



A NOVEL WIRELESS NETWORK BASED MOBILE E-BUSINESS GENERAL ARCHITECTURE

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ABSTRACT

The upcoming mobile and ubiquitous computing world will need new forms of information sharing and services collaboration between mobile devices, thus to support mobile commerce applications. In this paper, a general mobile business architecture (GMBA: General Mobile Business Architecture) was presented, which can be used in hybrid network environment with wireless network for GMBA. General mobile business architecture relies on wireless peer-to-peer communication model to provide mobile business services. More than 6 major main blocks of the GMBA are defined and the responsibility of each of them is described. In order to illustrate the validation of proposed GMBA, a mobile commerce services application based on GMBA was created, which contains several main blocks of GMBA to perform a particular task promotion mobile service for store vendors among wireless device holders in a reasonable moving area with mutual one-hop radio reachable distance.

Keywords: *E_business, Application architecture, wireless network*

1. INTRODUCTION

Internet characterized by open standard, public network, and broad connectivity [1], has made many traditional firms, particularly manufacturing firms, simultaneously increase sales and reduce operational costs by a strategic use of B2B e-business [2]. Moreover, B2B e-business technology can provide an efficient support for sharing information and knowledge and integrating business processes between supply chain partners [3]. Therefore, more and more traditional firms invest a lot of money in deploying e-business in internal value chain and external supply chain activities to significantly improve their performance. Extant research has made two important observations in the context of this steady. On the one hand, most researches show that although e-business are increasing in popularity, they are difficult to manage, and that firms generally fail with B2B e-business [1,4,5].

Recent advances in wireless technology along with demands for greater user mobility have led to the development of wireless sensor network, and wireless sensor network has always been a popular research topic among all of the wireless related research areas. Wireless sensor network devices can automatically recognize the presence of other

wireless device through sensing the presence of neighbor beacons. Applications on a PDA or any other mobile devices can initiate synchronization task with their desktop peers over a wireless interface. This allows the transfer of files, emails, and even personal schedules seamlessly from mobile devices to wired computing devices. E-commerce has been a revolution for the market place and has greatly influenced and changed the way people do business in terms both of speed and efficiency. Mobility has added a new dimension to the "global marketplace". Unlike the mobile commerce built from cellular phone communication with telecommunication network, wireless networks support a novel data transmission environment for e-commerce. This kind of high-bandwidth data transmission environment motivates the creation of a large set of value-added services. Most of them particularly target on potential mobile consumers. In this paper, the architecture for the designation and development of e-commerce applications with particular emphasis on the use of powerful portable and mobile devices for this new mobile environment in the future will be described.

The obstacles to general mobile commerce on cell phone network, such as the high cost of infrastructure, expensive services fee, and low bandwidth support have limited the services



evolution of wireless telecommunication. Due to the convenient and fast deployment characteristics of wireless network computing devices with wireless data transmission capability such as IPAD, intelligent cell phones and personal data assistants (PDAs) [6,7] will probably become daily constant companions. This trend will inevitably change the current e-Commerce process and lead to a whole new m-Commerce business process.

Now, wireless communication infrastructures will be convoluted as one big Inter-network with different gateways. However, individual network structure will still be different from each other and wireless network will be one of the infrastructures. In wireless networks, mobile services can be deployed much faster and support more functionalities. Mobile users can get the right information at the right place. For example, if a user is in a mall, information like the lowest price associate with a product can be made known, enabling them to make a decision. Being at the shopping mall allows a user to see and feel the real product that he/she plans to buy, but he/she can make the buying decision on-line.

As this paper mentioned above, this paper's motivation behind GMBA can be expressed as follows: "Develop a novel GMBA to support universal mobile applications providing reliable, in-time, service-oriented commerce framework around life." This paper presents the general mobile business architecture in which the components required to support mobile commerce in general architecture need be studied.

This paper is organized as follows: the latest research related work is introduced in section 2. Since this research needs to use wireless network, the definition of wireless network and corresponding applications will be described. In section 3, this section indicates the challenge of mobile peer-to-peer systems, it also illustrates the 4-layer framework of m-Commerce development for wireless network and presents the goal and overall architecture of GMBA. Section 4 gives a concrete example of m-Commerce application implementation, a mobile commerce services application based on GMBA. Finally, section 5 concludes this paper and discusses directions for future work.

2. THEORY AND HYPOTHESES

In light of the growing prevalence of B2B e-business and the generally low success that firms usually achieve with them, a firm can enjoy a

significant competitive advantage over its peers or rivals if it can achieve greater overall e-business success. Hence, the academics have become extremely interested in understanding factors that explain how firms have greater e-business success. Insights which address this question have been provided by research on information technology capability or e-business competence over the last decade.

Based on the discussion above, we propose that any firm must simultaneously develop and use e-business system in an efficient and effective way, if it wants to leverage e-business investment to have greater e-business success, and that this application capability is rooted in system development and usage activities. Application capability of e-business helps firms improve e-business success by two inter-independent and inter-connective mechanisms: (1) efficiently deploying and using e-business investment to develop a successful e-business system in order to build e-business systems capability, and (2) enabling all participant firms to effectively use the e-business system in order to support supply chain coordination and collaboration, thus achieving e-business success. Therefore, application capability of e-business can be defined as a firm's capability to efficiently deploy and use e-business technology resources and complementary resources to build high-quality e-business systems, and to effectively use the systems to support supply chain coordination and collaboration thus improving organizational performance.

Different from the wire-based P2P model, P2P in wireless network is a "transitory association of mobile nodes which do not depend upon any fixed support infrastructure. Connection and disconnection is controlled by the distance among nodes and by willingness to collaborate in the formation of cohesive, albeit transitory community." [8,9,10]. What heterogeneous between typical and wireless network will be simply presented. In addition, a few notions of JXTA in this GMBA will be used; therefore Wireless P2P system will be described in detail.

Some of the current platforms and applications for wireless network in this section will be described. These architectures are really P2P computing-oriented and notions of these are referenced by the proposed GMBA.

There exists a platform-independent framework[11]. It provides application development architecture as well as a large number

of possible services support. The infrastructure of this platform-independent framework is composed of two function modules[12].

Service discovery module: Each mobile device installs a service discovery module which is in charge of the service discovery mechanism. The agent acts as a broker to discover the require services. The service discovery module interacts with the message layer to send and receive the discovery and task messages. The message layer is built on top of the transport layer.

Service delivery module: Service delivery consists of a two-step process – service description where the client learns about the properties and capabilities of the service, and service usage where the client avails the capabilities.

In wireless networks users may not even be aware to which devices they are connected. Thus, not only must encryption be employed to avoid eavesdropping but also robust authentication procedures need to be established for connecting both trusted and non-trusted devices with each other.

3. GENERAL MOBILE BUSINESS ARCHITECTURE

In recent years, E-commerce has tremendous growth under fixed-wire network architecture. Lately, equipped with powerful handheld devices and wireless communication technologies, new business-style applications under mobile environments have emerged beyond the horizontal line. In this section, the m-Commerce framework concept will be first illustrated. Then, the GMBA within the mobile commerce component layer of this framework will be introduced.

3.1 The m-Commerce Framework

In order to understand the overall construction frame of mobile commerce hierarchical skeleton, a layer-tiled architecture, the m-Commerce framework will be introduced. This framework defines multiple functional layers. Each layer provides functions for its top layer to use. By doing so, the whole process of design and development of mobile applications is simplified. Those platform providers, system designers, and software developers can focus on specific layers where they have expertise and cooperate with each other to build the mobile business environment and corresponding applications. This framework is able to speed up the development methodology of m-Commerce applications and create new design and demand of m-Commerce business. This framework

is composed of four layers as shown in Figure.1 [13,14]Their details will be given in the following.

Network Infrastructure Layer: Networking support from wireless network is crucial in realizing mobile applications. There have been significant advances in wireless and mobile networks in the last few years in terms of protocols, standards, and technologies such as wireless network connection methods by GSM/GPRS, wifi, Bluetooth and 3G/4G protocols for wireless LAN.

Mobile Middleware Architecture Layer: With its ability to hide details of underlying wireless and mobile networks from applications while at the same time providing a uniform and easy to use interface, mobile middleware clearly is an extremely important component in developing new mobile commerce applications.

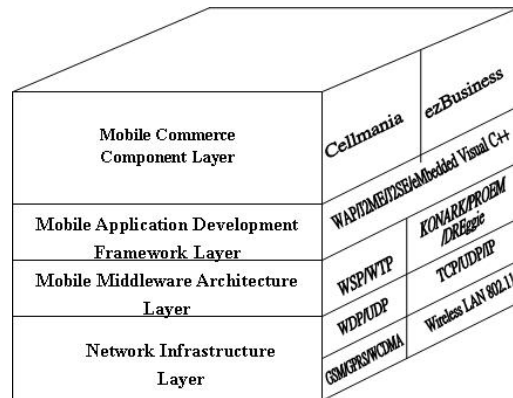


Figure 1. The M-Commerce Framework

Mobile middleware can be defined as an enabling layer of software and is used for developers to interact their applications with a common protocol in mobile networks. Typically aspect of wireless network, such a middleware must include support for a generally common protocol, such as discovery, delivery, naming, communication issue etc. [11], to reduce the complexity for further design the upon layer architecture.

Mobile Application Development Framework Layer: In addition to low layer of network, and middleware, platform frameworks and corresponding operating systems have acted as a very important role in the process of m-Commerce development model. Therefore, developers must consider about operating systems and the characteristics of a device platform in this layer. For instance, mobile devices with sufficient computation power in terms of processor, memory, display, and communications functionalities, such as IPA, and intelligent cell phone equipped with android operating system are emerging and these

are corresponding with several different development platforms.

Mobile Commerce Component Layer :As people rely more on personal handheld devices to communicate, the more demand on new style mobile business in terms of payment, shipping, shopping, information exchange, task, and all other kinds of services is created and waits for systematic methodologies to fulfill these need. Based on functions provided by these underlying layers common components for mobile environment business can be built and provide valuable benefits to emerging mobile businesses with quick application development and delivery.

Some paper aims at mobile commerce on mobile telecommunication and offers packaged applications based on the common mobile enterprise platform that provides a component suite allowing network operators and other enterprises to deploy mobile applications while reducing cost of ownership and time to market. The methods adopts an open, secure and scalable architecture to support thin-client and smart-client deployment structure. In order to expand required functions and components of mobile business, the GMBA need to be proposed. More detail of the GMBA will be revealed in the next section.

3.2 Mobile Commerce Components for Wireless Network

Recently the trend of providing intercommunication capability between 3G(WCDMA) /GSM/ GPRS and WLAN is getting a lot of attention than ever before. Consequently, mobile applications based on wireless network become an important development area. To have a friendly networking layer support, wireless mobile applications are usually built on the top of IEEE 802.11 standard series with service discovery/delivery mechanism at default.

Due to the radio transmission range constraint of wireless communication, services may not be directly acquired by mobile consumers in one radio hop distance; the multi-hop peer-to-peer communication pattern is used to advertise and exchange service information between a service provider and a service consumer. It is important to know what kind of function should be provided by mobile business architecture, a lot of components supporting m-Commerce applications development kit for the GMBA should be defined. A skeleton of m-Commerce application, mobilized metropolitan commercial area was given in Figure 2. Trading is available in everywhere and at any time via m-

Commerce services provided by multiple wireless access points and a lot of mobile laptop computers at each shop unit. Consumers with a wireless handheld device can search goods, compare prices among shops and purchase items electronically through the wireless network formed around the metropolitan commercial area.

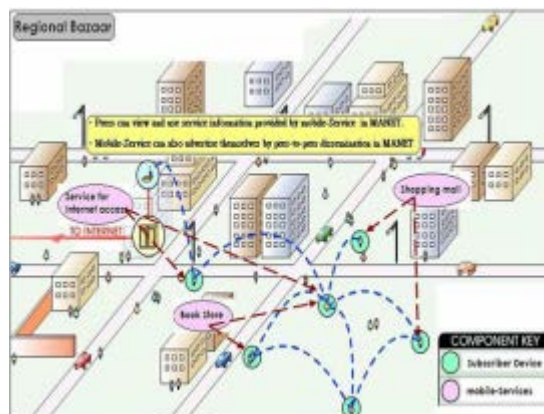


Figure 2. An Example Of Mobile Business In GMBA

3.3 General Mobile Business Architecture

In the Mobile Commerce Component Layer of the m-Commerce framework, the GMBA for mobile wireless applications has been defined. A general proposed mobile business architecture which is composed of six different components including service component, policy component, transaction component, security component, communication component, and profile component. Each component contains several modules oriented to support mobile applications with respective function.

Service component manages services provided by mobile applications and services consumed by mobile device users. Based on the wireless network characteristics three modules, service access point module, service control module, and service content module, are proposed here to help the potential need and future requirement of m-Commerce applications. Service access point module allows users with mobile device to manage all encountered service access points that can communicate with wireless mobile devices and provide all kinds of services for potential mobilized customers. Besides managing wireless service access points, service control module provides schemes to limit resources a service can acquire to perform its task on a mobile device such as continuous execution time and memory usage. Service content module controls or filters incoming service content or reply on a mobile device to prevent user being bothered by unwanted or non-useful information result.



Security component provides security supervision for m-Commerce applications. From m-Commerce application point of view two modules are very important: data security policy module and network transmission module. Data security policy module only provides important data in mobile device to legal user. Customized security policies can be specified via the module to meet different security level requirements. Regarding to data security during network transmission period, network transmission module is responsible to provide mechanism options and guarantee the data transmission security.

Transaction component controls the validation and success of a transaction task. Since data transaction among services or mobile devices will be one of the most important tasks and functions in m-Commerce applications, there exists two main modules, persistent session module and atomic transaction module, to perform related work. In order to maintain the current session between two transaction-executing parties, the existence of persistent session module is necessary. Atomic transaction module provisions transaction validation function and supervises the process of atomic transaction task.

Profile component is in charge of important user-related data. Personal information module and potential interest module are proposed modules in profile component. Personal or private information of a mobile device user/owner is managed by personal information module. Critical personal data can even get encrypted first, before submitting it to be managed by this module. Personal information module can also maintain other application-related personal information such as access or execution rights. Potential interest module is responsible to manage mobile device user's interested services or information. Mobile device users should provide their potential interests in advance and the information can be probed and utilized by services providers.

Policy component offers modules to deal with special marketing situation occurred in wireless network environment. Three modules cover different aspects are revealed here. They are discount bonus module, sub-policy module, and advertisement module, respectively. To encourage mobile device users providing his mobile device as a router or message relay station for other unnecessary and irrelative messages to broadcast through, some kind of benefit must be offered from service providers to mobile device users. Discount bonus module provides the management capability

of possible benefit such as discount coupons or bonus points for users. On the other hand, if service application running on a mobile device wants to promote its service to surrounding mobile device users, advertisement module will become its must-have function module. Advertisement module delivers advertisement messages with different formats and patterns based on device power consumption, wireless network bandwidth condition, message forwarding algorithms and other dynamic factors such as the current number of reachable neighbors. Sub-policy module constructs both advertisement distribution policy and advertisement acceptance policy. Therefore, both service providers and service consumers need to equip sub-policy module. Policies maintained in sub-policy module can be used to restrict advertisement functionality and recode current state of disseminated data, specify caching preferences like refresh rate and replacement strategy, and also describe advertisement preferences such as frequency, time-to-live, etc.

Communication component manages communication -related issues of an m-Commerce application in wireless network. There are two modules in the communication component need be discussed: cost accounting module and time usage module. Upon the emerging m-Commerce infrastructure how to charge reasonable service fee is a very serious and interesting topic. Cost accounting module and time usage module can help this matter by calculating service cost via communication expense and the consuming time of a service execution.

4. APPLICATION WITH GMBA

The destination consumer devices in GMBA are handheld devices with mobile communication support in at least 100 meter radio transmission range. There is no need of any central servers as message exchange center in the GMBA; instead, each user device is completely independent. Based on the GMBA, the mobile commerce services application which provides mobile consumers online commercial services via wireless network communication need to be expressed. In this case study, there exist two service providers, a bookstore and a music store, both of them have offered an online shopping website with wireless access capability implemented. The mobile commerce services application based on GMBA is assumed to be installed on consumers' mobile devices. In commerce services application based on GMBA, an interesting function called advertisement controller

is implemented based on this GMBA. This controller gives the capability for each mobile device to exchange online advertisements when they encounter each other. To reflect current mobile device communication capability, all communication between two peers is occurred directly with one hop radio transmission range.

4.1 Peer-to-Peer Advertising

The mobile commerce services application based on GMBA contains several modules within its advertisement controller in order to deal with commercial tasks. Figure 3 shows the control flow of sending and receiving advertisements. In the following, more details will be described about these essential components of advertisement controller.

Cache module. The cache module caches service advertisement data from neighboring devices. These advertisements describe services that are running on the neighboring nodes or as expressed information of stores such as discount coupons. The advertisement engine coordinates with the cache module to govern various characteristics like advertisement expiration, cache replacement strategy, cache size, etc. Other information related includes IP address and port number. The service name is also the target for cache module to maintain. Due to the dynamic nature of the wireless network topology, it is not easy to guarantee that services found in the cache are currently reachable. Whenever there is a hit in the cache for a service that is not currently available, the cache entry should be immediately deleted.

Forwarding module: The forwarding module processes service advertisements and service request messages. Based on the local incoming message handling policy, it decides whether to drop, or to propagate an incoming message. To prevent broadcast storms, this forwarding mechanism can use multicasting scheme to selectively forward messages. For example, forwarding module can decide to forward messages to a peer or a peer group.

Advertisement Engine: The advertisement engine is responsible for enforcing policies to control advertisement behavior. Policies are specified by advertisement scheme. The module is then responsible for ensuring that all peers are in compliance with the specified policies. Using this mechanism, scheme may be used to control the behavior of the advertisements and store the related information of advertisement situation. Policies which described in scheme data can be used to

restrict advertisement functionality and record current state of disseminated data. Policies can specify caching preferences like refresh rate, replacement strategy, etc. Also, policies could describe advertisement preferences like frequency, time-to-live, algorithms, etc. Furthermore, policies can specify advertisement and request message forwarding algorithms. Personal preferences and application specifics can be also expressed through policies.

4.2 XML Data Format and SOAP Message

Delivery

The advertisement controller is a container that advertisement can be passed from peer to peer using a common format. To provide a generalized format, this paper chooses to use XML document, which is independent of any language, self-describing, extensible, and strongly typed, to describe services and advertisement messages. Furthermore, XML data will be packaged into a SOAP message before transmitting between two connected peers. This paper defines an XML document for service description language to enable service to express their characteristics.

Within GMBA, applications in mobile devices can act as server or client. Once the XML document is defined and service has been discovered by client application, client application can deliver the XML document packaged in SOAP to service entity for invoking requested application execution. Client application can also send a SOAP message to obtain more information of service and the user can interact with the service by invoking any of the available service functions with proper parameters. For example, the travelers arrive in an unknown area and he has searched and gotten a service about map for tourism through his handheld device. Then he can use the "getLocation" function of this service to find out how to go to area 'Z' from area 'A'.

In this section, XML used in data expression was briefly presented, as well as used in service description and SOAP for delivery. Description language is based on WSDL, the current emerging language for service description to Web Service. However, since the description language is considering resource-limited mobile devices, it may not be as powerful as WSDL. In terms of applying this service description format to SOAP, the user can interact with the service by invoking any of the available functions with proper parameters. The user function invocation is packaged as a SOAP request and sent through HTTP protocol.

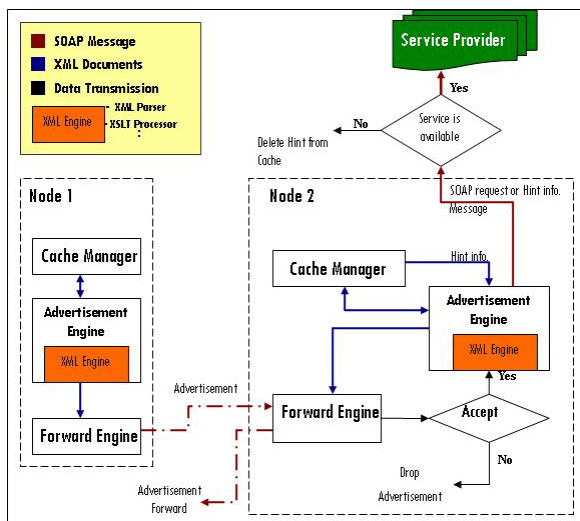


Figure 3 Advertisement Flow Between Mobile Node

4.3 Data Structure and Information Modeling

- Data Structure: The two important data structures in a mobile commerce services application based on GMBA application are two advertisement-related information lists: one list holds all advertisement messages either received from other peers or gotten from services/goods providers. The other stores the carried advertisements in a mobile device from service providers when a mobile commerce services application based on GMBA users ever bought preferential goods or services from there. These advertisement messages preserve until the predefined broadcast quota of these advertisements is reached. If the required broadcast times of an advertisement message are reached, this message will then be transferred to another.

- Information Modeling: A hierarchical advertisement structure is adopted in the design. Advertisement items are divided into categories which are further divided into data structure lists. Information Dissemination Agent

One particular component of a mobile commerce services application based on GMBA is information dissemination agent. Such agents are installed in service provider servers with wired and wireless network access capability. Its function is to publish useful information such as services locations and discount coupons to pass by mobile consumers. Information agents would typically be deployed in places like shopping malls, train stations, etc. In this case, an information dissemination agent provides services catalog, advertisement, coupons, and other shopping information online to nearby wireless reachable mobile commerce services application clients based on GMBA.

5. CONCLUSION

In this paper, a general mobile business architecture supporting mobile business application in hybrid network environment was presented. More than six major main blocks of the GMBA are defined and the responsibility of each of them is described. These defined modules could be implemented and deployed with a new business service. In order to illustrate the validation of proposed GMBA, a mobile commerce services application which contains several building blocks of GMBA was created to perform a particular advertisement promotion mobile service for store vendors among wireless device holders in a reasonable moving area with mutual one-hop radio reachable distance.

As part of this papers' future work, in order to enhance the task benefit and to promote the dissemination of task by mobile peers, more efficient marketing mechanism need to be developed. On the other hand, having a standardized mobile service description method may be an important trend and need in the near future. More new methods will be used to explore more details of the proposed GMBA in the future.

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