Architecture for Mobile P-Commerce: Multilevel Profiling Framework

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Abstract

Managing and sailing the Web content to mobile users based on their preferences and location are becoming now a leading trend in a mobile electronic commerce. Another trend is such that an ordinary mobile user is transforming now from a consumer of commercial services to also a supplier of them. In this paper we propose an architecture, which is based on the assumption that every person in the society in some way more or less participates in public business process, which we name as *public commerce* (p-commerce). This service should be able to integrate different types of information with geographical data and manage different type of profiles related to preferences, security, privacy, transaction management, etc. The multilevel profiling framework discussed in this paper should be able to allow business operations based on different levels of profiles to be able to reach consensus between a buyer and a seller about general and specific features of their relationships. We consider the following main levels of profiles from the top level to basic level: international and local laws, standards; metaprofiles; profiles; interpreted profiles (concrete XML documents with features of reached consensus).

1 Introduction

1.1 Mobile Electronic Commerce

The recent cellular phones have a lot of extra possibilities compared to the older ones. Percentage mobile users is expected to become more due to the fact that with new technologies new (and better) services can be offered. The ability of paying by phone is a service in which a lot of companies are interested. For example people in Finland are able to pay for certain products by using their cellular phone already. Sending and receiving images and video are also gaining interest. Since the wireless network will be more data oriented Internet will become a serious possibility as well. Mobile devices, which provide service not only for ordinary users but also for mobile applications software developers, are of big interest for the telephone companies. Nokia has recently announced the first Symbian-based Communicator - the Nokia 9210 [38], which is the world's first next generation mobile phone to be based on the Symbian open software platform that has been designed to enable third party developers to write powerful additional applications, services and content for users.

Because it is small, secure, personal, familiar and carried at all times, the mobile phone is rapidly evolving into much more than a wireless telephone. It is transforming into Personal Trusted Device with the ability to handle a wide variety of new services and applications, such as banking, payments, ticketing, and secure access operations [52].

Advances in wireless network technology and the continuously increasing number of users of hand held terminals make the latter a possible channel for offering personalized services to mobile users and give space to the rapid development of Mobile Electronic Commerce (m-commerce). M-commerce operates partially in a different environment than Internet E-Commerce due to the special characteristics and constraints of mobile terminals and wireless networks and the context, situations and circumstances that people use their hand-held terminals.

Ericsson, Motorolla and Nokia, as key facilitators of the mobile Internet and the mobile information society, together have established the MeT initiative [52], the first major cooperative effort to provide common open-core technology for the m-commerce market. MeT is targeted to define a common framework for m-commerce applications by extending existing industry standards and technologies and to ensure a consistent user experience across multiple phones, access technologies and usage scenarios.

1.2 Managing and Sailing the Web Content

In [12] it is discussed how people interface with electronic business, particularly Web-based commerce and mobile commerce. The key questions addressed are:

- How do customers interact with e-business technology?
- Why do people use the Internet?
- What are the roles of time, trust and culture?
- As society ages, how must interaction change?
- What are the processes that can help or hinder customer interaction?
- What unique business model can take advantage of customer interaction?

There are structured and semi-structured sources of knowledge on the Web that present implicit or explicit

ontologies of domains. Knowledge level models have a role to play in structuring and extracting useful and focused problem solving knowledge from these Web sources. An agent- and Internet-based problem solving architecture was designed in [14] to facilitate the retrieval, restructuring, integration and formalization of problem solving knowledge from the Web.

In [2] intelligent integration techniques for heterogeneous data sources and knowledge sources were considered, and the way of their implementation to problems in electronic commerce, knowledge management and information retrieval. A prerequisite for successfully integrating various information sources is a standardized and an access device friendly description of their semantics.

In [53] natural language definitions for all the terms into the following subject areas: activities, organization, strategy and marketing are given, starting with the foundational concepts (e.g. entity, relationship, and actor). Solutions were proposed for many problems occurring in the development of a wide range of ontologies also in other domains. Issues of converting an informal ontology into a formal one were studied.

In [19] the Ontology Inference Layer (OIL) that is being proposed as a description language for ontology interchange (i.e. static information) and also UPML language has been developed for describing reasoning components. Integrating these two description types is concluded as a necessary step toward a knowledge web.

The information integration approach in [32] uses generated wrappers for single pages, which are attached to classes in a domain schema. In this approach, domain schema and site structure are not decoupled completely however different site structures can be modeled.

The next-generation Web i.e. "Semantic Web", enables intelligent services such as information brokers, search agents, and information filters, which offers greater functionality than the current services. In [15] the role of ontologies is studied in the architecture of the Semantic Web. It was shown that the use of XML as a tool for semantic interoperability would be ineffective in the long run. Further layer is needed [36] on top of the Web's current layers, which can be a general method for encoding ontology representation languages into RDF/RDF Schema.

RDF is a data model for representing data on the Web. RDF defines the following modeling primitives:

- Object identity: which is represented by a Uniform Resource Identifier or generalized URL;
- Binary relationships: The RDF model is a directed graph with binary relations;
- Reification: each RDF relation can be reified or expressed by another objects with a certain set of properties;
- Container: RDF has specific container types, which represent sequences, alternatives, and multi sets.

RDF Schema is the language for RDF, which is similar to frame-based languages. The main modeling primitives in RDF Schema are classes with their explicit hierarchy, properties and property constraints.

In [5] intelligent reasoning services on the Web are discussed. An appropriate electronic market place consists of provider agents, customer agents and broker agents. An intelligent broker agent can handle web requests of customers by accessing libraries of reusable problem-solving methods on the Web, and selecting, adapting and configuring these methods in accordance with the customer's problem and domain. In [49] the anytime performance profiles are used to describe behavior of problem solving methods. A performance profile describes how the quality of the output of an algorithm gradually increases as a function of the computation time.

In [37] a SoFAR - multi-agent framework is presented for distributed information management tasks. SoFAR provides the means to enable agents to locate suitable service providers. The predefined set of agents was described, which make up the core of the system.

In [40] an argumentation framework is presented, which permits agents to negotiate in order to establish acceptable ways of solving problems. The framework provides a formal model of argumentation-based reasoning and negotiation, which gives the agents a tool to resolve their conflicting objectives, correct inconsistencies in their knowledge about each other and coordinate a joint activities.

Future of agent-mediated electronic business is discussed in [31]. It was concluded that agent-to-agent e-commerce transactions might soon dominate the global economy. Mobile commerce supported by personalized agents is not too far away from realization. Such optimistic views to the use of agents in electronic commerce one can find in many papers, for example in [44] where mobile agents are considered as able to participate auction's trading and contracting while their user is disconnected.

1.3 Different Concepts of P-Commerce

Historically before there was e-commerce, there was p-commerce, or *postal commerce* [29]. This is where you get a catalog in the mail, or read an insert in the local papers, call a toll-free number and order an item. A few days later a parcel appears at your door. P-commerce is a big and mature industry; people have been shopping by mail for decades. P-commerce is a natural precursor to e-commerce. Online technology makes it easier to search a bigger catalog and e-mail and profiling makes targeted and direct marketing so much more powerful.

Location is an element that can be used to filter and differentiate services. Location services are well suited to the mobile environment and can be used when on the move or to track things. They also are useful for locating specific places, such as a hospital or tourist attraction. Conversely, location services help other people locate a user in the event of an emergency, such as when the user has a flat tire. Location capability also allows a user to personalize information based on vicinity.

Location-based services [10]:

- Convenience - Navigation, concierge services, real-time traffic info, tourist info.
- Safety and security - emergency, asset tracking.

- Mobile information access – Data filtering, location-based promotions.

Initial consumer feedback on the concept of location-based or *position-commerce* (p-commerce) was positive according to a qualitative research study sponsored by ATX Technologies that owns the p-commerce concept [54]. This concept would enable wireless access to infotainment and commercial services that are based on a subscriber's location and personal preferences. The p-commerce model involves creating opportunities for marketing interaction between telematics subscribers and merchants that are triggered by geographical proximity. P-commerce would most likely be bundled with personalized infotainment services such as audio entertainment, Internet access, and other location-specific information. When you combine web-based information content and related transaction services with location-based services for use with mobile phones, you have a powerful p-commerce proposition [46]. Location is being seen as the fundamental enabler for next generation mobile phone services. Types of end-user applications include the ability to book a nearby restaurant and then receive a map showing how to get there. Another application could be to email all local car dealerships for a quotation on a new car - again, receiving location, directions and other details of the chosen supplier. Location- and content-based services will begin to come into their own as WAP phones gain in popularity [35].

Another concept *people commerce* (also p-commerce) was pioneered by Elgin Scott (the firm specialized on Human Resource Management). The concept is based on the idea that people like other business services such as advertising should be sourced from the single, best external supplier. This outsourced service allows IT companies to benefit from the centralized approach of an in-house recruitment function without the overheads. Using the p-commerce model Elgin Scott acts as a conduit between IT firms on the one side, and candidates, job agencies and other elements of the recruitment process on the other [17].

BarPoint.com Company is revolutionizing mobile and Internet use of unique product identifiers such as Universal Product Codes (UPC) for businesses and consumers is announced new *pocket commerce* (again p-commerce) platform. With this platform a user can simply swipe products as if checking out items in a grocery story and then let BarPoint deliver an in-depth profile for each one. "Imagine dining at a fine restaurant and you are served a really great Cabernet. You'd like to get a bottle for yourself. It will be as easy as entering or scanning the UPC code with your Pocket PC. Then the BarPoint Shopper will give you access to product specific information about that wine, including a color image of the label, a chart of expert comments and locations where the wine is sold, so you can purchase it for yourself, at your convenience. This is so much more engaging than a textual readout from a standard comparison service" - commented Jeff Sass, BarPoint's executive vice president [4].

The idea of *personalized commerce* (can be also treated as p-commerce) is to collect personal profiles, to deliver more targeted content and advertising. In [41] three levels of personalization are considered:

- Service Personalization: depending on their competence level, customers can further refine the own service structure on the basis of a service potential and of their required functionality;
- Content Personalization: users may provide own preferences as a means for steering the content selection of the service, and content providers may define push strategies driven by these profile data;
- Dynamic Personalization: users reveal their own anonymous profile during the use of the service. The collected tracking information is automatically exploited to generate improved user profiles: it refines and retargets the personalized offers.

There is also *pervasive commerce* (p-commerce!) trend, which means a transition from focusing on HTML browsers to focusing on multi-model interfaces and delivery. Such a paradigm supports rapid application development and deployment on a wide array of devices and interfaces [34]. According to p-commerce concept companies can quickly deliver business applications that utilize the full capabilities of each device to deliver the richest possible user experience. With this platform and hosting service, it is possible to bring shopping into the hands of consumers and to enhance the buying experience through customized content layout for each device. Consumers can browse, research, and compare prices for shopping items from any mobile phone or wireless PDA device.

In this paper we are giving generalized view to p-commerce concepts and developing concept of public commerce (p-commerce) as an integration of best features of previous concepts. We describing the architecture of public commerce services as an attempt to integrate modern mobile location based services with public business activities. We discuss multilevel profiling framework as the way to simplify for every ordinary person the way to e-commerce market.

2 Important Features of Location Based Services

The evaluation of mobility lies in satisfying the needs of immediacy and location [56]. The ability to make an immediate decision at the user's location demands a high premium for connectivity. There were three questions to answer before entering the mobile data world:

- Where shall I be active (own competence and potential, regulatory environment, social environment, competition)?
- Which services are attractive to my customers (market segments, horizontal vs. vertical services)?
- Which technology and products do I need (network infrastructure, platforms, applications, terminals)?

Users of mobile services already accept charging per usage, and they would accept advertising if that would make

the service cheaper. However, there are not yet many such users who approved of paying for products and services via their phones. The industry has a big job ahead to convince the public of the security of m-commerce via wireless. Integrated service bundles create more value for the user. If a user wants to go to the theatre, he should be able to use a location-dependent service to find a nearby show, book a reservation, get navigational directions to an event, receive relevant traffic information and use micro-payments to pay for all related transactions.

2.1 General Requirements

Combining positioning mechanisms with information about location of various objects one can develop very powerful and flexible personal information services [47]. Suppose there is some geographical area that contains certain number of objects (points of interests [21]). Each point of interest is assumed to have its virtual representation or, rather, a source of relevant to it information. A user of this information is expected to be mobile. The aim of the location-aware service is providing a user with information about the objects taking into account spatial relationships between him and objects. One of the main input parameters is user's location. It is obvious that system should have information about all objects with their spatial location and links to their information sources. If system has this information, it is able to find the near objects. Note that for mobile objects system has to periodically update location information via location service or request it directly from the objects. First could be done automatically if we have an access to location service. In second case, the user can input his location by himself as a street address or the name of region. After that, the service is able to provide a geographical description of his surroundings. These data act an auxiliary role of a navigator or a guide in order to connect real objects with their virtual representations.

System services are basically responsible for the following:

- Storing map information as well as general information about different objects (together with links to corresponding information resources).
- Selecting on the base of this data appropriate information providers and interaction with them in order to get data needed for user request handling.
- Analysis and integration of obtained data.
- Converting data to an appropriate for the user XML-format.

The traditional way to represent geographical information is in the form of maps. And we believe that in order to make the user interface really friendly it should be one of the main facilities of the client. We noted above that geographical data is transferred to the client in some XML format and we do not specify any representative requirements for it. In such way, the client can not only represent them in the most suitable form depending on device's type, but also analyze this information. For example, the client can give some brief description of objects, or show the way to reach them. This moves a part of functions to the client and makes it more mobile and independent of the server.

The next client's function is providing customers with information from sources associated with surrounding objects [21]. The user can either directly receive information from the chosen object or charge the server to find needed information. In the last case, the server performs all work, analyses information sources of objects according to user's directives and sends to him results of his query. If the answer includes a spatial component, the result can be represented over the map image for better interpretation.

Besides of the visualization of geographical and textual information coded with an XML language, the client should be able to analyze it. We need a more powerful platform than can provide WWW/WAP browsers with JavaScript or WMLScript. From our point of view, the best platform for the client implementation is Java. The main reason is its portability that is very important in order to provide with our client software a wide range of mobile devices. Java Micro Edition with corresponding profiles can be successfully used for development of the client [30].

2.2 Open Architecture

The need for open and scalable architecture for geographical information services is clear. In [28] is stated that requirements for such an architecture are similar to the attributes that made the World Wide Web a great success. It is mainly because of the following WWW features:

- People and companies who has information to be shared can very easily prepare it (creating HTML pages and other staff) and integrate to Web (opening a web-server and registering a domain name).
- Client-server interaction and appropriate formats are platform-independent. It makes possible to access information from various devices.
- System is well scalable for a huge number of users and amounts of information.

Geographical information service should be organized in the similar way. The service provider can easily add new information sources and functions as well as a new customer can get an access to the service with minimal effort.

2.3 GPRS Technology Challenges

The edge of the networks will be wireless to provide seamless mobile services, adapted from the wired environment. People will not browse with their handsets, however. Nokia for example is focusing on integrated IP solutions for different parts of the business [55]. The company sees three pieces to the next generation network: mobility, IP data and high-speed access. Mobility is the killer application for data. General Packet Radio Service (GPRS) will provide packet data capability and bring the Internet to wireless. It provides the opportunity to pay for data transferred, not for idle time; fast IP session set up, i.e. instant connectivity; continuous connectivity. However, there is no intrinsic value in IP, and customers do not pay for IP. They pay for what they can do with IP. GPRS applications will be more than just access to the Internet.

Technology challenges involve implementing new methods of billing that account for content, transactions, application, location, etc. Operators must also understand capacity requirements of applications and be prepared for rapid new service development and deployment. GPRS billing will be based on access point name or IP address location rather than the dialed digits. Usage will be based on data volume, content duration and SMS transactions rather than call duration. GPRS domains of issues include terminals, radio and base stations; service management, including billing, customer care and service provisioning; access and security; inter-operator connections for roaming; ISP functions through the service network that supplies applications; external content and service providers.

2.4 The use of XML

HTML that is the core technology of WWW defines primarily representation of information. It deals very a little with logical structure of information that is more important in our case in order to support information analysis. XML [58], which deals primarily with logical structure, is the core technology for geographical information systems. Another significant property of XML is platform-independence that allows organization of interaction among any platforms and systems. An example of the successful application of XML is e-commerce information systems that integrate various units of one or many companies in one infrastructure [23].

The Extensible Stylesheet Language (XSL) [19] is a language for expressing stylesheets. Given a class of arbitrarily structured XML documents or data files, designers use an XSL stylesheet to express their intentions about how that structured content should be presented. It also allows to control how the source content should be styled, laid out, and paginated onto some presentation medium, such as a window in a Web browser or a hand-held device, or a set of physical pages in a catalog, report, pamphlet, or book.

We assume information sources, i.e. points of interests, are XML-enabled, they can provide information in an XML format [21]. This is implied that the system can define semantic meaning of the information and use it for analysis. The system should not to be restricted by any particular XML-format. The use of one format is impossible because of variety of object types that can be used in the service. An information provider can use any XML format for its data. But, of course, he must provide us with information about logical structure of this format and semantic meaning of tags, otherwise, the system will be not able to extract needed information from this data. In such a way we make integration of new content providers into our service as painless as possible. We should maintain transformation rules for every information provider. Then a standard XSLT processor can be used for automatic extracting information from a XML format [60].

The system needs to have a description of registered objects with the location attribute, which is used for spatial analysis along with path networks. All these geographical information should be prepared at the beginning of the service deployment. At best, we can automatically perform this step by use some providers of geographical data in the XML form, i.e. GML (Geographic Markup Language) [39]. This might make easier service deployment in different regions. Because processing and converting geographical data is still a big problem for new geographical service development and it requires many resources. Of course, an effort also could be made to transfer to XML data from usual non-XML GIS sources.

2.5 The Use of Java

The next important technology after XML is Java. Because we would like to provide users with analysis functions, we can not use standard WWW/WAP browsers as client software. JavaScript or WMLScript could not provide enough facilities to process XML data. But the client developed with Java can implement analysis functions and be easily ported to different platforms. Many companies position Java as main tool for applications for mobile devices and provide Java Virtual Machines for widely spread operational systems for mobile devices as well as for stationary computers.

Java can be a key component to dynamic provisioning of new applications and services on demand [7]. It offers user interface widgets for flexible user interaction, graphics application specific interfaces for exciting games, and local execution and multi-threading to optimize slow communications. From the operator perspective, Java technology allows a carrier to *brand* the user experience anyway they want, add new APIs for content providers, create portal services or pass-through third-party applications, and offer value-added location-based services. Java's mantra is *write once, run anywhere*, which means that applications written in Java for one platform can run in many others. Java can be used with WAP to advertise Java service via the WAP browser and allow Java applications to communicate via the WAP protocol. By including Java with WAP, operators can have their own branded, Java-based service browser.

2.6 Transaction Management

Transactions in mobile environment are used to encapsulate operations and provide Atomicity, Consistency, Isolation and Durability. For mobile e-commerce it means the following as described in [48]:

Atomicity - transaction is *atomic* if either all operations necessary for preserving e-commerce atomicity are executed or all executed operations will become compensated. With money atomic protocols, funds are transferred from one party to another without the possibility of the money remaining in the middle of the money transfer infrastructure. Goods-atomic protocols are such that a good is received if and only if the money is transferred. Certified delivery protocols allow both a merchant and a customer to prove exactly which goods were delivered.

Consistency - transactions must preserve consistency at various levels. For instance, a customer should not be

allowed to draw funds from an account if this would result into a negative balance.

Isolation - various steps of a transaction do not interfere with steps of other transactions. For example, if a customer buys a product through its mobile phone, this purchase should not affect other transactions being made simultaneously at the device or at the merchant server.

Durability - once a transaction completes its execution, its results become permanent even in the presence of failures. For example, after the completion of an electronic purchase, the corresponding funds transfer from a bank is permanent even if the network fails.

IBM, Hewlett-Packard, Bowstreet, Oracle, and Sun Microsystems recently unveiled plans to develop a new standard to manage Internet-based transactions [24]. The initiative, called Transaction Authority Markup Language (TAML) will ensure that if XML-based data is not received by an application, the transaction will be abandoned without any changes to the participating systems. TAML resembles online transaction processing, a specification that guarantees that if a business-to-business transaction fails, it is reversed so that corporate databases are not altered.

The MeT initiative [52] was founded to establish a framework for secure mobile transactions, ensuring a consistent user experience independent of device, service and network. Creating a standard for secure mobile transactions also opens up the possibility for small transactions to be handled via mobile devices, for example ticketing applications.

2.7 Profiling

Businesses assign profiles to customers that describe their needs, requirements, and interests [8]. These profiles are then used to target the audience of particular products. When one visits an e-commerce web site, he provides them with some profile information when registers. Each time while a user making a purchase, his profile may be updated with the specific content that has been purchased. Some adaptive sites even have the ability to track users clicks through its content to determine user's interests. All this information is combined to create users personal profile. The profile is then used to target certain products for a user. XML allows marking up the data in such a way that the context of that data is described in the markup language itself. Additionally, attributes allow us to provide meta-data regarding that context. The target audience for the information is a type of meta-data and can be captured in attributes on each element. By profiling the information according to its target audience, we can match the information profile to the audience profile in order to deliver the information that best meets the needs, requirements, and interests of customers.

Lumeria is creating the new standard for personal profiling called the Profile Markup Language (PML) [6] - a profile description and exchange platform, which is based on XML. PML is an open source, industry-driven, XML-based collection of standards for defining profile data. At the heart of PML is the PML document type definitions – the set of rules by which PML documents are created and interpreted. The goal of this initiative is to provide a next-generation profiling standard for the Internet that can help create a more personal, custom, and trusted web environment [6].

Profile Miner [43] is an on-line data mining tool that tracks the relationship between a consumer's profile and buying behavior. This relationship is referred to as profile buying behavior. Profile Miner finds association rules that indicate a relationship between the profiles of consumers and the patterns of consumer transactions, so that one can determine that a particular profile implies a particular transaction. This helps to target marketing efforts and promotions on specific items. In addition, Profile Miner can find popular groups of items purchased together, which are called baskets. Profile Miner operates online by using an Online Analytical Processing (OLAP)-type methodology of preprocessing the transaction data and by using a multidimensional index to store the structure.

2.8 Security

Security Services Markup Language (S2ML) is recently announced standard to build a common vocabulary for sharing user information and transactions - and encourage single-sign-on - across multiple platform b-to-b portal and b-to-c environments [20].

Clients use totally different security and business rules, trying to do the same in different ways. New XML based standard is expected to make a bridge between them. S2ML defines standard XML schemas and XML request/response protocol for authentication and authorization through XML documents [20].

2.9 Privacy

Worries about loss of privacy over wireless devices will rock the budding wireless industry, analysts and users warned [27]. Privacy is the interest that individuals have in sustaining a personal space**,** free from interference by other people and organizations. According to Clarke [11] such personal space has multiple dimensions: privacy of the person (concerned with the integrity of the individual's body), privacy of personal behavior, communications, and data. Information privacy refers to the claims of individuals that data about themselves should not be available to others, and that, where data is possessed by another party, the individual must be able to exercise a substantial degree of control over that data and its use**.**

The growth of mobile services and m-commerce applications has resulted in rapid development of more accurate technologies of fixing location. Linked with those developments are ongoing plans to entirely replace location-identifying numbers with personalized numbers. This is being portrayed as a service to consumers. It is, of course. But the design of the scheme is such that it offers great advantages to marketers and others who have an interest in locating and tracking subscribers, which makes privacy intrusiveness is yet more serious problem [11].

XYPOINT Corporation, a provider of mobile e-commerce and location-aware applications announced in [22] that the nation's 80 million mobile phone consumers soon will be able to control whether their location is tracked when they access Internet services from their mobile phones. The Platform for Privacy Preferences Project (P3P) [42], developed by the World Wide Web Consortium, is emerging as an industry standard providing a simple, automated way for users to gain more control over the use of personal information on Web sites they visit. At its most basic level, P3P is a standardized set of multiple-choice questions, covering all the major aspects of a Web site's privacy policies. Taken together, they present a clear snapshot of how a site handles personal information about its users. P3P-enabled Web sites make this information available in a standard, machine-readable format. P3P enabled browsers can "read" this snapshot automatically and compare it to the consumer's own set of privacy preferences. P3P enhances user control by putting privacy policies where users can find them, in a form users can understand, and, most importantly, enables users to act on what they see.

3 Architecture for P-Commerce Services

3.1 Generalized Concept of *P-Commerce*

The proposed architecture is based on the assumption that every person in the society in some way more or less participates in public business process. We are buying something from another persons watching newspapers with public offerings or we are selling something unnecessary making announcements in numerous places by numerous ways. Some of us even sometimes make small business by finding in news such offerings and requests that fit each other. We name all mentioned activities as *public commerce* (p-commerce). Essential role in p-commerce activities plays location information. The use of mobile devices, WAP protocol and location services give new possibilities for p-commerce. The use of letter "p" fits well with another treatments of p-commerce described above. Public commerce provides commercial services that are based on a subscriber's location (position commerce). Public commerce service should be adaptive to subscriber preferences (personalized commerce) and to abilities of certain mobile device (pervasive commerce). It should provide possibilities to advertise, sell and buy goods (from postal commerce to pocket commerce), and even manage human resources (people commerce).

3.2 Client-Server Architecture of *P-Commerce*

We consider the client-server architecture (see Figure 1) to support location-based mobile p-commerce. We suppose to distribute the functionality of the appropriate p-commerce application between client and server parts as much as possible using resources of the mobile devices involved.

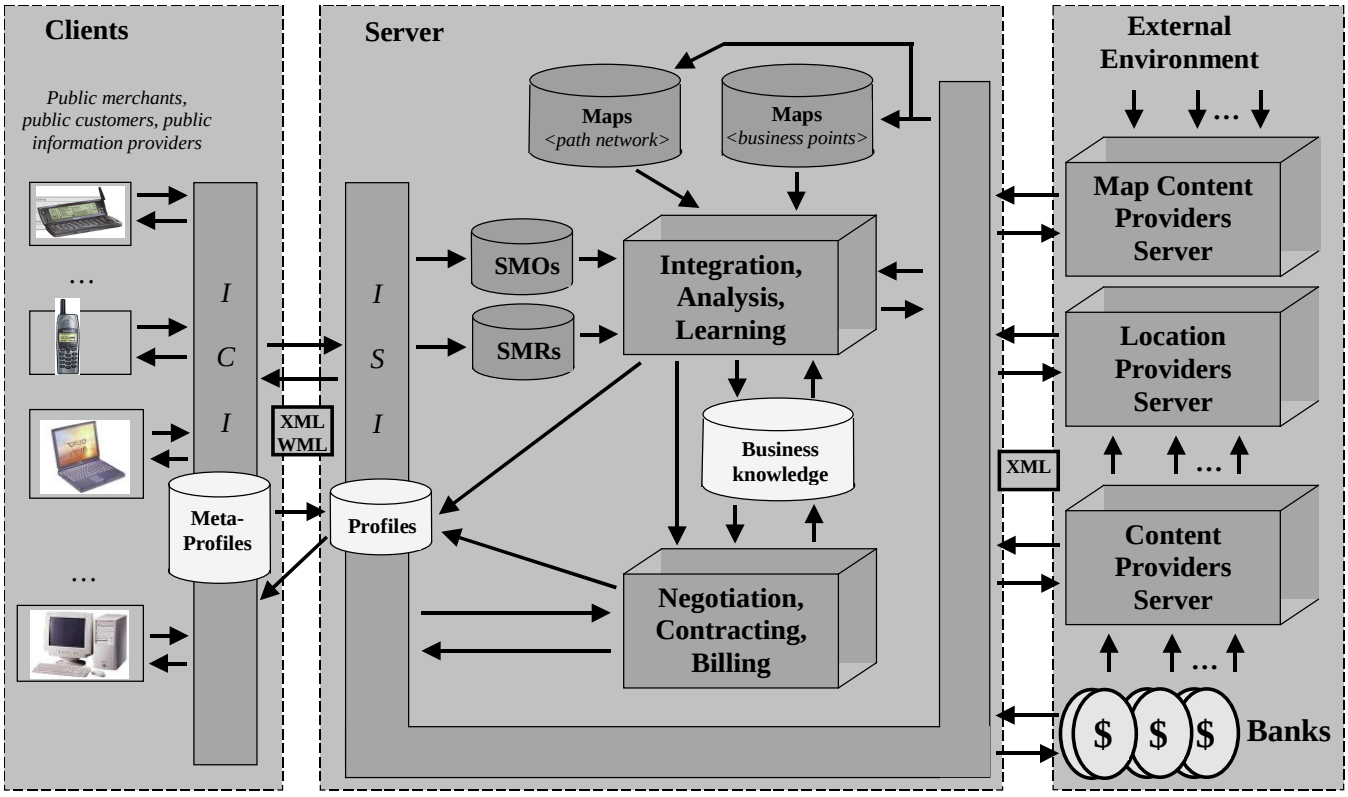

Figure 1. Client-Server Architecture for P-commerce services

We consider three types of clients: business clients (public merchants, information providers) and customers clients. Each mobile device should support behavior of its owner in all of three appropriate roles allowing him to take part in B-2-B, B-2-C or C-2-C location-based mobile p-commerce.

We suppose that there is restricted number of business profiles in p-commerce. To make perfect announcement each business client should first realize in what "cloth" he is coming to public market. The p-commerce application should help its business clients to find out their profiles from open profile database. Profile is certain frame by filling which one can specify his offering (request) for P-2-P or P-2-C p-commerce. We will name profile filled by a user as an interpreted profile. As the best representation form for interpreted profiles we consider the XML one, which allows further integrate profiles in application server databases. It is assumed that mobile business client represents interests of some company or some private interest and making appropriate short mobile offerings (SMO). Mobile business client software supports a user to classify his SMO as precise as possible, downloads profile (frame) from application server appropriate to the class and taking into account mobile device type, translates profile filled (interpreted) by the user to XML/WML format and submits it the application server. A mobile customer client can also represent interests of some company or his own private interests and making appropriate short mobile requests (SMR) about his needs. Mobile business client software supports a user to classify his SMR in a similar way as in the case of SMO, downloads appropriate frame from the server, translates frame filled (interpreted) by the user to XML/WML format and submits it the server.

Client part of the architecture consists on intelligent client interface (ICI) software and meta-profiles knowledge base. ICI should provide possibility to adapt incoming data to certain mobile device interface, to represent geographical data in the form of maps, to provide brief description of objects within some neighborhood around the user and show the way to reach them, to select, download and visualize profiles from server, to translate profiles interpreted by a user to XML/WML format and send them to the server. Meta-profiles knowledge base includes profiles of the highest layer of their classification, which being interpreted are necessary to select profiles of the lower classification layers from the server. Server part of the architecture consists on intelligent server interface (ISI) software, SMOs and SMRs databases, maps content databases, business knowledge base, profiles knowledge base, processor for data integration, analysis, and learning (data mining and knowledge discovery), and processor for negotiations, contracting and billing. ISI controls external transactions during profiling of clients, negotiations, contracting and billing between clients, converts formats of external inputs to internal format, completes SMOs and SMRs databases, supplies clients with requested profiles from the profiles knowledge base. SMRs is an open database, which collects requests of mobile clients. Objects of this database are active in a sense that for every incoming request data analysis processor tries to satisfy it (i.e. to find out nearest neighbor offering from SMOs database) and if this attempt fails then this object will be kept active until something appropriate comes to SMOs database. Thus according to the same sense the SMRs database contains passive objects (offerings). Maps content databases contain geographical objects connected by different layers of path networks: street networks and road maps, short description of geographical objects and links to information sources, which provide online content about these objects. Business knowledge base is created based on knowledge discovery from SMOs, SMRs databases in conjunction with map data. This knowledge is aimed for further reuse and considered also as subject of selling. Profiles knowledge base is collecting ontologies, which can be used for profiling business players based on their requirements and offerings, for profiling legal and optimal negotiation schemes to reach consensus and make contract, for profiling security and privacy requirements based on current context, for profiling scenarios for business transactions management. Processor for data integration, analysis, and learning integrates private and public business data with geographical data and location-based information content, i.e. interprets incoming queries in the context of law, security requirements, preferences, location and discovers the best matching between a SMO and a SMS. It also makes data mining of collected data from SMOs and SMRs databases and discovers new business ontologies in the context of different profiles groups and location. Processor for negotiations, contracting and billing interprets appropriate profiles and controls negotiations, contracting and billing transactions for every selected pair: public merchant - public customer.

4 Multilevel Profiling Framework

The architecture discussed below should be able to allow operations based on different levels of profiles to be able to reach consensus between a buyer and a seller about general and specific features of their relationships.

4.1 Profiles of Different Level

We consider the following main levels of profiles from the top level to basic level (Figure 2):

- International and local laws, standards (transaction management, payment, security, privacy, and so on);
- Metaprofiles (Meta DTDs - Meta Document Type Definitions);
- Profiles (for services, for security, for privacy, for preferences, for transaction management, for negotiations, for orders and invoices, for shipping schedules, for contracting and billing, and so on) - DTDs (Document Type Definitions), E-Speak Service Framework Specification [57], Common Business Library patterns [1, 13], etc.;
- Interpreted profiles (concrete XML documents, which described different features of reached consensus).

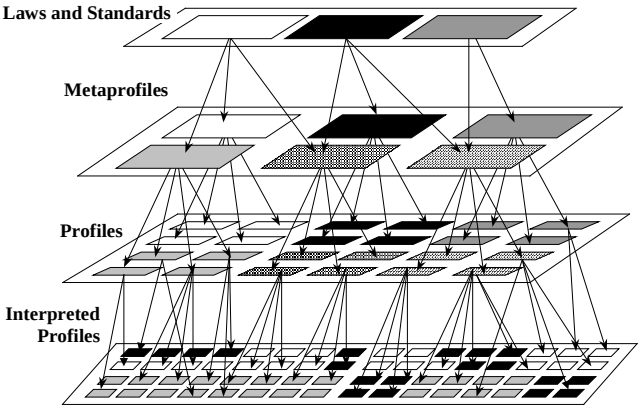

Figure 2. Multilevel structure of profiles

The advantage of using XML documents as profiles (interfaces in distributed business environment) instead of CORBA (Common Object Request Broker Architecture) objects is that they are easier to develop and use for a wider range of users, and that they represent naturally the documents, whether paper or EDI (Electronic Data Interchange) [1].

Document Type Definition (DTD) is some kind of frame by specifying slots of it one can get some piece of concrete knowledge in XML form. A DTD can be suitable to describe a pattern for certain area profiles so that it would be easy to mobile user to specify his offering or request having simple interface within a mobile device. XML Translator Generator [59] enables to convert XML documents and data based on one DTD to another without writing XSL scripts or any program code. It can also be used to filter data from HTML documents into XML documents. This process works in two phases: (1) Setup: first a common example in the two DTDs is used to generate a translator once. (2) Use: this translator is then used to translate XML documents. To translate documents from one DTD to another, first the same example data needs to be represented in both the DTDs. A simple way to do this is to take an example XML document using one set of tags and manually edit to generate an XML document using another set of tags. Next, the mapping facility is to generate a translator. This translator generation needs to be done only once for a given pair of DTDs. Each time one has a new XML document based on the first DTD, the translator generated in the previous step is used to translate it to an XML document based on the second DTD [59].

A meta-DTD [3] is the set of declarations, which defines architecture of DTDs. The occurrence of an architectural object in a document instance is checked against the meta-DTD to see if it is allowed. For a specific application, a specific DTD will be designed, respecting the constraints of the meta-DTD but enforcing stronger constraints to ensure the description correctness from an application point of view. This can also shorten the descriptions by fixing some attribute values in the DTD and dropping unused optional features. For example, with a meta-DTD approach, a specific touristic DTD can be defined. A specific element type would be defined to represent information nodes for hotels and its content model would list explicitly the required data items so that a regular SGML parser could check that none is missing [9].

E-speak [57] is Hewlett Packard's open software platform for the creation of dynamic, intelligent e-services. The Service Framework Specification (SFS) of E-speak defines standard business and technical conventions that allow e-services to dynamically interact with each other. These interactions which include discovery, negotiation, composition, measurement and monitoring are based on a common interaction model and enables disparate business processes. The E-speak Service Engine performs the intelligent interaction of e-services, gets description information from any e-service application, negotiates between multiple available e-services to make appropriate matches between buyers and sellers, offers continuous mediation of services between buyers and sellers so that e-services can make real-time adjustments according to user needs.

The Common Business Library (CBL) [1, 13] is being developed by Veo Systems, Inc. as a set of building blocks with common semantics and syntax to ensure interoperability among XML applications. CBL consists of information models for generic business concepts including: 1) business description primitives like companies, services, and products; 2) business forms like catalogs, purchase orders, and invoices; 3) standard measurements, date and time, location, classification codes. Industry-specific XML applications that reuse CBL for generic information and common business documents can be developed more quickly and better understood in other domains because of their common elements. CBL may be considered as 'glue' that connects pieces of existing e-commerce functionality. CBL consists of an extensible, public set of XML DTDs and modules, supported by reference documentation and samples. Thus CBL models can be also considered as profiles of certain level, which fit well the general architecture of p-commerce.

Commerce One CBL 2.0, the first open XML specification for the cross-industry exchange of business documents such as purchase orders, invoices, product descriptions, and shipping schedules. Commerce One CBL 2.0 is a set of XML building blocks and a document framework that allows the creation of robust, reusable XML documents for electronic commerce. To enable companies to preserve their investment in existing standards such as traditional Electronic Data Interchange (EDI), CBL 2.0 provides a transition path to XML-based commerce capability [13].

4.2 Modeling Profile Structure by Semantic Metanetwork

Semantic Metanetwork [50, 51] is considered formally as the set of semantic networks, which are put on each other in such a way that links of every previous semantic network are in the same time nodes of the next network (Figure 3).

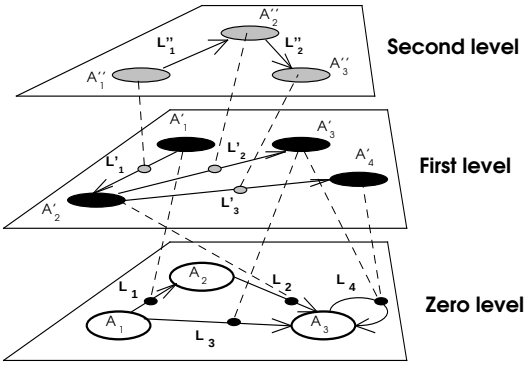

Figure 3. A semantic metanetwork [51]

In a Semantic Metanetwork every higher level controls semantic structure of the lower level. Simple controlling rules might be, for example, in what contexts certain link of a semantic structure can exist and in what context it should be deleted from the semantic structure [51]. Thus such multilevel network can be used in an adaptive control system which structure is automatically changed following changes in a context of the environment. Multilevel representation of a context allows *reasoning with contexts* [51] towards solution of the following problems:

- to derive knowledge interpreted using all known levels of its context;
- to derive unknown knowledge when interpretation of it in some context and the context itself are known;
- to derive unknown knowledge about a context when it is known how the knowledge is interpreted in this context;
- to transform knowledge from one context to another;
- to derive trends within any problem considering it in several contexts and to use such trends to derive more precise solutions for the problem.

The above abilities of a Semantic Metanetwork make it very suitable to model multilevel structure of profiles in p-commerce.

4.3 Modeling Profiles-Scenarios by Metapetrinets

High level Petri nets are a suitable formal method for the design of communication protocols because of their ability to express concurrency, non-determinism and system concepts at different levels of abstraction [26]. Colored Petri nets are used already to model and generate the possible primitive sequences of the wireless request/response transactional service [25, 26].

The idea of semantic metanetwork has been developed for facilitating flexible modeling and *control of complicated dynamic processes* using metapetrinets [50, 45]. *A metapetrinet* is able not only to change the marking of a petrinet but also to reconfigure dynamically its structure. Each level of the new structure is an ordinary petrinet of some traditional type. A basic level petrinet simulates the process of some application. The second level, i.e. the metapetrinet, is used to simulate and help controlling the configuration change at the basic level. There is conformity between the places of the second level structure and places or transitions of the basic level structure. Possible control rule is such that a certain place or transition is removed from the present configuration of the basic level if the corresponding place at the metalevel becomes empty. If at least one token appears to an empty metalevel place, then the originally defined corresponding basic level place or transition immediately is created back to the configuration (see Figure 4).

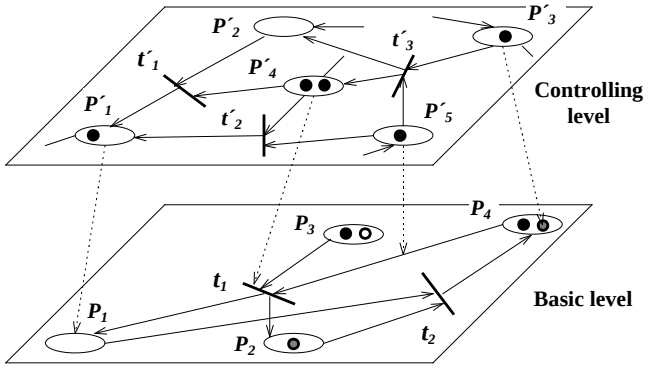

Figure 4. An example to illustrate the idea of metapetrinets [45]

In principle, the controlling level could effect all of the four attributes of a petrinet, i.e. places, transitions, links and tokens. It was shown that metapetrinets offer more compact facilities to the models of complex scenarios than single level petrinets [50].

These abilities of a metapetrinet make it very suitable to model multilevel structure of scenarios (transaction management profiles in location context) in p-commerce.

6 Conclusions

In this paper we study the concept of p-commerce as a public mobile electronic commerce. Paper is based into assumption that the future growth of m-commerce information services (more specifically - in location-based information content sailing) nowadays not as much depends on huge content providers but more depends on public business activity. An ordinary mobile user is transforming now from a consumer of commercial services to also a supplier of them. In this paper we propose an architecture, which is based on the assumption that every person in the society in some way more or less participates in public business process, which we name as *public commerce* (p-commerce). It is evident that such service should be able to integrate different types of information with geographical data and manage different type of profiles related to preferences, security, privacy, transaction management, etc.

A shared understanding of business domain that can be agreed among different players in p-commerce is necessary to provide reasonable service. The multilevel profiling framework discussed in this paper should be able to manage ontologies, which are necessary to standardize views to commercial operations and help users to reach consensus between any buyer and any seller about general and specific

features of their business relationships. Web content being interpreted via several contexts (filtered through different levels of profiles) becomes really useful for certain user in certain location and can be handled by small mobile devices. Also scenarios for business transaction management can be negotiated based on some profiles (like meta-scenarios) and then used for handling business transactions.

According to the "semantic web" trend, "the emphasis is on enriching the web's data markup languages with knowledge representation features, to permit inference over the content of web pages (prominent initiatives include DAML, OIL, and RDF). Goals include the production of: internet-scale inference mechanisms, knowledge markup languages, and active information-seeking services" [16]. Members of the e-business and the semantic web communities are starting cooperative effort to identify strengths, weaknesses, opportunities, and threats in the interaction between the two areas. One of the key questions is: where will be the biggest e-business pay-offs from using intelligent web technology [16]? Our answer is - public-commerce with mobile devices.

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