Shaking Grounds?
Technology Standards in China

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This white paper is based on work partly sponsored by the Kauffman Foundation and the National Science Foundation under grant SES-0964907. The authors thank both foundations for their generous support of this research. All mistakes and omissions are solely the authors'.

Napoleon is quoted as stating: "Let China sleep for when she awakes, she will shake the world." Since 2000, China seems to be living up to this prediction in the realm of high technology. Various statistics paint a picture of a world being shaken indeed. Starting at practically zero in 1990, by 2012 China annually exported over 548 billion dollars in high technology goods and services (MOST, 2012). R&D expenditure reached nearly 136 billion USD and was growing at nearly 22% per year, second only to the United States (BBC, 2011; Wang & Liu, 2012). In patenting, China was ranked third in the world by 2008 and surpassed Japan as number two in 2010 (Finance.591hx, 2011). China's scientific publications have also surged, ranking second only to the United States and leading in certain emergent fields such as nanotechnology.[1]

In the realm of technology standards, China has set its sights on achieving what it thinks is its due global stature. By 2020, China should have an innovation-based economy and be a world-leading R&D power (StateCouncil, 2006). Development of technology standards is central to these objectives. Within China, particularly in policy circles and academia, there is a pervasive belief that technology-based companies can be divided into three tiers: third-tier companies make products; second tier companies make technology; and first tier companies make standards.[2] In interviews, many policy makers and academies voiced a similar sentiment as stated by a leading researcher at Tsinghua University:

[1] It should be noted that in these statistics, similarly to many statistics used in the case of technology standards, there is an acute misunderstanding of the meaning and the causes behind this surge. For example, in the case of scientific publications much of the explosion can be explained by other means then a radical qualitative change of the entirety of Chinese research output in less than a decade. Simply looking at the journals themselves, one realizes that almost all the publications are in new ISI indexed scientific journals that have been established and managed by Chinese in China over the last fifteen years after a new incentive system for academics placed emphasis and material rewards on publication in ISI-cited journals. Thus, while the surge is nothing but miraculous, and hints at significant underlying changes, scholars who use aggregate statistics to reach sweeping conclusions on innovation rankings often miss their mark by a wide margin (Murray & Spar, 2006; Porter, Newman, Roessner, Johnson, & Jin, 2009).
[2] In Chinese: 三流企业做产品; 二流企业做技术; 一流企业做标准.

> "While regularly there should be only a limited role for government, China must develop its own standards in order to have room to set new directions for technology and make market space for Chinese innovations. This requires a stronger government role."

With this underlying perception, the Chinese state apparatus has moved strongly to promote new indigenous technologies and standards incorporating them. China's moves to develop unique, and at times mandatory, technology standards have shaken dominant foreign technology companies. There are significant differences in how standards are developed in China and particularly how IP is embedded and managed within them.

This white paper develops these arguments as follows. It first introduces the basic principles of technology standards, standards development and embedded intellectual property (IP) as practiced in the West an in international organizations. It then turns to China, introducing the influential 1989 Standardization Law, the legal basis for China's approach to technology standards. With this background, the paper then explores the how China incorporates IP in technology standards. The paper then describes the actual workings of China's technical committees and standards bodies, highlighting the differences between the Chinese approach and Western practices. Finally, the paper presents a brief discussion of the performance of unique Chinese standards development efforts.[3]

As this white paper explores, China is far from a single-minded strategic actor. Its formal organizations and institutions of standardization are still developing and changing, many of them still tied to a legal and agency infrastructure developed for a centrally planned economy. Bureaucratic infighting often undermines Chinese standards, even those which ostensibly present a real technological challenge to the West. The use of formal intellectual property rights – such

[3] This research was based on three months of field work in the spring and summer of 2012. Using a seven-point research theme instrument with various stakeholders in China's technology standards bodies, government ministries, technology companies, academia and consulting firms, we performed over sixty semi-structured interviews. Interviewees included both Chinese and foreigners, providing a wide range of insights and perspectives into China's technology standards system and policies.

as patents – in standards is only recently emerging. Most importantly, based on the business models of Chinese technology firms, it appears China's real challenge to the West is over the norms of IP monetization and use in standards.

Introduction to Technology Standards

Technology standards are agreed-upon technology platforms for interconnection, operation, or function on which other applications, improvements, and innovations can be made. Since the time of the unification and centralized codification of weights in Qin-era China and Florentine guild-masters checking the length of cloth merchants' meter-sticks, standards have been the staid domain of lawyers and government weights and measures officials (Kindleberger, 1983). While seemingly dull, standards are essential to the smooth operation of trade. For example, the difference in standard railroad gauge between Russia and China forces railroad operators to change the railcar carriages at the border which slows trade. Similarly, international travelers know well the irritation of not being able to use different electronic devices due to voltage differences and incompatible plug styles.

Technology standards are integral to modern life. Information technology, and particularly its ability to communicate, is entirely based on widely adopted and accepted standards. Whether internationally developed such as the ISO's OSI suite or DARPA's TCP-IP, common protocols are necessary for electronic devices to communicate and exchange data. To illustrate, the Universal Serial Bus (USB), developed by an initial group of US computer firms including Intel, IBM, and Microsoft, has become the global standard for interfacing computer peripherals with the main system. This has replaced the need for multiple incompatible jacks which had made it difficult to design and market products for any and all types of personal

computers. Use of USB has helped alleviate market confusion and increased the market for peripherals as buyers can confidently purchase hardware assured of its compatibility with their system.

While there may be, and often are, competing standards for a given technology – for example GSM and CDMA in second generation wireless telecommunication – technology standards often achieve quasi-monopoly status in world markets. While there are competing software options including free open-source and online tools, Microsoft's Office suite dominates the global market in word processing, spreadsheet, and presentation software. This monopoly enhances Microsoft's brand value and makes it difficult for competing, even potentially better, technologies to take root in the market. Firms whose technology is incorporated into a dominant standard can earn massive returns while those who supported a losing standard can find their R&D investment wasted.[4]

Technology standards can be divided into market-based or de facto and formal or de jure standards. De facto standards such as Microsoft Office are set through market competition where the winning standard or format pushes competitors out. Importantly, and sadly much confused in the media, a *technology* standard, even a market determined de facto one, is not a product by itself. While Microsoft Office is a standard for office software and a product; it is not a technology standard as such. WCDMA is a technology standard but not a product. The products are cell phone towers, transmitters and handsets using the protocols in the standard to enable the wireless sending and receiving of data. Technology standards are incorporated into goods and services to make them compatible or in compliance with regulations or even technological necessity (such as how to continue squeezing ever more data transmission into finite amounts of

[4] The victory of Sony's Blu Ray over Toshiba's HD-DVD standard led Toshiba to license its technology at very low rates to Chinese firms in order to cut its losses. The Chinese firms went on to use this technology as the basis for the supposedly indigenous China Brand High Definition violet laser disc standard.

broadcast-worthy spectrum). Only when the standard is incorporated into products does it have value. In our research, Chinese enterprises consistently emphasized the importance of standards in products, not the value of the standard – or even its embedded IP – by itself.

Formal or de jure standards are developed by, set and administered by institutionalized technology standards bodies. These can be non-governmental organizations with global membership, such as IEEE, or state membership-based bodies such as the International Telecommunication Union (ITU) and International Organization for Standardization (ISO).[5] At the national level, there are non-governmental bodies, such as the American National Standardization Institute (ANSI) or European Technical Standards Institute (ETSI) which define national or regional standards. While able to certify compliance, these actors too, lack an independent means of enforcement of their standards. National standards bodies such as the German Institute for Standardization draft, adopt and certify national standards, but generally are not formal government bodies, although their actions, as in the United Kingdom, may be certified as official for the country in question.

Within these organizations, specific technical committees are established to develop standards for a given technology or area of interest. Within technical committees, working groups of experts propose, test, debate, and adopt protocols to incorporate into the final standard. Inclusion of technologies or approval of protocols is accomplished through consensus and majority vote.

[5] IEEE is a professional organization made up of experts from electrical and electronics engineering. It sets standards for electronic and local wireless communications technologies. It has no enforcement capability of its own. ISO and ITU are state-based organizations whose membership is limited to representatives of different countries. These bodies set broad ranges of standards – such as ISO – or more narrowly focused ones – such as ITU which only sets long-range telecommunications standards. These organizations also have no formal enforcement capability but do certify products or technologies as compliant with their standards, thus providing consumer confidence about their interoperability.

Enforcement of standards set by the IEEE or international organizations such as the ISO is accomplished through the World Trade Organization. In response to use of technology standards as a trade barrier in the 1970s and 80s, the Uruguay Round of the GATT, which formally created the WTO, incorporated language regarding technology standards into the Technical Barriers to Trade (TBT) agreement. According to the 1995 TBT agreement:

> "Where technical regulations are required and relevant international standards exist or their completion is imminent, members shall use them, or the relevant parts of them, as a basis for their technical regulations" (WTO, 1995).

In effect, the TBT agreement requires WTO members use internationally accepted standards, except where there are significant security or local country challenges. WTO members who adopt non-conforming technology standards may face retaliatory action by offended parties through the WTO arbitration apparatus. While this makes standard compliance enforceable, the mechanism is rarely used. To date, only a single standards-based case has been brought for arbitration, concerning a European attempt to restrict use of the word "sardines" (WTO, 2003).

Internationally, the inclusion of protected intellectual property (IP) in technology standards through IEEE, ISO or other bodies is done using the good faith disclosure principle. Companies whose representatives are taking part in the development of a standard, or which are active in technology areas covered by a prospective standard, are expected to proactively disclose any patents which may be infringed by the proposed standard. This is usually accomplished by a "patent dump" where firms simply list virtually every potentially relevant patent they have. As the protocols of a standard are refined, it ideally becomes clear which patents may be infringed upon and therefore the standards committee must ensure means of

licensing of these technologies. Protected technologies can be incorporated into standards through multiple means of licensing:[6]

1. RAND Licensing: Reasonable and Non-Discriminatory (RAND) licensing, sometimes called FRAND, obligates the firm to license its relevant protected technologies to any interested firm without bias and to charge a "reasonable" royalty fee for the license. In the U.S., reasonableness is determined by legal precedent from comparable goods. China does not have a similarly developed tradition of using precedent to determine reasonableness.
2. RAND-RF: Where a firm is willing to license all or some of its protected technologies without demanding a licensing fee, they make a RAND-RF (royalty-free) pledge. For firms seeking to build their brand, increase final product sales, develop market allies or steer the direction of a standard committee, this can be an effective licensing strategy.
3. Patent Pool: certain technology standards use patent pools, often administered by incorporated bodies separate from the formal standards development organization. Member companies include their relevant technologies in the pool and all receive a pre-set royalty for each standard-compliant unit sold. Would-be adopters pay a flat rate for all of the relevant technologies in the standard but must accept the full pool, even if they believe some of the patents to be superfluous.
4. No-License: in certain cases, a firm may disclose that it has relevant protected technologies which the proposed standard would infringe upon. If it chooses to not license these technologies, it reserves the sole right to produce the component which uses those technologies. No-License disclosures often force a standard committee to "invent around" the patents in question.

Official policy statements and documents from China's standards development organizations generally follow these international patterns. Since the 1980s, China's standardization administration has learned much about how international standards bodies work and the means by which they create and administer standards. The remainder of this paper calls attention to the differences in the Chinese approach to standards versus the current international model, emphasizing the broad similarities but critical specific differences.

Technology Standards and IPR in China

[6] While not explicitly a means of licensing for standards, firms with roughly equal-sized and valued patent portfolios sometimes agree to share their entire portfolios on a royalty-free basis in exchange for similar rights to the other parties' portfolio. This practice is particularly common in Japan. In China, attempts to set up similar patent sharing agreements have met with mixed success as firms tend to be reticent to share their technology with their avowed competitors.

China's technology standardization system was established under Soviet tutelage in the 1950s.[7] This system, which governed weights, measures, health, safety and other non-controversial areas, endured until the 1980s. Despite various reorganizations and name changes, China's technology standards body, now known as the Standardization Administration of China (SAC), has existed continuously since the 1950s. It is important to note that structurally, and in terms of institutional culture, China's formal system of standardization is still influenced by the Soviet-designed planned economy standardization system. Although China began enacting new standards regulations and laws in the 1980s, this was still a period of mixed practices and expectations regarding planning (hence state leadership) versus the market. China in the 1980s was still heavily dominated by the planned economy. State enterprises contributed over 70% of industrial output (Naughton, 2007). Rural communes were disbanded (with a few exceptions) by 1984 (although the family responsibility system had been spreading rapidly through communes since 1979). Although growing, market-oriented township and village enterprises would not become industrially powerful until the 1990s. During this period there was constant tension between more economically liberal reformers led by Zhao Ziyang and more conservative reformists led by Chen Yun. The most famous metaphor for the Chinese state view of the proper role of the market in the economy was that of the "bird in a cage," coined by Chen Yun. The market sector was to provide vitality but, within the iron cage of planning, which was to remain present and dominant. Given the continued dominance of the planned economy, and the still uncertain role for markets, standards laws – which are still in force today – written during this period, included a major role for the state.

[7] China joined the ITU in 1920 and was an early ISO member. After the 1949 revolution, China's economic, political, and even standards institutions were completely realigned and reoriented toward the Soviet Union. China rejoined the ISO in 1978 (CCNA, 2006).

The 1989 Technology Standardization Law

The formal technology standardization organizations in China have developed over the past twenty years under the influence of the 1989 Technology Standardization Law, rapidly changing technologies, and high degrees of experimentation and learning. The 1989 Law, which is still the sole legal basis for China's standardization system and *has not been officially amended*, was drafted starting in 1985 and adopted in 1988. Given the time in which it was developed and adopted, it reflects a view on standards embedded in a now long-passed reality of a government-led planned economy and strong top-down approach to reforms. The strong leadership role for the government is formally enshrined in the law. As stated by one interviewee remarking on the differences between standards in the West and China, "What makes standardization special in China is the leadership of the state." The law is currently undergoing proposed reform to better account for the changes in the role and nature of standardization since the 1980s. In particular, reform attempts seek to address the question of the proper role for intellectual property, both foreign and domestic in technology standards. Critically, however, the reforms do not challenge the centrality of the state as the initiator and approver of technology standards.

Most of the provisions of China's standards law are uncontroversial. It is formally designed to encourage international trade, technology interoperability, adoption of international standards and development of standards for the protection of health and safety. One interviewee noted that at the time of the law there were really only standards made for health and safety. Technology standards, and their potentially controversial IP or protectionist implications, were not even envisioned as a possibility by the authors of the law, hence the desire to address these issues in recent reforms.

However, four articles in the law strongly influence the unique and at times controversial aspects of China's technology standards system:

> **Article 5:** Article 5 assigns responsibility for unified administration of standardization to a body under the State Council. This is the opposite of the situation in the United States, and even Europe, where bodies such as ANSI are non-governmental organizations. While China's SAC is officially a non-governmental body, even in China it is viewed and treated as an extension of the state. Article 5 also permits relevant bodies under different ministries and regional governments to also take responsibility for standardization within their various jurisdictions (whether industrial or geographic). This article (and Article 12) codifies a tendency toward state leadership.
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> **Article 6:** This article delineates the four legal types of technology standards within China. Where no standards exist and none are proposed for development, enterprises may define their own enterprise standards. Where a regional government sees the necessity of a standard for improving the coordination and functioning of local industry, it may adopt a regional standard. If adopted, this will supersede any existing enterprise standards in that jurisdiction. At a national industry level, different industrial ministries may promote, set and adopt standards for their different responsible areas (The Ministry of Industry and Information Technology, MIIT, is highly active in this area, pushing standards in ICT and telecommunications). Finally, where a standard will serve the national interest, the State Council appointed body should develop national standards. Revealing the emphasis on health and safety standards, the same article encourages enterprises to set standards even more stringent than national or industry standards.
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> **Article 7:** This article officially defines the two classes of Chinese standards, dividing standards into compulsory and voluntary ones. The United States does not use technology standards in this way. All American standards are voluntary while a mandatory requirement would come through a regulation or law. Due to this article in the law, China's authorities have the ability to make a technology standard compulsory and legally enforceable. Officially, only standards responsible for safety or as otherwise prescribed by law will be compulsory. However, as noted by USITO and the US Chamber of Commerce, there are other ways of making standards de facto compulsory such as mandating the use of a specific standard in a different regulation. The ability to make compulsory standards presents the possibility of using standards as a protectionist tool or to promote a given technology or enterprise through a mandated market.
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> **Article 12:** This article states that trade associations, scientific research institutions and academia should be involved in the formulation of standards but that "a department engaged in the formulation of standard shall organize a committee on standardization technology". This, again, places a government body at the center of standardization efforts by mandating that a state actor initiates committee formation. The committee, once so created, is responsible for drafting and examining the standard.

Despite its ongoing enforcement, in interviews concerning the status and meaning of the 1989 Law, Chinese business and even standards development bodies noted that the law was quite

outdated. A typical response concerning the law stated, "Standardization (in China) is based on the 1989 Law but this law only mentioned health and safety, not ICT. The law is obsolete."

Its obsolescence is also significant for the many issues in modern technology standardization that the 1989 Law fails to address. The law *does not mention intellectual property or the means by which it can be incorporated into technology standards*. The legal status of IPR in standards is thus somewhat ambiguous. Despite the initial ambiguity, China's standards and IP laws are not static. There have been repeated reforms, and attempted reforms, to China's intellectual property laws as regards IPR, particularly patents.

China's first patent law was passed in 1984 and entered into force in 1985. Since then, the law has undergone four sets of revisions, with the most recently adopted provisions being proposed in 2008 which attempted to balance private and public interests and national innovation strategy while strengthening IPR protections. A fourth revision is currently undergoing review. When initially made available for comment, the fourth revision included provisions making it possible to demand compulsory licensing of relevant patents for Chinese standards (SIPO, 2012). After receiving 400 comments, it has again undergone revision, particularly regarding mandatory licensing.

Similarly, in 2004, SAC issued a draft policy which formally declared that the state should guide national standards which: "grant bearing on industrial development and competitiveness" and address IPR and standard issues "so as to improve the proportion of self-proprietary technologies in Chinese standards" (Slater, 2009). A draft regulation from SAC the same year would have forbidden the use of proprietary technology in mandatory national standards or else mandate royalty-free or RAND licensing, regardless of the patent holder's

wishes (SAC, 2009; Willingmyre, 2010). This policy was not adopted but neither was it completely abandoned as it remains under revision.

In 2010, the China National Standards Institute (CNIS), proposed the Disposal Rules for the Inclusion of Patents in National Standards (Willingmyre, 2010). Although the initial January 2010 draft contained language broadly considered inimical to the interests of IPR holders, the subsequent April 2010 draft still contained ambiguities with regards the granting of licenses. For example, the Disposal Rules state that "For purpose of patent licensing, the licenser should fill out the Patent Licensing Declaration Form" but it does not clarify whether this language means a declaration of intent to negotiate licensing terms or commits the IPR holder to a license simply by filing the paperwork. Further, there is uncertainty over the language governing "essential patents" which makes it appear that commercial necessity, as opposed to purely technical, can obligate a firm to license. The proposal remains under revision. Thus, while related regulations, policies and amendments are being debated, the 1989 Law remains the formal regulation with its emphasis on state leadership and silence on the issue of IPR in standards. In reality this has meant that while constrained by overall state power, standards development organizations are allowed to freely experiment with different approaches to IPR.

Despite this freedom to adopt differing approaches to IPR incorporation, it should be noted that interviewees repeatedly mentioned that conforming to international standards and practices with regards to IP protection was important. Chinese standards making bodies all profess to follow international norms and practices as regards the inclusion of protected

intellectual property. Even the most techno-nationalistic among interviewees voiced support for protection of intellectual property, wherever it had originated.[8]

Given its reputation for lackluster enforcement of intellectual property rights, this emphasis on protecting IPR in standards appears somewhat surprising. Since WTO accession, however, China's enterprises – and government – have come to understand that IP theft will not be tolerated internationally and thus it is important to respect foreign, and increasingly domestic, IPR. China's State Intellectual Property Office (SIPO), enterprises, academics and those involved in formal technology transfer organizations all noted that as Chinese enterprises become more sophisticated and possess their own IPR, there is increasing pressure to protect, and increasingly monetize, IPR.

China's broad trend toward formalizing the role of IP in standards, tighter IPR protections and pursuit of monetization is tempered, however, by policy experimentation in China's technology standards bodies and the broader trends of which actors develop and contribute IP and why. This experimentation has set a new path, followed by most if not all organizations, toward a new set of norms and practices for the incorporation of proprietary technology into Chinese standards. These norms seek to make technology inexpensive through either free or low-fixed-priced licensing fees.

Embedded IP, Royalties and a New Norm?

There is a broad trend in China toward a norm of inexpensive licensing for embedded IP in technology standards. This has come about through experimentation and not by central government fiat. In the West, norms have emerged which strongly protect intellectual property

[8] Techno-nationalism is a belief that standards are necessary for China to free itself from dependence on foreign technology. State power should be used to help create new markets for technology or to otherwise reward Chinese innovators (Suttmeier & Yao, 2004; Yoshida & Carroll, 1997).

and the norms of "reasonableness" allow firms to extract large profits through licensing and royalties for their IP. Since the 1989 Standardization Law does not address the question of embedded intellectual property, there is no official legal position for IP in technology standards. This condition remains as the recent attempts to reform the Intellectual Property Law and Standardization Law are both still undergoing review as a result of broad opposition to their initial drafts which appeared to completely devalue IP, at least from a foreign perspective. Our research suggests that Chinese enterprises and standards alliances are seeking to establish a new norm, with or without state support. The Chinese norm downplays the direct monetization value of IP in favor or wide dissemination and incorporation in better quality, and hence more profitable, products.

Questions of how to select, administer and pay for embedded intellectual property are the responsibility of different representative bodies which oversee the development of standards. Different technical committees and standards development bodies or alliances adopt different strategies governing how and under what conditions proprietary technology will be included in a standard. The interests of Chinese enterprises are a major driving force toward a new norm of low licensing fees.

Two major forces influence attitudes and approaches toward the inclusion of IPR in standards. First, the main source of intellectual property in China is universities and research institutions rather than enterprises. Second, the competitive strategy and business focus of China's high technology enterprises emphasizes the sale of actual products as opposed to monetizing IP; Chinese firms see standards, and any embedded IP, as a means toward this goal, not an end in itself. To that end, Chinese enterprises and standards bodies appear to be pushing for a new norm of low prices for embedded IPR in standards.

Interviewees noted that unlike in the West, many of China's technology standards are led not by enterprises but rather by university researchers or scientists and engineers in major research institutions such as the Chinese Academy of Science. For example, the AVS standard for audio and video encryption began as a pooling of the various initiatives of multiple university labs. When the standard effort was initiated in 2002, the major contributing members were all university labs or research institutes, all of whom had existing projects in audio and video encoding technologies. Chinese firms, while active in the production of equipment using similar encoding technologies such as those in AVS, had only weak research capabilities. As a result, they did not contribute much technology to the standard.[9] This is not to say that Chinese firms do not possess IP or R&D capabilities. Indeed, many firms possess increasingly sophisticated capabilities and are developing competitive patent portfolios.[10] However, as yet in many standards groups, the submission of core technology remains dominated by universities and research institutes.

For research laboratories and university researchers, there is a strong incentive to participate in technology standards development. Active participation and submission of technology into Chinese standards, particularly getting the technology included in standards, affords bonuses, travel permissions, or credits toward promotions and tenure. Academics also need to secure funding in order to continue conducting research. Participating in standards development provides access to funds from the Ministry of Science and Technology (MOST), MIIT, and the National Development and Reform Commission (NDRC) and other bodies including local government funds. Contributing to standards provides access to grants ranging

[9] Although not the major initial contributors of technology, companies have joined the AVS working group and industry alliance. Today, the AVS group has 91 members of which 20% are universities.
[10] The widely reported surge in "junk" patents since 2008 may appear to belie the capabilities of Chinese firms. Nonetheless, many larger firms are filing for and receiving invention patents, as opposed to design or utility model patents, and attempting to use these in and for their products.

from a few thousand to tens of millions of RMB. These benefits strongly encourage participation in standards development work. As a result, university professors and labs tend to be highly active in the development of standards, in contrast to Western working groups where company representatives tend to dominate.

Second, and more critically for long term trends, China's high technology enterprises themselves hold a different view of intellectual property and technology standards. There are two competing business models for IP. One sees IPR as a potential gold mine, a source of revenue through licensing or patent sales. This model emphasizes the intrinsic value of IPR (and is the source of the growing international industry in patent mining and "patent trolls"). We term this model as "IPR as a source of profit." It is the perspective and business model of firms like Qualcomm which rely heavily on monetizing IPR for revenues. Companies following this business model seek to develop and protect or acquire as much potentially valuable intellectual property as possible and then license it to other firms which will actually use the information in that IP to produce goods or services. While common in the United States, this model is not widely seen in China.[11]

The second approach to IP could be called "IPR as a factor of production." Here, IPR is not a direct source of revenue but rather a means to improving products. A way to think about these differences is to think how Apple changed where value is created in the music distribution industry. When Apple released the iPod in 2001, it revolutionized the music industry by turning the prevailing logic on its head. Hitherto IP (songs and content) were expensive - $20 or more for a CD – while music players (the hardware) were increasingly commoditized and cheap. Apple made the hardware expensive, sleek and highly desirable, while charging a nominal price for the

[11] An exception is IWNComm, the creator of the WAPI wireless encryption standard. According to interviews, fifty percent of its revenues are based on licensing its approximately 600 patents in the WAPI standard.

IP. This model argues that profit is derived from maximizing the sales of pricey hardware, and hence, prefers to lower the price of all factors of production, IP included.[12]

Both of these models can be found in China. Although interviewees from standards working groups and IPR transfer exchanges said that monetization of IP was an increasingly important goal for Chinese enterprises, most Chinese enterprises see IP through the lens of the "IPR as a factor of production" model. Like their counterparts in Korea, Chinese high technology firms do not consider licensing of technology to be a major potential source of profits.[13] Even interviewees in IPR exchanges, whose job is to help firms monetize IP through arranging licensing or IPR transfers, stressed that Chinese firms strongly hope to keep their production capabilities even as they develop and protect more and more IP. A representative of a standards research body noted that keeping production capabilities was an important strategy for Chinese firms. In his opinion, the "IPR as a source of profit" business model would "at best have a fifty percent chance of success in China" while a strategy which includes the actual production and sale of goods and services using that IP has a much greater chance of success. This attests to a deeply held conviction that long term economic success, and enterprise profitability, stems from production and not from monetization of IP.

Chinese firms are interested in incorporating technology into standards as a means of decreasing the costs of the goods they produce. By removing the need to pay high royalties for essential technology, Chinese firms save on production costs and thus can increase their revenues. Since the sale of products is the ultimate goal of Chinese firms, receiving nominal per unit

[12] This is not to suggest that Apple does not have an extensive and highly valuable IP portfolio. Its recent purchase of 6000 Nortel patents shows its commitment to keeping a valuable, if often defensive, patent portfolio. Apple also jealously guards IP related to the success of its hardware such as its interface and style, for which it successfully sued Samsung for infringement.

[13] According an IP representative of LG, "The value of patents is determined by their contribution to a product and thus our overall business. The value of patents is in how they strengthen the technology in our products and hence the value of those products in the marketplace." The preferred use of IP is to improve actual products, not provide a source of direct revenue.

compensation for IP is accepted so long as it encourages broad market acceptance of the Chinese technology in question.

Deploying nominally priced technologies in standards serves to lower the royalties, and hence input costs, facing Chinese companies. Firms use two non-exclusive approaches to lowering royalty rates:

1. Encourage market acceptance of Chinese technologies (and IP) by charging as little as possible in order to entice other firms to support or adopt these technologies in lieu of foreign alternatives.
2. Develop a competitive alternative technology, especially one offered at a low price, to force foreign IPR holders to lower their rates for Chinese manufacturers.

In the case of the AVS standard, Chinese enterprises have utilized both strategies to try and secure lower rates, and hence higher profits. In AVS, the working group policy is to include essential technologies in a patent pool which will charge a low flat rate (initially about $0.12 per device) for adopters. The standard itself, for digital audio and video encoding, is also designed to be technologically competitive with global standards. The technology is twice as efficient as the MPEG-2 standard which makes it comparable to MPEG-2's successor, AVC. Unlike MPEG-2, however, AVC faces competition from AVS and a new lower royalty rate. While MPEG-2 charged $2.50 per device, AVC set a rate of $0.15. Interviewees agreed this was in response to the competitive challenge from the Chinese standard. By setting a low royalty rate, the Chinese were able to force a foreign competitor to lower their rates as well. Thus, whether a manufacturer uses AVS or AVC, they will pay significantly less than they would have otherwise.

Interviewees frequently mentioned another case of high royalty rates: Chinese DVD player manufacturers in the early 2000s. Despite the fact that Chinese manufacturers produced over seventy-five percent of the world's DVD players, their profit margins were thin, less than one dollar per unit in 2004 (Kanellos, 2004). High royalty rates became a source of constant friction with overseas brand and patent holders. Manufacturers claimed that their annual royalty

payments of over three billion USD were substantially greater than the entire industry's total profits (Cai, 2009; Chen, 2008; Ding, 2009). An alliance of Chinese manufacturers produced an alternative media player, the AVD. When faced with this alternative technology, the major patent holders for DVD players agreed to only charge full royalties (then twenty-one dollars) for exported DVD players and about twelve dollars for DVD players destined for the Chinese market (Linden, 2004). In 2004, foreign royalty fees were again reduced, to $13.80 USD per device, (Linden, 2004; PeoplesDaily, 2004). Lowering royalty rates partially alleviated the strain from thin profit margins facing Chinese manufacturers. The AVD player was a commercial failure but it successfully resulted in lower royalties.

Even China's leading technology firms, with large and potentially valuable patent portfolios, Huawei and ZTE, take a similar perspective on intellectual property and standards. The value of intellectual property is in its ability to increase the quality and price, or lower input costs, of their physical products. They have a strong incentive to seek low royalty rates on technologies they need to access. Both have used participation in technology standards work to encourage foreign IP holders to offer better licensing terms on technologies used in the telecommunications products they produce.[14] In working with other Chinese firms, they set low royalty rates to encourage others to do the same. Interviewees stressed that for Chinese companies, technology was seen as a costly input, one which should be accessed as cheaply as possible, whether through negotiations with foreign IPR holders or by setting new norms.

Chinese enterprises may be initiating a new norm for IPR in technology standards. So long as Chinese firms remain committed to manufacturing, they will pursue technology access at low prices. Patent pools, initially developed by standards alliances, with low rates per unit are

[14] For example, Huawei used the threat of TD-SCDMA to negotiate lower royalty payments for domestic and international CDMA products with Qualcomm technologies, the American holder of the standard (Sinocast, 2006).

becoming more popular as more alliances, including IGRS are interested in establishing them. Low royalties-based patent pools have also become the officially preferred method for IPR licensing in standards according to MIIT's China Electronic Standards Institute (CESI). Although CESI now advocates the use of patent pools, they have not yet found widespread use. Standards groups such as IGRS still officially conform to the RAND principle but also stress that setting low rates is in the best interest of its members. As Chinese firms become more important in global technology markets, this new norm – cheap technology – may threaten the business model of companies which rely on the intrinsic value of their IP as a means of earning returns. Attempts by the state to promote new laws or regulations mandating technology licensing or, better still, royalty-free licensing shows this desire for low-priced technology is broadly shared. That efforts to set a norm of low priced technology are emerging from industry and standards bodies in addition to the government shows the breadth of support for a new low-price embedded IP norm.

The State Intellectual Property Office and SAC

Formal intellectual property rights management is the responsibility of the State Intellectual Property Office (SIPO). Created in 1980 as the China Patent Office, SIPO has seven divisions which carry out its mission of promoting, developing, and protecting intellectual property, whether Chinese or foreign in origin. Of its seven divisions, legal affairs (tiaofa si), protection and coordination (baohu xietiao si), patent affairs (zhuanli guanli si) and planning and development (guihua fazhan si) are the most relevant to the question of IPR and technology standards as these bodies are responsible for the legal and regulatory aspects of China's IPR system. Legal affairs creates plans concerning drafting or modifying international IP treaties or

addressing foreign IP negotiations as well as creating and amending patent laws and regulations. It also formulates negotiation criteria for rights affirmation and infringement. It is therefore responsible for determining legally under what terms a patent is considered infringed and how far a patent can be extended to protect a technology.

The protection and coordination division manages and coordinates domestic IPR protection and law enforcement in collaboration with other government bodies. It is the enforcement arm of SIPO. The patent affairs division administers the patent office including 10,000 patent application clerks. It also drafts policies to standardize patent technology exchanges and the assessment of IP, and directs local authorities on how best to mediate patent disputes and crack down on piracy and infringement.

Most importantly, the planning and development division researches and drafts the national IP work development plan, carries out patent statistical analysis and works to build the national patent information platform. This division runs multiple programs designed to encourage enterprises to produce and protect more intellectual property. The "prosperity program," for instance, aims to create 20 cooperative programs to help companies do patent research and develop firm-level IP strategies. As many companies in China have little experience with IP, SIPO wants to help them to set up IP departments, create formal strategies and hire relevant staff. Mid-size firms in particular get help researching patents to understand the status of their domestic competitors in order to prepare for IP-based competition. This division aggressively promotes the filing of new patents by enterprises and encourages all firms to become active in generating intellectual property.[15] For standards, this means firms which follow SIPO's leadership may have more legally filed and protected technology to consider submitting

[15] One such program offered 5000 RMB to firms which filed for invention patents and 10000 for each approved invention patent. While not a lot of money, these subsidies covered the filing costs.

into standards protocols. As China pushes firms to patent more often, the amount of IP, of varying qualities, has grown exponentially.

SIPO and SAC are bureaucratically distinct as they are under different portions of the government bureaucracy. In many formal organizations, horizontal communication between organizations with different administrations is often quite difficult. This problem, known as stove-piping , makes inter-organizational collaboration difficult. Interviewees noted that China has a long tradition of bureaucratic stove-piping, both at the governmental level between different administrative bodies and even among enterprises. Collaboration without forming a new bureaucratic body with a single leadership is rare in China. This presents a major obstacle to collaboration between SIPO and SAC. SIPO is a vice-ministerial level body, not directly answerable to any other ministry. However, it does not have equal standing with ministries and commissions. The director of SIPO does not attend regular State Council meetings unless specifically invited. On the other hand, SAC, is a body under the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ). It has a direct relationship with a formal ministry. Placing standards under the administrative heading of quality supervision stems from the traditional utilitarian and safety perspective of standards.[16]

Their separate bureaucratic structures are a hindrance to collaboration. Dieter Ernst's research notes that more reforms are necessary to increase the collaboration and coordination between SAC and SIPO (Ernst, 2011). To date, however, formal collaboration and coordination remains limited. To understand the IP policies and practices of China's technology standards bodies, it is therefore necessary to look at the bodies themselves, rather than SIPO.

[16] This bureaucratic situation may change in the near future. Rumors suggest SIPO may be merged into the Ministry of Commerce. However, the merger of two large bureaucracies is never easy and it is likely there will remain great coordination difficulties between Commerce and SIPO. The proposed merger does suggest, however, an increasing attention by the state on the importance of intellectual property, its propagation and protection for economic development.

Technology Standards Development Bodies and Administration

Structurally, China's technology standards development bodies work much like those in the West. On paper, their organizations, regulations and practices closely resemble those in the West. China uses working groups, technical committees and alliances to develop, adopt, and promote standards much as the West does. However, the de facto practices of different bodies vary significantly from the Western model.

First, in the West, non-governmental standards development organizations such as IEEE can independently develop, adopt and promote their own standards without official state sanction. IEEE standards are generally accepted as industry standards for the IT industry.. However, as mandated by the 1989 Law, national and industry technology standards are only assigned numbers, making them official, by SAC or the relevant industrial ministry. Having a number issued by SAC gives a standards body and its technical committees and working groups the legal right to begin, or complete, development of a national standard.[17] Without a standard number, the project is without legal basis. This has complicated the process of developing IEEE-type organizations in China where standards are made by non-official bodies. Groups such as the China Communications Standards Association (CCSA) and CESI do not have the authority to independently approve or adopt standards. Any standard must have either SAC or ministry sanction.[18] For these bodies, their standards receive industry standard numbers from MIIT. These bodies, while ultimately responsible for the development of standards in their industry niches, still require official state permission in order to complete a standardization effort.

[17] National standards are identified by numbers beginning with "GB."
[18] Interviewees noted that state sanction was more than just a product of the 1989 Law. It was critical for lending legitimacy to a project and was often necessary to get firms and organizations to participate in standards development efforts.

In addition to granting numbers, SAC approves, and implements national-level standards. It is also responsible for representing China at international standards bodies such as ISO and IEC. SAC only plays a role in industrial, sometimes called trade, standards efforts when an industry standard is to be submitted as a national or international standard.[19]

The most important ministry involved in industrial standards development is the Ministry of Industry and Information Technology (MIIT). Most of the unique and controversial standards development projects, such as TD-SCDMA and WAPI have been developed under MIIT's auspices.[20] MIIT and other industrial ministries assign project numbers for industry or trade standards development efforts by technical committees and their various working groups. MIIT acts through dedicated standardization bodies, most notably CESI and CCSA. These bodies are responsible for electronics and near-field communications standards and telecommunications standards, respectively. CESI and CCSA administer the technical committees and working groups developing standards for projects assigned numbers by MIIT. Both bodies are the most powerful of China's semi-governmental technology standards development bodies. Administratively, CESI and CCSA work much like IEEE, being able to organize working groups and technical committees. Experts in CESI and CCSA can request formation of a group which the administration within CESI or CCSA will arrange. However, CESI and CCSA, unlike IEEE, cannot adopt standards in their own name. Official industry standard adoption must come from MIIT or, for a national standard, SAC.

[19] A related body is the China National Institute for Standardization (CNIS). This body is separate from SAC but is likewise under the administrative arm of AQSIQ. CNIS is responsible for conducting studies and policy-relevant research on standardization with the goal of improving the quality of Chinese standards and standards development practices.

[20] A long-time observer of Chinese standards noted that the rather extreme behavior of MIIT in the WAPI case was the result of pressures from parts of former military bureaucracies which had been absorbed into MIIT but not assimilated.

Second, as in the West, there are also industry alliances which exist to develop and promote certain technology standards. Similarly to other countries, technology standards alliances are not synonymous with technical committees or working groups (although their memberships overlap).[21] Rather, alliances are corporate or non-profit bodies which exist to promote the development, marketing and monetization of a given standard or suite of standards. These bodies are the acronyms most commonly heard in discussions concerning standards such as IGRS and AVS.[22] They are also responsible for setting the IPR policies of their members, and hence, are very important for understanding how IPR and technology standards work together in China. Alliances in China can exist without formal state sanction. Enterprises interested in promoting their internal standards may seek like-minded partners and forma an alliance. However, they cannot make a standard with any legal status without the permission of the government. While our research has not found a case where state sanction was withheld, the fact that the state remains the sole source of standard numbers means it retains influence over the types and content of standards. The state also often has a hand in the formation of industrial alliances. For example, the Beijing E-World Alliance which developed the EVD standard was created under MII aegis.

Technical Committee and Working Group Structures and Practices

This section explores the inner workings of technical committees and working groups. Most importantly, there are still practices which prevent full and equal participation in standards

[21] This is akin to the practice with MPEG. MPEG's audio-video encoding standards and upgrades are developed, proposed, debated and adopted through IEEE Working Group 11. However, the administration of the patents and commercial interests of contributing firms are managed by the MPEG Licensing Authority which manages MPEG's patent pool. This body sets the rates for the common license for would-be adopters of the standard produced by WG 11.

[22] In the West, standards alliances serve similar purposes and often have similar structures such as the MPEG-LA alliance which promotes the standards, and embedded intellectual property within them, produced by ISO/IEC Joint Technical Committee 1, Subcommittee 29, Working Group 11.

development by foreign firms. Voting rights, while now formally open to foreign firms, are also less critical since committees strive to achieve consensus before having a vote. Third, the chairmen of Chinese technical committees tend to wield more power and influence than their counterparts abroad.

Technical committees under China's industry standards bodies such as CESI and CCSA have two types of membership. The basic division is into observer and voting members. Some foreign enterprises, as well as USITO and the American Chamber of Commerce have observed and protested that Chinese standards bodies have policies, or practices, which bar foreign members from voting, or at least from participating in standards development on equal footing with Chinese enterprises and research organizations (AMCHAM, 2012; USITO, 2010). Our research shows that there is no formal prohibition against foreign enterprises voting. Indeed, the voting member lists of working groups such as AVS include foreign enterprises or their Chinese subsidiaries. However, while there may be no formal prohibition on foreign voting and increasingly foreign enterprises are encouraged to contribute technology, they still have no direct voice in the final direction and adoption of the standard or selection of individual technologies to incorporate into specific protocols.

In interviews, different technical committee heads stated explicitly that there are no longer formal rules in China barring foreign participation in standards development efforts. While, in the early 2000s, as late as 2003 according to some interviewees, there were such proscriptions, these are no longer in force. For example, the constitution of the AVS working group states that "Any unit or organization that is registered in Mainland China and is an independent legal entity under Chinese law may apply to be Official Member at will, provided it

agrees to abide by this Constitution " (AVS, 2004).[23] However, entities not registered in Mainland China may only seek observer membership. The constitution notes that the only difference in these two categories is the right to vote. Standards related to national security or information security, however, are more restrictive. Foreign companies argue that such standards are being developed in highly opaque ways. Security standards remain closed, often even to would-be Chinese members or organizations. Oftentimes, these standards, once proposed or published come as a surprise even to Chinese enterprises.

Be that as it may, even where a firm has voting member status in a working group, there are other subtleties as well, such as hierarchical membership structure in the standard alliances, which are more significant in shaping patterns of influence within a standards development group and mean that even full voting membership does not grant equal influence over a standard. Among standard voting members, standard alliances often have a higher class of "promoting members." Promoting membership is based on active participation in standard group meetings, technology submission, commentary on other submissions, and contributions to the success of the standard through producing goods certified by the standard. The highest and most influential rank of membership is inclusion in a "core members committee." This body controls the direction of the technology standard and may be viewed as an analog for standing committees in China's legislative or Communist Party bodies.[24] While all full members (that is, non-observer members) have a vote and an official voice in the development of standard, the core members

[23] In contrast, voting membership in standards bodies such as IEEE's 802.11 local wireless networking working group is awarded to individuals, not enterprises. Gaining voting membership is simply a matter of attending 2 out of four consecutive plenary meetings and paying the meeting fees. At the next meeting, an individual can vote (IEEE, 2012).

[24] The National People's Congress (NPC) is China's highest legislative body and the only body constitutionally allowed to approve laws. However, the NPC only meets in full plenary session once each year. For the rest of the year, a standing committee meets. Similarly, the highest body in the Communist Party, the Politburo does not always meet in plenary session. However, a standing committee meets regularly and wields the most influence. Core members committees work in much the same way by setting the overall direction for a standard and wielding more influence than full or even promoting members.

committee makes most of the major decisions and thus makes the actual voting process largely symbolic. The core members committee includes the founding members (representatives of the first companies or organizations involved) and the largest contributors. To date, for most unique Chinese standards development efforts, the core members committees are exclusively Chinese. In the IGRS working group constitution, Article 35 explains the power of the Core Members: "Unless specified in other provisions in this Articles of Bylaws, any proposal shall take effect only if it has been voted and approved by more than 2/3 (exclusive) of the participating Core Members" (IGRS, 2005). The iTopHome home networking standard alliance similarly uses multiple classes of membership, dividing members into "Trustee", "General" and "Registered" members. Registered members are analogous to observers in other organizations while the "Trustee" members are the original founders as well as general members nominated by existing trustees and approved by the Board of Trustees of the Alliance. Trustee members are responsible for "Alliance organization and operation" (iTopHome, 2004). Such a structure should not come as a great surprise since these structures are similar to other international standard alliances like the Sony-led Blu-Ray alliance. However, the main difference is that all the higher level members in Chinese alliances are only Chinese firms and it appears likely this will remain the case for the foreseeable future.

Voting in technical committees is also quite different from the practice in technology standards development in the U.S. and Europe. Whereas in an ISO committee voting may be highly contentious and competitive between proposals, in Chinese standards groups, voting is mostly a formality. Chinese standards bodies strive to achieve consensus before a vote is held. The core members committee and voting members within the group must generally feel that all parties have been satisfied before the formal vote is held. The result, arguably, is a more readily

accepted standard – at least for core members – and one in which the technology has been carefully considered and integrated. However, achieving such broad consensus is often difficult. Interviewees stated that this method is very slow and not ideal for developing standards in rapidly changing industries. Chinese standards development often lags behind market and technological development.

Accordingly, it is not voting in standards working groups that is the critical tool of influence; it is membership in the core members committee at the alliance level. Such membership affords significant influence over the direction and technology content of a standard. Since these core member committees are still exclusively Chinese, for foreign firms, this suggests that there remain obstacles to complete and open participation in Chinese standards even as old formal prohibitions are removed.

Third, committee (working group and technical committee) chairmen in Chinese standards bodies have different powers than in the West. Formally, the chairman of a committee is just a chief administrator. However, interviewees from different technical committees noted the powerful and highly influential role committee chairmen play. Chairmen, in effect, are the arbiter of disputes over inclusion of technology or new members. In addition to being a final arbiter, *committee members often delegate significant authority to the chairman*. This authority includes decisions on membership or type of membership, as well as – more importantly – deciding on the inclusion of different technologies. This is not to say that committee members or rejected applicants have no recourse. Those who disagree with decisions by the chairman can take their concerns to a vote by the whole committee. However, given the emphasis on influence

by core members and the importance of consensus, a general vote is unlikely to change the result.[25] One chairman stated his role explicitly:

> "I am the final decider of voting and non-voting membership. If an organization is rejected and still wants to vote, it can put its case to the committee members for reconsideration but this rarely happens."

Indeed, Article 35 of the IGRS Constitution explains the role of the Chairman directly: "If the voting result (among Core Members) is less than 2/3, the Chair shall make the final determination" (IGRS, 2005). Even where a majority supports a policy, unless there is a 2/3 supermajority, the Chair makes the final decision.

Thus, committee chairmen have significantly more authority than their counterparts in U.S. or European standards bodies. However, different committees have differing levels of power delegated to the chairman. In cases where the core membership is highly active, they may not vote to give much discretion to the chairman while other committee members are "too busy" and thus delegate responsibility to the chairman. In CESI-sponsored industry standards groups, officially chairmen are not able to determine the direction of their standards development committees. The Chair is supposed to be a third party expert able to be impartial when helping settle disputes over technology.

In technical committees and working groups, there is an official representative of the government body that initiated the standards making effort by assigning the standard number (a Ministry in the case of an industry standards or SAC in the case of a national standard). This representative is part of the core membership at the alliance level. There are also representatives, dispatched either by CCSA or CESI, at the working group level. At times, there is also a separate representative at the working group level directly from the ministry. The government or CESI/CCSA representatives are very rarely the chairperson of the group. Interviewees noted that

[25] In AVS, for example, a 75% affirmative vote is necessary to change a previously accepted protocol.

while in the past the state representative once had wielded influence and set the direction of the standard or veto proposals, by now the representatives' role has been greatly diminished. While the government representative may still formally have a quasi-veto, this power is no longer exercised. Further, as one interviewee noted, the government representatives often lack the necessary technology backgrounds to even follow the debates within the standard group and thus remain quiet.[26] Thus, while the state remains firmly entrenched in all levels of standardization activity, its actual influence and direct control is greatly reduced.

The Market Performance of Unique Chinese Technology Standards

Since the mid-1990s, China development of technology standards, both nationally and internationally, has grown dramatically. Overall, China has developed tens of thousands of new standards. However, most of these standards are uncontroversial and many are comparable or identical with international standards. Development of unique standards has been most notably, and controversially, prevalent in the realm of ICT.[27] Yet even in ICT, there have been fewer than 30 standards development efforts since the mid-1990s which have aroused foreign attention (See Chart). Some have been highly contentious, most notably standards in wireless encryption and mobile telephony. Because the 1989 Standards Law permits creation of compulsory standards, there is a constant fear that indigenous standards, and their embedded IPR, will be the only legal

[26] Interviewees did not universally agree that government representatives lacked technical savvy. MIIT representatives were said to have enough of a technical background to at least understand science and how research, testing, and other technical aspects of standardization work, even if the specific technology in question remains hard to understand.

[27] In interviews, it was stressed that the vast majority of Chinese standards are identical or essentially identical to those developed and adopted at the international level. Hence, while China develops large numbers of standards (generally catching up to the rest of the world), the only area of major contention has been in ICT. According to Kennedy, Suttmeier and Su's research, in the last 15 years to 2010, there were only twenty controversial or unique standards, all in ICT (Kennedy, Suttmeier, & Su, 2008).

standard in China. Such an action would effectively create a captive, but isolated, domestic market.[28]

Unique Chinese Standard Development Efforts (1993-2010)		
Technology	**Chinese Standard(s)**	**International Standards**
Digital Video Players	VCD 3.0, CVD, EVD, HDV, HVD, CBHD	SVCD, DVD, Blu-Ray, HD-DVD
Mobile Telephony	TD-SCDMA, TD-LTE	WCDMA, CDMA2000, LTE
Wireless Local Area Network Encryption	WAPI	IEEE 802.11i
Audio-Visual Encoding/Decoding	AVS	MPEG2, MPEG4-3 (AAC), MPEG 4-10(H.264), VC-1
Digital Trunking	GoTa, GT800	TETRA, iDEN
Document Formatting	UOF	ODF, OOXML
Home Networking	IGRS, ITopHome	DLNA, UPnP, KNX, ECHONET
Mobile Phone Charger	YD/T 1591-2006	None
Mobile TV	CMMB, T-MMB, CDMB, DMB-T, CMB	DVB-H, T-DMB, MediaFLO
Radio Frequency Identification	NPC	ISO 18000 and others, EPC/GS1, Uid
Security Computer Chip	TCM	TPM
Wireless Metro Area Network	McWill	WiMAX
Source: Kennedy et al, 2008 and Authors' Research		

Chinese interviewees stressed that China needed to use technology standards as a promotional policy for encouraging the development of indigenous innovation capabilities and to strengthen the market position of Chinese technologies. Interviewees stressed the difficulty China faces in pushing its own technologies into an already crowded marketplace. Using standards to potentially mandate use of Chinese technology is seen as a means of providing space for Chinese technologies to receive attention and fair testing in the market. Without such

[28] Foreign enterprises and industry organizations have noted that even where a standard is not compulsory, regulations can mandate the use of a voluntary standard, thus making it compulsory without setting a compulsory GB standard.

assistance, academics and officials in the standards bureaucracy believe Chinese firms will be unable to push their technologies into the market as they will simply be ignored. As summarized by one interviewee, "In a given technology, there are already dominant foreign technologies which China must overcome. Standards are a means of protecting infant technologies."

Another interviewee from a technical standardization body described the role for the state as essential in setting the overall trends for standards development: "The government is one step behind but one step higher than we are. This means they can see further and plan for the future but the actual technical work is left to experts."

Standards in China are not ends in themselves. Even techno-nationalists argue that having a successful standard, one that is adopted domestically or internationally, is meaningless if it fails to gain market traction. Some interviewees took a rather cavalier attitude toward foreign objections to Chinese development of unique standards. Their argument is that if foreign standards, and their embedded technologies, are better than Chinese ones then there is nothing to fear. Even if a Chinese standard is created and approved domestically or internationally, if it is technologically inferior, it will fail in the market and thus pose no threat.

Furthermore, China's central government – including SAC and standards-developing industrial ministries has almost never unequivocally committed to promoting a Chinese standard exclusively. One interviewee active in telecommunication standardization noted further that for all of the talk about protection, China's government has almost never barred foreign standards. Even in 3G mobile telecommunication, only China has carriers using all three of the accepted international standards.[29] As China has never unequivocally committed to use of its own standard, there is always the opportunity for a foreign standard and its technologies to compete in China.

[29] Although all three international standards were eventually permitted, the long delay in issuing spectrum licenses for 3G was admittedly done to afford Datang Telecom and other developers time to complete the testing and commercialization of TD-SCDMA.

When this occurs, even though a Chinese standard may be far more cost effective, the Chinese standard typically loses. Despite nationalistic rhetoric, foreign or internationally accepted standards tend to dominate Chinese developed ones, even in the Chinese market.

The market performance of unique Chinese technology standards has generally been underwhelming. If the goal for a standard is to be implemented widely and thus provide a source of royalties or new product sales for firms, then China has had almost no successes. Standards such as EVD (a high definition red laser-based alternative to DVD) failed to attract consumer interest. TD-SCDMA, despite performing arguably better than competing standards in simulations, implementation of TD-SCDMA actually hurt the relative market position of China Mobile.[30] China's standards similarly have failed to find interested overseas markets and thus appear to have been mostly costly diversions.[31]

Furthermore, even as a means of fostering wholly domestic innovation, many Chinese efforts have fallen short. Trumpeted standards such as TD-SCDMA are heavily reliant on foreign technologies. Indeed of the 148 Time Division Duplex patents filed with SIPO, over seventy percent are held by foreign companies (most notably Siemens and Qualcomm) (Ernst, 2011). As a Time Division Duplex-based standard, these patents are the most core essential patents in the standard. The initial SCDMA technology began development in Texas before the firm moved to Beijing (Breznitz & Murphree, 2011). Although the exact breakdown of total essential patents is hard to determine, the leading Chinese developed of TD-SCDMA, Datang Telecom, only

[30] China Mobile's market share in smart phone services is far lower than its extremely dominant position in 2G voice mobile telephony. Although China Mobile still has the largest number of 3G subscribers (27 million to China Unicom's 18.5 million in March 2011), its lead is greatly narrowed when compared to its profound dominance in 2G (Kumar, 2011). Chinese consumers have noted that the 3G services offered by China Mobile's competitors are more reliable and less prone to bugs. This perception of weaker technology has hurt adoption of TD-SCDMA.

[31] One interviewee put it bluntly and rather undiplomatically when summarizing the efforts in 3G standard development: "China has huge sunk costs with TD-SCDMA, and this was the only reason it got pushed through. They launched it but are trying to get away from it as fast as possible, since even the officials who pushed it in the first place now see these efforts as a huge waste of time and resources when China moves to 4G next year."

contributed 9% of the patents included in the standard. Nokia, Ericsson, and Siemens provided thirty-two, twenty-three and eleven percent, respectively, of the total patents for the standard. As a whole, foreign technology constitutes the majority of TD-SCDMA (Sinocast, 2006; Stewart, 2009; Stewart & Wang, 2009). Other indigenous efforts such as EVD and CBHD also include significant amounts of foreign technology (Hsu & Hwang, 2008). More recent standards development efforts are cooperative and encourage foreign participation. While the standards may contain significant amounts of Chinese technology, they are far from entirely indigenous. It is clear that even where a standards effort is trumpeted as Chinese, foreign participation and contribution is still welcomed, even in strategically important standards like TD-SCDMA.

Only in the case of the Wireless Local Area Network Application and Privacy Infrastructure (WAPI) networking encryption standard was there a clear government mandate for a Chinese technology, no foreign participation, and an explicit proscription against using the encryption method in the global foreign standard, IEEE 802.11 (known by its WiFi trade name). WAPI was a proposed as a means of correcting a known security flaw in 802.11 (corrected in the 802.11i amendment in 2004). In 2003, MIIT announced that all wireless LAN products in China would have to be WAPI certified and use its encryption method. However, as only 11 – all Chinese – firms had access to the encryption algorithms, firms seeking to make their technologies compliant would be forced to partner with these companies and, they argued, open their core technology to potential competitors. Industry opposition to the compulsory use of WAPI led MIIT to back down from initial plans to require all local wireless LANs to use the WAPI encryption method. The plans to impose the WAPI requirement were postponed indefinitely in late 2003. WAPI, however, has since been adopted, implemented and enforced for certain devices such as smart phones. It has imposed an added cost for foreign companies

seeking to sell in China's market. Our research has shown, however, that the WAPI case is actually unique and should not be considered indicative of patterns of behavior in standardization.

Given the lackluster market performance, and apparently independent innovation performance of China's unique technology standards, why do Chinese firms still participate in standards development? For many Chinese firms, participation in standards development is less about furthering the development or monetization of their technology than about strategic positioning and marketing. For small firms in particular, participation in standards development affords similar benefits to those sought by university professors or researchers: state grants. For small firms, the grant amounts are sufficient to provide an opportunity to conduct research which they would otherwise not be able to pay for. As many firms frequently note that a lack of capital constrains their ability to conduct R&D, this is a significant incentive. For large firms, the grants from the state are usually insignificant (the very large grants and loans made available to Datang Telecom and China Mobile for development and rollout of TD-SCDMA are a major exception). However, participation in standards does help large firms curry favor with the state by participating in government selected projects. It also provides an opportunity to keep abreast of the R&D actions and capabilities of their potential partners or rivals. Firms of all sizes also see strategic benefit in participating in standards work since, according to interviewed managers, approval of standards is a sign of technology sophistication with government approval. This is beneficial for firms seeking to win new customers since government approval provides powerful advertising. Firms also participate in standards development for the marketing benefits. Small firms in particular note that participation in working groups affords them the opportunity to meet with technology team leaders and managers from large companies.[32] This direct connection can

[32] According to the director of a major IT standards alliance: "Some small firms simply use membership as a networking opportunity to meet the chief engineers and important managers of large firms they otherwise would not

be leveraged into potential contracts or sourcing agreements. Without participation in standards, these firms argue, it would be difficult to impossible to catch the attention of major companies. Participating in standards makes it possible for small firms to directly grow their business. These benefits accrue to participating enterprises whether or not the standard itself is a market or technological success. Hence, there is an incentive to participate even if the efforts themselves seem market-irrational.

Techno-nationalism in Standards

Existing concerns regarding China's technology standards development efforts have emphasized techno-nationalism, bias against foreign companies, and trade protectionism (AMCHAM, 2012; Suttmeier & Yao, 2004; Suttmeier, Yao, & Tan, 2006; USITO, 2010). However, while these motivations are certainly present among certain actors within the Chinese standards development ecosystem, there is no unified consensus on the desirability of using standards to create a hothouse environment for Chinese technologies. Observers of China's technology standards development ecosystem must remember that China's political system is highly fragmented and internally competitive. While one unit of the bureaucracy may favor a given standard and endorse protectionist measures to ensure its success, other segments of the state may undermine these initiatives in order to preserve their own authority. These competitive games, and their impact on standards, are best viewed through the lens of bureaucratic politics. As one interviewee put it:

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be able to access. This is a very cost effective networking method since membership (in the alliance) is not very expensive."

> "China is a bureaucratic system, not a political one. Different ministries are constantly competing for influence and budget. Wars over standards are fought in the bureaucracy over power and fiscal turf."[33]

Bureaucratic politics argues that government action should be viewed as the result of internal negotiations and conflict among bureaucratic units (Allison, 1969, 1971). Each unit has predictable and relatively uniform interest and actors from different organizations act on behalf of their organizations' interest. These interests are most commonly the concrete objectives of increased authority and budget. In China, promotion of or support for a given standard depends on whether or not it advances the interests of the bureaucratic unit. Taking a bureaucratic politics perspective is useful for explaining outcomes of certain standardization efforts. For example, the AVS standards for digital media became a battle between the then-Ministry of Industry and Information (MII, today's MIIT) and the State Administration of Radio, Film and Television (SARFT). Developed in an MII-affiliated research center, AVS was a potential successor technology to the ISO-based MPEG-2 standard and its expensive licenses.[34] As no international standard had yet been established, AVS might have been able to compete with the newly released international MPEG-4 standard. However, SARFT, which has final authority over media content, reduced AVS's chances of domestic success by announcing China would also use MPEG-4 rather than establish a protected market for AVS. SARFT preferred to preserve its authority rather than allow MIIT to encroach on its jurisdiction (Kennedy et al., 2008; Suttmeier et al., 2006). Bureaucratic competition reduces the ability of the Chinese state to act in a unified manner. Thus, even where a standard appears to have strong government support, it is likely the support is fragmented.

[33] Another interviewee noted similarly that part of the slowness of Chinese national standards efforts was the result of SAC needing to balance the interests of different ministries. Seeking such broad compromise was often difficult especially when different ministries such as MOST and MIIT have different favored standards or protocols.
[34] MPEG-2 licenses cost $2.50 for encoding and decoding devices while AVS only cost 1 RMB (approximately 12 cents) per unit. MPEG-4 is only fifteen cents per license.

A final factor undermining the ability of the Chinese government to use standards as a technology development or protectionist tool is the general lack of enthusiasm for unique standards development by much of China's industry. For Chinese technology firms, government procurement may be an important market and a coveted one, but it is not the only or even the most important market for the vast majority of firms. China's export-intensive companies, including leaders such as Huawei and ZTE in telecommunications hardware, are strongly incentivized to implement established foreign standards rather than attempt to develop unique indigenous ones. Both firms are active contributors to international technology standards working groups and technical committees. While the goal of providing a forum for their unique technologies may be laudable, these firms are primarily interested in increasing their success in the market. Hence, they favor standards which will enable them to sell more products. As a result, they tend to support international standards. This means China's most capable innovators are not necessarily backing or significantly contributing to China's domestic unique standards. Interviewees noted that these firms tend to participate in China's standards development groups in order to curry government favor. However, they are not very active, participating mostly to keep abreast of technology developments and to network.

Thus, it may be concluded that while standards development efforts are widespread, their overall market impact has been minimal. Further, the emphasis on the techno-nationalistic and protectionist impulse behind China's state-led technology standards development efforts is arguably misplaced.[35] Our research suggests that while present, this is not the most important difference with foreign approaches to standardization, nor is it representative of how China will develop and implement standards.

[35] Both Chinese and foreign interviewees noted that continued emphasis on the WAPI case as evidence for Chinese government control or lack of respect for international norms of standardization is particularly outdated and should be dropped.

Conclusion

Our research in China has yielded several findings about how technology standards are made and enforced and how IPR is utilized. There are several key differences between the Chinese approach and foreign ones:

1. The 1989 Standardization Law gives the government the exclusive power to create standards (by assigning project numbers) and enables the setting of compulsory standards. Although the law never mentions ICT or proprietary technology in standards, it has not yet been amended to address changes in the global standardization landscape.
2. There is no clear legislation or policy establishing the legal status of IPR in standards. As a result, IPR policies have been developed in a somewhat ad hoc manner by different working groups and standards development organizations.
3. Much of the IP for many standards comes from academia and research institutions, not industry.
4. Chinese enterprises see IP, and IP embedded in standards, as a way to increase sales of hardware rather than a source of royalties income. They prefer and seek low licensing fees. This may represent the beginnings of a new norm regarding embedded IP.
5. Technology standards development bodies in China are all responsible to the government, either to SAC for national standards or to an industrial ministry for industry or trade standards.
6. Foreign firms are not prohibited from participating in standards development although their ability to influence the direction of Chinese standards is limited since they are not part of "core member committees" which set the direction for standards. Even having voting rights is not sufficient since voting in Chinese technical committees and working groups is usually only done after there is consensus.
7. The chairmen of technical committees and working groups often wield significant influence over the selection of IP to incorporate into standards and decisions on membership in the standards group.
8. Unique Chinese standards have generally performed poorly on international markets and even struggle domestically.
9. Despite the strong hand of the state, its influence is tempered by bureaucratic competition and resistance from Chinese industry. Would-be protectionist plans or standards will generally never receive complete unified state support and foreign technologies will almost always be able to compete with Chinese.
10. Much of the discussion about technology standards in China wrongly emphasizes techno-nationalistic impulses or purported trends toward protectionism. While there are certainly actors, and policies, which fall under these categories, they are not the main focus or interest in the development of the use of IP in technology standards.

China's technology standards system is still in flux. There are reforms being proposed to the formal structure of the intellectual property rights administration as well as ongoing efforts to create new norms for IP from the national policy to the working group level. There is tension between the legacy of a state-directed standardization system and the emerging needs of a fast

moving technology market place. Firms are increasingly developing their own IP and are interested in how standards may be able to improve their margins and market position. They are able to, and increasingly do, form standards alliances which, with the blessing of the state, are able to develop and promote standards. Nonetheless, while there is more room for market forces, and political leaders certainly do not direct working group-level technology discussions, the state remains the final arbiter. Understanding the direction of upcoming policy or new strategic standards efforts helps firms place themselves to benefit from state largess.

More research is needed to see which and how many of the differences between Chinese and foreign approaches to standardization will have long-term influence and which are just signs of a system adjusting to a new global reality.

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