

MOBILE COMMERCE APPLICATIONS AND SERVICES: A DESIGN AND DEVELOPMENT APPROACH

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ABSTRACT

Mobile Commerce is an evolving area of e-Commerce, where users can interact with the service providers through a mobile and wireless network, using mobile devices for information retrieval and transaction processing. M-Commerce services and applications can be adopted through different wireless and mobile networks, with the aid of several mobile devices. However, constraints of both mobile networks and devices influence their operational performance; therefore, there is a strong need for taking into consideration those constraints in the design and development phases of m-Commerce services and applications. Another important factor in designing m-Commerce services and applications is the identification of mobile users requirements. Furthermore, m-Commerce services and applications need to be classified based on the functionality they provide to the mobile users. This kind of classification results in two major classes: the directory and the transaction-oriented services and applications. This paper suggests a new approach for designing and developing m-Commerce services and applications. This approach relies on mobile users needs and requirements, the classification of the m-Commerce services and applications, as well as the current technologies for mobile and wireless computing and their constraints.

Key Words: m-Commerce, mobile network, mobile user requirements, mobile services and applications.

1. INTRODUCTION

Mobile commerce (m-Commerce) is creating entirely new opportunities both for mobile devices and services. M-Commerce means transactions using a wireless device and data connection, which result in the transfer of value in exchange of information, services, or goods. An m-Commerce transaction is defined [1] as any type of transaction of an economic value that is conducted through a mobile device that uses a wireless telecommunications network for communication with the e-commerce infrastructure. M-Commerce differs partially from e-Commerce (electronic commerce) due to the special characteristics and constraints the mobile devices and wireless networks have.

The number of users of mobile devices is continuously increasing. A projected number of hand-held (mobile) devices will exceed the number of stationary terminals in the world in the next few years.

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People on the move need services, information and entertainment that move with them. With access to mobile devices, such applications and services can happen here and now.

Mobile services benefit from three major factors [2] that boost information value to end-users: personalization, time-sensitivity, and location awareness. Combining these elements adds even more value.

M-Commerce services and applications can be adopted through different wireless and mobile networks, with the aid of several mobile devices. Although there are many systems supporting mobility and many solutions for wireless access, there are issues influencing the performance of the various mobile systems that need to be considered in the design of m-Commerce services and applications. This applies also to mobile devices that exhibit some major drawbacks compared to desktop systems.

An important factor in designing m-Commerce services and applications is the need for identification of the mobile users requirements, and the classification of the services with their unique properties.

In this paper we suggested a new approach for designing and developing m-Commerce services and applications. This approach relies on mobile users needs and requirements, the classification of the m-Commerce services and applications, as well as the current technologies for mobile and wireless computing and their constraints.

The paper is organized as follows: Section 2 reviews the various wireless and mobile networks and devices, as well as their constraints. Section 3 addresses the identification of mobile user requirements, and Section 4 classifies the m-Commerce services and applications in two major classes. Then Section 5 suggests a new design and development methodology for m-Commerce services and applications based on the previous findings. Finally, in Section 6 we present our conclusions.

2. MOBILE DEVICES AND TECHNOLOGIES

The mobile devices of the future will be more powerful, less heavy, and comprise new interfaces to the user and to new networks. However, a major problem, which has not been solved yet, is the energy supply. The more features built into a device, the more power it needs. Consequently, the higher the performance of the device, the faster it drains the batteries. Furthermore, wireless data transmission consumes a lot of energy [3].

Despite the rapid development of mobile computing, the mobile devices exhibit some serious drawbacks compared to desktop systems in addition to the high power consumption. Interfaces have to be small enough to make the device portable. Thus, smaller keyboards or hand scribing are used, which are frequently difficult to use for typing due to their limited key size, or current limitations of hand scribing recognition. Furthermore, small displays offer limited capabilities for high quality graphical display. Therefore, these devices have to use new ways of interacting with a user, such as, e.g., voice recognition and touch sensitive displays [3].

The evolution of radio and mobile core network technologies over the last two decades has enabled the development of the ubiquitous personal communications services, which can provide the mobile user with voice, data, and multimedia services at any time, any place, and in any format [4]. Business opportunities for such services are tremendous, since every person could be equipped, as long as the service is fairly inexpensive.

The necessary infrastructure for wireless mobile networking in general combines various wireless networks including cellular, wireless LAN, private and public radio [1]. The huge proliferation of digital

wireless telecommunication networks creates the need for the presentation and delivery of wireless information and services on mobile devices. These considerations resulted in the development of the Wireless Application Protocol (WAP) on one hand and TCP/IP with HTTP layers supporting mobile devices on the other [1].

WAP is the de-facto standard developed by the WAP Forum [5] to optimize Internet standards due to the constraints of the wireless environment and mobile devices. Its simple Wireless Markup Language (WML) and simple browsers for the language, as well as a special protocol stack (WAP stack), suit better the wireless environment than the standard TCP/IP with HTTP stack [6].

Many network technologies support WAP, such as GSM 900 & 1800 MHz (2G networks), GPRS (2.5G), and UMTS (3G). Circuit switched data networks, i.e., GSM infrastructure, offer typically a bandwidth ranging from 9.6 to 14.4 kbit/sec, for both downlink and uplink directions for the application data.

A new access technology has lately evolved, namely GPRS (General Packet Radio Service) that is a packet switch wireless protocol. It provides a continuous connectivity between the mobile device and the network offering up to 114 kbit/sec transmission rates (about 30 kbit/sec effectively). Furthermore, the EGDE (Enhanced Data rates for Global Evolution) technology offers up to 560 kbit/sec transfer rates (about 300 kbit/sec effectively).

Nowadays, the major interest is in the 3rd Generation (3G) networks, namely UMTS (Universal Mobile Telecommunications System) technology. 3G networks can provide up to 2 Mbit/sec connections for both uplink and downlink directions. They are expected to offer better system capacity and higher transmission speed to support wireless multimedia services (including audio, video, and images).

Although there are many systems supporting mobility and many solutions for wireless access, there is still a lot to be done in the field. The major issues influencing the performance of the various mobile systems are the following [3]:

- *Interference*: Higher loss rates due to the fact that radio transmission cannot be protected against interference.
- *Low bandwidth*: Although they are continuously increasing, transmission rates are still very low for wireless devices compared to fixed-wired networks. Local wireless systems reach some Mbit/sec while wide area systems only offer some 10s kbit/sec.
- *High delays, large delay variation*: High delays of hundred milliseconds to seconds can occur.
- *Lower security, simpler to attack*: The radio interface is prone to the danger of being attacked. Thus, wireless access always has to include encryption, authentication, and other security mechanisms (thus increasing complexity and delay).
- *Frequent disconnections*: Cell interference, limited cell capacity or lack of network coverage can lead to frequent disconnections.

The understanding of existing mobile devices and technologies together with mobile user requirements, described in Section 3, is necessary for the design and development of m-Commerce services and applications.

3. MOBILE USER REQUIREMENTS

M-Commerce includes features and characteristics that are different from e-Commerce, and these should be taken into consideration during the design and development of m-Commerce services and applications. **Table 1** provides examples of m-Commerce applications linked to their more salient features [7, 8].

- *Ubiquity*: Mobile users must have the ability to receive information and perform transactions in real-time, regardless of location. M-Commerce can be present in any location or several places simultaneously.
- *Personalization*: The huge amount of information, services and applications presented on the Internet is of great importance, but users of mobile devices require different services and applications that should be personalized according to their preferences.
- *Flexibility*: Users of mobile devices should be able to engage in activities such as, receiving information, and conducting transactions with ease.
- *Localization*: Mobile users should have access to local information and services. This can be accomplished by having service providers know the location of mobile users in order to promote their products and services directly to their customers in a local environment.

Table 1: Examples of m-Commerce applications with their more salient features

M-Commerce Features	Examples of M-Commerce Applications
Ubiquity	Stock Prices Weather
Personalization	Advertising Auctions
Flexibility	Purchase of goods Banking
Localization	Customer Service Local Directory

M-Commerce customers may be more demanding and less patient than e-commerce users [7, 8]. Mobile users require value-added services that can be feasible or non-feasible according to existing technologies and m-Commerce constraints, such as, performance, reliability, security, ease of use, bandwidth, etc. These requirements can be summarized as follows:

- Easy and timely access to information (e.g. the latest availability of flights)
- Immediate purchase opportunity (e.g. the immediate purchase of tickets)
- Provision of wireless coupons based on user profiles (e.g. the delivery of messages about a current sale in a local store)
- Bank transactions through mobile terminals (e.g. the withdrawal of money from an account that can be used later for an electronic payment)
- Location management (e.g. locating a person/ATM/restaurant that is nearby)

M-Commerce features and characteristics, mobile user requirements as well as, technology constraints orient the design and development of an m-commerce system and hence these must be used as the primary axons which will guide its production.

4. M-COMMERCE SERVICES AND APPLICATIONS CLASSIFICATION

One way to classify m-Commerce services and applications is based on the functionality they provide to the mobile users. This kind of classification results in two major classes: the *directory* and the *transaction-oriented* services and applications. The major categorization between these two classes of services is that in the former a mobile user performs only read requests to the directory, whereas in the latter a user performs read and write requests to the transaction server. It is necessary to note that an m-Commerce application can be a combination of both classes.

The directory-oriented class of m-Commerce services comprises applications that provide information to mobile users. This information can be location, content and user dependent, being localized and personalized in ways appropriate to the specific mobile user. For example, a mobile user, being away from home, needs up-to-date information regarding his current location, and local facilities that he can use. Note that directory-oriented m-Commerce services can be offered via broadcast.

The transaction-oriented class comprises various services and applications with which the mobile user conducts transactions with the service provider. The transactions contain read and write operations on behalf of the mobile user. For example, a banking service for mobile users falls into the transaction-oriented class of m-Commerce services.

The current mobile and wireless technologies suffer from constraints due to the wireless and mobile environment, as these were described in Section 2. These constraints influence the transaction-oriented m-Commerce services in a much higher degree in terms of operation, than the directory-oriented m-Commerce services. Problems like frequent and sudden disconnection, weak connectivity, and high delays degrade the quality of service offered to mobile users, and add complexity to the service provider. Consequently, the service provider must find ways and solutions to deal with these problems in order to maintain the quality levels of the service and reduce the computational overhead, which derives from the disconnected users' active sessions.

The above classification of services can help the service providers to deal with specific problems of each class independently. In the case of the directory-oriented m-Commerce services and applications replication, copies of the local content, and copies on the base stations of the mobile infrastructure can help the availability and increase the quality of this kind of services. On the other hand, strategies like the use of intercept agents and proxies on the fixed-wired network can help the increase of the availability and stability of the transaction-oriented m-Commerce. The use of intercept agents can also hide the problems and constraints of the mobile environment from the service provider and move the responsibility on the specially designed intercept agents [9].

Table 2 summarizes the constraints and the requirements for both the directory and the transaction-oriented m-Commerce services, which drive the design and development of m-commerce systems falling into each category of services. For example the last minute purchase of a flight ticket requires quick access and response time from a directory-oriented service and bounded transaction execution time, data integrity and security for the actual transaction to be made since this is a combination of both directory-oriented and transaction-oriented m-Commerce service.

Table 2. Constraints and requirements for directory and transaction-oriented m-Commerce services

Directory-Oriented	High availability Quick access time Quick response time Localization Personalization Filtering (Rules filtering) Security
Transaction-Oriented	Bounded transaction execution time Data consistency Data Integrity Security Redundancy

5. DESIGN AND DEVELOPMENT METHODOLOGY FOR M-COMMERCE SERVICES

In this section we will suggest a new methodology for designing and developing m-Commerce services and applications. This approach relies on the special needs and requirements of the mobile users as defined in Section 3, the classification of m-Commerce services and applications presented in Section 4, as well as the current technologies for mobile and wireless computing and their constraints, described in Section 2.

The m-Commerce services and applications analysis and design can be incorporated in a modified Web engineering (WebE) process [10] (see

Figure 1). This modified WebE process includes six phases: a) Formulation, b) Planning, c) Analysis, d) Engineering, e) Service Implementation & Testing, and f) User Evaluation:

- a. Formulation – Defines the tasks and goals of the m-Commerce service and application and specifies the length of the first increment.
- b. Planning – Estimates the total project cost and the risks associated with it, and sets a timeframe for the implementation of the first increment as well as the process of the next increments.
- c. Analysis – Identifies all the mobile user requirements.
- d. Engineering – It involves two parallel tasks: i). Content design and Production, and
 ii). Architectural, Navigation, and Interface design.
- e. Service Implementation & Testing – Development task for the creation of the m-Commerce service and application.
- f. User Evaluation – Evaluates each task and proposes new modifications and expansions that need to be incorporated to the next increment.

The Analysis phase should take into consideration the classification of the m-Commerce services and applications to directory and transaction-oriented, in order to identify the specific mobile user requirements for each class of services.

The directory-oriented class of services shares different constraints than the transaction-oriented class. Examples of m-Commerce constraints related to the service and application offered are navigation mechanisms, security, reliability, small screens, etc. In the paradigm of a mobile user that wishes to enter into a mobile transaction, the requirements of ease-of-navigation, high security and reliability are just few of the factors that are of a higher importance than in the case of a directory-oriented service or application.

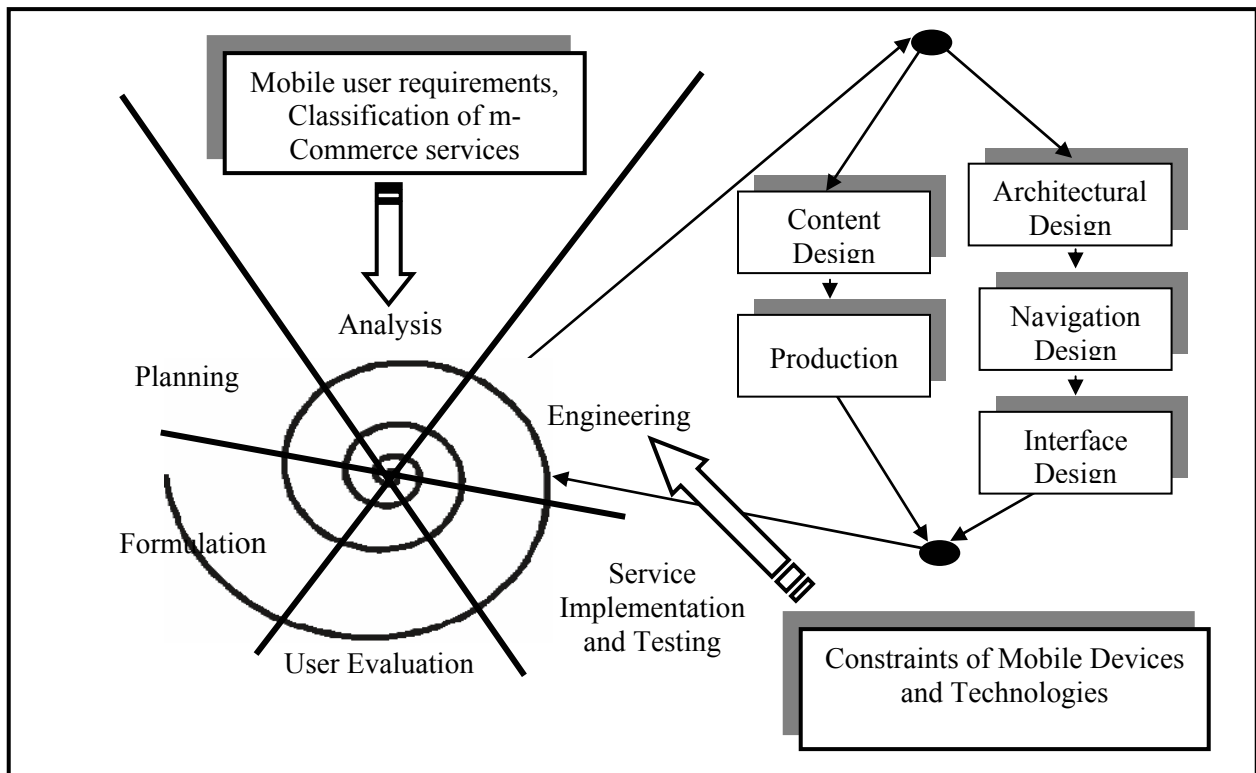


Figure 1: The modified WebE process for m-Commerce services and applications

In the Engineering phase, the peculiarities of the mobile environment and devices reported in Section 2 need to be considered (e.g. tiny displays, drain of batteries, connectivity problems, and diverse device profiles). This consideration will enable the orientation of both the type and volume of content, the form of the navigating facilities to access this content and finally, the m-Commerce device interface, as well as the architectural design of the whole system. Therefore it is necessary to classify the constraints of mobile networks and devices according to the type of mobile device since they share different characteristics and requirements. **Table 3** classifies the impact on the design and implementation phase of each constraint as high, medium or low for each type of mobile device. For example, a mobile service provider who wishes to offer its mobile users the ability to purchase flowers, has to take into account several constraints that affect the design and development of the m-Commerce application according to the mobile device used. If the mobile customer uses a mobile phone the constraints' impact is high, such as small screen, small

multifunction keypads, graphical limitations, etc., while if he uses a palm computer the constraints impact is lower.

In the User Evaluation phase the m-Commerce system must enter an evaluation phase by the end-users, that is, potential recipients of the system's services. The system can be evaluated by a selected group of people (e.g. 100 users) in terms of user requirements, constraints and the type of mobile device used for the m-Commerce service or application.

Table 3. Classification of M-Commerce constraints and their impact on the design process according to existing mobile devices

M-Commerce Constraints	Mobile Phone	PDA	Palm	Laptop
Small Screen	High	Medium	Low	Low
Small multifunction key pads	High	Medium/ High	Medium	Low
Limited Computational Power	High	Medium	Low	Low
Limited Memory	High	Medium	Low	Low
Limited Battery Life	High	High	High	High
Non-volatile Capacity	High	High	Medium/High	Low
Low Display Resolution	High	High	Low	Low
Unfriendly User Interface	High	Medium/High	Low	Low
Graphical Limitations	High	High	Low	Low
Complicated Text Input Mechanisms	High	Medium/ High	Low	Low
Limited Security	High	High	Medium	Medium
Limited Bandwidth	High	High	High	High
Low Connection Stability	High	High	High	High

Identifying, classifying and examining mobile user requirements in the Analysis phase and constraints of mobile devices and technologies in the Engineering phase is a critical aspect in the design and development of m-Commerce services and applications.

6. CONCLUSIONS

M-Commerce is an evolving area of e-Commerce, where users can interact with the service providers through a mobile and wireless network, using mobile devices for information retrieval and transaction processing.

M-Commerce services and applications can be adopted through different wireless and mobile networks, with the aid of several mobile devices. Although there are many systems supporting mobility and many solutions for wireless access, there are issues influencing the performance of the various mobile systems

that need to be considered in the design of m-Commerce services and applications. This applies also to mobile devices that exhibit some major drawbacks compared to desktop systems. An important factor in designing m-Commerce services and applications is the need for proper identification of mobile users' requirements, as well as mobile devices and technologies constraints. Services and applications are designed and developed according to these requirements and constraints.

M-Commerce services and applications can be classified based on the functionality they provide to the mobile users for allowing easier identification of constraints posed on the design and development process. This kind of classification results in two major classes: the *directory* and the *transaction-oriented* services and applications, with their unique properties.

This paper suggested a new approach for designing and developing m-Commerce services and applications. The proposed approach relies on mobile user needs and requirements, the classification of m-Commerce services and applications, as well as the current technologies for mobile and wireless computing and their constraints. Future work will include the verification of the methodology described through the actual development of m-Commerce services and applications for each of the two classes reported.

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