MOBILE MARKETING USING A LOCATION BASED SERVICE

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ABSTRACT

Considering the recent convergence of computing and telecommunications technologies with the tremendous success of the Internet, the World Wide Web, and Mobile Communications, the next step is expected to be the Mobile Web. The main promise of the Mobile Web is to satisfy user needs for anywhere, anytime access to information and services, including Location Based Services (LBS). This paper presents an innovative LBS service applicable to the Mobile Marketing industry sector. We describe the architecture of the information system supporting the proposed service and a software prototype we implemented using a simulation environment for providing location information. The technologies adopted for this design are based on open standards and have successfully met the requirements of scalability and autonomy.

Keywords: Mobile Advertising, Location Based Services, System Implementation

1. INTRODUCTION

Advances in wireless communications and information technology have made the Mobile Web a reality. The Mobile Web is the response to the need for anytime, anywhere access to information and services. Many wireless applications have already been deployed and are available to customers via their mobile phones and wirelessly connected PDAs. However, it seems that everyone is still looking for the "killer" wireless application. One such direction points to Location Based Services, which we discuss below.

The remainder of this paper is organised as follows. In the second section we provide basic definitions associated with Location Based Services (LBS), we describe the evolution path of such services and provide a brief market analysis. In the third section we present our motivation for examining such services and we give an overview of our proposed service for the mobile marketing sector. In the fourth section the technical aspects of the system which supports the proposed service are presented in detail. In the fifth section an agent to assist the user in the best super market store selection is described. Finally, in the sixth section we provide our conclusions.

2. BASIC DEFINITIONS & MARKET ANALYSIS

Location Based Services are services, which are enhanced with and depend on information about a mobile station's position. This kind of information has no meaning if it is presented as is. It has to be correlated with some types of services. Location Based Services take up the role to supply the user of these services with customised information according to his/her position.

In 2000 Gravitate Inc. has published a white paper which (correctly to our opinion) identifies three evolution steps for Location Based Services [3]. The first generation refers to services where the subscriber has to manually give his position information to the system. The second generation (existing services) refers to location services where the position of the subscriber is automatically discovered but with little accuracy. Finally, the third generation refers to services where the position of the subscriber is automatically discovered with accuracy and which have the intelligence to inform or warn the subscriber about events depending on his position (the subscriber doesn't have to initiate the service, the initiation depends on triggers according to his/her preferences).

2.1 Categories of Location Based Services

The GSM Alliance Services Working Group [11] has defined the following types of Location Based Services:

- Emergency Services
- Emergency Alert Services
- Home-Zone Billing
- Fleet Management
- Asset Management
- Person Tracking
- Pet Tracking
- Traffic Congestion Reporting
- Routing to Nearest Commercial Enterprise
- Roadside Assistance
- Navigation
- City Sightseeing
- Localised Advertising
- Mobile Yellow Pages
- Network Planning
- Dynamic Network Control

2.2 Driving Forces for LBS

Market Forces

Recent market researches (e.g. [12]) showed that consumers in Europe are ready and willing to pay for Location Based Services. Some indicative findings say that mobile subscribers would consider even changing mobile phone operator in order to gain access to location based services and pay up to 16 Euros as a monthly fee for these services. In the U.S mobile subscribes would pay as much as 50 Dollars to have GPS or other location technology built into a cellular phone, according to similar market research [9]. Some critical success factors for the adoption of LBS, as identified by these researches, seem to be the following:

- Protection of mobile user privacy
- Easiness of usage
- Non-intrusive way of LBS operation

Competition forces

Having established large customer bases, Cellular Service Providers will seek new ways to ensure customer loyalty by offering new types of services. Location Based Services are the most promising type of theses services, also called value added services. Some of the advantages for the Cellular Service Provider who offers Location Based Services are:

- Innovative service provision attracts new customers and enhances existing customer's loyalty to the provider.
- Revenue increase due to traffic generated by the use of such services.
- Capability to introduce new revenue streams through deals with third party companies (which specialise in LBS implementation and/or provision), in order to sell to these companies user location information.

Technology forces
The first location based services are expected or are already offered to mobile phone users via WAP or SMS. Every GSM mobile phone supports the SMS feature and there are many that also support WAP. The cost for a WAP enabled phone is under $80. This means that many customers can instantly make use of the location services provided. In addition the evolution from GSM to GPRS, which means a significant increase in the available bandwidth for data communication over mobile phones (from 9.6Kbps to 115Kbps) will also assist the provision of location based services that in many cases can be bandwidth demanding. Finally new type of phones such as media phones and communicators are slowly entering the market giving greater capabilities for displaying information (e.g. user interfaces enhanced with photos, buttons and not only text).

Regulatory forces
In USA the Federal Communications Commission has issued a directive requiring the identification of the geographical origin of an emergency call made by a mobile phone user. According to this directive, operators should be able to provide location information for every mobile subscriber, who makes an emergency call, with accuracy of 125 meters for 67% of the time [8]. The European Union is expected to produce a similar directive by the end of 2002.

3. MOTIVATION AND SERVICE OVERVIEW

3.1 Mobile Advertising

The proposed service belongs to the mobile advertising category. This category of LBS involves the provision of location aware advertising messages to cellular subscribers. Mobile advertising can be considered as a part of mobile commerce. It is an integral part of mobile marketing.

Mobile marketing can be described as all the activities required to communicate with the customer through the use of mobile devices in order to promote the selling of products or services and the provision of information about these products and services [10]. There are many optimistic predictions about what we can expect in the future from mobile marketing. Some of these predictions are the following [10]:

- From 2003 to 2005, analysts predict that mobile marketing as an industry sector will grow from 4 billion dollars to 16 billion dollars, serving over 500 million users world-wide (Chart 1, Source: Ovum Research Ltd.).
- Location aware advertising messages are expected to create 5 to 10 times higher click-through rates compared to Internet advertising messages. (Source: BWCS Consulting and Communications Services Inc.)
- By 2005 the 33% of a Cellular Service Provider's revenue will be coming from advertising and from payments and commissions from mobile commerce activities.(Source: BWCS Consulting and Communications Services Inc.)

Considering all these predictions as well as the history of advertising in other mediums like television and Internet, it would be quite realistic to say that advertising is going to play a significant role in the mobile web too. With the help of Location Based Services advertising companies can now provide truly location aware messages to the customer. This fact gives for the first time the opportunity to reach consumers with highly customised promotions and advertisements, which depend on the location of the consumer.

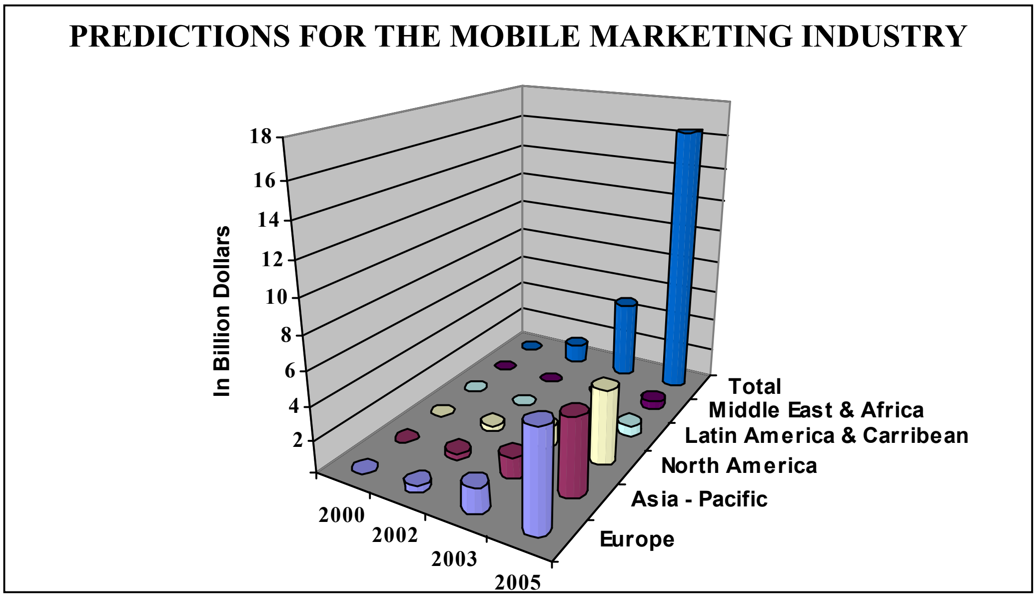

Chart 1: Worldwide Mobile Marketing Industry Predictions

3.2 The Proposed Service

The proposed LBS belongs to the category of Information Services and is about providing users with advertising messages. Mobile Advertising is an integral part of Mobile Commerce and, to be more accurate, of Mobile Marketing. The service operates in a way similar to directory services. To be more precise, there is a distributed information base storing data about product promotions offered by every supermarket in a given area where the service is provided. A user can search for promotions selecting the product categories he is interested in. The service returns all the available promotions offered by nearby supermarkets. The information system supporting the service described above has the following characteristics:

- The service is accessible through the WAP protocol. This means that the complexity and intelligence of the service is managed by a web server and not by a stand-alone application on the user's device.
- Users are located by the system at the level of a sector of a telecommunication's cell by using the CGI (Cell Global Identity) method. It is the simplest positioning method but can support efficiently the above service given the small size of the cells in urban areas.
- The information about available supermarkets and product promotions is stored in a Directory Information Tree, which is accessed through the Lightweight Directory Access Protocol (LDAP) . The information model used is hierarchical and is mainly used for search/read purposes than write purposes. The LDAP protocol is used for high-speed access to this kind of information. It also has valuable distribution capabilities (different servers store different parts of information), thus offering scalability to the system. The availability is also increased as there is no single point where the information is stored, the failure of which would mean the failure of the whole service.

The above system has been implemented in simulation environment but can also be tested against real-world conditions using available telecommunication network's infrastructure (telecommunications network with positioning capabilities) because it is based on well defined industry standards.

4. SYSTEM ARCHITECTURE

4.1 The System

During the design of information systems that support Location Based Services, emphasis is given to scalability, distribution and interoperability through the use of well-documented flexible ontologies and broadly accepted information access protocols [2][5]. Scalability and distribution refers to the capability of a system to expand providing support for more users and also to the capability of autonomous management of separate parts of the available information. The information access protocols, when standardised, give the opportunity to the system designer to use already well-defined interfaces. The ontologies used to describe the available information should be based on standards, which allow the easy expansion and management of the information (e.g. XML-like ontologies). Our approach for the architectural design of the proposed system is based on the above principles.

We will now thoroughly describe the operation of the proposed system (shown in figure 1). The user communicates with a Web Server over the WAP protocol through a WAP Gateway. The information which is sent to the Web Server upon service initiation is the user's id, password and telephone number (MSDN). All this information is used by the system for authentication purposes.

In order for the Web Server to grand user access, the information is sent to the Location Server. If the user is in the access lists of the Location Server then access is granted and the user's current position is recorded and sent back to the Web Server. The Web Server informs the user for successful sign in and allows the user to select the product categories in which he is interested. Upon user selection the Web Server communicates with the LDAP Server in order to create a list with all the available super markets located near the user. If there is no supermarket located at the cell-sector in which the user is located then the two adjacent sectors are searched. If no supermarket is found there either, then the system returns an appropriate message to the user. But if supermarkets (at least one) are found then the Web Server returns their credentials and addresses. The user by selecting a supermarket can be informed for available promotions for products (belonging to the categories he has already chosen) offered by that certain supermarket.

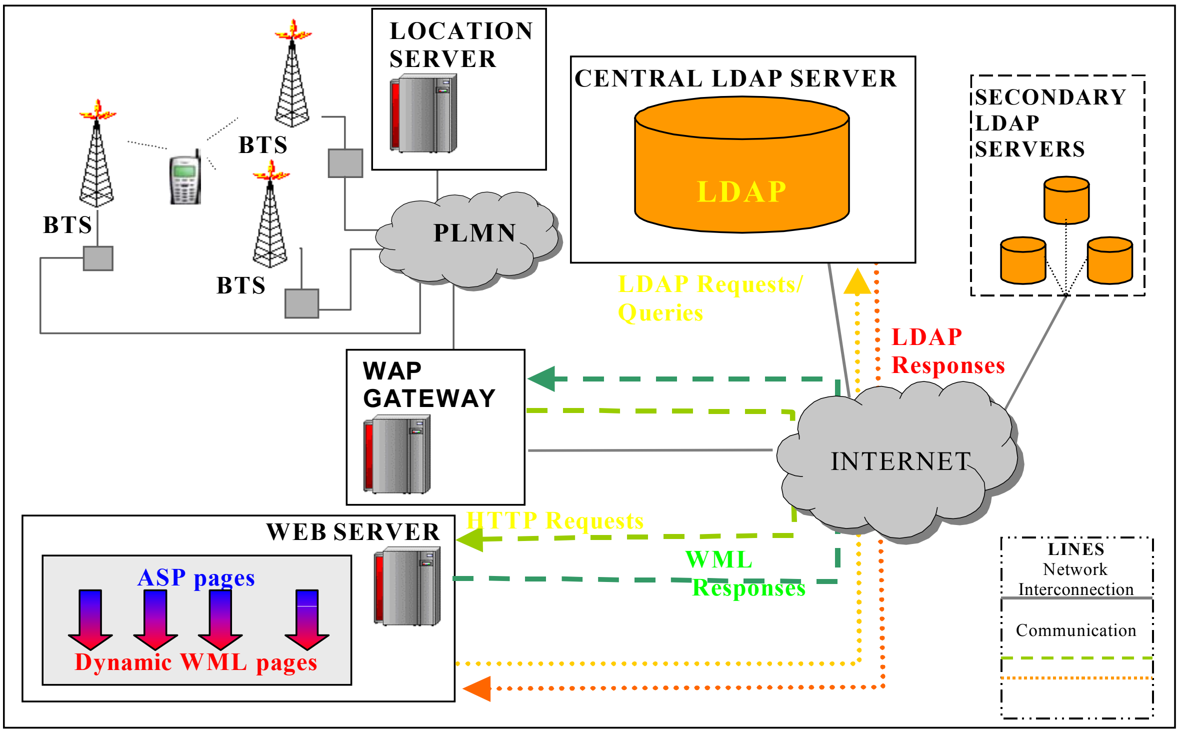

Figure 1: System Architecture

From the above it is made clear that the main building blocks for the proposed system are:

- Web Server
- Location Server
- LDAP Server

In the following paragraphs we study each on of them and analyse the technologies they utilise and their roles in the system.

Web Server

The Web Server acts as a central management unit being responsible for the following:

1. User Interface: The Web Server hosts static WML pages as well as dynamic ASP pages which generate new WML pages. The distinction between static and dynamic pages exists because only a part of the user interface remains the same (e.g. user authentication) while the rest contains pages, whose content is dependent on the user's location, the choices he has made and the contents of the product-promotions information base.

2. Communication with the Location Server: The Web Server constructs positioning requests, forwards them to the Location Server and then accepts the positioning replies from the Location Server. The requests and replies are constructed as XML documents following the Mobile Positioning Protocol (MPP) and the Web Server has the ability to compose and decompose these documents in order to encapsulate or derive information respectively. The MPP protocol is a kind of implementation of the official prototype MLP (Mobile Location Protocol), which is being developed by LIF (Location Interoperability Forum) and which describes the communication between an application and a Location Server. The MPP protocol is based on XML and it supports the CGI and CGI-TA positioning methods. In order for the positioning requests to be transferred to the Location Server the HTTP protocol is used and particularly HTTP POST requests.

*3. Communication with the LDAP Server***:** The LDAP Server waits for LDAP requests, which correspond to search queries on its content. After processing the request the LDAP server returns an LDAP response. Using the user's location information and the choices the user has made, the Web Server forms appropriate LDAP requests (following the LDAP v3 protocol specifications) and forwards them to the LDAP Server. Then, based on the LDAP responses received, the Web Server dynamically creates new WML pages containing the results and offers them to the user.

Location Server

The Location Server performs two tasks. The first one is to authenticate user access to the system and the second one is to provide user location information.

During access control the Location Server checks user credentials (id, password, telephone number). If any of these credentials doesn't match to the records of an access list kept on the Location Server then an appropriate message is returned to the Web Server. User credentials are transferred from the Web Server to the Location Server with the help of the MPP protocol.

Upon successful authentication, the Web Server constructs a positioning request (in XML) for the particular user and forwards it through an HTTP POST request to the Location Server. The Location Server communicates with various network elements and initiates the appropriate positioning methods. When the user's location information arrives to the Location Server, the Location Server constructs (in XML) a positioning reply containing this information and returns it to the Web Server. If the user couldn't be located by the system, the Location Server returns a positioning reply containing a failure notification.

LDAP Server

The LDAP Server holds all the information about products, promotions and supermarkets. To be more precise this information is about product promotions, available categories from which a user can choose, details about the supermarkets which offer the promotions and last but not least identifiers and other details concerning the cell sectors in which the supermarkets are located. We should note here that the requests are sent to a central LDAP Server. If the requests cannot be satisfied by the central server then they are propagated to secondary LDAP servers connected to that central server. This allows for information to be distributed across many different servers, which are responsible for information about certain supermarkets and/or certain geographic regions.

The LDAP requests are constructed at the Web Server as we have already mentioned. The first request sent searches for the available generic product categories (food, drinks, household). The second one searches for the available subcategories (e.g. for the food category some subcategories are meat, oils, fish etc.). The third request sent searches the information base for the cell sector in which the user is located according to the reply from the Location Server. When the sector is found then the product promotions for each supermarket located in that sector, are returned to the Web Server. Then the Web server dynamically constructs the user interface pages that will host all this information.

The main reason for using the LDAP protocol is because the information model is rather hierarchical than relational and is based in key-value pairs, matching perfectly the LDAP protocol's philosophy. The LDAP protocol is a broadly accepted standard for accessing such information and is mainly used in Internet applications, in Intelligent Networks and in modern multimedia communication networks [4]. Other reasons for using LDAP in the proposed system are:

- Even if a hierarchical model of information is «translated» to a relational one using normalised relational tables, there will be a need for recursive SELECT queries in order to retrieve knowledge that could be retrieved only through an LDAP query. This fact leads to lower response speeds of such a system.
- The X.500 type of services (The LDAP protocol enables access to such services) are used for storing and accessing mobility management data in public and private telecommunication networks (e.g. in 3G networks using UMTS) [1].

4.2 LDAP Directory Information Tree structure description

The first object in the DIT (Directory Information Tree) is the root (see Figure A in the Appendix). The first hierarchical level under the root contains objects of type CELL, which contain information about the cell global identity (CGI) identifier (CellID) and the cell's base station's geographic coordinates (longitude, latitude). One object of type cell is created for every cell in the coverage area of the service. For each one of these objects, three objects of type SECTOR are created at the next hierarchical level of the DIT. These objects store information about the sector identifier (SectorID) and the start and stop angle, which define the shape of the sector. Going one level further down the hierarchy we find objects of type SUPERMARKET for each supermarket located in the sector's covering area. These objects store information about the supermarket's identifier (SMBrand), their full name (Smname) and their geographic coordinates (smlong, smlat). These coordinates are not used by the application developed but are stored in order to make possible a transition to a system where better positioning accuracy can be achieved (e.g., accurate user location coordinates using the A-GPS positioning method). Three product categories can be found in every supermarket (food, drinks and household stuff), so under every object of type SUPERMARKET three objects of type PRODUCT_CATEGORY are created. If a certain supermarket offers promotions for any of the above categories a corresponding object is created one more level down the hierarchy. For example if a supermarket offers promotions on food products, then an object of type FOOD_CATEGORY will be created and it's identifier (foodcat) will store the value/name of a specific food product-subcategory for which promotions exist (e.g., meat, pasta, dairy products etc.). Finally the objects which appear as leafs in the DIT are objects of type PRODUCT storing information about their brand and the promotion-message.

The flexibility provided by structuring the DIT in the above way is justified in the following:

- Between the root and the objects of type CELL new objects can be added in order to group the cells in greater geographic regions. This allows the use of relatively less complex positioning methods (e.g. location by postal code which the user enters to the system) when advanced positioning methods are not available or for pilot-applications.

- New categories and subcategories can be easily added as long as the appropriate objects are defined. Moreover new supermarkets that participate to the service can be easily added and/or existing ones can be removed.
- Every part of the DIT that corresponds to a specific supermarket can be stored to a separate server due to the tree structure. So the DIT can easily expand to serve any number of supermarkets. As a direct consequence, the availability of the entire system is strengthened, as there are many places where the information is stored and not a single one, the failure of which would mean the failure of the whole service. In addition using the replication process, which the LDAP protocol easily supports, the system can be strengthened furthermore against failures.

5. AGENT BASED OPTIMIZATIONS FOR SUPER MARKET SELECTIONS

A very important architectural component to be integrated in the system described above is an agent residing on the Web server, which on behalf of the user makes the optimal super market store selection. If we assume that product prices are known (or alternatively that we can ''translate'' promotions to prices) and also that the user can clarify his cost and distance aversion, then the super market with the best cost-distance ratio for the specific user could be discovered. Here is the mathematical logic behind the computations that should take place:

If T1 = total cost for requested products from Super Market 1
A1 = distance from Super Market 1

And T2 = total cost for requested products from Super Market 2
A2 = distance from Super Market 2

Then these are the possible cases:
Case 1: $T1>T2$ and $A1>A2$ where the Super Market 2 will be chosen
Case 2: $T1<T2$ and $A1<A2$ where the Super Market 1 will be chosen
Case 3: $T1>T2$ and $A1<A2$ (or $T1<T2$ and $A1>A2$) where user preferences (cost and distance aversion) determine the Super Market that will be chosen

Assumptions
Let us assume that the user can state how important it is for him to find low prices by choosing a value between 0 and 1 (PriceRank variable). The value that the user has chosen is subtracted from 1 and the returned value represents the DistRank variable which expresses how important it is for the user to find a Super Market close to him.

Case 3 Analysis:

If PriceRank=1 and DistRank=0 then independently of the relations between T1/T2 and A2/A1 the user would prefer the cheapest Super Market no matter the distance

If PriceRank=0 and DistRank=1 then independently of the relations between T1/T2 and A2/A1 the user would prefer the nearest Super Market no matter the cost

If PriceRank=DistRank=0.5 and T1/T2 = A2/A1 then any of the 2 Super Markets can be chosen.

If PriceRank=DistRank=0.5 and $T1/T2 > A2/A1$ then the user would prefer the cheapest Super Market as the cost ratio is greater than the distance ratio and his valuation for each of them is the same (0.5).

If PriceRank=DistRank=0.5 and $T1/T2 > A2/A1$ then the user would prefer the nearest Super Market, since the cost ratio is lower than the distance ratio and his valuation for each of them is the same (0.5).

In the general case:
If PriceRank=x and DistRank=1-x then

If (T1/T2)x > (A2/A1)(1-x)

Then the user would prefer the cheapest Super Market

But
If (T1/T2)x < (A2/A1)(1-x)
Then the user would prefer the nearest Super Market

Next we present two representative examples, which demonstrate the logic behind the formulas:

Example 1

T1 = 1	A1 = 0.1
T2 = 0.9	A2 = 1

If the user prefers the cheapest super market then according to the above we should have:

(T1/T2)x > (A2/A1)(1-x)

Substituting we get:
⇔ (1/0.9)x> (1/0.1)(1-x) ⇔ x> 0.9-0.9x⇔x>0.9
Which means that in order for the user to accept to travel a distance of 0.9 distance units to benefit only 0.1 cost unit then the user should be very cost averse (with a PriceRank over 0.9).

Example 2

T1 = 1	A1 = 0.1
T2 = 0.9	A2 = 0.15

If the user prefers the cheapest super market then according to the above we should have:

(T1/T2)x > (A2/A1)(1-x)

Substituting we get:
⇔ (1/0.9)x> (0.15/0.1)(1-x) ⇔ (1/0.9)x> 1.5-1.5x⇔2.35x>1.35⇔x>0.57
Which means that in order for the user to accept to travel a small distance (0.05 distance units) to benefit 0.1 cost units then the user should not be too distance averse (with a DistRank lower than 0.42).

6. CONCLUSIONS

We implemented an information system supported by a Location Based Service for the mobile marketing sector. We defined an “open” distributed architecture to promote service reliability and fault tolerance. Our implementation was based on broadly accepted, standards-based technologies. We elected to put the complexity on the network-side rather than the client device, where we opted for a simple and easy to use user-interface.

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APPENDIX

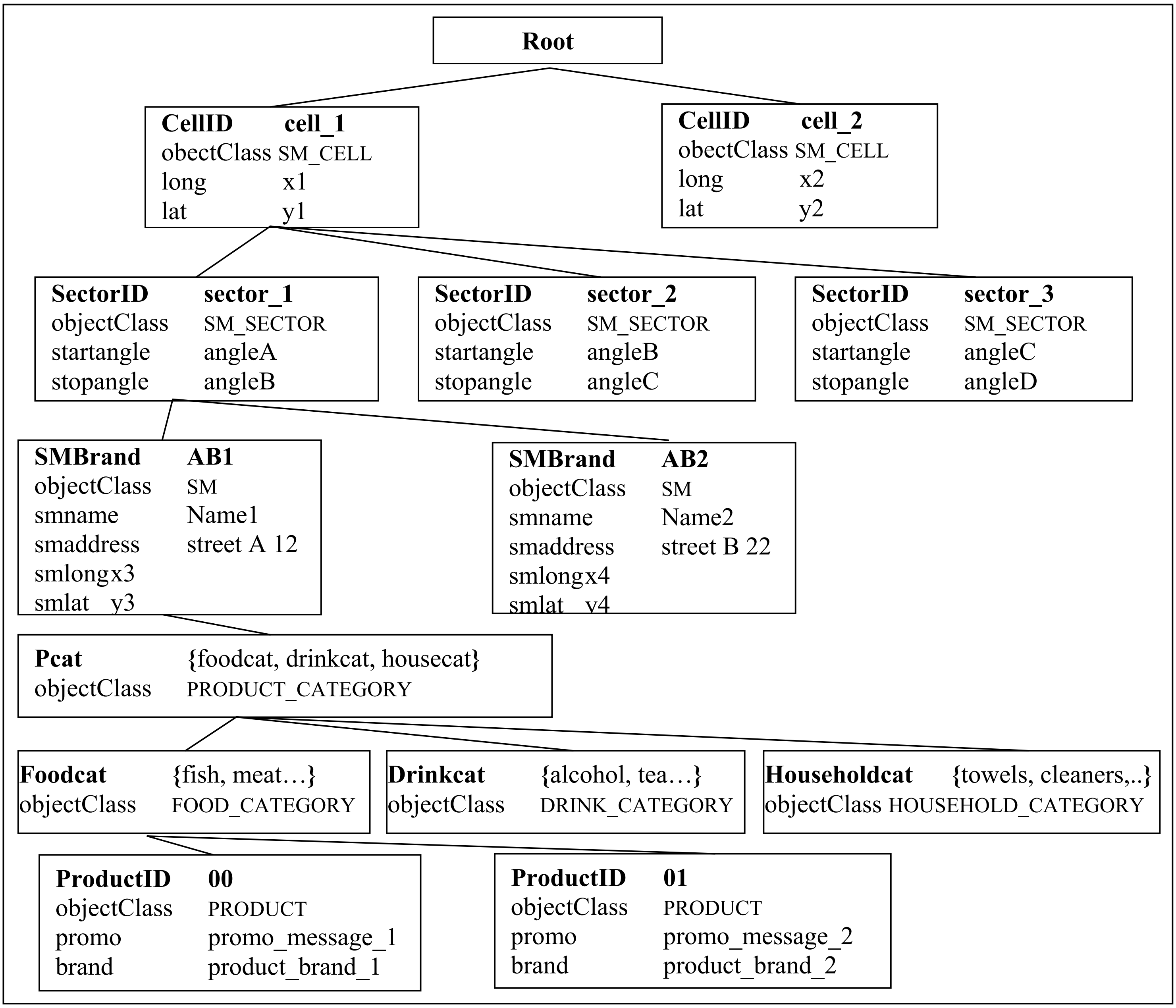

Figure A: The Directory Information Tree