

# Ubiquitous Computing Based Mobile Commerce : Toward the Ubiquitous Commerce

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## ABSTRACT

Mobile commerce is heading for advanced fourth generation (4G) mobile systems. However, rapid development of ubiquitous computing technology can implement and complement the 4G mobile systems. It enables anticipation that ubiquitous computing technology creates the new commerce, so called ubiquitous commerce. This paper analyzes the characteristics of mobile commerce service and ubiquitous computing service, and then extracts the core requirements for ubiquitous commerce. Moreover, this paper suggests technical requirements for the ubiquitous commerce. These requirements can lead the development of technology for the future and suggest the milestone that mobile commerce in present heads for.

**Keywords :** Mobile Commerce, Ubiquitous Computing Technology, Ubiquitous Commerce

## 1. INTRODUCTION

In the past few years, by technology advance, especially Information technology, mobile commerce has been marked as a new paradigm that is the next stage after electronic commerce and electronic business. However, appearing of new technology and increasing of customer needs promote development of highly advanced technology, and it presignifies another revolutionary paradigm shift. In this situation, it is valuable work that prospects the future about mobile commerce.

Generally, mobile commerce and mobile business are used reciprocally and mobile commerce is defined as any transaction with a monetary value - either direct or indirect - that is conducted over a wireless telecommunication network[3,19]. Mobile commerce is continuously prevailing and its market size is magnifying daily. Industry forecast statistics predict exponential growth in this sector

- International wireless data market is expected grow from 170 million to more than 1.3 billion subscribers between 2000-2004, equipping themselves with 1.5 billion wireless-capable handsets and other internet appliances by end 2004  
(Source : Cahners Instat Group)
- Wireless internet users in the Asia-Pacific region alone will rise ten-fold from 20 to 216.3 million between 2000-2007 (Source : Strategis Group)

Growth of market and increase of customer needs lead the technological advance, and it accelerates translation of fourth generation(4G) mobile systems from third generation(3G) mobile systems[5,23]. 4G mobile systems are project to solve still-remaining problems of 3G systems as to the perspectives of network and device, these technologies share common characteristics with

ubiquitous computing technology that has been rapidly developing recently[6,9]. Furthermore, ubiquitous computing technology aims at highly advanced technology surpassing the existing mobile commerce technology[4]. It enables anticipation that ubiquitous computing technology not only evolves the existing mobile commerce but also creates the new commerce. In other words, we can predict new paradigm shift confidently that converts mobile commerce into a new commerce, so called ubiquitous commerce.

Based on this assumption, this paper will extract the essential requirements for ubiquitous commerce in order to progress from existing mobile commerce. So, in section 2, we analyze the characteristics of mobile commerce service and ubiquitous computing service by studying related work. Section 3 shows the essential requirements for ubiquitous commerce and the technical demands for achieving each requirement.

## 2. LITERATURE REVIEW

### 2.1 Characteristics of mobile commerce service

There are many studies on mobile commerce. Table 1 shows the summary of these researches.

<Table 1> Studies of mobile commerce service characteristics

Author	Characteristics
Tsalgatidou And Pitoura (2001)	<b>Terminal</b> : small size keypad and screen, small resources including memory and disk capacity, reliance on the finite energy provided by batteries. (disadvantage) <b>Wireless network</b> : bandwidth restriction

	and network topology, variant bandwidth and burst traffic (disadvantage) <b>Usability</b> :location awareness, adaptivity, ubiquity, personalization, broadcasting (advantage)[19]
<b>Camponove And Pigneur (2003)</b>	<b>Mobility</b> : freedom of movement, ubiquity, localization, reachability, convenience, instant connectivity, personalization (advantage) device limitation, bandwidth limitation, expensive cost (disadvantage) <b>Network effects</b> : positive external effect <b>Exclusive control over important asset</b> : exclusive control over important assets exclusive control of MNO(Mobile Network Operator)[3]
<b>Kim et al. (2003)</b>	<b>Efficiency</b> : instant clearance, mobility, instant reaction <b>Effectiveness</b> : instant satisfaction of demand, usage of location information, personalized service[8]

Analyzing these characteristics synthetically, characteristics of mobile commerce service are derived from not characteristics of commerce itself, but technological features, especially handheld device and wireless network. Therefore, these characteristics can be represented in two criteria, mobility and connectivity, in terms of handheld device and wireless network[13].

Mobility means freedom of movement and is relevant to 'place' concept. In mobility perspective, it brings a number of unique benefits of mobile commerce[3]. Ubiquity is the most obvious advantage of a wireless terminal. A mobile terminal can fulfill the need both for real-time information and for communication anywhere, independent of the user's location[11]. Portability means that user can easily carry around mobile terminals. The smaller and lighter the devices are, the more portable they are[19]. Convenience is an attribute that characterizes a mobile terminal. Devices store data, are always at hand and are increasingly easy to use[11]. On the other hand, connectivity means overcoming of available time limitation and is relevant to 'time' concept. In the view of connectivity, mobile commerce serves instant connectable service. Instant connectivity means that it will be easier and faster to access information on the web anytime[11]. Combinations of mobility and connectivity provide rich characteristics for mobile commerce service. Reachability is important for many people who want to be in touch and be available to other people. With a mobile terminal a user can be contacted anywhere anytime. Localization of services and applications will add significant value to mobile devices. Knowing where the user is physically located at any particular moment will be the key to

offering relevant services that will drive users towards transacting on the network[11].

These characteristics are unique features of mobile commerce service. They are extracted by considering technological perspectives, such as device and network. Table 2 shows the summary of these characteristics.

<Table 2> Characteristics of mobile commerce service

<b>Mobility</b>	<b>Connectivity</b>
<b>Portability</b> Carrying the mobile device easily[19] <b>Ubiquity</b> The possibility of using services anywhere, independent of user's location[11] <b>Convenience</b> Mobile devices are always at hand[11]	<b>Instant connectivity</b> Easy and fast access information on the web anytime[11]
<b>Location awareness</b> User's location information can be exploit to offer location-based relevant services[11] <b>Reachability</b> User can be reached anywhere anytime[11]	

## 2.2 Characteristics of ubiquitous computing service

Mark Weiser stated that the most profound technologies are those that disappear and they weave themselves into the fabric of everyday life until they are indistinguishable from it[4]. Sakamura Ken in Japan emphasized ubiquitous network, and IBM suggested pervasive computing concept corresponding to ubiquitous computing. Like this, characteristics of ubiquitous computing technology are arguable and it's difficult to define the characteristics of ubiquitous computing exactly. However, opinions that ubiquitous computing technology will change not only the existing commerce but also all around environments drastically are converged[4]. At this point of view, such a forecasting becomes a good evidence of possibility that ubiquitous computing technology will evolve the mobile commerce technology and create the new paradigm of commerce. Many researchers predict an advent of new commerce, which is called ubiquitous commerce. Generally, ubiquitous commerce is defined as convergence of electronic commerce and mobile commerce, etc.[6]. The realm of ubiquitous commerce, previously isolated and intentional actions become automatic and even invisible, where commercial interaction in every physical and digital sphere will be ever-present. In a ubiquitous commerce environment, objects are always on, always aware, and always proactive by ubiquitous computing technologies[14].

Since Mark Weiser suggested the characteristics of ubiquitous computing in 1991, many researchers have added and developed the characteristics of ubiquitous commerce services. Yoo et al.(2004) suggested 6 characteristics of ubiquitous commerce service; Embeddedness, Mobility, Nomadicity, Proactiveness, Invisibility and Portability[24]. Table 3 shows these characteristics.

<Table 3> Characteristics of ubiquitous computing service, Yoo et al.(2004)

Characteristics	Description
<b>Embeddedness</b>	small intelligent devices are embedded in the physical world and connected to the fixed and/or wireless network
<b>Mobility</b>	client devices must be operated under the mobile and flexible network infrastructure
<b>Nomadicity</b>	the system provides a rich set of computing and communication capabilities and services to nomads as they move from place to place in a way that is transparent, integrated, convenient, and adaptive
<b>Proactiveness</b>	the system needs to be self-triggered to capture a priori what its users want to increase the service quality
<b>Invisibility</b>	to be as unobtrusive as possible, enable the user to put as little data as possible
<b>Portability</b>	providing services with hands-free or at least one-handed light device

### 2.3 Technical approach of 4G mobile systems and ubiquitous computing technology

As we have referred before, mobile commerce aims at fourth generation(4G) mobile systems[5,23]. Generally, 4G mobile systems should provide various multimedia services, ubiquitous services and extended service through seamless global roaming[7]. According to ITU-R WP8F's vision and objective of 4G, 4G mobile systems have characteristics of ubiquitous & seamless connection, high data rate, openness, and network convergence. 4G mobile systems have to solve these problems concretely [5,7].

- Average 200 Mbps high data rate
- More 10 times increasing capacity than 3G
- 3~6 GHz broad bandwidth
- QoS problem

- Mobility management

Table 4 shows hot technology issues to solve existing problems of 3G mobile systems.

<Table 4> Core technology for 4G mobile systems

Technologies	Description
<b>MIMO (Multi-Input, Multi-Output)</b>	- Both the transmitter and receiver use multiple antenna elements, or antenna arrays - Help mitigate channel impairments and help reduce interference, thus yielding better error rate performance to support an increased number of users
<b>UWB (Ultra Wide Band)</b>	- Transmit and receive over a wide range of frequencies supporting a variety of radio standards used around the world - Can be used in a broad array of applications ranging from voice and data communication to high - performance radar systems
<b>SDR (Software Defined Radio)</b>	- Performed by software residing in high-speed digital processors - The radios can consequently be easily reprogrammed to transmit and receive over a wide range of frequencies supporting a variety of radio standards used around the world

Ubiquitous computing technology can solve and complement these problems that 4G mobile systems pursue. Table 5 shows element technology of ubiquitous computing.

<Table 5> Technology classification table of ubiquitous network project in Japan

Technical type	Technology
<b>Ubiquitous system technology</b>	Flexible personalized system tech. Mobility control tech. Advanced location awareness tech. Profile portability tech. Advanced sensing system tech. Data-grid tech. Ubiquitous address operation management system tech. Architecture tech. Real-time OS tech.
<b>Network technology</b>	Seamless network access tech. Photonic network tech. Full IPv6 network tech. High capacity wireless tech. Zero administration tech. Network QoS tech. Distributed network tech.

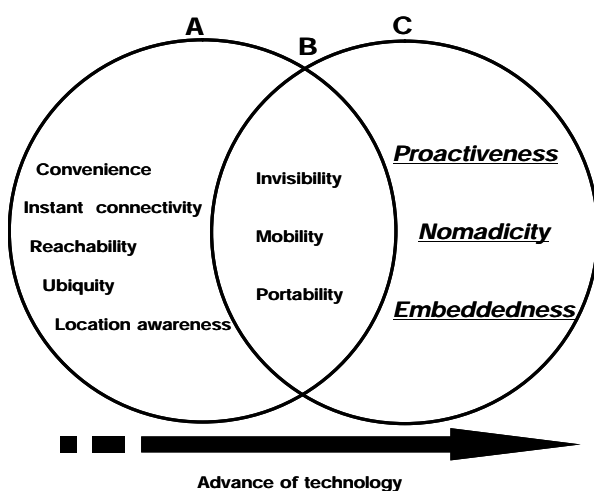
<b>Application technology</b>	Intelligent contents tech. Transcoding tech. U-agent tech. Optimistic and inference engine tech.
<b>Appliance technology</b>	MEMS Advanced electric power tech. Micro interface tech.
<b>Platform technology</b>	IC card certification tech. Personal certification tech. DRM tech. Optimistic security system tech.

### 3. ESSENTIAL REQUIREMENT FOR UBIQUITOUS COMMERCE

#### 3.1 Technical relativity

Considering the aims of 4G mobile systems and the technology of ubiquitous computing, Ubiquitous computing technology can not only solve the limitation of 3G mobile systems but also includes core technology for 4G mobile systems. For example data rate and capacity problems can be solved by network technology of ubiquitous computing. Additionally, fatal limitation of mobile commerce, especially small keypad and screen or computing capacity, can be overcome by using platform and appliance technology. Moreover, the core technologies for 4G mobile systems, such as MIMO, UWB and SDR, are included in ubiquitous computing technology ; ubiquitous system technology, network technology and application technology.

Then, what is the requirements for ubiquitous commerce? We can extract these requirements by comparing characteristics of mobile commerce service and ubiquitous commerce service. Figure 1 shows relativity of each characteristics.



<Figure 1> Ubiquitous commerce requirements diagram

Part A is the characteristics of mobile commerce service only. These characteristics are already developed. Part B is the shared-region of mobile and ubiquitous commerce and these characteristics are under development. Part C is the unique region of ubiquitous service only. This region is not developed yet and is an important part we have to focus on. Therefore, elements in part C become essential requirements for ubiquitous commerce.

#### 3.2 Nomadicity

Nomadicity means advanced network technology. The system needs to provide a rich set of computing and communication capabilities and services to nomads as they move from place to place in a way that is transparent, integrated, convenient and adaptive[24]. To accomplish this requirement, following technical demands must be developed.

- **Ubiquitous system technology**

Real-time O/S technology, Mobility control technology, Advanced location awareness technology

- **Network technology**

Seamless network access technology, Full IPv6 network technology, Network QoS technology

#### 3.3 Embeddedness

Small intelligent devices are embedded in the physical world and connected to the fixed and/or wireless network[24]. In other words, small device disappeared and user can be freed from the device. Embeddedness can create new business model. Health care toilet of Matsushita Electric Industrial Co. in Japan is a good example. Following technical demands must be developed.

&lt;Table 6&gt; Technical demands of each requirement

	Nomadicty	Embeddedness	Proactiveness
Ubiquitous system technology	Real-time O/S tech. Mobility control tech. Advanced location awareness tech.	Advanced sensing system tech.	Advanced sensing system tech.
Network technology	Seamless network access tech. Full IPv6 network tech. Network QoS tech.		Network QoS tech.
Application technology			U-agent tech. Optimistic inference engine tech.
Appliance technology		MEMS Advanced electric power tech.	Micro interface tech.

- **Ubiquitous system technology**

Micro sensing system technology

- **Appliance technology**

MEMS(Micro Electro Mechanical System),

Advanced electric power technology

### 3.4 Proactiveness

The system needs to be self-triggered to capture a priori what its users want to increase the service quality[24]. Proactiveness has the same meaning as context awareness. Context is defined as any information that can be used to characterize the situation of an entity[16]. Context awareness is a very important concept of ubiquitous computing. Without context awareness, there's no ubiquitous commerce[15]. Yoo et al.(2004) emphasized the importance of context awareness[24]. Proactiveness needs mixed-application of various advanced technology because of technical complexity.

- **Ubiquitous system technology**

Advanced sensing system technology

- **Network technology**

Network QoS technology

- **Appliance technology**

Micro interface technology

- **Application technology**

U-agent technology, Optimistic and inference engine technology

## 4. CONCLUSION AND FUTUREWORK

In present, mobile commerce is heading for advanced 4G mobile systems. But specific technical element of 4G mobile systems can be implemented and complemented by ubiquitous computing technology that is under development. Furthermore, ubiquitous computing technology will create new paradigm of commerce, so called ubiquitous commerce. Based on this assumption, this paper analyzed the characteristics of mobile commerce service and ubiquitous commerce service and extracted the requirements for ubiquitous commerce, which are Embeddedness, Nomadicty and Proactiveness. Finally, we suggested core technical demands.

This paper depends on uncertain future technology heavily. This is a fatal limitation of this paper. Therefore, we must study more cases of mobile commerce and ubiquitous computing technology, and for credibility of the requirements, there is a need to carry out case study and apply reliable methodology such as survey and factor analysis. In spite of this limitation, requirements extracted in this paper can suggest milestone that existing mobile commerce goes for, and we can expect the development of technology.

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