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MOBILE TELECOMMUNICATION NETWORKS AND MOBILE COMMERCE: TOWARDS ITS APPLICATIONS IN CHINESE MARKET

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LIST OF ACRONYMS

1G	First-Generation wireless communication system
2G	Second-Generation wireless communication system
2.5G	Two and half Generation wireless communication system
3G	Third-Generation wireless communication systems
AMPS	Advanced Mobile Phone Service
AOA	Angle of Arrival
ARPU	Average Revenue Per Unit
B2B	Business-to-Business
B2C	Business-to-Consumer
C2C	Consumer-to-Consumer
CDMA	Code Division Multiple Access
CDR	Call Detail Records
COO	Cell of Origin
CP	Mobile Content Providers
D-AMPS	Digital-Advanced Mobile Phone Services
EDGE	Enhanced Data for Global Evolution
E-OTD	Enhanced-Observed Time Difference
FDMA	Frequency Division Multiple Access
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HTTP	Hypertext Transfer Protocol
IDG	International Data Group
IETF	Internet Engineering Task Force
ITU	International Telecommunication Union
LBS	Location-Based Service
LDAP	Lightweight Directory Access Protocol
MLS	Mobile Location Service
MMS	Multimedia Message Service
NGN	Next Generation Network

NMT	Nordic Mobile Telephony
OSI	Open Systems Interconnection
PDC	Personal Digital Cellular
PHS(PAS)	Personal Handy-phone System(Personal Access System)
QoS	Quality of Service
ROI	Return on Investment
SIM	Subscriber Identity Module
SIP	Session Initiation Protocol
SMS	Short Message Service
SP	Mobile Service Provider
SOA	Service-oriented Architecture
SSL	Secure Socket Layer
TACS	Total Access Communications System
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TDMA	Time Division Multiple Access
UDDI	Universal Description Discovery and Integration
UMTS	Universal Mobile Telecommunications System
U-TDOD	Uplink Time Difference of Arrival
VoIP	Voice over IP
WAE	Wireless Application Environment
W-CDMA	Wideband Code Division Multiple Access
WCIS	World Cellular Information Service
WDP	Wireless Datagram Protocol
WLAN	Wireless Local Area Network
WML	Wireless Markup Language
WPAN	Wireless Personal Area Network
WSDL	Web Services Description Language
WSP	Wireless Application Session
WTLS	Wireless Transport Layer Security
WTP	Wireless Transaction Protocol
WWAN	Wireless Wide Area Network
XML	Extensible Markup Language

Résumé

La télécommunication mobile connecte les personnes de n'importe où à tout moment. La transmission de la voix et des données à travers les réseaux de télécommunication mobile permet d'envoyer des informations et de diriger des transactions d'une manière nouvelle. Cela crée un nouveau domaine d'affaires qui s'appelle du commerce mobile, une affaire étendue basée sur l'Internet avec de nombreux des caractéristiques uniques ajoutés. Comme un soutien fondamental du plate-forme, les réseaux de la télécommunication mobile joue un rôle essentiel dans le commerce mobile. Leurs caractéristiques techniques et le déploiement déterminent l'essence pour le commerce mobile. Dans cette mémoire, nous étudions et présentons les caractéristiques techniques des technologies communications mobiles du réseau 1G à 3G et au-delà. Nous étudions également les technologies WLAN et WAP qui sont courantes dans le commerce mobile en Chine et dans le monde.

Le commerce mobile est en train de se développer, le nombre d'utilisateurs de téléphones mobiles sont de plus en plus en Chine et dans ce monde. Les utilisateurs mobiles énormes en Chine ainsi que la maturité des technologies 3G affichent un fort potentiel pour offrir et d'adopter plus les nouveaux services mobiles. Après réviser l'évolution du commerce mobile et l'histoire du succès i-mode au Japon, nous nous concentrons sur le mobile du marché chinois de manière à découvrir son marché, l'infrastructure du réseau mobile, et le modèle d'affaires. Fondé sur la base de notre enquête sur le commerce mobile chinois, nous présentons, selon notre jugement, les services mobiles et des applications que sont convenables pour la Chine. Parmi eux, nous pensons qu'il y a la tendance sur les services basés sur la localisation et services orientées de l'architectures. Cette tendance peut attirer plus d'attention à offrir de nouveaux services. En plus, elle peut offrir des services d'intégration et de personnalisation qui viennent de fournisseurs de services mobiles et des utilisateurs finaux.

Mot-clé: Réseau de mobile, Commerce mobile, Marché chinois, Services basés sur la localisation, Services orientées de l'architectures

Abstract

Mobile telecommunications connect people anytime from anywhere. Transmission of voice and data through mobile telecommunication networks makes it possible to send information and conduct transaction in a new way. This creates a new business domain called mobile commerce, an extended business of Internet-based e-business with many added unique features. As underlying supporting platform, mobile telecommunication networks play a critical role in mobile commerce. Their technical characteristics and deployment determine the essence for m-commerce. In this thesis, we study and present the technical characteristics of mobile communication technologies from 1G network to 3G and beyond. We also cover the WLAN and WAP technologies that are common in mobile commerce in China and in the world.

Mobile commerce is on its way to grow, as the number of mobile phone users are increasing in China and globally. The huge number of mobile end users in China plus the maturity to 3G technologies display a strong potential for offering and adopting more emerging mobile services. After reviewing the mobile commerce evolution and the successful i-mode story in Japan, we focus on Chinese mobile market to discover its market, mobile network infrastructure, and business model. Based on our survey on Chinese mobile commerce, we present mobile services and applications that we believe are suitable for China. Among them, we believe that location-based services and service-oriented architecture are the trends that can attract more attention in offering brand new services and in service integration and customization from mobile service providers and end users point of view.

Keyword: mobile network, mobile commerce, Chinese market, location-based service, Service-oriented Architecture

CHAPTER 1

INTRODUCTION

1.1 Introduction

With the appearance of Internet and its maturity, Internet-based e-commerce has played an important role in people's life by offering various services, such as online financial services, entertainment and gaming, information access, online buying and selling, etc. Supported by rich contents and plenty of services, e-commerce has won the battle as an important business form backed with rich web sites that feature comprehensive offerings, fast transactions, and compelling value. It is doubtless that the Internet makes e-commerce possible, and the rich services and contents boost e-commerce.

The convergence of advance of wireless telecommunication and Internet created a promising business opportunity in Mobile e-commerce (M-Commerce). Digital telecommunication network, such as Global System for Mobile communications (GSM), created the first commercial mobile service of Short Message Service (SMS), beyond voice service. SMS can be used in various e-Commerce applications such as financial and banking services, commercial transactions, etc. Other mobile services were also widely adopted by mobile users, like ring tone and gaming. According to the statistics from World Cellular Information Service (WCIS), a live database continuously updated with tracked metrics for the global mobile industry maintained by Informa, the numbers of global and Chinese GSM subscribers have reached 2.6 billions and 520 millions respectively by year-end 2007 [1]. By December 2007, GSM technologies incorporated over 860 networks and 220 countries worldwide [2]. This huge number of subscribers offers an interesting customer basis for possible adoption of mobile commerce. However, the revenue structure from services provided by GSM networks does not show much difference than the first-generation telecommunication

networks, except the most popular SMS data service. Although mobile commerce has achieved significant progress from its initial launch, voice communication and SMS still dominate the revenue increase [2]. The high Average Revenue Per Unit (ARPU) from voice and text message reflects the fact that the majority of use of mobile phones is still for voice communication and limited data services in current telecommunication infrastructures with their limited bandwidth and available data services constrained by the bandwidths.

With the advance of mobile communication technologies towards next generation network (NGN) or Third-Generation (3G), barriers from telecommunication infrastructure to boost mobile commerce are swept away. Until 2007, the global mobile commerce revenue reached $426 billion US, among it, $277 billion US is from GSM [2]. Until January 2008, there are 125 commercial 3G operators in 56 countries, which count for over 156 million reported 3G Code Division Multiple Access (CDMA) subscribers worldwide [3]. While 3G networks promise a peak data rate of at least 144 kbps with their packet-switched networks and up to 2 Mbps in fixed or in-building environments, it is possible to provide more complicated applications and services without worrying about the necklace of traffic congestion. Therefore, mobile commerce is believed to be the next wave of economic pulse while the next generation network technologies constitute the foundations of possibility of abundant types of services the mobile users can expect [4].

Mobile commerce success is determined by mobile applications and services, as it is the services and applications that generate the revenues from both the mobile users' network usages and mobile service usage or subscription charges. Due to the advance of mobile networks that promises enough bandwidth, security and interoperability of different standards, mobile commerce faces many challenges in offering more complex services and keeping users to adopt them. These include business model research, customer behaviour study, trust from mobile user, integration of services and applications developed under different platforms and tools, security and micro

payment, and breakthrough point for applications and services ([5], [6]). Adaptation of suitable strategies on these issues will decide the fate of deployment and acceptance of mobile commerce. Participating parties, especially the mobile service providers and network operators, have to build up their strategies to ensure their profits and simply copying the models from the successful stories has a high risk of failure. One example is that carriers in the US and Europe have struggled to find profitability, even in the face of an increasing user base [7].

1.2 Problems

The worldwide commercial implementation of 2.5G or 3G mobile telecommunication technologies have been on for years. According to International Data Group (IDG), there are about 125 commercial 3G operators in 56 countries as of January 2008 and the number will be increasing stably. Driven by the quick global growth of market, the 2.5G and third-generation (3G) telecommunication systems, such as Universal Mobile Telecommunications System (UMTS) or cdma2000 1x have been deployed in some countries in offering more value-added data and multimedia services in addition to traditional voice service. Consequently, these mobile network operators have tried to boost their available services in order to increase subscribers to the new or existing data services, and to profit the revenue growth to compensate the huge investment in infrastructure and operation. Asia, North America and Europe will dominate the market share of mobile commerce.

Although many experts have predicted that mobile commerce would be the most popular business by 2004, these promises did not come to reality that early. In general, mobile commerce is still in its infancy worldwide. The only very successful example is in Japan, where NTT DoCoMo launched its i-mode built on its then 2.5G packet-switched General Packet Radio Service (GPRS) system. I-mode's success was so huge that it has boasted more than 43 million users in Japan and over 3 million users in Australia, Belgium, France, Italy, Germany, Netherlands, Spain and Taiwan [8]. This success is based on multiple factors: underlying telecommunication infrastructure with

proper data rate for data services and attractive price policy, business model for encouraging content providers (CPs) and service providers (SPs) to participate, carefully chosen development and integration environment, right services and applications, marketing strategy and promotion, etc. These universal factors can be used as good references for making mobile commerce strategy for any operator, but there are many distinct characteristics for each country and culture, which make the mobile commerce components significantly customized for each culture and regulatory situation. For example, the mobile user's experience in China is very different with that in Japan, therefore, the offering services and pricing have to reflect the reality to lure new subscribers and keep loyalty. As a result, study on how to do mobile commerce in each country will be done on a per-case basis.

Unlike Japan and North America, where markets are mature, China is doubtlessly a new big place for mobile commerce for the next coming years. This is primarily owed to its huge population of mobile device holders and fast economic progress, which are the root for potential purchase ability for suitable data services. China has been the No. 1 country in term of mobile user numbers in the world, and that number is continuing to grow rapidly with annual net increase of 60 millions. Its economic growth means that the average purchase ability is higher. According to Chinese government, the next generation networks will be launched by 2010. All of these indicate the possibility of a boost of mobile commerce when 3G license and mobile service and application are ready. Doubtlessly, it is worth to study the mobile commerce service and application in the 3G technologies to benefit from the advantage of 3G networks and to make profit from the new data services.

By far, most of China's mobile networks are still GSM networks, with some GPRS networks. The biggest revenue increase in China is from the no-data-related revenue, even the revenue from data-related is growing fast. And considering that among the data-related revenue, most is from the popular message services, like SMS, MMS, email, etc., which creates $16 billion of US dollars revenue in 2007 (near 30%

of total revenue). About 75 percent of 369 million mobile users of China Mobile send an average of more than 100 messages per month (Source: China Mobile). Other data services and applications are still in infancy. And most of the marketed "new value-added data services" from the two mobile operators are just the duplication of some other media channels. One of such examples is the "TV program in Mobile Phone", marketed by a branch of China Mobile to watch TV programs in real-time on mobile phones. Unfortunately, despite of the symbolic means, these "new" services don't add much value to both the operator and mobile user.

With the approaching of 3G license issuance in China by 2010, both the two mobile operators are planning to build commercial 3G networks, possible with the combination of W-CDMA, CDMA2000 and home-grown TD-SCDMA technology standards. It is estimated that the license fee to 3G network will be as high as 20 billion Chinese Yuan (about $2380.95 million US dollar). As the experience of 3G from Japan and other countries show, carefully designed business strategy and deliverable services will definitely blow out the limitation from 2G and 2.5G networks for mobile data services, there are many new challenges ahead of mobile operators: infrastructure and terminal support, mobile technology, business model, new service and application, service integration and personalization. Among these challenges, the business model, new service and application, service integration and personalization have critical impacts on the success of mobile commerce in 3G era. In other word, the following issues will be a big problem to mobile commerce development in China if not solved well.

- Business model: As 3G networks promises more technical advantages than current networks, this makes it inevitable necessity to have different business model and value chain than GSM based models. More parties will join the business cycle for 3G commerce, and relationship with CPs and SPs will determine the availability quality of what content the mobile users will consume and purchase.

- New services and applications: There are primary two forces to drive mobile operators to offer intensive new data services and applications backed on 3G technologies: costly license fee and 3G technical capability. High license fees force mobile operators to create new revenue channels from the new technology to get a return on investment and make further profit. The technical characteristics provide the rich resources for development of new services and applications. It is not a question of whether new services and applications should be deployed but what kinds of services and applications will be offered. Without pinpointing the market, mobile commerce will not succeed. And particularly in China, under the 3G systems, the individual-oriented market needs different service levels for different mobile user segments, and the enterprise applications are so far in its infancy. These two should be offered with different services and applications to enlarge the revenue sources.

- Service integration and personalization: While 3G technologies provide more space for diverse applications and development environments, the interoperability between different services and mobile terminals remains a big challenge for mobile commerce. Also, as the 3G technology advances, more personalized services will be introduced, particularly, the location-based service (LBS) with the aid of more precise positioning techniques. Another challenge is the trade-off of personalization and privacy in LBS, which involves much of confidential personal static and dynamic information, called user's profile and position information.

1.3 Motivations

As we believe that the success of e-commerce and advance of mobile communication technologies will become a strong enabler for m-commerce, we also believe that study of mobile commerce in Chinese market is a right worth. The factors and problems that motivate this research are:

- Huge number of mobile subscribers: As of December, 2007, there are about 490 million of mobile phone users, and 6.5 million of mobile local Personal Handy-phone System (PHS) users. China has become the biggest mobile telecommunication market in the world, and that number is still growing in a net rate of 60 millions annually. There is a lack in appropriate mobile applications in general and mobile commerce in particular and this requires a thorough study of the Chinese market (both in term of services and segments) as well as its constraints both in terms of business, and technological choices.

- Wide coverage of mobile communication networks: By far, there are 2 mobile telecommunication network operators: China Mobile and China Unicom. The coverage of their networks covers almost all cities in China. It is predicted that there will be three or four 3G licenses in China by 2010 according to Ministry of Telecommunication and Information of China [9]. Doubtlessly, the new 3G networks will be built in metropolitans and big cities, where people are much interested in and can afford for the new data-intensive services and competitions between service providers will be tough; therefore, right services and applications are the key to the market success. This poses the problems of choosing the right type of services that are suitable to the emerging technologies and its potential geographical coverage of all or parts of the Chinese territory. Also, one of the challenges is how to integrate applications and access procedures in the context of heterogeneous wireless networks (i.e. mobile phone networks and wireless LANs). In terms of implementation of new services, we will use standards such as web services and service oriented architectures (SOA) that facilitate this integration and favour the possible upgrade of the system.

- Upcoming upgrade to 3G: China government will issue 3G license to approve the commercial launch of 3G technologies by 2010 [9]. The pilot technical inter-network tests performed by both operators between W-CDMA,

CDMA2000 and TD-SCDMA have been completed on some cities, and voice communication and 3G data services presented acceptable quality of services for both W-CDMA and CDMA2000, while some issues raised with TD-SCDMA. These are mainly caused by poor 3G coverage and limitations from 3G mobile phone, in particular mobile phones for TD-SCDMA. Mobile phone makers, such as the leading market leaders—Nokia, Motorola, and Ericsson, have invested mainly on mobile devices based on W-CDMA and CDMA2000 technologies, but limited investment on TD-SCDMA due to its small market share of 15% in China only. Many companies, including mobile phone makers and telecommunication infrastructure manufactures, have promised to support and be compatible to 3G technologies if 3G pilot test satisfied and when 3G license are issued. This provides the technical support for more data services and applications under high data rate 3G networks. This poses the problem of determining what kind of technologies will be backing the services and how to attain the interoperability between these network standards.

- Acceptance of e-commerce: With the maturity of e-commerce worldwide, more and more people have experience of some kinds of e-commerce transaction. Despite the low transaction revenue in Internet-based e-commerce in China, mobile phone users show a strong interest in mobile business. This is particularly reflected by the mobile user's experience of messaging services (SMS, email, MMS, etc.) and entertainment consumption (online and stand-alone games, ring tone, picture, etc.). Surveys also reveal that more people have interest in more data services and applications under 3G networks if the services are very developed and marketed and the prices are reasonable. We assume that if right services at acceptable price are perfectly marketed to targeted user segments, there will be a big possibility of success and can be the breakpoint for 3G data services.

- Stable purchase ability: China maintains its high economic growth of 8% for more than 5 years [10]. Strong and healthy economic growth makes its people have more money to buy. And according to the Ministry of Information Industry, mobile user average monthly bill is about 200 Yuan (approximate $23.8 US) in 2007. Among that amount, most are paid for the voice communication, but surveys also discover that people are willing and able to pay more if they think the services are good at quality and price.

1.4 Objectives

The objective of this study is to present a prototype of services and applications brought and driven by approaching 3G networks in China. In details, this study will cover:

- Probing and analyzing the China mobile market to find the situation of mobile commerce development: This includes the mobile network infrastructure, mobile network operators, offered services and applications, mobile commerce revenue structure, and mobile user behaviour.

- Proposing a business model for mobile commerce in 3G networks: Because of the centralized governance of telecommunication industry in China, the business model should include the impact of government.

- Proposing the new data services and applications driven by 3G technologies. More emphasis is on the services based on location for both individual and enterprise.

- Discussing service personalization, particularly the location-based service with GIS application. Emphasis will be on the data exchange with Geographic Information System (GIS) and geocoding information, presentation of customized information, and perspective services and applications.

1.5 Methodology

To reach the objectives, two kinds of research paths are utilized: academic study and practical research. For the academic study, mobile communication technologies will be studied; experience from various mobile commerce providers will be examined; lessons from mobile service development will be presented; and government regulatory and academic research will be reviewed. For practical research, a questionnaire on mobile commerce in China is conducted to discover the situation of and attitude to mobile service; discussion with mobile network operators, academic researchers, game developers, and other mobile commerce value chain partners; and small survey of mobile users on mobile service consumption.

1. Examine the evolution of wireless telecommunication systems: In this item, we have studied the characteristics of all generations of wireless telecommunication networks, including current 2G and 2.5G network to 3G and the upcoming Fourth-Generation (4G). We also studied the state of current wireless telecommunication networks and transitions to commercial implementation of 3G. We will focus on the differences between current mobile systems and coming generations to know the capacities from the transition of 3G and/or 4G networks. The methodology consists of studying technical articles and books to fully understand these telecommunication systems.

2. Examine the mobile commerce in China and other countries: In this item, we will have a close look at the available commercial examples of mobile commerce in the world. Research coverage includes: provided services, using technologies, underlying telecommunication systems, development environment, subscribers, and market penetration strategies. This methodology includes the research of web site of world leading mobile commerce companies, academic articles and books, and other public sources. A

questionnaire on China market is also conducted to reveal the situation and attitude to mobile commerce in China.

3. Examine the positioning techniques and determine how to use the location information to deliver services based on mobile user's location. This item will compare different position techniques in multiple aspects, such as accuracy and cost, to adapt a better technique. Further, we will state our idea to what kinds of services related to location can be introduced. This item will investigate the use of push and pull techniques based on different services and user intentions.

4. Suggest a business model for the Chinese market: As our research is primarily on the implementation of mobile commerce in China, we will study the e-commerce and Internet, telecommunication infrastructure and network operators, consumer attitude, service providers, and wireless application developers in China. By examining these and looking other business models from Japan and Canada, we will propose a business model for the Chinese market.

5. Examine the adaptability of existing mobile commerce experiences: As mobile commerce in China is not currently present, we need to study the adaptability of this services and applications. In this item, study will be on the prediction of implementation schedule and acceptance from mobile users. This will include technical, financial, and political factors that we believe having impacts on adaptability.

6. Establish a development model for prototypes in the area of mobile commerce. This implies the investigation of the use of platforms, operating systems and programming environment that can help building mobile applications.

7. Suggest models for building application using Service Oriented Architectures (SOA). The use of web services will be investigated and integrated in an architectural model for mobile commerce applications.

Our research methodology will also involve:

1. Theoretical and technical studies. These: include location tracking, telecommunication systems, and business process.

2. Data about Chinese telecommunication infrastructure and operators will be collected from official reports on telecommunication industry, from network operator's web site and publishing materials (financial statement, for example), from academic articles and questionnaires. Data about other mobile commerce services in other countries can be gathered from their financial statements, research articles and company's web site.

3. Software architectural models for the development of mobile commerce applications.

CHAPTER II

WIRELESS NETWORKS AND MOBILE COMMERCE

Advanced wireless telecommunication technologies constitute the fundamentals for mobile commerce by acting as the operating platforms and providing diverse functions. Its capacities and characters in supporting security, high-data rate, global roaming, hybrid devices, complex applications, and multimedia make the mobile telecommunication networks a perfect enabler for mobile commerce. The services and applications of mobile commerce supported by wireless network can be fallen into two general categories: voice-centric and data-centric services; while the underlying wireless networks can be one of the three wireless communication networks: wide wireless area (WWAN), wireless local area networks (WLAN), and wireless personal area networks (WPAN). The communication technologies can be through satellite, mobile telecommunication networks, and infrared. As different technologies differentiate them with technical characters and financial impacts, therefore, the corresponding services and applications supported are different. For majority of mobile commerce, the carrying platform is mobile telecommunication networks under 2G/2.5G, and in some countries and regions using 3G technologies with WLAN technologies as supplementary forms. Therefore, the technical specifications and characters of these telecommunication technologies and WLAN define the possibility and feasibility of possible mobile services and applications available to mobile users.

As wireless telecommunication networks dominate the communication channels that mobile commerce relies on and almost all mobile commerce users use their mobile terminals backed by the wireless telecommunication networks to consume mobile services, we will focus on the technologies of wireless telecommunication networks.

Wireless telecommunications use radio frequency to carry signals (voice and digital). It has evolved from initial voice-only analog network or first-generation (1G) to today's advanced 3G and beyond networks which are able to offer data-intensive services with Quality of Service (QoS) comparable with wired e-commerce.

2.1 1G networks

First-generation of wireless networks was introduced in the late 1970s and early 1980s in the United States and Europe, respectively. Examples of 1G networks were Advanced Mobile Phone Service (AMPS), Nordic Mobile Telephony (NMT), and Total Access Communications System (TACS). These 1G systems were implemented worldwide to meet mobile users' needs for mobility. They were analog, circuit-switching networks that were built only for voice communications. Based on Frequency Division Multiple Access (FDMA) interface technology, each caller had a dedicated frequency channel and related circuit. The capacity of a 1G network was only determined and limited by the bandwidth of available frequency. Due to the dedicated frequency channel allocation in 1G systems, there was a waste of valuable radio spectrum resource. Figure 1 shows the frequency channel allocations in 1G telecommunication systems.

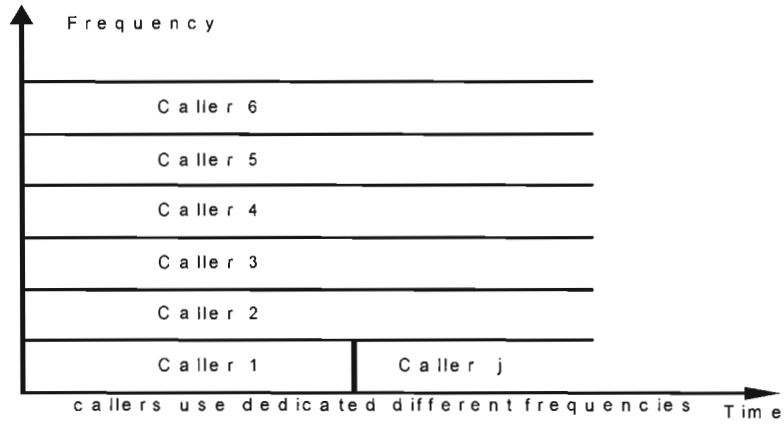


Figure 1 Frequency channel allocation in 1G systems

1G systems confront many technical limitations stemming from its FDMA and analogue characteristics. Among them are high interference of radio waves, poor handoff, path loss of radio signal, and difficulty in roaming, which resulted to ineffective usage of expensive radio spectrum, frequent drop-off connection and switching service between networks. Another distinct negative impact was that there is impossible to implement security over analogue signal that no security methods like encryption on confidential information to ensure the trust of transactions can be carried on. For the mobile terminal, 1G mobile phones had to be very large to be able to capture the radio signal, and in places where were far from a cell station, the analog signal could be very weak for communication due to radio deduction. All these limitations of 1G analog systems determined its quality of service (QoS) was unpredictable and its capacity to support other service rather than voice service was insufficient. 1G systems were not capable to offer real worldwide inter-network mobility due to the interoperability issue between different wireless network operators. Today, almost all 1G analog networks are out of service and have no contribution to mobile commerce.

2.2 2G networks

Second-generation of wireless systems was introduced in late 1980s in Europe with the initiative objectives of improving transmission quality, of increasing system capacity, and enhancing security, of which 1G analog networks lacked or functioned poorly. One significant distinction of 2G technologies over 1G systems is the digitalization of transmitted signals that allows encryption and data transmission, which is important and critical for mobile commerce.

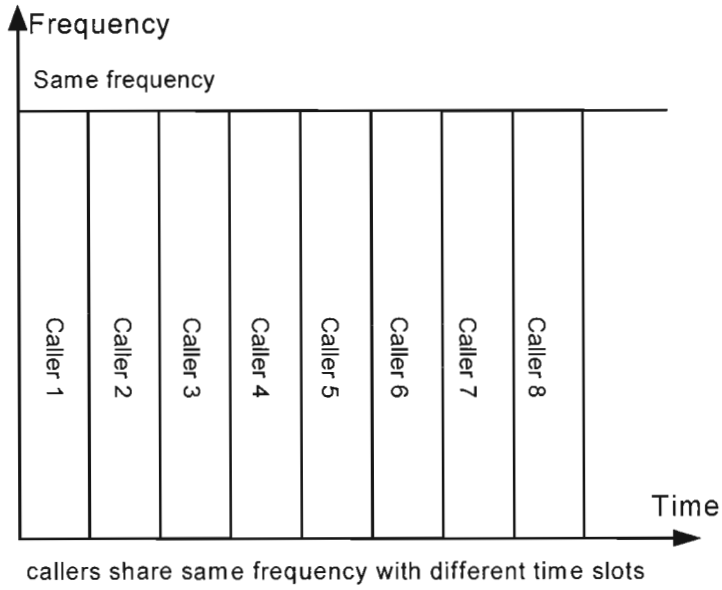


Figure2 Calls in TDMA mode

There are two major multiple-access technologies used in 2G systems: Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA). In TDMA, multiple calls share the same frequency channel with different time slots. A call is sliced into a series of time slots and each caller gets one time slot at regular arrivals as shown in figure 2. Therefore, multiple calls can be put on a specific valuable frequency channel and the total throughput of networks is higher than 1G systems.

Another access technology is CDMA in which all users occupy the same frequency but their signals are separated with different means of a special code as illustrated in figure 3. The randomly spread sequences are transmitted all at once, which means the capacity to serve more calls or data transmissions simultaneously. As a result, CDMA gains higher data rate and improved usage of the radio spectrum compared with TDMA and FDMA. Also because of the code multiplexing, CDMA provides better signal quality and security than TDMA, and is ideal for data communication particularly. In term of implementation, CDMA is more complicated

and needs more technical planning than TDMA because of the coding to separate each call.

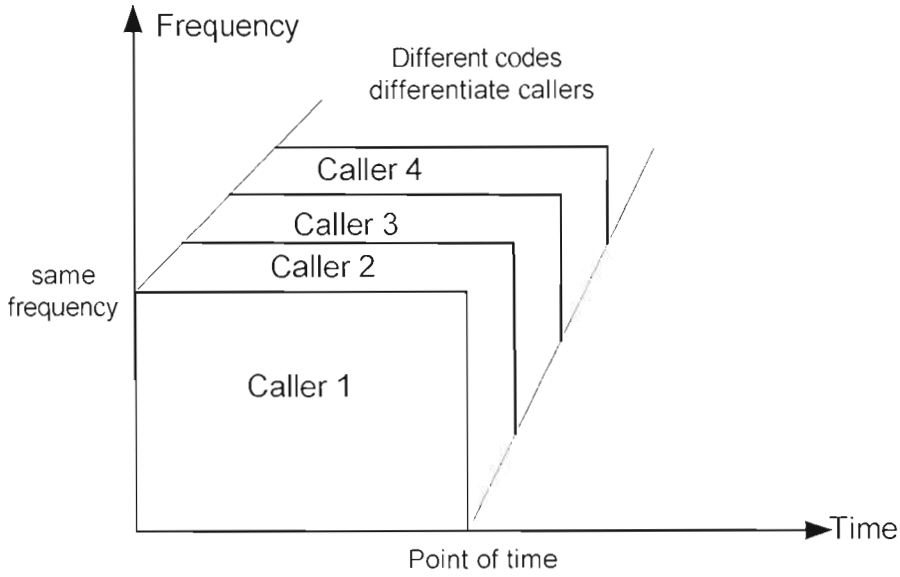


Figure 2.3 Calls in CDMA mode

Both CDMA and TDMA increase the capacity of network throughput with better usage of the available bandwidth and can be used independently or in mixture. Compared with 1G analog networks, 2G digital systems provide many unique advantages:

- Better quality of voice communication and effective usage of radio spectrum: Because of the digitalization of signal transmission, error correction techniques are introduced to improve the quality of communication. Processing over data such as compression can decrease each call's occupation time for bandwidth, therefore, achieve better use of the bandwidth. As a result, the valuable and expensive radio spectrum resource can be served for more calls.

- Ability for essential data service: 2G networks create the business opportunities of essential data services. SMS, Web surfing, call display,

financial transaction, and merchandising are among some of the new services, even though the quality of service is not so promising and users have to pay high bill for the lengthy duration of connection caused by the low data transmission rate and suffer inconvenience by unexpected drop-off on intensive data transmission.

- Capacity of roaming: This is a great advantage of 2G systems because it frees the mobile users from the limitation of geography and binding of an operator's network. Inter-network communication capacity permits integrating virtually all 2G operators' networks into one in term of technical possibility. One example is that the Short Message Service (SMS) and voice communication can span multiple networks. This capacity eases service providers from worrying about network interoperability while deploying more services and network infrastructures. User can consume the subscribed services no matter where he is and which network he physically uses.

- Possibility for more value-added services: 2G networks create the possibility for deploying more value-added services, and some of them are still important components even for today's mobile commerce. These value-added services can be generally sorted into 2 types: the extended features for existing voice communication function, and brand new commercial data transactions. Examples for the first type include call display, call waiting, call forward, voicemail, and third-party calling, etc., which are focusing on the extension of voice communication with digital features. The late type is fully new that begins with 2G networks and consists of most interests for mobile commerce, such as SMS, email, financial service, web surfing, ring tone download, business transaction, etc. The data services create a new business model for mobile commerce, because they require more participants ranging from mobile network operator and device maker to content provider and third-party service provider who all contribute to the value chain of mobile commerce.

- Means of security: 2G systems provide means of security, which is very important to business transactions to ensure the integrity of business data and to gain customer trust. Security includes the use of Subscriber Identity Model (SIM) card, encryption on transmitted data, authentication and authorization, etc. This has dramatically reduced fraudulent use of mobile phones and reduced the incidents of media exploitation of unauthorized recording of private communications.

Data rate that 2G networks support is low, ranging from 9.6kbps to 19.2kbps. This kind of data rate is feasible and acceptable only for simple text messages and small applications, like ring tone download. Information access, such as web surfing and picture transmission, is still a challenge due to the low data rate and weak functions of mobile terminals served 2G networks. Another biggest disadvantage of 2G networks is its circuit-switching technology, which means that the connection has to be maintained all the time during the transaction, even if there is no activity between the mobile terminal and the network. This leads to two major negative impacts: mobile users face a high bill for both the download time and the idle time, and communication channels have to be occupied for the duration of all the sessions of connection.

2G networks are widely implemented worldwide with TDMA or CDMA technologies. Dominated 2G commercial networks include GSM, D-AMPS, and CDMAone (IS-95A). Among them, GSM is the most widely used 2G systems and still dominates in some countries. The most popular subscribed services for 2G network are still voice service with some digital extension over that, like call display, etc., and SMS, which in any country ranks the No.1 data service in terms of both number of transaction and generated revenue. They contribute the major part of Average Revenue Per User (ARPU) in 2G network, and SMS is still regarded as a "killer application" for both 2G and beyond in countries where 3G networks are available.

2.3 2.5G networks

Even though 2G initiated the possibility of mobile commerce, its technical limitations hindered its capacity to offer for more data services than SMS and ring tone download and to provide accurate billing system. With increasing demands for more data services due to maturity of user's experience gaining from existing mobile services and Internet, mobile network operators had to upgrade 2G networks to serve greatly these demands. Deployment of 2.5G systems is a good option in terms of technical complexity and financial consideration.

Three leading 2.5G technologies are dominated the commercial implementation worldwide: General Packet Radio Services (GPRS), CDMA 2000 1x, and Enhanced Data for Global Evolution (EDGE). Table 1 lists the main technical characters and comparisons of these three 2.5G technologies.

	GPRS	cdma 2000 1x	EDGE
Communication mode	Packet- switvhing	Packet- switvhing	Packet- switvhing
Peak rate (kbps)	115	307	384
Practical rate (kbps)	50	115	150
Access mode	TDMA	CDMA	CDMA,TDMA
Technical highlights	Can upgrade directly from GSM, only a few changes to be added Always connected, Be a Core network for future 3G systems	Enhancements over cdmaONE include:power control, diversity of transmit,modulation-schema change, etc. Increase of capacities over IS-95A and IS-95B	Enhance advanced coding schema to allow each time slot to transport more data to improve capacity and efficiency over air interface

Table 1 Technical highlights of 2.5G technologies

Instead of using circuit-switching technology, 2.5G networks provide a significant advantage of packet-switching technology that maintains an always-on connection.

Communication between mobile terminal and mobile network occurs only when there is a need for data transmission. This enables more efficient usage of bandwidth as users don't need to dedicatedly occupy a communication channel with the enhanced CDMA or TDMA algorithms, as a result, wireless networks allow more users with the same bandwidth. Billing can be more precise and reasonable as user is charged only by the actual volume of data that travels between mobile phone and mobile network during the data service, instead of the connection time. This feature is extremely helpful and economic when user commits a long session with few data transmission, such as fulfilling information in business transaction or reading a message on mobile phone.

2.5G systems also provide higher data rate than 2G systems as shown in table 1. This makes 2.5G system capable to conduct complicated processing and large volume of data for more data services and applications, as data rate of 50~110 Kbps is generally capable to handle basic multimedia and applications like sending picture, transferring small file, watching movie clips, and playing video game. Its roaming enhancement improves the inter-network operability and makes it easy for smooth and seamless transmission between geographic locations and networks using different technologies, which is important for availability of and integration with more mobile data services and applications.

Another advantage that 2.5G networks have is to act as an intermediate between 2G and 3G, as they provide some functions that 3G technology promises. And majority of 3G implementations will be based on 2.5G networks, in particular GPRS, rather than from 2G systems directly.

2.4 3G networks

3G networks were first launched commercially in Japan over its 2.5G networks as new multimedia services were on the market. It is not a complete new one from scratch, but generally upgrade from 2.5G core networks. The major driven force of 3G

launch, from mobile subscriber point of view, is to support high-speed data transmission and, more importantly, to be able to provide the competitive multimedia services that users have experienced with Internet.

According to the International Mobile Telecommunications-2000 (IMT-2000), defined by International Telecommunication Union (ITU), a wireless standard must meet minimum bit-rate requirements shown below to be considered as 3G: [11]

- 2 Mbps in fixed or in-building environments
- 384 Kbps in pedestrian or urban environments
- 144 Kbps in wide area mobile environments

Although, 3G technologies were supposed to be a unified standard, there are several 3G technologies widely deployed worldwide in practice, including W-CDMA or UMTS, CDMA2000, and TD-SCDMA. The first two are commonly accepted as 3G solutions worldwide, and the third is claimed and supported by the world biggest market for mobile commerce--China.

- W-CDMA (Wideband CDMA): also called as UMTS and IMT-2000, is the dominated and most widely used 3G technology in Japan, Europe, and United States that is preferred by GSM, GPRS and EDGE with first commercial deployment in Japan by i-mode. It is a wideband spread-spectrum 3G mobile telecommunication air interface that utilizes code division multiple access (CDMA) to offer Internet access, multimedia, video, and other capacity-demanding applications. Voice, images, data, and video are first converted to a narrowband digital radio signal. Each signal is assigned with a marker to identify it from other users. It also utilizes various rate techniques in data processing to enable multiple rate transmission. It uses a new spectrum with a 5 MHz carrier, providing 50 times higher data rate than in present GSM

networks and 10 times higher data rate than in GPRS networks. Its data rate for local area access is up to 2Mbps and 384Kbps for wide area access.

- CDMA 2000: compatible with old CDMA and a very efficient and robust 3G technology. It was first developed by QualComm, a San Diego, California – based wireless telecommunications R&D company, and can support communication data rate from 144Kbps up to 2Mbps. Its key component is its ability to support full demands for advanced 3G services such as multimedia and IP-based services. Benefit from years of extensive practice from its proceeding technology CDMAone, this technology is practical good in support high-speed data services including multimedia streaming, video clip and clear voice service over the same channel. Due to its optimized radio technology, CDMA 2000 technology makes mobile network operators possible to invest a few cell sites and expect increase of revenue with fast return of investment (ROI). CDMA 2000 is the widely implemented technology worldwide, and there are about 231 operators of CDMA 2000 1x in 94 countries and 86 of CDMA 2000 1xEV-DO in 50 countries, respectively at the end of March 2007 [12].

- TD-SCDMA (Time Division Synchronous Code Division Multiple Access): a 3G standard belonging to TDD mode that is pursued by Chinese government and companies in attempt to be "home-grown" technology and has been approved by ITU as a 3G standard. It is an evolution of GSM and is based on spread spectrum CDMA technology and supports data rate up to 2Mbps. It supports both circuit-switched data and packet-switched data and putting TD-SCDMA on GSM phone will be fairly inexpensive as comparison of 3-4 times of cost as for putting W-CDMA on GSM. Due to the possibility of building TD-SCDMA totally over GSM, the upgrade costs will be much cheaper over other technologies. It is predicted to be projected as one mandate 3G standard in China if wireless network operators are planning to launch other 3G

systems. This standard will not be implemented outside China in predictable time.

3G systems target to provide more advanced features that include:

- High data rates: which is expected to be 2~4 Mbps for indoor use, 384kbps for walking people, and 144kbps for fast moving vehicles. These rates are generally capable to offer mobile users the same experiences that they have with Internet.

- Open architecture with intelligent antenna and QoS: 3G systems are built on open architecture that permit easily addition of service and application, which is suitable for introducing the concepts of Service Oriented Architecture (SOA) and web service. Its new intelligent antenna administration and control can determine and prioritizes the users' requests when setting up connections. Its new innovations through multiple technologies, such as handover enhancement, will provide the QoS comparable with that of wired telecommunication network.

- IP-based packet-switching network: This is the most important and distinct point that 3G technologies distinguish from preceding generations. 3G and beyond networks are IP-based, which means that integration of mobile telecommunication networks with other wireless networks (WLAN, WPAN, for example) is possible. 3G systems are fully packet-switching that can be easily upgraded from GPRS and co-exist with GSM systems. This packet-switching technology in 3G technology support for both circuit (GSM) and packet mode data as backward compatible.

- Enhanced roaming: Roaming between networks of different operators and with different technologies will be improved to be more seamless; therefore, the

possibility of service interruption during the move between operators and networks will be eliminated to least.

- More customization: 3G networks can have information about user profiles and are able to precisely locate user position information. This allows customization with more choice in both no-real-time and real-time ways. Also, customized services and applications can benefit from the high data rate of 3G networks in order to be able to offer user the demanded information in various presentations, such as video clip, voice, image, etc.

- Specific designed charging and billing systems: Because 3G networks are capable to support more complicated and multimedia services, the networks must be able to recognize the type of services it serves for precise charging and billing purposes. Its generated Call Detail Records (CDR) have to know the types of services it serves, for example voice, text, images, streaming clips, etc., and the original places they are from, and applying appropriate charging models. Also, these charging and billing systems have to be flexible to reflect the business models for different services and applications, for example, the revenue sharing with content providers.

2.5 WLAN

Originally designed for computer devices in indoor environment, WLAN can provide data rate ranging from 1Mbps to 108Mbps within 50-100 meters. WALN uses radio frequency (RF) in 2.4GHZ or 5GHZ to transmit and receive data over the air. Through access points (AP) fixed in places, computer devices can share the available bandwidth to access wired Internet and perform all computing and transaction activities in the same way as wired Internet connection. It was first to be implemented to free the cabling works in places where cables are difficult to be laid or to offer mobility in office. Computer devices must have installed a wireless network adaptor to be able to communicate with access points. The most popular WLAN standards in

commercial use are 802.11b, 802.11a, and 802.11g. Figure 4 illustrates the general architecture of WLAN terminals communicating with wired Internet services and applications.

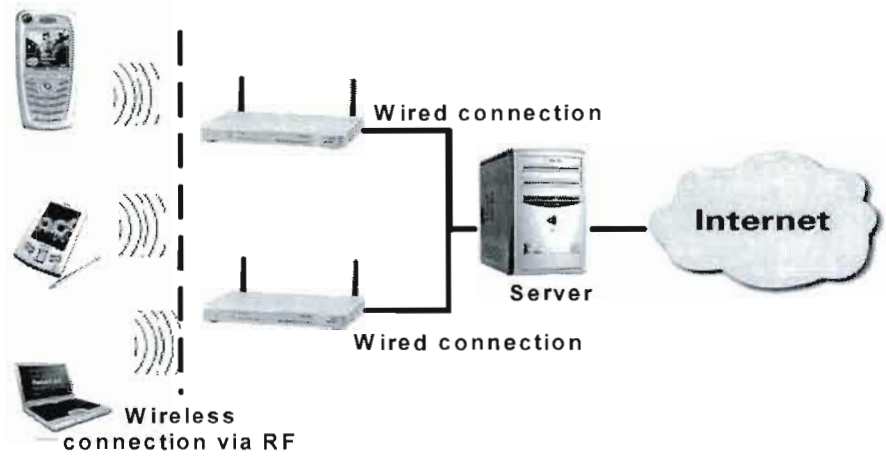


Figure 4 WLAN communication

WLAN can be utilized as extension of wireless telecommunication network for both consumer services and enterprise applications by individuals and enterprises, as mobile terminals like blackberry within WLAN usually can offer more computing capacities. Mobile phones with WLAN capacity are also available in market and interoperability between WLAN and WWAN is possible.

2.6 Wireless Application Protocol (WAP)

WAP is a standard protocol to present and deliver information to mobile devices through mobile telecommunication networks. It has 4 layers over any wireless data networks:

- Wireless Datagram Protocol (WDP): This layer interacts with lower Open Systems Interconnection (OSI) layers and provides interface to upper layers.

Security based on public key mechanism is realized in this layer by Wireless Transport Layer Security (WTLS) with Secure Sockets Layer (SSL).

- Wireless Transaction Protocol (WTP): This layer is responsible for transaction support by sending a request and confirming a response. WTP supports more effectively than TCP in problem of packet loss, which is common in mobile telecommunication networks and is often misinterpreted as network congestion by TCP.

- Wireless Session Protocol (WSP): This layer is responsible for the persistence of connection. It is regarded as compressed version of Hypertext Transfer Protocol (HTTP).

- Wireless Application Environment (WAE): This is the application layer that utilises Wireless Markup Language (WML), WMLScript, and other application-specific languages to deploy WAP applications.

WAP is commonly used in current mobile Internet access and information access after combination with SMS and MMS. Also, enhancement and effort on deploying contents on issues of device diversity, availability and usability have contributed to the increasing use of WAP. And more, PUSH character from WAP makes mobile users to easily get or reject the contents pushed on the mobile phones.

CHAPTER III

POSITIONING TECHNIQUE AND MOBILE COMMEREC

Mobile technology evaluation provides the opportunity for creating a brand new business domain that is greatly based on and benefited from mobile network characteristics. Characteristics of mobility and location identification promise the possibility of developing advanced mobile location services (MLS) or location-based services (LBS). Precise location information can be used to transform mass-produced services into more personalized services or provide brand new services that traditional business cannot offer in the context of personal location information. LBS can be utilised on both business-to-business (B2B) and Business-to-Customer (B2C) markets and has attracted more interests from both academic research and industry, as it is regarded as one of the potential services that could be " killer applications" in 3G technology and as one turn point to increase revenue for mobile commerce.

To lure mobile subscribers to consume location-based services, two important factors have to be better dealt: the accuracy of mobile device physical location, and the integration and customization of services and applications with that location information. The first factor requires that underlying position techniques should be able to provide precise and accurate location information at acceptable time arrival and cost to meet different requests from various mobile location services, and the second requires the seamless integration and delivery of services with gathered location information. Location awareness, which means the ability of mobile hosts to determine the physical location of mobile device, is the prerequisite for success of attractive mobile location services.

3.1 Positioning techniques

Positioning technologies are the tools to locate a mobile device and to gather the location information and convert into meaningful XY position. The XY location

information can be used for mobile applications to customize and deliver specific services integrated with the context of location information of a mobile device.

A number of positioning techniques exist and each one poses its own technical characters and advantages in terms of degrees of accuracy, complexity, and requirement for modifications and upgrades over mobile networks and mobile devices. These positioning techniques can be categorized as either GPS-based or network-based. GPS-based positioning techniques refer to self-calculated method that mobile device receives signals and calculates location information itself. Remote-calculated network-based positioning techniques need the mobile network to receive the signal of mobile device and calculate location information for mobile device.

3.1.1 GPS

Global Positioning System and Assisted GPS (A-GPS) are the worldwide satellite-based radio navigation system. It consisting of 24 satellites, which equally spaced in six orbit on 20,200 kilometres above the Earth, and transmit two specially coded carrier signals, one for civilian use and one for US military and government use. A GPS receiver embedded in mobile device uses the navigation message transmitted from satellite to compute and determine its position in terms of latitude, longitude, and altitude. Accuracy of GPS can be as precise as 10 meters or less under certain condition. One limitation of proper use of GPS is that receiver needs signals from at least 3 or 4 satellites to calculate and obtain accurate location information. A-GPS is more accurate positioning technique based on GPS by adding assistance server. Receiver in A-GPS will communicate with assistance server that has high processing power and access to a reference network to cut the time to determine location. This process is quicker and more efficient than regular GPS. A-GPS method can be accurate from 1 to 10 meters. The main advantage of GPS technique is its many-year usage and the reality that it is supported in various applications and mobile devices, which mean that it can be easily integrated into mobile commerce as a means of positioning method. Also A-GPS is more accurate in term of accuracy of device

position when comparing with other network-based positioning techniques, like cell-ID, Time of Arrival (TOA), Enhanced-Time of Arrival (E-TOA), etc.

3.1.2 Network-based positioning techniques

Network-based positioning techniques include cell-ID, Angle of Arrival (AOA), Enhanced-Observed Time Difference (E-OTD), and Uplink Time Difference of Arrival (U-TDOA).

- Cell-ID or cell of origin (COO): This positioning technique is a basic and simple method to provide device information for location-based services and applications. It is based on the fact that the mobile network is aware of the cell ID from which the mobile handset is served for at a given time. The mobile handset location is determined as within the cell size area. The advantage of this method is its simplicity and universal compatibility, as this method can be used with any mobile handset without any modification. The disadvantage is the low accuracy, which generally ranges about 500m or more, dependent on the density of cell sites. In urban areas with dense cell coverage, the performance may be good for some location-based services, but in rural areas, this method is less accurate to be feasible for location-based applications that can be up to 15km due to the number of installed cells. One possible improvement for accuracy is to use Cell-ID with Timing Advance (Cell-ID+TA), which adds the measured time between the start of a radio frame and a data burst to improve the location determination.

- Angle of Arrival (AOA): This method calculates the angles at which a signal from a handset arrives at two base stations and uses triangulation to find location. The big problem of this method is that in urban areas, it may work very poorly because of the interruption of signal by high-rising buildings. At rural areas, this method has the same accuracy issue as Cell-ID due to the density of cell sites and cell size. No modification is needed on handset.

- Enhanced-Observed Time Difference (E-OTD): E-OTD uses triangulation between three base stations (BTS) to provide more accurate location information of a mobile handset. Location of mobile handset is calculated by comparing the difference in time taken for a control signal sent by BTS to arrive at the mobile handset. E-OTD can improve the accuracy of standard Cell-ID of ten times, but the biggest disadvantage is that it requires significant investment in installing BTS and handset software to calculate and handle time difference.

- Uplink Time Difference of Arrival (U-TDOA): Due to the disadvantage of E-OTD, U-TDOA is introduced as an alternative. U-TDOA use advanced triangulation techniques to determine the precise location of a mobile phone. Distinct improvement of U-TDOA is that it works with any mobile phone and does not require special hardware and software in the phone. U-TDOA is widely used by major GSM carriers to meet US E-911 requirements and most accurate in commercial usage.

Comparing the available positioning techniques above, the accuracies are ranked in below figure 5.

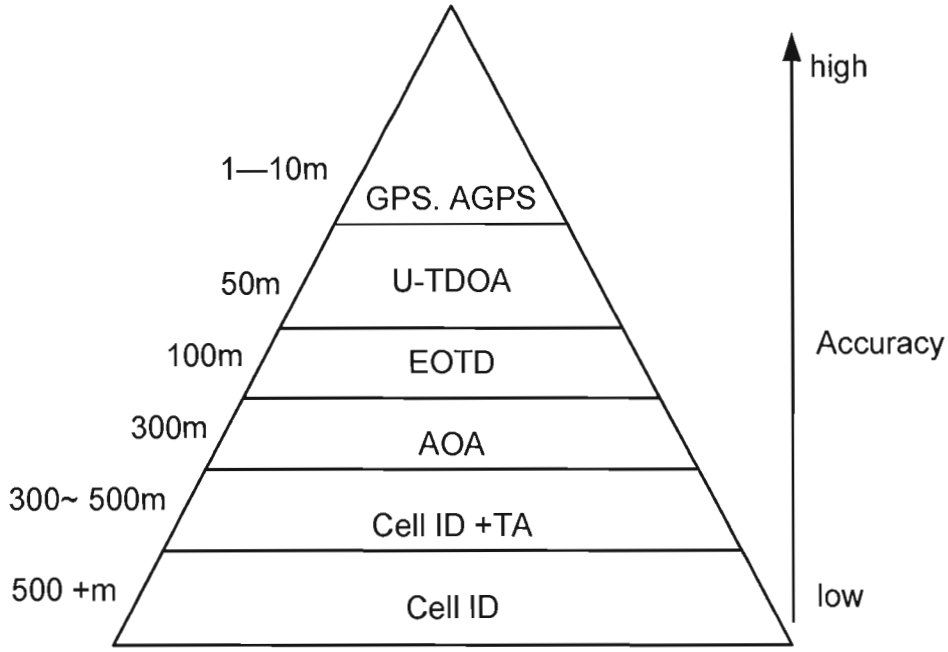


Figure 5 Positioning accuracy

Mobile commerce is the extension of Internet-based e-commerce with the use of mobile devices for end users and mobile networks as backbone supporting platform which provides mobility and ubiquity. As mobile networks constitute the underlying fundamental for mobile commerce, therefore, the evolution of mobile systems defines the ability and availability of mobile commerce.

3.2 Global Evolution of Mobile Commerce

Evolution of mobile commerce consists of the following milestones corresponding to the advancement of mobile telecommunication technologies: voice only, voice-centric and simple data service, voice and data-centric, and data-centric.

- Voice only: This stage reflected 1G mobile technologies that only voice communication was allowed over mobile networks. Mobile commerce was only presented as extension of fixed line communication service to meet the

need for mobility. Mobile service was expensive and was just consumed in case fixed line communication was not available. Revenue from mobile commerce counted a very small portion than other kinds of business, even though the communication charge for mobile end users was high. Number of subscribers was low compared with fixed line phone users and Internet-based business was still a new concept for most users at that time.

- Voice-centric and simple data service: This stage reflects 2G mobile technologies that all communications are in digital format. Because of the digitalization of voice communication, valuable spectrum can be utilized more effectively and efficiently and mobile telecommunication network capacities increase. Quality of voice communication service improves greatly and cost for voice communication decreases. New services associated with voice communications are first possible and available, such as call display, call waiting and forward, etc. Simple data services are introduced, though still in infancy. SMS dominates most transactions of data services and contributes mainly to revenue from data services. Other data services include ring tone, music, etc. In this stage, mobile commerce is regarded as an independent business by mobile network operators and content providers, and subscribers increase.

- Voice and data centric: This stage is supported by 2.5G and some 3G mobile telecommunication technologies that allow mobile users to experience both the similar features from wired Internet and unique features only from mobile commerce. Data rates in this stage are from 115kbps to 3Mbps, which is similar as the speeds of ADSL or high-speed Internet access. Packet-switching technology is used commonly in this stage that helps in precisely billing and always-on connection, as well charges to end users are calculated by the actual data volume traveling between mobile terminal and mobile networks. Horizon of mobile commerce is wide to include almost all features from Internet e-

business, such as financial service, information access, merchandising, etc, and multimedia. Location information and personal profile are gathered and used to customize services. More date services will be offered to create new revenue channel and to compensate the loss from voice communication caused by competition and technology innovation. Mobile commerce is in strong potential to grow.

- Data-centric: As the advance of mobile technologies, upcoming next-generation mobile systems will be implemented commercially in predictable time. These mobile systems will integrate seamlessly all types of mobile communications based on IP, including WLAN and WPAN. Mobile commerce focuses on data services heavily, while voice communication operates in a low cost and high quality. Mobile commerce will be beyond Internet-based commerce to be able to host any services based on IP.

3.3 i-mode

i-mode is the most popular mobile service in the world. It was first launched in Japan in 1999 to provide wireless Internet access. Instead of using WAP, i-mode uses c-HTML, a subset of HTML, to transform contents. We summarize the services that i-mode offer in table 2.

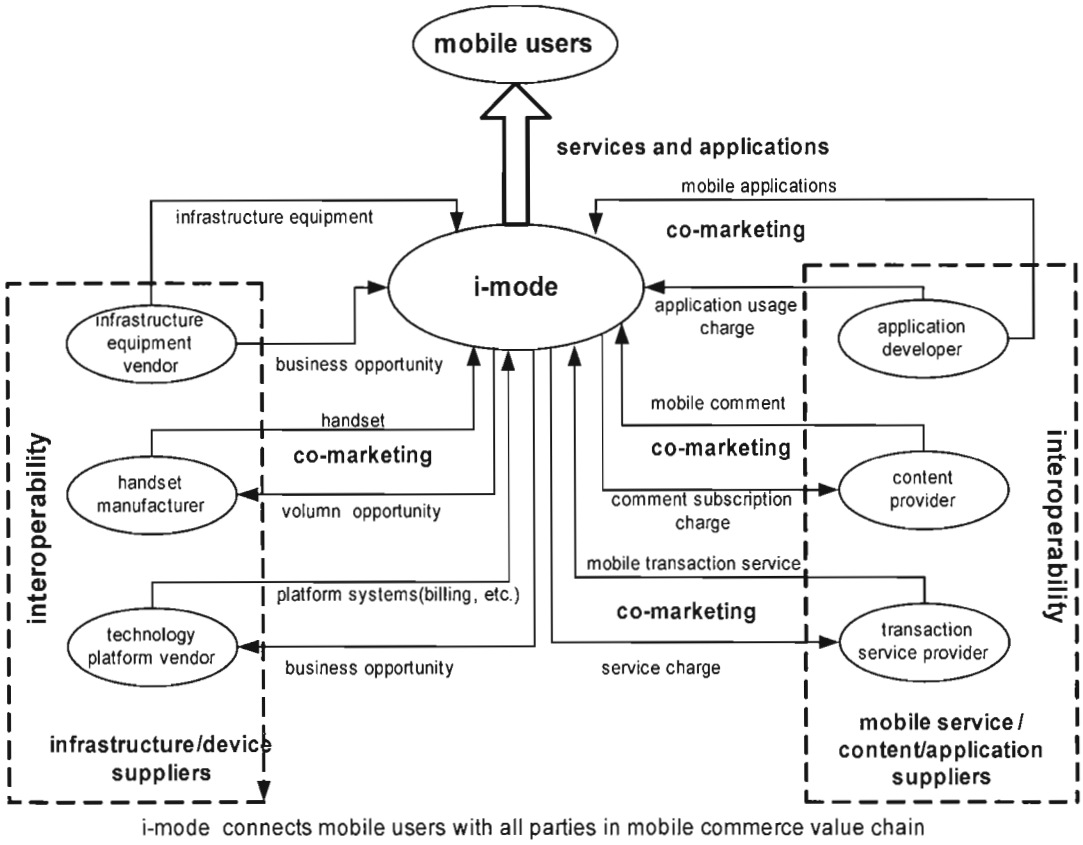
Source: Summarized from NTT DoCoMo web site

service	service description	launched time	price
i-mode	text message, Internet access	Feb. 1999	monthly fee of US$2 plus packet communication charge
i-appl	Java applications to obtain information about stock or weather, play games offline, display maps, etc.	Jan. 2001	packet communication charge, some sites apply i-mode price
i-area	location-based services-- contents and services are automatically customized with context	July 2001	subscription fee and packet communication charge applies
i-motion	dynamic video clip contents, such as sport highlights, movie information, etc.	Nov. 2001	monthly fee of US$2 plus packet communication charge
i-shot	allow sending still pictures taken by cell phone to other cell phones, email or other terminals	June 2002	packet communication charge applies
Osaifu-Kaitai	electronic wallet to allow payment with mobile phones	July 2004	charge are laid on merchant side on per transaction
i-channel	check latest news and daily information	Sept. 2005	subscription for US$1.3/month
ToruCa	electronic cards that allow downloading information onto mobile phones like store flyer and coupon, etc.	Nov. 2005	packet communication charge applies

Note: packet communication charge is in Japanese Yuan (0.03 /packet), about US$0.2/100 packets at rate of ¥ 100 =US$1

Table 2 i-mode services

i-mode introduced its business model on the principle of optimal mobile value chain that enables and encourages handset manufacturers, content providers, and platforms to focus on user interests and build win-win strategy. This model, as shown in figure 6, synchronize quality, content, and wireless technology to boost maximum value for mobile commerce, as all aspects in this business model are mobile user-oriented and in purpose to enhance user experience. This synchronization guarantees that customers, partners and shareholders share interests with end-users, thus enabling all parties to maximize value and to continue to improve the quality of products and services connected with i-mode [13].



i-mode connects mobile users with all parties in mobile commerce value chain

Source: summarized from own study on i-mode business value chain

Figure 6 i-mode business model

i-mode is still the most successful mobile commerce in the world since its initial launch in Japan. Until Feb. 2008, there are about 47.9 million of subscribers of i-mode and its associated services and its global expansion reaches Europe, Asia, Israel, and Australia in the form of establishing joint ventures to promote i-mode service with contents and terminals offering and customizing in each country.

3.4 Taxonomy of Mobile Commerce

Mobile commerce can be categorized into voice-centric and data-centric in term of transmission types. Voice-centric mobile commerce includes all voice communication and associated extension services of voice, such as call display, call forward, third

party conference, etc. These kinds of mobile commerce are the essential services that all mobile users consume at least one and revenues are directly related with number of mobile phone holders in specific region or country. The revenues from the voice-related services are determined by the average communication time and numbers of mobile phone holders. As innovations in communication technologies, communication costs decline greatly and mobile phone users are able to afford long-time communication charge, therefore, number of subscribers owned by a mobile network operator is important to revenue increase and market share. Data-centric services constitute the core of mobile commerce and present the upcoming trend of mobile commerce that 3G and beyond have promise.

Mobile commerce can also be categorized by its applications. These applications cover the domains of Business-to-Business (B2B), Business-to-Consumer (B2C), Consumer-to-Consumer (C2C), and others. Table 3 lists the categories of most common mobile commerce applications.

Application category	Description	Example Applications
transaction	Mobile transaction that involves the change of goods and services with third party by mobile handset users	banking, trading, ticket reservations, credit card info, etc.
Information	Subscribed information is pushed to the mobile handsets, usually with customized contents	news, weather, sports, stock quotes, city attractions
database service	information search and reference features on business and personal life, like "yellow" and "white" pages	telephone directory, restaurant guide, dictionary, etc.
entertainment	leisure and entertainment contents for online and download usages	games, screen download, music, vedio clips, and ring tone, etc.
enterprise	enterprise resource management with integration of mobile applications	inventory tracking and dispatching, mobile office, etc.
public service and urgence	public or government information and service available with mobile handsets	police alert, disaster information, government service, etc.
social contact	virtual social community	chat room, social contact, context-awareness, etc.

Source: summarized from own study

Table 3 Mobile commerce categories

3.5 Challenges for mobile commerce

With advance of telecommunication technologies and mature experiences from Internet E-commerce gained by both service providers and users, mobile commerce shows a strong trend of deployment worldwide, and all major countries and mobile network operators are committing to profit from it. Mobile commerce is regarded as the turn point for revenue increase for mobile network operators and new point of interest for mobile users. Despite of the great successes of i-mode and SKT (South Korea Telecommunications), for example, there are still many challenges that mobile commerce has to deal with. Failure to these challenges below will lead to delay or loss of mobile commerce opportunity as large investments have to be invested to prepare for deployment of mobile commerce.

- Infrastructure challenges: Mobile network underlying technologies are not unified and multiple standards, such as W-CDMA, CDMA 2000, and TD-SCDMA, are or will be implemented by mobile network operators in 3G commercial use. This raises a concern on inter-network operability or service roaming, as mobile commerce services and applications could risk compatible problem through different networks with different technologies. Mobile handsets may count problems while consuming services or applications due to technical capabilities from mobile phone design (memory, computing capacity, etc.). Co-existence of different bandwidths may degrade the performance of service or even cause loss of service.

- Service and application reachable ability and availability: As there is difficult to define a killer application in mobile commerce in 3G systems, reachable ability and availability of services and application are therefore critical for mobile commerce. These include roaming or transferring user's profile through different areas to enable full reachable ability of services, context-aware applications, diversity of available services based on customer segments, integration of mobile and Internet applications, openness of mobile service and application development environment, and location-sensitive services. Wide choice and tailored services will meet diverse needs from mobile commerce users in different segments and maximize the possibility of adoption for the services.

- Business model: Mobile commerce business model is the definition of roles and relationships of a mobile network operator with its customers, partners and suppliers, as well as the description of flows of money, goods and services between these parties. Each party in mobile commerce value chain plays a unique role in value creation and optimization of this relationship constitutes the construction of business model. As mobile commerce in 3G systems is still new, what business models will be proven to be sustainable is yet to be seen

and it varies from region to region. A successful and sustainable business model will profit to all players including customers.

- Privacy and security: Due to the inherent vulnerability of the mobile environment, users in mobile commerce are more concerned about security issues involved with mobile transactions. This issue deals with personal identity management and sensitive information transmission. Security methods include authentication, encryption and tracking of transactions to ensure mobile commerce users that confidential information is secure and transactions are safe. Privacy is another rising issue that prevents misuse or release of unauthenticated personal information. If security and privacy are considered at risk, it is difficult to attract and convince mobile users to consume mobile services and conduct mobile transactions. Mass adoption of mobile commerce will not be realized, and rebuild that trust is a tough task and takes very long time.

- Customer behaviour: It is defined that customers in mobile commerce are the consumers of mobile data services; therefore, studying the customer behaviour and defining corresponding customer segments are critical to guide mobile network operators to develop and market right services and applications. Culture, economy, educational level, and occupation have direct social impacts on user's consumption pattern and help in categorizing market segments.

CHAPTER IV

CHINA MARKET

As a country hosting the biggest mobile market, China is regarded as to boost mobile commerce with its approaching 3G technologies. Profiting from its huge number of and rapid increase in mobile phone subscribers, its mobile commerce is predicted to be popular as 3G technologies promise to provide solid technical capacity and its domestic economic development makes mobile commerce much more affordable. Mobile commerce, particularly data services, will become part of a life style.

4.1 Mobile network operator

As the biggest market in world with about 1.4 billion citizens, China owns the largest fixed-line and mobile networks in terms of both network capacity and number of subscribers. China's mobile market is monopolized by two stated-owned companies—China Mobile, and China Unicom. International telecommunication firms are not allowed to operate mobile networks in China in the predictable 5-10 year future even with China's entry to World Trade Organization (WTO). Mobile networks provided by the two operators cover almost every city and big villages in China. As a result of monopolization, Chinese mobile end-users have to pay higher price for products and services that don't reflect the quality in that price comparing with customers in US and Japan.

- ❖ China Mobile: is the largest mobile network operator in the world in term of number of subscribers and second one by turnover. It provides mobile communication service and related data services, like Internet access, etc. All its businesses are almost in China mainland. It operates both GSM and GPRS systems in China.

- China Unicom: is the third largest mobile operator in the world ranked by number of subscribers. It provides all its services in China mainland with business scope spanning various domains, including fixed line and mobile communications, Internet service and IP telephone, paging, etc. It is the only on in China that operates with and concentrates on CDMA networks with limited investment on GSM networks.

Both China Mobile and China Unicom are listed in Hong Kong Stock Exchange (HKSE) and operate only in China mainland and are governed by Ministry of Information Industry of China (MII). Table 4 shows the operation data of the two mobile carriers.

	2002		2003		2004		2005		2006		2007		Average increase rate	
	China Mobile	China Unicom	China Mobile	China Unicom	China Mobile	China Unicom	China Mobile	China Unicom	China Mobile	China Unicom	China Mobile	China Unicom	China Mobile	China Unicom
subscribers (millions)	117.7	43.1	166.1	80.8	204.3	112.1	246.6	127.8	301.2	142.3	369.3	162.5	25.9%	33.1%
revenue (RMB/US) (unit: billion)	148.8/ 17.7	40.6/4.8	158.6/ 18.9	67.6/8.1	192.4/ 22.9	79.3/9.4	243.0/ 28.9	87.1/ 10.4	295.3/ 35.2	95.3/ 11.9	356.9/ 44.6	99.5/ 12.4	19.3%	21.5%
Net Profit (RMB/US) (unit: billion)	32.6/ 13.9	4.6/0.5	35.5/4.2	4.2/0.5	41.7/5.2	4.4/0.5	53.5/6.4	4.9/0.6	66.2/7.9	6.5/0.8	87.1/ 10.9	9.3/1.2	22.0%	16.6%
voice revenue (RMB/US) (unit: billion)	145.4/ 17.3	45.7/5.4	141.1/ 16.8	58.7/7.3	172.3/ 20.5	65.4/7.8	192.8/ 22.9	70.2/8.4	207.2/ 25.9	78.2/9.7	242.6/ 30.3	80.7/10.1	11.1%	12.3%
Voice usage (billion minutes)	218.5	187.3	442.4	226.5	660.9	261.1	903.1	319.2	1252.1	399.9	1818.9	466.8	54.3%	20.1%
data revenue (RMB/US) (unit: billion)	0.98/ 0.12	1.8/0.2	10.5/1.3	3.2/0.4	12.6/1.5	7.2/0.9	18.3/2.2	11.9/1.4	24.4/3.1	14.2/1.7	32.1/4.0	15.3/1.9	32.4%	42.5%

Resource: Financial reports of China Unicom & China Mobile

Table 4 Operation data of mobile network operators in China

4.2 Mobile network Infrastructure

Mobile network infrastructure refers to the mobile technologies that implement in China to support the mobile communications, and its regional deployment that impacts

the availability of mobile services. Presence of mobile network infrastructure is the essential requirement for developing and deploying mobile services and determines what kinds of mobile services are available in terms of technical characteristics and mobile network availability.

- Geographic presence: Mobile networks of both China Mobile and China Unicom cover all the cities and towns in China with either GSM or CDMA/GPRS. These areas consist of about 30% of total populations in China (as of June 2007, about 1.4 billion population in total) and are perspective market in China in terms of revenue and life style. Due to unbalanced economic development, the rest of 70% populations are mainly in rural areas with very low revenue that can only prioritize for basic living needs but telecommunications. Also uneven economic development in China make eastern and central China the richest and Northwest of China the poorest, which means purchasing abilities for mobile services between these regions are distinct different, as a results, mobile network infrastructures in the less developed areas are very basic and only for voice communications with GSM network. CDMA and GPRS are mainly deployed in well-developed areas.

- Mobile Networks: GSM networks are still the main mobile network infrastructure for both mobile network operators, while GPRS of China Mobile and CDMA of China Unicom serve as supplementary. Table 5 shows the network capacities in China:

China Mobile	network capacity	subscribers	network utilization rate	China Unicom	network capacity	subscribers	network utilization rate
	500 million	369.3 million	77.86%		250 million	162.5 million	65%

Resource: China Mobile & China Unicom, as of Dec. 2007

Table 5 Network capacity and utilization rate

4.3 Services and applications

Service and applications available in China are fallen into two categories: voice and associated services, and data and associated mobile valued-added services (MVAD service). Both China Mobile and China Unicom provide these services for subscribers using either GSM or CDMA/GPRS.

- Voice and associated services: These are the principle services that are available and used for all mobile users in China. These services include: local and long distance call, roaming, call display, ring tone, voice mail, call waiting, call forwarding, call restriction, and call reference. These services are available for both GSM and CDMA/GPRS systems and are the main business activities of mobile users. Among these services, ring tone downloading is the more popular service that both mobile users consume and service providers advertise mostly, as well being a common service for all mobile user segments—youth, adult, and business people, as demonstrated by data from mobile operators and our survey.

- Data and associated value-added services: These services include SMS/MMS, email, Internet access, information access and customization, online game and downloading of picture and file, etc., and some financial services.

- WLAN: This is a service that allows laptop to access Internet with either GPRS (outdoor with GPRS connection) or WLAN (indoor with WLAN). Indoor WLAN access points are only at some public places like hotels, commercial building, or airports of some metropolitans. This service is only available from China Mobile as of December 2007.

- Information access and customization: Mobile users can access information provided by SPs (Service Provider) and CPs (Content Provider). Mobile end users can do some customization with their mobile phones, like choosing

weather information of a city, stock quota and currency exchange rate, news abstract, sport, etc. Users have to access Internet to subscribe customized info services and pay both communication fee and information access fee as the subscribed services are automatically delivered to their mobile phones for view. A few customized services can be sent via SMS/MMS, but due to low fee generated from SMS/MMS, there is a force to transfer this kind of service to Internet access or charge hidden fee for service delivered by SMS/MMS.

- Location service: Only China Unicom provides location service based on its CDMA networks. This service is for mobile end users and only location information is available by presenting either text location message or small digital map on the phone. Integration of location information with other services is not available nationwide as of January 2008, but some pilot implementations are done in a few provinces for test purpose. It uses gpsOne positioning technique in its CDMA 1x networks to offer location information by integrating gpsOne function into mobile phones. Accuracy can be among 50-200 m in CDMA network coverage.

Each mobile network operator has its brands that include a series of services and applications. Table 6 shows their brands, services, and applications under these brands. Services and applications under each brand may overlap.

China Mobile			China Unicom		
brand	Logo	Services and applications	brand	Logo	Services and applications
GoTone M-Zone Shenzhouxing		local call, long distance call, national and international roaming, SMS,call display, color ring tone, MMS, voice mail, call waiting, call forward, call restriction, WAP Internet access, wireless Internet access(GRPS /WLAN), information access (news, weather, stock, etc.),	Uni Net Uni-Wap Uni-Mail Uni-Magic Uni-Info Stream Media		Local and long distance call, national and international roaming, SMS, call display, color ring tone, MMS, voice mail, call waiting, call forward, call restriction, WAP internet access, wireless Internet access(WLAN/CDMA), info access (news, weather, stock, etc.), stream media, BREW applications, location info and simple LBS,

Source: Summarized from China Mobile and China Unicom web sites

Table 6 Mobile service brands and applications

4.4 Pricing

Price is still an important factor that has deep impact on mobile users' attitudes to adopt mobile services. Currently, the pricing policies of China Mobile and China Unicom are similar, that is, for voice communication, users have to pay for incoming and outgoing calls for every minute they communicate. Mobile users subscribed with different brands pay different base fee for voice communication, for example, China Unicom has base fee of ¥0.40/min for users with Uni-magic and Uni-Net, ¥0.60/min for users with Uni-Wap, and various fees set by its branches. For data services, the pricing policies are very confused and complex, as there is no simple way for end users to know how much they may pay for the services and there are many hidden traps that cost users to pay even more than they thought. The price is therefore the biggest issue that counts the most disputes against mobile network operators.

Both mobile network operators charge ¥0.10 for each SMS service. Comparing with the fee of ¥0.25/min for a local call with a mobile phone, a SMS message is

cheaper. That explains why SMS is widely used in China and generates the biggest revenues for data service due to its sending numbers.

Prices for mobile services and applications are often changed without notice in China. Unlike service providers in Canada and United States, each branch (at the levels of province or city) of China Unicom and China Mobile can determine the price they prefer and there is no unique price system for both China Unicom and China Mobile.

4.5 Mobile device

Mobile devices in China are made by both Chinese and International companies. Mobile users prefer international brands than national brands in terms of features and style, but price. While Chinese brands offer lower prices as one of their business strategies, they are the preferences for those price-sensitive users. As a brand new cell phone from international mobile phone maker may cost more than ¥4000, a cell phone of national brands with similar or less features can be as low as ¥2000.

Mobile devices in China can be divided into three classes: high-end, mid-end, and low-end. Each class focuses on its specific user segment. The marketing difference is:

- High-end phone: They are the phones from the international phone makers and a few big Chinese companies. These phone makers include Motorola, Nokia, Sony Ericsson, Samsung, LG, Toshiba, Datong (China), and Huawei (China), etc. High-end mobile phones provides features like camera, color screen with high resolution rate, BREW and Java environment, Bluetooth, internal radio, MP3 player, large memory, long standby time, etc. They are mainly for business people and youth generation who seek for new fashion and life style. The unit price range of this class is generally over ¥3000 per phone.

- Mid-end phone: Mobile phones in this level provide color screen, camera, medium resolution rate, BREW and Java environment, medium memory and limited computing capacity, reasonable standby time, etc. They are mainly targeted to most mobile users who may be interested in and are financially capable to afford for more data services in current 2G and future 3G networks. The unit price ranges from ¥1000 to ¥3000.

- Low-end phone: The low-end phones are only configured with very basic features, like mono color, limited memory, etc. Usually, low-end phones can not provide advanced features like WAP or MMS, and for GSM networks only. These phones can not use with GPRS or CDMA networks and are mainly for voice communication and SMS with very limited data service, such as ring tone downloading, simple game, etc. They are for the cost-sensitive mobile users who need to be touched anytime at any place with less or no experience in Internet and mobile commerce. As the price of SMS is quite cheaper than fix-line and mobile calls, SMS service and mobile calls are the dominated services for users in this class. Other data services and applications are not an option for mobile users at this level in a predictable time.

4.6 Business model

A business model is defined as a conceptual tool that represents the business logic and revenue gaining in a company. As defined by Linder and Cantrell, business model is a "description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams"[14]. There are three types of business models: conceptual business model, operation business model and scenario business model. Table 7 demonstrates the differences between the three ones.

Type of business model	Description	expected usage
Conceptual	generic conceptual on elements, components and relationship in any business	essential baseline for business model design and academic research
operation	real business model in real world for a company or industry	presentation from conceptual model in real world for revenue and profit generation
scenario	a virtual business model based on various scenarios	ideal for fostering innovation, stimulating opportunities, and guideline for choosing a business model based on scenarios

Table 7 Business model type

As mobile network operators is the core of mobile commerce value chain, its role as an intermediate between mobile end-users and other participants including service providers, content providers, and others in mobile commerce determines that business model in favour of the interest of mobile network operators, especially for the shareholder, is critical and sustainable. Operation business model for mobile commerce is posed from analysis on China mobile network operators, and scenario business model is hyped based on our research and analysis on China market and interviews as well.

- Conceptual model: A conceptual business model consists of elements that a company involves to its business in order to generate revenues. This model is for academic research and is generally treated as a baseline for companies to determine their operational business models. These elements describe how the company functions in defining its customer segments, organizing its resources, adopting technologies, and offering services and products. As new technologies and innovations have powerful forces on reaching customers and creating services and products, advance of technology and innovation makes business model much sophisticated. In general, conceptual business model consists of the four elements: technology, resource, customer, and service and product. This conceptual business model is illustrated in figure 7. This

business model is also suitable for mobile network operators in China in general.

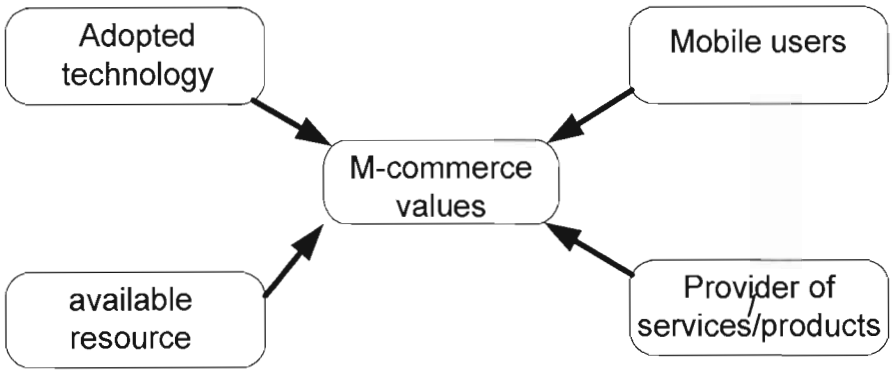


Figure 7 Conceptual business model

- Operation model: Operation model outlines the real business model in real world. It is specified for a company or an industry that gives more details on the elements related to revenue generation. This model reflects the current business operation, but there are no hypes or scenarios to predict the future business direction. Figure 8 shows the operation business model for Chinese mobile network operators.

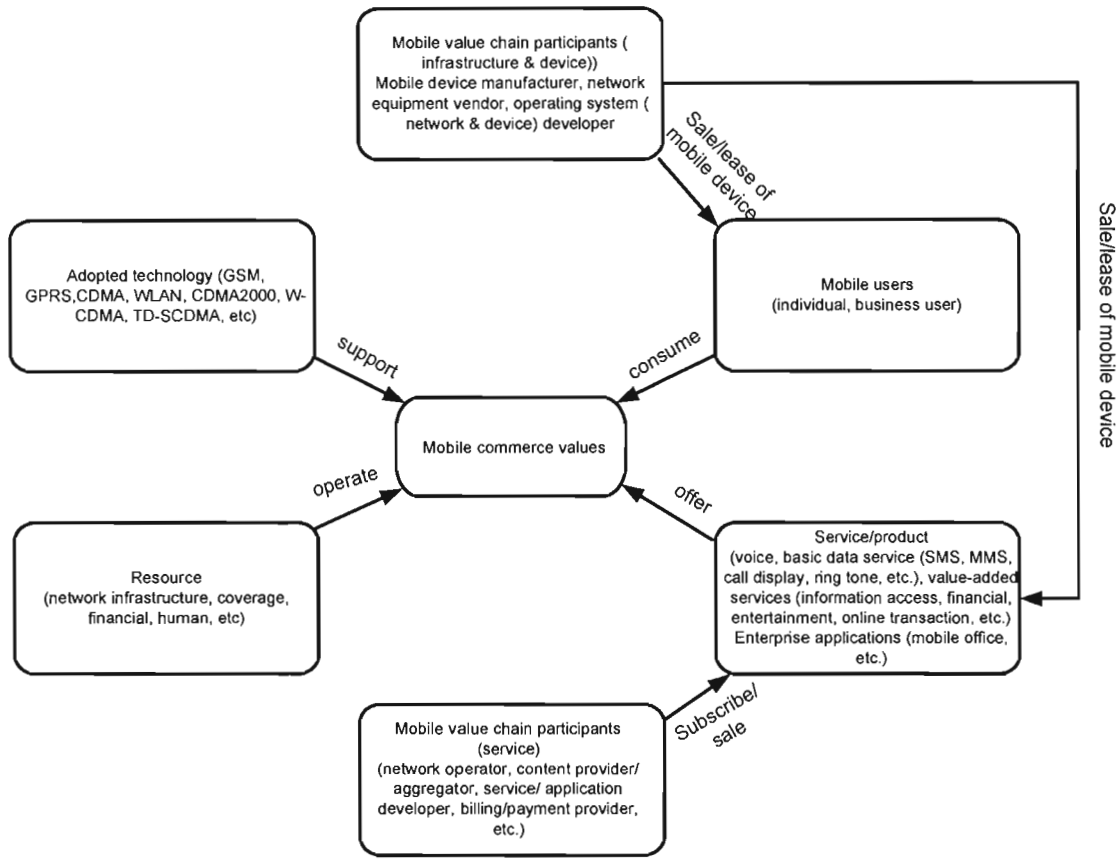


Figure 8 Operation business model

In this model, revenues for mobile network operators are sharing with partners like game developers, LBS service providers, content providers, etc.

- Scenario model: In 3G networks, mobile network operators face new challenges to take the advantages of 3G technologies to offer more data services in order to increase their revenues. Some of the services in 3G technologies are emerging, and adoption for these new data services and applications will make definitely efficient usage of 3G advantages and increase revenues for participants in mobile commerce value chain. This scenario is based on the new opportunity that 3G offers and business model is posed.

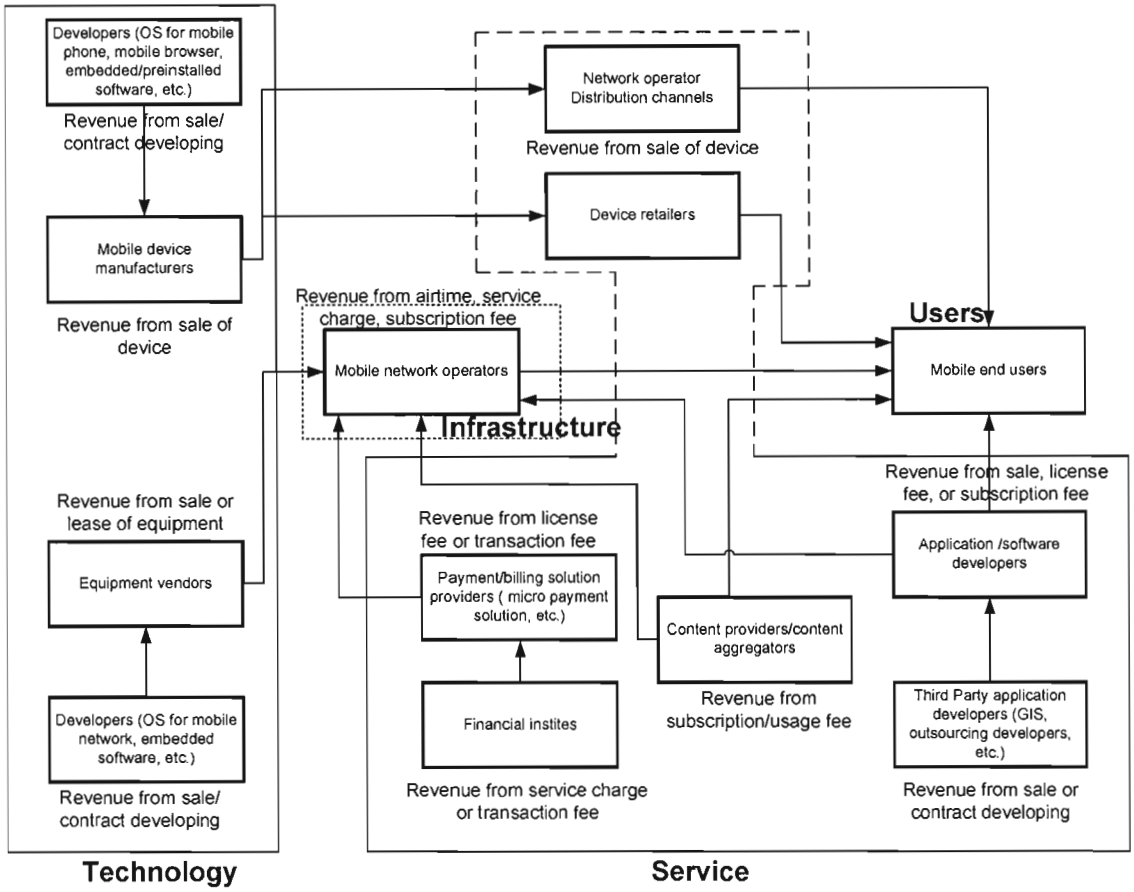


Figure 9 Scenario business model

In this scenario business model, there are four parts: technology, infrastructure, service, and users. Participants from technology, infrastructure, and service are to service the users. In terms of implementation of this business model, concerns are focused on particular points within each part.

- Technology: There are multiple choices of 3G technologies that mobile network operators can consider in constructing the next-generation mobile networks. This includes W-CDMA, CDMA 2000, and TD-SCDMA. As W-CDMA and CDMA 2000 are widely used and have been proven as a better choice in commercial implementation in terms of quality and

adoptability, Chinese mobile network operators may opt to use them as their choice. The adoption of these technologies can take advantages of the success of other mobile network operators and avoid the mistakes that other countries had. While China is still a country that government has a very strong power over company's business operations and regulations, and considering its preference on its own TD-SCDMA as well, we believe that Chinese mobile network operators will be forced to bundle with TD-SCDMA if they want to get licences for W-CDMA and CDMA 2000. Therefore, inter-operability between these three technologies will be a challenge as some pilot 3G performance tests have shown negative results over the TD-SCDMA networks.

- Resource: Beside the existing GSM, GPRS and CDMA network resources, 3G implementation will not be a quick and full scope implementation in China for mobile operators. That means, even licences are issued, mobile network operators will be careful on choosing regions and cities to build their 3G networks. 3G systems will be first implemented in some well-developed regions or cities where mobile end users have strong purchasing abilities and show interests for new services and applications that 3G promise. Implementation of 3G will be a very slow and long process in China, as mobile network operators need time to analyze the performance of their initial launch of services and figure out the further steps based on their analysis. As a result, the changes on resource aspect of this business model will be a do-and-see one.

- Service and product: This is the most important and dynamic part in this scenario model. As 3G technologies provide more capacity on data services and multimedia over voice communication, data services and applications will be the "selling point" and some services such as location-based services and multimedia, real-time services, etc. will dominate. Also,

enterprise services and applications like CRM (customer relationship management), EAI (enterprise application integration) will be attractive for perspective enterprises.

- Users: 3G technologies will create new customer segment, as the new services and applications from 3G systems will target business and social domains that preceding mobile systems have few impact on. Enterprise users will be more interesting in integrating their enterprise applications with their partners through mobile networks that have adequate bandwidth, low cost, security, and open-architecture. Virtual community creation within LBS will attract teens and youths to services like location-based gaming.

- Revenue: In this business model, revenues are from voice and associated services, and data services as well. For voice and associated services, all generated revenues are solely for mobile network operators as they own and operate the mobile networks. But for data services, there are many revenue modes depending on the services and the degree of its acceptance. For example, currently mobile network operators are sharing the revenues with content providers on commission base for subscribed services—mobile network operators get the communication fee over the mobile network by counting the volume of data (kb) through the delivery of services for per transaction. If there is a subscription fee for a service, that fee goes directly to content providers. Under 3G, as there are huge numbers of data services, mobile operators will ask for a part for subscription fee or may act as a content provider themselves.

CHAPTER V

PERSPECTIVE MOBILE SERVICES AND APPLICATIONS FOR CHINA MARKET

Mobile market in China is the largest in the world in terms of subscribers and business revenues due to its 1.4 billions of population and rapid economic development, with increase of millions of new subscribers each month. Table 8 illustrates the number of subscribers in China:

unit: million

Year	2002	2003	2004	2005	2006	2007	2008*	2009*	2010*
Fixed line	213	262	313	360	396	427	452	475	500
increase%	16.4	23.0	19.5	15.0	10.0	7.8	5.9	5.1	5.3
mobile	204	264	334	386	442	490	520	550	580
increase%	22.5	29.4	26.5	15.6	14.5	10.9	6.1	5.8	5.5

* Predicted by Gartner

Source: MII & Gartner group

Table 8 Fixed line and mobile subscribers in China

As the approaching of its 3G systems and its 2008 Olympic game in China, study on its mobile market and perspective services are critical for taking advantages of 3G technologies. Mobile network operators, service providers, content providers, and other participants in mobile commerce value chain need to classify the market segments and provide diverse services to reflect the demands from each segment. In order to determine the mobile services and applications in 3G era, a survey is conducted. This survey was carried in an International mobile conference held in China as respondents are familiar with the mobile service and mobile market in China.

The survey was sent to more than 240 attendants in the conference and returned survey paper was 198. Among the returned ones, 158 were completed and were used

for this analysis. Based on business research method, the minimum number of completed survey to conduct a reliable survey is 100; therefore our survey meets this minimum requirement and can be used for this research. All following analysis are based on these completed effective returned responses and the term "respondents" refers to people who have returned completed questionnaire sheets.

5.1 Respondents

Among all respondents, about 1/3 are from management level, who understand the mobile commerce and their business strategies at a high level. 24% of respondents are from technical staffs who are familiar with the technical aspects of mobile systems and service development and deployment. About 36% are from customer service and marketing who have direct contact with users and understand well about mobile users' expectations.

Type	Top management	Middle management	Technical staff	Marketing staff	Customer Service	
% of Total respondents	7	28	24	21	15	5

Table 9 Job type of respondents

Most of respondents (about 65%) work in companies with more than 200 employees, which means they are considering as medium- or large-size enterprises in China.

Employee	1000 +	500 to 999	200 to 499	50 to 199	Less than 50
% of Total respondents	15	20	22	19	13

Table 10 Company size of respondents

Revenue chart shows that only one third has annual revenues over ¥50 million (approx. US$5.95 million), which indicates they are big companies in China. Majority of enterprises are small or medium-sized ones with annual revenues between ¥10 – 50 million (approx. US$ 1.19 –5.95 million). This result proves our observation and hypothesis that most service developers and content providers are from SMEs (Small and Medium enterprise).

Revenues (¥ millions)	100+	50--100	20--50	10--20	Less than 10
% of Total respondents	3	30	34	21	12

Table 11 Annual Revenues

Majority of respondents are from industries with direct relationship of mobile commerce, these include wireless telecommunication operators, Internet content providers, application integration providers, and game providers, as shown in Table 12 below:

Type	Wireless telecommunication operator	Internet content provider	Application integration provider	Game provider	Research institute	Government	Other
% of Total respondents	15	20	22	19	13	7	4

Table 12 Respondents' Industries

5.2 Service development and deployment

Among all respondents, over 71% said that their services or applications are from outsourcing or buying. About 14% are collaborating with network operators. Only a small part of 15% is from in-house development. This seems strange at first glance, but after talking with some respondents, a reasonable explanation is that many

enterprises pay more attentions on how to market their services and applications than on how to develop services. This also explains why there are numerous small content providers, game developers, and service providers in China, as they are under subcontract from big companies.

Development type	Totally in-house	Most in-house	Collaboration with network operators	Most outsourcing	Totally outsourcing	Buying outside
% of Total respondents	5	10	14	19	24	28

Table 13 Mobile Commerce Service development Type

As most of services and applications now are still running on GPRS and CDMA systems owned and promoted by China Mobile and China Unicom over their core data communication networks, this symptom will last for a quite time as these services and applications dominate most of the data service revenues apart from SMS. We also note that there are some services available for GSM and others, but most respondents said that they will not add more for 2G networks, and they are interesting in the 3G services as shown in table 14, and high rate of about 70% will develop 3G services in 2 or 3 years for 3G mobile phones as 3G licences will be issued at that time as they predict. 2.5G systems, like GPRS and CDMA will remain the major underlying platforms for data services and applications for a long time.

Mobile system	GSM	GPRS	CDMA	other
Usage(%)	80	40	50	5
Service/ application	40%	78%	82%	10%

Table 14 Services/ applications and development platforms upon respondents

WLAN services are not popular in China due to the high price of mobile communication and easy access and low price to Internet with desktops. Most people believe the WLAN is with technical advantages but a little business value for mobile revenue increase, as shown in table 15.

WLAN Access available	In most cities	In some big cities	In some palces	optional	Not optional
	30%	50%	70%	50%	

Table 15 WLAN access in China

5.3 Expectation and importance of mobile commerce

We believe that the expectations from service providers' point of view are very important for the success of mobile commerce, as these determine the business strategies they will follow, as a result, will affect the service availability for the mobile users. If they conclude that mobile commerce will be a valuable and profitable, then they are willing to commit to develop and offer more services and applications to attract mobile users to subscribe. In that way, revenues will increase and push mobile commerce to wide use. This is quite critical for 3G era as the 3G systems need more and more new services and applications to support the operating costs and generate profits for mobile network operators and other participants in the mobile value chain.

From our analysis, over 2/3 of the respondents think that mobile commerce will be regarded as a new growth point of revenue for future years as they believe 3G licences will be issued by 2010, over 85% agree that mobile commerce is good for both service providers and mobile users. Most agree that current situation of service is not satisfied and there are lots of room for mobile commerce to improve and need to add more contents. There are about 1/3 of respondents who give negative response about mobile commerce as "enough". This also indicates that mobile commerce is considered as

expensive as about 95% of all respondents admit in their returned sheets. This result reflects the high pricing policy in China. This also explains why SMS is the most popular and used service in China from mobile user's billing point of view, as SMS is cheaper even than a local fixed line call.

	revenue growth	good	enough	Need improvement in QoS	expensive	Unsatisfied in revenue and subscription	Have Less content
% of respondents	64	85	30	75	95	73	70

Table 16 Comment on mobile commerce

5.4 Voice and VoIP

Voice is definite the biggest revenues for mobile network operators as survey indicates that voice communication ranks the first service by 95% of all respondents. This is the basis service for mobile phone users. Mobility and call quality are two concerns for users to choose mobile network operators.

Voice over IP (VoIP) is a new communication method for mobile commerce. Two major standards for VoIP are the Internet Engineering Task Force (IETF) Session Initiation Protocol (SIP) and the ITU's H.323. VoIP provides many advantages than traditional mobile communication. One big sale point for VoIP service is its low cost for mobile phone users. As most respondents admit the VoIP can attract mobile users to make more calls, they also doubt that VoIP service is an important one for them in term of revenue from network operator point of view. The reason is VoIP will trigger price war between mobile network operators and is against the interest of fixed line companies as well. So far only two Chinese companies are allowed to provide VoIP services by means of phone card and international VoIP services like Skype are not allowed and are illegal in China.

Table 17 shows the services ranking from our survey. Voice communication is regarded as the top one of service in term of revenue.

service	Voice	SMS/MMS	File transfer	Game	Email	Internet access	Financial service	Informatio n access	Information on demand	teleconfrence
Rank # by % of respondents	1 of 95%	2 of 85%	3 of 85%	4 of 76%	5 of 78%	6 of 80%	7 of 67%	8 of 70%	9 of 66%	10 of 54%

Table 17 Service ranking in China

Message service is among the top services in China among all data services. The simple and major reason is its low price. Message service is regarded as an important revenue resource in 3G networks as well.

5.5 Value-added service

We believe that value-added services in 3G are critical to boost mobile commerce, as these services are expected to grow exponentially with 3G solid support on data rate and security. So far, value-added services (VAS) account for about 20 –30 percent of total revenues from mobile operators' revenues. These value-added services will provide an m-commerce platform for C2C, B2C and B2B transactions over the 3G era, as we believe service providers and content providers will be ready to develop new VAS services from technical point of view. As many service providers and content providers are familiar with the open source environment, such Linux and Java, as well as proprietary technologies, like BREW, there is few limitation for them to deliver new services in term of technical readiness.

According our survey, most mobile users are expected to pay between ¥200 -400 per month for their services comparing with current average monthly cost of ¥89, and over half of that payment are for data services. People are more comfortable for mobile service like financial information and movie clips with their mobile phones (shown in table 18 and table 19).

Expected monthly payment	Less than ¥100	¥100-200	¥200-400	¥400-600	¥600 +
Percentage (%)	<5%	20	55	20	3

Table 18 Expected monthly payment for mobile users

topic	Use or possible use of mobile financial services	Mobile transaction (ticketing or reservation, etc.)	Attitude for Service customization	Privacy is important	Info access and email
% of YES/ positive	40	35	50	67	70

Table 19 Attitude to mobile value-added service

As there are almost half of respondents said the service customization is positive, and privacy concern is raising, we believe that location-based services can be an attractive area for 3G and more secure transactions are critical to ensure mobile users to conduct more transactions.

As most of Value-added Services in 3G are benefited from its wide bandwidth, services and applications, such as game, web access, financial transaction, and shopping, are able to implement with 3G mobile phones. These similar applications based on Internet e-commerce can be easily and quickly transferred to mobile commerce. Challenges that e-commerce doesn't face are these new services and applications integrated with mobile user's location information, that it, customization and delivery of mobile services with location information. Such services will create a new milestone for mobile commerce and generate value for mobile network operators, for example, child tracking will allow parents or guardians to track where a child is physically located, and this kind of service (with location info) is more accurate in 3G, and makes it practical and adoptable.

Another major issue in 3G is the possibility to support multimedia as this eliminates the restriction on presentation of services. Services can be presented and delivered in forms of text, voice, graphics, or video stream. This multi-format presentation will enhance mobile user experience on mobile service and help them to subscribe more.

5.6 Enterprise Applications

As in 2G and 2.5G systems, due to limitations from mobile networks and then implementation levels of enterprise applications themselves, enterprise service with 3G mobile systems as platform is very rare and limited. This is because telecommunication technologies in 2G or 2.5G are not able to support large volume of enterprise data and security is a big concern, also enterprise applications are not built with open architecture. With the introduction of web service and service-oriented architecture (SOA) in enterprise application development, enterprise application integration (EAI) becomes more possible and seamless despite of underlying platforms. This makes 3G mobile networks a possible platform for these new enterprise services, as 3G technologies are also open architecture.

As mobile enterprise service in China is still almost a blank field, it will be a new entry for 3G to create values. Our survey indicates over 70% think that mobile enterprise services and applications over mobile telecommunication networks need to be focused and promoted in 3G. Enterprise applications and services include mobile office, mobile inventory, mobile customer service, mobile government, etc. Service-oriented architecture can increase availability and adoptability for mobile enterprise applications.

CHAPTER VI

LOCATION-BASED SERVICES AND SERVICE-ORIENTED ARCHITECTURE

6.1 Perspective location-sensitive services

As positioning techniques advance and accuracy improves, mobile network operators are able to obtain mobile handset location information constantly. Such capacity of obtaining location information is obligated in United States and Europe stipulated by laws and government regulations that mobile network operators have to be able to locate the position of emergent mobile calls with defined accuracy. While in China, there is no such requirement for mobile network operators in a predictable period, mobile handset location information will be mainly used for commercial purpose.

In term of whether location information request is passive, three categories of location-based services exist: pull, push, and tracking. Pull applications or user-requested services require that the mobile users actively request location-dependent services related with their locations, such as query for a nearby point of interest or road map. Mobile users are aware that location information is sent to service providers and accept it implicitly. This service generally involves either mobile user location or relative service location. Mobile users pay for the services they consume and location information can be gathered only at the moment of service request. Push applications or triggered services mean that mobile users will be notified about availability of predefined specific services and information related to their location and profile if applicable. Users can accept, ignore, or reject the services at will. In push services, location information is collected at different time arrival depending on service requirements, even most of the time there is no push service triggered, because push services need the location information as an event to trigger. Examples are merchandising ad or e-coupon, which merchants pay the cost for communication and

service fees to service providers. Push services are generally free to mobile users. But it is not clear whether it is profitable and feasible as a regular marketable service. Tracking service reports the position of an object, such as vehicle or moving objects, even people, to applications. All these location-based services can be either B2B or B2C in term of service recipient.

Though theoretically, location-based services can be integrated into any existing application or service, but in reality, location-based services are limited to specific domains. One example is location-based weather forecast or real-time traffic condition, in which location-based service is hyped to provide mobile user with tailored information on weather and traffic condition with the context of physical location of a mobile subscriber and business revenue is generated through the usage fee paid by mobile users. In reality, such kind of service never succeeds in term of business revenue due to the availability and convenience of free radio broadcasting. One critical factor that makes location-based services ubiquitous and distinct from other services is its dynamic awareness of mobile user's location, and customization of services with that location information. Location-based services cannot be a turn point for 3G systems unless with careful study of its unique characteristics and utilization into appropriate fields. Indeed, location-based services are critical and irreplaceable in the following perspective domains:

- Information access: Information access based on location is the wide variety in location-based service. Standard or mass information is filtered with mobile user's location and optional profile. Examples include road map, city sightseeing, point of interest, mobile yellow page based on location, etc.

- Fleet management and inventory tracking: This service enables enterprises to location their inventory or asset. By integrated with enterprise applications, customers can track their goods via their mobile handsets, like the tracking service that FedEx provides.

- Location-based billing: Accurate billing is essential for consumer, mobile network operators and service providers. Precise location information helps determining the exact charge that mobile users need to pay for usage of such services in home zone or roaming to different geographic locations. Records of call (ROC) are therefore tracked and stored in mobile user's home network and visitor's networks if roaming, and billing systems must have the ability to identify the difference with prepaid and post paid mobile users to ensure prepaid mobile users not to run out of its money. A clearance agent is required to settle the transactions between different mobile network operators.

- Emergent service: This is the initial and essential service that triggers the introduction of commercial location-based services and is still in continuous growing need. By pinpointing the location of mobile handset, emergent agents can quickly response even there is no communication at all, like in nature disaster or crime prevention.

Unlike desktop-based GIS application, mobile location-based services are facing more challenges caused by the technical limitations and capacities of mobile handsets. These limitations include small screen, display mode and resolution rate, computing capacity, memory, etc. and such limitations determine that mobile location-based services and applications have to be treated and developed to cope with these limitations. Figure 10 shows the basic architecture of delivery of mobile location-based service to mobile user.

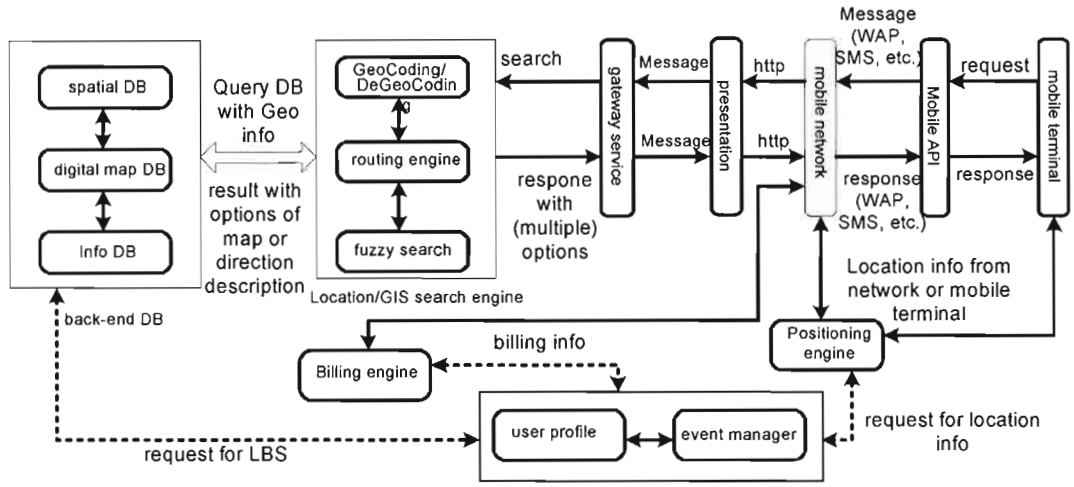


Figure 10 Architecture of location-based service

Facing the difficult challenges in growing both ARPU and number of subscriber, mobile service providers hope that location-based services will stimulate demand of data service in 3G networks. This leads to the development of advanced LBS with more personalization by introducing user profile (both static and dynamic) and events as input parameters. From a mobile user's point of view, as shown in table 20, these kinds of customized location-based services are much individual-oriented and present more possible adoption as concluding from the survey on Chinese market.

service	description
mobile yellow page	find points of interest nearby or at a specific place(sightseeing, favor restaurant, etc.)
emergent service	locate position of emergent calls
mobile marketing	location-based marketing using push technique
inventory management	use mobile phone to management warehouse inventory and delivery tracking
information access	provide information tailored by location, such as weather forecast, for travellers
entertainment and social contact	offer entertainment services and virtual community based on location
mobile office	provide office environment on the move, like dynamic job assignment based on location
security and customer care	mobile applications to provide customer care or security, such as parents locate kids' locations

Table 20 Perspective location-based services

6.2 Customization with location information

Customization is regarded as one of the most important factors to determine the success of mobile services, as it targets on each individual and enables the services delivering tailored to users' specific needs according to the context of a mobile user, such as terminal capacities and network characteristics, user preference, and location and events. Customization is used for many applications and services with the constraints of user profile, especially with predefined conditions like interests. As the approach of next generation mobile telecommunication, we believe the customization

with location information will be a new attractive point for mobile commerce, as this introduces dynamic location information into user profile and links that location information with specific information or service close to the user location. In a word, the new user profile with dynamic location information is the potential start point to blast new services and applications for perspective users.

6.3 User profile

User profile defines information about a user such as interests, context, location, etc. It is used for delivering customization of mobile services. Customization of service uses business rules to link the services and user profile, as shown in figure 11. Customization engine will first call for business rules to determine whether customization is availability and/or mobile user is authenticated for that customization, then it will search from registry of registered service providers and content providers to find the meta data of available contents and services that are coping with conditions from user profile. Only matched services and contents are passed to customization engine for further process.

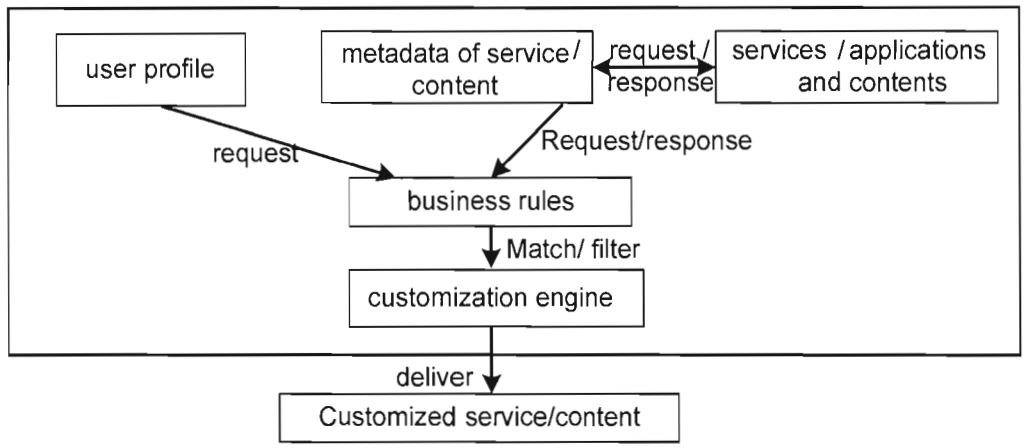


Figure 11 Usage of user profile

User profile is a key element in providing customization, therefore, a well-defined structure and API is critical for multiple applications and services to utilise user

profile. All user profiles include static information such as user name, address, etc. that are implicitly gathered when mobile users activate their mobile services. Dynamic part of user profile is optional but is able to provide more accurate customization of services and contents, as they are up-to-date with the contexts of mobile users. Statistic and mining techniques can be used to better track and investigate a mobile user's behaviour pattern such as purchasing interests and web surfing habits, for example, to push customized services and contents to mobile user's terminal with awareness of context. We present a structure of user profile which can be collected and used in offering customized services.

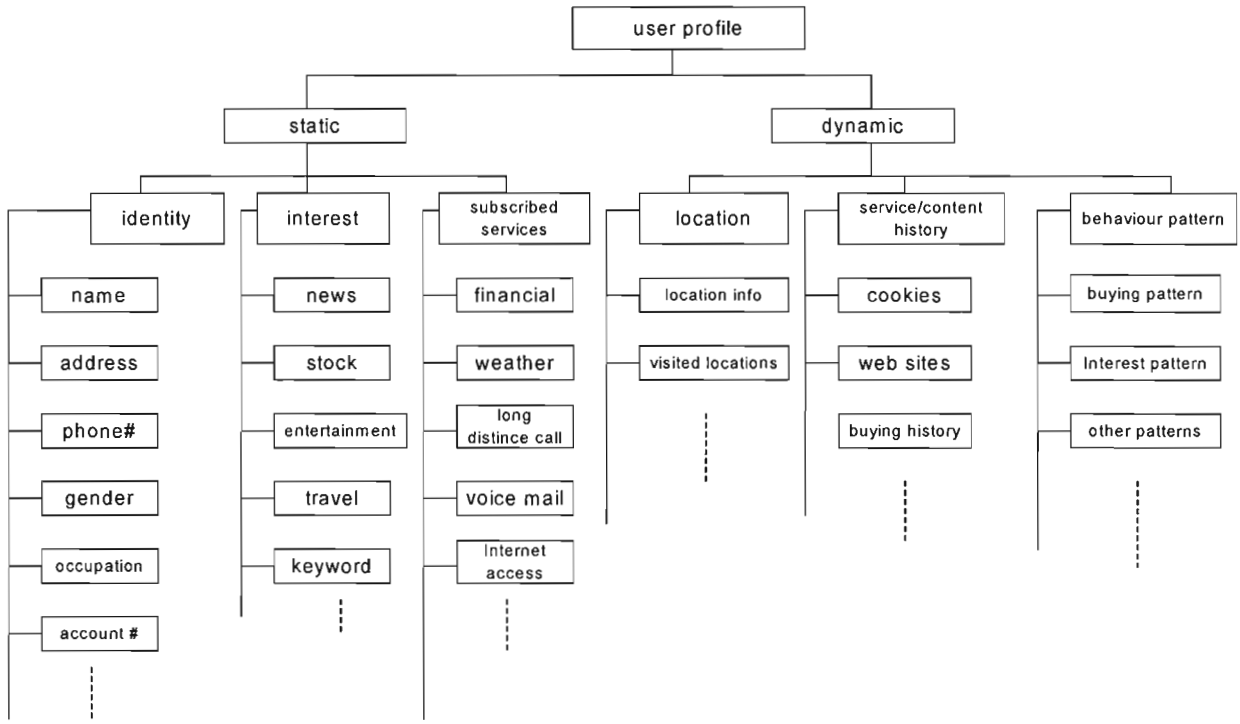


Figure 12 Structure of user profile

User profile is helpful in service customization and delivery, but the process of profiling also raises many new issues and concerns about the security of personal information. Such issues and concerns include, but not limit to, privacy, security, ownership, and scope and access control.

- Privacy: Privacy is the most important issue raising with user profiling from the mobile user point of view. Public perception is essential in profiling to avoid any lawsuit or dispute. Clear and unambiguous privacy policy must be presented and accessed to mobile users at registration for customization, that means, (a) users are giving permissions on profiling and are informed if user profiles are intended for new purposes, and (b) users are aware of the way the user data are used. Only mobile users accept and comfort with the privacy policy can lure them to subscribe customization, in this case, location-based services (LBS).

- Security: Mobile users must be convinced that their profiles are well protected and secured to be able to establish trust with the service providers. Security is about on the platform and software that use the profiles, and transport and delivery to other parties as well. Audit on the access of user profile and integrity must be provided to prevent unauthorized and illegal access and abuse on personal information.

- Ownership: It is always somewhat disputed on the issue of ownership of user profile. To ensure user acceptance, it is essential that the users themselves who own the user profiles. In business operation, it is very common that the mobile network operators hold and own personal profiles within a defined business scope, but allow mobile users to modify or view user profiles.

- Scope: This is clear that user profile should only include the minimum personal information necessary for customization of location-based services. If

multiple user profiles are involved, they should be bounded and limited to a business domain.

- Access control: Location-based services will constantly access and search user profiles to deliver customization. There are two ways that are commonly used to store user profiles: in a relational database or an LDAP-compliant directory. Use of a relational database is a quick and easy method to store user profile and provide all advantages associated with the used database system, the biggest disadvantage is inflexibility of user profile, as any change on the structure of user profile, such as adding or deleting a column, will force the extra work on maintaining the consistency and integrity of database. Use of LDAP directory provides suitable performance and a high level of platform independence.

6.4 Geocoding and presentation

Geocoding is the process of assigning an x,y coordinate of a position (latitude and longitude) into a given address. Once geometry of a position is computed, it is displayed on a map generated from GIS engine. Reverse geocoding is the process of translate an x,y coordinate into an address. Geocoding and reverse geocoding are used in two ways concerning location: a point location or direction with start and end point. In reverse geocoding over a point location, the x, y coordinate of that point, such as mobile terminal location gathered from positioning techniques, is computed and displayed. While with a direction, both the start point and end point are reverse geocoded and street segment is used to interpolate. In case of ambiguity that exact address is not found, approximate location can be computed and displayed. Geocoding is essential for location-based services as it makes possible for linking point of interest (POI) with mobile user location.

Presentation of geocoding and reverse geocoding can be in text or map formats, even voice, depending on the mobile terminal characteristics and user's intention. It

can be used for road map or locating an object location. Presentation service can be combined with other information, such as points of interest. There are two models for presentation services: centralized and distributed models.

- Centralized model: Mobile terminal communicates with a management center where mobile user's location and other information are collected and computed, and results are sent back to mobile terminal. In this model, requirement on mobile terminal is least, mobile terminal doesn't need computing capacity.

- Distributed model: In this model, it is the mobile terminal's responsibilities to collect and compute location information. Mobile terminal requires high computing ability.

6.5 Service Oriented Architecture (SOA) and LBS

SOA is perspective of software architecture that uses loose-coupled software services to support the requirements of business processes and software users. In an SOA environment, resources on a network are available as independent services that can be accessed without considering the internal implementation mechanism. Each service has a service description that can be accessed by other services to know its functions and access method. Characteristics of SOA include:

- Self-described: SOA has self-described interface that describes its capacities. This information is called service definition and is in platform-independent XML format for other services to access.

- Service invoked: Service providers and consumers communicate with message via XML schema. It is not necessary for service consumers to know the underlying service implementation.

- Registry: Services are maintained in enterprise by registry. Service consumers search the registry by looking its service description and invoke the service. Universal Description Discovery and Integration (UDDI) is the standard used for service registry.

- Security Constraints: Service has security constraints to define authentication and authorization.

- QoS: Service has information about its allowable failure rate.

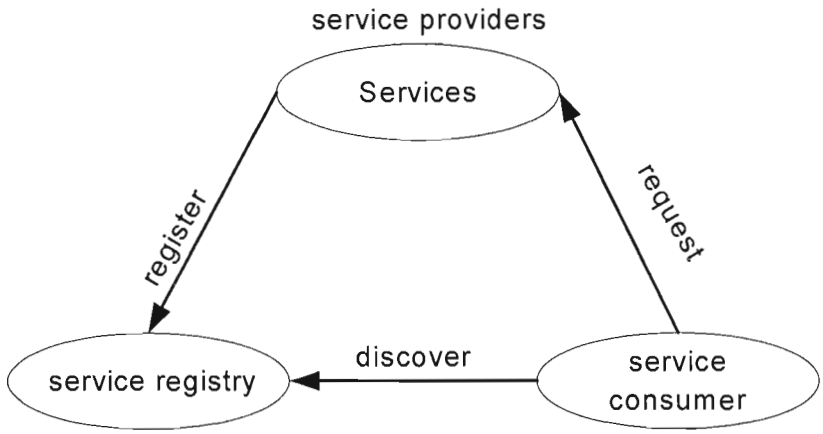


Figure 13 Architecture of service oriented architecture

SOA promises many advantages on enterprise application integration. These include:

- Reusability: SOA hides the logic to service consumers to promote reusability. Service consumers are only focusing on the functions of a service and its description.

- Discoverability: Services are designed as discoverable and registered in enterprise registry; therefore service consumers can search and discover them.

- ❖ Compose ability: Services can be coordinated and assembled to form composite services.

SOA promises a better way to integrate enterprise applications in Internet computing. It can also contribute to mobile commerce in offering seamless integration at low costs. There are two ways to use SOA for mobile commerce: mobile phone as service requestor directly or using a proxy/gateway as a requestor. The first can be good for simple services because of the limited capabilities of mobile phone is not able to process complex processes on the mobile phone side as shown in figure 14. The late method is very feasible for more complicated content delivery as shown in Figure 15.

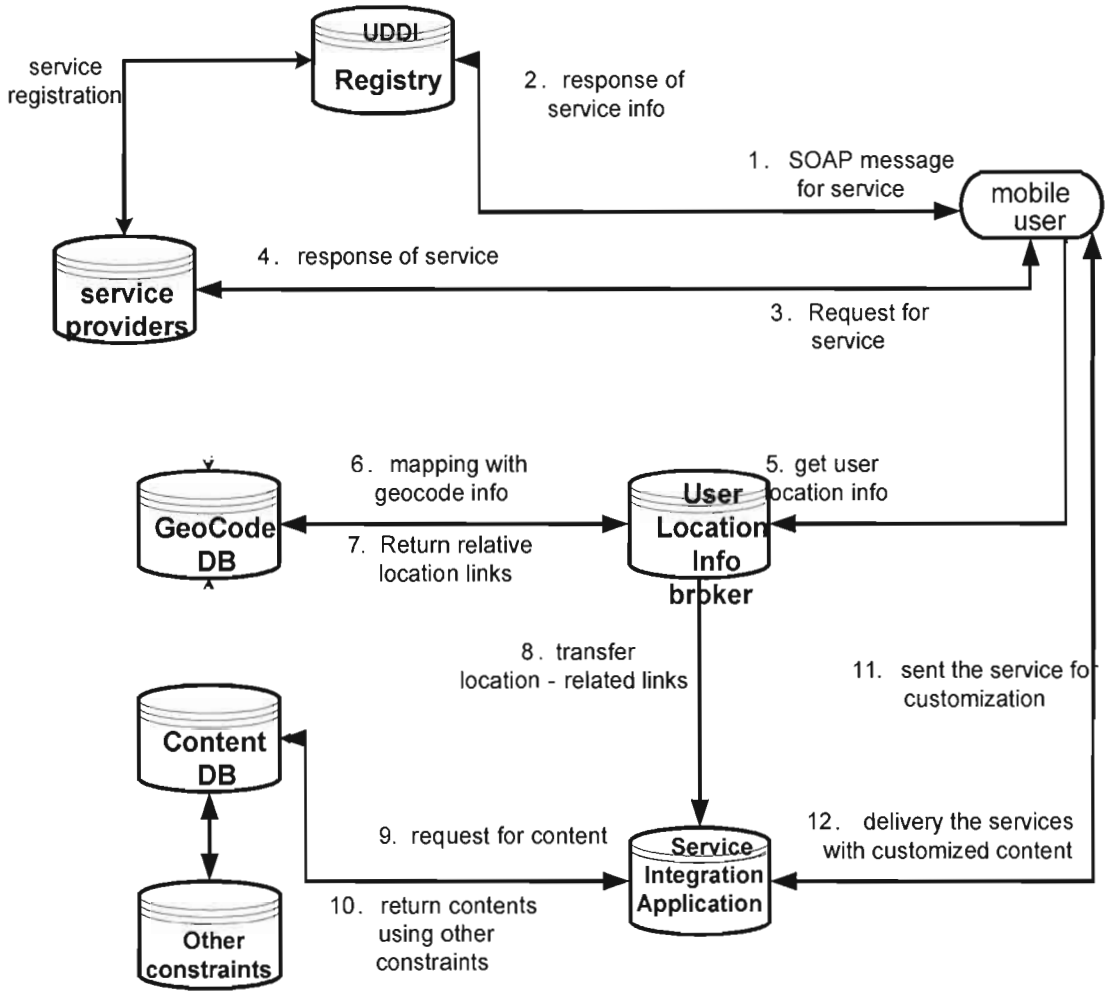


Figure 14 Mobile phone acts as service requestor directly

In this architecture, a third-party (usually a service integration provider) involves in the process of service customization using with user's location information. Location information broker is only responsible for the collection of up-to-date location information and mapping that information with a Geospatial database. Mobile network operator acts as a communication platform, and charges mobile users for the communication costs. Customization is done through service integration application, which will query the content DB with constraints (like user profiles) and mobile user location information, and return contents. If the results from web services usage are

not relative to the contents and location information, then they are not sent to mobile user.

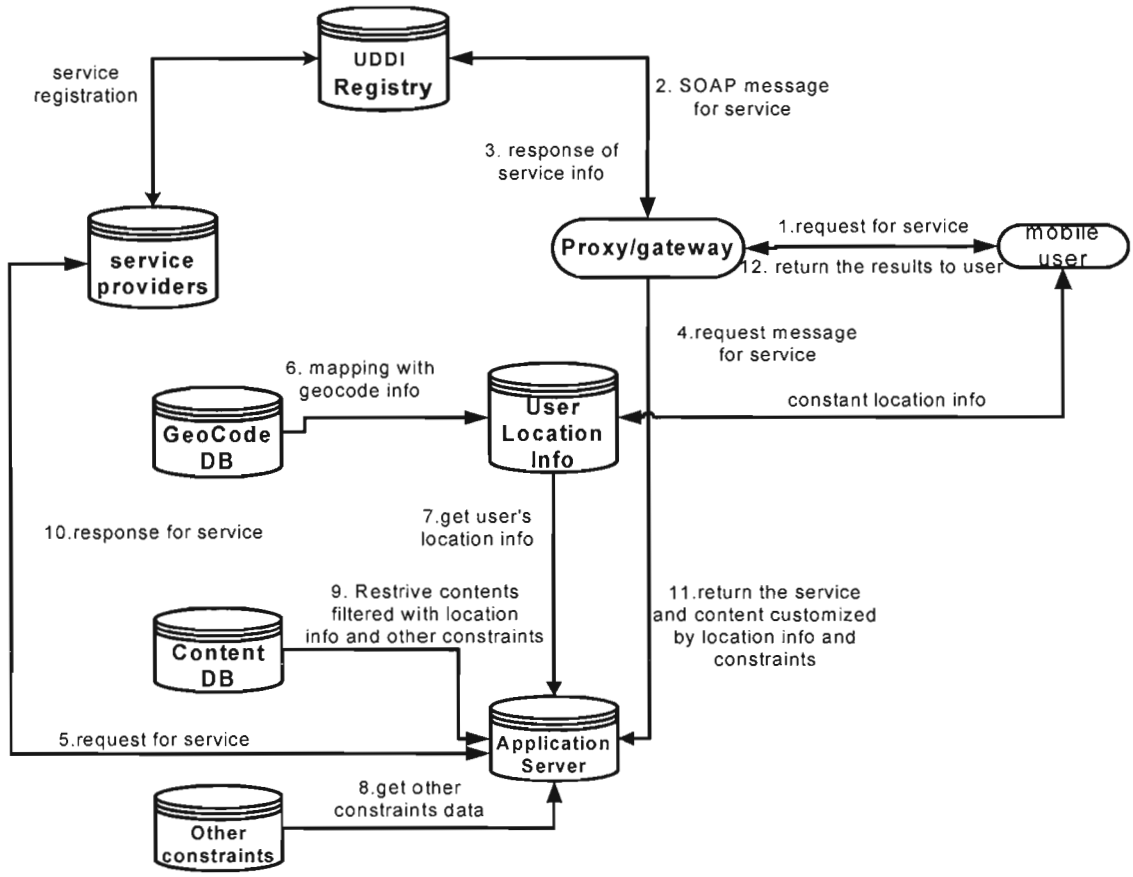


Figure 15 Delivery of LBS with SOA

The mobile phone sends a XML message including the required service. The XML message can be looked like below:

<search_word>Restaurant</search_word>

<style_>Japanese</style_>

<range_of>1000m</range_of>

The proxy/gateway will run as a secure agent to authenticate user identity and do the billing function. In this model, mobile network operator can run the application server at its own side, and it is the application server that recalls the services and does the customization. There is no need for mobile phone to send the services back for application integration.

There are several challenges need to be answered for this architecture:

- An agent needs to run at the proxy/gateway side to interpret the service registry files and automatically encapsulate a XML message sent to Application Server.

- User's location information must be fresh enough for different service levels. Definition or classification of these service levels needs to be studied more. One example is the different refresh time arrivals for high speed moving objects and slow moving objects.

- Map the user location information with the GeoCode DB. As the user's location information is presented as geodetic longitude and latitude positions, and the GeoCode DB must efficiently map that position data quickly and accurately. The quality of GeoCode DB in terms of size and granulites must support dynamically generation of location information in different forms, such as map and text, for mobile user.

- The customization of content is still in study. It must be both accurate and flexible.

CHAPTER VII

CONCLUSIONS

3G and beyond 3G mobile telecommunication systems promise many advantages for serving new mobile services and applications. Doubtlessly, mobile commerce will be pushed to a new level in 3G era due to the support for more secure and competitive bandwidth than 2G systems. The real important factor for mobile commerce acting as a ubiquitous service beyond low-end voice and data services is its ability to host rich contents and services. These new contents and services will contribute to a significant portion of revenue increase brought by the current and future telecommunication infrastructures.

3G technologies are becoming mature and commercial implementations have been launched in many countries and regions. Technically, the implementation of 3G mobile telecommunication networks is not a problem any more, and a wide range of new services and applications have been deployed, like location-based services and mobile enterprise applications. Even the China-grown 3G technology, TD-SCDMA, has been done some pilot performance tests. From technical point of view, 3G implementation is ready to go in China, possible by 2010 in some cities. Questions concerning the coming 3G network implementation are rising, such as issuing of 3G licenses and adopted technologies, but we believe that China's TD-SCDMA will be as a prerequisite for 3G licences even though mobile network operators prefer widely-used W-CDMA or cdma-2000 technologies.

With advance of research and development on 3G and beyond, mobile technologies will be more open architecture with very high data rate. 4G technologies will promise an all-IP based, open architecture, high data rate of 100mbps to 1G bps network with seamless integration with other forms of communication channels, like

WLAN. From service point of view, 4G systems will be service-oriented and multiple technology-supported, as shown in figure 16 below [15]:

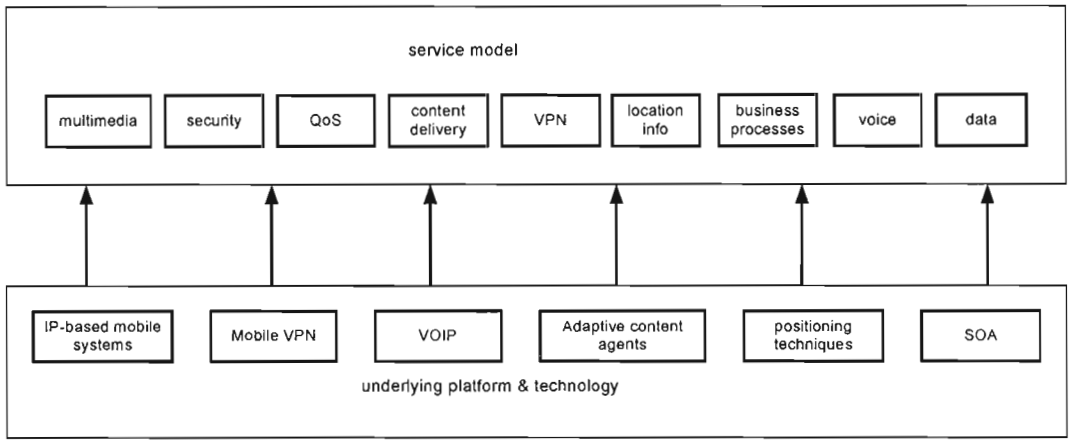


Figure 16 Service model for next-generation mobile systems

4G systems, as visioning from ITU, are able to provide multimedia data service in real time with reduced cost per bit and capacity to inter-network various networks based on a new radio access technology. It is defined in terms of service and application not purely by air interface protocol, IP backbone or bandwidth. Beyond the underlying technologies in 4G networks, it should be understood as a new milestone for new emerging services and applications. 4G systems are described as ubiquitous, seamless, open, integrated and diverse.

As the major purpose of 3G and beyond 3G systems is to offer new services and applications, study on mobile commerce has to be done to discover the market segments and predict the potential adoptability of 3G brand new services. Our survey shows that most of Chinese mobile phone users are budget sensitive and use mobile phones mostly as a way of basic communication, such as voice call and SMS. We conclude that Chinese mobile market is divided into 4 types:

- Low-end mobile phone users-- which are the biggest part of mobile phone users and have very tight budgets and are price sensitive on mobile services.

New services from 3G have very minimum impact on their behaviours as voice communications and MMS, etc. dominate their mobile activities. New services and applications from 3G can not expect revenue increase from this market segment in short term.

- Middle-end users—which are the possible potential segment for 3G services. This includes youths and working class users. Their adoptability for 3G services will contribute significantly to revenue increase and continuousness as they are willing and able to try and pay for new services and applications if services are what they like and of reasonable prices.
- High-end users—which are definitely with open budget for mobile commerce. They will use 3G services for either work or leisure without considering the price if they need. This segment is the most stable one for 3G services.
- Enterprise users—these are the new users emerging with 3G technologies. Enterprise applications will be brand new in 3G as the advance of 3G technologies is able to integrate ERP and other enterprise systems into new dimension. Mobile applications, such as mobile inventory management, mobile office, or mobile virtual community, etc. will create new important revenues.

Among 3G services and applications, location-based services play an important role in both individual mobile phone end users and enterprise users. More accurate positioning techniques make customization of services and application feasible and flexible by integrating location information with diverse services. Introduction of the use of open SOA make service availability and adoptability in a new level.

Unlike SMS's role in GSM or GPRS systems, it is very hard to find a "killer application" in 3G networks. In fact, 3G technologies provide the ability of supporting almost all complicated and multimedia services that users have had with Internet and ubiquitous new services that are only offered by mobile networks. Service availability and diversity make it impossible to define a "killer application". In contrary, revenues

from mobile commerce in 3G will split for each service, and data services will be expected to have a quick increase.

As mobile network operators play a decisive role in the mobile commerce value chain in China, monopoly is inevitable for a quite long period. This monopoly sometimes is protected implicitly by government and mobile users have no choice and power but to accept unfair rules. These include higher pricing policy, less competition, revenue allocation between mobile network operators and content/service providers, etc. Mobile network operation will not open to foreign operators, and international companies have to consider the politic factors while providing products and services, like handset compatible with both W-CDMA and TD-SCDMA standards. This will implicitly increase revenues for mobile network operators and cost more for users of mobile services and applications.

Adopting 3G services depends heavily on the characteristics of the services themselves, therefore collaboration between mobile network operators and service and content providers becomes more important as this determines the percentage of revenue sharing that content and service providers can have, and has impacts on their efforts towards the quality of available mobile services offered to mobile users. Business model will be carefully studied and be diverse to reflect the different needs. Revenue allocation and partnership/relationship building are critical for these business models.

Mobile commerce has been launched for years in the world. Except Japan's NTT DoCoMo, though mobile commerce does achieve progresses as general, it is not so excited as many expected. Success of mobile commerce depends on many factors and is still a long road ahead. In China, there are many things need to be done to boost mobile commerce. Increasing the number of valuable users for 3G services is still a tough mission that mobile service providers have to reach.

APPENDICE A: QUESTIONNAIRE

Dear participant:

This questionnaire is designed for the study of mobile commerce, and particularly the applications and services for mobile phone users in coming 3G networks and beyond. To reach that goal, this survey will cover several aspects focusing on:

- Current situation of mobile commerce
- Mobile user's attitude towards mobile commerce
- Technologies for mobile commerce services
- Roles of mobile commerce partners
- New services and applications, more specifically, location-based services

This questionnaire will take you about 20 minutes to finish. Some questions are multiple choices.

The information you provide will help us better understand the development and deployment of mobile commerce services and applications under 3G networks.

Your response will be kept strictly confidential and used solely for this research. You are not required to provide your personal information. A summary of the results will be available to you upon request after the data are analyzed.

Thank you very much for your time and cooperation. I greatly appreciate your help in furthering this research endeavor.

Qun Li

University of Quebec at Montreal, Montreal, Canada

Email: johnliqun@yahoo.com

Section One: About you and your company

1. Please specify your job status in your company

    1. Top management
    2. Middle management
    3. Technical staff
    4. Marketing staff
    5. Customer service
    6. Other, please specify _____

2. Please specify your company's size

    1. More than 1000 employees
    2. 500 to 999 employees
    3. 200 to 499 employees
    4. 50 to 199 employees
    5. Less than 50 employees

3. Please specify your company's annual revenue

    1. ¥100 million and up
    2. 50 million to ¥100 million
    3. 20 million to ¥50 million
    4. 10 million to ¥20 million

5. Less than ¥10 million

4. Please identify your company's location

1. North of China
2. Central China
3. East of China
4. South of China
5. Northwest of China
6. Southwest of China
7. Other, please specify _____

5. What's your company's major business?(Please select only one)

1. Wireless telecommunication operator
2. Internet content provider
3. Application integration provider
4. Game provider
5. Research institute
6. Government
7. Other, please specify _____

6. How does your company develop mobile commerce service? (Please select only one)

	Percentage
1. Totally in-house	90—100%
2. Most in-house	75-90%
3. Collaboration with network operators	50-75%
4. Most outsourcing	20-50%
5. Totally outsourcing	less than 20%
6. Buying outside	0%

7. How do you rank the importance of mobile commerce services in China?

1. Revenue growth point for coming years.
2. Good
3. Enough.
4. Need improving the quality of services.
5. Unsatisfied in both revenue and subscription.
6. Have less content.
7. Expensive.

Section Two: Telecommunication Infrastructure and services

1. Which wireless systems do you use?

1. GSM Yes _____ No _____
2. TDMA (IS-136) Yes _____ No _____

3. PDC Yes _____ No _____

4. CDMA (IS-95) Yes _____ No _____

5. GPRS Yes _____ No _____

6. 1x RTT Yes _____ No _____

7. EDGA Yes _____ No _____

8. UMTS Yes _____ No _____

9. cdma 2000 1x Yes _____ No _____

10. Other, please specify _____

2. Do you have plan to upgrade/migrate to 3G technology?

1. Yes, within 2 years
2. Yes, more than 2 years
3. Yes, but unclear when
4. No,
5. Don't know

3. Do you need to expand your network's capacity?

1. Yes, with GSM technology
2. Yes, with GPRS
3. Yes, with 3G technologies
4. No, at least in 2-3 year

5. No, we have enough network capacity

6. Don't know

4. What kinds of mobile devices do you introduce for mobile commerce?

1. Web phone	Yes _____	No _____
2. GSM phone	Yes _____	No _____
3. Low-end smart phone	Yes _____	No _____
4. Two-way pager	Yes _____	No _____
5. High-end smart phone	Yes _____	No _____
6. Palm-sized PDA with integrated wireless	Yes _____	No _____
7. 3G dual mode phone	Yes _____	No _____
8. Handheld PC	Yes _____	No _____

9.Other, please specify _____

5. Do you provide WLAN access?

1. Yes, in all cities

2. Yes, only in some metropolitans

3. Yes, in some sites

4. Not by far, but available soon

5. Not an option

6. Don't know

6. Which mobile operating systems does your company use or intent to use? (Please rank in order from 1 to 6 while 1 is most important and 6 is least important)

1. Windows CE Yes _____ No _____ Rank_____
2. Java &J2ME Yes _____ No _____ Rank_____
3. Palm OS Yes _____ No _____ Rank_____
4. Symbian OS Yes _____ No _____ Rank_____
5. Linux Yes _____ No _____ Rank_____
6. Proprietary OS Yes _____ No _____ Rank_____

7. How are you planning to change your subscriber's phones to 3G-compatible phones when you launch 3G technologies?

1. Users are forced to change
2. Users are offered limited-time promotion in price
3. Users are offered by more services
4. Users are offered free 3G phones
5. We haven't plan to 3G
6. Other, please specify _____

8. What factors have the most important impact on mobile phone purchase? (Please rank in order from 1 to 6 while 1 is most important and 6 is least important)

1. Mobile phone price Yes _____ No _____ Rank_____
2. Mobile phone function Yes _____ No _____ Rank_____

3. Service availability Yes _____ No _____ Rank_____

4. Service price policies Yes _____ No _____ Rank_____

5. Personality Yes _____ No _____ Rank_____

6. Life style Yes _____ No _____ Rank_____

9. Does your company use the following technologies in mobile commerce?

1. VoiceXML Yes _____ No _____

2. Web service Yes _____ No _____

3. mortal (Mobile Portal) Yes _____ No _____

4. Java Yes _____ No _____

5. Mobile middleware Yes _____ No _____

6. Other, please specify _____

10. Which languages does your company use for development?

1. XML Yes _____ No _____

2. HTML Yes _____ No _____

3. cHTML Yes _____ No _____

4. XHTML Yes _____ No _____

5. VoiceXML Yes _____ No _____

6. Java Yes _____ No _____

7.Other, please specify _____

11. Most of your mobile phone users use the phones with (Please rank in order from 1 to 8 while 1 is most important and 8 is least important)

1. Embedded camera Yes _____ No _____ Rank_____
2. Color screen Yes _____ No _____ Rank_____
3. WAP-enabled Yes _____ No _____ Rank_____
4. Java-enabled Yes _____ No _____ Rank_____
5. Voice only Yes _____ No _____ Rank_____
6. Voice and text message Yes _____ No _____ Rank_____
7. File and image transfer Yes _____ No _____ Rank_____

8.Other, please specify _____

12.What technologies does your company have experience with?

1. Windows & Windows CE Yes _____ No _____
2. Linux Yes _____ No _____
3. Unix Yes _____ No _____
4. Java & J2ME Yes _____ No _____
5. Databases Yes _____ No _____
6. BREW Yes _____ No _____
7. XML Yes _____ No _____
8. Web service Yes _____ No _____

9. WAP Yes _____ No _____

10. .NET Yes _____ No _____

11.Other, please specify _____

13. Does your company have experience in implementation of applications in:

1. Enterprise applications (ERP, SCM, etc.) Yes _____ No _____
2. E-commerce application Yes _____ No _____
3. System integration Yes _____ No _____
4. Financial application Yes _____ No _____
5. Game development Yes _____ No _____
6. Web site Yes _____ No _____
7. General application suite Yes _____ No _____

14. Does your company apply the latest technologies in your projects?

1. Yes, always
2. Yes, on demand of project
3. Yes, with difficult
4. No.

15. Which are the top 3 services ranked by revenue? (Please rank in order while 1 is most important and 3 is least important)

1. SMS & MMS Yes _____ No _____ Rank_____

2. Email Yes _____ No _____ Rank_____

3. File transfer Yes _____ No _____ Rank_____

4. Games Yes _____ No _____ Rank_____

5. Internet access Yes _____ No _____ Rank_____

6. Financial service Yes _____ No _____ Rank_____

7. Information access Yes _____ No _____ Rank_____

8. Information on demand Yes _____ No _____ Rank_____

9. Teleconference Yes _____ No _____ Rank_____

10. Voice communication Yes _____ No _____ Rank_____

Section Three: Attitude towards mobile commerce

1. Does your company provide customization?

1. Yes, all services can be customized
2. Yes, some services can be customized
3. No by far, but will have soon
4. Not at all. It's fixed
5. No, unknown how to customize

2. Do users use mobile phones for online transactions, like buying ticket or shopping in a grocery store?

1. Yes, often >80%

2. Yes, sometimes 40%~~~80%

3. Yes, but very occasionally 10%~~~40%

4. No, never <10%

3. How much do you think that mobile users would pay per month?

1. Above ¥600

2. Between ¥400--¥600

3. Between ¥200—400

4. Between ¥100-¥200

5. Less than ¥100

4. What type of services mobile users use?

	Used	within 6 months	Future(>6months)
1. E-mail and messaging	Yes_____	Yes_____	Yes_____
2. Web access	Yes_____	Yes_____	Yes_____
3. Location finding	Yes_____	Yes_____	Yes_____
4. Travel and Ticketing	Yes_____	Yes_____	Yes_____
5. Banking and Stock trading	Yes_____	Yes_____	Yes_____
6. News and sports	Yes_____	Yes_____	Yes_____
7. Gambling and Games	Yes_____	Yes_____	Yes_____
8. Shopping	Yes_____	Yes_____	Yes_____

9. Inventory tracking and dispatching

Yes_____ Yes_____ Yes_____

5. When surfing Internet, do mobile users visit the predefined URLs that are integrated in a wireless portal?

1. Yes, always >80%
2. Yes, at most cases 60%~~80%
3. Yes, half for predefined and half for user's entry 40%~~60%
4. Occasionally 20%~~40%
5. No, enter their owns <20%

6. Do mobile users customize their services?

1. Yes, almost >80%
2. Yes, often 60%~~80%
3. Yes, sometimes 40%~~60%
4. Yes, occasionally 20%~~40%
5. No <20%

7. According to you, which is the most important reason that people use mobile phone? (Please select only one)

1. Low communication price
2. Business on the move

3. Social contact on the move
4. Entertainment
5. Cool style
6. Other, please specify _____

8. Which criteria do you use to customize services?

1. User's profile
2. User's location
3. User's activities
4. There is no customization.

9. Do you think that the payment by mobile phone is secure?

1. Yes, strong agree
2. Yes, agree
3. Yes, sometimes
4. No, disagree
5. No, strong disagree

10. Do you think that the mobile phone price can be a barrier for mobile commerce?

1. Yes, it does much
2. Yes, but affordable services can increase subscription
3. Yes, but dependent on the marketing strategy

4. No, targeted groups will not care about the phone price

11. Do you think that the Internet surf by mobile phone is feasible in practice?

1. Yes, it provides many conveniences
2. Yes, because of the cost of a computer
3. Yes, because of the special design of wireless web sites
4. No, surfing Internet is easier by using a computer
5. No, because of the higher communication price for mobile phone
6. Don't know

12. What would you use mobile data services for?

1. For work Yes _____ No _____
2. For fun Yes _____ No _____
3. For social contact anytime anywhere Yes _____ No _____
4. For personal financial and stock services Yes _____ No _____
5. For information and sports Yes _____ No _____
6. For leisure Yes _____ No _____
7. For convenient, no time for shopping Yes _____ No _____
8. Other, please specify _____

13. Do you think the available content for mobile users are enough to meet their needs?

1. Strong agree
2. Agree
3. Modest
4. Disagree
5. Strong disagree

14. How do users think about the transactions by mobile phones?

1. Fast and secure
2. Easy
3. Some difficulties on small amount payment
4. Worry about the security of transaction
5. Not easy, because the financial institutes are not interoperated automatically
6. Not a wise option
7. Never try, don't know.

15. What price do you think reasonable for a 3G mobile phone?

1. ¥3000 +
2. ¥2000-3000
3. ¥1000-2000
4. ¥500-1000
5. Free with conditions of subscription of services

16. What are your concerns on dealing with mobile commerce? (Please rank in order from 1 to 6 while 1 is the most important and 6 is the least important)

1. Data rate Yes _____ No _____ Rank_____
2. Services availability Yes _____ No _____ Rank_____
3. Price policy Yes _____ No _____ Rank_____
4. Privacy and personal Information

   Yes _____ No _____ Rank_____
5. Quality of services and products (mobile transactions)

   Yes _____ No _____ Rank_____
6. Quality of services (Timely and accurately)

   Yes _____ No _____ Rank_____

17. How do you consider mobile services?

1. Must-have
2. Useful but expensive
3. Deluxe
4. Useless
5. Other, please specify _____

Section Four: Trends of mobile commerce

1. In deploying mobile commerce services, which parts have impact on user's decision of subscription? (Please rank in order from 1 to 10 while 1 is most important and 10 is least important)

1. Mobile phone's price Yes _____ No _____ Rank_____
2. Mobile phone's functions Yes _____ No _____ Rank_____
3. Mobile services quality Yes _____ No _____ Rank_____
4. Subscription fees and communication fees

   Yes _____ No _____ Rank_____
5. Network coverage and quality

   Yes _____ No _____ Rank_____
6. Service availability Yes _____ No _____ Rank_____
7. Usability of service Yes _____ No _____ Rank_____
8. Security of privacy Yes _____ No _____ Rank_____
9. Reputation of service providers

   Yes _____ No _____ Rank_____
10. Customer service quality Yes _____ No _____ Rank_____

2. Which will be the breakpoint for mobile commerce? (Please rank in order from 1 to 7 while 1 is most important and 7 is least important)

1. VoIP Yes _____ No _____ Rank_____
2. Voice reorganization Yes _____ No _____ Rank_____

3. Location-based service Yes _____ No _____ Rank_____

4. Video on demand Yes _____ No _____ Rank_____

5. Teleconference Yes _____ No _____ Rank_____

6. Gaming Yes _____ No _____ Rank_____

7. Mobile transaction Yes _____ No _____ Rank_____

3. How can data services get more revenue under 3G networks?

1. By marketing on data services

Yes _____ No _____ Rank_____

2. By increasing the number of subscriber of mobile phone

Yes _____ No _____ Rank_____

3. By adding more services Yes _____ No _____ Rank_____

4. By adding more personalized flexibility

Yes _____ No _____ Rank_____

5. By rising the price Yes _____ No _____ Rank_____

6. By lowering new service subscription fee

Yes _____ No _____ Rank_____

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