speed of sending an SMS (usually within seconds) directly to the consumer’s mobile phone. The time of delivery is precisely controlled by the SP on demand. The “push” nature of the SMS makes it possible to broadcast m-coupon to a huge amount of subscribers. Additionally, the m-Cinema can define the rules so as to broadcast m-coupons automatically rather than deliver in a manual way.

![Fig. 2 The questionnaire to collect customer’s preference](image)

At the beginning, customers need to subscribe to the service by completing an online application as well as a questionnaire so that demographic and personal preference can be collected (fig. 2). On the other hand, we implement the Rules Builder, which is an interactive toolkit facilitate the creating of trigger rules on a graphical interfaces. A sample rule here can be “if the show will be on in 30 minutes, the movie type is carton, and the vacancy rate is over 50%, send m-coupons to offer a 50% discount on ticket and snacks to those subscribers who prefer carton movies and are within the area of 2km from the theater”. The rule presented by the SRQL is shown on fig. 3.
The Rules Matching Engine monitors the change of the values of key indicators (in this case they are film_type and vacancy) to identify rules that satisfy the trigger condition. Once a trigger rule is matched, it will be sent to the Request Generator, which generates target subscribers who satisfy both the spatial constraint and profile constraint. A sample short message can be:

Dear Mr. Johnson,
You've been chosen to receive a 50% discount off for the movie “The Lion King” which will be showed at 8:15 pm tonight. If you are the first 90 customers replying this message, you will save HK$35 for the ticket.

Once a subscriber receives the m-coupons (figure 4), he can simply reply to confirm so that the SP (the cinema) is able to estimate the total number of subscribers that will redeem the m-coupon. If the m-coupon is acknowledged, the subscriber’s attendance status will be considered in the future as a profile factor to determine whether the m-coupon will be sent or not.
Conclusion and Future work

In this paper, we demonstrate the design of a framework to provide personalized SMS. Two types of contextual information, location and user profile are adopted to tailor the population of the message receivers. The former reflects the dynamic aspect of a customer and the latter accounts for customers’ demographic, preference, etc. In spite of the variety of the business needs in different trades, the framework can be customized by implementing the “connector” component and rewriting trigger rules. It is worth noting that even if we are able to incorporate “enough” context information into the system, it is still extremely difficult to model customer’s activities because of the inherent randomness of human’s behavior. Instead of being aware of what the customer is exactly doing, the proposed framework adds dynamic context feature (location) to the traditional recommendation systems which are usually only based on the demographic and historical rating records. The purpose is to provide more tailor-made services to mobile customers based on the existing recommendation mechanism. The proposed platform is opened to the incorporating of any new kind of contextual information which might be available to a real business application in the future. Therefore it has the characteristics of openness and generality. When implementing prototype system GOSMP, we only adopt the rules based approach to identify target receivers. However, as motioned previously, the spatial ontology (for location information) and intelligent collaborative filtering algorithms (for user profile), can support more sophisticated and intelligent business decision. Thus for future research, we plan to provide the spatial ontology for the Kowloon Tong area in Hong Kong as an experimental system. Besides, some other customer segmentation algorithms (e.g. Bayesian Classifier, C5.0) will also be implemented and incorporated into the system in order to provide more alternatives when profiling subscribers.

References


Appendix

The Backus normal form of SRQL (Short Message Service Rule Query Language)

```plaintext
<Rule statement> ::= CREATE RULE <rule name> ON [TOP n] < constraints clause> WHEN <trigger condition clause> ORDER BY <broadcasting order clause>

<constraints clause> ::= _SCORE <comparison operator> <score threshold>
// _SCORE is defined by the linear combination of different scoring factors incorporating the score of spatial context and a number of profile context
/< score threshold > is a constant value

<constraints clause> ::= <spatial constraints clause> AND <profile clause>

<spatial constraints clause> ::= 
```

-13-
|<spatial predicate> ::= |
|<spatial predicate> OR <spatial predicate> |
|<spatial predicate> AND <spatial predicate> |
|(<spatial constraints clause>) |
|NOT < spatial constraints clause> |

|<spatial predicate> ::= |
|<spatial variable> <comparison operator> <spatial constant> |

|<comparison operator> ::= |
| = | < | > | <= | >= | <> |

|<spatial constant> is a constant value of location, i.e., +23.676 or -35.261 or 2,000m, etc.|

//A spatial variable is a geographic feature of a client such as longitude, latitude, distance and the query can be implemented by the existing location-based query techniques.

// A spatial variable can also be the variables described by the spatial ontology.

|< profile clause> ::= |
|< profile predicate> |
|< profile predicate> OR < profile predicate> |
|< profile predicate> AND < profile predicate> |
|(<profile clause>) |
|NOT < profile clause> |

|< profile predicate> ::= |
|< profile expression> <comparison operator> < profile expression> |

// profile expression indicates an expression of a certain profile item, i.e., age, gender, hobby, etc. It can also be the probability that a certain client accepts the m-advertisement, which is predicted by any employed algorithm.

|<trigger condition clause> ::= |
|<trigger condition predicate> |
|<trigger condition predicate> OR <trigger condition predicate> |
|<trigger condition predicate> AND <trigger condition predicate> |
|(<trigger condition clause>) |
|NOT <trigger condition clause> |

|<trigger condition predicate> ::= |
|<trigger condition expression> <comparison operator> <trigger condition expression> |

|<trigger condition expression> ::= |
|<indicator expression> | <temporal expression> |

// indicator expression is the expression involving variables of which values are collected from the existing information systems

//temporal expression is the expression about date, time or day of week, say day_of_week = “Sat”.

|<broadcasting order clause> ::= |
|<order specification> [{},{…}] |

|<order specification> ::= |
|<spatial variable> [ASC|DESC] |
|<personalization expression> [ASC|DESC] |

//the order clause is used to indicate the delivery sequence of the message and doesn’t rely on whether the receiver replied or not.