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Chinese Innovations in Mobile Telecommunications: Third Generation vs. "Guerrilla Handsets"

Tomoo Marukawa
University of Tokyo

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Abstract: This paper analyses two cases of innovation which have taken place recently in China. Although both cases are related to mobile telecommunications, they represent very different types of innovation: One is a government-led, top-down type, which has been much publicized by the Chinese media as a successful case of China's "indigenous innovation," while the other is a bottom-up, unofficial one, which is usually not considered as an "innovation" in the Chinese media but rather as a case of industrial piracy. In this paper, however, I will shed light on the innovative aspect of the latter, and compare its market results with the former.

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Tomoo Marukawa
Institute of Social Science
University of Tokyo
Bunkyo-ku, Tokyo, 113-0033, Japan
e-mail: marukawa@iss.u-tokyo.ac.jp

Introduction

This study analyses two cases of innovation which have taken place recently in China. Although both cases are related to mobile telecommunications, they represent very different types of innovation: One is a government-led, top-down type, which has been much publicized by the Chinese media as a successful case of China's "indigenous innovation," while the other is a bottom-up, unofficial one, which is usually not considered as an "innovation" in the Chinese media but rather as a case of industrial piracy. In this paper, however, I will shed light on the innovative aspect of the latter, and compare its market results with the former. The comparison will enlighten us about the relationship between technical advancement and market success. Both cases, I believe, represent the "innovation with Chinese characteristics."(Jakobson 2007)

China is the world's largest market of mobile communications. The number of mobile phone subscribers reached 641 million at the end of 2008, occupying 15.8 percent of the world's total[1]. It is estimated that 270 million mobile handsets were sold in the year 2008, occupying 22 percent of the global sales[2]. China is also the largest mobile handset producer in the world. Its production volume reached 619 million units according to official statistics, which apparently underestimates the size of production. Considering the fact that China exported 600 million mobile handsets in the same year, and domestic sales must be no less than the former year's 270 million units, the real volume of shipment must have been around 900 million units, roughly 70 percent of the world's total.

Along with the growth of domestic market and production, the Chinese mobile telecommunications industry has gradually grown from a sheer importer of technology to a creator of some parts of the industrial technology. More than 600 models of handsets are released every year from more than 90 manufacturers, including foreign and local ones. Around 50 independent design houses engaging in designing mobile handsets and circuit boards have emerged in China since 2001 and provided handset designs and circuit boards to local and international brands (Shiu and Imai 2010). Chinese firms such as Huawei Technologies and ZTE are providing network equipment for mobile telecommunications not only to domestic telecommunication operators but also to operators around the world. Huawei Technologies applied more patents than any other global enterprises in 2008, indicating its strength in research and development.

Among all the evidences of China's development as a creator of

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1 According to ITU World Telecommunication/ICT Indicators Database.

2 The estimate of sales in China is from *Nikkei Communications*, No. 538, June 15, 2009. The estimate of global sales is from *Nokia Form-20F 2009*, p.66.

telecommunication technology, the most prominent one is the development of one of the global standards of third generation mobile telecommunication technology, "TD-SCDMA[3]". The next section of this paper will discuss the origins and features of this technology, the Chinese government's involvement in its development, and its market performance since the start of its operation in 2008.

Another interesting development which has occurred along with the recent development of domestic market and production is the emergence of the so-called "guerrilla handsets (*shanzhaiji*)" since 2004. The definition and name of these mobile handsets have changed from time to time. When they first appeared in the Chinese market, they were termed "illegal handsets (*heishouji*)," and the word referred to the mobile handsets produced by unqualified manufacturers. The Chinese government had introduced in 1999 a licensing system of mobile handset production, which restricted the production of mobile handsets only to those manufacturers that were given production license. The licensing system was abolished in 2007 and entry to mobile handset production was liberalized, so there should be no "illegal handsets" thereafter. Some former illegal handset makers, such as Tianyu Lantong—which ranked first among the domestic brands and forth among all brands in February and March, 2009—, have grown up to become one of the major brands. Many others, however, remain obscure and it is believed that their product development and manufacturing involve some illegal activities. Some mobile handsets produced by them are outright counterfeits of popular foreign models, and some are decorated with American or Japanese cartoon characters, which are used without the permission of the copyrighter. Some of their products make use of recycled popular handsets, retain the case and the popular brand but replace the circuit board and LCD (liquid crystal display) with new ones. Most of their products are believed to have omitted the full-type approval (FTA) procedure, which is necessary for handsets to be allowed into the GSM telecommunication network, and instead use a fake IMEI (international mobile equipment identity) number—an identification number which will be given to each handset if it passes the FTA procedure. By omitting the FTA procedure, handset makers can avoid the cost for it and improve the price competitiveness of their products. Handset makers also avoid the payment of value added tax and import duty by smuggling IC chips in and by exporting the assembled circuit boards to Hong Kong—to get the refund of value added tax, and re-smuggle them in. The present definition of "guerrilla handsets (*shanzhaiji*)" is handsets which are produced by obscure manufacturers that are involved in some kind of illegal activities during their

[3] Time division synchronous code division multiple access.

production process. The third section of this paper will discuss how the "guerrilla handsets" emerged, how they have evolved, and their market performance. The forth section concludes the paper.

Indigenous Third Generation Mobile Telecommunication Technology: TD-SCDMA

Origins and Features

TD-SCDMA is one of the technologies to link the mobile handsets and other mobile devices with the base stations using radio waves. It was accepted by ITU (International Telecommunication Union) as one of the five international standards for third generation system for mobile telecommunication, or IMT-2000 (International Mobile Telecommunication-2000), in 1999 along with W-CDMA and CDMA2000[4]. W-CDMA and CDMA2000 have been widely adopted by many mobile telecommunication operators around the world since 2001, attracting 389 million and 441 million subscribers respectively at the end of the second quarter of 2009[5]. TD-SCDMA resembles these two standards because it also uses CDMA technology, but at the same time it includes some different elements: smart antenna, terminal synchronization, and TDD (time division duplex). These elements reflect the origins and the features of TD-SCDMA.

Smart Antenna

The history of TD-SCDMA usually begins from the establishment of a company named CWill Telecommunications by two Chinese engineers, Chen Wei and Xu Guanghan, in 1995 at Austin, Texas (Yuan 2010; Shangwu zhoukan 2007). The purpose of establishing this company was to apply the smart antenna technology which Xu had studied in Stanford University and University of Texas at Austin to mobile telecommunication.

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[4] The "third generation system for mobile telecommunications" is a system that can transmit digitalized data, including voice, music, video, software, etc., between the mobile handset and base stations with a much higher speed than the second generation system. ITU expects that the third generation system provides transmission speed of at least 2Mbit/s (mega bits per second) for stationary and walking users, and 384kbit/s (kilo bits per second) in a moving vehicle, whereas second-generation systems can only transmit at a rate of 9.6kbit/s to 28.8kbit/s. The five technologies accepted by ITU as radio interface standards for third generation mobile telecommunication are: W-CDMA (Wideband Code Division Multiple Access), CDMA2000, IMT-TD (including TD-SCDMA and TD-CDMA), IMT-SC (which is also known as EDGE), and IMT-FT (which is also known as DECT).
(http://www.itu.int/osg/spu/imt-2000/technology.html#Cellular%20Standards%20for%20the%20Third%20Generation)

[5] Data is from GSM World website
(http://www.gsmworld.com/newsroom/market-data/market_data_summary.htm).

A smart antenna is a type of antenna used at the base stations of mobile telecommunication network. Unlike conventional omnidirectional antennas, it can differentiate the direction of the mobile handset from which it is receiving the signal and direct its transmission to a certain direction by using several antenna elements. Therefore, the antenna makes it possible to reduce the transmission power of mobile handsets, and increase the number of handsets which a single base station covers (Yomogida and Shindo 2002; Siemens 2004). Smart antenna is not a proprietary technology of TD-SCDMA. In fact, it has been used in the Japanese PHS (personal handy-phone system) network since 1998 (Tahara 2003). And because PHS technology was adopted by China's fixed telephone operators, China Telecom and China Netcom, as a cheap alternative to mobile phones and branded as "*Xiaolingtong*," smart antennas have already been widely deployed at the base stations of Xiaolingtong network.


A Smart Antenna used at a PHS base station

Though the smart antenna was not an original technology of CWill, it impressed the delegation of China's Ministry of Post and Telecommunications which visited the company in May 1995, because it enabled the base station to communicate with several handsets at the same time using the same frequency[6]. The head of the delegation, Zhou Huan, who was the chief of the Science and Technology Department of the Ministry, asked Chen and Xu to develop a smart antenna that could be used in CDMA network. Zhou promised to allocate funds from the "Key technologies R&D program of the ninth five year plan" to the project on the condition that CWill

[6] This technology is called SDMA (Space-Division Multiple Access). By using the same frequency to communicate with several mobile handsets, the technology can attain high spectrum efficiency.

established a joint venture with the Chinese Academy of Telecommunications Technology under the Ministry. Hence, the joint venture, Xinwei, was established in 1995. Li Shihe, the vice president of the Academy, became the president of Xinwei. Li, Chen, and Xu, however, found out that the smart antenna would not be of much use in the conventional CDMA technology developed by Qualcomm, so they decided to develop SCDMA (synchronous code division multiple access) technology in which the advantage of smart antenna would be more prominent (Shangwu zhoukan 2007).

Terminal Synchronization

Xinwei started to develop SCDMA, and in 1996 its experiment in Beijing succeeded. This again impressed Zhou Huan, who decided to invest 20 million yuan from "Key technologies R&D program of the ninth five year plan" to Xinwei. At this time, SCDMA was not intended to become a third generation mobile telecommunication technology, but rather a cheap alternative to the existing mobile and fixed telephone system. The first order Xinwei received was from Chongqing, where Chongqing Telecom, a local branch of the fixed telephone operator China Telecom, wanted to expand its fixed telephone network to remote rural areas using radio waves instead of installing fixed telephone cables. This function, which is termed "fixed wireless access," or "wireless local loop," has been the main purpose for which SCDMA technology is applied. After the split of all the R&D personnel from Xinwei in 1999, which will be discussed in the next part of this paper, Xinwei kept on selling SCDMA networks mainly to rural China. By May 2006, SCDMA telecommunication system had been installed in 116 cities, having more than 3 million subscribers (Chen 2006). It was not only used an alternative to fixed telephone for remote rural areas, but also as a cheap alternative to mobile telephones in cities, and therefore it was branded "*Dalingtong*," which indicated that it provided similar service with "*Xiaolingtong*," or PHS.

SCDMA is different from conventional CDMA in that it synchronizes the transmission from the mobile handsets to the base station, which means that the timing of transmission from mobile handsets is adjusted so that they arrive at the base station at the right time. This feature makes it possible to reduce the interference between mobile handsets and improve the data transmission speed (Esmailzadeh and Nobukuni 2004). Another advantage of SCDMA for its developer is, by adding "S" (synchronization), its developers can claim that it is a different technology from CDMA which Qualcomm holds most of important patents. This must be the reason why Zhou, Li, and Xu proposed to develop an indigenous third generation mobile telecommunication technology on the basis of SCDMA.

TDD (time division duplex)

SCDMA which Xinwei had been developing was different from W-CDMA and CDMA2000 in that it adopted TDD (time division duplex), while the latter two adopted FDD (frequency division duplex)(Xu 2007). Their difference lies in the method of differentiating the uplink (from mobile handset to base station) and downlink (from base station to mobile handset) transmissions. While FDD uses different frequency bands for uplink and downlink, TDD uses the same band by switching the timing of uplink and downlink transmissions. TDD can change the time allocated to uplink and downlink according to the data size of each. When the data size of uplink is small and downlink is large (which is often the case in third generation services), the downlink transmission can occupy more time than uplink in the TDD system, while in the FDD system downlink and uplink always occupy the same bandwidth. Therefore the spectrum efficiency of TDD can be higher than FDD (Siemens 2004; Nozawa 2004).

After deciding to develop a third generation mobile telecommunication technology on the basis of SCDMA and propose it to ITU as a candidate of the global standard, its developers decided to add "TD-" at the top of its acronym. This name not only indicated that it adopted TDD but also the developers' will to cooperate with similar standards proposed by other countries. The technology which Chinese developers had in mind was "TD-CDMA," which Siemens had proposed to European Telecommunications Standards Institute (ETSI) as a candidate for the Europe's common proposal for third generation mobile telecommunication to ITU. TD-CDMA was similar with China's SCDMA in that it also combined CDMA with TDD. It failed to be adopted by ETSI, but Siemens did cooperate with Chinese developers and joined the creation of TD-SCDMA since 1998 (Xu 2007).

Shortly after Xinwei had proposed TD-SCDMA to ITU, a divergence on Xinwei's policy of R&D between the company's investors broke out. The Chinese Academy of Telecommunications Technology insisted that Xinwei must devote its R&D resources to the development of TD-SCDMA, while CWill insisted that Xinwei must allocate some resources to the development and promotion of SCDMA, because it would take many years for TD-SCDMA technology to generate income, while SCDMA technology could be expected to generate income more quickly (Xu 2007; Tong, Zhang, and Fan 2006). This divergence led to the removal of all the R&D personnel from Xinwei to the Academy. The Academy then established Datang Telecom which would take charge of the development of TD-SCDMA.

Government's Involvement

The Chinese government has been deeply involved in the R&D and commercialization of TD-SCDMA. As mentioned earlier, the development project of SCDMA by Xinwei received a subsidy of 20 million yuan from the "Key technologies R&D program of the ninth five year plan." Since the removal of the R&D team from Xinwei to the Chinese Academy of Telecommunication Technology and then to Datang Telecom, the state owned enterprise has been responsible for the development of TD-SCDMA. Since its establishment in 1999, Datang Telecom (since 2002, its mobile telecommunication division became a subsidiary, Datang Mobile) has devoted 2000-3000 engineers to the R&D of TD-SCDMA[7] but the project did not generate any income until the beginning of commercial trial of TD-SCDMA in 2008. Siemens offered a great help to Datang, establishing a joint venture with the latter in 1998. But in 2004 Siemens discontinued to pour money and resources to the project which did not generate income.

Thinking that it would be difficult to develop various equipments for TD-SCDMA network by Datang alone, Ministry of Information Industry[8] let Datang Telecom organize the TD-SCDMA Industry Alliance with seven domestic manufacturers, including Huawei Technology, ZTE, and Lenovo. In order to induce the other members' commitment, the Ministry prepared a fund of 700 million yuan for the development of TD-SCDMA. The fund was provided to the members of the Alliance, and the members paid it to Datang as patent fees for the transfer of TD-SCDMA technology from Datang (Liu 2007). The contribution of Datang, Siemens, and the members of the Industry Alliance to the R&D of TD-SCDMA is reflected in the composition of related patents. As of October 2006 there were 214 patents filed at China's State Intellectual Property Office which were related to TD-SCDMA, of which 148 were on TDD and 66 were on SCDMA. Among the 148 TDD patents, Siemens had 21.6%, while Datang, Huawei, ZTE, and Qualcomm had 12.2%, 10.1%, 7.4%, 6.1% respectively. Among the 66 SCDMA patents, ZTE had 24.2%, while Siemens, Datang, and Huawei had 21.2%, 15.2%, 12.1% respectively. This composition, however, measures only the number of patents, and it does not reflect the economic value of the patents (Wang and Cheng 2006). These figures show that TD-SCDMA was not exclusively developed by the state owned enterprise Datang, but also by its partners such as Siemens, Huawei, and ZTE.

Besides allocating funds and establishing a state owned enterprise, the Chinese government has supported the development of TD-SCDMA through various

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[7] Interview by the author at Datang Mobile, August 29, 2007.

[8] The Ministry was formed in 1998 by merging Ministry of Post and Telecommunications and Ministry of Electronics Industry.

measures of protection.

First, the allocation of frequency spectrum tilted towards TD-SCDMA. In 2002 Ministry of Information Industry announced the allocation of frequency spectrum for third generation mobile telecommunication. In this allocation, 180MHz was allocated to FDD, while 155MHz was allocated to TDD. This meant that if the two international standards of third generation mobile telecommunication—W-CDMA and CDMA2000—were put into use, (since both of them adopted FDD,) each had only 90MHz, while TD-SCDMA, the only TDD system which would realistically be put into use in China, could have 155MHz. This means that the operator who adopts TD-SCDMA can build a telecommunication system with larger capacity than its competitors who adopts other technologies.

Secondly, the government did not allow domestic telecommunication operators to start third generation service using other technologies until TD-SCDMA technology was mature. Because the development of TD-SCDMA took more time than expected, the issue of the license for third generation service was postponed until 2009, eight years since the first third generation service in the world started in Japan. Besides this, the government allowed the third generation service using TD-SCDMA to start earlier than the services using other technologies: China Mobile, who uses TD-SCDMA, started the "commercial trial" of third generation service in April 2008, and its operation started formally in January 2009, while China Telecom's CDMA2000 service started in April 2009 and China Unicom's W-CDMA service started in October 2009.

Thirdly, the government allocated TD-SCDMA to the biggest mobile telephone operator, China Mobile, though it was reported that the operator preferred W-CDMA to TD-SCDMA (Kroeber 2007). Having more than 500 million mobile telephone subscribers, the government expected that China Mobile could induce a lot of its customers to use TD-SCDMA.

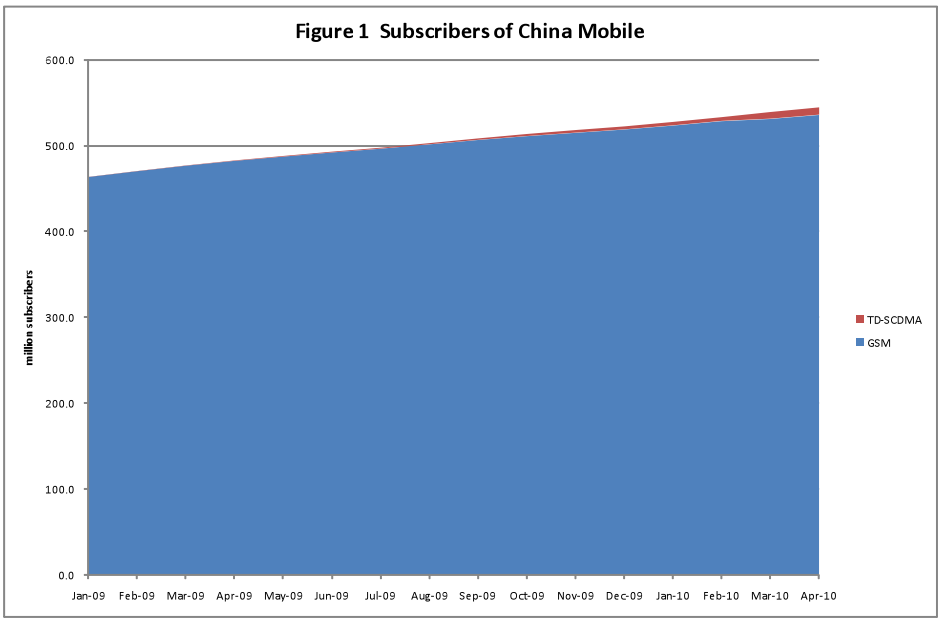
Market Performance

Although having all the support from the government, the growth of TD-SCDMA service subscribers until the time of writing this paper (June 2010) has been slower than expected. Before the TD-SCDMA service started, CCID Consulting, a company affiliated with Ministry of Information Industry forecast that the number of TD-SCDMA subscribers would reach 34 million in 2010 (Yuan 2010), but the actual number at the end of April 2010 was only 8 million. A seldom known fact is that the number of customers who use TD-SCDMA mobile handsets is much smaller than 8 million. The 8 million TD-SCDMA subscribers include the users of network cards and "fixed wireless

access" service using the TD-SCDMA network. The hardware for the fixed wireless access service is a telephone set which looks like a fixed telephone but uses radio waves instead of cables. This hardware is provided free of charge on the condition that the customer pays 120 yuan telephone charge in advance[9]. According to the interpretation of a marketing research specialist with whom the author had conversation in June 2010, the reason why China Mobile provides such a low value-added service using the TD-SCDMA network is that the company feels the pressing need to increase the subscribers of TD-SCDMA, which is a symbol of China's "indigenous innovation," and because the investment for building the infrastructure for TD-SCDMA network is already "sunk," the company will be better off by creating whatever income from the network.

The generational change among the subscribers of China Mobile is still not in progress yet: the increment of second generation service subscribers of China Mobile was more than six times larger than the increment of its TD-SCDMA subscribers in April 2010 (Figure 1). Although the number of China Mobile's TD-SCDMA subscribers is larger than China Unicom's W-CDMA subscribers (which was 5.5 million in April 2010), the growth rate of the latter has been higher than that of the former. W-CDMA grew by 32 percent monthly since the start of the service in October 2009, while TD-SCDMA grew by 24 percent monthly. One of reasons of the faster growth of W-CDMA service than TD-SCDMA should be the ampleness of the lineup of handsets. Because W-CDMA has been in use in the world for many years, China Unicom can make use of the lineup of international handset manufacturers, while there are still not so many manufacturers which can supply TD-SCDMA handsets. As of June 2010, China Unicom has 94 models for W-CDMA from 21 manufacturers, including nine foreign manufacturers, while China Mobile has 28 models for TD-SCDMA from 19 manufacturers including five foreign manufacturers.

[9] Based on the author's fieldwork in Tianjin in June 2010.



It may be still early to judge whether the TD-SCDMA project was a success or not. In the case of Japan, customers of the second generation service, PDC, began to decrease and the subscribers of the third generation service, W-CDMA, started to grow rapidly in the fourth year since the start of the latter. If this is the case in China too, we must wait until 2012 to see the rise of TD-SCDMA.

Evolution of the "Guerrilla Handsets"

Emergence

Mobile handset was not a simple commodity that could be easily manufactured. A team consisted of dozens of engineers in a government affiliated institute under the Ministry of Electronics Industry devoted six years to develop the first mobile handset designed and made in China in 1998 (Shiu and Imai 2010). The production licensing system introduced in 1999 mentioned earlier in this paper was a part of a government's policy to foster domestic manufacturers of mobile handsets. But, even though the license was only given to those companies which were regarded as having R&D capacity in electronics, the licensed domestic manufacturers often contracted the design and manufacturing of handsets out to Korean design houses and Taiwanese ODMs, because it was not easy for them to develop many models by their own. Some licensed manufacturers even lent their brands to some unlicensed manufacturers, who designed, manufactured, and sold handsets using the licensed brand[10]. The inclination of Chinese manufacturers to outsource, which was based on their need to have many models so

[10] Based on the author's interview with a small handset manufacturer in Shenzhen who rented the brands of Soutec and CECT at Nov. 4, 2005.

that they could compete with global handset manufacturers, has led to the development of independent design houses in China since 2001. The vertically disintegrated structure, consisted of brand manufacturers and independent design houses, was the basis of the proliferation of "guerrilla handsets."

Another condition that led to the emergence of "guerrilla handsets" is the strategy of IC vendors. Until the first half of 1990s, all mobile handset manufacturers in the world developed the core software (the "protocol stack") of handsets by their own, and some, including Panasonic and NEC, even developed and manufactured baseband ICs (ICs which process voice and other signals into digital codes) by themselves. Texas Instruments (TI), a leading vendor of baseband ICs, considered that the company could open up new customers by packaging the baseband ICs with protocol stacks, because, by providing such "platforms," those companies which were inexperienced in developing telecommunication software would be able to enter the mobile handset business. This "platform strategy" (Meyer and Lehnerd 1997) by TI made it possible for small and medium Korean handset manufacturers and design houses and Taiwanese ODMs to enter mobile handset production, and other baseband IC vendors, such as ADI, Lucent, and Infineon, followed TI's strategy. This environment, in which IC vendors provided the key component (baseband IC) with key software (protocol stack), together with reference designs and evaluation boards, also enabled the Chinese manufacturers and design houses to start designing and producing mobile handsets.

It was the entry of Taiwan's Mediatek (MTK), a fab-less IC vendor that had specialized in ICs for CD-ROM, to the baseband IC business that made it possible for the "guerrillas" (the unlicensed and small mobile handset manufacturers) in China to enter mobile handset business. MTK started developing baseband ICs in 2000, but it had a hard time finding customers at the beginning. The global market of baseband ICs was occupied by western IC vendors, such as TI, ADI, Qualcomm, Agere, Infineon, and NXP (Philips). No global handset manufacturers, even the Taiwanese ODMs, would take the risk of trying an immature IC made by a newcomer. Therefore, MTK invested in a Taiwanese design house and tried to sell finished mobile handsets (or their design) using MTK ICs instead of selling ICs. This cooperation did not last long, because the design house was merged by another company, but in 2004 MTK established a similar relationship with a design house in Shanghai named Longcheer (Shiu and Imai 2010).

The division of labor between MTK, the design houses, and handset manufacturers is somewhat different from the division of labor between western IC vendors and global handset manufacturers. MTK not only provides baseband ICs and protocol stacks to its customers but also application software and a detailed reference

design which includes a list of recommended components. Users of MTK ICs can quickly develop a new model, though it will be hard to differentiate the model's function from other models which use the same IC. Design houses such as Longcheer and Sim (another company located in Shanghai) design and assemble print circuit boards which are mounted with MTK ICs and other components. Longcheer and Sim sell the assembled print circuit boards, often together with LCD modules, to handset manufacturers. Handset manufacturers make the case and put the print circuit board, LCD module, and other components such as the key pad into it[11]. With MTK ICs and software and print circuit board assemblies made by Longcheer and Sim, the handset manufacturer's task became very simple.

Because MTK ICs facilitated the task of handset manufacturers, and because they incorporated the functions, such as MP3 and MP4 players, which were welcomed by Chinese end users, MTK ICs became a big hit in 2005. It was estimated that 55 percent of the mobile handsets manufactured in 2005 by domestic brands used MTK ICs (Pday Research 2006). Not only licensed manufacturers, such as Lenovo, but also a lot of unlicensed manufacturers started producing mobile handsets using MTK ICs. Hence the "guerrilla handsets" emerged.

After MTK's strategy turned out to be a success, a domestic IC vendor followed suit. Spreadtrum, a fab-less IC vendor located in Shanghai that specialized in ICs for mobile handsets, cooperated with Wingtech, a design house also located in Shanghai, and sold print circuit board assemblies for mobile handsets since 2006[12]. Because of the success of this strategy, Spreadtrum became the third largest baseband IC vendor to Chinese handset manufacturers occupying 12 percent of the market and Wingtech became the top design house in China in 2007 (Shiu and Imai 2010). It is believed that a large part of Wingtech's print circuit boards go to the "guerrillas."

It is estimated that there are around 1000 small handset manufacturers in Shenzhen which are engaged in the design of "guerrilla handsets." A huge market of "guerrilla handsets" and their components has developed in the downtown of Shenzhen. The market is a place where the "guerrillas" can procure all the necessary components, including the print circuit boards, ICs, LCDs, key pads, cases, and even the blueprints, find an EMS (electronic manufacturing service) who can assemble the handsets, and sell the products. Because the market offers the newcomers a rich variety of electronic components, manufacturing services, and sales channels, it may become a platform for innovative entrepreneurs. Some "guerrillas" have already started to produce new

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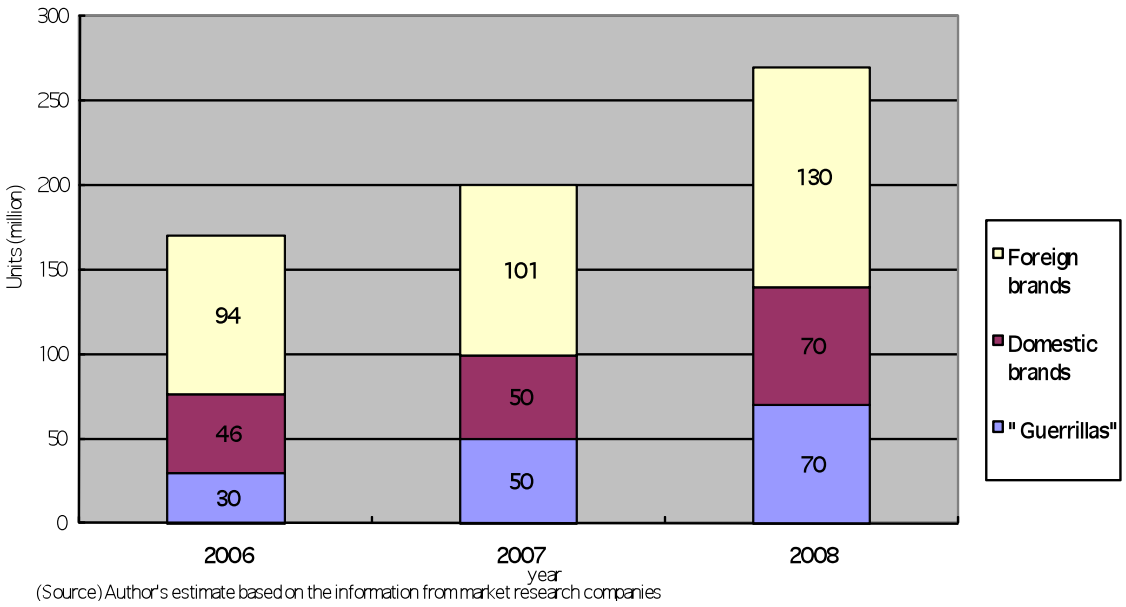
11 The author's interviews at Sim, June 7, 2007, and at Longcheer, June 8, 2007.
12 The author's interviews at Wingtech, July 21, 2008.

electronic products such as “netbooks.”

Market Performance and Innovation

If we measure market performance simply by the number of handsets sold, “guerrilla handsets” have been far more successful than the third generation handsets in China. As seen in the previous section, third generation services provided by three telecommunication operators have attracted no more than 20 million subscribers until April 2010, while in 2008 alone, 70 million “guerrilla handsets” were sold (Figure 2). If exports are included, some estimate that the total production volume of the “guerrillas” was 150 million in 2007 (CCTV zhongguo zaijing baodao lanmu zu 2009).

Figure 2 Sales of Mobile Handsets in China



(Source) Author's estimate based on the information from market research companies

Though most of the “guerrilla handsets” are copies of popular models in China, including some well-made copies of Apple’s iPhone, there are some original products which are not seen in the lineup of established brands. One example is the handset with large speakers. Handsets are usually designed not to emit big sounds, but considering the need of farmers who will put the handset on the ground and work in the fields some “guerrilla handsets” have large speakers. Another example is the handset which can insert two SIM cards and receive the call to two different telephone numbers. This function will be useful for those who travel often. The user of this mobile phone can subscribe in two cities and insert the two SIM cards so that he can choose the number which will be cheaper to make a call. This function was made possible by the new IC

developed by Spreadtrum in 2007. It was the "guerrillas" who first released the handsets which could insert two SIM cards[13]. Because the function became popular among "guerrillas," some domestic brands started to release handsets with such function.

Conclusion

The two cases of innovation discussed in this paper present a sharp contrast: one (TD-SCDMA) had a strong support by the government, while the other ("guerrilla handsets") was always a target of crackdown. One represents the cutting edge of technological progress in China, a technology that by no means inferior to its foreign competitors (W-CDMA and CDMA2000), while the other lingers upon an old and mature technology (GSM). The market performance of the former, however, has fallen far short of the latter. An irony is that the government's protection of TD-SCDMA by not allowing third generation services using other technologies has created the time for the "guerrillas" to absorb the mature technology and grow. Were it not for the protection, Chinese operators might have moved to the third generation earlier, making it difficult for the "guerrillas" to catch up with the present technology.

The poor performance of TD-SCDMA leads us to think that advanced technology may not be necessary so much in China, in which most of the population has only a low income. A mature and cheap technology like GSM has far more market here, and it may even open up a vast market in other low income countries for Chinese products, as was the case of "guerrilla handsets." The inventions made by some "guerrillas" may be the innovation which is really in need in China.

However, it is too early to judge that the development of an indigenous third generation mobile telecommunication technology was a failure. There is a possibility that the TD-SCDMA service will attract many subscribers. One strategy to develop the TD-SCDMA customer base is to invite more innovative entrepreneurs to the eco-system of TD-SCDMA. By popularizing or democratizing the innovation (von Hippel 2005) of the hardware and services based on TD-SCDMA, or by inviting the users and "guerrillas" to join the innovation of TD-SCDMA, the hardware and service may become cheap and attractive to the people in low income countries.

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[13] According to the author's interview with Kevin Wang of iSuppli Asia Ltd., July 22, 2008.

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