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Editorial

Emerging Technologies for Mobile Commerce

The emergence and popularity of 2G and 3G cellular networks as well as the high market penetration of mobile devices have created strong demands for introducing new applications in the area of mobile commerce (M-Commerce). M-Commerce deals with selling goods, services, and content, including related functions like advertising and payment transactions, over a cellular network, and hence follows similar purposes as E-Commerce in the fixed Internet. However, M-Commerce is characterized by interaction patterns between customers and services that are very different from those known from the E-Commerce area. Services are accessed via mobile devices with numeric keypads and small displays with low resolution, and hence viewing items, navigating web sites, entering URLs, or filling out forms are not as convenient as when made from a stationary PC or a notebook. In addition, mobile customers do not want to be disturbed while being occupied in a certain situation, for example, during a meeting or while driving a car. Rather, they want to shift service interactions to quiet times, for example, when waiting for a train.

Due to these reasons, service interfaces as well interaction and transaction patterns for M-Commerce cannot be simply adopted from the E-Commerce area, but must be built from the scratch by utilizing new and emerging technologies. In order to make M-Commerce a success and achieve a high degree of customer acceptance, the mobile services must be designed to be as convenient as possible and to serve the customer under consideration of her current situation.

Key technologies that can be used for fulfilling these demands are positioning, barcodes and Radio Frequency Identification Tags (RFIDs). Positioning is enabled, for example, by GPS receivers which in the near future will become a standard feature of mobile devices. It is especially suited for attracting the customer's attention to nearby shopping opportunities in the context of mobile marketing and advertising. Barcodes, on the other hand, can be scanned by each inbuilt camera of mobile devices and can be used on the spot when the customer wants to get additional information about a concrete product as well as for making transactions. RFIDs follow similar goals, but require that devices are equipped with dedicated radio technology. The following sections give an overview of these technologies.

Positioning and Location-based Services

Positioning is used to automatically derive the spatial location of a person, for example, in terms of coordinates of latitude, longitude, and altitude. It represents the key technology for realizing location-based services (LBSs), which provide information that has been created, compiled, selected, or filtered taking into consideration the locations of their users or those of other target persons. There is a broad range of applications LBSs can be used for, including health care, child tracking, navigation, and, most important in the context of this article, wireless advertising and marketing.

There exists various technologies for positioning, which can be roughly categorized according to their underlying infrastructure. The most well-known positioning system today is obviously the satellite-based Global Positioning System (GPS), which consists of nominally 24 satellites, each of it circulating the Earth twice a day and emitting pilot signals. GPS receivers located at the surface of the Earth then measure the traveling time of pilot signals from several satellites in order to obtain their positions by using circular lateration. A similar approach is followed by the European GALILEO system, which is expected to go into operation around 2010.

In mobile cellular networks, positioning is simply realized by deriving the location of a user by the coordinates of the serving base station, which is known under the term Cell-Id. Unfortunately, the accuracy of position fixes obtained in this way depends on the size of radio cells and varies between several hundreds of meters in urban areas and several kilometers in rural areas. To achieve higher accuracies yet, a number of advanced cellular positioning technologies have been developed and standardized. They are known under the terms Enhanced Observed Time Difference (E-OTD), Uplink Time Difference of Arrival (UTDoA), or Foward Link Trilateration (FLT), and are based on measuring the range differences between the mobile device and a number of fixed stations of the cellular network and calculating the position from that by using hyperbolic lateration. However, most of them require considerable extensions to be made in the cellular network infrastructure, which most operators so far avoid due to the high roll-out and operating costs.

While satellite and cellular positioning technologies have been specifically designed for outdoor applications, indoor systems based on, for example, WLAN can be used to obtain the position of a user inside a building. The position can be either derived by the serving WLAN access point (similar to the Cell-Id approach in cellular networks) or by comparing the signal patterns received from various access points with a database of signal patterns pre-recorded at well-defined positions. The major drawback of indoor positioning so far is a lack of standardization, and hence most systems available at the market today are based on proprietary measurement methods and protocols.

Unfortunately, the first generation of LBSs, which entered the market around the turn of the millennium, turned out not to be successful. The reasons for the bad acceptance are manifold and range from the usage of inaccurate and immature positioning technologies like Cell-Id to a lack of competition in this field. Both are being closely related to the fact that mobile network operators still represent the unique selling point for location data and often sell it to third party LBS providers against overpriced conditions or do not make it available at all.

However, the recently increasing market penetration of low-cost GPS receivers (which maybe even integrated into cellular phones) on the one hand and the appearance of new geographic content providers like GoogleMaps on the other dramatically change the way LBSs can be realized and applied. In conjunction with 2G or 3G data services, location data can now be easily obtained by third party LBS providers directly from the mobile device and easily combined with geographic content like maps or with yellow pages for obtaining nearby points of interest. Thus, the LBS supply chain, which was regulated so far by mobile network operators, opens up and results in highly competitive multi-provider environments, which are expected to generate LBSs with new and sophisticated functions.

In the area of M-Commerce, a special focus is on utilizing LBSs and positioning for the purposes of mobile marketing. In general, mobile marketing is a sales approach that helps manufacturers, shopping malls, and service agencies to promote their products and services by interacting with customers through their mobile devices. The contact with a consumer is usually established via short messages, a Web browser, or a dedicated front end based on the Java 2 Micro Edition (J2ME). Unlike conventional campaigns in television, newspapers, and journals, the target groups of special products and services can be selected very accurately by evaluating customer profiles and observing a customer's buying patterns in the past. Although the customer's location is only another data item in this process, it helps to significantly improve the distribution of advertisement messages under consideration of the customer's current situation.

In a rudimentary approach, location-based mobile marketing can be realized by so-called finder services, which provide the customer with information about nearby services and products, for example, restaurants or filling stations, maybe combined with the latest fees and conditions, opening hours, or telephone numbers for making reservations. In an advanced approach, it can be offered in a proactive fashion, where the customer specifies her interests for special products and services in advance and is then automatically informed by a short message as soon as she comes into close vicinity of shops or malls offering her favorite products and services. Optionally, this message might also contain additional benefits like coupons or allowances. Furthermore, it is possible to combine such service features with others, for example, navigation as provided by an on-board unit inside vehicles. Positioning can also be applied for controlling the access to non-public places like theatres, cinemas, and discotheques. For example, frequently visiting customers could receive benefits or even get access to such places free-of-charge, while others have to pay the usual fees.

Thus, from the point of view of customers in the context of M-Commerce the attractiveness of LBSs and positioning results from the fact that they can be provided with information about nearby shopping opportunities and services while not having to enter location information manually. From the point of view of providers, the major advantage lies in the knowledge about the customer's whereabouts, moving patterns, leisure habits, and favorite shopping places as well as in the distribution of advertisement messages right at the time when the customer comes into close proximity of the advertised products and services.

2-D Barcode Technology

It has been about 30 years since the first linear barcodes were used for railway transportation and tracking of the goods in USA. Since then, barcodes have been used almost everywhere, including manufacturing, postal, transportation, government, health care, retail business, trade show, and automotive business. Barcodes, as machine-readable representation of information in a visual format, can be easily stored, transferred, processed, and validated. A linear barcode refers a way of encoding numbers and letters in a sequence of varying width bars and spaces so that it can be read, retrieved, processed, and validated using a computer. Using barcodes provides a simple and inexpensive method of encoding text information that is easily read using electronic readers. Barcodes are used widely because barcode code technology and processing provide a fast and accurate tool to enter data without keyboard data entry.

Using 2D barcodes requires the following enabling technologies:

- Encoding, decoding, and scanning programs which are developed based on a selected 2D barcode symbology. They are installed and used on mobile devices or scanner devices.
- 2D barcode generation and management tools which support the diverse 2D barcode standards and symbologies.
- Mobile 2D barcode readers and scanner devices which are cost-effective and easy to work with mobile devices.
- 2D barcode-based mobile application systems that provide mobile users diverse mobile applications and M-commerce services using a specific 2D barcode technology.

The barcode symbology refers to the protocol that defines a standard for arranging the bars and spaces that comprise a particular type of barcode, such as UPC-A and EAN. It defines the technical details of a particular barcode type, including the width of bars, character set, method of encoding, checksum specifications, etc.

Since the earlier forms of linear barcodes were not capable of encoding letters, 2-D barcodes were invented to meet the needs of encoding alphanumberic data, including letters, numbers, and punctuation marks. At the end of 1980s, two-dimensional (2D) barcodes appeared. With a much larger data capacity, 2-D barcodes become popularly used in different areas. PDF417, Micro PDF417, and DataMatrix are typical examples. In general, there are two types of 2D barcodes: a) stacked 2D barcodes, and b) Matrix 2D barcodes. The table below provides more details about them.

 PDF417 Sample	Stacked 2D barcodes are stacked by several rows of linear barcodes. PDF417 is the best example. Stacked-bar symbologies can be read by rastering laser scanners, cameras, or CDDs.	 DataMatrix	Matrix codes are made up of a pattern of cells that can be square, hexagonal, or circular in shape. Matrix symbols must be read by a camera or CDD reader. DataMatrix is the best example.

With the fast increase of the number of wireless users, more M-commerce application systems and services are needed. However, one of the critical issues in building M-commerce systems is mobile data entry. For example, when a mobile customer wants to access a wireless internet site (http://yahoo.com) using a mobile phone, she must enter the address through 33 clicks using the device keyboards. Therefore, the major challenge in M-commerce is where to find an effective interface technology to support the simple and efficient interactions between mobile customers and M-commerce systems without mobile keyboard data entry. Barcodes provide a simple and effective solution to cope with this issue because of their advantages over linear barcodes in data capacity and visual representation size. For instance, using the shotcode solution given in http://www.shotcode.com/ mobile customers only needs two clicks to enter the URL http://yahoo.com.

Until recently, people are gradually realized the importance of 2D barcode and its great application value in M-Commerce because of the followings:

- 2D barcodes provide a new effective input channel for mobile customers carrying mobile devices with inbuilt cameras.
- 2D barcode is becoming a popular approach to present semantic mobile data with standard formats.
- 2D barcodes support a new interactive and efficient approach between mobile customers and wireless application systems.
- 2D barcode technology can be and are being used in diverse applications in mobile commerce.

The table given below lists a number of major players for 2D barcode technology.

Intelcom – www.intelcom.ru	It has been engaged in development of 2D barcode methods and software since 1999, and developed a software development kit for supporting encoding, decoding, and scanning of 2D barcodes (such as Data Matrix ECC200) on Nokia 7650/3650 mobile phones.
Xerox	It is a major player in data hiding with its DataGlyphs and Embedding Digital Data. Its applications include document management, fraud prevention, inventory tracking, ID cards, parts marking or product tagging.
RSVI Acuity CiMatrix Co.	It is a leader in machine vision and is inventor of DataMatrix Symbology. 2D barcode tags can also be used in personal identification based on biometric technology.
Sony Inc.	It has many research and experiment in use of 2D barcodes as a visual tag and way of human and computer or electric device interactions.
NTT DoCoMo	It is a leading Japanese company in wireless technology and mobile software applications for mobile phone uses. It has a number of research results on 2D barcode technology, and has built a 2D barcode-based application system for mobile consumers in food markets.
TAL Technologies Inc.- http://www.taltech.com	It is a player in developing tools for 2D barcode encoding barcodes and decoding.
AirClic-www.airclic.com	It provides tiny barcode readers, which can be attached to mobile phones.

As the fast advance of 2D barcode enabling technology, people have found its great value and diverse applications in M-commerce.

- *Wireless advertising and marketing* – 2D barcode becomes one of best cost-effective advertising and marketing tool for advertisers and manufactures. Using a mobile camera phone, a customer can easily input a 2D barcode on a product advertisement (posted everyone), found more product information from the barcode. When the

customer likes the product, only a very few clicks can lead to a trading transaction with the backbone M-commerce application system. Clear mobile 2D barcode ads on mobile devices are transaction-oriented ads, which allow mobile customers to purchase products as long as they see their ads at anywhere and anytime.

- *Wireless trading (pre-sale/sale-and-buy/ post-sale)* – Using 2D Barcodes on products and goods, merchants and manufactures allow mobile customers to find more detailed product information. For example, NTT DoCoMo, in Japan, is developing a system using 2D barcodes for food consumers. Using mobile camera phones, consumers can easily input a 2D barcode of a product by scanning product barcodes in the store, and found more detailed information about each product, including producers, harvest date, shipping date, and agricultural chemicals in each found. In addition, 2D barcodes also very useful in post-sale, including product tracking, shipping, and delivery. Furthermore, they can be used as very effective tool to prevent the frauds in luxury goods, such as paintings.
- *Mobile security*– As we know most security solutions are developed based on some kinds of encoding and decoding cryptographic algorithms, clearly it is easy to use 2D barcode technology to embed diverse security data (or code) as a party a 2D barcode in the encoding and decoding process.
- *Mobile customer and product verification* - Using 2D barcodes merchants (or delivery man) can easily perform various verifications using mobile scanner devices (or mobile devices) to scan 2D barcodes on a movie (or train/flight/sport) ticket, a coupon, a good, or an invoice. Consumers also be able to carry out product verification by accessing the 2D barcode of a product/package to check its detailed product information, track its shipping and transaction history.
- *Wireless payment* – Most current electronic payment systems are account-based payment systems (using ATM/credit/cash cards and e-checks), micro-payment system based on digital cashes, and e-wallets. 2D barcode technology provides a new way to develop mobile e-card based payment systems that allow customers to make payments using mobile phones with 2D barcode technology. For instance, 2D barcodes can be used as to present different digital mobile cards. They can be stored in a wallet of mobile devices, and used to make diverse type wireless payment transactions at anywhere and anytime. The typical mobile payment transactions are: a) peer-to-peer transactions between a buyer and a seller, and b) point-of-sale transactions between a mobile device and a terminal device, such as a vending machine, a casher's payment station, and a TAXI driver's payment device. With 2D barcodes, mobile payment solutions should be able to provide more secure, efficient, and easy to use payment solutions to mobile customers.

RFID

In the recent two years, the radio-frequency identification (RFID) has been becoming an important emerging technology, bringing much interest in the wireless world and the E-commerce community. RFID enabled systems refer to a system which automatically tracks and transmits identification numbers using radio as the media. The first generation of RFID-enabled systems had been used at the end of World War II to distinguish friendly and enemy aircrafts from a distance. Since then, RFID has been used for many different applications, including animal tracking, automatic toll collection, access control systems, and supply-chain.

An RFID-enabled system consists of three parts:
a) the RFID tag, which uniquely identifies an item (or object). Each tag includes a microcontroller, an antenna (either wire or printed using conductive carbon ink), and a wrapper made of polymer-encapsulating material.
b) the reader, which automatically initiates the identification process by generating an RF field using a specific frequency defined by the particular system. An RFID tag is detected when it is optionally authenticating the reader via a challenge-response mechanism, and is responded by transmitting its identifier.
c) the backbone supporting system, which usually provides the pre-defined RFID tag tracking, analysis, reacting and processing functions that enable to further applications.

According to [1], RFID tags can be classified into two types. The first type is known as passive tags which operate without a power source and have a high error rate in data transmission. They normally can be read by a reader within a few centimeters. The other type is known as active tags which operate with a power source, provide much more reliable communication in a range up to 100 meters.

The recent significant increase of the number of mobile device users leads a strong interest from merchants and manufactures in finding more personal and intelligent electronic commerce solutions. Using today's RFID technology, RFID-enabling application systems can be developed to bring the following major changes and impacts in e-commerce.

- Providing a direct interactive channel between tagged products (or goods) and consumers - For high-cost products, it is feasible to do item-based tagging in retails, so that item-based promotion, trading, and sale can be easily carried out among consumers with RFID enabled mobile devices.
- Easy to carry out the vendor-managed inventory (VMI) – VMI is one successful approach to advocating the use of information technology to maximize consumer value and minimize supply-chain inefficiencies. Using this approach, the vendor (rather than the customer) is able to specify delivery quantities sent through the distribution channel because using RFID to monitor the store-keeping units (SKU) further improves the VMI efficiency by eliminating manual scanning of stock. Therefore, enterprise resource planning (ERP) software can use more accurate real-time inventory information to perform optimized business logistics.

- Performing accurate consumer targeting for item-based product sales and promotion – Using RFID tags and RFID enabled mobile devices, more intelligent functions can be built into E-commerce systems, which controls and interacts mobile client software on RFID-enabled mobile devices to perform real-time consumer targeting and promotion for product items with RIFD tags in a store. This mobile client software will performs as an intelligent virtual sales man who matches a tagged product to a right on-site consumer.

With the fast advance of RFID technology and M-commerce, more RFID enabling M-commerce applications and systems will be developed to meet the current and future demand, even though there are a numerous issues and challenges in consumer privacy protection, RFID standards and risk management. In the near future, it is easy to see that the RFID technology will be widely accepted and used in the supply chain at the SKU level. More RFID-enabled retail stores and shipping malls will appear, in which high-cost product items are tagged with RFID labels, and RFID-enabled shopping carts are features with RFID readers. Consumers using an RFID-enabled shopping cart can easily find the desirable products and related information with the support of a backbone E-commerce system. Today, other RFID-enabled mobile devices (such as PDAs or Smart phones) are commercially available and becoming increasingly popular. They will be used as a part of future M-commerce application systems.

Concluding Remarks

Positioning, barcodes and RFID are key technologies for easing the interaction between mobile customers and M-commerce application systems, to introduce new interaction and advertisement patterns, and to serve customers under consideration of their current situation. However, these technologies will only gain acceptance if the privacy of customers is not violated in that the data derived by them is used for other purposes than it was initially collected for or misused in another, criminal sense. Furthermore, such services must be designed in a way that consumers do not feel harassed by incoming advertisement messages. They should be delivered to a customer only if they are in accordance with her interest profile, and it must be possible to conveniently cancel a subscription either permanently or temporarily. A major challenge in this context is also the development of privacy protection mechanisms, for example, privacy constraints for defining how to use and process a customer's personal data or anonymization techniques, which allow to hide a customer's true identity from certain actors participating in the supply chain of an M-commerce application system.

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