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The 3G Standard Setting Strategy and Indigenous Innovation Policy in China: Is T-SCDMA a Flagship?

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Abstract:
In the time of "network economy", industries and the public have stressed several "battles for dominance" between two or more rival technologies, often involving well-known firms operating in highly visible industries. In this paper, we are going to focus on the Chinese self-developed standard TD-SCDMA to perceive the implication and target of the nation's policy and strategy. The motivation of the research starts from the interesting fact we observed: TD-SCDMA is named as the Chinese made standard, however the Chinese hold core patent technology is still about 7%, while most of the rest part is still taken by other foreign companies. The "faultage" between the small share reality and a self made standard sweet dream implies a well plotted strategy. In order to understand it, we firstly raise the question of why the Chinese government postpones the 3G decision again and again. Then we go further to probe why the standard-setting of TD-SCDMA has aroused wide attention as a strategic tool to fulfill "indigenous innovation", and finally becomes part of national science and technology policy to increase international competitiveness? We are going to use economics theories to understand the essence of the creation of TD-SCDMA, and its relation to China's interests.

Key words: 3G, standard, innovation, China

Jel codes: O31; L96

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1. Introduction

In the time of “network economy”, industries and the public have stressed several “battles for dominance” between two or more rival technologies, often involving well-known firms operating in highly visible industries. Influence by standards can be dated back in history, such as the emergence of the automobile and the typewriter industry. In recent years, examples like high definition television, PC operating systems, modems, Internet browsers (IE and Netscape) and most recently the 3G wireless systems, have attracted significant attention from both the academic and the business community.

The case of GSM provides an example of a successful standard in 2G technologies. Europe and North America have taken divergent approaches to manage spectrum especially for wireless voice and data services. Unlike the market-determined standards in the US and Canada, the European Community has relied on mandated standards set by the European Telecommunications Standards Institute (ETSI). These decisions had impact on prices, penetration rates, service and feature availability, new technological development and deployment and coverage of 2G services in the EU and the US. GSM finally overcomes CDMA and dominates 2G. The universal standard makes it possible to export GSM technology worldwide and bring abundant revenue to European GSM manufacturers. Nokia emerged as an international giant, along with GSM to become a world standard. It has been widely recognized that EU adoption of a uniform GSM standard is one of the greatest successes of European telecommunications policy.

Along with the successful installation of GSM worldwide, China has already become the most important 2G market. When the time transits to 3G, a popular saying tells that “the world is looking at China, China is looking at hi-tech, hi-tech is looking at telecom, telecom is looking at mobile, mobile is looking at 3G”. Obviously, the selection of 3G standards in China has drawn wide attention in the telecom world, due to the huge market and vast potential investment in 3G infrastructure. Although the penetration rate is lower than in the western European countries, the Chinese market is the biggest in the world. China Mobile is ranked as the No.1 mobile operator world wide, with 139 million

subscribers, and China Unicom ranks as No.4 with 67 million subscribers[1] . Considering the huge success of 2G in China, the decision of a 3G standard will mean another round of huge investments in telecom infrastructure and market reward. However, because of China's unique social and market background, the selection of 3G in China is more complicated than the selection in other regions, and the 3G decision has been postponed again and again (See Appendix 2 for further information about mobile operators in China).

The complexity of standard selection is determined by the complicated relation between government, mobile operators and manufacturers. Xiaojie (2006) compares the Ministry of Information Industry to the King, the TD-SCDMA is the daughter of the King, and mobile operators are quasi-sons-in-law. The latter is more interested in another beauty WCDMA. Actually they have chased the beauty for a while and fell into deep love with her. However, because of the power and pressure imposed by the King, these quasi-sons-in-law have to keep flirting to the daughter of the King from time to time, while never giving a commitment to her. The marriage problem of the daughter has puzzled the King for long time, and he has had to postpone the date of marriage again and again, because none of the candidates loves his daughter truthfully, not only because the daughter is not as beautiful as the others (WCDMA, CDMA2000), but also by force of the pressure from the other "fathers-in-law". The marriage of TD-SCDMA will finally end as an arranged marriage [2].

In this paper, we are going to focus on the Chinese self-developed standard TD-SCDMA to perceive the implication and target of the nation's policy and strategy. The motivation of the research starts from the interesting fact we observed: TD-SCDMA is named as the Chinese made standard, however the Chinese hold core patent technology is still about 7%, while most of the rest part is still taken by other foreign companies. The "faultage" between the small share reality and a self made standard sweet dream implies a well plotted strategy. In order to understand it, we firstly raise the question of why the Chinese government postpones the 3G decision again and again? Then we go further to probe why the standard-setting of TD-SCDMA has aroused wide attention as a strategic tool to fulfill "indigenous innovation", and finally becomes part of national science and technology policy to

[1] Du Yanpeng, Focus on the debate of TD-SCDMA of the Chinese 3G development, China Telecom Industry, 2006

[2] Xiaojie, TD: the MII's daughter is difficult to get marry, Sohu IT, 2006

increase international competitiveness? We are going to use the theory of economics of information industry, including the concept of the installed base, path dependency, and the theory of infant industry and neo-techno-nationalism to understand the essence of the creation of TD-SCDMA, and its relation to China's interests.

2. Theories of the network economy, infant industry and neo-techno-nationalism

2.1 The interoperability of the network economy

The telecommunications industry is a typical "network economy". Consumers of computers and software programs, cellular phones, faxes, and Internet services all have more valuable products as the use of the products by others increases, the total social value of the product increases as it is shared with more consumers. According to Farrell and Saloner (1987) standardization can be defined as a coordination process which results in the production of goods that are interchangeable or compatible.[3] David and Steinmueller (1996) indicate that standards in telecommunications systems play a central role to maintain service quality, and standards will not involve tradeoffs between service quality and variety, but will knit together advanced telecom networks in a seamless web of interoperable technologies and services. This means that the highest priority of standard setting is interoperability. However, they also expressed that "in practice, there are many reasons why such a construction may prove difficult to achieve". Technical compatibility standards do not flow "neutrally" from the best engineering practice, but rather reflect the full range of strategic behaviors.

It has been widely agreed that a dominant design is often not the technologically superior one and is usually the result of a complex interplay between technological factors and user demands as well as political, social, and economic factors. Different technological designs backed by different sponsors compete for the position of dominant design through a process where economic, technological, and socio-political factors are intertwined. Technology is not working isolated -- coordination and compatibility with other products or systems are required. Tushman and Rosenkopf (1992) said that, generally, the more complex the product, the more actors aligned for a technological design, the more

[3] Farrell, J., & Saloner, G. (1987). Competition, Compatibility and Standards: The Economics of horses, penguin and lemming

complicated is the sponsoring role. A complex system requires additional attention to many different interfaces and negotiation with different users and producers of complementary products, thus evolving from simple technological artefacts to more complex ones[4].

2.1.1 Network effects

Network effects indicate that the utility derived by a consumer is affected by the total number of consumers subscribed to the same network, in other words, the demand or utility curve shifts upward with the increase of the total users in the network. The adoption of a certain system will be partially dependent on the number of other consumers purchasing similar systems. Network effects can be divided into direct and indirect effects[5]. Direct effects are present when a new customer joins a network, and a new network connection is created for all the members in the network. Direct effects depend on compatibility between system elements. For example, the utility of one user of an email system increases along with the increasing number of total users. Indirect network effects arise as a result of increased demand for complementary products or a service including specialized training, after-sale support, compatible software, etc. --- a positive dependency evolves between the spreading of a standard and increasing demand for complementary goods. For example, the spreading of an operating system plays an important part in determining the supply of compatible application software. Katz and Shapiro (1985) find that firms with good reputation or large existing networks tend to ignore compatibility; while firms with small networks or weak reputation tend to favor compatibility. This is because large firms have the market power to ignore compatibility when introducing new systems.

2.1.2 Installed base and switching costs

A larger installed base is associated with higher rates of adoption for a specific technology. The size of the installed base provides an “extra push” to increase the possibility of the specific technology to be a dominant one, firm can design its products to be compatible with a customer base that already exists on the basis of a previous technology. Some first-mover advantages have an influence on the

[4] Tushman, M. and Rosenkopf, L., 1992. Organizational determinants of technological change: towards a sociology of technological evolution. Research in Organizational Behavior 14, pp. 311–347

[5] Katz, M. and Shapiro, C., 1985. Network externalities, competition, and compatibility. The American Economic Review 75, pp. 424–440

emergence of a dominant design. If a firm can be the first to the market with a product for a period of time, switching costs will prohibit them from using other competitive products because of its existing installed base. This means that switching costs can have an effect, attracting or losing customers according to cost switching from one installed base to another.

It follows that the higher the switching costs, the more difficult it is for a firm to attract customers from rivals, which results in a more loyal customer base. For instance, it is agreed that network effects for end users of wireless technologies are weak. Once they have joined a particular network, users may be reluctant to switch to another network if switching cost is complicated or high, for instance changing their telephone number. From a path dependency perspective, a firm's ability and incentive to adopt a newer technology largely depends on its level of related experience with prior technologies. When using previous generations of inter-organizational system, firms have fostered skills for inter-organizational system implementation, and developed a deeper understanding about the economic and organizational impacts[6] . Acquired primarily through learning-by-doing, such skills and knowledge are critical for successful adoption of new technology standards.

2.2 Theory of infant industry and neo-techno-nationalism

Political forces influence largely in the making of a dominant design; they are complicated and difficult to predict. David and Steinmueller (1996) observe that government regulatory bodies may have an interest in standards setting, because some government agencies hold authority to regulate the industry's firms. They perceive that the result of standardization activity affects important national goals, such as protecting domestic employment or maintaining defense capabilities. Standard setting is complex in practice: the role of regulation in the process may present problems to government agencies. This can be understood as unequal information distribution and power of obtaining. Second, government intervention will also tend to accentuate identifiable "vested" interests. They point out that national governments have incentives both to promote and to discourage the adoption of inter-operable compatibility standards in telecommunications services. The incentives to promote standards arise when compatibility standards will contribute to user welfare, while having either

[6] Lyytinen K., Robey D. (1999): "Learning Failure in Information System Development", Information Systems Journal, vol 9, No 2, pp. 85-101

positive or negligible adverse effects on domestic producers. When governments must weigh the promotion of inter-operable compatibility standards against the demise of a domestic producer or the compromise of other perceived national interest, common international standards or inter-operable compatibility standards are likely to be sacrificed. As well, the national political appeal of some international revenue or employment shifting toward the home country is likely to be potent. One way to preserve domestic market position is to mandate or promote the use of compatibility standards to achieve inter-connectivity rather than inter-operability. Inter-connectivity assures that two devices may be connected through a converter or bridge that renders them mutually compatible. No doubt, a government policy favoring inter-connectivity is likely to provide more opportunities for domestic production, and they warn again, such protection must be weighed against the possibilities of retaliation and more importantly, large consumer welfare losses arising from promoting an "inferior" standard[7].

The infant industry theory is an argument for government intervention for a limited time period only to correct a transient distortion. List[8] argues that protection of domestic industry and the resulting monopoly would permit an eventual reduction in costs and prices allowed by the exploitation of the domestic market. Moreover, eventually the gradual introduction of domestic competition would safeguard the interests of consumers. Obviously, one of the reasons for protecting an infant industry is to stimulate the learning effects that will improve productivity. The Infant Industry argument suggests that protecting the domestic industries from foreign competition results in generating positive learning and spillover effects. Thus by protecting infant industries a government might facilitate more rapid economic growth and a much faster improvement in the country's standard of living relative to specialization in the country's static comparative advantage goods (Lyytinen & Robey 1999).

[7] David A Paul, W Edward Steinmueller, 1996, Standards, trade and competition in the emerging global information infrastructure environment, Telecommunications policy, Vol.20

[8] LIST F (1856). *The National System of Political Economy*. Philadelphia, JB Lippincott and Co.

As termed “Neo-techno-nationalism”[9] by Atsushi Yamada, this concept has four main characteristics: expanded state commitments to promote technical innovation domestically; further reliance on the private initiative and the public-private partnerships; further openness toward foreign R&D entities; and expanded commitments for international rule-making and policy coordination (Atsushi Yamada, 2001). There are two ways as consideration of national technology strategies to reconcile in the Neo-techno-nationalism. The first is “fast follower” mode. In this approach, the dominant architecture is not normally challenged, and it serves as a type of collective good, infrastructure, or framework. In this mode, the dominant architecture or standard is generally accepted, and strategy focuses on new products and services within the spaces which are provided by the accepted standard. A second approach would be to challenge the dominant architecture, attempt to replace it with a new one, and bear the costs of providing the collective good[10]. But it is a higher-risk, costly, and it is likely to be chosen only by countries with substantial resources— abundant in financial resource; large markets with the potential to attraction in terms of economy, institution and culture; an innovative R&D system which is linked to an economy of proven productivity; and substantial political power which is able to manage large risks. In addition, it might also be undertaken by countries which are dissatisfied with the royalties they must pay (Naughton & Segal, 2003).

3. TD-SCDMA’s: the Chinese self-developed standard

3.1 A historical review of TD-SCDMA

China has three options including TD-SCDMA, in which China has its significant property right ，and two global standards WCDMA and CDMA2000. TD-SCDMA is actually the key interest in the decision and selection of The Chinese 3G standard. TD-SCDMA (Time Division-Synchronous Code

[9] Atsushi Yamada, “Neo-Techno-Nationalism: How and Why It Grows,” Columbia International Affairs Online, March, 2000; Sylvia Ostry and Richard Nelson, Techno-Nationalism and Techno-Globalism: Conflict and Cooperation, Washington, D.C.: The Brookings Institution, 1995; and Sandro Montresor, “Techno-Globalism, Technonationalism and Technological Systems: Organizing the Evidence,” Technovation 21, 2001, pp. 399–412.

[10] Naughton Barry and Segal Adam, “China in Search of a Workable Model: Technology Development in the New Millennium,” in William Keller and Richard Samuels, eds., Crisis and Innovation: Asian Technology after the Millennium, New York: Cambridge University Press, 2003.

Division Multiple Access) is a 3G mobile telecommunications standard, being pursued in the People's Republic of China by the Chinese Academy of Telecommunications Technology (CATT), Datang and Siemens AG11, in an attempt to develop home-grown technology.

The research and development of TD-SCDMA's core technology began in 1995. Two Chinese engineers, a project manager at Motorola Semiconductor Department Chen Wei, and a lecturer from the University of Texas at Austin Xu Guanghan, established a technology start-up company Cwill, which means China wireless access. The company developed a core technology which is called uplink synchronous technology. A new system constituted by the new technology was named as SCDMA (synchronous CDMA). In 1995, under the arrangement by Zhou Huan, the director of science and technology department of Minister of Post & Telecom (former of MII), a joint venture "Xin Wei" company was set up by the Post &Telecom research institute and Cwill. The company was focused on the development of smart antennas, synchronous uplink SCDMA wireless access to core technology system. SCDMA originally provided wireless accession between fixed networks and fixed terminals, and acquired profits from installation fees of fixed telephone (Zheng, 2006).

In 1997, when the ITU solicited for the third generation mobile communications standards, the Post &Telecom Research Institute wanted to take the chance to promote SCDMA to an international level. In 1998, on behalf of China, Datang (Telecommunications Science and Technology Research Institute) proposed to the ITU the Chinese 3G standard (later named TD-SCDMA). At the end of 1999, when TD-SCDMA showed possibility to be a candidate of standard, a bifurcation happened between Datang and Xin Wei. Datang decided to transfer development of TD-SCDMA to the development group to Datang. Since most of the researchers were either assigned or recruited from Post &Telecom Research Institute, most of the personnel switched to Datang research center. SCDMA and TD-SCDMA broke partnership and each went its own way. The key technologies in TD-SCDMA such as smart antennas, uplink synchronization, are originated from the SCDMA system, which makes it difficult to distinguish from the other 3G standards. From this point of view, the technology of TD-SCDMA is

[11] Nokia and Siemens announced in June of 2006 that they intend to merge the Networks Business Group of Nokia and the carrier-related operations of Siemens into a new company, to be called Nokia Siemens Networks. The 50-50 joint venture will create a global leader with strong positions in important growth segments of fixed and mobile network infrastructure and services. (http://www.mobilemonday.net/mm/story.php?story_id=4848)

originated from wireless access technology SCDMA, and it is uplifted to a Chinese national standard under a special condition (ibid).

There are two reasons make the TD-SCDMA to be one of the three mainstream international standards. The first is the advantage of higher frequency spectrum utilization. TD-SCDMA only occupies one 1.6MHZ bandwidth, which means that the system capacity is several times bigger than WCDMA and CDMA2000. For mobile operators, the high frequency spectrum utilization means lower cost for users. On the other hand, the more important force is from the support of the Chinese government. After China submitted its 3G file to the ITU, manufacturers from Europe, America and Japan unanimously opposed to it immediately. MII gave a tough stand right away: "Even foreign forces tried to block the Chinese standards to be adopted, the Chinese market has sufficient space to support their own standards, we are fully capable to develop and operate TD-SCDMA in China!" (ibid). Taking into account the importance of the Chinese market and unwillingness to offend the Chinese government, the large telecommunications manufacturers did not take more radical opposition this time

Later during 1998 to 1999, when the WCDMA backed by European interest and the CDMA2000 backed the US, experienced hard rivals, it provided the TD-SCDMA with new opportunities and hopes. For example, in order to promote a uniform standard WCDMA in Europe, the Siemens proposed TD-CDMA was sacrificed, which led Siemens to switch their support to the Chinese TD-SCDMA. In 1999, TD-SCDMA emerged from the 16 files of 3G standards proposals received by the ITU and in May 2005 TD-SCDMA finally turned into an international standard (Zheng, 2006).

3.2 Strong government support vs patent distribution & installed base

MII (Ministry of Information Industry) gives vigorous support to TD-SCDMA development, arranging special funds as part of mobile projects and electronic development funds. MII and MST (Ministry of Science and Technology) and other government departments have invested 1 billion RMB ($120 million) since the late 1990s, involving nearly 3,000 scientists and engineers across the country. A team of 10 thousand technicians and researchers have been involved in the research, development and market promotion in 3G mobile services. In 2002, MII established the TD-SCDMA industry alliance with other ministries. They also support theoretical research in TD-SCDMA,

including design and R&D in crucial chips, system, antenna, terminal, network plan, testing and construction. MII invites more and more Chinese and foreign manufacturers to join the alliance. At present, more than 50 manufacturers are engaged in the development of TD-SCDMA. The members of the industry alliance have increased from 8 to 25. A basic industry value chain has already been established[12].

The radio spectrum is an enormously valuable and scarce natural resource. According to MII document, WCDMA standard obtains core frequency band of 60MHZ and the expansion frequency band of 60MHZ; CDMA2000 standard obtains the same; TD-SCDMA standard obtains the core frequency band of 55M and the expansion frequency band of 100MHZ, ranging from 1880MHZ to 1920MHZ[13], 2010MHZ to 2025MHZ, and 2300MHZ to 2400MHZ[14]. Although the allocated frequency to the three standards is all located in the core frequency according to ITU regulation, the 2300MHZ to 2400MHZ which has been allocated to TD-SCDMA is carefully planned by the government. Since this specific frequency band used to belong to military use, the government specially cleaned up the frequency in the interest of TD-SCDMA. The attitude of most foreign countries' to TD-SCDMA is not positive. Many of them have already allocated the core frequency to the two main stream standards, which makes it difficult for TD-SCDMA roaming to other countries. However, if China can successfully commercialize TD-SCDMA in these two expanded frequencies, it is also possible to influence neighboring countries, or even worldwide -- the frequency between 2300 to 2400 MHZ has not been occupied in most countries[15].

Despite strong government support, TD-SCDMA is still behind of the other two standards in terms of technology and market readiness. Actually these three standards are all developed from the technology of CDMA; therefore they share most of the patents. The major difference between FDD standards (WCDMA and CDMA2000) and TDD (TD-SCDMA) is to use one single symmetric frequency or two frequencies in up and down link. It is estimated that Datang holds 7.3% of the patent

[12] Liu Jin (2005), Summarization of MII's promotion of TD-SCDMA development, China Electronics, Li,

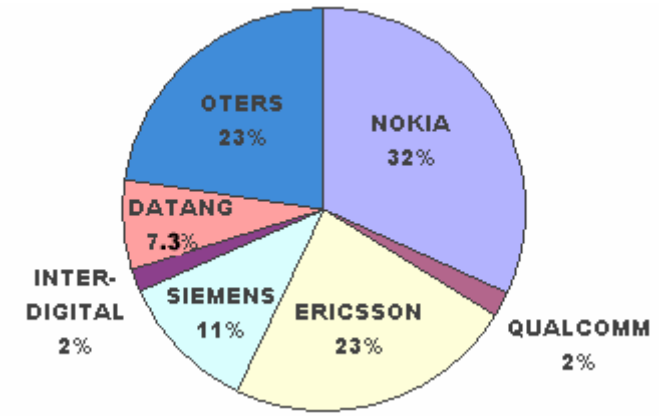
[13] This band is not now available for TD-SCDMA because of eg. PHS.

[14] All the current TD-SCDMA phones are now operating on this 15MHZ band only.

[15] Ren Leyi, Understanding impaction to operators and manufacturers: 3G frequency allocation, Telecom World

share and Ericsson, Nokia, Qualcomm and Siemens dominate more[16]. In addition, TD-SCDMA needs to build on the WCDMA core network, it is impossible to avoid the WCDMA transnational giants. The entire TD-SCDMA patents are distributed between Nokia, Ericsson, Siemens and other international corporations[17].

Figure (1): Patent distribution of TD-SCDMA



(Source: The 21.th Century Economics Report)

According to MII (Ministry of Information Industry) (2006) data, until Jan. 2006, there are 256 3G commercial networks worldwide, among which there are 99 WCDMA networks, 31 CDMA2000 1X EV-DO networks and 126 CDMA 1X networks[18]. Along with the improvement of WCDMA technology, the amount of commercial WCDMA networks develops rapidly. Table (1) displays the distribution of the 3G networks, licenses and users in a global view[19]. Although CDMA 2000 1X still attracts the majority of users, this advantage is gradually diminishing. Along with the resolving of

[16] Datang Telecom Technology & Industry Group (Datang Group) was constructed under the permission of Ministry of Information Industry in 1999 and now is under direct administration of Central Committee of Major Enterprises Management. Datang Group is a large high-tech industry group focusing on the R&D, production and sales of telecommunications equipment (http://www.catt.ac.cn/english/)

[17] Yan Yuelong (2005), Four critics to TD-SCDMA: China's pride or silent ending? Telecom World, the 15th Dec., 2004

[18] CDMA2000 1xEV-DO (1x Evolution-Data Optimized, originally 1x Evolution-Data Only), also referred to as 1xEV-DO, EV-DO, EVDO, or just DO, is an evolution of CDMA2000 1x with High Data Rate (HDR) capability added and where the forward link is time-division multiplexed. This 3G air interface standard is denoted as IS-856. CDMA2000 1xEV-DV (1x Evolution-Data/Voice), supports downlink (forward link) data rates up to 3.1 Mbit/s and uplink (reverse link) data rates of up to 1.8 Mbit/s. 1xEV-DV can also support concurrent operation of legacy 1x voice users, 1x data users, and high speed 1xEV-DV data users within the same radio channel. http://en.wikipedia.org/wiki/CDMA2000

[19] Du Yanpeng, Focus on the debate of TD-SCDMA of the Chinese 3G development, China Telecom Industry, 2006

terminal bottle-neck problems and increasing of the number commercial networks, newly added users for WCDMA have increased dramatically in 2004. CDMA 2000 1X shows a tendency of decreasing since 2004, while CDMA 2000 1X EV-DO increases slowly. But China's TD-SCDMA has not been commercialized.

Table (1): Network, license and subscriber of WCDMA, CDMA2000 and TD-SCDMA in a global view in 2006:

Index	**Total in worldwide**	**WCDMA**	**CDMA2000**	**TD-SCDMA**
Networks	256 3G networks	99 WCDMA networks[20]	31 CDMA2000 1X EV-DO networks 126 CDMA 1X networks	N/A
Licenses	141 3G licenses	137 licenses	4 licenses	
Users	217.4 million 3G users	42.2 million WCDMA users	153 million CDMA2000 1X EV-DO users 22.2 million CDMA 1X users	

(Source: Du Yanpeng, Focus on the debate of TD-SCDMA of the Chinese 3G development, China Telecom Industry, 2006)

4. Vested interest groups and the possibility of TD-SCDMA

4.1 Main players: MII, manufacturers and operators

Until now, the Chinese government has deliberately postponed the launching schedule for 3G again and again. Industry has already lost patience, extremely disappointed by the pendulous attitude. The speculated date of launching can be traced back to few years ago; then it was delayed repeatedly, until now it is designated as late as 2008, when China hosts the Olympic Games in Beijing. It is widely speculated that the postponement policy of the Chinese government is aimed at time conservation for TD-SCDMA improvement, or even for more advanced version of WCDMA or CDMA2000. But the government support for TD-SCDMA development is obvious. It is shown by the authority's spectrum allocation and industrial alliance promotion for TD-SCDMA.

[20] A recent source indiates that there are 139 WCDMA network globally. (www.gsacom.com)

Many manufacturers have been exhausted to speculate on the schedule of 3G. The telecommunications sector is most likely to implement de jure standards imposed by law due to government ownership of the communications infrastructure. In the 3G selection in China, the government is performing the central role to coordinate and balance the various interests. The ultimate decision power lies in the top official side, and it all depends on the government to balance interests among many different interest groups.

MII highlights the importance of TD-SCDMA for their future plans. Apparently, the argument of waiting policy of MII is to ensure that the technology of TD-SCDMA will be ready and commercially operable. The government intervention in standards setting has deliberate political implications. They hope to change the monopoly of foreign standards by supporting domestic development and thereby to reduce patent fees to foreign corporations. It is supported by infant theory that, if the TD-SCDMA survives, the protection from foreign competition would result in generating positive learning and spillover effects, therefore stimulating domestic production and encourage more positive effects. The Chinese government will have to wait for the TD-SCDMA technology to be more commercialized and mature; otherwise an immature technology will cause an unnecessary loss of benefits the industry, or country.

Foreign manufacturers are very active in pushing China's 3G schedule. The European mobile market has entered the saturated stage. In addition, there is another new phenomenon appearing in telecom industry: the voice market and revenue became saturated. Alongside the saturated voice business, the data service was on the rise actually. The 3G strategy was mainly aimed at the mobile broad band data service market. China is one of the fastest growing telecoms markets and the largest mobile market in the world; even with a slight slice of the cake, the absolute quantity may be attractive. Foreign manufacturers including Nokia, Motorola and Qualcomm will become the direct and instant beneficiaries in the value chain of 3G business. Because of their strong influence in the industry and abundant financial resource, they are actively lobbying the Chinese government. Domestic manufacturers are standing on the same side to actively promote the launching of 3G. The leading Chinese telecom equipment companies have participated in the TD-SCDMA alliance, including

Datang, Huawei, POTEVIO and established joint venture with Nokia, Nortel, Siemens and other foreign companies to develop TD-SCDMA technology21.

The telecoms operators have their own particular interests concerning 3G in the market, although there are still considerable business spaces in the 2G market. Neither China Mobile nor China Unicom has an inventive to start 3G service, due to the immense potential user source from Western China, where the penetration of mobile is still very low. Although the mobile subscribers in China reach 459 million in the end of 2006, the newly added user is still as high as 48 million22. Having always been excluded from the lucrative and faster growing mobile sector, the two operators China Telecom and China Netcom have looked jealously over the fence at the mobile market and consistently argued that they should also be allowed in cake sharing. They are eager to start 3G and they are lobbying force to promote 3G. Fixed line telephony may probably eventually be replaced by mobile service, and these two operators have observed the trend and actively switched their own business from fixed line to mobile service—the launching of 3G will be a great opportunity to them, no matter WCDMA, CDMA2000 or TD-SCDMA. However, the government is more interested in recommending the TD-SCDMA to operators. But it has to be considered that a less interoperable technology will make trouble in phone call connecting and roaming; a less compatible technology will cause additional investment in infrastructure construction.

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- Huawei established a JV with Siemens in the Feb. of 2004 to focus on the R&D of TD-SCDMA technology and product, and manufacturing, sales and service. The total investment is more than 100million USD. Siemens and Huawei hold 51% and 49% of the share respectively. (Siemens and Huawei invest 1 million USD to set up JV, in order to promote TD-SCDMA, People's Daily, Feb. 23, 2004)
- POTEVIO established JV with Nortel in the Jan. of 2005. The JV focuses on the TD-SCDMA product, solution, relevant network engineering and network optimization etc. Nortel and POTEVIO hold 51% and 49% of the share respectively. (POTEVIO and Nortel set up JV to focus on TD-SCDMA development, Beijing Evening Daily, the 31st of Jan., 2005)
- POTEVIO also established JV with Nokia in the June of 2006 to construct TD-SCDMA stations; project investment reaches about 150 billion USD, POTEVIO and Nokia hold 51% and 49% of the share respectively. (Nokia and POTEVIO set up JV to construct TD-SCDMA project, China Economy Network, the 1st of June, 2006)
- So far there are three additional JV for TD-SCDMA: NEC and Torch, Ericsson and ZTE, Alctel and Datang

22 Xin Hua News Agency, Mobile subscribers reach to 459 million in the end of 2006, Xin Hua Net, the 25th of Nov., 2005

4.2 The possibility of TD-SCDMA

As 3G in China will be a US$100 billion market, the decision will have significant implications for operators, domestic manufacturers and foreign vendors. The Ministry of Information Industry (MII) has kept silence on which standard China will adopt. Although TD-SCDMA has no obvious advantage in terms of technology, commercialization and industrial alliance etc, no one can assert that TD-SCDMA will be washed out in the final round, because the selection of a technology standard is much more complicated than the selection of a technology. The selection of a technology standard can really be regarded as a “black box”, where lots of tact and strategies have been manipulated clandestinely.

An independent TD-SCDMA network will spend hundreds billion of national assets, it is not worthy to decide on a standard which has no obvious advantage and is short of commercial competitiveness. The business operation of a 3G network needs a long term and complex industrial chain, involving chips, terminals, operational platform, network management systems, test instruments, network planning software, optimization software, operational platform, OSS(operation support system)/BSS(business support system) system and various ancillary and support equipment. Errors or bugs in any of the link will affect the operation of the entire industry. The technology matured date claimed by Datang has been postponed from 2003 to 2004, and to 2005 then till an unknown date. This has misled both the public and government and brought negative impact on the industry. The "Great Leap Forward" style development method caused worries by the Chinese telecommunications operators. As a new 3G mobile network in an initial period will face the problem of poor quality, which makes operators take risk of damaging their reputation. The less matured technology will lead to an uncertainty of the duration of the stage and make operation risk incalculable. In addition, if TD-SCDMA can only form a closed domestic industry, it is difficult to compete with another open international standard and will always face considerable pressure to be eliminated out. The 3G era is a typical buyer's market, domestic users have 2G or 3G technologies to choose. The fairy good quality of domestic 2G network has trained users to be very sensitive to the mobile quality. Immaturity of technology will largely inhibit the expansion of 3G users.

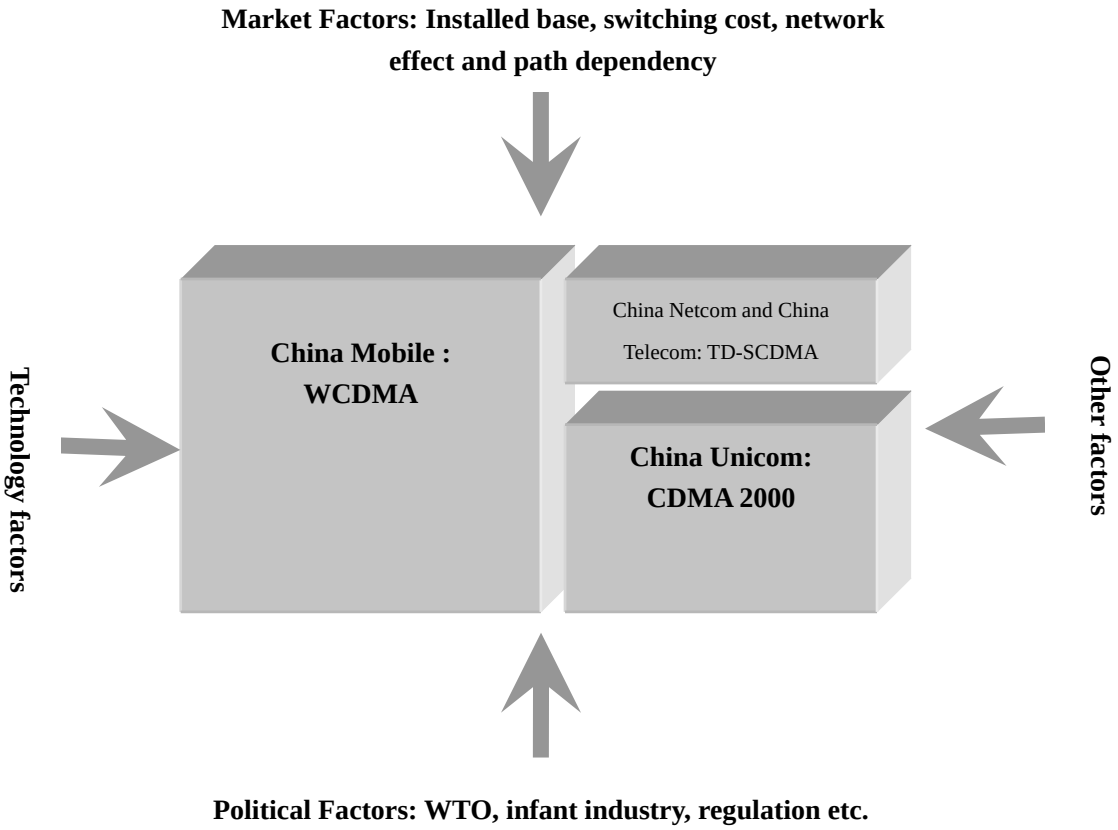
So, by its technical features and conditions, TD-CDMA is insufficient to emerge an independent network. Operators are not willing to keep the gambling stake in a technology which is immature and has never undergone the market test. MII would like to use 3G as an impetus to the Chinese mobile industry. However, due to the fact that both China Mobile and China Unicom have been partly and indirectly listed in overseas stock markets, the MII would not like to force operators to adopt a specific standard, as this might give investors the impression of an excessive government intervention and a characteristic of the "socialist" market. This could give an unfavorable profile to these operators. China's accession into the World Trade Organization (WTO) also brought some restraints on the elaboration of the MII intentions. Therefore, it is considered as the most probable solution to construct a hybrid network which includes the three standards. The government could require a certain proportion for TD-SCDMA. China hopes that, after 3G mobile systems come into operation, the TD-SCDMA standard will play its due role in promoting the development of this promising industry. As a natural continuity of GSM/GPRS, China Mobile will obtain a WCDMA license indisputably. China Unicom has its advantage in adopting CDMA2000, since it is a rather economic way to transform its existing CDMA network to CDMA2000---the cost of transformation is lower than that of the GSM/WCDMA. China Telecom and China Netcom are in a possible position to get a TD-SCDMA license. Although they are both interested in the WCDMA technology, considering the Chinese government's vigorous support of TD-SCDMA technology, China Telecom and China Netcom are closely tracking the TD-SCDMA technological development, and actively participate in TD-SCDMA network tests23.

The government has to weigh the promotion of an advanced standard against the decline of a domestic producer (like the mobile terminal producers), or other perceived national interests. Concerning the large potential market of the country, it seems that the government will not make a hurried decision to launch 3G standard only according to technology superiority. Many other factors are worth considering, including politics, domestic industry and national welfare. On the one hand, the government is enduring pressure from the US government to adopt CDMA2000. On the other hand, it has been also recognized that WCDMA is the most feasible choice because there is a large installed

[23] Xia Yongjun, Making clear government's strategy of 3G license, Information Network

base of GSM in China, which will give a natural and compatible route of transformation. Finally, the government is making every effort to cultivate the TD-SCDMA technology, in order to avoid being squeezed out from the3G technology race, since China's ultimate goal is to transfer welfare to national consumers through the introduction of domestic standards. In general, the interaction between governments and foreign manufacturers is characterized by two levels: aggressively pushing by foreign manufacturers, cautiously weighed by the government in order to balance the different sponsors behind, see Figure (2).

Figure (2): An assumption of standard selection by different operators in China market:



5. TD-SCDMA and national interest: indigenous innovation as national science and technology policy

5.1 Indigenous innovation

The Chinese central government has proposed to construct on "innovation-based nation" and promoted "indigenous innovation" activities. Indigenous innovation is aimed to develop predominant

core technologies and core products, and improve core competitive ability of the country, region or industry/company. From the company's point of view, along with the internal technology breakthrough, the integrated intellectual capital endows the systemic development to possess strong self-organized ability and market leadership. So that it can get rid of independency and attachment to foreign technology. In general, indigenous innovation is a process to explore potential markets through in-house R&D activities and external knowledge acquisition (Chen 2004). It is also recognized that only by forming a large number of national "an innovation-based enterprises", and Chinese enterprises acquiring indigenous innovative development and progress, the strategic goal of "innovation-based state" can be fulfilled. The Chinese effort in 3G standard setting is one of the most important strategic targets to achieve the goal. Why does this critical mission fall on TD-SCDMA?

Information technology is the high ground of state-of-art technology in the world. Among them, mobile communications is the most important and fastest growing field of technology. No matter in the area of CPU or the other technology areas, China may still experience difficulty to make a breakthrough in the near future. In this way 3G becomes the best choice to acquire that breakthrough. The emergence of TD-SCDMA enables the Chinese government to find such opportunities. According to State Council Development Research Center's forecast24 "the overall input of the Chinese 3G mobile communications network in the beginning 6 years will reach 75 billion USD, of which more than one billion annually." Especially, the 3G chance is particularly important to few of the domestic indigenous innovative based enterprises including Datang and ZTE. It is said that25, the Chinese 3G standard is assumed a historical mission, of the same importance as the value of manned spaceflight. China is also seeking breakthroughs in other areas than 3G communications. For example, in the area of consumer products, due to the relatively weak capacity of independent R&D and the fast changing standard, Chinese enterprises find difficulty to challenge the industry standard. In contrast, the R&D capacity of communications equipment manufacturers is stronger than in other areas, and the cycle of establishing and eliminating of a standard in telecommunications is longer than for the other industries'. This enables the Chinese enterprises to have enough time to challenge the current standard.

[24] Chen Heli, 3G times: Domestic industries facing "innovation revolution" opportunity, the 8th, Mar., 2006

[25] Wang Tao, 3G and the Chinese civilization renaissance, China Computer, the 10th, Oct, 2005

TD-SCDMA has been regarded not only the model of indigenous innovation in the field of telecommunications, but also an important practice of indigenous innovation based on enterprises. In 1997, after submitting TD-SCDMA to the ITU by Datang Group, a TD-SCDMA industrial alliance was rapidly established in the active guidance of the Ministry of Information Industry. The enterprises of the industrial alliance have expanded from the 8 in the beginning to 25. The number of domestic and foreign enterprises which engaged in TD-SCDMA R&D is up to more than 50. A value chain from system, chips, terminals, software, test instrumentation to test environment has been preliminarily established. Nearly 10,000 people form a professional team of product development, marketing, technical research. Among them, Datang, Huawei, ZTE, PITC have developed four sets of system equipment. Datang, Haixin, Legend, Haier and other enterprises have developed nearly 20 types of TD-SCDMA mobile phone and data card products26.

But the meaning of the TD-SCDMA to “indigenous innovation” is still debatable. A Standard is a combination of various technology applications, so it makes less sense in the absence of dominating patent share. Although TD-SCDMA is called "indigenous standards", China holds only no more than 16 patents in the core 260 patents, which means that China holds a small part of the real technological content. It makes the technology as a "domestic made foreign technical standards," just like one wants to use the patent of a wheel to control the standard of automobile industry. The current three mainstream 3G standards are all evolved from the second generation technology CDMA. This determines that a significant number of technologies are in common, the basic algorithms and technologies are also directly transposed from the CDMA2000 or WCDMA. Because of the openness of 3G technology, most part of the TD-SCDMA patents are still held by foreign manufacturers. 3G system includes two parts: core network, and radio network. The core network of TD-SCDMA adopts the standard from WCDMA; this implies that Nokia, Ericsson and Siemens own both the patens of WCDMA and TD-SCDMA patents. Qualcomm, which controls the second generation technology CDMA also dominates the patents of CDMA2000. In addition, same as the WCDMA, the evolution of TD-SCDMA standard also imports the technologies of HSDPA and OFDM27, foreign competitions

[26] Luan Yongping, TD-SCDMA has the capability for form network, People’s daily, the 5th, Jan, 2006

27 High-Speed Downlink Packet Access (HSDPA) is a new mobile telephony protocol and is sometimes referred to as a 3.5G technology. In this respect it extends WCDMA in the same way that EV-DO extends CDMA2000. Orthogonal frequency-division multiplexing

are more advanced in both in HSDPA and OFDM, especially as the HSDPA has been commercialized, China has to face the predicament of further dilution of the core patent. Therefore the essence of the "indigenous innovation" is actually susceptible.

However, the significance of the TD-SCDMA has also been exaggerated. The significance of the TD-SCDMA standard has been lifted to bear on national security. The core network of TD-SCDMA is originated from WCDMA and most of the patents are from foreign manufacturers. The reason that European insisted to apply WCDMA is because the CDMA2000 technology must rely on the United States GPS system to achieve synchronous satellite system, while WCDMA does not need use GPS. However TD-SCDMA still depends on the U.S. GPS satellite systems to be simultaneous, therefore it is unable to achieve the purpose to protect domestic technology. In China, public media has compared the TD-SCDMA with the industry of spaceship, it is inappropriate. Because the spaceship is a military used product which is unnecessary to follow intellectual property. The risk to develop a spaceship is assumed by government, and its client is also government. However the operation of TD-SCDMA is assumed by enterprises, its clients are also ordinary consumers, it is hard to say that how many consumers will choose the TD-SCDMA due to the "national standard" (Zheng, 2006).

5.2 Standard-setting: national science and technology policy

Further, why is the Chinese government interested in standard-setting as part of its national science and technology policy? The emerging interest in standard-setting by the Chinese government is grown out of China's position in the international economy: China realizes that it has to balance between huge market opportunities, as well as difficult economic restrictions based upon the standard setting arena which is dominated by other countries, especially the enormous core patent and non-core patent portfolios filed by multinational corporations.

(OFDM), also sometimes called discrete multitone modulation (DMT), is a complex modulation technique for transmission based upon the idea of frequency-division multiplexing (FDM) where each frequency channel is modulated with a simpler modulation. (www.wikipedia.com)

The awkward situation is: on the one hand, China has the rising bargain power of a huge market and booming economy. China has become the seventh largest economy and one of the world's great export economies, and has rapidly moved up in the value chain in producing and exporting higher value-added products. China can use its huge market as an asset to develop distinctive standards with an expectation that its standards will be taken by international level, in ways that small countries are not able to do. Lester Ross has observed that market size and conditions "where dynamic technological developments threatened to eclipse existing standards" are the factors which encourage Chinese policymakers to formulate domestic standards, "....in the expectation that market size may result in international adoption of the China's standard28. In addition, several conditions founded the confidence for the Chinese to move ambitiously in standard-setting. Although the Chinese patent share in TD-SCDMA is rather low, the general R&D level is improving along with the accumulation of national capital. China's technological capabilities are increasing significantly, which raise the possibility to devise the Chinese technical standards attaining international attention. For instance, there are large number of R&D scientists and engineers in (810,000 in 2002) in China; the Chinese expenditure on R&D in purchasing power parity terms is the 3rd in the world after the United States and Japan; increasing and active patenting activities; China positions as 2nd place in producing published papers for the world's international science and engineering journals29. These conditions improve the competency and qualification for the country to seek its self-developed standard.

On the other hand, China's participation in the global economy is characterized as low level of technology participation, which is due to restriction of low technology level and the others-established international production networks. In the international manufacturing pyramid, the Chinese manufacturing industry is located in the low end, although lots of manual work have been used, corresponding profit and value-added ratio are very low. National Bureau of Statistics information

[28] Lester Ross, "Regulatory Foundations for Chinese Technological Development: Legal, Financial, Standardization, and Environmental," paper presented at the Conference on China's Emerging Technological Trajectory in the Twenty-first Century, Rensselaerville, New York,
September 2–7, 2003.

[29] Ministry of Science and Technology, China Science and Technology Statistics: Data Book, 2003 (cited hereafter as MOST, 2003), Beijing, Ministry of Science and Technology, 2003.

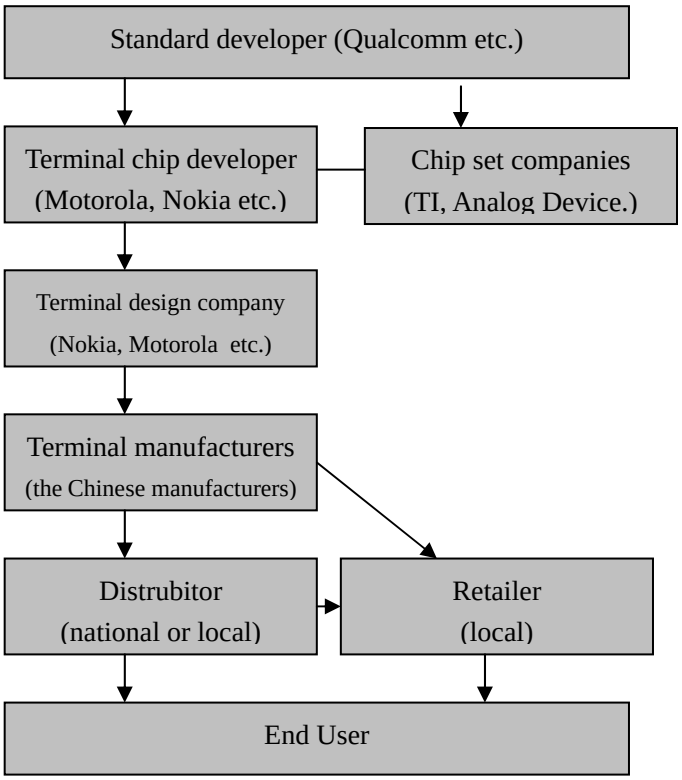
showed that the value-added to product of the Chinese manufacturers is 26.2%, which is largely lower than the US (49%), Japan (48%) and Germany (37%). Particularly in the communications equipment, computers and related equipment manufacturing field, the ratio is only 22%, which is lower than the US exceeded 35%30.

The international production networks employ technical standards which are set by multinational corporations. For instance in telecom industry, except few excellent companies (Huawei, Datang and ZTE etc.), who are actually highly supported by local and central government, other second class manufactures are mostly engaged in mobile terminal production. The production of mobile terminals (Figure 3) is typically characterized as low technology entrance hurdle, low margin profit and harsh competition. Both the large companies and small enterprises hurried to the production of mobile terminals in order to catch a share in the booming mobile industry. The manufacturers import key parts and software and hardware from developed countries, and assemble in China by local labor force. In addition, the Chinese manufactures also need to pay patent fee for each mobile terminal they produced, which is as high as 8-15% of the sales price for each terminal, so ironically, the more they sell, the more they have to pay. Although China has already lifted the technology level during the past 20 years, the Chinese government also starts to have concerns about its excessive dependence on foreign technology, which could be at the expense of a the development of a higher level of the national innovations system. Besides, there is the increasing concern about the benefit distribution within international division of labor and the relative gains accruing to the standard setters in international production network31. China is still in a subordinate position vis-à-vis global industry leaders, and China has not emerged as a significant force of innovation in production networks. These lessons have been forced as the motivation for the country to seek its own standard in order to reduce its excessive dependence on foreign technology, which could be at the expense of the development of a higher level of national innovations system.

Figure (3): Mobile Terminal production value chain

[30] Yang Jun, 2006, China's manufacture is approaching to a critical point, Nan Feng Chuang, the 6th of Aug. 2008

[31] Richard P. Suttmeier and Yao Xiangkui, 2004, China post-WTO technology policy: standards, software, and changing nature of techno-nationalism, The national bureau of Asia research, University Way NE, Washington



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The situation pushes China to interpret and implement an approach of standard which focuses on market power in the face of technological weakness, under the condition that China has confidence in its ability to set innovation standards which can positively affect its international competitiveness32. This approach is reflected in the "indigenous innovation" policy. As it has been introduced, the policy highlights the internal technology breakthrough through the efforts of China originated technology development, instead of borrowing imported technology from other countries, hence to improve the overall R&D level and lift its technology competency in global production network. Here, a homegrown standard for 3G network could give Chinese companies an edge and allow them to grab a slice of a market dominated by European and U.S. supplier, and through the process to promote the standard of TD-SCDMA, relevant mobile industries can be upgraded to a new technology level. Therefore, the rising interest of standard setting by the Chinese government is actually a strategic

[32] Daniel H. Rosen, "Low-Tech Bed, High-Tech Dreams," China Economic Quarterly, Q4, 2003, pp. 20–40; Barry Naughton, "China's Economic Growth and Technology Development: International Linkages and Implications for the U.S.," testimony presented to the U.S.-China Economic and Security Review Commission, February 12, 2003.

response to globalization and the global economy, where standards have become important tool to leverage gains in international production networks. A good example is in Korea, domestic firms have contributed intellectual property to worldwide video compression standards by rapidly expanding patent portfolios33. Even the smaller economy can procure domestic made standard. China's large and growing market allows more possibilities and ambition for domestic firms to pursue local standards and to let the standards find their own way. From this point of view, China's raising interest in standard setting is to practice the neo-techno-nationalism by taking a risky and costly task to device its own standard.

The existing standard system has already provided a favorable framework for developed countries, because international production networks employ technical standards set by the multinational corporations from developed countries. Therefore, these multinational corporations capture value from their controlled system over standards and intellectual property, while the Chinese manufactures endure minor margin profit because of "patent trap" which requires paying substantial royalties to patent holders. It implies that, developing countries are facing difficulties during the process to upgrade their position in the international labor division through the implementation of national innovation strategy. "Deft execution" that required a government to steer smartly between a narrow techno-nationalism which causes friction and resentment in international business, and a marginalization of domestic industry, and insensitive to national economic interests34. The infant industry theory indicates that that the government intervention for a limited time could permit domestic companies to strive for time to catch up competitors from developed countries. The country anticipates that the self-developed standard would internalize and absorb the process of developing technology and eventually enhance its own technology competency. Meanwhile, firms can develop new technologies of their own, and become more capable to join global competition.

Applying the theories, in the context of the still-evolving national innovation system of Lundvall (2005), a smart government can act as coordinator and guide to compensate for weaknesses in firms

[33] Albert, et al. (1998). patents in the information technology field filed by Korean inventors rose from 4 in the period 1982-1986 to 1,629 in the period 1992-1996

[34] Richard P. Suttmeier and Yao Xiangkui, 2004, China post-WTO technology policy: standards, software, and changing nature of techno-nationalism, The national bureau of Asia research, University Way NE, Washington

and universities. Some of the firms participating in government-sponsored standards projects will internalize the process of developing advanced technology. This direct participation of Chinese firms in international standard setting indicates that the experience of China's official intervention is part of a larger learning process for firms and for policymakers. Firms can develop new technologies of their own, and become more capable to join global competition. As some Chinese companies become technologically sophisticated to pursue their own interests in global standard-setting procedures, the role of government will likely be reduced, as is the experience from Japan, Korea and Taiwan. The policy of "indigenous innovation" is visible practice and attempt to implement the concept of infant industry and neo-techno-nationalism to establish its own technology standard, and eventually build its own innovation system to win a competitive position in international production value chain with a higher R&D competency.

6. Concluding remarks:

The 3G standard-setting system in China is featured as highly politicized in comparison with the usual standard setting in elsewhere. In fact, the telecommunication industry is most likely to be determined by government committees due to government ownership of the communications infrastructure in many countries. But this is not a unique state of affairs, for example Japan uses government consortia to drive standards development for new markets such as networked digital products35. In Europe, the effort to create the very successful GSM standard in the 1980s was initially led by state-owned telecom operators and the European Commission. Why does China postpone 3G launching again and again? Obviously, the Chinese government wants to seize the opportunity of 3G's taking off to deliver its own standard. The government wields industrial policy to help improve the competitive position of Chinese firms, especially for the standard of TD-SCDMA to be more matured and commercialized. From a view of short-term benefit, Chinese standard policy is designed to decrease dependence on foreign know-how by developing domestically-controlled technology. It can reduce burdensome royalty payments by domestic producers of high-tech goods, which is hundreds of millions of dollars annually.

[35] "METI, Electronics Firms to Jointly Craft Net Appliance Standards," *Nikkei Electronics Asia*,26 August 2004

Further, a longer-term goal is to help leading Chinese firms to secure technological leverage and through the procurement of the standard setting policy, it is possible to close the gap with more advanced countries over the next ten years, and the impact on global standards can be expected to increase. Especially, during the process of opening telecom markets and the introduction of foreign technology, China has already fostered few telecom manufacturers (Huawei, Datang and ZTE etc.) which are harvesting world wide reputation and an aggressively increasing market share in a global view. These enterprises have the capability to catch up through the procurement of standard-setting and eventually drive the telecom and relevant industry to a higher technical level. In general, China is pursuing the domestic development and application of intellectual property in a determined manner. Although most Chinese firms are little-known today outside their own industries, except a few large firms like Huawei and ZTE who are already developing a brand presence in developed countries, it is possible to see that in ten to twenty years, the combination of an evolving innovation system, maturing firms, a thriving economy, and government-supported technology development may come together to build a comparable industry economy to those of Europe, Japan, and the United States.

Therefore, the policy deliberately implemented by government is laying a foundation for future developments.

The Chinese effort in promoting TD-SCDMA is one of the most important strategies to implement the national policy of “indigenous innovation”, and assumed to take the historical mission to make the breakthrough.

Through this process the country is aimed to develop into an “innovation-based” economy, which could largely reduce patent fee dependence on the developed countries and enhance the position of the Chinese enterprises in global production value chain. Along with the closing gap between Chinese firms and global leaders, it becomes more likely that a Chinese company will contribute valuable intellectual property to a worldwide standard. China realizes that it has to balance between huge market opportunities and booming economy versus low level technology participation in global production networks. The situation pushes China to seek an approach to make standard-setting by its market power in the face of technological weakness. Through the process to promote a domestic set

standard, relevant industries can be upgraded to a new technology level and eventually to positively improve the country's international competitiveness. Thus the rising interest of standard-setting by the Chinese government is actually a strategic response to globalization, and it is part of an important policy tool to leverage gains in international production networks.

From a practical view, the Chinese government could focus more on building an innovation system within enterprise scope. In China, manufacturers like Huawei and ZTE have occupied most of domestic market share including transmission equipment, switching equipment, also rapidly expanded in international market. This is driven by the highly independent innovation mechanism within the enterprise. In order to develop such a huge 3G network, it is particularly important to foster an innovation mechanism. The competition of international standards is not only the game between governments, but also played by the first class international giants backed by governments. Europe, the United States, Japan and South Korea all rely on the powerful multinational corporations to participate in the international standards competition. These companies play significant role in standard setting: mostly they grasp technical standards thoroughly, and actively integrate technical standards, marketing, industrial resources and finally form up a "de facto standard"36 in the market. With the absence of the underpinning of the first class companies', government can only get half of the result by the twice effort in the competition of standard setting. The domestic manufacturers' advantage does not lie in basic research but to integrate technology, cost, service and performance closely. It is hard to compete with foreign competitors in terms of basic patents, therefore imitating is a realistic solution. In the current stage, more attention could be given to indigenous innovation based on the introduced advanced technology from foreign countries. China's current international status in the field of basic research and development is very similar to the Japan's in the1960s. Although a substantial patent fee was required to pay, it scored great success by the close integration between market and technology introduction, absorption, innovation. Both Huawei and ZTE demonstrate strong ability to innovate through R&D. The strategy could lay key support to several selected companies and develop them into the first class multinational corporation, hence switch the government-lead standard competition to company-lead competition.

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www.gascom.com

Appendix 1: Leading Chinese Telecom Manufactures

Company	Description
Huawei	Established in 1998 and located in Shenzhen Canton, Huawei has been grown into the largest telecom manufacturers in China. Huawei has over 35,000 employees, and 48% of them are dedicated to R&D. Huawei's global R&D centers are located in Bangalore India, Silicon Valley and Dallas USA, Stockholm Sweden and Moscow Russia in addition to those in Beijing, Shanghai, Nanjing, Shenzhen, Hangzhou and Chengdu China. Huawei has set up over 100 branch offices worldwide to provide customers with quick and excellent services. Products and solutions cover wireless products (HSDPA/WCDMA/EDGE/ GPRS/GSM, CDMA2000 1X EVDO/CDMA2000 1X, WiMAX), core network products (IMS, Mobile Softswitch, NGN), network products (FTTX, xDSL, Optical, Routers, LAN Switch), application and software (IN, mobile data service, Boss), as well as terminals (UMTS/CDMA). Major products are based on Huawei's self-designed ASIC chips and shared platforms to provide high-quality and cost-effective products and solutions with quick response. Huawei is also the only private owned companies among the leading telecom manufacturers.
ZTE	Established in 1985, also in Shenzhen Canton, ZTE is now listed telecoms manufacturersr with shares publicly traded on both Hong Kong Stock Exchange and Shenzhen Stock Exchange Telecommunications equipment, mobile terminals and services. ZTE recorded the contract sales of approximately USD 4,111 million (RMB 34 billion) in 2004, which is the second largest one in China. The company has three product series, i.e. wireless, network and terminal (mobile phone), global customers with diversified integrated telecommunications networking solutions and a wide range of professional services on a 24×7 basis, and has been involved in the market of international telecommunications operation services.
Datang	Established in 1998 and located in Beijing, Datang is listed telecoms manufacturers in Shanghai Stock Exchange. Datang Telecom Technology Co., Ltd. mainly engages in various types of communications equipment systems, communication terminals, computer software and hardware, system integration, microelectronics, and other operations. As a domestic manufacturers who provides the widest coverage of communications equipment, Datang Telecom have formed its own intellectual property rights, exchange access industry which is cored by SP30iEX technology, chip industry which is based on SOC technology, terminal industry which is based on chip technology, the software industry which has the core technology of business support systems and a new generation of wireless communications industry and its core business.
POTEVIO (Putian)	POTEVIO is an IT products and service provider in telecommunication industry. The company was founded in 1980, originally called China Posts and Telecommunications Industry Corporation. It is a state key enterprise directly under the leadership of the State-owned Assets Supervision and Administration Commission of the State Council (SASAC). POTEVIO's business scope covers both fixed and mobile communications. Its available communication equipments and terminal products include: mobile communication network equipments and handsets, optical transmission equipments and communication cables, PDF and connectors, power supplies, microwave communication equipments, telecommunication network Operation Support Systems (OSS), SPC switch, videophones and IC card payphones, PHS handsets, logistics information system and equipments for industries, ITS series products, office information equipments and etc, as well as project contracting home and abroad, international cooperation, technology transfer, products import and export and etc. POTEVIO is a leading one among top 100 enterprises in China's IT industry, and ranked excessively the No. 1 of Top 100 Chinese Electronic & Information Enterprises in 2001 and 2002. In 2003, POTEVIO ranks No. 1 among the overall listing of China's largest enterprise groups in the manufacturers sector of electronic and communication equipments. It ranks No. 5 both in the listings of 500 largest import & export and 200 largest export enterprises issued by the Ministry of Commerce of China.

Appendix 2: Major mobile Operators in China

Company	Description
China Mobile	China Mobile is the largest mobile operator in the world according to subscribers. China Mobile was officially established in 2000 and is directly under the central government. It is a key state-owned enterprise based on the mobile business that split from the former China Telecom as a result of the reform and restructuring of China's communications industry. China Mobile Communications Corporation has a registered capital of 51.8 billion RMB Yuan, assets of over 320 billion RMB Yuan and 120,800 employees. It fully holds the equity of China Mobile (HK) Group Limited. China Mobile (HK) Limited, of which China Mobile (HK) Group Limited is the major shareholder, set wholly-owned subsidiaries in 21 provinces (autonomous regions and municipalities directly under the central government) in China and went public in HK and New York Stock Exchanges. China Mobile provides GSM Services and operates their services in 31 provinces of China with roaming facility in 240 cities, and GSM market share is about 65%. In addition to above services china mobile offers data services, VoIP calling cards and Internet access
China Unicom	China Unicom is the second largest mobile operator in China, also the fourth largest mobile operators based on subscriber.. China Unicom was established in 1994 and is the only Chinese operator that has a license to provide full range of services. At present, the Company is engaged in the cellular business (both GSM and CDMA) in 30 provinces. the provision of international and domestic long distance calls, data and Internet services, and other related telecommunication value-added businesses. China Unicom Ltd is listed on the New York Stock Exchange and the Stock Exchange of Hong Kong
China Telecom	China Telecom group is first operator for fixed line service. The Company is the leading provider of wire-line telecommunications services in 20 provinces / Autonomous Regions and Municipalities of China, also provides PHS service in China. China Telecom is the second largest operator after China Mobile in term of revenue. In 2002, the Company was listed on the Hong Kong Stock Exchange and ADS listed on the New York Stock Exchange.
China Netcom	China Netcom was established in 2002 on the basis of the former China Telecom Group Corporation and its affiliated telecom companies in the 10 Northern provinces. It is listed independently in national finance and relevant plans. China Netcom has a total registered capital of RMB 60 billion RMB, and the value of its total assets exceeded RMB 250 billion RMB by end 203. The business covers various national and international fixed telecommunications network facilities and related telecommunications services. In April 2004, the number of its telephone users hit the mark of 100 million. Now, the company is dedicated to the development of broadband communications, among which "PHS Value-added" etc.