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Xiaolingtong versus 3G in China: Which will be the winner?

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Abstract

Xiaolingtong (XLT), a new type of mobile phone system based on PHS technology for wireless access of fixed-line telephone networks, has grown very rapidly in China. However, there are many doubts about the future of XLT once 3G (the third generation of mobile communication) is finally employed. This paper proposes a theoretical framework to assess and compare XLT and 3G from four perspectives: technology, market demand, business models and government policy. It concludes that XLT and 3G will coexist with existing 2G/2.5G mobile communication networks for a considerable period of time. With service collaboration and integration, the coexistence of both of these technologies can enhance China's mobile communication infrastructure and support the growth of mobile commerce.

Keywords: Mobile communication; Technology assessment; Business model; Government policy; PHS; 3G; 2G/2.5G

1. Introduction

Xiaolingtong (meaning "a little smart" in Chinese and abbreviated as XLT) is a new type of wireless mobile phone systems developed in China, which is based on the Personal Handy Phone System (PHS) technology that originated in Japan in 1995. Connecting to existing fixed-line telephone networks through micro-cell radio, it provides mobile wireless access to ordinary local Public Switched Telephone Networks (PSTN) services. By providing low-cost outgoing calls and free incoming calls, XLT services have experienced very rapid growth in China. From its 1998 launch in Yuhang, a small city in Zhejiang province, XLT has spread to more than 600 cities nationwide with subscribers reaching nearly 80 million as of June 2005 (iResearch, 2005). The growth of XLT subscribers in China is shown in Fig. 1. Besides voice communication, XLT can provide data transmission and a variety of value-added services such as short message service (SMS), Internet access, downloading of pictures and ring tones. The introduction of XLT in China, however, has not been smooth. It has been accompanied by many criticisms and suspicions about its survival and future growth.

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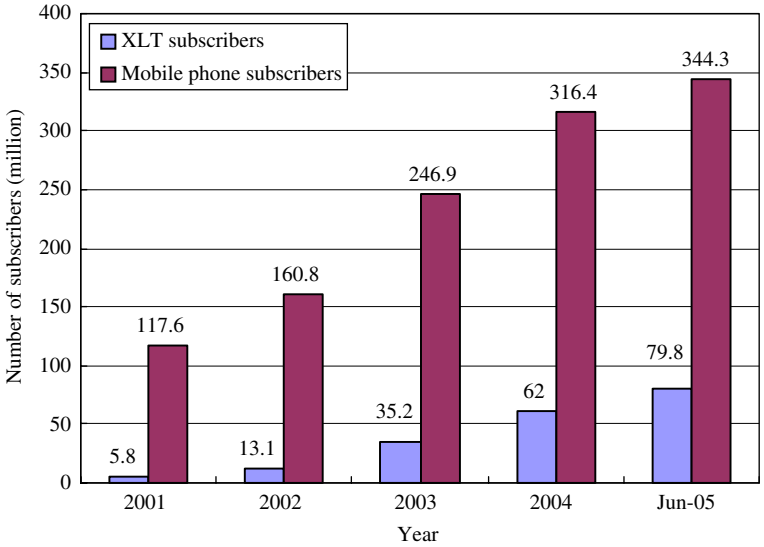

Fig. 1. Growth of subscribers of XLT and mobile phones in China.

One criticism is that XLT is an inferior technology. Its main defects are unstable transmission quality and its inability to allow inter-city roaming. Some experts[1] claim that XLT service is technically obsolete and predict that it will be driven out of the market within 3 years.

Others say that XLT is a low-quality quasi-mobile service that gains market share only because of its low price and with fierce price wars launched by the major mobile communication competitors such as China Mobile and Unicom, XLT will lose its only advantage of cheap rates.

Can XLT provide successful value-added services? Some experts have contended that because of the problems with interconnection, lack of service provisioning and an immature value chain, the prospects for XLT's value-added services are not bright. The planned nationwide interconnection of SMS within XLT has not taken place. The mobile networks operated by China Mobile and Unicom are reluctant to connect with XLT and are likely to delay opening up interconnection as long as possible. The content that XLT's current value-added services can provide is limited. The development of XLT's data services needs the full cooperation of a whole value chain which has not formed yet.

Most importantly, when 3G (the third generation of mobile communication) licenses are issued by the Chinese government, will XLT survive? 3G has long been expected to accelerate the development of mobile commerce. Both China Netcom and China Telecom, the two service providers of XLT, are eyeing 3G. Will they continue to support XLT, which is claimed by some to be a service that undercuts this upcoming business? China is expected to roll out its 3G mobile licenses in 2008 and XLT's radio frequency appears to interfere with the 3G radio spectrum. Many analysts believe that the development of 3G networks will spell the end of XLT infrastructure development. XLT looks to have an uncertain future.

Despite all the criticisms of XLT and the promises of 3G, XLT's subscriber base keeps growing and 3G still has not come to the market. Which will be the final winner between XLT and 3G in China? In order to answer these questions, this paper proposes a theoretical assessment model that integrates different views from four major stakeholders: technology developers, consumers, service providers and governments.[2] This model can help analysis of the development and the future of XLT and 3G in China. It can also provide useful references

[1]Professor Kan Kaili, a well-known telecommunication policy expert in China, claimed that XLT service is technically obsolete and predicted that it will be driven out of the market within 3 years (BYN, 2003). Others said that XLT is a low-quality quasi-mobile service that will only gain market share because of its low price (Gao, 2002).

[2]The plural form is used to refer to different levels of government because the Chinese government should not be viewed as a single entity. Since China is so large, central government does not have full control of regional and local governments. This is evident in their differing attitudes towards the development of XLT, where different ministries and governments at varying levels and regions have acted in pursuit of their own respective interests.

for other countries in the world and more importantly, aid exploration of some potential paths along which mobile commerce may evolve.

The paper is organized as follows. Section 2 presents a theoretical assessment model. Sections 3–6 assess and compare XLT and 3G from each of the four perspectives: technological, market demand, business model, and government policy. Finally, Section 7 concludes the paper and makes suggestions for the future development of XLT and 3G in China.

2. Theoretical assessment model

Assessing the business value and the future of a new technology is a complex task. To undertake a meaningful analysis, it is important to identify the dimensions and criteria for evaluation that integrate the interests of multiple parties with different perspectives. Benson, Sage, and Cook (1993) propose a triple-gateway methodology for evaluating emerging technologies at a very early stage of their development. The triple-gateway methodology postulates that a technology must pass through three gateways to become commercially or socially worthwhile: a market gateway, a systems management gateway and a technology gateway. In the market-gateway analysis, they look at the following elements of market uncertainty: new uses, user scepticism about "improved" performance characteristics, requirements for behavior adjustment by the user, competitive technologies, unpredictable technological developments and legal barriers. In systems-management gateway analysis, they look at the structure of the firm. Across the technology-gateway threshold, they look at four elements of technology uncertainty: innovativeness of technology, number of constituent technologies, manufacturing difficulties, and institutional changes required to introduce the new technology (Benson et al., 1993). The model was developed as a general one, not specifically for telecommunications. The role of government regulation was not emphasized, yet it can play a critical role in the telecommunications industry. Here the authors suggest a framework that represents and integrates four perspectives from four major stakeholders: the technology perspective from the technology developers, the market demand perspective from the customers, the business model perspective from industry and the government policy perspectives. This framework is summarised in Table 1.

2.1. Technology

Technology is viewed as human-originated advances that increase the effectiveness and efficiency of specific tasks (Good & Schultz, 2000). The development of new information technologies is expected to result in improvements in firm performance, such as reducing transaction costs and closer coordination of economic

Table 1
Framework of theoretical assessment model

Perspective	Dimension	Questions
Technology (developers)	Cost savings	Does it have advantages of cost savings?
	Environment protection	Does it provide better environment protection?
	Roaming capability	Does it provide broad roaming capability?
	Quality of service	Does it provide high quality of service?
Market demand (customers)	Market target	What is the market segment it serves?
	Size of the market	How big is the market?
	Potential growth	Can it sustain future growth?
Business model (industry)	Value proposition	What value can it provide to customers?
	Business partnership	Can it form an effective value chain for value-added services?
	Competitive advantage	Can it provide competitive advantages over competitors?
Government policy (government)	Government objectives	Can it meet government's long term objectives?
	Government support	Can it receive financial support from government?
	Government license	Can it receive a license or privilege from government?
	Government price regulation	Can it have healthy growth under government regulation?

activity among business partners (Malone, Yates, Benjamin, 1987; Mukhopadhyay, Kekre, & Kalathur, 1995). Likewise, the development of telecommunication technologies is expected to result in performance improvements such as cost saving, better or higher quality of service, new functions or improved capability and environmental protection. Considering the nature of mobile communication technology, the paper analyzes technology issues in terms of four performance dimensions: cost savings, environmental protection, roaming capability and quality of service.

2.2. Market demand

Satisfying customers' needs is at the core of success in any business endeavor (Porter, 1985). Technology developments are primarily driven by the market forces of demand. Inventors develop products to meet demands in the marketplace. If profits are possible through the commercial application of these products, entrepreneurs will see these benefits and drive the product to commercial realization. Thus, the underlying development and commercialization of technology is governed by economic forces within a marketplace (Basalla, 1989). Some studies of mobile commerce also indicate that long-term mobile commerce business success is likely to emanate from consumer-oriented, rather than technology-based strategies (Clarke, 2000). This paper will analyze market demand along three dimensions: target market, size of market and potential growth.

2.3. Business model

A business model constitutes an architecture for the product, service and information flows, including a description of the various business actors and their roles, a description of the potential benefits for the various actors and a description of the sources of revenues (Timmers, 1999). A business model consists of the following components: customer value, scope, pricing, revenue source, connected activities, implementation, capabilities and sustainability (Afuah & Tucci, 2001). Business models should work as a mediating construct between technology and economic value. The business model maps from the technical domain of inputs to the economic domain of outputs and the essence of a business model is "how you get paid" or "how you make money" (Chessborough & Rosenbloom, 2002). The paper will address the business model from the following three aspects: value proposition, value chain, and competitive strategies.

2.4. Government policy

Regulation is a form of control of an industrial activity by government (Waterson, 1988). Traditionally, telecommunications has been a highly regulated industry. The nature of increasing returns to scale associated with telecommunications has granted legitimate excuses for governments to accommodate the monopolistic status of the industry through various regulations (Xing, 2001). Despite some trends towards deregulation the regulatory process remains one of the most powerful ways in which government can influence activities in the telecommunication industry (Weidenbaum, 1977) and government interference in the telecommunication industry has spanned virtually all dimensions of business activity: ownership, entry, pricing and output choices. (Boylaud & Nicoletti, 2001). The Chinese government has played a significant role in the development of telecommunications in China. Under the umbrella of policy, this paper will discuss aspects of government objectives, government licensing, government support and government price regulation.

As the above discussion shows, all four stakeholders play significant roles and their viewpoints cannot be ignored or considered separately. The following sections will analyze and compare XLT and 3G following these theoretical assessment frameworks.

3. The technology perspective

3.1. Introduction to XLT and 3G technology

XLT uses technology that originated in PHS. PHS was initiated in Japan in 1995. It is a mobile communication system that works at 1.9 GHz, a transmission power of about 10 mW and a 300 KHz carrier

spacing. PHS uses micro-cells each covering an area of only 100–500 m in diameter resulting in low equipment costs but requiring many base stations. Using the PHS Internet Access Forum Standard (PIAFS), PHS provides up to 128 Kbps of data transfer (PHS MoU Group, 2004).

3.1.1. XLT

XLT is based on Personal Wireless Access System (PAS) technology, a variant of PHS. When DDI in Japan deployed PHS in 1995, it installed a mobile switch on top of a regular telecom network switch, in a similar way to traditional cellular networks. In contrast, PAS simply connects base stations to the existing fixed line infrastructure, minimizing redundancy and cost and contributing to rapid deployment. A basic PAS system provides citywide mobile phone service for communities of up to 1 million subscribers at a traffic density of 15,000 subscribers per square kilometer. XLT uses the PSTN to route calls, so customers pay the same rate as fixed line calls. XLT provides mobility in local metropolitan areas but does not have roaming capability between cities. Due to its low power and the limited coverage of micro cells, signals may be dropped on fast moving vehicles or in an enclosed environment like buildings and subways. With a handset similar to a traditional cell phone, XLT provides voice communication as well as many value-added services normally available only to cell phone users, such as SMS, Internet access and location-based services.

3.1.2. 3G

3G is the third generation of mobile communication services. An industry standard called International Mobile Telecommunications-2000 (IMT-2000) was approved by the International Telecommunication Union (ITU) in 1999 as the global standard for 3G wireless communications. Defined by a set of interdependent ITU Recommendations, IMT-2000 provides a framework for worldwide wireless access by linking the diverse systems of terrestrial and/or satellite-based networks. It will exploit the potential synergy between digital mobile telecommunications technologies and systems for fixed and mobile wireless access systems. Originally, 3G was supposed to be a single, unified, worldwide standard but in practice the 3G world has been split into three main camps: UMTS (W-CDMA) which is the solution generally preferred by countries in Europe; CDMA2000 whose proponents are in the Americas, Japan and Korea; and TD-SCDMA which is being developed in China.

3.2. Technology comparisons

The technological comparisons between XLT and 3G are conducted along the dimensions of cost saving, environmental protection, roaming capability, and quality of service. The paper summarizes the comparisons of XLT and 3G from the technology perspective in Table 2 and discusses them in detail as follows.

3.2.1. Cost saving

Cost saving is often a motivation for new technology development and XLT has a low cost advantage. It makes full use of the existing fixed line networks. It does not require operators to modify their central switch or to invest in mobile switching equipment. The main cost in establishing the infrastructure lies in the installation of base stations. (Each base station costs about RMB 700 yuan (US$80)), so the cost of building the XLT infrastructure is relatively low. Since XLT is a rather simple technology, the investment in R&D for XLT technology is small. Operating costs and handset costs are also relatively inexpensive for XLT.

In contrast, the costs related to 3G are relatively high. The capital cost of building 3G networks is high. Although much of the 2G infrastructure will remain useable, 3G will require substantial investment in new infrastructure to upgrade existing 2G networks (Lehr & Lee, 2003). Since China wants to develop its own 3G standard TD-SCDMA, the R&D cost of 3G is very high. Operating costs and the costs of 3G phones are both much higher than those associated with XLT.

From the discussion above, it is clear that XLT has a big advantage over 3G in terms of cost savings.

3.2.2. Environmental protection

There are important concerns about the radiation emitted by mobile telecommunication devices that may cause adverse health effects. A typical cell phone operates on about 0.75–1 watt of power. Studies on the

Table 2
Comparison of XLT and 3G in the technology perspective

	XLT	3G
Cost saving	• Low cost due to simple technology and reuse of existing fixed line infrastructure • Inexpensive handsets • Low operation costs	• High cost of R&D on complex technology and heavy investment on infrastructure • High cost of 3G cell phones • High operation costs
Environment protection	• Low radiation impact on human body • No interference with other devices	• Health concerns caused by radiation • Possible interference with other devices
Roaming	• Local mobility within city	• Global roaming
Quality of service	• Bandwidth up to 512 kbps • Limited coverage, less reliable and unstable	• High bandwidth up to 2 Mbps • Reliable

health issue contradict one another. The US Food and Drug Administration (FDA) states that "the available scientific evidence does not demonstrate any adverse health effects associated with the use of mobile phones." However, that does not mean that the potential for harm does not exist. High levels of RF radiation can damage human tissue according to the US Federal Communications Commission (FCC) (Howstuffworks, 2005).

Unlike cell phones, XLT uses low-power environmentally friendly micro-cell technology. XLT handsets transmit at 40 mW, only 4% of the equivalent 1-W transmitter power emitted by GSM handsets. XLT is known as the "Green Phone" for its environmental friendliness. The low transmission power also helps to extend the handset's standby time to up to 800 h and the talk time to up to 8 h. Due to the low radiation and low levels of electronic interference from XLT handsets and base stations, XLT does not interfere with precise instruments. XLT systems can be deployed in areas where traditional cellular phones are not permitted. Several hospitals in China have deployed XLT systems enabling doctors and nurses to communicate. If people are concerned about the radiation of cell phones, they may prefer XLT over traditional cellular phones for health reasons.

In comparison, 3G will be powered in a similar fashion to 2G/2.5G, and thus does not have any advantage in terms of environmental protection.

3.2.3. Roaming capability

Roaming is a general term in wireless telecommunications that refers to the extension of connectivity and services to a network that is different than the network with which a station is registered. It allows subscribers to use their mobile phones while in the service area of another operator. As a technology that provides mobile wireless access to local fixed line phone services, XLT has limitations in terms of roaming capability. XLT provides mobility within local metropolitan areas, but users cannot roam outside of their own city.

Global roaming is one of the main objectives of 3G. Through international standardization and superior interoperability, a 3G subscriber should be able to use the same 3G terminal to make and receive calls globally without any restriction. For example, NTT DoCoMo started a new service which enables foreign mobile subscribers to make and receive calls as though they were in their own country (NTTDoCoMo, 2004). Enabling global roaming is the main promise of 3G. However, great effort and international collaboration will still be needed to fully realize this promise.

3.2.4. Quality of service

Quality of service is a measure of performance that reflects a system's transmission quality and availability of service. The paper compares the quality of service between XLT and 3G in terms of bandwidth and the reliability of service.

XLT provides voice communications equivalent to that of existing wired telephone systems. It can also provide high-speed data services. Using the PHS Internet Access Forum Standard (PIAFS), users can connect to the Internet through XLT at rates from 32 kbps to as much as 64 kbps. In the near future, data speeds may reach 128 kbps and up to 512 kbps. In comparison, 3G is designed for high-speed multimedia data and voice service. Speeds of up to 2 Megabits per second (Mbps) are achievable with 3G.

In terms of reliability of service, XLT has problems with unreliable and unstable signals, frequently interrupted communications and limited coverage areas. Due to its low power and the short coverage of micro cells, signals may be dropped on fast moving vehicles or in an enclosed environment like buildings and subways. Although 3G service has not yet been launched in China, studies have shown that 3G will be more reliable than 2G. The handover failure probability can be improved by more than one order of magnitude and packet loss probability can be effectively regulated to a predefined level and provider revenue is significantly increased for all pricing policies (Lindemann, Lohmann, & Thümmler, 2003).

To summarize, XLT is a much simpler technology than 3G. XLT has advantages over 3G in terms of cost saving and environment protection, while 3G has advantages over XLT in terms of roaming capabilities and quality of service.

Foster (1986) suggests that the performance improvements of a technology should be considered to be a function of effort. His model of technological trajectories proposes an S-shape curve, which consists of three parts: a lower part, an upward slope part and a near limit part. The lower part of the S-curve represents a period in which tremendous amounts of effort are required to obtain little or no improvement in performance. At some point an upward sloping region occurs. This region represents a situation in which small amounts of effort result in substantial improvements. Finally, the technological trajectory approaches a physical limit—a barrier to performance that cannot be overcome. As this performance barrier is approached the rate of improvement of the technological trajectory declines, since this physical limit can be approached but not reached—the trajectory is asymptotic to the physical limit. It would seem that XLT has passed the upward sloping point and is approaching its limits as far as technology is concerned. In China, 3G is still at the initial lower part of the S-curve and it is not clear how long it will stay at this stage before development efforts are rewarded with rapid improvements in performance.

4. Market demand perspective

This section will review the mobile communication market in China and identify the target markets for XLT and 3G. It will then analyze the market size and the growth potential of these markets. This analysis is summarized in Table 3.

4.1. Overview of Chinese mobile telecommunication markets

The mobile communication market in China can be divided into three segments: high-end, middle-level, and low-end (Li, 2003). The high-end market includes businessmen, high ranking managers, field service engineers, and journalists who have the ability to pay and are frequently on the move and in great need of high-quality communication. It also includes early adopters of new mobile services such as young IT professionals and

Table 3
Market demand for XLT and 3G

	XLT	3G
Market target	• Low-end and middle level market: cost sensitive customers with limited mobility	• High-end market: users with high quality requirement on data services, especially multimedia and Internet access
Market size and potential growth	• Big • Great potential	• Small • Potential growth is uncertain

university students. All of the high-end users already have mobile phones and use them heavily. The middle-level market includes salaried or retired people and other students. These are people in moderate need of communications with local mobility. This group of people does not have high purchasing power. Their spending on communication is less than RMB 100 yuan (US $16) per month. Although most middle level users have mobile phones, they use them only when it is necessary. The low-end market includes farmers, low-income workers and those who usually stay locally. Their spending on communications is less than RMB 30 yuan (US $8) per month. The vast majority of them do not even have regular fixed-line phones.

4.2. Target market for XLT and 3G

Based on the market segmentation above, the target market for XLT is the low-end market and middle-level market while the target market of 3G is the high-end market.

As an alternative to the current, rather expensive cellular communication services, XLT's low-cost "wireless local call" makes mobile communications affordable for many new users. In addition, those who already have a cellular phone may switch to an XLT phone or buy an additional XML phone to save costs. In the latter case, they would use the XLT phone for local calls wherever it is connectable and use the cellular phone only when they travel out of the city.

As a more advanced technology than 2G/2.5G, the initial target market of 3G will be the high-end market. 3G will be attractive to those who need additional high-quality mobile communication services, over and above what 2G/2.5G can provide and are willing to pay the premium.

4.3. Size of the market and growth potential

China's wireless market expanded very rapidly in the early 1990s, and then continued to grow, but at a gradually flatter rate. By 2001, the major operators and service providers had lowered their expectations for revenue growth. Even so, double-digit growth in this market has continued against a backdrop of 8 percent economic growth for China and despite a worldwide recession (Xu, 2004). By the end of June 2005, the total number of wireless users in China had reached 344 million (iResearch, 2005).

The size of the high-end market may be estimated from the number of mobile Internet users and Multimedia Message Service (MMS) users. MMS was viewed as the pioneer of 3G services. China Mobile launched GPRS-based MMS service in October 2002 and by the end of that year it had about 50 000 MMS service users. China Mobile expected to increase MMS subscribers to over one million users by the end of 2003 (Xu, 2004). Based on these numbers, the initial demand for 3G does not seem great.

Most of China's existing mobile phone subscribers are middle-level users. A market survey in the city of Changshu shows that 90 percent of the residents in the city spend 90 percent of their time locally (Longkou Informatio Harbour, 2004). XLT's local wireless calls therefore can meet most of their communication needs. It was estimated that the market demand for local wireless calling may reach as high as 200 million subscribers by the year 2005 (Li, 2003).

There are a total of 1.3 billion people in China but about 80% of the people still do not have phones. The phone penetration in China is quite low in comparison with more developed countries. It is expected that most of the estimated 160 million new mobile phone users in the next 2 years will be low-end users who may prefer to use XLT. Also, there are 800 million people who live in the countryside. If 30 percent of them use XLT, then XLT subscribers will number as high as 240 million. Significantly this is a very attractive market (Li, 2003).

In summary, it is argued here that XLT and 3G serve different market segments. XLT's target market is the low-end and middle-level segment. This market is large and has great growth potential. The target market for 3G is the high-end segment. This market is relatively small and is not expected to grow rapidly in the near future.

5. Business model perspective

The paper analyzes the business models of XLT and 3G from the aspects of value proposition, value chain, and competitive strategies. This analysis is summarized in Table 4.

5.1. Value proposition

The main value proposition of XLT is low-cost communication with limited mobility. The cost comparison between XLT and cell phones is shown in Table 5. Customers certainly want better services, however compared to more developed countries, Chinese per capita income is still very low (National Bureau of Statistics of China, 2002). Consequently, the low cost of XLT should be very attractive in the Chinese market.

Another value proposition of XLT is its environment friendly features. Due to the low transmitting power of its base station and handsets, XLT does not interfere with radio-sensitive equipment. As a result, XLT can be used in special fields such as hospitals. People who are concerned about the health effects of radiation may also prefer XLT.

The main value proposition of 3G is high-quality value-added services for mobile multimedia and Internet access services. Another value proposition of 3G is international standardization and global roaming—the provision of ubiquitous mobile connection anywhere, anytime. Rosalie Nelson (2004), the Research Director of Ovum, believes a sustainable business case for 3G in China must be built on low-cost robust networks which can quickly provide scale and coverage and also the provision of a range of low-cost voice-centric handsets (Nelson, 2004). That requires technological maturity and economies of scale, particularly for W-CDMA. The required technological maturity however, is not yet present.

5.2. Value chain

The mobile commerce value chain consists of network equipment providers, end user terminal providers, technology developers, network operators, service providers and customers. There are four big telecommunication network operators in China. Mobile 2G/2.5G phone services (GSM and CDMA) are provided by China Mobile and China Unicom. XLT services are provided by fixed line phone providers China

Table 4
Comparison between 3G and XLT on business model

	XLT	3G
Value proposition	• Cost savings for local mobile communication • Environmental friendliness	• Enable high quality value-added services • Standardization and global roaming
Value chain	• Simple value chain dominated by network operators	• Utilize and extend the existing 2G/2.5G value chain
Competitive strategy	• Low cost competition with 2G/2.5G for low end market • Improving quality of service and value-added services	• Prepare technical migration from 2G/ 2.5G to 3G • Create demand for multimedia and high quality value-added services

Table 5
Cost comparison between XLT and cell phone

	XLT	Cell phone (2G/2.5G)
Per-minute rate for voice communication	RMB 0.11 yuan (one-way charge) (US$ 0.013)	RMB 0.36- 0.40 yuan (two-way charge) (US$ 0.044—US$ 0.048)
Monthly user fee	RMB 25 yuan (US$3.00)	RMB 45–50 yuan (US$ 5.40–6.00)
Hand set price	RMB 580–2800 yuan (US$70.00–350.00)	RMB 1000–5000 yuan (US$ 120.00–600.00)

Source: http://www.chinatelecom.com.cn, http://www.chinanetcom.com.cn, http://www.chinamobile.com.cn, http://www.chinaunicom.com.cn

Telecom and China Netcom. The business position of the big four telecommunication operators are illustrated in Table 6.

The obvious 3G operators will be the current 2G/2.5G providers who have formed relatively mature value chains. China Mobile's value chain is called Monternet, while China Unicom's value chain is called Uni-info. There are about 400 service providers for Monternet and about 100 service providers for Uni-info (Mei, 2003). After the launch of 3G, it is expected that China Mobile and China Unicom will utilize or extend the existing 2G/2.5G value chain to 3G.

XLT is offered by two fixed-line phone companies and they can use their Internet connection and e-commerce services to build their own XLT value chain and compete with 2G/2.5G to attract content and service providers. At present XLT can provide services that are similar to the services of 2.5G, including short message, web browsing, ring tones and picture downloading, etc. China Telecom names its XLT value chain "C-Mode" (meaning Chinese i-mode).

Operators China Telecom and China Netcom dominate the XLT value chain. In the XLT network, three major players act as XLT's network equipment providers, end user terminal providers and technology developers. UTStarcom is the largest vendor followed by ZTE and Lucent. Coordination may be realized easier and more effectively in a rather simple value chain. Furthermore, the XLT value chain is more integrated than the 2G/2.5G value chain while generally the 2G/2.5G value chain is a loose alliance with the network operators as the core.

To compete with XLT, China Mobile and China Unicom have adopted a policy of signing "exclusive" contracts with their service providers. This means that these service providers cannot provide similar services to XLT operators. China Mobile and China Unicom were also reluctant to make short message interconnection with XLT and viewed it as a competitive threat. 3G has not yet been implemented in China and the four telecommunication operators all want to enter the 3G market. The final form of a 3G value chain is difficult to predict.

5.3. Competitive strategies

The growth strategy of XLT was to move from small towns to big cities and focus on the low-end market. It attempted to compete with cellular phones through massive promotions featuring low rates and free handsets. In response, China Mobile and China Unicom introduced their own low fee package and low-cost mode of handsets. As a result XLT has recently had less of a low-cost advantage.

China Telecom and China Netcom, the two XLT providers, have focused their attention on improving the quality of service while providing more and better value-added service. They now provide good XLT connections in the subways of Beijing and Shanghai. To improve indoor coverage, a new type of service named QBOX has been promoted. This service allows a XLT handset to act as a cordless phone at home.

Table 6
Four telecommunication operators in China (Source: http://www.iresearch.com.cn)

	Mobile operators		Fixed line operators	
	China mobile	China unicom	China telecom	China Netcom
Business scope	Mobile voice and data communication, IP telephone		Local and long distance fixed line telephone, Internet backbone services, IP telephone	
Network	Wireless networks: GSM and GPRS	Wireless networks: CDMA and GSM	PSTN (Public Switched Telephone Network), DDN (Digital Data Network), FR (Frame Relay), ATM (Asynchronous Transfer Mode)	
Subscribers (end of 2004)	204.3 million	112.1 million	186.6 million (including 42 million XLT users)	80.4 million (including 15 million XLT users)
Subscribers in 2003	166.1 million	80.8 million	161 million	69.6 million
Subscribers in 2002	117.7 million	43.1 million	133 million	58.4 million

In 2005 the connection of SMS between XLT and cellular phones was launched. This will partially compensate for XLT's disadvantage in roaming capabilities. More value-added services such as news, weather, games and short message interaction with TV and Radio programs have been provided. China Telecom and China Netcom will attempt to use this experience with XLT value-added mobile services to enter the 3G market and they have started to put less investment into XLT.

As the world's largest telecommunications market, China has become a "must-be-there" market for almost all 3G equipment providers and terminal producers, including Motorola, Nokia, Siemens, Nortel Network, Ericsson, Huawei, ZTE, Samsung and LG. To date, the most vocal 3G supporters are the international 3G equipment providers who want to become established in the Chinese market and the Chinese 3G developers who want to get financial support from the government, develop initial market share and start to bring in returns from their investment.

Migration from 2G to 3G is a high cost and very complex task (Kalavakunta & Kripalani, 2005). The current cellular phone operators, China Mobile and China Unicom, are interested in using 3G technology to upgrade their services. However, they have to find the most cost-effective way to migrate to 3G. They need to consider the utilization of their existing 2G/2.5G capacity and the recovery of this investment. They must also attract existing 2G/2.5G users who are willing to pay higher costs for better services. The successful launch of 3G in China will depend on many factors including the maturity of the technology, the real market demand and the timing. There is great opportunity as well as high risk.

To sum up, XLT and 3G offer different value propositions. The profitability mechanism of XLT is more realistic than 3G for the time being. In terms of the value chain, there are respective advantages for both XLT and 3G. They have also chosen very different competitive strategies.

6. Government policy

China's telecommunication policy is moving from totally centralized monopoly to gradual deregulation. Competition is being introduced in value-added markets while the government is continuing to maintain state ownership of the major telecommunication industry segments. There are six regulatory areas in China's telecommunication industry. They are: (1) competition safeguards, (2) interconnection, (3) universal service, (4) licensing criteria, (5) independent regulators and (6) resource allocation (Gou, 2003). Here the paper will discuss government objectives, government licensing, government support and government price regulation with regards to XLT and 3G. These items are summarized in Table 7.

6.1. Government objectives

Telecommunications are crucial for China's economic development. Realization of universal service is an important goal for the Chinese government. Universal service means the provision of quality telecom service at acceptable price levels for all users and areas, including low-income users and remote and other high-cost areas (Yu et al., 2004). Recent years have seen rapid development of telecommunications networks, but there are still only 20.1 phone sets in service for every 100 people in China. Furthermore, there is a big gap between the eastern (more developed) and the western (less-developed) areas of the country (Yu et al., 2004). There is a big digital divide or gap in information and telecommunications services between China and the developed countries between the rich and the poor areas of China and between China's cities and countryside. XLT, as a low-cost communication tool, can play a critical role in improving universal service and bridging the digital divides within China.

Due to its huge telecommunication market, establishing world leadership in mobile communication technology and standards is a strategic goal of the Chinese government. The number of mobile phone subscribers in China topped 344 million by the end of June 2005—more than the total population of the United States. In order to better position itself in the mobile communication field, the Chinese government has expended great efforts to develop China's own standard for its 3G of mobile telecommunications. The Chinese-made 3G standard, TD-SCDMA, meets international standards and has been approved by the International Telecom Union (ITU). By adopting TD-SCDMA, business opportunities worth hundreds of billions of Chinese yuan will be created for domestic companies. If China uses domestically developed

Table 7
Comparison of government policy toward XLT and 3G

	XLT	3G
Government objectives	• Provide universal service to all people • Bridge the digital divide	• Establish world leadership in mobile communication technology and standards
Government support	• Limited local government support	• Heavy investment in R&D of 3G technology
Government licensing	• Changing attitude from negative to passive acceptance • XLT is a kind of unlicensed business	• Careful feasibility study and assessment • Waiting for a good time as far as technology and market readiness
Government price regulation	• Use price regulation to control competition between XLT and mobile phone operators	• No price policy for 3G has been set up yet

technology, Chinese companies will pay much lower patent fees than those they would pay to European or American patent holders. Since its approval by the ITU, TD-SCDMA has attracted the attention of all of the 3G equipment vendors.

6.2. Government licensing

A government licence is required to operate any telecommunications network. The Chinese government has paid considerable attention to 3G licensing while taking a cautious approach. The government believes that the issue of 3G licenses must take into account the circumstances of the economy, resource allocation, technology and the market. Careful assessment and feasibility studies of 3G are currently being conducted in China. The Chinese government has not set up a timetable for 3G licensing and Minister of Information Industry (MII) officials noted recently that previous predictions about the timing for the issue of 3G licenses are not correct. Although the Chinese Government has been at the center of fierce political and industry lobbying on 3G licenses, its current cautious pragmatism, which emphasizes technological maturity and evidence of market demand, show that it believes that China will benefit from judicious delay (Nelson, 2004).

The granting of 3G licenses has been widely discussed world wide and different countries have taken different approaches for releasing 3G licenses (Yan, 2004; Andersson, Hultén, & Valiente, 2005; Jain, 2001). Many European 3G operators spent heavily to obtain 3G licenses in government-run auctions. As a result, some operators became cash-strapped when starting their 3G network deployment. Learning this lesson, the Chinese government is unlikely to auction 3G licenses but instead will likely award licenses to state-owned operators at no charge.

In Japan and Korea, the government issued licences for the development of PHS services (Ahn et al., 2004; Ishii, 1996). However, the Chinese government did not take a proactive attitude towards XLT. XLT was launched in a small town as a trial in 1998. Because of its successful launch and its subsequent popularity, XLT has become a symbol of the competition between China's fixed line and mobile operators and is a prominent target of regulation by the MII.

Under pressure from the two mobile operators and with the perception that XLT was an outdated technology, the Chinese government has actively discouraged the implementation of XLT. In October 1999, MII issued its first order demanding that those provinces that had not yet started XLT service should not introduce it. However, this order failed to stop the expansion of XLT. In May 2000, MII issued another order that required Telecom and Netcom's local subsidiaries to cease offering XLT service and wait for MII's re-assessment of the service.

With the continued expansion of XLT demonstrating its ability to satisfy market needs, the Chinese government eventually started to relax its restrictions on XLT. On 29 June 2000, MII issued a notification that recognized Xiaolingtong as a supplement and extension of fixed line telephones for the first time and defined it

as a wireless communications terminal with low-speed mobility and limited coverage. In February 2001, MII made a fourth announcement that restricted XLT service to small and medium-sized cities in rural China. Services in major cities areas such as Beijing and Shanghai were not allowed. Despite such restrictive regulations and pressures from MII, XLT survived and grew. Eventually, the Chinese government passively adopted a new, neither-forbid-nor-encourage policy towards XLT. In March 2003, MII announced that "the government does not encourage its development, but it will not regulate XLT's progressive march in cities." This statement from the top of MII implies that China Telecom and China Netcom have received approval to extend XLT service nationwide. The survival of XLT owes much to its strong market demand, which forced the government to gradually relax its restrictions on this technology.

Although the regulator has continually relaxed its policy on XLT, it has never received official recognition as a mobile communication service. In the telecommunication business categories issued by MII, there is no XLT service listed. XLT has none of the normal "credentials" such as service licences or network entry certification of equipment and handsets. It seems that XLT is a kind of "unlicensed business." Since MII defined XLT as the "supplement and extension of fixed line phone", China Telecom and China Netcom have exploited this definition to continue to run the XLT business. They have expanded the "supplement and extension of the fixed line" to whole cities but have not implemented inter-city roaming.

6.3. Government support

The telecommunications industry is largely characterized by its huge initial investment and capital expenditure. Fixed-asset investment in China's telecommunications industry stood at RMB 105.6 billion yuan (US$12.7 billion) in 1997 and more than doubled to reach 222.4 billion yuan (US$26.8 billion) in 2000. In the past 5 years, annual investment has remained at around 200 billion yuan (US$24.1 billion), (Wang, 2005).

Although XLT has not received any financial support from the Chinese central government, local governments have invested greatly in XLT. It is said that the total investment in XLT is as high as RMB 30 billion yuan, which is equal to the CDMA network investment of China Unicom (Chinanews, 2003).

The Chinese government has invested huge sums of money in the development of TD-SCDMA technology, showing its determination to support its home grown 3G technology. With government support, Datang Mobile Communications Equipment Co., Ltd became the dominant Intellectual Property Rights (IPR) holder of the TD-SCDMA 3G standard and a major provider of telecom equipment in China. It has been engaged in the research and development of mobile communication equipment and is focused on becoming one of the leading Chinese vendors for TD-SCDMA technology and network solutions. China's 3G investment in 2005 reached RMB 55 billion yuan (US$6.63 billion), 60 per cent of which is spent on equipment. If the government awards all of the top four telecommunications operators with 3G licences, the expenditure on building the 3G network alone could be more than 1 trillion yuan (US$120 billion) (Wang, 2005).

It is expected that after the operators start building 3G networks their further investment in 2G networks and the XLT networks will be limited.

6.4. Government price regulation

The primary purpose of price regulation is to realize efficient allocation of resources and to stabilize the revenue of mobile network operators by eliminating vicious competition. In China, the mobile operators price their services in accordance with government-directed "floor prices". Real prices cannot be lower than these government-directed prices. On the one hand, price regulation has eliminated the potential for vicious competition between XLT network operators and mobile network operators. On the other hand, it has somewhat protected XLT by maintaining the price difference between them.

Since 3G service has not yet been launched in China, discussion here focuses on the government's price regulation policies towards XLT and 2G/2.5G. The current cell phone rate was set in 1996. Despite constant requests to reduce the communication fee for mobile phones, the MII has persisted in not changing the government-directed price. In order to compete with XLT and to circumvent MII's specified rates, the mobile

carriers have implemented various promotion services through their subsidiary companies in local areas. Prices offered during periodic promotions are very close to XLT's per minute charge or less. To directly compete with XLT's one-way charge policy (only callers are charged), mobile phone rates have been substantially transformed from two-way (both callers and receivers are charged) into one-way charges for within-city calls.

At the same time, MII has tried to increase the rate charged for XLT. In November 2000, MII announced it would require China Telecom and China Netcom to raise XLT's basic monthly fee and per minute usage charges. However, the XLT service providers ignored this demand. Early in 2004, the MII said it would gradually loosen its control over telecommunications fees that year to further boost the development of the country's telecommunications industry.

In summary, it is concluded here that the Chinese government can use XLT and 3G to realize different national objectives. The government has taken a cautious approach to both XLT and 3G. However, government support has been much stronger for 3G than it has been for XLT. Although the government financially supported development of a 3G Chinese standard, it has been conservative in issuing 3G licenses. One concern is the maturity of Chinese 3G technology in comparison to foreign companies, another concern is the level of economic development and the actual market demand. In addition, central government took a negative attitude towards XLT and only passively allowed its subsequent growth. Conversely, at the local level, the development of XLT received more enthusiastic support.

7. Conclusions and recommendations

This paper has analyzed XLT and 3G from a holistic view in terms of technologies, market demand, business models, and government policy. Although XLT is perceived as an inferior technology and 3G is perceived as an advanced technology, they each have their own advantages and disadvantages. In general, XLT and 3G can be viewed as complementary rather than competitive technologies as they can be used to serve different target markets. XLT will serve the low and middle end markets, while 3G will serve the high-end market. As a result, XLT and 3G providers will have different business models. The government has taken a cautious approach to both XLT and 3G. However, it is clear that 3G has received much stronger government support. The authors believe that there can be a win–win, not a win–lose, relationship between XLT and 3G in China.

The analysis of XLT and 3G in this paper implies that the success of a technology is not only dependent on the performance of the technology itself but on many other factors, including market demands, business models and government policy. Experiences in Korea and Japan help to demonstrate this point. While XLT has been successfully implemented in China, a similar technology Cordless Telephone 2nd generation (CT-2) failed in Korea and Personal Handy Phone System (PHS) achieved only moderate success in Japan (Ahn et al., 2004; Ishii, 1996; PHS MoU Group, 2004).

Based on the framework proposed in this paper, some policy suggestions are made in the following paragraphs.

First, in terms of technology, improvements to the quality of service are the key to the survival of XLT and technology maturity is the major challenge of 3G. Standardization is another important issue. There are already too many different mobile networks and mobile devices. Standardization of the user interface is very much needed to foster mobile commerce development (Yuan & Zhang, 2003). Since the functions of mobile phones and XLT phones are very similar, a unified user interface could be established and users should be able to use such a unified user interface to access a variety of value added services. For instance, when a user is carrying out mobile banking, he/she should be able to operate in the same way whether using an XLT phone or a 2G/3G phone. Another approach is to build a dual mode handset. UTStarcom Inc. has already developed a dual mode phone for XLT and GSM. The company is also developing WCDMA/PHS and CDMA2000/PHS phones that support both XLT and 3G standards (Liu, 2004). A handset with dual or triple communication mode should be able to automatically switch from one mode to another in order to select the best network resource. For instance, in a city where local XLT access is available, the phone can operate in XLT mode for voice communication. When a person is traveling, and roaming is needed, it can switch to 2G mode. For multimedia and fast Internet access, 3G mode may be needed.

Secondly, in terms of meeting market demands, different technologies can be used to provide different levels of services with different price ranges in order to serve different market segments. This is especially important due to China's huge population characterized by large income gaps and regional differences. Currently 2G/2.5G services still dominate the mobile communication market. XLT is suited to low-end users while 3G services are suitable for high-end users. Competition between XLT, 2G/2.5G, and 3G will benefit the consumer in terms of cost and quality of service. XLT, 2G/2.5G, and 3G providers should compete as well as collaborate to enlarge the mobile communication market as a whole and provide different levels of service suited to different customers' needs.

Thirdly, in terms of a business model, the current separate value chains for mobile networks and XLT could be integrated. The service providers are expected to provide content to any kind of network operator. Since different networks are owned and operated by different companies, collaboration and service integration are difficult to achieve but could lead to industry growth and prosperity. Although XLT has gained a considerable market share, its survival will depend partly on its ability to provide a broad range of value-added services. For 3G, its success also relies on bringing viable high-end value-added services to justify its cost. Mobile service providers could work together to increase the number and value of these services. As an example, enhancing the interconnectivity of messages, payments and location-based services between different networks is beneficial not only for the users but also for all providers.

Fourthly, in terms of government policy, it is clear that in order to reach the objectives of universal service and developing leading edge technology, the government needs to support both XLT and 3G. XLT and 3G are complementary rather than competitive technologies. The government should be supporting and encouraging collaboration between XLT and 3G providers. Since the RFs used by XLT and 3G overlap, it will be important to allocate the frequency spectrum based on the demand for and future development of both services. The relationship between XLT and 3G is like that between bicycles and cars. Although cars are more advanced than bicycles, the majority of the Chinese population still use bicycles as their main transportation tool. In this case, designated bicycle lanes are used so that cars and bicycles can share the roads in China. Because it can help to reduce the growing gap between rich and poor, the government should be more supportive towards XLT.

The government has long adopted a cautious approach towards 3G deployments as the costs of network upgrades and terminal handsets are issues of concern. Analysts believe that the immaturity of the Chinese TD-SCDMA standard, compared to WCDMA and CDMA 2000 which have been put into commercial use in the global market, is a major reason for delays in the government's decision-making process. To better pave the way for its introduction, regulators have conducted two large tests on all-3G related equipment and facilities in the past 3 years (Chinanews, 2005). "We will plan the 3G technologies and market as a whole to ensure industry sustainability while rolling out our 3G strategies," said Lou Qinjian, vice-minister of the Ministry of the Information Industry (Chinanews, 2004).

The authors consider that the successful development of both XLT and 3G will greatly enhance China's mobile communication infrastructure and support the growth of mobile commerce. The success of XLT in China also can shed light on the development of mobile communications and mobile commerce in other countries. While 3G is very much expected but still struggling for profitability in developed countries, PHS is quietly penetrating into developing countries (PHS MoU Group, 2004). A win–win situation is desirable where both technologies are used to meet different needs.

This paper has used publicly available data to articulate an assessment framework. However, to empirically verify the framework, more in-depth user and business surveys and case studies are needed. This is central to the authors' future research agenda.

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